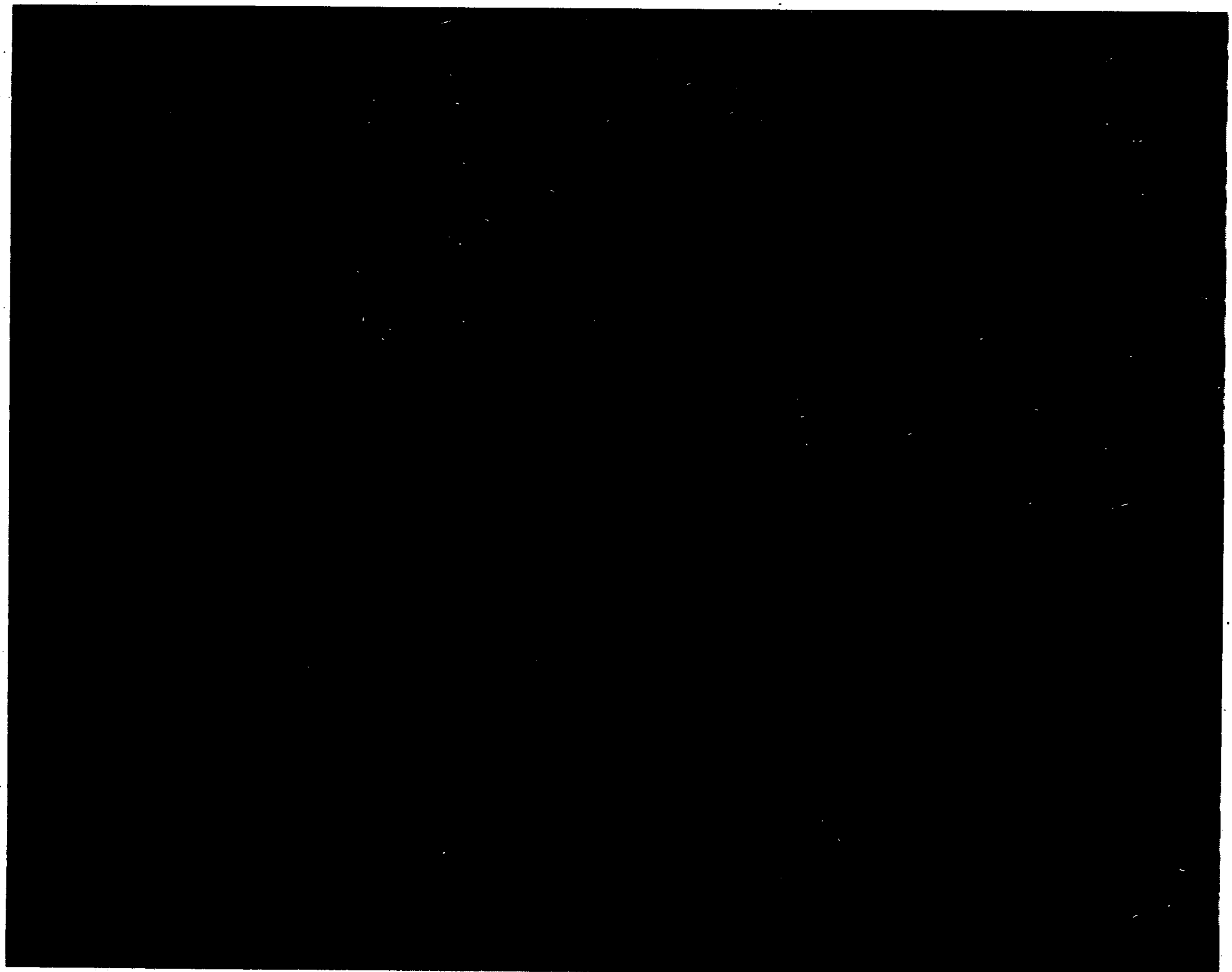
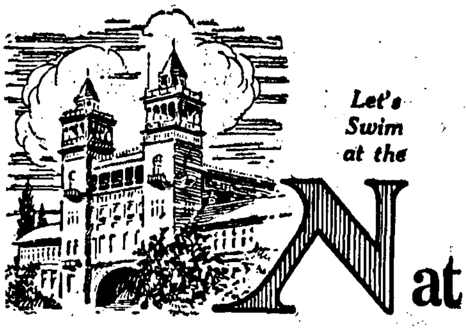


BOISE Geothermal ENERGY SYSTEMS PLAN

CITY OF BOISE
ENERGY OFFICE
150 N. CAPITOL – BOISE, IDAHO 83702

It required imagination and courage



T. B. JACKSON, Mgr.

LARGEST AND FINEST NATURAL HOT WATER PLUNGE IN THE WEST

◇ ◇ ◇

STEAM VAPOR & TUB BATHS

◇ ◇ ◇

ELECTRIC HAIR DRIERS FOR THE LADIES

◇ ◇ ◇

DANCING

SPECIAL ARRANGEMENTS HAVE BEEN MADE THIS SEASON FOR THE ACCOMMODATION OF PARTIES DESIRING TO SERVE LUNCH OR PLAY CARDS. THE SERVICE INCLUDES THE FREE USE OF ELECTRIC RANGE, DISHES, TABLES AND CHAIRS.

◇ ◇ ◇

Swimming Instruction

UNDER THE DIRECTION OF

MISS THELMA PAYNE

NATIONAL DIVING CHAMPION AND MEMBER OF THE UNITED STATES OLYMPIC TEAM.

ANALYSIS OF

Natural Hot Water

MADE BY C. F. CHANDLER, PH. D., C. E. PELLEW, E. M., OF NEW YORK

Chloride of Sodium	[illegible]
Sulphate of Potassa	[illegible]
Sulphate of Soda	[illegible]
Bicarbonate of Ammonia	[illegible]
Bicarbonate of Lithia	[illegible]
Bicarbonate of Soda	[illegible]
Bicarbonate of Lime	[illegible]
Bicarbonate of Magnesia	[illegible]
Phosphate of Soda	[illegible]
Oxide of Iron and Alumina	[illegible]
Silica	[illegible]
Organic and Volatile Matter	[illegible]
TOTAL	[illegible]

Temperature at Wells, 172 Degrees Fah.

EARLY settlers in the vicinity of Boise noted that a certain piece of ground lying at the base of the hills closing in the east end of the valley was perpetually warm and free from snow in the winter. They observed this natural phenomenon, but there was no recorded effort on the part of anyone to explore its cause or consider its possibilities until four men, all but one of whom having since passed on, saw the evidence of a huge subterranean reservoir lying beneath the surface and storing perhaps many thousands of gallons of scalding hot water. They visualized its being tapped and the water being diverted to the use of man for his comfort and convenience.

It was in the year 1890 that W. H. Ridenbaugh, Hosea B. Eastman, Timothy Regan and J. W. Cunningham decided to prospect for hot water on this ground. They secured an option on 10 acres, bought a well drilling machine, drilled a six-inch well and at a depth of four hundred feet struck a good flow of hot water.

Quite naturally they were pleased with results so far and enthusiastic over the idea of converting their discovery into a material blessing. But no one among many experts consulted could give them any assurance of the permanency of the flow, fearing that it might be diverted by natural causes into other channels at any time. Doubt was also expressed that even though the water should continue to flow without variation in gallons, its temperature might lower to a point which would make it of no value.

However, with fine courage, these men put more of their capital into the venture, drilled a second well of the same size as the first and succeeded in doubling the flow, making a daily output of approximately 800,000 gallons of water with the steaming temperature of 172 degrees Fahrenheit at the wells.

In 1891 these owners turned the property over to the Artesian Hot and Cold Water Company, which company, upon securing the deeds, immediately started building the Natatorium.

When one considers that the population of Boise at that time (1891) perhaps did not exceed 2500, one can better appreciate the faith these men had in the future of Boise, in planning a bathing and pleasure resort costing in the neighborhood of $100,000.00.

The building, of Moorish design and extraordinary beauty, was opened for business on May 25, 1892. In addition to being equipped with one of the largest indoor pools in the country, and facilities for steam vapor, shower and tub baths, the structure included a large dancing balcony, sumptuously furnished parlors, billiard and card rooms and on the top floor a cafe, whose furnishings and cuisine compared with the finest in cities of ten times the population.

For many years all big social functions, including the inaugural balls, were held at the Natatorium, space for the inaugural balls being provided by draining the big plunge and covering it with sectional flooring supported by trestles placed in the tank.

Just prior to the opening of the Natatorium, C. W. Moore and H. B. Eastman completed their residences on Warm Springs avenue, and, bringing a pipe line down from the main serving the Natatorium, demonstrated that the heating of homes in Boise by means of natural hot water was a practical thing.

The main was soon extended to the city and, as the company had no exact information for their guidance, the system of heating homes with natural hot water being without precedent in the whole world, they, of necessity, had to perfect their methods by the slow process of experimentation, many of the experiments being costly and in the end proving useless. However, the work was carried on, until today, 34 years after the natural hot water gushed from its confinement under the hills at the east end of the Boise valley, the system which is now owned by the company whose name appears at the end of this article has grown to include two 16 inch wells equipped with Byron Jackson five stage electrically driven centrifugal pumps, producing a continuous flow of 1,200,000 gallons of water per day at the invariable temperature of 172 degrees Fahrenheit, nearly ten miles of steel main ranging from 12 to 2 inches in diameter and the Boise Natatorium, supplied with a 4-inch main.

In the foregoing we have attempted to set down within the limits of the space the more important facts concerning the discovery and development of the natural hot water wells at Boise and pay some measure of tribute to the men whose acts we think are well expressed in the caption at the top of this page, "It Required Imagination and Courage."

THE NATATORIUM COMPANY

W. V. REGAN, President
RAYMOND MOORE, Treasurer
BEN S. EASTMAN, Vice President
JOSEPH J. TURNER, Secretary

About the Cover:

The photograph of the Natatorium was provided by the Idaho State Historical Society. The introductory article was taken from the April 17, 1925 issue of the Idaho Statesman (also provided by the Idaho State Historical society).

DISCLAIMER

GEOTHERMAL ENERGY SYSTEMS PLAN FOR BOISE CITY

By:

Energy Ofice
Boise City
P.O. Box 500
Boise, Idaho
(208) 384-4370

January 1979

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ACKNOWLEDGEMENTS

This document was actually written by many people under the overall project management of Ms. Lee Post, Boise City Energy Coordinator. Mr. Phil Hanson, Boise Center for Urban Research, provided general technical guidance, wrote portions of this report, and compiled the report. The lions share of the work, however, was completed by the people listed below with their areas of project responsibility noted.

<u>Lyons, Mooney, Bohner, and Chasen</u>

Dr. Tony Bohner Mr. Andy Chasen	Legal Briefs and Research

<u>CH2M Hill</u>

Mr. Larry Martin Mr. John Austin Mr. Nathan Little Mr. Roger Bissell	Environmental Engineering Design and Research

<u>Boise State University</u>

Dr. Mike Merz Dr. Robert Behling Dr. Rick Hart Dr. John Mitchell	Economics, Financing, and Accounting Studies
Dr. Ken Hollenbaugh Dr. Paul Donaldson Dr. Jim Applegate	Geological Studies and Materials

<u>Boise City</u>

Mr. Floyd Ayers	Financial
Ms. Suzy Vader	General Geology and Well Data
Mr. Rod Gibson	Property Ownership
Mr. Lou Uranga	Water Rights

<u>Consultants</u>

Dr. Sherl Chapman	Geology

There have also been innumerable and valuable suggestions made by DOE and EG & G personnel as well as individuals in private business in Boise, many of whom are on the Boise City Task Force. The entire report was typed by Ms. Cathy Hampton.

ABBREVIATION OF TERMS

Btu	British thermal units
Btu/hr	British thermal units per hour
COP	Coefficient of performance
CTR	Cooling tower return
CTS	Cooling tower supply
CWR	Cooling water return
CWS	Cooling water supply
gpm	Gallons per minute
GWR	Geothermal water return
GWS	Geothermal water supply
kW	kilowatt
kWhr	kilowatt - hour
NC	Normally closed
NO	Normally open

CONCLUSIONS

Geology

1. Although not appearing as a severe threat to this project subsidence and mounding are two areas that will require close scrutiny as a Boise geothermal system is developed.
2. The geothermal reservoir appears to be very large, based on preliminary testing, and is being recharged at a rate higher than the rate of withdrawal.
3. The fluoride content of the geothermal water exceeds EPA and State of Idaho water quality standards. Thus, if disposal of spent waters to the Boise River were contemplated by this project, it would be necessary to dilute the waters 1:22 to attain acceptable standards of fluoride content.
4. Recent geophysical studies have not been completely documented but preliminary results suggest that there are five "hot areas" where future study should probably be concentrated.
5. There are a relatively large number of existing hot wells that generally tend to group a manner consistent with expectations from geological study. Many of these wells have been producing for years, at consistent temperatures, and for a wide variety of uses.

System Design

1. Supply wells, in a preliminary design concept, were originally intended to be located in Camelsback Park. Subsequently transfer of subsurface rights to Military Reserve Park to the City make that a more likely supply well location if confirmed by geologic studies.
2. The system will be based on a nominal supply well rate of 1000 gpm. It is planned that Warm Springs plus Boise City wells will have a total production capacity of approximately 8000 gallons per minute.
3. Twelve large office buildings were studied for retrofit to geothermal plus the residences in the vicinity of Warm Springs Ave. The office buildings aggregate in excess of 1,000,000 square feet and a system to serve them would cost approximately 4.5 million dollars.
4. Waste waters may be disposed of either through reinjection or to a cascade use. A cascaded use would be the most desireable as waste waters will still have temperatures of 100^{o} to 120^{o} F. Heat pumping this water could save 50% of a residential heating bill for one year (based on natural gas), and up to 70% for commercial buildings.

Economic Feasibility

1. The State Health Laboratory has been retrofitted to use geothermal water for space heating. Use of geothermal has resulted in savings of approximately 65% when comparing the first four months of 1977 with 1978, and adjusting for the number of degree days.
2. The price per therm for geothermal space heating is estimated to be 29.6¢ for a publicly owned system and 80.9¢ for a privately owned system. This compares to 99.9¢ for electricity, and 60.1¢ for residential and 53.3¢ for commercial natural gas heating.
3. There are a number of pricing policies that must be followed for a geothermal system. The most important of these is the need to provide a strong economic incentive for potential customers to use this source of energy, and the geothermal system must be a self supporting enterprize whether public or private.

4. The operating costs for a 15 million dollar system would range from an estimated $246,070 in 1982 to in excess of a half million dollars in 1995.
5. Cash flow requirements range from a minimum $5,000 for the first month of the project to $1,614,600 at the height of construction activity in mid-1980. Otherwise cash needs run around $250,000 per month.

Legal

1. Anyone contemplating development of a geothermal system should have both a geothermal permit and water rights.
2. It would be prudent to unitize the resource as a means of insuring the continuity of a geothermal system by guaranteeing equitable participation by all owners.

Organization

1. There are many criteria by which to judge organizations or individuals who may wish to develop or operate a geothermal system but the overriding criterion, in Boise, has been interest in pursuing this enterprize.
2. The strongest interest in pursuing this enterprize has been consistently expressed by Boise City and Boise Warm Springs Water District who are now partners in a geothermal project.
3. The City and the District will determine the organization and operation of geothermal over the next four years but they will also need to plan for the future beyond four years.

PURPOSE

This report has been produced to fulfill the tasks specified in Contract No. EY-76-5-07-1631, Modification No. A001, between Boise City and the U.S. Department of Energy. These tasks entail planning for a Boise geothermal system in terms of legal, engineering, organizational, geological, and economic requirements. As a result, this report is a plan for development of a Boise geothermal space heating system. In some cases the plan provides for definite detail as in the Section on system design. In other cases the information provided is definite, as on legal issues, but the exact meaning or future implications of the data are not clear. Finally, some sections of the report are indefinite and unclear because they are so heavily dependent upon future institutional developments. The section on organizational issues falls in this category.

In any event this document offers many types of planning advice regarding the future of geothermal development in Boise. This plan has already taken the form of an implementation project as described in PON-78-M-03-2047. Even as this plan is being completed the first steps toward implementation are beginning.

I. INTRODUCTION

The present Boise geothermal project is a single organization with separate office, phone numbers, letterhead, and management structure. This organization is referred to, appropriately enough, as Boise Geothermal. This organization is the product of a moderately long and complex history, a history of evolving objectives, funding structures, etc. Past history finds us, at the present moment, on the verge of important actions regarding geothermal energy. Over the next few years additional layers of history will be added. This future history will see additional organizational evolution, which all believe will lead to a stronger project. A project which, in all of its facets will represent the clear and definite implementation of national energy policy.

Geothermal energy must be an important consideration in national policy and, if the plan recorded in this document is implemented, will become an important fact of local energy plans and usage. The content and orientation of this plan is the result of direction provided from the national and local levels. The national level input is motivated by a mandate to implement national energy policies. As far as Boise is concerned, that national policy takes the specific form described in subsequent sections of this document. Stated another way the Boise system of using geothermal energy, based on national policy needs, will be the first, and at this writing, largest scale low temperature, direct use application of this form of energy outside of Reykjavik, Iceland. The success or failure of this plan, therefore, has a distinct and important national impact. It is believed, perhaps correctly, that if such a large system can succeed technically, legally, and organizationally in Boise, that then the chances of doing the same thing elsewhere are very high. It then can be concluded that there is hope that geothermal systems can make a substantial contribution to national energy policy. Conversely in the extent to which there are major problems in Boise, there is a good chance that similar problems will arise elsewhere and should be planned for.

The federal level input to this plan has taken many forms, not all of which can or should be recorded here. One important form of input, however, should be noted. That form is the contract between DOE and the City that has resulted in this report. The contract, and amendments, identify important DOE concerns and the City's agreement to those concerns or requirements. This report is the principal means of formally satisfying contract requirements. The following items are contract requirements and may consequently often be found as separate, distinct sections of this document.

- Important decision points - Describe the decisions which have been made at all levels with respect to the Boise Geothermal Project so other metropolitan areas considering geothermal development may benefit from the experience at Boise.

- Potential heating districts - Describe areas where heating districts may be formed within the city limits of Boise or within areas considered likely candidates for future annexation to the City.

- Energy Conservation Plan - Formulate an Energy Conservation Plan for the downtown area of Boise with special emphasis on the downtown redevelopment area.

- Heat pump applications - Feasibility study of the utilization of water heat pumps to boost the temperature in areas of the City where the resource appears too cold for direct utilization.

- Define a range of legal constraints and incentives that would enhance possibilities for equitable use of geothermal energy by Boise City public and private users.

- Develop criteria against which the possible energy scenarios may be evaluated to select the "most reasonable" for planning purposes.

- Develop a plan to demonstrate the various aspects of using geothermal energy to heat buildings based on the "most reasonable" scenario.

- Review alternative beneficial uses of geothermal waste waters, resulting from heating buildings, by, for example, local agricultural enterprises or recreational facilities.

- Evaluate results of state sponsored research and action in relation to research proposed here.

- Define comprehensive organizational and procedural guidelines that would facilitate effective use of geothermal resources to the maximum extent.

- Define and evaluate the economic and financial support required by a heat supplying utility for downtown public and private buildings.

- Define and evaluate the legal ramifications of exploiting geothermal resources for heating buildings such as geothermal water rights, liability of wastewater disposal, utility ownership, etc.

It is also worth noting that federal interest is in a functioning hardware system, and, perhaps even more important, in the political organizational, etc. "events" that led to the system. Knowledge of these "events" is required if the federal government is to have a role of any kind in participating with local governments to implement national policy.

The federal governments input to this plan has been explicitly stated, and stated with a sense of clear direction, i.e., a direction based on national policy. The local input has been far less definite. The indefiniteness of local input may be attributed to many causes. One cause is the fact that inputs are constantly being received and as constantly change, in large or subtle ways, the direction of geothermal in Boise. As this document is being prepared discussions are in progress to define the organizational basis for proceeding. These discussions have paramount importance to the future of geothermal energy in Boise. No less important are recurring requests for service, or the need for a subsidence monitoring system, or the legal basis for unit resource areas. The number of issues being discussed daily is very large and constantly changing.

Another cause for indefinite local input is the force of political motives at local government levels. The State got an early start in geothermal out of which has grown an increasing role as reflected in many actions of state government. Warm Springs Water District has its own motivations. As a recently created subdivision of the state they have a requirement to serve a market area dating from the 1890's. The City government is a newcomer to geothermal energy, and because of this recent arrival on the scene, has perhaps fewer preconceptions about this form of energy. But as a newcomer they must define a legitimate role for themselves while, at the same time, trying to appreciate the longer standing experience of the State and the Warm Springs Water District.

Yet another cause is based on entrepreneurial interest. This interest includes local individuals and business as well as those from outside Ada County. Idaho Power Company interest is primarily in high temperature geothermal for generation of electricity, an interest comprising some utility and resource overlap with low temperature applications. Intermountain Gas Company interest has been more direct but has also varied more for undefined corporate reasons. In addition to these more conspicuous sources of interest are the large number of entrepreneurs ranging from the New York based W.R. Grace Company subsidiary Geothermal Resources Corporation to owners of wells on the resource.

In other words virtually every segment of the local community and many from outside have suggested the direction which a geothermal project in Boise should take, and all of the suggestions have slightly different directions. The most desirable strategy would be to include all of these suggestions in one project while preserving the integrity of each. That strategy is not easy. A compromise strategy would be to select those suggestions with the highest degree of commonality. If one were to chose this strategy, it is probable that the following would show up as local requirements.

- Make improvements on existing service such as the Warm Springs Water District system or productive hot wells on the Boise front.

- Complete enough additional geology work to maximize chance of drilling new productive wells and minimize potential for adverse impacts of well work such as subsidence or mounding.

- Take all steps necessary to insure preservation of natural environment of front especially in or on park lands.

- Extend space heating service to buildings not now served by that energy source. This requirement can be divided into important segments that include residential buildings, commercial buildings outside of downtown, existing commercial buildings downtown, and the downtown redevelopment area.

- Make provision for the largest feasible expansion especially to new developments along the foothills such as the Dallas Harris property.

- Develop mechanisms for the maximum exploitation of remaining energy content of "spent water," and minimize potential adverse effects of system waste water disposal.

These are the most important requirements that have been suggested by local groups or agencies. In addition, most have a vague feeling that there may be some legal requirements but they have rarely been articulated. There has been even less articulation of organizational/institutional needs.

As noted earlier the explicit federal requirements are covered in sections of this document. Many of the local requirements are also covered but, because they have changed more frequently, they are not discussed as thoroughly. The result of this frequent change in requirements is that the content of this document has changed and will undoubtedly change again. Some snapshots have been taken of this change. One snapshot was the report to the Governor in 1975.[1] Another was the Boise City preliminary plan.[2] Still another was the proposal prepared in response to PON-78-M-03-2047.[3] Many snapshots have been taken some of which appear in the bibliography. Among snapshots that have not yet been developed is the most recent geophysical work completed on the front.

The most recent photograph in this sequence is the present document. It is an incomplete picture. Many features are simply not clear and some show little promise of clearing up in the near future. Consequently, the picture as presented in this document is incomplete. Nonetheless, this record is the most complete and comprehensive possible at this time.

---

1. "Report to the Idaho Governor: Project Summary for the Boise Space Heating Project", R. C. Schmitt, et. al., INEL. (1975)
2. "Preliminary Boise Geothermal Energy Systems Plan", City of Boise, Energy Office. April 1977.
3. PON EG-78-N-03-2-47, "A Field Experiment: Commercial & Residential Space Heating", City of Boise & Boise Warm Springs Water District (2 Vols.) July 1978.

II. RESOURCE CHARACTERISTICS

The geological issues confronting a geothermal project are complex. The complexity of these issues increases directly in proportion to the scope of the project. Since a geothermal system for Boise could be very large the geological issues are of paramount importance. As a matter of fact, a Boise geothermal system should probably not proceed to implementation until the geological issues have been clarified, and at least some of them settled.

The issues of concern to this project cover a wide range of topics within the field of geology. Many of these topics and the issues that they reflect, have been studied by geologists. These studies data from the 1890's, and the work of Lyndgren, to more recent work by BSU, INEL, and DOE. In some cases recent geological work has been completed but not yet documented. In still other cases primary data which is just now being assembled will be subject to interpretation in the near future, and will have a bearing on many features of a proposed Boise geothermal system.

This document is already very large. It's size would be at least double if all completed and pending geological work were included. Also in many cases inclusion of geological studies in this document is not possible because of the difficulty of obtaining study documentation. Instead, therefore, of including past studies explicitly, or in summary, the various studies are related to issues facing planning for this project. In many cases past studies have not been conclusive on these issues with the result that additional study is indicated.

A. General Area Geology

Any assessment of the impact of geothermal development within the City of Boise should take into account the regional geologic setting, the stratigraphy of the units present, their structure and lithology. While not all units are pertinent to the geothermal project in question, a few of these units are extremely important in understanding the impact of the withdrawal and reinjection of geothermal water on the ground-water environment. The geologic units within this area have been mapped by a number of investigators in the recent past and their work leaves little doubt as to the general geologic framework of the Boise front and Camel Back Park area.

The oldest rock unit in the project area is the Idaho Batholith composed primarily of Cretaceous gray quartz monzonite and granodiorite and includes gneisses and schists in the vicinity of the study area. The unit outcrops slightly north of the Camel Bank Park area and forms the basement rock for much of the Boise foothills area and the mountainous area to the north. Jointing is prevelant in the rocks and numerous dikes, pegmatites and quartz veins are prominent. Where the rock has been faulted, shear zones, generally filled with yellow-brown fault gouge and alteration products are usually present. Typically upon faulting, the rock is broken into numerous subparallel shear zones steeply dipping and movement is generally in a dip slope direction. One such very prominent and extensive zone has been named the Foothills Fault and trends parallel to the Boise front. It is this fault that provides the conduit for the upward migration of much of the geothermal water that occurs along the Boise front and is used for the thermal development for the Boise Warm Springs Water District.

The next most important formation to be considered in this report is the Glenns Ferry Formation mapped by Malde and Powers (1962). This unit consists of thickly interbedded clay, sand, silt, thin layers of fine gravel with occasional discontinuous basalt flows. This unit is the most extensively exposed in the foothills and Boise Valley area and is easily recognizable because of its fine grain size, light color, and typical lacustrine appearance. At its type section, the unit is more than 2,000 feet in thickness, but the total thickness within the boundaries of the study area is unknown. Some of the beds within the unit are poorly cemented with both calcium and silica but upon surface exposure, weather rapidly forming fairly low smooth slopes. It is in this unit that the thermal wells will probably be developed adjacent to the contact with the underlying granitic rocks. The Glenns Ferry Formation is also the source of ground water for numerous wells in the Boise Valley and one of the prime sources for Boise Water Corporation which is the major supplier for the City of Boise domestic water supply. Because of the dual usage of the Glenns Ferry Formation as an aquifer, this unit is the most important to be considered in any assessment of thermal water withdrawal or injection.

The third unit of importance are the Terrace Gravels overlying the Glenns Ferry Formation. These gravels reach a thickness of approximately 200 feet in some areas and provide a great deal of the water to private wells in the municipal fringes and urban-rural areas in the Boise Valley. While withdrawal and injection of the thermal water will be considerably below the bottom of this aquifer, the upward migration of thermal water or excessive drawdowns in the vicinity of the production wells could impact the ground water system used for this supply. These gravels are well sorted and the entire unit, as a whole, is composed primarily of relatively clean sand with some silt interbeds, small gravel, and occasional thin clay layers. To the southeast of the project area, outcrops of very large gravel and coarse sand are prevalent in road cuts and have been encountered in some wells.

The general structure of this area is that of a juncture between two physiographic provinces. The foothills area and area to the north are considered to be part of the Rocky Mountain Physiographic Province while the Boise River flood plain and Treasure Valley are considered to be part of the Columbia River province. This juncture is separated by the termination or margin of the Idaho Batholith along which is found the Foothills Fault. This fault trending northwest/southeast is estimated to have displacement of as much as 9,000 feet and is high angle, dip slope in nature. Sympathetic or secondary faults also occur in the vicinity of the Foothills Fault and trend north/south and northeast/southwest respectively. The Foothills Fault can be traced on the surface for several miles and inferred along the Boise front to the vicinity of east of Mountain Home. Malde and Powers (1962), have indicated that this fault zone may continue to the vicinity of King Hill. It is believed that the Foothills Fault is a zone of fractures perhaps several hundred yards wide that extend deep enough into the earth's crust to allow vertical migration of water to a great depth allowing it to be heated and returned to the near surface to be tapped by wells. The concept of the Foothills Fault, being such a zone, would provide a rationale for the fairly high transmissivity that appears to characterize the geothermal system.

The production zone will probably be permeable lenses within the Glenns Ferry Formation near the contact with the granitic rocks adjacent to the Foothills Fault. Since production will take place in relatively young sediments (Plio-Pleistocene), and at a relatively shallow depth (1,000 to 1,500 feet), a distinct possibility of subsidence exists. Evaluation of subsidence problems in other areas indicate that most are located in areas of youthful geologic materials which are sedimentary in nature, and have incurred large fluid withdrawals from a relatively shallow depth. However, other areas that have experienced subsidence such as Houston; Goose Creek, Texas; Willmington, California; Las Vegas, Nevada; Phoenix, Arizona; and the Raft River Valley, Idaho, have withdrawals of fluids many magnitudes greater than that contemplated in this area. Additionally, the type of well, the construction of the intake section, and well spacing will also have to be taken into account in this analysis. Similar concerns must be considered in the area of reinjection within Julia Davis Park. While the materials at this location will be similar in nature to the formation along the front, the concern here will not be that of subsidence but of mounding of the ground water system and potential upward movement of the land surface. Again, the same geologic and hydrologic parameters must be considered before any complete analysis of subsidence or mounding phenomenon can be analyzed.

Since the geothermal project will be in an area of high population and dwelling density, concern must be given to the natural and potentially induced seismicity that could develop as a result of the project. The Geophysical Department of Boise State University has, over the past few years, collected a large body of seismic data for the Boise area. Both seismic and microseismic activity has been detected outside of the Boise area and at various locations along the Boise front, but there is no record of large seismic activity that can be attributed directly to the Foothills Fault or the geothermal system not in use by the Warm Springs Water District. None of the faults known to occur along the Boise front in the vicinity of the project appear to be tectonically active which, while in itself does not preclude the possibility of future movement, does indicate a geologic stability that can be assumed to be reasonable for the future.

However, because of the high production anticipated to be generated from Boise geothermal wells and the proximity to the Foothills Fault as well, it is reasonable to expect that some minor seismic activity may be induced during the life of the project. This seismicity, however, is not anticipated to be severe since the Foothills Fault does appear to be relatively stable and other well development along the fault has not generated significant activity for nearly the past 100 years. Since, however, the prediction of seismic activity is extremely inexact, it would be advisable to establish, prior to the initiation of the project and during, at least, the first several years of operation, a network of microseismic sensors to determine if any seismicity is induced. Such a net could be established easily and would provide assurances that no seismic activity was being generated by the project and additionally provide data for future geothermal development in other areas. Additionally, there should be at least two observation wells drilled to monitor fluid pressure near the area of production to insure that the pressure does not radically change during the operation of the project. A rapid fluid pressure change could indicate the possibility of induced seismic activity.

B. Subsidence and Mounding

1. Background

There is an unmeasured potential hazard from this project attributable to subsidence and mounding. It is known that three kinds of induced ground movements may occur in geothermal areas: subsidence or rebound of the land surface due to fluid pressure changes; horizontal movements caused by induced fluid pressure gradients; and vertical movements attributed to thermal expansion or contraction of the reservoir rack. These processes have been studied by Lefgren, 1973; Maxwell, 1960; Papadapoulos et. al., 1975; Kreitler and Gustavson, 1976; and Atherton et. al., 1976. Much of this work applies only to high temperature reservoirs, i.e., 200+°C. Some of the implication of findings in this work have been reviewed as it related to Boise area geology (Hollenbaugh, 1973). This review indicates a definite potential for subsidence along the Boise front, especially in the Glenns Ferry formation.

Some of the effects of subsidence can be gauged from experience in the San Joaquin Valley of California. Subsidence in this area has resulted in damage to buildings estimated to be in the millions. Although the volume of water withdrawn in the San Joaquin Valley is much larger than we may expect, at least in the near future, many of the geological characteristics are similar. Other occurences of lesser extent have been reported from Washington, Montana, Utah, Wyoming, Arizona, and Colorado.

The areas of potential subsidence for the Boise geothermal system would be in the vicinity of the production wells, with potential for mounding in the general area of the reinjection wells. An initial Boise system would include six production wells and two reinjection wells. Possible location of these wells is shown in Figure 2. In general terms the potential for subsidence and mounding can be measured by the fact that the initial system would have a production capacity of about 8,000 gpm.

2. Fluid Withdrawal

As indicated previously in this report, the source of the geothermal water is anticipated to be from a deep circulation aquifer which leaks water from the Foothills Fault zone into the Glenns Ferry Formation. This water mixes with the colder waters that now exist in the formation and move laterally into the area of production. Obviously the closer to the Foothills Fault the intake section of the production wells are the hotter the water will be. Because of the occurrence of several warm water wells along Hill Road in the Boise area, it is apparent that some of the warm water is leaking vertically into the shallow ground water system and is being tapped by the shallower wells. Several wells to the northwest of the project area have been used for space heating for many years.

The initial withdrawal for this project is anticipated to be about 8,000 gallons per minute. In anticipation of this withdrawal and making the necessary assumptions regarding the hydrologic parameters and characteristics of the Glenns Ferry Formation, several conclusions can be made regarding the potential impact of withdrawal on the area.

Based upon data collected during well testing for Boise Water Corporation wells, private wells, and other data collected for the Glenns Ferry Formation, one can assume that the transmissivity (T) of the Glenns Ferry Formation in this area will range from 20,000 to 25,000 gallons per day per foot. This coefficient of transmissivity is defined as the rate at which water will flow through a vertical strip of the aquifer one foot wide, extending the full saturated thickness of the aquifer under a hydrologic gradient of 100 percent. This parameter allows a calculation of the approximate rate of flow in the aquifer, the estimated yield of a well, and an estimated drawdown for that yield at a given rate of flow. Since it is anticipated that the rate of flow from the Camels Back Park area will be in the neighborhood of 3,000 gallons per minute, it can be estimated that the drawdown in each of the geothermal wells will be approximately 80-100 feet. This assumption is based upon a T value of 20,000 gallons per day per foot and a 50 percent well efficiency for each well.

The radius of influence for these wells cannot be calculated, however, since there does not exist any available data that is required for this figure. During the initial phase of the project these data should be collected in order to estimate this radius. Since the geothermal system, the deep aquifer system which is considered to be the water within the Glenns Ferry Formation, and the shallow ground water system which is that included in the shallow Terrace Gravels, are all interconnected, some impact is anticipated to be felt in wells near the geothermal project area in the shallow aquifer. However, because of the recharge from the geothermal system and the amount of water that exists for withdrawal within the Glenns Ferry Formation, the amount of drawdown in private wells near the project area is anticipated to be very slight and should not be considered to interfere with other water rights. Because of the concern for private well supplies and the consideration that needs to be given to the private well owners, it is recommended that at least three wells in the vicinity be monitored as to depth to water, pumping levels, and water quality both before and during the operation of the project. These data will provide a basis for comparison if, in any event, a claim is made of interference.

Potential subsidence of the earth's surface in the vicinity of the geothermal project should be considered carefully. As previously indicated, most areas that have incurred subsidence in the past have been in geologic environments of fairly youthful sediments where large quantities of water have been withdrawn from a shallow depth. Since production of geothermal water will take place from approximately 1,000 to 1,500 feet below land surface in young sediments, one cannot dismiss the possibility of subsidence. Because of the nearness of numerous dwellings and other structures, such subsidence could be of relatively severe consequence. However, because of the general history of the Boise Valley area and the lack of such problems at the Warm Springs Water District production site and further the lack of documented subsidence in areas where relatively large volumes of water have been produced from the Glenns Ferry formation for many years, it is not anticipated that there will be subsidence due to this project.

A potential source of subsidence could exist if the wells are not completed in a proper manner and sand or other fine materials are produced with the geothermal water thus removing the formational materials from the aquifer. Such removal of sediment has caused local subsidence in wells finished in the upper Terrace Gravels in many areas around the Boise Valley, but the subsidence has been related directly to sediment withdrawal rather than fluid withdrawal.

Through evaluation of the Glenns Ferry Formation and the relative quantities of water to be withdrawn and strength of the geologic materials in the section, it is not anticipated that any subsidence will occur. It is recommended, however, that because of the concern that may exist among administrative officials and residents of the area, a series of levels should be run into the area of withdrawal and reinjection from benchmarks located at least one mile outside of the perimeter of the project area. Monitoring of these stations should be initiated prior to the beginning of the project and be continued for the duration of the project as a general precaution. The monitoring system for fluid pressure suggested earlier would also provide an indicator of potential subsidence occurrences. If, during initiation of the project additional data indicate that subsidence may be a problem, well spacing analysis, and flow reduction can be initiated to allevaite the problem if it exists. If, during construction of the wells the transmissivity of the production zone is found to be significantly lower than that estimated, the drawdown and radius of influence will increase proportionately. This would cause increased influence on other wells in the area and would necessitate additional aquifer analysis and perhaps a well spacing program to distribute drawdowns and their influence over a wider area with a lesser magnitude.

3. Injection

One possible injection site of spent geothermal waters is in Julia Davis Park. This Park lies upon the Terrace Gravels and the Glenns Ferry formation. It is anticipated that the injection zone will be approximately 1,000 to 1,500 feet below land surface in the Glenns Ferry formation which has similar hydrologic characteristics to those near Camel Back Park. Based upon these assumptions, it can be anticipated that mounding of the ground water system will occur in the neighborhood of approximately 80-100 feet above the static water level during injection of the thermal water. To some extent, this will be dependent upon the injection pressure and will have to be determined in the field during injection tests. It is obvious that by over pressuring the injection wells, greater mounding of the water table will occur which could eventually result in a slight mounding of the surface of the ground.

It is not anticipated that such high pressures will have to be used to inject the water and that no such mounding or excessive increase in water table will occur. While the construction of the exhaust section of the well is not yet known, it should be established that disposal of the water should take place through a relatively long section of well screen. In this case where injection of the thermal water is at a temperature much greater than that of the natural ground water system, a high quality stainless steel well screen should be used for the exhaust section. Such a screen would allow periodic chemical treatment of the well in order to eliminate any fouling or plugging that may occur because of silicate or carbonate encrustation in the well bore of formation. Because of the temperature differential, it is anticipated that such encrustation will occur which will cause a decrease in the efficiency of the injection wells. Since the precipitates are natural materials, there will be no adverse environmental impact either to the formation or the ground water system in the vicnity of the well. However, unless the material is periodically removed through chemical cleaning, it is entirely possible that the injection wells may become inoperable after several years.

The primary concern of this author regarding injection is that of the distribution of the fluoride (F) and temperature plume in the Glenns Ferry aquifer. Because of the many unknowns in this area and the relative shallow depth of injection, only broad estimates may be made regarding the chemical effect of injection of spent thermal water.

Ground water flow in the vicinity of the injection site is to the northwest both in the shallow and deep groundwater systems. The water contained in the Glenns Ferry formation is under low artesian pressure which results in slight upward movement through the discontinuous confining layers in the aquifer. Higher artesian pressures resulting in flowing wells occur near the towns of Meridian and Eagle approximately 8-10 miles down gradient. Thermal water injected into the deep aquifer will move to the northwest toward these areas of higher artesian pressure, increasing the potential for upward migration of the injected fluid. This upward migration, however, increases the dilution factor thus reducing the possibility of contamination.

Martin and Clapp (1976) studied the quality of the ground water in the area and of the geothermal water near the old penitentiary site. (A portion of the water analyses contained in the report is shown in Appendix D.) The thermal water quality is excellent with the exception of the fluoride content which ranges from two miligrams per litre (mg/l) to 24 mg/l. The quality of the ground water in the area is also good with the fluoride content of about 0.4 mg/l and the temperature at about 16° Celsius (C). Assuming the rate of injection in the Julia Davis Park area to be a maximum of 5,000 gpm a plume of higher temperature, high fluoride water will be formed that will extend down gradient or northwesterly roughly the shape of an elliptical parabaloid. Data are not available at present to evaluate the volume of the plume to the point of acceptable concentration but rough estimates may be made using estimated T and S values. The ratio of natural ground water necessary to dilute the injected fluid to an acceptable F limit of 1.2 mg/l approaches 30:1. Using the T value of 20,000 gpd/ft, an S value 1×10^{-4}, a gradient of 19 feet/mile and the water quality data in Appendix D, it is estimated that F concentrations of greater than 1.2 mg/l may exist as much as 1.4 miles down gradient from the injection site. The assumptions made also include a narrow annulus of injection and a 100 foot section of exhaust section in the wells. The down gradient distance will be shortened considerably if the injection wells are drilled in a northeast/southwest line, widening the annulus of disposal. Additionally, factors such as adsorption of F by clay particles and upward ground water movement will accelerate diffusion and reduce the distance of detectability above 1.2 mg/l.

If such a program of well layout is used and injection is between 1,000 and 1,500 feet in depth, it would not appear that ground water contamination because of the F content will be of concern.

The increase in temperature of the natural ground water due to the thermal injection is not anticipated to create a water quality problem. This thermal effect will dissipate very rapidly in the aquifer and is not anticipated to be detectable more than a few hundred feet from the injection area.

Because of the numerous assumptions necessary to estimate the dispersion of the chemical constituents in the injected water, it is recommended that once the initial injection wells are drilled, cold water injection tests be conducted to further determine T and S coefficients and injection well head pressures. Based upon these data, a dispersal model may be established for the aquifer and more accurate estimates of the shape and volume of the effluent plume may be determined. Well spacing, injection depth and pressures and other variables may then be finalized in order to prevent any possibility of contamination.

C. Reservoir Production Capacity

In the last quarter of 1977 Boise City requested that some well testing be conducted along the front. INEL personnel pump tested the Beard (BHW-1) and BLM (BEH-1) wells on the Military Reserve Park. Both of these wells had been drilled in 1975 under an ERDA grant. The wells are 1,283 and 1,222 feet deep, respectively, for the Beard and BLM wells. The final report of this testing is now being printed by the Department of Energy. Although the final report will not be available for some time, there are preliminary notes that were made available in 1978.

These preliminary notes describe the testing procedures as follows.

- Temperature profiles of the wells were taken during drilling and after the well had stablized. The temperature profiles of the BHW-1 (Beard) and BEH-1 (BLM) are essentially identical, i.e., asymptotic 170° at 1200 feet.

- Artesian wellhead pressure was monitored all during the 1976-77 heating season at BEH-1 (BLM). No correlatable pressure communication was observed as a result of the pumping conducted at the old penitentiary wells. A seasonal pressure decline of 2-1/2 psia was observed during the winter but had recovered by June.

- Artesian and pumped flow tests on each of the exploratory wells was conducted. A shaft driven pump set at approximately 185 feet (56 m) was employed for the pumped flow tests.

- Interference testing revealed a rapid pressure communication between the two wells; 0.1 psia change within two minutes of the start of a test.

The preliminary conclusions reached by these tests are provided below.

- The reservoir is being recharged at a higher rate than the current withdrawal rates.

- The reservoir is more extensive than previously thought.

- Similar geologic conditions occur in several locations along the Boise Front Fault that apparently control the geothermal resource as now defined by the existing four wells.

- Test results confirm that future production wells (properly located) will have high production rates in the order of 600-1000 gpm for 12-16 in. (30-40 cm) wells.

- The geothermal resource can be encountered at relatively shallow depths (<1000 ft or 305 m) and at temperatures (170°F or 77°C) adequate for large scale space heating. The wells should be located close to the intersection of NE trending linears with the Front Fault for the greatest possible production rates and highest temperatures close to the service areas.

This initial reservoir testing resulted in generally optimistic results concerning reservoir productivity potential. The testing also revealed the need for additional study to more precisely define reservoir extent, structure, and potential.

D. Hydrology and Ground Water Supply

Limits on ground water use are set by two factors: discharge and recharge. The discharge which is allowed to take place is directly related to recharge, that is, a balance must be maintained between the two which places recharge waters in the system in a quantity greater than or at least equal to the amount which is being withdrawn. Failure to do this could cause a mining condition within the ground water system resulting in depletion of the water resources.

In 1976 Mink and LeBaron concluded a study of the Boise area hydrology system. Their work is described in a BCUR report, "Hydrology and Groundwater Supply of the Boise Area." The major findings of this study are provided below.

- Investigations reveal that the water supply for the City of Boise comes mainly from precipitation in the form of rain and snow and the infiltration of these waters into the subsurface aquifer.

- Available water appears to be at least 34,094 acre-feet, with actual water being much greater than this in all likelihood.

- Discharge from the aquifer is mainly by the Boise Water Corporation for use in domestic and light industrial situations. The majority of it is used by individual homeowners and residents of the City.

- Water withdrawal amounts to approximately six billion gallons annually, or 18,400 acre-feet/year. This amounts to slightly more than 53 percent of the annual recharge indicating that substantially larger quantities of water could be withdrawn before any serious depletion of the reservoir would occur.

- The extended outlook for the area shows that 17.1 billion gallons are going to be needed by the year 2000. According to the study conducted by CH2M Engineering (Water Study Committee, 1975), this quanitity will be available.

- Reserves in underground storage appear to be sufficient to last 10-15 years if no recharge takes place. Taking into consideration the recharge which does take place, it appears the Boise Water Corporation could nearly double production before any depletion or mining of ground water were to take place.

- If large areas of irrigated land are taken out of production, there is a possibility that the shallow water table system will undergo a decline and increased lifts from previously shallow wells will be necessary. This may not affect the immediate urban area, however, since the amount of irrigated farm land in the area is small. Lawn irrigations and canal seepage make up the major infiltration of this type for the Boise area.

- Retain agricultural lands in their present state for use in maintaining the shallow aquifer at its present level by irrigations.

The Boise geothermal system, as envisioned in the PON proposal, by 1983 could possibly be withdrawing water at the rate of 10,000 gallons per minute. Even in an intense heating season this would not constitute a major part of the six billion gallons annual use. Nonetheless, a 10,000 gpm pumping rate is significant especially when withdrawal will be from one depth along the front (ca. 1,200 feet) for reinjection, possibly, at a different depth, in a different part of the hydrologic system of the area. Clearly more work is needed to elucidate the relationship between the area hydrology, future water demand, and the moderately large geothermal system pumping rates.

E. Surface Water and Geothermal Water Quality

The geothermal waters in the Boise area are exceptional in terms of possessing a very high quality, they are almost of drinking quality. (See Appendix D for a description of water samples taken from hot water wells.) There are few enough contaminants in the water so that residents along Warm Springs Avenue are reputed to have drunk the water for many years without apparent ill effect. They have also been using it for other domestic purposes evidently without adverse reaction. While the water is generally pure its high concentrations of flouride and boron have been the source of some concern. These ions exceed standards set for domestic use and for discharge to surface waters. Planning for a Boise geothermal system must consider discharge to gravelly surfaces, for percolation, to surface water systems, or, by reinjection, to ground water systems as possible means of disposal of spent waters. Any such discharge must consider the effect of Fl and B ion concentrations on receiving systems.

This investigation acquired analytical data on the fluoride and boron content of water samples from the Boise River and the Boise geothermal reservoir, acquired data on the daily stream flow volume of the Boise River for a three-year period, determined the mixing ratio for geothermal water and Boise River water allowable under EPA pollution standards for fluorine and boron, and construct a table of values that will show the maximum allowable surface discharge of geothermal water to the Boise River as determined by the mixing ratio and the volume of stream flow, in the event discharge to the river is the alternative eventually chosen.

1. Fluoride and Boron Standards

All analytical work required during the conduct of this study was performed by the Idaho Department of Health and Welfare Chemical Lab on Penitentiary Drive, Boise, Idaho. Standard procedures approved by the EPA were used.

The Idaho Department of Health and Welfare and the U.S. Environmental Protection Agency have established a range of 1.6 to 2.4 mg/liter for the allowable fluoride content of drinking water. The State of California has established water quality criteria that limits fluoride to 1.6 mg/liter for the protection of aquatic life and to 1.0 mg/liter for livestock watering sources.

The boron content of water samples from the Boise River and the Boise geothermal reservoir was anlayzed and the results are reported in Table 1 . The maximum allowable value for boron in irrigaiton water as established by the EPA and reported in the California Water Quality Criteria manual ranges from 1.0 to 4.0 mg/liter, depending on the crops to be irrigated. All boron values obtained during this study are well below the 1.0 mg/liter maximum so boron will not be considered as a limiting factor in determining the mixing ratio.

For the purpose of calculating the mixing ratio of geothermal water and river water, the lowest safe limit for fluoride content established by the EPA, Idaho, and California will be used. Thus, the flouride content of the product of the mixing process will be exceed 1 mg/litter.

2. Boise River Stream Flow Data

The U.S. Geological Survey records the stream flow volume of the Boise River on a daily basis. The gaging station is located at the Capital Boulevard bridge. Data for the period October 1974 through September 1977 were obtained from the USGS and are used as the basis for calculating maximum allowable discharge of geothermal water to the river. The daily stream flow volume in cubic feet per second is given in Table 2 , for the years 1976-

TABLE 1.

ANALYTICAL DATA, FLUORIDE AND BORON

Boise River Samples

Sample Location	Mg/L Flouride	Mg/L Boron
Arrowrock Reservoir	0.05	NA
Spring Shores Well 180'	0.25	NA
Lucky Peak Reservoir	0.10	NA
Discovery Park	0.10	NA
Diversion Dam	0.10	NA
Barber Dam	0.10	NA
Barber Park	0.27	0.16
Boise Cascade Mill	0.10	NA
Ann Morrison Park	0.20	NA
Western Idaho Fairgrounds Bridge	0.15	NA
Strawberry Glen	0.29	0.56
Eagle Bridge	0.15	NA
Star Bridge	0.15	NA
Middleton Bridge	0.10	NA
Notus Bridge	0.15	NA
Parma Bridge	0.15	NA
Confluence of Boise and Snake Rivers	0.20	NA

Geothermal Samples

Sample Location	Mg/L Fluoride Ion Electrode	Mg/L Fluoride SPANDS Spectroscopic	H&W	Mg/L Boron
Penitentiary Well (hot)	17.4	15.0	19.0	0.53
1414 Warm Springs Ave.	17.0	15.0	--	--
1400 Warm Springs Ave.	17.0	15.0	--	--
1312 Warm Srpings Ave.	17.0	15.0	--	--
314 Warm Springs Ave.	--	--	19.5	0.28
East Jr. High Drain	--	--	18.3	0.34
Beard Well (hot)	--	--	19.3	0.43
BLM Well (hot)	--	--	17.3	0.37
Milstead Nursery (hot)	10.0	10.5	--	--
Edwards Nursery (hot)	--	--	10.6	0.39

Table 2. Boise River Stream Flow Data from U.S.G.S.

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY PROCESS DATE IS 02-17-78

STATION NUMBER 13202500 BOISE RIVER AT BOISE, IDAHO STREAM SOURCE AGENCY USGS
LATITUDE 433723 LONGITUDE 1151227 DRAINAGE AREA 2750.00 DATUM 2675.46 STATE 16 COUNTY 001

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1976 TO SEPTEMBER 1977
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	474	276	282	276	108	102	99	1220	790	1050	892	611
2	467	276	262	283	105	102	209	1220	778	1050	892	593
3	467	276	282	*283	105	102	262	1200	778	1050	906	611
4	*474	276	269	276	105	102	203	●1100	778	1060	934	642
5	445	269	269	276	102	99	440	1100	814	1110	964	653
6	445	269	262	283	102	99	*604	1050	838	1110	920	664
7	445	262	269	283	102	99	631	1020	826	1060	906	*642
8	447	269	269	227	102	99	742	962	838	1060	920	631
9	357	269	269	134	102	105	838	850	948	1050	906	642
10	432	269	269	134	102	96	878	864	*1050	1040	878	653
11	412	269	269	134	105	96	934	802	934	1000	892	631
12	432	269	269	134	105	95	920	584	850	990	892	631
13	432	269	269	134	105	93	920	*820	854	944	920	575
14	392	262	269	151	108	93	906	714	878	920	878	593
15	364	*262	269	147	*105	90	934	790	920	920	906	543
16	297	262	269	133	105	90	962	802	948	948	920	467
17	287	262	283	*133	105	93	962	765	948	934	920	438
18	281	262	276	133	102	90	990	892	948	948	920	458
19	*181	262	276	133	105	90	1000	842	976	948	906	449
20	240	262	276	133	105	87	1040	802	948	934	892	467
21	332	255	276	133	102	87	1050	754	906	*920	878	449
22	318	255	276	117	105	*87	1130	730	934	920	878	432
23	297	255	276	104	102	85	1170	742	942	920	878	432
24	269	255	283	105	105	85	1170	853	976	920	892	449
25	263	255	283	105	102	82	1190	820	976	920	878	449
26	263	262	283	105	102	80	1170	853	990	934	850	392
27	274	262	283	105	102	77	1170	864	976	920	730	297
28	274	262	283	104	99	75	1190	875	990	892	686	252
29	274	262	276	104	---	75	1220	860	1050	892	664	252
30	276	262	276	104	---	70	1220	847	1090	892	620	259
31	276	---	276	105	---	75	---	730	---	892	593	---
TOTAL	11061	7937	8458	5027	2916	2801	26214	25314	27492	30212	26695	15312
MEAN	357	265	273	162	104	90.4	874	823	916	975	861	510
MAX	474	276	283	283	108	105	1220	1220	1090	1110	964	664
MIN	181	255	262	104	99	70	99	584	778	892	593	252
AC-FT	21940	15740	16780	9970	5780	5560	52000	50620	54530	59930	52950	30370

CAL YR 1976 TOTAL 524424 MEAN 1433 MAX 5730 MIN 181 AC-FT 1041000
WTR YR 1977 TOTAL 189852 MEAN 520 MAX 1220 MIN 70 AC-FT 376600

1977. It is important to note the minimum flow volume, the magnitude of fluctuation in flow volume, and the time of year when minimum flow occurs. Although each of these values change from year to year, the low flow period occurs during the winter months, when the volume of geothermal water to be discharged would be the greatest.

3. Determination of Mixing Ratio

The average value for fluoride content of the Boise River is 0.15 mg/liter based on a broad distribution of samples from Arrowrock Reservoir to the Snake River. The average fluoride content of water samples from geothermal wells is 15.83 mg/liter. The highest fluoride content was detected in water from the Beard well adjacent to Reserve Street. That value is 19.3 mg/liter, as recorded in Table 1 .

It is reasonable to assume that the fluoride content of the hottest wells probably most closely approximates the true value for the reservoir as a whole. Also, the many years of production at constant temperature of hot water from the Penitentiary wells would indicate that the water being produced is probably characteristic of the reservoir and not subject to wide variation in chemistry due to mixing with nongeothermal subsurface water. Thus, the fluoride content would not be expected to change significantly with increased production, unless the geothermal and chemical characteristics of the water are not accurately reflected by the production history of the Penitentiary wells. If that should be the case, an increase in water temperature could possibly be accompanied by an increase in fluoride content and the mixing ratio for disposal would need to be adjusted accordingly.

The mixing ratio of geothermal water with Boise River water is calculated using the highest fluoride value obtained from the samples of geothermal water in order to provide the most accurate figure for projected geothermal production that present data will permit. Thus, the average value of 0.15 mg/ liter is used for the fluoride content of the river water and the maximum value of 19.3 mg/liter is used for the geothermal water.

The mixing ratio is calculated as follows:

$$\frac{19.3 + X(0.15)}{1 + X} = 1$$

$$19.3 + 0.15X = 1 + X$$

$$0.85X = 18.3$$

$$X = 21.53$$

A mixing ratio of 1:22 produces a blend of geothermal water and river water that will have a total fluorine content of less than 1.0 mg/liter.

4. Determination of Maximum Geothermal Discharge

By applying the mixing ratio of 1:22 to the flow volume of the Boise River it is possible to determine the maximum allowable discharge of geothermal water. This in turn sets the limit on geothermal production unless some additional means of disposal such as an injection well is available.

Table 3 provides the range of values for geothermal discharge to the Boise River as determined by the recorded flow rate of the river and the mixing ratio. The values are given in cubic feet per second and can be converted to gallons per minute by the following formula:

(cu ft/sec) (448.8) = gal/min

For example, during the calendar year 1974 the lowest flow of the Boise River was recorded to be 76 cfs which is equivalent to (76) (44.8) = 34,108.8 gpm. At a mixing ratio of 1:22 the following volume of geothermal water could have been discharged on that day:

(76) (.0455) = 3.46 cfs, (3,46) (448.8) = 1552.8 gpm

For that same year, the greatest flow of the Boise River was recorded to be 7,460 cfs, which would equate to an allowable geothermal discharge volume of 152,336 gpm.

5. Conclusions

- No consideration was given to the means or process that would be required to cool the geothermal effluent before discharge to the Boise River.

- Any proposed development of the Boise geothermal reservoir that would require a disposal rate in excess of 2,000 gallons per minute must include a provision for disposal of that excess by some means other than discharge to the Boise River, in order to avoid the possibility of a winter time operational slow down due to low river flow and the resulting inability to dispose of the geothermal water without exceeding the environmental standards for fluoride in the river water.

- Within the limitation imposed by fluoride content and flow volumes, it is feasible to consider surface discharge of cooled geothermal water to the Boise River as an alternative means of disposal.

- Although the lowest possible discharge rate of geothermal water to the Boise River that could have occurred during the period 1974 to the present was 1,432 gallons per minute for one day only, the allowable discharge rate over the entire period is in the range from 2,000 gpm upward.

- The cooled geothermal water can be mixed with the water of the Boise River at the ratio of 1:22 and be within the limits of fluoride water quality standards set by the State of Idaho and the EPA.

Table 3.

Monthly Stream Flow and Allowable Geothermal Discharge
October 1974 to October 1977

Year & Month		Total Discharge in cfs		Max. Discharge		Min. Discharge		Mean Discharge		
		Boise River	Geothermal effluent	Boise River	Geothermal effluent	Boise River	Geothermal effluent	Boise River	Geothermal effluent	(g
1974	Oct.	9,610	437	595	27	145	7	310	14	(6,
	Nov.	6,547	298	313	14	190	9	218	10	(4,
	Dec.	6,753	307	236	11	212	10	218	10	(4,
1975	Jan.	6,358	290	213	10	195	9	205	9	(4,
	Feb.	7,079	322	504	23	119	5	253	12	(5,
	Mar.	61,521	2,799	4,990	227	246	11	1,985	90	(40,
	Apr.	189,920	8,641	6,510	296	5,280	240	6,331	288	(129,
	May	203,430	9,256	6,680	304	6,390	291	6,562	299	(133,
	June	79,980	3,639	6,590	300	1,530	70	2,666	121	(54,
	July	43,110	1,962	1,550	71	1,240	56	1,391	63	(28,
	Aug.	33,573	1,528	1,240	56	826	38	1,083	49	(22,
	Sept.	24,090	1,096	930	42	679	31	803	37	(16,
	Oct.	12,795	582	657	30	295	13	412	19	(8,
	Nov.	8,968	408	388	18	262	12	298	14	(6,
	Dec.	8,427	383	295	13	256	12	271	12	(5,
1976	Jan.	40,717	1,853	2,990	136	256	12	1,313	60	(26,
	Feb.	39,341	1,790	3,100	141	227	10	1,356	62	(27,
	Mar.	50,780	2,310	2,400	109	1,000	46	1,638	75	(33,
	Apr.	108,100	4,919	5,730	261	1,320	60	3,603	164	(73,
	May	126,500	5,756	5,670	258	1,690	77	4,080	186	(83,
	June	44,490	2,024	1,890	86	1,250	57	1,483	67	(30,
	July	41,510	1,889	1,490	68	1,110	51	1,339	61	(27,
	Aug.	28,213	1,284	1,080	49	813	37	910	41	(18,
	Sept.	17,797	810	918	42	331	15	593	27	(12,
	Oct.	11,081	504	485	22	181	8	357	16	(7
	Nov.	7,937	361	276	13	255	12	265	12	(5
	Dec.	8,458	385	283	13	262	12	273	12	(5
1977	Jan.	5,027	229	283	13	105	5	182	8	(3
	Feb.	2,904	132	108	5	99	5	104	5	(2
	Mar.	2,801	127	105	5	70	3	91	4	(1
	Apr.	26,214	1,193	1,220	56	99	5	874	40	(17
	May	25,519	1,161	1,220	56	585	27	823	37	(16
	June	27,492	1,251	1,080	49	778	35	916	42	(18
	July	30,212	1,375	1,110	51	892	41	975	44	(19
	Aug.	26,695	1,215	948	43	593	27	861	39	(17
	Sept.	15,312	697	664	30	262	12	510	23	(10

- Fluoride analyses of the Boise River water indicate an average fluoride content of 0.15 mg/liter.

- Fluoride analyses of water samples from the geothermal wells indicate an average fluoride content of 15.83 mg/liter, but a maximum content of 19.3 mg/liter.

- Analyses for boron in water samples from the Boise River indicate an average boron content of 0.36 mg/liter, and a maximum of 0.56 mg/liter.

- Boron analyses of the geothermal well samples indicate an average boron content of 0.47 mg/liter and a maximum content of 0.53 mg/liter.

- Boron content of the geothermal water is well below established water quality standards and does not pose any threat to the quality of surface or subsurface waters of the Boise region.

F. Geophysics

Geophysical data concerning the Boise front comes from regional studies by USGS, a single seismic line shot by Standard Oil of California, and work undertaken by BSU (Applegate and Donaldson). The Standard Oil data is not yet available for local study although efforts should be made to obtain this data. USGS data includes gravity and aeromagnetic surveys which have been assembled by BSU. The BSU geophysics study of the Boise front has not yet been published although preliminary results from this data have been made available. Until data from all of this work is analyzed in greater detail only preliminary conclusions are possible. These conclusions suggest that there are high probability drilling areas in the vicinity of Hillside Junior High School, Camels Back Park, Military Reserve Park, the Old Penitentiary Area, and area just to the southeast of Warm Springs Mesa. These general areas would probably be the most fruitful for future geophysical work. In any event, a drilling program for the Boise geothermal project will probably entail some additional geophysical work to confirm probable drilling sites. The extent of geophysical studies needed cannot be determined until Standard Oil data is made available, and pending BSU work completed.

G. Existing Wells

The records concerning existing wells are a significant source of information about the Boise hydrological reservoir. Mink and Graham have reveiwed data for these wells as the basis for estimating the extent of the geothermal reservoir. Data concerning existing wells has been assembled in Appendix B. No detailed analysis of this data, apart from Mink and Graham, is provided but it is inevitable that this data will be found useful in future geological studies, and also as objective evidence in possible future litigation over water or geothermal rights. Future geothermal development in Boise will require more extensive analysis of this well data, and associated water rights, ownership, and lease information.

III. SYSTEM DESIGN AND FEASIBILITY

A. System Conceptual Design

1. Purpose

The proposed project will supply space heating to commercial and public buildings in downtown Boise. In doing so, the project will demonstrate the large scale use of geothermal water for commercial space heating. The data collected and evaluated will be added to the growing scientific knowledge of viable alternative energy systems.

This preliminary design report establishes potential service locations, outlines the preliminary pipeline routes and discusses building retrofit. In addition, the report tabulates estimated system costs and presents the proposed project schedule.

2. Background

Geothermal energy use began in the 1890's when Boise was a thriving commercial center and the established capital city of Idaho. Wells were developed privately near the old penitentiary and in Hulls Gulch. Both of these sites are located along the Boise Front. The penitentiary site is east of the city, and Hulls Gulch is at the northwest edge. The wells at the penitentiary site, commonly referred to as the Warm Springs Wells, still produce reliably and provide hot water for space heating under ownership of the Boise Warm Springs Water District (BWSWD). (See Figure 1, Location Map.)

The first commercial geothermal use in the nation was employed in Boise to provide building space heating. Several homes along Warm Springs Avenue were connected to the original system. On a wave of popular enthusiasm and local support, the system expanded to serve a hotel and several commercial buildings in old downtown Boise. In the mid-1950's with the advent of fossil fuels, use of the naturally hot water diminished until in 1973 only 164 homes remained on the geothermal system.

Beginning in 1975, renewed interest has focused state and national attention on the Boise natural energy source. The City of Boise began to consider seriously geothermal space heating for both renovated and new buildings in the downtown area. An ERDA/INEL project completed exploratory drilling and during that time, geophysical mapping at Military Reserve Park along the Boise Front. The associated study by Aerojet/ Boise State University/BWSWD defined the surface geology denoting productive areas, and other areas of high potential. Preliminary parameters of well productivity were established at that time.

In 1976, the State of Idaho Energy Office with Pacific Northwest Regional Commission funding undertook an experimental project to geothermally heat the State of Idaho Health and Agricultural Laboratory (total 38,000 square feet). The results of this project have established the efficiency of the design system, defined new economic parameters, and explored the impacts of discharge of spent geothermal water to the Boise River.

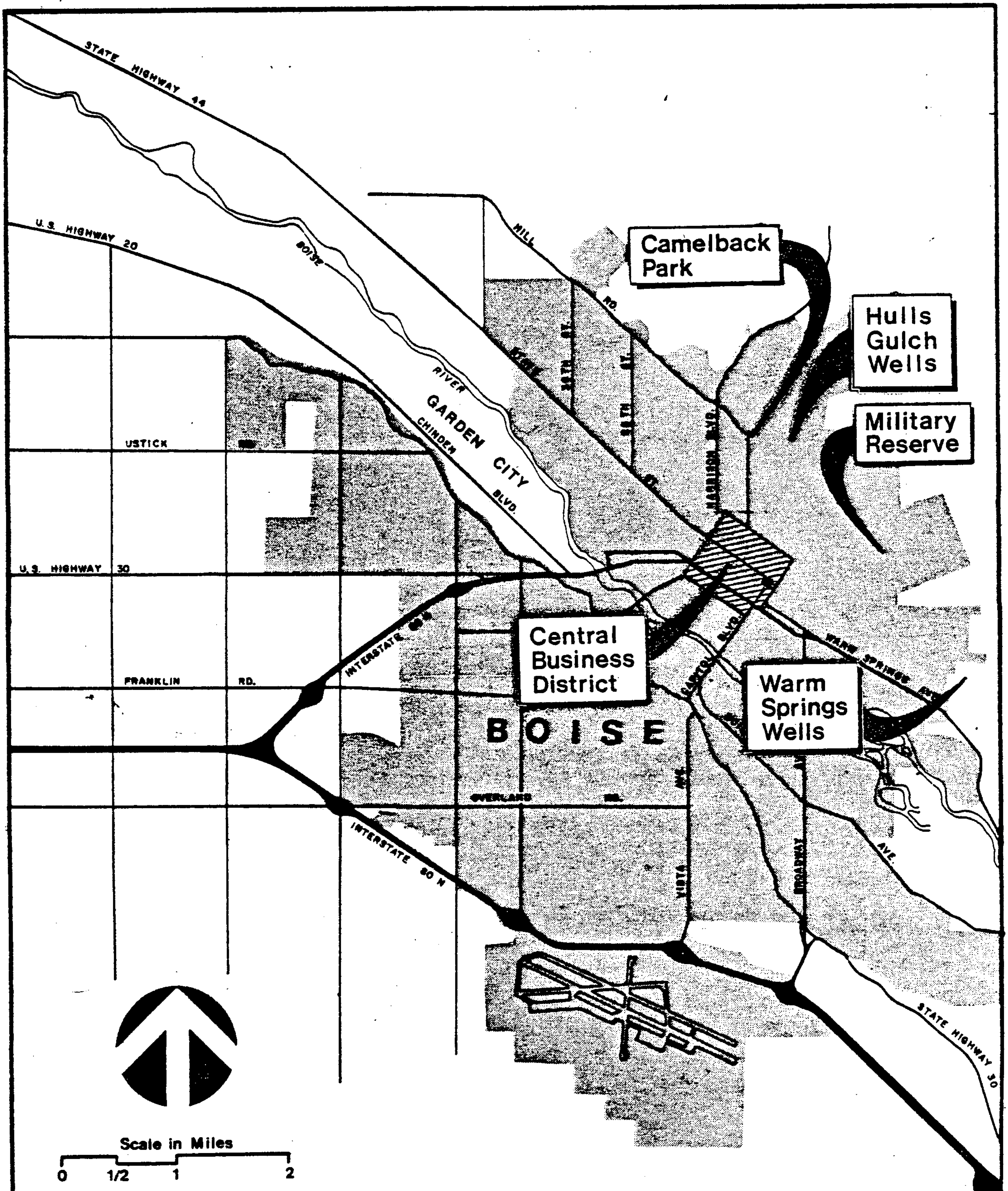

Figure 1. Location Map

City of Boise

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Starting in late 1976, the U.S. Department of Energy (DOE) funded a project which enabled Boise City to extensively examine the state and federal requirements of a geothermal energy utility. Data resulting from this study included capital and operating costs, pricing structures, organizational alternatives, and various methods of financing.

The proposed geothermal system will include supply wells and pumps, the distribution and collection systems, pumphouses and controls, and the reinjection wells. The supply wells will be drilled along the Boise Front; reinjection wells are tentatively located near the Boise River in the vicinity of Julia Davis Park. Drilling and reinjection will follow the guidelines of the State of Idaho, Department of Water Resources. The pumps, pumphouses, and controls for both systems are described in more detail in the following pages.

The proposed supply system will enter the downtown area at about 13th and State Streets, and will initially provide service connections to 12 buildings. Figure 2 illustrates the pipeline layout.

A number of additional buildings were originally considered for retrofit. From the original investigation, several of these buildings are considered unsuited for retrofit during this phase of development. In these cases, the heating system retrofits are uneconomical or the buildings are remotely situated from the proposed mains. During later phases of development, these buildings could be considered as potential geothermal customers.

Both the supply and collection lines are proposed to be oversized to facilitate future expansion. All selected building heating systems will require alterations to allow the use of geothermal water for heating. Most of the systems will be monitored to gather data for evaluation of the cost effectiveness of the geothermal energy systems.

3. Supply Wells

The primary target area for development of the geothermal resource for Boise, Idaho is the Military Reserve Park. Extensive geological data have been gathered and several wells drilled and developed which demonstrate the presence of a substantial resource. This location is in proximity to most prime potential users of geothermal energy including downtown Boise, and the state and federal building complexes. The ownership of the geothermal resource in Military Reserve Park has been in a state of uncertainty. Pending federal action is expected, to resolve the problem.

In the case of Camelback Park, exploratory test wells have not been drilled at the park; however, the presence of an extensive geothermal resource has been suggested by several geologists based on preliminary geologic data of the area. Actual well siting may require additional geologic work to locate the production wells. The considerations for well siting would include the impact on the developed portions of the park, and the geologic constraints which may be present. Alternative well field sites are being considered for future expansion along the Boise Front. These include Camelback Park as well as other public and private properties that may be considered promising sites.

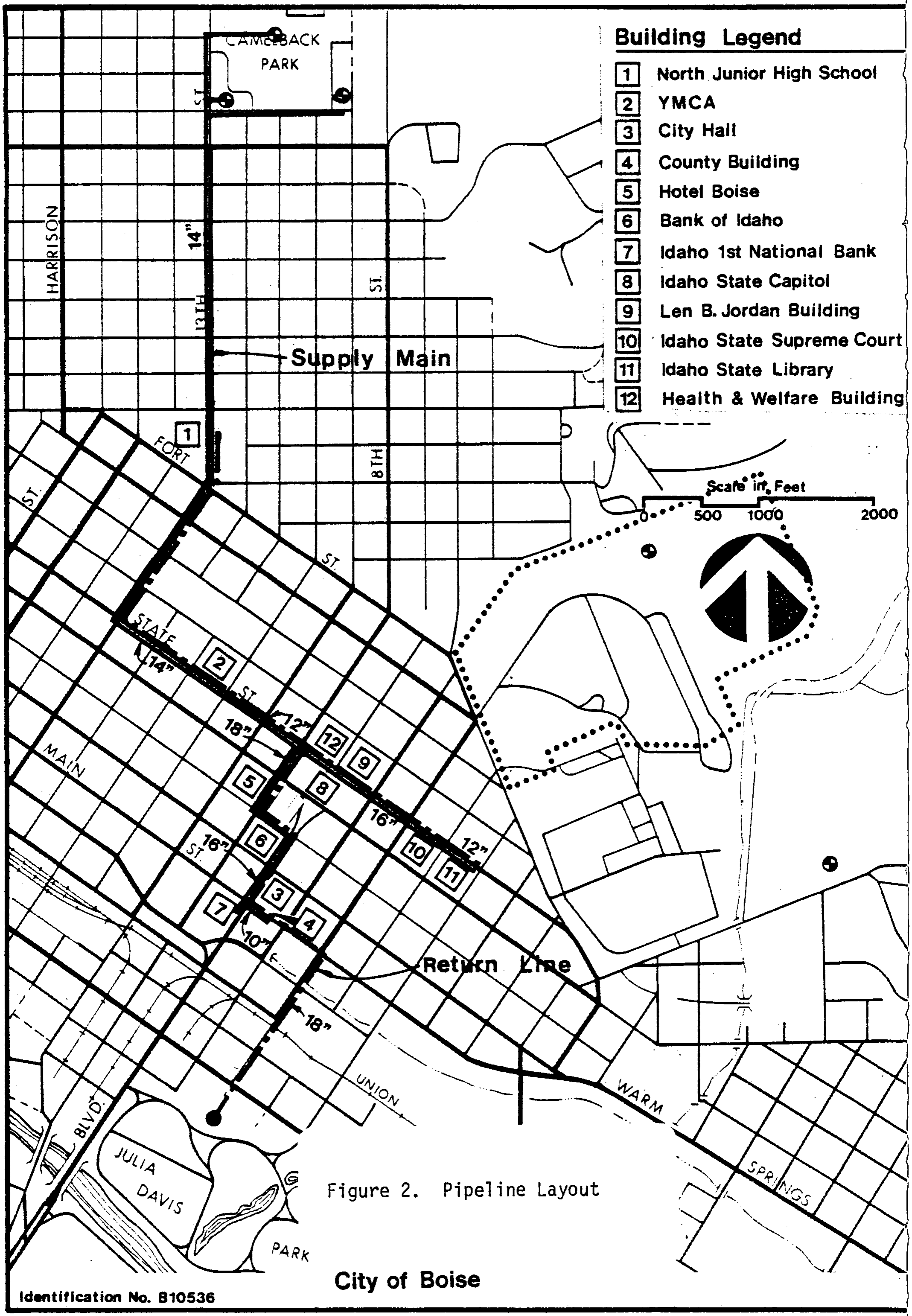

Figure 2. Pipeline Layout

Geothermal drilling experience along the Boise Front would suggest that the geothermal wells can be developed at a depth of approximately 1,200 feet. In order to achieve the planned production rate of 1,000 gallons per minute (gpm) per well, the well casing will be approximately 14 inches in diameter. The drilling of the geothermal wells would be performed in strict accordance with the guidelines and regulations of the State of Idaho Department of Water Resources. This includes the disposal of cutting fluids, providing proper seals, logging geologic data, and recording test procedures.

4. Pumps

The geothermal well pumps will be continuous duty vertical turbine types suitable for pumping 170°F geothermal waters. Pump bowl settings are assumed to be 400 feet. Pumps will be sized to deliver 50 pounds per square inch (psi) of line pressure or a total dynamic head of approximately 515 feet. Pump bowl settings and actual flow rates of the pump cannot be determined until after the well tests have been performed. A flow rate of 1,000 gallons per minute (gpm) for each well was assumed. Based on this assumption, the pump brake horsepower (hp) will be 185 hp with a pumping efficiency of approximately 70 percent. One or more of the geothermal well pumps will need to be equipped with variable speed drives so that well production can be regulated to match the system demand at any given time.

5. Pump Control

Pump control is critical. The volume and pressure of the geothermal water supply must match closely the varying demands of the system. Several measures will be incorporated to provide this control. Pump control valves will be used to eliminate pressure surges caused by the starting and stopping of the deep well geothermal pumps. These valves will be hydraulically operated so that the rate of valve operation can be adjusted to match the operation of the pump and the system. In addition, pressure and vacuum relief valves will be installed near the pumps and at system high points to vent air and gases from the supply system.

A combination of variable speed and fixed speed pumps will be utilized to match hot water production more accurately with the actual system demand. The speed of the variable speed motors will be automatically adjusted in response to system pressure and flow rates.

6. Injection Wells

The injection wells are tentatively located in the vicinity of Julia Davis Park. Actual well siting will be based on the interpretation of the Boise geological survey data. One or two wells will be required, depending upon the characteristics of the injection wells. The park location will minimize the length of return piping required, and will provide easy access to the Boise Zoo which offers a potential cascade use of the spent geothermal water in the 80° to 100°F temperature range. This relatively low temperature water could be used for slab heating of animal cages prior to deep well injection.

The final design of the injection wells would be based upon the geologic data of the specific site. For purposes of this preliminary design report, the injection wells were assumed to be approximately 1,200 feet deep and 14 inches in diameter. These assumptions were used as the basis for the injection well cost estimate. The injection wells will be designed and drilled in accordance with the Idaho Department of Water Resources rules and regulations.

The injection well pumps will be of the horizontal split-case centrifugal type. The units will be mounted at ground level in the injection pump station building. It is anticipated that the geothermal water will enter the injection well pump station at a slight positive pressure. For purposes of the preliminary design, however, it was assumed that the return water may depend upon the injection pump's suction for flow. Based upon this assumption, the pumps will be selected to overcome the full injection well back-pressure which was estimated to be 100 psi. Therefore, the injection well pumps will require 125 brake hp, with 230 feet of head capacity at 1,500 gpm.

The injection well pump control systems would consist primarily of pump start/stop functions, which would be interlocked with the supply well control systems. In addition, the injection pumps suction line will be equipped with a pressure switch to shut down the pumps on abnormally low pressure. The discharge side of the injection pumps, will be equipped with both air and vacuum relief valves.

7. Pumphouse

Pumphouses for both the supply and injection wells will be concrete block construction. Figure 3 shows a typical pump station section. The floors will be constructed of continuous, cast-in-place, reinforced concrete. Those buildings in developed park areas will be made aesthetically appealing by the addition of a brick veneer finish and landscaping. These buildings will be sized as necessary to shelter all of the equipment including pumps, motors, control valves, speed control equipment and electrical switchgear.

Normally unoccupied, the pumphouses will require minimal heat to prevent freezing of any exposed cold water piping. Thermostatically controlled unit heaters will be installed for this purpose.

Electrical power will be supplied to the buildings at 480/240/120 volts for general power, lighting, control, and the operation of repair or maintenance tools.

Potable water will be made available at each pumphouse for cleaning and maintenance purposes. Floor drains and sink drains will be connected to the nearest sanitary sewer line.

If required, pumphouses will be enclosed in a chain link fence to prevent unauthorized entry to the area. In addition, landscaping will be provided around buildings and fences in developed park areas.

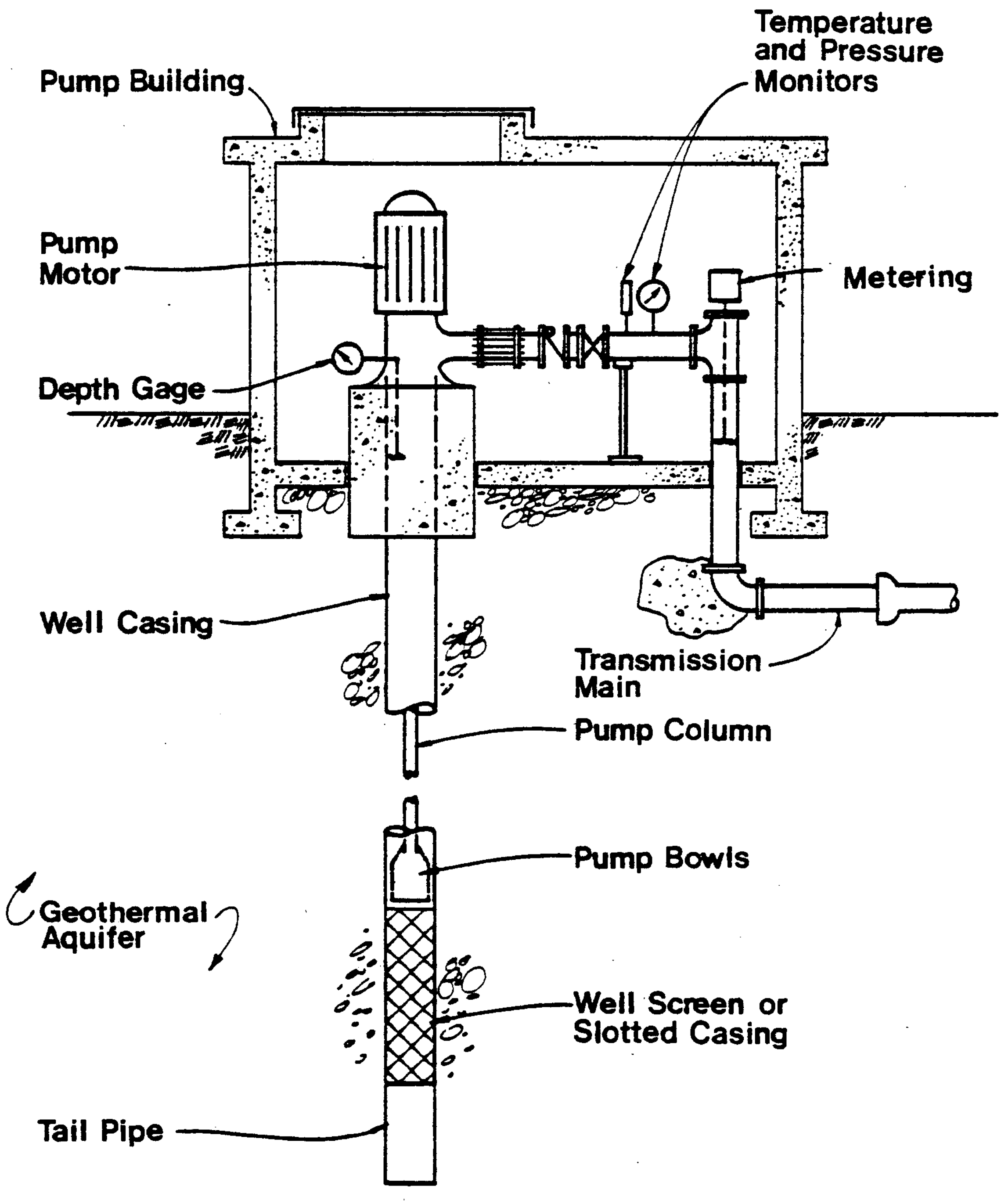

Figure 3. Typical Pump Station Section

City of Boise

8. Supply Main

The main supply line will run from the well field to all of the buildings described in Section 9, BUILDING RETROFIT. Portions of this line will be sized to allow for future expansion of the system.

The preliminary pipeline layout is based on the assumption that the wells would be established at Camelback Park because the ownership question at the Military Reserve Park has not yet been resolved.[1] Should the latter site become available to the city, minor modifications to the system layout would become necessary.

The three initial wells were assumed to have a capacity of 1,000 gpm each. Lines from the individual wells were sized at eight inches. Transmission mains carrying water from all three wells were sized at 14 inches in diameter to carry a peak flow of about 3,000 gpm. The 14-inch diameter line runs from the intersection of 13th and Heron Streets south on 13th to State Street, then turns east on State to 8th Street (see Figure 2). Along this route, service connections will be provided for both North Junior High School and the YMCA.

The proposed line would then continue along State Street from 8th to 3rd Streets. This section of pipeline is tentatively sized at 16 inches for a maximum flow of 4,000 gpm in anticipation of additional geothermal water from wells on the Military Reserve being tied in later. Service connections would be provided in this section to serve five state buildings including: the Capitol, Health and Welfare, Len B. Jordan, Supreme Court, and the State Library. The line will be capped at 3rd Street.

At the State and 8th Streets intersection, another line branches off south along 8th Street to Bannock, then east on Bannock to Capitol Boulevard, then south one block on Capitol to Idaho Street. This section is sized at 18 inches to carry 5,000 gpm. It is anticipated that the largest future demands will be in the downtown area. Service connections will be provided in this section for the Hotel Boise, and the Bank of Idaho. A 16-inch diameter main will continue south on Capitol for approximately one block and be capped for future use.

A service connection would be provided for the Idaho First National Bank building. The 10-inch diameter line along Idaho Street will extend approximately 300 feet to serve the City Hall. The line will be capped at this point, with the potential of being extended down Idaho Street to supply other users or tie into the Boise Warm Springs Water District system.

The 10-inch diameter line east along Main Street will extend less than a block with the primary purpose of supplying the new Ada County building. The line will have the potential of being extended to other users in that area.

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1. The issue of ownership of subsurface rights at Military Reserve Park was settled by federal legislation giving the City of Boise those rights.

9. Collection Line

Initially the collection line will run from all of the retrofitted buildings to the common injection well which will be located near Julia Davis Park. This line will be sized conservatively to provide additional system capacity for the future (see Figure 4).

Beginning at North Junior High, a 12-inch collection line will follow the route of the supply line described in the previous section, SUPPLY MAIN. Connections along this route will be provided for North Junior High, the YMCA, Health and Welfare building, the Capitol, Len B. Jordan, the Supreme Court, and State Library, as well as a tee at the State and 8th Streets intersection.

An 18-inch line will begin at the State and 8th Streets intersection following the supply line to the Capitol Boulevard and Main Street intersection, then east along Main two blocks to 5th Street. The 18-inch line will then continue south on 5th Street into the Julia Davis Park area.

The pipeline trench will nominally be excavated to a depth of four feet, and finish grade will be established by hand. A minimum depth of six inches of pipe bedding material such as 1/4-inch minus gravel will be placed into the trench. The pipe will be laid to established grades on pipe chairs or blocks, and insulated with three inches of foamed-in-place polyurethane foam. The pipe zone material will be placed and properly tamped to minimize settlements to pavement, sidewalks, curbs, etc.

During construction, a minimum amount of trench will be open at any one time to reduce hazards and inconvenience to the general public. Each completed section of pipeline will be subjected to a hydrostatic pressure test to 150 percent of its normal operating pressure to ensure its integrity.

Isolation valves will be located in the supply main at all critical branches to allow for system maintenance and repair. The valves will be gear operated butterfly valves with valve boxes clearly marked. Valve materials will be compatible with the geothermal water.

A flowmeter will be installed in the service line for each building to determine the quantity of water used by each building. The meter will have the accuracy required for billing purposes, as determined by the utility.

Supply and return mains will be installed under streets and roadways as much as practicable. Offsets will be made to avoid interference with existing utilities (see Figure 4).

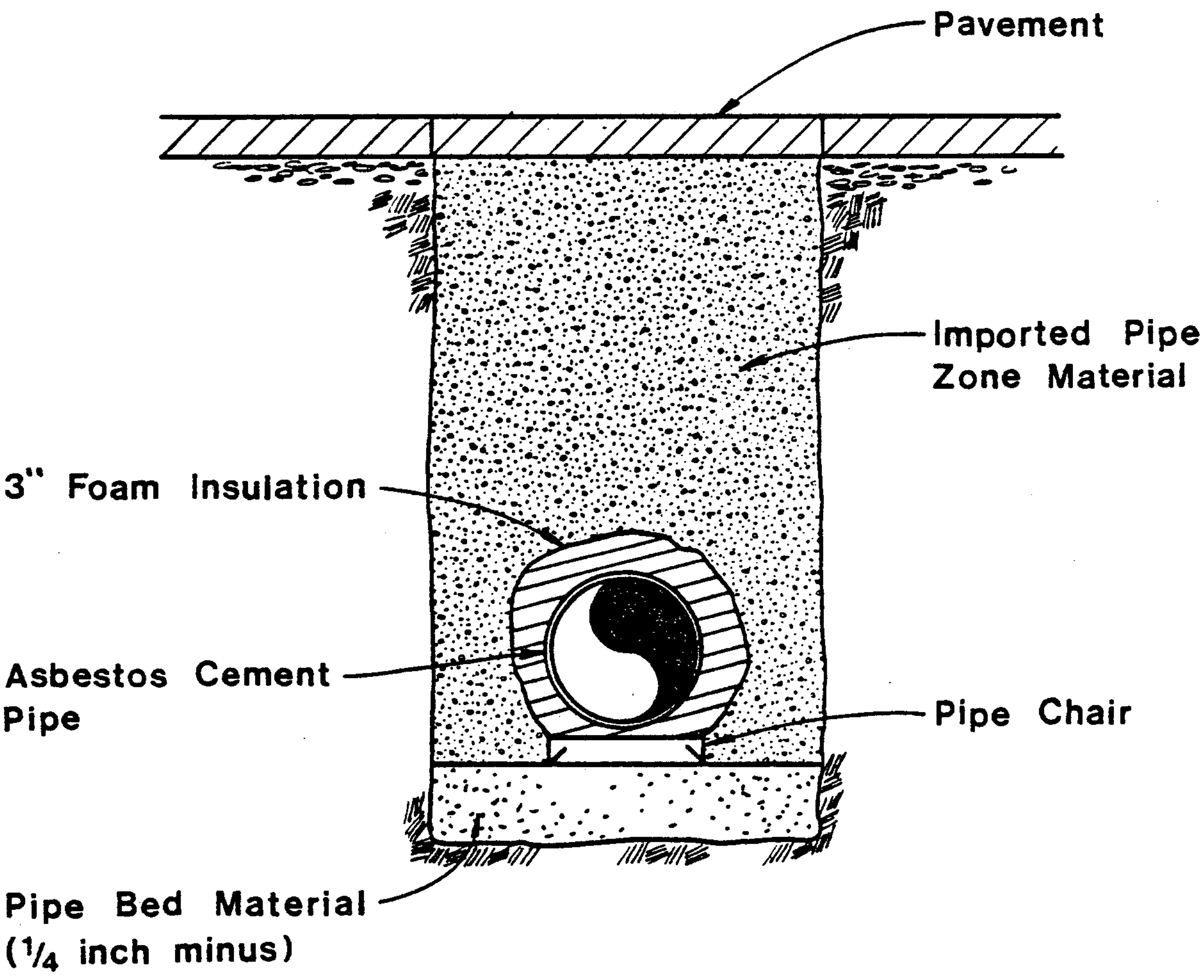

Figure 4. Supply & Collection Mains Installation Detail.

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10. Building Retrofit

The initial phase of development would involve retrofitting 12 buildings for use of geothermal water. Each of the buildings are located in the central part of Boise. Figure 2 identifies the buildings and their locations. The retrofit for each building heating system will have some common elements with other retrofit systems. These would include pumping geothermal water, control valves, metering, and instrumentation.

Each building will have a geothermal circulation pump to boost the pressure through a heat exchanger and associated piping which is mated to the building's existing heating system. The geothermal water will be pumped through the heat exchanger, control valves, etc. and then the spent geothermal water will be discharged to a collection line to be reused or reinjected in the aquifer.

Each major piece of equipment, including pumps, heat exchangers, and hot water coils, will have isolation valves and balancing valves where necessary.

All heat exchangers and steam coils will be designed so the existing heating system can function independently, or as a backup for the new system if required. The new system would have similar capabilities so that it could also function independently.

11. Building Inventory

A number of buildings in Boise were examined as candidates for using geothermal water for space heating in the initial phase of development. The field was narrowed to 12 buildings. The remainder will be considered for retrofit as the system is expanded. The inventory consisted of examining a number of features unique to the building such as; building age, floor space, type of use, type of heating system, and ease of conversion. The basic features and characteristics of each building are presented in Table 4

12. Conversion

Each of the buildings have been investigated to determine the best method of converting the existing system to geothermal heat. For each of the 12 buildings the requirements for conversion are discussed below. Typical retrofit schematics are attached as Appendix F.

a. Boise City Hall

The primary heating system for this building is a 12,600 cubic feet per minute (cfm) multizone air-handling unit which utilizes hot water coils for heating. Water at 180°F is generated by an electric boiler and circulated to the hot water coils. Electric duct reheaters are used on some upper floor zones.

Table 4. Building Features

Building	Age (years)	Floor Space (sq ft)	Type of Use	Type of Heating	Ease of Conversion
1. Boise City Hall	2	80,000	Office	12,600 cu ft/min multizone air handling unit - utilizing hot water coils for heating	Adequate space exists for conversion
2. Ada County Building	Under Construction	86,000	Office	Multizone air handler unit with hot water coils and reheaters on first and fourth floors	Adequate space exists for conversion
3. North Junior High	42	17,700 (new addition only)	Education facility	The new addition is heated by a multizone air handler with hot water coils and hot water unit heaters	The original portion of the buildings are not being considered for conversion at this time
4. Boise YMCA	8	36,800	Recreation facility	Major portion of building is heated by a low pressure steam utilizing steam unit heater and air handlers. 7,300 sq ft are heated by hot water	The steam heated portion of the building is not feasible to retrofit at this time
5. Hotel Boise	48	98,000	Office	Hydronic heat pump system with small heat pump units on each floor	Central water loop can be retrofitted to geothermal
6. Idaho First	New	280,000	Office	Space heating is offered by two hot water heating systems. One is a hot water system, the other a tempered water system	Cost of converting the hot water system (30 percent) of the heat load) cannot be economically justified at this time
7. Bank of Idaho	15	100,000	Office	A multizone air system with hot and cold decks supplies 60 percent of heat load. 40 percent of heat load is supplied by three independent loops of hot water circulating three fan coil units and natural air convectors	Adequate space available for conversion. Geothermal booster pumps required in basement.

(more)

Table 4. Building Features (cont'd)

Building	Age (years)	Floor Space (sq ft)	Type of Work	Type of Heating	EasE of Conversion
8. Idaho State Capitol	58	128,000 *	Office	The building is heated by a fan coil unit. Steam to water converters produce 180° water which circulates throughout the building	Present mechanical room houses hot water converters. Adequate space available.
9. Len B. Jordan	8	97,000	Office	The building utilizes two multizone air handling units. One smaller unit is used for the emergency operation center	Adequate space is available for conversion
10. Idaho Supreme Court	4	65,000	Office	Heating is accomplished by a larger air handler. A small multizone unit supplies heat to the courtrooms and judges' chambers. Heat is provided by pressure steam coils	Adequate space is available for conversion
11. Idaho State Library	3	30,000	Library, and archives	Heat is provided by a multizone air handler, supplied by steam coils	Adequate space is available for conversion
12. Idaho Health and Welfare Building	4		Office	Heat is provided by a single forced air multizone unit for the building perimeter, and with electrical energy for the building interior. Heat is supplied by steam coils	Adequate space for conversion is uncertain

* Exclusive of rotunda, stairways, and corridors

Conversion will require installation of a plate heat exchanger and geothermal circulation pump in the basement mechanical room near the present boiler. Adequate space exists for the additional equipment. A three-way mixing valve will divert the flow through the boiler as additional heating is needed in response to the temperature of the recirculating water leaving the new heat exchanger. Flowmeters will be installed on both the geothermal and recirculating loops to monitor system performance.

Hot water design loads total 950,660 Btu/hr at flows of 94 gpm. The new plate type heat exchanger would be sized to supply this entire load, using a geothermal flow rate of 96 gpm and a 20°F temperature drop. To accommodate the lower temperature geothermal energy, the present system operating temperature will be lowered to 155°F.

b. Ada County Administration Building

The primary heating system will be a multizone air handling unit utilizing hot water coils, with reheaters on the first and fourth floors. Hot water will be supplied by an electric boiler and will circulate through three heating coils in the 13,000 cfm central air handler and through the reheat units.

Conversion to geothermal energy will require installation of a plate heat exchanger and geothermal circulation pump in the mechanical room. Adequate space exists for this purpose in the building mechanical room. A three-way mixing valve will divert the recirculating heating water through the boiler if more heat is needed. The mixing valve will be controlled by the temperature of recirculating water leaving the new heat exchanger. Flowmeters will be provided on both the geothermal and recirculating lines to monitor system performance.

Hot water loads for the multizone unit and reheaters totaled 1.04 million Btu/hr, with recirculation flows of 104 gpm.

The plate heat exchanger would be sized to supply the entire heating load with a geothermal flow rate of 72 gpm and a temperature drop of 29°F.

c. North Junior High School

The original portions of the building are heated by steam convectors and radiators, and have not been considered here for conversion to geothermal heating. The new addition is heated by a multizone air handler with hot water coils. In addition, there are several hot water unit heaters in the industrial arts area. The circulating water loop is heated by a steam-to-water converter. The steam is generated by natural gas boilers in the mechanical room.

Conversion will require installation of a plate heat exchanger and geothermal circulation pump in the mechanical room. A three-way mixing valve will divert the recirculating flow through the existing converter if more heat is needed. The existing steam control valve will regulate steam flow through the existing converter. The valves will be controlled by the temperature of recirculating water leaving the new heat exchanger. Flowmeters will be installed on both geothermal and recirculating lines for data collection. There is space available either near the existing converter and recirculating pump, or in the main area of the mechanical room.

The total hot water load based on the original design was 2.42 million Btu/hr with recirculating flow of 231 gpm. The plate heat exchanger will be sized for this heat load with a geothermal flow of 123 gpm. Major modifications are needed to the industrial arts heating system. Exhaust fans installed later in the industrial arts area are operated during the day, and significantly increase the heat load. Present unit heater capacity is not adequate to maintain room temperatures and on some occasions room temperature has dropped to 40°F. It is suggested that the heating system for the industrial arts area be modified to solve this problem.

d. Boise YMCA

Approximately 7,300 sq ft of the 37,000 sq ft building is heated by hot water. The remainder of the building is heated by a low pressure steam system. At this time it is not considered feasible to retrofit the steam heated portion.

The hot water for the existing heating system on the first floor is supplied by a steam-to-water converter in the mechanical room, and circulated through air-water convectors. The air conditioning system is a two-pipe system connected to a chiller unit, which supplies cooling during the summer. The two swimming pools in the building and domestic water are heated by a steam-water converter.

The office areas, pools and domestic hot water can be converted to geothermal energy heat by the addition of four plate heat exchangers and recirculation pumps in the basement mechanical room. Floor space is somewhat limited in the mechanical room.

From the main, geothermal water will be circulated through the plate heat exchanger serving the office area and domestic hot water systems. The geothermal flow through each of these exchangers will be regulated by a control valve to maintain the temperature of either the recirculating heating water or the domestic hot water. The outlet geothermal water from these two exchangers will be mixed together and then piped to the two new pool heat exchangers.

The geothermal water flow through each pool heat exchanger will be regulated by a control valve to maintain the main pool or diving pool temperature. In the event the pool heating load cannot be met by the cascaded water from the domestic hot water and space heating, additional 170°F geothermal water can be mixed with the cascaded water to supply the necessary temperatures for the pools. If more water is being rejected from the first two heat exchangers than is required by the two pools for heating, a control valve will bypass the two pool heat exchangers allowing excess water to pass directly to the geothermal return main. This control valve will operate in response to back pressure on the two pool exchangers.

Flowmeters will be installed on geothermal and recirculating water lines of each heat exchanger to permit performance evaluation.

The heating system steam-to-water converter appears oversized at 1.5 million Btu/hr with 157 gpm. Total capacities and flows of the individual heating units is 845,000 Btu/hr at 85 gpm. The new heat exchanger would be sized to supply one million Btu/hr at 98 gpm. This results in a geothermal flow rate of 70 gpm with a temperature drop of 28°F. The domestic hot water system was designed to supply 4.67 million Btu/hr to 67 gpm, raising the temperature from 40° to 180°F. The geothermal domestic hot water system will provide 67 gpm heated from 50° to 155°F. The domestic water heating load was reduced to 3.5 million Btu/hr with a maximum temperature of 155°F. To supply the modified domestic water heat load, a geothermal flow of 200 gpm is required, with a temperature drop of 35°F.

The main pool was designed with a 1.68 million Btu/hr load at 225 gpm. To maintain the present pool temperatures, a geothermal flow of 63 gpm with a temperature drop of 61°F should be adequate. The diving pool has a design heating load of 1.15 million Btu/hr and a flow of 153 gpm. The calculated geothermal flow required is 42 gpm with a temperature drop of 61°F.

e. Hotel Boise

The Hotel Boise is currently undergoing major remodeling, including a new heating system and addition of a penthouse above the top floor. The new heating system is a hydronic heat pump system with small heat pump units located on each floor. Water is circulated through these units and a large shell and tube heat exchanger. Heat is supplied to the existing heat exchanger by low pressure steam generated in a boiler in the basement mechanical room. Maximum design water temperature in this system is to be 90°F.

Conversion will require installation of a plate heat exchanger and geothermal circulation pump in the mechanical room. Adequate space for equipment installation is available, but future use of the mechanical room is somewhat uncertain.

An existing steam control valve will regulate steam flow to the existing heat exchanger when system load demands exceed the capacity of the new plate exchanger. Flowmeters will be provided on both the geothermal and the recirculating system for data collection purposes.

The plate heat exchanger was sized at 1.5 million Btu/hr. Flow through the secondary heating loop will be 540 gpm; to accommodate the large flow, the heat exchanger would be oversized. The system will require a geothermal capacity of 76 gpm with a temperature drop of 40°F. Additional building heat requirements will be supplied by the heat pumps.

f. Idaho First National Bank

The building space heating is provided by two separate hot water heating systems. Hot water, supplied by natural gas boilers in the 19th floor mechanical room is piped to heating coils in the main building air handler on the same floor. The water is piped to the basement parking levels for use in several unit heaters and a hot water coil unit. A second system utilizes tempered water for heating through baseboard fin tube units on the first through 18th floors. The tempered water is also used in the fire sprinkler system. It is heated by direct mixing with hot heating water, and by heat reclaimed from the chiller condenser unit on the 19th floor. The tempered water supplies 70 percent of the total building heat load.

The major energy savings will be realized by the conversion of the tempered water system to geothermal heat. Costs will be minimal and the majority of the heat load will be met. Cost for converting the hot water system (30 percent heat load) is considerably higher, and cannot be justified economically at this time.

A plate heat exchanger and pump will be installed in the fire storage tank room on the intermediate basement level where space is available. The exchanger will be tied into the existing tempered water system. The existing control valves for mixing hot heating water and tempered water will be reset to allow the geothermal heat exchanger to provide the load. A bypass will be provided around the new heat exchanger, and tempered water flow through this line will be controlled by a manually operated valve. Under ordinary operating conditions this valve will be closed. Flowmeters will be installed in both the tempered water flow and the geothermal flow to facilitate data collection on the geothermal system.

Sizing of the new heat exchanger will be based on the manufacturer's specifications of the fin tube heaters and available design information. The estimated fin tube heat load is 7.6 million Btu/hr. Of this, 1.68 million Btu/hr will be supplied by reclaiming the condenser heat rejected by the chiller unit. The total tempered water flow is 380 gpm. The remaining 5.93 million Btu/hr of heating load will be supplied by 310 gpm of geothermal water with a temperature drop of 39°F.

g. Bank of Idaho Building

The heating system is comprised of two systems. A multizone air handling system with hot and cold decks supplies about 60 percent of the heating load. Ventilation air is heated by an air intake preheat coil and reheated by the hot deck heating coil. All coils use steam, which is generated by two natural gas-fired boilers. The remaining 40 percent of the heating load is supplied by three independent loops of hot water circulating through fan coil units and natural air convectors. Water is heated by steam-to-water converters and pumped from the mechanical room to the heating zones.

Conversion of the building will involve installation of three new heat exchangers on the 13th floor, and new hot water coils in the preheat coil area and the main air handler. Space is available in the mechanical room. Fan speeds and motor sizes will have to be adjusted to compensate for the additional pressure drops introduced by the new geothermal coils.

The geothermal pumps will be located on the ground floor in the pump room. Valving will be provided to prevent the returning geothermal water from pulling a vacuum at the top of the column of water. The flow rate of the recirculated water will be regulated through the two existing converters by three-way valves whenever the demand for heat exceeds the capacity of the heat exchangers.

Steam control valves will regulate steam flow through the converters. Both valves will be controlled by the temperature of recirculating water leaving the new heat exchanger. New steam control valves will be installed on the existing steam coils and will be controlled by the downstream air temperatures.

A geothermal bypass will be provided around the new geothermal preheat coils, and around the new geothermal air handler coils. Automatic control valving for each bypass will prevent excess water pressure from building up in the system. Under normal operating conditions the control valves will be closed. Flowmeters will be installed in geothermal lines to each heat exchanger and coil, and in each of the recirculating heating loops to provide information on the geothermal system.

Heat exchangers and coils were sized according to the available design data. Zone 1 was designed for 1.5 million Btu/hr with a flow of 148 gpm. The geothermal flow will be 74 gpm with a temperature drop of 40°F. Zone 2 was designed for 850,000 Btu/hr with a flow of 85 gpm. Geothermal flow in this exchanger will be 43 gpm with a temperature drop of 40°F. The third zone has a load of 250,000 Btu/hr and a flow of 25 gpm. Geothermal flow for this loop will be 13 gpm with a temperature drop of 39°F. The preheat coil was designed to supply 470,000 Btu/hr. A similar size hot water coil supplying 475,600 Btu/hr will require a geothermal flow of 15 gpm with a temperature drop of 64°F. The main coil was designed to supply 2.7 million Btu/hr. A similar sized hot water coil supplying 2.72 million Btu/hr will require 200 gpm of geothermal water with a temperature drop of 27°F.

h. Idaho State Capitol[1]

The Idaho State Capitol is primarily heated by fan coil units. One hundred psi steam generated at the Capitol Mall central plant is piped to the main mechanical room of the capitol. Steam-to-water converters produce 180°F water which is circulated throughout the building. Provisions now exist for the addition of a second heat exchanger in the capitol's mechanical room.

Conversion to geothermal energy will require installation of a plate heat exchanger and a geothermal circulation pump in the mechanical room. The flow of geothermal water will be controlled by a pneumatic control valve which responds to the space heating water temperature. The existing steam control valve will regulate steam flow through the existing converter. As the demand for heat exceeds the capacity of the geothermal system, the steam valve will open.

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[1]Donovan, L.E.; Richardson, A.S. "Feasibility/Conceptual Design Study for Boise Geothermal Space Heating Demonstration Project Building Modifications," Aeroject Nuclear Co. for ERDA, Contract No. E(10-1)-2375; September 1975.

This report suggests the use of geothermal water directly on coils. This approach will be analyzed during the final design phase.

The geothermal system will be such that it can be bypassed if necessary. Flowmeters will be installed in the geothermal and recirculating flows to provide data on the geothermal system performance.

Sizing of the new exchanger was done in a 1975 study.[1] Results of the study indicate 227 gpm geothermal flow with a 20 °F temperature drop to supply the 2.25 million Btu/hr building design load.

i. Len B. Jordan Building[1]

The heating system in the Len B. Jordan building utilizes two multizone air handling units for most of the building's 97,000 square feet. One smaller unit is used for the Emergency Operation Center area. Heating is accomplished with steam coils and cooling by chilled water coils.

Conversion will require installation of hot water coils in each of the three units. Space is available in all of the units for hot water coils supplying the same heating capacity as the existing steam coils. Fan speeds and motor sizes will be adjusted to compensate for the additional pressure drop caused by the new coils. Steam flow through the existing coils will be regulated by the downstream air temperature, using existing steam control valves or new valves if necessary. A single bypass for geothermal flow around all three units will be provided with automatic control valving to prevent excessive pressure buildup in the system. This valve will be closed under normal operating conditions. A flowmeter will be installed in the geothermal line to provide operational data on the geothermal system.

Sizing of the hot water coils would be based on the heating capacity of the existing steam coils. The two large units have air flow capacities of 51,700 cfm and will require two coils in each unit, each coil with a heating capacity of 1.3 million Btu/hr and a flow of 52 gpm. The small unit supplies 12,000 cfm and requires a single hot water coil to supply 1.17 million Btu/hr at flows of 46.7 gpm of geothermal water.

j. Idaho Supreme Court[1]

Currently, heating of the Supreme Court building is accomplished with a large air handler located in the basement, which supplies most of the 65,000 sq ft of the building, and a small package multizone unit in the penthouse, supplying the courtrooms and judges' chambers. Heat is provided by high pressure steam coils in both units. The steam and chilled water is supplied from the central plant.

Conversion will be accomplished by the installation of geothermal water coils in the air handling units. Space is available for the new coils, although extensive sheet metalwork will be necessary for the smaller penthouse unit. Fan speeds and motor sizes will be adjusted to compensate for the additional pressure drop caused by the new coils. Steam flow through the existing coils will be regulated according to the downstream air temperature, using either existing steam control valves or new valves if necessary. A single bypass for geothermal flow around both units will be provided with automatic control valving to prevent excessive pressure buildups in the system. A single flowmeter will be installed in the primary geothermal flow to provide data on the system.

Sizing of the new hot water coils would be based on the heating capacity of the existing steam coils. The large unit has an air flow capacity of 63,600 cfm and requires four geothermal water coils, each with a heating capacity of 744,000 Btu/hr and a geothermal flow of 30 gpm. The smaller unit delivers 15,000 cfm and requires a single geothermal water coil with a heating capacity of 744,000 Btu/hr and a geothermal flow of 30 gpm.

k. Idaho State Library

The State Library is heated by a multizone air handler having hot and cold decks serving the total 30,000 sq ft building. Heat is supplied by steam coils, and cooling by chilled water coils.

Conversion will require installation of geothermal water heating coils in the central air handler. Space is available for installation. Fan speeds will be increased to compensate for the added pressure drop, and a new fan motor will be required for the necessary speed increase. Steam flow through the existing coils will be regulated according to the downstream air temperature, using the existing steam control valves. A geothermal bypass around the coil will be provided with automatic control valves to prevent excessive pressure buildups in the system. A single flowmeter will be installed in the primary geothermal flow to provide data on the geothermal system through the year.

Sizing of the new hot water coils would be based on the heating capacity of the existing steam coils. Two hot water coils will be required in the 32,600 cfm air handler. Each coil will provide 1.28 million Btu/hr with a geothermal flow of 85 gpm.

l. Idaho Health and Welfare Building

The Health and Welfare building is heated by a single forced air multizone unit for the building perimeter, and with electrical energy for the building interior. Heating is supplied by steam coils and cooling by chilled water coils.

Conversion will require installation of hot water coils in the air handler. Space availability should be verified by a field inspection. Fan speeds will be adjusted to compensate for added pressure drops due to the new coils. Steam flow through the existing coils will be regulated according to downstream air temperature, using either existing steam control valves or new valves if necessary. A single bypass around the unit will be provided with automatic control valving to prevent excessive pressure buildups in the geothermal system. This valve will be closed under normal operating conditions. A single flowmeter installed in the primary geothermal flow will provide data on the system.

Sizing of the new hot water coils would be based on the heating capacity of the steam coils. Three hot water coils will be required, each having a capacity of 600,000 Btu/hr at 40 gpm geothermal water flow. This assumes a 30°F temperature drop.

13. Cost Summary

The cost summary is a preliminary estimate for the geothermal system design and construction described in the report. Included are the initial geological exploration to select the well locations, well drilling, and pump station costs, and retrofit costs for the initial 12 buildings. (Table 5)

Costs have been adjusted for inflation to the dates when they will be incurred, as shown in the Time and Construction Schedule. Background assumptions and data for these figures are given in Appendix G.

14. Time and Construction Schedule

The project described in this document would encompass nearly four years, 1979 through 1982. The following bar chart graphically represents the time schedule for the various activities (Figure 9). The schedule represents an estimate of the time required to complete certain tasks and is subject to change as the project proceeds. As changes become necessary, the effect on subsequent tasks will be reflected.

B. Potential for Cascade System

A major national concern is the availability of energy to supply industrial, commercial and residential needs. Inherent in this concern, should be the desire to utilize the energy resources presently available in the most conservative manner possible. Boise City has completed a preliminary plan[1] to develop a geothermal space heating system for some buildings in the city. This plan primarily addresses the utilization and disposition of geothermal water for direct heating of residential and commercial buildings. After heating these buildings, the geothermal water can be used again in other types of systems. Such cascade systems (Figure 10) complement the proposed space heating systems, and extract the maximum useful energy from geothermal resources.

This report is an engineering analysis of several systems for implementing cascade use of geothermal resources relative to the proposed geothermal space heating project proposed for Boise City.

1. Resource Availability

In design, the conservation of an energy resource is achieved by matching the demand temperature with the resource temperature. For example, it is more conservative to heat a building to 70°F with an energy resource which

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1. "Preliminary Boise Geothermal Energy Systems Plan", City of Boise, Fnergy Office. April 1977

Table 5. Cost Summary

Item	Amount
Geological Exploration	
Boise Geological Survey	$80,000
Data Analysis	5,000
	$85,000

	Supply Wells			Injection Wells
	1	2	3	1 and 2
Supply and Injection Wells				
Design Well	$ 5,000	$ 5,000	$ 5,000	$ 10,000
Contract with Driller	2,000	2,000	2,000	4,000
Drill Well	123,000	131,000	135,000	276,000
Well Test and Analysis	5,000	5,000	3,000	10,000
Design Pump Station	12,000	12,000	12,000	16,000
Equipment	85,000	93,000	95,000	130,000
Construct Pump Station	24,000	27,000	28,000	60,000
Pump Station Start-Up and Tests	3,000	3,000	3,000	6,000
Project Management @ 15 percent	39,000	42,000	42,000	77,000
Inspection @ 2 percent	5,000	7,500	7,500	15,000
TOTALS.	$303,000	$327,500	$332,500	$604,000

(more)

Table 5. Cost Summary (Cont.)

Item	Administration	Construction	Total
Pipeline			
Pipeline - Boise Well to City	$125,000	$1,782,000	$1,907,000
Pipeline - State Street from 8th to 3rd	25,000	255,000	280,000
Retrofits*			
State Capitol	7,000	55,000	62,000
Len B. Jordan Office Building	6,000	54,000	60,000
State Supreme Court	5,000	48,000	53,000
State Library	6,000	35,000	41,000
State Health and Welfare Building	6,000	35,000	41,000
Boise City Hall	6,000	46,000	52,000
Ada County Building	6,000	43,000	49,000
North Junior High School	7,000	54,000	61,000
Boise YMCA	15,000	109,000	124,000
Hotel Boise	5,000	48,000	53,000
First National Bank	15,000	75,000	90,000
Bank of Idaho	17,000	117,000	134,000

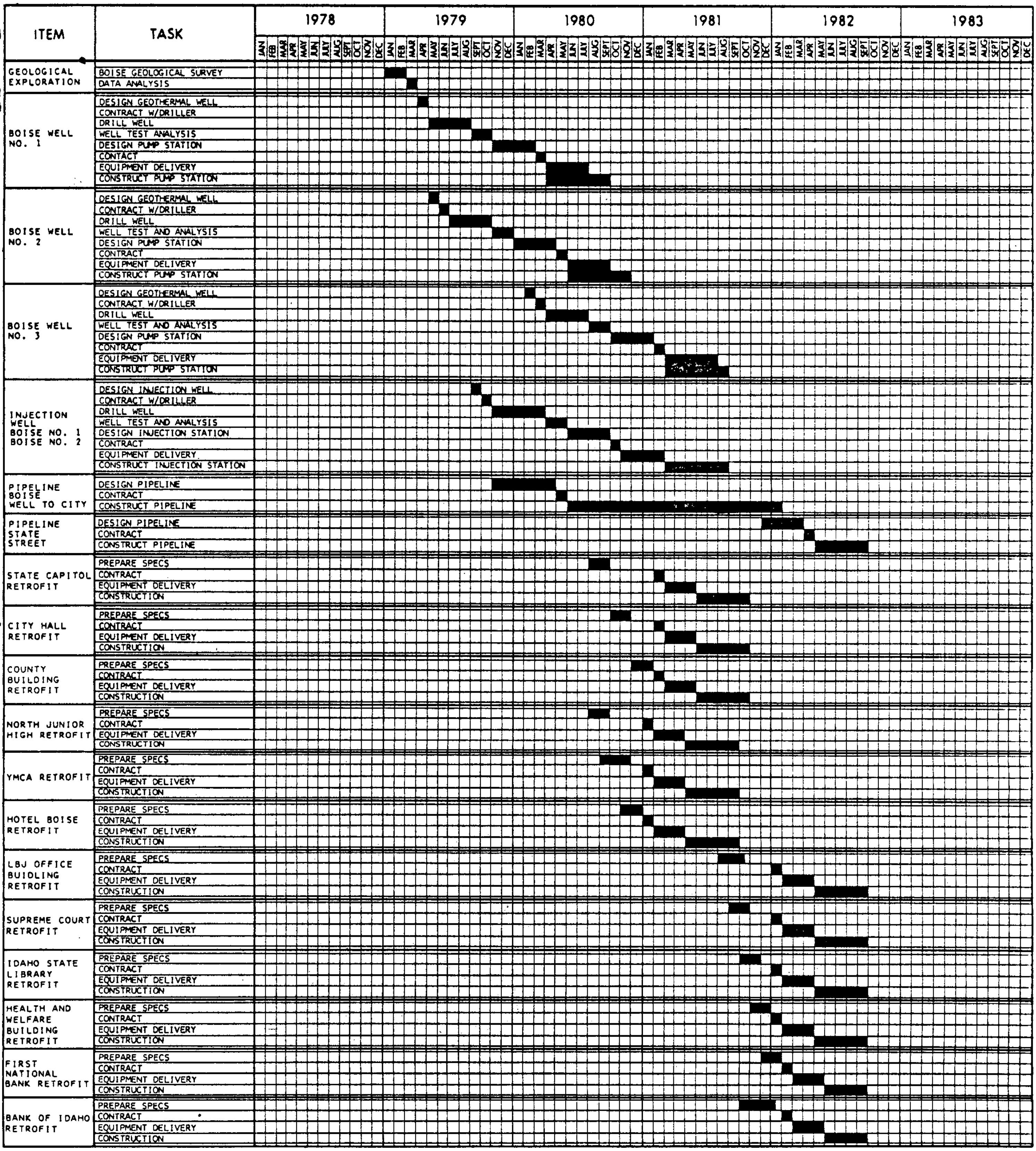
*Administration costs include project administration, engineering, drafting, documents, expenses, and contingency. Construction costs include contract, equipment and materials, and actual construction.

(more)

Table 5. Cost Summary (Cont.)

Item	Amount
Final Summary	
Geological Exploration	$ 85,000
Supply Well 1	303,000
Supply Well 2	327,500
Supply Well 3	332,500
Injection Wells - 1 and 2	604,000
Pipeline - Boise Well to City	1,907,000
Pipeline - State Street	280,000
Retrofits	
State Capitol	62,000
Len B. Jordan Office Building	60,000
State Supreme Court	53,000
State Library	41,000
State Health and Welfare Building	41,000
Boise City Hall	52,000
Ada County Building	49,000
North Junior High	61,000
Boise YMCA	124,000
Hotel Boise	53,000
First National Bank	90,000
Bank of Idaho	134,000
TOTAL COST	$4,659,000

FIGURE 5
Program Schedule
City of Boise



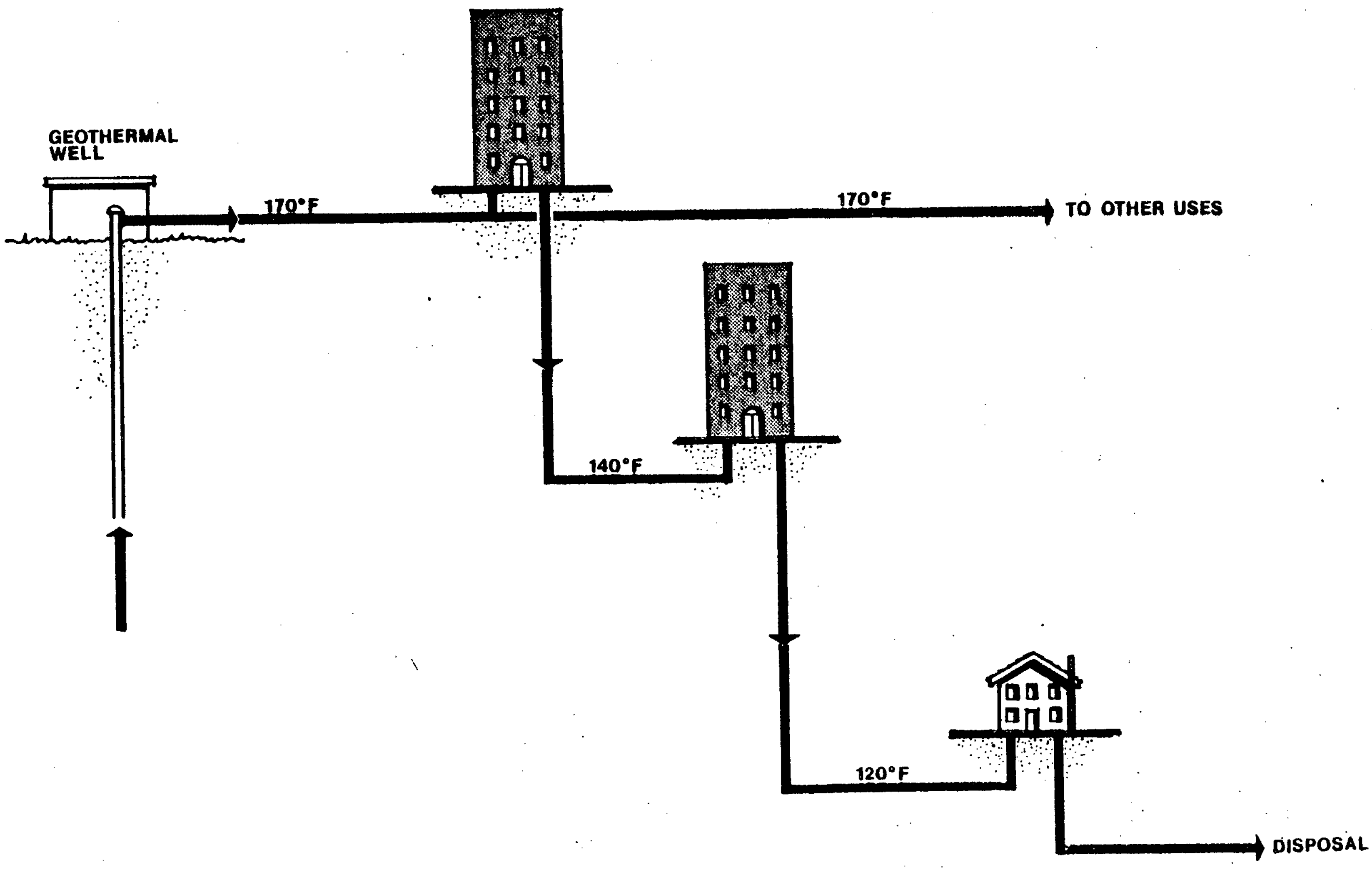


Figure 6. Cascade System

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is at 170°F than it is to heat a building with a resource at 1,000°F. The proper design of a cascade system recognizes that an optimum design matches resoruce temperatures with demand temperatures. In addition, the amount of energy available for cascade systems is an important parameter for designing such systems.

