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South Dakota Geothermal Institutional Handbook

A User's Guide of Agencies
Regulations, Permits and
Aids for Geothermal
Development
1980

MASTER

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SOUTH DAKOTA GEOTHERMAL HANDBOOK

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INTRODUCTION

The purpose of this handbook is to familiarize the citizens of South Dakota with geothermal energy.

The existence of a low temperature hydrothermal resource gives South Dakota a viable alternative to conventional petroleum products that are uncertain and expensive.

Examples of possible utilization in South Dakota are as follows:

1. Space Heating

The hardware and expertise exist that make low temperature space heating (less than 200°F) possible on the district level. Sophisticated heat exchangers and groundwater heat pumps are allowing the use of highly saline fluids and lower temperature waters. An example of individual home space heating is in Klamath Falls, Oregon where over 400 wells are used for space heating, using water from 100-230°F.

2. Agricultural Growth Applications

The following agricultural growth applications are feasible in SD.

- a. Greenhousing: all commonly marketed vegetables, flowers, house plants and many tree seedlings are suitable for greenhousing. Greenhouse temperatures are a function of the crop; typical highest

maintained temperatures range from 65°-80°F.

Greenhouse heating can be accomplished by (1) circulation of air over finned-coil heat exchangers carrying hot water, (2) hot water circulating pipes or ducts located in the floor, (3) finned units located along the walls or under benches, or (4) a combination of these methods. It should be noted that a market for the product must be established for greenhousing to be profitable.

- b. Animal husbandry: environmentally controlled livestock raising provides significant advantages as compared to the typical practice of outdoor exposure to the elements. These advantages include: lower mortality, more weight gain per unit of feed, faster growth, better disease control, lower fat levels in the final meat products, improved quality by-products, large litter sizes for those species raised for multiple births, and relative ease of waste management. The level of thermal environmental control currently practiced ranges from floor heating for mostly open cattle finish-feed lots to totally enclosed raising of hogs and chickens. The totally enclosed systems utilize both space heating

and floor-slab heating at about 90°F to maintain 70°F.

- c. Aquaculture: aquaculture is the cultivation and husbandry of fresh water and/or marine organisms under levels of control on the aquatic growth environment which are functions of the intensity of the aquacultural operation.

Fish farming is that portion of aquaculture which includes the rearing and harvesting of aquatic animals. Among farmable species are: common carp, Chinese carp, Indian carp, buffalo fish, paddle fish, catfish, pike, perch, black bass, sunfish, tilapia, frogs, mullet, milkfish, eels, salmon, salmonids, smelt, sturgeon, shad, striped bass, shrimp, lobster, crayfish, crabs, oysters, clams, scallops, mussels, (Barduck, 1972). Heating can be accomplished using hot water (90°-110°F) bearing pipes in the growth ponds or by direct addition of suitable quality hot water (70°-90°F) in order to maintain pond temperature near 80°F.

- d. Soil warming: another application of geothermal water that shows some promise is that of increased production for certain crops through soil warming. From experimental work continuing at

various sites throughout the world, it has been shown that certain root crops and certain rapid growth tree species show enhanced growth and larger crop yields if the soil is maintained at approximately 70°F. As another secondary use or the last step in a cascading system, the geothermal water can be piped through an underground grid system made up of one of the more inexpensive plastic pipe selections. By maintaining a pipe-run spacing of approximately three feet and an installed depth of two to three feet, crops can be planted and harvested almost directly over the top of the pipes without damage to the installation. Polyethylene tubing available in continuous 1000-ft. or greater rolls has shown to be an economical pipe material selection for this application.

- e. Biogas generation: the decomposition of organic matter in the absence of oxygen is called anaerobic fermentation and is the basis of biogas production. Anaerobic fermentation of organic products results in methane, carbon dioxide, hydrogen, traces of other gases and the production of some heat. The residue remaining is hygienic, rich in nutrients and high in

nitrogen. Weed seeds and potentially damaging germs are killed by the absence of oxygen during the fermentation process rather than by the significantly higher heat generated by the aerobic (in the presence of oxygen) process.

The biogas-producing activities are optimal in temperatures ranging from 85^o-105^oF although digestion will occur from freezing to 156^oF. Fermentation, however, is less stable in the higher of these two ranges consequently, biogas units are typically maintained in the lower optimal range (Singh, 1975). The key equipment element in the biogas process is the enclosed biomass digestion tank. The temperatures of such digestors is controlled by the addition of heat to maintain the desired 85^o-105^oF temperature range. This heating can be accomplished by circulating hot water through metal coils either inside the tank or in the tank walls; insulation is typically provided to minimize this heating requirement.

3. Industrial and Agricultural Processing

- a. Washing: large amounts of low temperature energy is consumed in several industries for washing and clean-up. One principal consumer is food processing, with major uses in meat packing for scalding, carcass wash and clean-up (140°F); in soft drink container and returnable bottle washing (170°F); in poultry dressing as well as canning and other food processes.

Sizable amounts of hot water and other hot fluids at temperatures under 200°F are used in the several metal-fabricating industries for parts degreasing, bonderizing, and washing processes. Most of these are non-consumptive uses with a 10°-20°F range in the fluid and reheating to the use temperature.

- b. Vegetable and fruit dehydration: vegetable and fruit dehydration involves the use of a continuous operation, belt conveyor, or batch process using fairly low temperature hot air from 100°-220°F. The heat historically has been generated from steam coils and natural gas, but can be provided by geothermal energy. Typical continuous operation processing plants will handle 10,000 pounds of raw product per hour (single

line), reducing the moisture from around 83 percent to 4 percent, depending on the product. A crop currently being dehydrated with geothermal energy is onions. A similar dehydration process could be applied to fruits and other vegetables. High powered blowers and exhaust fans move the air through water coils which contain either the geothermal fluid or a water in a secondary loop heated from geothermal energy and through the beds of onions on the dryer conveyor, to evaporate the necessary tons of water removed from the product each hour.

- c. Slaughter operations: applications of hot water in slaughter operations are numerous and include: water at about 180°F for required plant sanitation; heated water (140°F) for washing of carcass shrouds and work clothing; heated soak tanks for hog dehairing; circulation of hot water through coils in waste tanks to prevent coagulation of fats, employee hot-water requirements and absorption refrigeration for many cooling requirements.
- d. Grain drying and barley malting: significant amounts of energy are consumed annually for grain drying and barley malting. These processes can

be easily adopted to geothermal energy in the temperature range of 100⁰-180⁰F. The kiln or grain dryer typically is a large vertical vessel with the grain entering at the top. Hot air is forced up through the grain, extracting the moisture before being exhausted.