The preliminary plan for the Boise geothermal space heating system identifies 12 buildings which can be heated by geothermal water. Table 6 identifies these buildings, the maximum heating loads, and the geothermal water requirements expected at each building. The preliminary plan assumes that three geothermal wells will be drilled to provide the required 2,215 gpm at 170°F for these buildings. After heating these buildings, the temperature of the geothermal water available for cascade uses will be somewhat less than 170°F depending upon the heating demands of these 12 buildings. Figure 7 shows this temperature by month for the proposed system.

Figure 8 shows the heat available by month for utilization by the cascade systems. This figure is based upon finally disposing of the geothermal water at 100°F. If all of this heat were utilized, an energy equivalent of 119,000 barrels of oil would be saved per year.

2. Systems Analysis

a. General

This portion of the report will categorize and analyze several methods of utilizing geothermal resources in heat pumps and cascade systems. These systems can be separated into two major user groups: commercial; and residential and light commercial. This distinction is primarily due to the type of space heating system which is most economical for each group.

Several considerations are common to both user groups when interfacing new or existing space heating systems with the geothermal systems. These are temperature fluctuations, pressure fluctuations, water flow rate fluctuations, energy conversion efficiencies, and relative capital and operating expenses. These considerations will be discussed with reference to each system type.

All systems would share a common method of tapping into the geothermal system. Each connection would include a water meter for utility billing, plus a secondary pump which would be sized for the user requirements of flow and pressure. If the connections are made as shown in Figures 9 through 12, the operation of the user's pump would guarantee adequate flows and pressures within the building, while not adversely affecting the geothermal system.

Table 6.

BUILDING HEAT AND GEOTHERMAL WATER DEMANDS

Building	Peak Heat Demand Btu/hr	Geothermal Water Demand gpm
Boise City Hall	950,660	96
Ada County Administration Building	1,035,100	72
North Junior High School	2,414,700	123
YMCA	7,331,000	375
Hotel Boise	1,500,000	76
Idaho First National Bank	5,930,000	310
Bank of Idaho	5,794,300	345
State Capitol	2,250,000	227
Len B. Jordan Office Building	3,766,400	151
Supreme Court	3,720,000	150
State Library	2,550,000	170
Health and Welfare Building	1,800,000	120
TOTALS	39,042,160	2,215

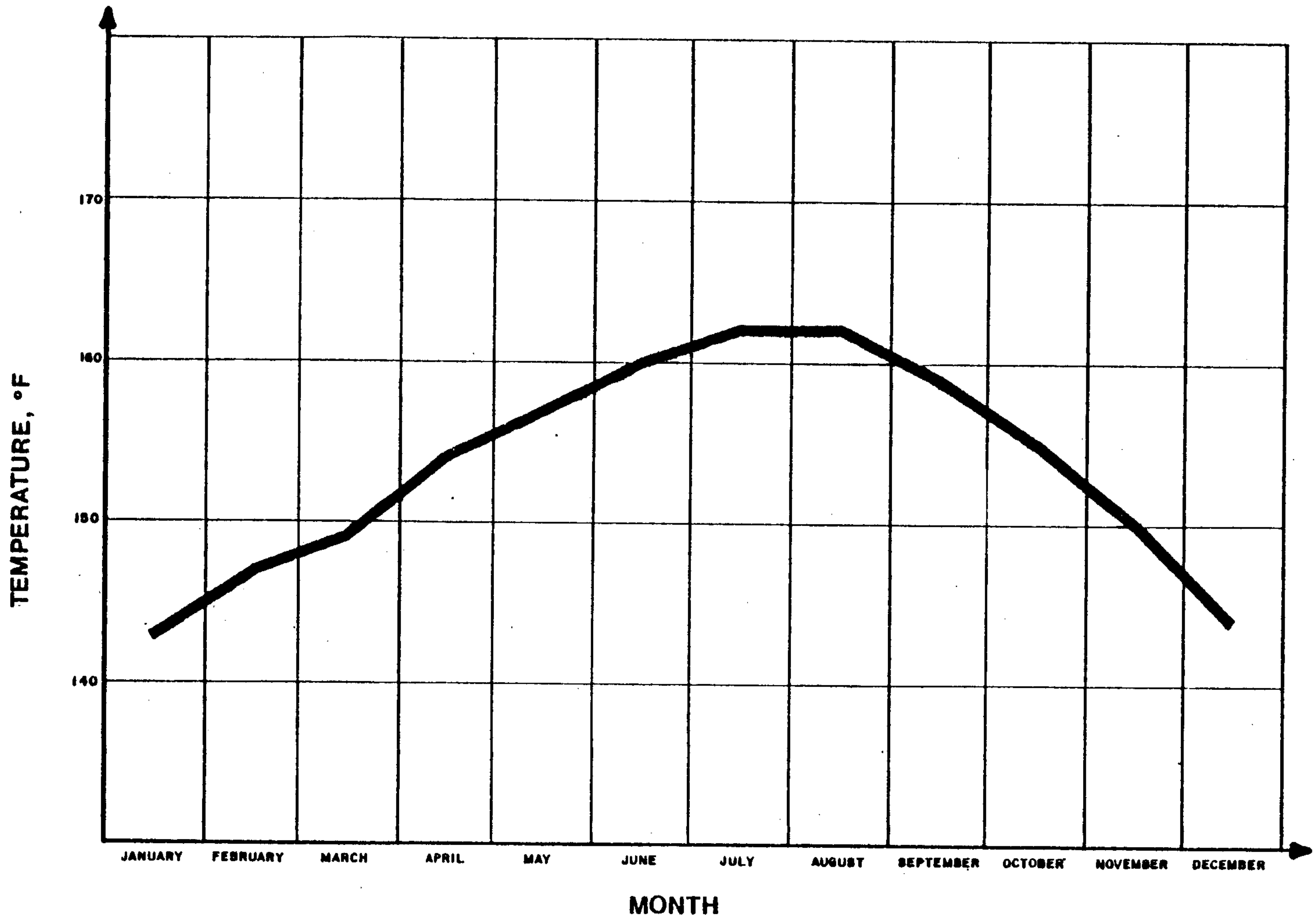

Figure 7. Geothermal Water Temperature for Cascade System

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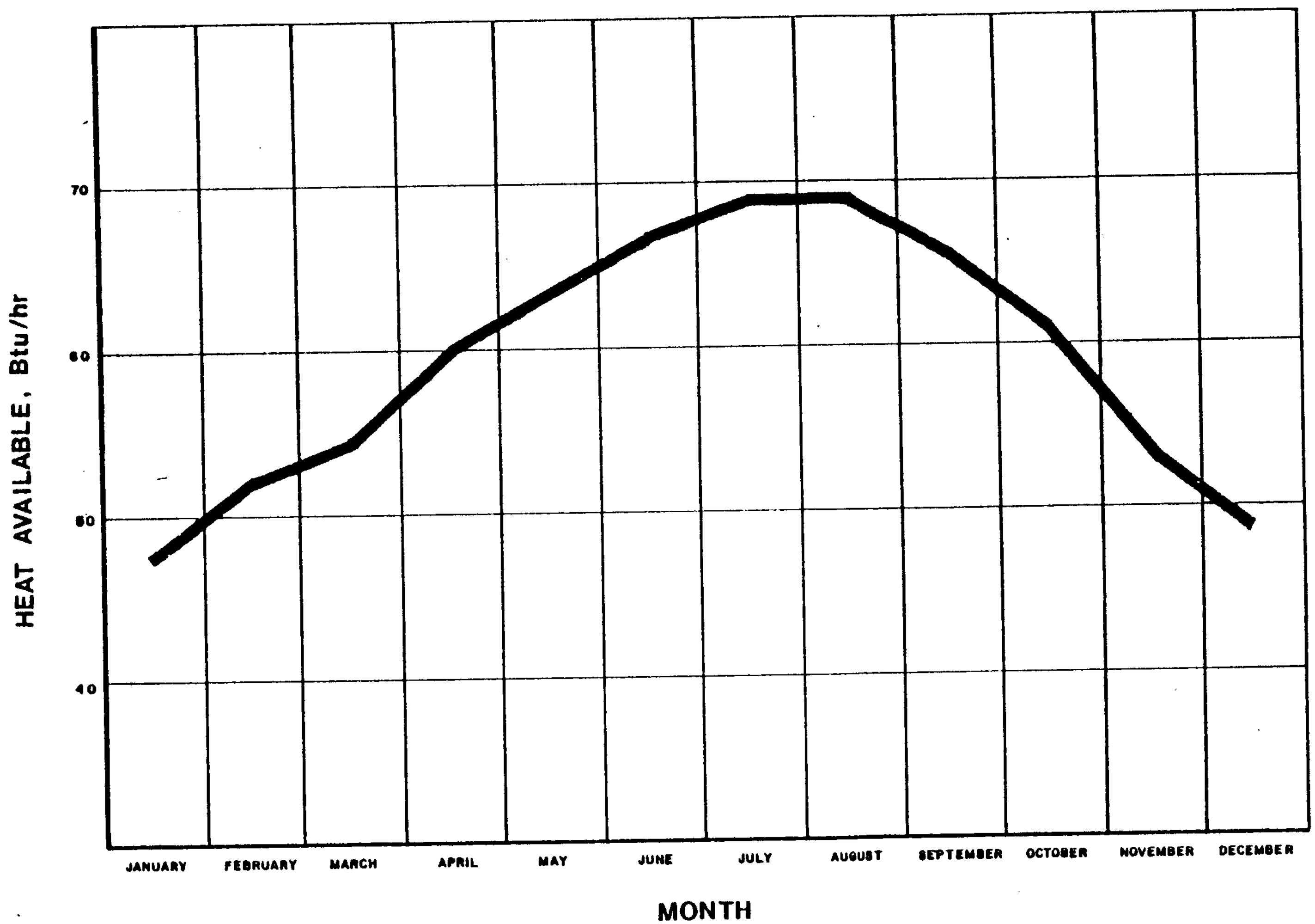

Figure 8. Heat Available for Cascade System

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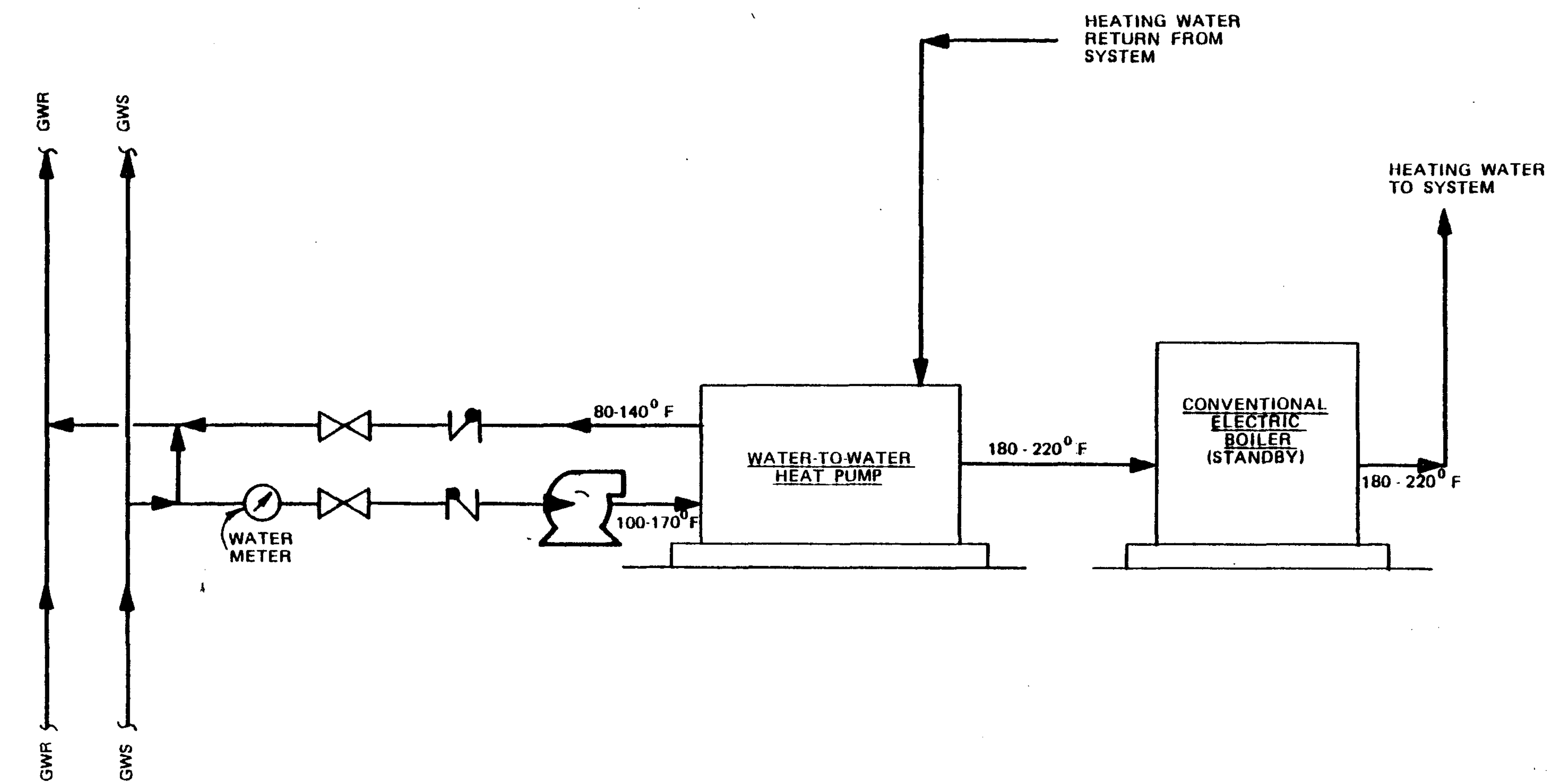

Figure 9. Electrice Boiler Replacement with Water-to-Water Heat Pump

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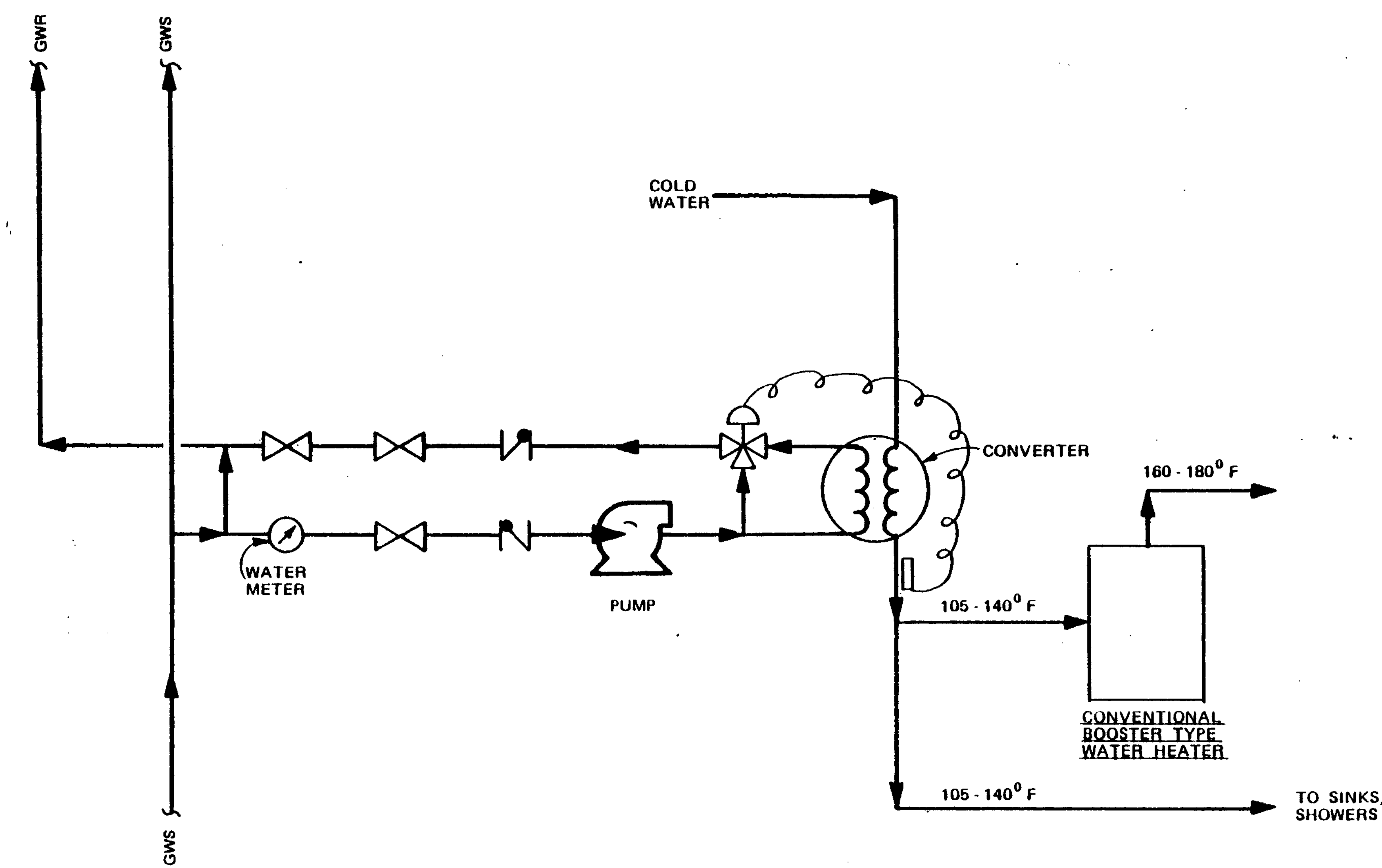

Figure 10. Domestic Water Heating

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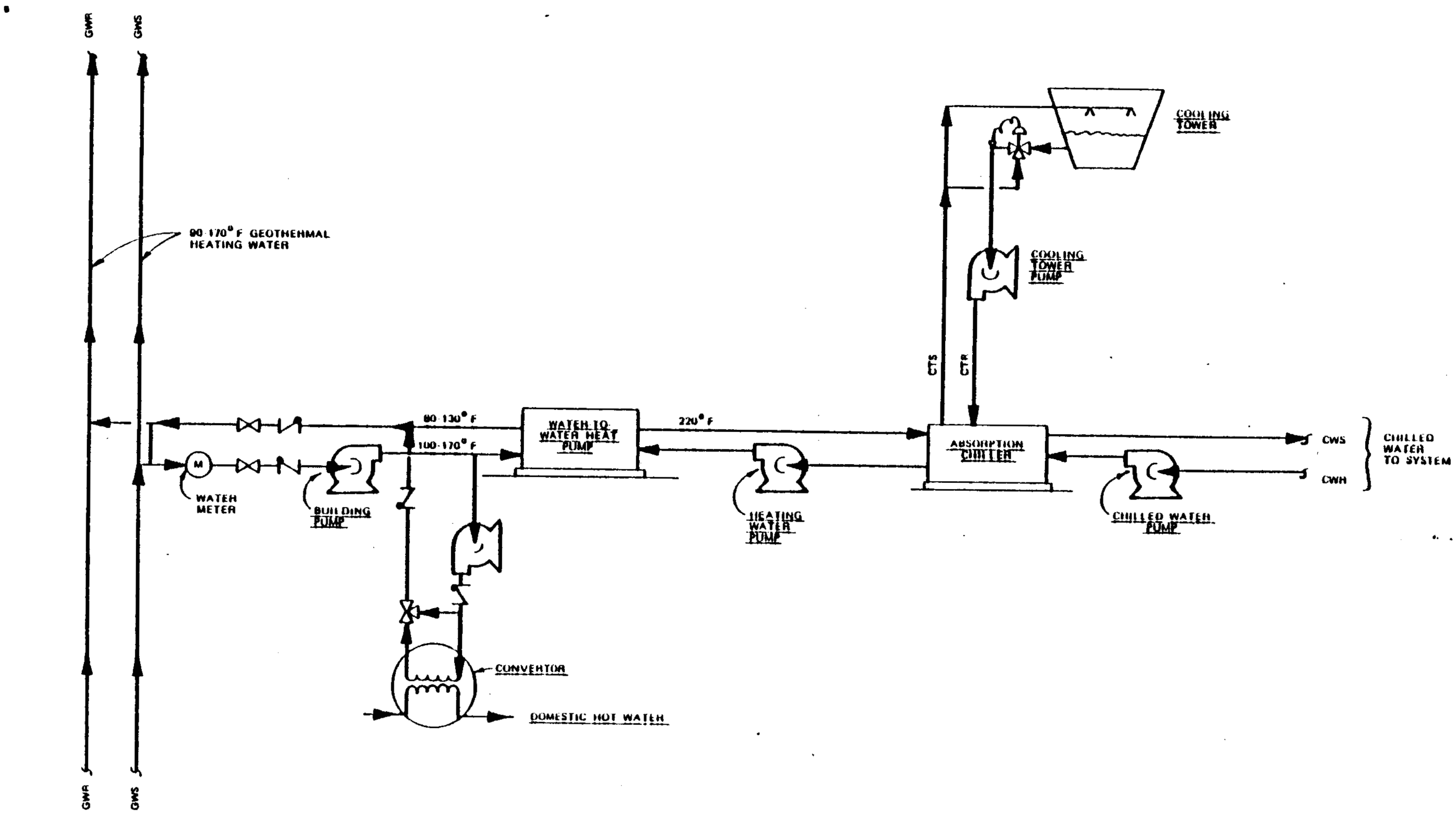

Figure 11. Absorption Air Conditioning

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b. Commercial Application

The heating and cooling requirements of many commercial buildings are met by one of several systems: perimeter heating systems, domestic water heating, water-to-air heat exchangers (coils located in air handling systems), absorption water chillers, and feed water preheaters for steam systems. (See Table 7.)

(1) Perimeter Heating System

A perimeter heating system consists of finned tube radiators or forced air heating units located along the inside of the exterior walls of buildings. The system is supplied with heated water from a closed loop piping system. In most systems of this type, the water temperature, or flow, is adjusted according to the outdoor temperature or by settings of individual building zone thermostats. Traditionally, these water systems utilize water temperatures between 70° and 160°F. Therefore, cascade use of geothermal water would allow direct use of the geothermal water in most systems, with or without an intermediate heat exchanger. For those systems designed for even higher water temperatures, the geothermal water temperature could be boosted to the required operating temperatures.

Due to the low cost and availability of electric power, many commercial buildings presently utilize electric hot water boilers. With future electric rates expecting to escalate, use of an electric water-to-water heat pump, as shown in Figure 9 could be used to boost low temperature geothermal water (100° to 140°F) up to 220°F with coefficient of performance (COP) of 2.8 to 5.2. Thus for every kW of energy put into the system, 2.8 to 5.2 kW of energy would be put out.

(2) Domestic Water Heating

Domestic water in commercial buildings is usually heated with gas or electric water heaters; or with hot water generators (heat exchangers) with the heating water supplied by hydronic or steam boilers. The delivery temperatures for lavatories, showers, and similar domestic uses could be as low as 105° to 140°F. However, if the water is used for commercial dishwashers or laundries, then higher water temperatures, between 160° to 180°F would be required. The most economical use of the geothermal water for such requirements would be direct utilization method (with an intermediate heat exchanger) to generate hot water in the 105° to 140°F range, and to rely upon gas or electric booster type water heaters to raise the water to the required delivery temperature. This type of system is shown schematically in Figure 10.

(3) Water-to-Air Heat Exchangers

Water-to-air heat exchangers are used in air handling systems to heat or cool buildings. Water heating systems which utilize these heat exchangers generally operate between 160° to 180° F. Thus, if geothermal water is used in these heat exchangers at a lower temperature, a modification of flow rates or heat exchanger surface areas would be necessary to maintain comfortable temperatures in the building while utilizing the existing

Table 7.
GEOTHERMAL CASCADE USE
APPLICATIONS SUMMARY

System Use	Temperature Range	Conversion Method	Remarks
Perimeter Radiation	70 - 170°F	Direct or Indirect	
Domestic Water Heating Or Preheating	90 - 170°F	Direct or Indirect	
Water-to-Air Coils	120 - 170°F	Indirect	
Water-to-Water Heat Pumps (Commercial)	90 - 170°F	Indirect	*COP = 2.8 to 5.2
Water-to-Water Heat Pumps (Residential)	40 - 90°F	Indirect	COP = 2.7 to 3.9
Water-to-Air Heat Pumps (Residential)	40 - 90°F	Indirect	COP = 2.5 to 3.9

*COP: Coefficient of Performance

hardware. An alternate method would be to use a water-to-water heat pump, as described previously, to boost the geothermal water temperature.

(4) Absorption Water Chillers

Absorption chillers traditionally have been used for producing chilled water for building air conditioning systems where a steam source has been available for carrying out this process. In recent years, with the advent of solar collector systems, manufacturers have been modifying absorption chiller equipment for use with hot water, instead of steam. This decreases the operating efficiency of the chillers while requiring the same capital costs. A geothermal water temperature of 170°F or less would probably not be satisfactory for operation of an absorption chiller. The only practical way of making use of the geothermal resource would be to increase the water temperature to 220°F with a water-to-water heat pump before using the water in the chiller, as shown in Figure 11. This would require a capital outlay for both the absorption chiller and the heat pump.

(5) Feedwater Preheaters

Steam heating systems normally operate at temperatures much higher than the geothermal water temperature, available in Boise. Thus, the geothermal water cannot be used directly for preheating the water for such systems. However, steam heating systems require blowdown (the discharge of some portion of the steam flow) to prevent solids from accumulating in the system. All such water that is wasted, has to be replaced with fresh water. This make-up water, if preheated to a temperature close to that of the operating steam system, would provide more efficient steam system operation. Geothermal water could be used for this preheating operation.

c. Residential and Light Commercial Systems

This type of user does not differ greatly from the large commercial user of cascaded geothermal systems having many of the same hot water demands. The main difference is the relative size of the mechanical systems, and the associated costs. For instance, a typical residence contains a domestic water heating system, a space heating system, and a space cooling system. Many of the equipment types and sizes used in a residence would not be appropriate for use in major commercial buildings.

Relatively cool geothermal water can be used easily in space heating systems which utilize commercially available water-to-air heat pumps. Water-to-air heat pumps have found wide acceptance in recent years as a means to provide space heating from a practically limitless source of heat, namely, groundwater. Many units have operating source temperatures between 40° to 90°F. A system schematic is shown on Figure 12. This system employs two features that were not necessary with the previous systems. First, a mixing valve is used to maintain a maximum loop temperature of 90°F to safeguard the refrigeration system. Second, a cooling tower (closed circuit) is employed to keep the loop temperature down to 40°F in the summer when the heat pump is used for cooling the building. Typical COP's are between 2.7 to 3.9 for heating and cooling, with typical flow rates between 5 to 20 gpm.

There are water-to-water heat pumps in the small capacity ranges of 22,000 to 103,000 Btu per hour for boosting water temperatures.

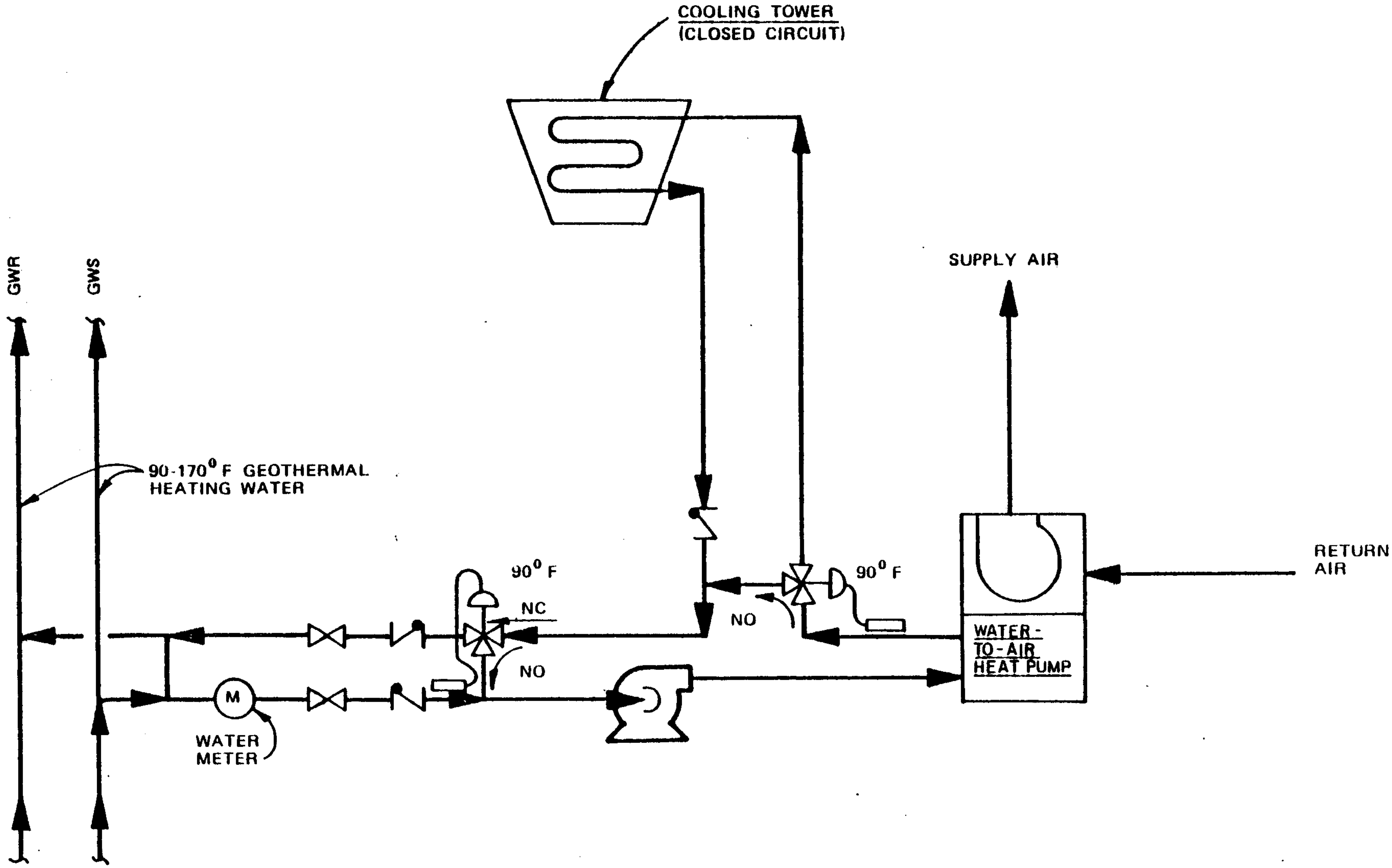

Figure 12. Refrigerant Changeover
Water-to-Air Heat Pump

(FOR RESIDENTIAL AND SMALL COMMERCIAL SYSTEMS)

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d. Miscellaneous Cascade Uses

The variety of uses available for low temperature geothermal water is limited only by the water source and the end-use temperature requirements. If a process or system cannot use the water directly because of chemical composition, then indirect systems using heat exchangers must be employed (similar to Figure 12). Each heat exchanger application must be analyzed separately, but in general, the minimum temperature difference between the geothermal water and the process system water should be not less than 5° to 10°F. This will provide for the most economical heat exchanger selection. Some possible end uses for geothermal water are listed:

- Washing systems for cars, buildings, trucks
- Industrial dryers of paper, textiles, lumber
- Snow removal from streets and sidewalks
- Heating animal cages at the zoo
- Process or industrial heating systems for paint, petroleum products
- Aquaculture

One can anticipate that the demands of other uses could be met by either the direct applciation of geothermal water, or by a system similar to those discussed in this report.

e. System Cost Example

The total costs for the systems discussed in this report are the combined costs of the equipment and the cost of the energy required to operate the equipment. In general the capital cost for equipment, such as the heat pumps proposed in this report, is greater than the capital cost of more traditional heating and cooling equipment. This situation may change as the demand for such equipment increases.

Energy costs are escalating rapidly. Thus, capitally intensive, but energy conservative heating systems are becoming more economical. Heating costs of such systems for various fuel prices can be determined from Figure 13. For example, if the price of gas is $3.20 per thousand cubic feet the heating cost is $4.25 per million Btu. Similarly, if the cost of electricity is $0.021 per kilowatt-hour, the heating cost for electrical resistance heat (COP = 1.0) is $6.10 per million Btu. These are typical energy prices payed by the consumer in the Boise area today.

These heating costs can be used to determine what the yearly heating bill paid by the consumer would be for some typical buildings for several different kinds of heating systems. Some typical calculations are summarized in Tables 8 and 9.

Table 8 shows the yearly heating costs paid by the consumer for a 2,000-square-foot residence, assuming a heat loss from the residence of 30-Btu/hr/ft^2. The costs are shown for electric heat, gas heat, and heat pump systems. Similarly, Table 9 shows the yearly heating costs paid by the consumer for a 50,000-square-foot commercial building, assuming a heat loss from the building of 40 Btu/hr/ft^2.

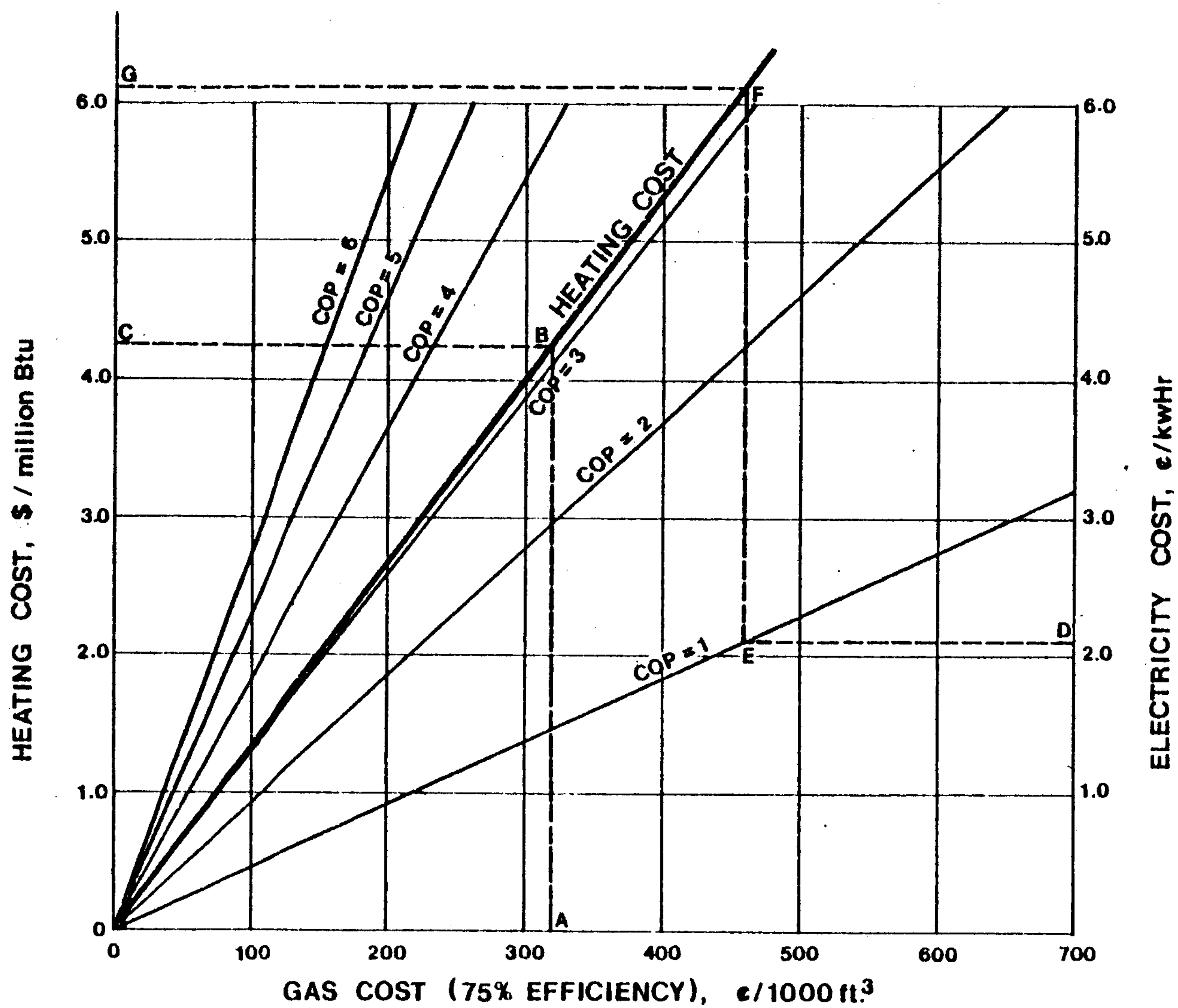

Figure 13. Heating Costs

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Table 8. Example of Residential/ Small Commercial Heat Costs

	Energy[3] Unit Cost	COP See Table 2	Heat Cost $/Million Btu See Figure 8	Yearly Heat Demand, Btu[1]	Yearly Heat Cost
Electric Heat	$0.021/kWhr	1.0	6.10	119.4×10^6	$ 728
Gas Heat	$3.20/1000 Ft^3	---	4.25	119.4×10^6	$ 507
Heat Pump	$0.032/kWhr[2]	3.9	2.30	119.4×10^6	$ 275

(1) Building assumed to be 2000 square feet with a heat loss of 30 $Btu/hr/ft^2$.

(2) Assumes cost of geothermal water is the same as the cost of gas, for the same energy content.

(3) Typical residential rates, Boise, Idaho; 1977-1978.

Table 9. Example of Commercial Building Heat Cost

	Energy[3] Unit Cost	COP See Table 2	Heat Cost \$/Million Btu See Figure 8	Yearly Heat Demand, Btu[1]	Yearly Heat Cost
Electric Heat	\$0.021/kWhr	1.0	6.10	3978×10^6	\$ 24,266
Gas Heat	\$2.64/1000 ft^3	---	3.55	3978×10^6	\$ 14,122
Heat Pump	\$0.030/kWhr[2]	5.2	1.70	3978×10^6	\$ 6,763

(1) Building assumed to be 50,000 square feet with a heat loss of 40 $Btu/hr/ft^2$.

(2) Assumes the cost of geothermal water is the same as the cost of gas, for the same energy content.

(3) Typical commercial rates, Boise, Idaho; 1977-1978

3. Summary

There is ample opportunity to cascade the use of geothermal resources based upon the proposed geothermal space heating system plan for Boise City. If the proposed heating system is developed fully as described in the preliminary report, approximately 2,215 gpm of geothermal water at a temperature of approximately 140°F will be available for cascade uses.

The application of geothermal resources in heat pumps and cascade systems has been generalized by proposing several systems to utilize the geothermal resource. These systems should be considered as a starting point for designing systems for specific applications.

The capital costs of utilizing geothermal energy in cascade systems are in general, greater than for more conventional systems today. However, the operating costs for such systems are expected to be substantially less than these conventional systems. In addition, as native energy sources diminish, the imperative becomes one of extracting the maximum energy from energy resources. The economics of such systems will become increasingly favorable, if present trends of increasing energy rates continue.

IV. ECONOMIC FEASIBILITY

The economic analysis presented in this section is based on real costs experience of space heating, using geothermal energy in Boise; evaluates probable prices for geothermal energy based on a 15 million dollar "basic system " and, using results from these analyses, provides some indication of possible operating cost and cash flow requirements. As with other sections of this document, conditions have changed frequently as study work was being completed. As an example, the project initially analyzed cost factors for six different scenario systems. These systems ranged in cost from 2 to 6 million dollars. The most cost realistic system involved a downtown segment and a Warm Springs segment. Together these segments would serve approximately 12 major downtown buildings plus some few hundred residences in addition to those presently served by the Warm Springs Water District.

When the Department of Energy Program Opportunity Notice (PON) arrived and the decision was made to submit a proposal, the "most realistic" scenario referred to above became the basis for a PON proposal. The original six million dollar cost grew to 15 million with the addition of some new system elements, the inclusion of indirect costs such as legal and clerical, and provision of significant matching funds. The soft matching funds covered such things as value of land on the resource that would be used directly in any future systems. New cash match funds also showed up in connection with major building retrofits, and residential requirements such as metering. Finally, costs also grew due to inflationary change in prices.

As a result of growth to a project of 15 million dollars economic studies were completed once again to verify previous estimates of energy prices. Systems have thus been studied whose price ranges from a few hundred thousand dollars, through medium size systems of a few million to serve downtown, to the 15 million dollar system noted above. The general conclusions in all cases are similar, implementation of a "small" system would result in less than optimum energy prices vis a vis natural gas or electricity. Conversely a moderately large, "basic" system offers the potential of very price competitive energy. All of the analysis provided below are based on the basic system, i.e., the system described in PON EG-78-N-03-2047, and experience from systems recently implemented. The inevitable conclusion also arises that, while these studies are optimistic, regarding prices, there will be a need for additional studies of costs, pricing strategies, and the market for geothermal energy.

A. Experience at State Health Laboratory

Recent study of geothermal resources in the Boise area indicate that natural hot water may be an efficient form of heating for public and commercial buildings in the downtown area. Presently, the only commercial size structure in Boise utilizing geothermal heating is the State Health and Welfare building (Ag. Health Lab) on Penitentiary Road. A review of the experiences with this building provides useful data to assist in determining whether it would be feasible to further develop this resource for other commercial size building applications.

The Ag. Health Lab System (see Figure 14) has several unique heating and air handling problems that should be noted.

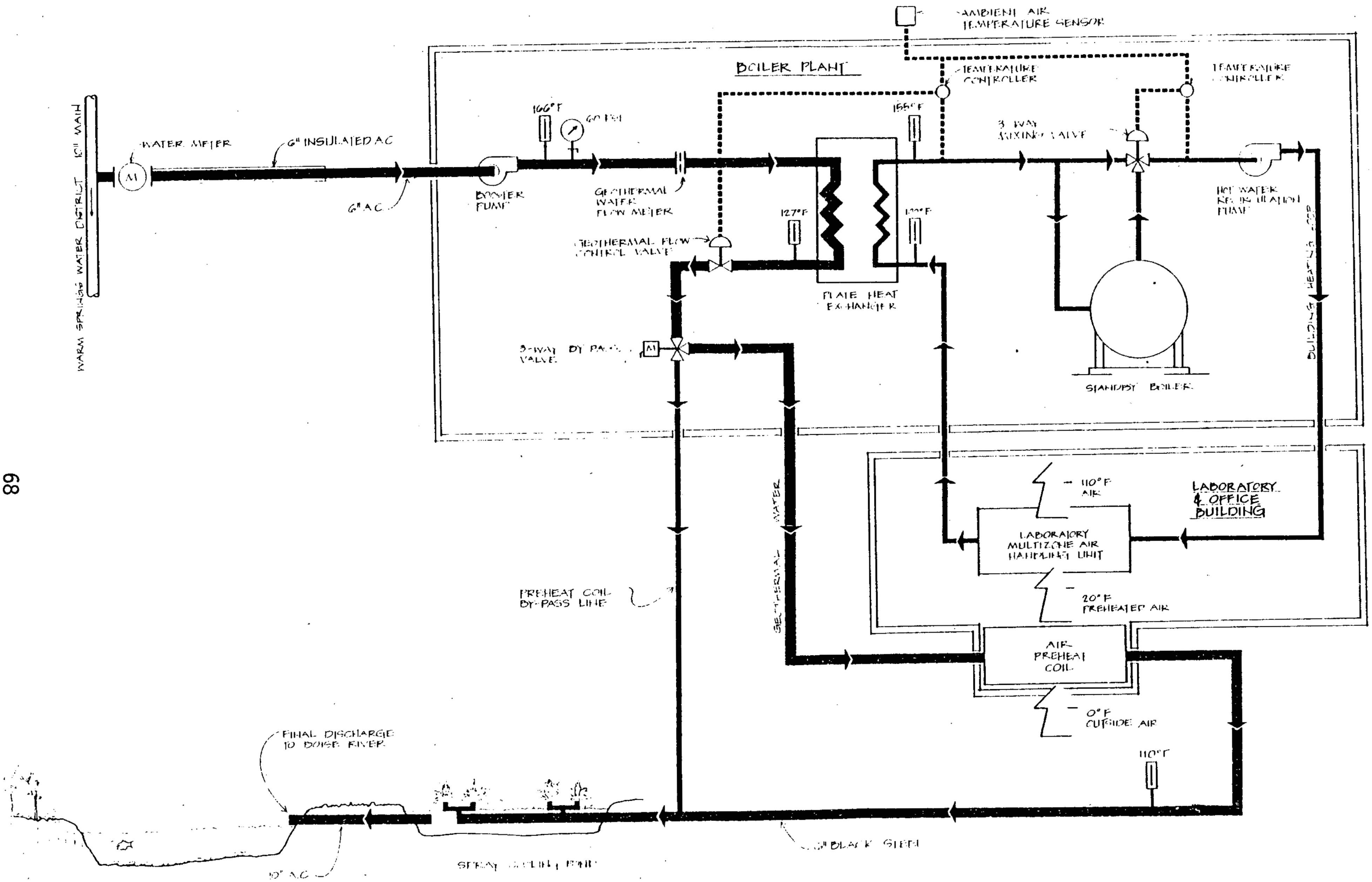


Figure 14. Agricultural Health Laboratory System

- The air flow system is not a recirculating system, it uses the warmed air only once before it is exhausted. The nature of the lab activities requires this once through air flow. Air is brought into the system from outside the building, requiring a sizable temperature change to maintain a 70° environment throughout the building.

- The Lab has a water cooling pond and discharge system to the Boise River. Normally, several users of a geothermal resource would share a discharge system. The ultimate cost of the system installed at the Lab may be higher because of the one-user discharge cooling system.

- The hot water well location required that a long, single user line be installed from the well to the lab. In the more dense downtown environment the line would have multiple users. The cost of delivery may be higher than would be experienced with a multiple-user system.

The Lab was originally built with a boiler fired heating system, and required retrofit and minor modification to accommodate the geothermal water. The corrosive effects of the water required a closed system, with a heat transfer or heat exchanger coil. Because of the low peak temperature of the geothermal water, there was a need to install additional air handling coils. The conversion that was done would be similar to the conversion necessary on most existing commercial buildings, and should reasonably reflect the costs that could be expected in other building retrofit and conversion activities.

The retrofit and engineering expenses for the Ag. Lab are detailed in Table 10. If the waste water system costs were removed ($23,000 for trenching, $34,000 for pipe, pond @ $4,000, manhole @ $1,000, road crossing @ $3,000, railroad crossing @ $6,000 and river outfall @ $2,000) the net price of the conversion is reduced to $47,000. An additional $7,200 was expended for steel piping, which also would be reduced with a concentrated downtown system. This would reduce the initial conversion expense even more.

1. Description of the Project

The demonstration project was conceived in March 1974 and utilizes geothermal wells on the old penitentiary site. Idaho's former governor, Cecil Andrus, requested that the U.S. Energy Research and Development Administration (ERDA) study Boise's geothermal resource. ERDA awarded the study to Idaho National Engineering Laboratory (INEL); the final report was submitted to the governor in April 1976 recommending further study through actual use. The governor carried a funding request to the Pacific Northwest Regional Commission which approved $355,000 for design, construction, and management of the experimental project. The Idaho Office of Energy has coordinating responsibility, and CH2M Hill's Boise Office is the major geothermal consultant to the state. CH2M Hill assisted in drafting the contract with the Boise Warm Springs Water District, prepared an environmental assessment, investigated alternative disposal methods, designed the retrofit system, and continues to review data and technically modify the geothermal demonstration project to improve efficiencies.

Table 10.

AG HEALTH LAB
GEOTHERMAL CONVERSION COSTS

Pipe Trenching (3,715 feet) @ $6 per foot (Delivery System)	$23,000
Travsite Pipe 10" and 6" (Delivery System)	34,000
Steel Pipe 450'	3,600
Trenching & Repair 450'	3,600
POnd Construction	4,000
Manhole	1,000
Road Crossing	3,000
Railroad Crossing	6,000
River Outfall	2,000
Preheat Coils	1,500
Mechanical Room Conversion	5,000
Instrumentation/Controls	2,000
Electrical Modification	2,000
Insulation	1,500
Construction Contingency (10%)	9,200
Air Handling Coils	5,250
Heat Exchangers	12,000
Labor	1,350
	$120,000

Source: CH2M Hill
J. Austin

The project serves to demonstrate the feasibility of geothermal space heating for state agency buildings. In addition, it has demonstrated technology for retrofitting an existing heating system for use with a geothermal source. The State of Idaho is purchasing the geothermal water from the Warm Springs Water District at a rate of 40 cents per 100 cubic feet for flows not to exceed 400 gallons per minute (gpm).

The demonstration project contains two separate water loops, the geothermal loop and the space heating loop; these systems or loops are interfaced through a heat exchanger. No actual mixing of the geothermal water and the space heating water occurs. The Boise geothermal water is generally corrosive to copper coils, brasses, and aluminum, and if used directly would destroy the air handling coils and the existing boiler, which is being used as a standby unit.

The geothermal water is delivered from the Warm Springs Water District's 10-inch cast-iron main and a 6-inch line which extends to the existing state boiler plant. A water meter records actual water usage for billing purposes.

The 170° geothermal water enters the boiler plant at approximately 15 psi, (pounds per square inch), pressure and is boosted to 60 psi by a centrifugal pump. A second in-pipe measuring device indicates and records the geothermal flow for analyzing system energy use.

From the flow measuring device, water enters an APV plate heat exchanger at nearly 170°F. Within the reverse flow exchanger about eight million btuh of geothermal energy are given up to the space heating loop at maximum flow. Under design conditions the geothermal water exits the exchanger at approximately 127°F.

The geothermal water flow rate is regulated by a pneumatic control valve on the discharge side of the heat exchanger. The pneumatic valve is positioned in response to a temperature sensor, which monitors space heating water temperature leaving the exchanger. As more energy is required to raise the heating water temperature, the control valve opens to allow more geothermal water to flow through the system.

Under normal operations, the discharged geothermal water flows through a three-way diverting valve to an air preheat coil. The water enters the coil at approximately 127°F and leaves at about 100°F. The coil tempers make-up air for the laboratory by raising the incoming air temperature some 20°F prior to entering the laboratory's main multizone heating unit. From the preheat coil, the geothermal water flows to a spray pond for further cooling before discharge.

During the warmer months when the additional heating is not necessary, the three-way valve can divert the water directly to the spray pond, bypassing the air preheat coil. Operation of the valve may be either manual or automatic. In the automatic mode, the preheat coil water temperature controls flow through the valve. If the geothermal temperature approaches 40°F, the valve bypasses the preheat coil and a solenoid valve automatically drains the preheat coil to prevent freezing.

The spray pond is 100 by 120 feet by four feet deep. Water enters nominally at 100°F and is reduced to 80°F through the spray unit. A fixed gravity overflow standpipe in the pond controls the water level and conducts the spent geothermal water to the Boise River via a 2800-foot long 10-inch AC (asbestos cement) gravity main. A 15-foot perforated discharge header on the river bed disperses the geothermal water in the main river channel. Discharge is controlled to meet the lowest projected flow (50 cubic feet per second) of the river.

In the demonstration project, the laboratory-office building plus two smaller buildings are heated by geothermal energy. The laboratory-office building has a gross area of approximately 40,000 square feet and is heated by two multizone air handling units. The laboratory areas require 100 percent outside air, while the offices can recycle up to 90 percent of the air supply. The smaller buildings use a system parallel to the office.

The space heating water loop is a closed system including the existing boiler, pumps and piping with the new heat exchanger. The closed loop allows accurate control of the water chemistry to prevent corrosion. The multizone air handling units are located in the laboratory-office building basement mechanical room. The original system was designed to operate with water temperatures of 180°F. To take full advantage of the geothermal water, the air handling unit coils were replaced with larger coils designed to operate at 155°F. With this small modification and the installation of the heat exchanger in series with the boiler, the system was converted to total geothermal heat.

The space heating water enters the plate heat exchanger at 100°F and the energy given up by the geothermal water raises the space heating water to 155°. This outlet temperature is maintained by regulating the incoming amount of geothermal water with the pneumatic valve in the geothermal loop.

From the exchanger, the space heating water flows through a three-way mixing valve which is positioned in response to the mixed water temperature. When this temperature drops below 150°F, the valve diverts a portion of the water through the standby natural gas fired boiler system which will boost the temperature as required to maintain 150°F. Under normal operating conditions, this diversion will not be necessary; it is available in the event of a loss of water or under extreme conditions of extended cold weather. The geothermal supply to the laboratory-office complex may be interrupted due to a broken main, pump outage or increased geothermal demand by higher priority use, such as residential heating. From this three-way valve, the space heating water continues through parallel circulating pumps which are rated at 200 gpm at 40 psi to the multizone air handling unit.

Laboratory activities require that the environment be maintained at a constant temperature, and that the air not be recirculated. The system operates on once-through, 100 percent outside air; creating an exceptionally high heat load for a building of this size. Operations data indicate the summer months have a significant load due to low night-time temperatures which range downward to 55°F.

The system is being instrumented with flow recorders and temperature monitors to accurately track overall system performance; geothermal water temperature in and out; space heating loop water temperature in and out; ambient temperatures; and building space temperature. This information will be recorded on tape and sent to the University of Idaho Department of Engineering for reduction and analysis. Based upon the result of this data, modifications to the system of operations will be made to improve efficiences of both the geothermal system and the overall building heating system. Several refinements in the operations have been developed thus far. These include a temperature relay system which will monitor outside air temperature. The control temperature for the geothermal flow valve can be set lower than 155°F to compensate for higher ambient temperature, creating further energy savings with less geothermal water use.

During this demonstration project, the Boise State University Biology Department has been involved. The department is monitoring environmental impacts posed by the discharge of the geothermal water. This work includes evaluating the effect spent geothermal water may have on the spray pond area and the stretch of the Boise River receiving the final discharge. Initial indications are that no adverse effects will result from the discharge. The formal environmental study will continue for approximately one year.

2. Preliminary Results

The system began operation in the fall of 1977 and experienced the minor problems which are to be expected in a prototype system. By year end, adjustments had been made and the system was considered fully operational. A review of the costs for January through April of 1977 and 1978 provides a basis for comparison with the previous years heating using natural gas and the current geothermal/gas backup system. It should be noted that the nature of the lab activities requires some natural gas for bunsen burners, etc., that cannot be eliminated by the geothermal conversion. The comparitive cost figures are as follows:

Month	1978 Geothermal	Gas	Total	1977 Gas
January	$1,115	$300	$1,415	$3,871
February	1,008	300	1,308	4,478
March	790	300	1,090	2,618
April	453	300	753	3,021
Total	$3,366	$1,200	$4,566	$13,988

The U.S. Weather Services reports that Boise experienced a heating load of 3,400 Degree Days during the first four months of 1977 versus only 2,591 Degree Days for the same period in 1978, so that some of the cost reductions resulted from warmer weather. However, if adjustments are made to account for both the lab uses of gas and the warmer weather in 1978, the geothermal system operated at less than one-half the cost of the gas fired boiler.

An additional benefit of the geothermal system is less routine maintenance and operating expense. The normal maintenance of a fired boiler is reduced substantially, as the boiler is used only for backup heating. The closed loop/automatic valve design of the system removes much of the day-by-day maintenance usually experienced in a boiler system, reducing those operating expenses as well.

It is too soon to draw any definite conclusions from the data, but preliminary indications are that the geothermal system will effect significant savings, both in cost of fuel and maintenance expenses.

B. The Boise Geothermal System As An Economic Entity

After it is constructed, a Boise geothermal system would operate as an economic entity which sells hot water for the space heating requirements of commercial and residential customers. To be economically viable, the system must provide energy for space heating at prices which compare favorably with competing energy forms, namely electricity and natural gas.

For a capital investment of about $15 million, the system will have the capability of providing peak flow rates of about 8,000 gallons per minute (gpm) of geothermal water which is equivalent to about 190 million BTU's per hour. During peak heating periods, 5,000 gpm will be provided to heat large, commercial buildings in downtown Boise and 3,000 gpm will be provided by the Warm Springs Water District to heat residences. The revenue generated from sale of the hot water to all customers must cover all of the system's costs.

In the following economic feasibility analysis, each of the components of system cost and revenue will be estimated and analyzed to determine if the system will be economically viable.

C. Components of Economic Analysis

1. Investment

The Net Investment for investment analysis purposes is slightly different from the total project cost of about $15 million for the several reasons discussed below. Therefore the total project cost will be summarized and then adjusted as necessary to arrive at the net investment.

a. Total Project Cost

The "grand total project cost" was defined in PON E6-78-N-03-2047 as follows:

Phase 0	$ 3,409,000
Phase I	708,000
Phase II	8,054,500
Phase III	971,000
Phase IV	919,000
Phase V	1,043,000
Reporting	212,000
GRAND TOTAL	$15,316,500

b. Non-Capitalized Cost

Several elements of the total project represent "expenses" rather than "capital investments." These elements, which probably should not be considered as part of the system investment, include the following:

Phase 0	-	Proposal Conference	$ 1,000
		Conceptual Design	3,000
		Proposal Preparations	18,000
		Submission of PON	1,000
Phase I	-	Environmental Assessment	20,000
		Secure Permits	5,000
		Boise Geological Survey	80,000
		Data Analysis	5,000
Phase II		Market and Rate Analysis	25,000
Reporting			212,000
	Total, Non-Capital Items		$370,000

c. Capitalized Interest Cost

Assuming that some portion of the project must be financed by borrowing from a financial institution, the interest on the borrowed funds during project construction should properly be considered as part of the investment. If, say $5 million were borrowed two years before system completion at municipal interest rates of about 8 percent, then capitalized interest would amount to $800,000 ($5,000,000 @ 8% for 2 years). The final economic analysis will examine various financing alternatives.

d. Additional Wells

Upon completion, the system will have six producing wells capable of delivering a nominal 6,000 gpm of geothermal water flowing into a pipeline system capable of transporting 8,000 gpm to customers. The pipeline was intentionally oversized to take advantage of the economies of scale which reveal only slight differences in the total installed cost between say an 8 inch and a 10 inch pipeline. To take full economic advantage of system capacities, two additional wells will be drilled after the initial system becomes a proven success. At a nominal cost of $200,000 for the completed well and pumping equipment, the two additional wells will require a future investment of $400,000.

e. Net Investment

The net investment for analysis purposes will be the total project cost per the PON submitted previously with the adjustments described:

Total Project Cost per PON	$15,316,500
Less: Non-Capital Costs	(370,000)
Plus: Capitalized Interest Costs	800,000
Plus: Investment in 2 More Wells	400,000
Net Investment for Economic Analysis	$16,146,500

The net investment will vary with different financing arrangements, several of which will be analyzed in the Economic Analysis, Section D, page .

2. Revenue

The quantity of geothermal water used by each customer will be measured by a flow meter and charged to each customer at a predetermined price per 100 cubic feet. Total annual revenue will then be the total volume of water used during the year times the price. In an average year, 5,809 F degree days occur in Boise, equivalent to a heating load factor of 24 percent.[1] This means that on an annual basis, geothermal system customers will use only 24 percent of the peak capacity of 8,000 gpm. Thus, when the system becomes fully operable, sufficient buildings will be connected to demand 8,000 gpm at peak space heating periods when the outside temperature is about 0°F. In the aggregate, these customers will use 134.9 million cubic feet per year during the average year.

Annual Quantity of Water Delivered By System

= 8,000 gpm peak flow rate
x 525,600 minutes per year
÷ 7.48 gallons per cubic foot
x 24 percent heating load factor in Boise

= 134.9 million cubic feet per year

The economic analysis will determine what price must be charged for this quantity of water to pay all system costs.

3. Operating Costs

All operating costs have been carefully estimated for the proposed system as described in Section G , "Projected Operating Expenses, Geothermal Project." For analysis purposes, operating costs are best categorized into "fixed expenses" which do not vary with the volume of water delivered by the system and "variable expenses" for the electrical energy required to pump the geothermal water through the systems. Estimates of the operating costs are summarized below for several years.

[1] A degree day is a measure of space heating demand defined as a 24 hour period during which the outside temperature is 1° below the temperature at which heating systems must be turned on, usually considered 65°F. Thus, if the outside temperature remained at exactly 0°F for a 24 hour period, the heating demand would be 65 degree(F) days.

	Annual Operating Cost Estimates		
	1982	1985	1990
Fixed Operating Expenses (Personnel, Maintenance and Administrative)	$132,500	$163,300	$235,800
Variable Operating Expenses (Electric Pumping Costs)	$.0842 per 100 ft^3	$.105 per 100 ft^3	$.159 per 100 ft^3

The fixed operating expenses are expected to increase as shown because of inflation averaging 7.2 percent per year predicated upon a detailed analysis of how inflation is expected to influence each expense item. Average inflation of 8.0 percent per year is expected in Idaho's electricity rates according to the recent Dames and Moore study for the Idaho Public Utilities Commission.

4. Depreciation

From a financial standpoint, depreciation represents the return of investment to the owners as the investment declines in value through use or through the passage of time. Since most of the investment for the Boise geothermal system will be paid for by Federal and public funds, the decision of whether or not depreciation should be included in the cost base for setting rates is primarily a policy decision. On similar systems, such as sewers, the City of Boise has decided to include depreciation on the total investment within the cost base for setting user rates. This policy is considered prudent financial management, because system revenues then include a provision for depreciation which the City can use to continually upgrade the system and replace portions of the system as they wear out.

As currently planned, a Boise geothermal system will be jointly owned by the City of Boise and the Warms Springs Water District, both of which are public, not-for-profit entities. Straight line depreciation of those elements of the system which will wear out in time will be included as a system cost even though the major portion of the investment came from federal funds which do not have to be repaid.

5. Debt Service

Preliminary discussions with various financial institutions have indicated that a Boise geothermal system will be able to borrow a portion of the system cost. Interest rates may be as low as 8 percent for municipal borrowing with tax free interest income or as high as 12 percent for a commercial type loan considered somewhat risky. The loan term will typically provide for no payments for the first two years during construction and equal payments to amortize the loan over either 10 or 15 years. Annual debt service which would have to be covered by system revenues would be as follows for each $1 million borrowed.

Annual Debt Service for a $1 Million Loan
Assuming No Payments During a Two Year
Construction Period

	Interest Rate		
	8%	10%	12%
Amortization Period After 2 Year Construction Period:			
10 Years	$173,800	$196,900	$222,000
15 Years	136,300	159,100	184,200

Such loan service charges will be included in system cash outflows for various financing alternatives.

6. Taxes

If the Boise geothermal system were privately owned and operated by a profit seeking corporation, it would be subject to the following taxes.

a. Property Tax

All of the systems' property, which would be the net investment in the system, would be subject to property taxes. The tax rate will be limited to one percent of market value under the recently approved Idaho Tax initiative which should be implemented by the time the system becomes operational.

b. Federal Income Tax

Assuming that a relatively large corporation owns the system, taxable income would be subject to a Federal Income Tax rate of 46 percent, the new rate on income over $100,000 approved in the 1978 Tax Law for 1979 and subsequent years.

c. Idaho Income Tax

Idaho taxes corporate income at 6 1/2 percent.

d. Franchise Tax

A privately owned Boise geothermal system would probably have to pay a city franchise tax on gross revenues to Boise. The most probable rate is three percent of revenues, the current franchise rate that Boise imposes upon the Boise Water Corporation.

7. Return on Investment

If the Boise geothermal system is publicly owned, provision for a Return on Investment (ROI) in the pricing structure may or may not be appropriate. The effect upon geothermal energy prices of including modest ROI's in the cost base will be shown as part of the eocnomic analysis for the publicly owned system.

A profit motivated owner of the system would, of course, require a ROI as inducement for investing in the system. If privately owned, the system would become a public utility, regulated by the Idaho Public Utilities Commission (IPUC). Currently, the IPUC permits the Intermountain Gas Company (IMG) to earn a 9.75 percent ROI on their weighted cost of capital. Since IMG finances projects with some equity funds and some relatively cheap borrowed funds, a 9.75 percent ROI on weighted capital yields about 14 percent return on stockholder's equity. In the economic analysis of energy prices if the system were privately owned, a 10 percent ROI will be included in the pricing structure.

D. Economic Analysis

1. Energy Cost if Publicly Owned System

If the Boise Geothermal System were publicly owned, then the total energy costs would include: 1) operating costs, 2) depreciation, and 3) debt service. Estimates of these costs are shown in the following summary based upon certain critical assumptions tabulated after the cost summary.

Summary of Energy Costs
for a Publicly Owned
Boise Geothermal System

Aunual System Costs:	1982	1995	2000
Operating Costs	$ 246,000	$ 667,000	$1,001,000
Depreciation	256,000	256,000	256,000
Debt Service	682,000	682,000	--
Total	$1,184,000	$1,605,000	$1,257,000
Energy Cost per 100 ft^3	$ 0.878	$ 1.190	$ 0.932
Energy Cost per Therm	$ 0.281	$ 0.381	$ 0.299

ASSUMPTIONS FOR ENERGY COST COMPUTATION

a. Public ownership not subject to taxation and not requiring any return on investment.

b. System useful life of 50 years.

c. Financing to include $5 million borrowed at 8 percent municipal rates to be paid back over a 15 year period following a 2 year construction period.

d. Debt service over the first 15 years is considered as system cost.

e. Water delivery of 8,000 gpm during peak demand period. With a 24 percent average annual heating load factor in Boise, 134.9 million cubic feet of geothermal water will be sold in the average year.

f. Energy content of 3.12 therms per 100 cubic feet assuming a 50°F temperature drop through each space heating installation.

2. Energy Cost if Private Sector Ownership

If a private sector entity owned the Boise geothermal system for profit earning purposes, then the total energy costs would include: 1) operating costs, 2) depreciation, 3) taxes, and 4) profit so that the owner earns a reasonable ROI. The introduction of taxes complicates the analysis since the effects of both the Investment Tax Credit and Accelerated Depreciation on after tax cash flow must be considered. Inclusion of the profit motive requires that Discounted Cash Flow (DCF) methods be used to predict energy costs to incorporate the time value of money into the analysis. Such an analysis on a computerized DCF program on Boise State University's HP-3000 computer yielded the following energy costs.

Summary of Energy Costs for a
Privately Owned Boise Geothermal System

	1982	1995	2000
Energy Cost per 100 ft^3	$2.40	$3.242	$3.639
Energy Cost per Therm	$.769	$1.039	$1.166

ASSUMPTIONS FOR ENERGY COST COMPUTATIONS

a. Private ownership of system subject to franchise tax, property tax, state and federal income taxes.

b. ROI of 10 percent on total capital equivalent to about 14 percent return on equity assuming that the system is financed with equity, preferred stock and long term borrowing typical of an Idaho utility.

c. System useful life of 50 years.

d. Water delivery of 8,000 gpm during peak demand period.

e. Energy content of 3.12 therms per 100 cubic feet assuming a 50°F temperature drop through each heating installation.

3. Comparison of Geothermal Energy Costs With Gas and Electricity for Space Heating

The IPUC recently commissioned the consulting firm of Dames and Moore to study the long run supply and prices of natural gas and electricity and prices of natural gas and electricity in Idaho. The consultants' report in November 1977 predicted the following prices.

Predicted Energy Prices in Idaho
Dollars Per Therm

	1982	1987	1992
Residential			
Natural Gas	$.541	$.655	$.921
Electricity	$.949	$1.374	$2.083
Commercial			
Natural Gas	$.400	$.606	$.896
Electricity	$.949	$1.360	$2.066

The energy costs for geothermal energy and the prices of gas and electricity represent the price a customer must pay to purchase one therm. However each form of energy has a different heating efficiency defined as the percent of useful space heating energy yielded from the total energy consumed by the building's heating system. Since electricity has a higher heating efficiency than gas, more therms of gas would be required to heat any building than therms of electricity. Relative heating efficiencies are as follows.

Heating Efficiency Rates

Natural Gas	75%
Electricity	95%
Geothermal	95%

Therefore, the energy user is interested in the price comparisons for a useful therm of energy equal to the price divided by the heating efficiency. Price comparison for the alternatives considered for 1982 are as follows.

Energy Price Comparisons for 1982

	Purchase Price In Cents Per Therm	Percent Heating Efficiency	Adjusted Price In Cents Per Useful Therm
Geothermal			
Public Ownership	28.1¢	95%	29.6¢
Private Ownership	76.9¢	95%	80.9%
Electricity			
Residential	94.9¢	95%	99.9¢
Commercial	94.9¢	95%	99.9¢
Natural Gas			
Residential	45.1¢	75%	60.1¢
Commercial	40.0¢	75%	53.3¢

These price comparisons, which are plotted over time in Figure 15, on next page clearly show the economic desirability of using geothermal energy for space heating and, therefore, represent the final results of the economic feasibility analysis.

E. Pricing Policy for the Boise Geothermal System

Constructing an equitable and economically sound pricing policy for a Boise geothermal system presents several complex problems. Prices must be fair to commercial, residential and institutional users. Prices should reflect whether the investment to retrofit a building's conventional heating system is borne by the building's owner or by the geothermal system. Finally, prices should reflect philosophical and economic differences between the City of Boise and the Warm Springs Water District (WSWD). The following general policies could be followed.

1. General Pricing Policies

a. There must be a strong economic incentive for each customer to use geothermal energy for space heating. For existing buildings, the economic incentive must be sufficient to induce the owner to bear the perceived risk and "hassle" of converting to geothermal.

b. A Boise geothermal system must achieve early success. Therefore, prices charged to early users should be low enough to assure that system operations begin on a very positive note.

c. The maximum price which might be charged for geothermal energy is the price of competing energy sources, namely gas and electricity.

d. The lowest price possible for geothermal energy is the price which just covers all system costs. In other words, geothermal energy users should not be subsidized.

e. Geothermal prices must not be too low to upset other Boise residents for whom geothermal energy is not available.

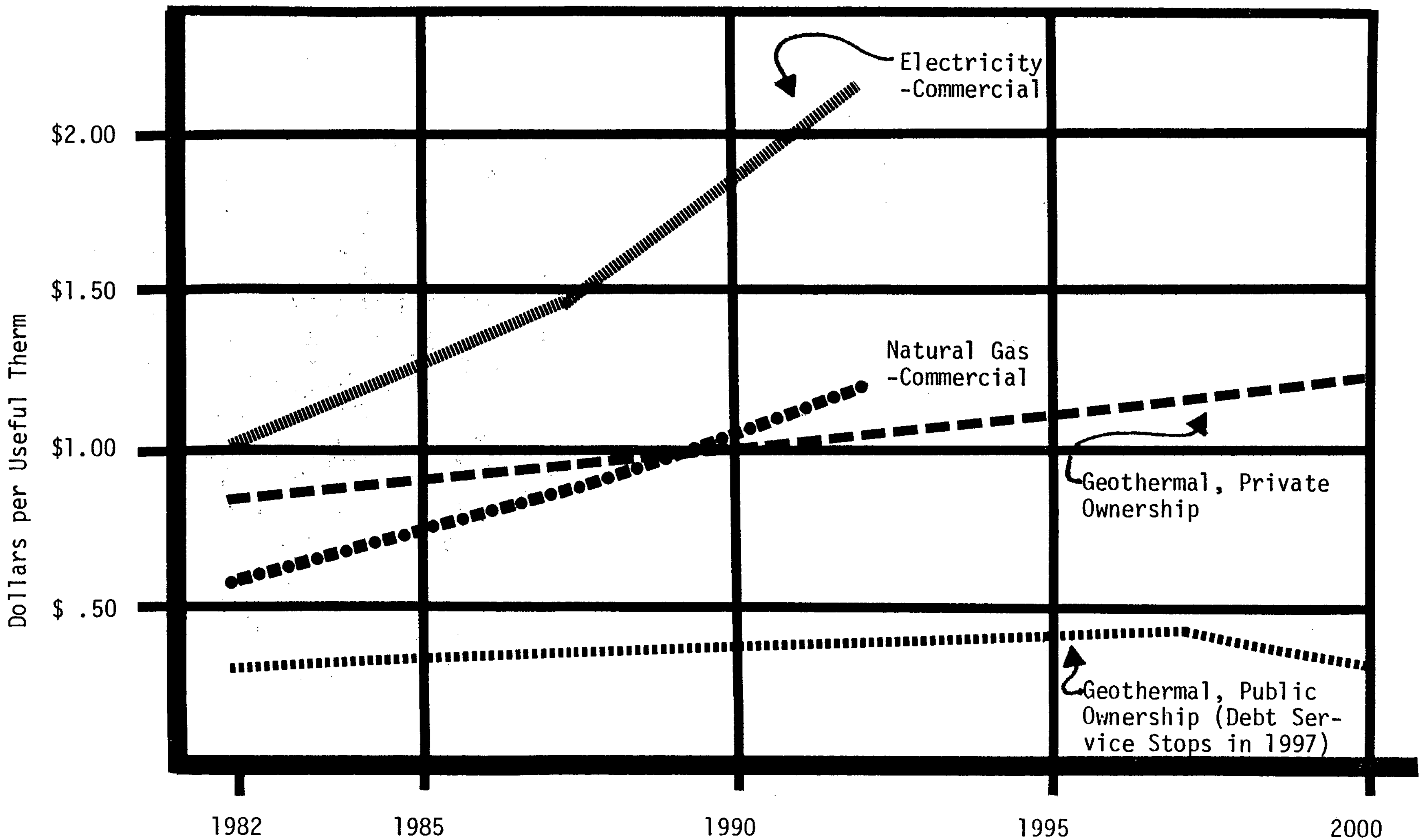
f. Geothermal prices must not be too low to upset those Boise area utilities which are privately owned, tax paying corporations selling energy to the public at a profit.

Fortunately, the predicted energy costs for the Boise Geothermal System appear low enough so that prices may be comfortably set within the maximum and minimum constraints described in the general policies above. (See BCUR Working Paper P-59, "Energy Costs for the Boise Geothermal System," by C.M. Merz, January 1979). Specific pricing policies to be followed are described below for various classes of customers.

2. Boise City System Customers

Prices charged to customers of the Boise portion of the system will cover all system costs plus a modest profit. Since the publicly owned system will

Figure 15. Energy Price Comparisons with Prices Adjusted for Relative Heating Efficiencies.



not be taxed, it would be appropriate to include a modest profit in the price structure to partially compensate the City of Boise for lost property and franchise taxes.

For commercial customers, long term contracts (about five years) will be negotiated so that building owners can be certain of their future energy costs. The system will probably bear the retrofit cost of the first 10 or 12 commercial buildings. A single geothermal energy price will be charged which will include recovery of the retrofit cost. The system will get out of the retrofit business for commercial buildings as soon as practicable. The second generation of commercial users will pay their own retrofit costs and accordingly pay lower prices for geothermal energy.

Similar policies will be followed for pricing geothermal energy to residential customers of the Boise portion of the system with one important exception. Providing service to residential customers requires a relatively higher investment in pipelines and entails higher administrative costs. Therefore, residential prices will reflect this higher cost of doing business. Different price structures for residential and commercial structures has become a well established practice in contemporary utility pricing.

3. Warm Springs Water District Customers

A preferentially low price to existing WSWD customers is an appropriate reward for those persons who somehow have kept the original system operating over the years. A price which covers operating costs but not depreciation would permit WSWD to charge their old time customers slightly more than the total annual heating cost they now enjoy. For their new residential customers, WSWD will be able to price geothermal energy well below gas or electricity, but high enough so the system is self-supporting and generates enough capital to gradually expand.

4. Summary

The Boise Geothermal System's pricing policy will result in a number of different prices so that each class of customer is charged an equitable amount for using geothermal energy. Fortunately, the predicted energy costs for the system are low enough so that system costs can easily be recovered through the price structure which will still offer significant economic incentives for use of geothermal energy.

F. <u>Public Utility Versus Private Utility</u>

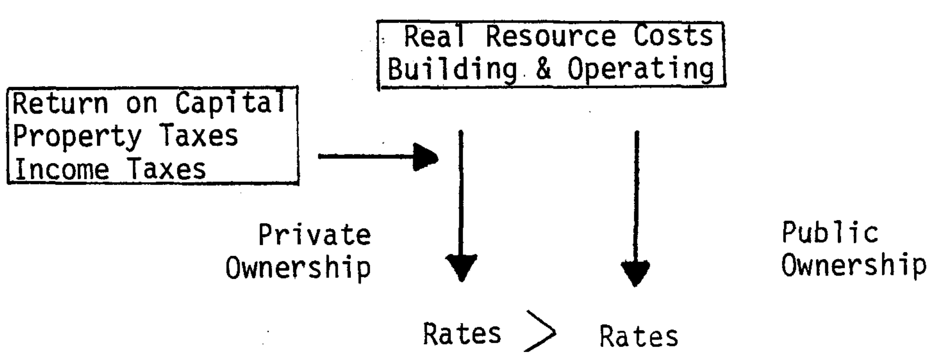
As the Boise geothermal project moves off the drawing boards, a decision will have to be made as to the ownership of the system - shall it be a publicly owned utility or a privately owned firm. This is an important decision that should be carefully made. This section will not be concerned with the ideological question of public versus private ownership, but rather the questions of costs, rates, and regulation.

Making the assumption that the efficiency with which the system could be operated by the public entity and the private entity is the same, it follows that the real resource costs of the system in terms of pipe, concrete, pumps, valves, insulation and the like would be identical. It takes the same resources to build the system, regardless of who owns it. Again making the assumption of equal efficiency, the real resources in terms of labor, power and equipment to operate and maintain the system would be identical.

The real resource costs would be identical, but there could be differences in the rates charged to the users of the system depending on the ownership. The possible differences in rates follow from insitutional aspects of our political and economic system. Privately owned utilities have property taxes and franchise taxes levied on their operations, they must pay income taxes upon earnings, they must borrow in the private capital markets, and to exist over time they must earn a return on the resources that are tied up in the system. If the utility does not earn a return sufficient to attract resources, disinvestment will take place. A good example would be many of the nations railroads. North Idaho has just seen the bankruptcy of the Milwaukee Railroad, much of which will likely be abandoned. The firm could not earn a return on the investment - a signal that societies resources could better be used elsewhere.

The taxes that are levied upon utilities are in essence a contribution made to the social overhead of the system - the defense, the welfare, the police, the fire protection and the educational systems to name a few. Many of these services are not in any way directly connected with the production or distribution of the utility services. These taxes reflect the decision of the political system. Localities have been forced to rely on property taxes, while the state and the federal governments have put more stress on income taxes. These levies are not for the most part related to services received - they are levies to pay for the public sector. The incidence of the taxes - who really pays them - is a subject of some dispute, but in imperfectly competitive markets as a regulated utility is, one would expect much of the tax to be shifted forward to the buyer of the service. The owners are entitled to a fair return and the tax can be viewed as a cost to be covered. If the taxes are not shifted forward to buyers, they will fall upon the owners or the employees of the firm in the form of a lower rate of return or wages. In regulated utilities with an assured return, it would be reasonable to expect the taxes to be shifted forward to the purchaser of the service.

The diagram below summarizes the points made thus far on the costs, taxes and rates. These institutional considerations would result in higher rates for a privately owned system.



On the basis of rates, it would seem that public ownership would be clearly preferable to private ownership, but additional factors must be considered. The lower rates for the publicly owned system result from the fact that the customers of the publicly owned system are not making a contribution to the social superstructure through their rates and the investment does not have return enough to insure that resources can be maintained in the industry. There is an implicit subsidy to the users of the system from the rest of the society. This is perhaps clearest in the case of property taxes. The mill levy is based on the assessed valuation in the jurisdiction. A decrease in the valuation with the same budget results in higher taxes for everyone else in the district. The use of the tax exempt securities has an similar effect in that some are able to avoid paying taxes.

In Boise the alternative sources of energy for space heating would be primarily gas and electricity which are delivered by Intermountain Gas and Idaho Power Company. These are, of course, private utility companies regulated by the Idaho Public Utility Commission. This fact relates to the purpose of the Boise geothermal project. The purpose of the project is to demonstrate the economic feasibility of a geothermal heating district in the 1970's and beyond. The economic feasibility will involve customers comparing their payments for geothermal energy with those made for the alternative sources. Comparing private electric rates and public geothermal rates is like comparing apples and oranges. There is no question that if enough subsidies are given to a service, people can be made to use it, but that is hardly economic feasibility. From an equity standpoint, it would be questionable for the general taxpayer including the user of electricity and gas to be picking up part of the costs of the geothermal system via the taxation process. It would seem that if the project is to demonstrate the economic viability of a geothermal district, the pricing of the service should be such that it could cover all the costs that would exist if it were a private utility. This would be important even if the city decides to own and operate the system. Pricing in this fashion would preserve the option of selling the utility to private operators should the voters of the city elect this option. Failure to do this would result in a situation analagous to the competitive relationship of the railroads, the barge lines and the trucking industry. The latter two modes do not pay rates on the right of way sufficient to provide a return and cover property taxes. The problems of this type of competition are legion and cause serious problems for the regulating authorities. In addition, this pricing approach would negate any criticism that the city was subsidizing the energy costs to some segments of our society at the expense of the users of other utilities.

In summary the pricing of the geothermal energy should be at a rate sufficient to cover the full costs of a private utility. This would lead to useful cost comparisons among alternative sources of energy, and preserve the option of selling the system at a later date if the city owns and operates it at first. This is certainly not intended to be advocacy of private or public ownership, but simply a suggested guide for pricing that would enhance the usefulness of the project to the Boise community and preserve options for the city.

The regulatory process would differ with the organization of the system. A private system would be regulated by the Idaho Public Utilities Commission, while a city operated system would be supervised by the local government.

The Idaho Public Utility Commission has extensive experience in rates and costs and competitive interaction, while some of this would be a new activity for the local government which would entail real costs. It is also very likely that the rates and the rate structure decision would involve conflict with the private utilities in the community. City operation and regulation might offer more flexibility than the private operation in that portions of the time consuming regulatory process might be avoided. This could be especially important in a new type of operation in which the economic and the operational problems are only projected.

The organizational decision will be a difficult one to make and may be forced by the funding source that is used for the project. In light of the attempt to demonstrate the viability of the geothermal heating district concept, the choice of the organizatonal structure should be made on grounds other than cost because the costs to the society of public or private ownership will be identical.

G. Projected System Operating Costs

The projection of operating expenses serves two purposes. It provides data that is necessary in determining the appropriate rates for delivered water and it provides data utilized in the cash budgeting for the project. The operating expense projection at the end of this Section is on an annual basis and includes some general assumptions. These assumptions are:

- That the economy of Idaho continues to grow at a rate that is similar to the growth rates experienced in the past.
- That the pump operator is skilled in basic plumbing and pump repair, and performs routine maintenance on the pumping equipment.
- That all distribution system maintenance can be performed with equipment and personnel assigned to the project.
- That inflation rates accurately reflect Idaho and the increases that will be found in the costs of goods and services.

With these assumptions in mind, the projected operating expense budget can be broken down into four categories: 1) personnel, 2) maintenance, 3) energy requirements, and 4) administrative overhead. Expenses for each of these categories are forecasted through 1995 in Table 11.

1. Pumping

The pumping stations, producing and reinjection wells, and initial delivery plumbing for a geothermal system can be operated by one experienced pump operator. With modern telemetry equipment, it is possible to have the wells located at several geographic locations with central control. The pump operator would be responsible for day to day operations, minor maintenance on the pumps and well site equipment, and monitoring the entire system.

Table 11. Projected Operating Expenses for the Boise Geothermal Project

	1982	1983	1984	1985	1986	1987	1988
Personnel							
Pump Operator	$ 25,424	$ 27,280	$ 29,271	$ 31,408	$ 33,701	$ 36,161	$ 38,801
Maintenance	25,424	27,280	29,271	31,408	33,701	36,161	38,801
Assistant	16,924	18,160	19,485	20,908	22,434	24,072	25,829
System Manager	33,849	36,320	38,971	41,816	44,869	48,144	51,659
Total Personnel	$101,621	$109,040	$116,998	$125,540	$134,705	$144,538	$155,090
Maintenance							
Pump Repair	$ 2,000	$ 2,200	$ 2,420	$ 2,662	$ 2,928	$ 3,220	$ 3,542
Supplies: Pumps	2,000	2,240	2,508	2,809	3,147	3,524	3,947
Lines	5,000	5,600	6,272	7,024	7,867	8,811	9,868
Total Maintenance	$ 9,000	$ 10,040	$ 11,200	$ 12,495	$ 13,942	$ 15,555	$ 17,358
Administrative							
Supplies	$ 300	$ 324	$ 350	$ 378	$ 408	$ 441	$ 476
Communications	600	600	600	600	600	750	750
Insurance	600	600	720	720	720	864	864
Travel/Ed.	2,000	2,000	2,000	1,000	1,000	1,000	1,000
Office Rent	2,400	2,568	2,747	2,940	3,145	3,366	3,601
Answering Service	300	321	343	367	393	420	450
Emergency Vehicle	3,600	3,852	4,121	4,410	4,718	5,049	5,402
Total Administrative	$ 9,800	$ 10,265	$ 10,881	$ 10,415	$ 10,984	$ 11,890	$ 12,543
Fixed Overhead	$120,421	$129,345	$139,079	$148,450	$159,631	$171,983	$184,991
Contingency (10%)	12,042	12,934	13,907	14,845	15,968	17,198	18,499
Total	$132,463	$142,279	$152,986	$163,295	$175,594	$189,181	$203,490
Energy Purchased Projected growth ratio from Dames & Moore Study, p. 7.	$113,607	$122,241	$131,531	$141,527	$155,114	$166,903	$181,423
Total Operating Expense	$246,070	$264,520	$284,517	$304,822	$330,708	$346,084	$384,913

Table 11. Projected Operating Expenses for the Boise Geothermal Project (Continued)

	1989	1990	1991	1992	1993	1994	1995
Personnel							
Pump Operator	$ 41,633	$ 44,672	$ 47,933	$ 51,434	$ 55,188	$ 59,217	$ 63,540
Maintenance	41,633	44,672	47,933	51,434	55,188	59,217	63,540
Assistant	27,714	29,737	31,907	34,237	36,736	39,418	42,295
System Manager	55,430	59,476	63,818	68,477	73,475	78,839	84,594
Total Personnel	$166,410	$178,557	$191,591	$205,582	$220,587	$236,691	$253,969
Maintenance							
Pump Repair	$ 3,897	$ 4,287	$ 4,715	$ 5,187	$ 5,706	$ 6,276	$ 6,904
Supplies: Pumps	4,420	4,951	5,545	6,210	6,955	7,790	8,725
Lines	11,053	12,379	13,865	15,529	17,392	19,479	21,817
Total Maintenance	$ 19,352	$ 21,617	$ 24,125	$ 26,926	$ 30,053	$ 33,545	$ 37,446
Administrative							
Supplies	$ 514	$ 555	$ 599	$ 647	$ 699	$ 755	$ 815
Communications	750	750	750	750	750	750	750
Insurance	864	1,036	1,036	1,036	1,244	1,244	1,244
Travel/Ed.	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Office Rent	3,853	4,122	4,411	4,720	5,050	5,404	5,782
Answering Service	581	515	551	589	631	675	722
Emergency Vehicle	5,780	6,185	6,618	7,081	7,577	8,107	8,675
Total Administrative	$ 13,242	$ 14,163	$ 14,965	$ 15,823	$ 16,951	$ 17,935	$ 18,988
Fixed Overhead	$199,044	$214,337	$230,681	$248,331	$267,588	$288,171	$310,403
Contingency (10%)	19,900	21,433	23,068	24,833	26,758	28,817	31,040
Total	$218,904	$235,770	$253,749	$273,164	$294,346	$316,988	$341,443
Energy Purchased	$197,207	$214,364	$233,014	$253,286	$275,321	$299,274	$324,311
Projected growth ratio from Dames & Moore Study, p. 7.							
Total Operating Expense	$416,111	$450,134	$486,763	$526,450	$569,667	$616,262	$666,754

These activities and responsibilities are similar to a pump operator for a cold water delivery system, and the skills required are the same. Presently, Boise Water Company employs several pump operators within their organization at an average salary of $14,000 per year, plus an additional 37% of salary in fringe benefits. Their benefit package is considered average for the area. The total salary expense for an employee with these skills in 1979 is estimated to be $20,580, and is consistent with the local salary scale.

Projecting the salary of the pump operator presents a problem in defining the anticipated wage and fringe benefit inflation expected between 1979 and 1995. Forecasting wages this far in advance leaves the opportunity for inaccuracies due to growth in Idaho, supply and demand for particular employee skills, national inflation trends, etc. Two resources were evaluated to develop the expected average increase in personnel costs over this fifteen year period.

The Department of Employment, State of Idaho, provided data on the annual average employment and annual payroll for Ada County from 1965 through 1976. The data was for unemployment insurance covered employees and includes government employees. Based on this data, the average wage increase has been 6.3% over the last eleven years. (Table 12)

The Economic Model for the State of Idaho, developed by Dr. Don Holley and Dr. Pete Lichtenstein has provided salary and wage forecasting data for several years. Although the model encompasses the entire state, it does categorize the forecasted wages into several areas, including a category titled Manufacturing Wage Rates. Based on data from 1967 through 1975, and for forecasted wages through 1980, the average change is 7.34%. The forecasted changes for 1977 through 1980 are:

1977-1978	7.45%
1978-1979	7.42%
1979-1980	7.40%

as predicted by the model (Table 13). There is a slight downward trend each of the three years, which may be significant in future budget planning. The model does not predict wages past 1980, therefore, is not directly usable in predicting wages through 1995.

It is difficult to develop model data that is accurate beyond a short time frame. Because the prediction period is long, and the Department of Employment data shows an average historical increase of 6.3% (perhaps low for skilled workers), the best course of action to provide for salary increases over time is to take the higher estimated average change (the Economic Model for the State of Idaho using both historical and predicted data) and budget according to this average change. Based on this approach, personnel costs have been forecasted with a 7.3% increase for each year through 1990. Using the higher increase percentage will allow for greater actual fluctuation in salary increases without serious impact on the projected expense over the next fifteen years. There are many variables that could influence the

Table 12.

Ada County Employment Data
Department of Employment

Year	Average Employment	Average Salary	Annual Change
1965	27,664	5,346	
1966	29,403	5,278	(1.3)
1967	29,892	5,754	9.0
1968	31,468	6,125	6.4
1969	34,133	6,511	6.3
1970	36,373	6,905	6.1
1971	38,885	7,208	4.4
1972	44,776	7,555	4.8
1973	48,400	8,099	7.2
1974	51,590	8,736	7.9
1975	54,259	9,695	11.0
1976	58,266	10,354	6.8

Average Annual Change 1965-1976 6.3

Table 13.

Estimated Manufacturing Wage Rates
Economic Model of the State of Idaho

Year	Estimated Salary	Change
1967	$5,616	
1968	6,032	7.4
1969	6,432	6.6
1970	6,802	5.8
1971	7,199	5.8
1972	7.718	7.2
1973	8,243	6.8
1974	8,909	9.1
1975	9,873	9.8
1976		
1977	11,412	
1978	12,263	7.5
1979	13,174	7.4
1980	14,149	7.4
Average Annual Change 1967-1980		7.3

future course of events that cannot accurately be predicted at this time, including wage and price guidelines by the federal government, etc.

2. Maintenance

Maintenance includes two general areas, distribution line maintenance and pumping equipment. The pumping equipment is subject to stress failure, friction, wear and tear, etc., as well as the usual small parts and gasket replacements. The pump operator can provide routine and regular maintenance and small repairs, but would need the assistance of a pump expert to perform the more complex repairs. This estimated repair expense is based on the experience of Boise Water Co. with similar size pumps in wells of similar depth. Many of their wells are operated in the summer irrigation season only, making the average annual operating period approximately 7.6 months. (31 wells in operation only during the six month irrigation season, and 11 wells in operation twelve months each year, 1977 data.) It is anticipated that the geothermal distribution system will be operational September through May, a nine month period. This pumping activity closely parallels the average experience of Boise Water Co., therefore it is believed that their experience in pump maintenance is similar to what can be expected with a geothermal pump. The BWC average maintenance cost per pump during 1977 was $1,800. This includes routine maintenance performed by pump operators. The contracted geothermal pump maintenance expense for 1982 is projected to be an additional $2,000, and because of the technical nature of the repair activities, it is projected to increase at a 10% annual rate, a rate that is 2.7% higher than the personnel cost increases, but only slightly higher than the expected increase in energy cost. Repair supplies are projected at $2,000 with a 12% increase per year, consistent with construction inflation rates.

The line and delivery system will have several miles of buried distribution pipeline, as well as the pumping equipment. The system will be large enough to keep a regular maintenance team of two busy. A decision will have to be made whether to contract the maintenance or to provide it on an employee basis. Maintenance personnel would be expected to be involved with meter reading, system monitoring, vacation relief, customer complaints, etc., and would appear to be the best approach with this system. One skilled maintenance person and one less skilled assistant would be able to perform the necessary maintenance and keep the system operational. The maintenance man will have approximately the same level of skills as the pump operator, therefore the 1976 base wage is the same, $20,580. The maintenance assistant wages are based on a salary of $10,000 per year, plus 37% fringe benefits.

The alternative of contracted maintenance through one of the local underground construction contractors would offer some advantages. The system, being new, may experience a lower maintenance need during the initial operating years. This could reduce the billable hours charged to the project by the contractor, and therefore reduce the initial years operating expenses. It must be remembered, however, that any underground contractor must charge a pemium to maintain a state of readiness in manpower and equipment. These costs may eliminate any potential savings that could be made from the initial system life reduced maintenance activity. Also the response time of the contractor may not be as quick as would be found with a system employee. Building heating is critical for the users, both commercial and residential. Although many will have backup heating capabilities, it is anticipated that new construction will probably not have an alternate heating system. Quick response to a system failure, then, could become a critical issue during the heating season. The liability for system failure could become a more important concern than the wages of the maintenance personnel.

Because this decision does not need to be made until system construction is completed, there is adequate time to evaluate both alternatives. Present recommendations are for employee oriented maintenance, unless it can be shown that a substantial cost savings can be made by utilizing contract maintenance.

In addition to the maintenance activities, there are repair supplies necessary to maintain the system. Construction costs have been inflating at approximately 1% per month over the last several years, and it is assumed that this inflation will continue. Therefore, the line maintenance supplies have been increased by 12% per year on the projected operating expense statement.

3. Administrative

Administrative costs include all components of the overhead for the management of the system. The system manager will monitor the overall performance and operation of the pumping and distribution system, prioritize and assign work responsibilities, plan, perform and coordinate system and customer activities, changes, etc., and be responsible for the efficient operation of the enterprise. Current Boise salary scales indicate that $20,000 per year, plus 37% fringe benefits would be needed to hire a system manager. This salary has been increased at the same rate as the pump operator and the maintenance supervisor.

A decision must be made concerning clerical support for the system manager. The preliminary budget does not include a salary allocation for clerical help, as the activities such as billing and report writing will be limited when the system becomes active. As the volume of system users expands, there could be the need for help with the billing activities. The initial plan calls for the maintenance and pump operation employees to assist with some of the office detail. This could provide several benefits to the enterprise. First, there would be more than one employee that would be familiar with office and administrative procedures, that could take over during period of illness, vacation, etc. Second, this cross training would provide the opportunity for employees to develop the necessary skills and knowledge to be considered for management responsibilities.

Supplies have been initially projected at $300 for the first year, and include the stationary and other supplies necessary to operate a business office. An estimated increase of 8% per year has been projected for these expenses.

Communications include a telephone charge for local calls. The basic phone fee is $18.72 per month in the downtown and first bench area, and should be appropriate for any selected office location. A phone will also be necessary in the primary pump house, making a total of $450 per year local charges. In addition to local calls, it is expected that an occasional long distance call will be made, and an additional $150 has been included in the budget to accommodate these calls. The nature of the telephone industry in recent years is such that the monthly charge has been very stable. Increased operating expenses have been compensated for by improved technology on rate adjustments for specific or specialized services. It is anticipated that sometime within the next ten years monthly rates will be adjusted upward, and the expense projections have increased communications expense by 25% in 1987 to allow for a rate increase. Historical data evaluation is of little consequence in making this determination, as the basic rate in Boise has remained unchanged for more than ten years. Discussion with the Idaho Public Utitilies Commission analysts provided input that led to this best estimate, although it is acknowledged that there could be some variance in the timing or size of the adjustment.

4. Insurance

There is some disagreement on the importance of insurance for a geothermal delivery system. Several insurance underwriters contacted were very concerned with the possible liability exposure from a system failure, and were unwilling to quote a premium without extensive underwriting analysis. The risk manager for the State of Idaho expressed some concerns, and urged caution in making a determination. A research associate with the Geo-Heat Utilization Center, Office of Energy, State of Idaho, indicated that his research found that this was not an area to be greatly concerned with. Blanket policies, generalized coverages, etc., appear adequate to protect from public liability claims. The delivery system is located under a roadbed or sidewalk, and there would be little opportunity for a leak to cause serious damage or flooding. It is assumed that the heat exchanger and plumbing that is located within a building would not belong to the system, therefore, would not present a liability exposure. If this were not the case, the budgeted premium would have to be reevaluated. A premium expense of $600 per year has been projected, with a 20% adjustment at two years, then every three years to cover the increased underwriting expense for policy renewal.

5. Travel and Education

Both management and the pump operator will have educational needs during the first few years of the project. Also, they will be asked to assist others with their geothermal expertise, as well as attending meetings and conferences dealing with geothermal energy. The budget allows for $2,000 for each of the first three years. At the end of the third year, it reduces to a $1,000 annual expense. This is a very controlable expense, and can be adjusted at the discretion of management during any period.

6. Office Rent

The business activities require that the system manager maintain a modest office. It is not anticipated that there will be a great deal of customer activity, therefore, the office could be located in almost any geographic part of Boise. A modest office rent of $200 per month has been budgeted with a 7% per year increase.

7. Emergency Vehicle

A small truck with tools and repair parts will be necessary to the maintenance function. Total cost of ownership and operation is budgeted at $300 per month, inflated at a 7% rate.

8. Contingency

Although every attempt has been made to fairly estimate system operating expenses, there are unanticipated influences on wages and costs. A modest 10% contingency has been added to allow for those unexpected influences.

9. Energy Requirements

The starting point to determine the energy required to operate the pumps and telemetry equipment was an analysis of the Boise Water Company data. The maximum output of the system is expected to be 134.9 mil ft^3 at a maximum flow of 8000 gpm. One factor that has not been considered in the cost of energy analysis is the effect of the artesian pressure on the pumping operation. The greater the artesian pressure, the less energy consumed in lifting the water from the ground and delivering it through the system. Also, there may be a need for additional pumping on the return flow to maintain line pressures for reinjection. Alternative disposal plans could also impact this additional energy use somewhat.

Based on present system design concepts, pump size and delivery flows, and Boise Water Company deep well energy cost data, anticipated energy costs for 1982 would be a maximum of 103,922. This calculation is based on the Boise Water Company cost of $0.0269940 per hundred ft^3 pumping cost in 1977, adjusted for inflation through 1982. The energy cost assumes that the pumping cost for reinjection equals the cost of well pumping, and that the water volumes are the same. The projected growth rates can be found in the Dames and Moore Study, page 7. The projection of energy costs through 1995 have utilized data developed in a recently released study "Natural Gas Supply Requirements for the State of Idaho," prepared for the Idaho Publc Utilities Commission by Dames and Moore Consultants, San Francisco, California. The study has evaluated an extensive data file and has projected on a year by year basis the expected increases in the cost of electrical energy. These projected cost increases have been accepted and used as a basis for the estimated energy costs on the projected operating expense summary. It is believed that these estimates of cost increases are as accurate as any that are presently available.

10. Conclusion

It is believed that the attached Projected Operating Expense Summary describes costs to operate a geothermal system in Boise through the year 1994. Assumptions that have been made with regard to annual increases/ adjustments to accommodate inflation and economic trends are subject to revision in time, as forecasting for more than a year or two always requires a number of "educated guesses." With present conditions, it is believed these projected expenses are reasonable and appropriate.

H. Cash Flow Projections

A cash budget identifies cash needs on a month by month basis during the life of a project. The primary purpose of this detailed analysis of cash outflow is to allow for capital planning. Because the Boise Geothermal Heating project will be utilizing funds from several sources, it is critical that estimates be made as to when these funds will be needed. This will provide adequate lead time for report preparation, funds requests and any other documentation that might be necessary to keep the funds flowing properly.

The cash budget is basically considered planning data, and will be subject to revision for numerous reasons. Every attempt has been made to ascertain the special conditions that will impact this particular project, and to incorporate these into the data. The original cost figures are from the PON, and no attempt has been made to refine or change this data. Therefore, the cash budget matches those recorded in the PON.

Several general assumptions were made in the preparation of the cash outflow budget. These assumptions are as follows:

- There is a 30 day lag on payment for goods and services, with the exception of the well driller and drilling expenses. These were accounted for in the month that they are scheduled to occur.
- For the major construction activities (distribution systems) one-third of the cost is accounted for in the first month of the project. This is to accommodate delivery of materials for the entire project at its inception.
- Inspection and project administration costs are distributed evenly over the life of the activity/project.
- Design costs have been allocated over the anticipated design time.
- Materials delivery for retrofit have been distributed to allow for varying delivery schedules.
- Project cash flows are for Phases I through V of the system described in PON submitted to DOE in July 1978.

Total Project Cost (pg. 59,60 in PON)	$15,316,500
Less Phase 0, completed in 1978	3,409,000
Cost of Phases I through V	$11,907,500

The time schedule of project activities is defined in the schedule following page 14 in the PON.

Combining these assumptions and the budget recorded in the PON results in the cash flow estimates shown in Table 14.

Table 14.

BOISE GEOTHERMAL PROJECT

INVESTMENT CASH OUTFLOWS

Month	1979	1980	1981	1982
January	$ 5,000	$ 226,400	$ 314,000	$ 189,600
February	68,100	944,400	306,600	212,600
March	89,100	285,400	341,500	136,600
April	41,600	290,400	355,500	133,600
May	73,100	298,400	325,500	186,600
June	100,600	261,600	267,500	142,600
July	170,100	1,614,600	210,500	141,600
August	164,600	467,600	186,600	144,600
September	123,600	492,500	223,600	169,600
October	137,600	308,500	124,600	168,600
November	256,600	256,000	167,600	50,600
December	249,600	319,000	162,600	400
Annual Total	$1,479,600	$5,764,800	$2,986,100	$1,677,000

Project Total for Phses I through V: $11,907,500

Prepared by: Behling & Merz
Date: December 14, 1978

Table 14. (Cont.)

CASH BUDGET BOISE GEOTHERMAL
1979 First Half Outflows

Activity	Jan.	Feb.	Mar.	Apr.	May	June
Secure Permits	5,000					
Environmental Assess.		10,000	10,000			
Geological Survey		40,000	40,000			
Data Analysis				5,000		
Boise Well #1						
Design Well					5,000	
Contract Driller					2,000	
Move In/Set Up					7,000	
Drill Well					40,000	40,000
Refurbish East Well						
Prepare Specs		4,000				
Equipment Delivery			10,000	10,000	5,000	5,000
Well Testing						2,500
Refurbish West Well						
Prepare Specs/Design		7,500	7,500			
Contract				1,000		
Inspect West Well					3,500	3,500
Geothermal Well #2						
Design Well						5,000
Geothermal Well WSWD						
WSWD Geological Survey			15,000	15,000		
Well Design						5,000
Project Administration						
Phase I Activities		4,000	4,000	4,000	4,000	4,000
Phase II Activities						29,000
Phase III Activities				4,000	4,000	4,000
Documentation		2,600	2,600	2,600	2,600	2,600
Monthly Totals	5,000	68,100	89,100	41,600	73,100	100,600

TOTAL -- $377,500

Table 14. (Cont.)

1979 Second Half

Activity	July	Aug.	Sept.	Oct.	Nov.	Dec.
Boise Well #1						
Drilling	20,000	16,000				
Well Test/Analysis			3,000	2,000		
Develop. Decision					2,000	
Pump Station Design						3,000
East Well Equip. Del.	10,000					
Refurbish		9,000	9,000			
Well Testing	2,500					
West Well Equip. Del.		20,000	20,000	30,000	15,000	
Construct Pump Station					20,000	20,000
Market & Rate Study						5,000
Boise Well Pipeline						
Design						21,000
River Run Pipeline						
Design				6,000	6,000	6,000
Injection Well-Design				20,000		
Drilling Contract					8,000	
Move In/Set Up					16,000	
Drill Well					150,000	150,000
Boise Well #2						
Driller Contract	2,000					
Move In/Set Up	7,000					
Drill Well	40,000	40,000	24,000	20,000		
Well Test/Analysis						2,500
Project Administration						
Phase I Activities	4,000	4,000	4,000	4,000	4,000	4,000
Phase II Activities	29,000	29,000	29,000	29,000	29,000	29,000
Phase III Activities	4,000	4,000	4,000	4,000	4,000	4,000
Documentation	2,600	2,600	2,600	2,600	2,600	2,600
New WSWD Well						
Contract Driller	2,000					
Move In/Set Up	7,000					
Drill Well	40,000	40,000	28,000	20,000		
Well Test/Analysis						2,500
Monthly Total	170,100	164,600	123,600	137,600	256,600	249,600

TOTAL -- $1,102,100

Table 14. (Cont.)
1980 First Half

Activity	Jan.	Feb.	Mar.	Apr.	May	June
Well #1						
Pump Station Design	3,000	3,000	3,000			
Pump Equip. Delivery					10,000	30,000
Construct Pump Station					4,000	4,000
West Well Pump Station	20,000					
Construction Inspection	12,000					
Market & Rate Study	5,000	5,000	5,000	5,000		
Boise Well Pipeline						
Design	21,000	21,000	21,000	21,000	20,000	
River Run Pipeline						
Design	6,000					
Materials Delivery		600,000				
Construction		150,000	150,000	150,000	150,000	150,000
Warm Springs Pipeline						
Design	12,000	12,000	12,000	12,000	11,000	
Pipeline Inspection		5,000	5,000	5,000	5,000	
WS Collection Pipeline						
Design	2,800	2,800	2,800	2,800	2,800	
Injection Well-Drilling	100,000	100,000	36,000			
Well Testing					10,000	10,000
Boise Well #2						
Test/Analysis	2,500					
Pump Station Design		3,000	3,000	3,000	3,000	
Boise Well #3-Design			5,000			
Driller Contract				2,000		
Move In/Set Up				7,000		
Drill Well				40,000	40,000	28,000
Project Administration						
Phase I Activities	4,000	4,000	4,000	4,000	4,000	4,000
Phase II Activities	29,000	29,000	29,000	29,000	29,000	29,000
Phase III Activities	4,000	4,000	4,000	4,000	4,000	4,000
Documentation	2,600	2,600	2,600	2,600	2,600	2,600
New BSWD Well						
Well Test/Analysis	2,500					
Design Pump Station		3,000	3,000	3,000	3,000	
Monthly Total	226,400	944,400	285,400	290,400	298,400	261,600

TOTAL -- $2,306,600

Table 14. (Cont.)
1980 Second Half

Activity	July	Aug.	Sep.	Oct.	Nov.	Dec.
Well #1--Equip. Del.	40,000	5,000				
Construct Pump Station	4,000	4,000	4,000	4,000		
Pump Station Test				3,000		
Boise Well Pipeline						
Materials Delivery	600,000					
Construction	59,000	59,000	59,000	59,000	59,000	59,000
River Run Pipeline						
Construction	150,000	150,000	171,000			
Warm Springs Pipeline						
Materials Delivery	210,000					
Construction	39,000	39,000	39,000	39,000	39,000	39,000
Pipeline Inspection	5,000	5,000	5,000	5,000	5,000	5,000
WS Collection Pipeline						
Materials Delivery	330,000					
Construction	61,000	61,000	61,000	61,000	61,000	61,000
Injection Well						
Design Station	8,000	8,000	8,000	8,000		
Equipment Delivery						60,000
Retrofit Design - Pub.			3,000	3,000	3,000	3,000
Boise Well #2						
Equipment Delivery	20,000	25,000	25,000	23,000		
Construct Pump Station	5,000	5,000	5,000	5,000	5,000	2,000
Inpsection		1,500	1,500	1,500	1,500	1,500
Start Up						3,000
Boise Well #3--Drill	20,000					
Test/Analysis			1,500	1,500		
Project Administration						
Phase I Activities	4,000	4,000	4,000	4,000	4,000	2,000
Phase II Activities	29,000	29,000	29,000	29,000	29,000	29,000
Phase III Activities	4,000	4,000	4,000	4,000	4,000	4,000
Phase IV Activities		3,000	3,000	3,000	3,000	3,000
Documentation	2,600	2,600	2,600	2,600	2,600	2,600
Interm Report						5,000
Boise Well #3						
Design Pump Station					3,000	3,000
New WSWD Well						
Equipment Delivery	20,000	30,000	30,000	16,000		
Construct Pump Station	4,000	4,000	3,000	3,000	3,000	3,000
Inspection		1,500	1,500	1,500	1,500	1,500
Retrofit Design-Priv.			5,400	5,400	5,400	5,400
WSWD Meters		27,000	27,000	27,000	27,000	27,000
Monthly Totals	1,614,600	467,600	492,500	308,500	256,000	319,000

TOTAL -- $3,458,200

Table 14. (Cont.)
1981 First Half

Activity	Jan.	Feb.	Mar.	Apr.	May	June
Phase II						
Construct Pipeline- Boise Well To City	59,000	59,000	59,000	59,000	59,000	59,000
Construct Pipeline - Warm Springs Avenue	39,000	39,000	39,000	39,000	40,000	
Pipeline Inspection	5,000	5,000	5,000	3,000	3,000	3,000
Retrofit City Hall, etc.						
Prepare Specs	3,000	4,000				
Contract						
Equipment Delivery				23,000	22,000	28,000
Retrofit Heating Systems						
Injection Well						
Equipment Delivery	70,000	70,000	60,000			
Construct Injection Sys.				25,000	25,000	25,000
Boise Well #3						
Design Pump Station	3,000	3,000				
Equipment Delivery			19,000	19,000	19,000	19,000
Construct Pump Station			5,900	5,900	5,900	5,900
Retrofits - Specs.	5,400					
Equipment Delivery			27,000	55,000	24,000	
Retrofit						
WSWD Well--Start Up	3,000					
Specs for Retrofit						
WSWD Meters	27,000	27,000	27,000	27,000	27,000	27,000
Collection Pipeline	61,000	61,000	61,000	61,000	62,000	
Maintenance Equipment						50,000
Project Administration						
Phase II Activities	29,000	29,000	29,000	29,000	29,000	29,000
Phase III Activities	4,000	4,000	4,000	4,000	4,000	4,000
Phase IV Activities	3,000	3,000	3,000	3,000	3,000	3,000
Documentation	2,600	2,600	2,600	2,600	2,600	14,600
Monthly Totals	314,000	306,600	341,500	355,500	325,500	267,500

TOTAL -- $1,910,600

Table 14. (Cont.)
1981 Second Half

Activity	July	Aug.	Sep.	Oct.	Nov.	Dec.
Construct Pipeline to City	59,000	59,000	59,000	59,000	59,000	59,000
Pipeline Inspection	3,000	3,000				
Retrofit City Hall etc.		23,000		21,000		27,000
Construct Inject. Station	25,000	25,000	37,000			
Boise Well #3--Pump Station Equipment Delivery	19,000					
Construct Pump Station	5,900	6,000				
Startup			3,000			
Retrofits	27,000		54,000		24,000	
Specs for Retrofit			6,000		6,000	5,000
Meter WSWD	27,000	26,000				
Retro Mall - Specs			20,000		20,000	
Retrofit Mall - Equip Delivery						
Retrofit Heating System						
Retrofit Post Office, Bank of Idaho, Idaho 1st, Specs.					15,000	
Maintenance Equipment						50,000
Project Administration						
Phase II Activities	29,000	29,000	29,000	29,000	29,000	10,000
Phase III Activities	4,000	4,000	4,000	4,000	3,000	
Phase IV Activities	3,000	3,000	3,000	3,000	3,000	3,000
Phase V Activities	6,000	6,000	6,000	6,000	6,000	6,000
Documentation	2,600	2,600	2,600	2,600	2,600	2,600
Monthly Totals	210,500	186,600	223,600	124,600	167,600	162,600

TOTAL -- $1,075,500

Table 14. (Cont.)
1982 First Half

Activities	Jan.	Feb.	Mar.	Apr.	May	June
Spec's for Retrofit	6,000					
Equipment for Mall Retrofit	90,000	90,000	90,000			
Retrofit Heating System				37,000	40,000	40,000
Retrofit Post Office, Bank of Idaho, Idaho 1st - Specs.	17,000	15,000				
Equipment P.O. Retrofit				50,000	50,000	57,000
Pipeline - Boise Well to City	59,000	61,000				
Design State Street Pipeline	6,000	6,000	6,000	7,000		
Construct State Street Pipeline					85,000	34,000
Retrofit HEW, etc. - Equipment Delivery Retrofit		29,000	29,000	28,000		
Project Administration						
Phase IV Activities	3,000	3,000	3,000	3,000	3,000	3,000
Phase V Activities	6,000	6,000	6,000	6,000	6,000	6,000
Documentation	2,600	2,600	2,600	2,600	2,600	2,600
Monthly Totals	189,600	212,600	136,600	133,600	186,600	142,600

TOTAL -- $1,001,600

Table 14. (Cont.)
1982 Second Half

Activity	July	Aug.	Sep.	Oct.	Nov.	Dec.
Retrofit Mall Heating System	40,000	40,000	40,000	40,000		
Equipment for Retrofit of Post Office, etc.						
Retrofit Post Office, Bank of Idaho, Idaho 1st	37,000	40,000	40,000	40,000		
Construct State Street Pipeline	34,000	34,000	34,000	34,000		
Retrofits	17,000	17,000	17,000	17,000	18,000	
Inspect Retrofits	2,000	2,000	2,000	2,000	2,000	
Project Administration						
Phase IV Activities	3,000	3,000	3,000	3,000	3,000	
Phase V Activities	6,000	6,000	6,000	5,000		
Documentation	2,600	2,600	2,600	2,600	2,600	400
Final Report			25,000	25,000	25,000	
Monthly Totals	141,600	144,600	169,600	168,600	50,600	400

TOTAL -- $675,400

I. Computer Modeling of Possible Prices

1. Model Background

In 1976, Battelle Pacific Northwest Laboratories developed a computerized simulation model which designs systems of geothermal heating districts and calculates cost attendant to the production, distribution and disposal of hot water.[1] The model, called GEOCITY, consists of two submodels. One simulates the development and operation of geothermal wells (reservoir model) and the second simulates the design and operation of the distribution system. These two submodels in tandem calculate the total cost of geothermal energy for space heating.

GEOCITY has apparent possible value, in areas with potential geothermal resources suitable for space heating, because the cost of geothermal heat can be compared with other available energy forms. By using a simulation model such as GEOCITY, "what if" questions can be asked and answers rapidly received via computer output.

With the gracious cooperation of Battelle personnel, data pertinent to Boise's weather, population and geothermal resource together with relevant financial information, were treated by the GEOCITY model in a comparison of five different district heating modes. These district types, identified and defined by the model, are explained in Table 15.

2. Description of Residential District Types for Use in the Geocity Model

Many residential areas in the United States can be described by one of five residential district types defined in the GEOCITY model data base. These district types are:

- Suburban
- High density single family
- Garden apartments
- Townhouses
- Highrise apartments

The district type parameters of peak heat demand, hot water demand, density, reject temperature and diversity factor have been calculated for each of these district types. The user may use these district types as defined or may modify one or more parameters as required.

Peak heat demand was calculated by designing typical residential units for each district type and calculating the heat loss according to ASHRAE* procedures assuming -5° outside temperature, 67°F inside temperature and a 15 mph wind. Floor plans, dimensions and construction parameters for each of

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[1] McDonald, C.L.; Bloomster, C.H.; and Schulte, S.C.; GEOCITY: A Computer Code for Calculating Costs of District Heating Using Geothermal Resources. Battelle Pacific Northwest Laboratories, Richland, Washington. February 1977. Explanatory narrative for this simulation is taken from this publication.

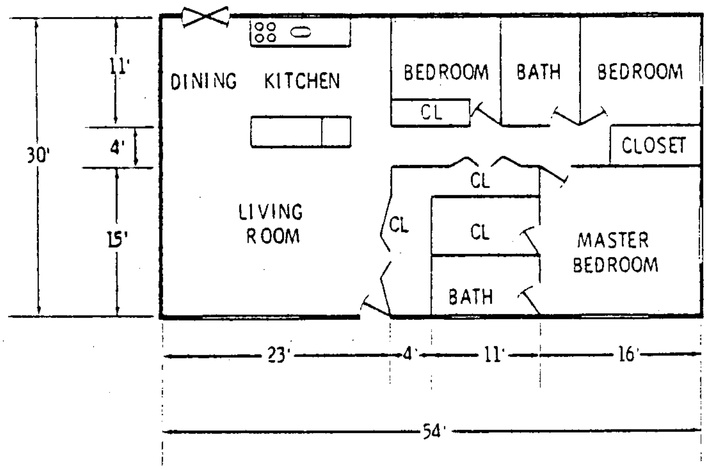
Table 15.[2]

DESCRIPTION OF THE FIVE RESIDENTIAL DISTRICT TYPES DEFINED BY THE GEOCITY MODEL

District Type	Density (Buildings/ sq. mile)	Building Peak Heat Demand (MB tu/hr)	Building Hot Water Demand (gallons/ day	Number of Residences Per Unit	Floor Area (sq. ft./ Residence)
1. Suburban	2560	0.053	60	1	1620
2. High Density Single Family	4480	0.034	55	1	1000
3. Garden Apartments	293	1.38	3030	60	990
4. Townhouses or Rowhouses	373	0.9	1515	30	1012
5. High Rise Apartments	385	1.728	5400	108	780

2. Data for Table 15 and those contained in district descriptions following are from the citation in footnote 1, on the preceeding page.

Table 15 (Continued)

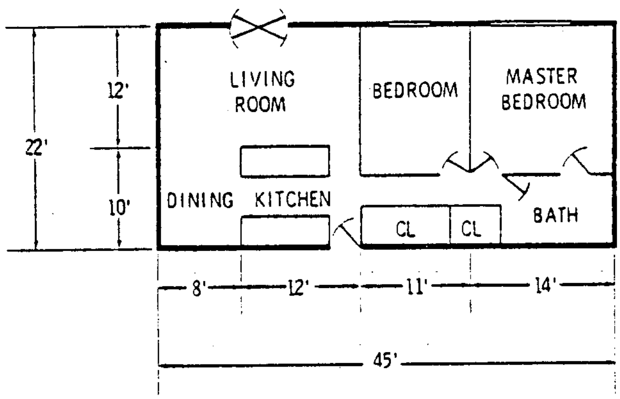


Plan of Suburban Residential House
125 x 30 ft. Attached garage not shown.