The two important variables in the drying operation are the air-mass flow rate and the temperature at the inlet to the dryer. To maintain the fuel at the lowest possible level, the air-flow rate should be minimized because the air is exhausted. However, two factors impose a practical lower limit on air flow: the rate must be high enough to provide uniform and sufficient contact between air and grain or malt across the entire bed, and the rate must also be high enough so that the moist air leaving the bed is somewhat less than saturated with water. As a general rule, about 40-60 cubic feet of air per minute are required per bushel of green malt in the kiln. If the drying rate is too rapid, the grain will shrink and crack and suffer general physical damage.

All the above-described facilities exist--no new technology is required, just proper material selection and design.

The handbook is designed to acquaint laymen, developers and financial institutions with the incentives and institutional barriers that exist in the geothermal energy field.

The text describes the sources of geothermal fluids in South Dakota and details some of the problems that exist in utilization and materials selection. Methods of heat extraction and the environmental concerns that accompany geothermal fluid development are briefly described.

The major portion of the handbook explains governmental rules, regulations and legislation. The time and steps necessary to bring about the development of the geothermal resource are explained in detail.

The last section of the handbook summarizes some of the federal incentives that encourage the use of geothermal energy.

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SECTION 1.0: SOURCES OF GEOTHERMAL FLUIDS IN SOUTH DAKOTA

To date, the hottest known geothermal resource in South Dakota is the water contained in the deeper portions of the Madison Limestone which underlies most of western South Dakota. The Madison limestone ranges in thickness from approximately 100 to 700 feet and in depth from 2000 to 8000 feet in the hotter areas. The temperature will range from 100° to 200°F in these deeper wells. Figure 1 shows the general extent of the Madison in South Dakota with selected well temperatures. Figure 2 lists the required temperature of geothermal fluids for a number of possible uses.

The water within the Madison limestone is believed to flow within fissures, fractures, and cavernous zones. This means, of course, that in areas of low porosity and permeability the amount of water which can be withdrawn can be quite low compared to existing wells. Because there are less than a dozen Madison wells with complete and reliable data, it is difficult to predict with certainty the success of a projected well. However, Madison wells in western South Dakota have produced water for domestic use, irrigation, space heating, and stock tank warming, since the early 1900's with consistent head and temperature.

The Inyan Kara group is composed of several sandstones which are usually called Dakota sandstone and can be located under most of South Dakota. This aquifer is perhaps one of

Figure 1: Extent of Madison in South Dakota and selected well temperatures.

Lindal Unesco 1973.

Figure 2 Temperature Versus Use

the oldest and best documented in the area. It has produced large quantities of variable quality water, ranging from acceptable to totally unsuitable for even livestock. This water has measured temperatures ranging from 60° to 125°F which can be directly utilized at the upper end or enhanced with heat pumps at the lower end. The unfortunate problem with the Inyan Kara sandstone aquifer is that it has been observed to have a steadily decreasing hydraulic head--meaning that more water is being withdrawn than is being replaced by nature.

Finally there are numerous shallow aquifers which produce water in the 50° to 80°F range. By utilizing a heat pump, the energy contained in this temperature range is very easy to extract. This will undoubtedly be the largest source of geothermal energy to be utilized in South Dakota.

SECTION 2.0: UTILIZATION PROCEDURE

Unless there is an existing well at the site where the energy is required, the first requirement will be to drill a well. Before drilling a well, it is necessary to evaluate what formations are present in the area and the amount of heat required. By evaluating existing wells in the area and projecting water potential from oil well tests it is possible to determine expected depths and flow potentials which can be used to calculate the amount of heat that might be reasonably extracted from such a well.

If the total well depth is less than 2500 feet the costs are much more reasonable than for deeper wells, because the job can be completed by small drill rigs which are much more available in South Dakota. The deeper the well and larger the diameter at the bottom of the well, the larger the rig. The large rigs are generally of the oil-field type which are in short supply and correspondingly much more expensive to operate. In 1975 costs were projected to be between \$40 to \$60 per foot. In 1979 two wells were completed at costs which ranged from \$100 to \$130 per foot. And in each case it was difficult to get the drillers to agree to leave the oil fields to come to drill a water well.

If there are other existing wells in the area in which a new well is proposed to be drilled, caution must be exercised that the new well will not affect the existing wells. This is particularly important in aquifers with uniform porosity and permeability. Sandstone aquifers are so sensitive to drawdown that it is possible to dry up completely an existing well. Effects of heavy pumping on the Inyan Kara sandstone wells at Wall, South Dakota, have been well documented.

SECTION 3.0: MATERIALS SELECTION AND PROBLEMS

The selection of materials which stand up to the unusually aggressive corrosion characteristics of most of the waters which are potential geothermal resources is an important issue. Materials such as plastics are successful in resisting

most of the corrosion and, therefore, can be used in some applications. Unfortunately, plastics are good insulators and cannot be used for heat exchangers. Another problem with plastics is that some are easily deformed under increased pressures and, therefore, are not suitable for pressure applications.

The conventional metal alloys used in most heat exchangers, such as copper and carbon steel, are often harmed by chemicals in geothermal fluid, resulting in unacceptable life expectancies. In addition, the rates and mechanisms of corrosion vary widely between the different wells and between different formations. It is therefore very important to perform a comprehensive materials evaluation prior to the final design of the system to maximize the life expectancy of the various components and correspondingly to minimize the costs of the total system.

Materials most resistant to Madison waters are titanium, certain stainless steels, and some aluminum bronzes. Nickel alloys which normally are quite resistant to corrosive waters have proven to be quite unsatisfactory. These results in general appear to be what researchers in other areas of the United States have also observed. Table 1 shows the rates of corrosion observed at four different sites in South Dakota.