Design Basis for Suburban Residential
House 125 x 30 ft

SUBURBAN RESIDENTIAL		
NUMBER OF STORIES - 1		
DIMENSIONS		
FLOOR ft^2	1620	
EXTERIOR WALL AREA ft^2	918	(NET OF GLASS)
GARAGE WALL AREA ft^2	240	
WINDOW GLASS ft^2	186	
DOOR AREA ft^2	21	
CEILING ft^2	1620	
STORY HEIGHT ft^2	8	
CONSTRUCTION PARAMETERS		
FLOOR	MAPLE FINISH FLOORING ON YELLOW PINE SUBFLOORING.	
EXTERIOR WALLS	BRICK VENEER, BUILDING PAPER, WOOD SHEATHING, STUDDING, METAL LATH, 2 in. INSULATION	
CEILING	METAL LATH AND PLASTER, 6 in. INSULATION	
WINDOWS	DOUBLE-HUNG WOOD WINDOWS	
DISTRICT TYPE PARAMETERS		
PEAK HEAT DEMAND	53,000 BTU/hr	
HOT WATER DEMAND	60 gallons/day	
DENSITY	2560 HOUSES/SQ. MILES	
REJECT TEMPERATURE	100 °F	
DIVERSITY FACTOR	0.7	

Table 15. (Continued)

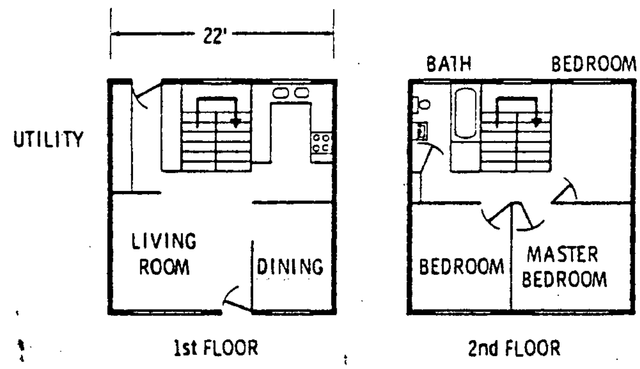


Plan for Garden Apartment Unit

Design Basis for Garden Apartment Unit

GARDEN APARTMENT	
NUMBER OF STORIES	EACH APARTMENT IS ONE STORY AND IS CONTAINED IN A 2 STORY BUILDING
DIMENSIONS	
FLOOR ft^2	990
EXTERIOR WALLS ft^2	617
WINDOWS ft^2	82
DOOR ft^2	21
CEILING	1/2 (990) FOR HEAT LOSS
STORY HEIGHT ft	8
CONSTRUCTION PARAMETERS	
FLOOR	MAPLE FINISH FLOORING ON YELLOW PINE SUBFLOORING
EXTERIOR WALLS	BRICK VENEER, BUILDING PAPER, WOOD SHEATHING, STUDDING, METAL LATH, 2 in. INSULATION
CEILING	METAL LATH AND PLASTER 6 in. INSULATION
WINDOWS	DOUBLE-HUNG WOOD WINDOWS
DISTRICT TYPE PARAMETERS	
PEAK HEAT DEMAND	1.38 MBTU/hr
HOT WATER DEMAND	3030 gallons/day
DENSITY	293 BUILDINGS/SQ. MILE
REJECT TEMPERATURE	100 °F
DIVERSITY FACTOR	0.7

Table 15. (Continued)

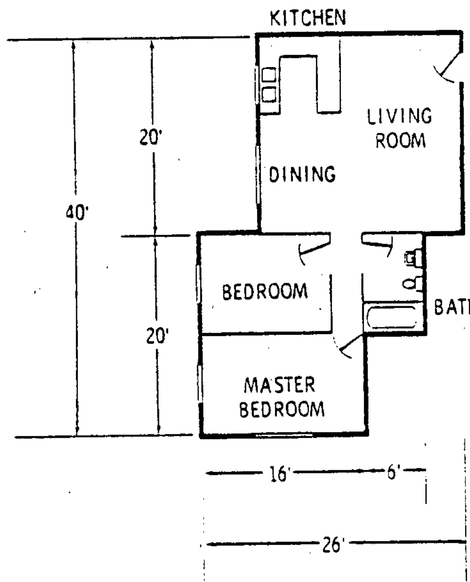


Plan for Townhouse Unit

Design Basis for Townhouse Unit

ROW HOUSE	
NUMBER OF STORIES - 2	
DIMENSIONS	
FLOOR ft^2	506 (1st STORY)
FLOOR ft^2	506 (2nd STORY)
EXTERIOR WALL ft^2	582
WINDOW ft^2	124
DOOR ft^2	21
CEILING ft^2	506
STORY HEIGHT ft	8
CONSTRUCTION PARAMETERS	
FLOOR	MAPLE FINISH FLOORING ON YELLOW PINE SUBFLOORING
EXTERIOR WALLS	BRICK VENEER, BUILDING PAPER, WOOD SHEATHING, STUDDING, METAL LATH, 2 in. INSULATION
CEILING	METAL LATH AND PLASTER, 6 in. INSULATION
WINDOWS	DOUBLE-HUNG WOOD WINDOWS
DISTRICT TYPE PARAMETERS	
PEAK HEAT DEMAND	0.9 MBTU/hr
HOT WATER DEMAND	1515 gallons/day
DENSITY	373 BUILDINGS / SQ. MILE
REJECT TEMPERATURE	100 °F
DIVERSITY FACTOR	0.7

Table 15. (Continued)



Plan for High Rise Apartment Unit
Eight Apartments per Floor

Design Basis for High Rise Apartment Unit

HIGH RISE APARTMENT	
NUMBER OF STORIES -	EACH APARTMENT IS ONE STORY AND IS CONTAINED IN A 9 STORY BUILDING.
DIMENSIONS	
FLOOR ft^2	780
EXTERIOR WALL ft^2	370
WINDOWS ft^2	78
DOOR ft^2	21
ROOF ft^2	1/9 (780) FOR HEAT LOSS
STORY HEIGHT ft	8
CONSTRUCTION PARAMETERS	
EXTERIOR WALLS	BRICK VENEER, BUILDING PAPER, WOOD SHEATHING, STUDDING, METAL LATH, 2 in. INSULATION
CEILING	METAL LATH AND PLASTER, 6 in. INSULATION
WINDOWS	DOUBLE-HUNG WOOD WINDOWS
DISTRICT TYPE PARAMETERS	
PEAK HEAT DEMAND	1.73 MBTU/hr
HOT WATER DEMAND	5400 gallons/day
DENSITY	385 BUILDINGS/SQ. MILES
REJECT TEMPERATURE	100^0F
DIVERSITY FACTOR	0.7

these district types are summarized in Table 15. Hot water demand is based on the number of residents in a typical building and ASHRAE design recommendations. Density data is an average of the values recommended in various planning books and zoning guides. The district type parameters used by GEOCOST are also summarized in Table 15.

3. Results of Model Use

The assumptive data used are lengthy and found in Section 4. Many assumptions are subjective. Changes in assumed values would obviously alter the results, but little effect would result in relative values among the five heating districts. In other words, proportionately there would not be much difference in the results, although absolute values could and would change depending on changes made in the assumptions.

For example, it was assumed that a private utility would be operating the sytsem necessitating the payment of various taxes. A public entity would be exempt from such costs and would result in lower energy costs to consumers. (Also lower tax revenues.) Further, each district was assumed to be one mile square. A change in the district configuration would result in a different piping system and a likely change in costs.

The summary contained in Table 16, shows the variance in energy costs depending on the type of heating district served.

TABLE 16

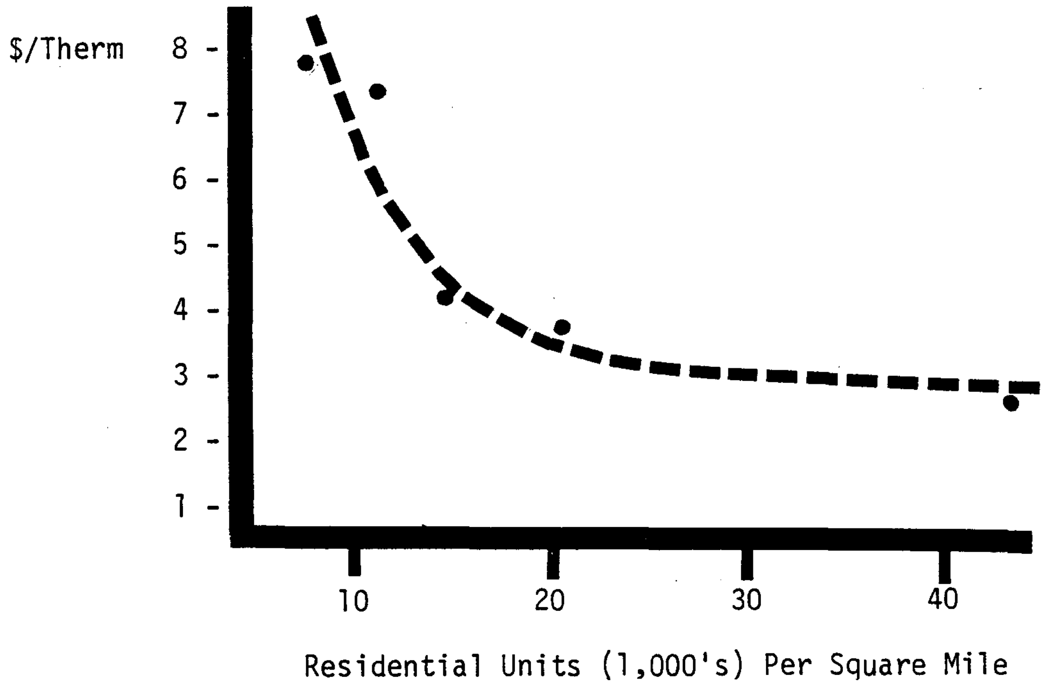
District Type	Cost of Heat $/Therm	Residences Per Square Mile
1. Suburban	.799	2,560
2. High Density, Single Family	.787	4,480
3. Garden Apartments	.382	17,580
4. Townhouses or Rowhouses	.432	11,190
5. High Rise Apartments	.328	41,580

The relationship between residential density and cost of geothermal space heating is apparent at a glance. When graphed, that relationship appears to decrease sharply to about 10,000 residential units per square mile and then diminish gradually out to 40,000 units as shown in Figure .

Obviously the least economical type of district to heat with geothermal water is the single family residence in a suburban setting. The economics of scale bring about significant reductions in costs between 10,000 and 20,000 residential units per square mile. These densities are not found in the Boise area, however.

FIGURE 16.

EFFECTS OF RESIDENTIAL DENSITY ON
COSTS OF GEOTHERMAL SPACE HEATING



The implications are, though, that relatively high density flooring such as office building complexes and public buildings would benefit most, economically, relative to other types of district. Or, a mixed district might be considered. If a system is designed to basically serve a high density area, any excess capacity could be used to run spur lines into lighter density areas. The cost of service would likely be lower for both.

The cash flow and power costs for the five hypothetical districts are shown in Tables 17 through 21 .

4. Data Assumed for the Geothermal District Heating Model

If values are not available, the default value will be used in the program. If the default value appeared to be unrealistic for Boise, an estimate was made.

ADGDAY <u>6100</u> — Total annual degree days (°F), used for calculating supplemental heat requirements.

DDGDAY <u>5800</u> — Degree days (°F) at the system design temperature. Average demand and total power sales are derived from this quantity.

TMIN
-20°F
: Minimum outdoor temperature (°F).

TDES
0°F
: Design outdoor temperature (°F).

TNEJ(N)
N=2
120
: Temperature °F of the water at the outlet of the building heating system for district type N.

DIVF(N)
N=2
.7
: Diversity factor for district type N. The diversity fact is used to reduce the size of mains supplying a district by considering that the peak load for all buildings in a district will not occur simultaneously.

ELDIFF(M)
M=1, 20
40 Ft.
: Elevation of district M above the end of the transmission line. This parameter alters the sizing of the pumps, and the calculation of pumping requirements.

PO
1
: Pipe option, controls the configuration of the conduit bundle (pipe, insulation, and casing). The pipe options are:

1. Two pipes, only supply insulated in common casing.
2. Two pipes, supply and return in common insulation and casing.
3. Two pipes, supply and return insulated separately in a common casing.
4. Two pipes, supply and return separately insulated in separate casing.
5. Two pipes, supply pipe insulated only and in separate casing from the return pipe.
6. Single pipe, supply insulated in casing.

PMO
1
: Pipe material options:

1. Carbon steel, schedule 40
2. Fiberglass reinforced plastic, schedule 40

IO
1
: Insulation options are:

1. Calcium silicate
2. Polyurethane foam

CO
1
: Casing options are:

1. Prefabricated steel, Class A casing
2. Prefabricated plastic (PVC) casing
3. Field erected poured concrete casing

TA
.0254
: Annualar air space size (meters). The annualar air space is between the insulation and the casing to allow air circulation to dry out the insulation.

DPTH
1
: Burial depth of casing (meters), measured from the top of the casing to the surface.

CP 1.3	Thermal conductivity of the pipe (joules/sec M^2 °C).
KINS .0156	Thermal conductivity of the insulation (joules/sec M^2 °C).
TG 278 °K	Year round average ground temperature, °K.
ETA .60	Combined efficiency of the pump and motor.
AVGWL 50	Average production life (years) of reservoir wells.
FLORAT 500,000	Flow rate (lb/hr) of the geothermal fluid from the reservoir well-head.
FRCEPW .2	Fraction of excess of producing wells to provide spare wells.
FRCNPW .2	Fraction of nonproducing (dry) wells.
PRDRAT 2	Ratio of injection well to producing well flow rate. (Default = 2.)
PWTEMP 76°C	Temperature of the geothermal fluid at the reservoir wellhead. Positive input values are treated as Centigrade and negative input values as Fahrenheit.
WELSPC 20	Reservoir well spacing in acres.
WPH2S .002	Weight percentage of hydrogen sulphide in the geothermal fluid at the reservoir wellhead.
WPCO2 0	Weight percentage of carbon dioxide in the geothermal fluid at the reservoir wellhead. (Default = 0.975%.)
WPCH4 0	Weight percentage of noncondensible gases other than hydrogen sulphide, carbon dioxide, and methane in the geothermal fluid at the reservoir wellhead. (Default = 0.)
TOTNCG .002	The total weight percentage of noncondensible gases is calculated in subroutine LOAD as the following sum of noncondensible gases: TOTNCG = WPH2S + WPCH4 + WPONCG
EVALUE(N) .015	Design parameters to change the internal diameters of all pipes in the fluid transmission system in order to alter the pressure degradation.
PSALVG .1	Fraction of transmission or disposal pipe that can be salvaged from a depleted or plugged well and used with a replacement well.

PLINJP Distance (meters) from the city to the injection field.
1000

DINPUT(N)

275 (8) Reservoir power level (MWe).

50 (9) Depreciable life of reservoir wells (years).

40 (26) District heating system operating life (years).

40 (61) District heating system operating life (years).

NYC Number of years to construct the district heating system.
2

WLEAK Percentage of fluid lost to leakage in the distribution system.
0

TRCCF Trenching difficulty factor, used to change the cost of trenching
1 depending on local conditions.

CSHEAT Cost of supplemental heat ($/MBtu). The difference in demand
4 between design conditions and the coldest weather is met by using an auxiliary heat source to elevate the temperature of the circulating water.

VMBTU Value of one million Btu's (F/MBtu), used for determining the
4 value of lost heat for optimization of the insulation thickness.

AC Annualized cost factor, this input factor is used only in the
.1 pipe and insulation optimization routines.

Mike Merz

DCPW Total cost ($) of all tasks involved in drilling one producing
$40,000 well.

DCNPW Total cost ($) of all tasks involved in drilling one nonproducing
$30,000 well.

DCINJW Total cost ($) of all tasks involved in drilling either one
$40,000 exploratory well or one injection well.

PERCNT(N) Fraction (not percentage) tangible and intangible parts respec-
N=1,2 tively of the drilling costs for producing wells.
3/4,1/4

CINLAB Cost of labor ($/ft) for installing pipe insulation in the fluid
$2 transmission system.

DINPUT(N)

.7 (4) Fraction of initial investment in bonds.

.08	(5)	Bonds interest rate.
.10	(6)	Earning rate on equity after taxes.
.40	(7)	Federal income tax rate.
.065	(15)	State income tax rate.
0	(16)	State gross revenue tax rate.
.03	(17)	Property tax rate.
.0005	(19)	Property insurance rate.
5%	(27)	Royalty payments; percentage of reservoir annual power sales.
.02	(28)	Transmission system maintenance rate, fraction of transmission capital cost.
.70	(39)	Fraction of initial investment in bonds.
.08	(40)	Bond interest rate.
.10	(41)	Earning rate on equity after taxes.
.40	(42)	Federal income tax rate.
.50	(44)	Depreciable life of power plant (years).
.065	(50)	State income tax rate.
0	(51)	State gross revenue tax rate.
.03	(52)	Property tax rate, fraction of district heating system capital investment.
.01	(53)	Interim capital replacement rate, fraction of district heating system capital investment.
.0005	(54)	Property insurance rate, fraction of district heating system capital investment.
LL2 1		Depreciation option for recovering the reservoir and district heating system capital costs, including interim capital requirements. 1 = straight line 2 = sum-of-years-digit
CKW .015		Cost of electricity (F/KwH).

TABLE 17.

DISTRICT #5 - HIGH RISE APARTMENTS
CASH FLOW AND POWER COSTS

Cost Distribution	Detailed Cash Flow Cents Per Therm	Detailed Cash Flow Annual ($ Millions)	Equivalent Cash Flow Cents Per Therm	Equivalent Cash Flow Annual ($ Millions)
Initial Plant	2.427078	.11450	3.599142	.16979
Interim Capital Replacements	.350075	.01651	.667401	.03148
Energy Supply	16.783631	.79175	17.950407	.84679
Operating Expenses	9.104696	.42951	9.737643	.45936
Porperty Taxes & Insurance	.772759	.03645	.826480	.03899
State Revenue Tax	2.130770	.10052		
State Income Tax	.068816	.00325		
Federal Income Tax	.395959	.01868		
Bond Interest	.747289	.03525		
Total Cost of Heat	32.781073	1.54642	32.781073	1.54642

TABLE 18.

DISTRICT #3 - GARDEN APARTMENTS
CASH FLOW AND POWER COSTS

Cost Distribution	Detailed Cash Flow Cents Per Thrm	Detailed Cash Flow Annual ($ Millions)	Equivalent Cash Flow Cents Per Thrm	Equivalent Cash Flow Annual ($ Millions)
Initial Plant	3.243808	.07921	4.734952	.11562
Interim Capital Replacements	.467878	.01142	.891986	.02178
Energy Supply	18.732181	.45740	20.034418	.48920
Operating Expenses	10.777016	.26315	11.526220	.28145
Property Taxes & Insurance	1.032797	.02522	1.104596	.02697
State Revenue Tax	2.488991	.06078		
State Income Tax	.081194	.00198		
Federal Income Tax	.467176	.01141		
Bond Interest	1.001132	.02445		
Total Cost of Heat	38.292173	.93502	38.292173	.93502

TABLE 19.

DISTRICT #4 - TOWNHOUSES OR ROWHOUSES
CASH FLOW AND POWER COSTS

Cost Distribution	Detailed Cash Flow Cents Per Thrm	Detailed Cash Flow Annual ($ Millions)	Equivalent Cash Flow Cents Per Thrm	Equivalent Cash Flow Annual ($ Millions)
Initial Plant	3.627562	.05752	5.192046	.08232
Interim Capital Replacements	.523230	.00830	.997511	.01582
Energy Supply	20.819682	.33011	22.267039	.35306
Operating Expenses	12.664376	.20081	13.544787	.21476
Property Taxes & Insurance	1.154981	.01831	1.235274	.01959
State Revenue Tax	2.810383	.04456		
State Income Tax	.076049	.00121		
Federal Income Tax	.437577	.00694		
Bond Interest	1.122819	.01780		
Total Cost of Heat	43.236658	.68556	43.236658	.68556

TABLE 20.

DISTRICT #1 - SUBURBAN
CASH FLOW AND POWER COSTS

Cost Distribution	Detailed Cash Flow Cents Per Thrm	Detailed Cash Flow Annual ($ Millions)	Equivalent Cash Flow Cents Per Thrm	Equivalent Cash Flow Annual ($ Millions)
Initial Plant	12.972133	.07257	18.845834	.10542
Interim Capital Replacements	1.871065	.01047	3.567093	.01995
Energy Supply	30.629471	.17134	32.758792	.18325
Operating Expenses	18.997394	.10627	20.318068	.11366
Property Taxes & Insurance	4.130204	.02310	4.417330	.02471
State Revenue Tax	5.193963	.02906		
State Income Tax	.311896	.00174		
Federal Income Tax	1.794601	.01004		
Bond Interest	4.006392	.02241		
Total Cost of Heat	79.907117	.44700	79.907117	.44700

TABLE 21.

DISTRICT #2 - HIGH DENSITY, SINGLE FAMILY
CASH FLOW AND POWER COSTS

Cost Distribution	Detailed Cash Flow Cents Per Thrm	Detailed Cash Flow Annual ($ Millions)	Equivalent Cash Flow Cents Per Thrm	Equivalent Cash Flow Annual ($ Millions)
Initial Plant	14.238647	.09051	20.917964	.13297
Interim Capital Replacements	2.053744	.01305	3.915360	.02489
Energy Supply	28.046926	.17828	29.996713	.19068
Operating Expenses	17.817554	.11326	19.056208	.12113
Property Taxes & Insurance	4.533450	.02882	4.848609	.03082
State Revenue Tax	5.117765	.03253		
State Income Tax	.375569	.00239		
Federal Income Tax	2.160968	.01374		
Bond interest	4.390231	.02791		
Total Cost of Heat	78.734854	.50048	78.734854	.50048

V. LEGAL OVERVIEW

One of the foremost legal concerns to a developer of geothermal energy (as apparent from legal work done on this project) is the problem of interpreting the legislative intent and regulations surrounding geothermal leasing, drilling and ongoing production. In this regard, the Geothermal Resource Act and accompanying regulations are not court tested and are still in their infancy. As such, whether or not a particular geothermal project, depending on when it was first founded and for what purpose it is being used, even comes under the scrutiny of Idaho Geothermal Resources Act is not clear. The legal effect of the language of the Act is also unclear as to what extent geothermal development is to be regulated. A very close working relationship with the Department of Water Resources and Land Commission is vital to insure compliance with the state regulations surrounding geothermal development (see Appendix C for a detailed analysis).

In addition to the above and the assessments made in the research memorandum attached in the appendix, legal advice, counseling and review of the technical aspects of the project has been given. One of the main concerns, not identifiable at the beginning was developing a means of circumventing the potential problems associated with the Federal leasing requirements of the geothermal resources underlying the City of Boise's surface rights in Military Reserve Park. The end result of this research was the initiation of federal legislation which was passed by the United States Congress, and sponsored by Senator Frank Church. This federal legislation directed that the United States sell the geothermal resources underlying the Military Reserve Park to the City of Boise in lieu of opening such resources to the competitive bidding requirements of the Federal Steam Act.

The passage of this legislation has put to rest the legal concerns associated with the leasing and development requirements of the Federal Steam Act that would have otherwise unduly burdened this project and the City of Boise.

In progressing into the implementation phase of this project all of the legal areas which have been identified to date must be reevaluated as technology, statutes and case law are continually being updated. Besides this continuing updating, new legal issues will appear in the implementation phase. Those that are identifiable at present are as follows:

- Formalizing the legal relationship between the City of Boise and Warm Springs.
- Identifying and formulating the type of entity to be formed to operate the geothermal system.
- Develop a workable plan of unitization of the resource to ensure the best and longest possible use of the resource without interferance with other geothermal users and or vested water rights.
- Assist in the preparation of the necessary legal documents associated with drilling and construction phases including: drilling ordinances, issuance of necessary permits, securing of water rights, securing geothermal rights, and environmental assessment.

- Coordinate with the City of Boise and Warm Springs as to legal questions and issues which will arise as the implementation phase progresses, but have not been identified at the present time.

These are the issues not yet researched or resolved. The legal research under this project has resulted in significant findings. These findings are discussed in detail in Appendix C of this document. The legal areas reported on in the appendix include:

- Detailed review of the U.S. Geothermal Steam Act of 1970.
- Review of the Idaho Geothermal Resource Act.
- The pattern of geothermal regulation in other states.
- Evaluation of Idaho geothermal leasing statutes.
- Outline of legal steps required for geothermal development.
- Legal opportunities for cooperative or unit development of the geothermal resource.
- The effect of current case law upon Idaho.

Even as this document is being published there are new legal considerations developing in the Idaho Legislature. These considerations will have an impact on the future of the Boise geothermal project and, for this reason, must be carefully evaluated.

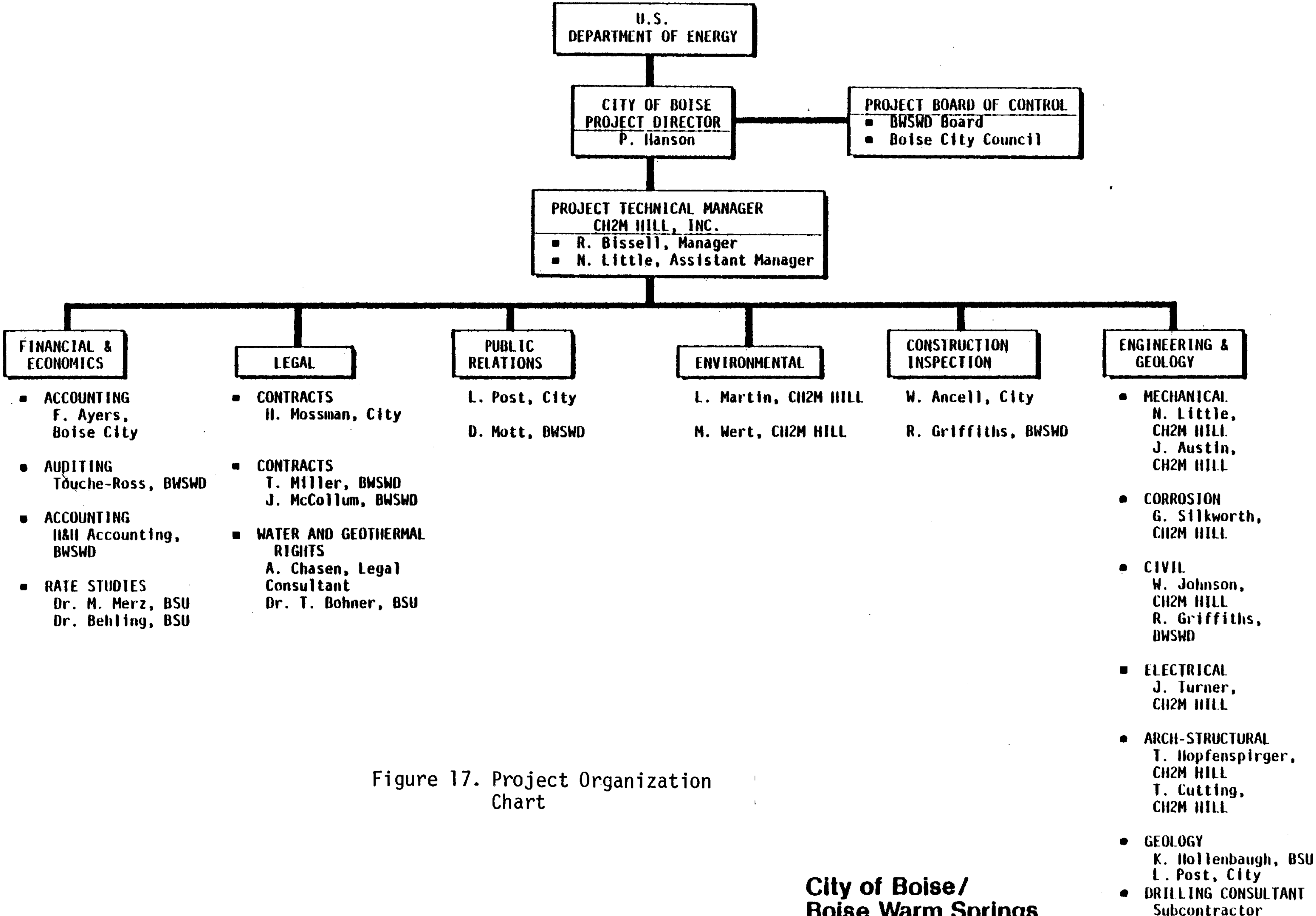


Figure 17. Project Organization Chart

**City of Boise/
Boise Warm Springs
Water District**

Identification No. B 10536

VI. ORGANIZATIONAL ALTERNATIVES

The institutional options available to insure development of geothermal energy cover a very wide range. The options chosen elsewhere include development under a private utility, by privately held corporations, by individuals, by special districts, by local governments, and by consortia of these groups. All of these options are possible in Boise but, as it has turned out, they are not equally probable.

All of those options noted above were discussed in the "Preliminary Boise City Geothermal Systems Plan." Subsequent to publication of that preliminary plan all of the options were explored with people in the community, and with entrepreneurs from outside of Boise. Each option was judged against the criteria of technical, management, financial, and legal capability to undertake an enterprize of this magnitude. Many of the options met all of these criteria to varying degree. But in the end the overriding criteria was interest in pursuing this enterprize. Measured against this criteria very few of the original options remained. The history of this interest is partially documented in Appendix E.

The only organizations remaining with any interest in implementing the project were the State government, the Boise Warm Springs Water District, Boise City, and some private individuals. Residual private interest has fallen, since award of the PON, into two groups. The first group consists of those individuals owning land on the resource and possessing an interest in having geothermal energy available, but having little interest in being the leading entrepreneurial force in geothermal development. The second group includes local entrepreneurs with varying forms of real property interest in the resource and also some interest in leading, or participating in the lead, geothermal development.

As it has developed these two groups will be accommodated in a couple of ways. The first group could become partners, in a manner not fully defined at present, with the Boise City-Warm Springs project. The second group may become partners by default. Many in this group, for one reason or another, have not been able to promote complete financial underpinnings for their own systems. In spite of this they appear to possess a persistent interest in initiating some form of geothermal enterprize and for this reason, any partnership that may develop with them will be complex. In some cases members of this group may develop some form of local geothermal enterprize within Ada County especially if they are associated with some other business, e.g. residential development, that may become geothermal users.

The future disposition of these groups remains to be seen. The balance of those interested include the State, the City, and BWSWD. The State has taken the lead in heating large buildings with geothermal, but also in the past have had an informal policy of desiring to be uers of this energy source without necessarily getting themselves into the energy business. The State is presently evaluating its role with respect to the Boise project, an evaulation which it is hoped will soon be concluded. Completion of this evaluation will define the States role in an evolving Boise geothermal project organization.

The remaining two entities interested in pursuing a geothermal enterprize are Boise City and Boise Warm Springs Water District (BWSWD). These two governments, one a city and the other a special district of the state, have formed a combined organization. As a result of this cooperative development the organizational future of geothermal energy will be determined by these two governments working together, at least for the next four years. At the present time these governments are working together under a series of informal agreements. It is being planned that these agreements will be formalized most likely, unless there are legal barriers, as a Joint Powers Authority. The informal cooperative agreement, or soon a JPA, will persist for the duration of the PON project. During the project a major decision will be the future disposition, beyond four years (1983 and following), of this cooperative arrangement. All of the future possibilities may be the same as those considered in the preliminary plan.

The various historical developments have resulted in the present cooperative arrangement. This arrangement includes a governing board, (Project Board of Control) made up of all the members of the Boise Warm Springs Water District Board, and the Boise City Council. Working within this Board is an Executive Committee composed of two BWSWD members and two City Council members. The Executive Board is responsible for day-to-day business of the Board and for formulating policy recommendations to the full Board. A project director reports to the Board and is responsible for overall project management. Working with the project director is a technical manager responsible for management of detailed project activities.

This organization, shown in Figure 12, will certainly evolve to different forms and functions in the future. One major task will be to plan for this evolution in the enterests of geothermal energy in the Boise area. In any event institutionalization of geothermal energy as an organization is no longer an academic question, as a very definite organization structure has been created to begin implementation of a geothermal project.

VII. CONSERVATION

A. Introduction

Americans emerged from the national energy crisis of the early 1970's with a new realization of their dependence upon energy. In Idaho, as well as in other western states, this dependence was amplified further as citizens survived a drought-parched 1977, watching reservoirs empty little by little, as water supplies and energy sources were increasingly threatened.

Our dependence upon fossil fuels and generated energy extends to all walks of life. The food we eat has been planted, fertizlied, harvested, processed, packaged, transported and finally prepared for consumption either directly or indirectly from fossil fuels and/or generated power. Much of what we own, wear and use has been manufactured through the use of energy. Housing, heating and transportation depend upon energy. In fact, everything we do on a daily basis requires some form of energy.

Among energy specialists a concensus of opinion is that conventional energy resources such as oil, gas, coal and uranium are physically limited and some, except perhaps for coal, are approaching exhaustion. It has been suggested that our oil and gas resources are diminishing at such a rapid rate that by the turn of the century supplies could be greatly depleted. Because civilization requires an increasing amount of energy merely to sustain itself, and because fossil fuel quantities are so limited in the U.S., the City of Boise feels that the time has come to take steps to seek alternative sources of energy, and, perhaps more importantly, to stress the urgent need for energy conservation. Most experts feel that conservation is perhaps the cheapest and most efficient method of solving the energy problem. Basically, the conservation situation is one of supply and demand. When the demand is greater than the supply, a shortage of energy occurs, suppliers charge more money, consumers are less apt to buy. As a result, energy supply can be rebuilt, a surplus occurs, and the price lowered on the national level. Conservation decreases the demand, because less energy is consumed. With this in mind, this report was written to:

- Provide insight into Boise City's energy problems.
- Discuss what programs have been initiated in the area.
- Suggest recommendations for Boise City officials.

B. Background of Energy Conservation in Boise City

Boise City is the fourth fastest growing city in the U.S. Due to this rapid growth, construction has increased appreciably, schools are bulging at the seams, and traffic is boggled at nearly every intersection. It is estimated that by the year 2000 the population in Ada County may reach 293,581, a 161.6% increase from 1970.* This extreme projected growth will result in an increase in energy demand. Even if the per capita demand remains the same, a highly unlikely situation, the energy demand for Ada County in the year

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*Robin Meal and Jack Weeks, Population and Employment Forecast-State of Idaho, Series 2, Projections 1975-2000. Idaho Department of Water Resources and Boise State University, Center for Research, Grants and Contracts, Boise, July 1978, pp. 10-13.

2000 could reach as high as 60 trillion BTU's, or twice what it is now, necessitating a greater supply of energy. Since at present Ada County residents are utilizing approximately 80 million gallons of gasoline per year and 1.4 billion KWH's of electricity per year, it is easy to see why conservation efforts must begin in years prior to 2000.

In summary, Ada County's greatest energy demand appears to be for fossil fuels. Unfortunately, these fuels may be the most difficult to obtain in the future. Electricial demand is highest in Boise, with the residential sector accounting for most usage. It is interesting to note, however, that the greatest users for length-of-time occupied may well be large public buildings and offices. Although these structures are occupied for only 8 to 12 hours per day, space and water heating, cooling and lighting systems--often the major users in a building's energy budget--continue to operate a full 24 hours. Fortunately, however, in these large public buildings and offices, heating and lighting can be controlled, and it is usually easy to implement positive conservation techniques and programs. With the assistance of a well-guided conservation program, Boise City could cut energy demand from 10 to 30 percent, enabling the City itself to take the lead, thereby setting a positive example for the entire community.

During the summer of 1977, Richard R. Eardley, Mayor of Boise City, asked the City Building Department staff and other City departments, along with citizens of the community, to cut back on energy use, particularly in use of water. The following steps resulted:

- Lighting: Downtown street lighting was reduced by turning off two lights at each intersection.

  Reduction in number of bulbs near Morrison-Knudsen Building where there were more lights than in similar locations.

  Reduction in lighting on the Capitol Boulevard, Vista, Broadway, Fairview-Main-Chinden interchange, Orchard overpass, Cole Road interchange, Curtis Road overpass (pending ACHD/State approval).

  Further reductions are possible, or some lights could be turned back on, depending on review and statistics involving vandalism and accidents.

  Residential street lighting was left untouched for security reasons.

  Incandescent street lights maintained by Boise City are currently but gradually being replaced with high pressure sodium vapor lights. Incandescent lighting on Harrison Boulevard is being replaced at a savings of approximately 300 watts per blub--each sodium lamp having a lifetime of four years, compared with the six-month lifespan of an incandescent bulb. Lights at the Union Pacific train depot and on the Capitol Boulevard bridge have been changed to 100 watt sodium.

- Parks watering: a 10% reduction was effected in electrical pumping needs, along with a reduction of water use during summer months.

- Public: Businesses were asked to review lighting needs and to reduce sign and store lighting where possible and within safety limits. Residents were asked to do the same, especially concerning watering. A 25% decrease in watering was requested and achieved.

- Other areas: During the summer of 1977 the Boise City Police Department effected a change in police vehicles, choosing a mid-size model rather than the larger, less economical model.

  State environmental officials were asked about reducing levels of treatment for sewage disposal plants--a heavy energy user--during times that water flows in the Boise River are adequate to prevent environmental damage.

Many of the above energy conservation plans are underway at present throughout City operations, most noteably at the Airport, Library, Fire Stations and within the Park Department. Each department was asked to determine ways within its own operation to reduce electrical consumption. Each has responded with a variety of methods with a range of savings from large to small--one example calling for the shutting down of the airport escalator for 4 1/2 hours each night during hours of extremely limited airline traffic.

Another foresightful plan that Boise City has had in operation for many years involves the recovery and use of methane gas at the Lander Street sewer plant. The methane powers blowers which aerate the treated water. Leftover sludge is sold as fertilizer. These early experiments with biogas conversion point out the great potential in methane recovery for the Boise Valley where huge feedlots create a water quality problem and useful waste remains unused.

Boise City has also formed a RE-HAB (rehabilitation) low-interest program for elderly and low-income bracket individuals to upgrade housing and heating systems for more efficient utilization of energy. In many cases storm windows and doors--even complete furnace systems--have been added. In some instances it was necessary to remodel the complete house. This program appears to be the only operable plan in the U.S. that has achieved such success in the area of rehabilitation.

Not to be ignored is Boise City's realization of the importance in use of its foremost natural resource-geothermal energy--in public, commercial, and residiental buildings. This potential has been studied and promoted by the City since 1976. It is planned that 1979 will produce an innovative geothermal large-scale implementation program for the downtown sector as well as lay the goundwork for the residential areas along the fault line.

Another significant conservation milestone occurred in February, 1978, when Boise City passed an ordinance that sets up a minimum standard for heat loss in new residential structures, including single-family dwellings, multifamily houses, apartments, condominiums and town houses. Rather than concentrating on regulating insulation standards, this ordinance attempts to maximize energy efficiency by measuring BTU's escaping per living unit -- average square foot heat loss not to exceed 24 BTU's. City officials advise that not only is this approach the only noteworthy plan in the U.S., but that minimizing heat loss this way may be more efficient and may cause fewer regulatory problems than a compulsory insulation code.

Boise Urban Stages (BUS) operates a total of 20 buses and is the 7th fastest growing bus line in the nation. An estimated 27.3% more riders were using BUS during August of 1978 than were riding during August of 1977. The fare has been raised recently to 35¢ per ride, $11.00 monthly, and 15¢ for senior citizens who ride from 9:00 a.m. to 3:30 p.m. weekdays and all day Saturday. New rates are effective February 1, 1979. Door to door service is offered in special cases (senior citizens and handicapped individuals); free transfers are given and free rides are extended upon request to passengers traveling within the central business district. BUS is expanding rapidly, but since it relies on public support to further its services, ways must be found to encourage a greater level of public interest and use for this valuable transportation mode and conservation design.

Boise City also offers a vanpool program. Valley Commuter Ride operates one van from Kuna, two from Meridian, and two from southwest Boise with an average occupancy of 9.06 passengers per van and an average trip of 39.6 miles. Cost is low, ranging from $25 to $35 per month. Poolers average an annual savings of 396,000 vehicle miles, or 26,400 gallons of gas and $67,320 in operating costs annually.*

Carpooling is a method of transportation rapidly gaining favor as fuel prices increase. Boise City's carpool program, initiated in 1975, has met with some success. A computer matches interested individuals living in the same area, so that a pool can be formed. This method has succeeded fairly well for those working normal 8:00 to 5:00 hours, but has seen limited success for others. Carpoolers receive parking discounts at the Eighth and Grove Street parking lot, and the average Boise pooler driving 21 miles per day saves approximately $148 in gas annually.

Another area in which conservation has been practiced in Boise City involves Boise Warm Springs Water District, a non-profit corporation in operation since the 1980's, and servicing as many as 400 customers at a time with 170°F geothermally heated water from its two wells. The system provides for approximately 200 customers at present, but hundreds more hold places on a waiting list.

More conservation techniques have evolved as the State of Idaho's Energy Department has become actively involved with innovative ideas in the areas of conservation and alternative energy sources. The State's program in conservation includes, but is not limited to, the following measures:

- Education of the general public and of the public school systems throughout the state.

- Lighting and thermal standards.

- State and local government procurement programs.

- Carpool/Vanpool programs.

- Bicycle program.

- Right turn on red light to conserve gasoline consumption.

- Energy audit programs for schools, residential homeowners and state buildings.

- Weatherization program for low-income and elderly through State Health and Welfare Department.

- Education programs for transportation. Coordination with BUS. Working with legislative and administrative proposals concerning transportation.

- The program has many optional measures to include buildings, transportation, industry, commerce, agriculture, education communications.

- Working with individual cities and counties to assist in finding energy alternatives and conservation techniques.

- Producing many publications, packets and briefings regarding all energy sources and encompassing all walks of life. Personnel in the State Energy Office have delved into geothermal planning, solar development, utilization of energy from waste and other alternatives.*

In the area of conservation in education the Boise City School System has adopted an energy conservation curriculum which will be implemented at all levels of education from kindergarten through grade 12 and is the first major school district in the U.S. to adopt the entire program including ENERGY, THE ENVIRONMENT, AND THE ECONOMY, developed by the DOE and the National Science Teachers Association. Specific responsibilities will be assigned in specific areas -- science, math, social studies, and at each grade level students will study the energy curriculum at a different focus. The Idaho State Office of Energy will aid in funding, planning and implementation of this program.

C. <u>Recommendations</u>

1. Energy Audit

The Boise City Energy Office strongly recommends a comprehensive energy audit for City-owned facilities. Such a survey should be carried out at each of the buildings under consideration. In conducting this audit, it is recommended that the City Energy Office seek the services of professional building engineering and operating personnel. This audit should identify where energy is being used, where it is being wasted, and where corrective action could do most good. The results of an audit should be used to develop the following standards and to identify problem areas.

- Heating, lighting, air conditioning -- distinguishing between offices and warehouses.

- Installation of instruments, additional metering and/or control devices.

- Identify specialized machinery where special conservation measures can be developed.

- Create a formalized program for existing and newly constructed structures by:

  a. conservation measures,
  b. monitoring responsibilities and energy dollar savings,
  c. reporting procedures,
  d. regular plan of evaluation and updating.*

The City Energy Office shall evaluate annually the effectiveness and the economy of a conservation program in City buildings, including proposed downtown redevelopment. The annual report shall include recommendation for program improvement, if applicable.

2. General Conservation Recommendations

It is strongly suggested that the City Council adopt energy conservation standards beginning with the downtown area, then work toward all areas of community operations, so that energy efficiency is a prime consideration from the outset in any operation, activity or new construction. There are at present several conservation practices which require changes in existing laws, regulations and codes and also require coordination with government agencies, local organizations, the building community, utility companies and other organizations. These revisions include:

Working with the Public Utilities Commission to:

- Revise power utility rate structures, so that greater users of power are not favored economically.

- Implement peak-load and off-load pricing rates.

- Encourage use of easily read power meters which show not only the quantity of energy consumed, but also the cost of the energy.

Working with the zoning commission to:

- Encourage neighborhood grocery stores.
- Permit apartments in existing homes.
- Encourage neighborhood parks.
- Allow small offices in homes.

Working with the tax commission to:

- Encourage the state and federal governments to allow deductions for alternative energy devices and conservation measures--storm windows and doors, insulation, heat pumps--installed in businesses, secondary residences and rentals (including apartments).

- Encourage the federal government to allow deductions for the purchase of energy-efficient vehicles (cars, trucks, motorcycles)--any vehicle obtaining a minimum of 20 miles per gallon.

3. Alternative Energy Recommendations

As Boise City continues to grow, energy demand will increase to the point where conservation cannot make up the difference. Alternative energy sources must be employed before this occurs. These sources should be considered now, in fact, to save fossil fuels, cut down on pollution and save money. Following are suggestions for possibilities in this area now and for the future. Happily, some of these suggestions are in effect at present.

a. Geothermal Recommendations:

Boise City's planned downtown mall should be designed to utilize geothermal energy. The question of a closed mall structure versus an open mall structure must be resolved. Total energy efficiency must be the criterion.

Adopt and continue funding for large-scale development of geothermal energy.

Adopt regulations to design all new buildings in the downtown area so that the structures can be retrofitted easily to geothermal energy.

Study the feasibility of the geothermal energy as it corresponds with the PUC rate structure.

Require sufficient control systems, as well as proper metering techniques, for each building.

Implement cascading (secondary) uses as an important potential factor to conservation.

b. Solar Recommendations:

Design all new buildings to make maximum use of solar radiation.

Continue to encourage the federal government requirement that by the year 2050 a total of 25% of all structures in the U.S. will utilize solar energy.

Coordinate with appropriate agencies of all levels of government and with building contractors and other interested and involved individuals and agencies to formulate solar standards for Boise City.

Study solar techniques to ascertain ways to combine solar and geothermal energy for use in the downtown mall.

c. Solid Waste Recommendations:

Buy recycled paper when possible. White paper or newsprint is easier to recycle.

Recycle all paper used in City offices.

Revise filing procedures to utilize less copies.

Replace paper towels in restrooms with cloth-roller type towel dispensers.

Work with garbage collection agencies to explore the possibilities of:

- Weekly or bi-monthly pick up of aluminum cans, glass, paper, and newspapers for recycling. Boise's North End has done this for several years.

- Employ a formalized solid waste recovery program. This Office feels that a great deal of consideration should be given to the establishment of a phrolysis plant in Boise City.

4. Transportation Conservation Recommendations

In recent years, Boise City has worked diligently to improve the bus, carpool and vanpool systems. The following few additional measures would save taxpayers money and would help conserve energy resources:

Often city employees are less energy conscious with city-owned vehicles. Therefore, it might be a good idea to limit the number of vehicles loaned to city employees and the circumstances under which they are loaned. Bus passes could be supplied instead.

City-owned vehicles should have:

- Standard transmissions.
- Diesel engines.
- No air conditioners.
- The minimum mileage of 20 miles per gallon of gas.

Vanpooling and Carpooling could be encouraged by:

- Raising parking rates.
- Providing exclusive parking for pools that is close, convenient, safe, covered and insures assigned, guaranteed parking spots.

Provide bus passes for City employees at a lower rate.

Allow employees flexible hours to coincide with bus and pooling schedules.

Reduce lunch hours to discourage driving and/or provide interesting lunch hour activities (ping pong tournaments, etc.).

Provide a place where adolescents can park cars on Friday and Saturday nights to discourage "dragging Main Street."

Work with the zoning commission to devise a plan to cut down excess idling at drive-in banks and drive-in restaurants.

Provide funding for expansion of the bike plan system.

Provide good parking facilities for bicycles.

Boise City's BUS Board has proposed innovative ideas for the future, several of which could cut down pollution in the area. However, implementation of these procedures may be slowed by enforcement of the one percent iniative legislation. Nevertheless, BUS efficiency could be increased by the following:

- Have buses run later Monday and Friday nights to coordinate with downtown merchant shopping hours.

- During the Christmas season, have buses run every night and on Sunday.

- Persuade businesses to encourage bus riding and carpooling.

- Work with the County to add more buses to the line to serve areas such as Five Mile Road and Amity, Cole Road and outlying areas.

5. Heating and Cooling Conservation Recommendations

Heating and cooling expenses are Boise City's largest expenditures, yet the City has few programs encouraging solutions for the problem. In Boise City it would be possible to:

Persuade building owners to enforce controls on thermostats.

Require that heating and cooling systems be turned down to a reasonable temperature during the last hour of occupancy and be kept down when not in use.

Utilize outside air for cooling during summer nights where security permits.

Continue to augment implementation of a mass weatherization program including:

- Caulking and weatherstripping doors and windows.
- Insulating ceilings, floors and walls to trap escaping heat.
- Install year-round storm doors and windows.
- Berming up to window level in buildings where possible.

Require a yearly "check-up" for maintenance of heating and cooling systems.

Require that water heaters be set at maximum levels for difficult heating jobs.

Require all new buildings to:

- Utilize wood frame, thermopane windows.

- Insulate for efficiency.

- Include vestibules and entry areas designed to trap cold air at its initial entry point.

- Use automatic thermostats.

- Be designed so that they can be converted easily to geothermal energy--especially those structures in the downtown area and ultimately all new residential structures where possible.

In conclusion, it is impossible to overrate the importance of the continuance and implementation of conservation techniques for Boise City's downtown and residential areas. Citizens and agencies, as well as private business firms, must be encouraged to support and augment programs to relieve the present fossil fuel crisis and existent pollution problems.

Although Boise City can be acknowledged as far ahead of many cities in the U.S. in recognition and discovery of alternative energy sources and conservation techniques, there remain significant areas in which improvement must be accomplished. As stated in the preceding report, the following recommendations must be considered carefully in order to raise Boise City's level of conservation techniques to peak performance:

- Boise City energy audit.

- Coordination with Public Utilities Commission to correct rate structure for better utilization and conservation of electricity.

- Forging ahead strongly with geothermal planning and implementation.

- Looking closely at solar systems and solid waste disposal programs.

- Careful consideration of transportation conservation, especially with regard to City-owned vehicles, BUS system, vanpooling, carpooling, invocation of the one percent iniative notwithstanding.

As the citizens of Boise City strive toward significant improvements in conservation systems, the nation's leaders may well look to the west for excellence in energy innovation.

APPENDIX A

Property Ownership Patterns on the Boise Front (Major Parcels)

Knowledge of property ownership along the Boise Front is critical to both the short and long term success of any geothermal project. Ultimately surface and subsurface rights will play a role in development of a geothermal system. Subsurface rights are, of course, the most important. Under almost any circumstance these rights would be of material concern to a large geothermal system. In a negative sense, future system development must have sufficient knowledge of rights as the basis for probable litigation concerning water rights. Information collected about subsurface rights would constitute a data base upon which to draw in any future litigation. Surface rights may also be important in the event that access to hot wells may be across property on which there are no hot wells.

There are two sources of data describing property rights. One is the County Recorder, and the other the County Assessor. These records indicate "taxable" ownership and geographical configuration of parcels. This type of information is provided on pages A-2 to A-20. The data includes assessor's parcel number, area of parcel, legal owner for tax purposes, and owner address. This data is provided for each section of land presumed to be within the geothermal resource area and adjacent to Boise City incorporated boundaries.

The resource area is, of course, much larger. Any future resource development beyond the area shown in Figure B-1 must be based on a broader property ownership search. In addition to this limitation, it should be noted that only large real property parcels have been cataloged. At least for the near distant future leases will only be practical with large property owners. The data presented is accurate as of August 1978. As ownership will undoubtedly change, this data must be periodically updated.

On the tables provided in this appendix there are some special codes. An asterisk indicates that there are some improvements on the property. A (C) denotes the presence of a cold well on the property while an (H) signifies a hot well on the property. More detail about these wells are supplied in Appendix B.

I. T3N, R2E

A. Section 1 (Page A-21)

1. S1001110000 78.88 Acres
Highland Livestock & Land Co., Ltd., Box 488, Emmett, ID 83617

*2. S100131175 1.61 Acres
Edgar T. Hawkins, 1713 S. Curtis Rd., Sp. 5, Boise, ID 83705

*3. S1001212700 2.27 Acres
Brian C. & Louise Flowers, 1319 E. Washington, Boise, ID 83702

*4. S1001131250 60.57 Acres
Verna Severe Hawkins, Cont. Edgar T. Hawkins, 1713 S. Curtis Rd., Sp. 5, Boise, ID 83705

(C) 5. S1001130000 229.9 Acres (2 parts)
Earl W. Hawkins, et al., C/o Grover J. Hawkins, 345 Panorama Place, Boise, ID 83702

*6. S1001241600 8.57 Acres
Boise Police Assn., Box 935, Boise, ID 83701

7. S1001341250 25.573 Acres
Robert E. Brown, et al., 6881 W. State St., Boise, ID 83703

8. S1001340000 65.43 Acres
Maria Aldape, C/o Futura Industries, 410 Idaho 1st Nat'l Bank Bldg, Boise, ID 83702

*9. S1001232240 & S1001232250 .55 Acres
Gover T. Hawkins et us. Cont. R.W. Cushman

B. 3N2E Section 2 (Page A-22)

1. S1002111010, 112300 42 Acres (2 parts)
Claremont Realty Co., Box 2777, Boise, ID 83701

2. S1002131000 28 Acres
Claremont Realty Co., Box 2777, Boise, ID 83701

3. S1002131120 10 Acres
Claremont Realty Co., Box 2777, Boise, ID 83701

4. S1002123800 54 Acres (2 parts)
Claremont Realty Co., Box 2777, Boise, ID 83701

5. S1002126000, 120010 30 Acres (2 parts)
Claremont Realty Co., Box 2777, Boise, ID 83701

6. S1002210000 28 Acres (2 parts)
Claremont Realty Co., Box 2777, Boise, ID 83701

*7. S1002212310 12.25 Acres Boise Hills Village
Hills Village Associates 10-19-1977

8. S1002224500 3 Acres
Claremont Realty Co., Box 2777, Boise, ID 83701

9. S1002231025 3 Acres
Claremont Realty, Cont. L.E. Haight, Box 2777, Boise, ID 83701

10. S1002242500 3 Acres
Claremont Realty Co., Box 2777, Boise, ID 83701

11. S1002241180 22.9 Acres
Claremont Realty Co., Box 2777, Boise, ID 83701

(H) 12. R8222000005 .25 Acre±
H.F. Koch, 257 Circle Way Dr., Boise, Idaho 83702

(C) 13. No A.P. # 72.26 Acres U.S. Vets. Adm. Grounds Part of Ft. Boise Reserve
U.S. Veteran's Administration, 550 W. Fort St., Boise, ID 83702

14. S1002343450 4.11 Acres
Boise City, Box 500 Boise, ID 83701

15. No A.P. # 20.98 Acres Governor's Mansion Site
State of Idaho, Dept. of Lands, Office of the Director

16. No A.P. # 1.19 Acres Ft. Boise Military Cemetery
Boise City, Box 500, Boise, ID 83701

(H) 17. S1011120600 about 449 Acres± Military Reserve Park (undev.)
Boise City, Box 500, Boise, ID 83701

C. 3N2E Section 3 (Page A-23)

1. S1003111000 10.4 Acres±
Claremont Realty Co., Box 2777, Boise, ID 83701

(C) 2. No A.P. # 5.05 Acres Memorial Park
Boise City, Box 500, Boise, ID 83701

(C) *3. No A.P. # 8.01 Acres U.S. General Services Adm. Ft. Boise Reserve
U.S. General Services Adm., 550 W. Fort St., Boise, ID 83702

*4. No A.P. # 8.99 Acres U.S. Army HQ Ft. Boise Reserve
U.S. Army, 410 W. Fort St., Boise, ID 83702

D. 3N2E Sec. 11 (Page A-24)

*1. S1011223100 .92 Acres
Boise Ind. School District, 1207 W. Fort St., Boise, ID 83702

*2. S1011223100 13.1 Acres
Boise Ind. School District, 1207 W. Fort St., Boise, ID 83702

3. S1011223300 .94 Acres
Boise City, Box 500, Boise, ID 83701

*4. S1011223140 4.02 Acres± Elks Rehab. Center
Idaho State Elks Association, 9th & Jefferson St., Boise, ID 83702

(H) *5. S1011223300 6.3 Acres± Ft. Boise Comm. Center
Boise City, P.O. Box 500, Boise, ID 83702

6. S1011233600 19.5 Acres± Ft. Boise Park, Boise Little Theatre
Boise City, Box 500, Boise, ID 83701

*7. No A.P. # 4.1 Acres± Boy Scout & Girl Scout Areas
Boise City, Box 500, Boise, ID 83701

*8. S1011212700 12.5 Acres±
U.S. Bureau of Land Management, 550 W. Fort St., Boise, ID 83702

*9. S1011223000 4.6 Acres± Idaho Vets. Home
U.S. Veterans Administration, 550 W. Fort St., Boise, ID 83702

*10. S1011212900 3.03 Acres± Former Cottonwood School Site
Boise Ind. School District, 1207 W. Fort St., Boise, ID 83702

11. S1011212400 16.3 Acres± Flood Control Basins
Children's Home Finding Society of Idaho - no address

*12. R5032001780 6.12 Acres National Guard Armory
Boise City, Box 500, Boise, ID 83701

*13. R5032001675 5.04 Acres
Miles B. Thomas, et al., C/o Don J. Black, Box 1228, Boise, ID 83701

*14. S1011131200 2.38 Acres Treasure Valley Manor Nursing Home
Pacific Convalescent Foundations, Inc., Box 4304, Boise, ID 83705

15. R2884000080, R2884010005 15.7 Acres Lot 1, Blk 1, Foot
"The Public" (Boise City, Box 500, Boise, ID 83701)

16. S1011110400 13.4 Acres±
Howard W. & Sarah K. Paul, 1516 Shaw Mtn. Rd., Boise, ID 83702

17. S1011110100 4.9 Acres±
Howard W. & Sarah K. Paul, 1516 Shaw Mtn. Rd., Boise, ID 83702

*18. R8222250060 .2 Acre±
Cedric G. Easum Et. Ux., 1086 Krall St., Boise, ID 83702

*19. R8222250050 .2 Acre±
Irene Stewart, 1090 Krall St., Boise, ID 83702

*20. No A.P. # .04 Acre± Pumphouse site for Aldape Heights Subd.
Ditch Right of Way

*21. S1011323850 4.1 Acres±
Boise City, Box 500, Boise, ID 83702

*22. R1767000150, 1767000011, 1767000065, & 1767000100 8 Acres±
East Junior High School
Boise Independent School District, 1207 W. Fort St., Boise, ID 83702

*23. S1011336300 8 Acres±
Morrison-Knudsen Co., M-K Plaza, Boise, Idaho 83729

E. 3N2E Section 12 (Page A-25)

(C) *1. S1012110500 95 Acres±
Maria Aldape C/o Futura Industries Co., Drawer F, Suite 1010,
1 Capitol Center, 999 Main St., Boise, ID 83702

2. S1012141900 38 Acres±
Ernest E. Day et al., Box 8286, Boise, ID 83707

3. S101231300 60 Acres±
Robert L. Day, C/o Sunday Co., Box 8286, Boise, ID 83707

*4. S1012131400 2.07 Acres
Arthur L. Troutner et ux., Skyline Dr., Boise, ID 83702

5. R6121310100 3.95 Acres Lot 1, Blk 3, Northridge Sub #1
Day Realty Co. Inc., Box 8286, Boise, ID 83707

6. R6121310005 5.26 Acres Lot 1, Blk 1, Northridge Sub #1
Day Realty Co. Inc., Box 8286, Boise, ID 83707

7. S1012212500 4 Acres±
Joel C & Agnes E. Olsen, 657 Dana, Santa Paula, CA 93060

(C) 8. S1012223060 3 Acres
Joel C. & Agnes E. Olsen, 657 Dana, Santa Paula, CA 93060

(C) 9. S1012223380, 3381 1 Acre±
Steven A. Matecki, John S. and Muriel J. Matecki, 1680 Shaw Mtn. Rd,
Boise, ID 83702

*10. S1012223400 5 Acres±
David V. and Virginia L. Wheeler

*11. S1012223430 .6 Acre±
Joseph W. III and S. Jan Shelton

*12. R5785830490, -500, -510, -520, -530, -540, -550 15 Acres±
(Montevideo Sub. Common Areas)
Common Areas and Most Units Owned by Glenmar Enterprises, Inc., Box 7805, Boise, ID 83707

13. S1012325460 5 Acres± Foothills East #6, North Part
Danmor Development, Inc., 400 108th Ave., N.E., Bellevue, WA 98111

14. S1012233800 35 Acres±
Danmor Development, Inc., 400 108th Ave., N.E., Bellevue, WA 98111

15. S1012325460 10 Acres± Foothills East #6, South Part
Danmor Development, Inc., 400 108th Ave., N.E., Bellevue, WA 98111

16. S1012314900, -4980 37 Acres Foothills East #5
Danmor Development, Inc., Gary L. and Jeanne Drown, 400 108th Ave., N.E., Bellevue, WA 98111

17. S1012315150 .2 Acres±
Peter D. Quarles et al. and Ralph E. Colburn, 1302 S. Washington Avenue, Emmett, ID 83617

18. S1012315200 6.41 Acres
Peter D. Quarles et. al. and Ralph E. Colburn, 1302 S. Washington Avenue, Emmett, ID 83617

19. S1012315300 2 Acres±
Danmor Development, Inc., 400 108th Ave., N.E., Bellevue, WA 98111

(H) 20. S1012325600 65.73 Acres Proposed Morningside Heights Sub. #1
Horace H. Quarles Jr. and Peter D. Quarles and Ralph E. Colburn (Colburn Realty), 1302 S. Washington Avenue, Smmett, ID 83617

(H) *21 S1012346900 10 Acres
Boise Warm Springs Water District, Old Penitentiary Rd., Boise, ID 83702

(H) 22. S1012438400 40 Acres
State of Idaho, Department of Lands, Statehouse, Boise, ID 83702

23. S1012428040 4.5 Acres±
Day Realty Company, Box 8286, Boise, ID 83707

24. S1012428200 4.9 Acres±
Day Realty Co. Inc., Box 8286, Boise, ID 83707

25. R6121320005 to -0190 12 Acres± Northridge Sub. #2 (38 parcels)
Day Realty Co., Box 8286, Boise, ID 83707

26. S1012427960 5.3 Acres
Danmor Development, Inc., 400 108th N.E., Bellevue, WA 98111

(C) *27. S1012427880 2.75 Acres
Arthur L. Troutner et ux., Skyline Drive, Boise, ID 83702

28. S1012428220 5.1 Acres±
Day Realty Co., Box 8286, Boise, ID 83707

29. S1012417200 .4 Acres±
Ernest E. Day et al., Box 8286, Boise, ID 83707

30. S1012417300 1.51 Acres
John T. Ogden et ux., 3203 Bellomy, Boise, ID 83703

31. S1012417700 58 Acres±
Emma N. Day, Box 8286, Boise, ID 83707

F. 3N2E Section 13 (Page A-26)

(CH) *1. S1012438400 160 Acres Old State Penitentiary
State of Idaho, Dept. of Lands, Statehouse, Boise, ID 83702

*2. S1013241000 2.35 Acres
State of Idaho, Dept. of Lands, Statehouse, Boise, ID 83702

*3. S1013241100 .12 Acres
State of Idaho, Board of Correction

*4. S1013242000 1.18 Acres
Caroline Green, C/o Michael Baker, 2045 Rockridge Rd., Boise, ID 83706

*5. S1013241150 .76 Acres
H. Herman Koppes, Box 1226, Boise,ID 83701

6. S1013241160 .04 Acres
Silver Leaf, Inc., Box 1368, Boise, ID 83701

*7. S1013241125 1.2 Acres
Silver Leaf, Inc., Box 1187, Boise, ID 83701

8. S1013241500 1.15 Acres
Boise Stake, Church of Jesus Christ of Latter-Day Saints

*9. S1013241450 .14 Acres
Wilt and Eva Eytchison, c/o C.W. Simmons, 2971 Starview Dr., Boise, ID 83706

10. S1013241250 1.44 Acres
Boise Stake, Church of Jesus Christ of Latter-Day Saints

*11. S1013241175 .29 Acres
Omar and Velma Stallings, 2373 Goodman, Boise, ID 83706

(C) *12. S1013241750 8.76 Acres L.D.S. Church
Boise Stake, Church of Jesus Christ of Latter-Day Saints

*13. S1013241760 2 Acres±
Glenn F. and Ruth C. Blaser, Carl H. and Georgia L. Shaver.

14. S1013241550 1.48 Acres
Chester M. and Bette Belcher, 5158 S. 1870 E., Salt Lake City, UT 84117

*15. No A.P. Number

*16. No A.P. Number

*17. No A.P. Number

*18. No A.P. Number 2.4 Acres (Total of #15-18 above)
Idaho State Parks and Recreation Office, State of Idaho, Dept. of Parks and Recreation, Boise, ID 83702

*19. S1013233900 26 Acres± Part of Warm Springs Golf Course
Boise Water Corp., 500 W. Idaho, Boise, ID 83702

20. S1013322250 10 Acres± Part of Warm Springs Golf Course
Boise City, Box 500, Boise, Idaho 83701

21. S1013321200 30 Acres± Part of Warm Springs Golf Course
Boise City, Box 500, Boise, Idaho 83701

(H) *22. S1013321210 90 Acres± Part of Warm Springs Golf Course
Boise City, Box 500, Boise, ID 83701

23. S1013422700 .52 Acres
Mountain States Telephone and Telegraph Co., 218 N. Capitol Blvd., Boise, ID 83702

*24. S1013420000 39 Acres±
Neil W. and Barbara E. Pyle, Cont. Idaho Land Developers, 10 S. Cole Rd., Boise, ID 83704

25. S1013410000 40 Acres
Albert F. and Pauline M. Munio, 1405 Promontory Rd., Boise, ID 83702

26. S1013440000 40 Acres
Frank H. Davison, 617 Wyndemere, Boise, ID 83702

27. S1013431000 13 Acres
C.W. and Katherine B. Jones, 3100 Warm Springs Ave., Boise, ID 83702

*28. S1013321200 1.47 Acres±
Boise City, Box 500, Boise, ID 83701

*29. S1013432580 27.8 Acres±
Idaho Land Developers, Inc., 10 S. Cole Rd., Boise, ID 83704

G. 3N2E Section 24 (Page A-27)

1. S1013321210 5 Acres±
Boise City, Box 500, Boise, ID 83701

2. S1013432580 20 Acres±
Idaho Land Developers, Inc., 10 S. Cole Rd., Boise, ID 83704

3. No AP# 1 Acre
Louise D. Rose Estate, c/o Ivy Rose Bauer, 2048 Broadway, Boise, ID 83706 (This parcel is not listed on Tax Notices, but is mentioned as excluded from the legal description of parcel #111060.)

4. S1024111060 22.17 Acres (2/3 interest)
Ivy Rose Bauer, 2048 Broadway, Boise, ID 83706

S1024111070 11.08 Acres (1/3 interest)
Bruce and Beth Bowler, 1111 Shaw Mtn. Road, Boise, ID 83702

5. S1024113125 5.75 Acres
Craig and Barry Marcus, c/o Marcus-Merryweather Enterprises, Rm 625, 1st National Bank Bldg., Boise, ID 83702

6. S1024141310 33.5 Acres
Capitol Title and Trust Co., and J.W. Wise and Sons, Inc., 4315 Star Circle, Boise, ID 83706

(H) 7. No AP# 35 Acres±
Jack Eisenberg, 2733 Warm Springs, Boise, ID 83702

II. 3N3E

A. 3N3E Sec. 6 (Page A-28)

1. No AP# 80 Acres
B.L.M., 550 W. Fort St., Boise, ID 83702

*2. S0906210000 40 Acres Mtn. Cove Ranch
W.A. and Viola M. Shepherd, Mtn. Cove Ranch, Boise, ID 83702

3. No AP# 440 Acres
State of Idaho, Department of Lands, Office of the Director, Statehouse, Boise, ID 83702

4. S0906430000 40 Acres
Summer and Joyce M. Delana, c/o Guy Johnston et al., Shaw Mtn. Road, Boise, ID 83702 (Contract: Milton R. and Maxine L. Johnston and Guy M. Johnston)

5. S0906441000 30 Acres
Harlow H. Oberbillig et al., c/o Harlow J. Oberbillig, 4404 Rim St., Boise, ID 83704

6. S1006444250 5 Acres
Harlow H. Oberbillig, 4404 Rim St., Boise, ID 83704

7. S1006444000 5 Acres
Milton Johnston et ux., Shaw Mtn. Road, Boise, ID 83702

B. 3N3E Section 7 (Page A-29)

1. No AP# 20.65 Acres White Mineral Lode
Unsurveyed Mining Claim in east half of northeast quarter of section

2. S0907110000 59.35 Acres
John Aldape et al., R.V. Hansberger

3. S0907121000 80 Acres
Joe P. Aldape, et al., and Futura Industries, Drawer F. Suite 1010, 1 Capitol Center, Boise, ID 83702

4. S0907200000 145.16 Acres
Maria Aldape and Futura Industries, Drawer F, Suite 1010, 1 Capitol Center, Boise, ID 83702

(C) 5. S0907321000 66.52 Acres
Emma N. Day, Trustee for Ernest G. Day Estate, Box 8286, Boise, ID 83702

6. S0907311000 80 Acres
Emma N. Day, Trustee for Ernest G. Day Estate, Box 8286, Boise, ID 83707

7. S0907411000 160 Acres
John Aldape et al, 2800 Shaw Mtn. Road, Boise, ID 83702

C. 3N3E Section 8 (Page A-30)

1. No AP# 40 Acres
BLM, 550 W. Fort Street, Boise, ID 83702

2. S0908123000 30 Acres
Geo. Robt. McAlpine, c/o Eva McAlpine, 1214 Broadway, Oklahoma City, OK 73103

3. S0908122000 70 Acres
John Aldape et al, 2800 Shaw Mtn. Road, Boise, ID 83702

4. S0908220000 40 Acres
Harlow J. Oberbillig et al, c/o Harlow J. Oberbillig, 4404 Rim, Boise, ID 83704

5. S0908231000 120 Acres
John Aldape et al., 2800 Shaw Mtn. Road, Boise, ID 83702

6. S0908240001 40 Acres
John Aldape et al, 2800 Shaw Mtn. Road, Boise, ID 83702

7. S0908140000 300 Acres
John Aldape et al, 2800 Shaw Mtn. Road, Boise, ID 83702

D. 3N3E Section 17 (Page A-31)

1. S0917110000 40 Acres
Jesse Little Naylor, Box 488, Emmett, ID 83617

2. S0917230000 100 Acres
Dallas H. Harris, 200 S. Wise Way, Boise, ID 83706

*3. S0917311000 20 Acres
Idaho Power Company, Box 70, Boise, ID 83721

*4. S0917330000 80 Acres
Esther Butler, 411 Washington, LaCrosse, KS 67548

*5. No AP# 400 Acres
State of Idaho, Dept. of Lands, Statehouse, Boise, ID 83702

E. 3N3E Section 18 (Page A-32)

1. No AP# 80 Acres
State of Idaho, Dept. of Lands, Statehouse, Boise, ID 83702

2. S0918120800 40 Acres
Flora D. Aldape et al., Warranty deed to Sun Mountain Co.

3. S0918243550 .07 Acre Table Rock Cross
Boise Junior Chamber of Commerce, 709 W. Idaho, Boise, ID 83702

4. No AP# 210.03 Acres
State of Idaho, Dept. of Lands, Statehouse, Boise, ID 83702

5. S0918311000 29.69 Acres (2/3 interest)
Ivy Rose Bower, 2048 Broadway Ave., Boise, ID 83706

S0918311200 14.54 Acres (1/3 interest)
Bruce and Beth Bowler, 1111 Shaw Mtn. Road, Boise, ID 83702
(Parcel has 2 parts)

6. No AP# 39 Acres
State of Idaho, Dept. of Lands, Statehouse, Boise, ID 83702

7. S0918311990 .23 Acres
Tel-Car, Inc., Box 414, Meridian, ID 83721

8. S0918311975 .23 Acres
Idaho Power Co., Box 70, Boise, ID 83721

9. S0918420000 40 Acres
Ansgar E. Johnson, Jr., et al., 1601 Garfield St., Boise, ID 83706

10. S0918343000 66.6 Acres (2/3 interest)
Jack & Ivy Rose Bauer, 2048 Broadway Ave., Boise, ID 83706

S0918343040 33.3 Acres (1/3 interest)
Bruce and Beth Bowler, 1111 Shaw Mtn. Road, Boise, ID 83702

11. S0918110300 40 Acres
Flora D. Aldape et al., 2800 Shaw Mtn. Rd., Boise, ID 83702

12. S0918131400 40 Acres
Flora D. Aldape et al., 2800 Shaw Mtn. Rd., Boise, ID 83702

F. 3N3E Section 19 (Page A-33)

1. S0919111010 77 Acres (2/3 interest)
Ivy Rose Bauer, 2048 Broadway Avenue, Boise, ID 83706

S0919111050 38 Acres (1/3 interest)
Bruce and Beth Bowler, 1111 Shaw Mtn. Road, Boise, ID 83702

2. S0919123000 45 Acres
J.H. Wise and Son, Inc. and Capitol Title and Trust (@ ½ interest)
2843 Star Circle, Boise, ID 83702 (4315 Star Circle as below?)

3. S0919213100 20 Acres
J.H. Wise and Son, Inc. and Capitol Title and Trust Co. (½ interest)
4315 Star Circle, Boise, ID 83706

4. S0919211000 40 Acres (2/3 interest)
Ivy Rose Bauer, 2048 Broadway Ave., Boise, ID 83706

S0919211150 20 Acres (1/3 interest)
Bruce and Beth Bowler, 1111 Shaw Mtn. Road, Boise, ID 83702

5. S0919231000 48 Acres
J.H. Wise and Son, Inc. and Capitol Title and Trust Co., 4315 Star Circle, Boise, ID 83706

6. S0919231075 5 Acres±
J.H. Wise and Sons, Inc., 4315 Star Circle, Boise, ID 83706

*7. S0919311000 40.45 Acres
J.H. Wise and Sons, Inc., and Capitol Title and Trust Co., 4315 Star Circle, Boise, ID 83706

*8. S0919313350 7.24 Acres
Eugene M and Verna Hadristy, 4801 Starview Dr., Boise, ID 83706

9. S0919314130 1.6 Acres
Eugene M. and Verna Hardisty, 4801 Starview Dr., Boise, ID 83706

10. S0919313170 3.1 Acres
Dallas Harris et ux., 200 S. Wise Way, Boise, ID 83706

11. S0919314150 2.17 Acres
Douglas M. and Marla K. Preston, 1600 Latimer, Boise, ID 83705

12. S0919314200 2.2 Acres±
Udell and Ethel Witchey, 1119 Garfield St., Boise, ID 83706

*13. S0919422000 19 Acres
Claire B. Hardisty, 5417 Old Barber Road, Boise, ID 83706

*14. S0919421000 20 Acres
Claire B. Hardisty, 5417 Old Barber Road, Boise, ID 83706

*15. S0919411000 18.17 Acres
Jesse D. Danielson et ux., 1605 N. 25th St., Boise, ID 83702

*16. S0919314100 42 Acres
Dallas H and Alta Harris, 200 S. Wise Way, Boise, ID 83706

17. S0919411700 34.14 Acres
Dallas H. Harris, 200 S. Wise Way, Boise, ID 83706

G. 3N3E Section 20 (Page A-34)

1. S0920100000 280 Acres
Dallas H. Harris, 200 S. Wise Way, Boise, ID 83706

*2. S0920211000 40 Acres
Idaho Power Co., Box 70, Boise, ID 83721

3. S0920212000 80 Acres
Dallas H. Harris, 200 S. Wise Way, Boise, ID 83706

4. S0920230000 40 Acres
Sally Lou Brown and Austin Spenser Walker, 19441 N.E., Multnomah City, Portland, OR 97230

*5. S0920312000 120 Acres
Dallas H. Harris, 200 S. Wise Way, Boise,ID 83705

*6. S0920311000 40 Acres
Idaho Power Company, Box 70, Boise, ID 83721

7. S092043100 47 Acres±
Dallas H. Harris, 200 S. Wise Way, Boise, ID 83706

8. S0920433500 6.9 Acres
Edith B. Hutchings

III. T4NR2E

A. 4N2E Section 26 (Page A-35)

1. S0626134700 12 Acres
The Highlands, Inc., 2714 Bogus Basin Rd., Boise, ID 83702

2. S0626111000 135 Acres
The Highlands, Inc., 2714 Bogus Basin Rd., Boise, ID 83702

3. S0626211000 160 Acres
The Highlands, Inc., 2714 Bogus Basin Rd., Boise, ID 83702

4. S0626311000 14.82 Acres
The Highlands, Inc., 2714 Bogus Basin Rd., Boise, ID 83702

5. S0626321000, S0626321001 40 Acres
The Highlands, Inc., 2714 Bogus Basin Rd., Boise, ID 38702

*6. S0626323250, -53, -56 5 Acres Highlands Baptist Church
Home Mission Board, S. Baptist Convention, Bogus Basin Road and Curling Drive, Boise, ID 83702

(H) *7. S0626133600, -331100, -332100, -343600, -343650 and S0635212100
132.2 Acres (Tax 4 of Sections 26, 27, 35) Highlands Golf Course
Crane Creek Country Club, 500 W. Curling Dr., Boise, ID 83702

8. S0626341700 19 Acres
The Highlands, Inc., 2714 Bogus Basin Rd., Boise, ID 83702

9. S0626413700 24 Acres
The Highlands, Inc., 2714 Bogus Basin Rd., Boise, ID 83702

10. S0626411000 30.3 Acres
The Highlands, Inc., 2714 Bogus Basin Rd., Boise, ID 83702

B. 4N2E Sec. 27 (Page A-36)

*1. S0627414975 2 Acres
Claremont Realty Co., Box 2777, Boise, ID 83701

*2. S0627140000 76 Acres Highlands Stables
Ruby Co., Box 2777, Boise, ID 83701

3. S0627420550 & S0627133301 12.41 Acres
Howard & Gwendolyn Mitchell, Rt. #1, Cartwright Rd., Boise, ID 8370

*4. S0627133300 & S0627133301 3.5 Acres
Howard & Gwendolyn Mitchell, Rt. #1, Cartwright Rd., Boise, ID 83702

5. S0627130500 33.1 Acres
Title and Trust Co., Trustee, Box 2187, Boise, ID 83701

6. S0627110000 200 Acres (2 parts)
Claremont Realty Co., Box 2777, Boise, ID 83701

7. S0627210000 40 Acres
Ruby Co., Box 2777, Boise, ID 83701

8. S0627320000 80 Acres
Barr N. Smith et al., 2417 Bogus Basin Rd., Boise, ID 83702

9. S0627310000 60 Acres
B.E.C. Corp, 2417 Bogus Basin Rd., Boise, ID 83702

10. S0627341000 10 Acres
The Highlands, Inc., 2714 Bogus Basin Road, Boise, ID 83702

11. S0627432500 1.5 Acres
Robert E. Kissinger et al., c/o The Highlands, Inc., 2714 Bogus Basin Road, Boise, ID 83702

*12. S0627438400 10.75 Acres
The Highlands, Inc., 2714 Bogus Basin Road, Boise, ID 83702

*13. S0627438500 3.5 Acres
Church of Jesus Christ of Latter-Day Saints

14. S0627431100 16 Acres
Claremont Realty Co., Box 2777, Boise, ID 83701

*15. S0627441250 14 Acres Highlands School
Independent School District of Boise City, 1207 W. Fort Str., Boise, ID 83702

*16. S0627441775 1.5 Acres
Independent School District of Boise City, 1207 W. Fort Str., Boise, ID 83702

17. S0627438300 .75 Acre
The Highlands, Inc., 2714 Bogus Basin Rd., Boise, ID 83702

C. 4N2E Section 28 (Page A-37)

1. S0628110000 80 Acres
R.D. and Hazel Blessinger, 5316 N. 36th St., Boise, ID 83703

(CH) 2. S0628130000 40 Acres
Victor L. Nibler, 4520 N. 36th St, Boise, ID 83703

*3. S0628120000, S0628211000 96 Acres
Victor L. Nibler, 4520 N. 36th St., Boise, ID 83703

(C) *4. S0628223750, S0628322115 50.3 Acres±
Independent School District of Boise City, 1207 W. Fort Str., Boise, ID 83702

(C) *5. S0628321250 5 Acres
Robert V. Cushman et ux., 3220 Hill Road, Boise, ID 83703

(C) 6. S0628310000 120 Acres
Franklin B. Smith Jr. et al., Barr N. Smith Contr., 2417 Bogus Basin Road, Boise, ID 83702

7. S0628341000 5.2 Acres
Barr N. Smith Jr., et al., 2417 Bogus Basin Rd., Boise, ID 83702

8. S0628431000 14 Acres
Barr N. Smith Sr., Franklin B. Smith, and the Wyndemere Co., 2417 Bogus Basin Rd., Boise, ID 83702

9. S0627440100 18.55 Acres
Franklin B. Smith Jr., Barr N. Smith, and the Wyndemere Co., 2417 Bogus Basin Road, Boise, ID 83702

10. S0627449000 1.4 Acres±
North Mountain Development Corp.

11. S0627440101 21 Acres
North Mountain Development Corp.

12. S0627431001 7 Acres
North Mountain Development Corp.

13. S0628322500 1.45 Acres±
Hunt Brothers Floral, 2833 N. 36th, Boise, ID 83703

D. 4N2E Section 29 (Page A-38

1. S0629110590 4.14 Acres
Glenn Arend Tennant, 10233 Inwood Ct., Sun City, AZ 85351

2. S0629110420 4 Acres
Leroy and Nelda Thompson, 4600 Ginzel St., Boise, ID 83703

(C) *3. S0629110360 3 Acres±
Wren B. McLochlin et ux., 3848 Ginzel St., Boise, ID 83703

*4. S0629110355 5 Acres±
David O. and Sandra E. Duncan, 4385 Ginzel St., Boise, ID 83703

*5. S0629110450 13 Acres
Katherine B. Poe, 3998 Hill Road, Boise, ID 83703

6. S0629120600 6.35 Acres
Bruce and Annalee Blaser, 3532 Magnolia, Boise, ID 83703

7. S0629120630 3 Acres±
Phyllis Taylor, c/o Donald Taylor, State Dept. of Employment, Coeur d'Alene, ID 83814

8. S0629120690, S0629120695 8 Acres±
Marjorie Ellen Fairchild, 4020 Hill Road, Boise, ID 83703

9. S0629120725 2.5 Acres±
M.R. Priest and Sons, Inc., 515 Highland St., Boise, ID 83706

10. S0629120750 3.85 Acres
Claude Harrison, James G. Nelson Cont., 1706 N. 9th St., Boise, ID 83702

11. S0629212500 2.5 Acres±
James and Barbara Nelson

*12. R2129500150 5 Acres±
Paul W. and Wilma J. Edwards, 4203 Catalpa, Boise, ID 83703

(H) *13 R2129500006 4.5 Acres±
Paul W. and Wilma J. Edwards, Edwards Greenhouses, 4106 Sand Creek Street, Boise, ID

14. R2129500006 .3 Acres±
Paul W. and Wilma J. Edwards, Edwards Greenhouses, 4106 Sand Creek Street, Boise, ID

*15. S0629131330
Paul Edwards, 4203 Catalpa, Boise, ID 83703

*16. S0629131430 .5 Acres±
Wayne F. and Leota Church, 3911 Whitehead St., Boise, ID 83702

*17. S0629131470 .4 Acre±
Wayne F. and Leota Church, 3911 Whitehead St., Boise, ID 83702

*18. S0629131450 .5 Acre±
Wayne F. and Leota Church, 3911 Whitehead St., Boise, ID 83702

(HC) *19. S0629417210 5.98 Acres±
Hunt Brothers Floral, 3823 N. 36th, Boise, ID 83703

E. 4N2E Section 33 (Page A-39)

1. S0633110101 10 Acres±
North Mountain Development Co.

2. S0633110100
Franklin B. Smith Jr., et al., 2417 Bogus Basin Rd., Boise, ID 83702

3. S0633110121
North Mountain Development Co.

F. 4N2E Section 34 (Page A-40)

1. S0634221000 24.75 Acres
Barr N. Smith, et al., 1st National Bank Bldg., Boise, ID 83702

2. S0634224050, S0634224975 4 Acres± (2 parcels)
Robert M. Struwe and Raymond W. Cotner, 110 E. Highland View Dr., Boise, ID 83702

*3. S0634231100 and -1001 2.2 Acres± Brass Lamp Pizza (2 parcels)
Nat J. and Sally L. Adams, 100 W. State St., Boise, ID 83702

4. S0634242150 and -2180 4 Acres±
Samuel R. Baker and George R. Winn, 2520 Hillway Dr., Boise, ID 83702

5. S0634211000 26 Acres±
Highland Center, Inc., 2417 Bogus Basin Road, Boise, ID 83702

*6. S0634213000 1.8 Acres±
The Highlands Inc., 2714 Bogus Basin Rd., Boise, ID 83702

7. S0634213100, -231990, -241050, and R0169000015 and -0035 17 Acres±
Highlands Mall Site (5 parcels)
Highland Square Bldg. Co., 2417 Bogus Basin Rd., Boise, ID 83702

8. S0634241550 and 1551 6 Acres±
Thomas L. Smith, Trustee, et al., Box 1253, Boise, ID 83701

9. S0634243760 6.39 Acres
Thomas W. Patton, C/o the Highland, Inc., 2714 Bogus Basin Road, Boise, ID 83702

10. S0634311000 8.93 Acres
Orin Givens Construction Co., Rt. 1, Eagle, ID 83616

*11. S0634310000 1.03 Acres Water Storage Tank
Boise Water Corp., Box 70, Boise, ID 83707 (Tax Notice: 500 W. Idaho St., Boise, ID 83702)

(C) *12. S0634200000 72 Acres± Camelback Park
Boise City, Box 500, Boise, ID 83701

13. S0634424880 5 Acres
Martin C. Warberg et al., Richard B. Smith, 2417 Bogus Basin Raod, Boise, ID 83702

*14. S0634410000 78 Acres
Boise Water Corp, Box 7488, Boise, ID 83707

15. S0634143000 19.5 Acres
The Highlands, Inc., 2714 Bogus Basin Rd., Boise, ID 83702

16. S063414990 12 Acres
The Highlands, Inc., 2714 Bogus Basin Rd., Boise, ID 83702

17. S0634110000 1 Acre
Robert E. Kissinger et al., c/o The Highlands Inc., 2714 Bogus Basin Road, Boise, ID 83702

18. R3484250130 11.5 Acres±
Lila S. Elam, 1415 Harrison Blvd. Boise, ID 83702

19. R0169000005, -25, -30, -45, -80, -90, and -95 6 Acres± (7 parcels)
Howard Mitchell et ux., c/o Richard B. Smith, 2417 Bogus Basin Rd., Boise, ID 83702.

G. 4N2E Section 35 (Page A-41)

1. S0635111100 .45 Acre
The Highland, Inc., 2714 Bogus Basin Rd., Boise, ID 83702

2. S0635111000 40 Acres
The Highlands, Inc., 2714 Bogus Basin Rd., Boise, ID 83702

3. S0635121000 & S0635121001 25 Acres
Title and Trust Co., 711 W. Bannock St., Boise, ID 83702

4. S0635213600 9 Acres (2 parts)
Highlands, Inc., 2714 Bogus Basin Road, Boise, ID 83702

5. S0635213560 1.5 Acres
Theodore G. and Jean A. Obenchain, 2955 Selkirk Dr., Boise, ID 83270

6. S0635213425 2 Acres
Dr. Jude N. Werth, 119 E. Highland View Dr., Boise, ID 83702

*7. S0635213350 9 Acres
Daly Production Corp, Box 1188, Boise, ID 83701

*8. S0635133250 20 Acres
Joel H. McCord et ux., Mile High Road, Boise, ID 83702

*9. S0635130000 and 130001 222.2 Acres
Boise Water Corp, Box 7488, Boise, ID 83707

10. S0635332000 20 Acres
Claremont Realty Co., Box 2777, Boise, ID 83701

11. S0635330000, S0635341000, S0635442600 212 Acres
Claremont Realty Co., Box 2777, Boise, ID 83701

12. S0635431060 .7 Acres±
Ernest Edward Day et ux, (Lois Day)

H. 4N2E Section 36 (Page A-42)

1. S0636111000 80 Acres
Claremont Realty Co., Box 2777, Boise, ID 83701

2. S0636121000 80 Acres
Jessie Little Naylor, Box 488, Emmett, ID 83617

3. S0636211000 80 Acres
Claremont Realty Co., Box 2777, Boise, ID 83701

4. S0636221000 40 Acres
Jessie Little Naylor, Box 488, Emmett, ID 83617

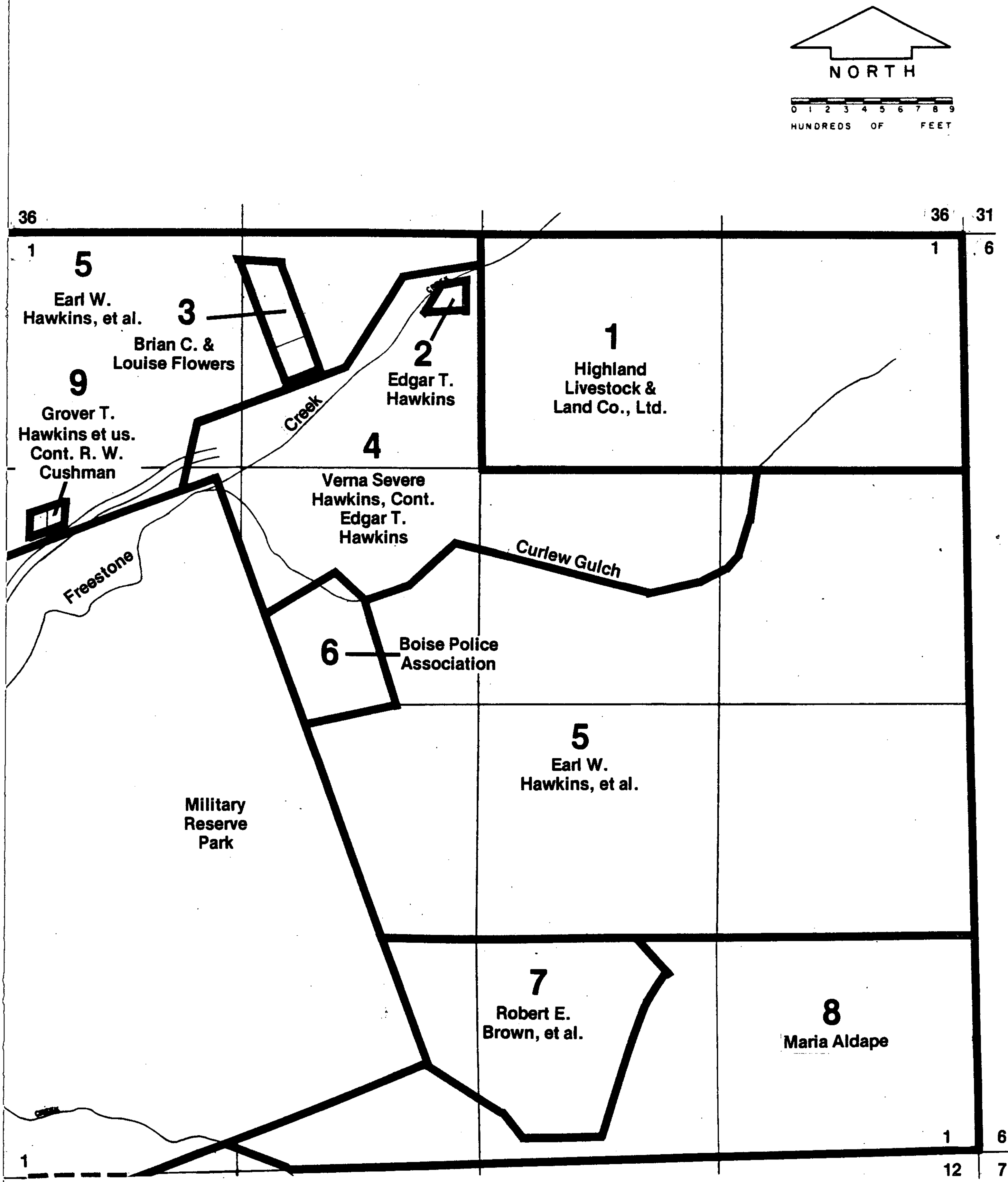
5. S0636230000 40 Acres
Boise Water Corp., Box 7488, Boise, ID 83707

6. L0636314800 320 Acres
Claremont Realty Co., Box 2777, Boise, ID 83701

Note: Ownership is current as of June 1978. State of Idaho and BLM Lands were checked with the proper sources.

* Indicates improvements on the parcels.

3N, R2E Section 1



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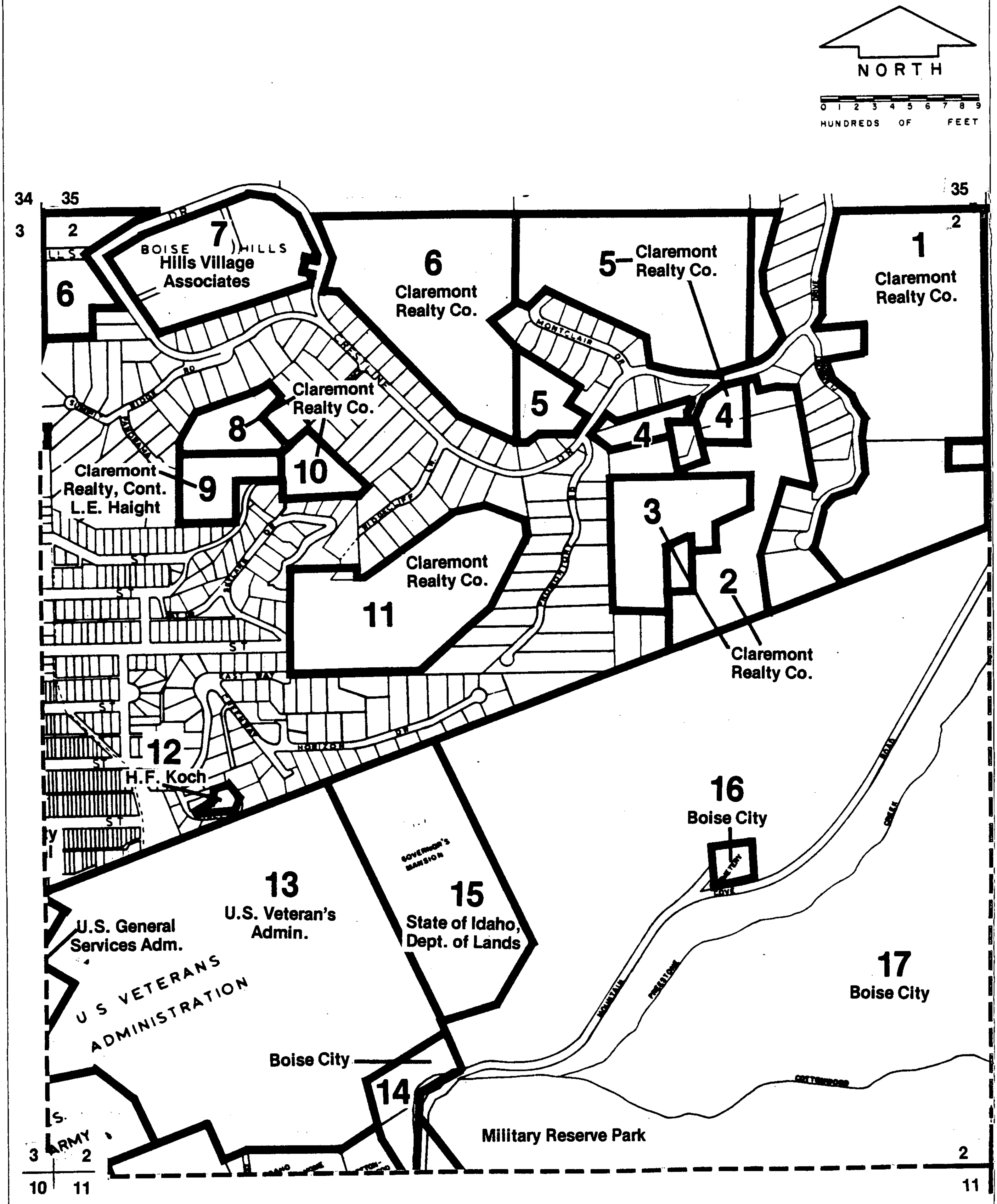

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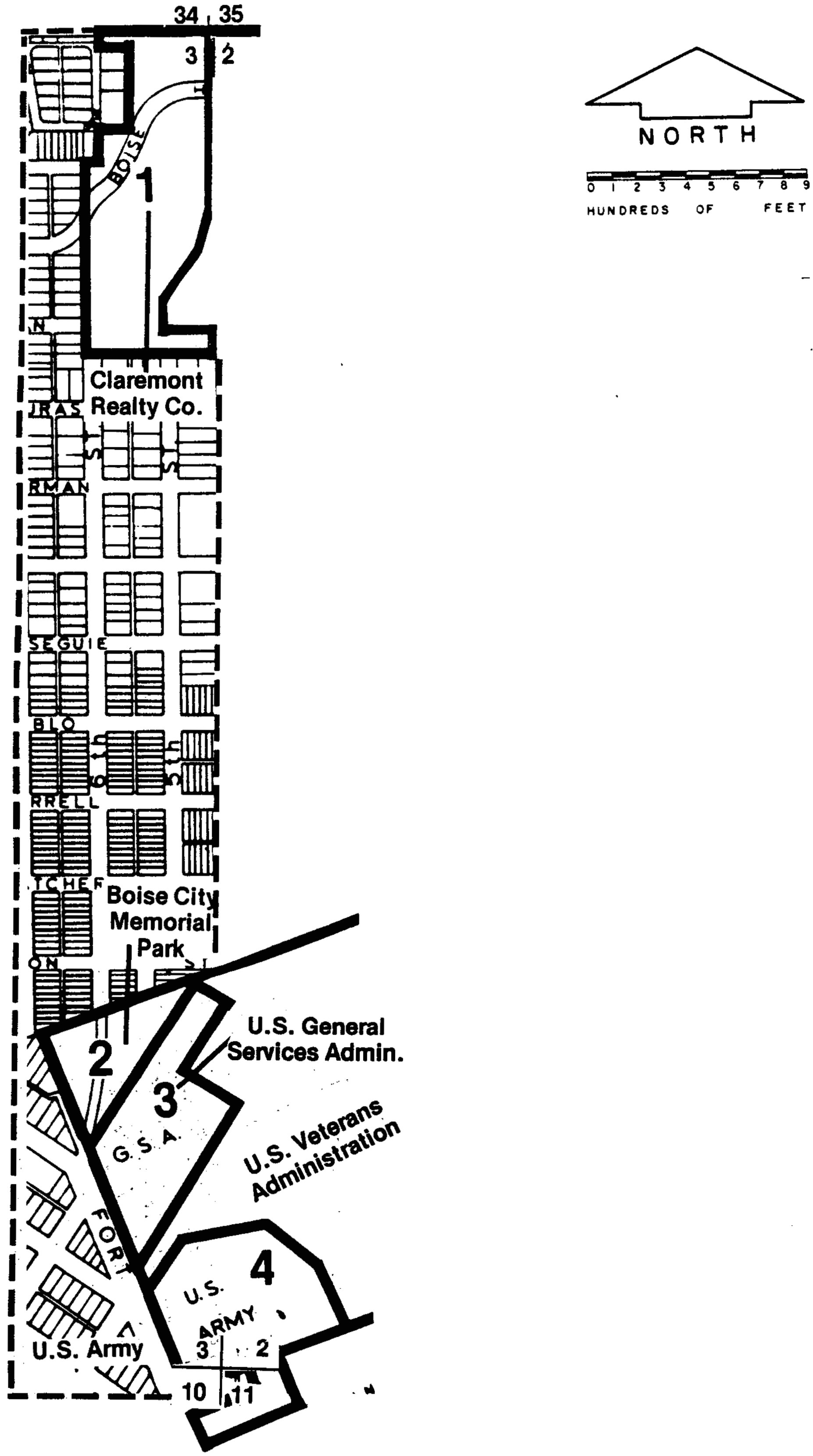

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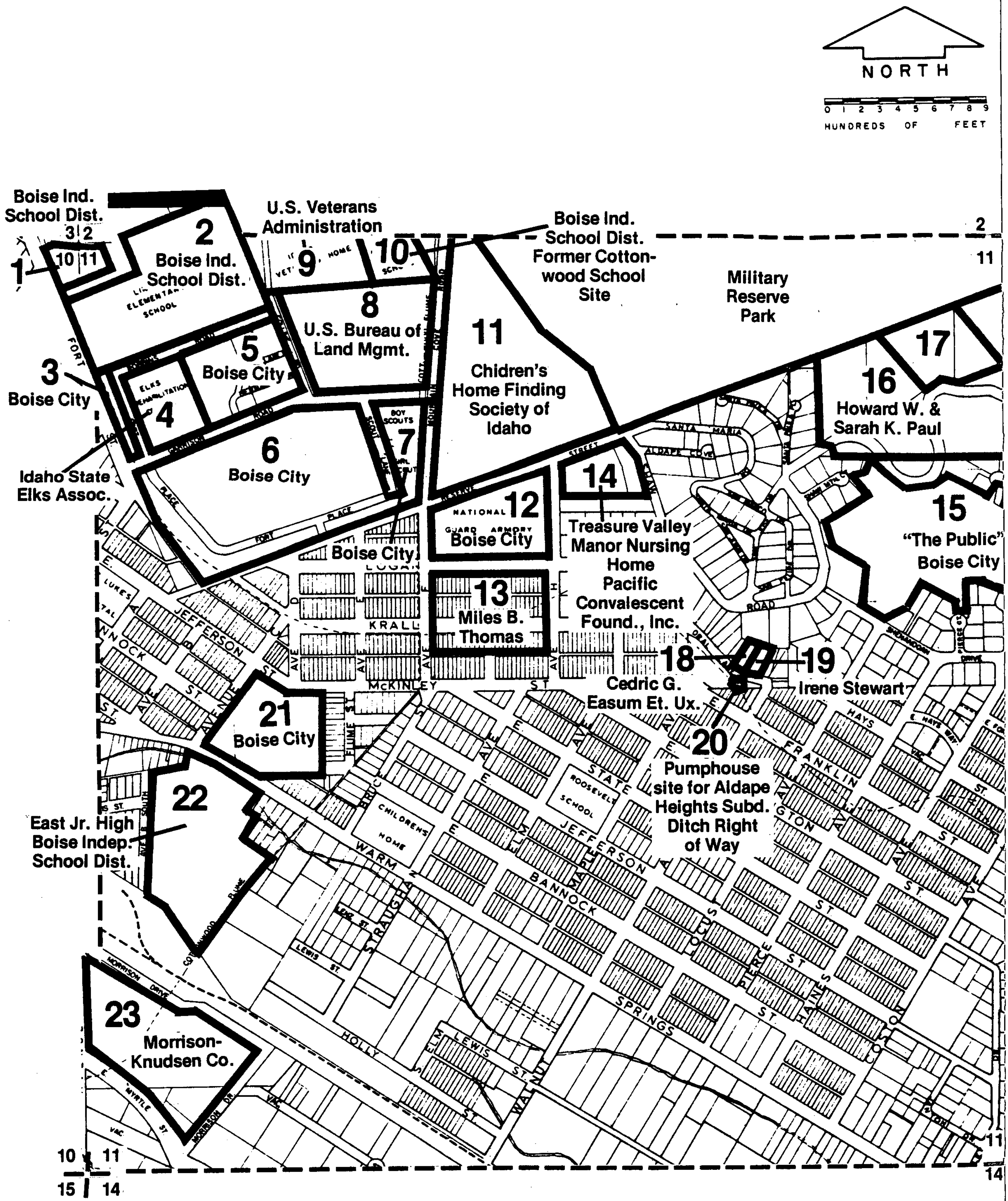

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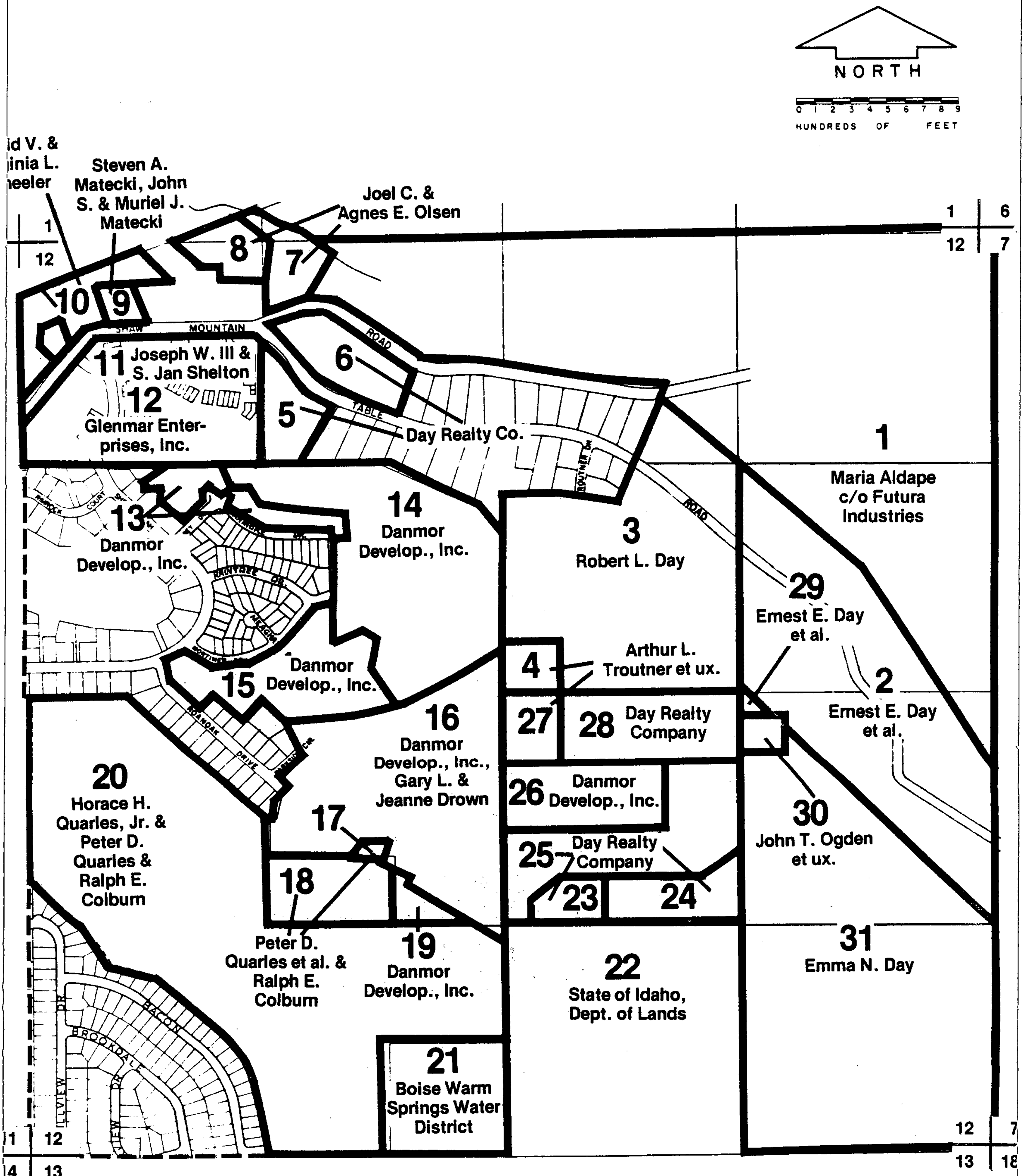

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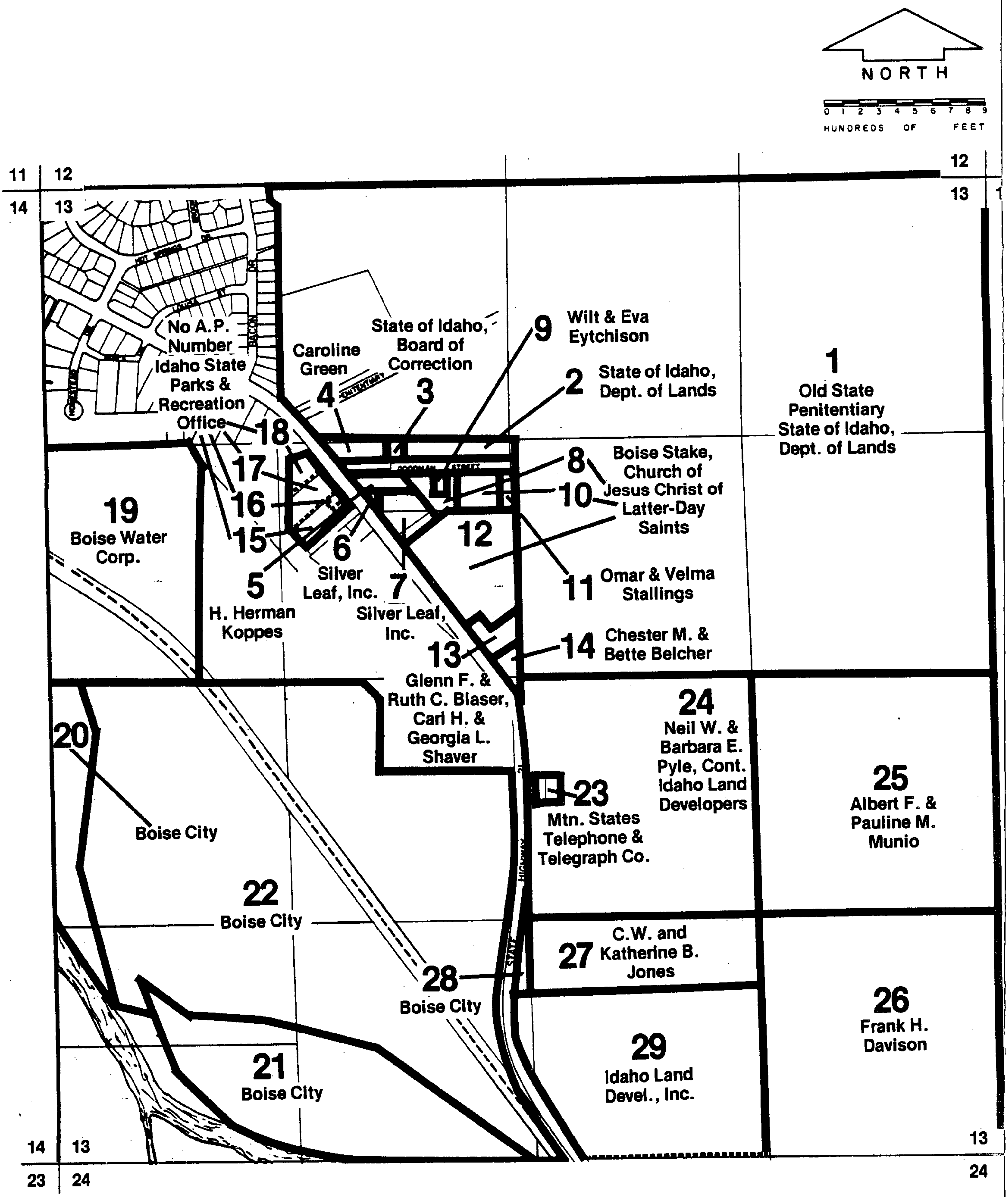

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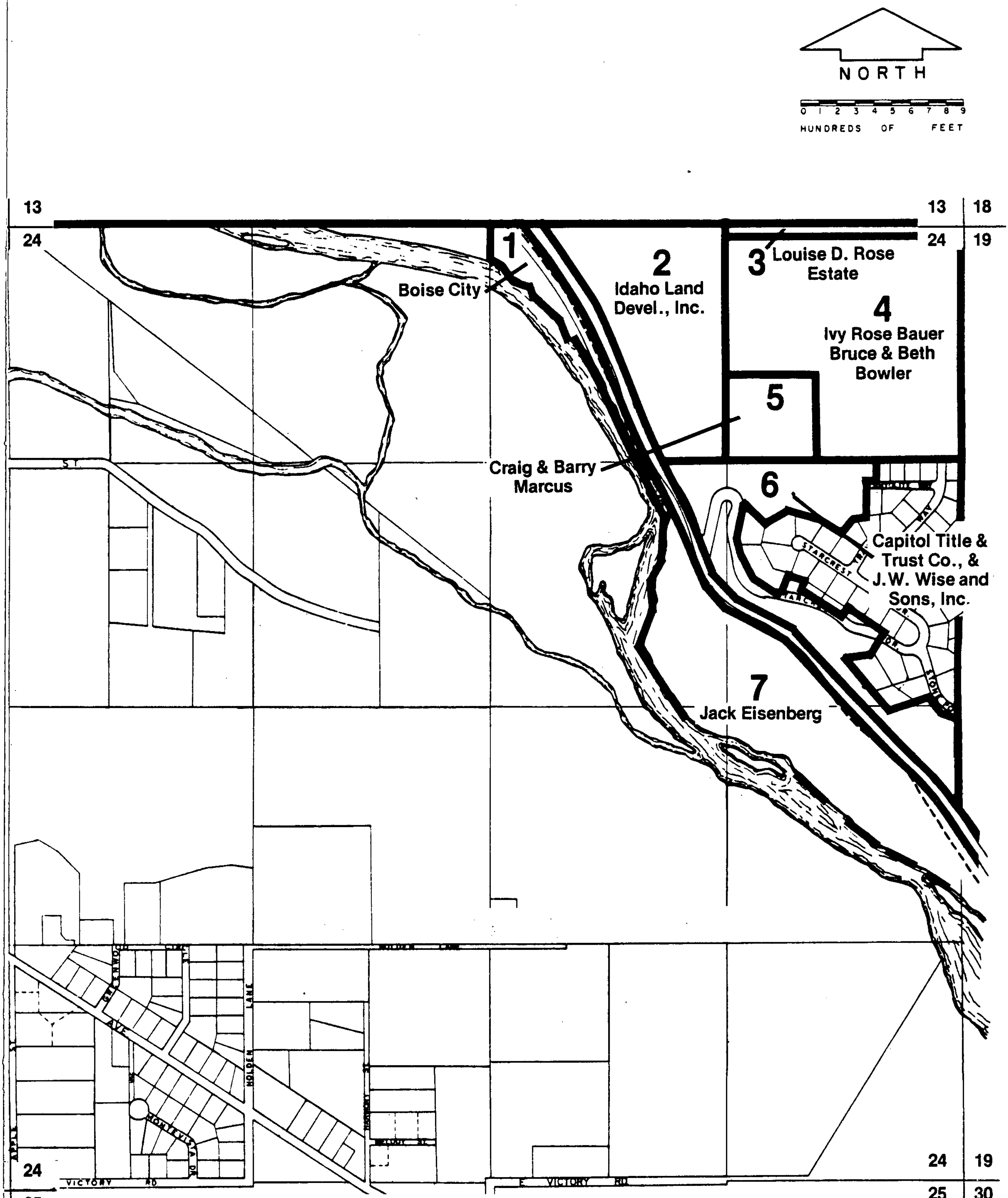
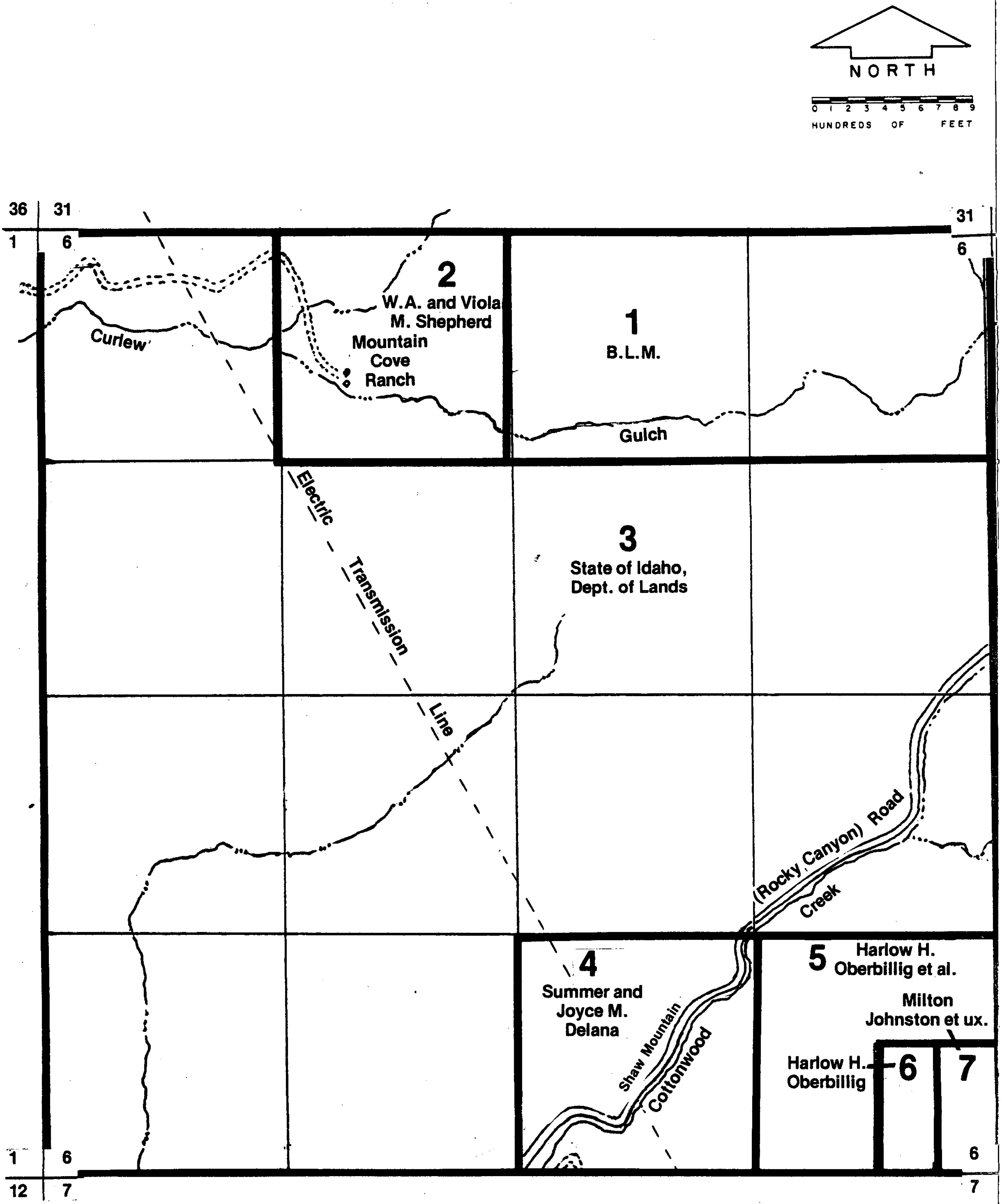


3N3E Section 6



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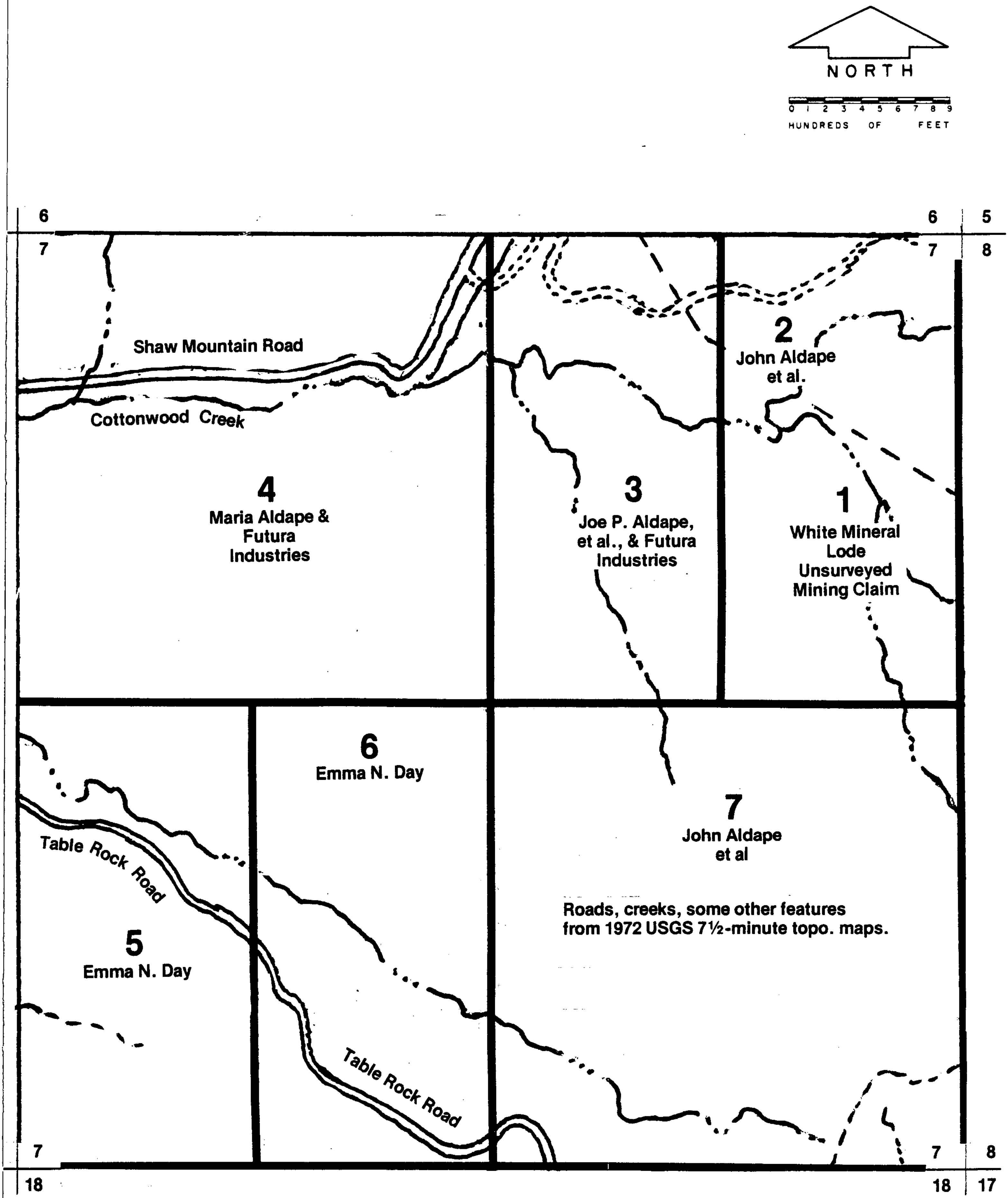

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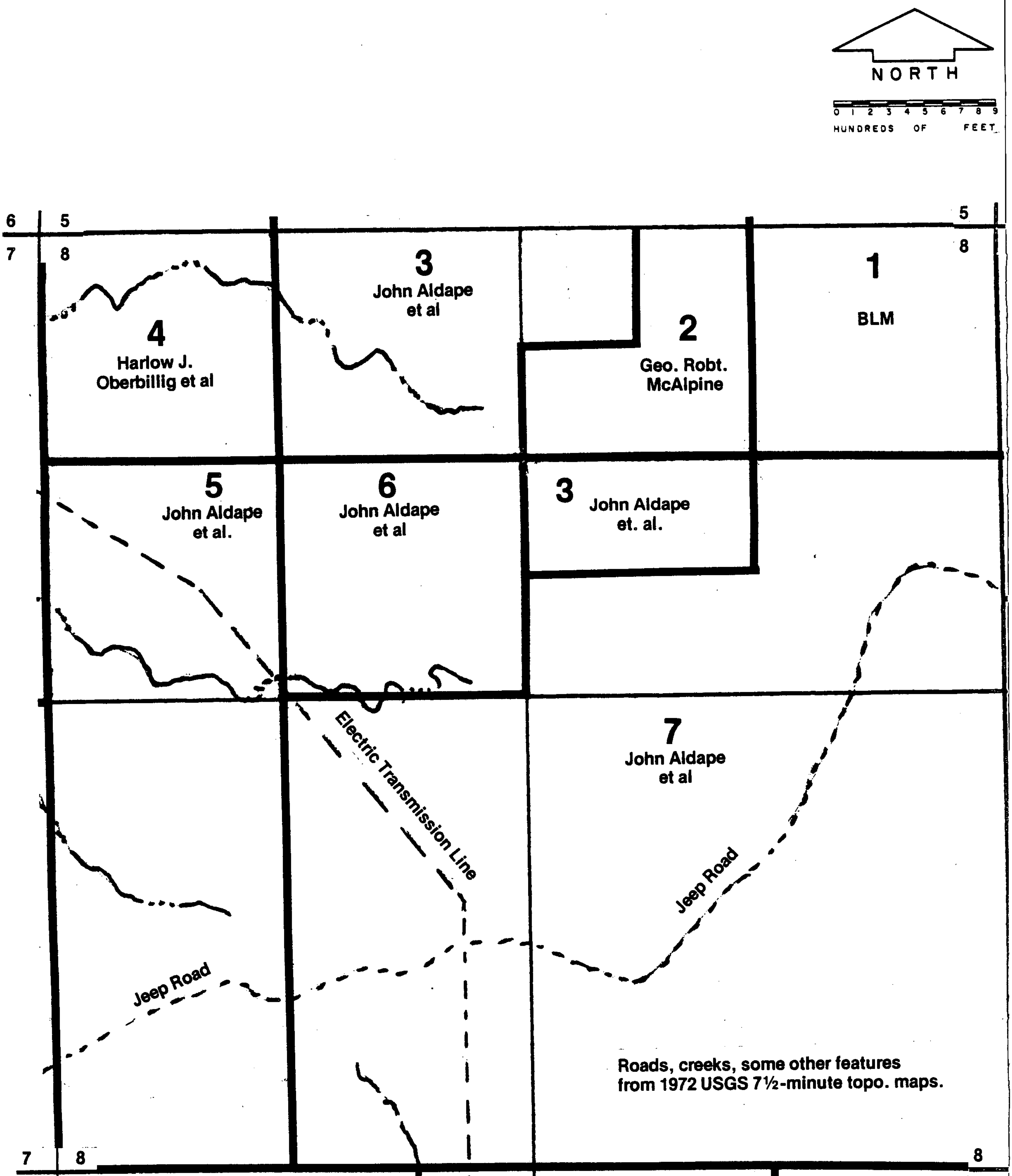

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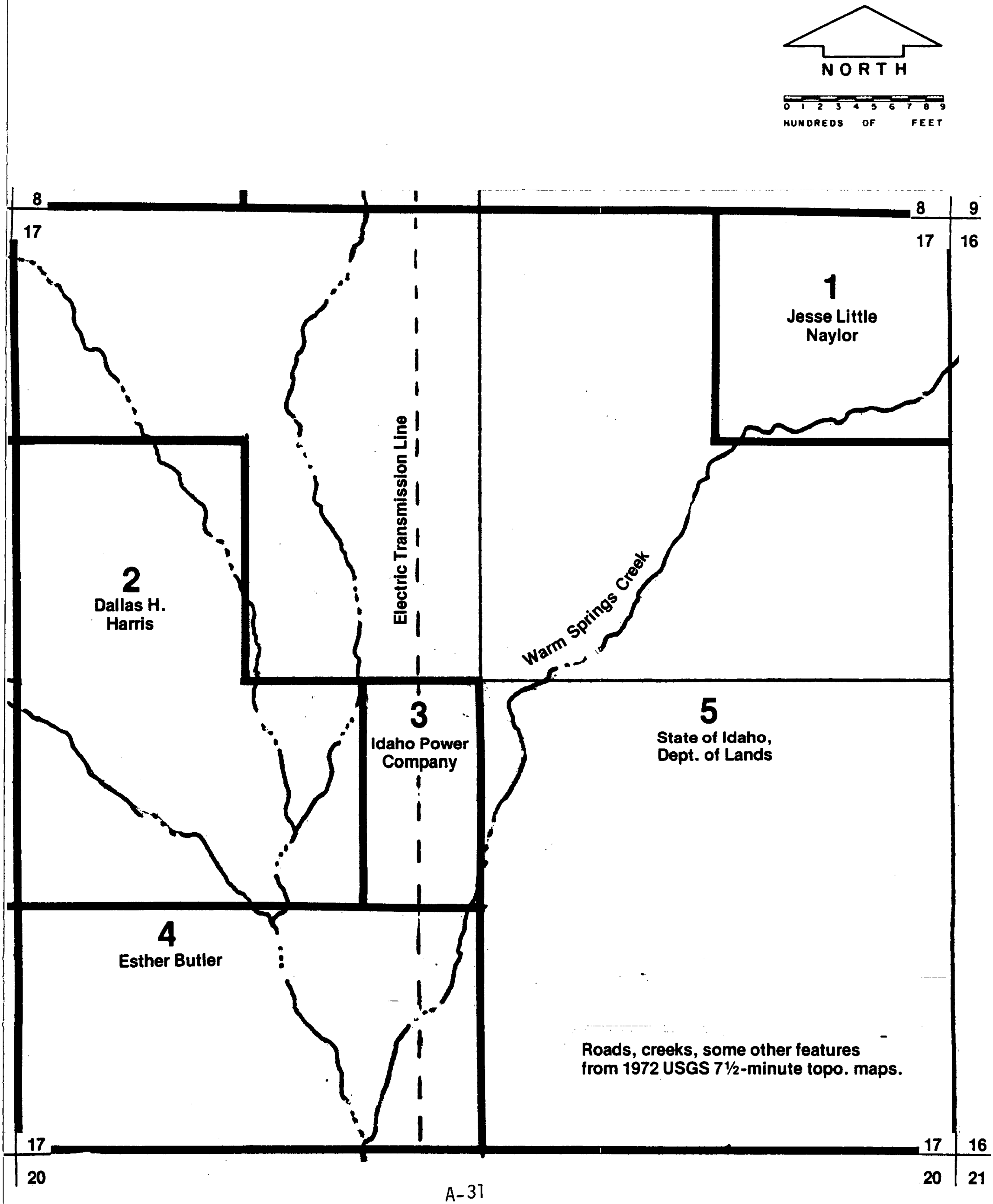
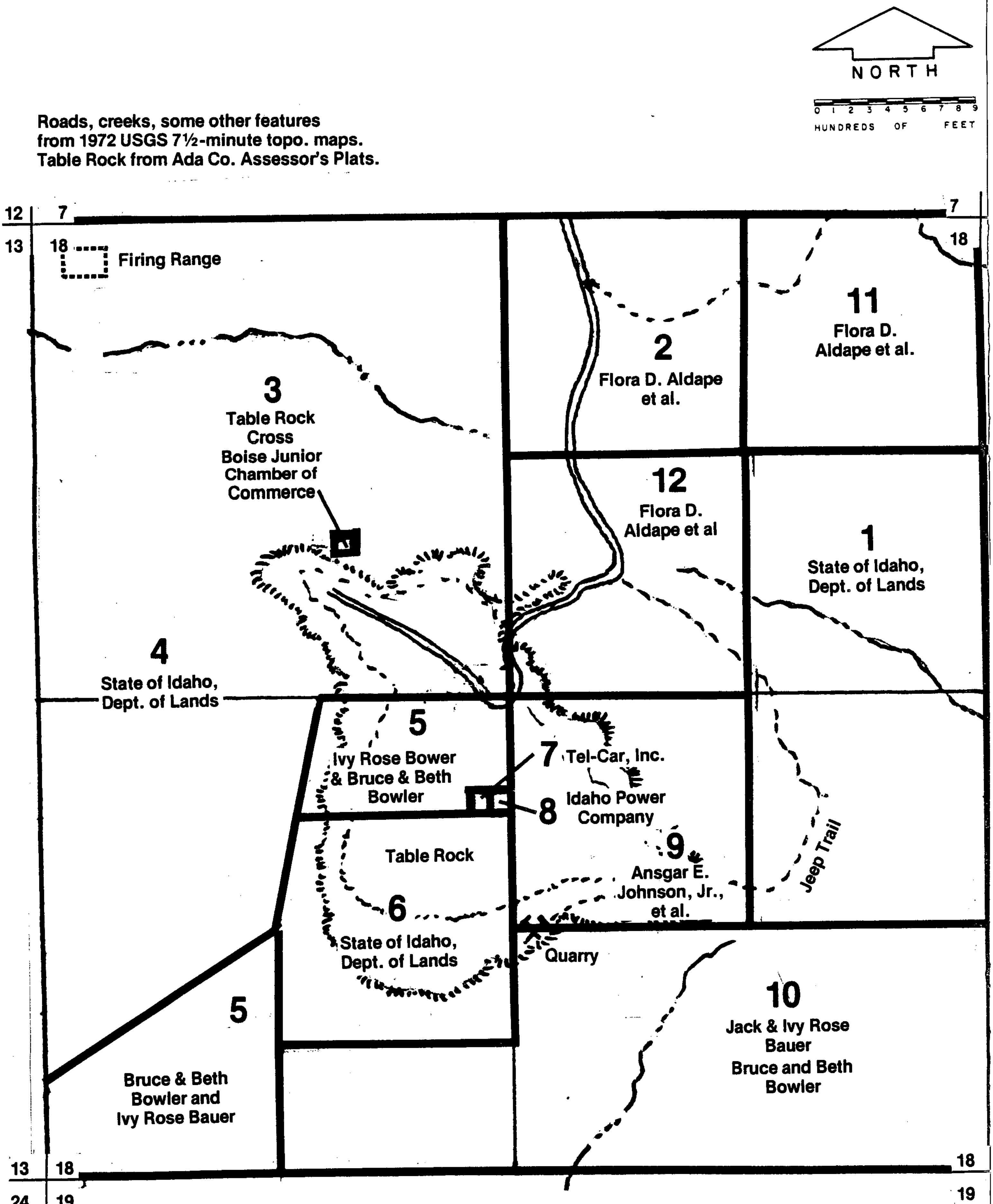


3N3E Section 18

Roads, creeks, some other features from 1972 USGS 7½-minute topo. maps. Table Rock from Ada Co. Assessor's Plats.