Water containing high levels of dissolved solids can also create scaling problems. These scale deposits not only

Table 1

CORROSION TEST RESULTS IN MILS PER YEAR

<u>Alloy</u>	<u>Madison</u>			<u>Inyan Kara</u>
	<u>Diamond Ring</u>	<u>Philip Waggoner Lake</u>	<u>Edgemont #2 Well</u>	<u>Capitol Lake Well</u>
Ampco 483	.390	.160	.050	1.73
Ampco 483 welded	.480	.170	.090	1.73
Ampco 8	.571	.350	.040	.120
Ampco 8 welded	.360	.350	.110	1.98
Copper	3.220	.550	.160	1.31
Admiralty Brass	.550	.050	.490	.050
Copper: Nickel	.469	.280	.330	.500
Monel	.949	.240	.720	.007
SS 304	.350	.004	.009	.017
SS 316	.140	.004	.009	.003
Carbon Steel	15.8	17.6	11.8	47.5
Aluminum	+	-	+	-
Titanium	.000	.000	.004	-

- Not Tested

+ Sample Completely Destroyed

restrict the flow but also can cause the material to be corroded underneath the scale, thereby reducing the rate at which heat can be conducted. Therefore, the formation of these scale deposits must be prevented whenever possible by adequate chemical or other treatment.

SECTION 4.0: METHODS OF HEAT EXTRACTION

Methods of heat extraction generally consist of three major types: water-to-water, water-to-air, and heat pumping. In the water-to-water system, the geothermal fluid passes through a heat exchanger transferring some of its heat to another liquid which in turn circulates to the point of use such as a baseboard radiator. The advantage of this type of system is that a highly corrosive water can be "isolated" from the end use location. Disadvantages are the inability to use "lower" temperature fluids and the expense of a more complex system.

The water-to-air system is less complex and correspondingly less expensive to install and operate. This system can be as simple as placing heating coil in a concrete floor or in a forced air system. This system can generally use fluids with temperatures as low as 90°F but requires a large exchanger size at the lower temperatures. The most common method of installing a system of this type is the use of a fan coil or radiator.

The third type of heat extraction is the heat pump which has applications in waters with temperatures ranging from 130°F down to as low as 40°F. Heat pumps operating against water have been shown to reduce heating bills to one-third of the normal amount of previous years (Lenners, 1978). Installation of this type of system has the added benefit of air conditioning capability.

SECTION 5.0: ENVIRONMENTAL CONCERNS

The principal environmental problem associated with geothermal systems is the disposal of the used fluids and any associated nuisance emissions. Disposal of fluids can be a severe problem in the case of a well with a capacity of 400 gpm and high levels of dissolved solids. One method of disposal is reinjection into the same or another aquifer. In some cases reinjection can be expensive and not acceptable economically. However, reinjection is being considered more frequently by developers. Human consumption is a possibility in some cases; agricultural applications may be acceptable in other areas. If the used water has an objectionable element in it, then that element may have to be removed before disposal, a process which also adds expense to the total cost. Even discharge into lakes and streams can be a problem. The warm temperatures can induce the growth of plants, which can eventually choke out most forms of aquatic life. High levels of dissolved solids can cause unsightly deposits on

shorelines and lower the quality of the water to make it unsuitable for fish. There is also the possibility that the water may contain undesirable levels of radioactivity as evidences by several wells in the Philip area and other areas of the world.

The nuisance emissions include steam, hydrogen sulfide gas, methane gas, noise, and thermal pollution. These are items which in themselves are not dangerous at the levels at which they are produced, but they are objectionable to the senses--sight, smell, hearing, and feeling.

Even though there are problems to overcome in the utilization of geothermal energy, it is a useful resource which is available and will be more fully utilized within the next few years. Attached is a listing of some of the existing projects in South Dakota.

<u>PROJECT LOCATION</u>	<u>PROJECT TYPE</u>	<u>FUNDED BY</u>
Western South Dakota	Feasibility	Dept. of Energy
Edgemont, South Dakota	Feasiblity	Dept. of Energy
Douglas School System	Demonstration	Dept. of Energy
Philip School System	Demonstration	Dept. of Energy
St. Mary's Hospital	Demonstration	Dept. of Energy
Diamond Ring Ranch	Demonstration	Dept. of Energy
Little Scotchman Ind.	Utilization	Owner
Philip Water Plant	Utilization	City
Midland School System	Utilization	City

Willard Lenners Residence	Utilization	Owner
South Dakota State Complex	Feasibility	S.D.O.E.P.
St. Joseph's Indian School	Feasibility	Owner

SECTION 6.0: STATE GOVERNMENT INSTITUTIONAL PROCEDURES

6.1 General

The development of geothermal resources within South Dakota is primarily controlled by the Department of Water and Natural Resources. The Division of Water Rights within the Department regulates the development of geothermal resources under existing water statutes. The various applicable statutes will be analyzed in this document in a separate section. Existing state law dealing with water resources development is relevant, principally because (1) the geothermal resources found in South Dakota are principally hot water resources and (2) the use of water for heating and cooling purposes is deemed a "beneficial use" of the resources.

Geothermal use is classified a "beneficial use" by both the Secretary of the Department of Water and Natural Resources and the Board of Water Management. This is a citizens board, appointed by the governor, with the responsibility of establishing broad regulatory policy pertaining to water development.

Although there are numerous locations in South Dakota where geothermal resources are being utilized by private citizens and public entities, the total potential for use is

relatively untapped. Because of this the Department of Water and Natural Resources strongly promotes geothermal resource development.

Another agency of state government involved in the regulation of geothermal resources is the Department of School and Public Lands. Many of the lands under which geothermal resources may lie are administered by the Department of School and Public Lands. For this reason, if one desires to develop a geothermal resource on state-owned public land, the Department of School and Public Land would be involved in the process. The state agencies responsible for geothermal regulation activities are listed in Table 6.2.

The regulatory requirements of both the Department of Water and Natural Resources and the Department of School and Public Lands will be discussed in the following sections.

The South Dakota Office of Energy Policy (OEP) is not involved in the regulation of geothermal resource development but rather serves as an information source for all citizens of the state. The Alternative Energy Technologies section of the OEP maintains current files on research, development and application of geothermal resources and would be pleased to assist any interested party.

6.2 Key State Government Contacts

*Department of Water & Natural Resources

Secretary, Warren R. Neufeld

773-3151

Division of Water Quality, Jim Nelson	773-3351
Division of Water Rights, John Hatch, Chief Engineer	773-3352
Division of Geologic Survey (Vermillion) Duncan MacGregor	677-5227
*Department of School & Public Lands	
Commissioner, John Gerken	773-3303
Oil & Gas Administration, Jerry Ortbahn	773-3303
*Office of Energy Policy	
Director, Harry Christianson	773-3603
Alternative Energy Technologies, Verne Brakke	773-3603
Director, Geothermal Program, Phil Lidel	773-3603
*Department of Game, Fish and Parks	
Secretary, Jack Merwin	773-3387
Attorney, Clint Nagel	773-3484
*Public Utilities Commission	773-3202

6.3 State Statutes

6.31 Statute Analysis Section

SDCL 46-1 outlines the basic principles and definitions for water law. Of particular interest within this section is the definition of "Beneficial Use".