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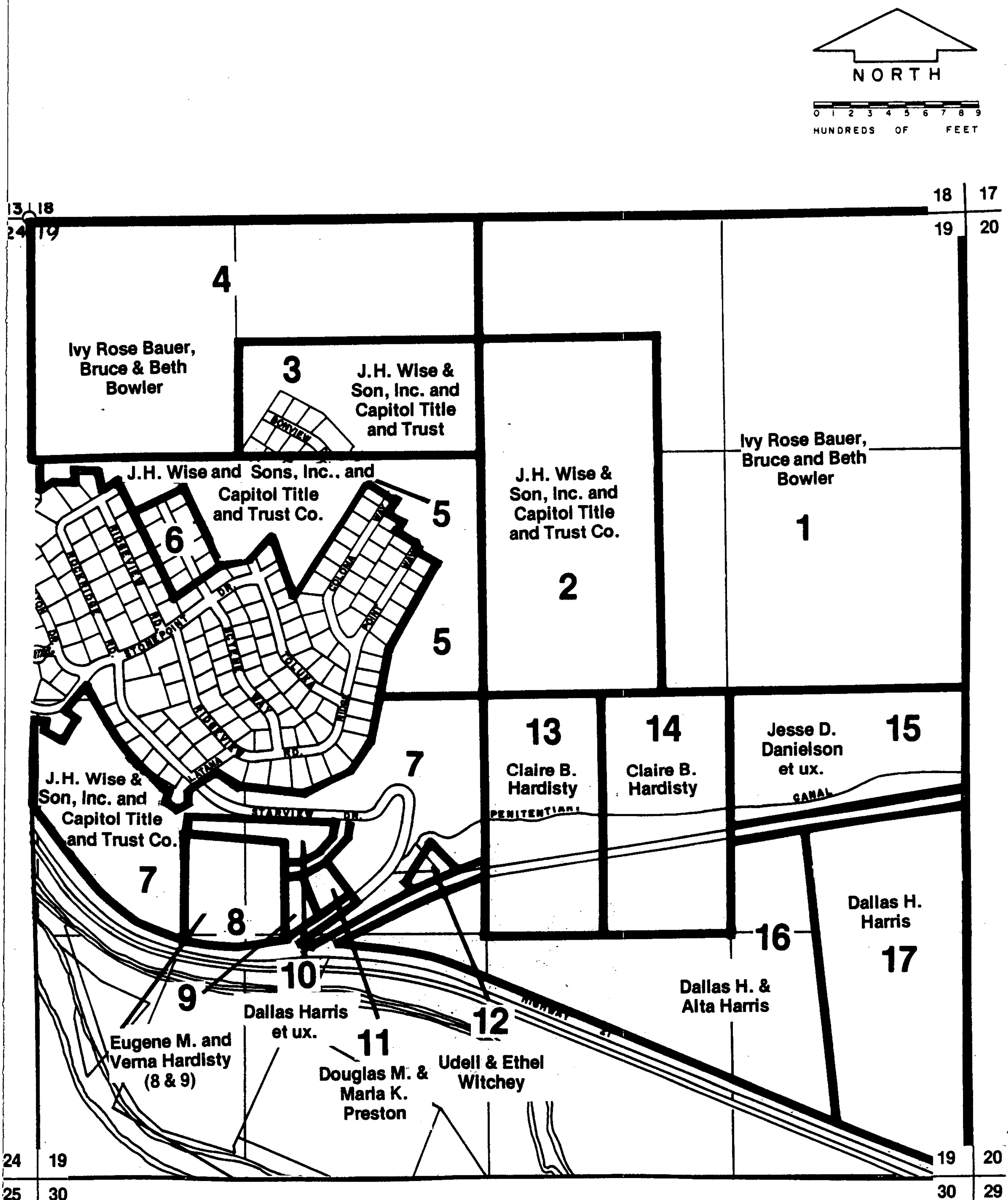

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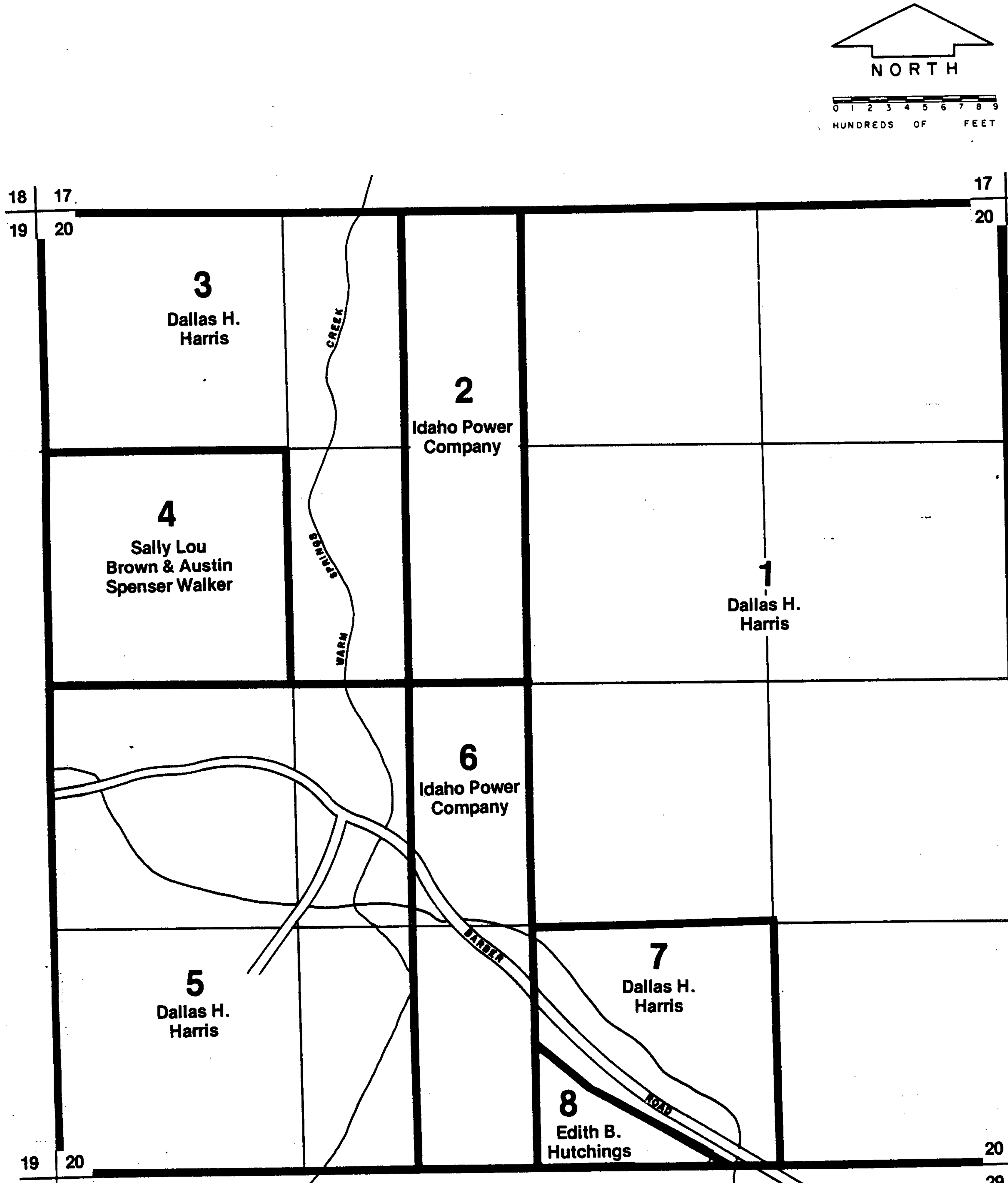
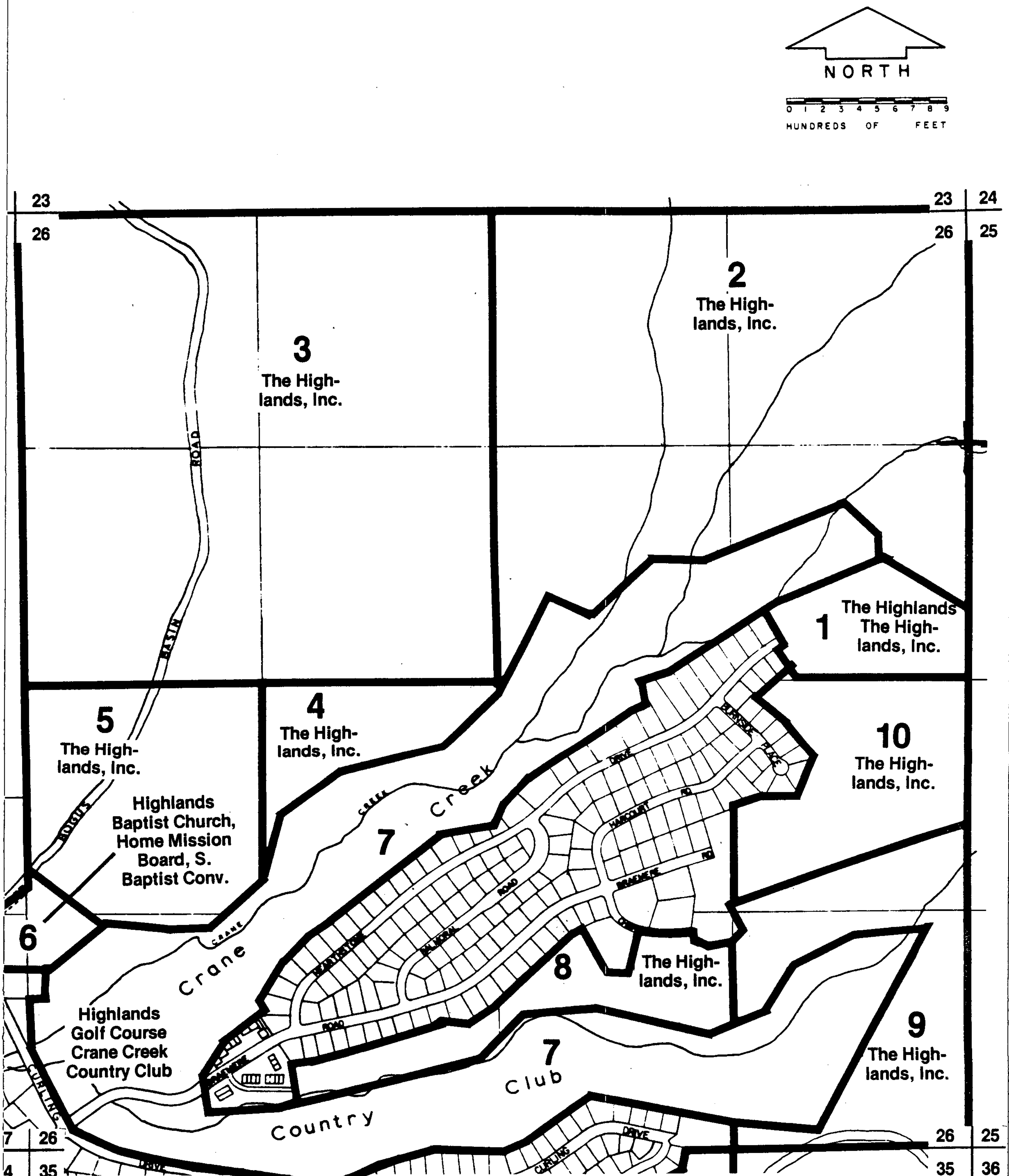
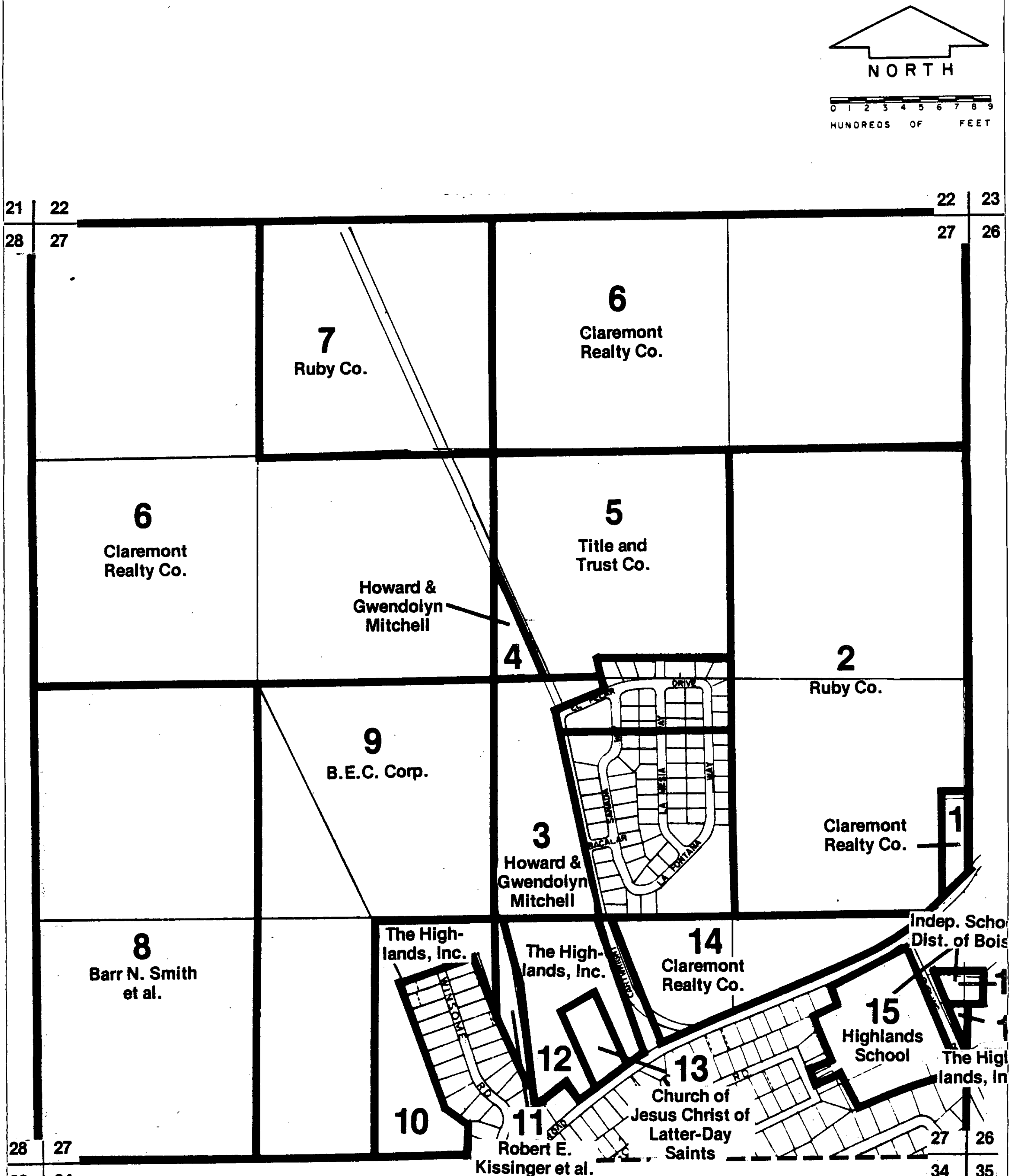


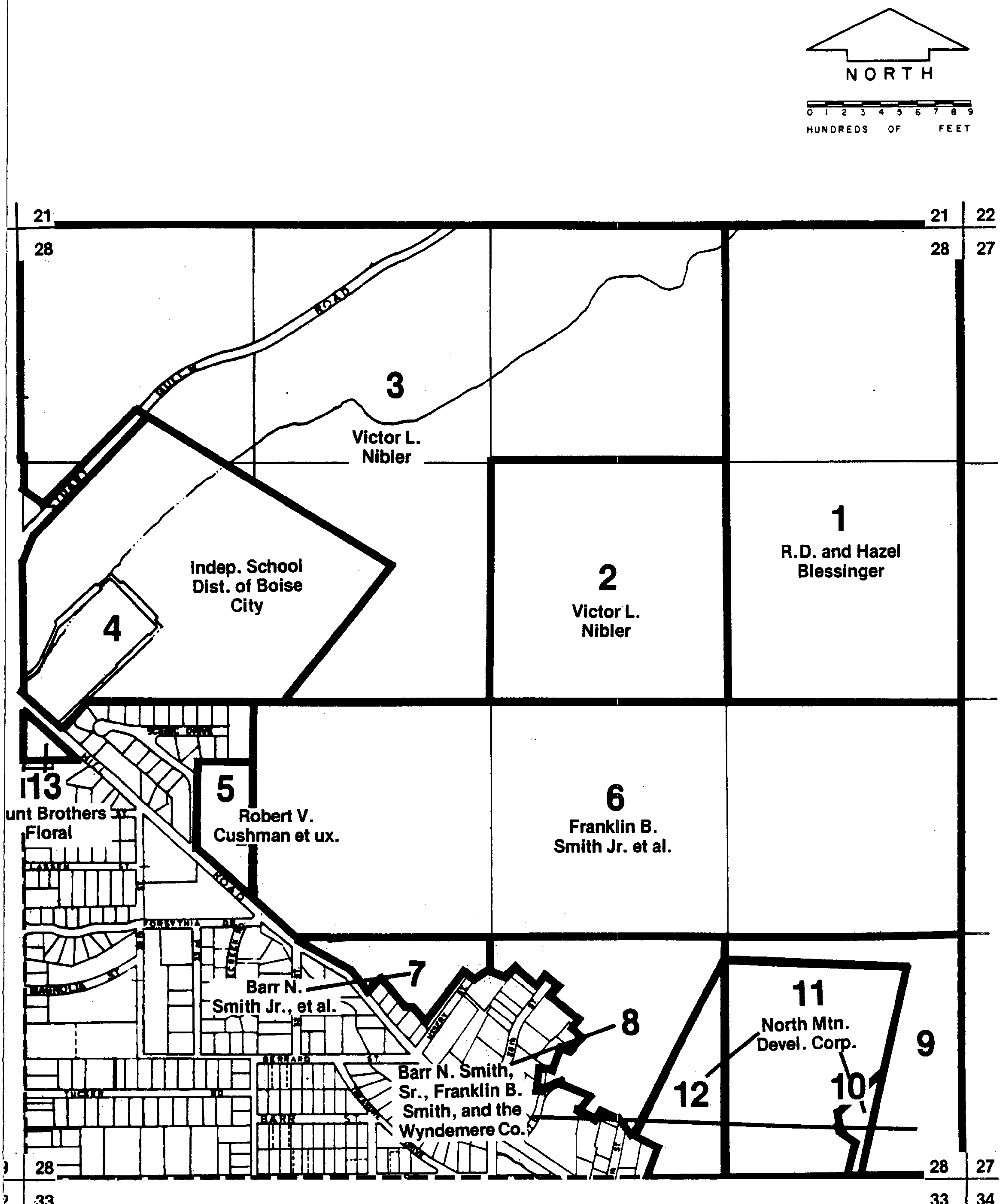
4N2E Section 26



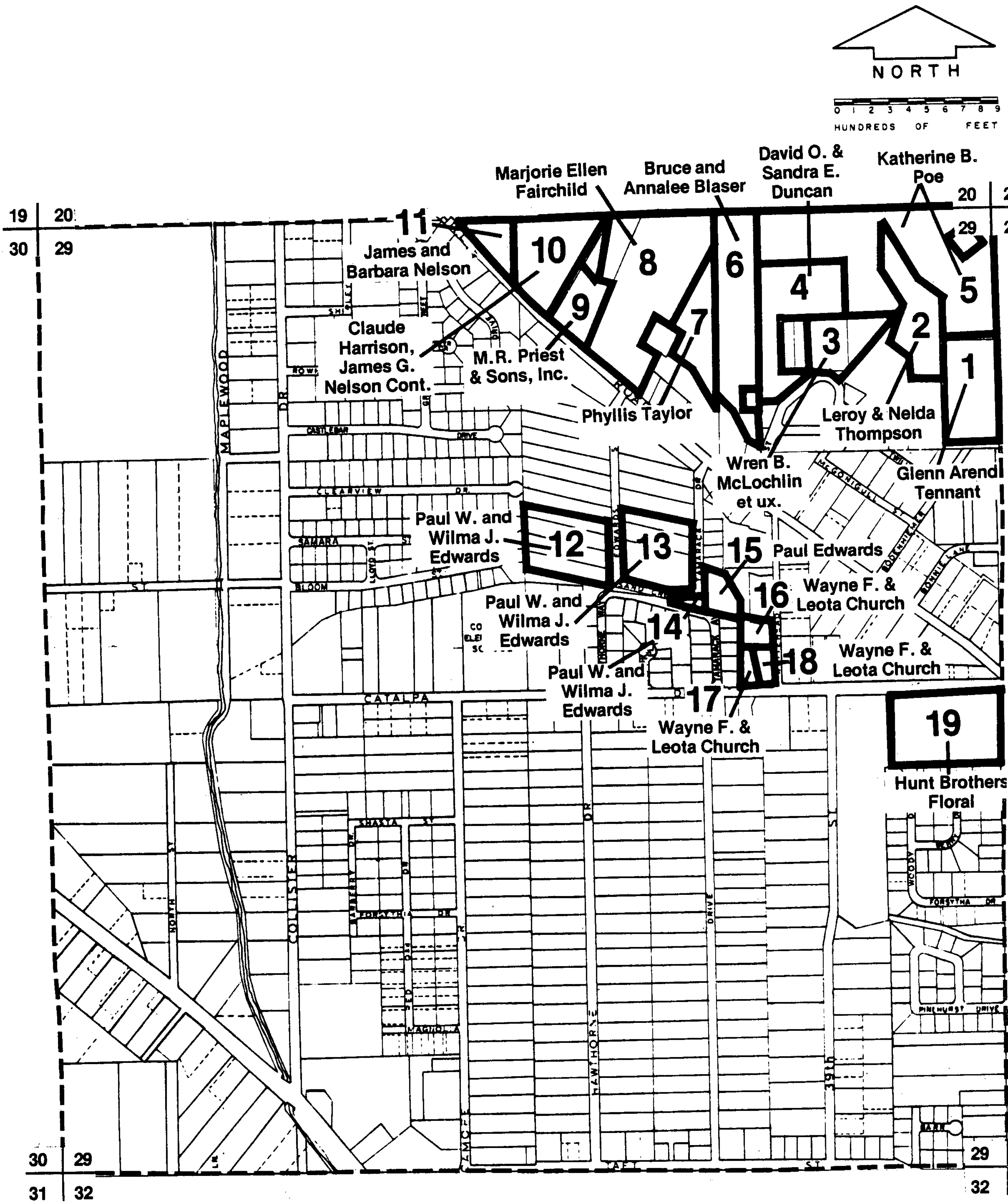
4N2E Section 27



4N2E Section 28



4N2E Section 29



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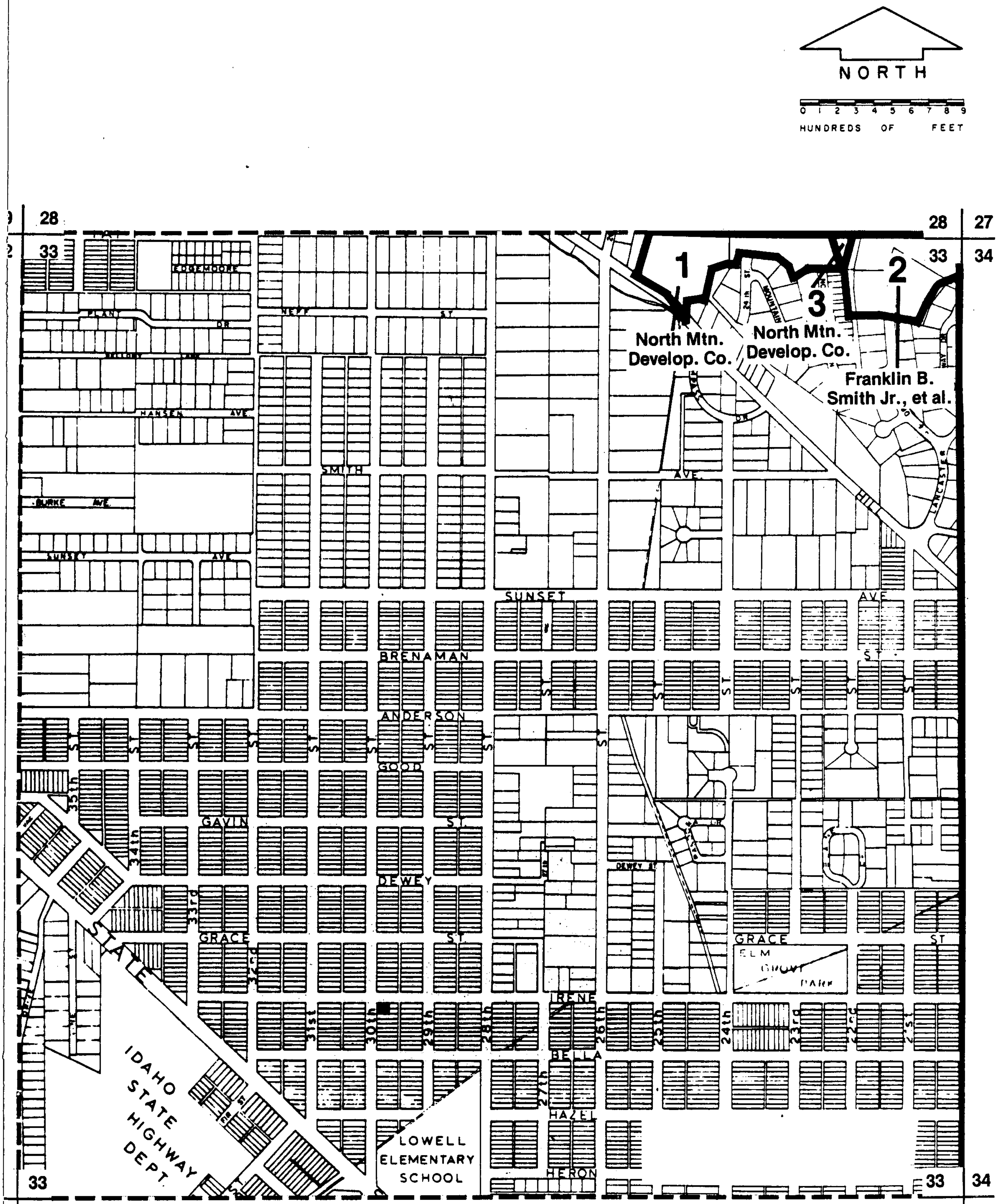
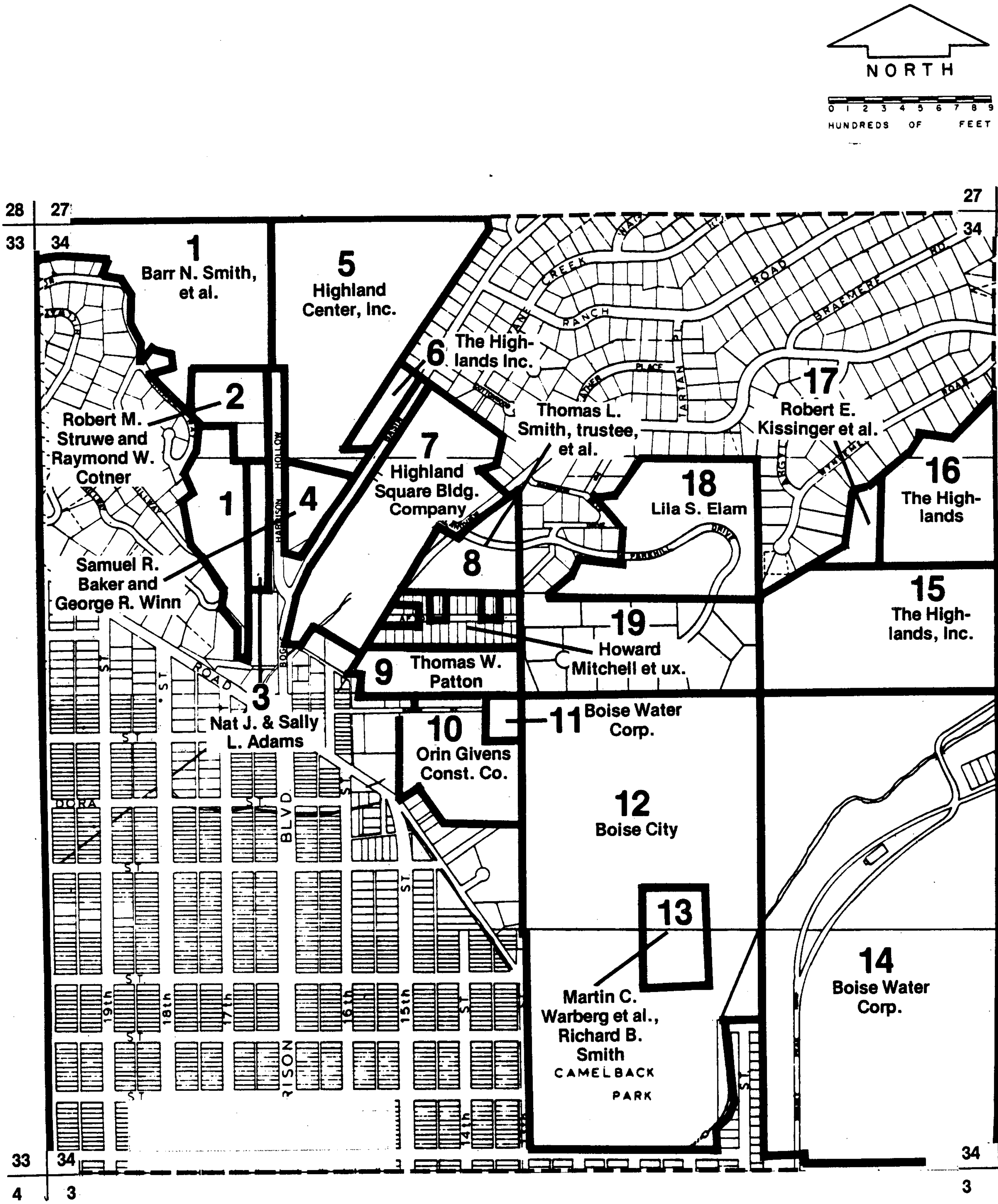
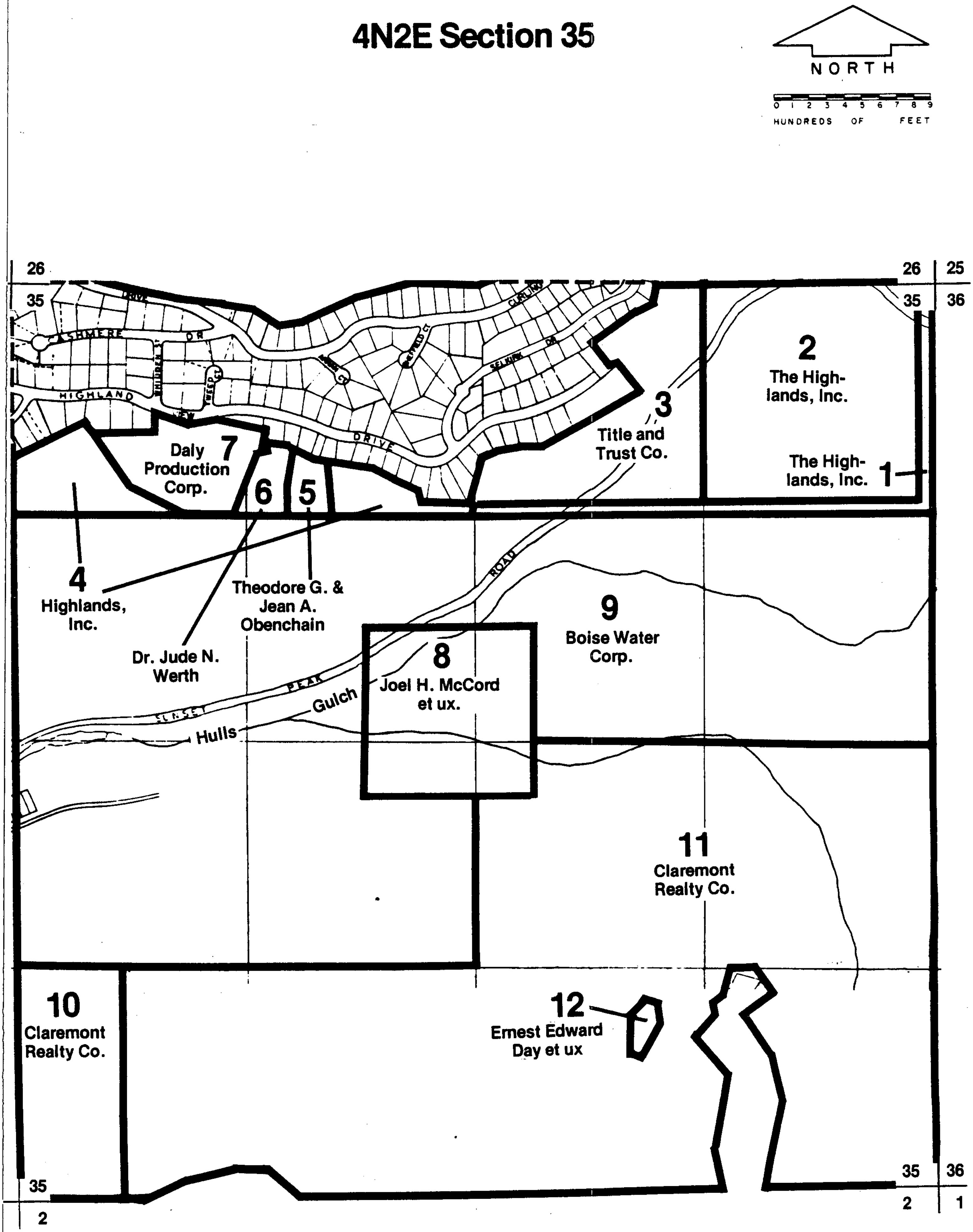


4N2E Section 34



4N2E Section 35



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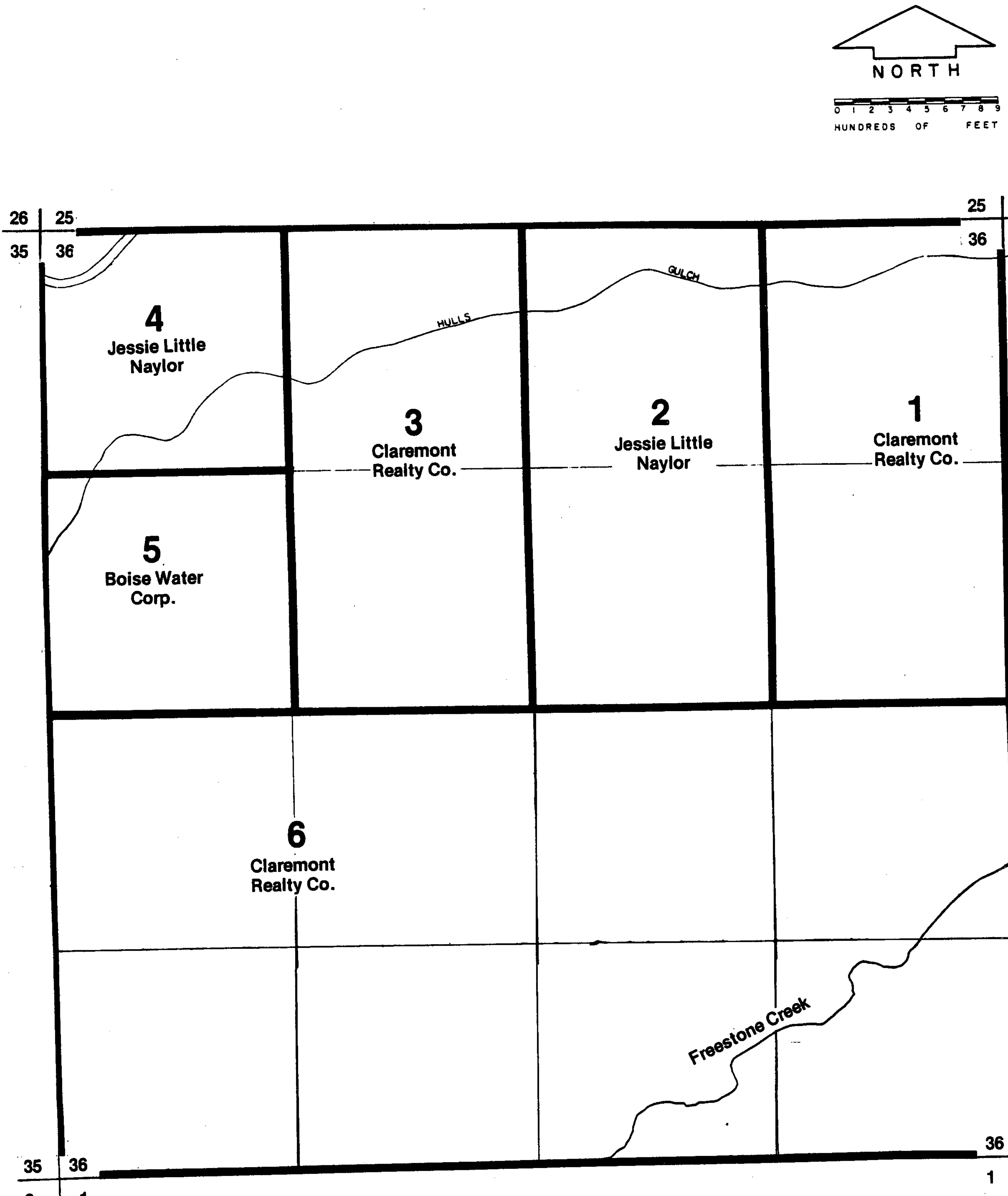


APPENDIX B.

EXISTING HOT WELL DATA

Introduction

This appendix is a reference guide designed to:

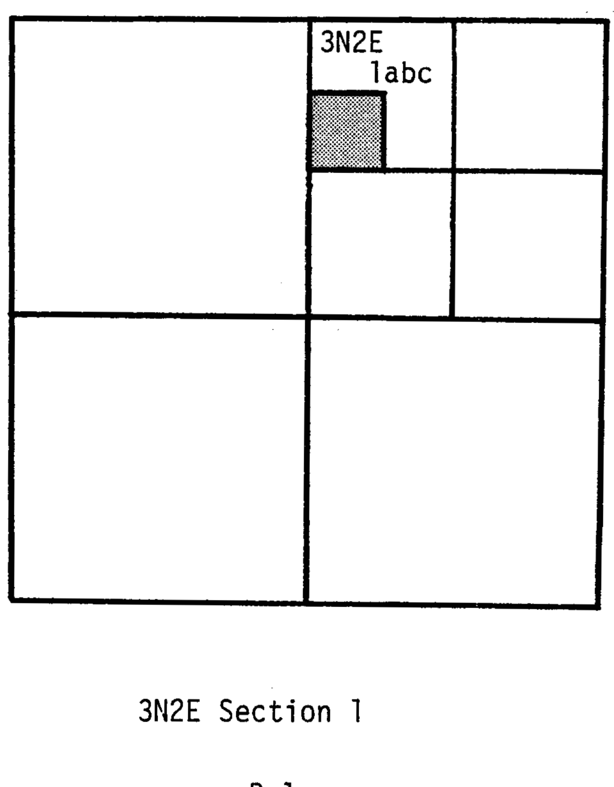
1) Locate known thermal wells in northern Ada County.
2) Identify well and water right ownership in a limited area of geothermal interest along the Boise Front.
3) List major leases in areas with geothermal potential.

This data has a number of uses. First, it can be used to estimate the geothermal potential of the area. In this sense the data provided is an expansion of earlier studies by Mink and Graham. Second, the data provides a background that will be useful in future resource development. This is also related to a third use which is providing a framework for testing reservoir overall potential.

The primary area covered by this appendix is shown in Figure B-1. Data provided is geographically located by the Township Range System which incorporates a sequence of letters and numbers to specify a particular plot of land. 3N2E labc means, for example, Township 3 North, Range 2 East of the Boise Baseline Meridian. The number following indicates the section number. The small letters show part of the section; the first letter is the quarter section, second is 1/16, and the third is 1/64 of a section. These are lettered counterclockwise starting in the northeast quarter.

b	a
c	d

3N2E labc means the southwest quarter of the northwest quarter of the northeast quarter of Section 1, Township 3 North, Range 2 East.



3N2E Section 1

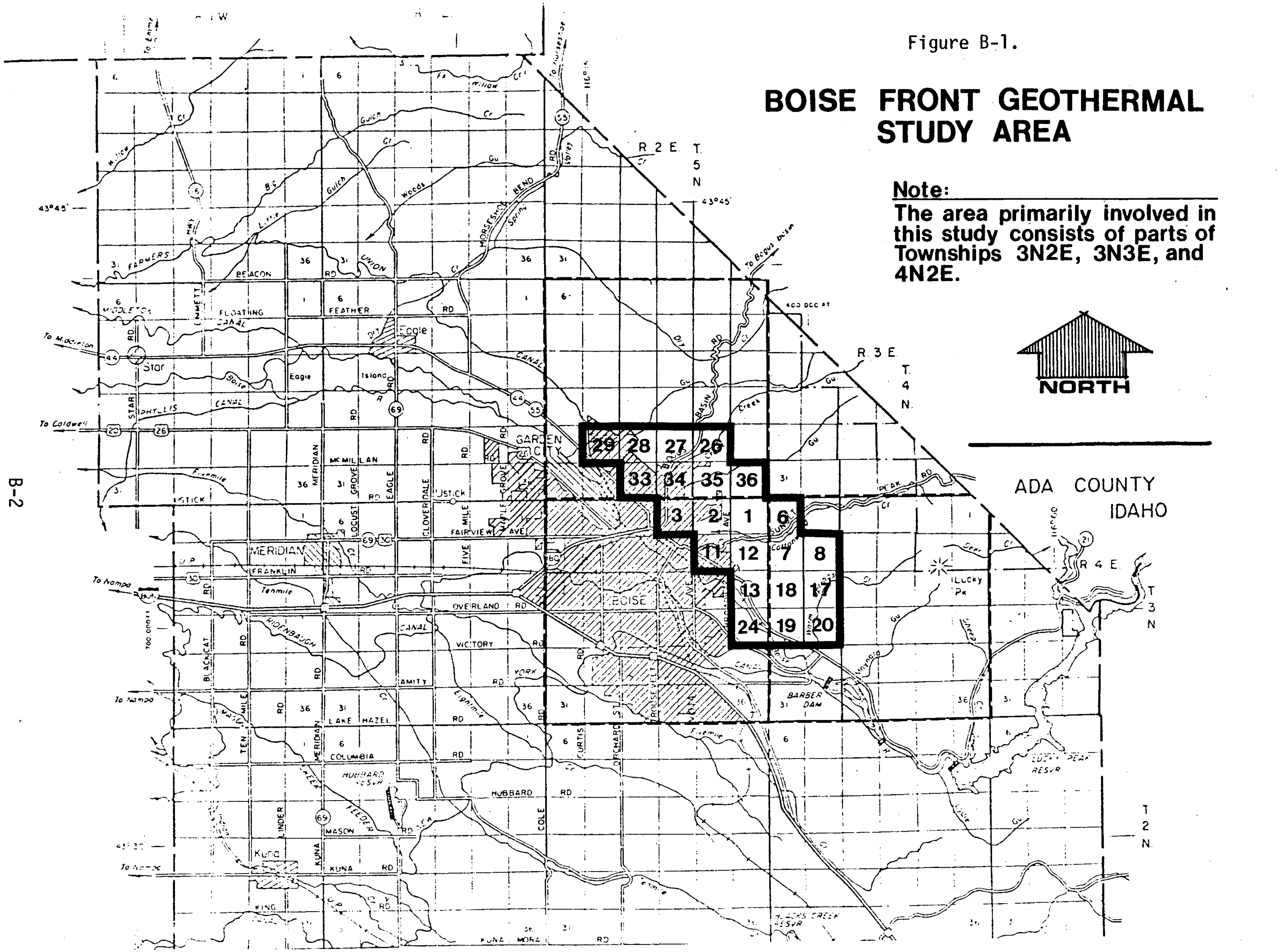


Figure B-1.

BOISE FRONT GEOTHERMAL STUDY AREA

When well data (listed in Tables B-1 and B-2) is plotted on a small scale, as on Figure B-2, "hot spots" show up. These tend to fall near faults and/or drainage systems. Part of this can be explained by accessability to the area, but much of it is due to underlying geologic processes. Hot spots occur in the area where Dry Creek intersects with Horseshoe Bend Road, Pierce Gulch, the area where Stuart Gulch intersects with Hill Road, Military Reserve Park (Cottonwood and Freestone Creeks), and the area around the Old Penetentiary. Following the same pattern it appears there may be "hot spots" near Camelsback Park (Hulls Gulch) and in Barber Flats near Warm Springs Creek.

Figure B-3 shows known thermal wells in northern Ada County numbered by temperature with #1 being the warmest. Table B-1 lists the data for these wells and Table B-2 lists these wells by location for reference purposes. Well data was gathered from many sources including the Idaho Department of Water Resources Geothermal Office, the Mink-Graham studies, Idaho Office of Energy Geothermal Files, and INEL. Because of the variety of sources, changes in aquifer quality, and thermal mixing, a few of these wells may be duplicated, listed under a wrong location or name, or no longer warm. Taking these problems into consideration, the data is believed to be at least 90% accurate as of January 1, 1979.

The warmest wells in the county lie along the Boise Front. Figure B-4, page B12 is a cross section of the front with the blue line representing depth and the red line temperature - both drawn to scale. Moving south-east along the foothills, temperatures seem to rise and depths become shallower. Wells tend to be concentrated along the faults and in drainage basins such as Stuart Gulch and Cottonwood Creek.

Figure B-5 illustrates temperature and depth for wells along the front with the majority of wells showing a slight rise of temperature with increased depth, but the least square line being offset by a few very warm but relatively shallow wells such as the Boise Warm Springs Water District wells which are 77°C, but only 400 feet deep.

Table B-3 lists water rights and wells by date. A few wells show no corresponding water rights but may have, as much of the data is inaccessable. This information is from the Idaho Department of Water Resources in Basin Index #2, Ada County Groundwater Index, well logs, and water right files.

Table B-4 lists property ownership for wells, water rights, and leases in selected sections of the front. Table B-5 provides more detailed information on leases, lessors, and lessees and was derived from data at Ada County Recorders and the State Department of Lands Office.

Figure B-2.

THERMAL WELLS IN NORTHERN ADA COUNTY

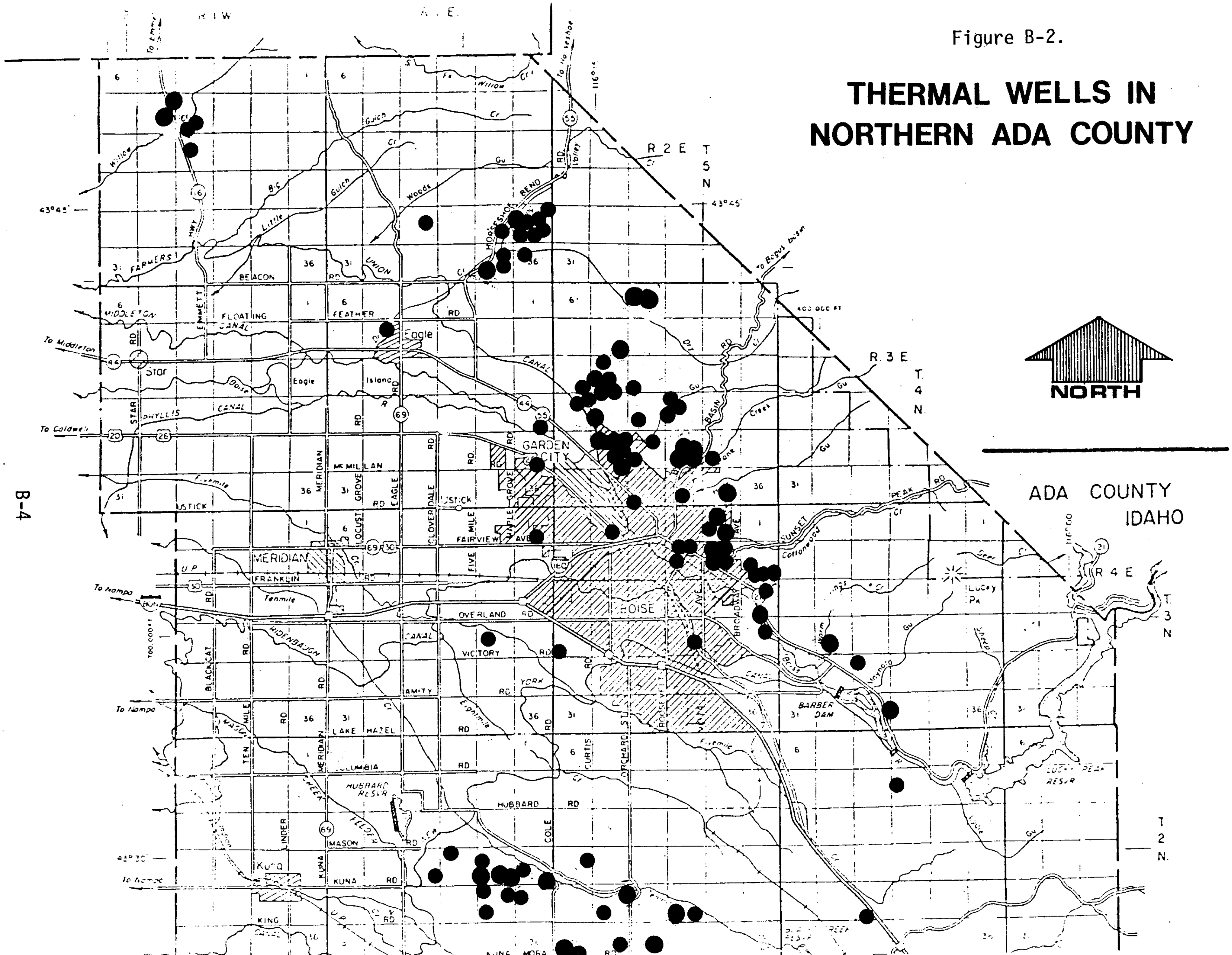


Table B-1.

THERMAL WELLS IN DESCENDING TEMPERATURE ORDER, NORTHERN ADA COUNTY

Well Number	Location	Name	Temp. (°C)	Depth (ft.)	Production Potential (gpm)
1	3N2E 11baa	ERDA, BHW-1 (Beard Well)	78[1]	1283	100
2	12cdd	Warm Spr. Water Dist.	77	400	1920
3	12cdd	Warm Spr. Water Dist.	77	400	1920
4	11ba	ERDA, BEH-1[2] (BLM Well)	74	1222	120
5	3N3E 20ca	Dallis Harris	67	531	
6	3N2E 13acb	State of Idaho-Pen3	58	872	700
7	11ba or 2cd	BSU, BSH-2	56	650	
8	2ca	See Footnote 4	51		
9	2cb	H.L. Koch	50	1160	80
10	4N2E 29aca	Edwards Greenhouse	49	1295	378
11	27ca	See Footnote 5	48	3770	
12	28abc	V.L. Nibbler[5]	48	1300	270
13	28cbb	Hunt Bros. Floral	48	1240	190
14	29bad	Ryan Well-4401 Castlebar	47	1100	378
15	29daa	Robert Hunt	46	1250	
16	3N2E 10aba	Statehouse Deep Well[3]	44	1075	300
17	10abb	*Hotel Boise (cemented over)	44		
18	4N2E 29daa	Robert Hunt	44	1250	
19	5N1E 35aca	J. Jeker	44		55
20	35ca	See Footnote 5	44	1000	
21	4N2E 17ba	*	43	1700	
22	22bcd	*J. Tertling	43	595	
23	22cc	J. Tertling[5]	43	600	400
24	29acd	W.F. & Kerry Church	42	1390	36
25	8dc	Lilian Barnes[5]	41	1685	73
26	16cc	See Footnote 4	40	900	
27	5N1E 35aca	J. Jeker	40		22
28	4N2E 21cca	Jess Donaho (Caved in)	36	900	
29	3N2E 12cbb	BSU, BSH-3	35	550	
30	4N2E 4bc	See Footnote 5	34		
31	17cba	Lilian Barnes[5]	34	1240	300
32	27dba	Cartwright Water Dist.	32	700	
33	27dba	Cartwright Water Dist.	32	700	
34	27dba	Cartwright Water Dist.	32	500	
35	2N2E 31dca	I.D.U. Land & Beef	31	428	2000
36	3N2E 24aca(lot 2)	Warm Springs Mesa	31	495	800
37	4N2E 4bdc	Carl Rush	30	250	
38	5N1E 25acc	John Boehm	30	200	
39	25bcc	Ben Stadler[2]	30	303	1700
40	25bdb	See Footnote 5	30	500	
41	26da	Ben Stadler	30	688	900
42	26dcd	Shadow Valley	30	688	
43	3N2E 11bbd	City of Boise	29	385	600
44	4N2E 35d	Scott Simplot[6]	29	720	
45	5N1W 9cdd	Bill Leach	29	450	
46	2N2E 19aad	Ronald Yanke	28	870	1980
47	3N2E 2d	BSU, BSH-1	28	283	
48	12dc	State of Idaho - Pen	28	487	18
49	4N1E 24dcc	Dennis Flake	28	1017	
50	2N1E 23dda	*Al Clifford	27	311	26

Table B-1.

THERMAL WELLS IN DESCENDING TEMPERATURE ORDER, NORTHERN ADA COUNTY
(Continued)

Well Number	Location	Name	Temp. (°C)	Depth (ft.)	Production Potential (gpm)
51	2N1E 24dad	*George Whitmore	27		
52	26aba	Charles Bair	27	288	
53	4N2E 17ca	*Barnes or Scott Baird[5]	27	525	500
54	18ddc	*Clement Taylor[5]	27	815	11
55	5N1W 8adc	*Clifford Smith	27	480	
56	2N2E 29cda	State of Idaho-Pen	26		2400
57	31cdc	I.D.U. Land & Beef	26	398	
58	4N2E 17ca	See Footnote 5	26	510	
59	19aac	Ed Genther	26	210	
60	2N1E 23cab	David Neal	25	280	
61	26ada	Desert View Estates	25	320	1100
62	2N2E 29aad	L.D.S. Farm #1	25	550	
63	33cdc	David Weiss	25	504	
64	4N2E 19aab	William Galloway	25	230	
65	2N1E 22bab	Tom Bevins	24	350	
66	23bac	Niles Clark	24	385	
67	24cba	Kuna East Water	24	308	2115
68	25bcd	Ed Johnson	24	300	1500
69	26ca	*Darrell Perkins	24	390	278
70	2N2E 27ccc	State of Idaho-Pen	24	605	1750
71	32dba	State of Idaho-Pen	24		
72	4N1E 25dca	Id. Dept. Trans.	24	900	256
73	4N2E 22bcd	J. Terteling	24	165	
74	5N1E 25ac	See Footnote 5	24	303	
75	36bdb	J. Jeker	24	400	15
76	2N1E 21dda	*John Cooknell	23	280	
77	3N2E 10bdc	Clark Magstadt	23	630	750
78	5N1E 25aa	See Footnote 5	23	175	
79	26cdc	D.A. McArthur	23	650	
80	2N2E 27dbd	State of Idaho-Pen	22	575	
81	2N3E 28cad	Id. Dept. Trans.	22	975	55-75
82	5N1E 28acb	*John Burgess	22	509	
83	3N2E 5dca	Village of Garden City	21	811	450
84	19cc	*	21	88	15
85	22dab	Osher Holcomb	21		28
86	3N3E 28bb	*7400 Warm Sprs. Ave.	21	400	30
87	4N2E 17cda	*E.L. Van Hendricks	21	690	15
88	19aa	*See Footnote 5	21	191	20-25
89	19aac	*Ethyl Ficks	21	225	
90	26cc	Crane Creek Cnty Club	21	741	700
91	29acd	W.F. & Kerry Church	21	82	36
92	5N1W 8add	Dee Rachilla	21	351	
93	16bdc	Letha Fisher	21	963	

Table B-1.

THERMAL WELLS IN DESCENDING TEMPERATURE ORDER, NORTHERN ADA COUNTY
(Continued)

Well Number	Location	Name	Temp. (°C)	Depth (ft.)	Production Potential (gpm)
94	5N1E 25cbc	Donald Swanson	21	300	40
95	2N3E 10bcb	*Warren Tozer	20	471	
96	3N1E 1cad	*Paul Larson, Claude High	20	655	1000
97	23bd	*K Bar T, Inc.	20	500	618
98	3N2E 13cd	State of Idaho-Pen	20	470	1600
99	3N3E 33,34	*John Reynolds	20	125	15
100	4N1E 8ab	*Howard Reynolds	20	55	20
101	4N2E 19,20	*W.H. Resser	20	115	60
102	33ccc	*Id. Dept. Trans.	20	1150	275
103	5N1W 9cad	David Traylor	20	400	
104	2N1E 23	*David Neal			
105	4N2E 34cad	*Richard B. Smith			

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* Not Verified.
1. At 875'
2. At 1050'
3. At testing. From Idaho Office of Energy, Geothermal Files.
4. Data from "Geothermal Investigations in Idaho, Part 8," Idaho Department of Water Resources, p. 84.
5. From "Geothermal Potential of the West Boise Area," L. Mink & D. Graham, p. 27.
6. There are more warm wells in the area but information is not available.

Table B-2.

THERMAL WELLS IN LOCATION ORDER, NORTHERN ADA COUNTY

Well No.	Location	Owner's Name	Date	Temp. (in degrees Celsius)	Depth (in feet)	Depth to Water (in feet)	Production Potential (in gal. per minute)	Diameter (in inches)
76	2N1E 21dda	*John Cooknell		23	280			
65	22bab	Tom Bevins		24	350			
66	23bac	Niles Clark		24	385			
60	23cab	David Neal		25	280			
104	23	*David Neal						
50	23dda	*Al Clifford		27	311			
67	24cba	Kuna East Water		24	308		2115	
51	24dad	*George Whitmore		27				
68	25bcd	Ed Johnson		24	320		1500	
61	26ada	Desert View Estates		25	320		1100	
52	26aba	Charles Bair		27	288			
69	26ca	*Darrell Perkins	5-71	24	390		278	
46	2N2E 19aad	Ronald Yanke	6-68	28	870		1980	
70	27ccc	State of Idaho-Pen		24	605		1750	
80	27dbd	State of Idaho-Pen		22	575			
62	29aad	LDS Farm #1		25	550			
56	29cda	State of Idaho-Pen		26			2400	
57	31cdc	IDU Land & Beef		26	398			
35	31dca	IDU Land & Beef		31	428		2000	
71	32dba	State of Idaho-Pen		24				
63	33cdc	David Weiss		25	504			
95	2N3E 10bcb	*Warren Tozer		20	471			
81	28cad	Idaho Dept. Transp.	11-66	22	975		55-75	
96	3N1E 1cad	*Paul Larson & Claude High	6-54	20	655		1000	
97	23bd	*K Bar T, Inc.	8-75	20	500		618	
8	3N2E 2ca	See Footnote 1		51				
9	2cb	H.L. Koch		50	1160	16	80	
47	2d	BSU, BSH-1		28	283			3
83	5dca	Garden City	10-52	21	811		450	
16	10aba	State of Idaho (Statehouse)[3]		44	1075		300	8
17	10abb	*Hotel Boise (Cemented over)		44				
77	10bdc	Clark Magstadt		23	630		750	12
7	11ba	BSU, BSH-2 (or 2cd)		56	650			3
4	11ba	ERDA, BEH-1 (BLM Well)		74	1222		120	7
1	11baa	ERDA, BHW-1 (Beard Well)		78	1283		600	8
43	11bbd	City of Boise		29	385		600	
29	12cbb	BSU, BSH-3		35	550			3
3	12cdd	Warm Sprs Water Dist	1890	77	400		1920	
2	12cdd	Warm Sprs Water Dist	1890	77	400		1920	
48	12dc	State of Idaho-Pen		28	487	103	18	12
6	13acb	State of Idaho-Pen[3]	7-65	58	872	73	700	16
98	13cd	State of Idaho-Pen	9-65	20	470	10	1600	16
84	19cc	*	9-72	21	88		15	6
85	22dab	Osker Holcomb	6-66	21	38	5	28	
36	24aca (lot 2)	Warm Springs Mesa	1-61	31	495	28	800	12
5	3N3E 20ca	Dallas Harris		67	531			
86	28bb	*7400 Warm Spr. Ave.	1966	21	400	45	30	

Table B-2.

THERMAL WELLS IN LOCATION ORDER, NORTHERN ADA COUNTY
(Continued)

ell o.	Location	Owner's Name	Date	Temp. (in degrees Celsius)	Depth (in feet)	Depth to Water (in feet)	Production Potential (in gal. per minute)	Diameter (in inches)
9	3N3E 33,34	*John Reynolds	10-72	20	125	40	15	8
00	4N1E 8ab	*Howard Reynolds		20	55		20	
9	24dcc	Dennis Flake		28	1017			
2	25dca	Idaho Dept. Transp.		24	900		256	
0	4N2E 4bc	See Footnote 2		34				
7	4bdc	Carl Rush		30	250			
5	8dc	Lilian Barnes[2]	1962	41	1685	240	73	
6	16cc	See Footnote 2		40	900			
1	17ba	*		43	1700			
3	17ca	*Joe Barnes or Scott Baird[2]	6-68	27	525	184	500	
8	17ca	See Footnote 2		26	510	172		
1	17cba	Lilian Barnes[2]		34	1240	73	300	
7	17cda	*E.L. Van Hendricks	8-73	21	690	210	15	
4	18ddc	*Clement Taylor[2]	1968	27	815		11	
8	19aa	*See Footnote 2		21	191	96	20-25	
4	19aab	William Galloway		25	230			
9	19aac	Ed Genther		26	210			
9	19aac	*Ethyl Ficks		21	225			
01	19,20	*W.H. Resser	1-64	20	115		60	
8	21cca	Jess Donoho (caved in)		36	900			
2	22bcd	*J. Terteling		43	595			
3	22bcd	J. Terteling		24	165			
3	22cc	J. Terteling[2]		43	600	129	400	
0	26cc	Crane Creek Country Club		21	741	112	700	20
2	27dba	Cartwright Water Dis.		32	700			
3	27dba	Cartwright Water Dis.		32	700			
4	27dba	Cartwright Water Dis.		32	500			
1	27ca	See Footnote 2		48	3770	250		
2	28abc	Victor Nibler[2]		48	1300		270	
3	28cbb	Hunt Brothers Floral		48	1240		190	
0	29aca	Edwards Greenhouse		49	1295		378	
4	29acd	W.F. & Kerry Church		42	1390		36	
1	29acd	W.F. & Kerry Church		21	82		36	
4	29bad	4401 Castlebar-Ryan Well		47	1100		378	
8	29daa	Robert Hunt		44	1250			
5	29daa	Robert Hunt		46	1250			
02	33ccc	*Idaho Dept. Trans.		20	1150		275	
105	34cad	*Richard B. Smith	6-78					
44	35d	Scott Simplot[4]	1978	29	720			12
55	5N1W 8adc	*Clifford Smith	1963	27	480	401		
92	8add	Dee Rachilla	1963	21	351	312		
45	9cdd	Bill Leach	10-66	29	450	300		
103	9cad	David Traylor		20	400			
93	16bdc	Letha Fisher		21	963			
78	5N1E 25aa	See Footnote 2		23	175	54		
74	25ac	See Footnote 2		24	303	112		

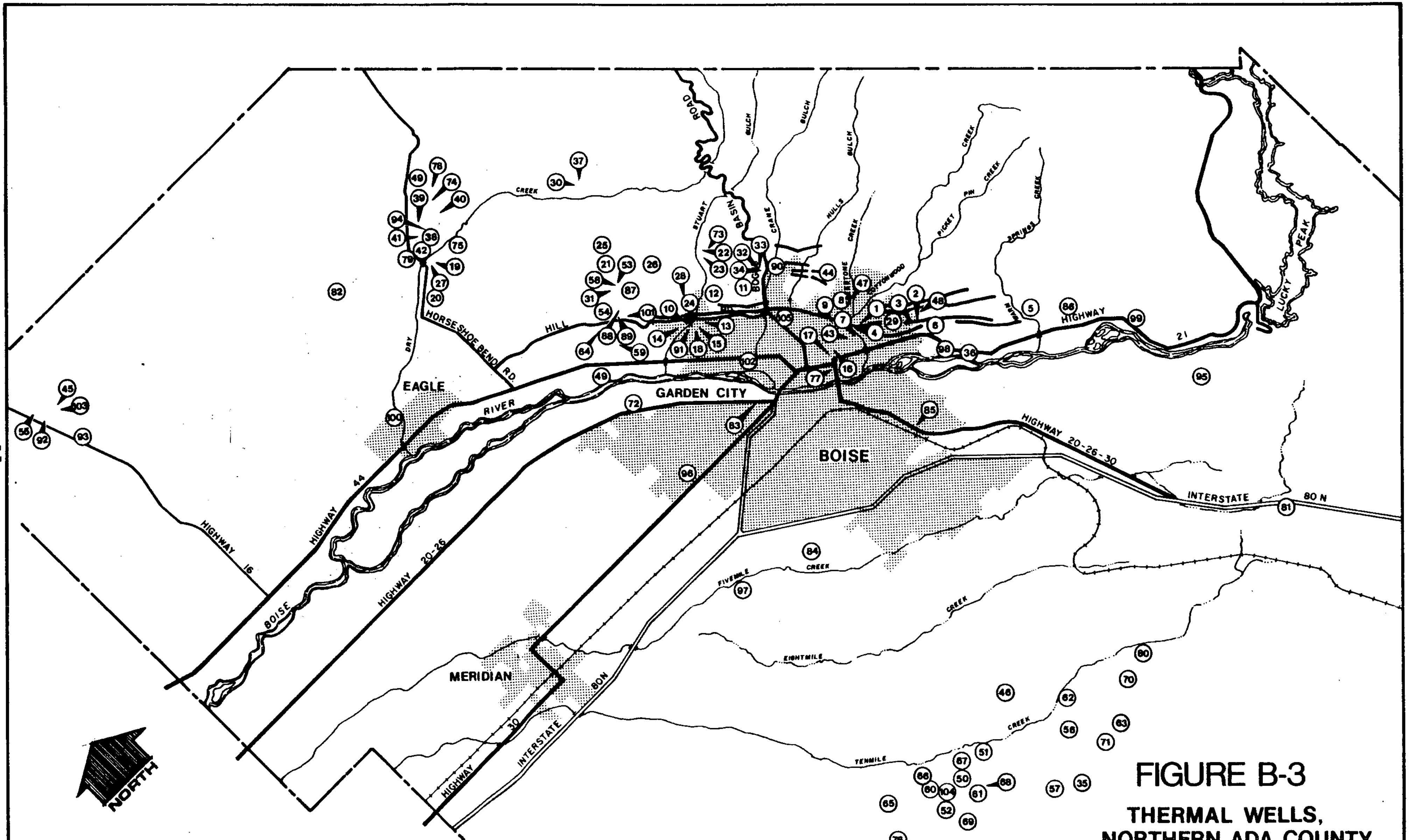
Table B-2.

THERMAL WELLS IN LOCATION ORDER, NORTHERN ADA COUNTY
(Continued)

Well No.	Location	Owner's Name	Date	Temp. (in degrees Celsius)	Depth (in feet)	Depth to Water (in feet)	Production Potential (in gal. per minute)	Diamete (in inches)
38	5N1E 25acc	John Boehm		30	200			
39	25bcc	Ben Stadler		30	303		1700	
94	25cbc	Donald Swanson	11-73	21	300		40	
40	25db	See Footnote 2		30	500	86		
79	26cdc	D.A. McArthur		23	650			
41	26da	Ben Stadler[2]		30	688		900	
42	26dcd	Shadow Valley		30	688			
82	28acb	*John Burgess	1-78	22	509		10	
19	35aca	J. Jeker		44			55	
27	35aca	J. Jeker		40				
20	35ca	See Footnote 2		44	1000			
75	36bdb	J. Jeker		24	400		15	

* Not Verified.

1. Data from "Geothermal Investigations in Idaho, Part 8," Idaho Dept. of Water Resources, p. 84.
2. "Geothermal Potential of the West Boise Area," L. Mink & D. Graham, p. 27.
3. At testing. From Idaho Department of Energy, Geothermal Files.
4. There are more warm wells in the area but information is not available.



Note:
The wells are numbered consecutively by temperature with the warmest being (1).

FIGURE B-3
THERMAL WELLS, NORTHERN ADA COUNTY

Figure B-4.

CROSS SECTION OF THE BOISE FRONT

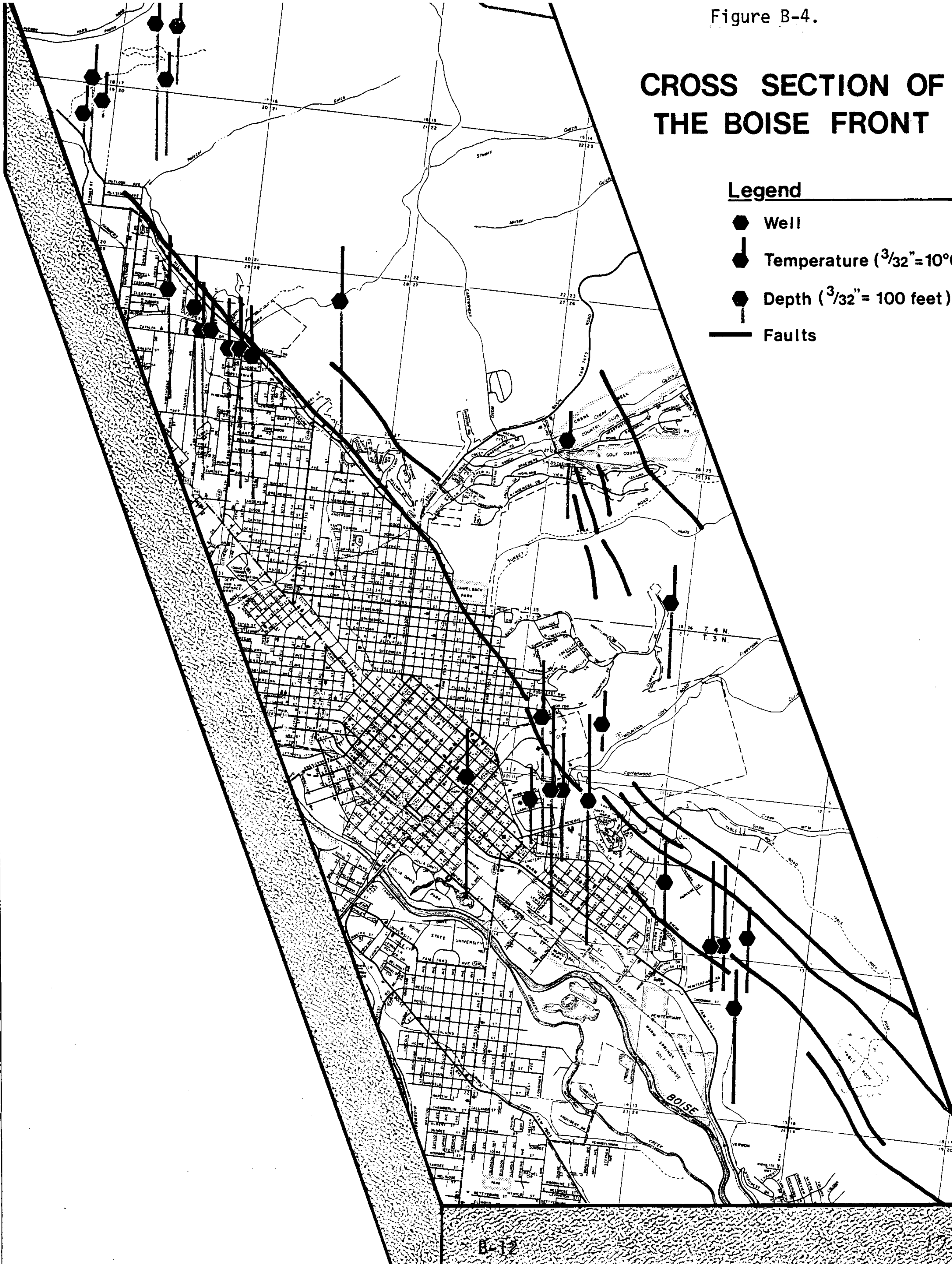


Figure B-5.

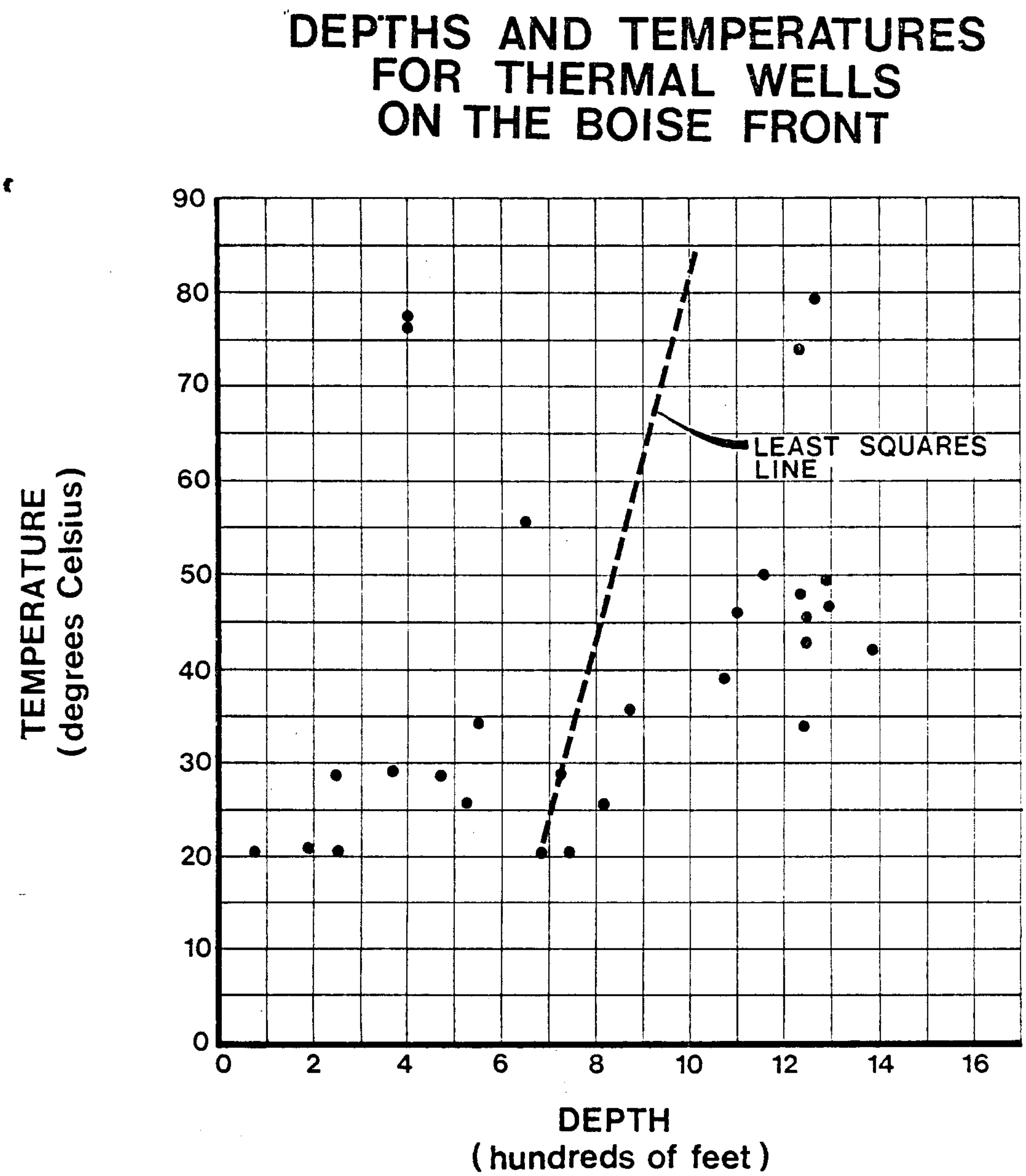

DEPTHS AND TEMPERATURES
FOR THERMAL WELLS
ON THE BOISE FRONT
TEMPERATURE
(degrees Celsius)
90
80
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
14
16
LEAST SQUARES
LINE
DEPTH
(hundreds of feet)

Table B-3.

DATES OF WATER RIGHTS AND WELLS IN SELECTED SECTIONS OF THE BOISE FRONT

Location	Name	Water Right Date	Status	Well Date	
3N2E 12cdd	Warm Springs Water Dist.			1890	H
12cdd	Warm Springs Water Dist.			1890	H
12cdd	Warm Springs Water Dist.	11/1894			H
4N2E 29daa	Robert Hunt		(1)	7/21	H
29daa	Robert Hunt		(1)	7/22	H
29aca,ab	Edwards Greenhouse	11/26	Licensed		H
29acd	Edwards Greenhouse		(1)	11/26	H
28cbb	H.W. Tiegs	3/27	Cancelled[1]		H
28cbb	Hunt Brothers Floral		(1)	5/27	H
29bad	4401 Castlebar-Ryan	9/27	Cancelled[1]	9/27	H
3N2E 1bb	W.G. Sloan	4/31	Cancelled		
4N2E 26	Jackson Ownby	12/31	Cancelled		
3N2E 11bb	Boise School Dist.	6/42	Licensed		
4N2E 34	Jane Clampett	4/43	Cancelled		
3N2E 2	Julian Shoop	8/46	Cancelled		
11ab Lot 2	Joe Aldape	9/46	Licensed		
12ab,ba	Felipe Aldape	9/46	Cancelled		
4N2E 29ad	Loris Prohaska	3/47	Licensed		
3N2E 3aa	J. O. Jordan	5/48	Licensed		
4N2E 34bc	F & B Smith	1/49	Relinquished		
3N2E 12bb	Walter Dufresne	7/49	Cancelled	1949	
3aa	Clarence Rigney	9/49	Licensed		
13cb	Boise Water Corp.*			4/50	
4N2E 34bd	Harold Fredrikson	11/50	Licensed		
3N2E 12bb	Lou Krall	11/51	Licensed	11/51	
12ab,ba	Felipe Aldape	12/51	Relinquished		
4N2E 33ab	Peter Heppner Cohn	5/52	Licensed		
3N2E 11bbd	City of Boise			7/53	H
11bb	Boise Parks Dept.	10/53	Licensed		
11cb	City of Boise	12/53	Licensed		
2cb	H. L. Koch	3/54	Licensed	no date	H
1ba	Seth Hawkins			8/54	
1ba	Seth Hawkins	5/55	Cancelled		
4N2E 34ab	The Highlands	6/55	Cancelled		
35bd	E. C. Underhill	12/55	Licensed		
3N2E 11bc	George Atkinson	8/56	Licensed		
4N2E 26ca,cb,db,bcc	Crane Creek Country Club	7/57	Licensed		
34dc	Boise Parks Dept.(Camelsback)	6/58	Licensed		
3N2E 1da	Randall Smith			6/59	
4N2E 27da	Clifford Higby			6/59	
33cc	Idaho Dept. Transportation			5/60	
3N2E 24ac	Warm Springs Mesa			1/61	H
4N2E 34ac	Thomas Smith	8/61	Licensed		
35bb	Daly Production	10/61	Licensed		
3N2E 12bb	Joel Olsen			7/62	
12bb	Joel Olsen	9/62	Licensed		
11aa lot 1	Howard Paul	9/62	Licensed		

(H Indicates Hot Water)

Table B-3.

DATES OF WATER RIGHTS AND WELLS IN SELECTED SECTIONS OF THE BOISE FRONT (Continued)

Location	Name	Water Right Date	Status	Well Date	
4N2E 26cc	Barr Smith Realty	11/63	Lapsed	8/63	
3N2E 12db	Day Realty	11/63	Lapsed	8/63	
4N2E 34bc	Barr & Carmen Smith	1/64	Lapsed		
3N3E 19c	Boise Cascade			5/64	
4N2E 26cc	Crane Creek Country Club			8/64	H
27da	Jennie Higby	10/64	Lapsed		
3N2E 3dd,bc	Boise Parks Dept.[2]	10/64	Licensed	1/65	
13ac,cd	State of Idaho	2/65	Cancelled		
13ac	Dr. E.D. Parkinson			4/65	
4N2E 29aa	Coy Cooper			6/65	
33aa	Elizabeth Schrupp	6/64	Licensed		
3N2E 24ac	Warm Springs Mesa	7/65	Licensed		
13acb	State of Idaho			7/65	H
13cd	State of Idaho			9/65	H
4N2E 33ab	Maxine Horsley	9/65	Lapsed	6/67	
34cc	M.M. McCuthen	4/66	Licensed		
28	Al Blaser			6/67	
3N2E 12db	Art Troutner			7/67	
29ac	Henri Petri	12/67	Licensed		
29ab	Henry Poe			12/67	
3N2E 12aa	Joe Aldape			4/68	
4N2E 28cb	Robert Cushman			5/68	
3N3E 20ad	Dallas Harris	5/68	Licensed		
20ca	Dallas Harris	8/68	Lapsed		
3N2E 1ba	Grover Hawkins			8/68	
11cc	Morrison-Knudson	11/68	Licensed		
13aa	Fearless Farris Whsle.	11/68	Licensed		
3N3E 7cd	Day Realty	11/68	Lapsed	1/69	
3N2E 3dd	General Service Admin.	5/69	Lapsed	no date	
4N2D 28ab	Victor Nibler	5/69	Claim	no date	H
28bc	Boise School Dist. (Hillside)			10/69	
29bbba	Alfred Lung			12/69	
27ac	Howard Mitchell	12/69	Lapsed		
3N2E 12bb	Joe Aldape			7/70	
3N3E 19cd	Boise Cascade			1/71	
34dc	Boise Parks Dept.			3/71	
3N2E 24aa	Ronald Berst	5/71	Licensed		
12ba	R.V. Hansberger	6/71	Claim		
3N3E 7aa	R.V. Hansberger	7/71	Claim		
7ba	R.V. Hansberger	7/71	Claim		
3N2E 12aa	R.V. Hansberger	7/71	Claim	7/71	
12aa	R.V. Hansberger	7/71	Claim		
12bb	R.V. Hansberger	7/71	Claim		
12bb	Lou Krall	7/71	Approved		
4N2E 28ca	Rowell Subdivision	11/71			
34bc	Carmen & Barr Smith	1/72	Lapsed		

Table B-3.

DATES OF WATER RIGHTS AND WELLS IN SELECTED SECTIONS OF THE BOISE FRONT (Continued)

Location	Name	Water Right Date	Status	Well Date	
3N2E 1db	Hawkins			1/73	
13ac	Montie Ralston			3/73	
12cc	Homer Jackson	6/73	Licensed		
4N2E 35dd	Boise Hills Corp.	6/73	Filed		
27ac	Howard Mithcell	11/73	Lapsed		
3N2E 12bb	Paul Martin	12/73	Licensed		
12bb	Steve Matechi			1973	
2aa	Gary LaFay	2/74	Claim		
13bd	Boise L.D.S. Church	2/74	Licensed		
3N3E 19ca	Ronald Koch	5/74			
3N2E 13bd	Boise L.D.S. Church		Claim	6/74	
2cc	Veterans Administration			9/74	
1bb	Ted Hawkins			11/75	
4N2E 27db	Ray Dowding	2/76	Approved		
3N2E 2db	BSU			2/76	H
11ba	ERDA	2/76	Lapsed		H
11ba	ERDA			1976[3]	H
11ba	ERDA			1976[3]	H
11ba	BSU			1976[3]	H
12cbb	BSU			1976[3]	H
4N2E 33cc	Idaho Transportation Dept.	6/76	Filed		
3N2E 11ba	ERDA	7/76	Approved		H
3N3E 6ba lot 2	W.A. Shepherd	11/76	Claim		
3N2E 24ad	Ada Cnty. Highways			11/76	
12dc	Joe Kanta	2/77	Application		H
3N3E 20ca	Dallas Harris	3/77	Approved		H
17ac,db,dc	Joe Kanta	3/77	Protested		H
6ac,ad,bd,ca, cd,da,db,lots 4,5,6,7,8	Joe Kanta	3/77	Protested		H
4N2E 33bc	Boise Parks Dept.	3/77	Application		
29da	Hunt Brothers Floral			4/77	
3N2E 13db	Cookes Greenhouse	6/77	Approved		H
11bb	Id. Dept. Health & Welfare	10/77	Filed		
13aa,ab,ac,ba	Joe Kanta	1978	Filed		
4N2E 35d	Scott Simplot			1978	H
4N2E 34dc	City of Boise	4/78	Licensed		H
3N2E 11ba	City of Boise	4/78	Application		
2cc,cd	City of Boise	4/78	Application		
4N2E 34cad	Richard B. Smith*			6/78	H

* Not Verified.
1. See decree - page .
2. Also for 3N2E 4db, 10cb, 10ab, and 4N2E 33dd.
3. Date not verified.

PROPERTY OWNERSHIP FOR WELLS, WATER RIGHTS, AND LEASES IN SELECTED SECTIONS OF THE BOISE FRONT

		Well					Water Right			
Location	Name	Temp. (C°)	Depth (ft.)	Production Potential (gal/min)	Depth to Water (ft.)	Well or Water Right Date	Allocated Discharge (ft³/sec or acre ft.)	Status	Lessee	Property Owner
3N2E										
1ba	Seth Hawkins	---	302	83.3	28	5-55	0.50	Cancelled	---	Hawkins
1ba	Grover Hawkins	---	146	---	97	8-68	---	---	---	Hawkins
1bb	Ted Hawkins	---	270	20.0	9	11-75	---	---	---	Earl Hawkins
1bb, lot 2	W.G. Sloan	---	---	---	---	4-31	5.00	Cancelled	---	Earl Hawkins
1da	Randall Smith	---	348	35.0	318	6-59	---	---	---	Earl Hawkins
1db	Hawkins	---	120	---	100	1-73	---	---	---	Earl Hawkins
2	Julian Shoop	---	---	---	---	8-46	0.04	Cancelled	---	---
2aa	Gary LaFay	---	---	---	---	2-74	0.05	Claim	---	---
2ca	See Footnote 1	51	---	---	---	---	---	---	---	---
2cb	H.L. Koch	50	1160	80.0	16	3-54	0.06	Licensed	---	---
2cc	Veterans Adm.	---	474	550.0	31	9-74	---	---	---	Veterans Adm.
2cc,cd	City of Boise[2]	---	---	---	---	4-78	12.00	Application	---	City of Boise
2d	BSU, BSH-1	28	283	---	---	2-76	---	---	---	City of Boise
3aa	Clarence Rigney	---	---	---	---	9-49	0.02	Licensed	---	---
3aa	J.O Jordan	---	---	---	---	5-48	0.02	Licensed	---	---
3bc,dd	Boise Parks-Mem.	---	80	155.0	25	10-64	2.89	Licensed	---	City of Boise
3dd	General Service	---	150	120.0	35	5-69	0.18	Lapsed	---	General Service
11aa lot 1	Howard Paul	---	---	---	---	9-62	0.04	Licensed	---	Howard Paul
11ab lot 2	Joe Aldape	---	---	---	---	9-46	0.67	Licensed	---	---
11ba	ERDA[3]	---	---	---	---	2-76	0.20	Lapsed	---	U.S. BLM
11ba	ERDA[3]	---	---	---	---	7-76	1.00	Approved	---	U.S. BLM
11ba	ERDA, BEH-1 (BLM)	74	1222	---	---	---	---	---	---	U.S. BLM
11baa	ERDA, BHW-1 (Beard)	78	1283	100	---	---	---	---	---	City of Boise
11ba or 2cd	BSU, BSH-2	56	650	---	---	---	---	---	---	U.S. BLM
11ba	Boise City[1]	---	---	---	---	4-78	12.00	Application	---	
11bb	ID Dept H & W[4]	---	---	---	---	10-77	0.02	Filed	---	State of Idaho
11bb	Boise Sch Dis (E)	---	---	---	---	6-42	0.30	Licensed	---	Boise Sch Dist
11bb	Boise Parks Dept.	29	385	600.0	---	10-53	0.04	Licensed	---	City of Boise

Table B-4.

PROPERTY OWNERSHIP FOR WELLS, WATER RIGHTS, AND LEASES IN SELECTED SECTIONS OF THE BOISE FRONT

		Well					Water Right			
Location	Name	Temp. (C°)	Depth (ft.)	Production Potential (gal/min)	Depth to Water (ft.)	Well or Water Right Date	Allocated Discharge (ft³/sec or acre ft.)	Status	Lessee	Property Owner
3N2E										
11bc	George Atkinson	---	---	---	---	8-56	0.02	Licensed	---	---
11cd	Boise City[5]	---	---	---	---	12-53	0.12	Licensed	---	City of Boise
11cc	Morrison-Knudson	---	---	---	---	11-68	3.00	Licensed	---	Morrison-Knudsoı
12aa	R.V. Hansberger[6]	---	?	?	?	7-71	0.02	Claim	---	Maria Aldape
12aa	R.V. Hansberger[7]	---	---	---	---	7-71	1.00	Claim	---	Maria Aldape
12aa	Joe Aldape	---	370	10.0	32	4-68	---	---	---	Maria Aldape
12ab,ba	Felipe Aldape	---	---	---	---	9-46	3.00	Cancelled	---	Maria Aldape
12ab,ba	Felipe Aldape[8]	---	---	---	---	12-51	3.00	Relinquished	---	Maria Aldape
12ba	R.V. Hansberger	---	---	---	---	6-71	0.70	Claim	---	Maria Aldape
12bb	R.V. Hansberger	---	---	---	---	7-71	0.02	Claim	---	---
12bb	Lou Krall	---	87	---	---	11-51	0.14	Licensed	---	---
12bb	Lou Krall	---	---	---	---	7-71	0.20	Approved	---	---
12bb	Walter Dufresne	---	63	---	---	7-49	0.10	Cancelled	---	---
12bb	Joel Olsen	---	9	---	---	9-60	0.03	Licensed	---	Joel Olsen
12bb lot 1	Steve Matechi[9]	---	465	15.0	150	12-73	0.04	Licensed	---	Steve Matechi
12bb	Joe Aldape	---	264	65.0	148	7-70	---	---	---	---
12cbb	BSU, BSH-3	35	550	---	---	7-76	---	---	---	Colburn et. al.
12cc lot 9	Homer Jackson	---	---	---	---	6-73	0.04	Licensed	---	---
12cdd	Warm Sp Water Ds	77	400	1920	---	1894	4.2731	?	---	Warm Sp Water D
12cdd	Warm Sp Water Ds	77	400	1920	---	1894	4.2731	?	---	Warm Sp Water D
12dcd	Day Realty	---	---	---	---	11-63	4.00	Lapsed	---	Day Realty
12db	Art Troutner	---	260	---	80	7-67	---	---	---	Art Troutner
12dc	State of Id (Pen)	28	487	18.0	103	---	---		---	State of Idaho
12dc	Joe Kanta	---	---	---	---	2-77	14.00	Application	Kanta	State of Idaho
13aa,ab,ac,ba	Joe Kanta	---	---	---	---	?	?	Application	Kanta	State of Idaho
13a,ba,bda,ptc	Joe Kanta	---	---	---	---	---	---	---	Kanta	State of Idaho
13aa	Fearless Ferris	---	---	---	---	11-68	0.12	Licensed	---	State of Idaho
13ac	Montie Ralstin	---	50	---	20	3-73	---	---	---	State of Idaho
13ac	E.D. Parkinson	---	82	---	---	4-65	---	---	---	State of Idaho

Table B-4.

PROPERTY OWNERSHIP FOR WELLS, WATER RIGHTS, AND LEASES IN SELECTED SECTIONS OF THE BOISE FRONT

		Well				Well or Water Right Date	Water Right			
Location	Name	Temp. (C°)	Depth (ft.)	Production Potential (gal/min)	Depth to Water (ft.)		Allocated Discharge (ft^3/sec or acre ft.)	Status	Lessor	Property Owner
3N2E										
13acb	State of Idaho	58	872	700.0	73	2-65	6.70	Cancelled	---	State of Idaho
13bd	Boise LDS Church	---	79	90.0	40	2-74	0.04	Licensed	---	Boise LDS Church
13cd	State of Idaho	20	470	1600.0	10	2-65	6.70	Cancelled	---	State of Idaho
13db	Cookes Greenhouse	---	---	---	---	6-77	0.40	Approved	---	---
24aa	Ronald Berst	---	---	---	---	5-71	0.06	Licensed	---	Bruce Bowler & I.R. Bauer
24ac lot 2	Wm Sprs Mesa	31	495	800.0	28	1-61	1.67	Licensed	---	Jack Eisenburg
24ad	Ada Cnty Hwy	---	95	5.0	57	11-76	---	---	---	---
3N3E										
6ba lot 2	W.A. Shepherd	---	---	---	---	11-76	0.30	Claim	---	W.A. Shepherd
6ac,ad,bd,ca,cd,da,db, lots 4,5,6,7	Joe Kanta	---	---	---	---	3-77	10.00	Protested	Kanta	State of Idaho
7aa	R.V. Hansberger[10]	---	---	---	---	7-71	0.01	Claim	---	Aldape/Hansberger
7ba	R.V. Hansberger	---	---	---	---	7-71	0.02	Claim	---	Aldape/Hansberger
7cd	Day Realty	---	290	---	100	11-68	7.00	Lapsed	---	Emma Day
7d	Gulf Oil	---	---	---	---	---	---	---	Gulf	Aldape
8abb,ac,ad,ba,bc, bd,c,d	Gulf Oil	---	---	---	---	---	---	---	Gulf	Aldape
17ab,ac,ad, ba,bb,bd,d	Joe Kanta	---	---	---	---	---	---	---	Kanta	State of Idaho
17ab,ac,ba, bd,db,dc	Joe Kanta	---	---	---	---	3-77	10.00	Protested	Kanta	State of Idaho
18aa,ab,ac	Gulf Oil[11]	---	---	---	---	---	---	---	Aldape	Flora Aldape
18aa,ab	Joe Kanta[12]	---	---	---	---	---	---	---	Idaho	Flora Aldape
18ad,b,pt.c, da	Joe Kanta	---	---	---	---	---	---	---	Kanta	State of Idaho
18bb	Joe Kanta	---	---	---	---	?	?	Application	Kanta	State of Idaho
19c	Boise Cascade	---	50	20.0	3	5-64	---	---	---	---

Table B-4.

PROPERTY OWNERSHIP FOR WELLS, WATER RIGHTS, AND
LEASES IN SELECTED SECTIONS OF THE BOISE FRONT
(Continued)

		Well					Water Right			
Location	Name	Temp. (C°)	Depth (ft.)	Production Potential (gal/min)	Depth to Water (ft.)	Well or Water Right Date	Allocated Discharge (ft³/sec or acre ft.)	Status	Lessor	Property Owner
3N3E										
19ca	Ronald Koch	---	---	---	---	5-74	.06	Claim	---	---
19cd	Boise Cascade	---	54	---	3	1-71	---	---	---	---
19dc	Harry Balcom	---	---	---	---	---	.20	Cancelled	---	---
20ad	Dallas Harris	---	---	---	---	5-68	1.4	Licensed	---	Dallis Harris
20ca	Dallas Harris	---	---	---	---	8-68	.8	Lapsed	---	Dallas Harris
20ca	Dallas Harris	67	53[1]	---	---	3-77	6.0	Approved	---	Dallas Harris
4N2E										
26--	Jackson Ownby	---	---	---	---	12-31	6.6	Cancelled	---	---
26ccc	Crane Ck Cnt Clb	21	741	700.0	112	---	---	---	---	Crane Ck Cnt Cl
26ca,cb,cc db,b	Crane Ck Cnt Clb	---	---	---	---	7-57	1.84	Licensed	---	The Highlands
26cc	Barr Smith Realty	---	427	550.0	117	8-63	---	---	---	---
27ac	Howard Mitchell	---	---	---	---	12-69	0.06	Lapsed	---	Howard Mitchell
27ac	Howard Mitchell	---	---	---	---	11-73	1.00	Lapsed	---	Howard Mitchell
27ca	See Footnote 13	48	3770	---	250	---	---	---	---	---
27da	Clifford Higby[14]	---	408	---	150	10-64	0.10	Licensed	---	---
27db	Ray Dowding	---	---	---	---	2-76	4.00	Approved	---	---
27dba	Cartwright Wtr Dst	32	700	---	---	---	---	---	---	---
27dba	Cartwright Wtr Dst	32	700	---	---	---	---	---	---	---
27dba	Cartwright Wtr Dst	32	500	---	---	---	---	---	---	---
28	Al Blaser	---	53	---	15	6-67	---	---	---	---
28abc	Victor Nibler[13]	48	1300	270.0	---	5-69	2.40	Claim	---	Victor Nibler
28bc	Boise Sch Dst-Hlsd	---	500	1.7	6	---	---	---	---	Boise Sch. Dist
28ca	Rowell Subdiv.	---	43	30.0	13	---	---	---	---	---
28cb	Robert Cushman	---	60	---	28	5-68	---	---	---	Robert Cushman
28cbb	Hunt Bros Floral[15]	48	1240	190.0	---	---	---	---	---	Hunt Bros Flora
28cbb	H.W. Tiegs[15]	---	---	---	---	3-27	0.80	Cancelled	---	Hunt Bros Flora

Table B-4.

PROPERTY OWNERSHIP FOR WELLS, WATER RIGHTS, AND LEASES IN SELECTED SECTIONS OF THE BOISE FRONT

Location	Name	Well: Temp. (C°)	Well: Depth (ft.)	Well: Production Potential (gal/min)	Well: Depth to Water (ft.)	Well or Water Right Date	Water Right: Allocated Discharge (ft³/sec or acre ft.)	Water Right: Status	Lessee	Property Owner
4N2E										
29aa	B. McGlochlin	---	655	20.0	---	---	---	---	---	Wren McGlochlin
29aa	Coy Cooper	---	115	---	78	6-65	---	---	---	---
29ab	Henry Poe	---	100	---	35	12-67	---	---	---	---
29ac	Henri Petri	---	---	---	---	12-67	0.02	Licensed	---	---
29aca	Ed. Greenhouse[15]	49	1295	378.0	---	---	---	---	---	Edwards Greenhouse
29ab,aca	Ed. Greenhouse[15]	---	---	---	---	11-26	0.84	Licensed	---	Edwards Greenhouse
29acd	WF, Kerry Church	42	1390	36.0	---	---	---	---	---	W.F. Church
29acd	WF, Kerry Church	21	82	36.0	---	---	---	---	---	W.F. Church
29ad	Loris Prohaska	---	---	---	---	3-47	0.10	Licensed	---	---
29ba	Ed Blazer	---	?	---	---	?	---	---	---	---
29ba,bb	Alfred Luna	---	120	---	50	12-69	---	---	---	---
29bad	4401 Castlebar, Jacob Ryan Power[15]	47	1100	378.0	---	9-27	0.80	Cancelled	---	Tom Harris
29da	Hunt Bros Floral	---	65	---	28	4-77	---	---	---	Robert Hunt
29daa	Robt. Hunt[15]	44	1250	---	---	---	---	---	---	Robert Hunt
29daa	Robt. Hunt[15]	46	1250	---	---	7-22	---	---	---	Robert Hunt
29daa	Frances Silkey[15]	---	---	---	---	---	.80	?	---	Robert Hunt
33aa	Eliz. Schrupp	---	---	---	---	6-65	0.02	Licensed	---	---
33ab	P.H. Cohn	---	---	---	---	5-52	0.03	Licensed	---	---
33ab	Maxine Horsley	---	---	---	---	9-65	0.02	Lapsed	---	---
33bc	Boise Parks	---	---	---	---	3-77	.04	Application	---	---
33cc	Id Dept Trans*	20	1150	275.	---	6-76	1.34	Filed	---	---
33cc	Id Dept Trans	---	60	900.0	31	5-60	---	---	---	---
33dd	Boise Parks	---	---	---	---	10-64	2.89	Licensed	---	---
34--	Jane Clampett	---	---	---	---	4-43	0.20	Cancelled	---	---
34ab	The Highlands	---	---	---	---	6-55	0.58	Cancelled	---	The Highlands
34ac	Thomas Smith	---	---	---	---	8-61	0.40	Licensed	---	---
34bc	F & B Smith	---	---	---	---	---	---	Cancelled	---	Smith
34bc	F & B Smith	---	---	---	---	1-49	0.70	Relinguished	---	Smith
34bc	C & B Smith	---	---	---	---	1-72	0.50	Lapsed	---	Smith
34bc	C & B Smith	---	---	---	---	1-64	---	Lapsed	---	Smith
34bd	H. Fredrikson	---	---	---	---	11-50	0.04	Licensed	---	---

Table B-4.

PROPERTY OWNERSHIP FOR WELLS, WATER RIGHTS, AND LEASES IN SELECTED SECTIONS OF THE BOISE FRONT

		Well				Well or Water Right Date	Water Right			
Location	Name	Temp. (C°)	Depth (ft.)	Production Potential (gal/min)	Depth to Water (ft.)		Allocated Discharge (ft³/sec or acre ft.)	Status	Lessee	Property Owner
4N2E										
34cad	Richard Smith*	---	---	---	---	6-78	---	---	---	Orin Givens Const
34cc	M.M. McCuthen	---	---	---	---	4-66	0.02	Licensed	---	---
34dc	Boise Parks-Cambk	---	221	250.0	51	6-58	0.20	Licensed	---	City of Boise
34dc	Boise City[16]	---	---	---	---	4-78	8.00	Licensed	---	City of Boise
35bb	Daly Production	---	---	---	---	10-61	0.12	Licensed	---	Daly Production
35bc	E.C. Underhill	---	---	---	---	12-55	0.10	Licensed	---	Boise Water Corp
35dd	Boise Hills Corp	---	---	---	---	6-73	1.66	Filed	---	Claremont Realty
35d	Scott Simplot[17]	29	720	---	---	1978	---	---	---	---

* Not verified.
1 From Geothermal Investigations in Idaho, Part 8, Idaho Dept. of Water Resources, p. 84.
2 In care of City Legal Department for 5 wells.
3 For 2 wells, State Land Permit #I-9719.
4 Veterans Home.
5 Masonic Cemetery.
6 Artesian spring.
7 For Cottonwood Creek.
8 Relinquished to State of Idaho.
9 Water rights registered to Paul Martin.
10 For Picket Pin Creek.
11 Rights transferred by Anchutz Corp. to Oxy Petroleum, Ada County Recorders #892475 and #7620394.
12 Leased to Kanta by State of Idaho - H-482.
13 From Geothermal Potential of the West Boise Area, L. Mink & D. Graham, p. 27.
14 Water rights registered to Jennie Higby.
15 See Decree, page .
16 In care of City Legal Department.
17 There are more warm wells but iniformation was not available.

Table B-5.5

MAJOR LEASES FOR NORTHERN ADA COUNTY

Location	Lessor	Lessee	Lease
3N2E 12dc	State of Idaho	Joe Kanta	Geothermal Lease
13a, ba, pt bda, pt.c	State of Idaho	Joe Kanta	Geothermal Lease
3N3E 1ab, ac, bd, lot 4	Joe Aldape et. al.	Gulf Oil	Steam[1]
2aa, ab, da, bd, ca, lots 2,3,4,5,6	Joe Aldape et. al.	Gulf Oil	Steam[1]
6ac, ad, bd, ca, cd, da, db, lots 4,5,6,7	State of Idaho	Joe Kanta	Geothermal Lease
7d	Joe Aldape	Gulf Oil	Steam[1]
8ac, ad, ba, bc, bd, abb, c, d	Joe Aldape	Gulf Oil	Steam[1]
17ab, ac, ad, ba, bb, bd, d	State of Idaho	Joe Kanta	Geothermal Lease
18aa, ab, ac	Joe Aldape	Gulf Oil	Steam[1,2]
18aa, ab, ad, b, pt.c, da	State of Idaho	Joe Kanta	Geothermal Lease
4N1W 15 lots 7, 8	Pete Anchustegui	Oxy Petroleum	Geothermal Lease
15 pt. c	Elias Aldape	Oxy Petroleum	Geothermal Lease
16 lot 3	Elsie Duncan	Oxy Petroleum	Geothermal Lease
16, 30 acres by lot 1	Elias Aldape	Oxy Petroleum	Geothermal Lease
17, lot 7	U.S. BLM	Thomas Robinson	Oil & Gas
21, lot 1, ad, pt. da	Elias Aldape	Oxy Petroleum	Geothermal Lease
21a, bb, bc, pt.c	Hattie Brogen	Oxy Petroleum	Geothermal Lease
22abb, abc, acb, acc, pt. bb, pt. bc, lot 1	Elias Aldape	Oxy Petroleum	Geothermal Lease
22bb, bc, cb	Elsie Duncan	Oxy Petroleum	Geothermal Lease
22aab, aaa	Lee Owsley	Oxy Petroleum	Geothermal Lease
22aac, aad, d, abb, aca, acb, ad	Helen Simpson	Standard Oil	Oil, Gas, Mineral
23, lot 2, ac, ad, bc, bd, c	Helen Simpson	Standard Oil	Oil, Gas, Mineral
26bb, bcaa, bcab, bcba, bcbb	Helen Simpson	Standard Oil	Oil, Gas, Mineral
26, tax 2	Jimmie James	Standard Oil	Oil, Gas, Mineral
28ab, ac	Travis Duncan	Oxy Petroleum	Geothermal Lease
4N2E 1, lots 1, 2, ac, bda, bdd, cb, cc	Joe Aldape et. al.	Gulf Oil	Steam[1]
1, lots 1-4, ac,ad,bc,bd,ca,db,dc	U.S. BLM	Nancy Anschutz	Oil & Gas
2, lots 2,3,4, ac,ad,bc,bd,cd,db,dc	U.S. BLM	Nancy Anschutz	Oil & Gas
12aa, ab	U.S. BLM	Nancy Anschutz	Oil & Gas
4N3E 26pt.c	Joe Aldape et. al.	Gulf Oil	Steam[1]
27dd	Joe Aldape et. al.	Gulf Oil	Steam
35, lots 2,3,4,5,8,9, cb, cc, d	Joe Aldape et. al.	Gulf Oil	Steam

Table B-5.

MAJOR LEASES FOR NORTHERN ADA COUNTY
(Continued)

Location	Lessor	Lessee	Lease
5N1W 4cc, cd, bd, bc, cb	Little Cattle Co.	Gulf Oil	Steam
5bc, bd, c, db, da, dc, lots 3,4	Little Cattle Co.	Gulf Oil	Geothermal
6ac, ad, bd, ca, cb, d, lots 1,2,3	Little Cattle Co.	Gulf Oil	Geothermal
7aa, ab, ac, ba, bd, lots 2,3	Little Cattle Co.	Gulf Oil	Geothermal
9bb, bc	Little Cattle Co.	Gulf Oil	Geothermal
18aa, ad, cd, dc, dd, lots 3,4	Little Cattle Co.	Gulf Oil	Geothermal
19, lots 1,2,3, aa, ab, ad, ba	Little Cattle Co.	Gulf Oil	Geothermal
5N1E 1, lot 1, ac, ad, cd, db, dc	Colin McLeod	Transcontinental Oil	Mining
1, lots 2-4, bc,bd,ca,cb,cc,da,dd	Spring Valley Livestock	Transcontinental Oil	Mining
2, lot 3, bc, bd, c, d	Spring Valley Livestock	Transcontinental Oil	Mining
3ca, cd, d	Colin McLeod	Transcontinental Oil	Mining
4bc, bd, ca, cb, cd, da, db, dd	Colin McLeod	Transcontinental Oil	Mining
4, lot 1, aa	Spring Valley Livestock	Transcontinental Oil	Mining
7cd, dc	Spring Valley Livestock	Transcontinental Oil	Mining
7, lot 4	Colin McLeod	Transcontinental Oil	Mining
8dd	Spring Valley Livestock	Transcontinental Oil	Mining
9aa, ab, ac, b, d	Spring Valley Livestock	Transcontinental Oil	Mining
10c	Spring Valley Livestock	Transcontinental Oil	Mining
10ad	Colin McLeod	Transcontinental Oil	Mining
10ac, bd, bc, d	Arthur Bollar	Gulf Oil	Steam[1]
11ab, ac, ad, ca, cb, dd, d	Arthur Bollar	Gulf Oil	Steam
11aa, ab	Spring Valley Livestock	Transcontinental Oil	Mining
11bc, bd	Colin McLeod	Transcontinental Oil	Mining
12ab, ba	Colin McLeod	Transcontinental Oil	Mining
12aa, ac, ad, bb, bc, bd, c, d	Spring Valley Livestock	Transcontinental Oil	Mining
13a, b, ca, c, pts. d	Spring Valley Livestock	Transcontinental Oil	Mining
14dc	Spring Valley Livestock	Transcontinental Oil	Mining
14aa, ab, ba, bb	Arthur Bollar	Gulf Oil	Steam[1]
18ab, ac, ad, ba, bd, ca, cd, d	Spring Valley Livestock	Transcontinental Oil	Mining
18, lots 1,2	Colin McLeod	Transcontinental Oil	Mining
19, lots 1,2	Colin McLeod	Transcontinental Oil	Mining
19ab, ac, ba, bd	Spring Valley Livestock	Transcontinental Oil	Mining
24aa, ab	Spring Valley Livestock	Transcontinental Oil	Mining

1. For the development of natural steam and steam power.
2. Rights were sold by Anchutz Corporation to Oxy Petroleum, 4/26/76.

APPENDIX C

Legal Briefs

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(Appendix C.)

C-1 U.S. GEOTHERMAL STEAM ACT OF 1970

Introduction

The Geothermal Steam and Associated Geothermal Resources Act, Public Law 91-581, 30 U.S.C.A. 1001 through 1025, was promulgated in 1970 to govern the leasing of federally owned or controlled lands for geothermal purposes. As such, it regulates the terms of a geothermal lease, acreage limitations, the rents and royalties due under such a lease, cooperative development, and waste prevention. The following highlights the various aspects of this Act and is meant to serve as an introduction to its complexaties.

1. Lands Subject to Geothermal Leasing

The Act authorizes the Secretary of Interior to issue leases on land administered by him, including public, withdrawn or acquired land, as well as similar land in a national forest administered by the Department of Agriculture, and all lands conveyed by the U.S. subject to a geothermal steam reservation. (30 U.S.C.A. 1002)

2. Methods of Acquiring a Lease

The method of acquiring a lease depends upon the status of the land intended to be leased. If such land is an area in which the geology, nearby discoveries, competitive interests, or other indicia would, in the opinion of the Secretary of Interior, engender a belief in men who are experienced in the subject matter that the prospects for extraction of geothermal steam or associated geothermal resources are good enough to warrant expenditures of money for that purpose, then it is classified as a "known geothermal resource area" or KGRA. (30 U.S.C.A. 1001 (e)). A lease for KGRA land is awarded on the basis of competitive bidding. Lands not within a KGRA are leased to the first qualified applicant. (30 U.S.C.A. 1003).

a. KGRA Determination: The exact definitions of "geology," "nearby discoveries" and "competitive interests," the terms used to define the existence of a KGRA, are governed by regulations promulgated by the Secretary of the Interior. Whether or not the "geology" of an area is such as to qualify the land for KGRA status is determined by the U.S. Geological Survey by considering a myriad of technical data. (43 CFR 3200.0-5 (K) (1)). A "discovery" is any well deemed by the U.S.G.S. to be capable of producing geothermal resources in commercial quantities and, where the geological structure is not known, "discovery" is considered "nearby" if it is within five miles of the area in question. "Competitive interests" are determined to exist in the area covered by a lease application if at least one-half of such land is covered by another application which was filed during the same filing period, whether or not the other application is subsequently withdrawn or rejected. (43 CFR 3200.0-5 (K) (2+3)). Furthermore, it is important to realize that the director of U.S.G.S. is not limited to the above criteria alone in making these determinations.

b. Issuance of Lease: Before a lease may be issued, a proposed plan of operation consisting of a map, a statement of the measures proposed to be taken to prevent or control pollution and regards to health and safety must be submitted and accepted. (43 CFR 3210.2-1 (d), 3220.4).