46-1-6. "Beneficial Use is the use of water is reasonable, useful and beneficial to the appropriator, and at the same time is consistent with the interests of the public in the best utilization of water supplies;"

As stated earlier the decision has been made by the Board of Water Management and the Secretary, Department of Water and Natural Resources that geothermal use is a beneficial use. This policy sets the stage for the inclusion of geothermal uses into the existing processes for the obtainment of a water right.

The Section entitled permitting procedures will outline the necessary steps for the obtainment of a Water Right for geothermal purposes.

Another definition found in SDCL 46-6-1 is worthy of discussion. The definition of Domestic Use is important in that if a geothermal use meets the requirements set forth in the definition, a water right need not be obtained and the developer of geothermal resource shall be afforded the full protection a law given to all other domestic water users.

46-6-1. "Domestic Use, is the use of water by an individual, or by a family unit or household, for drinking, washing, sanitary, culinary purposes; and irrigation of a family garden, trees, shrubbery or orchard not greater than one-half (1/2) acre. Stock watering shall be considered a domestic use;"

In making a decision as to whether or not a particular geothermal use is considered a domestic use, the Department of Water and Natural Resources will determine if the intended use can be considered an "ordinary household" use.

For example, the heating and/or cooling of a single farm dwelling and associated out-buildings such as a barn, may be considered a domestic use; but the heating and/or cooling of an individually-owned commercial livestock operation may not be domestic. Because each case must be reviewed by Department staff before a decision can be made, it is strongly recommended that each potential user of a geothermal resource contact the Department of Water and Natural Resources before beginning development. This will preclude any potential future problems concerning the necessity of a permit.

Additional statutes that pertain to obtainment of geothermal water rights include: SDCL 5-7-2 lists the minerals that are subject to the mineral leasing procedures of School and Public Lands.

5-7-2. Minerals subject to lease by advertising and auction or oral bids - Exemptions. "It is hereby specially provided that all leases for prospecting for, providing and marketing oil and gas, bentonite and gypsum, shall be issued after advertising and sale at public auction, to the highest bidder on oral bids. The sale of fissionable materials, feldspar, mica coal, sand, gravel, rock, stone, clay shale and any and all other minerals are specially exempted from the provisions of this section".

The above statute is one of numerous statutes which supports in whole or in part the position of the Department of School and Public Lands. All available statutes

relating to mineral leasing of state lands omit water as a leaseable mineral resource.

(Additional references: see SDCL 5-7-3, 5-7-4, 5-7-5, 5-7-7, 5-7-12.)

SDCL 5-5-3 allows the Department of School and Public Lands to designate lands which may be leased for "Agricultural purposes". It is the judgement of the Department that instituting a well for extraction of geothermal resources for farm use is an "Agricultural purpose."

5-5-3. Designation of lands to be leased - Establishing of regulations - The board of school and public lands shall designate from time to time such lands as may be leased for meadow and pasturage purposes only, also such lands as may be leased for either meadow and pasturage, or for agricultural purposes. It shall establish such regulations as in its judgement shall be necessary in order that such lands may be leased most profitably for the state, and upon designation of the lands as herein provided, the commissioner shall proceed to offer the same for lease.

(Additional references 5-5-1, 5-5-32.)

SDCL 5-5-22 sets forth the procedures required for gaining permission from the Department of School and Public Lands for making improvements on land leased from the State. Developing a geothermal resource on leased land is considered an improvement and a permit must be obtained.

5-5-22. Permit for improvements and conservation activities by lessee - Right of removal - State not liable for material or labor. - In offering any land for leasing or at any time after the lease has been made, the commissioner of school and public lands may grant to any lessee of land under the provisions of this chapter a permit to erect thereon such buildings, corrals, fences, and well apparatus as may be necessary to fully carry out the purposes of the lease, and such lessee shall have the right to remove such improvements as are capable of removal without damage to the land at any time before the expiration of the term or upon cancellation of the lease, and during a period of sixty (60) days from the date upon which such dams thereon as may be necessary, the cost of which shall not exceed twenty-five hundred dollars. In addition, the commissioner of school and public lands shall have the authority to grant in like manner a permit to prepare the ground and to plant shelter belts on such land, and to perform government approved ripping, furrowing, contouring and reseeding. Provided that the lessee shall notify the county auditor and the commissioner of school and public lands in writing whenever any such improvements are placed upon such lands. In no event shall the state become liable for any material furnished for, nor for any labor performed on, such improvements.

(Additional references 5-5-22, 5-5-23, 5-5-29, 5-5-32.)

A statute of particular note in the instance where a potential geothermal developer wishes to buy a parcel of School and Public Land is SDCL 5-9-5.

5-9-5. Offer to Purchase Particular Tract - Forfeiture or Return of Deposit - Any person may file with the commissioner

a written offer on any tract, which offers shall be accompanied by a cash or certified payment deposit of three dollars for each acre in the tract on which the offer is made. If said tract of land be selected for sale in the year in which the offer is made, and the offeror fails, at the time and place of sale, to appear and bid on such tract in an amount at least equal to his said written offer, said deposit shall be forfeited. If the tract be not selected for sale by the board of appraisal in the year in which the offer is made, or if the tract is sold for a price higher than the said written offer, the deposit shall be returned to the offeror. If the board of appraisal appraises said tract higher than said offer, said deposit shall be returned to the offeror, and the board of appraisal and the commissioner need not offer said tract for sale."

Although possessing a surface lease is all that is absolutely necessary before one can develop a geothermal resource on state-owned land, it may be more prudent to purchase the surface ownership to ensure long term use of the resource.

The South Dakota Legislature has also made provisions for a public entity to purchase state-owned land for public purposes.

SDCL 5-9-34. Sale of small tract for public purposes or landing field - Maximum size and location - Air space easement. - Whenever a civil, religious or public organization shall make an application for the purchase of any common school or endowment land to be used for public purposes, not exceeding ten acres in a square form, located on a section line or on a regularly established highway at one corner of a legal subdivision,

and, however, when a civil or public organization in cooperation with the department of transportation shall make an application for the purchase of land without restriction as to area or shape to be used as a landing field and provided that such land applied for shall be adjacent to a regularly established highway, or section line, and a plat and a statement of the purpose for which the land is to be used, shall have been filed in the office of the commissioner of school and public lands, the board of school and public lands is authorized to direct an appraisement of such tract, and the same may be appraised in the manner provided by law for the appraisement of school and public lands. The provisions of this section and SDCL 5-9-35 shall include and apply to the acquisition of an easement for the unrestricted passage of aircraft in the air space over state lands.