3. Operations Under The Lease

Although a lease has been awarded, a lessee can still not proceed to develop the land other than pursuant to "casual use" (i.e. practices which do not create appreciable damage or disturbance to lands, resources, or improvements) until a "plan of operation" is approved. (43 CFR 3203.6) (See 43 CFR 270.34 for contents of such plan).

Furthermore, each geothermal lease is subject to the requirement of "diligent exploration" until there is production of geothermal resources in commercial quantities, and failure to perform such exploration can result in termination of the lease (43 CFR 3203.5). Diligent exploration requirements are a common means used to ensure that a lessee actively seek the resource and begin producing revenues, by way of royalties, for the government.

Exploration operations, in order to qualify as diligent exploration, must be approved and evidence of all expenditures therefore and the results thereof must be submitted annually to the government. Moreover, after the fifth year of the primary lease term, exploration operations, to qualify as diligent exploration for a year, must entail expenditures during that year equal to at least two times the sum of the minimum annual rental required by statute, and the amount of rental for that year in excess of the fifth year's rental. However, these financial landmarks can be met in a variety of ways. In this regard, a lessee's expenditures need not exceed twice the rental for the tenth year. In addition, any expenditures for diligent operations during the first five years of the lease and any expenditures for diligent operations during any subsequent year in excess of the minimum required expenditures for that year may be credited in such proportions as the lessee wishes, either against expenditures needed to qualify exploration operations as diligent operations for future years, or against any rental requirement for that or any future years in excess of the fifth year's rental. In all cases, the lessee must pay the basic annual rental specified in the lease for the initial five years of the primary term until there is production of geothermal steam in commercial quantities on the leased lands.

4. Bonding Requirements

Generally, there are two types of bonds that must be furnished by the lessee which have the purpose of protecting government interests:

a. Lease compliance bond. The lessee must, prior to his entry on the leased lands, furnish and maintain a bond of not less than $10,000 conditioned on compliance with all the terms of the lease.

b. Protection bond. A lessee will be required, prior to entry on the leased lands, to furnish and maintain a bond of not less than $5,000 for indemnification for all damages occasioned to persons or property as the result of lease operations. (43 CFR 320.61-1).

Nationwide bonds of at least $150,000 and statewide bonds of at least $50,000 are available instead of the above, pending departmental approval of operating agreements. (43 CFR 3206.5, 3206.6).

5. Acreage Limitations

No person or entity can take, hold, own or control at any one time, any direct or indirect interest in federal geothermal leases in any state exceeding 20,480 acres. (30 USC 1006). An examination of the regulations shows that "interest is defined broadly:

> 'Interest in the lease' means any interest whatever in a geothermal lease, including, but not limited to: A record title interest; a working interest; an operating right; an overriding royalty interest; a claim to any prospective or future advantage or benefit from a lease; a participation in any increment, issue, or profit which may be derived, or accrue in any manner, from the lease based upon, or pursuant to, any agreement or understanding in existence at the time when the offer is filed; and an agreement pertaining to any of the foregoing. 943 CFR 3200.0-5 (f))."

In computing acreage holdings or control, a lessee owning an undivided interest in a federal geothermal lease is charged with his proportionate part of total lease acreage. By the same extent, a party owning an interest in a cooperation, partnership, or association is charged with his proportionate share of entity's accountable acreage. However, a person is not so charged with a pro rata share unless he is the beneficial owner more than 10% of the stock or other instrument of control or ownership of such entity. (43 CFR 3201.2(b)). If a person violates acreage limitations then the last lease or leases or interest acquired by him which created the excess acreage holdings must be canceled or forfeited in their entirety, even though only part of the acreage in the lease or interests constitutes excess holdings. (re CFR 3201.2 (d) (2)).

It should be noted however, that acreage limitations do not apply to any unit or cooperative plans as well as leases operated under approved drilling or development. (43 CFR 3201.2 (c)).

6. Term Of The Lease

Leases are awarded for primary terms of ten years. If steam is produced or utilized in commercial quantities within that time, then the lease continues in effect for so long as production is maintained up to 40 years. (30 USC 100 5(a)). The lessee is then given a preferential right to renew for another 40 year term if steam production continues in commercial quantities and the land is not needed for other purposes. (30 USC 1005 (b)). As with other such statutes, an extension of the primary term is granted in the case of a lease for land on which an approved cooperative or unit plan of development or operation exists. In these situations while actual drilling operations were commenced prior to the end of the primary term and are diligently prosecuted extensions of five years not to exceed a total of 35 years are granted so long as geothermal steam is being produced in commercial quantities (30 USC 1005 (c)). Extensions are also granted for production of byproducts even when steam can no longer be commercially produced. (30 USC 1005 (d)).

7. Rents And Royalties

Royalty payments range from a minimum of 10% to a maximum of 15% of the amount or value of the steam produced or utilized or reasonably susceptible to sale or use. A maximum royalty of 5% is allowed for byproduct minerals. (30 USC 1004 (a)).

Annual rentals of not less than one dollar per acre, payable in advance of the anniversary date of the lease, are due under penalty of automatic termination (30 USC 1004 (c)). In the case of leases on land with producing wells, a minimum royalty of $2 per acre is allowed in lieu of rental payment at the expiration of each lease year. (30 USC 1004 (d)).

Rents and royalties are readjustable at not less than 20 year intervals beginning 35 years after production begins. However, neither the rent nor the royalty may be increased by more than 50%, and in no event can the royalty exceed 22 1/2 percent.

C-2 REVIEW OF THE IDAHO GEOTHERMAL RESOURCE ACT

Introduction

The Idaho Geothermal Resources Act (hereinafter referred to as the "Act") was promulgated in 1972 to regulate a "natural resource that the Act was to define as the natural heat energy of the earth in whatever form" it may be found. In Idaho, this resource predominantly exists as hot water. Therefore, previous to the Act's enactment incidental regulation occurred under the auspices of the Department of Water Resources which issued water permits to those persons using water for its heat content (e.g. to heat greenhouses or create fish propagation pools). Since the Act has awarded control of geothermal resources to the Department of Water Resources (hereinafter referred to as the "Department") the practical effect of the Act was to formally delineate the regulation of the traditional uses of water from the use of water as a material medium for heat energy. Theoretically then, if the use of water involves net depletion of that liquid resource the water user falls under traditional water law and is required to obtain a water permit to legally use that resource. On the other hand, if the use of water is solely to extract its heat content with only incidental depletion (geothermal water might be reinjected into the aquifers from which it was derived) then the user would be required to obtain a geothermal permit pursuant to the Geothermal Resources Act.

It is important that such geothermal regulation exists. The prior incidental regulation that formerly existed is no longer sufficient because modern expertise has allowed the use of geothermal energy on a massive scale to produce electricity, for use as space heating, and to produce mineral by-products. As such, unstated purposes of the Act must include an ability of the geothermal user to protect the quality of his resource and the quantity of the water he requires to extract the heat both as against other geothermal users as well as water users who desire the same liquid for other purposes. In addition, the Act sets forth its own purpose for enactment in the compilers notes found under 42-4001. As explained therein, the Act is to allow the regulation of a natural resource of limited quantity and unique value. Such regulation is to ensure that the benefits of the utilization of this energy source be maximized, while minimizing the costs and detriments. Thus, the Act expressly promotes the efficient utilization of geothermal resources while minimizing environmental degradation to the resource itself and the surrounding environment.

With the above in mind, the following is an analysis of the Geothermal Resource Act, especially with reference to the interpretation and statutory construction.

1. Definitions:

Section 42-201-402 is merely a title and definition section which sets forth the use of the terms therein and is self explanatory. The only concern that may be stated with reference to these definitions is found in 42-402 (c), where the term "A geothermal resource" is defined. The Idaho legislature has attempted to define a geothermal resource as "sui generis," being neither a mineral resource nor a water resource. Recent litigation throughout the country concerning the definition of a geothermal resource in reservation clauses of deeds to real property has found the courts unanimously interpreting a "geothermal resource" as a mineral. At this time, the Idaho definition of a geothermal resource has not been challenged, but it is merely pointed out that there could be some problems concerning the statutory interpretation in light of the existing case law. Also, as a practical effect, it should be noted that since the Idaho legislature has deemed a geothermal resource to be neither a water nor a mineral, the standard reservation or exception clause in a deed reserving or excepting water and mineral rights would have no effect with reference to the ownership of a geothermal resource. Therefore, it is important that the draftsman, in preparing legal documents relating to geothermal resources, set forth such resource specifically and directly in those legal documents to ensure that the interpretation and the intent of the parties with reference to a geothermal resource is clearly and fully carried out.

2. The Permit Requirement

As a supervising tool, the Geothermal Resource Act requires any person, whether an owner or an operator, who proposes to construct a well, to alter a well, or to construct or alter an injection well, to apply to the Director of Water Resources for a Geothermal Resource Well Permit. Such applicant is required to set out detailed facts concerning financial strength, location, and type of proposed well; type and size of casing and other pertinences thereto; and other devices or techniques that will be used to avoid waste and protect other natural resources. The permit also requires an explanation of the means proposed to contain and manage the geothermal resource which shall be derived from the proposed well. It seems that these requirements as set forth by the legislative enactment are to be used by the director to make an intelligent decision as to the effect such well will have on the environment in all phases.

It is evident from this explanation that the permit process will or should provide the director with a data bank from which to make an intelligent decision, and from which to allow him control over the development and drilling of geothermal resources. This proposed intent and control by the director seems to be directly undermined by the statutory language contained in several subsections of 42-4003 which allow exemptions from the necessity of securing a permit. The first such subsection is 42-4003 (e) which states:

"(e) Nothing in this act shall be construed as affecting any valid, vested water rights for water in use on or before January 1, 1972. No person operating or proposing to operate a greenhouse, hot house, swimming pool, hot springs bath or hot water fish propagation facility, space heating plant, or similar facility, unless such operation is in conjunction with geothermal resource use not specified in this subdivision:

(1) Shall be compelled to comply with any of the permit requirements of this act if such operation was in existence on January 1, 1972, and

(2) Shall be compelled to comply with the geothermal resource permit requirements under this act if such person obtains a valid water right permit for such operation and provides the director with such data as he may require for the proper administration of this act."

According to the plain language of this subsection if a geothermal user falls within one of the delineated categories of use, he is not required to obtain a geothermal resource permit if he meets the dual requirements set forth in subparagraphs (1) and (2). These dual requirements are: (a) the above delineated use was in existence on or before January 1, 1972; (b) such persons using one of the above delineated uses had obtained a valid water right permit for such operation and provided the director with data which he may require. However, it should be noted that if "such operation is in conjunction with a geothermal resource use not specified in this subdivision" then whether or not subparagraphs (1) and (2) are satisfied, a permit is still needed. Although the term "a geothermal resource use not specified" is not further defined, it is intended to mean the production of electricity and mineral by-products. The problems apparent with section 42-4003 (e) are further explored in Section 3 of this analysis.

"(d) No person shall construct or alter a well or an injection well without having first secured a permit therefore; provided however, that the director may, by general rule or regulation adopted pursuant to chapter 52, title 67, Idaho Code, exempt specfic categories of wells or injection wells otherwise embraced by this act upon a finding that the purposes of this act do not require that such wells be subject to the permit requirement of this section."

Subsection (d) is a discretionary section which seems to provide a loophole for any exemption that the Director may be inclined to pursue. A legal concern with the interpretation of this section would surround a determination whether there was an abuse of discretion, by the Director in finding that "the purposes of this act do not require that (a well) be subject to the permit requirements" of 42-4003.

Subsection (g) of the 42-4003 attempts to tighten and restrict the exemptions as set forth above in subsection (e) by stating that any well for any purpose, thus seemingly including those exempt uses in subsection (e), that is in excess of 3000 feet in depth and located within a "geothermal area" must have a permit. 42-4003 (g) states:

"(g) 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 area" without first obtaining a permit under the provisions of this section. Such permit shall be in addition to any permit required by other provisions of law."

Accordingly, subsection (g) dealing with well permits for wells in excess of three thousand feet in depth, does not apply unless such well is being drilled in a "geothermal area." The definition of a "geothermal area" is set forth in the definition section of the geothermal act and is specifically referred to in subsection (f) of 42-4003. Basically, the Director has the discretion under 42-4003 (f) to designate any area as a "geothermal area" if he feels that such designation is necessary to protect the geothermal resource from waste or to protect other resources of the state from contamination or waste. However, to truly understand section 4003(g) one must know the original purpose for its promulgation. Based upon informal discussions with various DWR personnel, these authors were informed that the purpose of section 42-4003 (g) was to avoid creating undue problems under the statute for water users the drafters of the Act never intended to include under the Act's provisions. Specifically, section 42-4003 was designed to alleviate bonding and permit requirements for farmers or the "small" geothermal prospector while including a safety measure to prevent misuse of the resource and the environment. Furthermore, the 3000 foot requirement was believed to be needed to alleviate possible use of the geothermal permit to extract oil and gas, since such hydrocarbon fuels are found at depths beginning at that level.

Before conlcuding this section, it is important for the prospective geothermal user to realize that even if he qualifies for a permit exemption under any of the previously discussed sections, his geothermal well is still controlled by the Geothermal Resource Act. Therefore, despite the fact that a geothermal owner need not file a geothermal permit, he must be careful to comply with all other regulations of the Act.

3. Interpretation of 42-4003 (e) by The Water Resource Board:

Pursuant to the discussions between the authors of this paper and the Water Resources Board, it is our understanding that 42-4003 (e) is being interpreted by that department in a significantly different manner than has previously been discussed in part 2 above.

In this regard, the phrase, "Unless such operation is in conjunction with geothermal resource use not specified in this subdivision" is critical to the department's interpretation of said section. The department feels that this phrase indicates a legislative intent whereby the geothermal resources act was promulgated to address the problems created by primary or pure geothermal resource uses, namely, the generation of electricity and the production of by-products. As such, the delineated uses as set forth in subsection 4003 (e) are to be considered secondary geothermal resource uses which were believed not to pose the threat to the environment, property, human life, and other resources that the purpose of the act was intended to address. Therefore, the department reads subsection (1) and subsection (2) of 4003 (e) as being separated by a semicolon and not the conjunction "and" as written. Accordingly, the department's interpretation does not require the dual requirement of both (1) and (2) be satisfied for any of the delineated uses to be exempted from the permit requirement. In other words, analyzing the department's interpretation, if a greenhouse were in existence (whatever the term "in existence" means) then such greenhouse would be exempt from the provisions of the geothermal act; or if such greenhouse obtained a valid water right permit it would also be exempted whether before or after January 1, 1972.

This view is taken by the Department because it feels that 4003 (e) is tacit recognition by the legislature of the historical action taken by the DWR of issuing water licenses for these exempted uses before the Act was in existence. Since it has always been done this way without problems, the Department feels it unnecessary to change policy. This is so for two reasons: first, technical expertise within the Department believes the low temperature water commonly found in Idaho (especially in the Boise Front) does not require any greater standards for safety than those otherwise imposed under existing water laws of the State of Idaho; second, 4003 (e) exempts these uses from the Geothermal Acts permit filing requirements only, and therefore other purposes of the Act are fulfilled because the use is still controlled.

Such an interpretation though, does not fit the plain meaning of the statute derived from the commonly used procedures of statutory interpretation. It is important, to ensure uniform application of this statute, that all who use the act and administer it have a uniform basis of understanding as to its application and meaning. Such a scheme combined with existing exceptions creates undue confusion and results in an unnecessarily complicated statute. It is not necessary that distinctions between types of uses by made so that various types of permits may be filed. If a person uses water for its heat content then he should be required to file a geothermal permit. If his use involves a net depletion of the water beyond incidental loss occasioned by the use of the water as a material medium of heat energy, then under the present view a water permit should also be necessary. The fact that the geothermal use remains under the Act while being exempted only from the permit requirement serves only to deceive the layman who undoubtedly will believe himself exempted entirely. All in all, all parties would find that administration and enforcement under the Act would be fairer, less complicated, and easier to comply with if there were no distinctions in permit requirements whether pursuant 4003 (d), (e), or (g), regardless of whether someone must now pay a bond or whether "it has always been done this way."

4. Protections Afforded Under the Act as Between Geothermal and Water Users:

Section 42-4005 sets forth the requirements for issuance of a geothermal well permit and gives the Director of Water Resources the authority to issue or deny such permits depending upon the particular situation and circumstances of each application.

The language of subsection (b) charges the director with the responsibility of finding that any proposed permit for the drilling or alteration of a geothermal well or injection well will not "unreasonably reduce the quality of any surface or ground waters below the quality which such waters would have had but for a proposed well." In addition, subsection (e) charges the director with the responsibility of making a finding that any operation of any well will not "unreasonably decrease groundwater available for prior water rights in any aquifer or other ground water source for water for beneficial uses." In reading these two subsections together it seems clear that the protection of prior perfected water rights both as to quantity and quality is to be monitored and protected by the Director of Water Resources. The specific charges of subsections (b) and (e) must also be read in light of the broad mandate which is set forth in subsection (a) of 42-4005 wherein the following language is found:

> "If the director does not find that the well or injection well as it is proposed to be constructed or altered, will be against public interest he shall issue a permit therefore."

In analyzing subsection (a), it is clear that the director may deny a permit based upon a determination that the best interest of the public will not be served.

Since the public interest determination is defined in section 42-4005 to include both control of quantity and quality of water, it is supposedly designed to preclude a potential conflict between a prior vested water right and a geothermal resource use. While this discretionary authority will seemingly eliminate potential conflict between perfected water rights and geothermal rights at the initial stage of reviewing permit applications, such a statutory approach does not address itself to the potential problem of a conflict that occurs once the director has made the initial determination that a permit should be granted. The question then becomes, "what are the rights of a geothermal user who has drilled a well under the authority of the geothermal resource act, and with the blessing of the director, when such well and geothermal user are subsequently charged with interference by a prior perfected water right or by a subsequent water right which came about and was perfected subsequent to the drilling and operation of the geothermal well?"

One may argue that subsections (c), (d), and (e) of Section 42-4010 grant the Director the power to alleviate this potential problem. But an analysis of those subsections indicate that while the Director has the broad base of discretion and power to enforce the provision of the geothermal act, he in fact, merely has the power to enjoin or regulate only the geothermal user and no authority to interfere or regulate the water right. As such, the geothermal resource user is not effectively protected by the stringent regulations found within the terms of the act. It follows then that the way the geothermal user is to be protected is to file for a water right under the statutory scheme for perfection of water rights. While this policy by a geothermal user of attempting to "cover all bases" may seem feasible, the practical effect of such an approach is in doubt.

In defining the term "beneficial use," the Idaho Supreme Court in Public Utilities Commission versus Natatorium Company (1922), 36-Idaho 287, 211 P. 533 held that the use of hot water in the heating of dwelling houses comes within the "domestic purposes "section" of a beneficial use of water. This determination by the Supreme Court of a "beneficial purpose" of hot water readily classifies space heating use of a geothermal resource as a beneficial purpose under the water law which classification is necessary to appropriate and maintain a water right in Idaho. The question to be answered today is two pronged: (a) does the term "beneficial use" encompass all geothermal uses in addition to space heating and (b) will the Supreme Court statement in the Natatorium decision stand the test of time in light of the statutory definition given to a geothermal resource in 42-400 (c) in which a geothermal resource (the hot water analyzed in the Natatorium Decision) is found and declared to be sui generis, "being neither a mineral resource nor a water resource." In light of the sui generis definition, the question becomes whether something other than water can gain the protection of the beneficial use clause of Idaho water law without being found and determined to be wtaer. If the answer to this question is no, then a water permit filed under water law by a geothermal user in an attempt to perfect a right as to time would be of no significance since his appropriation could be defeated from the lack of putting water "to a beneficial purpose." Practically and realistically speaking it is necessary that a geothermal resource use be found to be a beneficial use under the water laws. This is so because there is no protection afforded the geothermal user (other than at the time the permit is issued) in the geothermal resources act.

5. Potential Conflicts Among Geothermal Users:

Consider the potential conflict between two geothermal users within the same geothermal area. The power of the Director, as has been described before, with reference to permit requirements is codified in section 42-4005 subsections (a), (b), and (e). A review of these subsections indicates that the Director is required to make findings with reference to "The possibility that the construction and maintenance of the proposed well will cause waste or will damage any geothermal resource, reservoir . . . . by unreasonable reduction of pressures or unreasonable reduction of any geothermal resource material medium or in any other manner, so as to render geothermal resource of unreasonably less value." Additionally, Regulation 4.5.3 in the regulations on Minimum Well Construction Standards allows the Director to approve and monitor proposed well spacing programs and to prescribe such modifications as he deems necessary to the proper development of geothermal resource wells. It could be argued then, that this authority within the regulations would allow him to reject the drilling of any geothermal well which does not conform to the well spacing plan which the Director felt was necessary within that given geothermal area to provide efficient use of the resource.

In the event well-spacing or the initial application screening does not preclude a conflict, Section 42-4013 might be used. In section 42-4013, the Idaho legislature has set forth two statutory requirements for the utilization and cooperative unit agreements between persons holding or controlling royalties or other interests in separate properties within the same geothermal area. Subsection (b) gives the Director of Water Resources the authority to enforce an involuntary cooperative or unitization agreement if the Director finds after a hearing, that such involuntary agreement is necessary to avoid waste within the unit and that the persons owning an interest in such area or a royalty have refused to enter into a cooperative agreement under the voluntary provisions of subsection (a) of this section.

The writers of this paper are concerned with subsection (b). Such concern stems from the fact that a hearing is required before the Director has the authority to mandate an involuntary cooperative agreement. Any aggrieved person may appeal the order issued pursuant to the hearing in accordance with the provisions of 42-4012 (b) to the District Court within the 30 days of service or notice of the order. Subsection (b) also allows a direct appeal from District Court proceedings to the Supreme Court in civil actions originally brought in District Court. The hearing procedure set forth is reinforced in Rule 11 of the Rules and Regulations for Minimum Well Construction Standards. The concern that is generated from this type of appellate procedure stems from the present time lag and delay that exists on appeals to the Supreme Court, and pursuant to administrative hearings. As a practical matter, a determination by the Director that mandatory unitization or cooperative agreement should be entered into could be the subject of litigation which could take anywhere from two to four years for a final determination depending upon the actions of the particular parties involved. This type of time lag could be a detriment to the involvement of the type and amount of risk capital that is necessary to adequately and fully develop a geothermal resource.

Further problems are created by the definition sections of the Geothermal Act, particularly 42-4002 b(1), b(2), and b(3). These sections define the term "waste" in a very broad sense, thereby allowing the Director to control every phase of development of the resource including unitization. However, according to Section 42-4013 (b), before the Director can initiate the procedure for mandatory and involuntary cooperative agreements he must make a finding that a geothermal resource area will incur waste as defined within the act. As such, it is at least arguable that such determination by the director immediately infers that such resource is not being managed correctly or properly and actions are taking place which the geothermal act itself is designed to prevent, namely, inefficient and improper use of the resource. This in turn means that the public interest is being damaged by virtue of the detriment taking place to the resource.

Two results can occur once the Director makes the determination of waste under subsection (b) as above stated: (1) the geothermal user would prevail at a hearing and the Director would be enjoined for mandatory and involuntary cooperative unitization; or, (2) the Director would prevail and shut down the geothermal user or geothermal area under the provisions 42-4010 until such time as a hearing and final determination was made with reference to an involuntary cooperative unitization. It is very clear then, that on either alternative, the geothermal resource itself cannot be developed within the meaning of the geothermal act during what may be a lengthy period of delay for a determination of the judicial issues involved, and during which there is presumable misuse of a valuable resource.

Conclusion:

In summary, the Idaho Geothermal Reosources Act is inadequate in its coverage of, or approach to, three main areas: permit requrements, conflicts between water rights and geothermal rights, and conflicts between geothermal users. The concern of this paper was not to advocate solutions but only to point out problem areas. As such, it is the hope of the authors that whatever solution can be created, it allow a thorough and uniform approach by the Director of the Department of Water Resources in his dealings under this Act.

C-3 STATE REGULATION OF GEOTHERMAL RESOURCES

Introduction

The following is an examination of various existing state legislation regulating geothermal resources. Generally, these laws are patterned either after the existing oil and gas regulatory scheme or the existing state water laws. In more cases than not, some form of statutory consideration has been given to the regulation of geothermal wells and drilling, as well as the leasing of land for exploration and production of geothermal resources. This does not mean, however, that such statutory consideration is always extensive. In many cases, state legislation in this area consists of not much more than a grant of power to a regulatory agency to devise and supervise the details of the statutory framework that the legislation has provided; in these cases, regulation is essentially according to the rules and regulations promulgated by the pertinent agency, and examination of those rules and regulations is beyond the scope of this memo. It should be noted, however, that control of resource development largely by agency regulation is not necessarily a better or worse method than control by a detailed statutory framework. In all likelihood, if the rules and regulations are promulgated with care and foresight, they will be every bit as good as, and will accomplish the same goals as, any legislation enacted by any legislature.

ALASKA

1. Generally. The Alaska statute gives the Commissioner of the Department of Natural Resources authority to issue prospecting permits and leases and to adopt rules and regulations providing for operations under these leases. Prospecting leases allows for exploration, discovery, development and utilization, extraction, and removal of geothermal resources. Ala. Stat. Sec. 38.05. 181(c)(1). Regulations prescribed by the Commissioner include provisions for the following: prevention of waste; development and conservation of geothermal and other natural resources; protection of public interest; assignment and relinquishment of leases, unitization, pooling and drilling agreements; royalty agreements; surety bonds to assure compliance with the terms of the lease and to protect surface use and resources; use of the surface by the geothermal lessee or permittee; maintenance of an active development program by the lessee; and protection of water quality. Ala. Stat. Sec. 38.05.181(c)(3).

2. Definitions. (a) Geothermal resource. The Alaska statute defines a geothermal resource in terms used by the Idaho Geothermal Resources Act, i.e., as the natural heat of the earth, the energy from that heat and all minerals in solution or other products, and then specifically includes: (1) all products of geothermal processes embracing indigenous steam, hot water and hot brines; (2) steam and other gases, hot water and hot brines resulting from water, gas, or other fluids artifically introduced into geothermal formations; (3) heat or other associated energy found in geothermal formations; and (4) any byproduct derived therefrom." Ala. Stat. Sec. 38.05.181(q)(6).

(b) "Byproduct" is defined using essentially the U.S. Geothermal Steam Act definition, so that a mineral is a byproduct when it is 75% of the value of the geothermal resource (not 75% of the value of steam, as in the Federal definition) or it is not of sufficient value to warrant extraction and production by itself. Ala. Stat. 38.05.181(q)(1). Notably, the Statute has no definition of waste.

3. Cooperative Development. Lessees are allowed to unitize or to co-mingle wells, but the Commissioner has no real power under the Statute to order cooperative development or make regulations in that regard without consent of the lessees. Ala. Stat. 38.05.181(c)(3-4).

4. Production Requirements. The Commissioner can require the production of a valuable byproduct. Ala. Stat. 38.05.181(e)(2).

5. Rights of the Surface Owner. Rights of the surface owner are protected in that the geothermal lessee is entitled to use only as much of the surface of the land covered by his geothermal lease as is reasonably necessary for exploration, production, utilization and conservation of geothermal resources. Ala. Stat. 38.05.181(j)(5). In addition, well drilling is prevented within 300 feet of an outer boundary of leased parcel of land or of a public road or highway. Ala. Stat. 38.05.181(j)(5). Further, the relative rights of the surface and geothermal user are defined by the fact that the Alaska Statute is administered under the principle of multiple use of public land, thus allowing for the coexistence of various types of leases on the same land. As such, operations under any lease, whether or not a geothermal lease, may not interfere unreasonably with or endanger operations under any lawfully issued lease or permit. Ala. Stat. 38.05.181(e)(1).

6. Leasing. The Alaska Statute embodies a "known geothermal resource area" (KGRA) concept. As such, if an area in which the geology, nearby discoveries, competitive interest, would lead a man who is experienced in the area to believe that prospects are good enough to warrant expenditure of money for extraction of geothermal resources, then the Commissioner may declare the area to be a "KGRA," Ala. Stat. 38.05.181(q)(8), and lease the land under a competitive bidding system. Ala. Stat. 38.05.181(h). In addition, the declaration of an area allows the Commissioner to prescribe the development program. Ala. Stat. 38.05.181(h). Note that the surface owner has the first right to lease a KGRA if he meets the highest bid made. Ala. Stat. 38.05.181 (n).

In a case where the land in question has no KGRA status (i.e., it is "unknown land"), it is leased to the first applicant who pays not less than $1.00 per acre. In return, the applicant is given a prospecting permit with essentially a five-year term, granting the applicant the exclusive right to prospect for geothermal resources. Upon discovery of a geothermal resource, the permittee is entitled to lease the land with provisions for royalties, acreage limits, rent, etc. Ala. Stat. 38.05.181(g).

7. Minimum Acreage. The Statute provides for a minimum lease acreage of 640 acres and a maximum of 5,760 acres, with total holdings by any one person not to exceed 25,600 acres. This total acreage limitation may be increased to 51,200 after 15 years and public hearings. Ala. Stat. 38.05.181(j).

8. Annual Rental. There is an annual rental payment of not less than $1.00 per acre for each year of the lease. Ala. Stat. 38.05.181 (k).

9. Royalties. Royalties are set as following:

(a) A royalty of not less than 10% nor more than 15% of the gross revenue made or incurred with respect to transmission or other services or processes, received from the sale of steam, brines (from which no minerals have been extracted) and associated gases as the point of delivery to the purchaser of them;

(b) A royalty of not less than 2% nor more than 10% of the gross revenue received from the sale of mineral products or chemical compounds recovered from geothermal fluids in the first marketable form for the primary term of the lease; Ala. Stat. 38.05.181 (k). These royalties are paid even where the geothermal resource is used by the lessee himself, and in such cases value is determined by the Commissioner and set out in the lease. Ala. Stat. 38.05.181 (k).

10. Duration of the Lease. The Statute provides for a primary term for each lease of 10 years. The lease may be renewed in two 40-year intervals and can be maintained up to a period of 99 years, as long as the geothermal resources are being "produced or utilized in commercial quantities" (i.e., one or more completed wells are producing or are capable of producing geothermal resources for delivery to or utilization by a facility or to or by a facility scheduled for installation not more than 15 years from the date of commencement of the primary term of the lease.) There is also an extension of 5 years allowed for production of byproducts in commercial quantities. Ala. Stat. 38.05.181 (l).

11. Readjustment of Lease Terms. The Commissioner has the power to readjust any and all terms of the lease at 10-year intervals. However, with regard to rent and royalties, readjustment is allowed only at 20-year intervals, beginning 35 years after the date the geothermal resource is produced. Such readjustment cannot increase the rent or royalty by more than 50% of the amount paid in the preceeding period, and in no event may the royalty payble exceed 22 1/2%.

12. Termination. A lease may be terminated by the Commissioner for failure to exercise diligence and care in prospecting for or developing the geothermal resource, as well as for any violation of the Statute or regulations promulgated under it. Failure to make timely rent payments results in automatic termination by operation of law. A lease so automatically terminated can be reinstated if, in the Commissioner's opinion, the failure to pay timely was justifiable, if the lessee files a petition for reinstatement together with the required money, and if no lease has been issued on the affected land before the reinstatement petition has been filed. A lease may also be relinquished. Ala. Stat. 38.05.181(o).

13. Well Regulation. The Statute also addresses itself to conservation and to the prevention of waste and pollution. Ala. Stat. 38.05.181 (p). That section requires all wells to be constructed with methods approved by the Commissioner.

Conclusion

Alaska's statute is really a public land leasing statute in outlook and purpose. As such, the provisions with respect to the term of the lease, rents and royalties are commendably explicit. However, those areas that would normally be governed by a law aimed specifically at recovery of the resource (including areas such as well construction standards, bonds, well abandonment procedures, requirements as to filing of records and information, and drilling procedures and standards) are left entirely to coverage by regulation.

ARIZONA A.R.S. Secs. 27-651 through 675. (1972 and 1977)

1. Generally. In 1972 Arizona enacted a Geothermal Resources Act which gave the Oil and Gas Conservation Commission the power to supervise and promulgate regulations as to the drilling, operation and maintenance, and abandonment of geothermal resource wells and other related matters. In 1977, a House Bill was passed by the Arizona legislature ammending the Act to provide for the leasing of state lands for geothermal resource development by the State Land Department and giving the Department the power to prescribe rules and regulations necessary for that purpose. (House Bill 2257, 1977).

2. Definitions. The Arizona Statute defines geothermal resource in terms very similar to those used in the Federal Act, adding only the phrase "including any artificial stimulation or induction thereof" to the phrase "heat or other associated energy found in geothermal formations" of the Federal definition. The Arizona Act replaces the Federal definition of byproducts with the phrase "any mineral or minerals, exclusive of fossil fuels and helium gas, which may be present in solution or in association with geothermal steam, water or brines." This phrase is part of the definition of geothermal resources and can be construed to refer to byproducts. A.R.S. Sec. 27-651 (5).

3. Geothermal Resource Regulation. The Commission generally regulates resource development and drilling.

(a) Bonds. A drilling bond of $5,000 for each individual well, or $25,000 for any number of wells, is required. The bond is conditioned upon proper performance of duties required by the Statute and an abandonment that is approved by the Commission. A.R.S. Sec. 27-654.

(b) Collection of data. The Commission also collects and causes the well operator or owner to file records, such as a drilling history, core records, etc. A.R.S. Sec. 27-661. Such information is confidential for 2 years at the request of the operator. A.R.S. Sec. 27-653. The Commission requires a monthly procedures report from an owner or operator of any well producing geothermal resources. A.R.S. Sec. 27-662.

(c) Regulation and Approval of Drilling. The Commission requires an application be filed and approved before a well is drilled or entered, or an abandoned well is deepened. A.R.S. Sec. 27-659. It has the power to promulgate safety requirements, A.R.S. Sec. 27-660; and very importantly, to require approval by hearing of the owner's plan of operation before any stimulation, induction, or creation of a geothermal resource.

(d) Unitization and Pooling. A plan of unitization is not effective unless approved by owners or lessees of 63% of the royalty interest (exclusive of owner's or lessees' interest). In the case where the Commission orders a plan, that plan must be approved by the owners and lessees in some fashion within six months, unless such plan pertains to a unit area previously established. A.R.S. Sec. 27-664 to 666.

(e) Notice of Sale or Conveyance of Well or Land. Such notice is separately required of both the transferor or transferee within 10 days of the transaction.

4. Leasing Regulations.

(a) Powers of the Land Department. The State Land Department is given the power to prescribe rules and regulations necessary to carry out the leasing of state lands for development of geothermal resources and the selling of geothermal resource leases, A.R.S. Sec. 27-668, and in that regard, the Department has the power to refuse to lease land or to sell a geothermal resource lease if it finds such refusal to be in the best interest of the state. A.R.S. Sec. 27-669.

(b) Leasing of Land. Leasing is accomplished by awarding the lease on the basis of a bonus bidding system. Bids are called for by the Department upon an application to lease any state lands for geothermal purposes. A.R.S. Sec. 27-670. Note: Arizona has no provision in the Statute for procurement of a lease by any method other than bidding, and that under A.R.S. Sec. 27-669 the Department has the power to designate known geothermal resource areas, but why that power exists is open to question.

(c) Royalties and Rents. All leases provide for a royalty of not less than 12.5% of the gross value of the resource at the well head, and for an annual rental of not less than $1.00 per acre for each year the lease is in effect. A.R.S. Sec. 27-671 (a and b).

(d) Duration of the Lease. Each lease runs for a primary term of ten years and as long thereafter as geothermal resources are procured and produced in paying quantities. An extension of two years beyond the expiration date of any lease is allowed where drilling operations are being prosecuted diligently, and for so long thereafter as geothermal resources are procured and produced in paying quantities. A.R.S. Sec. 27-671 (c).

(e) Acreage Limitations. No more than 2,560 acres can be included in any one lease. A.R.S. Sec. 27-671 (e). Note: There are no statewide acreage limitations per leaseholder.

(f) Unit Operations. Cooperative plans are allowed with approval by the Department. A.R.S. Sec. 27-672.

(g) Surface Rights and Bonds. The geothermal lessee is given the right to use as much surface as is reasonably necessary for his operations, but he is liable for damage caused to the surface. Thus, the Department can require a bond be executed to be released upon payment of such damages and for reclamation. An approasal procedure is used to determine damages. A.R.S. Sec. 27-673.

(h) Assignment of Lease. Assignment of a lease or any portion thereof is allowed only upon written approval. In the event as assignment segregates portions of land formerly leased by one person, then rent is apportioned by surface area. A.R.S. Sec. 27-674.

(i) Surrender of a Lease. A lessee may surrender a lease, but no refund will be made of any part of rental paid. Sec. 27-675.

5. Relationship of Geothermal Resources to Water Law. Geothermal resources are exempt from Arizona's water laws, unless the resource is comingled with surface or ground water or the development of the resource causes impairment or damage to ground water. Note: This provision puts the development of any hot springs in limbo, or at least forces compliance with two statutes (water and geothermal resources) if a hot springs resource is to be developed.

6. Sale of Land. A.R.S. Sec. 37-258 was amended by House Bill 2257 in 1977 to provide that no sale of state lands was allowed where the land in question contained paying quantities or where state lands adjoining such land contain producing wells. Note: Such sale is allowed where the land will be within the exterior boundaries of an incorporated city or town and the land will be used for public purposes. In addition, any land sold is sold with a reservation of geothermal resources.

7. Deductions for Depletion and Exploration Expenses. These are allowed under A.R.S. Sections 43-123.15 and 43-123.33, as revised by House Bill 2257.

Conclusion

House Bill 2257 has amended all pertinent statutes to provide a fairly comprehensive and consistent statutory regulation of geothermal resources. However, much of the regulatory details for resource development and drilling remain to be promulgated by the Oil and Gas Conservation Commission.

CALIFORNIA

1. Generally. California law creates a Geothermal Resources Board as an adjunct of the State Oil and Gas Supervisor's Office of the Department of Conservation, which generally regulates geothermal wells and related matters. California Public Resources Code Sections 3700-76 (hereinafter referred to as C.P.R.C.). California's Geothermal Resources Act of 1967, C.P.R.C. Sections 6902-25, establishes a leasing system for lands containing these resources.

2. Well Regulation and Related Matters. Note: The following area of the California Geothermal Resource law is characterized by expedited procedure.

(a) Organization and Procedure. The State of California is divided into districts, each district being in control of a District Deputy who is directly responsible to the Oil and Gas Supervisor. The Deputy and Supervisor are directly responsible for regulation of geothermal wells with right of direct appeal to the Geothermal Resources Board of any order. The hearing before the Board is de novo and takes place within 15 days of the notice of appeal with the possibility of postponement by the Board for good cause not to exceed 5 days. Any order issued by the Deputy Supervisor may be stayed by appeal within 5 days of date of service of the order. If no written decision is made by the Board within thirty days after notice of the hearing, then the order of the Supervisor is deemed approved. C.P.R.C. Sections 3762-3765, 3716, and 3720.

(b) Prudent Operator Provision. In order to increase recovery and to eliminate waste, in absence of an express provision to the contrary contained in his lease, the operator or lessee is deemed to be allowed to act as a prudent operator using reasonable diligence would, having in mind the best interest of the State, the lessor and the lessee. C.P.R.C. Sec. 3715.

(c) Sale or Assignment of Lease. Both transferor and transferee must give notice to the Board of any sale or assignment within 30 days or the same. C.P.R.C. Sections 3722 and 3723.

(d) Bonds. California requires an indemnity bond of $25,000 per well (except for observation wells of not lower than 250 feet, which are approved in writing) or a blanket bond for any number of wells of $250,000. A cash bond or security of $30,000 per well or a blanket bond of $300,000 is allowed in lieu of an indemnity bond. The bond is required to be in exact compliance with all provisions of the statute and orders of government. Cancellation provisions are provided for. C.P.R.C. Sections 3725, 3726, 3727, 3728, and 3728.5.

(e) Drilling Requirements and Safety. The owner or operator of any well must give written notice containing pertinent data to the Supervisor or District Deputy of his intent to commence original drilling, redrilling of an abandoned well, the redrilling or deepening of a completed well, the plugging of a well, or any operation permanently altering the casing. Drilling or any of the above enumerated operations may not commence until approval is given, but if there is no written response by the required official within 10 working days, such notice shall be deemed approved. An allowance is made for shallow wells of a depth not greater than 250 feet, in that a written program may be submitted for approval of up to 25 such wells, and once approval is given (or deemed to be given within 10 days), drilling of all shallow wells can proceed without further notice. Casing requirements as to prevention of blowouts, explosion and fires, and as to whether the casing is adequately watertight, are provided for. If the casing is to be removed, there must be notice of the same 5 days before to the Supervisor. The Supervisor must respond with a written report stating what work must be done as to removal or the notice submitted is deemed approved. In addition, the Supervisor must require such tests or remedial work as in his judgment are necessary to prevent damage to life, health, property and natural resources from damage, or to prevent infiltration of detrimental substances into ground or surface water suitable for domestic or irrigation purposes. C.P.R.C. Sections 3724, 3724.1, 3724.2, 3724.3, 3737, 3739, 3740, and 3741.

(f) Abandonment. A well is not abandoned until it has been shown to the satisfaction of the Supervisor that underground and surface waters are protected from infiltration by detrimental substances and that no fluids will escape. As such, written notice must be given before the proposed date of abandonment stating the method proposed to be used and the condition of the well. Failure by the Supervisor to respond in writing within 5 days is deemed approval of the method. Once abandonment has been completed, another report is required which the Supervisor must approve or disapprove within 10 days. C.P.R.C. Sections 3729, 3746, 3747, 3748, 3749.

(g) Cooperative Operation. Agreements to cooperate as to operation and development, or as to fixing time, locations and manner of drilling and operating wells for production will be allowed if the Board finds it necessary to protect geothermal resources. C.P.R.C. Section 3756.

(h) Collection of Records and Gathering Data. The owner or operator is required to keep drilling logs, core records, drilling histories, which must be filed with the District Deputy within 60 days after completion of a well or abandonment or upon request by the Deputy or Supervisor. Monthly statements of production utilized are also required of the owner of any producing well. C.P.R.C. Sections 3730, 3731, 3732, 3733, 3734, 3735, 3736, and 3745.

(i) Well Location. Various standard requirements exist in this regard. Sections 3757, 3757.1, 3757.2, 3758, 3759.

(j) Relationship to Water Law - Certificate of Primary Purpose. Such a certificate is issued when it is established that the well in question is used for the primary purpose of production of a geothermal resource. The certificate establishes a rebuttable presumption that the holder of such certificate has absolute title to the geothermal resource reduced to his possession from such well. This is rebutted by showing that the water content of the geothermal resource is useful for domestic or irrigation purposes without further purpose.

3. Leasing Provisions.

(a) Leasing System. The Geothermal Resources Act establishes a leasing system in which permits to prospect in areas not classified a "known geothermal resource areas" (such classification is based on the presence of at least one well capable of producing geothermal resources in commercial quantities) are grants to the first qualified applicant. A permit allows prospection for up to 5 years and gives the permittee a preference right for leases in the areas which later become classified if he has done the prospecting there. If no one holds a permit in land classified as a "KGRA," then a competitive bidding system is used to award the lease. Where land has been sold by the State with a reservation of geothermal resources, the owner of such land has the first right to a permit or lease by filing an application within six months of the notice of application for a permit by a third party, or in the case of a KGRA, meeting the highest bid within 10 days of notice to him of the same. C.P.R.P. Sections 6904, 6905, 6907, 6909, 6910, 6911, 6912, and 6922.

(b) Development Program. The Commission has the power to prescribe a development program considering economic factors such as market conditions and the cost of drilling for producing, processing and utilizing of geothermal resources. C.P.R.C. Sec. 6912 (c).

(c) Duration of Lease. A lease is issued for a primary term of 20 years or so long as commercial quantities of geothermal resources are being produced or utilized or the same are capable of being produced or utilized. C.P.R.P. Section 6918.

(d) Acreage Limitations. No lease can be issued for more than 2,560 acres and no less than 640 acres. There is no limit on the number of leases, but no one person may hold more than 256,000 acres within the State. Computation of a party's interest for the purpose of the total acreage limitation takes into account such factors as a party's proportionate undivided interest in a lease or permit, his proportionate share of corporate interest if that party has a greater than 10% "beneficial interest" in the corporation, and any ownership of an interest determined as a percentage of production, e.g. royalties. C.P.R.C. Section 6908.

(e) Rents and Royalties. There is an annual rental requirement os $1.00 per acre. The royalty provisions are more complex and provide for an accounting of the sale of byproducts. This technique was originally unique among state laws, but has now been copied by many other states.

Royalty provisions call for a minimum royalty of $2.00 per acre and a royalty of 10% of the gross revenues, exclusive of charges, for the sale of steam, brines, and other resources from which no minerals have been extracted. In addition, the lessee must pay not less than 2% nor more than 10% of the gross revenues from sales of mineral products or chemical compounds recovered from geothermal fluids. Such royalty payments are required for all geothermal resources sold to a third party or used by the lessee or permitee himself. If resources are used by the lessees, the royalty is determined as though there had been a sale to a third party at the prevailing market price in the same market area and under the same market conditions. C.P.R.C. Section 6913.

Royalties are subject to renegotiation after 20 years from the effective date of the lease and at 10 year intervals thereafter. Renegotiations are not subject to the above maximum royalty limitations.

(f) Surface Rights. The lessee or permitee is entitled to use as much of the surface as is reasonably necessary. C.P.R.C. Section 6915.

(g) Cooperative Development. The geothermal resources from any two or more wells may be commingled as long as production from each well is separately measured. Unitization is also allowed among lessees with the Commission's approval. C.P.R.C. Sections 6920, 6923.

(h) Termination. The Commission has the power to terminate any lease.

4. Definitions. California defines a geothermal resource under the leasing provisions as the natural heat of the earth, the energy, in whatever form, below the surface of the earth present in, resulting from, or created by, or which may be extracted from, such natural heat, and all minerals in solution or other products obtained from naturally heated fluids, brines, associated gases, and steam, in whatever form, found below the surface of the earth, but excluding oil, hydrocarbon gas or other hydrocarbon substances. Note: This definition includes the meaning of a byproduct because of the phrase "all minerals in solution and other products obtained ..." C.P.R.C. Section 6903.

Conclusion

As is the case in many other areas of the law, the State of California was the forerunner in geothermal resource law. Its legislation has been used by many other states as a model in developing their own law, and it is still regarded as one of the more comprehensive and sophisticated state statutes in this area.

COLORADO

1. Generally. 1974 legislation places control of geothermal resources under the State's Oil and Gas Conservation Commission, because of the similarity in development of oil and gas and geothermal resources. 1975 legislation grants to the State Board of Land Commissioners the right to lease state lands for the purpose of exploring for, producing and developing the geothermal resources thereunder.

2. Definitions.

(a) Geothermal Resources. The Geothermal Resources Act defines a geothermal resource in terms very similar to the Federal definition: "Geothermal Resources means geothermal heat and associated geothermal resources, including but not limited to:

(I) Indigenous steam, other gases, hot water, hot brine, and all other products of geothermal processes.

(II) Steam, other gases, hot water, hot brine, and all other products of geothermal processes resulting from water, brine, steam, air, gas, or other substances artifically introduced into subsurface formations.

(III) Natural heat, steam energy, and other similar thermal energy in whatever form found in subsurface formations.

.....such term shall not include thermal energy contained in mineral deposits (including deposits of coal, oil shale, crude oil, natural gas, and other hydrocarbon substances and other substances and materials associated and produced in connection with such minerals) which are explored for, developed, and produced primarily for the mineral value thereof and not primarily for the thermal energy contained therein." Colo. Stat. Sec. 34-70-103(6).

(b) Byproduct. Colorado defines a byproduct as any substances which remain after thermal energy has been removed from geothermal resources, including but not limited to cooler waters, solution minerals, chemical compounds, extractable salts, rare earths, and other mineral substances. Colo. Stat. Sec. 34-70-103(4).

3. Well Regulation and Resource Development.

(a) Powers. The Commission has the power to require that wells for discovery and production of geothermal resources be drilled, operated, maintained and abandoned in such a manner as to safeguard life, health, property, public welfare, and the environment and to encourage maximum recovery of the resource and prevent its waste. The Commission promulgates regulations to effect the same. Colo. Stat. Sections 34-70-102 and 105.

(b) Enumerated Powers. In light of the above, the Commission has the following enumerated statutory authority:

(1) To issue or deny permits for exploration or development of geothermal resources. Colo. Stat. Section 34-70-106(3).

(2) To require a written statement prior to the issuance of an exploration well permit containing information as required by the Commission, but specifically including geological data and opinion. Colo. State. Sec. 34-70-106(4). By the same extent, another written statement is required before the issuance of a permit to drill, detailing protective measures and plans of operation. Note: This written statement allows the Commission to control surface land damage, waste, and other related matters. Colo. Stat. 34-70-105(5).

(3) To require public liability insurance to protect against damage to the surface, improvements, and crops and livestock. Colo. Stat. Sec. 34-70-106(6).

(c) Relation to Water Law. The Geothermal Resources Act specifically maintains existing water law and water rights, so that water law is fully applicable to water produced or used in connection with geothermal resources. Furthermore, no geothermal well permit may be issued until the state engineer finds that water in question will not materially injure any vested water right unless the requested permit does not contemplate the appropriation of use of ground water.

4. Leasing. The State Board of Land Commissioners is empowered to lease state lands for geothermal production. These leases must include provisions for a surety bond, for royalties, and for protection of the environment. Note: No provision for maximum term of maximum number of leases held by any one person or maximum acreage held by any person. Rights as between surface user and geothermal resource user are also not covered.

Conclusion

This is a statute which relies heavily on oil and gas law, and which leaves virtually all regulation of the area to rules and regulations promulgated by the appropriate agency.

HAWAII

Hawaii defines a geothermal resource to mean "the natural heat of the earth, the energy, in whatever form, below the earth present, resulting from, or created by, or which may be extracted from, such natural heat," and includes byproducts within that definition by adding, "and all minerals in solution or other products obtained from naturally heated fluids, brines, associated gas and steam, in whatever form, found below the surface of the earth, but excluding oil, hydrocarbon gas or other hydrocarbon substances." Hawaii Rev. Stat. Sec. 182-1.

In addition, the terms "mining leases" and "mining operations" are defined to include geothermal resources. Hawaii Rev. Stat. Sec. 182-1. As such, certain aspects of Hawaii's mining and mineral law are deemed to include geothermal resources as a unique area. As legislation now stands in Hawaii, more questions are created with regard to geothermal resources than are answered.

MONTANA

1. Generally. In 1974, legislation was passed empowering the State Board of Land Commissioners to lease State lands for prospecting, explorations, well construction, and the production of geothermal resources. Revised Code Montana Sec. 81-2601. The Board is given power to promulgate rules and regulations to effect this power. Rev. C. Mont. Sec. 81-2603.

2. Definitions. The meaning given by the Montana legislation is the one used by Idaho. As such, Montana defines geothermal resource as the natural heat energy of the earth, including all minerals in solution or other products obtained from the material medium of any geothermal resource. Like Idaho, the definition continues, stating that "geothermal resources are sui generis, being neither a mineral resource nor a water resource, but they are closely related to and possibly affecting and affected by water resources in many instances. Note: No specific definition of byproducts is given. Rev. C. Mont. Sec. 81-2602.

3. Surface Rights. Every geothermal resource lease granted reserves to the state the right to sell, lease, or otherwise dispose of the surface of lands covered by the lease, subject to the rights and privileges granted the lessee under the terms of the lease. Rev. C. Mont. Sec. 81-]604. In addition, the lessee must compensate the surface lessee for surface damage, and the Board can require the geothermal lessee to post a bond in that regard. The extent of damage is fixed by arbitration.

4. Term of the Lease. A lease is awarded for a primary term of 10 years and so long thereafter as geothermal resources are produced in paying quantities. The leasing term may be extended so long as drilling operations are diligently continued even if paying quantities are not being produced. Rev. C. Mont. Sec. 81-2604.

5. Rents and Royalties. Rents are fixed at an annual minimum of $1.00 per acre. Royalties are fixed at not less than 10% of the amount or value of steam or other forms of heat or energy derived from production under the lease and sold or utilized by the lessee or reasonably susceptible to sale or utilization. There is also a minimum 5% royalty for any byproduct derived and sold or reasonably susceptible of the same. Rev. C. Mont. Sec. 81-2605.

6. Bond. The Board can require a bond to exact compliance with the provisions of the lease and pertinent law. Rev. C. Mont. Sec. 81-2606.

7. Cooperative Development. The Board is empowered to approve agreements among lessees as to drilling and other operations and to enter into agreements for pooling acreage for unit operations for production of geothermal resources and apportionment of royalties. Note: No power to order cooperative development. Rev. C. Mont. Sec. 81-2604.

8. Water Rights. A lessee may secure a water right at any time prior to one year before the expiration of his geothermal resources lease if the geothermal development requires the utilization of water. Rev. C. Mont. Sec. 81-2611.

9. Conflict Among Leases. Where there is a conflict among leases (including e.g. geothermal, oil, gas, and mineral), the person who was first issued a lease shall be entitled to priority of rights. Rev. C. Mont. Sec. 81-2612.

Conclusion

Montana's legislation totally ignores the problem of development of geothermal resources (e.g., well drilling provisions). Leasing provisions are without terms as to the method of acquiring the lease, development of the lease, and acreage holding limitations.

NEVADA

1. Generally. The State Department of Conservation and Natural Resources is authorized to lease any State lands (Nev. Rev. Code Sec. 322-010) and to appoint an engineer to adopt regulations necessary to the property development, control and conservation of Nevada's geothermal resources. Nev. Rev. Code Sec. 534 A. 020.

2. Definitions

(a) Geothermal Resource. Geothermal resource means heat or other associated geothermal energy found beneath the surface of the earth. Nev. Rev. Code Sec. 534a.010.

(b) Byproduct. A byproduct is defined as a tangible substance produced or extracted in the utilization of a geothermal resource. Nev. Rev. Code Sec. 322.030.

3. Leasing.

(a) Award of Leases. Leases for the development of gas, oil and geothermal resources are awarded by competitive bidding on a cash bonus basis. Nev. Rev. Code Secs. 361.606 and 361.607.

(b) Acreage Limitations. Leases are for blocks of not less than 40 acres nor more than 1,280 acres. Nev. Rev. Code Sec. 322.020.

(c) Rents and Royalties. Nevada has a fixed annual rental of $1.00 per acre. Royalties are fixed at 12.5% of the amount of value of any geothermal resource derived from the lease and sold or utilized or reasonably susceptible to sale or utilization by the lessee, and 5% of the amount or value of any by-product sold or utilized or reasonably to the same by the lessee. Nev. Rev. Code Sec. 322.030.

4. Well Regulation and Resource Development. The Director of the Department of Conservation and Natural Resources must appoint a state engineer who may adopt regulations necessary to insure proper development, control, and conservation of Nevada's geothermal resources. Such regulations include the following:

(a) safety requirements,
(b) casing and safety device requirements,
(c) record keeping requirements,
(d) procedures to prevent pollution and waste,
(e) well spacing requirements,
(f) investigation and research by governmental agency.

Nev. Rev. Code Sec. 534.A.040.

5. Relation to Water Law. Any water or steam encountered during geothermal exploration is subject to water appropriation procedures.

Conclusion

Nevada's approach to geothermal resource is based on regulation by agency and affords little statutory guidance.

NEW MEXICO

1. Generally.

(a) New Mexico adopted a Geothermal Resources Act in 1967 which gives the Commission of Public Lands the power to lease state lands for geothermal resource development. N.M. Stat. Ann. Sec. 17-5-5. In 1975, a Geothermal Resources Conservation Act gave the Oil Conservation Commission the power to regulate wells, prevent waste, and protect correlative rights. N.M. Stat. Ann. Secs. 65-11-2 and 65-11-7.

(b) *Summation of the Geothermal Resources Conservation Act*. This statute is unique among state geothermal resource acts. Its approach is to emphasize correlative rights as a means of preventing waste and promoting efficient economic development of the geothermal resource. As such, the heart of the statute consists of provisions dealing with the regulation of production. In contrast, provisions concerning such areas as drilling and casing requirements, bonds, information filing, abandonment, etc., which one would typically expect to be detailed in the companion statute to a leasing law, are listed mater of factly as subjects which the Commission may regulate by promulgation of rules and regulations. The allocation provisions borrow largely from the oil and gas field and are additionally notable for the thoroughness as well as their complexity.

2. Definitions.

(a) Geothermal Resources. This is the standard "natural heat of the earth and all minerals in solution and other products" definition. Note: By-products are seemingly defined by the phrase "and all minerals in solution and other products." N.M. Stat. Ann. Sec. 65-11-3.

(b) Correlative Rights. This is the right of each owner within a geothermal reservoir to produce his just and equitable share of resources within that reservoir. A just and equitable share is an amount, so far as can be practicably determined, that can be obtained without waste substantially in the proportion that recoverable geothermal resources under the owner's property bears to the total recoverable geothermal resource in the reservoir. In addition, this definition includes the right of the owner to use his just and equitable share of the natural heat or energy in the reservoir. N.M. Stat. Ann. 65-11-2.

(c) Waste. In addition to its ordinary meaning, the term "waste" includes: (1) underground and surface waste as the term is generally understood, in the geothermal business; (2) production in excess of reasonable market demand, in excess of the ability of a geothermal transportation facility connected to the well in question to efficiently transport and receive such resource, and in excess of the capacity of the geothermal utilization facility to efficiently receive and utilize such resource; and (3) the nonratable purchase or taking of a geothermal resource within a geothermal reservoir. Note: Many, if not most state laws, define waste, but none of them do so to this extent. N.M. Stat. Ann. 65-11-3.

3. Resource and Well Regulation. The Commission may make rules, regulations, and orders for the purposes and with respect to the following:

(a) requirements as to the plugging of wells,

(b) bond not to exceed $10,000,

(c) preventing geothermal resources from escaping from the strata in which they are formed,

(d) requirements as to record keeping and filing,

(e) prevention of premature cooling,

(f) prevention of blow-outs and caving,

(g) prevention of injury to property and persons,

(h) injection,

(i) disposition of the geothermal resource or residue therefrom.

N.M. Stat. Ann. Sec. 65-11-8.

4. Production Regulation; Allocation, Spacing Units and Pooling.

(a) Allocation. Upon determination by the Commission that geothermal resource production from a particular geothermal reservoir is causing waste or is about to result in waste, the Commission must limit, allocate and distribute the total amount of geothermal resources which may be produced from such reservoir. Allocation among wells is done on a reasonable basis, recognizing correlative rights, and giving equitable consideration to acreage, pressure, temperature, quantity and quality of the resource, and other pertinent factors. An allocation order can only be made after a hearing where the Commission must make a finding as to the particular type of waste, as delineated in the definition, that is present. In addition, such allocation is only done on the basis of three month allocation periods. N.M. Ann. Stat. Secs. 65-11-9 and 65-11-10.

(b) Spacing and Pooling. The Commission is empowered to establish a spacing unit for any geothermal reservoir. A spacing unit is the area that can be efficiently and economically drained by one well. The purpose of a spacing unit is to prevent owners and operators within the same reservoir from drilling an excessive number of wells and thereby overdrawing the reservoir and reducing its production potential. The Commission can approve voluntary pooling agreements, but it must require the pooling of all separately owned interests within an established spacing unit where the separate owners of land or interests have agreed not to pool, and one of them is proposing to drill. Such a pooling order may be issued only after hearings and subsequent findings that the order is required to avoid the drilling of unnecessary wells, to protect correlative rights, or to prevent waste. It is the obligation of the owner planning to drill a well within a spacing unit with divided ownership to obtain voluntary agreements or initiate the procedure for an order by the Commission. All owners within the unit must advance the costs of development and operation or provide for reimbursement to the obligated owner out of production. The obligated owner is otherwise responsible for the costs incurred, but he may charge for supervision and the risks involved in drilling the well. Production from the unit well is allocated among the owners in the proportion the acreage owned by each individual has to total acreage of the spacing unit. Finally, 7/8 of the pooled interest of any owner is considered a working interest and 1/8 is considered a royalty interest. In all events, the owner is paid 1/8 of all production from the unit and creditable to his interest. N.M. Stat. Ann. Secs. 65-11-11 and 65-11-13.

5. Purchase, Sale and Handling of Geothermal Resources. The Geothermal Resource Conservation Act requires that any person engaged in purchasing or taking geothermal resources from more than one producer within a single geothermal reservoir must purchase, without unreasonable discrimination in favor of one producer against another in the price paid, quantitites taken, the bases of measurement or the facilities offered. In the event such purchaser is also a producer, he is prohibited to the same extent from discriminating in favor of himself. N.M. Ann. Stat. Sec. 65-11-14.

In addition, the Commission grants certificates of clearance or tender which allows a person to "handle" (i.e., sell, purchase, acquire, transport, utilize, or process) a geothermal resource without penalty. The certificate creates the presumption that the resource in question is not an "illegal geothermal resource," i.e., deemed in whole or in part to be produced in excess of the amount allowed by statute or regulation. N.M. Stat. Ann. Secs. 65-11-15 and 65-11-16.

6. Emergency Rule. A hearing is required before any order, rule or regulation is issued. However, when an emergency is found to exist which the Commission in its judgment feels requires the making of a rule or order, it may issue such rule or order without hearing, effective up to 15 days. N.M. Stat. Ann. 65-11-17.

7. Leasing.

(a) Definitions. Geothermal resource is defined in the same way as under the Conservation Act. N.M. Stat. Ann. Sec. 7-15-2.

(b) Method of Leasing. The Commissioner of Public Lands may lease state land for geothermal resource development to the first qualified applicant unless such land is declared to be a KGRA (i.e., capable of producing geothermal resources in commercial quantities), and then land in those areas is leased in a competitive bidding system. N.M. Stat. Ann. Secs. 7-15-5 and 7-15-6.

(c) Acreage Limitations. No lease can be made for less than 640 acres nor more than 2,560 acres, and no person can own, hold or control leases in which the direct or indirect interest therein exceeds 25,600 acres. N.M. Stat. Ann. 7-15-5.

(d) Rents and Royalties. New Mexico provides for an annual rental of $1.00 per acre. Royalties are provided for as follows:

(1) a royalty of 10% of the gross revenue, exclusive of charges received from the sale of steam, brines, from which no minerals have been extracted, and associated gases at the point of delivery to the purchaser thereof;

(2) a royalty of not less than 2% nor more than 10% of the gross revenue received from the sale of mineral products or chemical compounds recovered from geothermal fluids in the first marketable form for the primary term of the lease;

(3) a royalty of 8% of the net revenue received from the operation of an energy producing plant on the leased land;

(4) a royalty of not less and 2% nor more than 10% of the gross revenue received from the operation of the geothermal resource for health and recreational purposes.

After the discovery of geothermal resources in commercial quantities, rents and royalties under each year must equal the sum of $2.00 per acre or the lessee must make up the difference. Royalties can be renegotiated after 20 years, and then again at 10 year intervals thereafter, but new royalties may not vary more than 50% from previous royalty rates. (Note: there is no upper limit stated as in some state statues for royalties.) Rents and royalties both may be renegotiated at other rates than as stated above where surface has been sold, but the mineral rights reserved. Finally, royalty payments for geothermal resources used but not sold by the lessee are determined as if the same had been sold at the then prevailing market price in the same market and under the same market conditions. N.M. Stat. Ann. 7-15-7.

(e) Development. The Commissioner has the power to prescribe development programs and to require the production of "other" geothermal resources where such other resources are susceptible to being economically produced in commercially valuable quantities. N.M. Stat. Ann. Secs. 7-15-7 and 7-15-4.

(f) Relinquishment or Cancellation of Lease - Suspension of Operations. The Commissioner can suspend operations under a lease, after public hearing, in the interest of conservation. However, the duration of the lease must thereafter be extended for a period of time equal to the time of suspension. A lessee is allowed to relinquish his lease, but he must continue payments of all accrued rents and royalties, protect and restore the surface, and ensure proper abandonment of all geothermal wells. Cancellation of the lease is allowed for a violation of any of the terms of the lease and for nonpayment of rents or royalties. Before any cancellation is made, however, the Commissioner is required to give 30 days notice and allow the lessee to remedy the default within that 30 days. Note: There is no automatic cancellation of the lease for nonpayment of rent, as in Idaho. N.M. Stat. Ann. Secs. 7-15-10 and 7-15-8 and 7-15-23.

(g) Duration of the Lease. Each lease entered into is for a primary term of 5 years with a right to renew for succeeding 5-year terms, so long as geothermal resources are being produced or utilized in commercial quantities or are capable of the same. N.M. Stat. Ann. Sec. 7-15-11.

(h) Comingling and Cooperative Development. Geothermal resources from any two or more wells may be combined with approval by the Commissioner. Cooperative development or operation of geothermal resource lands is also allowed with approval. N.M. Stat. Ann. Secs. 7-15-12 and 7-15-14.

(i) Surface Rights. The geothermal lessee is entitled to use so much of the surface as is reasonably necessary. N.M. Stat. Ann. 7-15-17.

(j) Bonds. A $5,000 bond must be executed to secure payment for damages to tangible improvements before any person commences development on operations of a geothermal resource under a lease. A bond may also be required to secure payment of royalties. Note: The required bond applies only to damages to tangible improvements and not to general surface area of the leased area as in many other state laws. N.M. Stat. Ann. 7-15-18.

(k) Assignment, Transfer or Sublet. Any lease may be assigned, transferred, or sublet with approval of the Commissioner. N.M. Stat. Ann. 7-15-21.

(l) Grandfather Clause. The Geothermal Resources Act provides a clause giving a preference right to holders of general mining leases from the state if those lessees can show that the lease was applied for or issued for geothermal resource development purposes. N.M. Stat. Ann. 7-15-20.

Conclusion

As indicated in the summary, New Mexico law is patterned after oil and gas legislation and emphasizes protection or correlative rights and efficient utilization of geothermal resource. Otherwise, it uses a KGRA/bid system for leasing land. Much of the control of the resource development has been left to be detailed by regulation.

OREGON

1. Generally. The State Department of Geology and Mineral Industries is given control of drilling, construction, operation, and abandonment of wells used for the discovery and production of geothermal resources. The Division of State Lands has control of drilling leases.

2. Definitions.

(a) Geothermal Resources. Oregon uses the usual "natural heat of the earth" definition, but specifically includes: (1) all products of geothermal processes, embracing indigenous steam, hot water and hot brines; (2) steam and other gases, hot water and hot brines resulting from water, gas or other fluids, artificially introduced into geothermal formations; (3) head or other associated energy found in geothermal formations; and (4) any byproduct derived therefrom. Ore. Rev. Stat. Section 522.005(7).

(b) Byproduct. A byproduct means any mineral, exclusive of helium or of oil, hydrocarbon gas or other hydrocarbon substances, which are found in solution or in association with geothermal resources and which have a value of less than 75% of the value of the geothermal resource or are not, because of quantity, quality, or technical difficulties in extraction and production, of sufficient value to warrant extraction and production by themselves. Ore. Rev. Stat. 522.005(2).

3. Leasing. Mineral and geothermal resource rights in property owned by the state or retained as an interest in land previously sold, are subject to exploration permit or lease by the Division of State Lands, in accordance with rules and conditions established by law or adopted by the division. Ore. Rev. Stat. Sec. 237-780. All leases may be without limitation as to time, but the Division may cancel any lease upon failure by the lessee to exercise due diligence in the prosecution of the prospecting, development or continued operation of the well. Ore. Rev. Stat. Sec. 237.551.

4. Regulation of Geothermal Resources and Wells.

(a) Prospect Wells. Prospect wells are geothermal resource wells less than 500 feet deep and used for geophysical tests, exploration drilling, etc. No drilling of prospect wells is allowed without a permit, which is granted within 30 days of the State Geologist's receipt of application. The State Geologist may allow the permit, subject to such conditions as he deems proper, including the proper and safe abandonment of each well. a $5,000 bond is required to be posted before the permit is issued. This bond covers all wells which are included within the application, the return of which is conditioned upon proper abandonment. Ore. Rev. Stat. Sections 522.055, 522.065, 522.075, 522.085 and 522.005(9).

(b) Geothermal Wells.

(1) Permit. No person is allowed to drill or operate a geothermal well without a permit issued by the State Geologist imposing drilling requirements and conditions. This permit is issued, denied, modified, revoked, or not renewed within 45 days after the receipt of the application. The State Geologist issues the prmit subject to such conditions as he considers necessary

to carry out the purposes of the geothermal resources legislation, but he must incorporate any conditions made by the Water Resources Director and by the Department of Environmental Quality. Ore. Rev. Stat. Secs. 522.111(5), 522.125, and 522.135.

(2) Bond or Security. A bond of $10,000 is required to be filed for each well drilled, or $25,000 for all wells drilled statewide. This security is conditioned upon compliance with the terms of the Department's rules and regulations. Ore. Rev. Stat. Sec. 522.145.

(3) Protection of Ground and Surface Water-Casing Requirements. An operator is liable for damages caused by the failure to comply with a condition in a permit requiring him to provide for the protection of ground and surface water. In addition, rule standards have been promulgated for blowout prevention, equipment and casing design and removal, and procedures necessary to shut out detrimental substances from strata containing ground or surface water usable for beneficial purposes. No operator may alter the casing without written authorization. Ore. Rev. Stat. Secs. 522.155 and 522.165.

(4) Notice of Transfer. Both parties to a purchase, assignment, transfer, or exchange of a geothermal resource well must notify the Department of such transaction within 15 days of its occurrence. Ore. Rev. Stat. Sec. 522.205.

(5) Abandonment. Before commencing any operation to abandon a geothermal well, the operator must give notice to the Department of his intent to do so, and such notice must be at least 24 hours prior to the proposed date. Before the proposed date of abandonment, the Department must either approve the abandonment operation as stated in the notice; conditionally approve it, stating what work or tests will be necessary before approval will be given; or issue a report stating what specific information is required by the Department from the operator before any action may be taken upon the proposed abandonment operation. Thirty days after completion of the abandonment, the operator must submit a report of all work done, and the Department then issues a final written approval or disapproval setting forth the conditions upon which the disapproval is based. Ore. Rev. Stat. Secs. 522.225, 522.235, and 522,245.

No operator is allowed to suspend drilling or operation of a geothermal well for more than six months without obtaining permission. In such cases, intent to abandon is presumed and actions are taken for unlawful abandonment. Ore. Rev. Stat. Sec. 522.215.

Finally, upon completion of a geothermal well, the operator is required to file a production and abandonment bond in addition to previously filed security. This bond is not cancelled until production has ceased and the well has been lawfully abandoned. Ore. Rev. Stat. Sec. 522.185.

(c) Well Records. The operator of a geothermal well must keep and file records, including a log, core record and drilling history. Ore. Rev. Stat. Secs. 522.235 and 522.236.

Conclusion

Oregon has a very complete law regulating well drilling and resource development. It has left the area of leasing to be regulated entirely by rule and regulation, without even any guidance to the agency as to areas such regulation will need to cover.

TEXAS

1. Generally. The Geothermal Resources Act, Texas Stat. Art. 5421s, is a brief statute enacted to promote the rapid and orderly development of geothermal energy and associated resources in order to provide a dependable supply of energy while affording consideration to protection of the environment, of correlative rights, and of natural resources.

2. Definitions. The act defines a geothermal resource as geothermal energy embracing indigenous steam, hot water and hot brines, and geopressured water; steam and other gases, hot water and hot brines resulting from water, gas, or other associated energy found in geothermal formations; and any byproduct derived therefrom. (Note: This is the federal definition.) Byproduct is defined to mean any element found in a geothermal formation which, when brought to the surface, is not used in geothermal heat or pressure inducing generation. Texas Stat. Art. 54215, sec. 3.

3. Resource Development. The Railroad Commission regulates the exploration, development, and production of geothermal energy on public and private land. It must enact rules and regulations pertaining to: (a) protection of the environment; (b) prevention of waste; (c) protection of the general public against injury or damage resulting from development and production of geothermal energy; and (d) protection of correlative rights against infringement. Texas Stat. Art. 54215, sec. 4.

4. Leasing. The School Land Board may lease any lands belonging to the Permanent School Fund, excluding wildlife refuges and recreational areas, for the exploration, development, and production of geothermal energy. All leases are awarded pursuant to a sealed bidding system. The School Land Board also has authority to approve unit agreements. Texas Stat. Art. 54215, sec. 5.

Conclusion

This statute uses the approach of empowering state agencies to promulgate rules and regulations which will provide regulation for the resource development and leasing of land, instead of providing detailed statutory provisions. As such, the statute is brief, and apparently mentions only those broad areas of concern which the legislature feels the agency must be sure to cover.

UTAH

The Division of Water Rights has been given jurisdiction and authority by way of 1973 legislation to require that all wells for the discovery and production of water to be used for geothermal energy production be drilled, maintained and abandoned in such manner as to safeguard life, health, property, the public welfare, and encourage maximum economic recovery. Utah Code Ann. Sec. 73-1-20. In addition to this, the State Land Board has adopted a rule providing for the leasing of geothermal contained in or under the lands of the State. These leases will be issued only when the state owns both the surface and mineral rights for the land involved. The State lessee has a prior right to a separate mineral lease for the minerals of possible recoverable value found in formations intercepted by mining or drilling operations in connection with geothermal production. Rule 30, Rules and Regulations of the Utah State Land Board Governing the Issuance of Mineral Leases (as amended June 19, 1973).

C-4 STATE OWNERSHIP OF WATER: WATER CONFLICTS BETWEEN STATE AND FEDERAL GOVERNMENT

Introduction

The question of who owns the water found within a state's boundaries can pose a confusing problem. As between private citizens, for an individual to gain title to, and a better claim to the water than his neighbor, the laws of the State of Idaho are clear that water must be diverted and put to a beneficial use according to the statutory scheme of appropriation. However, the rights between the Federal government and the state comprise an area that is less understood but vitally important to the Boise Geothermal project. Since Idaho geothermal resources largely exist in a liquid state, and since large areas of this State are federally reserved, the question of whether the Federal government has a claim to the hot water within or without the boundaries of its reserved parcels becomes significant. As such, this paper presents a short examination of some of the significant laws concerning the Federal government's right to water within the boundaries of Idaho.

Discussion

Originally, all Idaho land was federally owned and controlled, and accordingly, so was the water. The Organic Act of Congress established the Territory of Idaho in 1863 (12 Stat. L. 808, ch. 117), and Idaho was admitted to statehood by Act of Congress in 1890 (26 Stat. L. 215, ch. 656). In so doing, Congress admitted Idaho "into the union on an equal footing with the original states in all respects whatever." (26 Stat. L. 215, ch. 656, 11). No specific reservation was made to the United States concerning public lands or unappropriated waters within Idaho in that act. As such, whether or not Idaho had a legitimate claim to the public land and waters remained, at least in part, a matter of statutory interpretation and subsequent congressional legislation. However, a school of thought prevalent during the nineteenth century, and still highly regarded today, held the view that under the equal footing doctrine, the western states, upon their admission to the Union, acquired exclusive sovereignty over the unappropriated waters in their streams. This belief has been supported by state law and case law.

In this regard, Idaho asserted ownership of its nonnavigable waters in Section 42-101, Idaho Code which states in pertinent part:

> 42-101. Nature of property in water.--Water being essential to the industrial prosperity of the state, and all agricultural development throughout the greater portion of the state depending upon its just apportionment to, and economical use by, those making a beneficial application of the same, its control shall be in the state, which, in providing for its use, shall equally guard all the various interests involved. All the waters of the state, when flowing in their natural channels, including the waters of all natural springs and lakes within the boundaries of the state are declared to be the property of the state, whose duty it shall be to supervise their appropriation and allotment to those diverting the same therefrom for any beneficial purpose, and the right to the use of any of the waters of the state for useful or beneficial purposes is recognized and confirmed.

Other states such as Colorado and Wyoming have similar statutory assertions and these provisions have been upheld on the ground that the States gained absolute dominion over their nonnavigable waters upon their admission to the Union. California vs. United States, 98 S. Ct. 2985, 2991, ft. 9 1978; See e.g., Stockman vs. Teddy, 55 Colo. 24, 27-29, 129 P. 220 (1912); Farm Inv. Co. vs. Carpenter, 9 Wyo. 110, 61 P. 258 (1900). Although Idaho has no specific state case which upholds the validity of 42-101, the case law is filled with supporting statements verifying the state's claim.

As such, it is clear, said the Supreme Court, that the title to the public waters of the State is vested in the State for the use and benefit of all citizens under such rules and regulations as may be prescribed from time to time by the legislature. Walbridge vs. Robinson, 22 Idaho 236, 241-242, 125 Pac. 812 (1912). See also Idaho Power and Transportation Co. vs. Stephenson, 16 Idaho 418, 429, 101 Pac. 821 (1909); Speer vs. Stephenson, 16 Idaho 707, 715, 102 Pac. 365 (1909); Poole vs. Olaveson 82 Idaho 496, 502, 356 Pac. (2d), 61 (1960). The court has further stated that it is not an interest or title in the proprietary sense, but rather in a sovereign capacity as representative of all the people for the purpose of guaranteeing that the common rights of all should be equally protected. Walbridge, supra; Poole, supra.

Despite such language, the federal government still believes, and often asserts, it possesses greater rights to a state's nonnavigable public water than a state like Idaho cares to acknowledge. Such assertions usually take place in the context of litigation over the extent of the reservation made by the United States in grants of land for such things as a national forest, see e.g. United States vs. New Mexico, 98 S. Ct. 3012 (1978); or a federal reclamation project, California vs. United States, 98 S. Ct. 2985 (1978). Even so, the United States' position is none too good. For example in the two cases cited immediately above, Justice Penquist delivered very strong opinions that supported the respective state's right to control public water. In the case of Idaho, a federal court held in 1911 that in the reclamation of land under the Reclamation Act, 32 Stat. L. 388, the United States acquires appropriative water rights not in it sovereign by proprietary capacity as the owner of arid lands, by complying with the laws of the State. Twin Falls Canal Co. vs. Foole, 192 Fed. 583 (C.C.D. Idaho, 1911). By the same extent, specific provision is made by the water-rights statute for appropriation of water by the Division of Grazing subject to the provision that this statutory authorization shall not be construed to prevent the United States Bureau of Reclamation from filing application for or completing the appropriation of the state. Sections 42-501 to 42-505, Idaho Code. Therefore, the conclusion to be drawn is that generally, Idaho has a sovereign right to rights public nonnavigable waters to the exclusion of the federal government.

C-5 ANALYSIS OF GEOTHERMAL LEASING STATUTE

Introduction

Title 47, Chapter 16 of the Idaho Code deals with the issuance of geothermal resource leases and governs the conduct of any operations thereunder. The State Department of Lands is responsible for the administration of these laws and pursuant to its legal authority, has promulgated rules and regulations which provide a legal framework whereby such administration is possible. As stated in the Rules and Regulations governing the issuance of geothermal resource leases:

> "It is the express policy of the State Board of Land Commissioners to encourage prompt exploration and development of geothermal resources within the State of Idaho while minimizing the detriments and costs of all kinds that could result from exploration and development."

In addition, it can be fairly assumed that the State leases land for geothermal development pursuant to various rent, royalty and production obligation provisions to ensure itself a maximum profit, without detriment to the resource or the environment, and in a manner that maintains private enterprise as a feasible proposition.

It is the purpose of this paper to critically analyze the laws, rules, and regulations with respect to geothermal resource land leases in light of the above purpose and assumptions. This analysis will attempt to point out ambiguities, loopholes, and general problems in the existing legal framework as well as explain the more complicated provisions and underscore areas of significance for a future developer. Where possible and appropriate, suggestions as to alternative legal provisions are supplied. (NOTE: For an overview of the pertinent provisions of Geothermal law as to land leasing, see Section D-6 entitled Legal Schematics for Geothermal Development.)

Rule 3 - Application and Processing

This rule requires that an application be submitted on an appropriate form and that formal approval of that application be made by the Board of Land Commissioners before any development under the lease takes place. There is however, no time limit imposed on the Board within which the decision to grant formal approval must be made. As such, this omission represents a direct contradiction to the stated purpose of "prompt exploration." It means that any application submitted for approval will be subject to inevitable bureaucratic review, and therefore subsequent geothermal resource development will be delayed.

In addition, the lack of any stated time limits for approval may constitute a significant deterrent to business involvement in the general development of geothermal resource. In this regard, geothermal development requires the commitment of a substantial amount of capital in order to pay for rent under the land lease, bonds under the land lease, bonds for drilling, and the cost of drilling and maintaining exploratory and production wells, just to mention the most obvious costs. A good businessman will not only want to have his start-up capital for this project on line when awarded a lease, but he will also need to know what kind of time-table he will be faced with as to how much money will be necessary at what points in time. Therefore, Rule 3 will very possibly inhibit the involvement of high-risk capital that traditionally funds such projects, and shunt such monies into other investment arenas that at least are not characterized by this initial draw-back.

Rule 15 - Diligent Exploration

To fully understand the import of Rule 15, one must be acquainted with the statutory leasing scheme as provided according to Title 47, Chapter 16, Idaho Code. Accordingly, the rules provide for a primary lease term (Rule 6) of ten years, at the end of which, production of geothermal resources must be in process, or at least such resources must be "demonstrably capable of being produced" (as that term is defined in Rule 6(B)). If this requirement is not met, then the lease is not renewed.

Rule 15 is present in the legal framework to allegedly ensure that leasable land is not tied-up for the entire primary term without an owner making a diligent effort to explore, thereby discovering the geothermal resource and allowing the owner to be capable of production as required under Rule 6 at the end of the ten years. This purpose is accomplished under Rule 15 by requiring the following penalty of lease termination:

> "Beginning with the 6th year of the primary lease term, and each year thereafter, exploration operations, to quality as diligent operations, must entail expenses during that year equal to at least four times the lease rental for the same year. Exploration expenses incurred during any year of the primary lease term in excess of those required herein may be credited toward diligent during subsequent years of the primary lease term. (Emphasis supplied)."

However, a careful analysis of this language shows that there is no real incentive to force a leasee into diligent exploration other than the threat of termination under 6B at the end of ten years. To understand this fully consider a minimum lease hold of 640 acres. Annual rentals for the second five years of the lease are required to be $2.00 per acre per year. As such, "diligent exploration" under Rule 15 would be satisfied if at least $5,120.00 were spent each of the last five years of the lease, or if a total of $25,600.00 was spent over the life of the lease. This means that one exploration well drilled to 1,000 feet at today's minimum cost of $30.00 per foot, would satisfy Rule 15 for all ten years of the primary term! Therefore, anyone practically speaking, can tie-up a lease with a small relative cost plus the annual rental fee. This would allow such abuses as speculators waiting until the price for the resource is high to engage in production so that the consumer would have to pay more; or it would allow a major energy supplier to tie-up land at a very small cost that could otherwise be used to produce this alternative and competitive energy source. Despite the above criticism there are three good reasons for the statutory scheme of supervision under Rule 15. First it allows the "small guy" an opportunity to enter the field that would naturally occur in the infancy stage of this new technological area. Finally, ten years seems to be a sufficient period of time to overcome the setbacks and false starts that would inevitably occur during the exploratory stage of resource development.

But such advantages do not overcome the point that the purpose of "prompt exploration and development of geothermal resources" is not being as fully promoted as might otherwise occur if a system other than the one of Rule 15 was employed to encourage exploration. This conclusion is especially true when one considers the nature of the geothermal resource as it naturally occurs in Idaho, and why a period of ten years was arbitrarily chosen as a primary term.

In this regard, the ten-year primary leasing system was originally introduced to the nation in a geothermal resource context under the 1970 U.S. Geothermal Steam Act. The Federal legislation was developed to handle the leasing of land containing a geothermal resource capable of producing electrical power. Geothermal resources capable of electrical production are generally characterized by the presence of steam and a high content of mineral by-products which often prove to be toxic for agricultural or domestic use, and corrosive to a majority of piping systems used to implement production. In addition, this type of geothermal resource required sophisticated and expensive technology which requires years to implement beofre production can ever be instituted. Idaho, on the other hand, has a geothermal resource that is generally found at relatively shallow depths (1,000 - 3,000 feet), is composed largely of hot water (180° - 210°F generally), and is relatively free of detrimental mineral content. This type of geothermal resource is largely incapable of electrical production, at least during the foreseeable technological future, and its present major industrial use would be for space heating. The technology required to implement space heating through the use of "hot water" is simple and relatively inexpensive as compared to that required for electrical production.

Therefore, the Rule 15 of "diligent exploration," although useful in purpose, may not provide as pertinent and efficient a system as might be employed in cases where electrical production is not feasible, or perhaps "diligent exploration" should not be solely judged by financial criterion. Instead, money spent toward implementation should be used only as a minimum evaluation standard, and a flexible time-table should be developed on a case-by-case basis subject to the Director's discretion, by which "diligent exploration" would be judged. In this way, the "prompt development" of the resource can be logically gauged and compelled on a basis that considers problems in development on a more pertinent basis.

Rule 6 and Rule 17 - Operational Requirements and Production Obligations

As stated in the introduction, the State leases land to make a profit. This profit is ensured through a variety of statutory measures with which a lessee must comply. Therefore, a brief review of these measures is useful.

As mentioned previously, Rule 6 requires that geothermal resources are being produced or "demonstrably capable of being produced" from the leased land by the end of the primary term before any extension is granted. Rule 15 guarantees that a diligent effort is made by the lessee through the primary term to discover the resource. Once the primary term is extended because of production, then Rules 6 and 17 mandate certain other actions by the lessee to ensure greater profit by way of royalties to the State.

In this regard, Rule 6 allows extension of the primary term up to additional terms of 40 years* only so long as the geothermal resource is being produced or utilized in paying quantities, and only so long as the lessee uses "due diligence" to market or utilize these quantities of the resource. In cases where production is "shut-in," then the lessee must proceed diligently to acquire a contract to sell or utilize the production, or progress with installations needed for production. So long as the Director determines that this is being accomplished, then a lease can continue in force, upon payment of rentals, for a five-year period, subject to review and an award of additional five-year extensions.

The final measure is found in Rule 17. It requires the lessee to use reasonable precautions to prevent waste of <u>any</u> resource found in the land. In addition, and of at least equal significance, is the following production obligation:

> The lessee shall, subject to the right to surrender the lease, diligently drill and produce such wells as are necessary to protect the Board from loss by reason of production on other properties, or in lieu thereof, with the consent of the Director shall pay a sum determined by the Director as adequate to compensate the Board for failure to drill and produce any such well. The lessee shall promptly drill and produce such other wells as the Director determines a reasonably prudent operator would drill in order that the lease be developed and produced in accordance with good operating practices. The Director shall determine the value of production accruing to the Board where there is loss through waste or failure to drill and produce protection wells on the lease, and the compensation due to the Board as reimbursement for such loss. Payment for such losses will be paid when billed.

Simply stated then, a lessee must either drill and produce, pay, or surrender the lease if there is "production on other properties" or a "reasonably prudent operator" would have done so. As such, the Director is provided with a very powerful weapon which on paper fully compliments Rules 6 and 15.

Two observations should be made with respect to these Rules. First, "shut-in" extensions for five-year periods subject only to review once at the end of that period are actually self-defeating. There is no reason why reports should not be submitted and a review by the director not be made on a much more frequent basis. This is especially true since as pointed out previously, the nature of Idaho's geothermal resource is unique and requires a simpler technology to institute utilization thereof. This means that a five-year extension may not necessarily be a valid time frame and a reappraisal of the rule in this respect may be required.

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* Extensions for five-year periods are allowed if production of geothermal resource itself is not commercially feasible, but valuable by-products are present in commercial quantities.

Second, although the principal of Rule 17 is excellent, its practical effect is certainly in doubt. The standards by which loss and the necessity for "protection wells" are judged (i.e. "loss by reason of production on other properties" and a "reasonably prudent operator") are so ambiguous and subject to differing interpretation that in all but the most clear-cut cases will enforcement of Rule 17 have any effect but to produce extensive litigation. In fact, it can be easily argued that Rule 17 compels waste of the geothermal resource. Forcing competition between properties over the same resource pool could easily lead to a draw-down of the resource pool beyond its recharge capacity thereby depleting it before its natural time. Hence, although the rule allegedly protects the State's short-run monetary gain, it in effect defeats a major goal of minimizing costs and detriments.

<u>Rule 14 and Rule 20 - Water Rights</u>

Rule 20 controls the rights to ownership of water discovered pursuant to operations under a geothermal lease. It prohibits sale, assignment, or transfer of any water right without written approval of the Director and requires the lessee to take whatever actions are necessary to assign to the Board all rights upon termination.

The effect of this rule is to prevent a lessee from obtaining a personal vested water right. Any water rights obtained in conjunction with the lease, whether applications, permits, or licenses, are property of the State and must be assigned to the Board. Thus, a lease becomes a contract by lessee to assign his water rights and he should realize this before he invests time and money into such a project. Furthermore, a water user apart from the lessee should contract with the State as well as the lessee if he wants to insure his right to water beyond the term of the lease.

Rule 14 E.1 compliments Rule 20 and its effect. Rule 14E states that where the lessee finds only potable water of no commercial value as a geothermal resource in any well drilled, then if the water is of such quality or quantity as to be valuable and useable for agricultural, domestic or other purposes, the Board, surface lessee, or contract purchaser shall have the right to acquire the well and casing for the fair value of the casing. This result is as it should be, since Rule 22 affirms that the Leasing Statute is not designed to allow a geothermal lessee to acquire water rights.

<u>Rule 16 - Operations Under the Lease and the "Best Practice" Rule</u>

Rule 16 is an extensive rule governing operations under the lease. It is not difficult to understand, but one of its requirements bears a word of caution. Part A of Rule 16 requires that "all operations will conform to the <u>best</u> practice and engineering principles in use in the industry." Notice that it does not say the <u>average</u> practices, or <u>accepted</u> practices. It uses the word "best." Nor does the rule mention whether the techniques and technology used to develop the resource must be maintained at the "best" level once installation has incurred nor how often a lessee's system of development must be updated. As such, a lessee should be wary. He should confer with the Director as to what technical standards his machinery and practices are expected to meet before initial installation and then request notices of any substantial change in requirements. In this way, a lessee can prevent lease termination.

Rule 25 - Surrender, Termination and Expiration of the Lease

Rule 25 deals with the lessee's responsibilities in event of surrender, termination or expiration of the lease. Surrender describes the lessee's voluntary relinquishment of the lease for the remainder of his rightful term by filing a written notice. A surrender takes effect on the date the notice of relinquishment is filed subject to the following continued obligations of the lessee and his surety:

1. To make payments of all accrued rentals and royalties;
2. to place all wells on the land to be relinquished in condition for suspension of operations or abandonment;
3. to restore the surface resources in accordance with these rules and the terms of the lease; and
4. to comply with all other environmental stipulations provided for by these rules or lease.

These obligations are necessary and useful in maintaining the integrity of the entire leasing system. However, a critical problem appears to be present within the present legal framework with respect to these requirements. In this regard, Rule 25 makes no similar obligations mandatory in the cases of termination or expiration of the lease. Obviously, it is a matter of mere oversight, but that does not alter the fact that the present language of the rule makes such a construction difficult. Since Part B of Rule 25 states such requirements specifically pertain only to relinquishment and no similar requirements are found anywhere else within the rule there is a gap in the Director's enforcement ability in such cases. Although the bond furnished under Rule 26 creates a stopgap against this protective lapse because it is conditioned upon compliance by the lessee of his obligations under the lease and the rules, it is not enough. A bond of only $2000.00 is required as long as wells are less than 1,000 feet deep. This amount is increased to $10,000.00 for wells deeper than 1,000 feet, but in view of the nature of Idaho's geothermal resource, especially the shallow depths at which it is found, greater ease in administration may be accomplished by a change in the present language of Rule 25.

Rule 8 - Royalties

The royalty provisions of Rule 8 are the keystone in the State's ability to earn a profit from its geothermal resource leases. The intent of Rule 8 is to place a royalty on the value of the geothermal resource or by-product sold or utilized. However, the manner by which this end effect is achieved is a matter of dubious reliability and therefore the following analysis is offered as constructive criticism.

According to Rule 8, a royalty of 10% is assessed on the amount or value of production from the geothermal resource itself, and 5% of the value of any by-product. Most problems, however, arise in subpart B which defines the method of determining the value of geothermal production for the purpose of computing royalties. Rule 8B states in pertinent part:

The value of geothermal production .... shall be the following:

(1) The total consideration accruing to the lessee from the sale thereof in cases where geothermal resources are sold by the lessee to another party in an arms-length transaction; or

(2) The value of the end product attributable to the geothermal resource produced from a particular lease where geothermal resources are not sold by the lessee before being utilized, but are instead directly used in manufacturing power production, or other industrial activity; or

(3) When a part of the resource only is utilized by the lessee and the remainder sold, the sum of (1) and (2) immediately above.

Accordingly, the value of the geothermal resource or by-product is the total consideration from a sale in an arms-length transaction, the value of the end-product when the resource is directly used in industrial activity, or the combination of these values. With respect to the first situation two problems are apparent. First, "total consideration" is not defined as a net or gross figure. Certainly arguments could be made for either case, and therefore this ambiguity should resolve before it inevitably results in litigation. Second, the term "arms-length transaction" unnecessarily complicates this section. A royalty should be assessed in any situation where value is received by sale, whether or not pursuant to an arms-length transaction. So long as the lessee receives consideration in exchange for his resource, a sale should exist. In this way, greater ease in administration results for both the Director and the lessee because the areas of possible argument are reduced.

Subpart B(2) attempts to cover the situation where the lessee makes a product (e.g. dried wood, electricity, or fish) from the geothermal resource and then sells it. However, the rule's language results in confusing application.

The first problem in this regard arises because Rule 8B(2) assesses a royalty as a percentage of the value of the end-product produced by way of the geothermal resource. On the other hand, subpart A(1) of Rule 8 states that a royalty is to be paid on 10% of the value of the "geothermal resources, or any other form of heat or energy derived." Since "end-product" and "resource" are not equivalent in meaning, a contradiction exists within the rule. (Note, that this contradiction is not resolved by referring to 8A(a) which defines a royalty or associated by-products since by-products are defined to be minerals or demineralized water under Rule 1.)

In addition, a problem arises from the use of the word "attributable." The fact that a royalty is to be paid on the "value of the end-product attributable to the geothermal resource produced from a particular lease" creates an incredibly complicated computation situation. Rule 8B(2) forces a determination of that portion of the value of end-product which results from the use of the geothermal energy without any guidelines. For example, if geothermal energy is used in a lumber plant to dry the wood, or to heat a florist's greenhouses, then the State is due 10% of that portion of the value of the wood or flowers which is "attributable" to the use of geothermal energy. If the "value attributable" was 15%, then the State would receive a royalty of 10% of 15% of the value of the flowers.

The practical result of the lessee of these ambiguities inherent in Rule 8 is that he should get a very exact understanding from the Director as to what royalty percentage will be assessed on it and on what it will be based, and how it will be computed before he begins production.

Rule 11 - Contiguous Land Leases and Conflicts

Subparts F and G of Rule 11 deal with the situation where there are conflicting lease applications with respect to contiguous land. These rules are complicated and difficult to understand. Therefore, they require a word of explanation.

Rule 11F concerns the situation where less than 1,280 acres (or 2 sections) are available for leasing. In this case, the lease is awarded as between two conflicting applicants to the one who holds the rights to explore and develop geothermal resources on lands having a common boundary of at least one-half of the total boundary of the land in dispute. However, the applicant claiming this right is obligated for a lease rental of two times the normal amount. Seemingly, the extra rent is considered a quid pro quo for the right to be guaranteed the lease on such lands.

Rule 11G covers the situation where the land in question is more than 1,280 acres. In that case, if there is a conflict upon all or some of said lands, the Director may block said lands and applications together for the purpose of selecting a single lessee. If the conflicts are not complete, the Director may require applicants in less than complete conflict to file additional applications to include contiguous State lands not the subject of their applications first filed, so as to create a complete conflict. If an applicant refuses to do so, his pending applications for said contiguous State lands will be denied. Once the competing applications are blocked together, a single applicant shall be selected by a public drawing.

As such, there are distinct differences between 11F and 11G. Rule 11F awards a priority or guarantees the lease to the applicant with a common boundary of more than one-half in return for twice the normal rent. If a qualifying applicant prefers not to pay twice the rent, then he must apply in a normal manner under normal rules and take his chances. On larger tracts of land, 11G allows the Director to force an interested applicant to bid on the entire parcel (not just the portion he was originally interested in), or not bid at all.

Seemingly, the effect and purpose of these rules is to discourage competitive development with respect to the same resource area and thereby inadvertently deplete the resource before its time. This is an admirable goal. However, for the result to be guaranteed the term" contiguous" should be better defined.

Rule 10 - Leasehold Limitations

Rule 10 prevents a person from acquiring an interest in a lease located in more than 50 townships and ranges within the State. This is a curious limitation. Most state leasing acts limit a person to a total number of acres statewide in an effort to prevent monopolization. Whether the purpose of Rule 10 is the same is unknown, but if it is, then a total acreage limitation would certainly be a more effective method of control.

C-6 LEGAL SCHEMATICS FOR GEOTHERMAL DEVELOPMENT

The following are outlines of the essential legal steps necessary for the development of geothermal resources. There are two outlines: one dealing with requirements as to geothermal leases administered by the Department of Lands; the other deals with the requirements pertaining to drilling for the resource which are governed by the Department of Water Resources.

It is important to realize that these outlines are intended to acquaint a potential developer with only the most important legal criteria which must be satisfied throughout various stages of development. They are not intended as a complete explanation of the pertinent law and should not be used as such. Therefore, any potential developer should and must consult the pertinent law in depth before actual development takes place. In addition, a developer may always call the respective agencies which administer the law for advice which is free.

Finally, please realize that the requirements of the leasing and drilling law must be separately satisfied. This is so despite the fact that many requirements appear to be overlapping. The authors have tried to point out those overlaps they felt to be important or particularly confusing.

Geothermal Resource Act

A. Application for Permit

1. Who can apply:

   Any person or legal entity who is an owner or operator who proposes to construct or alter a well or injection well. (See: 42-4003(1) as to technical requirements.)

2. Application must include technical information as to size and type of casing, plan for drilling, and maintenance of the well, etc. (See: 42-4003(a)(2) through (a)(6) for more specific information.)

3. Filing fee - $100.00 for a well, $50.00 for an injection well.

B. Exception to Permit Requirements

1. Any one proposing to use geothermal energy for a: greenhouse, hothouse, swimming pool, hot springs bath, fish propagation facility, space heating or similar facility may apply for a water right permit and not a geothermal permit, if:

   a. Such proposed uses were in existence on January 1, 1972, and

   b. So long as such operation is not in conjunction with any other geothermal use not listed above, and

   c. So long as owner or operator provides the Director of DWR with any data he may require.

2. Any category exempt by the Director according to rule or regulation. (See: 42-4003(d).)

C. Water Right Permit Requirement

Valid Water Right Permit is required if water yield from geothermal resource well is used for any beneficial purpose other than as a mineral source, energy source or as a material medium for the heat energy (e.g. agricultural, domestic or manufacture purpose).

D. Additional Permit

Additional Permit required if:

1. Drilling in an area designated by the DWR as a "geothermal area" and

2. Such well is drilled to a depth of 3,000 feet or greater.

NOTE: Designated geothermal area is not equivalent to KGRA of the Leasing Act. (See: 42-4003(f) for definition of "Geothermal Area" and see Rule 13 of Geothermal Resource Lease Regulations.)

E. Issuance of Permit

1. Permit issued after investigation by Director into such areas as owner's or operator's financial resource; potential interference with quality or quantity of vested water right or previous geothermal permit, or geothermal resource material medium.

2. A permit may be issued conditionaly, subject to limitation, or refused entirely.

3. a. If refused, applicant may appeal determination to Water Resources Board. Such Board may affirm, modify or reject Director's decision.

   b. Decision of Water Resource Board may be appealed to the District Court.

4. Bond Requirements:

   A bond of at least $10,000 is mandatory per well. NOTE: This bond is in addition to bonds required under leasing regulations. (See: Rule 26 of Geothermal Leasing Rules and Regulations.

F. Well Abandonment or Discontinuance of Operation

1. Plan to abandon with proposed method must be submitted to Director at least 5 days prior to proposed abandonment date.

2. Director may approve, disapprove or conditionally approve.

If disapproved or contionally approved, must set forth criteria to remove disability or conditions.

3. No person may commence operations to abandon a well without approval by the Director.

4. Within 5 days after abandonment must submit written report on all work done to accomplish abandonment. Director may accept or reject. Bond will not be released until abandonment is completed in accordance with Director's order.

Geothermal Leasing Regulations

A. File Application-pay fee of $25.00 (Rule 3,4,&5)

B. Aware of Lease:

   1. If land applied for has been declared a KGRA, then lease is awarded to the highest bidder pursuant to public hearing.

   2. If land applied for has not been declared a KGRA then lease is awarded to the first qualified applicant.

C. Term of Lease

   1. Primary term of 10 years (Rule 6). Lessee must diligently explore during the primary term (Rule 15).

   2. (a) Lessee must be diligently operating by end of 10 years for primary term to be extended. (Rule 6B)

      (b) May get 120 day extension of primary term for good cause. (Rule 6B)

   3. Extension of lease beyond primary term:

      (a) 40 years or so long as geothermal resources are produced in paying quantities (Rule 6C).

      (b) Second 40 years may be granted if production in paying quantities.

      NOTE: Lessee has the duty to diligently market if paying quantities present (Rule 6D)

      (c) Extension of lease for by-product production for five year period so long as they are produced in commercial quantities and there is no geothermal resource production (Rule 6E).

4. "Shut in Lease" - 5 year review made by Director to determine whether lessee has diligently attempted to acquire a contract to sell or to utilize production or is progressing with installations needed for production. If so, lease continues in full force for an additional five years.

D. Operational Requirements:

1. Rule 16:

(a) Lessee must use best practices of the industry (Rule 16).

(b) Requires detailed plan of operation before drilling wells in excess of 1,000 feet. (See Rule 26 as to Bonding requirements, see Rule 27 as to insurance needs.)

(c) Director may require surveys, tests or samples as to quality and quantity of resource.

(d) Each well must be marked, properly maintained and safely operated and abandoned with permission of Director according to Rule 16J and requirements of the Geothermal Resource Act.

2. Rule 17:

(a) Generally requires lessee to minimize waste, maximize recovery and protect the natural resources.

(b) Requires lessee to insure employee safety.

(c) Creates drilling and production obligations:

(1) Rule 6D requires lessee to use due diligence to market or utilize geothermal resources in paying quantities.

(2) Rule 17B requires lessee to diligently drill and produce such wells as are necessary to protect the state from loss by reason of production on other properties, or pay a sum that would compensate State for the loss, and to drill wells that a reasonably prudent operator would drill, or lessee must surrender lease.

(d) Allows determination of damages for failure to diligently drill, operate or prevent waste.

3. Rule 37:

Allows director to cancel lease for failure to comply with rules and regulations. Hearing provisions setforth in Rule 36.

4. Record keeping requirements, (Rules 18 and 19):

(a) Board inspection of records during business hours.

5. Abandonment (Rule 14F):

Reclamation of leased land must take place within one year of abandonment of any exploration site, well, road or trench in accordance with Sections 47-1509 and 1510, which must be consulted for their detailed provisions.

6. Water Rights:

(a) Rule 20 - Requires compliance with water law and surrender of all water rights obtained in conjunction with lease.

(b) Rule 17D - Defines demineralized water as a "by-product" and therefore lessee can be forced to produce potable water for sale.

(c) Rule 14E.1 - Potable water wells of no commercial value as a geothermal resource but capable of domestic or agricultural use may be acquired by the State or surface owner for the market value of the casing.

7. Bond Requirements - Rule 26:

(a) Amounts - $2,000.00 paid at time of execution of lease, no matter how many acres held under lease.

(b) Amount of $10,000, at time of drilling of well in excess of 1,000 feet, per well.

(c) "Blanket" State Bond of $50,000, "cover all lessee's leases and operations" throughout the State.

8 Insurance Requirements - Rule 27:

(a) Public liability and property damage and products liability insurance required.

(b) Amounts - $250,000/$500,000, per lease without any lowering or raising because of size for liability property damage, $100,000.

(c) Explosions and underground hazards insurance must be purchased before drilling below 1,000 feet.

(d) Surface owner and/or the State must be named insureds; special endorsement, as found in Rule 27, must be included within policy.

9. Surrender, Termination and Expiration of Lease (Rule 25)

(a) Voluntary Surrender:

(1) Voluntary surrender prior to expiration according to relinquishment procedures. NOTE - This may be partial surrender, i.e. surrender of only a portion of leasehold.

(b) Involuntary Surrender:

(1) For failure to pay rental fees on or before anniversary date; surrender is automatic without notice for lessee.

(2) For failure to correct violations of Rules or lease provisions after being given 60 days written notice.

(3) Rule 37 - Cancellation - Failure to exercise due diligence and care in the operations.

E. Rents and Royalties

1. Rents on Leases:

(a) $1.00 per acre per year for first 5 years of primary term; $2.00 per acre for second 5 years of primary term; $3.00 per acre thereafter during term of lease (Rule 7).

(b) Payment due to advance each year on or before the anniversary date, unless royalty production in process, wherein rental fee will be deducted from accured royalties on a monthly basis. (Rule 7)

(c) First year rental payment, a bond and an executed lease must be received within 30 days of notification of approval of lease application.

2. Royalties: Accrued as follows:

(a) 10% of value of sale or utilization of resource other lessee's operational use.

(b) 5% on sale or utilization of by-products other than lessee's operation use.

3. Royalties must be paid monthly.

4. Notification of discovery of resources must be made to Director within 15 days of the discovery or prior to removal or use of resources, whichever comes first.

5. Copies of contracts receipts of sale or utilization, total volumes of resource used, and royalty due the State must be filed monthly.

6. Overriding royalty interests: (Rule 10B and Rule 22). An overriding royalty cannot exceed a total of 5% per lease. (Note: Overriding royalties are used to calculate acreage limitations) To create such royalties there must be approval of Director.

F. Lease Size

1. Leases are limited to 540 acres per lease (Rule 9).

2. A single entity shall not hold, own or control directly or indirectly interest in Geothermal Resources in more than 50 Townships or Ranges whether title to surface rights is owned by the State of Idaho, see Rule 10 as to definition of holding.

3. No limitations on acreage statewide per legal entity. (Rule 9 and Rule 10.)

4. A lease may include more than 640 acres per lease if contiguous leased land is available and meets the requirements of Rule 11F and 11G, or if such lease is included in cooperative plans of development under Rule 23.

G. Unitization

1. Voluntary - No power of Director to force cooperative development.

2. Refer to Department of Water Resources power under S42-4013, Idaho Code, if applicable.

3. All leases are excepted from acreage limitations requirements under Rule 10.

4. All lease terms may be extended beyond time limitations provided in Rule 6C to the term of the Cooperative Agreement.

5. In lieu of separate bonds there is a unit bond requirement.

C-7 COOPERATIVE DEVELOPMENT OF GEOTHERMAL RESOURCES

Introduction

Cooperative development of geothermal resources is governed by Section 42-4013 of the Idaho Geothermal Resoruces Act and Rule 23 of Title 47, Chapter 16, Idaho Code pertaining to Geothermal Resource leases. Cooperative development of a resource is an idea borrowed directly from oil and gas law where it has spawned two specific procedures: unitization and pooling. Pooling is a joining of interests within a drilling and spacing unit to limit well location and number of drilling sites without regard to the oil pool as a natural physical entity. As such, although pooling reduces the number of competitive units within a pool because drilling units increase in size, competitive operations still exist between the enlarged units to the extent permitted by state law (Summers, Oil and Gas Law, 3951). Unitization, on the other hand, is an attempt to plan production of the pool without regard to property lines, but rather according to the idea that a resource pool is a natural energy mechanism unit. (Summers, supra, 1961). This means operations are gauged to drilling locations and rates of production that produce the most efficiency.

Discussion

Despite their different physical results, the legal consequences of pooling and unitization are largely the same. Therefore, we will use the terms interchangeably to signify the concept of centralized management of a resource pool for the purpose of greater efficiency. However, we will mostly be borrowing from the concept and purpose of unitization. As such, it would be beneficial to explore the basic geological concepts upon which unitization is based; concepts which are applicable to geothermal resources. (For a more complete discussion of this topic see "Unitization for Geothermal Resources: United We Save" by Dennis b. Goldstein).

In this regard, a resource pool behaves as a single physical unit. Whether existing as steam or hot water (in the case of geothermal resources), it has a natural rate of recharge both as to heat and fluid production. Thus, depending on how this energy mechanism is handled an engineer can produce desirable or undesirable results. This has been shown time and time again in the oil and gas industry where poor or decentralized field management, or high rates of production caused by competition or greed, have resulted in overly rapid depletion of the reservoir's resource and a resulting loss in natural production. By the same extent, geothermal resource reservoirs have an optimum fluid production rate which will result in the greatest amount of heat production. Production above this optimum rate will shorten the life of the well and decrease the amount of heat produced while rates below the optimum will result in less heat production but longer well life. In both extremes the economics of the project will be adversely effected. (See Goldstein, supra, quoting Robinson and Morse, A Study f the Effects of Various Reservoir Perimeters on the Performance of Geothermal Reservoirs.) Therefore, by gauging the rate of production and well spacing to the physics of the resource pool, and by being able to use techniques not otherwise available when a pool is disrupted by property lines, greater gain will result to all persons involved.

Finally to be considered is the economic benefit gained through cooperative development. A large number of operators pooling their financial resources can develop a better and more efficient facility on a dollar per dollar basis than could a single individual. This assures better profits and maximizes an operator's return over a shorter period of time.

Idaho Law Requirements

1. The Resource Plan

Section 42-4013 of the Idaho Geothermal Resources Act authorizes both voluntary and involuntary cooperative unit agreements. Voluntary cooperative agreements may be allowed between any of the working and royalty interest by the director within the same geothermal area "whenever (he) finds it is in the public interest and especially in the interest of the conservation of natural resources and of the protection of the geothermal resources from waste," and so long as there is Board approval. The purpose of the agreement is to bring about "the cooperative development, operation, and maintenance of all or a portion of the geothermal resources of the geothermal area as a unit; or for the purpose of fixing the time, location, and manner of drilling, operating, and maintaining of wells and injection wells."

By the same extent, "whenever the director finds that a geothermal resource area should be cooperatively developed as a unit to avoid waste, and the persons owning tracts or interests in such area refuse to enter into a cooperative agreement pursuant to (the procedure for voluntary agreements), the board, after notice and hearing, may issue an order that such area shall be operated as a unit. Such order (must provide for) an equitable sharing of proceeds and liabilities from the geothermal resource area among the several owners of tracts and interests therein."

In summary, the procedure under 42-4013 is to encourage voluntary unit agreements. If this can be achieved, the parties may organize into units that operate either as pooling or unitization units would in the oil and gas field. Also, voluntary units may be formed as to all or part of a geothermal area. However, should the Director decide that cooperative operations must occur to avoid waste, then presumably his office would initiate voluntary agreement negotiations, or use its mandatory powers as leverage in an already ongoing negotiation. If the persons owning interests in the affected area cannot agree to voluntarily cooperate, then the Board may issue an involuntary order after a hearing. Presumably, and unlike a voluntary agreement, involuntary cooperation applies to an entire geothermal area since the order must provide for an "equitable sharing of proceeds and liabilities from the geothermal resource area among the several owners." Although no specific procedures are stated guidelines for the operation of, and the equitable sharing within the involuntary unit, this language strongly suggests the concept of correlative rights. Therefore, procedures under Idaho's Oil and Gas Law, Title 47, Chapter 3, Idaho Code, would presumably be used for guidance.

2. The Leasing Plan

Since the State plan of control as to geothermal resources involves control of the land by way of lease, as well as control of the resource itself, Rule 23 of the Geothermal Resource Leasing statute (Title 47, Chapter 16, Idaho Code) authorizes "Unit or Cooperative Plans of Development or Operation" to avoid confusion. A plan of unitization is authorized with written consent of the Director of the Department of Lands who must certify that the same is necessary or adivsable in the public interest. To implement unitization, the Board of Land Commissioners may, with the consent of its lessees, modify and change any and all terms of leases which are committed to such unit plan. By the same extent, Rule 23 exempts these leases to acreage and term limitations. However, all owners of any right or interest in the goethermal resources to be developed "must be invited to join as parties to the agreement. If any owner fails or refuses to join the agreement, the proponent of the agreement (must) declare this to the Director and (must) submit evidence of efforts made to obtain joinder of such owner and the reasons for nonjoinder." Because Rule 23 does not exempt the parties from procurring the approval of the Department of Water Resources, these procedures are hopefully present as a logical compliment to the more stringent requirements of Section 42-4013, Idaho Code. If so, this would help explain the failure of Rule 23 to address voluntary and involuntary unitization despite the obligation to obtain joinder of all owners. If not, a lessee and resource owner is faced with the unenviable prospect of dealing with two different states attempting to control different aspects of development of a single resource.

Unitization As A Practical Tool

Unitization by way of a unit agreement can be an extremely practical tool in protecting interested parties from legal, economic and financial, and production problems. If not used effectively though, this same device can be the cause of severe disruptions to an operation.

In this regard one of the greatest drawbacks to private investment in and development of the geothermal resource industry is the high risk factor that is present with respect to the investment dollar and operating capital. Such risk results from many factors: industry's relative inexperience in producing and marketing this resoruce; the uncertainty of the public's acceptance of this form of energy; the unforseen technological problems that invariably exist in the infancy stage of any industry; and, the unforseen legal problems and issues that always develop when an industry initiates competition within itself to produce and market its new product.

As alluded to previously in the introduction, unitization is an aid to efficiency in production and in the use of available dollars. However, it is also valuable to help prevent the factors enumerated above. This is so because centralized management creates a greater source of resources and information than could otherwise be available to an owner on individual basis, and because it eliminates competition between individual owners within the same pool. In this regard, unitization could provide a data bank reflecting information of the resource pool as a whole. This would enable the unitized group to determine the true feasibility of their enterprise before implementation of production, without an otherwise relatively significant financial investment by each individual, and because the unit would be able to project a more realistic minimum rate of return. Once production was initiated, then the economic considerations of greater financial prowess through group contribution and more efficient operations because of centralized management would come into play.

By the same extent, unitization would be particularly helpful in preventing litigation. Idaho law in its present form creates substantial questions as to the relative rights of ownership as between geothermal users within the same geothermal area and as between geothermal users and water users, as well as how and under what conditions the state could involuntarily enforce cooperative development. Unitization would alleviate the need to decide the former questions between geothermal users and would help in establishing geothermal rights as against water rights.

The problem of state enforced unitization deserves a more detailed treatment. Unitization is a problem to a developer because the criterion used to establish the need for involuntary unitization are unclear, and because the procedures used to implement it are cumbersome. To understand the problem more fully consider this scenario: A group of developers within the same resource area have begun intense drilling and recovery operations. The smallest of the operators realizes that he does not have the resources to compete on an equal basis with the others and so begins voluntary unit agreement proceedings. Negotiations fail and so the smallest operator approaches the Director of the Department of Water Resources and argues that cooperative development must occur "to avoid waste" under 42-4013. He then demonstrates that the competitive drawn-down rate on the resource pool is such that the life of the reservoir could be enhanced by ten to twenty years with better well placement, less drilling sites, and a rate of recovery geared to the natural rate of recharge. The Director and the Board become convinced and enjoins all operations under Section 42-4010 (e), Idaho Code, of the Geothermal Resources Act. Negotiations again proceed and breakdown, and a hearing is held. The disgruntled looser appeals at all levels. Operations have been held up for years.

To avoid the above story, and to further enhance all the benefits of centralized management, the authors have concluded that mandatory unitization should be initiated with respect to any discovered resource area. If geothermal rights are quieted at the infancy stage of development, then a major risk to capital is eliminated. This could be accomplished by naming the State of Idaho as a party for parcels not yet leased and binding all successors and assignees. Further, diligent exploration requirements of the leasing rules could be ammended to be satisfied by a diligent attempt to reach a unit agreement.

The appraoch advocated above is not as drastic as it may first appear. Practically speaking, it accomplishes little more than a correlative rights approach already in use for oil and gas in Idaho and presently used in several other states haveing geothermal legislation. By so doing, an efficient operation, that protects the rights of all owners, and that invites investment of highrisk capital is ensured.

C-8 TECHNICAL ANALYSIS OF CURRENT GEOTHERMAL CASE LAW AFFECTING IDAHO

Introduction

This is an analysis of three leading cases in geothermal law. These three cases deal with the question of who owns the geothermal resource. All of these cases address the question of interpretation of the mineral reservation clause contained in a deed made and executed at a time when the existence of the geothermal resource was unknown. As such the courts in each case have been asked to interpret the meaning of such reservation clauses to determine whether a geothermal resource is to be considered a mineral, and thus reserved to the mineral estate, or a non-mineral and therefore reserved to the surface owner.

In their analysis of the deed reservation clauses, the courts are initially bound by real property law to determine whether or not the deed on its face is ambiguous as to the meaning and intent of the parties at the time of execution of such documents. It is evident, and will be clearly shown as each case is analyzed, that the mineral reservation clauses contained in the deeds to these three cases made no reference to a "geothermal resource." The courts then had little trouble making a determination that the deed on its face was ambiguous as to the intent of the parties on the question of the ownership of geothermal resources. Once the courts made this determination evidence outside the deed was presented to the courts in order to enable the courts to make a determination as to what was the intent of the parties at the time the deed was executed as to the ownership question of geothermal resources.

In analyzing these cases, it is important to realize that the factual situation surrounding these cases is just as important as the legal conclusions reached by each judge. Accordingly, all three cases deal with an area commonly known as the "geyser fields of California." The geothermal energy found in this area is the result of a naturally occurring phenomenon whose origin is the heat of the interior of the earth. The geothermal resources of the Geysers is due to a layer of molten material called magma which has risen from the interior of the earth to relatively shallow depths. This intrusion of hot magma expells gases and liquids which combine with ancient water trapped in the surrounding sediment to form a geothermal fluid or brine. This fluid converts to steam which circulates in a sedimentary formation and transports mineral and heat from the magma toward the surface. Convection currents cause water to rise and cool, forming a mineral shell of silica and calcium carbonate which seals off the magma intrusion from the surface. As such, a silica carbonate seal is formed. Below the seal circulates geothermal steam and other gases as well as boiling brine. The seal over the steam reservoir permits only a small amount of ground water to penetrate. The amount of this groundwater is insignificant compared to the volume of geothermal steam and brine; its penetration of the seal does not serve to materially deplete the supply of groundwater available for surface use. Thus it has been generally held in these cases that the groundwater system and the geothermal steam reservoir are separate and distinct. As such the following three cases are being discussed:

- United States vs. Union Oil Co. of California*
- Geothermal Kinetics vs. Union Oil Co. of California
- Pariani, et. al. vs. The State of California

These cases are included as Appendices D-9, D-10, and D-11 for the reader's reference.

Finally, before a detailed analysis of each case is given, it is important to realize that these cases do not interpret any statutory provisions dealing with geothermal resources, but only decide the limited question of who owns the resource.

Analysis

These three cases are important because they are the first cases in the country to deal with geothermal resources as a distinct entity. Accordingly these are trend setting cases whose judicial impact will be felt in Idaho. Exactly what sort of impact they will have is a matter of hypothesis, but a reasonably educated guess can be made based on the factual basis and the legal reasoning used by each court to arrive at the legal conclusions within each case. Possibly the most important case, as far as Idaho is concerned, is the Geothermal Kinetics case. This is so because the court established the use of the "functional approach" in analyzing the ownership of the geothermal resource.

Functional Approach

In this approach the court attempts to ascertain the intent of the parties at the time of the execution of the deed, based on the premise that the parties to a mineral lease or deed expect that the term "minerals" will include those substances which are extracted for a profit. On the other hand it is assumed that the surface estate was intended to include those substances which are necessary for the enjoyment and use of the surface land.

In light of the above test, the court considered the following five factors:

1. Whether the geothermal resource was the result of a geological formation separate and distinct from the surface groundwater system;

2. Whether the water or steam from the geothermal resource was too toxic, as a result of its mineral content, to allow domestic or agricultural use;

3. Whether the cost of drilling a geothermal well was prohibitive relative to surface use and benefit;

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* Geothermal Kinetics vs. Union Oil C9. of Cal., app. 141 Cal. rptr. 879, 88-881, 1970.

4. Whether the extraction of the mineral resource would involve destruction of the surface. (To explain this factor, the court relied upon Acker vs. Guinn (test. 1971) 464 S.W.dd 348, 351, in which iron ore was found to be a part of the surface estate due to the method of extraction, strip mining, which effectively consumed or depleted the surface estate. Note however, that Acker is a drastic example of interference with the surface states and future courts may not base their tests on total destruction, but merely on the presence of substantial interference.);

5. Whether the intent of the surface estate owners was to use the geothermal resource in a manner associated with surface use. This fifth factor was not enunciated by the court, but these authors feel that such a factor was inherent in the reasoning and final decision of the court. This conclusion is not only based on the flavor of the opinion, but on the fact that such argument was clearly and ably made by the respective parties in their briefs to the court. As such, the mineral owners argued to the court that the surface owner was interested only in the heat from the geothermal resource and therefore should be denied any right to such resource because they wanted only the energy which the water and steam carried and not the water and steam itself. This implies that the surface owner was more interested in the geothermal resource for its mineral content than for its value in maintaining the surface estate.

As seen from the case syllabus, based upon the evidence presented in Geothermal Kinetics, the court was able to answer each of the questions above in a way that allowed it to conclude that the geothermal resource was a part of the mineral estate. On the other hand, an Idaho court using these same factors may reach a contrary result based upon the characteristics of the Idaho geothermal resource. This is particularly so in light of the geological fingings in reference to the Boise front. In this regard, the material medium in which geothermal energy is found is water and not steam or mineral brine. Furthermore, this water has been found to have low mineral toxicity and is capable of being used for both domestic and agricultural purposes. There is also evidence that before this "hot water" reaches the surface it mixes with cold water ground aquifers, indicating a communication between the geothermal aquifer and the surface water system. In addition, the expense of drilling the geothermal wells in Idaho is not as great as the expense incurred in drilling the wells in the Geyser fields of California. This is so because the resource in Idaho is found at shallower depths and in a form that does not necessitate as complex a drilling system.*

In light of these factual differences, if the court in Idaho were to adopt the functional approach, they could easily find that a geothermal resource in the form of "hot water" is not a distinct geological entity, because it can be used for maintenance of the surface estate, and since it can be drilled in a fashion more akin to the drilling of water wells. Thus many of the compelling reasons for including the geothermal resource as part of the mineral estate in Geothermal Kinetics are lacking here in Boise. A valuable practical consideration derived from this analysis is that a potential geothermal resource user in Idaho should drill deep enough to alleviate a potential interference between the geothermal reservoir and the groundwater system.

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* Geological and hydrological expert supports.

Legislative Intent Approach

In both Union Oil and Parianni, the courts were interpreting a deed reservation clause which reserved the mineral estate to the sovereign. In analyzing the intent of the sovereign at the time of such execution, the courts placed great emphasis upon the legislative intent of the respective legislative bodies at the time of said transfer. This was done both by analyzing the legislative history as well as examining extrinsic evidence with regard to the meaning of the term "mineral" at the time of said execution.

With respect to Union Oil, the court therein felt the geothermal steam must be included as part of the mineral reservation because the intent of Congress was to reserve to the United States all energy sources. The conclusions reached in Union Oil may have impact in Idaho because of the existence of federally controlled lands upon which geothermal resources exist and which contain mineral reservations to the federal government. However, the effect of the conclusion in Union Oil is not as great as it might otherwise be, because of the form in which geothermal resources are found in Idaho, mainly "hot water." As shown above, hot water can be used to maintain the surface estate. As such, Idaho geothermal resources have a dual nature because they contain both thermal energy and a capability of surface use. That this dual nature, in effect, negates the energy sources conclusion arrived at by the 9th Circuit Court of Appeals, is something only time will tell.

Following in the footsteps of the Union Oil decision, Parianni uses a similar approach to interpret the state's statutory miner reservation clause, finding that the geothermal resources contained within the Geyser area were included within the mineral reservation clause and reserved to the state.

The state court, like the federal court before it, after determining that the intent of the parties could not be found on the face of the deed as to the ownership question of geothermal resources, and finding that California statutory definition of a mineral resource was applicable to the reservation clause in said deed, allowed extrinsic or parol evidence in interpreting the meaning of this clause in the deed. The court was very liberal in this regard and allowed extensive expert testimony, and numerous documents in deciding the definition of the term "mineral" within the reservation.

In analyzing the effect that this decision may have on Idaho, one should compare the Idaho Mineral Reservation Clause as codified in section 47-701 Idaho Code with the Reservation Clause of the State of California as enunciated in the Parianni decision. Section 47-701 Idaho Code in its pertinent parts, reads as follows:

> "47-701. Reservation of mineral deposits to state - Terms defined. The terms "mineral lands," "mineral," "mineral deposits," "deposit," and "mineral right," as used in this chapter, and amendments thereto shall be construed to mean and include all coal, oil, oil shale, gas, phosphate, sodium, asbestos, gold, silver, lead, zinc, copper, antimony and all other mineral lands, minerals or deposits of minerals of whatsoever kind or character. Such deposits in lands belonging to the state are hereby reserved to the state and are reserved from sale except upon a rental and royalty basis as herein provided,..."

The Idaho definition cited above seems to be broader in definition than the California statute as interpreted by the Court in Parianni. Even so, there is a possibility, in the State of Idaho, that the above mineral reservation clause would not include geothermal resources whether or not known to exist at the time the deed was executed. This position is supported on two fronts, (1) the long history, substantial strength, and important position that water law has held in the state of Idaho; and (2) the existing case law which has held the "hot" water for space heating purposes is deemed to be a beneficial purpose under Idaho water law.* In light of these two reasons, it could be ablely argued that at the time the mineral reservation statute was adopted in the state of Idaho it was well-settled that what was later to become known as "geothermal resources" was commonly believed and thought of as hot water, and therefore, not a substance akin to a mineral deposit.

On the other hand, the line of reasoning used by the court in Union Oil, that the Congress intended to reserve unto the sovereign all energy resources, could be persuasively used to interpret the Idaho state statute. In this regard, section 47-701 could be interpreted to reserve to the state, any and all substances which could either produce an energy source, such as oil or oil shale and coal, or could produce a profit such as gold and silver. As such, the Idaho judicial system would find itself on the horns of a dilemma, having to make a "policy decision" as to which approach to adopt in the state of Idaho.

Geological Characteristics Analysis

This particular approach becomes a "battle of the experts" in defining whether a geothermal resource is more akin to a "mineral" than any other type of geological entity. In arriving at this decision, the courts have relied upon expert opinion as to the similarities between "minerals" and geothermal resources by looking to historical geological formation, possible uses and functions, and the scientific characteristics of each substance group.

In all three cases whether using the court's approach explicitly or implicitly, have found, that a geothermal resource is scientifically akin to a "mineral." It is important to realize, however, that these interpretations have only been made with reference to the Geyser fields of California, wherein, the geothermal resource was found to be the end product of a distinct geological formative process. Therefore, it will be up to the geological experts in Idaho to determine whether or not Idaho's geothermal resources are more akin to a mineral or other substance.

Heat Is Not A Substance

This argument has been made by the surface owner in every case so far considered and is important for that reason alone. The essence of this argument is that the key element of a geothermal resource is the "heat energy" and not the material medium which conducts the heat energy. Therefore, it is argued by the surface owners, that a geothermal resource, unlike a mineral, has no physical substance and could not be a part of or classified as a mineral. Thus far, the courts have dismissed this argument. The courts look more to the intended use of the resource, its physical characteristics, the intent of the parties at the time

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* Natatorium case and others.

of the execution of the deeds, and the fact that the distinguishing characteristic of the resource is its thermal energy.

Conclusion

In analysing these cases, it must again be emphasized that the existing case law is based upon factual circumstances wherein pre-existing deeds are being interpreted as to their intended meaning at a time when the geothermal resource was unknown and prior to the enactment of any geothermal resource acts. To avoid the problems that these cases address themselves to, any and all transfers of real property within the state of Idaho should explicitly reserve to the grantor or accept in the transfer the geothermal resources if such is the intent. Unless the geothermal resource is specficially set out in a reservation or exception clause, it will endow to the grantee.

It is also important, in analyzing the effect of these cases on Idaho, to realize that the physical characteristic of the resource as enunciated in these three California based cases is completely separate and distinct with reference to the physical characteristics of the resource as found in the State of Idaho. Therefore, the import of the above cases is the fact that the courts have enunciated certain "approaches" which may be used by the Idaho courts in their reasoning with regard to such problems. Furthermore, these approaches are more than likely to be used in some combination to affort the court a balanced perspective in arriving at its conclusion.

Note: When interpreting a deed which was entered into between two individuals and in which no state or federal entity is involved, the functional approach is probably the most appropriate since that type of "private" deed does not have any legislative history to interpret.

75 Cal.App.3d 56

56 GEOTHERMAL KINETICS, INC., a Nevada Corporation, Plaintiff and Respondent,

v.

UNION OIL COMPANY OF CALIFORNIA et al., Defendants and Appellants.

Civ. 40447.

Court of Appeal, First District, Division 3.

Nov. 15, 1977.

Hearing Denied Jan. 26, 1978.

The owners of the surface estate appealed from a judgment entered in the Superior Court, County of Sonoma, Kenneth M. Eyman, J., quieting title to the geothermal steam and power and geothermal resources in owner of the mineral estate. The Court of Appeal, Scott, Acting P. J., held that absent any expressed specific intent to contrary, the general grant of minerals in, on or under the property included a grant of geothermal resources, including steam therefrom, even if the presence of geothermal resources may not have been known to one or both of parties to the conveyance.

Judgment affirmed.

Mines and Minerals ⇔55(5)

Absent any expressed specific intent to contrary, the general grant of minerals in, on or under the property included a grant of geothermal resources, including steam therefrom, even if the presence of geothermal resources may not have been known to one or both of parties to the conveyance. West's Ann.Public Resources Code, § 3700 et seq.; West's Ann.Civ.Code, § 829.

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Fitzgerald & von der Mehden, John D. Fitzgerald, Santa Rosa, for plaintiff and respondent.

Evelle J. Younger, Atty. Gen., N. Gregory Taylor, Asst. Atty. Gen., Dennis M. Eagan, Deputy Atty. Gen., San Francisco, for amicus curiae in support of respondent Geothermal Kinetics, Inc.

SCOTT, Acting Presiding Justice. 58

The issue presented here is whether geothermal resources belong to the owner of the mineral estate or the owner of the surface estate. We conclude that the general grant of minerals in, on or under the property includes a grant of geothermal resources, including steam therefrom.

The owners of the surface estate, Union Oil Company of California, Magma Power Company, Thermal Power Company, and George and Hazel Curry, appeal from a judgment quieting title to the geothermal steam and power and geothermal resources in Geothermal Kinetics, Inc., the owner of the mineral estate. The subject of this action is a geothermal resource existing beneath the surface of approximately 408 acres of property located in an area of Sonoma County known as "The Geysers."

Geothermal Kinetics derives its title from a 1951 deed wherein the owners of the property conveyed to Geothermal Kinetics' predecessor in interest "all minerals in, on or under" the property. George and Hazel Curry succeeded to the surface estate and in 1963 leased to Magma and Thermal (who subsequently assigned a portion of their lease to Union Oil) the right to "drill for, produce, extract, remove and sell steam and steam power and extractable minerals from, and utilize, process, convert and otherwise treat such steam and steam power upon, said land, and to extract any extractable minerals."[1] At the time of execution of the lease, the Currys, the surface fee holders, apparently believed they owned the mineral rights. Geothermal Kinetics, however, has the only valid mineral lease. Therefore, appellants rely solely on their interest in the surface estate for the right to the geothermal resources. In 1973, Geothermal Kinetics, as holder of the leasehold of the mineral estate, drilled a geothermal well on the property at a cost of approximately $400,000.

I. Appellants' primary contention is that geothermal energy is not a mineral; they argue that the resource is not steam, rocks or the underground reservoir but the heat transported to the surface by means of steam. A mineral, appellants claim, must have physical substance and heat is merely a property of a physical substance. In sup-
59 port of this contention, appellants cite several definitions of "mineral" containing reference to "substance." Appellants then reason that because they own everything in the property except for "mineral" substances, they own the geothermal resources, citing Civil Code section 829 which provides: "The owner of land in fee has the right to the surface and to everything permanently situated beneath or above it."

Respondent contends that since the parties did not specify particular minerals that were intended to be within the scope of the grant nor include any limitations on it, the grant conveyed the broadest possible estate. It urges that the "grant is to be interpreted in favor of the grantee." (Civ.Code, § 1069.) Respondent urges that we not adopt a mechanistic approach based upon textbook definitions of the term mineral; instead we should adopt a "functional" approach which focuses upon the purposes and expectations generally attendant to mineral estates and surface estates. Since normally the owner of the mineral estate seeks to extract valuable resources from the earth, whereas the surface owner generally desires to utilize land and such resources as are necessary for his enjoyment of the land, the geothermal resources should follow the mineral estate. We agree with respondent's contention.

II. Geothermal resources have been used commercially for several centuries, including their use to generate electricity in the early 1900s. In the United States, exploration and utilization of such resources has occurred generally in the western part of the nation, particularly in California. Commercial development of The Geysers area near Santa Rosa began in 1955 with the successful drilling of four wells. In 1960, Pacific Gas & Electric Company opened an electrical generating plant at The Geysers using the geothermal steam to power the generating turbines. Geothermal steam from respondent's well is piped to the P.G.&E. plant located about a mile away.

Geothermal energy is a naturally occurring phenomenon whose origin is the heat of the interior of the earth. The geothermal resources of The Geysers is apparently due to a layer of molten or semi-molten rock, called "magma," which has risen from the interior of the earth to a depth of 20,000 to 30,000 feet. Above this mass of magma, which constitutes the basic heat source for the area, are protuberances of magma called "plugs" or "stocks," which may rise within 10,000 to 15,000 feet of the surface of the earth. This intrusion of hot magma expels gases and liquids which combine with ancient water trapped in the surrounding sediment to form a geothermal fluid or brine. This fluid converts to steam which 60
circulates in a sedimentary formation and transports mineral and heat from the magma toward the surface. Convection currents cause water to rise and cool, forming a mineral shell of silica and calcium carbonate which seals off the magma intrusion from the surface. This shell is approximately 1000 feet thick in the area of re-

1. There is no contention here that appellants derived their title from the U.S. Government; therefore, the holding of *United States v. Union Oil Co. of California* (9th Cir. 1977) 549 F.2d 1271, cert. den. —— U.S. ——, 98 S.Ct. ——, 53 L.Ed.2d ——, wherein the U.S. Government was deemed to retain the right to geothermal resources by virtue of its reserving mineral rights to the patented property, is not dispositive of the present appeal.

spondent's well. Immediately below this silicacarbonate seal is circulating geothermal steam and other gases; below these gases is boiling brine.

The seal over the steam reservoir permits only a small amount of ground water to penetrate. The amount of this ground water is insignificant compared to the volume of geothermal steam and brine; its penetration of the seal does not serve to materially deplete the general supply of ground water available for surface use. Hence, the ground water system and the geothermal steam reservoir are separate and distinct. Some geothermal steam escapes from the reservoir to the earth's surface through cracks in the silicacarbonate seal.

At The Geysers wells drilled through the silicacarbonate seal bring geothermal steam to the surface. Respondent's well is approximately 7,200 feet deep. The extracted hot steam, which contains minerals, powers steam turbines to produce commercially valuable electric power. The minerals in the condensed steam are generally toxic, requiring the reinjection of this water back below the silicacarbonate seal. Purification of the condensed steam so as to render it safe for agricultural or domestic purposes is not economically feasible. Geothermal resources are not necessary or useful to surface owners, other than as a source of electricity. The utilization of geothermal resources does not substantially destroy the surface of the land. The production of the energy from geothermal energy is analogous to the production of energy from such other minerals as coal, oil and natural gas in that substances containing or capable of producing heat are removed from beneath the earth. In fact, the wells used for the extraction of the steam are similar to oil and gas wells.

III. In the construction of a grant or reservation of an interest in real property, a court seeks to determine the intent of the parties, giving effect to a particular intent over a general intent. (Civ.Code, §§ 1066, 1636; Code Civ.Proc., § 1859.) In the present case, the 1951 grant of mineral rights makes no specific mention of geothermal resources; hence, the general intent of the parties must be ascertained. In the absence of an expressed specific intent, several courts have sought to determine the general intent of the parties in construing the word⌊"mineral" in a deed, rather than ⌊61 resort to attempts at rigid definition. (See *United States v. Union Oil Co. of California* (9th Cir. 1977) 549 F.2d 1271, 1274, fn. 7; *Northern Natural Gas Co. v. Grounds* (10th Cir. 1971) 441 F.2d 704, 714, cert. den. (1971) 404 U.S. 951, 92 S.Ct. 268, 30 L.Ed.2d 267; *Acker v. Guinn* (Tex.1971) 464 S.W.2d 348, 352.)

Initially, we observe that "as a general rule a grant or reservation of all minerals includes all minerals found on the premises whether or not known to exist." (*Renshaw v. Happy Valley Water Co.* (1952) 114 Cal.App.2d 521, 526, 250 P.2d 612, 615.) Thus, the fact that the presence of geothermal resources may not have been known to one or both parties to the 1951 conveyance is of no consequence.

Generally, the parties to a conveyance of a mineral estate expect that the enjoyment of this interest will not involve destruction of the surface. (See *Bambauer v. Menjoulet* (1963) 214 Cal.App.2d 871, 872–873, 29 Cal.Rptr. 874; but see *Yuba Inv. Co. v. Yuba Consol. Gold Fields* (1920) 184 Cal. 469, 194 P. 19; *Trklja v. Keys* (1942) 49 Cal.App.2d 211, 212, 121 P.2d 54.) In *Acker v. Guinn* (Tex.1971) 464 S.W.2d 348, 351, the deed of "oil, gas and other minerals in and under" the property did not convey an interest in the iron ore. The court observed that the parties to a mineral lease or deed usually think of the mineral estate as including valuable substances that are removed from the ground by means of wells or mine shafts, but "a grant . . . of minerals . . . should not be construed to include a substance that must be removed by methods that will, in effect, consume or deplete the surface estate." (At p. 352.)

Here, the trial court found that the exploitation of geothermal resources does not substantially destroy the surface of the property. Wells for the extraction of the energy of geothermal steam are similar to those wells used in drilling for oil. Appellant Union Oil Company apparently considered the development of geothermal resources to be a natural extension of their oil and gas drilling operations. The court found that the production of energy from geothermal resources is analogous to the production of energy from such other mineral resources as coal, oil and natural gas in that materials containing energy are extracted from the earth and transported to facilities where this energy is transformed into electrical energy.[2] The fact that extracted coal, oil and natural gas ⊥62 contain chemical energy while geothermal resources contain thermal energy is not significant; uranium ore is not denied the status of a mineral because it contains nuclear energy instead of chemical energy.

The parties to the 1951 grant had a general intention to convey those commercially valuable, underground, physical resources of the property. They expected that the enjoyment of this interest would not destroy the surface estate and would involve resources distinct from the surface soil. In the absence of any expressed specific intent to the contrary, the scope of the mineral estate, as indicated by the parties' general intentions and expectations, includes the geothermal resources underlying the property.

In *United States v. Union Oil Co. of California, supra,* 549 F.2d 1271, the court, dealing with other property in The Geysers area, interprets mineral reservations of "all the coal and other minerals" in patents issued under the Stock-Raising Homestead Act of 1916 to include geothermal resources underneath the patented land (at p. 1273). Although the basis for the holding is partly the Congressional intent to retain government control over energy resources, the court stated that "the words of the mineral reservation in the Stock-Raising Homestead Act clearly are capable of bearing a meaning that encompasses geothermal resources" (at p. 1274). The court further noted that "all of the elements of a geothermal system —magma, porous rock strata, even water itself—may be classified as 'minerals' " (at p. 1273). Also, in *Reich v. Commissioner of Internal Revenue* (1969) 52 T.C. 700, affd. (9th Cir. 1972) 454 F.2d 1157, wherein the Tax Court concluded that the geothermal steam at The Geysers was a gas for purposes of the oil and gas depletion allowance in the Internal Revenue Code, the court rejected the contention that heat, not gas, was being produced at The Geysers.

The cases cited by appellants involving the ownership of geologic formations, are readily distinguishable. *Emeny v. United States* (1969) 412 F.2d 1319, 188 Ct.Cl. 1024, holds that the owner of oil and gas leases did not have a right to use an underground geologic structure on the leased property to store helium gas produced elsewhere; the case deals only with the ownership of a geologic formation having value as a storage facility, and not an extractable commercially valuable resource. Contrary to appellants' suggestion, *Edwards v. Sims* (1929) 232 Ky. 791, ⊥63 24 S.W.2d 619 is silent as to the ownership of underground geologic structures where the mineral and surface estates are severed. *Edwards* states that the owner of property is entitled to the free and unfettered control of his land above, upon and below the surface "unless there has been a division of the estate" (24 S.W.2d at p. 620).

Several courts have held that the grant or reservation of a mineral estate does not include rights to surface or subsurface water. (See *Fleming Foundation v. Texaco* (Tex.App.1960) 337 S.W.2d 846; *Mack Oil Co. v. Laurence* (Okl.1964) 389 P.2d 955.)

2. The first California legislation, in 1965, enacting a statutory scheme for the regulation of geothermal resources was made a part of Division Three of the Public Resources Code (§ 3700 et seq.), which is entitled "Oil and Gas." The Geothermal Resources Act of 1967, relating to the leasing of public lands for the extraction of geothermal resources, is also located in the Public Resources Code in Division Six dealing with "Oil and Gas and Mineral Leases." It can be inferred from the placement of these statutes that the Legislature viewed geothermal resources as a mineral.

However, such cases concern water that is part of the normal ground water system. As the trial court found, the water and steam components of geothermal resources are part of a separate water system cut off from these surface and subsurface waters by a thick mineral cap. Only insignificant amounts of ground water enter the geothermal water system. Unlike the surface and subsurface waters, the origin of geothermal water is not rainfall, but water present at the time of the formation of the geologic structure. Because rainfall does not replenish geothermal water, it is a depletable deposit. (See *Reich v. Commissioner of Internal Revenue* (1969) 52 T.C. 700, affd. (9th Cir. 1972) 454 F.2d 1157.)

Not only is there a sound geologic basis for distinguishing between the usual ground water system and geothermal waters, but the rationale for recognizing the rights of the surface estate to these ground waters is largely inapplicable to geothermal waters. (See Bjorge, *The Development of Geothermal Resources and the 1970 Geothermal Steam Act—Law in Search of Definition* (1974) 46 U.Colo.L.Rev. 1, 22–23; *United States v. Union Oil Co. of California, supra,* 549 F.2d at p. 1280, fn. 21; Olpin, *The Law of Geothermal Resources* (1968) 14 Rocky Mt. Min. L.Inst. 123, 140–141.) Several of the cases cited by appellants in support of the proposition that the surface estate includes rights to surface and subsurface waters, refer to the necessity of this water for the enjoyment of the surface estate. (See *Mack Oil Co. v. Laurence, supra,* 389 P.2d at p. 961; *Vogel v. Cobb* (Okl.1943) 141 P.2d 276, 280.) In the present case, the extraction of geothermal water for a domestic water source is impractical; the cost of respondent's well was approximately $400,000. In addition, geothermal water contains toxic minerals making it unfit for surface, agricultural or domestic use. Purification is not economically feasible. The water is so toxic that the Water Quality Control Board requires its reinjection deep into the earth. The analysis leading to the conclusion that geothermal resources are part of the mineral estate also leads to the conclusion that geothermal water is ⊥64 a mineral and thus, not part of the waters included in the surface estate. Recognition of rights of the owner of the surface estate to geothermal water would mean that resources consisting of hot rock without any fluid system belong to the mineral estate while fluid geothermal systems, like that in the present case, would be subject to a divided ownership with the surface estate owner having an interest in the water, and the mineral estate owner having an interest in any commercially valuable dissolved minerals. The difficulties of determining the type of system or systems on a particular property, as well as the confusion and complexity attendant to such an approach, are clear.

Examining both the broad purpose of the 1951 conveyance of the mineral estate and the expected manner of enjoyment of this property interest, it appears that the rights to the geothermal resources are part of the grant. A principal purpose of this conveyance was to transfer those underground physical resources which have commercial value and are not necessary for the enjoyment of the surface estate. (See *Western Development Co. v. Nell* (1955) 4 Utah 2d 112, 288 P.2d 452, 455.) The trial court correctly determined that the mineral grant herein conveyed to respondent the right to the geothermal resources located in, on or under the property in question.

Judgment is affirmed.

FEINBERG and DRAPER (Retired Presiding Justice of the Court of Appeal, assigned by the Chairperson of the Judicial Council), JJ., concur.

Hearing denied; MOSK, J., dissenting.

UNITED STATES OF AMERICA,
Plaintiff-Appellant,

v.

UNION OIL COMPANY OF CALIFORNIA et al., Defendants-Appellees.

No. 74-1574.

United States Court of Appeals,
Ninth Circuit.

Jan. 31, 1977.

Rehearing and Rehearing En Banc
Denied March 23, 1977.

United States brought quiet title action under the Geothermal Steam Act of 1970 to determine whether the mineral reservation in patents issued under the Stock-Raising Homestead Act of 1916 reserved to the United States geothermal resources underlying the patented lands. The United States District Court for the Northern District of California, George B. Harris, J., 369 F.Supp. 1289, granted the patentees' motion to dismiss and the United States appealed. The Court of Appeals, Browning, Circuit Judge, held that the mineral reservation in the patents reserved to the United States geothermal resources underlying the patented lands.

Reversed and remanded.

1. Public Lands ⇐35(5)

Mineral reservation in patents issued under Stock-Raising Homestead Act of 1916 reserved to United States geothermal resources underlying the patented lands. Geothermal Steam Act of 1970, § 21(b), 30 U.S.C.A. § 1020(b); Stock-Raising Homestead Act, § 9, 43 U.S.C.A. § 299.

2. Public Lands ⇐35(5)

In imposing mineral reservation upon land grants under Stock-Raising Homestead Act of 1916, Congress meant to retain governmental control of subsurface fuel resources, appropriate for purposes other than stock raising or forage farming. Stock-Raising Homestead Act, § 9, 43 U.S.C.A. § 299.

3. Public Lands ⇐35(5)

Patentee under Stock-Raising Homestead Act of 1916 receives title to all rights in land not reserved. Stock-Raising Homestead Act, § 9, 43 U.S.C.A. § 299.

4. Public Lands ⇐35(5)

Mineral reservation in Stock-Raising Homestead Act of 1916 is to be read broadly in light of agricultural purpose of grant itself, and in light of Congress' equally clear purpose to retain subsurface resources, particularly sources in energy, for separate disposition and development in public interest. Stock-Raising Homestead Act, § 9, 43 U.S.C.A. § 299.

5. Statutes ⇐219(1)

Contemporaneous construction by administrators who participated in drafting statute is entitled to great weight in interpreting statute.

John E. Lindskold, Atty., Dept. of Justice (argued), Washington, D. C., for plaintiff-appellant.

Dennis B. Goldstein, Deputy Atty. Gen., State of Cal. (argued), San Francisco, Cal., as amicus curiae for plaintiff-appellant.

David J. Wynne, Brobeck. Phleger and Harrison, George B. White (argued), San Francisco, Cal., for defendants-appellees.

Before BROWNING and WALLACE, Circuit Judges, and TURRENTINE,* District Judge.

BROWNING, Circuit Judge.

This is a quiet title action brought by the Attorney General of the United States pursuant to section 21(b) of the Geothermal Steam Act of 1970, 30 U.S.C. § 1020(b), to determine whether the mineral reservation in patents issued under the Stock-Raising Homestead Act of 1916, 43 U.S.C. § 291 *et seq.*, reserved to the United States geothermal resources underlying the patented lands. The district court held that it did not. 369 F.Supp. 1289 (N.D.Cal.1973). We reverse.

Various elements cooperate to produce geothermal power accessible for use on the surface of the earth. Magma or molten rock from the core of the earth intrudes into the earth's crust. The magma heats porous rock containing water. The water in turn is heated to temperatures as high as 500 degrees Fahrenheit. As the heated water rises to the surface through a natural vent, or well, it flashes into steam.[1]

Geothermal steam is used to produce electricity by turning generators. In recom-

* Honorable Howard B. Turrentine, United States District Judge, Southern District of California, sitting by designation.

1. *Reich v. Commissioner, of Internal Revenue,* 52 T.C. 700, 704–05 (1969), *aff'd,* 454 F.2d 1157 (9th Cir. 1972); H.R.Rep. No. 91–1544, 91st

mending passage of the Geothermal Steam Act of 1970, the Interior and Insular Affairs Committee of the House reported: "[G]eothermal power stands out as a potentially invaluable untapped natural resource. It becomes particularly attractive in this age of growing consciousness of environmental hazards and increasing awareness of the necessity to develop new resources to help meet the Nation's future energy requirements. The Nation's geothermal resources promise to be a relatively pollution-free source of energy, and their development should be encouraged." H.R.Rep. No. 91-1544, 91st Cong., 2d Sess., *reprinted at* 3 U.S.Code Cong. & Admin.News 5113, 5115 (1970).

Appellees are owners, or lessees of owners, of lands in an area known as "The Geysers" in Sonoma County, California. Beneath the lands are sources of geothermal steam. Appellees have developed or seek to develop wells to produce the steam for use in generating electricity. The lands were public lands, patented under the Stock-Raising Homestead Act. All patents issued under that Act are "subject to and contain a reservation to the United States of all the coal and other minerals in the lands so entered and patented, together with the right to prospect for, mine, and remove the same." Section 9 of the Act, 43 U.S.C. § 299. The patents involved in this case contain a reservation utilizing the words of the statute.[2] The question is whether the right to produce the geothermal steam passed to the patentees or was retained by the United States under this reservation.

[1] There is no specific reference to geothermal steam and associated resources in the language of the Act or in its legislative history. The reason is evident. Although steam from underground sources was used to generate electricity at the Larderello Field in Italy as early as 1904,[3] the commercial potential of this resource was not generally appreciated in this country for another half century. No geothermal power plants went into production in the United States until 1960.[4] Congress was not aware of geothermal power when it enacted the Stock-Raising Homestead Act in 1916; it had no specific intention either to reserve geothermal resources or to pass title to them.

It does not necessarily follow that title to geothermal resources passes to homesteader-patentees under the Act. The Act reserves to the United States "all the coal and other minerals." All of the elements of a geothermal system—magma, porous rock strata, even water itself[5]—may be classi-

Cong., 2d Sess., *reprinted at* 3 U.S.Code Cong. & Admin.News 5113, 5114 (1970); Brooks, *Legal Problems of the Geothermal Industry*, 6 Nat.Resources J. 511, 514–15 (1966); Barnea, *Geothermal Power*, Scientific American, Jan. 1972, at 70, 74.

2. The reservation reads:

> Excepting and reserving, however, to the United States all coal and other minerals in the lands so entered and patented, together with the right to prospect for, mine, and remove the same pursuant to the provisions and limitations of the Stock-Raising Homestead Act.

See 43 C.F.R. § 3814.2(a) (1976).

3. Brooks, *supra* note 1, at 512; Barnea, *supra* note 1, at 71.

4. Barnea, *supra* note 1, at 70. *See* H.R.Rep. No. 91-1544, *supra* note 1, at 5115.

5. *Hathorn v. Natural Carbonic Gas Co.*, 194 N.Y. 326, 87 N.E. 504, 508 (1909); H.R.Rep. No. 91-1544, *supra* note 1, at 5126–27 (letters from Dep't of Interior); A. Ricketts, *American Mining Law* 64, 70 (4th ed. 1943); *Webster's Third Int'l Dictionary* 1437 (1961); 13 *The New Int'l Encyclopedia* 537 (Gilman, Peck, & Colby ed. 1913); 10 *The Americana* (1907-08) (unpaginated article on mineralogy includes water as mineral). *See* Kuntz, *The Law Relating to Oil & Gas in Wyoming*, 3 Wyo.L.J. 107, 109 (1949).

Moreover, geothermal steam has been held to be a "gas." *Reich v. Commissioner of Internal Revenue*, 52 T.C. 700, 710-11 (1969), *aff'd*, 454 F.2d 1157 (9th Cir. 1972). *See Geothermal Exploration in the First Quarter Century* 185, 187 (Geothermal Resources Council 1973) (letter from George R. Wickham, Ass't Comm'r, Dep't of Interior, July 8, 1924—natural gas is a mineral within purview of mining laws).

No one contends that water cannot be classified as mineral. Appellees argue only that the water should not be included in the term "minerals" in this statutory setting. This is basically a question of legislative intent, dealt with in detail later in the text. To the extent that the argument rests on the meaning of the word fied as "minerals." When Congress decided in 1970 to remove the issue from controversy as to future grants of public lands, it found it unnecessary to alter the language of existing statutory "mineral" reservations. It simply provided that such reservations "shall hereafter be deemed to embrace geothermal steam and associated geothermal resources." Geothermal Steam Act of 1970, 30 U.S.C. § 1024.[6] Thus, the words of the mineral reservation in the Stock-Raising Homestead Act clearly are capable of bearing a meaning that encompasses geothermal resources.

The substantial question is whether it would further Congress's purposes to interpret the words as carrying this meaning. The Act's background, language, and legislative history offer convincing evidence that Congress's general purpose was to transfer to private ownership tracts of semi-arid public land capable of being developed by homesteaders into self-sufficient agricultural units engaged in stock raising and forage farming, but to retain subsurface resources, particularly mineral fuels, in public ownership for conservation and subsequent orderly disposition in the public interest. The agricultural purpose indicates the nature of the grant Congress intended to provide homesteaders via the Act; the purpose of retaining government control over mineral fuel resources indicates the nature of reservations to the United States Congress intended to include in such grants. The dual purposes of the Act would best be served by interpreting the statutory reservation to include geothermal resources.[7]

Events preceding the enactment of the Stock-Raising Homestead Act contribute to an understanding of the intended scope of the Act's mineral reservation. Prior to 1909, public lands were disposed of as either wholly mineral or wholly nonmineral in character. *United States v. Sweet,* 245 U.S. 563, 567–68, 571, 38 S.Ct. 193, 62 L.Ed. 473 (1918). This practice led to inefficiencies and abuses. In 1906 and again in 1907, President Theodore Roosevelt pointed out that some public lands were useful for both

itself, however, the government is entitled to have the ambiguity resolved in its favor under "the established rule that land grants are construed favorably to the Government, that nothing passes except what is conveyed in clear language, and that if there are doubts they are resolved for the Government, not against it." *United States v. Union Pac. R.R.,* 353 U.S. 112, 116, 77 S.Ct. 685, 687, 1 L.Ed.2d 693 (1957). *See Caldwell v. United States,* 250 U.S. 14, 20, 39 S.Ct. 397, 63 L.Ed. 816 (1919); *Southern Idaho Conf. Ass'n of Seventh Day Adventists v. United States,* 418 F.2d 411, 415 n.8 (9th Cir. 1969).

Appellees argue that the term "minerals" is to be given the meaning it had in the mining industry at the time the Act was adopted, and that this understanding excluded water. This is a minority rule. *United States v. Isbell Constr. Co.,* 78 Interior Dec. 385, 390–91 (1971), even as applied to permit conveyances. 1 American Law of Mining § 3.26, at 551–53 (1976).

6. Members of the Subcommittee on Mines and Mining of the House Committee on Interior and Insular Affairs went to some lengths to make it clear that whether the term "minerals" as used in prior legislation included geothermal resources was a question for the courts, on which the official position of the 89th Congress was one of neutrality. *See* Hearings on H.R. 7334 *et al.* on Disposition of Geothermal Steam, 89th Cong., 2d Sess., ser. 89–35, pt. II, at 295–96 (1966). The point made here, however, is that in fact Congress thought the term sufficiently broad to encompass such resources.

7. The Stock-Raising Homestead Act "define[s] the estates to be granted in terms of the intended use . . . . The reservation of minerals to the United States should therefore be construed by considering the purposes both of the grant and of the reservation in terms of the use intended." 1 *American Law of Mining* § 3.26, at 552 (1976). *Accord, United States v. Isbell Constr. Co.,* 78 Interior Dec. 385, 390 (1971). *See also United States v. Union Pac. R.R.,* 353 U.S. 112, 77 S.Ct. 685, 1 L.Ed.2d 693 (1957); *Caldwell v. United States,* 250 U.S. 14, 21, 39 S.Ct. 397, 63 L.Ed. 816 (1919).

A similar approach has been taken in construing grants and reservations in deeds between private parties involving minerals. *See, e. g., Northern Natural Gas Co. v. Grounds,* 441 F.2d 704, 714 (10th Cir. 1971); *Acker v. Guinn,* 464 S.W.2d 348, 352 (Tex.1971). The "general intent [of the parties] should be arrived at, not by defining and re-defining the terms used, but by considering the *purposes* of the grant or reservation in terms of manner of enjoyment intended in the ensuing interests." Kuntz, *The Law Relating to Oil & Gas in Wyoming,* 3 Wyo.L.J. 107, 112 (1949) (emphasis in original).

agriculture and production of subsurface fuels, and that these two uses could best be served by separate disposition of the right to utilize the same land for each purpose. The President called the attention of Congress "to the importance of conserving the supplies of mineral fuels still belonging to the Government." 41 Cong.Rec. 2806 (1907). To that end, the President recommended "enactment of such legislation as would provide for title to and development of the surface land as separate and distinct from the right to the underlying mineral fuels in regions where these may occur, and the disposal of these mineral fuels under a leasing system on conditions which would inure to the benefit of the public as a whole." *Id.*[8]

In 1909 the Secretary of the Interior returned to the same theme, arguing that "inducements for much of the crime and fraud, both constructive and actual, committed under the present system can be prevented by separating the right to mine from the title to the soil. The surface would thereby be open to entry under other laws according to its character and subject to the right to extract the coal. The object to be attained in any such legislation is to conserve the coal deposits as a public utility and to prevent monopoly or extortion in their disposition." 1909 Dep't Interior Ann. Rep. pt. I, at 7 (emphasis omitted).[9] The Secretary made the same suggestion with respect to "oil and gas fields in the public domain." *Id.*

In the same year "Congress deviated from its established policy of disposing of public lands under the nonmineral land laws only if they were classified as nonmineral in character and enacted the first of several statutes providing for the sale of lands with the reservation to the United States of certain specified minerals. These statutes were soon followed by statutes providing for the sale of lands with the reservation to the United States of all minerals. . . ." 1 American Law of Mining § 3.23, at 532 (1976).

The first of these statutes "separating the surface right from the right to the underlying minerals" was the Act of March 3, 1909 (35 Stat. 844), 30 U.S.C. § 81, followed shortly by the Acts of June 22, 1910 (36 Stat. 583), 30 U.S.C. §§ 83 *et seq.*, April 30, 1912 (37 Stat. 105), 30 U.S.C. § 90, and August 24, 1912 (37 Stat. 496). *See The Classification of the Public Lands,* 537 U.S. Geological Survey Bull. 45, Department of Interior (1913). In the latter report, the Geological Survey pointed out that where lands were valuable for two uses, both uses

8. The President said:

> If this Government sells its remaining fuel lands they pass out of its future control. If it now leases them we retain control, and a future Congress will be at liberty to decide whether it will continue or change this policy. Meanwhile, the Government can inaugurate a system which will encourage the separate and independent development of the surface lands for agricultural purposes and the extraction of the mineral fuels in such manner as will best meet the needs of the people and best facilitate the development of manufacturing industries.

41 Cong.Rec. 2806 (1907).

Appellees argue that the executive department statement preceding the enactment of the Stock-Raising Homestead Act dealt primarily with coal deposits. But the concern of the statements was with the conservation of underground energy sources, as the President's references to "fuel lands" and "mineral fuels" illustrate.

9. *See also id.* at 57–58, and the following at 178:

> No principle is more fundamental to real conservation and at the same time more beneficial to the mining and other industries than this of giving preference to the highest possible use for the public lands. The earliest land laws, those of a century ago, provided for the reservation of mineral lands from disposal for other purposes, and the present coal-land law expresses this principle of relative worth by giving gold, silver, and copper deposits priority over the coal, and coal in turn preference over agricultural values. With classification data at hand the principle of relative worth can be further developed. Wherever the different values conflict the higher use should prevail. On the other hand, wherever the different values can be separated that separation by appropriate legislation is at once the easiest and best solution of the problem; for instance, the surface rights may be separated from the right to mine underlying beds of coal.

could be served by "a separation of estates." The report urged adoption of legislation embodying "the extension of the principle of the separation of estates," plus the leasing of natural resources, as means of protecting such resources without delaying agricultural development.[10]

In 1914, within a year of this appeal, Congress began consideration of a forerunner of the Stock-Raising Homestead Act. The bill was referred to the Department of Interior for comment, revised by the Department, and reintroduced. H.R.Rep. No. 626, 63d Cong., 2d Sess., *reprinted at* 52 Cong.Rec. 3986–90 (1915). It was enacted into law the following year.

[2] This background supports the conclusion, confirmed by the language of the Stock-Raising Homestead Act, the Committee reports, and the floor debate, that when Congress imposed a mineral reservation upon the Act's land grants, it meant to implement the principle urged by the Department of Interior and retain governmental control of subsurface fuel sources, appropriate for purposes other than stock raising or forage farming.[11]

We turn to the statutory language. The title of the Act—"The Stock-Raising Homestead Act"—reflects the nature of the intended grant. The Act applies only to areas designated by the Secretary of Interior

10. The report states (45–47):

The carrying out of the withdrawal policy for protecting the mineral and water resources of the public domain is in many cases rendered difficult and embarrassing by the agricultural value of the land withdrawn. . . . [S]ome of the best farming lands in the West are underlain by coal or phosphate, and some are so situated as to be of strategic importance in power development. Any hindrance to bona fide home building or other agricultural development of the public domain is indeed unfortunate, but in order to protect the public's natural resources withdrawals resulting in such hindrance have been necessary. For certain lands the situation has been relieved by the passage of acts separating the surface right from the right to the underlying minerals. . . .

In carrying out its function of classifying the public lands and in making its fund of information available in the administration of the existing land laws the Geological Survey has become acutely cognizant of the need for certain new legislation. The laws desired are primarily of two types and embody two fundamental necessities—first, the extension of the principle of the separation of estates, and second, the application of the leasing principle to the disposition of natural resources.

As has already been pointed out, the public lands can not be divided into classes each of which is valuable for one purpose only. Instead, the same tract of land may be valuable for two or more resources. In one tract—for example, agricultural land that is underlain by coal—both resources may be utilized at the same time without interfering with each other. In another tract—for example, agricultural land within a reservoir site—the land may be valuable for one resource only until it is utilized for another. In the first case the problem is so to frame the laws that no resource will be forced to await the development of the other. In the second case the problem is to permit the use of the land for one purpose pending its use for another without losing public control of the development of the second. In both cases the answer is found in a separation of estates. The extension of this principle, now applied to coal, to withdrawn and classified minerals and to the uses of water resources would permit the retention of the mineral deposits and power and reservoir sites in public ownership pending appropriate legislation by Congress without in any way retarding agricultural development. Bills have already been introduced applying this principle to oil in other States than Utah and to phosphate in the State of Idaho. It is to be hoped that such bills will be passed and approved, or, better still, that a comprehensive act providing for the separation of the various estates will be introduced and enacted.

11. The court in *Skeen v. Lynch*, 48 F.2d 1044, 1046 (10th Cir. 1931) stated:

The legislative history of the Stock-Raising Homestead Act when it was reported for passage including the discussion that followed relevant to this subject leave us no room to doubt that it was the purpose of Congress in the use of the phrase "all coal and other minerals" to segregate the two estates, the surface for stockraising and agricultural purposes from the mineral estate, and to grant the former to entrymen and to reserve all of the latter to the United States.

Although the Supreme Court of New Mexico specifically rejected the *Skeen* analysis in *State ex rel. State Highway Comm'n v. Trujillo*, 82 N.M. 694, 487 P.2d 122, 125 (1971), it did so in reliance upon the absence of an express provision in the Act, especially rejecting an invitation to examine the legislative history.

as "stock-raising lands"; that is, "lands the surface of which is, in his opinion, chiefly valuable for grazing and raising forage crops, do not contain merchantable timber, are not susceptible of irrigation from any known source of water supply, and are of such character that six hundred and forty acres are reasonably required for the support of a family. . . ." 43 U.S.C. § 292. The entryman is required to make improvements to increase the value of the entry "for stock-raising purposes." *Id.* § 293. On the other hand, "all entries made and patents issued" under the Act must "contain a reservation to the United States of all the coal and other minerals in the lands," and such deposits "shall be subject to disposal by the United States in accordance with the provisions of the coal and mineral land laws." *Id.* § 299. The subsurface estate is dominant; the interest of the homesteader is subject to the right of the owner of reserved mineral deposits to "reenter and occupy so much of the surface" as reasonably necessary to remove the minerals, on payment of damages to crops or improvements. *Id.*

The same themes are explicit in the reports of the House and Senate committees. The purpose of the Act is to restore the grazing capacity and hence the meat-producing capacity of semi-arid lands of the west and to furnish homes for the people, while preserving to the United States underlying mineral deposits for conservation and disposition under laws appropriate to that purpose. The report of the House Committee reproduces a letter from the Department of Interior endorsing the bill. The Department notes that "all mineral[s] within the lands are reserved to the United States." H.R.Rep. No. 35, 64th Cong., 1st Sess. 5 (1916). The Department continues, "To issue unconditional patents for these comparatively large entries under the homestead laws might withdraw immense areas from prospecting and mineral development, and without such a reservation the disposition of these lands in the mineral country under agricultural laws would be of doubtful advisability." *Id.* Moreover, "[t]he farmer-stockman is not seeking and does not desire the minerals, his experience and efforts being in the line of stock raising and farming, which operations can be carried on without being materially interfered with by the reservation of minerals and the prospecting for and removal of same from the land." *Id.* This language is quoted with approval in S.Rep. No. 348, 64th Cong., 1st Sess. 2 (1916).

Commenting upon the mineral reservation, the House report states:

> It appeared to your committee that many hundreds of thousands of acres of the lands of the character designated under this bill contain coal and other minerals, the surface of which is valuable for stock-raising purposes. The purpose of [the provision reserving minerals] is to limit the operation of this bill strictly to the surface of the lands described and to reserve to the United States the ownership and right to dispose of all minerals underlying the surface thereof. . . .

H.R.Rep. No. 35, *supra*, at 18.

The floor debate is revealing. The bill drew opposition because of the large acreage to be given each patentee. *See, e. g.*, 52 Cong.Rec. 1808–09 (1915) (remarks of Rep. Stafford). In response, supporters emphasized the limited purpose and character of the grant. They pointed out that because the public lands involved were semi-arid, an area of 640 acres was required to support the homesteader and his family by raising livestock. *E. g., id.* at 1807, 1811–12 (remarks of Reps. Fergusson, Martin and Lenroot). They also pointed out that the grant was limited to the surface estate,[12] and they emphasized in the strongest terms that all minerals were retained by the United States.

For example, asked whether the reservation would include oil, Congressman Ferris,

12. Representative Burke, explaining the earlier and, for our purposes, identical version of the Act (*see* 53 Cong.Rec. 1170 (1916)), stated that "Section 2 of the bill . . . limits the entry to the surface and provides that the land must be chiefly valuable for grazing and raising forage crops . . . ." 52 Cong.Rec. 1809 (1915).

manager of the bill, responded, "It would. We believe it would cover every kind of mineral. All kinds of minerals are reserved . . . [The bill] merely gives the settler who is possessed of any pluck an opportunity to go out and take 640 acres and make a home there." 53 Cong.Rec. 1171 (1916). It was pointed out that oil was not, technically, a "mineral." Congressman Ferris replied, "if the gentleman thinks there is any conceivable doubt about it we will put it in, because not a single gentleman from the West who has been urging this legislation wants anybody to be allowed to homestead mineral land." *Id.* During the closing debate on the Conference report, reference was twice made to the Department of Interior communication quoted above—including the assertion that without a broad mineral reservation the grant would be unjustifiable, and the representation that "the farmer-stockman is not seeking and does not desire the minerals, his experience and efforts being in the line of stock raising and farming, which operations can be carried on without being materially interfered with by the reservation of minerals and the prospecting for and removal of same from the land." 54 Cong.Rec. 682, 684 (1916).

There is little in the debates to comfort appellees. Appellees cite a discussion between Congressmen Mondell and Ferris, in which Mondell objected to Ferris's describing certain laws as "surface-entry laws, for they are not." Congressman Mondell continued, "They convey fee titles. They give the owner much more than the surface, they give him all except the body of the reserved mineral." 53 Cong.Rec. 1233–34 (1916).[13] Representative Mondell was not referring to the Stock-Raising Homestead Act at all, but to three earlier statutes that reserved only particularly named substances, and not minerals generally.[14] Representative Mondell opposed the Stock-Raising Homestead Act's general mineral reservation for the very reason that it restricted the patentee's estate more than the earlier statutes, and to an extent Representative Mondell thought undesirable. Congressman Mondell remarked that the general reservation contained in the Act as adopted rested on "the monarchical theory" which, he asserted, "is to reserve all minerals to the crown, upon the theory that the mere subject is not entitled to anything except the soil that he stirs." 51 Cong.Rec. 10494 (1914).[15] Although Representative Mondell eventually voted for the Act, he continued to protest the scope of the mineral reservation. His closing comment is worthy of notice. It confirms the view that the mineral reservation in the Stock-Raising Homestead Act was novel in its breadth. It also reveals that this broad reservation of subsurface resources was included at the insistence of the Department of Interior because of the large surface acreage granted under the Act:

> . . . the fact should be emphasized that the bill establishes a new method and theory with regard to minerals in the land legislation in our country. It reverts back to the ancient doctrine of the ownership of the mineral by the king or the crown and reserves specifically everything that is mineral in all the land entered. It was, it was claimed, necessary to accept a provision of that kind in order

13. Appellees also observe that the proviso to the mineral reservation in the Act originally stated that "patents issued for the coal or other mineral deposits herein reserved shall contain appropriate notations declaring them to be subject to the provisions of this act with reference to the disposition, occupancy, and use *of the surface* of the land," (italics added) and that the italicized phrase was stricken in the House. 53 Cong.Rec. 1233 (1916). The change was made by committee amendment, adopted without explanation or discussion. Even considered alone, its effect is unclear. It may have been thought, for example, that the stricken phrase might be construed to render the broad mineral reservation of the Act inapplicable to patents for a particular mineral, thus inadvertently broadening the mineral grant.

14. Act of Mar. 3, 1909, 35 Stat. 844, 30 U.S.C. § 81 (coal); Act of June 22, 1910, 36 Stat. 583, 30 U.S.C. §§ 83 *et seq.* (coal); Act of July 17, 1914, 38 Stat. 509, 30 U.S.C. §§ 121 *et seq.* (phosphate, nitrate, potash, oil, gas, or asphaltic minerals).

15. *See also* 52 Cong.Rec. 1809 (1915).

to secure the larger acreage. The Interior Department insisted upon it, and many supported that view. My own opinion is that that policy is not wise and that in the long run it will be found to be infinitely more harmful than beneficial or useful or helpful to anyone, either the individual or the public generally. When one takes into consideration the wide range of substances classed as mineral, the actual ownership under a complete mineral reservation becomes a doubtful question.

54 Cong.Rec. 687 (1916).[16]

Appellees argue that references in the Congressional Record to homesteaders' drilling wells and developing springs [17] indicate that Congress intended title to underground water to pass to patentees under the Act. These references are not to the development of geothermal resources. As we have seen, commercial development of such resources was not contemplated in this country when the Stock-Raising Homestead Act was passed. Moreover, in context, the references are to the development of a source of fresh water for the use of livestock, not to the tapping of underground sources of energy for use in generating electricity.[18]

[3, 4] This review of the legislative history demonstrates that the purposes of the Act were to provide homesteaders with a portion of the public domain sufficient to enable them to support their families by raising livestock, and to reserve unrelated subsurface resources, particularly energy sources, for separate disposition. This is not to say that patentees under the Act were granted no more than a permit to graze livestock, as under the Taylor-Grazing Act, 43 U.S.C. §§ 315 *et seq.* To the contrary, a patentee under the Stock-Raising Homestead Act receives title to all rights in the land not reserved. It does mean, however, that the mineral reservation is to be read broadly in light of the agricultural purpose of the grant itself, and in light of Congress's equally clear purpose to retain subsurface resources, particularly sources of energy, for separate disposition and development in the public interest. Geothermal resources contribute nothing to the capacity of the surface estate to sustain livestock. They are depletable subsurface reservoirs of energy, akin to deposits of coal and oil, which it was the particular objective of the reservation clause to retain in public ownership. The purposes of the Act will be served by including geothermal resources in the statute's reservation of "all the coal and other minerals." Since the words employed are broad enough to encompass this result, the Act should be so interpreted.

[5] Appellees assert that the Department of Interior has expressed the opinion that the mineral reservation in the Act does not include geothermal resources, and that this administrative interpretation is entitled to deference under *Udall v. Tallman,* 380 U.S. 1, 16, 85 S.Ct. 792, 13 L.Ed.2d 616 (1965), and similar authority. The documents upon which appellees rely do not reflect a contemporaneous construction by administrators who participated in drafting the Act to which courts give great weight

16. Congressman Raker also linked the size of the surface grant with the breadth of the reservation of sub-surface resources. 52 Cong.Rec. (App.) 521 (1915).

17. 52 Cong.Rec. 1810 (1915); 52 Cong.Rec. (App.) 521 (1915); 53 Cong.Rec. 1127, 1170 (1916).

18. "A fair and reasonable [ruling] would hold the surface owner to be entitled only to fresh waters that reasonably serve and give value to his surface ownership. Salt water and geothermal steam and brines should be held the property of the mineral owner who owns such substances as oil, gas and coal, since the functions and values are more closely related. Geothermal steam is a source of energy just as fossil fuels such as oil, gas and coal are sources of energy." Olpin, *The Law of Geothermal Resources,* 14 Rocky Mountain Mineral Law Institute 123, 140–41 (1968). *See Reich v. Commissioner of Internal Revenue,* 52 T.C. 700 (1969), *aff'd,* 454 F.2d 1157 (9th Cir. 1972); Allen, *Legal and Policy Aspects of Geothermal Resources Development,* 8 Water Resources Bull. 250, 253–54 (1972).

in interpreting statutes.[19] Nor is this a case in which Congress has approved an administrative interpretation, explicitly or implicitly.[20] On the contrary, Congress noted the Department of Interior's interpretation, observed that a contrary view had been expressed, concluded that "the opinion of the Department is not a conclusive determination of the legal question . . . ," and provided for "an early judicial determination of this question (upon which the committee takes no position)." H.R.Rep. No. 91–1544, 91st Cong., 2d Sess., *reprinted at* 3 U.S.Code Cong. & Admin.News 5113, 5119 (1970).

Appellees contend that enactment of the Underground Water Reclamation Act of 1919, 43 U.S.C. §§ 351 *et seq.*, three years after passage of the Stock-Raising Homestead Act, indicates that Congress did not consider subsurface water to be a "mineral." We disagree; indeed the more reasonable implication seems to us to be to the contrary.[21]

19. *Zuber v. Allen*, 396 U.S. 168, 193, 90 S.Ct. 314, 24 L.Ed.2d 345 (1969); *Power Reactor Dev. Co. v. International Union of Electrical, Radio & Machine Workers*, 367 U.S. 396, 408, 81 S.Ct. 1529, 6 L.Ed.2d 924 (1961); *United States v. American Trucking Ass'ns*, 310 U.S. 534, 549, 60 S.Ct. 1059, 84 L.Ed. 1345 (1940).

Appellees rely upon three letters by officials of the Department of Interior stating that "geothermal steam" is not a "mineral" within the meaning of the mining laws or the mineral reservation. Two of the letters, both dated Dec. 16, 1965, are responses by Edward Weinberg, Deputy Solicitor, to letters of inquiry from interested citizens. They are reproduced in an appendix to the district court's opinion, 369 F.Supp. at 1300–02, and as part of H.R. Rep. No. 91–1544, *supra* note 1, at 5126–28. The third letter was written by the Associate Solicitor for Public Lands to counsel for appellee Magma Power Company on Feb. 16, 1966, and apparently has not been published.

The letters do not reflect an agency view contemporaneous with the passage of the Act—they were written a half century after the statute was adopted. Appellees also rely upon a Department of Interior memorandum from Edward Fischer, Acting Solicitor, to the Director of Bureau of Land Management, stating that geothermal steam is not a "mineral material" for the purposes of the Mineral Act of 1947, 30 U.S.C. § 601. Dep't Interior Mem. M–36625, Aug. 18, 1961. But this view is contrary to that expressed by Solicitor Stevens only seven months earlier in a letter to appellee Magma Power Company dated Jan. 19, 1961. Brooks, *supra* note 1, at 524 & n.56; Note, *Acquisition of Geothermal Rights*, 1 Idaho L.Rev. 49, 56 & n.44 (1964). This inconsistency, *see* Hearings on H.R. 7334 *et al.* before the Subcomm. on Mines & Mining of the House Comm. on Interior and Insular Affairs, 89th Cong., 2d Sess., ser. 89-35, pt. II, at 194-95 (1966) (statement of Emmet Wolter) is another factor indicating that we should not accord deference to the administrative construction. *See Udall v. Tallman*, 380 U.S. 1, 17, 85 S.Ct. 792, 13 L.Ed.2d 616 (1965).

Moreover, the expressions of opinion relied upon by appellees are weakly reasoned. They rest entirely upon the premise that geothermal resources are simply water. Water, the argument then proceeds, ordinarily is not included in mineral reservations by the courts, or treated as a mineral in public land laws. But all of the court decisions relied upon in the communications concern fresh water brought to the surface by means of a well. *See Mack Oil Co. v. Laurence*, 389 P.2d 955 (Okl.1964); *Fleming Foundation v. Texaco*, 337 S.W.2d 846 (Tex. Civ.App.1960). *See Estate of Genevra O'Brien*, 8 Oil & Gas 845 (N.D.Tex.1957) (charge of the court). And if geothermal resources are indeed "water," the later enactment of the Geothermal Steam Act has undercut the statement that "water" is not treated as a mineral in public land laws. But the principle deficiency in the documents relied upon by appellees is this: the sole question is the meaning of the statute; the answer therefore turns entirely upon the intent of Congress, and the documents do not mention that subject at all.

20. *See, e. g., Power Reactor Dev. Co. v. International Union of Electrical, Radio & Machine Workers*, 367 U.S. 396, 408–09, 81 S.Ct. 1529, 6 L.Ed.2d 924 (1961).

21. The Underground-Water Reclamation Act authorizes the issuance of permits to explore for underground water on not to exceed 2,560 acres of public lands in Nevada (§ 351). The Act provides that if a permittee discovers and makes available for use a supply of underground water in sufficient quantity "to produce at a profit agricultural crops other than native grasses upon not less than twenty acres of land," he will be entitled to a patent on 640 acres of the public land embraced in his permit (§ 355). The Act further provides for reservation of "all the coal and other valuable minerals in the lands" patented (§ 359). Appellees argue that the term "minerals" in the latter provision must not include underground water, for if it did the reservation would deprive the patentee of the very water he had discovered.

But again, the obvious distinction is between underground water suitable for agricultural purposes and geothermal resources. The purpose of the Underground-Water Reclamation

The district court granted appellees' motion to dismiss for failure to state a claim upon which relief could be granted. 369 F.Supp. at 1299. The State of California, as amicus, suggests that questions of fact are presented as to the nature of geothermal resources. We are persuaded that the facts necessary to decision are not disputed. The appeal presents only a question of law as to the proper construction of the statute, which we have answered.

Whether the United States is estopped from interfering with the rights of private lessees without compensating them for any losses they may sustain will be open on remand.

Reversed and remanded.

C-11 LEGAL ANALYSIS OF ENVIRONMENTAL ASSESSMENT

Statutory Framework

The need for environmental assessment on Federal Geothermal Projects stems from implementation of Section 102 (2) (C) of the National Environmental Protection Act of 1969 as codified in 42 U.S.C. 4321 eta seq. and Executive Order 11514 March 5, 1970 as setforth in 35 Federal Register 4247.

In essence, Section 102 (2) (C) of the National Environmental Protection Act (NEPA) directs that all federal government agencies shall, with respect to major federal actions which may significantly affect the quality of the human environment, prepare as fully as possible, a detailed statement which will take into consideration on any such action the following five criteria:

1. The environmental impact of the proposed action;
2. Any adverse environmental effects which cannot be avoided should the proposal be implemented;
3. Alternatives to the proposed action;
4. The relationship between the local short term uses of man's environment and the maintenances and enhancement of long term productivity; and
5. Any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

Since the directives of Section 102 (2) (C) as set forth above are unclear as to what is a "major" federal action, the Federal Energy Administration (FEA) is directed to prepare a "environmental assessment." This environmental assessment is preliminary to aid the FEA in making a determination as to whether or not a more detailed environmental impact statement is required.

The code of federal regulations (CFR) in sections 208.4 through 208.15 sets forth the required contents of an environmental assessment and also that of an environmental impact statement should the same be determined appropriate after an environmental assessment is done.

In reviewing the necessary elements of an environmental assessment and a determination as to whether or not an action is major and significantly affecting the human environment, the following criteria or guidelines are set forth as a necessary part of an environmental assessment:

1. An evaluation of the project which will describe the proposed action and the environmental affect thereon;
2. A statement by the FEA as to whether an environmental impact statement is considered necessary.

In analyzing the requirement of subsection 1 above, an environmental assessment becomes a "Mini-environmental impact statement" since the CFR refers to the applicability in an environmental assessment of the criteria necessary for an environmental impact statement.

If a determination is made at this point that an environmental impact statement is not necessary then the environmental review process would stop. If it is determined that the environmental impact statement is neccessary and that the proposed action is therefore a "major federal action" then an environmental impact statement must be prepared in two phases: (1) a draft statement, and (2) a final statement. CFR Section 208.5 through 208.16 set forth the criteria necessary in both the draft EIS and the final EIS.

CFR Section 208.5 and 208.6 set forth the administrative requirements as to the formal preparation and the number of copies to be prepared and distribution therein.

CFR Section 208.7 sets forth the necessary areas of environmental impact that must be contained in an EIS. As set forth in CFR Section 208.7 they are identifiable as follows:

1. A description (as detailed as possible) of the proposed action and the types of environment which may be effected by such action.

2. Describing the probable impacts of the proposed action on the environment.

3. Describing whether or not there are any probable adverse environmental effects which cannot be avoided should the proposal go forth.

4. Describing the relationship between local short term uses of the long term productivity of the environment in relationship to the proposed project.

5. Describing any irreversible or irretrievable commitments of resources that would be involved with the proposed action should it be implemented.

6. Providing an assessment of the alternatives of the proposed action.

7. Describing the relationship of the proposed action to land use plan policies and controls for the affected area.

8. Providing a discussion of considerations offsetting potential adverse environmental impacts of this proposed action.

In order to carry forth the requirements of NEPA and Executive Order 11514 of March 5, 1970, the Department of Energy issued guidelines for environmental review. These guidelines of environmental review are contained in CFR 711.1 through 711.83.

In CFR 711.7 the need for some type of environmental assessment is mandated on any "action" which may affect the quality of the human environment. An environmental impact assessment (EIA) is specifically identified and defined in Section 711.7 subparagraph C as follows:

A written document which evaluates the environmental impacts of proposed ERDA actions to assure that environmental values are considered at the earliest meaningful point in the decision making process which provides a basis for the determination of whether an environmental impact statement shall be prepared.

CFR Section 711.5 proceeds to set forth the matters that should be contained in an environmental impact assessment. Basically the regulations require a "brief, factual analysis of the environmental consequences." The exact contents as codified in Section 711.25 are somewhat more detailed than as set forth earlier. CFR Section 711.25 specifically states that an EIA should contain the following information: (1) a description of the proposed action; (2) a description of the existing environment; (3) a description of potential environmental impacts including comments with reference to construction, operation, and sight restoration; (4) an analysis of coordination with federal, state, regional or local plans for development which may propose conflicts; (5) a description of the alternatives to the proposed action.

Once the EIA is prepared then a determination may be made as to whether or not the proposed action is of such "federal magnitude" that an environmental impact statement is necessary. CFR Section 711.41 attempts to set forth guidelines for the determination as to whether or not a particular action is a "major action," therefore requiring preparation of an EIS.

This determination provides one of the earliest legal concerns that a developer faces. The governmental guidelines which have been initiated and that we are discussing are very open ended and subjective as to their meaning. As such, there is no real objective standards by which to determine whether or not an EIS is necessary. The decision not to prepare it could provide the framework for a legal attack on the proposed project. The courts are replete with injunction cases stopping federally funded projects because of the failure to provide the correct environmental impact statement. The key to avoiding this potential problem is to insure that if any question arises as to whether or not an environmental assessment or environmental impact statement is necessary then the latter should be performed to avoid potential conflict. It can be of little satisfaction to a developer, that several months or years later a particular court agrees with the developers early determination that merely an assessment and not an impact statement was necessary. The delay that may be involved is greater than the actual satisfaction of winning in the courtroom. It is the disaster of this potential setback to the proposed project that gives rise to a legal concern of insuring that the maximum protective steps be taken to avoid procedural conflicts by fully complying with the law. Therefore, should a question arise as to the need for a more comprehensive detailed environmental study, that comprehensive study should be done.

Areas of Potential Litigation

Beyond the type of environmental study that must be done, remains the legal definition of what is an adequate assessment or study. There have been a number of civil actions which have attacked the information contained within particular environmental studies as not being comprehensive enough or not assessing all of the environmental impacts of a particular project.

Attacking the adequacy of an EIS has been a favorite tool of those who are not in favor of a particular project which requires such an environmental assessment. Frankly, they have been very successful with this type of attack in postponing and delaying projects.

What has developed from these attacks are case decision guidelines to aid the preparer of an EIS. The Courts have been consistent in stating that it is the procedural adequacy of a particular EIS that the courts are concerned about. How specific the statement is in the preparation of each procedural step has and will remain the main source of litigation.

Three basic areas of vulnerability exist and have been the cause of much of the litigation. They are:

1. An adequate discussion of viable alternatives to the proposed project. In the case of geothermal development this would seem to indicate a study of alternative sources of energy or means of meeting existing and future energy needs. The EIS requirements dictate a discussion of viable alternatives to the proposed project. The courts have resisted ruling on the specific conclusion reached or on how detailed the discussion was in the FIS. The Court's concern has been that the alternatives were discussed and reviewed.

2. An inadequate assessment of social and/or economic impacts associated with a project. In the public hearings associated with Idaho Power's proposed Coal Fired Plant these types of concerns were very evident. The same type would not be present in this project but the social and or economic assessment of a project is required. The main economic impact would stem from the fact that an alternative source of energy would be issued.

3. An inadequate assessment of all potential physical impacts and proposed mitigation measures. This area of assessment can open a Pandora's box to opponents of a particular project. The key from the legal perspective is to insure that the EIS does indicate an evaluation of these types of impacts and ways of potential mitigation if necessary. The need for detailed analysis in the statement does not seem to be of great concern to the courts, but it must be covered.

<u>Areas of Adverse Environmental Impact</u>

The types of potential areas of adverse environmental impact can be categorized as potential land use conflicts, air pollution, water pollution and noise problems. The importance of each category to this project is as follows:

Land Use. Since most of the ongoing geothermal projects are related to the production of electrical energy, the land use aspects of this project would be limited to access road, well site preparation and well drilling. Most of these types of activities would be of a short duration and the legal significance at this time would seem to be minimal.

If the demonstration project is successful and a geothermal field is constructed then the same environmental land use concern is as any industrial development may occur. A showing that the geothermal use can co-exist with the present use of the land space becomes essential. With the type of land displacement which is necessary for this type of project, no significant legal problems in this area are identifiable at this time.

Air Pollution. There should not be any legally significant environmental air pollution effects of this project.

The geothermal energy being produced by the Warm Springs Wells, which have been in existence for the past 90 years, have not contributed as far as is known to any air pollution problems. The most common type of offensive discharge given off by the geothermal wells is hyrdogen sulfide. As this project goes on line, and as more scientific research becomes available, continued efforts must be maintained to insure that air pollution does not become a legal concern.

Water Pollution. As is the case with potential air pollution problems, water pollution does not give rise to any serious legal complications.

The water which carries the geothermal energy is potable water. It has been and is being used for domestic and agricultural purposes. The only real significant element present to any extent is fluoride. At the present time it is not anticipated that the level of fluoride will cause any significant legal concern. If it would, technology can easily overcome any potential problems. One other possible negative long range impact could be heat discharged in the Boise River or other body of water should reinjection not be used.

The reinjections of the water back into the reservoir, if found to be necessary, should not cause any legal environmental concern. This would be true even if the geothermal reservoir would mix with the present ground water system, since the water in both, except for temperature, is relatively the same.

The necessity of reinjection because of potential subsidence problems is presently being studied but the reuslt has not been fully confirmed.

Noise. The main noise pollution concern would come from well drilling. This source of nuisance would be of a temporary nature and very localized. The exact location of drilling, proximity to population has a great influence as to whether a legal concern would be generated. If a legal concern would be present, the use of a muffler receptor or a drilling walk would alleviate legal concern in this area.

One other potential source of noise pollution may exist from necessary bleeding of the walk prior to production and at various times during production. This bleeding process can be very noisy. At the present time, this process has not been necessary on the Warm Springs wells.

In spite of the above, it should be reailized that depending on the location of the wells, the noise level, at least at temporary stages of development and production, will vary. The density of the surrounding area will also effect the noise level. Nevertheless, the severity of the potential of noise pollution in this project, as with air and water pollution, is minimized by the type of geothermal energy being produced in this project. The drilling required is almost identical to domestic and irrigation well drilling. The present environmental standard in these areas should be adequate. Local ordinances may be considered to insure that noise levels during the construction of a well is minimized but it is not felt that a local ordinance would be necessary for this project if project requirements were issued to any potential driller being used on this project. As the implementation phase takes form, the environmental procedure process must be clearly evaluated to insure it conforms to all existing laws and current guidelines.

<u>Summary</u>

It can be concluded that the main legal concern with reference to the procedural aspects of environmental assessment is not whether an entity attacking the assessment is correct or not, but the fact that this project could be stopped while that determination is being made. The potential of the attack itself is hard to defend, but the substance of the attack can be defended to insure the least possibility of successfully gaining injunctive relief.

In preparing for such an attack, selecting the proper type of assessment is critical. Once an EIA is prepared a very critical and detailed study should be commenced to determine the necessity of an EIS. If there is criteria to support the conclusion that an EIS should be prepared, then from a legal point of view such should be done. Of course there are other factors to take into consideration other than the legal factors, such as the time period needed to produce such a statement and the money needed to prepare it.

However, not withstanding the possible problems discussed above, the overall conclusion with reference to potential legal problems is minimal. The time factor involved in producing the necessary environemntal assessments and obtaining the necessary approvals relating thereto is probably a more significant problem. This time factor has become the thorn in the side of many projects. The delays are caused by inability of the responsible lead agencies to find time for a particular project and by entities which are requested to give input as well as public hearing scedules. To minimize both the time period for producing EIS's and the possibility of attack to the reports, very close scrutiny by the technical producer, legal advisors and agencies involved is critical.

Thus far, the infancy stage of geothermal development has not produced a clear environmental strategy that can be relied upon. That strategy and the environment assessments produced from this project will become a part of this development.

At the present time, in light of the action taken thus far, and that which is tentatively proposed, it seems unlikely that the environmental impacts of this project could trigger injunctive relief to a complaining party, but it is possible. It is the possibility that necessitates the careful watchdog and strict compliance with all environmental laws affecting this project.

C-12 HARRY PARIANI, ET AL., VS. THE STATE OF CALIFORNIA

Nature of the Action

The question presented in this case is the ownership of the "heat of the earth" which has otherwise been designated as thermal resources, geothermal resources or geothermal energy. Geothermal resources have been defined by the State of California in the Public Resources Code, Section 6903, enacted in 1967, as follows:

> "For the purposes of this chapter, 'geothermal resources' shall mean the natural heat of the earth, the energy, in whatever form, below the surface of the earth present in, resulting from, such natural heat, and all minerals in solution or other products obtained from naturally heated fluids, brines, associated gases, and steam, in whatever form, found below the surface of the earth, but excluding oil, hydrocarbon gas or other hydrocarbon substances."

As far as this action is concerned, the heat of the earth manifests itself in the superheated steam which is being produced from the numerous wells in the underground thermal reservoirs in The Geysers area which is being used for the production of electricity.

The heat of the earth is one of the fundamental forces of nature, which man, through his ingenuity, is beginning to convert to energy to meet the basic needs of society. In this regard, it is similar to the wind which, in time past, was used for the powering of windmills, water used for hydroelectric systems, the rays of the sun, and oil, gas and other hydrocarbons, coal and uranium, all of which basic substances have been used in accordance with their economic feasibility for the production of energy to satisfy the needs of society.

The instant action involves the claim of ownership between the persons, hereinafter designated Patentees, and the State of California, hereinafter designated State, as to the geothermal resources on property granted by the State to the Patentees. Some of the Patentees are Plaintiffs and Cross-Defendants and some are Cross-Complainants and Cross-Defandants. The word Patentee will be used to designate all Patentees, unless reference is made to a specific group of Patentees who will be designated as Patentee Pariani, Patentee Ottoboni and Patentee Emerson.

The State is the Defendant and Cross-Complainant.

The Patentees, successors in interest of grantees of the State of California, claim title to the geothermal resources herein involved pursuant to various grants, five in number, made by the State of California, the first dated November 25, 1949, and the last dated January 19, 1956. The various Patentees paid the full appraised value in the acquisition of the land from the State of California. Each said patent contained a mineral reservation clause pursuant to Public Resources Code Section 6401, wherein there was reserved by the State

> "all oil, gas, oil shale, coal, phosphate, sodium, coal, silver and all other mineral deposits claimed in said lands....and further reserving

to the State of California, and persons authorized by the State, the right to drill for and extract such deposits of oil and gas, or gas, and to prospect for, mine, and remove such deposits or other minerals from said lands...."

The land involved was vacant Federal land which was obtained by the State from the Federal Government and is designated as in lieu lands.

Both the Patentees and the State have separatedly entered into lease agreements with the present Lessees being Defendants, Cross-Defendants, Cross-Complainants, Union Oil Company, Magma Power Company and Thermal Power Company, hereinafter designated as Lessees, or Union-Magma-Thermal, giving the Lessees the right to explore for geothermal energy. The lease agreement of the Patentees, dated November 15, 1965, provides that the Lessee pay a 12 1/2% royalty to the Patentee. The lease agreement of the State dated May 27, 1971, provides that the Lessee pay a 10% royalty to the State. Since 1972, electricity has been commercially produced by the Pacific Gas and Electric Company from the geothermal energy being produced from the area in question from five power plants on the land in question.

From the commencement of the production, the Lessees have paid to the Patentees only 2 1/2% of the royalty. From that date until November 30, 1973, the Lessee paid the State a 10% royalty, and commencing with the royalties from the month of December 1973, the said 10% has been deposited with the Clerk of the Court pursuant to Order dated January 23, 1974.

The matter of interest on the said 10% for the period of time that the 10% royalties were paid to the State and not deposited with the Court, that is up to November 30, 1973, is also in dispute as between the Lessees and the State as will hereinafter be discussed and determined.

Contention of the Parties

Both the Patentees and the State agree that at the time the patents were issued, that is, the period from November 25, 1949 through January 9, 1956, neither the State nor the Patentees had any knowledge of geothermal resources underlying the patented land nor was any thought given to the potential development of electricity through the use of the then undiscovered geothermal resources, nor was there any specific intention of either the Patentees or the State relative to the geothermal resources.

Broadly stated, the contentions of the parties are the following:

Patentees: That title passed to the Patentees to everything not specifically reserved in the mineral reservation; that the State did not intend to nor did it in fact reserve the hot water, steam, thermal energy or geothermal resources; that the geothermal energy, steam or hot water is not within the term "gas" or "mineral deposits" in the mineral reservation; that the "steam" is not a "mineral" or "gas" or "mineral water" under the mineral reservation, and that "heat" which is the force which is producing the electricity is not a "substance" or a "mineral."

State: That under the general intent theory, the intent of the State in the mineral reservation clause was to reserve everything of value beneath the surface of the earth, whether known or unknown, the production of which would not interfere with the rights of the surface owners; that the State did intend and did in fact reserve to itself the hot water, steam, thermal energy and geothermal resources on the land in question; that the geothermal resources come within the reservation of "gas" and "mineral waters," and that the geothermal system is a "mineral deposit" within the reservation.

Geothermal Systems

The heat of the earth involved in the case is the heat from the radioactive decay deep within the earth's crust of uranium, thorium and potassium, which, over the years and in certain areas, has caused an intrusion of magma or molten rock to a shallow depth. Eventually, a geothermal system has developed.

Geothermal systems are three kinds, the first two generally being described as hydrothermal convective systems and the third as a dry hot rock conductive system.

Briefly, as to the two hydrothermal systems, the most common type is the hot water dominated system. The hot water dominated system is characterized by liquid water as the continuous pressure controlling fluid. The fluid enters the producing well as liquid water and remains as liquid water as it flows up the well until the pressure decreases with the continued upward flow and the water "flash boils" to steam which is used as the source of energy. This is the more prevalent of the geothermal systems around the world.

In the vapor-dominated geothermal system, which is the type involved in The Geysers, there is a reservoir of superheated steam over an area characterized as boiling brine and thus it has also been characterized as a dry steam system. This is the type also involved in the Larderello system in Italy where electricity has been produced commercially since 1904, the system having theretofore been used starting in 1822 for the production of boric acid from the steam. In the vapor-dominated system, the superheated steam exerts the continuous pressure for producing the energy. While the Larderello system and The Geysers are both vapor-dominated or dry-steam systems, each has peculiar characteristics of its own because of the different geology involved.

The third system mentioned above, which is not a hydrothermal system, is known as a dry hot rock system. In this system, there is an area of magma or hot rock with no associated fluids. The method of exploration would involve the fracturing of the rock by injection of water, or by a nuclear explosion. Thereafter, water would be injected into the system which would be heated by the dry hot rock and converted to steam which would be the source of energy.

The Geysers

Specifically, The Geysers, the area with which we are concerned, is an area of collision between American Plate and the Pacific Plate, with the Pacific Plate being subducted or pushed under the American Plate, causing a tremendous amount of force resulting in major earthquakes and volcanoes. As a result of this plate tectonism, the magma, a collection of molten minerals, has protruded through the earth's crust to a shallow depth of about 20,000 to 25,000 feet below the surface of the earth. This has been going on for millions of years. The magma has been responsible for the development of the volcanic activities in the area. The very hot magma at very high tempratures brought an enormous source of heat which moved through all of the rocks and developed the hydrothermal activity -- the movement of water and heat through the rocks. The magma was the source of heat which encountered the graywache, the sandstone, which was metamorphosed into a very dense low porosity and low permeability rock that was deposited in water. The high temperature molten magma heats up the waters present in the system which then rise to the outer regions. As the water cools, it goes downward, is reheated and the convection process beings. The hot water dissolves many of the minerals which are carried in the water and which are then deposited into fractured areas of the rock when the water cools.

A seal from the dissolved mineral, primarily of silica, was formed creating an impermeable barrier around the geothermal fluid and thereafter a vapor dominated system of dry steam has developed. The dry steam system of The Geysers developed over 10,000 years ago. As the steam formed an area between the water and the steam developed which is called brine, boiling water with a high concentration of dissolved salts -- silica, boron, arsenic and other minerals.

The first geothermal area developed in The Geysers in the 1950's was the shallow reservoir from 500 to 2,000 feet, and later in the development the deep reservoir of from 3,000 up to 9,000 feet was discovered. The pressures within the system from the shallowest wells of about 500 feet to the deepest wells of over 9,000 feet are the same in general area of 500 lbs. per square inch. The hydrostatic pressure at 10,000 feet would be 4,000 lbs. per square inch. The constancy of pressures within the geothermal system establishes the general impermeability of the seal and the balance within the system.

The original development of The Geysers for its geothermal activity in the 1950's is an area where The Geysers resort activity had been conducted in years past and which is near Sulphur Creek, wherein the wells were from 500 to 2,000 feet in depth. This is the area where the surface manifestations of the nature of the area were discovered in 1846, as set forth in detail hereinafter in Appendix E. This is the area wherein an abortive attempt was made to use steam for the commercial production of electricity in the 1920's, as set forth in detail in Appendix D.

Since the original development of the shallow reservoir, a reservoir has been discovered which has been tapped by wells up to 10,000 feet in depth.

The testimony of all of the witnesses has indicated that there is some communication between the shallow and deep reservoirs and that they are part of one system. The Geysers is the only area where dry steam geothermal reservoirs have been found at a depth up to 10,000 feet.

Of the steam which is presently produced by the Lessees at the rate of 10,000,000 lbs. per hour, 80% evaporates in the air and 20% is processed through the cooling and condensing towers and returns as condensate with substantial contents of arsenic, boron and amonia. The large quantity of hydrogen sulfide in the steam evaporates in the air and gives the odor of rotten eggs prevalent in the area, because of the detrimental effect on the area in question, the

Lessees have been required to dispose of the condensate by reinjection in wells into the ground and when so reinjected has become part of the steam which might again return to the surface.

In the area which is the subject of this litigation, five power plants -- power plants 7 and 8, 9 and 10, and 11 -- have been constructed by the Pacific Gas and Electric Company for the production of electricity from the superheated steam which is being secured from the land in question and delivered to the power plant from a system of pipes from the well-head.

The General Intent Theory of the State

As stated above, all parties concede that neither the State nor the Patentees had any specific intention at the time the patents were issued as to the matter of geothermal resources.

The State has advanced the contention that rather than any specific intent as to the reservation in question the Court should look to the general intent of the State as manifested by Public Resources Code Section 6407 (originally enacted in 1947 as Public Resources Code Section 6403 and renumbered as Section 6407 in 1959 and hereinafter referred to as Section 6407) to reserve in effect everything of value below the surface, whether known to exist or not, which would not interfere with the beneficial use of the surface by the owner of the land.

The State has referred to the Law Review article entitled "Law Relating to Oil and Gas in Wyoming" in 3 Wyoming Law Journal 107 wherein the contention is urged that in attempting to determine the intention of the parties, the intention test is one of a general intent rather than any supposed but unexpressed specific intent and that the general intent should be arrived at not by defining and redefining the terms used in the mineral grant or reservation but by considering the purposes of the grant or reservations in terms of manner of enjoyment intended in the ensuing interest. The article states at page 113:

> "Applying this intention, the severance should be construed to sever from the surface all substances presently valuable in themselves, apart from the soil, whether their presence is known or not, and all substances which become valuable through development of the arts and sciences, and that nothing presently or prospectively valuable as extracted substances would be intended to be excluded from the mineral estate."

A limitation upon the mineral estate according to the article should be that only those substances can be removed without compensation, which can be removed without unreasonable injury to the enjoyment of the surface estate.

In Public Resources Code Section 6407, the Legislature specifically declared "the legislative intent with respect to the reservation deposits reserved by the state pursuant to Section 6501." This section was amended in 1975 in its definition of "mineral deposits" by changing "...oil, gas...." to "...oil and gas, and other gases including but not limited to hydrocarbon and geothermal gases..." and by adding after "mineral waters" the following: "uranium, trona and geothermal resources."

The Court does conclude that the general intent approach referred to in the Wyoming Law Journal article, <u>supra</u>, should not be applied because of the provisions of Section 6407 of the Public Resources Code wherein the Legislature has specifically declared the legislative intent with respect to the reservation of mineral deposits reserved by the State and has thereafter set forth in effect a definition of mineral deposits which admittedly contains all minerals and other matters which although found in the subsurface area are not generally considered to be mineral deposits. The Court concludes that the scope of the reservation must be determined by the provisions of Public Resources Code Section 6407.

In regard to the interpretation of the reservation, the Court does recognize the provisions of Civil Code Section 1069 which provides the following:

> "A grant is to be interpreted in favor of the grantee, except that a reservation in any grant, and every grant by a public officer of body, as such, to a private party, is to be interpreted in favor of the grantor. (Enacted 1872.)"

<u>The Geothermal Steam As "Mineral Waters"</u>

While the testimony and exhibits in the trial on the mineral water agrument of the State were minimal in relation to the entire record, the Court is first going to direct its attention to the contention that the geothermal steam produced from The Geysers is "mineral water." The term "mineral water" is not specifically used in the reservation in any of the patents. However, by virtue of the definition of "mineral deposit" in Public Resources Code Section 6407 which specifically includes "mineral waters," mineral waters would be within the reservation by the State as a mineral deposit.

The reservation of "mineral waters" in Public Resources Code Section 6407 together with other items such as sand, clay, and gravel, which are not in fact minerals, establishes that the term "mineral deposits" in the government reservation is not restricted only to things mineral in the scientific definition. It may be broader to include all things within the specific definition of mineral deposits in the section whether they are in fact mineral or not.

There is no specific definition of "mineral waters" in the legislation. There may be a question whether mineral waters are in fact "minerals" within the strict scientific definition of the term mineral.

The attorneys have conceded that there is no legal definition of mineral waters and the various experts who have testified are unanimous in that there is no accepted scientific definition of mineral waters.

Dr. H. Tsvi Meidav, a geophysicist who testified as a witness for the Patentees, stated that "mineral waters" was not a scientific term, was never used in scientific communications and seldom, if ever, in verbal communications, and was not used in the professional community in his field. He called it a vernacular term used by lay people in a variety of meanings which might vary from one community to another.

Professor George C. Kennedy, a witness in behalf of the State, testified that in earlier volumes the mineral waters had been included in the annual report of the United States Geological Survey regarding mineral resources in the

United States but had not been included in later volumes because of the fluctuation in the popularity of mineral spas and concluded that the United States Geological Survey reports did not contain any scientific definition of the term mineral waters. Dr. Kennedy did concede that the term mineral waters could well include waters with low as well as a high mineral content. He had made a study of mineral waters worldwide and concluded that they had two things in common: (1) that they were sharply different from the surrounding surface and underground waters and (2) that there was evidence of source from a magmatic hearth.

Some of the witnesses have testified as to "mineral waters" from certain foreign countries and the legislation which has defined it in those countries, particularly in connection with bottled drinking water.

Reference to the specific testimony has been made solely to point out the fact that the fields of law and science are of little assistance to the Court in determination of the scope of the reservation by the State under the term "mineral waters."

The Court is called upon in this case to make a determination as to whether the geothermal steam falls within the reservation of "mineral waters."

The Court has concluded that while there are no specific definitions, legal or scientific, for the term mineral waters, certain waters, such as the ordinary ground or surface waters used in agricultural communities, would certainly fall within the classification of non-mineral waters and that at the other extreme the waters in the world-renowned spas, where for centuries people have gone for therapeutic purposes to bathe and ingest the waters for their specific mineral content, would be unquestionably mineral waters.

The historical background relative to the use of mineral waters for therapeutic purposes has been set forth in the volume by Anderson, entitled Mineral Springs and Health Resorts of California (Appendix I), which will hereafter be referred to.

There is a long history of reference to "mineral waters" in official documents of the State and Federal Governments which will hereinafter be pointed out. The Court concludes that these documents are of assistance in the determination of the scope of the term "mineral waters" as used by the Legislature of the State of California in Public Resources Code Section 6407. The Court also concludes that these documents are of assistance in the relation of "mineral waters" insofar as The Geysers area is concerned. Portions of such documents referred to because of their relative inaccessibility, are being set forth in detail as Appendices to this Memorandum and incorporated herein by reference as if fully set forth.

In the Fourteenth Annual Report of the Director of the United States Geological Survey in 1894, there is included a section "Nautral Mineral Waters of the United States" by A.C. Peal (Appendix A) and, on pages 56 through 59, there are set forth definitions and classifications of mineral waters. On page 68, under the subheading "Thermal Springs," there is a discussion of the two groups of springs occurring in the same geological position, that is, the thermal and the non-thermal springs and, specifically, it states as to the solid contents seen, as follows:

"At the California geysers the coldest spring, with a temperature of 70°F, has 7.12 grains per gallon, while the hottest, at 212°F, contains 296.4 grains per gallon."

The _List and Analyses of the Mineral Springs of the United States_ by Albert C. Peale, M.D., (Appendix B) was published by the United States Geological Survey in 1886. In the Introduction on page 10 there is a discussion of the term mineral water and on page 11 the classification is set forth in two categories of the springs which are reported. The first is a characterization in regard to the temperature as either thermal or non-thermal and, secondly, as to the gases usually present in the waters of most springs. These are indicated by the terms carbonated, sulphurated, carburated, etc.

On page 202, relative to California, it states,

"The best known springs are probably the Geyer Springs of Sonoma County, which are really a collection of fumaroles, solfataras, and boiling springs,"

and on page 204, where specific springs in California are listed, the following is set forth as far as:

"Geyser Springs, Geyser Springs, Sonoma County
Number of Springs 30
Flow in gallons per hour 1,000
Temperature, Fah. .... 212°
Character of the water.......... Alkaline
Remarks .... Used commercially and as a report."

The next volume referred to is the United States Department of Agriculture Bureau of Chemistry, Bulletin No. 139, issued June 13, 1911, entitled _American Mineral Waters: The New England States_ (Appendix C), wherein, under the heading "Mineral Waters Defined" the following is stated:

"The term mineral water has been variously defined, the defination having gradually changed from the restricted sense, meaning a water used only for medicinal purposes, to a water used for drinking or sometimes bathing purposes. Thus Dr. Peal, in his report to the Geological Survey on the statistics of mineral waters and the mineral water industry of the United States, says: 'Our reports do not restrict the term "mineral water" to medicinal waters, but include all waters put on the market, whether they are utilized as drinking or table waters, or for medicinal purposes, or used in any other way.'"

Reference is next made to the _Report XXII of the State Mineralogist Covering Mining in California_, Dated July, 1926 (Appendix D), wherein in the section dealing with Sonoma County the following is stated under the heading "Mineral Water," at page 339:

"They vary in character and composition from the cold seltzer of Lytton's to the boiling hot waters and steam vents of The Geysers..."

and, at page 343, speaking of The Geysers:

"The mineral waters here form a remarkable series, containing sulphates, carbonates, silicates, and borates of potassium, sodium, magnesium, calcium, iron, and aluminum. Gases from the steam vents (and wells drilled in the fumarole area) have been shown to be radioactive."

Commencing at page 345 under the heading of "Development of Natural Steam Wells for Power Purposes at 'The Geysers,'" there is a report in detail of the early attempts in 1922 for the production of power from the steam wells located at The Geysers.

It is interesting to note the inclusion of this attempt in 1922 to develop the power capacity of the steam wells in the report of the State Mineralogist of California.

Water-Supply Paper No. 338 of the United States Geological Survey published in 1915, entitled Springs of California, by Gerald A. Waring (Appendix E), (a portion of which was introduced in evidence in the trial), gives (at pages 83 to 85) a description of The Geysers of Sonoma County, the springs, the hotel and baths erected about 50 years earlier. It refers to the addition of cottages and bathing facilities and speaks of 12 flowing hot springs, 10 hot pools, 12 vapor vents and areas of vaporous exhalations. It also speaks of the cooler pools used for bathing of the feet or eyes, which have received names as Corn Spring and Eye Spring, which were referred to during the trial.

At pages 86 and 87 there is an analysis of the chemical constituents of the 12 springs of The Geysers which, according to the footnote, was made in 1888 by Winslow Anderson in a volume which will hereinafter be referred to.

Reference is made on page 38 to the Little Geysers, about 4 miles above The Geysers, and to the three small hot springs, seven hot pools and four vapor vents which were counted there, and also to the Socrates Quicksliver Mine about one mile southward of the Little Geysers, and to the relation of the quicksilver deposits to the hot springs having been mentioned in an earlier geological report.

The earliest reference found in the official documents is in the volume Geology, Volume 1, Geological Survey of California, published in 1865, which makes reference to the hot springs known as The Geysers. It also refers to the Little Geysers. On page 94 the following is states: (Appendix F)

"Both the water and the steam are highly charged with sulphuretted hydrogen and sulphurous acid, and the waters hold in solution a great variety of salts, especially sulphates of iron, lime, and magnesia; these salts, as well as crystallized sulphur, are deposited over the rocks in the canon, giving them a peculiar and vivid coloration, which is perhaps the most striking feature of the place."

In the Division of Mines Bulletin 139 of the State of California, entitled California Mineral Production for 1946, published in April, 1948, just a few years before the issuance of the patents here involved (Appendix G), it is stated at page 83:

> "The annual production figures for California mineral water refer to water actually bottled for sale, or for local consumption. Health and pleasure resorts are located at many of the springs. The waters of some of the hot springs are not suitable for drinking, but are very efficacious for bathing. California is particularly rich in mineral springs."

At page 84, it states:

> "Mineral water was bottled for sale at the Napa Soda Springs, Napa County, as early as 1856, and at other springs in California, notably The Geysers, Sonoma County, at early dates; but no production figures are available earlier than the year 1887."

Bulletin No. 21 of the California State Mining Bureau (Appendix H-1) showing by counties the mineral production of California for the year 1900, lists the following "minerals" under the classification "Non-Metallic: Borax, Coal, Mineral Waters, Salt and Miscellaneous" and under the listing of Mineral Waters, lists Sonoma County as the second largest in production of any county in California. (See also Appendix H-2.)

All of the above documents hereinabove referred to are official documents of the United States and of the State of California which the Court concludes are of great aid in determining the sepcific intent of the States in the reservation of "mineral waters" in Public Resources Code Section 4307.

Two other volumes of an unofficial character have come to the Court's attention, which the Court has concluded are particularly relevant, although they do not actually add anything to the official documents already referred to.

The earliest volume of a non-governmental nature is Mineral Springs and Health Resorts of California, published in 1892 (Appendix I), and is an elaboration of the prize essay awarded by the Medical Society of the State of California in 1889 to Dr. Winslow Anderson, the author. This volume is also written from the medical point of view and points out the therapeutic value of mineral springs and mineral waters. It gives a chemical analysis of the 12 springs and The Geysers which apparently have been the basis of subsequent reports, as hereinbefore and hereinafter mentioned.

The next is Mineral Waters of the United States and American Spas by William Edward Fitch, M.D., in 1927 (Appendix J), a volume of over 750 pages which, among other things, goes into the classification of mineral waters from the medical and chemical point of view, the ingredients therein, radioactivity, the physiological action of mineral waters, the therapeutic application of mineral waters in the treatment of disease and gives a list of the mineral springs of the United States, state by state.

Under "California" on page 231, it states:

"A large number of the springs of the state have been improved and used as resorts. The best known, probably, are The Geyser Springs, in Sonoma County which are a collection of fumaroles, solfatares and boiling springs."

At page 242, listed among the springs throughout the entire 48 states, in the section of California, is "The California Geysers" which sets forth a description of the area, the hotel and bathing facilities therein located, and describes the various springs and gives a chemical analysis and a medicinal classification for 10 of the springs in the California geyser area which is the chemical analysis of Dr. Winslow Anderson, made in 1887.

The Court has gone into such detail in setting forth the governmental documents and other treatises on "mineral waters" to establish that the term "mineral waters," when used by the California Legislature in its reservation in Public Resources Code Section 6407, did have a specific meaning.

The statistics referred to in the reports have been restricted to bottled water sold for drinking purposes which is the commercial aspect readily identified with quantity and value. The term "mineral water," however, cannot be restricted solely to drinking water. All of the discussion specifically extends to uses for bathing and medicinal purposes, and the therapeutic value to be derived therefrom. Under that meaning there can be no question that the steam and hot springs in the area of The Geysers and the steam vents and fumaroles, the external manifestation of the steam reservoir underlying the area, are "mineral waters." That the State intended to reserve "mineral waters" is expressed by the Statute itself.

It is conceded that at the time the patents were issued there was no knowledge on the part of either the State or the Patentees that the underlying conditions which gave rise to the steam vents and fumaroles in the Sulphur Creek area and The Geysers resort area were such as to extend to the patented land some considerable distance away.

The Court concludes that there is no difference between the hot springs, the fumaroles and the other surface manifestations of the underlying shallow geothermal reservoir, which, in view of the foregoing discussion, must be conceded to be "mineral waters," and the geothermal steam which is produced by the wells under the patented land, whether they be wells that tap a shallow reservoir of 500 to 2,000 feet or the deep reservoir of 3,000 to 10,000 feet. The steam presently being produced does have substantial mineral content of arsenic, boron, and ammonia which would put it in one of the many classifications of mineral waters set forth in the documents hereinabove referred to. Additionally, even apart from the aforesaid mineral content, the steam itself would place it into the "thermal" classification of mineral waters, which would have a therapeutic effect for bathing by virtue of the heat alone. Certainly, no distinction can be made in the waters by the difference that in the one instance the "surface manifestation" of "fumaroles, solfatras and boiling springs" has been brought about by nature, while in the case here involved man through his ingenuity and technical knowledge, has drilled to the depths of the earth to gather the same resource. There can be no question also that the "superheated steam" is "water" for the Patentees in many of their arguments as hereinafter pointed out have conceded this point.

For the reasons stated, the Court therefore concludes that the steam from the underlying reservoirs on the patented land, both in the shallow and deep reservoirs, are within the reservation of "mineral waters" as used in the Public Resources Code Section 6407.

The State being the owner of the "steam" hereinabove referred to by virtue of its being "mineral waters," may use it in any way it may desire, that is, for therapeutic purposes, for the production of electricity, or for any other use.

Certain arguments of Patentees will be considered.

Patentee Pariani argues that "heat" is not a substance and therefore not within the reservation. In this connection, it should be pointed out that heat is an essential part of the "mineral water" inasmuch as one of the breakdown of classification of mineral waters is Thermal and Non-thermal Waters. The thermal waters -- the superheated steam -- is what it is by virture of the heat and the heat is therefore an integral and essential part of the mineral water which is the subject of the reservation.

This also answers the contention of Patentee Emerson that all that each party wants is the heat and that the heat can be separated at the power plant and that the mineral parts of the condensate and the water can be then given to the State after the Patentees have used the heat.

Patentee Emerson also argues that the geothermal steam is not a mineral water because the California Resources Act of 1967 does not include "mineral water within geothermal resources." The Court finds there is no merit to this argument. First of all, the definition of geothemral resources in the 1967 Act is a broad definition which would include geothermal resources in detail and specifically includes steam. It is broad enough to include a dry hot rock geothermal system which would not have been included within the definition of "mineral waters" of the Public Resources Code being reserved by the State. Mineral waters would come only from a hydrothermal system whether vapor dominated or liquid dominated and not from a dry hot rock system. Secondly, with a detailed definition of geothermal resources which specifically included steam, there was no necessity for the mention of mineral waters either in the Statute or in the two State leases.

Patentee Pariani argues also that the fact that geothermal legislation was passed in 1967 subsequent to the deeds of the Patentees indicates that the State did not by its mineral reservation intend to reserve geothermal resources or that any geothermal resources were within the mineral reservation. Here, again, the argument is without merit. With the new resources being developed commercially, it would be necessary for the State through appropriate legislation to set forth the procedure for the orderly development and utilization of the natural resources to its maximum extent and to regulate the leasing and exploitation of the resource.

Additionally, as already pointed out, the new geothermal legislation is broad enough to include a dry hot rock geothermal system. While the hydrothermal geothermal systems produce steam naturally, which, under the Court's conclusion, falls under the reservation as "mineral water" such would not be the case insofar as a dry hot rock system. In the dry hot rock system, the steam would be produced only by injection of water, and it would not be the natural steam of the system itself.

The matter of the recharge in the geothermal system both by the surface and underground waters and by the reinjection of the condensate will be discussed in a subsequent portion of the opinion but the extent of the recharge does not in any way affect the Court's conclusion hereinabove set forth.

The Court also finds no merit to the argument of Patentee Emerson based on Section 3 of Article XIV of the State Constitution governing water resources. The Court concludes that that constitutional provision is restricted to the surface and ground waters and not applicable to the steam in the reservoirs in question. The steam is certainly not the type of water which was within the contemplation of the constitutional provision.

Additionally, it should be pointed out that both the State and the Patentees desire to make the same use of the "steam," which is water; that is, to use it for the production of electricity. Therefore, even if the constitutional provision were applicable, by virtue of the reservation of the State, the State as the owner would be the party entitled to the beneficial use of the "water" which would not be restricted to its use as water but to every property of the water. In this case, the heat being the factor which brings the water within the mineral reservaton, the State could make beneficial use of the heat which as stated is the same beneficial use for which the Patentees are contending.

Petitioner Emerson also argues that the heat in the steam, which is water, is similar to the force of gravity which is used to produce electricity by water in the hydroelectric systems. The Court finds no merit in this argument. The force of gravity is an extrinsic force brought to bear upon the water because of its physical location. Here the heat is an integral part of the water, and the very force which converts the water from its liquid state to its gaseous state, and makes it steam.

Geothermal Steam As "Gas"

It is the contention of the State that the word "gas" as used in Public Resources Code Sections 6401 and 6407 and in the mineral reservation clause in the patents hereinvolved includes the geothermal steam which is a "gas," while the Patentees contend that the word "gas" is restricted to hydrocarbon gas. (As hereinafter used, the word "Section" means Public Resources Code Section, unless otherwise noted.)

The Court has concluded that the term "gas" in Sections 6401 and 6407 and in the mineral reservation clause is restricted to "hydrocarbon gas" and not to all "gas," and that "steam" is not a "gas" within the said Sections or the mineral reservation.

The reasons for the Court's conclusion follow"

Section 6401, covering the reservation of minerals by the State at the time of the patents, provided that:

> "All oil, gas, oil shale.......are reserved to the State."

Section 6407, dealing with such reservation at the time of the patents, provided:

"Mineral deposits reserved to the State shall include all mineral deposits ...... including, but not limited to, oil, gas, oil shale..."

In the patents issued to the Patentees, the reservation reads as follows:

"..... reserving to the State of California all oil, gas, oil shale ..... and further reserving to the State of California the right to drill for and extract such deposits of oil and gas, or gas, and to prospect for, mine and remove such deposits of other minerals from said lands......."

Sections 6401 and 6407 are included in Division 6 of the Public Resources Code in a section dealing with "Public Lands" and are included in the particular section dealing with "Reservation of Minerals." Included in said Division 6 are other parts dealing with (1) leases for oil and gas and minerals; (2) leases solely for oil and gas; (3) leases for minerals other than oil and gas; (4) Sections dealing with oil and gas and mineral leases by public agencies, all of which sections use the term "oil," "gas" and "minerals."

Specific Definitions

Section 6004, which is the definition of "oil and gas" for all of Division 6 dealing with the Public Lands provides:

"Oil and gas includes oil, gas, and all other hydrocarbon substances."

Nowhere in said Division 6 of the Public Resources Code is there a definition of "gas."

Sections Dealing With Reservation of Minerals

Public Resources Code Sections 6401 and 6407 at the time the patents were issued and the sections herein involved as stated above used the terms:

"..... oil, gas, oil shale ....."

Sections Dealing with Lease of Oil and Gas and Minerals

Public Resources Code Section 6804 in effect in 1955 covering assignment, etc., of leases, or prospecting permits, provided in part:

"..... but, in the case of any lease for not less than two years after the date of discovery of oil or gas in paying quantities, or commercially valuable deposit of minerals .... and so long thereafter as oil and gas is produced in paying quantities..... shall continue in full force and effect for two (2) years and so long thereafter as oil or gas or minerals are produced in paying quantities....."

Public Resources Code Section 6804 in effect in 1955, dealing with cancellation, provided in part:

"The commission shall reserve and may exercise the authority to cancel any prospecting permit or lease upon which a commercially valuable deposit of minerals other than oil or gas has not been discovered or upon which oil or gas has not been discovered..... After discovery of a commercially valuable deposit of minerals other than oil or gas on land subject to any permit or lease issued pursuant to Section 6895, or after discovery of oil or gas in paying quantities on lands subject to any lease, such permit or lease may be forfeited ....."

Sections Relating to Oil and Gas Leases Generally

Section 6827 in effect in 1955, dealing with bidding, term, etc., as to oil and gas leases refers to the removal of oil and gas deposits, and provided in part:

"Leases for the extraction and removal of oil and gas deposits may be made by the commission ..... Such a lease shall include all oil and gas deposits in the leased land ..... for so long thereafter as gas or oil is produced in paying quantities."

Sections Dealing with Minerals Other Than Oil and Gas

Article 5 of Part 2, Division 6, relating generally to prospecting permits and leases of minerals other than oil and gas makes no reference to the word "gas" other than in the phrase in Section 6890:

"..... extraction and removal of minerals other than oil and gas or other hydrocarbons ....."

Sections Dealing with Oil and Gas and Mineral Leases by Public Agencies

Section 7051 in effect in 1945 provided:

"The board of supervisors ..... may ..... lease for the production of oil, gas or other hydrocarbons or for the mining of any other minerals whatsoever ....."

Section 7057 in effect in 1945 provided:

"The property of any municipality may be leased for the purpose of producing or effecting the production of minerals, oil, gas or other hydrocarbon substances ....."

General Discussion

With the absence of any specific definition of "gas" in Division 6 of the Public Resources Code dealing with "Public Lands" and with the use of the word "gas" in the manner hereinabove set forth in the sections as generally being restricted to "hydrocarbon gas," the Court concludes that

that was the intention of the Legislature when the word "gas" was used in Sections 6401 and 6407 in the reservation of "..... oil, gas, oil shale ....."

This conclusion is reaffirmed by the amendment of Section 6407 in 1975 wherein the phrase

> "..... oil, gas, oil shale ....."

was changed to:

> "oil and gas, other gases, including, but not limited to, nonhydrocarbon and geothermal gases, oil shale ....."

While the Court has refused the admission into evidence of certain leases and sales by the State made in effect after the commencement of the development of geothermal resources, the Court does note that no offer was made of any lease or sale or reservation under any of these provisions as to any "gas" other than hydrocarbon gas, notwithstanding the sections herein referred to and their predecessor sections have been in effect for many years.

The Court does note that in the reservation in the patents here involved, the reservation is of

> "..... oil, gas, oil shale ..... and reserving ..... the right to drill for and extract such deposits of oil and gas, or gas, and to prospect for, mine and remove such deposits of other minerals from said lands ....."

The Court must conclude that the phrase "..... oil and gas, or gas" contemplated the extraction of "gas" apart from the "oil," which, according to testimony in the trial, was not unusual.

The Court concludes, therefore, as hereinabove stated that the word "gas" does not include the "steam" here involved.

The Geothermal System As A "Mineral Deposit"

The Court has hereinabove concluded that by virtue of the steam being "mineral water" it was therefore reserved to the State and would come within the reservation of Public Resources Code Section 6407 as a "mineral deposit."

The State has separately urged that because the entire geothermal system is intricately involved with minerals both with its geological development and its present operation that it is *per se* a mineral deposit apart from its being "mineral water." In this regard mention is (1) made of the heat of the earth being the result of the radioactive decay of certain specified minerals, to wit: radium, thorium and potassium, (2) the intrusion of the magma which is a mass of molten minerals to a shallow depth, (3) the creation of the seal of silica through the circulation of the geothermal fluids in the fractured rock in the convection system. This has finally resulted in the geothermal reservoir from which the geothermal fluids, gases and steam are produced and from which the heat is removed for the generation of electricity.

The Patentees, on the contrary, state that none of the minerals involved as herein set forth have any commercial value and that all that is in fact here involved is "the heat of the earth" which is not a "mineral" and not a "substance" and therefore not within the reservation by the State as a mineral deposit.

Unquestionably, here we are dealing with a unique resource which may not fit in the ordinary and customary definition of "mineral" nor give the appearance or manifestation of ordinary minerals mined for the commercial value. Nonetheless, the Court concludes that the geothermal system is a "mineral deposit: as set forth in Public Resources Code Section 6407 even apart from the finding hereinabove made of "geothermal steam" being "mineral water."

The geothermal system is so inextricably involved with minerals in its geological development since the commencement of the earth to its present state that the conclusion is inescapable. It is conceded by all parties that the magma which has intruded to the shallow depth is from the radioactive decay of uranium, thorium and potassium; that the magma itself is a mass of molten minerals, that the rising and cooling of the geothermal fluids containing minerals penetrating the fractured rocks and the depositing of minerals have caused the formation of mineral veins and ultimately caused the impenetrable seal of silica to form which has created the geothermal reservoir. The reservation by Statute is of "mineral deposits" and there can be no conclusion but that the entire system must be considered as a mineral deposit. It is unrealistic to speak of the heat alone and by saying that it is not a "substance" nor a "mineral," and isolating it from the entire system to ignore the fact that in its entirety the geothermal system is the ultimate result of action of minerals which has been going on for millions of years and is still continuing.

In this case, nature in the production of heat in the geothermal system is doing what the subject of other minerals reserved, such as oil, gas, oil shale and coal, are generally sought for, that is, as a source of "heat" for the production of energy. Admittedly, the minerals can be used for other purposes as well, especially in the petro-chemical industry, just as the heat from hydrothermal systems may have other uses as has been above pointed out. In the very form in which the heat is carried to the surface, that is, in the geothermal steam, there are items of minerals, such as, arsenic, boron and ammonia, which remain in the condensate and are reinjected and there is also hydrogen sulphide which evaporates in the air and which is processed for the production of sulphur. Admittedly, the cost of the production of sulphur. Admittedly, the cost of the production of sulphur is more than ten times the value of the sulphur received and the production is more for environmental purposes than commercial. This is pointed out to indicate that from beginning to end there is a great involvement of the minerals of the world to such an extent that the inevitable conclusion is that what we are speaking about here is a viable mineral deposit which is in active operation.

The Court concludes therefore that The Geysers geothermal system is a "mineral deposit" within the provisions of Public Resources Code Sections 6041 and 6407 and within the mineral reservation of the State in the patents of the Patentees.

Other Matters

Substantial testimony from experts was adduced by both the Patentees and the State on the following matters:

1. Whether there is a natural recharge in the geothermal system from the meteoric waters, and the effect and results of the tritium testing, the deuterium analysis, the fluctuation in the Oxygen 18 - Oxygen 16 ratio, the relation of temperature versus production, and the effect of present rainfall on the system;

2. Whether the geothermal system at The Geysers is a depletable resource;

3. What other uses can be made of the geothermal steam;

4. The deleterious effect of the condensate;

5. The effect of the geothermal operations on the use of the surface area by the Patentees.

In regard to the aforesaid testimony, it must be pointed out that in the only Appellate decision involving the question before this Court, which decision also involved some of the Patentees and The Geysers, the same geothermal system here involved, the United States Court of Appeals for the Ninth Circuit by summary judgment determined that the mineral reservation in patents issued under the Stock-Raising Act of 1916, 43 U.S.C. Section 291, et seq., reserved to the United States geothermal resources underlying the patented lands. That case is the United States of America vs. Union Oil Company of California, Court of Appeals Ninth Circuit No. 74-1574, 549 Fed. 2d 1271. A petition for Certiorari before the Supreme Court of the United States has been filed. The Court therein based its opinion on the legislative intent as manifested by the Congressional hereings in the adoption of the Act in question in effect to grant to the purchasers of the land only the surface rights in the land therein involved.

The case was decided on the motion for summary judgment, the Court stating that the facts necessary for the decision were not in dispute and the appeal presented only questions of law as to the interpretation of the statute. The Court did not believe it necessary to determine questions of fact as to the nature of geothermal resources.

The Court is also mindful of the Reich case before the Tax Court of the United States (52 T.C. 700), decided in 1969, also involving The Geysers geothermal system, which was before the discovery of the deep reservoir at The Geysers. Some of the testimony of the experts in that case has since been found to be in error by virtue of the subsequent discovery of the deep reservoir. The Court is mindful that time and subsequent discovery and exploration have caused experts to revise their opinions, and that this may well be the case as to the opinions expressed before the Court as far as discovery and exploration may continue in the future.

As far as the matters hereinabove referred to, the Court has made the following determinations based upon what it finds to be the preponderance of the evidence:

1. Recharge. The Court concludes that there is some natural recharge in the system. The testimony as to the results of the tritium testing the Court finds to be in hopeless confusion and conflict in that (a) two separate laboratories came to different conclusions while testing samples from the same source; (b) there were admitted errors by the laboratory which did find the tritium; (c) questions were raised as to the correction factor used to compensate for the admitted error in the testing; and (d) questions were raised as to the methods of collecting the samples for the testing.

The Court did note the testimony as to the effect of the excessive rainfall in a particular year on the geothermal system.

Mindful that every geothermal system is peculiar to itself, nonetheless, it is conceded by all that there is natural recharge in the Larderello system, also a vapor dominated geothermal system.

However, conceding the finding of natural recharge, the evidence as to the amount of recharge is such that the Court can only concluded that it does not play any substantial factor in the determination of the issue which the Court has heretofore resolved. The largest amount of recharge testified to was 10%, the basis for which figure was never satisfactorily explained. The Court has determined that the amount of recharge is uncertain. Even conceding the amount to be 10% for the sake of argument, the Court finds that it would be insufficient to sustain the conclusions contended for by the Patentees.

2. Depletion. The Court has concluded that The Geysers geothermal system is depletable. There was no testimony as to what the specific life expectancy The Geysers geothermal system would be as a productive system. The Court has concluded that it will not continue to be productive indefinitely and that it will terminate some time in the future. It was also testified that the Larderello system was possibly nearing its end and that in The Geysers some of the wells have had to be abandoned while new ones have been developed.

3. Other Uses of the Geothermal System. There was much testimony as to uses of the geothermal steam other than that of the generation of electricity. Admittedly, geothermal steam has been used in other places for other uses depending in part on the particular location and needs of the area.

However, in The Geysers geothermal area, because of the natural terrain and the general area, as of now, the only productive use has been that of the generation of electricity. This is because the steam must be used in the area where it is discovered and cannot be transported as in the case of other resources.

The nature of other uses of the geothermal steam the Court concludes would not in any way be relevant to the question of ownership of the geothermal resource.

4. The Deleterious Effects of the Condensate. There was substantial conflict as to the effect of the boron, the arsenic and the ammonia in the condensate. The Court can only conclude that the condensate in its condition immediately after the generation of electricity is deleterious to the environment. This is substantiated by the fact that the Lessees have had to devise a method of reinjection into the wells for its disposal after the governmental

agency has prohibited its disposition on the surface. However, whether or not the condensate is deleterious does not in any way affect the question of the ownership under the patent and the reservation.

5. The Effect of the Geothermal Operations on the Use of the Surface by the Patentees. It is generally conceded that in the removal of mineral resources there cannot be unreasonable injury in the enjoyment of the surface area by the owners of the land. In making this determination, the totality of the circumstances must be reviewed to determine the effect of the removal of the mineral resources upon the use of the surface area. The area herein involved is a sandy, rocky, steep, mountainous area. It is poor grazing land and its only value is for hunting and watershed protection. It is of no value for agricultural purposes. No permanent residences have been erected in the area and the land has been used only for hunting.

While the use of the geothermal resources for the generation of electricity does involve the use of the surface area, the Court concludes that it is not a use to such an extent that it will vitiate the right of the owners of the geothermal resources to use it for the generation of electricity. We do not have a situation of open pit mining where the effect of the utilization of mineral resources is the complete disruption of the surface area for its beneficial use.

At the Larderello geothermal field, the surface area has been used productively for agricultural purposes and the wells, the gathering lines and the power plant have not substantially affected the productive use of the land. In The Geysers area, there has been no testimony that since the development of the geothermal field for the generation of electricity there has been any change in the use theretofore made of the surface area. As pointed out, the surface use has a very limited potential which has in no way been affected by the drilling of the wells, the gathering lines and the power plant

Case of Defendant, Cross-Defendant and Cross-Complainant, Union-Magma-Thermal

The case of Defendant, Cross-Defendant and Cross-Complainant, Union-Magma-Thermal, against the State of California involves the right to interest on certain royalty monies which the State of California had on deposit for a certain period of time and would have to return in the event the State was unsuccessful in this litigation. As the Court has here concluded that the State by its reservation is the owner of the geothermal steam, the Defendant, Cross-Defendant and Cross-Complainant, Union-Magma-Thermal, has no claim to the interest on the money for the period in question.

Judgment

JUDGMENT IS ORDERED as follows:

1. For the Defendant and Cross-Complainant, State of California, and against Plaintiff and Cross-Defendant Pariani, Cross-Defendant and Cross-Complainant Ottoboni, and Cross-Defendant and Cross-Complainant Emerson, declaring ownership of the State of California in the geothermal resources here involved and quieting title of the State of California to said geothermal resources; and

2. For the Defendant and Cross-Complainant, State of California, and against the Defendant, Cross-Defendant and Cross-Complainant, Union-Magma-Thermal, as to the claim for interest.

Judgment and Finding of Facts and Conclusions of Law, if requested, are to be prepared by the Defendant and Cross-Complainant, State of California.

DATED: June 30, 1977.

Lawrence S. Mana
Judge of the Superior Court

TITLE X—TO CONVEY CERTAIN GEOTHERMAL RESOURCES TO THE CITY OF BOISE. IDAHO

SEC. 1001. (a) The Congress hereby authorizes and directs that the rights to the geothermal resources, including minerals present in the geothermal fluid, presently vested in the United States of America in real property designated as Tract 37 (contained in secs. 2 and 11) consisting of 4.13 acres, more or less; Tract 38 (contained in secs. 1, 2, 11 and 12) consisting of 449.16 acres more or less; Tract 39 (contained in sec. 2) consisting of 14.64 acres, more or less; and Tract 40 (contained in sec. 11) consisting of 4.95 acres, more or less: all in T. 3N., R. 2E., B.M.; together with a parcel described as follows: Commencing at the southwest corner of the Old Fort Boise Military Reservation, thence north seventy degrees zero minutes east one thousand four hundred forty-eight and two-tenths feet; thence north four degrees thirty-two minutes east six hundred and twenty-seven feet to the true point of beginning; thence the following courses and distances: South eighty-seven degrees eight minutes west six hundred ninety-six and five-tenths feet; thence north twenty-one degrees two minutes west five hundred and thirty-two feet; thence south sixty-nine degrees four minutes west twenty-one and nine-tenths feet; thence north twenty-two degrees forty minutes west eighty-six and three-tenths feet; thence north eighty-four degrees fifty minutes east nine hundred ninety-three and six-tenths feet; thence south four degrees thirty-two minutes west six hundred twenty-four and ninety-five one-hundredths feet to the point of beginning; consisting of 11.53 acres, more or less (contained in sec. 11, T. #N., R. 2E., B.M.); be transferred by the Secretary of the Interior in fee to the City of Boise upon payment by the City of Boise of the fair market value, as determined by the Secretary, of the rights conveyed.

(b) Development of geothermal resources pursuant to this Act shall not be grounds for the Secretary of the Interior to assert the reversionary interest of the United States in the subject lands.

SEC. 1002. Development of the geothermal resources conveyed by this Act shall not unreasonably interfere with development of other mineral interests retained by the United States. The City of Boise shall permit the United States, its lessees and agents access for exploration of mineral resources not conveyed to the City.

Mr. CHURCH. Mr. President, this amendment transfers the geothermal resource rights on 485 acres of land from the United States to the city of Boise, Idaho. The city will use the geothermal resources for space heating residences and commercial buildings in the business district. The transfer would occur when the city pays the Federal Government the fair market value for the rights.

The amendment transfers only the geothermal resource rights. It does not transfer mineral rights or other rights to the city. The amendment has the full support and endorsement of the Department of the Interior and Energy, the State of Idaho, and the city of Boise. I ask unanimous consent that letters of support for the transfer be printed at this point in the RECORD.

There being no objection, the letters were ordered to be printed in the RECORD, as follows:

U.S. DEPARTMENT OF THE INTERIOR,
Washington, D.C., September 27, 1978.
Hon. FRANK CHURCH,
U.S. Senate,
Washington, D.C.

DEAR SENATOR CHURCH: We have reviewed your draft bill, "To transfer rights to certain geothermal resources and related minerals to the City of Boise." We have no objection to the draft bill if it is amended to provide that the City of Boise is to pay the fair market value of the resources conveyed.

The proposed bill would direct the Secretary of the Interior to transfer in fee to the City of Boise rights to geothermal resources, including minerals present in the geothermal fluid, presently vested in the United States.

A review of information available to the U.S. Geological Survey reveals that the resources involved in the bill are of relatively low value and of limited extent. Although we have not determined the amount of royalty that would be paid to the Federal Government if the resources were leased pursuant to the Geothermal Steam Act, we believe that the amount would be nominal. We estimate that if the resources were offered for competitive bids, the bonus bids would be $5 per acre or less; there is a possibility that we would receive no bids at all. (A recent geothermal lease sale in Klamath Falls, Oregon, involving a similar resource, yielded no competitive bids.)

The Geothermal Steam Act, unlike the Federal Coal Leasing Amendments Act, contains no provision authorizing exemption from the competitive bidding requirement of the Act when a public entity seeks to develop a mineral resource. A Task Force within the Department is considering recommending amendment of the Geothermal Steam Act to include such a provision.

In view of the small royalty which would probably be received if the resources involved in the draft bill were offered for competitive bids and the apparent benefits to the public from the demonstration project which the Department of Energy proposes to establish with the City of Boise, we do not object to legislation to permit the Secretary of the Interior to convey to the City of Boise without competitive bidding rights to the geothermal resources in question.

As noted above, we believe that the City of Boise should be required to pay the fair market value of the interests conveyed by the United States. Such a provision is consistent with the requirement in the Federal Land Policy and Management Act of 1976 that the United States receive a fair return when public resources are leased or sold. We, therefore, recommend that the following phrase be added after "to the City of Boise" in section 3, "upon payment by the City of the fair market value, as determined by the Secretary, of the rights conveyed."

We have several additional comments on the draft bill. Some of the surface overlaying the geothermal resource has been patented under the Recreation and Public Purposes Act (43 U.S.C. 869 *et seq.*), with reversionary interests in the United States should the purposes for which the surface was conveyed be abandoned. We believe that it is advisable to state in the bill that the City of Boise is authorized, notwithstanding restrictions in the deeds, to develop the geothermal resources conveyed in the bill. We, therefore, recommend that section 3 of the bill be amended by adding a second sentence, to read as follows:

"Development of geothermal resources pursuant to this Act shall not be grounds for the Secretary of the Interior to assert the reversionary interest of the United States in the subject lands."