The above statute would be applicable in the case where a municipality wished to develop a large scale geothermal heating system for its members.

(Additional references 5-9-1, 5-9-38.)

6.32 South Dakota Public Utilities Commission

SDCL 49-41B-1 states that the PUC will assume permitting authority for energy conversion facilities and transmission facilities in South Dakota. SDCL 49-41B-2 defines an energy conversion facility as:

Any new facility expansion, designed for or capable of generation of one hundred megawatts or more of electricity.

Transmission facility is defined as:

An electric transmission line and associated facilities with a design of two hundred fifty kilovolts or more; or (b) an electric transmission line and associated facilities with a design of one hundred fifteen to two hundred fifty kilovolts, if the facility does not follow section lines, property lines, roads, highways, or railroads.

Since the low temperature geothermal resource in South Dakota does not have enough heat to generate electricity, the PUC permits are not required; furthermore, there are no direct space heating regulations in South Dakota.

6.4 State Legislation

The 1980 Legislature passed a bill entitled "An act to define geothermal resources and to provide for the leasing of geothermal resources on state lands". The act amends South Dakota Compiled Laws as follows: SDCL 5-1-2 Definition of Terms.

(3) "Geothermal resources," the use of the natural heat of the earth or the energy, in whatever form, below the surface of the earth for commercial or industrial heating or electrical generating purposes. Chapter 5-7 of SDCL "Minerals on School and Public Lands" is amended to include geothermal resources with oil and gas regulations, however, Chapter 5-7 is also amended by adding a new section to read as follows: "All leases granted by the Commissioner of School and Public Lands for the development of geothermal resources for industrial or commercial heating or production of electricity of

minerals in solution, are subject to all of the provisions of Chapters 46-5 and 46-6 inclusive".

Chapter 46-5 has 46 sections pertaining to the appropriation of water and Chapter 46-6 has 23 sections pertaining to water and wells.

In addition, two other new sections were added to South Dakota Compiled Laws Chapter 5-7. Section 8 of the bill states:

The term of all geothermal leases shall be for a period not to exceed ten years and as long as geothermal resources are produced from the leased lands.

Section 9 of the bill amends Chapter 5-7 as follows:

All geothermal leases shall provide for the payments of royalty to the state. The royalty payments shall consist of:

- (1) Not less than ten percent of the gross revenue, exclusive of School and Public Lands, that were 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 at the point of delivery to the purchaser; and
- (2) A royalty of five percent of the gross revenue, exclusive of charges, approved by the commissioner of School and Public Lands, that were made or incurred with respect to transmission or other services or processes, received from the sale of mineral products from geothermal fluids or chemical compounds.

All royalties shall be subject to renegotiation after ten years from the

effective date of the lease and at ten year intervals thereafter.

All geothermal leases shall provide for the payment of a reasonable annual rental, as fixed by the rules and regulations of the commissioner of School and Public Lands, but in no event to be less than one dollar per acre per year.

Apparently on School and Public Lands, geothermal resources are governed by oil and gas regulations for leasing and sale purposes and by water regulations for permitting, drilling, reporting, logging, and well construction purposes. The exception to the above is when the geothermal resource is used for domestic purposes, then it would be classified wholly as water.

SECTION 7.0: PERMITTING REQUIREMENTS

This section includes a narrative description of the processes involved in the obtainment of necessary permits and licenses.

7.1 Determining Ownership (Step 1)

The first step for a potential geothermal resource developer would be to ascertain who owns the surface of the land which he intends to develop. Five distinct cases exist and each requires a slightly different procedure for obtaining necessary permits.

- a) The surface is owned by the State and developer wishes to lease the surface and develop the

resource. (Proceed directly to Step 2 - Lease of State-Owned Surface.)

- b) The surface is owned by the State and the developer wishes to buy the surface rights before development. (Proceed directly to Step 3 - Purchase of State Land.)
- c) Surface and subsurface resource owned by Federal Government. (Proceed directly to Step 4 - Federal Leases and Permits.)
- d) The surface rights are presently owned by an individual who wishes to develop the resource. (Proceed directly to Step 5 - Obtainment of a Water Right.)
- e) Indian Jurisdiction. (Proceed to Step 6.)

7.2 Lease of State-Owned Surface (Step 2)

Under South Dakota law the Department of School and Public Lands is empowered to lease, for grazing or other agricultural purposes, all common school, indemnity and endowment lands. At present, leases are issued for 10 year periods. An individual wishing to use a parcel of land for geothermal development would be responsible for determining the lease status of the land.

The time and date of public auction and the locations of land to be leased can be obtained from either the county auditor or the Department of School and Public Lands.

Upon finalization of lease agreement with the Department of School and Public Lands, in order to proceed with geothermal resource development, the lessee is required to file an improvement application form with the Department. The Commissioner of School and Public Lands shall determine if the improvements are necessary to fulfill the purpose of the lease and shall approve or disapprove, accordingly.

If approval is granted for improvements, the lease holder is then required to apply for a Water Right from the Department of Water and Natural Resources, unless his operation falls within the scope of "domestic use". Proceed to Obtainment of a Water Right (Step 5).

7.3 Purchase of State Land (Step 3)

In the event that a potential geothermal resource developer wishes to purchase a parcel of state land he is required to follow the procedure set forth by the Department of School and Public Lands.

Any person in the state can offer to purchase a parcel of school and endowment land. An offer to purchase must be submitted in writing, with the amount offered per acre and a three (3) dollar per acre deposit. If the parcel of land is selected for sale the Department will file notice of a public auction and conduct such auction at a time of their choosing.

The parcel of land shall then be sold to the highest bidder providing that the highest offer is not less than the appraisal price.

If the initial offer submitted is the highest bid and such bid is accepted by the Commissioner of School and Public Lands and approved by the Governor, the bidder shall then receive title to the land.

Upon being presented with title to the land the new surface owner must then file for a Water Right from the Department of Water and Natural Resources, unless the intended geothermal use of the water resources falls within the scope of a "domestic use".

Proceed to Obtainment of a Water Right (Step 5).