In addition, since only the geothermal and not the other mineral interests are being conveyed by the bill, we recommend that a section 4 be added to the bill, to read as follows:

"Development of the geothermal resources conveyed by this Act shall not unreasonably interfere with development of other mineral interests retained by the United States. The City of Boise shall permit the United States, its lessees and agents access for exploration of mineral resources not conveyed to the City."

The Office of Management and Budget has advised that there is no objection to the presentation of this report from the standpoint of the Administration's program.

Sincerely,

GARY R. CATRON,
Assistant to the Secretary and Director of Congressional and Legislative Affairs.

DEPARTMENT OF ENERGY
Washington, D.C., October 10, 1978.
Senator FRANK CHURCH,
Chairman, Subcommittee on Energy Research and Development, U.S. Senate, Washington, D.C.

DEAR MR. CHAIRMAN: In behalf of the Department of Energy (DOE), I am very pleased to have an opportunity to comment on the draft bill which you intend to introduce in the Senate, transferring the rights to certain geothermal resources and related minerals to the City of Boise.

For the past two years DOE and a predecessor agency, ERDA, have enthusiastically supported planning efforts of the City of Boise to develop and demonstrate the country's first modern, urban geothermal heating district. We therefore view the project as particularly important for demonstrating direct thermal application. We understand that Boise's commitments to its projected first-stage geothermal heating system now amount to 2 million square feet of space, and that the City is working to finance construction of the system from among a range of available funding sources. Savings which the project planners anticipate appear to be in the order of 25 percent of next year's fuel costs in Boise and the equivalent of 20,000 barrels of oil annually, even without taking newly proposed Federal incentives into account.

For these reasons we strongly support the draft bill which you intend to introduce. However, we defer to the views of the Department of the Interior with respect to technical and land management matters associated with the transfer, including the question of whether the City should pay the fair market value for the rights involved.

We also wish to offer for your consideration a number of minor changes in the bill's description of the property and resources involved. These changes are indicated in the enclosure.

The Office of Management and Budget has advised that there is no objection to the submission of this report from the standpoint of the Administration's program.

Sincerely,

LYNN R. COLEMAN,
General Counsel.

Mr. CHURCH. Mr. President, favorable action on this amendment will allow the city of Boise to commence work on a nationally significant geothermal demonstration project, and will give us additional knowledge and confidence to develop direct geothermal heating for many of our cities.

Mr. President, having explained the amendment and it having been cleared on both sides of the aisle with the Budget Committee, I move its adoption.

APPENDIX D.

Environmental Data

NOTE: This draft environmental report may be used to supplement and expand findings of Environmental Assessment Record #ID-010-7-88, Geothermal Leasing on Boise Front (June 8, 1977) Bureau of Land Management; "Geothermal Drilling Plan for Boise Barracks Area", Preliminary Boise Geothermal Energy Systems Plan (April 1977), Boise City, Energy Office; and "Environmental Assessment: State of Idaho Alternative Energies Feasibility/Demonstration Heating Project" (December 1976), Idaho Department of Water Resources.

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PREFACE

This report has been prepared as part of the City of Boise program to demonstrate the technical, economic, environmental and organizational feasibility of using low temperature geothermal fluid for a large scale space heating system. This document presents the environmental effects associated with the proposed geothermal space heating system for commercial and public buildings in downtown Boise.

This draft environmental impact assessment (EIA) does not address any specific Federal action required in support of the proposed project, although the potential for such Federal action exists in conjunction with the proposed project. In advance of a formal request to prepare an environmental impact assessment, the City of Boise has offered to prepare an EIA that could be used by Federal agencies in satisfying their environmental requirements, if and when needed. Because the proposed project is energy-related and the U.S. Department of Energy (DOE) guidelines appear to be most comprehensive - this EIA has been prepared in accordance with DOE guidelines contained in ID CFR711 and CFR 790.

In the fall of 1978, the U.S. Department of Energy announced its intent to fund a portion of the City of Boise proposal to design and construct a demonstration geothermal space heating system. It is anticipated that the Department of Energy would assume the lead agency role in the formal Federal environmental review process. This process would commence after a signed contract has been approved by the program participants. The draft EIA presented here has been designed to satisfy the department's need for an environmental report. An independent review conducted by the DOE will determine its adequacy. The DOE then will make a determination of environmental significance. The determination could lead to either the preparation of an environmental impact statement or a negative declaration, depending upon the finding of the department.

INTRODUCTION

The proposed project will supply geothermal fluid for space heating twelve commercial and public buildings in downtown Boise. The geothermal system will include supply wells and pumps, distribution and collection systems, pumphouses and controls, and reinjection wells. The proposed location for the supply wells is the Military Reserve; the exact location within the confines of the reserve will be determined following geologic studies to locate the most favorable drilling sites. The withdrawn geothermal fluid will be piped to 12 buildings in the central Boise business district for space heating. Changes to the buildings conventional heating systems will be required to use this energy. The geothermal fluid will cool during use. This spent fluid will be collected and reinjected into the earth via deep wells.

The proposed project has been conceived as a demonstration. The project will be helpful in providing evidence of a suitable geothermal resource, adequate cost data and economic analysis, potential energy savings and transferability to other uses. Once the practicality of the system is learned, system modifications and expansions are anticipated. These could include residential space heating, secondary uses of the geothermal fluid before reinjection, and alternative disposal methods for spent geothermal fluid.

STATEMENT OF THE PROBLEM AND PROJECT OBJECTIVES

A major national concern is the availability of adequate sources of energy to supply national needs. Essential national expenditure of energy resources appears to be exceeding a long-term energy budget, as reflected in known reserves. This national concern translates to local communities in the United States as a series of specific problems in supply and demand. For the Boise metropolitan area, a number of supply and demand problems exist in many sectors of the community. These include availability of gas for general public and commercial use; fuel oil for industrial and agricultural purposes; and natural gas for public and private uses. The City of Boise cannot deal effectively with many of these problems because the necessary societal and institutional mechanisms are either not available to local government or are not feasible.

Boise is one of the most rapidly growing cities in the United States, measured both by population increases and improved economic conditions. This growth has been accompanied by continuing downtown redevelopment and construction of new public and private buildings. This activity includes new state buildings, new county, and city government buildings, and new commercial construction. Residential construction is also occurring at a high rate in all Boise City communities. All of these buildings require energy for space heating, and known or probable geothermal energy reserves could supply these requirements. The fundamental need is to develop appropriate, long-range plans and institutional mechanisms to meet this requirement. The City of Boise has just completed preparation of a preliminary plan to develop a geothermal heating system for the city and preliminary engineering designs for a demonstration geothermal project. The principal topical areas addressed in the plan have included:

Provision of heat to public and commercial buildings

Definition of the approximate location and extent of sources of geothermal energy

Institutional alternatives for the development and operation of the resource

Legal implications of the rights to, or ownership of, this resource; and disposal of wastewater resulting from its use

Possible public and private incentives that would encourage commercialization of the use of this resource

The first problem that must be addressed in conjunction with the geothermal project will be demonstrating the practicability of the various aspects of the geothermal system development. For this reason, this will be a demonstration project. The city believes much remains to be learned about system operations and system economies. The demonstration project will provide reliable data concerning the use and disposal of geothermal waters that would help refine any future expansion of the system. Hopefully, the demonstration project will describe the technical and cost details of the heating system, and will provide more detailed investigation of the effects of the selected disposal method.

PROJECT DESCRIPTION

GENERAL

The proposed geothermal system will include supply wells and pumps, the distribution and collection systems, pumphouses and controls, and the reinjection wells. The supply wells will be drilled in the Military Reserve; reinjection wells are tentatively located near the Boise River.

The proposed supply system will enter the downtown area at about Fifth and State Streets, and will initially provide service connections to 12 public and commercial buildings. The original investigation considered several buildings unsuited for retrofit during this phase of development. In these buildings, the heating system retrofits were either uneconomical or the buildings were remotely situated from the proposed mains. During later phases of development, these buildings as well as residences could be considered as potential geothermal customers. Future residential customers would include the low income and the elderly located in either the North End or River Street areas.

Both the supply and collection lines are proposed to be oversized to facilitate future expansion. All selected building heating systems will require alterations to allow the use of geothermal water for heating. Most of the systems will be monitored to gather data for evaluation of the cost effectiveness of the geothermal energy systems.

LOCATION

The proposed geothermal project will be located within the incorporated limits of the City of Boise, Idaho. Boise, the largest city in the state, is located in southwest Idaho (Figure D-1). The system components will generally be located in Sections 2, 3, 10 and 11 of Township 3 North and Range 2 East (approximately 43°37' by 116°13').

The head of the system will be composed of a well field at the Military Reserve in the northeast part of the city (Figure D-2). The supply system and collection system will be a subsurface pipeline located in a narrow utility corridor within public rights-of-way as much as practicable. The pipeline corridor shown in Figure D-3 would enter the downtown area at Fifth and State Streets. The system would branch from that point serving 12 buildings in downtown Boise. A spent geothermal fluid collection system would parallel the supply main. The collection system will deliver the spent fluid to a reinjection well(s) for disposal. The location of the well(s) would be in the area bounded by Broadway Avenue, Americana Boulevard, Main Street, and the Boise River. A specific site will be selected in this area following further study and coordination with local governmental bodies.

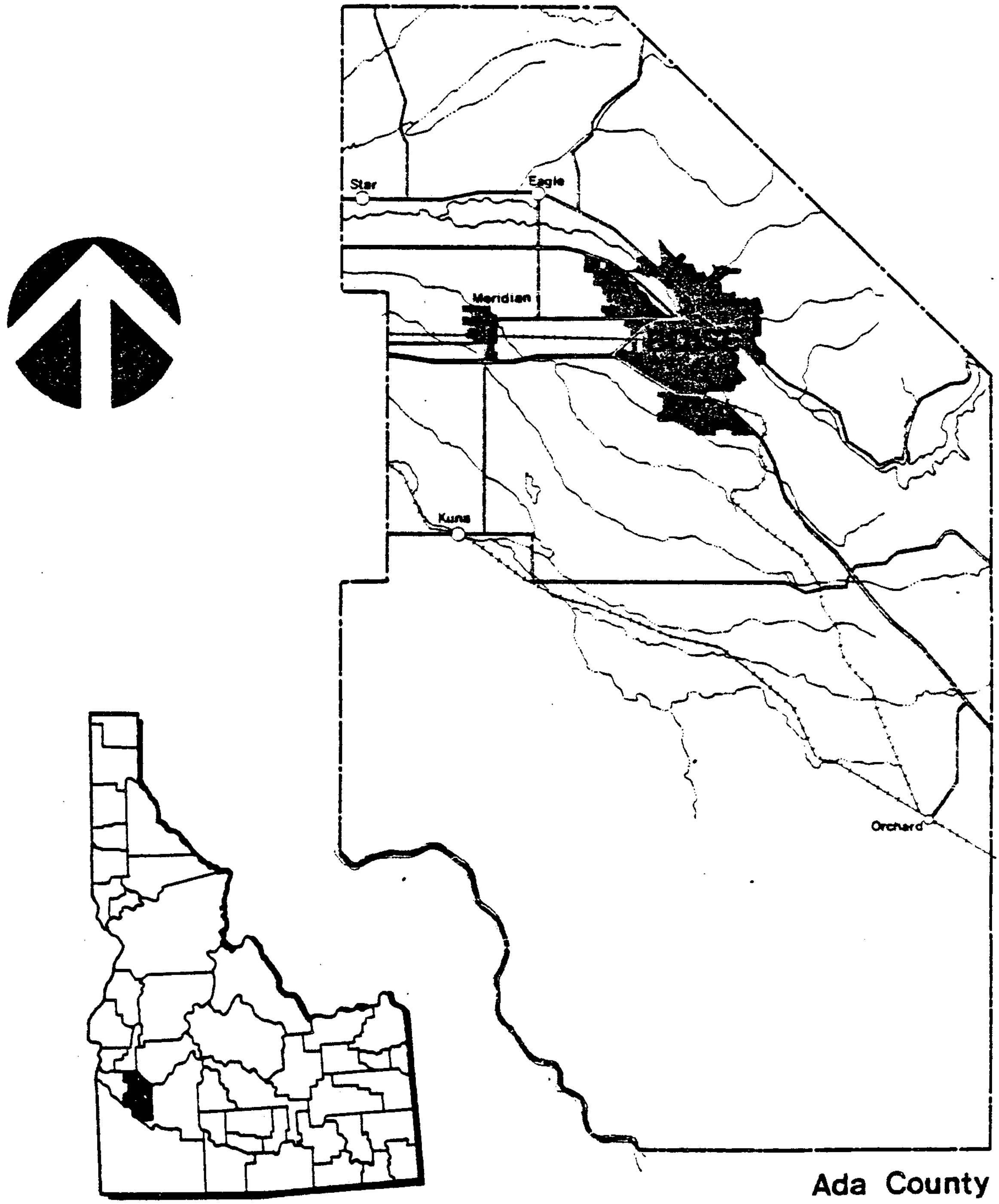

Figure D-1. Regional Setting

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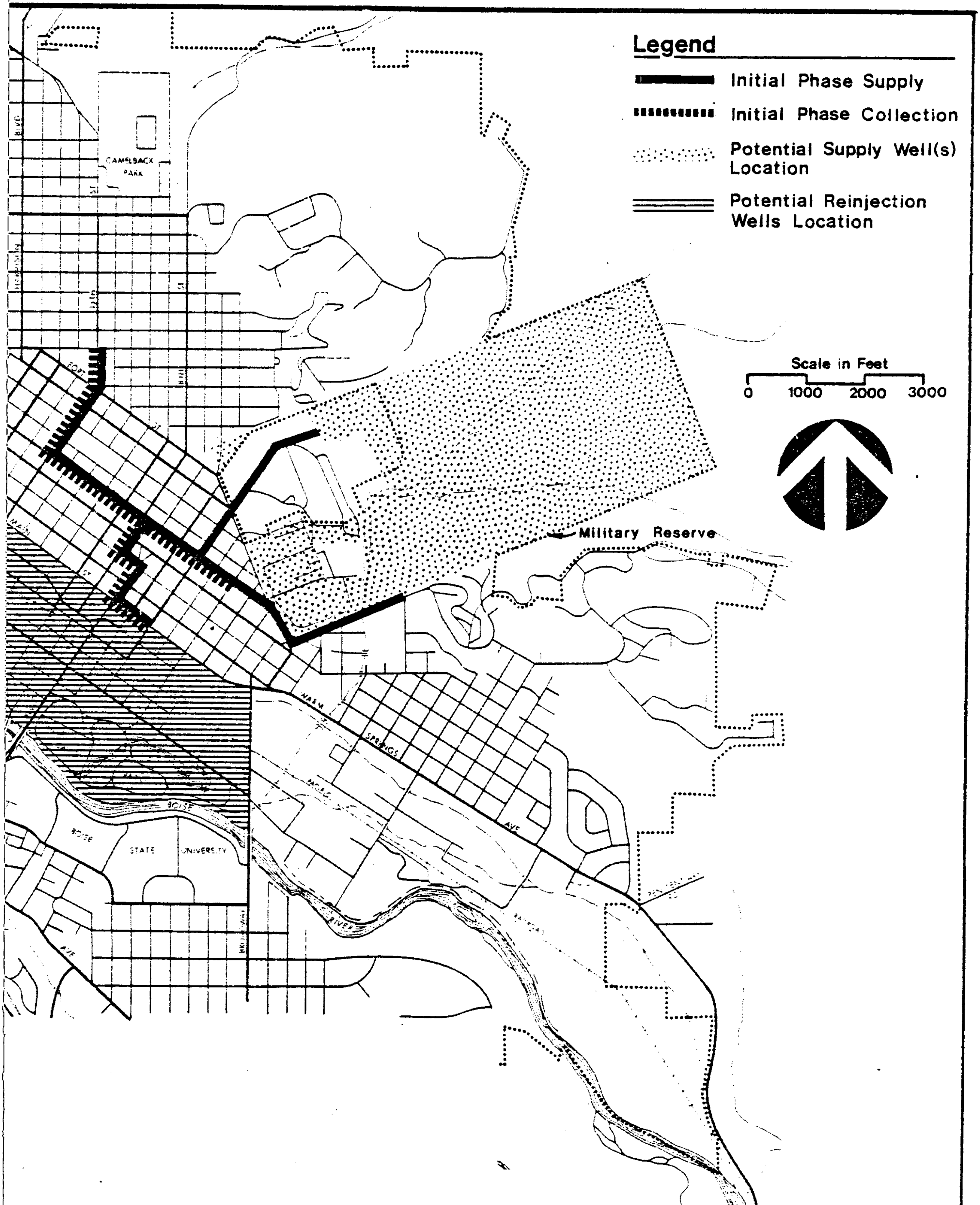

Figure D-2. Project Plan

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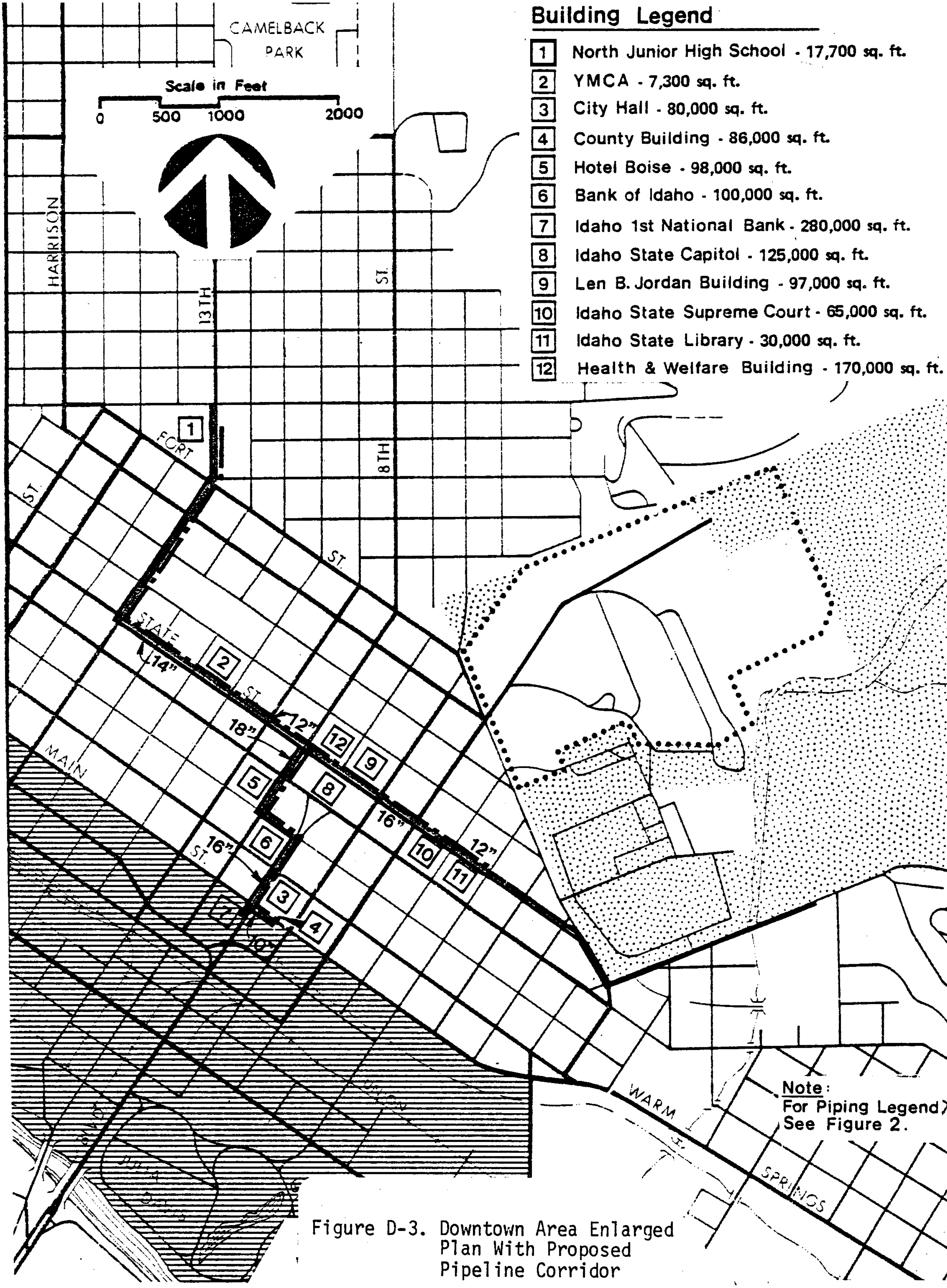

Figure D-3. Downtown Area Enlarged Plan With Proposed Pipeline Corridor

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A variety of studies including geological, geophysical, and hydrological show the Military Reserve to be a principal area for geothermal development. The Military Reserve is a large parcel of land (482 acres), one of two parcels in the Boise area on which geothermal well drilling of any extent has taken place. The reserve is comprised of ten tracts of land, Figure D-4 which was originally owned in its entirety by the Federal government. Eight tracts (tracts 37, 38, 39, 40, 43, 44, 45, and 46) representing the majority of the land area have been patented or deeded by the Federal government to the City of Boise between the years 1950-1969. Two smaller parcels (41 and 42) are Federal properties occupied by the Veterans Administration Hospital and other Federal buildings.

Recent Congressional and Presidential actions have released the geothermal rights once retained by the Federal government on tracts 37, 38, 39, and 40 to the City of Boise. This action now clears the way for the City of Boise to develop the geothermal resource on these key tracts of land. The Federal government reserved only "fissionable materials" on tracts 43, 44, 45, and 46. The geothermal resource on these tracts is available to the city. The Federal government continues to retain the surface and subsurface rights on parcels 41 and 42.

PROJECT FEATURES

The project will consist of five basic elements: 1) the well field, 2) supply main and collection pipeline, 3) retrofit mechanism, 4) spent geothermal water disposal system, and 5) site restoration. This section will describe the features of each of these principal parts.

<u>The Well Field</u>

The well field development will be preceded by an extensive geological analysis to determine the most suitable location for the initial well within the limits of the Military Reserve. The well field development will begin by drilling one well and testing for a variety of parameters, including flow rate, temperature, drawdown, resource magnitude, water quality, and material testing for screens and casing.

If satisfactory test results are achieved, the test well will continue in operation as a production well. Data gathered from the initial well will be helpful in determining the location for a second and third well. Ideally, this demonstration phase will require three wells to produce the necessary supply. Recent drilling experience in the Military Reserve suggests that the geothermal wells can be developed at a depth of approximately 1,200 feet. In order to achieve a planned production rate of 800 to 1,500 gallons per minute (gpm) per well, the well casings will be approximately 14 inches in diameter.

<u>Drilling</u>. The drilling will be performed in strict accordance with the guidelines and regulations of the State of Idaho Department of Water Resources. This will include disposal of cutting fluids, providing proper seals, logging geologic data, and recording test procedures. Approximately two months will be required to drill each well. It is recommended

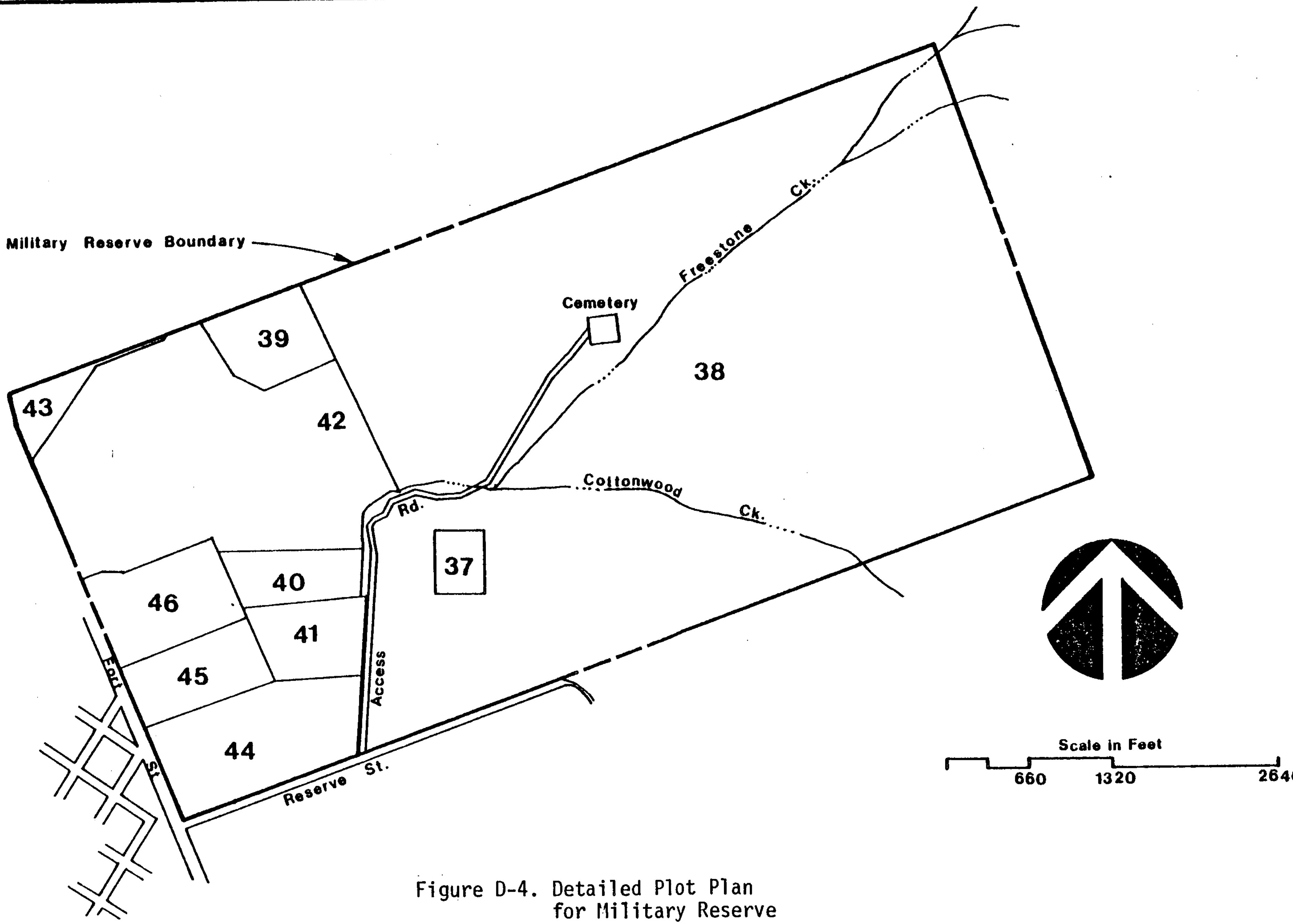

Figure D-4. Detailed Plot Plan for Military Reserve Park

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that cable rather than rotary drilling methods be employed to minimize the amount of mud and water discharged at the surface. Materials which are discharged from the well hole will be containerized and regularly disposed of at a licensed landfill site.

Well Testing. After penetration of the reservoir, tests will be performed to determine the production rate, quality, and composition of the geothermal resource. Testing at the initial well will involve an extensive period of investigation for up to ten days. Periodic tests will follow, extending over a period of several months. One of the tests will be a production test for a period of at least 12 hours with a pumping rate at approximately 200 gpm. The production test will require more than 150,000 gallons of water to be disposed. Production test waters will be discharged to the retention basins for the Cottonwood drainage area on Reserve Street. The water will be conveyed to the second basin in series. Normal practice involves diverting the flow in Cottonwood Creek through the first basin. To avoid heating this water, the second basin, which is dry, will be used. The geothermal fluid from the production tests would be contained in the basins and allowed to percolate through the bottom of the basin or evaporate. The maximum quantity of hot water to be disposed is so small, there is no danger of jeopardizing the floodwater storage capacity of the basin.

Site and Road Preparation. Drilling activities in the Military Reserve may require the construction of some minor access roads. Where possible, the access roads will be constructed to disturb a minimum area by using existing roads when available or by following the natural topography.

Each proposed well site will be cleared, leveled, and compacted for an area of 1,000-1,500 square feet to provide for drill pads, other equipment, and storage areas at each site during construction.

Pumps, Pump Control, and Pumphouses. The geothermal well pumps will be continuous duty vertical turbine types suitable for pumping 170°F geothermal waters. Pump bowl settings are assumed to be 400 feet. Pumps will be sized to deliver 50 pounds per square inch (psi) of line pressure or a total dynamic head of approximately 515 feet. Pump bowl settings and actual flow rates of the pump cannot be determined until after the well tests have been performed. A flow rate of 1,000 gpm for each well was assumed. Based on this assumption, the pump brake horsepower (hp) will be 185 hp with a pumping efficiency of approximately 70 percent. One or more of the geothermal well pumps will need to be equipped with variable speed drive so that well production can be regulated to match the system demand at any given time.

Pump control is critical. The volume and pressure of the geothermal water supply must match closely the varying demands of the system. Several measures will be incorporated to provide this control. Pump control valves will be used to eliminate pressure surges caused by the starting and stopping of the deep well geothermal pumps. These valves will be hydraulically operated so that the rate of valve operation can be adjusted to match the operation of the pump and the system. In addition, pressure and vacuum relief valves will be installed near the pumps and at system high points to vent air and gases from the supply system.

A combination of variable speed and fixed speed pumps will be utilized to match hot water production more accurately with the actual system demand. The speed of the variable speed motors will be automatically adjusted in response to system pressure and flow rates.

Pumphouses for the supply wells will be subsurface concrete structures. The buildings will be sized as necessary to shelter all of the equipment. It is estimated that their size will be about 200 square feet. Landscaping is planned around the surface of the structure.

Normally unoccupied, the pumphouses will require minimal heat to prevent freezing of any exposed cold water piping. Thermostatically controlled unit heaters will be installed for this purpose.

Electrical power will be supplied to the buildings at 480/240/120 volts for general power, lighting, control, and the operation of repair or maintenance tools.

Potable water will be made available at each pumphouse for cleaning and maintenance purposes. Floor drains and sink drains will be connected to the nearest sanitary sewer line.

Well Siting. The selection of well sites and designs for the facility to be located in the Military Reserve will be reviewed with the City of Boise Parks Department prior to any final decisions.

Supply Main

The supply main will run from the well field to 12 major buildings in downtown Boise - Figure D-3. The pipeline will be constructed of asbestos cement material, with necessary connections and isolation valves. The pipeline will be about 13,000 feet long and 16 inches in diameter, with a design capacity of approximately 5,000 gpm. It will be buried approximately three to four feet beneath the ground surface and will lie as much as practicable within public rights-of-way.

Portions of the supply main will be sized to allow for future expansion of the system. It is anticipated that the largest demand will be in the downtown area along Eighth Street to Bannock and from Bannock to Capitol Boulevard. The pipelines passing through residential areas will be sized to accommodate potential future residential users, including the low income and the elderly. Service connections will be provided at major street intersections in residential areas for future use.

The pipeline trench will nominally be excavated to a depth of four feet, and finish grade will be established by hand. A minimum depth of six inches of pipe bedding material such as 1/4-inch-minus gravel will be placed into the trench. The pipe will be laid to establish grades on pipe chairs or blocks, and insulated with three inches of foamed-in-place polyurethane foam. The pipe zone material will be placed and properly tamped to minimize settlements to pavement, sidewalks, curbs, etc.

During construction, a minimum amount of trench will be open at any one time to reduce hazards and inconvenience to the general public. Each completed section of pipeline will be subjected to a hydrostatic pressure test to 150 percent of the normal operating pressure to ensure its integrity. A periodic maintenance check will be conducted to check for leaks or breaks.

Isolation valves will be located in the supply main at all critical branches to allow for system maintenance and repair. The valves will be gear operated butterfly valves with valve boxes clearly marked. Valve materials will be compatible with the geothermal water.

A flowmeter will be installed in the service line for each building to determine the quantity of water used by each building. The meter will have the accuracy required for billing purposes.

Collection Line

Initially the collection line will run from all of the retrofitted buildings to the common injection well(s). This line will be sized conservatively to provide additional system capacity for the future.

The line will range in size from 12 to 18 inches in diameter. The pipe route will parallel much of the supply main. The pipeline construction techniques will be similar to those discussed under the supply main.

Building Retrofit Mechanism

The geothermal hot water system will provide service connections to 12 buildings in the Boise central business district. The buildings are commercial and governmental structures having a total of 1.16 million square feet; and their locations are indicated on Figure D-3. The five State of Idaho buildings are tenatively planned for inclusion in the system. The heating systems in these buildings currently use oil, natural gas, or electrical energy. The building retrofit will vary depending upon each building heating system. Typically, a heat exchanger will be mated to the existing heating system. A typical retrofit schematic is presented on Figure D-5. The average temperature of water entering the exchanger will be 165°F and the average exit temperature will be in the range of 120°F. Each of the building systems will be complemented by its existing fossil fuel or electrical heating system.

The geothermal water system will be designed to provide about 80 percent of the design-load demand. Peaking requirements will be provided by fossil fuels.

Reinjection Well(s) Disposal System

The reinjection well(s) are tentatively located in an area bounded by Americana Boulevard, Broadway Avenue, Main Street and the Boise River. Actual well(s) siting will be based on the interpretation of the Boise geological survey data. One or two wells will be required, depending upon the characteristics of the reinjection wells.

The final design of the reinjection well(s) would be based upon the geologic data of the specific site, and coordination with the Boise Park Board

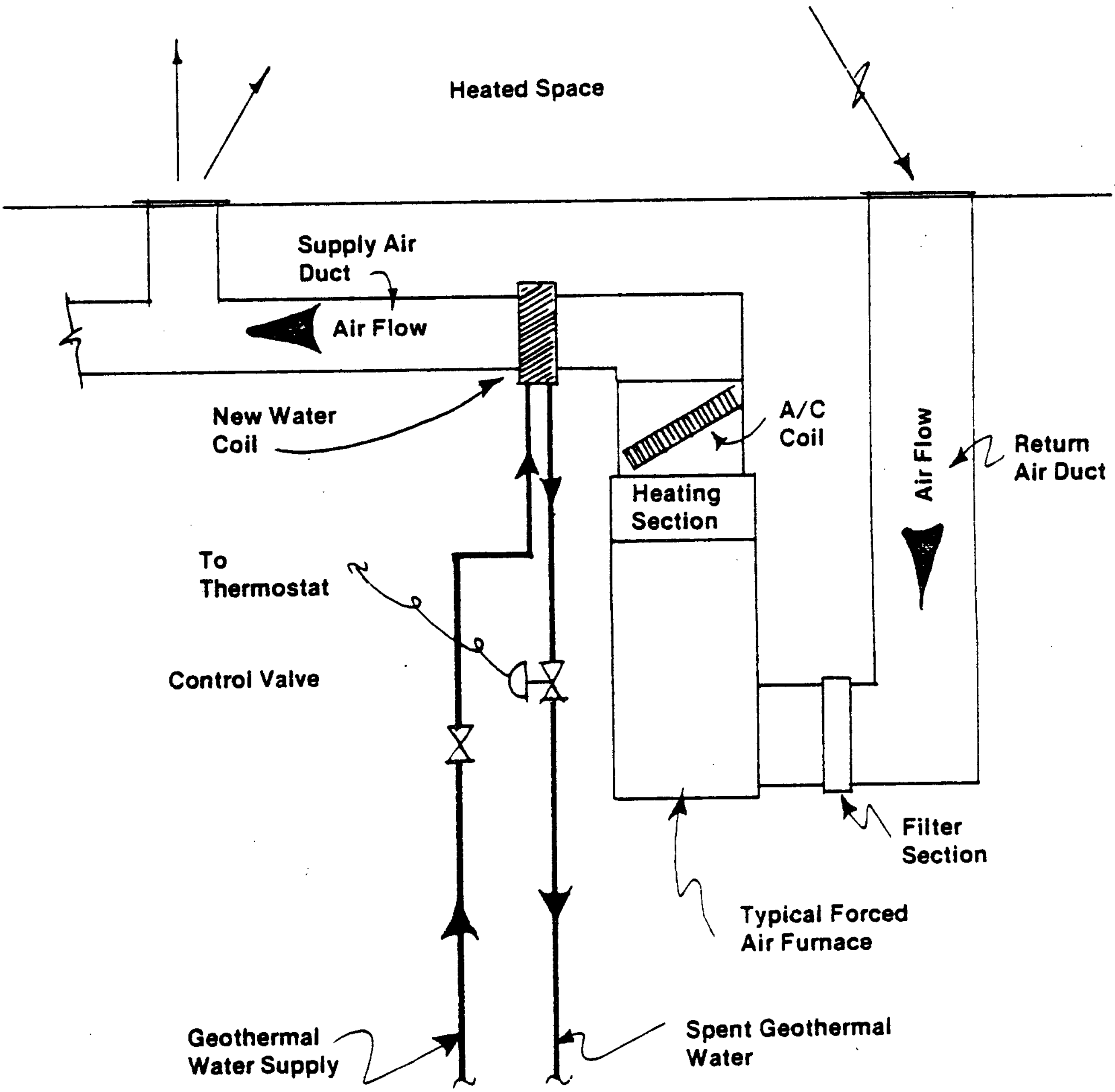

Figure D-5. General Design for Geothermal Modifications to Forced Air Systems and City Council. Preliminary designs assume the injection well(s) to be approximately 1,200 feet deep and 14 inches in diameter. The well(s) will be designed and drilled in accordance with the Idaho Department of Water Resources rules and regulations. The drilling operation will be similar to the production wells.

The well head and other equipment will be housed in a pumphouse similar to the supply wells. Landscaping will be provided around the pumphouse. Security fencing will be provided depending on the location.

Several alternatives for disposal of the spent geothermal water have been considered. These include deep well reinjection; disposal directly to the Boise River; disposal to the City of Boise sanitary sewer system; disposal to agricultural canals, leach ponds and evaporation ponds; and reuse of the geothermal water. The advantages and disadvantages of each of these methods of disposal are discussed in the Alternatives to the Proposed Action section. At this time deep well reinjection represents perhaps the most expedient and environmentally safe means of disposing the spent geothermal fluid. In the future as the project continues to expand and develop the other options, particular reuse will be examined further for incorporation into the system. The proposed plan for disposal is by no means an irreversible process.

Site Restoration

Indications of an inadequate resource at any stage in drilling can result in either abandoning or relocating the well field. Any wells which are abandoned will be plugged with cement or welded shut below ground level and the area returned to predrilling condition.

Well field development will not require development of extensive site access. Existing vehicular routes will provide excellent access to the general vicinity of most drill sites in the Military Reserve. In some cases, access may be required across short expanses of lawn or undeveloped areas. Drill sites will be regraded and replanted or resodded to return the setting to near pre-existing conditions. All drill-rig equipment will be dismantled, and all salvagable equipment removed. Nonrecoverable items will be disposed of in a suitable manner. Pumphouses will be subsurface structures, and appropriately landscaped to the setting.

Pipeline construction will be similar to installing either a sewer or water distribution line. Portions of the pipeline will cross undeveloped property; whereas the majority of the pipeline will be in city streets. The natural areas will be completely resodded or replanted following construction. Construction in the streets can be expected to impose temporary inconveniences to traffic; however, street restoration will immediately follow pipe installation.

Development of the reinjection wells will cause minor disturbances to natural and developed settings. Following construction, minor surface disturbances will be restored to near pre-existing conditions. Any disturbances to existing reserve facilities will be restored to pre-existing condition as each phase of the project is completed.

PROJECT SURVEILLANCE AND MONITORING

The withdrawal of geothermal fluid may create a condition for surface subsidence or seismic activity. Several measures would be employed to monitor any such occurrence. Initially, a series of levels should be run into the area of withdrawal and reinjection from benchmarks at least one mile outside the perimeter of the project area. Monitoring these stations would be initiated prior to production, and will be continued for the duration of operation as a general precaution. Since the prediction of seismic activity potentially induced by the project is inexact, microseismic sensors should be installed to collect background information prior to the development of the project. Following production, a smaller sensory network may be maintained, with instrumentation continuing for at least the first several years. Additionally, there would be at least two observation wells drilled to monitor fluid pressure near the area of production to ensure that the pressure does not radically change during the operation phase. A rapid fluid change could possibly induce seismic activity. These observation wells would have a very small diameter (approximately three-six inches) and would be used to detect minute changes in pressure. At least three domestic wells in the vicinities of each of the production wells and the reinjection wells would be monitored for depth to water, pumping level, water quality, and major pressure changes. These data would be collected both prior and during operation. The data would provide a basis for comparison if a claim is made for domestic well interference.

ACTIVITY SCHEDULE

The entire project will cover a five-year period and will include five phases. The first phase includes securing the necessary approvals and right-to-build, and general resource investigations. Permits obtained from the Department of Water Resources will require conditions such as proper drilling methods, proper abandonment, and perhaps a bond. Logs, well histories and other pertinent information, as well as notification prior to drilling and abondonment, will also be required. During Phase I, the first test/production well will be designed, drilled, and tested.

Upon successful completion of Phase I, pipelines will be designed and constructed coincidental with retrofitting City Hall, the County Building, and the Capitol to enable them to use the resource. At the same time, two reinjection wells and a second production well will be designed, drilled, and tested. Phase III includes design, drilling, and testing of the third production well and retrofitting North Junior High School, the YMCA, and Hotel Boise. Phase IV includes laying of additional pipeline and retrofitting the IDHW, LBJ, Supreme Court, and the State Library buildings. The final phase is retrofitting the Bank of Idaho, and the First National Bank.

Throughout the project, reports will be prepared to document progress and to provide general public awareness of the project.

It is the long-term goal of the Boise geothermal project to implement a complete geothermal space heating utility providing service to residential, commercial, and institutional customers in the area. Completion of this project will be one step in realizing this continuing development of the geothermal resource in the Boise area.

PROJECT COSTS

The project would be a multimillion dollar system. The project would be cost-shared by the City of Boise and the U.S. Department of Energy. Information on the percent breakdown for the two participants is not currently available.

DESCRIPTION OF THE EXISTING ENVIRONMENT

GEOLOGY

Regional Setting

Boise is located on the boundary between two physiographic provinces and on the border of two geologic provinces. The area immediately north of Boise, including the Boise Front, Lucky Peak, and Shafer Butte, is part of the Rocky Mountain physiographic province. To the south of Boise, the Boise River floodplain and the Snake River Plain are part of the Columbia River physiographic province.

The geologic provinces to the north and south of Boise are only informally designated but are justified on the basis of their very distinctive differences in the nature of the geologic materials, structures, and history. The area north of Boise is predominantly granitic terrain, with a few exposures of basaltic and rhyolitic lava, and scattered deposits of loess.

From Boise southward, the geologic setting is predominantly flat-lying lava flows interlayered with, and locally covered by tabular deposits of sand, gravel, silt, and clay. Separating these two geologic provinces is a major structural break known as the Foothills Fault, which closely follows the topographic change between the Boise River floodplain and the lower Boise foothills (Figure D-6).

Rock Types

The major rock units exposed in the Boise area are listed in order of decreasing age: granites of the Idaho batholith, flows of Columbia River basalt, flows of Owyhee rhyolite, sediments of the Glenns Ferry Formation, flows of Snake River basalt, and surficial deposits of alluvium. The major rock units of the Boise Front area and their general physical characteristics are presented on Figure D-7.

Idaho Batholith. The oldest rock exposed in the area is the fine-to-coarse crystalline, granitic rock of the Idaho batholith. They are exposed on the higher slopes of the Boise foothills, and elsewhere, they underlie all of the younger igneous and sedimentary rocks. The granitic rocks range in composition from quartz monzonite to quartz diorite, but the average composition is granodiorite. Quartz veins, pegmatite, rhyolite, and basaltic dikes are abundant locally. The rocks are closely jointed and broken by numerous faults; shear zones several feet thick are common. The unit outcrops slightly north of the Camel's Back Park area and forms the basement rock for much of the Boise foothills area and the mountainous area to the north.

In many outcrops, the rock is so completely shattered that blocks greater than three feet in diameter are nonexistant. This physical condition of the rock causes smooth, moderately steep slopes to form, in response to the weathering and erosion processes. Where the granite is more coherent, steeper slopes and craggy outcrops form. The great majority of slopes underlain by granitic rocks exceed 14 degrees in steepness and are only thinly covered with loess and colluvium.

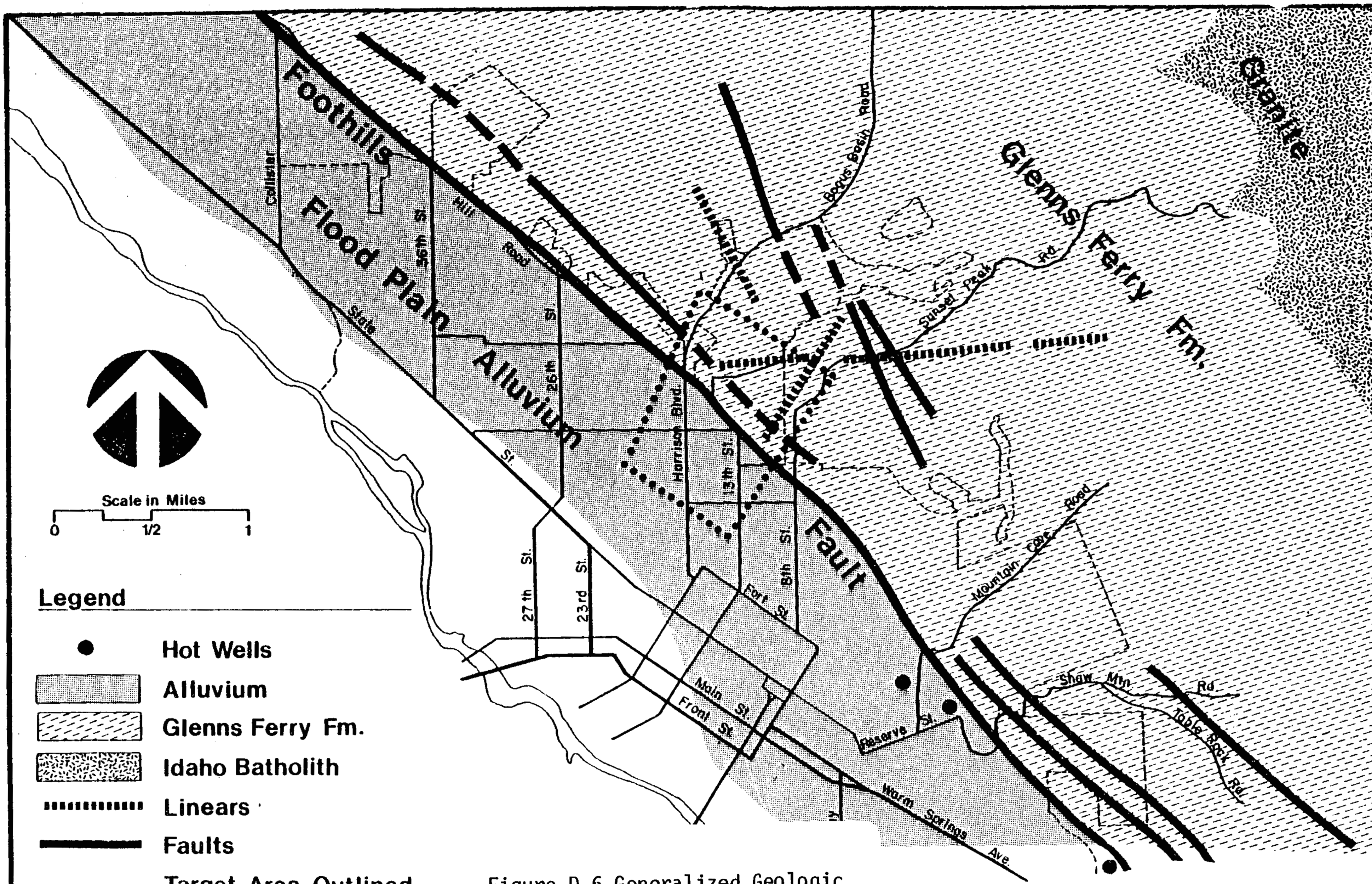

Figure D-6 Generalized Geologic Map

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Figure D-7. Major Rock Units of the Boise Front Area & Physical Characteristics

QUATERNARY	Recent	Recent alluvium and surficial deposits	Unconsolidated clay, silt sand, and fine-to-coarse gravel of fluviatile origin. Overlies older deposits of the Glenns Ferry Fm. in the Boise Region.
TERTIARY AND QUATERNARY	Pleistocene	Snake River Basalt	Light-to-dark-gray, vesicular, olivene basalt. Columnar jointing.
	Pliocene	Glenns Ferry Formation	Layered sediments of varied composition with interlayered basalts.
TERTIARY	Miocene	Late Columbia River Basalt	Light-to-dark-gray, dense, glassy basalt.
CRETACEOUS	Late-to-Mid Cretaceous	Idaho Batholith	Light-to-medium-gray quartz monzonite and granodiorite.

Late Columbia River Basalt. In several areas along the Boise Front, and farther west in the vicinity of the City of Emmett, erosional remnants of basaltic lava flows and volcanic ash and cinder beds lie directly on the granitic rocks of the Idaho batholith. These basaltic rocks are exposed in the drainage of Dry Creek, just to the west of the Boise foothills, and in the central portion of Warm Springs Creek, on the eastern margin of the City of Boise.

Owyhee Rhyolite. Spectacular outcrops of Owyhee rhyolite are exposed in Rocky Canyon, on Cottonwood Creek. The rhyolite intrudes a thick clay layer at the base of the Glenns Ferry Formation, but is overlain by layers of sand and silt that make up the upper part of the same formation. The rhyolite is closely fractured and jointed but stands in vertical outcrop. Very steep slopes and cliffs characterize the outcrops of this rock unit, and the more gentle slopes are mantled with boulders and thin soil.

Glenns Ferry Formation. The Glenns Ferry Formation (Malde and Powers, 1962) is the most extensively exposed rock unit in the Boise foothills. The sand, silt, and clay layers of this formation were derived primarily from the granitic terrain to the north and were deposited in shallow lakes, stream channels, and floodplains. The formation has an exposed thickness of over 600 feet and drill-log information indicates a total thickness of over 1,400 feet. Interbedded with the sediments are flows of basalt, thin layers of volcanic ash, and deposits of diatomite.

The Glenns Ferry Formation becomes more thickly bedded from east to west; and lateral change of grain size, composition, and clay content becomes less abrupt. In the eastern part of the foothills, clay layers make up a greater percentage of the total thickness of the formation and the individual layers range in thickness from a few inches to over 200 feet. Toward the west, thick layers of cross-bedded, semiconsolidated sand become more common. Thick layers of silt with variable amounts of clay are present throughout the foothills area, but they are especially obvious in the Stuart Gulch drainage.

Some of the sedimentary layers, such as the conglomeratic sandstone on top of Table Rock, are strongly cemented with secondary silica thought to be derived from circulating geothermal fluids. The great majority of the layers are only weakly cemented, however, and subject to extremely rapid erosion on unprotected slopes.

The Glenns Ferry Formation is the source of groundwater for numerous wells in the Boise Valley and is one of the prime sources for Boise Water Corporation. This corporation is the prime supplier for the City of Boise domestic water supply.

Snake River Basalt. Outcrops of dark-gray to black, fresh-appearing basalt are present to the east and south of Boise. In layered sequence, they underlie much of the Snake River Plain. The outcrops are especially prominent along the Boise River Canyon from Diversion Dam to Discovery State Park and along the southern margin of the Boise River floodplain.

Flows of basalt and layers of volcanic fragmental material are present in the foothills area north of Boise, but the age of these deposits is uncertain. Available evidence indicates an age younger than the Columbia River basalt flow, but older than the Snake River basalts. These deposits are, in part, equivalent in age to the Glenns Ferry Formation with which they are interbedded.

Alluvium. Alluvium is present in the channels and on the floodplains of the major streams that drain the Boise Front area, as well as in the Boise River. These deposits are derived from the destruction of older rock outcrops and consist mainly of granitic and basaltic erosional materials. Alluvium is different from soil in that it has a wide range of particle sizes and has not yet attained the capability to support widespread growth of vegetation.

Surficial Features

The Boise region is comprised of three distinct topographic terrains. The City of Boise and adjacent areas are characterized by flat floodplain topography, accentuated by flat-surfaced terraces that rise in succession from the primary floodplain of the Boise River. To the north is the foothills terrain, which is transitional between the floodplain and the Boise Front-Shafer Butte terrain, which dominates the local landscape.

Most of the foothills terrain is characterized by smooth slopes, gently to moderately inclined ridge crests, and rounded peaks. About half of the slopes are steeper than 14 degrees. The ridges are generally narrower and slopes are steeper in the western part of the area. Natural terraces border several of the streams. The main streams of the area flow west to southwest and have gradients that range from 440 feet per mile for Warm Springs Creek down to 254 feet per mile for Stuart Gulch. The gradient of each stream changes significantly at the point where it passes from the granite of the Idaho batholith to the sediments of the Glenns Ferry Formation. For example, the gradient in granitic terrain for Stuart Gulch is 338 feet per mile; and where the stream flows on the Glenns Ferry Formation, the gradient is 175 feet per mile. The Boise River, by contrast, has a local gradient of 12 1/2 feet per mile, and its floodplain slopes at the rate of 15 feet per mile.

Several of the streams, especially Cottonwood Creek, show evidence of superposition. Others, such as Picket Pin Creek, show evidence of structural control. These data indicate a complicated geomorphic history of drainage and topographic development in the Boise foothills.

Seismicity

The record of seismic activity in the area is very short and incomplete, but the body of data is growing as a result of the seismic monitoring program now in progress at Boise State University. Seismic and microseismic activity has been detected from outside the Boise area; historically, earthquakes occurring elsewhere that were felt in Boise have been recorded. (Figure D-8 & D-9) indicate recorded seismic events from 1880-1977.) No seismic activity has been recorded that is directly related to

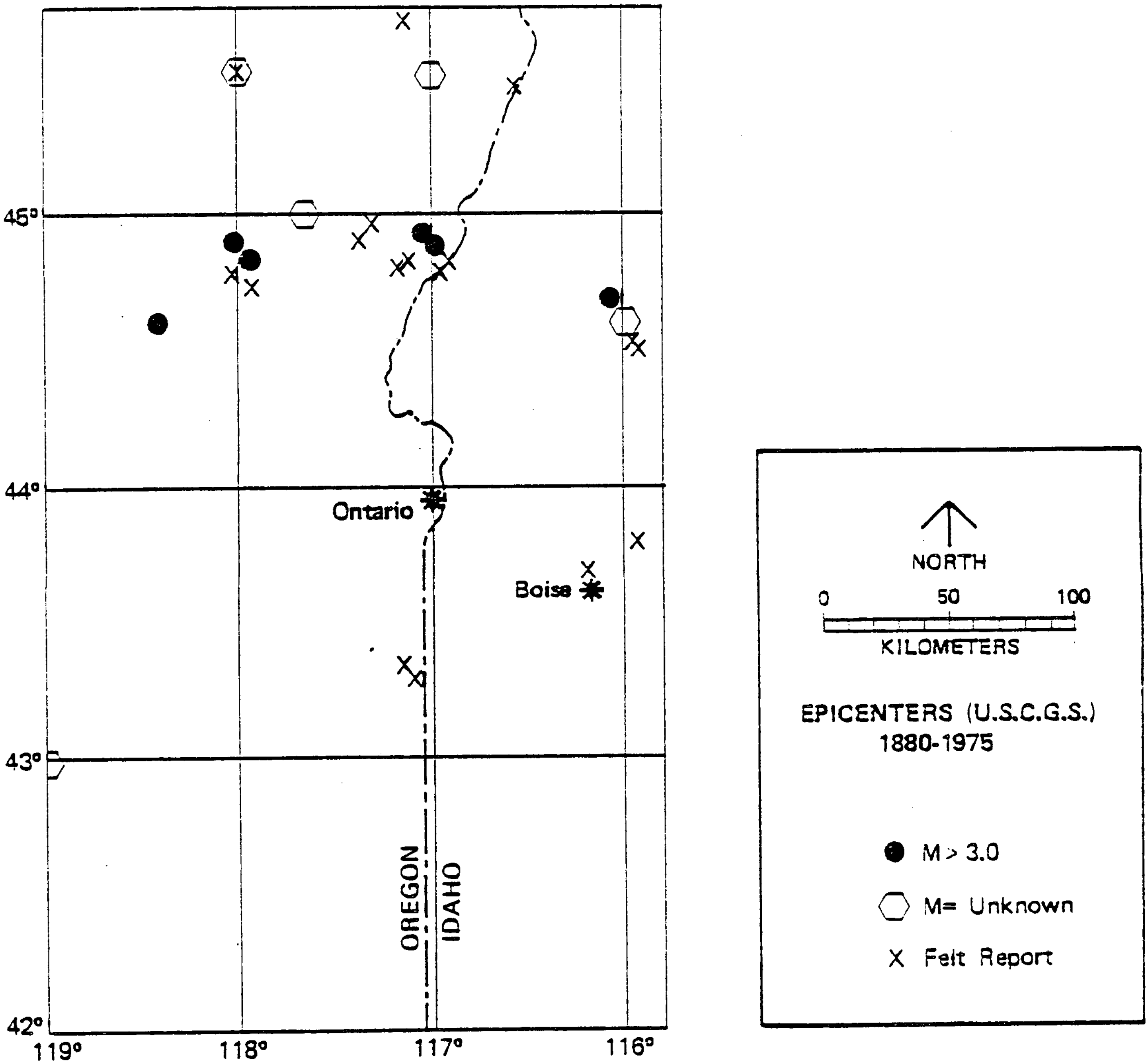


Figure D-8. Historic Earthquake Epicenters from U.S.G.S.

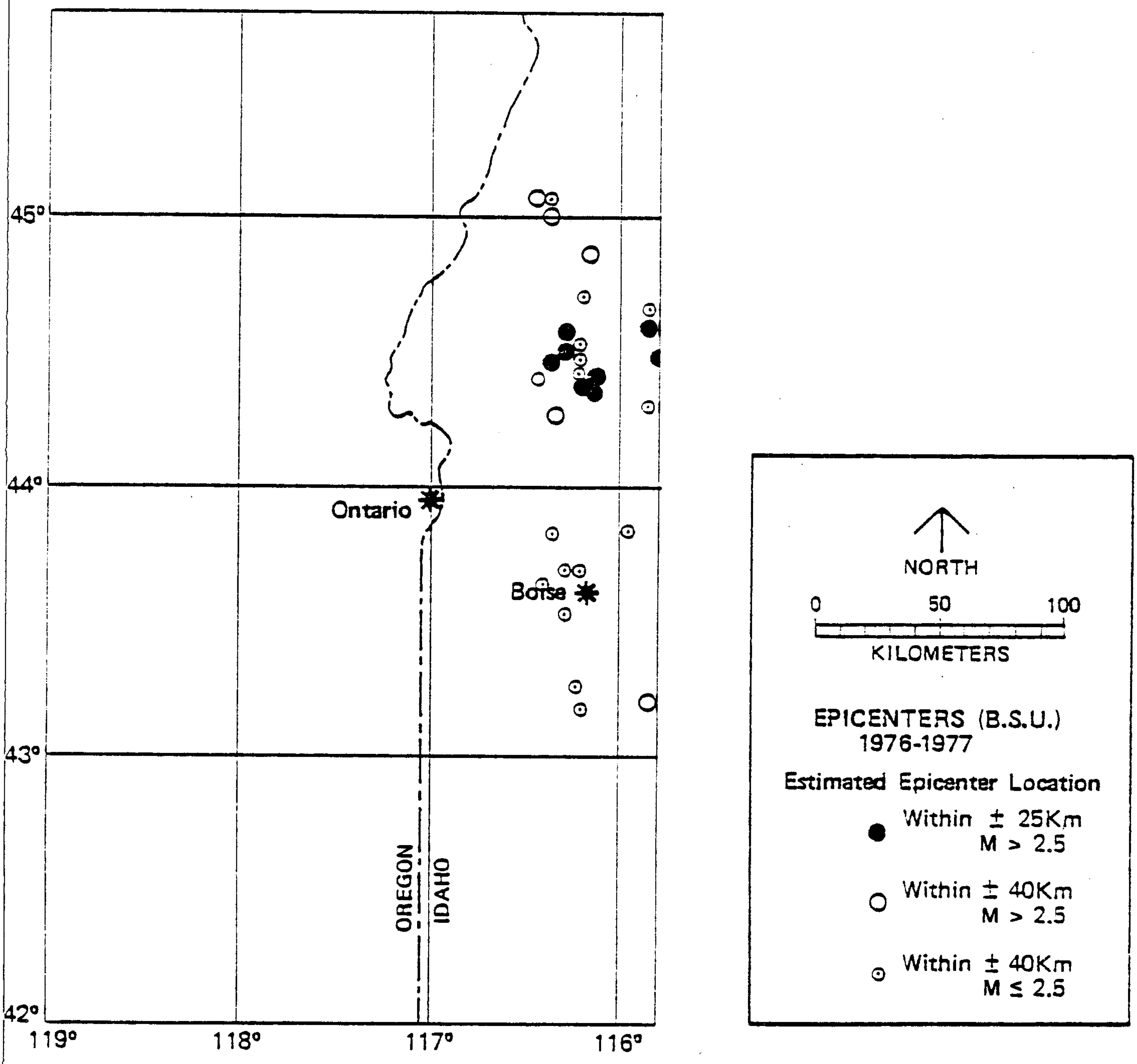


Figure D-9. Earthquake Epicenters from BSU Array (Modified from Vincent & Applegate, 1978) geologic structures or processes within or immediately adjacent to Boise, however. In addition, none of the faults of the Boise foothills exhibits evidence of recent movement, as would be expected if they were tectonically active and prone to the generation of seismic events.

Faults and Linears

Many faults are present in the Boise area, especially in the granitic rocks. Most have relatively small displacements, but some have evidence of movement in excess of several hundred feet. The major fault of the area is the Foothills Fault which has an inferred displacement of about 9,000 feet. Nearly all of the faults are high-angle, dip-slip or diagonal-slip, and show preferred orientation to the northwest. Two sets of secondary faults have orientations north-south and northeast-southwest, respectively.

The Foothills Fault lies at the edge of the Boise foothills, strikes N. 45°W., dips steeply southwest, and can be traced a distance of nine miles. Evidence for the existence of the fault is ample but its location can only be approximately established. The Foothills Fault is part of a system of faults that define a regional zone of weakness along the northern edge of the Snake River Plain. Rather than being a single planar feature, the Foothills Fault is probably a wide zone of closely spaced, subparallel faults. It is within a few hundred feet of Hillside Junior High School, is directly beneath many residences along Hill Road, and underlies metropolitan Boise for several miles. It is close to the Veterans Hospital, the National Armory, and the State Penitentiary. The Foothills fault provides the conduit for the upward migration of much of the geothermal water that occurs along the Boise Front and is used for the thermal development for the Boise Warm Springs Water District.

Linears are features identified from aerial photos that exhibit an unusually straight or uniformally curved geometry over relatively long distances. Such features often are related to the structural geology of the area and are the ground-surface expression of subsurface features such as faults, joints, fold axis, dikes, contacts between adjacent rock types, steeply inclined tabular rock bodies, or some other type of planar discontinuity.

In the Boise area, linears are suspected to have influenced the development of many of the drainages and, more important, are suspected to exert a strong influence on the distribution of the geothermal resource.

SOILS

In the Boise area, approximately 25 different soil types have been identified and described by the USDA Soil Conservation Service. The soils are predominantly of the coarse-to-fine, granular type and are derived from the underlying bedrock materials. Several soils of limited distribution and extent have a relatively high clay component, and exhibit unusual shrink-swell characteristics. Most soil types of the area are readily susceptible to the processes of erosion, and once disturbed, do not recover their vegetative cover for several years.

HYDROLOGY AND WATER QUALITY

Surface Water

Most of the streams of the Boise area are intermittent, with the exception of the Boise River. In some years, Dry Creek and the Cottonwood-Freestone Creek system flow continuously. All streams receive inflow from surface runoff. Some of the larger drainage nets receive inflow from snowmelt on the Boise Front as well as inflow from seeps and springs.

Water quality is generally good, except where low flow rates combine with point sources of pollution such as feed lots and heavily grazed pasture lands. Table D-1 presents an analysis of water quality of the Boise River for water-year October 1969 to September 1970. Discharge of the river for the same period is presented in Table D-2. The flood season on the Boise River is normally during April, May or June and is caused primarily by snowmelt.

Located within the city limits of Boise are a number of large canals that serve a network of secondary canal systems. These canals are used for irrigation of agricultural lands to the west of the city. They are normally drained during the winter and early spring for maintenance purposes.

Groundwater

Recent groundwater studies by Dr. L. L. Mink indicate that the Boise area has three separate aquifer systems. These systems are the shallow aquifer or the water table surface; the deep system, which occurs under an artesian head (piezometric surface); and the geothermal system, which originates deep in the fractures of the Idaho batholith and migrates upward. Some interaction occurs among all three systems, but each has its own distinct water-bearing characteristics.

Shallow Aquifer (Water Table Surface). The shallow aquifer, which is found under water table conditions, derives most of its water from surface sources such as infiltration from rainfall, recharge from surface streams, and irrigation. The depth to this system is quite variable, and it is highly dependent upon seasonal variation and meteorological phenomenon. The water table more or less coincides with the topography and tends to flow in a west-southwest direction. Figure D-10 presents month-end groundwater levels in key wells west of Boise and reflects the effect of summer irrigation on the groundwater table.

The shallow system of the foothills area is similar to the shallow aquifer found in the Boise River Valley. Although they are probably interconnected, they are separate systems. The water table located in the Boise Valley is found in river alluvium; whereas, the water table along the front is mainly located in the Glenns Ferry Formation.

Deep Aquifer (Piezometric Surface). The deep aquifer of the Boise area is that system which occurs at depths in excess of 500 feet. Its source lies in the Glenns Ferry Formation where interbedded sands, silts, and clays, along with an abundant amount of basalt, make up the aquifer material. This deep system is a confined aquifer occurring under considerable artesian head creating a piezometric surface.

Table D-1. CHEMICAL ANALYSES OF WATER QUALITY OF BOISE RIVER WATER-YEAR OCTOBER 1969 TO SEPTEMBER 1970

Station: Boise River Near Boise, Idaho
Lat. 43° 31' 33"; Long. 116° 04' 02"

	Discharge (cts)	Silica (SiO_2) (Mg/l)	Dissolved Calcium (Ca) (Mg/l)	Dissolved Magnesium (Mg) (Mg/l)	Sodium (Na) (Mg/l)	Potassium (K) (Mg/l)	Bicarbonate (HCO_3) (Mg/l)	Carbonate (CO_3) (Mg/l)
Dec 04	96	12	11	1.3	4.1	.7	46	0
May 25	7,340	14	9.2	1.3	3.8	.7	42	0
Aug 31	4,020	5.5	8.3	1.0	3.2	.7	38	0

	Sulfate (SO_4) (Mg/l)	Chloride (cl) (Mg/l)	Dissolved Floride (F) (Mg/l)	Nitrate (NO_3) (Mg/l)	Dissolved Solids		
					Residue at 180 C (Mg/l)	Ton/acre-feet	Tons/day
Dec 04	3.6	.0	.4	.6	62	.08	16.1
May 25	2.4	.0	.4	.8	54	.07	1,070
Aug 31	.4	.0	.4	.6	38	.05	412

	Hardness (Ca,Mg) (Mg/l)	Non-Carbonate Hardness (Mg/l)	Sodium Absorption Ratio	Percent Sodium	Specific Conductance (Micro mhos)	pH (units)	Temperature (°C)
Dec 04	33	0	.3	21	83	7.4	6.0
May 25	28	0	.3	22	74	7.5	11.0
Aug 31	24	0	.3	21	65	7.5	16.5

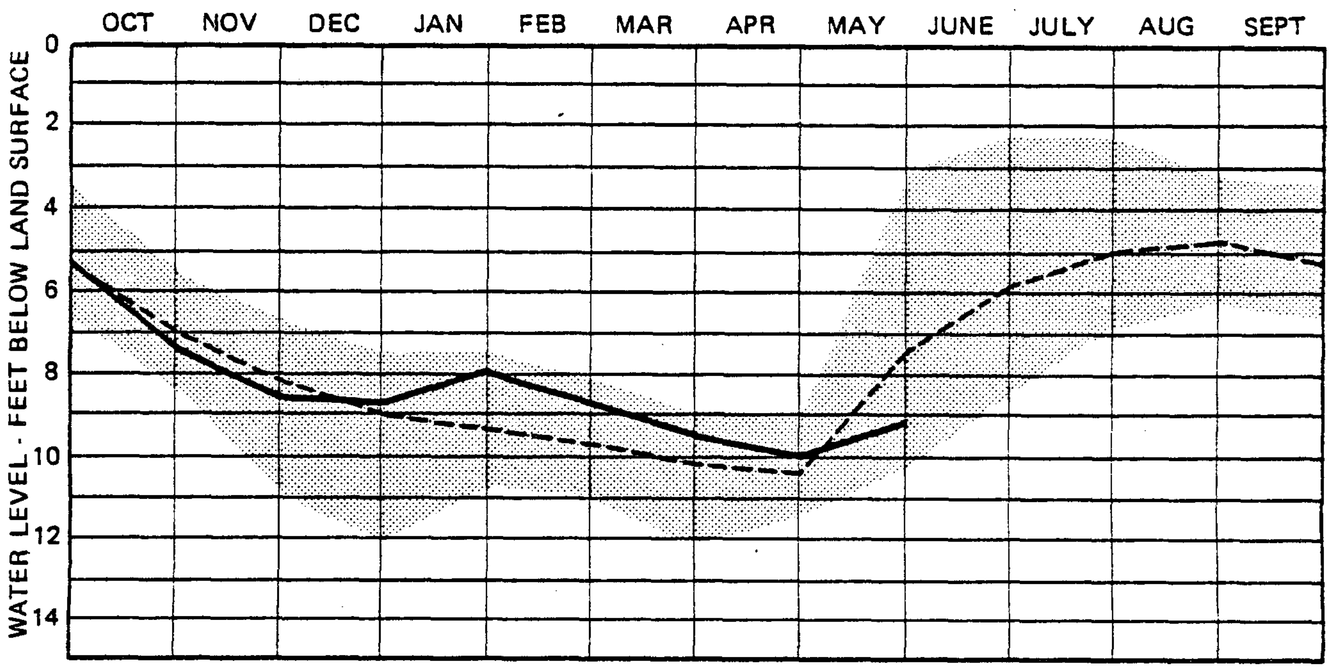
Source: U.S. Geological Survey. Quality of Surface Waters of the United States, 1970.

Table D-2. DISCHARGE (cfs) OF BOISE RIVER AT BOISE, IDAHO
WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Mean	458	197	1,122	264	2,741	4,457	7,983	10,400	9,229	4,745	4,397	3,674
Minimum	73*	110	722	50**	850	2,000	5,000	8.160	7,800	4,400	4,180	3,180

* One day
** Six consecutive days below 77 cfs

Source: Preliminary Boise Geothermal Energy Systems Plan



Section 35, T4N, R1W
Years of Record, 1934-77

Range between highest and lowest record for the month.

Average of monthly levels in previous years.

Level in current year.

Figure D-10. Month-End Groundwater Levels in Key Wells Near Boise Meridian

SOURCE: U.S. Geological Survey, Pacific Northwest Water Resources Summary, May 1978.

The direction of flow of the artesian system is approximately the same as that of the water table system. The main recharge area of the system is the Boise Front. Most of the water available for recharge is precipitation falling along the ridge.

Geothermal Water. The geothermal system may be related to the water of the deep artesian system in the Boise area. The water of the geothermal system is associated with major structural features, including major faults in the area and numerous linears that have been mapped by photogeologic methods.

The heat source for the geothermal water is believed to originate from the deep fracture systems within the Idaho batholith. Water is heated at depth and moves upward along asos fault and fracture zones, mixing and heating the water found in the Glenns Ferry Formation. This water is then intersected in wells tapping the Glenns Ferry sediments. Geothermal gradients of wells in the Boise area indicate a normal increase in temperature with an increase in depth.

The geothermal resource of the Boise area is unique in two ways. First, it is a major hot water resource located immediately adjacent to a potential market; and second, the purity of the water exceeds that of all other major geothermal systems of the Western United States. The geothermal water quality is exceptionally high and has been used domestically for 80 years in the Boise area. Recent analyses of samples from hot wells indicate a flourine content somewhat higher than that of cold groundwater, but no other objectionable qualities are known to be present. Chemical analysis of a grab sample taken at a producing geothermal well of the Warm Springs Water District is presented in Table D-3.

GEOPHYSICAL EVIDENCE OF GEOTHERMAL RESOURCE

The Boise area is located on the boundary that separates the volcanic rocks of the Snake River Plain from the mountainous, granitic terrain to the north. The area is traversed by a major structural break called the Foothills Fault. The fault strikes northwest, dips steeply southwest and has an estimated displacement of more than 9,000 feet. The rock types present in the Boise area are granite of the Idaho batholith, overlain by sediments and volcanic materials, predominantly of the Glenns Ferry Formation. The geology of the area has been mapped at a scale of four inches to one mile; and has been supplemented by a collection of data from ERTS satellite imagery and electrical and magnetic geophysical surveys. Geochemical geothermometry of the geothermal fluids (as determined by the Idaho Department of Water Resources) indicates a maximum reservoir temperature of approximately 255°F, although the maximum observed temperature to date has been approximately 170°F.

The existence of a geothermal groundwater system in the Boise area has been known for almost 100 years, and utilization of that system for private and commercial purposes began at the turn of the century. The geothermal system is related to the geologic structure, which provides a reliable guide for further exploration and development of the system.

Table D-3. CHEMICAL ANALYSIS OF OLD PENITENTIARY GEOTHERMAL WELL GRAB SAMPLE WARM SPRINGS WATER DISTRICT, BOISE, IDAHO

CHEMICAL COMPONENT	ppm
H_2	0.0054
He	0.0016
CH_4	0.065
N_2	18.51
O_2	0.029
Ar	0.62
CO_2	0.20
H_2S	(t)
Al	(m)
As	0.05
B	0.14
Ba	0.2
Ca	1.7
Cl	10
Cr	(m)
CO_3	4
Cu	0.08 (m)
Fe	0.13 (m)
HCO_3	70
Hg	0.14
K	1.6
Li	0.05
Mg	0.05 (m)
Mn	0.01 (l)
Na	90
Ni	(t)
Pb	(m)
SiO_2	160
SO_4	23
Sr	0.01
Ti	(t)
Zn	(t-m)
Zr	--
F	14± (Min 2, max 24 recorded
pH	9.0

m = minor = <5% > 1%

t = trace = 0.1%

The most intensive effort to define the geothermal resource in the Boise area was completed in 1975 and 1976. In those two years, geological, geophysical and hydrological surveys were conducted. The geological studies included aerial photography, fault zone alteration, and ground mapping. The geophysical studies included resistivity mapping, magnetometer profiles, and microseismic monitoring. Hydrological studies involved well productivity and temperature gradient measurements.

Detailed mapping of these measurements were produced by the Boise State University Geology Department. Five probable resource areas were identified: see Alternatives to the Proposal Action section. These measurements suggest a resource covering a fairly extensive area.

The five exploratory wells were drilled in the Military Reserve, in 1975 and 1976. The wells ranged in depth from 250 to 1,222 feet with associated water temperature increases with depth. Temperatures for the deeper wells were approximately 180°F, comparable to those for the Warm Springs wells which are much shallower.

Nearly all of the hot wells of the Boise area, including the penitentiary wells and the recently completed Bureau of Land Management and Beard exploration wells, are located within or adjacent to the Foothills Fault zone. Warm wells located farther away from that major fault zone probably intersect other faults of lesser magnitude or intersect permeable strata that are connected hydrologically to deep-seated faults and linears.

The long history of limited production from the Boise geothermal reservoir and the recent success of exploration drilling guided by interpretations of the geological and geophysical characteristics of the bedrock, strongly support the probability of successfully intersecting the reservoir along the strike of the Foothills Fault. The Military Reserve area exhibits combination of geological and geophysical characteristics to be a potential drill site.

CLIMATE

Boise enjoys a mild, sunny climate. On an annual average, 68 percent of the days are sunny. Pacific and continental air masses are considerably modified by surrounding mountain ranges to the west and north before reaching the Boise Valley. These barriers limit the average annual precipitation to 11.4 inches. Storms generate great amounts of precipitation and the most intense storm recorded since 1899 is 1.23 inches in a two-hour period. Snowfall averages 21.6 inches per year; the maximum recorded for any one month was 36 inches. Compared with conditions nationwide, the average relative humidity at Boise is low (58 percent).

Mean annual temperature is 51°F, with an average of 75.2°F in July and 29.1°F in January. The extreme high and low recorded temperatures are 112°F and -28°F. The average date of the last freeze in the spring is May 6; that of the first freeze in the fall is October 12, for an average growing season of 158 days.

Winds of destructive force are rare in the Boise Valley. Predominant winds are southeasterly and average nine miles per hour.

AIR QUALITY

In the Boise metropolitan area, air pollutant measurements have been reported by the Idaho Air Quality Bureau for total suspended particulates (TSP), sulfur dioxides (SO_2), carbon monoxide (CO), and nitrogen dioxide (NO_2). Based upon study by the bureau, information has been collected at various points around the state to assess improvements or reductions in obtaining the ambient air quality standards adopted by the state. In general, pollutant levels for most air quality parameters measured are below state and Federal ambient air quality standards. The exception, however, is CO, which has frequently been exceeded during the winter months.

Particulates in the Boise region are attributed to the dry climate, dusty roads, and agricultural practices. The annual geometric mean for particulates in Boise was about 73 micrograms per cubic meter in 1977. This measurement is below the 75 micrograms per cubic meter standard.

Measurements for SO_2 have shown a running annual average of less than .01 parts per million (ppm). The average annual standard for SO_2 is .03 ppm.

Boise, located against a range of mountains and in a valley, has higher CO levels than most cities of similar size. Data for the past two years show that the one-hour Federal ambient air quality standard for CO (35 ppm) was exceeded more in 1977 than in 1976, but the eight-hour standard (9 ppm) was exceeded less in 1977 than in 1976. A study is being conducted to determine the extent of the CO problem in Boise.

Measurements for NO_2 in the Boise metropolitan area indicate that the annual average of 1977 was less than 50 percent of the standard (.05 ppm). The maximum daily level was less than the annual standard.

NOISE

Noise is an undesirable sound, and, for analytical purposes, is assumed to decrease in desirability as loudness increases. Loudness of sound is measured in decibels (dB), a logarithmic scale of comparative intensity with respect to the threshold of human hearing. Since the human ear perceives high-frequency sounds at lower intensity than it does intermediate- and low-frequency sounds, noise measurements are usually weighted to account for this by using the "A" scale (dBA). A unique aspect of this scale is that almost any sound increasing in level by 10 dB will be judged to have approximately doubled in perceived loudness. Table D-4 presents typical A-weighted sound levels and human responses. It indicates the noise levels that could be expected near the drill sites.

In determining the daily measure of environmental noise, it is important to account for the difference in response of people in residential areas to noises that occur during sleeping hours as compared to waking hours. During nighttime, exterior background noises generally drop in level from daytime values. Further, the activity of most households decreases at night, lowering the internally generated noise levels. Thus, noise events become more intrusive at night, since the increase in noise levels of the event over background noise is greater than it is during the daytime. In general, the

Table D-4 TYPICAL "A" WEIGHTED SOUND LEVELS AND HUMAN RESPONSE

Sound source	dbA*	Response criteria	Intensity ($\mu W/m^2$)
Carrier deck jet operation	150		10^9
	140	Painfully loud; limited amplified speech	10^3
	130		10^7
Jet takeoff (200 ft)		Maximum vocal effort	
Unmuffled geothermal well			
	120		10^6
Discotheque			
	110		10^5
Jet takeoff (2,000 ft)			
Shout (0.5 ft)			
	100		10^4
Heavy truck (50 ft)		Very annoying; hearing damage (8 hr)	
	90		10^3
Pneumatic drill (50 ft)		Annoying	
	80		10^2
Freight train (50 ft)			
Freeway traffic (50 ft)		Telephone use difficult intrusive	
	70		10^1
Air conditioning unit (20 ft)			
	60		1
Light auto traffic (50 ft)		Quiet	
	50		10^{-1}
Living room			
Bedroom			
	40		10^{-2}
Library			
Soft whisper (15 ft)		Very quiet	
	30		10^{-3}
	20		10^{-4}
Broadcasting studio		Just audible	
	10		10^{-5}
		Threshold of hearing	
	0		10^{-6}

*Typical A-weighted sound levels taken with a sound level meter and expressed as decibels on the scale. The "A" scale approximates the frequency response of the human ear.

SOURCE: Environmental Impact Assessment for Cu1 Venture Application for Geothermal Loan Guaranty.

method used characterizes nighttime noise as more severe than corresponding daytime events; that is, to apply a weighting factor to noise that increases the numbers commensurate with their severity. The weighting applied to the non-daytime periods differs slightly, but nighttime activities are usually weighted by about 10 dB - with daytime extending from 7 a.m. to 10 p.m. and nighttime extending from 10 p.m. to 7 a.m. The symbol for the 15-hour daytime equivalent sound level is L_d, the symbol for the 9-hour nighttime equivalent sound level is L_n, and the day-night weighted measure is symbolized as L_{dn}. The L_{dn} is defined as the A-weighted average sound level in decibels during a 24-hour period with a 10 dB weighting applied to nighttime sound levels.

Two sound-level surveys were recently conducted within Boise. The U.S. Environmental Protection Agency (EPA) conducted a survey in Boise in April 1977. The City of Boise Planning Department conducted a survey in November and December 1977 in the northern part of the city. These studies showed that the average sound levels for residential and park areas (L_{dn} values from 53 to 54 dB) are near those of typical, quiet, suburban small-town environments. Sound levels at night often diminish to those of the natural geographical area without human activity. The studies also showed that, on the average, residential areas are quieter than would be expected for a city the size of Boise. The industrial, commercial, and central business districts, however, have a range of sound levels typical of a noisy urban environment (L_{dn} values from 62 to 63 dB); and in places, these levels decrease only slightly, even late at night.

The principal source of noise in Boise is street traffic. Approximately three quarters of the local noise intrusion occurring outside of the airport-influence area is due to cars and trucks, with an additional ten percent due to air jet traffic and four percent to dog barking. More detailed information concerning the noise environment in Boise is available in both the EPA and the city surveys.

LAND USE

Site and Surrounding Land Use

The Military Reserve site is bordered on the west by residential development; on the south by Lincoln School, the Elks Rehabilitation Hospital, and Fort Boise Park, and on the north and east by some residential and undeveloped land. The Veterans' Administration Hospital, Federal office buildings, and the O'Farrell Cabin, Boise's first home and place of worship are located on the western edge of the site; the eastern portion of the site is primarily in a natural state.

Freestone and Cottonwood Creeks intersect Tract 38 in the Reserve. Freestone Creek is intermittant, containing water only during drainage throughout the year and has good water quality. During spring runoff, flooding may occur in Cottonwood Creek Canyon. A series of detention ponds has been developed by the city along Cottonwood Creek within the Military Reserve for the purpose of flood control and desilting. The area around the Veterans Hospital and the Federal complex drains to the city street and storm drain system; all drainage ultimately flows to the Boise River.

The proposed pipeline corridor is through a residential neighborhood into the Boise central business district; it terminates in the vicinity of the developed Julia Davis Park.

Land-Use Regulations

The development of the proposed project will be subject to review by regulatory agencies having specific legal and licensing requirements. The agencies and corresponding requirements are listed:

Jurisdiction	Requirements
City of Boise	Building Permit(s) Park Board Approvals
Ada County Highway District	Right-of-Way Encroachment Permit
State of Idaho Department of Water Resources	Water Rights, Well Drilling, and Discharge Permits
State of Idaho Department of Labor and Industry	Plumbing and Electrical Permits
U.S. Department of Energy	Environmental Impact Assessment Environmental Impact Statement Negative Declaration

ECOLOGY

The living components associated with the project areas are typical of Southwestern Idaho and urbanized areas. The proposed well field at the Military Reserve is located in the Boise foothill regime. Three major vegetation associations characterize this area. The undeveloped portion of the reserve contains two major natural vegetational associations: sagebrush-bitterbrush-grass association occurs on the foothills, while the willow-cottonwood-box elder association occurs in the drainages. A large variety of flora, including trees, shrubs, grasses, and forage covers the site. Much of the vegetation in the developed portions of the reserve has been introduced by man for ornamental purposes, as has the vegetation in the urbanized portion of the study area. Shrubs, trees, and lawn are used extensively throughout the developed area for landscaping. A list of vegetative species in the project area is included in Appendix 1.

The wild onion *Allium aaseae* is known to occur in Boise's foothills. This plant is listed by the Smithsonian Institution as a potentially endangered plant in Idaho. It normally grows on sandy, southfacing, sparsely vegetated slopes, sometimes in association with bitterbrush. It is perhaps the only April-blooming onion found on the Boise Front. Correspondence from the U.S. Fish and Wildlife Service indicates that no other known plant species on the Boise Front are considered threatened or endangered.

Wildlife in the project area is located primarily in the natural areas of the Military Reserve. Fauna of the area includes mammals, birds, reptiles, amphibians, and insects. Species inhabiting the area are listed in Appendix 2. No known rare or endangered animal species are known to be residing permanently in the area. The bald eagle and osprey, although not common, occasionally frequent the area during migration.

The ecological interrelationships in the area are those relating to the sagebrush-bitterbrush-grass association and those relating to willow-cotton-box elder association. The variety of flora covering the natural portions of the Military Reserve is influenced primarily by differences in microclimates. No unique ecological interrelationships are known to exist on these lands.

HISTORY AND ARCHAEOLOGY

Boise was founded in 1863 after the discovery of gold within the basin. The U.S. Army located a fort within the area on July 4, 1863, and at the same time the town was platted by William C. Ritchy, Tom Davis, and Henry C. Riggs. The town was designated the territorial capital in 1864, but it was not until 1866 that it was formally incorporated. After that, it grew steadily from a population of 1,658 in 1864, to 2,000 in 1885, and 17,358 by 1910. Its prosperity was due to a number of factors in addition to gold: irrigation transformed what was originally a surrounding sagebrush desert into a prosperous farming region; the Idaho Central Railroad served the town by 1887, which, enhanced its location on the river, and provided good transportation service; and the city became the state capital. The expression of this prosperity was found in the construction of a number of graceful and imposing residences and public structures laid out with expansive grounds and numerous shade trees. The name "Boise" meaning wooded, applied by the French trappers, seemed to fit. The Federal Assay Office, the State Capitol, Courthouse, and the Boise High School were all objects of considerable public pride.

A literature search and meeting with the State Historian has identified numerous sites and five historic districts as being of either historic or architectural interest in the project vicinity. Five historic districts listed below are currently listed on the National Register of Historic Places. The Fort Boise District is limited to the Federal complex - tract 41 and 42. Thirty-four sites have been identified on the following list as having historic or architectural significance in the vicinity of the project. Of the 34 sites, 15 are currently on the National Register of Historic Places - these have been indicated by an asterisk (*). Numerous residences in North Boise have been identified as having architectural significance. Because of their number and scattered locations, they have not been included here.

The Office of the State Archaeologist indicated several archaeological surveys have been conducted in the Military Reserve area. One survey was conducted in the area of the old Military Fort, and two or three surveys in the building complex area.

HISTORIC DISTRICTS

1. Capitol Area Historic District
2. State Street Historic District
3. West Warm Springs Aveune Historic District
4. Fort Boise Historic District
5. South Eighth Street Historic District

The Office of the State Archaeologist indicated several archaeological surveys have been conducted in the Military Reserve area. One survey was conducted in the area of the old Military Fort, and two or three surveys in the building complex area.

HISTORIC SITES

1. Polo grounds, Fort and Reserve Streets
2. Boise Little Theater, 100 West Fort
3. John T. Morrison House, 211 West State
4. Alexander House*, 304 West State
5. Saint Alphonsus Hospital, 506 North 5th
6. State Capitol*, 700 West Jefferson
7. G.A.R. Hall*, 714 West State
8. Saint Michael's Cathedral*, 722 West State
9. Temple Beth Israel*, 1102 West State
10. Boise Cascade Building, 1100 West Jefferson
11. Carnegie Library, 815 West Washington
12. Hotel Boise, 802 West Bannock
13. Federal Building*, 304 North 8th
14. Idaho Building, 216 North 8th
15. Statesman Building, 300 North 8th
16. Ada County Courthouse*, 514 West Jefferson
17. Boise Elks Lodge, 821 West Jefferson
18. Boise High School, 1010 West Washington
19. Boise State Tabernacle (LDS), 900 West Washington
20. Christian Science Building, 315 North 8th
21. Friedlin Terrace, 1312-1326 West State
22. James Laidlaw House, 210 West State
23. White Savage Apartments, 1305 West Washington
24. Ireton Building*, 315 North 8th
25. U.S. Assay Office*, 210 Main
26. J. H. Brady House, 140 Main
27. Eastman Building*, 8th & Main Street
28. Idanha Hotel*, Main & 10th
29. Simplot Building*, Main Street
30. Union Block Building, 718 West Idaho
31. Cy Jacobs House*, Grove Steet
32. Ada Theater*, 700 Main
33. Falks, 100 North 8th
34. Bush House*, 12th and Franklin

A portion of the Military Reserve was used as a dump site and military cemetery for the original Fort Boise Military settlement. The dump site has been explored in past years and is being excavated by the Idaho State Historical Society. The site has produced some items that apparently date to the Civil War period, and the military cemetery has been fenced for the protection of the graves and markers.

This area was also used by Indians that inhabited the Boise Valley. As a result, there may be significant artifacts on the site. The flood of 1959 deposited significant soil and gravel on portions of the area, and this may prevent any existing artifacts from being readily discernible.

SOCIAL PROFILE

Population

According to the "1977 Survey of Buying Power," prepared by Sales and Marketing Management, the Boise Standard Metropolitan Statistical Area (SMSA) is the twenty-second fastest growing metropolitan area in the United States. From 1960 to 1970, the Boise SMSA increased in population from 93,460 to 112,230; an increase of 20.1 percent. By 1975, the area increased to a population of more than 137,000; an increase of 22.1 percent. Estimated 1977 population figures are 145,706 for the Boise SMSA. At the same time, the City of Boise has increased from 34,481 in 1960 to 74,990 in 1970; an increase of 117.5 percent. The city population estimate for 1977 is 101,000. In 1970, Ada County (Boise SMSA) contained 15.7 percent of the population of Idaho; the City of Boise contained 66.8 percent of the population of the county.

Projections for Ada County range from a low of 175,000 to a high of 364,000 to the year 2000 (Figure D-11). All available population and employment data seem to bear out the high rate of anticipated growth.

Part of the rapid growth of the area is the result of net in-migration of population. According to the Commerce Department, 69 percent of the total increase in population in Ada County between 1970 and 1974 was a result of net in-migration. The county is drawing about 46 percent of the new households from within Idaho and is serving in the traditional role of a metropolitan area drawing residents from more rural areas.

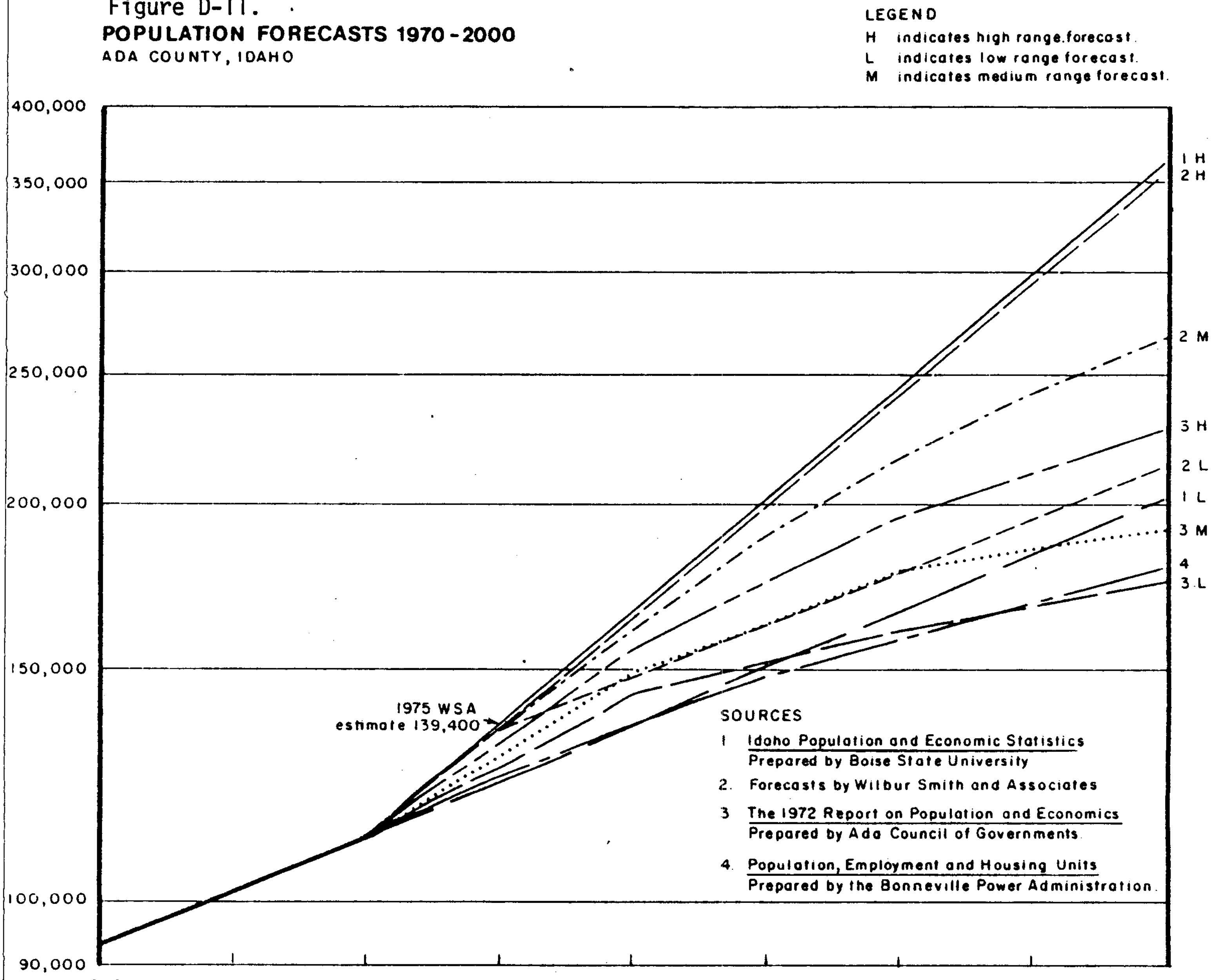
Local Economy

The early economy of Boise was based on mining supply, government, and transportation. As the mining areas were worked out, the economy switched to agriculture and commercial lumbering activities, which are still significant to the local and regional economy.

Ada County is a regional center, supplying services to an extensive hinterland. The world headquarters of Morrison-Knudson Construction Company and Boise Cascade Corporation are located in Boise, and Ore-Ida, Hewlett-Packard and Albertson's Food Stores are other large employers. Vacant land amenable to plant, warehouse, or other commercial uses is readily available. Reasonable tax rates and good transportation and communications provide additional inducement for businesses to locate in the area.

The county also seems not to be strongly influenced by either regional or national economic trends and has increased in population and economic development faster than either the State of Idaho or the United States. As a result of the many advantages perceived for Ada County, forecasts are based on the assumption that it will continue to grow and develop in a pattern similar to that experienced in the last 15 years.

Figure D-11.
POPULATION FORECASTS 1970-2000
ADA COUNTY, IDAHO



roduced from Wiber Smith and Associates

Table D-5 shows the components of the labor force for 1960, 1970 and 1973. The total civilian labor force has increased 81.2 percent during the 13-year period compared with a 36 percent increase in population. In terms of labor force participation, this represents an increase from 37.0 percent to 49.2 percent reflecting both an older population and the greater participation by females.

In 1960, unemployment was at a relatively high rate, 4.9 percent compared with 3.2 percent in 1973. Agricultural employment accounted for 6.8 percent of the total. Non-agricultural employment was 93.2 percent of all employed. Of total employment, 7.8 percent was involved in manufacturing pursuits and 69.5 percent in non-manufacturing. The remaining 15.8 percent were in the non-agricultural self-employed and domestics category. Most economic activity revolved around non-manufacturing. In addition to self-employed and domestic employment, important sectors included retail trade, miscellaneous service and government including education.

Manufacturing employment increased from only 2,550 employees in 1960 to 5,800 in 1973, and represented 9.6 percent of total employment up from 7.8 percent in 1960. Within manufacturing, major increases were noted in lumber and timber products which include saw mills and prefabricated structural wood products, and in the transportation equipment category which includes mobile home, trailers and campers.

Total non-manufacturing registered a more significant increase from 69.5 percent of total employment in 1960 to 79.6 percent in 1973. Major increases were noted in the construction industries, finance, insurance and real estate, miscellaneous services and government administration.

Although agriculture, the former mainstay of the Ada County economy, has declined only slightly in terms of numbers of employees, growth in Ada County exhibits a transition towards a manufacturing and non-manufacturing economic base. Naturally, for the capital city of the state, government is a major "industry" but augmenting this mainstay are increases in employment in virtually all manufacturing and non-manufacturing categories.

The labor force in Idaho normally shows seasonal fluctuations, particularly in the construction, service, trade, and manufacturing industries. Unemployment rates are lower in Ada County than in Idaho generally. Median income for all families was about $9,700 in 1969 and rose to $16,000 by mid-1975.

Housing

Generally speaking, adequate housing is in short supply in the Boise area. Because of the rapid population growth, good quality apartments and small home rentals are difficult to locate. New home construction has been increasing to keep up with the demand. The addition of new trailer parks in the area has helped to meet the demand for available trailer spaces, and expansion of this type of housing is continuing.

Table D-5. EMPLOYMENT TRENDS - ADA COUNTY
1960, 1970, and 1973

	1960		1970		1973		CHANGE 1960-1973	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Civilian Labor Force	34,550		52,900		62,590		28,040	81.2
Unemployment	1,700		1,600		2,260		560	32.9
Percent of Labor Force Unemployed	4.9		3.0		3.6			
Total Employment	32,850	100.0	51,300	100.0	60,300	100.0	27,450	83.6
Agricultural Employment	2,250	6.8	2,100	4.1	1,950	3.2	- 300	-13.3
Non-Agricultural Employment	30,600	93.2	49,200	95.9	58,350	96.8	27,750	90.7
Non-Agricultural Self-Employed & Domestics	5,200	15.8	7,400	14.4	4,560	7.6	- 640	-12.3
Non-Agricultural Wage & Salary Workers	25,400	77.3	41,800	61.5	53,790	89.2	28,390	111.8
Total Manufacturing	2,550	7.8	4,800	9.4	5,800	9.6	3,250	127.5
Food Processing	850	2.6	1,050	2.1	1,200	2.0	350	41.2
Lumber & Timber Products	350	1.1	1,200	2.3	1,480	2.4	1,130	322.9
Fabricated Metal & Machinery	270	0.8	500	1.0	540	0.9	290	116.0
Transportation Equipment	350	1.1	1,000	2.0	1,210	2.0	860	245.7
All Other Manufacturing	750	2.3	1,050	2.0	1,370	2.3	620	82.7
Total Non-Manufacturing	22,850	69.5	37,000	72.1	48,010	79.6	25,160	110.1
Construction	1,800	5.5	2,550	5.0	3,870	6.4	2,070	115.0
Transportation	1,100	3.3	1,300	2.5	1,410	2.3	310	28.2
Communications & Utilities	1,650	5.0	1,950	3.8	2,170	3.6	520	31.5
Wholesale Trade	1,760	5.3	2,900	5.7	3,300	5.5	1,540	87.5
Retail Trade	5,600	17.0	8,650	16.9	10,650	17.7	5,050	90.2
Finance, Insurance & Real Estate	1,700	5.2	2,800	5.4	3,610	6.0	1,910	112.4
Service & Miscellaneous	3,750	11.4	6,650	13.0	9,100	15.1	5,350	142.7
Government Administration	1,300	4.0	7,550	14.7	9,400	15.6	8,100	623.1
Government Education	4,200	12.3	2,650	5.1	4,500	7.4	300	7.1

Source: Idaho Department of Employment

Community Services

Boise is served by a municipally-owned sewage treatment plant. Electrical power is furnished by the Idaho Power Company; natural gas by the Intermountain Gas Company; and telephone service by the Mountain Bell Telephone Company.

The Boise Metropolitan Area potable water is supplied exclusively by groundwater. Domestic water is supplied by privately owned utilities or individuals in the rural areas. The Boise Water Corporation is the single largest purveyor of water in the area.

The municipal air terminal is the base of operations for United, Cascade, and Hughes Air West Airlines and various intrastate airlines. Bus lines serving the city include Greyhound Bus Lines, Trailways Bus Lines, Boise-Winnemucca Stages, and Northwestern Stages. Boise Urban Stages and taxicab service provides local transportation; and the Boise Urban Special, a door-to-door service, is available to the elderly and handicapped.

Medical and hospital facilities include four hospitals, with a total of 648 beds. These include St. Luke's, St. Alphonsus, the U.S. Veterans Hospital, and the Elks Rehabilitation Center. Future expansion could provide an additional 160 beds in St. Alphonsus Hospital. The Mountain States Tumor Institute is also located in Boise.

Boise is served by 29 elementary schools, six junior high schools, and three senior high schools. Non-public schools include one parochial high school and four parochial elementary schools. Boise State University is also located in the city.

The city has over 50 park areas, totaling about 1,700 acres, with over 400 acres developed. The city is served by two local television stations and seven radio stations; the Idaho Statesman publishes a daily morning newspaper.

Community Characteristics

The population of the city is 1.2 percent non-white, slightly greater than that of the county population - 1.0 percent. The majority of the non-white population consists of Negro, Indian, Japanese, and Chinese residents. The population is slightly older than the county average, with 33.7 percent under 18 years of age and 10.1 percent, age 65 and over. The median age for males in 1970 was 26.4 and 28.6 for females.

The median years of school completed by persons 25 years of age and older was 12.6 in 1970, the same as the median for the state. Population completing four years of high school was 72.8 percent, with 15.5 percent completing four years of college or more.

POTENTIAL ENVIRONMENTAL IMPACTS

PHYSICAL/ECOLOGICAL ENVIRONMENT

Geology

Subsidence. The production zone will probably be permeable lenses within the Glenns Ferry Formation near their contact with the granitic rocks adjacent to the Foothills Fault. Since production will take place in relatively young sediments, and at a relatively shallow depth (1,000 to 1,500 feet), a definite potential for subsidence due to withdrawal of water exists. Evaluation of subsidence problems in other areas of the nation indicate that most are located in areas of youthful geologic materials which are sedimentary in nature, and that have incurred large fluid withdrawals from a relatively shallow depth. However, other areas that have experienced subsidence, such as Houston, Texas (domestic water); Goose Creek, Texas (oil and gas); Wilmington, California (oil and gas); Las Vegas, Nevada (domestic water); Phoenix, Arizona (domestic water); and the Raft River Valley, Idaho (irrigation water), have withdrawals of fluids many magnitudes greater than that contemplated in Boise.

Subsidence has the potential for occurring where there are relatively young unconsolidated sedimentary rocks. The withdrawal of fluids from these geologic formations could cause a decrease in the hydrostatic head of the aquifer causing a transfer of additional load to the coarse- grained and fine-grained rocks. The potential results of this event is compaction on compaction.

An additional source of potential subsidence exists if the production wells are not completed in a proper manner and sand or other fine-grained materials are produced with the geothermal water, thus removing the formational materials from the aquifer. Such removal of sediment has caused local subsidence in wells finished in the upper Terrace Gravels and Ten Mile Gravels in many areas around the Boise Valley; but the subsidence has been related directly to sediment withdrawal rather than fluid withdrawal.

The general history of the Boise Valley area, the lack of such problems at the Warm Springs Water District production site, and the lack of documented subsidence in areas where relatively large volumes of water have been produced from the Glenns Ferry Formation for many years, do not suggest that major subsidence would be anticipated from the proposed project. Nevertheless the nearness of the project to numerous dwellings and other structures, require that precautionary measures be considered and incorporated into the project to mitigate the potential for subsidence and property damager.

Because of the potential for subsidence and a need for lead time to implement preventive measures, a series of second order levels will be run into the area of withdrawal and reinjection from benchmarks located at least one mile outside of the perimeter of the project area. Monitoring of these stations will be initiated prior to the beginning of the project and be continued for the duration of the project as a general precaution. The monitoring system for fluid pressure suggested for seismicity detection would also provide an indicator of potential subsidence occurrences. If, during early phases of the project additional data indicate that subsidence may be a severe problem, reinjection, well spacing analysis, flow reduction or other appropriate measures will be planned to alleviate the problem.

Seismicity. Since the geothermal project will be in an area of high population and dwelling density, concern must be given to the potential for induced seismic activity that could develop from either the production or reinjection of geothermal fluid. The Geophysical Department of Boise State University has, over the past few years, collected seismic data near the Boise area. Seismic and microseismic activity has been detected both in the Boise Valley and at various locations along the Boise Front, but there is no record of large-scale seismic activity that can be attributed directly to the Foothills Fault or the geothermal system now in use by the Warm Springs Water District. None of the faults known to occur along the Boise Front in the vicinity of the project appear to be strongly active which, while in itself does not preclude the possibility of future large-scale movement, indicate a geologic stability that reasonably can be assumed to continue.

Because of the proximity of the production wells and injection wells to the Foothills Fault, it is reasonable to expect that some minor seismic activity may be induced during the life of the project. This seismicity, however, is not anticipated to be severe since the Foothills Fault appears to be relatively stable and other well development along the fault has not generated significant activity for the past 100 years.

Since the prediction of seismic activity is inexact, and data are meager, microseismic sensors would be installed, to collect background information prior to the development of the project. Subsequent to production, a similar network should be maintained and instrumentation should continue during at least the first several years of operation. If subsidence or induced seismic activity is found to be occurring, analyses of thermal water production, and injection water, the magnitude of the activity, or subsidence and other data can then be analyzed to determine specific remedial measures. Some of these measures may include a reduction of flow from the geothermal wells, wider well spacing, or intermittent usage of the production and/or injection wells.

Additionally, there would be two, observation wells (small diameter) drilled to monitor fluid pressure near the area of production to ensure that these pressures do not radically change during the operation of the project. A rapid fluid pressure change could indicate the possibility of induced seismic activity or subsidence. Design of the observation wells must necessarily follow drilling and completion of the production wells in order to accurately monitor the horizons critical to the determination of problem areas.

Mounding. The proposed injection of spent geothermal waters will be located south of the central business district near the Boise River. This area is located on Boise River Terrace Gravels and the Glenns Ferry Formation. It is anticipated that the injection zone will be approximately 1,000 to 1,500 feet below land surface in the Glenns Ferry Formation which is assumed to have similar hydrologic characteristics to those near the Military Reserve. Based upon these assumptions, it is anticipated that mounding of the groundwater system will occur to a level approximately 80 to 100 feet above the present water level during reinjection of the thermal water. To some extent, this will be dependent upon the injection pressure and will have to be determined in the field during injection tests.

It is obvious that by over-pressuring the injection wells, greater mounding of the water table will occur which could eventually result in a slight mounding of the surface of the ground. However, it is not anticipated that extremely high pressures will have to be used to inject the water nor that excessive mounding nor increase in the water table will occur. Additionally, careful monitoring of peizometric pressures in the aquifer should be conducted to determine the pressure threshhold at which mounding begins, if in fact it does occur.

While the construction of the exhaust section of the well is not yet known, disposal of the water should take place through a relatively long section of the well screen. In this case where injection of the thermal water is at a temperature much greater than that of the natural groundwater system, a high quality stainless steel well screen should be used for the exhaust section. This type of screen will allow periodic chemical treatment of the well in order to eliminate any fouling or plugging that may occur because of silicate or carbonate encrustation in the well bore or formation. Because of the temperature differential, it is believed that such encrustation will occur which will cause a decrease in the efficiency of the injection wells. Since the precipitates are natural materials, there will be no adverse environmental impact to either the formation or the groundwater system in the vicinity of the well. However, unless the material is periodically removed through chemical cleaning, it is entirely possible that the injection wells may become inoperable after several years.

<u>Impact on Nearby Wells</u>. The source of the geothermal water is anticipated to be from a deep aquifer which leaks water from the Foothills Fault zone into the Glenns Ferry Formation. This water mixes with the colder waters that exist in the formation and move laterally into the area of production. The closer the intake sections of the production wells are to the Foothills Fault, the hotter the water will be. Because of the occurrence of several warm water wells along Hill Road in the Boise area, it is apparent that some of the warm water is leaking vertically into the shallow ground system and is being intercepted by the shallower wells. Several wells to the northwest of the project area have been used for space heating of private residences for many years.

The initial withdrawal for this project is projected to be approximately 3,000 to 5,000 gpm from the three wells in the Military Reserve area. Anticipating this withdrawal and making the necessary assumptions regarding the hydrologic parameters and characteristics of the Glenns Ferry Formation, leads to several conclusions regarding the potential impact of withdrawal on the environment of the area.

Based upon data collected during well testing for Boise Water Corporation wells, private wells, and other data collected for the Glenns Ferry Formation, it can be assumed that the Transmissivity (T) of the Glenns Ferry Formation in this area will range from 20,000 to 25,000 gallons per day per foot. This coefficient of transmissivity is defined as the rate at which water will flow through a vertical strip of the aquifer one foot wide, extending the full saturated thickness of the aquifer under a hydrologic gradient of 100 percent. This parameter allows a calculation of the approximate rate of flow in the aquifer, the estimated yield of a well, and an estimated drawdown for that yield at a given rate of flow. Since it is anticipated that the total rate of flow from the Military Reserve area will be in the neighborhood of 3,000 to 5,000 gpm, it can be estimated that the drawdown in each of the geothermal wells will be approximately 80 to 100 feet. This assumption is based upon a T value of 20,000 gallons per day per foot at 50 percent well efficiency for each well, and no mutual interference between wells. The radius of influence for these wells cannot be calculated, however, since available data required for calculation of this figure does not exist. During the initial phase of the project these data should be collected in order to estimate the radius of influence for each well and the project wells as a group.

Since the geothermal system (the deep aquifer system which is considered to be the water within the Glenns Ferry Formation) and the shallow groundwater system (in the shallow Terrace Gravels) are interconnected, some impact is anticipated in wells near the geothermal project area in the shallow aquifer. However, because of the recharge from the geothermal system and the amount of water that exists for withdrawal within the Glenns Ferry Formation, the amount of drawdown in private wells near the project area is anticipated to be miminal and are considered not to interfere with other water rights. Because of the concern for private well supplies and the consideration that must be given to private well owners, at least three wells in the vicinities of both the production and reinjection wells would be monitored - as to depth to water, pumping level, and water quality both before and during the operation of the project. These data will provide a base level and provide a basis for comparison if a claim is made of interference after initiation of the project.

If, after construction and testing of the wells, the transmissivity of the production zone is found to be significantly lower than that estimated, the drawdown will be greater than estimated and radius of influence will increase proportionately. This will cause increased interference with other wells in the area; and would necessitate additional aquifer analysis and perhaps a well spacing program or other remedial measures to distribute drawdown and its influence over a wider area with a lesser magnitude.

Water Quality

Groundwater flow in the vicinity of the injection site is to the northwest both in the shallow and deep groundwater systems. The water contained in the Glenns Ferry Formation is under low artesian pressure which results in slight upward movement through the discontinuous confining layers in the aquifer. Higher artesian pressures resulting in flowing wells occur near the towns of Meridian and Eagle approximately eight to ten miles down gradient. Thermal water injected into the deep aquifer will move to the northwest toward these areas of higher artesian pressure, increasing the potential for upward migration of the injected fluid. This upward migration, however, increases the dilution factor thus reducing the possibility of contamination.

Martin and Clapp (1976) studied the quality of the groundwater in the area and of the geothermal water near the Old Penitentiary Site (see Table D-3). The thermal water quality is excellent with the exception of the fluoride (F) content which ranges from two milligrams per litre (mg/l) to 24 mg/l. The quality of the groundwater in the area is also good, with the fluoride content at about 0.4 mg/l and the temperature at about 46°F. Assuming the rate of injection to be a maximum of 5,000 gpm, a plume of higher temperature, high fluoride water will be formed that will extend down gradient or northwesterly roughly the shape of an elliptical parabaloid. Data are not available at present to accurately evaluate dimensions of the plume to the point of acceptable concentration for the human consumption, but rough estimates may be made using estimated transmissivity (T) and storage coefficients (S) values.

The ratio of natural groundwater necessary to dilute the injected fluid to an acceptable F limit of 1.2 mg/l approaches 30:1. Using the T value of 20,000 gpd/ft, an S value 1×10^{-4}, a gradient of 19 feet/mile and the water quality data published by Martin and Clapp, it is estimated that F concentrations of greater than 1.2 mg/l may exist as much as 1.4 miles down gradient from the injection site. The assumptions made also include a narrow annulus of injection and a 100-foot exhaust section in each of the wells. The down gradient distance will be shortened considerably if the injection wells are drilled in a northeast/southwest line, widening the area of disposal. Additionally, factors such as adsorption of F by clay particles and upward groundwater movement will accelerate diffusion and reduce the distance of detectability above 1.2 mg/l. If such a program of well layout is used and injection occurs between 1,000 and 1,500 feet in depth, it would appear that groundwater contamination to the degree that the water is unfit for human comsumption because of the flouride content will not be of concern.

The increase in temperature of the natural groundwater due to the thermal injection is not anticipated to create a water quality problem. This thermal effect will dissipate very rapidly in the aquifer and is not anticipated to be detectable more than a few hundred feet from the injection area.

Because of the numerous assumptions necessary to estimate the dispersion of the chemical constituents in the injected water, it is recommended that once the initial injection wells are drilled, cold water injection tests be conducted to further determine T and S coefficients and necessary injection well head pressures. Based upon these data, a computer dispersal model may be established for the aquifer and more accurate estimates of the dimension and volume of the effluent plume may be determined. Well spacing, injection depth and pressures and other variables may then be finalized in order to prevent any possibility of contamination.

In the reinjection area, the transmissivity values of the formation or other hydrologic parameters may be found to vary widely from those assumed, resulting in higher groundwater temperatures or floride concentrations; deeper injection, additional injection wells, or alternate methods of disposal then should be considered. If mounding of the groundwater system is excessive or surface mounding begins to occur, remedial measures might include a reduction of well head pressures, additional injection wells or deeper injection of the thermal fluid in the Glenns Ferry Formation.

Air Quality

Well testing at the Military Reserve will result in the direct release of a minimal amount of gases and particulates. Carbon dioxide, methane, hydrogen, nitrogen, argon, carbon monoxide, hydrogen sulfide, radon, ammonia, and vapors, such as boric acid and mercury, are often associated in varying amounts with steam from geothermal sources. Hydrogen sulfide is the contaminant of most concern because, in addition to being toxic, it has a nuisance odor of rotten eggs and is detectable in concentrations as small as .025 ppm. A Union Oil Company well in the North Brawley, California, area produced a total flow of 49,500 lb/hr, of which three percent was noncondensable gases. Ninety-nine percent of this was carbon dioxide, and the remainder was a mixture of gases mentioned above. Because of the lack of steam due to the low temperature of the resource (below boiling point), it is not expected that odors of any significance will be experienced as a minimal surface exposure of the resource will occur.

Although noncondensable geothermal gases will be released during drilling and well testing, maintenance of sufficient pressure within the wells to protect against blowouts should result in acceptably low levels of gaseous emissions during drilling. Particulates released with the geothermal fluids or raised by equipment should not add significantly to the existing background level.

The air quality of the Boise area is generally high, but may experience minor improvement with the use of geothermal heat replacing the use of fossil fuels.

Noise

Noise production will occur principally during site preparation, well drilling, and well testing. Noise levels that could be expected from the geothermal operation are presented in Table D-6.

Site preparation will include clearing, leveling, and compacting areas to provide drill pads and construction of minor access roads as necessary. Peak noise levels should range from 85 to 95 dBA at 50 feet from the source, and would be comparable to general road construction noise levels. Site preparation should take from one to two weeks. To minimize impacts on adjacent residential land uses, site preparation activities should be limited to normal working hours.

Drilling of the wells would create noise levels from 65 to 105 dBA. Two months are expected to be required for drilling each well. Flow tests and other well tests would have no significant noise impact.

Because of the potential proximity of the proposed well sites to urban uses, nearby residences and commercial operations well drilling may have some temporary noise impacts. The serene atmosphere of the proposed well field development will be disturbed by the operations. Unless specific approval is granted by the city, operations should be limited to normal business hours to minimize this impact. If non-business hours are necessary for drilling and testing operations, any nearby property owners should be contacted to inform them of the expected noise impacts and the temporary nature of the operation. This will be a short-term impact, and no long-term noise impacts are expected.

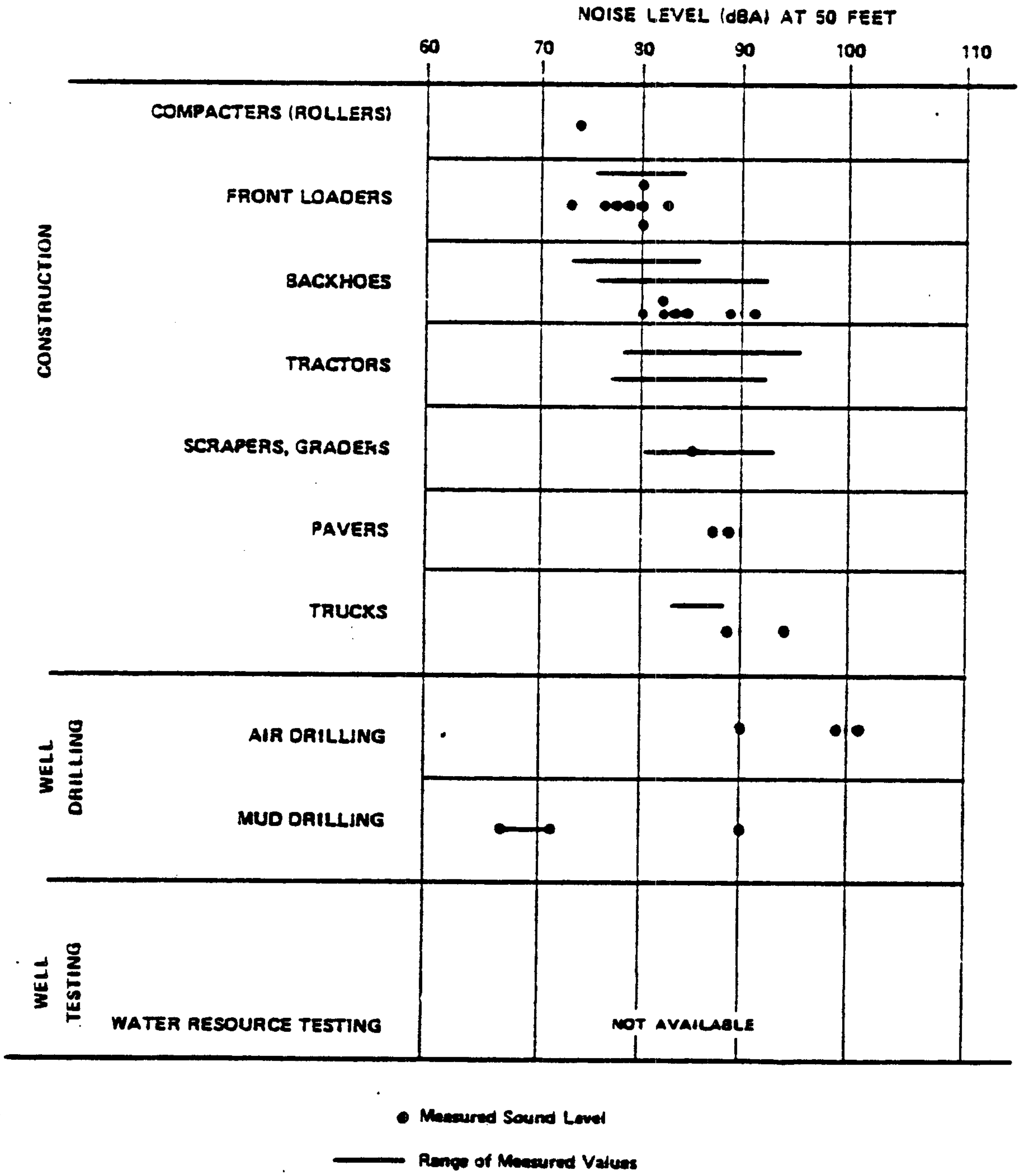


TABLE D-6 - Noise Levels from Geothermal Operations

SOURCE: Environmental Impact Assessment for Cul Venture Application for Geothermal Loan Guaranty

During pipeline construction, noise and dust usually associated with sewer or water main installation will occur in the residential and commercial areas. This noise would include pneumatic drill and some heavy truck traffic during the construction phase.

Terrestrial Ecology

Disturbance to vegetation and soils will occur on the well sites, and a scar running the length of each pipeline will be evident until revegetation occurs. Development will also require access road construction, which may cause erosion during exploration and initial production stages of development.

Drill sites will be regraded and replanted upon completion of the project to return the settings to pre-existing conditions. The pipeline corridor within the reserve site will also be replanted or resoded to return the areas to their natural situation.

Because specific locations of the wild onion *Allium aaseae* have not been identified, it is recommended that upon selection of the most appropriate drill sites, the U.S. Fish and Wildlife Service be contacted to determine the distribution of the plant in the proposed well locations.

Proper site preparation, drilling, and flow testing practices will result in the protection of aquatic biota in the Freestone and Cottonwood Creeks and will protect nearby surface water quality.