7.4 Federal Leases and Permits (Step 4)

The process of obtaining permission to develop a geothermal resource on Federal land is divided into two separate procedures. The Bureau of Land Management (BLM) is responsible for the first step, which is the leasing of Federal land upon which one wishes to develop a geothermal resource. Once monthly, the BLM staff in Billings, Montana, accept bids for lease of Non-KGRA lands. In the case of KGRA's, the scheduling of competitive bids is determined by industry interest. In both cases an Environmental Assessment must be completed prior to land leasing.

After a lease has been issued by the Bureau of Land Management, the Federal jurisdiction is shifted to the United States Geological Survey (USGS). The USGS is then responsible for conducting further environmental assessments, reviewing the Plan of Operation for the proposed development and issuing necessary permits. Both the Bureau of Land Management and the United States Geological Survey carry out their responsibilities in full cooperation and consultation with appropriate Federal and State agencies.

It is strongly advised that anyone proposing to develop a geothermal resource on Federal land also contact the State Department of Water and Natural Resources, since a water rights permit is required before development can occur. In this manner both permitting processes can be coordinated. (Proceed directly to Step 5).

7.5 Obtainment of a Water Right Step 5)

Obtainment of a water right is necessary before development of a geothermal resource unless the proposed development can be classified as a "Domestic Use" of the water resource.

The first step for any developer would be to contact the S.D. Department of Water and Natural Resources and discuss with them the proposed development. In this manner the question of whether or not the development is a domestic use can be resolved. (Please refer to Statute Analysis Section, page 13, for a discussion of domestic use.)

It is also advisable to consult with Department staff on the question of a National Pollution Discharge Elimination System (NPDES) permit. These permits are issued by the Environmental Protection Agency (EPA) in instances where discharge water presents a pollution problem. The Water Quality staff with the Department of Water and Natural Resources are familiar with the process and can provide considerable assistance to the developer.

It has been determined that a Water Right is necessary prior to development, a Water Right application form must be obtained from the Department of Water and Natural Resources. The completed application will then be reviewed by Department staff, public notice of receipt of application shall be filed and following the review period, the application will be taken to the Board of Water Management for their action.

Upon approval from the Board of Water Management, the Division of Water Rights within the Department of Water and Natural Resources will issue a Water Right. The applicant may then proceed to develop the geothermal resources.

Once the construction of the facility is completed, the Department of Water and Natural Resources staff shall inspect the work and issue a certificate of completion if all construction work is satisfactorily performed. Additionally, on or before the date that the resource is to be put to a beneficial use, the Department shall again inspect the

facility and shall issue a license to appropriate water which is subject to all conditions prescribed in the Water Right.

If a prospective developer intends to develop on land owned by the Department of Game, Fish and Parks (GF&P), the GF&P Commission must act on the application.

The Game, Fish and Parks Commission requires that a recommendation be forwarded to them from the principal permitting agency. After receipt of the recommendation and associated applications, development plans, etc., the Game, Fish and Parks Commission shall review all aspects of the proposed development and make their decision.

7.6 Indian Lands (Step 6)

On all lands under the jurisdiction of tribal governments, the Water Rights process as described above is not applicable. If one desires to develop a geothermal resource on lands under Indian jurisdiction, the tribal authority should be contacted.

Table 2 lists the estimated time required for necessary permit obtainment.

SECTION 8.0: LOCAL GOVERNMENT

In South Dakota if the hydrothermal resource is to be used for any purpose other than domestic use, a Water Right permit must be obtained from the South Dakota Department of Water and Natural Resources. Local units of government have

Estimated Time Required For Necessary Permit Obtainment

Agency	Permit	Required Prior To	Estimated Issuance Time*	Notes
Counties	Zoning	Zoning Ordinance depends on county	Variable	Early county contract advisable
Dept. of S&PL	Lease	Use of land	Variable 2 mos. - 10 years	Competitive bids
Dept. of S&PL	Improvement on lease land	Development	30 - 60 days	
Dept. of S&PL	Purchase of state land	Use of land	60 days - 1 year	In most cases competitive bid
Dept. of W&NR	Water Right	Development of Resource	60 days - 90 days	"Domestic Use" does not require a permit
Dept. of W&NR	Certificate of Completion	Use of geothermal well	90 days - 5 years	Dependent upon developer
Dept. of W&NR	Water license	Application for a beneficial use	1 - 10 years	Dependent upon developer
EPA	National Pollution Discharge Elimination System (NPDES)	Discharge of water into state water bodies	180 days	Permit generally required if discharged into state water body. Advisable to consult with Dept. of W&NR

Agency	Permit	Required Prior To	Estimated Issuance Time*	Notes
Dept. of GF&P	Use of FG&P owned land	Use of land	30 - 90 days	Direct application not necessary. Dept. works with existing permitting agencies.
BLM	Lease of federal land	Use of land	Variable 2 mos. - 7 years	Prior to use, permit from USGS and Dept. of W&NR required.
USGS	Development permit	Development	Variable 2 mos. - 6 years	State Water Right required prior to development.

*All times listed are variable - It is highly recommended that pre-application contact be made with each applicable agency - in this manner, time required for agency response may be significantly shortened.

no responsibility for the drilling of geothermal wells. Geothermal systems will be required to meet all local zoning, building, plumbing, and electrical codes; therefore, it is advised that the owner/developer contact the public works director or city engineer before the construction of any project.

Municipal Rights

A South Dakota municipality would have the authority under South Dakota State Law to construct, operate, and maintain a system to provide heat from geothermal resources (SDCL 9-39-1). Such a municipality could, by vote of its electors, place the control of such a utility in the hands of the municipal utility board or manage it within the framework of their existing governing body. State Law also provides the mechanisms and authorization for municipalities to finance its utility system by the utilization of revenue bonds (SDCL 9-40). Such revenue bonding must be approved by the electors of the municipality.

SECTION 9.0: FEDERAL PROCEDURES AND POLICIES

9.1 Federal Leasing Procedures

The foundation of the Federal geothermal leasing program is the Geothermal Steam Act of 1970 (84 stat. 1566; 30 USC 1001-1025). The Act authorizes the Secretary of the Department of the Interior to dispose of Federal lands to develop

geothermal steam found within public, withdrawn, and acquired land. The Department of Interior has assigned the responsibility for geothermal leasing to its agency, the Bureau of Land Management (BLM). For the purpose of lease administration, geothermal resources and by-products are defined as follows:

- a) "Geothermal resources" means geothermal steam and associated geothermal resources which include: (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, and other fluids artificially introduced into geothermal formations; (3) heat or other associated energy found in geothermal formations; and (4) any by-products derived from them.
- b) "By-product" means (1) any mineral or minerals (exclusive of oil, hydro-carbon gas and helium) which are found in solution or in association with geothermal steam and which have a value of less than 75% of the value of the geothermal steam or are not, because of quantity, quality or technical difficulties in extraction and production of sufficient value or warrant extraction and produc-

tion by themselves, and (2) commercially demineralized water, (84 stat. 1566; 30 USC 1001-1025).