Care should be taken to maintain adequate distance between the well sites and the Freestone and Cottonwood Creeks in the Military Reserve, and the Boise River to minimize degradation of water quality by construction activities.

Land Use

The construction and operation of the project would have no significant direct effects upon existing land use. For the most part, the below surface utilities would cause minimal interference with existing development or future uses.

The proposed project may have more significant secondary impacts that should be addressed. Utilities, such as sewer and water are considered to be community life-support systems. Generally, they support a particular quality of life, as well as foster orderly and controlled growth without unnecessary nuisance or environmental degradation. The availability of major utilities or facilities such as roads, sewer and water have growth inducing effects. The questions one must ask are: Could the availability of a cheaper energy resource for building space heating cause changes in land use patterns? Is there a possibility for new development to cluster around the proximity of this resource? Of course, definite answers would be difficult. In proximity to the known resource, development has reached upper holding capacities, with the exception of the foothills. The pressure to develop the foothills has already been demonstrated. Local land use policy involving foothill development will now dictate future development - not the presence of a cheap energy source. Similarly a buildup in Boise's central business district is controlled by so many factors other than the availability of a geothermal resource that the resource cannot be identified as a significant determinant for expansion in Boise's downtown. Development in East Boise, which is in reasonable proximity to the resource is being encouraged by city land use planners. Several sizable developments have been proposed for the area. It is entirely possible that geothermal water could serve these areas in the future.

Development in the proximity of the resource that hasn't already been stimulated by other economic forces would be induced if an inbalance in energy costs were to occur. If fossil fuels or electricity were to dramatically increase in price - far outstripping the cost of geothermal energy - the impetus for development will have been created.

Open Space/Aesthetics

The production wells are proposed for development in the Military Reserve, with reinjection to occur south of the Boise central business district. Noise from the drilling and testing operations may have short-term adverse impacts on any nearby recipients. Permanent or long-term noise impacts would not result from the project.

Since the wells and pipelines will be constructed underground, the project would have no permanent visual impacts.

HUMAN RELATED ENVIRONMENTS

Socioeconomic

The pipeline corridor will run through residential and commercial areas and will cause temporary inconvenience to area residents during the construction phases. The pipelines will be laid similar to the process used for laying sewer or water lines and will cause the same type of noise and dust impacts. This impact will last the term of the installation phase. Mufflers on construction equipment will reduce some noise impacts. Limitations on hours of operation should be imposed to coincide with normal working hours.

The project would have no adverse effects on property values. In fact, quite the contrary should be true. The availability or the potential for geothermal energy would have a positive impact on property values.

The disruption of city streets will also cause inconvenience for transportation. This disruption can be reduced by use of flagpersons, signs, and detours as necessary. Upon completion of each phase of installation of the pipelines, normal neighborhood characteristics should return to normal.

The project would have no permanent or lasting adverse effects upon low income citizens or the elderly. In the future when the resource is made available to residential users - the cheaper resource would lessen the burden of winter fuel bills for low income or fixed income groups. In some cases, special assistance, such as long-term, low interest loans may be required to assist these people in retroffing their homes.

In order to use the geothermal resource, the structures to be served in the initial phases will require retrofitting of existing heating systems. This will cause additional disruption for pipelines to be laid to each structure and modifications to be made to existing heating systems. The city, with support from DOE, will construct the wells and the conveyence system. Commercial participants in the project will bear the cost of conveying the resource to their buildings and retrofitting the buildings to utilize the resource.

Several commercial and residential developers in the city have expressed an interest in using geothermal power in existing and proposed developments. Long-term economic effects of the project may include the economic incentive for development in the area, because of the savings in fuel costs. This will assist the city in further development of its own economic potential.

Displacement or relocation of any kind will not be caused by the project.

Historical and Archaeological Sites

Archaeological materials have been found in the Military Reserve area and an on-site archaeological survey should be conducted in the areas of well drilling prior to any construction activities.

The proposed project would not result in any disturbance, change, or modification to historic districts or sites.

Energy

Previous studies prepared by INEL have indicated that nearly 50 million Btu of commercial-building heating demand in the Boise area could be easily converted to geothermal energy. Subsequent studies and contacts with prospective users indicate that this estimate was probably conservative. Interest among prospective users has increased substantially in recent months, and the Boise Warm Springs Water District has a waiting list of potential customers.

The proposed system will ultimately provide essentially all of the space heating requirements for at least 12 commercial buildings that otherwise would be heated with energy from fossil fuels. Thus, from specifically identified applications, the system will save a total of seven million therms, equivalent to 161,000 barrels of oil over a five-year period computed as follows:

- Annual space heat demand for 12 commercial buildings
  . . . . . 1.562 million therms

- Total energy savings for five years
  . . . . . seven million thems

This assumes the geothermal system supplies 90 percent of the energy requirements during the five-year period. The energy cost to construct the geothermal system has not been included in these computations.

If this first system proves successful and the geothermal resource is proven to be as large as the current geological and geophysical data indicate, then the system will be gradually expanded. An additional 3.3 million square feet of commercial floor space are located close enough to the geothermal resource to receive substantially all of its space heating from geothermal water. Potential energy cost savings using a geothermal system are presented in Table D-7.

In these cost figures, it was assumed that all buildings to be converted to geothermal currently use natural gas for space heating. Projected energy prices are from *Natural Gas Supply Requirement for the State of Idaho,* prepared by Dames and Moore for the Idaho Public Utilities Commission, November 1977.

Potential Accidents

During the drilling program, the most likely problems to occur will be blowouts, lost circulation zones, cave-ins, tools lost to the well, and drilling fluid problems. Dependent upon the type of drilling rig to be utilized, several standard pieces of equipment may be used to contain blowouts of gas or high temperature water. If a standard water well drilling rig is to be used, precautions should be taken to ensure that the surface casing is properly cemented and sealed; and that the appropriate flanges and valves are established on the well head prior to drilling into the thermal zone.

Well blowouts can result in significant venting of steam, associated gases, and water to the atmosphere, ground, and water courses. This would create air and water contamination, as well as high noise levels, and would expose individuals to possible injury. Accidents may have short-term impacts, depending upon the nature and volume of the discharge involved. Corrective measures, such as dilution, diversion of waste waters, etc., should provide adequate measures against serious or long-term impacts.

In the event of a blowout, short-term impacts on aquatic biology would depend upon the nature and volume of the discharge involved and the proximity of the well site to a surface water body. Since the quality of the geothermal water is high, the major impact would be thermal and would result in damage to land and aquatic biota if the temperature is high on contact. The impact would be felt as long as it would take the damaged biota to reestablish itself in the affected areas.

Areas immediately surrounding the drill sites should be signed and restricted from access by the public. Any areas used within city properties will be coordinated with the appropriate city department.

Workmen on the drill rig will be required to wear safety belts on the super structure. Steps from the ground surface to the deck of the drill rig will also be provided to prevent injury. Flammable fuels will be stored in fire retardant barrels. Fire extinguishers will be available on-site and tested periodically. In general, the drilling operation will comply with appropriate Federal safety regulations.

Table D-7.

ENERGY COST SAVINGS FOR GEOTHERMAL SYSTEM

Year	From Proposed System	From Expanded System	Total	Additional Electrical Use	Net Savings
1980	$ 470,000	--	$ 470,000	$ 37,000	$ 433,000
1981	960,000	--	960,000	48,000	912,000
1982	1,250,000	--	1,250,000	92,000	1,158,000
1983	1,417,000	$ 200,000	1,617,000	139,000	1,478,000
1984	1,560,000	673,000	2,233,000	140,000	2,093,000
1985	1,699,000	2,371,000	4,070,000	161,000	3,909,000
. . . .					
1990	2,520,000	11,230,000	13,750,000	240,000	13,510,000
. . . .					
1995	2,670,000	15,010,000	17,680,000	320,000	17,360,000
. . . .					
2000	2,830,000	18,930,000	21,760,000	400,000	21,360,000

SYSTEM EVALUATION AND CONTINUED DEVELOPMENT

Once the initial building retrofitted systems begin operation, data will be systematically collected for each building; and the systems will be evaluated for economic and technical performance. Evaluation of system performance will be an on-going process with a summary report prepared at the completion of the entire project outlining total annual energy savings realized.

Throughout the program, quarterly progress reports will be submitted to the DOE, addressing technical status, project costs, and contract management. An interim draft and a final report will be prepared for the entire project, documenting the various elements of the project.

It is the long-term goal of the Boise geothermal project to implement a complete geothermal space heating utility providing service to residential, commercial and institutional customers in the area. Completion of this project will be one step in realizing this continuing development of the geothermal resource in the Boise area.

ALTERNATIVES TO THE PROPOSED ACTION

Every element of the proposed project has an array of potential alternatives. Alternatives associated with some elements, however, are less important to consider here than others. For example, several pipeline corridors were evaluated to serve the 12 buildings. The one which was chosen provides the straightest route to serve all the buildings, thus minimizing construction impacts as much as possible. In actuality, any one of the pipeline corridors would present very similar impacts during the construction phase.

For the purpose of this project it was concluded that a system serving either public or commercial office buildings would have the greatest value as a demonstration. If the feasibility of geothermal energy is to be demonstrated on the large scale for space heating, it can be accomplished most prudently with the use of large structures. Besides the use of geothermal energy in Boise for space heating residential structures has been in practice for over 70 years.

A number of buildings in Boise were examined as candidates for using geothermal water for space heating in this initial phase of project development. The field was narrowed to 12 buildings. The remainder will be considered for retrofit as the system is expanded.

Two elements of the project - the well field and the method for disposing spent geothermal fluid - were considered to have important alternatives for development associated with them.

The location of the well field was guided by prior investigations and proximity to the market area. A most intense effort to define the geothermal resource in the Boise area was completed in 1975 and 1976. With ERDA funding through INEL and technical assistance from BSU, the city drilled a number of exploratory wells on the Military Reserve; and completed surface geophysical measurements along the Boise Front. Unfortunately, not all of the geophysical measurements were completed on the exploratory wells before they were cased because of funding limitations. Nonetheless, the wells and measurements did provide more specific data concerning the resource. The completed measurements include resistivity studies in various locations along the Boise Front, as an effort to determine probable resource drilling areas.

A summary of findings shows five probable resource areas based on geophysical measures, surface features, and a history of hot springs. The most attractive geothermal area is east of Table Rock. Another area is in the vicinity of Boise Warm Springs Water District wells. The third area is the Military Reserve in which recent exploratory wells were drilled. The Camel's Back Park area was noted to be another promising location, although it has not been explored. The final location is near existing hot water wells such as Edwards Greenhouse, and Milstead Floral.

The Military Reserve was considered the most favorable location to drill the city wells. Determining factors included close proximity to the market; the availability of specific data concerning the geothermal resource which was produced from the exploratory drilling program; the majority of the surface rights are retained by the city; and recent Congressional and Presidential action releasing the rights to the geothermal resource to the City of Boise. The combination of these factors will expedite the project and an expanded program.

The other locations that were mentioned as well as newly found sites could all be candidates for future geothermal development. The myriad of ownerships along the Boise Front will require indepth study of organizational structures and strategies for unifying the resource toward the common benefit of the community.

Of the many problems associated with developing an areawide geothermal space heating project, perhaps a major concern is the disposal of spent geothermal water. Geothermal water used in the Boise area today for space heating is discharged in several ways. The quantity of discharge, is small and environmental problems resulting from these practices are nonexistent. The proposal to develop the geothermal resource on a large scale, however, does bring with it the problem of disposing large quantities of spent geothermal water. Under these conditions, methods for disposing of the water in an environmentally safe and acceptable manner were examined. Several alternatives for disposal of geothermal water are possible and were investigated:

- Reinjection
- River disposal
- Disposal to sanitary sewers
- Disposal to an agricultural canal
- Leach/evaporation pond, and
- Reuse

REINJECTION

The method of reinjecting the spent geothermal water into the ground has long been considered as a means of disposal. Reinjection wells are normally drilled in a manner similar to that used for drilling a production well. The hole is cased and perforated in the zones where reinjected water is to be dispersed. Depending upon the relative dispersion depth, reinjection wells can be considered either shallow or deep.

Deep wells are necessarily more expensive than are shallow wells. However, dispersing the geothermal water at greater depths reduces the possibility of interference with shallow aquifers. In shallow reinjection, contamination may result from increased thermal temperatures and/or trace chemicals such as fluoride in domestic wells.

The actual depth which the geothermal water would be discharged should be determined after careful analysis of the existing wells in the area including those of Boise Water Corporation which are relatively deep.

Under present Department of Water Resources guidelines, several observation wells would probably be required to monitor the effect of the geothermal water on the subsurface strata and groundwater.

The reinjection well(s) could be located either near the source geothermal wells, or near the project site. Locating the reinjection well near the end user eliminates the need for long transmission mains back to the reinjection well. The reinjection well may interfere with existing domestic or Boise Water Corporation wells, depending upon the location of the end user.

Reinjection wells located near the source wells have the advantage of putting the spent geothermal fluid back into approximately the same aquifer, replenishing the supply. This would reduce the possibility of ground subsidence near the source wells.

The possible disadvantage with reinjecting near the source wells is short-circuiting within the aquifer, resulting in lower temperatures being produced from the source wells. Actual temperature reduction in the source wells would be a function of many parameters including extent of the resource and/or direction of flow of the resource, and possibly rock formation.

In general, there are many advantages to the use of reinjection wells. It eliminates odor problems associated with the spent water, thermal contamination of surface waters, and environmental problems caused by high-temperature water or minerals being discharged to the environment.

The major disadvantage associated with disposal wells are those of cost and the long-term effect on the groundwater near the area of the reinjection well. This latter concern, of course, would be monitored by the observation wells.

RIVER DISPOSAL

An often mentioned and highly controversial disposal method would reject the spent geothermal water to the Boise River. Small quantities of geothermal water rejected to the river now do not appear to be impacting the river ecology to any measurable extent. The disposal of several thousand gallons per minute of geothermal water, however, could have a marked impact upon river life. Under current operating procedures, the Boise River flow may be reduced to 50 cubic feet per second or approximately 22,000 gallons per minute for extended periods of time during the months of December, January, February, and March. This period of low flow corresponds with the period of peak heating demand and consequently the maximum geothermal discharge rate.

At 5,000 gallons per minute, the geothermal input to the river would be approximately 20 percent of the total river flow. At this discharge rate, the impact of temperature and flouride should be considered. The actual effect of temperature on the river biology has not been thoroughly studied or documented. Subsequently, the result of the high temperature on fish and other forms of wildlife including plants and algae is not known at this time. It is anticipated, however, that algae growth in the river would increase. The effect of the high fluoride geothermal water is also unknown. Current tests indicate that native trout become affected by fluoride in the range of six to seven milligrams per liter. Fluoride effect on other species of life is not documented for the Boise River.

An additional potential problem with the geothermal water is the high oxygen demand. The water upon entering a stream such as the Boise River actually requires oxygen, thereby reducing the amounts available for aquatic life. The total effect again is not well documented.

One method of overcoming the problem associated with disposal to the river could include the use of holding ponds during the period of peak flow. Such ponds would be constructed with an impervious liner and of such size as to hold the majority of the water during periods when the Boise River flow is low. These holding ponds would have the added advantage of reducing the geothermal water temperature before entering the river. Oxygen could be added thereby reducing the impact on the river. Holding ponds have a disadvantage that they require large amounts of land and may give rise to odor or fog conditions. Also the ponds would do nothing to reduce the fluoride concentration of the water. The advantage of the holding ponds is that the water could be held until the Boise River flow rate is high enough to adequately assimilate the geothermal water. Geothermal water could then supplement river flow for use during the irrigation season.

Boise State University, under contract to the State of Idaho, has recently completed an extensive study entitled *Biological Impacts of Geothermal Wastewater Discharge into the Boise River* in conjunction with the Agricultural Health Demonstration Project. From this study the demonstration project produced negligible environmental impact. Larger scale projects may necessitate additional studies.

DISPOSAL TO SANITARY SEWER SYSTEM

Some geothermal water enters the City of Boise sanitary sewer system. The current flow is estimated to be in the neighborhood of 150 to 200 gallons per minute (gpm) maximum, and is causing some problems. The added temperature of the water causes the sewage to become septic and results in odors being released from the sewer lines. Dumping several thousand gallons per minute of hot water into the sanitary sewer system would greatly compound this odor problem.

In addition, the disposal of several thousand gallons of geothermal water into the sanitary sewer system raises many questions regarding capacity. First, the capacity of the branch and mainlines of the sewer system serving the area of the geothermal user. In many areas of Boise, the sewer mains are eight-inch and are flowing to capacity. Additional load of the magnitude considered here could not be added to the system. This would require major sewer redesign and construction to adequately handle the increased load. Secondly, the treatment plant which serves the Boise downtown area is sized for a capacity of 15 million gallons per day (gpm). Rejecting 2,000 gpm of geothermal water to the sanitary sewer system would increase the total plant load by approximately five mgd - or 25 percent. This added flow would increase user costs both for the geothermal user and the citizens of Boise in general. The effect of the heated geothermal water upon the sewage treatment plant has not been analyzed in any detail, and may or may not have any adverse effect.

Municipal waste treatment plants do not have means for removal of fluoride which is the element of most concern in the Boise geothermal water. This fluoride would pass from the treatment plant into the Boise River. Therefore, putting the geothermal water into the sewer rather than direct disposal to the river gains only reduction of temperature and oxygen demand. All concerns over the effect of fluoride are still valid as discussed in direct river disposal of geothermal water.

The disposal of geothermal water to the sewer at first would appear to be the cheapest means of disposing the water for the user. An indepth analysis would indicate the contrary. Actual costs would be substantial making this disposal system impractical for Boise.

DISPOSAL TO AGRICULTURAL CANALS

Located within the city limits of Boise are a number of large canals serving a network of secondary canal systems. These canals are used for irrigation of agricultural lands to the west of Boise. Spent geothermal water could be disposed into the agricultural canal system. The geothermal water would then mix with the irrigation water and be utilized in the farmland areas. Several advantages to this arrangement exist. First, the increase in the amount of water available would permit higher agricultural production. This water would also be outside the realm of normal water rights governing water extraction from the Boise River system. The higher temperature of the geothermal water when it is mixed with irrigation water may also increase the productivity of farmland to some extent. The actual increase in productivity, however, has not been analyzed.

Based on several studies conducted by ERDA (DOE) funded projects at Raft River, there appears to be little effect on plant life as a result of fluoride. Soil binding should not occur at the low levels of solid concentration which the Boise geothermal water possesses. More study into both of these effects should be implemented before the spent geothermal water is used extensively for irrigation.

The major problem associated with geothermal disposal to canals is that the peak flow of the geothermal water occurs during the winter and does not coincide with the maximum demands for the agricultural water. It is the current procedure of the local canal companies to completely drain the canals during the winter and early spring months of the year. This allows maintenance crews to refurbish and rebuild canals and canal structures before the irrigation season starts in early summer. Several thousand gallons of geothermal water from a heat project may not be welcomed by the canal companies during this annual maintenance period. If this method were used, the geothermal water could be stored in reservoirs until the agricultural season. Depending upon actual flow conditions and reservoir levels, concentration of fluoride might accumulate and potentially become a problem. It might become necessary to establish a monitoring program to establish the extent of fluoride concentration.

One further disadvantage of using the canal is the problem presented by the potential generation of fog during certain atmospheric conditions. To some extent, odor may become a problem with this disposal method.

LEACH POND AND EVAPORATION PONDS

The disposal of geothermal fluid in leach ponds and evaporation ponds has been mentioned as a potential disposal alternative. Both types of ponds, however, have serious drawbacks. In the case of leach ponds, contamination of the groundwater from fluoride and other salts may occur as the water leaches into the water table. This may result in contaminated domestic wells. In an effort to preclude this occurrence, a number of observation wells would probably be required. It is generally agreed that fog and odor are two other problems which normally can be associated with leach ponds of this type. Depending upon the soil conditions and the flow rates, the leach pond may also require large surface areas in order to function properly in the disposal of geothermal water.

Evaporation ponds differ slightly from leach ponds in that they are lined with an impermeable membrane such as bentonite clay or some synthetic liner which prevents the seepage of water into the water table. All of the water which enters the ponds, therefore, must evaporate. One can readily see the problems which this creates for high flow rates during the winter months when the evaporation is low. Large areas of land must be appropriated for the use of the evaporation ponds.

Similar to the leach ponds, fog and odor may be a problem which must be considered. It can also be generally concluded that observation wells may be required to monitor any leaching of the geothermal fluid into the ground.

REUSE OF GEOTHERMAL WATER

One of the best uses for spent geothermal water from a space heating project is to extract more and more heat in successive uses. These might include residential space heating; of fish ponds; shrimp ponds; greenhouse operations, including hydroponic gardening; architectural fountains; and perhaps the irrigation of golf courses during the colder months. For example, an excellent opportunity would exist for the city to demonstrate reuse of geothermal water in a low income elderly area near the downstream end of the collection system. The water could be easily diverted to this area prior to reinjection. Retrofitting the homes for geothermal usage could be accomplished through the use of long-term low interest rate home improvement loans.

The opportunities for reuse will be examined further after the system is operational. Reuse of the water, however, does not eliminate the need for final disposal of the water in some form. In those methods outlined, the most promising at this time appears to be deep well reinjection.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

The proposed geothermal system is a closed-loop system with reinjection of the spent geothermal fluid. This is a constant renewal process and should cause no irreversible impact on the geothermal resource. Potential for subsidence, which is an irreversible process, is expected to be minimal.

A minor amount of land will be used for well field development. Since the wells will be constructed underground, there would be minimal interference by the well operations and maintenance with surrounding or adjacent uses.

The commitment of fuel resources will be greatly reduced by utilization of the geothermal resource for space heating.

COMPLIANCE WITH REGULATIONS AND OTHER CONTROLS

Development of this project causes no known conflicts with state, local or regional plans. Submission of formal requests for permits or opinions required from governmental agencies will be coordinated with all agencies having jurisdiction or interest in the proposal.

Because of the possibility of development in or near designated park areas, the Boise City Parks Department and Board of Commissioners will be given the opportunity to comment on all project proposals which may affect park development. This will ensure compatibility of the project with present and future plans for development of park areas within the City of Boise.

To assure that the proposed project does not set precedence for allowing other non-conforming uses within the Military Reserve, the city may wish to impose conditions of proper geothermal facility construction and document limitations on all other non-conforming park uses.

COMMENTS

A preliminary draft of this document was circulated to city departments, city officials, selected state agencies, and interested citizens for review and comment in October 1978. Comments received from the reviewers are contained in Appendix 3. This draft document has attempted to incorporate the modification for all substantive comments.

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APPENDIX 1

Flora in the Proposed Geothermal Development Area

Flora in the Proposed Geothermal Development Area

Lower Plants

Mosses
Lichens

Grasses

Giant Wild Rye - Elymus cinerus
Bulbed Bluegrass - Poa bulbosa
Cheatgrass - Bromus tectorum
Japanese Chess - Bromus japonicus
Rattlesnake Brome - Bromus brizaeformis
Bluebunch Wheatgrass - Agropyron spicatum
Crested Wheatgrass - Agropyron cristatum
Beardless Wheatgrass - Agropyron spicatumv. inerme
Foxtail Barley - Hordeum jubatum
Meadow Barley - Hordeum Nodosum
Red Three Awn - Aristata longiesta
Western Needle and Thread - Stipa comaia
Witchgrass - Panicum capillarie
Common Reed - Phragmites communis
Rabbits foot Grass - Polypogon monspeliensis
Yellow Bristlegrass - Setaria luteseens
Squirreltail - Sitanion histrix
Barnyard grass - Echinochloa crusgalli
Orchard grass - Dactylis glomerata
Reed grass - Calamogrostis sp.
Bluegrass - Poa sps.
Redtop - Agrostis sp.
Idaho Fescue - Festuca idahoensis
Cultivated Barley - Hordeum
Cultivated Rye - Secale cereale

Forbes

Sedges - Carex sps.
Tules - Scirpus sp.
Rushes - Juncus sps.
Arrowleaf Balsa - Balsamorhiza sagittata
Spike Rush - Eleocharis sp.
Yarrow - Achillea millefolium
Sego Lily - Calohortus macrocarpus
Wild Lettuce - Lactuca sp.
Night Shade - Solanum sp.
False Dandelion - Agoseris sp.
Mullein - Verbascum Thapsus
Horsetail - Equisetum sp.

Field Mallow - Malva neglecta
Dock - Rumex sp.
Water Parsnip - Sium suave
Monkey Flower - Mimulus sp.
Cocklebur - Xanthium strumarium
Daisy - Aster sp.
Thistle - Cirsium sp.
Scorpion weed - Phacelia sp.
Stinging nettle - Urtica sp.
Poison Ivy - Toxicodendron radicans
Morning Glory - Convolvulus sp.
White Sweet Clover - Medicago alba
Alfalfa - Medicago sativa
Yellow Sweet Clover - Medicago officinalis
Milk Vetch - Astragalus sp.
False Mallow - Sphaeralcea sp.
Evening Primrose - Oenothera sp.
Fire Weed - Onenothera sp.
Peppergrass - Lepidium perfoliatum
Pigweed - Chenopodium sp.
Russian Thistle - Salsola kali
Tansy Mustard - Descurania sp.
Filary - Erodium circutarium
Watercress - Rorippa nasturtium
Virgins Bower - Clematis ligusticifolia
Knotweed - Polygonum sp.
Tarweed - Madia sp.
Wild Onion - Allium sp.
Plantain - Plantago sp.
Goat's Beard - Tragopogon sp.
Cattail - Typha latifolia
Catnip - Nepeta sp.
Bachelor's Button - Centaurea cyanus

Shrubs and Trees

Sandbank Willow - Salix exigua
Yellow Willow - Salix lasiandra
Scouler's Willow - Salix scoulerania
Black Cottonwood - Populus trichocarpa
American Elm - Ulmus americana (escaped)
White Alder - Alnus tenuifolia
Russian Olive - Eleagnus angustifolia
Black Hawthorne - Crataegus douglassi
Bitterbrush - Purshia tridentata

Sagebrush - _Artemisia tridentata_
Dogwood - _Dornus sericea_
Ninebark - _Physocarpus sp._
Golden Currant - _Ribes aureum_
Boxelder Maple - _Acer negundo_
Western Chokecherry - _Prunus virginiana_
Wild Rose - _Rosa woodsii_
Siberian Elm - _Ulmus pumila_
Black Locust - _Robina pseudoacacia_
Honeysuckle - _Lonicera sp._

Cultivated Trees: V.A. Grounds and Memorial Park

Red Elm - _Ulmus rubra_
American Elm - _Ulmus americana_
Siberian Elm - _Ulmus pumila_
Black Locust - _Robinia pseudoacacia_
Black Poplar - _Populus nigra_
Tamarix - _Tamarix pentandra_
Russian Olive - _Eleagnus angustifolia_
White Oak - _Quercus alba_
Black Oak - _Quercus sp._
Plum - _Prunus sp._
Tree of Heaven - _Ailanthus altissima_
Cult. Yew - _Taxus sp._
Weeping Birch - _Betula pendula_
Austrian Pine - _Pinus nigra_
Norway Maple - _Acer platanoides_
Ponderosa Pine - _Pinus ponderosa_
Larch - _Larix sp._
Honey Locust - _Gleditsia triacanthos_
Ginko - _Ginko biloba_
Eastern Cedar - _Juniperus virginiana_
English Ash - _Fraxinus sp._
Silver Maple - _Acer saccharinum_
American Linden - _Tilia americana_
Blue Spruce - _Picea pungens_
Black Walnut - _Juglans nigra_
Horse Chestnut - _Aesculus hippocastanum_
Arborative - _Thuja occidentalis_
Douglas Fir - _Pseudotsuga menziesii_
Poplar - _Populus sp._
Pine - _Pinus serotina_

APPENDIX 2

Fauna In the Proposed Geothermal Development Area

Fauna in the Proposed Geothermal Development Area

FAUNA

Birds

Gamble Quail
Starling
Robin
Magpie
Meadow Lark
Blackbird
Mourning Dove
Cliff Swallow
Red Shafted Flicker
Sparrow Hawk
Pigeon Hawk
Red Tailed Hawk
Night Hawk
Killdeer
Bunting
Kingbird
Finches
Pheasant

Reptiles

Garter Snake
Lizards

Amphibians

Tadpoles
Frogs

Mammals

(Small)
Field Mice
Pocket Gophers
Cottontail Rabbits
Ground Squirrel
Rock Chuck

(Large)
Red Fox
Badger

Invertebrates

(Insects)
Cicadids
Grasshoppers
Ants
Antlions
Bees
Damselflies
Caddis Fly Nymphs
Butterflies
Aquatic Nymphs
Water Boatmen

(Mollusks)
Snails

(Other Arthropods)
Waterstriders
Beetles
Spiders

APPENDIX 3.

Review and Comments

CITY OF BOISE

Inter-Department Correspondence

): Miss Lee Post

From: Laura Rose
Jim Lanz
Community Development

Subject: Environmental Assessment

Date: August 29, 1978

In reviewing the Preliminary Draft of the "Environmental Impact Assessment for a Space Heating Project", (August 3, 1978) we found some serious deficiencies

Item 1: EPA regulations state:

(a) The statuatory clause "major Federal actions significantly affecting the quality of the human environment" is to be construed by agencies with a view to the overall, cumulative impact of the action proposed related Federal actions and projects in the area and further actions contemplated...In considering what constitutes major action significantly affecting the environment, agencies should bear in mind that the effect of many Federal decisions about a project or complex of projects can be individually limited but cumulatively considerable.

Since the City sumbitted a geothermal project proposal in July, 1978, to the Department of Energy which included six well sites and two re-inspection wells, the environmental assessment should address the impacts of the complete system. A detailed project description outlining phasing for the five year project and incorporating the five stages for the demonstration Camel's Back line is required.

Item 2: We were confused about the area of impact and assessment is addressing. Is the impact area limited to Boise City? (River Run identified in Appendix 1 is outside the city limits.) A map would be helpful. Along the same lines, measurements of impacts varied. At one point regarding historic preservation, only North End locations were given. Yet in the discussing socio-economic impacts, information for the City as a whole was used. This doesn't seem consistant.

Item 3: On page 3 under 1. 2 Project Location, no mention is made of the actual size of the developed portion of the park, 8.9 acres of which the project proposes to use 4.5 for well fields. Essentially the project will close the park for general recreation during drilling. The impact of the park closure on the surrounding lower income neighborhood needs to be assessed. Since lower income families traditionally have more health problems and more housing problems than other groups the impacts of noise adjacent to their homes should be considered.

According to the project location maps and according to John Austin, the developed portions of Camel's Back will in all probability be closed for the drilling sites. Thus the opening statement under 3. 8.1 (p.34) is incorrect.

How large will the well sites be during and after testing? Several figures were given, but nothing actually described the appurtenances and size of the permanent wells.

Item 4: Under the discussion of Ground Water, no mention is made of the recent experience the Park's Department has had with their cold water well in Military Reserve Park. The irrigation pumping system is now pumping hot water, whereas previous to the exploritory testing for geothermal water, it had been drawing cold water.

Item 5: In Section (4) Potential Environmental Impacts, the report fails to mention that the residents suffering the direct impacts of the odor nuisance and high noise levels are predominantly lower income persons, many of whom are elderly. Depending on the location of the drilling sites, residences could be located within 50 feet of the noise and odor source. The direct impacts of park closure, noise, and odor have to be addressed and mitigating measures suggested. Also pipeline construction nusiances will impact predominantly lower income persons and school children.

Item 6: In the discussion Energy, the calculations leading to the 10 million therms savings includes the heat demand for 500 residences. Since the project as shown in Figure 3 includes no residences, how can you include the 960,000 therms saved? Are the figures in Table 8 based on the same numbers?

Item 7: We have recieved complaints from the Parks Department concerning your statement on page 60, coordination of opinions "from agencies having jurisdiction or interest in the area of the proposal." The Department did not receive a copy of the draft and did not know the size and scope of the activities in Camel's Back Park. Since the project will impact neighborhood residents and a park which attracts an average 58 visitors/day, all parties should work closely to mitigate the adverse project impacts.

Item 8: We feel the issue of possible subsidence with consequent serious impacts was not thoroughly addressed. While Section 7 points out a minimized risk if wat is reinjected into the same aquifer, the process seems ambiguous. If the geother water system is similar to the deep artesian system in the Boise area which flows in a west-southwest direction, how will the reinjected water get back 1.6 miles to the North? Also, the question of monitoring for subsidence and responsible for it should it occur is not addressed.

CITY OF BOISE

Inter-Department Correspondence

To: Mayor Richard Eardley and Members of the City Council

From: Board of Park Commissioners

Subject: Geothermal - Environmental Impact Assessment **Date:** October 20, 1978

Upon review of the preliminary draft of the EIA released Oct. 5, 1978 by the City Energy Office, we find that very little Park Board input has been made a part of the EIA record despite submission of such material by the Park Board. The Board therefore forwards the following information for inclusion in the geothermal report:

1. March 12, 1976 - Correspondence U.S. Dept. of Interior
2. August 8, 1977 - Correspondence Boise City Park Board
3. June 29, 1978 - Memo Boise City Park Board
4. October 10, 1978 - Memo Boise Center for Urban Research

Since we are essentially partners in this venture, although we are not enthusiastically involved, we feel that this Board's contribution to the basic geothermal project is essential. Of particular concern to the Board is the draft report's lack of acknowledgement of the advisory position of the Park Board in determining recommendations to the Council for advisable uses of park areas. In fact the report specifically stated that community open space is going to be utilized in the geothermal project despite the Board memo of June 29, and the Boise Center for Urban Research memo of October 10, indicating possible alternatives. The report position on park utilization for the project is questioned by the Board since little statistical information is provided to support the necessity of park area use. Several other areas are acknowledged as being of equal geologic potential to the parks named, but these areas are not reviewed by the report.

As a citizen Board charged with the responsibility of assuring the Community that its open space needs will be provided, the Board of Park Commissioners feels that it should be included in all discussions involving major decisions concerning park use. In fullfilling the responsibility of providing open space, the Board emphasizes the following:

1. That all feasible geologic studies be conducted on all potential well sites to determine the most favorable drilling site prior to designating a production well field location.

2. That consideration be given to acquisition of property other than parks, that show favorable geologic statistics, rather than sacrificing currently used park land to non-park use.

3. That should park sites be entertained as well field locations, consideration be given to not only the initial potential loss of functional open space but consideration also be given to the loss potential of open space as the geothermal project is expanded in the park to meet additional commercial demand for the resource.

4. That should a park be statistically determined as the most feasible site to tap the hot water resource, all phases of the project involvement in the park be reviewed with the Park Board & Staff to incorporate into the project operations park oriented attitudes to minimize park damage and open space reduction.

5. That should a park become a well field site, a reasonable percent of revenue derived from the wells' production be assigned to the community's open space program. Since the well production revenue would be acquired from existing open space land holdings, an appropriate expenditure of a portion of the new revenue would be for additional open space acquisition.

The Park Board continues to support the geothermal project concept and recognizes the project value to the community. In the best overall interests of the public however, the Board requests that attention be given to project location alternatives so that the proven community asset of the City park open space is not diminished in any manner.

cc/ Energy Office

United States Department of the Interior
FISH AND WILDLIFE SERVICE
~~BUREAU OF SPORT FISHERIES AND WILDLIFE~~
ECOLOGICAL SERVICES
4620 Overland Road
Boise, Idaho 83705

March 12, 1976

Ms. Janet Ward, Member
Boise City Park Board
1910 Manitou
Boise, Idaho 83706

Dear Ms. Ward:

Your letter of March 5, 1976 asked information on endangered plants which may be within the boundaries of Boise City parks.

The wild onion Allium aaseae of the Boise Front has been listed by the Smithsonian Institution as a potentially endangered plant in Idaho. The plant is listed as endangered in the report entitled "Research Natural Area Needs in Idaho, A First Estimate," published in December 1974 by the University of Idaho. The onion is found only in Ada and Gem Counties of Idaho. It normally grows on sandy, south-facing, sparcely vegetated slopes, sometimes in association with bitter-brush. The species is known to occur in Boise's Camelback Park and may occur in or adjacent to (1) the Boise City park near Hillside Junior High School and (2) Military Reserve Park. We understand that the plant is the only April-blooming onion found on the Boise Front. Therefore, the Park Board could search the city's foothill parks next month to determine its presence. As an aid in such a search, and in response to your informal request, we are sending three photographs of the species, plus a copy of this letter to Park Board Member, George Baggley.

The U. S. Fish & Wildlife Service is now considering whether or not to bring this onion under the protection of the Endangered Species Act of 1973 (P.L. 93-205). A decision on that matter is several months away. At present, we consider this plant a species of concern and a candidate for endangered status.

We know of no other plant species on the Boise Front whose survival may be threatened.

Sincerely,

Richard J. Fisher

Richard J. Fisher
Field Supervisor

cc: G. Baggley (w/photos)

CITY OF TREES

BOISE CITY, IDAHO

ARD R. EARDLEY
MAYOR

COUNCIL MEMBERS
RALPH J. McADAMS, PRESIDENT
MARJORIE J. EWING, PRES. PRO-TEM
FRED L. KOPKE
BERNE K. JENSEN
JOY BUERSMEYER
CORKI ONWEILER

August 8, 1977

D. Dean Bibles, District Manager
Boise District Office
Bureau of Land Management
230 Collins Road
Boise, ID 83702

Dear Mr. Bibles:

The Boise City Park Board has reviewed the EAR #ID-010-7-88, Geothermal Leasing on the Boise Front. We have several comments we would like to have included in the record.

Generally, the EAR tends to either overlook or depreciate the amount of recreational use of Military Reserve Park and the efforts by Boise City to manage the area. The statement on page 2, "The patents issued on Tract 38 have thus far not been fully developed for recreation and public purposes." misconstrues the value of a natural park. It was never the objective of the Park Board to "fully develop" this area in traditional ways, e.g., turf it over, provide playgrounds and install baseball diamonds. The Board felt Military Reserve Park presented a unique opportunity to have a natural area, close to the heart of the city, suitable for walking, quiet reflection and nature study. This park could be used by walkers, horsemen, archers, scout groups and classrooms studying ecology or history. These uses were enthusiastically endorsed at a public hearing. They have been integrated into the updated park plan, which was filed with the Boise District BLM in July 1976. Management of the park was included in the schedule outlined in the park plan. (Incidentally the Park Department has never received written acknowledgment of the filing of the updated plan).

Managing this natural area poses special problems. It had been a favorite place for motorcycles. Since this area is steep and highly erosive, all ORV use has been discouraged. Barricades and prohibitive signs have been erected at key locations. Tracks have been reseeded with natural grasses.

Motorcycle groups once advocated using the park as a parking lot and trailhead. This was not included in the park plans for such use is not compatible with a natural area and the BLM does provide for ORV use on other areas of the Boise Front. A 4-wheel club asked to hold an overland rally in the park; this request was also denied.

A natural area does invite trespass. The City has embarked on a firm policy; a complaint has been filed against Grover Hawkins for unauthorized road construction. An unauthorized school bus shelter was moved onto private property. Dumps of composting leaves and rubble have been removed. Dumping is discouraged by frequent patrolling of the park. These management efforts have been effective and should be recognized. Yet page 7 of the EAR states "The majority of Tract 38 has received significant use by motorcycles and four-wheel drive vehicles. The numerous roads and trails detract from natural beauty of this area as does the indiscriminate dumping of discarded materials."

Our ORV policy was implemented in part to protect a rare species of wild onion, Allium aaseae. This onion, found only on the foothills in Ada and Gem counties, is listed by the Smithsonian as a potentially endangered species. The Fish and Wildlife Service considered the plant a species of "special concern" and a candidate for endangered status. Page 6 of the EAR notes that "The subject lease area does not contain any known rare or endangered species." This should be amended and appropriate protection included in the recommended mitigating measures, pages 15 - 17.

An interesting proposal is made on page 9, "...monies that would be saved... could then be diverted to park development and maintenance." On page 18 this suggestion was phrased, "Monies saved would be spent on park improvements and recreational facilities for the public." Is this a firm proposal, one which would be written into any geothermal development lease? We would like to discuss this proposal further with the BLM at a future Park Board meeting.

Very truly yours,

Wm. K. Dunkley, President
Boise City Board of Park Commissioners

JW:vw

To: Mayor Richard Eardley and Members of the City Council

Inter-Departm Correspondenc

.om: The Board of Park Commissioners

Subject: Proposed Geothermal Drilling in City Parks **Date:** June 29, 1978

The Board of Park Commissioners wishes to express appreciation for the opportunity to meet with you in the pre-council meeting May 22 to participate in discussions concerning possible geothermal drilling in the Parks.

We believe you are as interested in the integrity of the Parks as we are.

It seems to us, however, that there are a few concerns which should be upper most in the minds of all of us in evaluating geothermal programs whenever and wherever the parks are involved. This is especially true when staff people are promulgating programs and estimates on the subject.

1. We believe every feasible alternative to drilling in a park should be studied and explored in depth both as to location and cost.

2. In no event does it seem necessary to drill in a developed section of a park.

3. If the only acceptable water source is under a park, we recommend that slant drilling be considered from outside the park property, thereby eliminating damage to park grounds and facilities.

4. Estimates of cost on any alternatives concerning park land should include adequate funds for site preparation, restoration, underground power supply, access to the installation, public safety and appearance of the finished product.

5. As we have indicated we feel the parks should share in any income derived from the use of geothermal resources originating on park lands.

BOISE CENTER FOR URBAN RESEARCH

1910 UNIVERSITY DRIVE / BOISE, IDAHO / 83725

RECEIVED
OCT 12 1978

PHILLIP HANSON / DIRECTOR / (208) 385-1573

TO: Jack Cooper
FROM: Phil Hanson
SUBJECT: Geothermal Project
DATE: October 10, 1978
COPIES: Mayor, City Council, George Baggley

We should soon know the disposition of grant funds to support the geothermal project. It is possible that we will receive funds from a number of sources. Until we receive funds the exact configuration of the project is speculative at best. The exact details of a number of issues remain to be resolved.

1. There is at least a good chance that a combination of wells on public and private lands will be used. In other words wells may not be solely on park lands.

2. No decisions have been made about specific locations of future drilling sites or wells whether they are on public or private lands. The only definite sites are for existing wells.

3. The environmental impact assessment is not an environmental impact statement although it could be used as the basis for an EIS. The assessment document was prepared "in advanance of a formal request to prepare an environmental impact assessment, the City of Boise has offered to prepare an EIA that could be used by Federal agencies in satisfying their environmental requirements if and when needed."

These are only some of the issues being discussed, as of today. The discussion is part of the City's program to plan for geothermal energy. Soon these planning discussions will change to implementation negotiations. This change will take place when the City receives funds for development. When implementation begins I will have principal responsibility. Based on information that I presently have and a responsibility I may soon have, I would like to again offer to discuss any aspect of the geothermal project with you or the Park Board. My schedule can be adjusted to meet the needs of you or the Park Board.

A Statement on the Boise Geothermal Environmental Impact Assessment
(Released October 5, 1978 - Boise City Energy Office)

By - John Cooper
Director - Boise Park Department

1. General Critique

2. Specific Revisions

Directed to:

Boise Mayor & Council
Boise Park Board
Boise Energy Office
Boise Community Development Office
Boise Center for Urban Research

Critique: Environmental Impact Assessment
Boise Geothermal Project
by John Cooper, Director -
Boise Park Department

In general terms the EIA project objective explains the significance of the geologic characteristics of the Boise area. These characteristics are cited as being the reason for the relative ease of access to the geothermal resource.

Historically, the American development of natural resources can best be described as exploitation of the resource region. Access to fossil fuels, metal and fertilizer components has stripped so many acres of land of all character that the grand total of devasted acreage is not comprehensible. Only in the last 10-20 years has planned consideration been given to minimizing the ecological devastation and to reclaiming the land in a fossil fuel or metal ore acquisition project. This incompatibility between resource development and maintenance of the land character need not occur. Since the Boise water resource will and in time perhaps must be developed, extensive safe guards must be implemented to protect any land involved in the hot water project. Aspects of the overall geothermal project can include community wide benefits far beyond economic savings due to the new heating system.

As the Boise community has "advanced" to todays social and economic level it is interesting to note the significant alteration of the role of community service facilities in the geothermal picture. The single largest utilization of hot water in one of the original major applications of the resource was the construction of a Natatorium. This community service park and recreation facility was widely used by the community and brought national recognition to Boise. The current geothermal implementation study recommends utilization of existing park and recreation facilities to obtain and dispose of the resource at a cost to rather than as an asset to the park and recreation facility now available to the community. Somewhere in our "advance" parks have become acceptable locations for abuse rather than leisure use. As metropolitan and interstate highways were constructed in the lat e 1950's and early 60's parks were consumed as the easiest corridors for acquisition. Many residents of these metropolitan areas now regret that mis-utilization of park land-open space. However, little if any corrective action can now be taken in these communities. Designating Boise parks as locations of geothermal well operations, although not as devastating a use proposal as was highway construction, can also lead to significant open space loss. Boise is fortunate to have expressed concern for the highway intrusions proposed several years ago. As a result Boise today does not suffer from open space loss or community bisection due to highway construction. The irreversible open space loss experienced by other communities should not be repeated here. Although the "cause" is now titled differently (transportation then, geothermal now) the same lack of appreciation of open space, until it is lost, permits the consideration of parks for the project.

The current geothermal report "EIA For A Space Heating Project" pays lip service to minimizing park land damage without considering alternates to park land utilization by the project. Statements such as "drilling activities . . . will require the construction of some minor access roads and site leveling. Where possible . . . . following natural topography; and by avoiding cut and fill operations.", prevail throughout the report. This statement diametrically opposes itself since site leveling cannot possibly be accomplished without cut and fill - that is the essence of leveling a site. These statements are apparently poorly camouflaged attempts to soften the impact of the project on the site. The information that should be stated is the actual extent of alterations that will occur on the site, if these changes are irreversible and if possible, how the reclamation of the site can be achieved. The report fails in most instances in providing an accurate description of the effects of the construction on the sites. Aside from the conflicting information provided in statements as illustrated above, page 10 of the EIA refers to drilling in the developed area of Camels Back Park while several references, starting on page 37, indicate that the undevelop area of the same park is proposed for the production wells. Why are test wells proposed in the developed area and production wells in another area? This procedure allows double abuse! Despite moderately high level noise from both the drilling operation and the water injection process, tranquil Julia Davis Park (location of: 1) a zoo containing delicately tempered animal specimen; 2) passive picnicking; 3) boating facilities; 4) a museum and 5) an art gallery is proposed for the injection location. Our society advance has now managed open space abuse in a multiple of five. A third park site under consideration is the Military Reserve, which due to recently enacted federal legislation has had geothermal rights conveyed to the city. At this point however, access authorization appears to remain with the Federal Government.

Cursory review of available material seems to indicate that the 3 park sites (Military and undeveloped Camels Back are now designated as Reserves) selected may be in need of additional tests other than actual drilling to substantiate the resource location. Assuming that the general area of three selected park/reserve locations remains geologically valid other considerations should be reviewed at two of the sites as part of this project: 1. CAMELS BACK CURRENTLY CONTAINS A NON-CITY OWNED TRACT OF FIVE ACRES IN THE GENERAL SW CORNER AREA WHICH HAS PRELIMINARILY BEEN INDICATED AS A DESIRABLE DRILLING LOCATION. ACQUISITION OF THIS PROPERTY WOULD ELIMINATE THE CURRENT NON-OWNERSHIP PROBLEM AND LOCATION OF THE DRILLING WOULD NOT INTERFERE WITH CURRENT PARK AND OPEN SPACE USE; 2. LAND ADJACENT TO JULIA DAVIS PARK COULD BE ACQUIRED TO PROVIDE THE SUITABLE GEOLOGIC LOCATION FOR THE INJECTION FACILIT BY NOT CONSUMING PART OF THE EXISTING JULIA DAVIS OPEN SPACE THE OBTRUSIVE FACILITY WOULD NOT DENY PUBLIC USE OF PUBLIC OPEN SPACE. The report reference to the viewing of geothermal drilling as a viable substitute for lost open space is as inept a social statement as are other statements alleged to be valid statistical data. In addition, location off of but adjacent to the park would reduce the associated offensive noise of the facility referred to in the report and would substantially reduce the potential for damage to existing park facilities due to soil mounding. EVENTUAL ASSIGNMENT OF THE ACQUIRED PROPERTIES TO THE PARK DEPARTMENT WOULD COMPLEMENT BOTH PARKS INVOLVED.

The compatibility of the production well operation and the complete functioning of the selected parks and reserves as open space is certainly possible. This possibility could be stated as a project objective and should then be reflected in all the written material pertaining to the geothermal proposal. The EIA does not validly consider the value of the parks for the asset the parks are as they exist. The EIA also understates the total impact of the project on the parks and the park using public.

Proliferation of on grade well structures in Camels Back or Military Reserves will certainly diminish the open space value currently offered to the community. The opening of Military Reserve to extensive geothermal development sets precedence for allowing other non conforming uses in the reserve. The location of arterial road corridors and private housing within the reserve are now proposed by private elements within the community. These possibilities are real, are contrary to Park Department goals and are incompatible with the Reserves existing character. None of these possibilities are reviewed by the EIA.

With proper geothermal facility construction and with documented limitations imposed on all other non-conforming park uses, geothermal and open space - recreation can successfully co-exist.

The geothermal project concept is good for the future of particular portions of the community. When an existing positive aspect of the community, the park system, can not only be reasonably and effectively protected from but physically and aesthetically improved by association with the geothermal project, life in the community as a whole is enhanced.

EIA Report Revisions
Boise Geothermal Project
by John Cooper, Director
Boise Park Department
(part 2 of 2)

The following report excerpts are in conflict with this Department's goals and philosophy. The excerpts are explained and erroneous sentences corrected within the following listing:

I. Page 10 P2

"At present only 8.9 acres of the park . . . is improved for public use, with the remainder in a natural state."

Reply - All of the park is improved and available for public use. The improvement ranges from paths throughout the Reserve area to intensive development of formal athletic and other leisure use facilities in the Park area.

Revised sentence - At present, 8.9 acres of the site in the vicinity of Heron and Thirteenth Streets is developed with picnic and active athletic facilities. The remaining acreage is utilized for informal leisure activities with several paths crossing the naturally vegetated topography.

II. Page 14 P3

"Drilling activities . . . will require . . . site leveling. Where possibl . . . disturb minimum area . . . following the natural topography; and by avoiding cut and fill operations."

Reply - This statement diametrically opposes itself since site leveling cannot possibly be accomplished without cutting and filling - that is the fundamental process involved in leveling a site.

Revised Sentences - Drilling activities in Camel's Back Park will require the construction of access roads to the well sites and the regrading of each site (to accommodate the drilling equipment.) Where possible existing roads will be used for access. New roads will follow the natural topography so that minimum disruption of the hillsides will occur.

III. Page 14 P3

"A drilling mud sump will be provided to hold the drilling fluids . . . and control of surface runoff."

Reply - If a park site is used for drilling, an open mud sump existing for 2-3 months is an unrealistic situation due to youngster-park use. Any site used should have a container for the run off which is legally emptied off site, on a periodic basis. The area for each well site is now set at 1,500 sq. ft. Previous areas estimates were 1.5 acres. Substantiate final recommended area.

Revised Sentences - Required drilling fluids shall be containerized in a secured area of the drill site. Operation over-burden or runoff shall be containerized and shall be periodically removed from the site and disposed of in a legal manner.

IV. Page 15 P2

"Each of the wells will be housed in a block-type building . . . "

Reply - The addition of 3 above grade buildings in a 9 acre park with 2 park service buildings already on site will be unsightly, space consuming and generally unnecessary. If the wells can be sunk 1000 feet the well operation building floor can certainly be constructed 8'-0" to 10'-0" below grade to allow earth covering.

Revised Sentence - Each of the wells will be housed in a 300 square foot building constructed below grade or when possible into the natural slope. All required utilities to service the well buildings will also be below grade. Vandal-proof, inconspicuous air vents shall be the only above grade features of the completed well buildings.

V. Page 17 P3

"The spent geothermal hot water . . . will be disposed of by deep well injection"

Reply - Why is injection the only consideration? Alternatives should be specifically mentioned and detailed.

Revised Sentences - One alternative to dispose of the spent geothermal hot water will be by deep well injection. Other possibilities include potential commercial uses that can utilize moderate temperature water and recreation uses such as swimming pools, water display basins and fishing ponds.

VI. Page 18 P4 & P5

"In some cases access may be required across short expanses of lawn . ."

Reply - Daily man power and equipment access will be conducted at the site. The schematic plan of drill site locations at Camels Back shows 2 wells within the newly completed park re-construction areas. These locations are not acceptable. Roads and well area restoration must be completed for site immediately upon withdrawal. Approximately 700 ft. of pipe would be laid simply to reach street ROW from the proposed well locations. If the wells are interconnected by pipe-line, extensive trenching would be done throughout the park.

Revised Sentences - Wells will not be located to interfere with any current park use determined significant by the Park Board. All turf, irrigation equipment and other improvements damaged by the project will be replaced with like or better kind immediately upon completion of the associated phase of the project.

VII. Page 32 P2

"Linears cross northern, central and NE areas of Park."

Reply - What effects does this geologic feature have on the geothermal reasource? These features also exist outside of the park area. This paragraph refers to a linear extending for more than two miles. A NW-SE tranching linear illustrated on figure 5 of the report, outside of Camels Back Reserve, is apparently not even mentioned in this paragraph.

Revision Sentences - In addition to the presence of the Foothills Fault in the general Camel's Back area, several linears also cross the area.

(If more detailed linear location is to be written, the Linear should be properly illustrated on figure 5.)

VIII. Page 33 P1

States that "several major areas suitable for further geothermal exploration" exist. "Camel's Back Park lies within one of these areas."

Reply - No substantiation is given as to why Camels Back Park is the only site detailed. If a specific site had to be reviewed any site within the several areas mentioned could have been included.

Add-on Sentence - The geophysical data, upon final interpretation, shall be the major criterion for establishing well locations.

IX. Page 33 P2

"The Camels Back Park area exhibits the combination of geological and geophysical characteristics to be a potential drill site."

Reply - This general statement can be made for many sites within the several areas that preceding paragraphs indicate are satisfactory for investigation. In effect nothing more, in terms of geologic evidence, exists at Camels Back than at many other sites. Yet, the public use open space is proposed for a drill site rather than acquiring other property for the well location.

Revised Sentence - The general Camels Back Reserve area exhibits . . . to locate potential drill sites in accord with the geophysical data previously discussed.

X. Page 39 P1

"The project areas do not contain any known rare or endangered plant species"

Reply - The wild onion is now growing at both Camels Back and Military Reserve It is a rare species and has been considered for the endangered species list.

Revised Sentence - The project areas are habitat for the Allium aaseae (wild onion) which is a rare plant species; a list . . .

XI. Page 50 P1

"Additionally, there should be at least two observation wells drilled . . near the area of production . . . . "

Reply - "Near the area" is extremely vague. If a park is a production well site, it is safe to conclude that the observation wells are also included on the park site. Five non leisure use, open space consuming facilities are then located on the park which include the buildings of 3 production wells and the two observation wells.

Revised Sentence - Additionally, there will be at least two observation wells drilled to . . . . of the project. Service structures for the observation wells will be below grade.

XII. Page 51 P2 & 3

"Mounding"

Reply - A potential problem is noted under this topic but little information is provided. Vertical height of the mounding and distance from the injection point that may be affected must be noted with more explanation.

No revision

XIII. Page 59 P2

"The serene atmosphere of the proposed developments in the Camels Back and Julia Davis Park areas will also be disturbed by the operations"

Reply - No consideration is given to the effects of the +133 dBA on the zoo animals at Julia Davis. With Military Reserve as a consideration for production, review on the effects on hospital patients at neighboring facilities may also be appropriate. When locations, other than parks, are available to either reduce or eliminate the projected disturbance, those alternates should be utilized.

Revised Sentence - The serene atmosphere of the proposed developments in the park areas will be disturbed to some extent. With the operations located with park users enjoyment as a consideration, the disturbance is expected to be minimal.

XIV. Page 60 P1

"scar will be evident until revegetation occurs."

Reply - Sod must be replaced on maintained turf areas. Seeding of site - predominant vegetation, with irrigation provided, must be done on other areas.

Add on sentence - . . . . revegation occurs. This revegetation will be hastened by seeding a mix of the areas prevailing plant species and by providing suitable irrigation in those natural areas affected by the project. In maintained turf area restoration sod will be placed to match the undamaged park appearance.

XV. Page 62 P2

"The impact of unavailable recreation space may be offset somewhat . . ."

Reply - Loss of open space can only be offset by the addition of open space. Camels Back Park is in the fastest demographic changing neighborhood in the county and is now deficient in terms of the City open space standards on an acreage to population ratio.

The influx of young adults to the neighborhood requires open space for active sports. Youth sports activities including football, soccer, tennis, cross country and pick up softball and football games constitute the majority of current park use. Large group picnicking is also a very popular activity at Camels Back. These uses cannot be offset by watching geothermal operations as proposed in the report.

Revised Sentences - The recreation space now available for the public will be maintained throughout the project, although some inconvenience may be encounte due to area construction. In some instances the eventual assigning of propert acquired for the geothermal project, to the park department will increase the available community open space.

NORTH END

October 17, 1978

Ms. Lee Post
Boise City Energy Office
P. O. Box 500
Boise, Idaho 83701

Dear Ms. Post:

The Steering Committee of the North End Neighborhood Association wishes to have on public record our opposition to using Camel's Back Park for geothermal wells. While we whole heartedly support the development and use of geothermal energy we feel that a developed park in a residential area is not the best solution.

On October 13, 1978 The Idaho Statesman announced the United State's Senate's approval of the transfer of subsurface rights for 485 acres in Military Reserve Park to Boise City. This area is where the original test wells have been done and have proven adequate flows and temperatures are available in Military Reserve Park. Military Reserve Park is closer to the areas planning to use the geothermal heating systems and yet it is not in a residential area. We feel Military Reserve Park is a more responsible and financially advantageous solution than "wild cat" drilling in Camel's Back Park.

CH2M Hill's "Preliminary Draft Environmental Impact Assessment For A Space Heating Project City Of Boise Geothermal Space Heating System" reads like a formal and final statement, not like the preliminary report that we are assured that it is. On page 9 it states, "The head of the system will be composed of a well field at Camel's Back Park in the northwest area of the city with subsequent development in the Military Reserve Park also in the northwest area of the city. A total of three wells will be drilled in Camel's Back Park a minimum of $\frac{1}{4}$ mile apart and will occupy no more than 500 square feet of surface area each." That is a very positive statement for a preliminary report. Before a statement this positive is accepted more thorough geologic reports should be prepared and public hearings should be held.

Please keep us apprised of any further developments.

Thank you for your time and consideration.

Nancy Fitzgerald

Nancy Fitzgerald, Steering Committee Member
North End Neighborhood Association
2230 N. 9
Boise, Idaho 83702

cc: Mayor R. E. Eardley
Boise City Parks Board

1910 Manitou
Boise, Idaho 83706
November 1, 1978

Lee Post
Boise City Energy Office
Boise, Idaho

Dear Lee,

Thank you for the opportunity to respond to the draft Environmental Impact Assessment for Boise City's Geothermal Space Heating System. I do appreciate the extra time to study the statement. I would like my concerns to be included in the record of this report.

I find it incredible that no alternatives to drilling in the parks were considered especially since NEPA requires careful considerations of alternatives in environmental impact statements. Obvious alternatives abound. The fault runs nine miles along the front; probably any location along the fault would produce the quantity of hot water needed for this development. Drilling does not <u>have</u> to take place in our parks--the limited open space so valued by our community.

Warm Springs Water District or the City could purchase a few lots over the fault. The 1500 sq. ft. required for a drilling site could be accommodated in an average North End lot. There are areas which are not developed and would be much more suitable for drilling. The cost to acquire these lots might be $12,000 an acre, but this is minimal compared to the value of our parks.

Unfortunately our parks are to be used as "credit" in the matching funds necessary for the DOE grant. I feel this accounts for the "tunnel vision" the geothermal project has demonstrated by not considering obvious alternatives. That leaves those of us who care so much about our parks little choice but to oppose the project. This is unfortunate for I do support geothermal development. It is a logical energy source for Boise and the City does deserve credit for its development plans.

However, a geothermal production field doesn't belong in the developed area of Camel's Back Park. As for the location of reinjection wells in Julia Davis Park, what can I say? Julia Davis is our oldest and best beloved park. It houses the Historical Museum, the Art Museum, and the Zoo. To sacrifice Julia Davis to such an incompatible use for "credit" on grant matching funds displays stunning insensitivity. I feel very frustrated trying to communicate fully to you my concern. I oppose it isn't nearly strong enough. Would " ***!!!! &&&!!!! ****----!!!! in our park"? give you an idea of my feelings?

I do have several specific comments:

Last summer in Camel's Back Park $50,000 of community development funds provided a new restroom, a parking lot, and returfing an abandoned road. The Parks Department contributed the labor so the total cost of this park improvement was more than the $50,000. Essentially this investment would be lost if the park is used as a production well field.

Three production wells and two observation wells in the developed area of Camel's Back Park would restrict the use of the park both during and after drilling. Now the park is used by various youth ball teams, scarcely the quiet, passive recreation of the elderly depicted in the report. Page 61 states " drilling operations will be limited to normal working hours to allow evening and weekend use of the park." This will give the neighbors a little peace and quiet, but it's hard to imagine ball teams using the park with the mounding up of fill to form the sump ponds necessary to hold the 6000 gal./day of water, mud, and caustic soda from the drilling operations.

I can't help but wonder about the initial well. Where will the water be diverted or held while testing the production flow potential? Catch basins built for flood control of Cottonwood Creek were used during tests at Military Reserve Park. Nothing comparable exists at Camel's Back.

Reinjection wells in Julia Davis just doesn't seem logical. The aquifer flow is from the mountains toward the river. Would reinjection waters really flow back toward the production well sites? Geological support data is needed, especially for the necessity of reinjection in Julia Davis Park.

On page 52 it is noted that " injection wells may be inoperable after several years." What then? Will another well be drilled in Julia Davis? Can we expect constant disruption of the park?

Page 39 says"the project areas do not contain any known rare or endangered species." In 1976 the park board pointed out to the Mayor and the BLM that Allium aaseae is found in Camel's Back and probably in Military Reserve. I hope the next draft of this report will mention this lovely wild onion species.

I would appreciate the opportunity to review the revision of this report.

Thank you!

Sincerely,

Janet Ward

Janet Ward

Preliminary response to EIA from Water Resources -- Bill Lewis telephoned 11/1/78 (4:30PM)

Regarding agencies calling for permits. As to water rights permits over which his office has power, they will require conditions such as proper drilling methods, proper abandonment, possibly a bond (probably wouldn't be over $10,000, depends on drilling prospectus. Bond is a possibility, not a surety. All these conditions should be known beforehand.

Notification will have to be given to them prior to drilling and abandonment. They will require logs, well histories, pertinent information.

As to system failures. Not addressed. Persistant slow leaks. How will they be discovered, handled? What environmental impact will they have?

As to test waters, flow test waters, how to be disposed of. What will be impact?

Potential accidents and hazards to employees and citizens. How to protect.

Martin & Clapp--mentioned in EIA, but not in bibliography.

Chemical cleaning of injection wells, but nothing about methods, possible impact on acquifer.

Nice to have information about locations of wells in area of the injection wells and possible fluoride contamination. Take brief look at impact area.

Monitoring wells for chemical analysis.

These are just random thoughts of Bill Lewis. He has given report to their environmental group, which will be back Friday, Nov. 3. They may or may not be ready at that time to give more comments. If not, comments will be forthcoming next week.

TELEPHONE CALLS TO THE COUNCIL CONCERNING THE ENVIRONMENTAL ASSESSMENT

RALPH J. MCADAMS 10-23-78 A.M. no response

MAYOR EARDLEY 10-26-78 8:30 the scope needs to be changed back to MRP

MARGE EWING 10-26-78 8:35 no response to the assessment
She is concerned that this office WILL be involved in the negogiations of the PON. I told her that we were having a meeting tommorrow and that was one question that will be discussed.

DEAN BIBLES 10-31-78 9:20 no comments to the environmental report -- The BLM environmental group has not issued thier comments to date, but I am assuming that the group will give directly to Larry Martin.

GLENN SELANDER 10-31-78 10:15 Everything is too final? Map on Camelsback Park shows three areas of drilling and the geology work has not been completed and/or began. MRP should now be included for the 3rd draft. We should reconsider injection at Julia Davis Park maybe a better alternative would be to stop short of north on Myrlte Street.

JIM LANZ 10-31-78 10:45 Is the City going to actual pay for retrofitting of buildings or are they going to be borrowing the monies through some source to paid back by each individual building owner. This should be clarified more clearly.

JOY BUERSMEYER 11-1-78 9:20 rtn call. Need to include MRP -- Concerned about Julia Davis injection hole -- Did not understand why we had an oder problem.

NORM YOUNG 11-1-78 9:44 he has not seen a copy of the report, but will check with the environmental group to see if they have any comments.

BERNE JENSEN 11-1-78 9:47 was not in the office

FRED KOPKE HAS BEEN OUT OF TOWN

JANET WARD 11-1-78 12:00 she does not have her comments ready, but will try for tommorrow A.M.

APPENDIX E

Decision Point Communications

This appendix has gone through many changes and before it will be found to be of maximum usefulness, will probably go through a few more. The changes have been necessary in the struggle to portray the long trail of decisions which have brought geothermal energy to its present state in Boise. Those past decisions do not look as significant now that we are on the verge of implementing a system. But they have brought us to our present situation and represent a path which others will probably follow in trying to convert geothermal potential into operating reality. They are, for these reasons, of great importance. They represent the complex process of policy formulation and decisions leading from a national energy policy to a local energy system.

Initially, this appendix consisted of literally hundreds of communications, in various forms, e.g., letters, resolutions, articles etc., which represent steps toward decisions or debate about decisions. Each communication possesses its own significance in the overall policy/decision process. Often the significance of each communication is buried in verbiage not necessarily directly related to implementing geothermal energy. Consequently, one of the first changes was to take out those documents where the major significance was buried in tangent issues. Repetition of this process resulted in very few documents and eventually a list of major decision points. This stark list, provided below, does not adequately provide a picture of the hundreds of documents written or the many hours consumed in producing or discussing each document, and the decision implications it represents. Nonetheless, this list does produce a chronological list of significant events leading to an operational system.

2/16/79	First meeting with Governor's representative regarding geothermal project and state involvement.
2/7/79	Meetings with Board of Control, EDA and DOE to discuss bureaucratic relationships in joint funding of project. EDA approves proceeding with final application.
2/1/79	First meeting of project Board of Control.
12/78--2/79	Meetings with BLM to establish mechanisms for transferring deed to Military Reserve Park to Boise City.
12/19/78	First contract negotiation meeting with DOE, Idaho Falls.
11/17/78	Park Board members and staff traveled to Twin Falls to view the geothermal development of College of Southern Idaho.

11/8/78	1% initiative passed. Placing limits on raising funds for project.
10/78	EDA approval of preliminary project profile for total of $1,000,000.
10/26/78	Joe Kanta expresses interest in participating in project. Represents access to resource area over about 1500 acres of leased state land plus unused penitentiary wells and 700 new dwelling units.
10/16/78	DOE letter selecting Boise for PON negotiations.
10/12/78	Notified that federal legislation granting subsurface rights to Military Reserve Park to City had been approved by Senate.
10/8/78	Park Board reacts to environmental impact report.
Sept. & Oct. 1978	Commitments by large property owners. These commitments involve the potential of land transfers or royalty payments to insure access to the resource. In addition these land owners are developers whose building programs are large direct use applications.
9/10--21/78	Producers Lumber expresses interest in participating in project. Involves approximately 2000 acres, 4000 commercial/residential units, and at least one well of 150°F+.
9/10--15/78	Claremont Realty expresses interest in participating in project. Represents additional resource area access plus hundreds of dwelling units.
9/11/78	Mayor, President of City Council, and Chairman of BRA send TWX to EDA supporting grant application and offering 2 mill capital levy as match.
9/78	Richard B. Smith properties express interest in participating in project. Represents resource area access plus hundreds of dwelling units and commercial buildings.
8/3/78	Project profile submitted to EDA for $1,250,000 for downtown phase of project.
7/3/78	Letter from Intermountain Gas Company president concluding "... that the financial risk involved in this proposed geothermal project is too great to be assumed by Intermountain Gas Company."

5/31/78-- 7/25/78	Council approves joint PON application with Boise Warm Springs Water District. Council discussion causes some furor in connection with geologist/geophysicist debate and public domain models.
5/30/78	Boise Warm Springs Water District Board of Directors formally request City Council to join in geothermal project PON.
5/24/78	Letter to Governor Evans from Mayor Eardley formally inviting their participating in geothermal project emphasizing commitment regarding Capital Mall buildings.
5/23/78	Major briefing for City Council describing probable system alternatives with costs, prices of delivered energy, buildings involved, etc. Raises question as to who should be involved in such a project. Begin work on PON EG-78-N-03-2047.
5/22/78	EPA notifies City that geothermal wastewater plans are not eligible for EPA waste treatment facilities grants.
5/18/78-- 9/30/78	Discussions with senatorial, state and federal personnel regarding the KGRA on Military Reserve Park.
5/5/78	Letter from Governor's office postponing decision about state involvement in project.
4/19/78-- 4/27/78	News presentation by local entrepreneurial interest, one council member plus an energy staff member. This raises several questions concerning the nature and future direction of the geothermal project.
4/4/78	Formal request for determination of lead agency responsibility in preparing environmental reports on project.
4/4/78	Private entreprenuers show interest in secondary uses of the hot fluids.
3/23/78	Project progress briefing to DOE staff, Washington, D.C.
3/8/78	Major technical and non-technical briefings for (a) Energy Task Force, and (b) other potentially interested local agencies and businesses. Important results are no strong local corporate interest in geothermal except Intermountain Gas Company and first notice of geologist/geophysicists controversies.
3/3/78	Initial expression of interest by Winmar in using geothermal heat for downtown shopping center.

2/24/78	Ore-Ida announced as one of PON winners. Plan on drilling wells to use geothermal wells in food processing.
2/20/78-- 3/5/78	Assist Boise School District in calculating information on heating systems.
Feburary, 1978	Initial meeting with State personnel on EDA funding and geothermal progress.
1/20/78	Principle investigators report geothermal progress to Intermountain Gas personnel.
1/19/78-- 3/22/78	Prepared and submitted applications for geothermal/water rights to eight (8) wells in Camelsback and Military Reserve Parks.
1/17/78	Geothermal briefing given to the personnel at Idaho Water Resource Board.
1/13/78	Conclude well testing program.
1/12/78	Began discussions on financing opportunities with DOE/Loan Guarantee personnel and Wells Fargo Bank.
January- March 1978	Major structuring of finite system alternatives with Phase II project researchers. Accomplished as a series of meetings and memos.
12/20/77	Mayor appoints City Directors to view energy progress on a semi-monthly basis.
12/19/77	Intermountain Gas Company formally expresses interest in project involvement at Council meeting. Interest limited to private corporate utility alternative.
12/19/77	Important project progress briefing to City Council.
12/8/77	Technical meeting with Task Force members.
11/30/77	Geothermal update on well testing to Task Force and Council.
11/23/77-- 1/15/78	Legal concerns are discussed among agencies regarding the resource.
11/21-29/77	Boise "consortium" proposes to complete Phase II project work. This provides first public notice of realtor interest in project, local entrepreneurial interest in project, and raises many "political" issues.

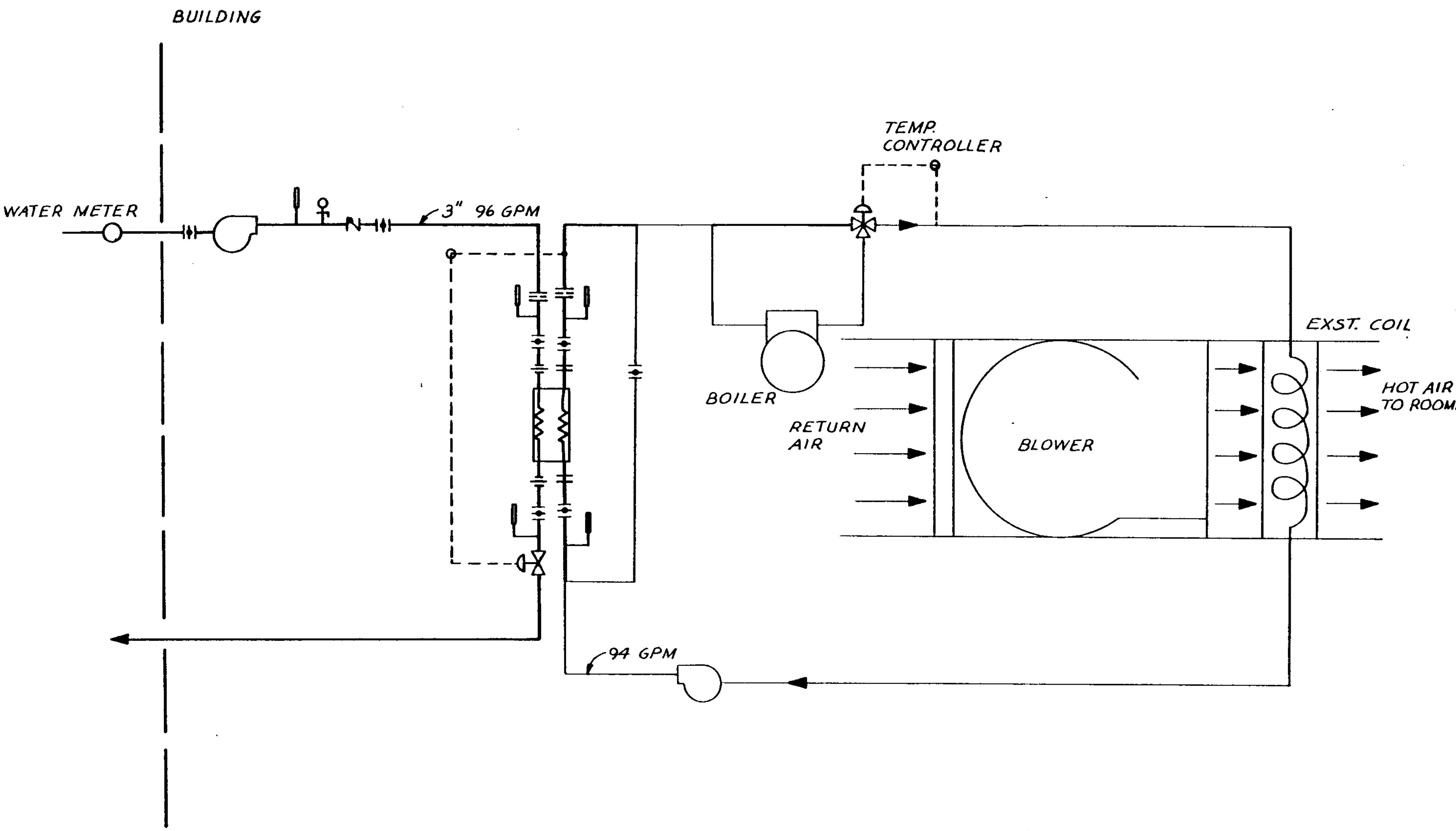
11/16/77	Task Force meeting concerning working relationship of WSWD and Boise City.
10/11/77	Period of incipient interest in City-BWSWD cooperation, some solidification of opposition to KGRA designation of Military Reserve Park, and interest of building owners for geothermal heat first expressed to City.
9/30/77	Notice of ERDA award of $141,848 to Boise City for Phase II Geothermal Project.
9/22/77	Governor Evans dedicated geothermal system to State Health Laboratory.
8/30/77	Well testing program begins at Military Reserve Park.
8/19/77	Non-local entrepreneurial interests convenes local meetings, news releases, etc. Fairly extensive local reaction to this interest.
7/26/77	Phase I preliminary plan presented to Council and public.
7/23/77-- 8/10/77	Letters between City and BWSWD. District proposes extension of service to include downtown buildings, and City response with documents describing work of Phases I and II.
7/11/77	Resolution approved by Council to test wells at Military Reserve Park, work to be completed by EGG, Idaho and ERDA.
6/2/77	Environmental assessment report on BSU lease completed by BLM and transmitted to a number of agencies and individuals including Parks Department.
5/19/77	Meeting with BLM local offical and ERDA concerning subsurface properties at Military Reserve Park.
5/13/77	Meeting with ERDA concerning progress of Phase I.
5/9/77	Letter from BRA providing estimate of new downtown shopping center space and expressing first formal interest in using geothermal energy.
5/8/77	Preparation for and conduct of reservoir testing through Military Reserve Park Wells. Release of preliminary results in mid-September occasions some controversy from local and non-local entrepreneurial interests.
3/77	Submitted second phase proposal to ERDA.

3/18/77	Request to HUD for funds to support Phase I study complementary to the ERDA grant.
2/11/77	Letter from BSU to BLM to extend termination date on lease application for preparation of a preliminary drilling plan of operation which was delivered 3/15/77.
2/1/77	Pre-council update on geothermal energy.
January-- Feburary 1977	First meetings to structure Phase I study.
1/21/77	Presentation concerning geothermal energy to Federal agencies in Washington, D.C.
1/4/77	Task Force meeting concerning geothermal Phase I.
11/23/76	Task Force discussed solid wase and disclosure ordinance for residential users and geothermal implementation.
10/18/76	BLM suspends consideration of BSU lease application until ERDA/BSU drilling and exploration work completed.
10/7/76	Task Force met with the Idaho Water Resource Board to discuss geothermal permits on drilling and regulations.
9/30/76	Notice of ERDA award of $71,502 to Boise City for Phase I of geothermal project.
5/27/76	Energy Task Force meeting with utilities to discuss their specific areas of interest.
4/22/76	ERDA, Washington, D.C., visited Boise to discuss funding opportunities for the City to study geothermal.
4/21/76	Discussion concerning reduction of fuel consumption for residential and commercial areas in Boise by the Task Force.
3/25/76	Update on geothermal energy given to the Task Force members along with a solid waste film.
3/3/76	Task Force meeting concerning how to proceed with energy alternative for the City.
2/11/76	Mayor Eardley appoints a group of citizens to serve on an Energy Task Force for the City Energy Office. The first meeting.
1/26/76	Mayor and City Council open the City Energy Office.

11/75	City Council approaches ERDA for funding of city geothermal planning.
9/76-- 9/75	Initial resource geological and drilling exploration. Hot water found and estimates of two years to bring heat to Capital Mall buildings. BLM-1 flows from 1283 feet at 170°F.
5/5/74	State Board of Education approves BSU submitting lease application for BLM land and subsurface rights on Military Reserve Park.
3/29/74	BSU geothermal lease application filed.
2/28/74	Original Boise Geothermal proposal including BSU, and Aerojet Nuclear, submitted to AEC.

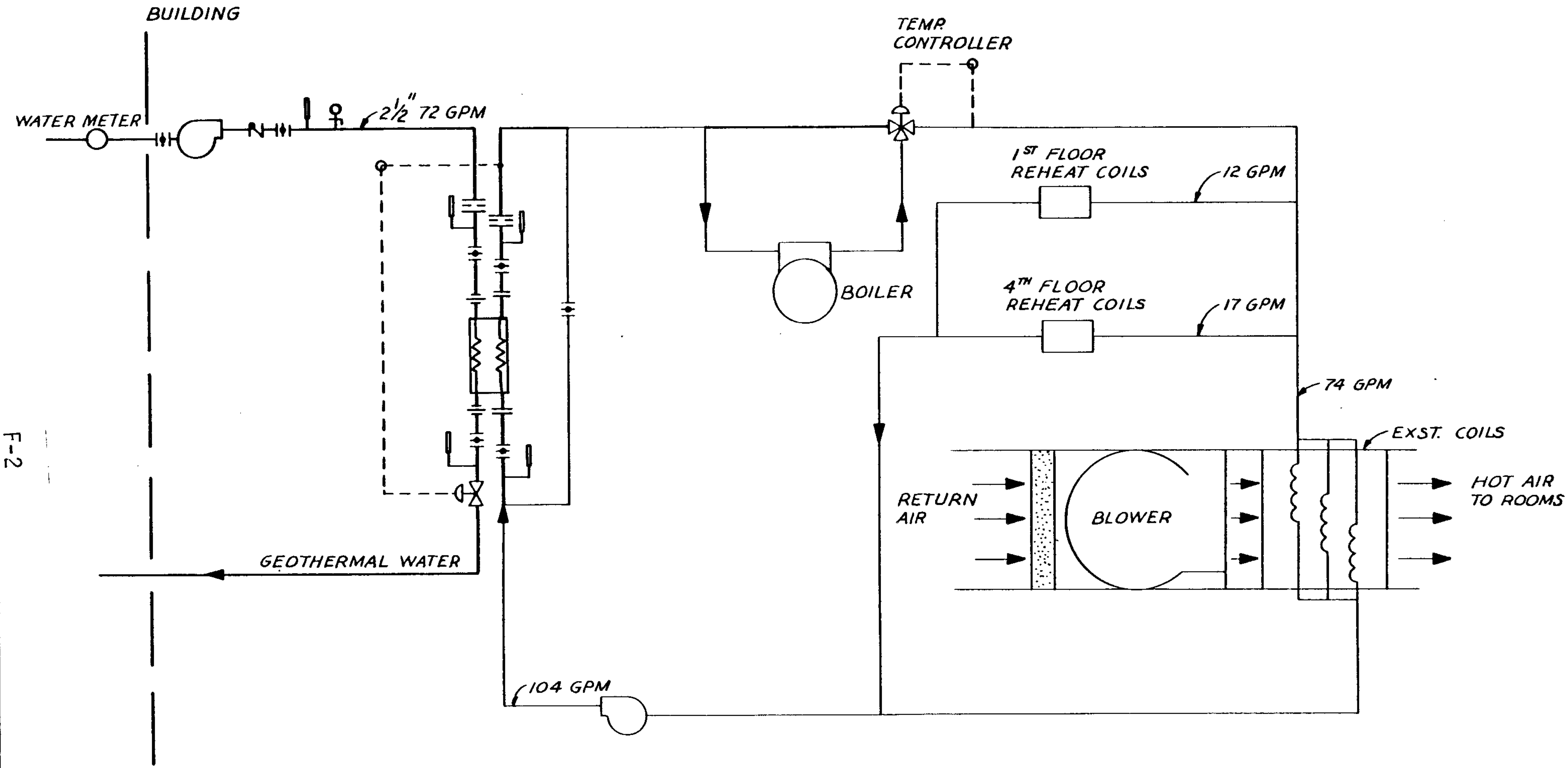
APPENDIX F.

Typical Building Heating System Retrofit Schematics



B-10536.CO CITY HALL GEOTHERMAL SCHEMATIC

CH2M HILL



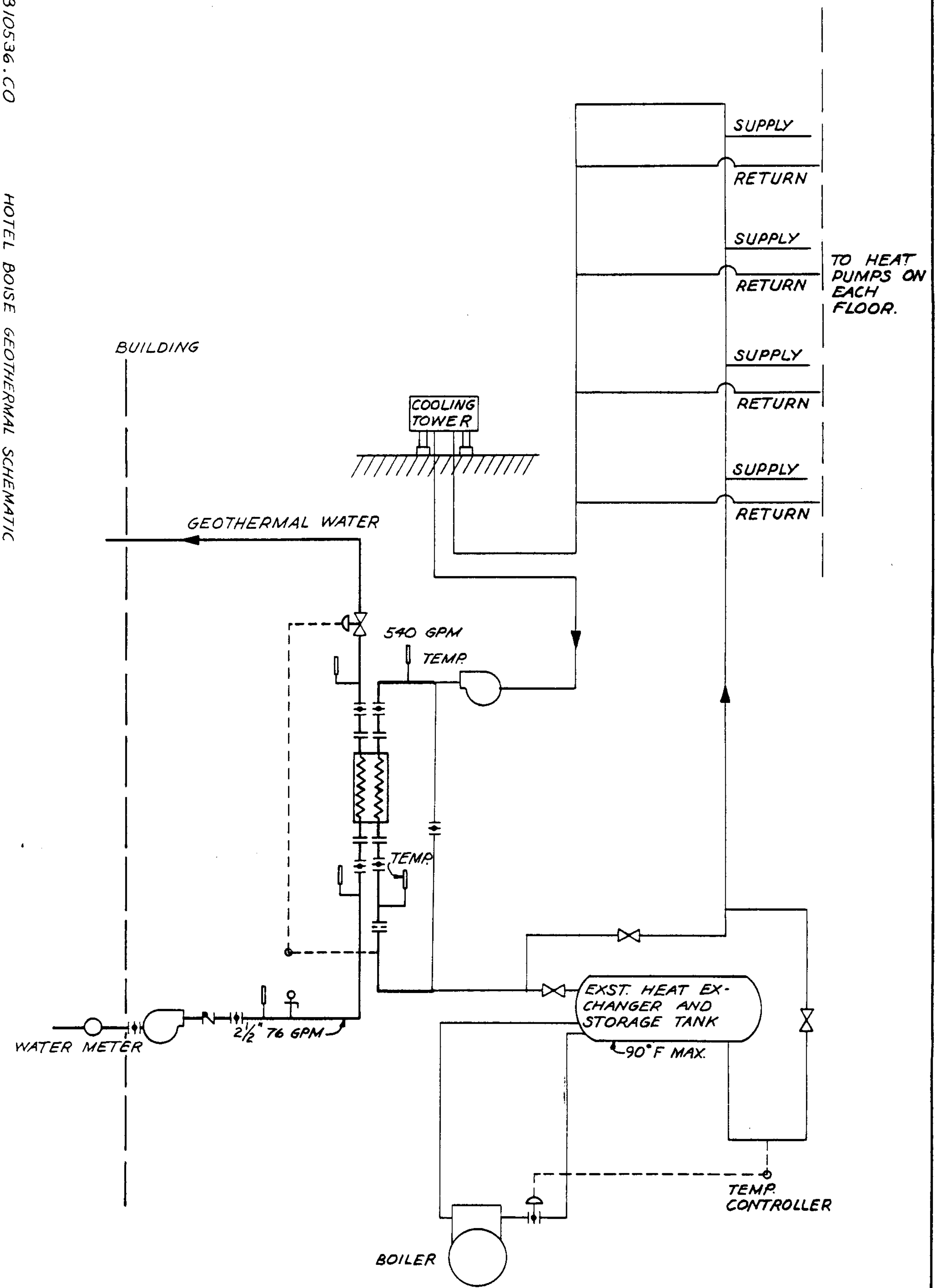
F-2

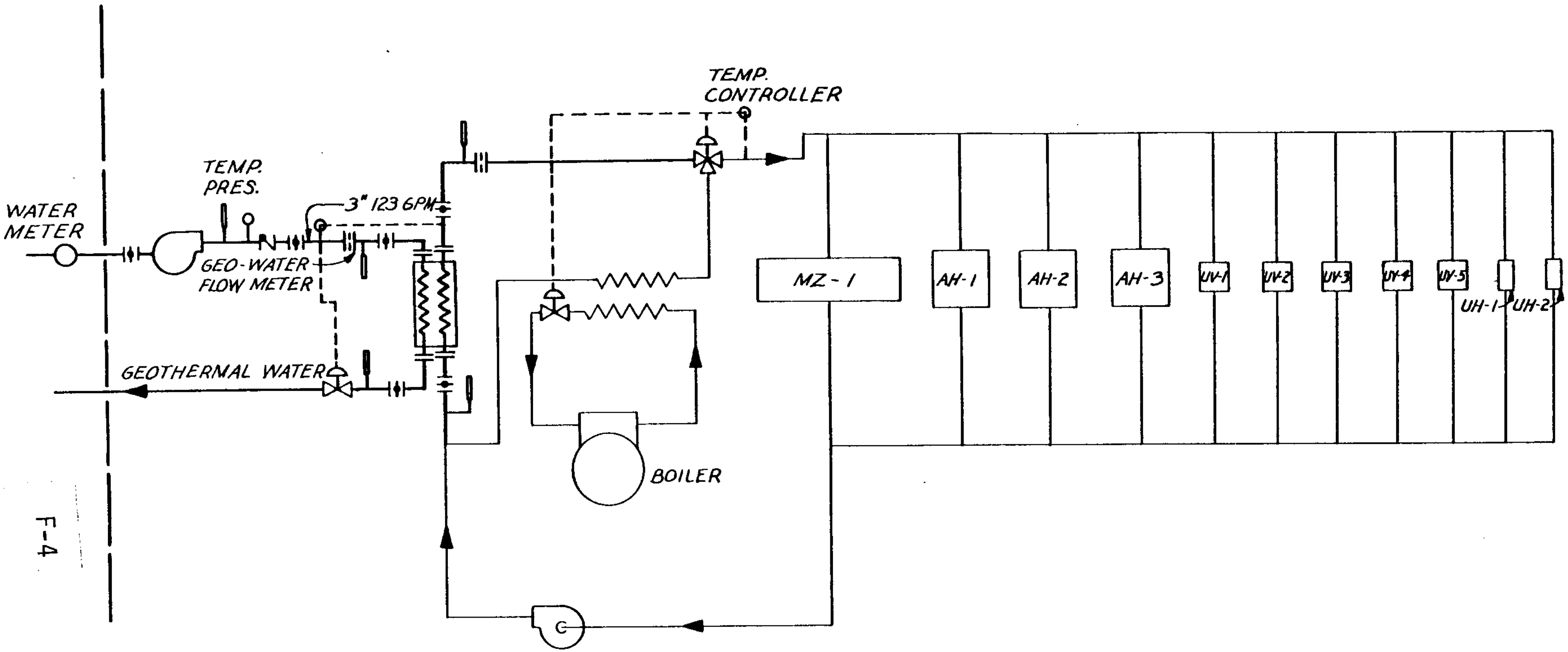
B10536.CO NEW COUNTY BUILDING GEOTHERMAL SCHEMATIC

CH2M HILL

B10536.CO

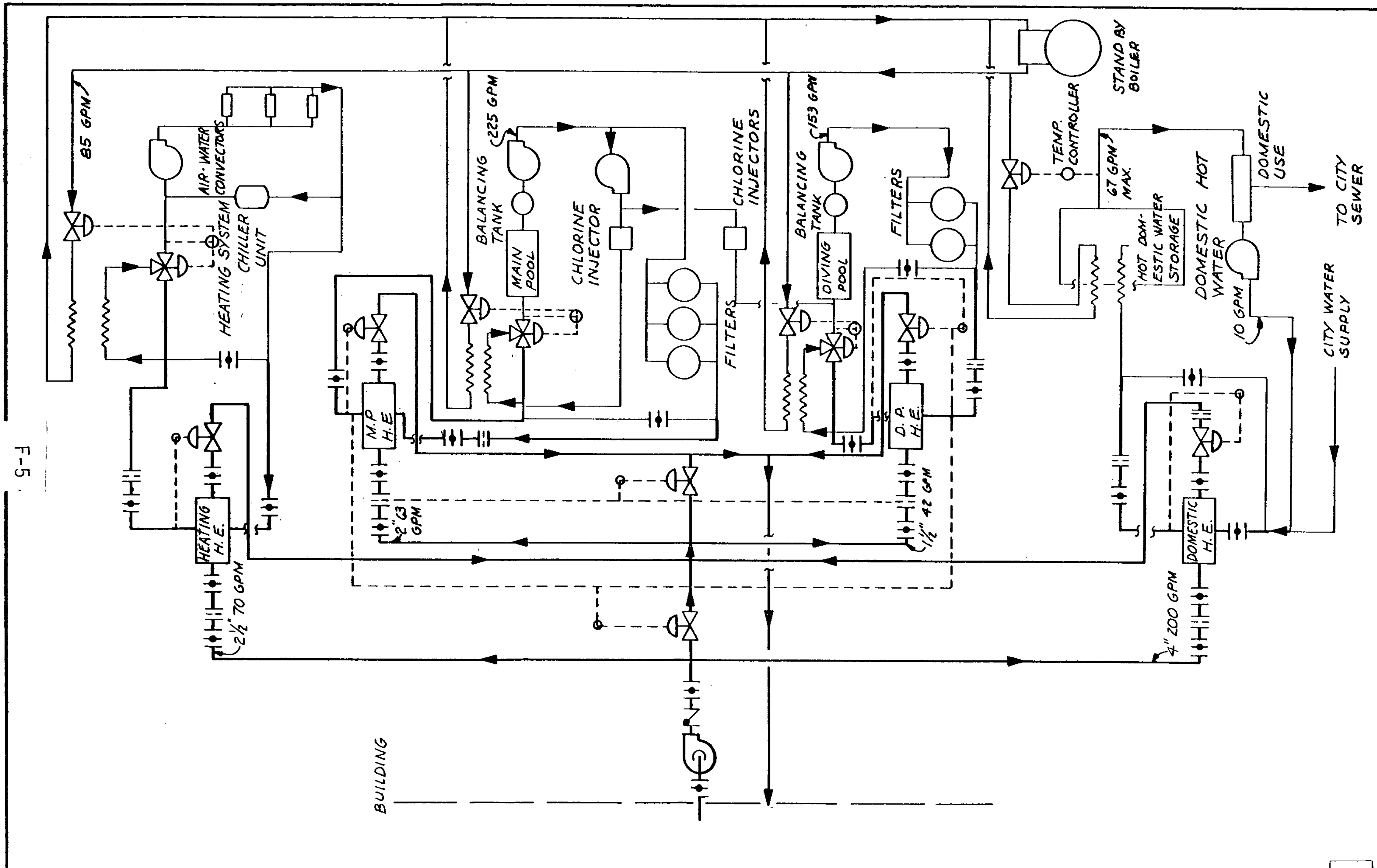
HOTEL BOISE GEOTHERMAL SCHEMATIC



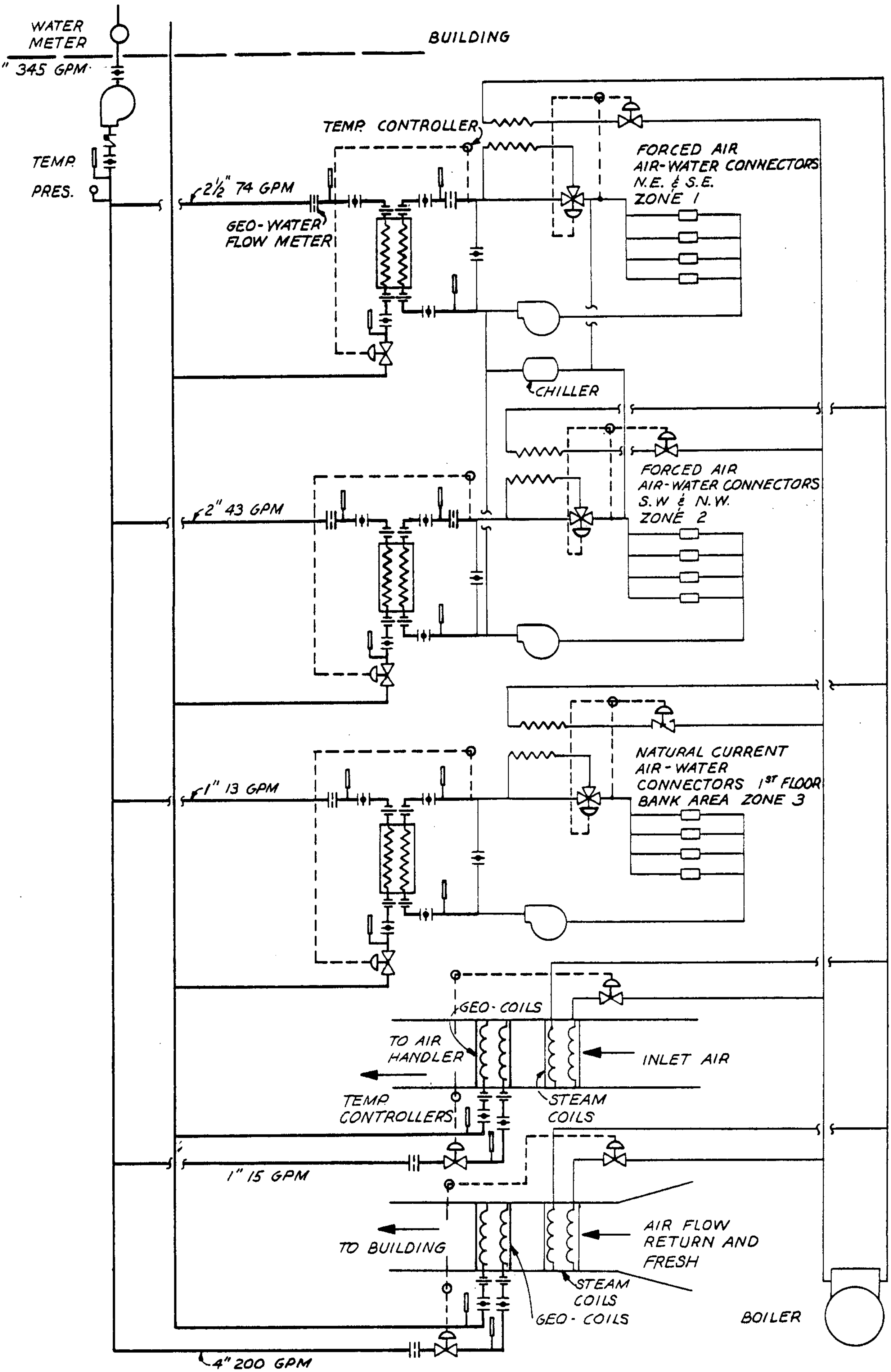


F-4

B10536.CO NJHS GEOTHERMAL SCHEMATIC



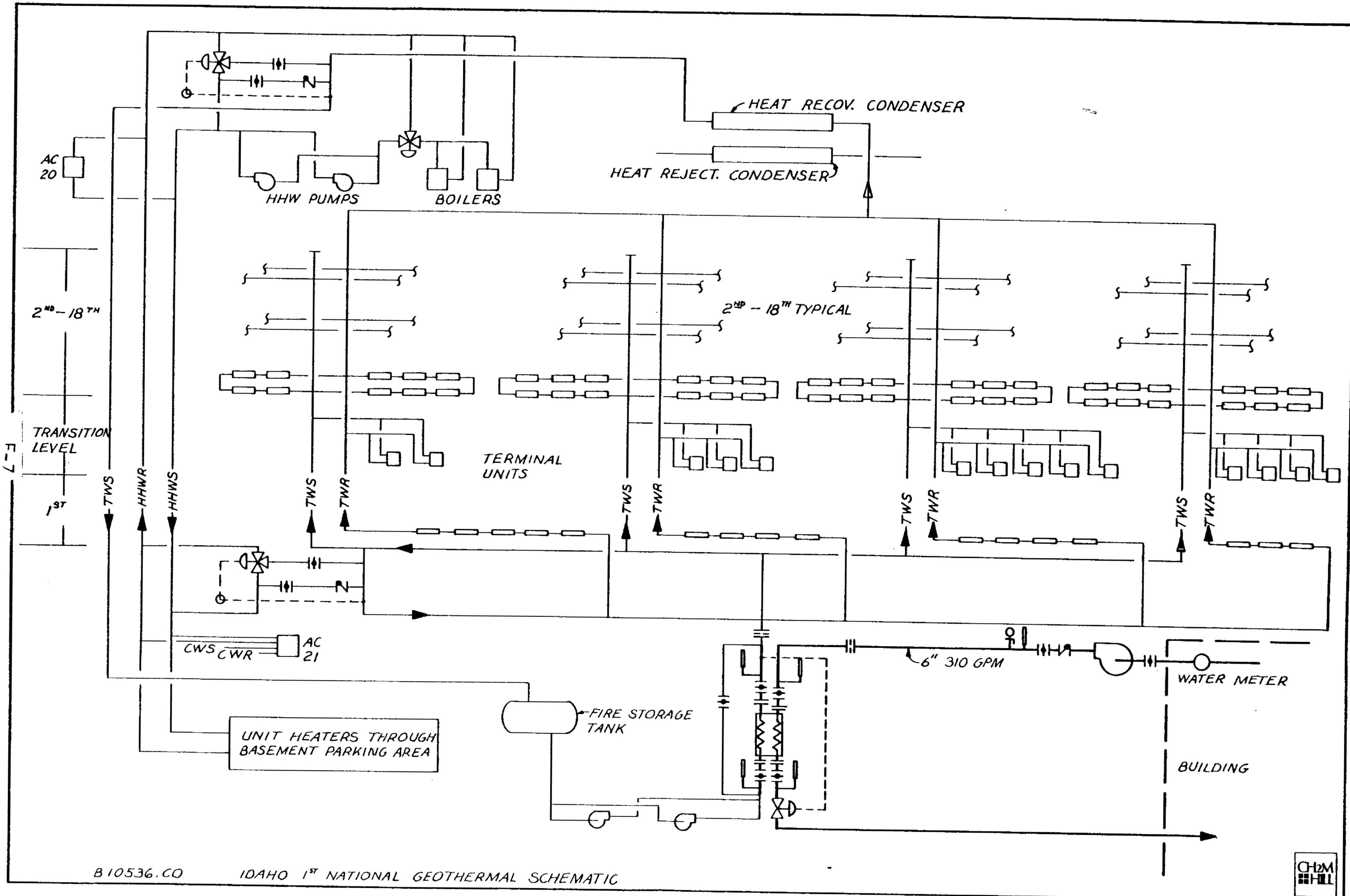
B 10536.CO Y.M.C.A. GEOTHERMAL SCHEMATIC



B 10536.CO

BANK OF IDAHO GEOTHERMAL SCHEMATIC

F-7


HEAT RECOV. CONDENSER
HEAT REJECT. CONDENSER
AC 20
HHW PUMPS
BOILERS
2ND – 18TH
2ND – 18TH TYPICAL
TRANSITION LEVEL
1ST
TERMINAL UNITS
TWS
HHWR
HHWS
TWR
CWS
CWR
AC 21
6" 310 GPM
WATER METER
FIRE STORAGE TANK
UNIT HEATERS THROUGH BASEMENT PARKING AREA
BUILDING
B10536.CO
IDAHO 1ST NATIONAL GEOTHERMAL SCHEMATIC
CH2M HILL

SPECIFICATIONS

The following is an outline of specifications that will be used for preparation of the final specifications for the construction work.

A. General Construction

1. Codes and Standards - use latest applicable rules, regulations, requirements, and specifications of the following:

   Uniform Building Code
   American Institute of Steel Construction
   American Concrete Institute
   American Society of Testing Materials
   American Association of State Highway Officials
   American Welding Society
   Metal Building Manufacturers Association

2. Structural Design Data

Seismic	Zone 2 Uniform Building Code
Roof Load	30 psf
Wind Load	UBC 20 psf zone
Concrete Design	3,000 psi
Structural Steel	Tensile Stress, fy = 36,000 psi
Reinforcing Steel	Tensile Stress, fy = 40,000 psi

3. Site Work

   Pipe will be installed on an imported gravel bed. Backfill compaction will be 95 percent of maximum density. Street surfaces will be restored.

4. Foundation and Floor Slabs

   Pumphouse foundations and floor slabs will be continuous, cast-in-place, reinforced concrete. low alkali cement shall be used. Aggregates will conform to ASTM C-33, and reinforcing will be intermediate grade and conform to ASTM A-615.

5. Structural and Miscellaneous Steel

Structural steel will conform to the requirements of the AISC Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings. Cold formed steel will be designed in accordance with the American Iron and Steel Institute publication, Light-Gage Cold-Formed Steel Design Manual.

B. Mechanical

1. Codes and Standards

ASTM Standards (where applicable)
ASHRAE
AWWA
ASME

2. Design Data

Elevation	2,800 Feet Above Sea Leve
Outside Design Temperature	-10°F
Geothermal Water Supply Temperature	170°F

3. Supply Well Pumps and Controls

Pumps for the supply wells will be vertical turbine type capable of 1,000 gpm at 515 feet of head, Allis-Chalmers type M12 x 10 VTLC-7 or equal. Pump control valves will be deep well type; hydraulically operated, Clayton 61-01 or equal. Pressure relief valves will be diaphragm type, hydraulically operated Clayton 50-01 or equal. Air release and vacuum breaker valve will be diaphragm actuated, hydraulically operated, Clayton 50-05 or equal.

4. Injection Well Pumps and Controls

Injection will be with single stage, double suction, horizontally split case centrifugal pumps, PACO type KP or equal, each capable of delivering 1,500 gpm at 230 feet of head. Pump control valves will be booster pump type, hydraulically operated, Clayton 60-01 or equal. Pressure relief valves will be diaphragm type, hydraulically operated, Clayton 50-01 or equal. Air release and vacuum breaker valves will be diaphragm actuated, hydraulically operated, Clayton 50-05 or equal.

5. Piping

Transmission and collection pipe will be asbestos-cement of the sizes designated on the Plans, and shall meet the requirements of ASTM C 296, Type II. Furnish the pipe in the manufacturer's standard lengths, except as otherwise required and as approved. Pipe will have couplings preassembled onto pipe ends at the place of manufacture.

Standard couplings will be Ring-Tite, or Fluid-Tite, with rubber-ring gaskets, and will be furnished by the pipe manufacturer. Cast iron fittings will be especially designed for use with asbestos-cement pipe.

Black steel pipe - Piping will be standard weight, black steel pipe, ASTM A 120 with 120 pound, black, screwed, cast iron fittings, Federal Specification WW-P-501, Type I, Class A.

Gate Valves - Valves 3 inches and smaller will be 200-pound w.o.g., bronze body gate valves with nonrising stem. Gate valves will be Crane No. 438 or Laboratory approved equal.

Check Valves - Valves 3 inches and smaller will be 200-pound w.o.g., bronze, wye pattern, swing check, bronze disc, Crane No. 36 or Laboratory approved equal.

6. Building Pumps

Pumps for the building retrofits will be end suction, centrifugal types and will be capable of delivering maximum design flows at maximum design heads for each building.

7. Heat Exchangers, Hot Water Coils

Plate heat exchangers will be constructed with plates of 316 SST, paracril gaskets, and conforming to ASME standards.

Hot water coils will have copper or cupra-nickel tubes and be rated to 125 psig. Row numbers and sizes as necessary for each building.

8. Meters

Flowmeters will be an annular primary flow element to measure the flow through piping, one for each metering location. The element will be made of 316 SST and rated to 125 psig.

Water supply meters will be as specified by the utility delivering the geothermal water.

9. Valves

150-pound Butterfly Valves

Butterfly valves will be 150 psi rated, flanged end, cast steel valves conforming to AWWA.

Swing Checks

These valves will be 150 psi rated, flanged end, cast steel, swing check valves. The discs and seat rings will be stainless steel.

3-way Control Valves

Control valves will be 150 psi rated, flanged end, cast steel, 3-way control valves, Fisher Type YS or approved equal. Valve plug and seat ring will be stainless steel.

Valve actuator will be a Fisher 323-YS or approved equal.

Globe Body Control Valves

Globe body valves will be 150 psi rated, flanged end, cast steel valves, Fisher ED series or approved equal. Valve plug, cage, valve plug stem, and seat ring will be stainless steel.

Valve actuator will be a Fisher Type 323-EDR or approved equal.

C. Electrical

1. Codes and Standards - use latest applicable rules, regulations, requirements, and specifications of the following.

American National Standards Institute
Institute of Electrical and Electronics Engineers
National Electrical Codes
National Electrical Safety Codes
National Electrical Manufacturers Association
National Fire Protection Agency, International

2. Conduit and Tubing

Conduit, Rigid Steel

Rigid steel conduit, including couplings, elbows, nipples, and other fittings will be galvanized. Set screw type couplings will not be used.

Conduit, Rigid PVC

Rigid polyvinyl chloride conduit will be Schedule 40 UL listed for concrete encased, direct burial underground, and exposed uses. PVC will be rated 90°C.

Conduit, Flexible

Flexible conduit will be moisture proof flexible steel, polyvinyl chloride jacketed type with continuous copper ground path in the flexible steel tube. Flexible conduit used in dry, concealed areas for lighting fixtures may be flexible steel conduit without being moisture proof.

3. Conductors

Conductors 600 Volts

Conductors in raceways and cables will be copper with the type of insulation specified. Conductors No. 8 AWG or larger will be stranded and will have insulation of a heat-and-moisture-resistant grade THW. Smaller conductors will have thermoplastic insulation type TW, and will be factory color coded.

Conductors Above 600 Volts

High voltage conductors will be copper with butyl rubber, ethylene-propylene rubber, cross-linked polyethylene or polyethylene insulation and a neoprene or polyvinyl chloride jacket.

Equipment Grounding Conductors

Conductors for equipment grounding will be stranded copper. Conductors will be bare or have type TW insulation with a minimum thickness of 1/32 inch.

4. Pushbuttons, Indicating Lights, and Selector Switches

Pushbuttons, indicating lights, selector switches, and stations for nonhazardous indoor dry locations will be of the heavy duty, oil-tight type. For nonhazardous outdoor or normally wet locations these devices will be of the heavy duty. Indicating lights will be transformer type.

APPENDIX G.

Background Assumptions
and
Data for Cost Summary

Field Data Sheet

Building City Hall

Project Number B10536

I. General

a) Information contact: Name: Dave Crogen

Phone: 384-4000

Position: head of building maintenance

Name: Rudy Paulson

Phone: 375-5451

Position: Design engineer with Engr. Inc.

b) Floor area to heat geothermally:

all enclosed floorspace 80,000 S.F.

c) Description of present heating system:

Electric boiler, electric reheaters on upper floors, central air handlers with hot water coils.

d) Available system voltage 480 V

e) Loop operating temperatures Design 190°F in, 170°F out

Actual 160°F max.

f) Heating load

i) Design: 950, 660 Btu/hr @ 94 gpm

g) Description of present equipment

i) Blower (from fan schedule)

Manufacturer Barry Airtoil #7245 CLII

Capacity 12,614 cfm

Hp. 25

Characteristics 480 V 3 phase

Future Volume 15,163 cfm w/variable inlet vanes.

ii) Recirculation Pump

Hp 5

Performance 110 gpm

40 ft. head

iii) Heating Coils

No. of coils 2

Area of each 33" x 96"

Capacity of each 475,330 Btu/hr @ 37 gpm

II. Building Piping Requirements

a) Distance from main to heating system hookup (one way):

50 L.F. from main line.
Assumes main line runs down Idaho street.

b) Estimate of fittings required:

13 90° bends (supply and return)

III. Construction Access

a) Access to mechanical room: double wide doors at base of entry ramp from garage. Some problems with very long parts possible.

b) Installation space for heat exchanger: ample room, space was designed into mechanical room.

Field Data Sheet

Building New County Building

Project Number B10536

I. General

a) Information contact: Name: Jeff Schneider

Phone: 343-4635

Position Architect for building

b) Floor area to heat geothermally:

All enclosed floor space 86,000 S.F.

c) Description of present heating system:

Electric boiler, hot water reheaters on upper floors, central air handlers with hot water coils.

d) Available system voltage 460 V 3 phase

e) Loop operating temperatures Design 155°F in, 135°F out

f) Heating load

i) Design: 1,035,100 Btu/hr @ 104 gpm

g) Description of present equipment

i) Blower (from fan schedule)

Manufacturer BC Airfoil D1DW-C1 III

Capacity 13,000 cfm

Hp. 25

Characteristics 460 V 3 phase

ii) Recirculation Pump

Hp 5

Performance 155 gpm

75 ft. head

iii) Heating Coils

No. of coils 3

Area of each 48" x 29"/48" x 29"/42" x 33 1/4"

Capacity of each 251,000/251,000/254,000 Btu/hr

II. Building Piping Requirements

a) Distance from main to heating system hookup (one way):

75 L.F. into mechanical room.

Assumes main line runs down Main Street.

b) Estimate of fittings required:

13 90° bends (supply and return)

III. Construction Access

a) Access to mechanical room:

not ascertainable from available plans.

b) Installation space for heat exchanger:

ample room, space was designed into the mechanical room.

Field Data Sheet

Building North Junior High

Project Number B10536

I. General

a) Information contact: Name: Joe Schultz

Phone: 336-1370 ext. 204

Position Head of maintenance, Boise schools

b) Floor area to heat geothermally:

Cafeteria and industrial arts area. Total 17,700 SF.

c) Description of present heating system:

For this area, hot water multizone air handling unit, plus smaller units serving isolated areas. NG heating of steam type boiler with heat exchanger for hot water loop.

d) Available system voltage 220-480 3 phase

e) Loop operating temperatures 140-160°F

f) Heating load

i) Design: 2,414,700 Btu/hr @ 231 gpm

g) Description of present equipment

i) Blower May get from info. contact.

Manufacturer ______

Capacity ______

Hp. ______

Characteristics ______

ii) Recirculation Pump

Hp 10

Performance 250 gpm

100 ft. head

iii) Heating Coils (see attached copy of HVAC equipment schedule)

No. of coils ______

Area of each ______

Capacity of each ______

II. Building Piping Requirements

a) Distance from main to heating system hookup (one way):

280 L.F.

b) Estimate of fittings required:

14-90° bends (supply and return)

III. Construction Access

a) Access to mechanical room: 4x4 ft. hole in ceiling w/light duty hoist available.

b) Installation space for heat exchanger:

7 ft. between boilers and recirc. pump, but low overhead. Room in main area of mechanical room.

Field Data Sheet

Building YMCA

Project Number 10536

I. General

a) Information contact: Name: Darrell Scott

Phone: 344-5501

Position Manager of Boise YMCA

b) Floor area to heat geothermally:

Northwest end of building, main floor 7,320 s.f. Main pool, diving pool, domestic hot water (see heating loads)

c) Description of present heating system:

low pressure steam from NG boilers, steam to water heat exchangers (also on pools and domestic water), air water convectors.

d) Available system voltage 208 3 phase

e) Loop operating temperatures Domestic hot water heated from 50°F to 140°F

Heating loop 150°F in, 130°F out

Pool loops 82°F in, 65°F out

f) Heating load

i) Design: Domestic hot water 4.330,000 Btu/hr @ 67 gpm
Heating loop 1,500,000 Btu/hr @ 156.5 gpm
Main pool loop 1,682,000 Btu/hr @ 225 gpm
Diving pool loop 1,149,000 Btu/hr @ 153 gpm

g) Description of present equipment

i) Blower - (see attached copy of air-water convector schedule)

Manufacturer __________

Capacity __________

Hp. __________

Characteristics __________

ii) Recirculation Pump

Domestic hot water:	Hp	1/6
	Performance	8 gpm 12 ft. head
Heating Loop:	Hp	5
	Performance	230 gpm 53 ft. head
Main pool:	Hp	7 1/2
	Performance	340 gpm 47 ft. head
Diving pool:	Hp	5
	Performance	154 gpm 65 ft. head

iii) Heating Coils (see attached copy of air-water convector schedule)

II. Building Piping Requirements

a) Distance from main to heating system hookup (one way):

270 L.F. from center of State Street to pool converter pumps.

b) Estimate of fittings required:

24 90° bends (supply and return, assuming shortest direct route from main; includes fittings for heat exchanger installation).

III. Construction Access

a) Access to mechanical room:

Double wide doorway after vertical drop of 1 floor from ground level.

b) Installation space for heat exchanger:

Available area limited, will require careful selection and clever piping for hookup.

Field Data Sheet

Building ______ Hotel Boise ______

Project Number B10536 ______

I. General

a) Information contact: Name: ______ Dick Christian ______

Phone: ______ 342-3668 ______

Position: Mechanical contractor designing heating system for remodeled bldg.

b) Floor area to heat geothermally:

all enclosed floor space 98,000 S.F.

c) Description of present heating system:

hydronic heat pump system with NG steam boiler, hot water converter.

d) Available system voltage ______ 230 or 460 3 phase ______

e) Loop operating temperatures Design 75° min, 90°F max.

______

f) Heating load

i) Design:

4,000,000 Btu/hr, but only 1,500,000 Btu/hr from NG
@ 5# steam (227°F)

Loop flow = 540 gpm

g) Description of present equipment

not available at this time. Contact Dick Christian when needed.

i) Blower

Manufacturer ______

Capacity ______

Hp. ______

Characteristics ______

ii) Recirculation Pump

Hp ______________________

Performance ______________________

____

iii) Heating Coils

No. of coils ______________________

Area of each ______________________

Capacity of each ______________________

II. Building Piping Requirements

a) Distance from main to heating system hookup (one way):

150 L.F. down Bannock Street

b) Estimate of fittings required:

11 90° bends (supply and return)

III. Construction Access

a) Access to mechanical room:

probably good with removable concrete slab over boiler room space.

b) Installation space for heat exchanger:

appears to be plenty available at this time, base on observation and barring a lot of equipment being moved in which we don't know about.

Field Data Sheet

Building Idaho 1st National

Project Number B10536.C0

I. General

a) Information contact: Name: Don Long

Phone: 384-7082

Position Building Manager

Name Cal Bursendine

Phone: 342-2681

Position: Mechanical-Electrical coordinator for MK during construction.

b) Floor area to heat geothermally:

total building is supplied by hot water heating, or about 280,000 S.F.

c) Description of present heating system:

Hot water from NG boilers supplies unit heaters in basement parking areas, and the compressor room and emergency generator room on the 19th floor. A tempered water system supplies both the fire sprinkler system and perimeter baseboard heating. Tempered water is heated by direct mixing with the hot water system, and by reclaimed heat from the chiller heat rejection unit. Tempered water is separated into 4 loops and is pumped from 1st floor to chiller unit on 19th floor through the baseboard heaters.

d) Available System voltage 460v-3 phase

e) Loop operating temperatures
i) Design: UH 190 in, 150 out

Heating coils 190 in, 160 out

Fin tubes 160 in, 117 out

f) Heating load

i) Design: UH 1,470,200 Btu/hr

Heating coils 1,650,440 Btu/hr.

Fin tubes 7,608,500 Btu/hr.

g) Description of present equipment

i) Blower

Manufacturer Trane

Model No. #41 Horizontal Draw thru

Capacity 30,000 cfm

Hp. 25

Characteristics 460v-3 phase

Identification Tag AC 20

Manufacturer Trane

Model No. #6 Horizontal Draw thru

Capacity 2,600 cfm

Hp 2

Characteristics 460v-3 phase

Identification Tag AC 21

ii) Recirculation Pump

TWP 1 & 2

Hp 20

Performance 173 gpm, 167 ft. head

HHWP 1 & 2

Hp 15

Performance 173 gpm, 125 ft. head

iii) Heating coils

AC 20: capacity 1,600,000 Btu/hr.

area 24" x 108" and 30" x 108"

AC 21: capacity 50,440 Btu/hr

area 18" x 45"

II. Building Piping Requirements

a) Distance from main to heating system hookup (one way):

heating tempered water only, the exchanger would be located on the intermediate basement level, requiring a maximum of 100 L.F.

b) Estimate of fittings required:

16 90° elbows (supply and return)

III. Construction Access

a) Access to mechanical room:

basement not observed.

b) Installation space for heat exchanger:

From plans, there appears to be room to locate exchanger and pump in fire pump room in basement, next to the fire storage tank.

Field Data Sheet

Building Bank of Idaho

Project Number B10536.CO

I. General

a) Information contact: Name: Harry Watson

Phone: 345-7018

Position Building Manager

b) Floor area to heat geothermally:

about 30 percent of building heated by peripheral hot water system, or 30,000 S.F. If forced air system can be converted from steam, then entire building, or 100,000 S.F.

c) Description of present heating system:

2 major independent systems, 1) overhead air system with hot/cold decks, hot coils are low pressure steam (about 10 pounds), also has air preheater steam coil at inlet, carries about 70 percent of building heat load, 2) perimeter heat by hot water loop through fan coil units, both hot or chilled water circulate through 3 zones, zone 1 on NE and SE sides, zone 2 on SW and NW sides, zone 3 is first floor bank area with natural air flow units and provides heat only. Each zone has separate pump and steam converter, located on 13th floor. Both systems served by 2 NG steam boilers (only one usually on line).

d) Available system voltage 480v-3 phase

e) Loop operating temperatures Design 180°F max.

Actual max, 140°F

f) Heating load

i) Design: Overhead air system, 3,170,000 Btu/hr.
Perimeter system, 2,600,000 Btu/hr.

ii) Actual: Estimate by building manager, 3,000,000 Btu/hr. total

g) Description of present equipment

i) Blower

Manufacturer D.W.D.I. - CLII

Capacity 75,250 cfm @ 2,800 ft. elev.

Hp. 75

ii) Recirculation Pump

Zone 1:	Hp	10
	Performance	296 gpm, 75 ft. head
Zone 2:	Hp	7 1/2
	Performance	170 gpm, 80 ft. head
Zone 3:	Hp	1 1/2
	Performance	25 gpm, 55 ft. head
Condensate:	Hp	20
	Performance	750 gpm, 60 ft. head

iii) Heating coils

Main steam coil capacity 2,700,000 Btu/hr.
area: 24" x 6'6"

Preheat steam coil capacity 470,000 Btu/hr.
area: 24" x 5'6"

Individual units - see attached for descriptions

II. Building Piping Requirements

a) Distance from main to heating system hookup (one way):

340 L.F. through building + 165 L.F. up to 13th floor.

b) Estimate of fittings required:

26 90° elbows supply and return, includes heat exchanger connection.

III. Construction Access

a) Access to mechanical room:

Stairway or light duty service elevator to 12th floor. Stairs only 12th to 13th, with single wide fire doors. Crane hoist can handle up to 3,500 pounds, otherwise will need to hire crane and come through a wall.

b) Installation space for heat exchanger:

Mechanical room is open with plenty of floor space for installation. Will need to check on floor strength for handling exchanger weight.

c) Installation space for hot water coils in air handler: looks very tight in unit-see photos for more.

d) Miscellaneous--the building manager mentioned there is no basement and foundation walls are very thick due to soft ground during construction.