The maximum acreage allowed per lease is 2,560 acres and the minimum acreage allowed per lease is 640 acres. A single lessee may hold a maximum of 51,200 acres per state, except that any lease which contains a well shown to be capable of being commercially productive as determined by the USGS is exempted from this acreage limitation. The terms of the lease are for a primary term of 10 years and as long as steam is produced in paying quantities, up to an additional 40 years. If the lease is producing at the end of this forty year period, another forty year term may be allowed.

The annual rental rate is a minimum of one dollar per acre per year for the first five years. Beginning with the sixth year, the rental rate escalates at the rate of one dollar per acre per year until commercial production is achieved. The royalty rate is between 10 and 15% of the value of the resource upon production. By-products from production are subject to a royalty rate of not more than five percent. The specific royalty rate is set by the USGS.

There are two basic leasing processes on Federal lands: competitive and non-competitive. The competitive process is used when the land in question is in a "Known Geothermal Resource Area" (KGRA). A KGRA is defined as:

An area designated by the Secretary as known geothermal resources area prior to October 1, 1979, under this Act, or an area for which there is substantial physical evidence including but not limited to the geology of or a discovery on such lands, which would, in the opinion of the Secretary, engender a belief in persons who are experienced in the subject matter that the prospects for extraction of geothermal resources for the primary purpose of generating electricity in commercial quantities warrant substantial expenditures for that purpose, or an area for which competitive interest has been demonstrated in accordance with regulations issued by the Secretary of Energy: Provided, That such competitive interest shall have been demonstrated, in accordance with such regulations, within thirty days after the filing of a lease application for such lands, and any such demonstration of competitive interest after such thirty-day period shall not constitute a basis for designation as a known geothermal resources area.

"Any known geothermal resources area which receives no bids when offered for sale shall be declassified and leased to the first noncompetitive applicant: Provided, That the Secretary's authority to reclassify such lands as known geothermal resources areas at a later date on the basis of new information shall not be affected".

The USGS is responsible for the classification of lands as KGRA's. They delineate KGRA's by information available or by the overlapping of several lease applications.

If an area up for lease is part of a KGRA, it is subject to competitive bidding. Tracts within a KGRA may be put up for competitive leasing either by nominations from the public

or by the BLM's own initiative. The applicant files a lease request with the BLM and they in turn forward it to the USGS who determine if the area qualifies as a KGRA. The surface management agencies (BLM, Forest Service and Bureau of Indian Affairs) then assess the environmental impact; if deemed necessary, they complete an Environmental Impact Statement (EIS) and circulate it to other agencies and the public. If the leasing is acceptable, the BLM (with the approval of the Secretary of Interior) publishes a notice of a lease sale in a newspaper of general circulation in the area where the land is located. This notice must contain information regarding time and place of sale, description of the lands, procedure for submitting bids, terms and conditions of the sale, and the royalty rates as determined by USGS. A separate sealed bid is required for each lease along with half of the bid amount and a statement of qualifications. Leases are offered to the "highest responsible qualified bidder." The Secretary of the Interior has the right to reject any and all bids. If a lease is granted, before it is issued, the successful bidder must file a \$50,000 statewide bond or \$150,000 nationwide bond to insure lease compliance and to indemnify damages.

If the land to be leased is not part of a KGRA, it is subject to non-competitive leasing. In this process, an application (along with a \$50 filing fee and the first year's rent) must be submitted to BLM in a sealed envelope. The

FIGURE 3 NON-COMPETITIVE LEASING PROCESS FOR FEDERAL (NON-INDIAN) LANDS FOR GEOTHERMAL DEVELOPMENT

FIGURE 4 COMPETITIVE BIDDING PROCESS FOR THE LEASING OF FEDERAL (NON-INDIAN) LANDS FOR GEOTHERMAL DEVELOPMENT

date of filing is stamped on each application. BLM in turn forwards the application to USGS to determine if the lands are or are not a part of a KGRA. Once again, the surface management agencies assess the environmental impact. Leases are then awarded (at the discretion of the Secretary of Interior) on the basis of priority according to the filing date stamped on each application. As in competitive lease procedures, the surety bond must be filed before the lease is issued.

Periods in excess of two years are realistic in obtaining a Federal land lease. This is because of the lengthy processes involved in assessing the environmental impacts and drafting and circulating the EIS.

Figure 3 details the non-competitive leasing process for Federal lands and Figure 4 details the competitive bidding process for Federal lands.

9.2 Indian Land Leasing

Actions that relate to trust resources on Federal lands ultimately rest with the Secretary of the Department of the Interior. Accordingly, the leasing of Indian lands for geothermal development has been assigned to the Bureau of Indian Affairs (BIA) and the USGS. The BIA provides technical and administrative assistance to the Indian Tribe in bid publication, lease contract review, and operations monitoring. USGS evaluates any environmental assessments or impact

statements and also provides similar technical assistance. In addition, USGS has enforcement authority in operation compliance of resource development. The individual Indian tribes maintain some flexibility in that they determine the terms of the lease, for instance, rents, royalties, period of lease and whether a lease will be sold by a competitive or non-competitive bidding process. The time periods involved in obtaining an Indian land lease for geothermal development purposes depend on whether the BIA or other Federal agencies determine that an EIS is necessary. In such cases, periods of two years or more would be realistic in obtaining a lease.

It is possible to do pre-lease exploratory work on Indian lands. This would require obtaining an exploration permit from the individual tribes involved. The terms of the permit (cost, length of permit, extent of exploration work, etc.) would be determined by the tribe.

9.3 Exploration and Development on Federal Land

The regulations relating to geothermal resources operations on Federal leases are embodied in 30 CFR Part 270. The regulations are administered by the USGS. Before permitting operations on leased Federal land, USGS shall determine if the lease is in good standing; whether the lessee is authorized to conduct operations; whether the operator has filed an acceptable bond; and whether the operator has an approved plan of operation, notice of intent to do exploratory

work, sundry notices or other appropriate permit applications, (30 CFR, Part 270.11).

Application for lease of Federal land for geothermal purposes involves many Federal agencies, however, the Bureau of Land Management serves as the leasing agency (43 CFR 3210.2).

In large part, geothermal resources are handled in much the same way as oil and gas resources. The United States Geological Survey (USGS) classifies federally-owned land as KGRA's (Known Geothermal Resource Areas) where it meets the legal requirements. According to the USGS, KGRA's have known temperature and geologic configurations and are likely to produce electrical power. KGRA's require competitive leasing. Non-KGRA's may be leased by filing with the Bureau of Land Management.

After necessary leases have been issued by the Bureau of Land Management (BLM) and drilling for the resource is anticipated by the developer, the permitting process will be found in the permitting section of this document.

Prior to commencing operations on the leased lands, the lessee must first obtain the joint approval of a plan of operation from USGS and the appropriate land management agency. The USGS also issues permits and oversees operations on Federal land relating to:

- a) The drilling and development of production wells.
- b) The drilling and development of injection systems.
- c) Plugging and abandoning of resource wells.
- d) Construction of power plants.
- e) Use of the resource for power production.

SECTION 10.0: FEDERAL INCENTIVES

10.1 Federal Geothermal Loan Guaranty Program

A major incentive toward the development of geothermal energy offered by the Federal Government is the Federal Geothermal Loan Guaranty Program. This program is under the auspices of the Department of Energy (DOE) and has two main objectives:

- a) To encourage and assist the private and public sectors to accelerate development of geothermal resources by enabling DOE to minimize a lender's financial risk that is associated with the introduction of new geothermal resources and technology.
- b) To develop normal borrower - lender relationships which will in time encourage the flow of credit so as to assist in the development of geothermal resources without the need for Federal assistance.

Under this program, DOE can guaranty up to 75 percent of a loan with the borrower putting up the remaining 25 percent. The maximum loan guaranty limit is one hundred million dol-

lars for any single geothermal project and two hundred million dollars for a single borrower. The loans can be guaranteed up to 30 years.

Application Procedure - The application and supporting documentation may be jointly submitted by the lender and borrower or individually by the borrower. A pre-application conference is offered by DOE. Those projects having a plan of operations which shows substantial promise of the prompt development and utilization of energy from undeveloped geothermal resource areas will be given top priority for a loan guaranty. The estimated time involved in the processing of an application is between 120 and 180 days, depending on the type of project, completeness of data submitted, and extent of environmental consideration.

10.2 Program Research and Development Announcement

The purpose of the Program Research and Development Announcement (PRDA), sponsored by DOE, is to provide an opportunity for interested parties to propose site specific engineering and feasibility studies of direct applications of geothermal energy. DOE's primary interest under the PRDA Program is for studies covering a detailed analysis of engineering, economic, and institutional factors associated with single-purpose or multiple usage of geothermal heat in application areas such as industrial and agricultural

ing, mineral extraction and space/water heating and cooling for commercial building complexes and residential development. Results of these studies are expected to aid in selecting the location and design of possible follow-up applications experiment, help to identify impediments to commercialization, and directly stimulate private development of direct applications of geothermal energy. These PRDA studies are generally funded 100% by DOE, but are competitive, positive solutions.

10.3 Program Opportunity Notice

The purpose of the Program Opportunity Notices (PON) that have been sponsored by DOE on several occasions, is to provide an opportunity for interested parties to propose direct use demonstration projects (field experiments) using geothermal energy. These field experiments are needed to provide visible evidence of the profitability of various direct heat applications in a number of geographical regions and to demonstrate a variety of types of applications. These PON demonstration projects are funded on a cost-sharing basis between the developer and DOE.

10.4 Geothermal Energy Technical Assistance Program

The Geothermal Energy Technical Assistance Program, administered by DOE, acts as an incentive by providing technical assistance to the general public, industry, DOE contrac-

tors and Federal and State/local agencies on a request basis. Specifically, the Technical Assistance Program offers a maximum of 100 man-hours of technical assistance in the following areas:

- a) Resource definition
- b) Resource evaluation
- c) Preliminary engineering evaluations
- d) Engineering preconceptual design
- e) Material technology information

Requests for this assistance are to be directed to DOE through the South Dakota Office of Energy Policy.

10.5 User-Coupled Reservoir Confirmation Drilling Program

The User-Coupled Confirmation Drilling Program is designed to provide financial and technical support in the financially high risk period of resource reservoir confirmation. This expensive and uncertain period includes exploration of the drill site, drill site preparation and modification, actual well drilling, flow testing, and completion of the well.

The program also applies to wells that have already been drilled but have not been tested for hydrothermal applications.

DOE will pay 90 percent of the costs, not to exceed \$2.0 million, for a project of one production well that is unsuccessful, and 90 percent of the costs, not to exceed \$3.6 mil-

lion, for a project with one production well and one injection well that is unsuccessful.

If the drilling projects are successful and the wells can be used for the desired application, the user must pay 80 percent of the drilling costs, and the Federal government will pay 20 percent of the costs, not to exceed \$440,000 for one well, and \$800,000 for a project that uses a production well and an injection well.

A successful well is defined as one that produces a hydrothermal resource having the necessary temperature, flow and production characteristics suitable for the intended direct application.

Aproximately \$10 million will be available for this program in FY '81.

This program applies only to low-to-moderate temperature wells. They are defined as being 300^oF or below in temperature. Most geothermal scientists agree that there are many more hydrothermal resources in this temperature range than in the high-temperature range of over 300^oF.

The purpose of the User-Coupled Confirmation Drilling Program is to stimulate hydrothermal development by reducing the reservoir confirmation risk to the developer, and to promote development of an infrastructure of specialists in low-to-moderate hydrothermal resources.

Individuals; education institutions; commercial, industrial or other private entities; public entities, including state and local governments are eligible for this program.

A potential proposer is one who 1) has a site with hydrothermal potential, 2) has an intended end use or has an arrangement with a potential user with an end use, 3) has solutions to institutional barriers, and 4) can provide a self-sustaining financial package.

Some examples of low-to-moderate temperature hydrothermal resources as an alternate energy are space heat, industrial process heat, and ethanol production.

Proposals which include more than one end user, e.g., cascaded end uses and multiple end uses will receive a more favorable evaluation than one which proposes only one end use. Proposals which primarily address electrical generation, hot dry rock technology or geopressured resources will not be considered in this program.

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