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ENVIRONMENTAL REPORT

DEEP GEOTHERMAL TEST WELLS IN THE RAFT RIVER VALLEY

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ABSTRACT

This brief environmental analysis was prepared by the Idaho Geothermal R&D Project in order to provide interested persons with the principal environmental ideas and concerns affecting the exploratory stage of geothermal development in the Raft River Valley. Exploration of this type for natural resources customarily does not require a formal environmental analysis report of this extent. This document has been prepared principally for information purposes. It should be noted that this brief analysis is only concerned with the drilling of two exploratory wells and the setting up of a test loop (pipe) between these wells. In this pipe, components and materials of proposed geothermal systems may be tested. As such, the environmental impact is negligible. No attempt has been made to cover the impacts of subsequent development related to the geothermal resource at this time because such development: 1) hinges on the discovery of an adequate resource, and 2) has not been authorized to date by this agency (research or otherwise) of the Federal government. If such development should occur, the usual practice of preparing a complete and formal environmental impact statement would be expected to be followed. A preliminary environmental study for the power plant development phase has been performed independently by the University of Utah (UTEC ME 74-101) and is available from the INEL Geothermal Project. That document identifies only the major significant concerns of a power plant development program, and also is not intended in any manner to represent the format and content of a complete environmental analysis report.

TABLE OF CONTENTS

	<u>Page</u>
1.0 THE PROPOSAL	1
2.0 THE EXISTING ENVIRONMENT	7
2.1 General Region and Drill Site Location	7
2.2 Land	7
2.3 Climate.	12
2.4 Natural Vegetation	12
2.5 Fish and Wildlife	12
2.6 Water	13
2.7 Recreation	14
2.8 Archeological and Historical Sites or Areas with Special Aesthetic Value.	14
3.0 ENVIRONMENTAL IMPACTS.	18
4.0 ALTERNATIVES	22
4.1 No Action.	22
4.2 Alternate Site	22
4.3 Alternate Methods of Exploration	22
5.0 ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED. . .	24
6.0 RELATIONSHIPS BETWEEN THE SHORT-TERM USE OF THE ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY	25
7.0 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES. .	26
8.0 COST-BENEFIT ANALYSIS.	27

FIGURES

1	Typical Drill Site Plan.	3
2	Southern Raft River Valley and Frazier Known Geothermal Resource Area.	8
3	Proposed Drill Site and Vicinity	9
4a & 4b	Land Use and Land Use Capability in the Raft River Valley.	11

TABLE OF CONTENTS

(Cont'd)

Page

TABLES

I	Chemical Analyses of Hot Wells in Raft River Valley. . . .	16
II	Chemical Analyses of Hot Wells - Specified Elements. . . .	17

1.0 THE PROPOSAL

The purpose of this environmental analysis is to assess the impact of the construction and testing of two deep geothermal test wells to be drilled within the Frazier Known Geothermal Resource Area (KGRA) in the Raft River Valley of Idaho. The first well will be located in the NE 1/4 SW 1/4 Section 23 T15S R26E (BM) and the second well is expected to be within two miles of the first. The wells are part of a geothermal research program being conducted at the Atomic Energy Commission's Idaho National Engineering Laboratory (INEL) by Aerojet Nuclear Company (the prime contractor), with cooperative efforts in research and development from the U.S. Geological Survey (USGS), Raft River Geothermal Development Corporation, Northwest Public Power Council, the State of Idaho, Boise State University, Idaho State University, the University of Idaho, University of Utah, and the Colorado School of Mines. The goal of this program is to illustrate the feasibility of developing and using low temperature ($\leq 150^{\circ}\text{C}$) geothermal resources for power generation and non-electric applications. A basic consideration in the various stages of the program is the reduction of adverse environmental impacts to support the contention that the development of geothermal resources is more environmentally compatible than some other forms of energy resources in terms of air and thermal pollution. Proper design and operational controls can reduce the potential for water quality degradation to a negligible level of concern.

During the past year, detailed hydrological, geophysical, and geochemical surveys have been performed in an attempt to construct as extensive a model of the geothermal resource as is possible with current surface or near surface exploration methods. In addition, these surveys will become a case study for future geothermal exploration in other areas. The drilling of a test well will provide the only means for evaluating the results of these surveys and their applicability in postulating the presence of a geothermal resource.

Plans for the evaluation of the resource, if it is found with a sufficient temperature and flow rate, include the set-up of a production-reinjection test loop where materials and processes can be tested. Further

development of the resource, if and when authorized, is expected to include the construction of a 10 MW (nominal) demonstration geothermal power plant, and perhaps ultimately the incorporation of several non-electric utilization demonstration units such as feed lots, greenhouses, and food processing plants.

Initial site preparation is expected to begin in mid-December 1974, with the actual commencement of the first deep well drilling being about one month later. Approximately 2 acres of land will need to be cleared and leveled for each of the two drill sites themselves (Figure 1). A maximum of an additional 1/2 acre will be cleared and graded for access roads. Part of the drill site and the access roads will be surfaced with gravel to facilitate all-weather travel and to help prevent erosion. The access roads will not be considered "permanent" unless extensive development occurs at the site in the future; therefore, they will not be paved under this phase of the program.

A reserve pond with a three acre-foot storage volume will be constructed as a catchment for fluids associated with drilling and testing of the well. It will be surrounded by an earth berm (3:1 slope) designed to provide a minimum of 3 ft of freeboard at design capacity. A barbed wire fence will surround the pond to prevent ready access to it. In addition, a series of small, interconnected pits will be excavated for storing drilling mud and for cooling purposes.

Prior to the drilling of each of the deep test wells, two shallow holes (the rat-mouse holes) and an approximately 100 ft deep water well will be drilled to provide domestic and rig water requirements (<4,000 gallons per day).

A rotary drill rig will be used for the test well. The rig stands 170 feet high and will occupy about 7,000 square feet of land surface. Additional structures on the site include tanks for fuel and water storage, generators, mud tanks and pumps, equipment storage houses, and pipe racks. Office trailers and sanitary facilities will be provided for the 24 people (four shift crews) involved with the 168 hour per week drilling program.

Fig. 1 Typical Drill Site Plan

The proposed drilling program, scheduled to begin in January and terminate in approximately 120 days, will consist of the following stages:

1. Drill a 42-inch hole to 40 ft. Set and cement a 30-inch conductor pipe to surface.
2. Drill a 26-inch hole to 900 ft. Set and cement 20-inch surface casing to the surface.
3. Drill a 12-1/4 in. hole until the geothermal resource is encountered or to a maximum depth of 8,000 ft.
4. If a usable resource is found, prepare the hole and cement a combination string of 9-5/8 in. casing from near the bottom of the hole to approximately 900 ft and a 13-3/8 in. casing from 900 ft to the surface.
5. Within the production zone, perforate the casing, acidize, etc. to complete the hole and prepare it for production. An alternate completion procedure may be employed in which the production zone would be left uncased or would be cased with an uncemented slotted liner.
6. Clean the hole and develop flow of geothermal fluids from it. Either air lift or piston "swabbing" techniques could be employed to develop flow. A pump installed at a depth in the range of 200 to 600 ft may be used.

The entire drilling phase will be supervised by a qualified engineer and will conform to all State and Federal regulations concerning geothermal well drilling.*

Extensive monitoring and measurements will be provided during drilling and at the termination of drilling. Such measurements will include various electrical, sonic, and other logging techniques, drill stem tests and temperature surveys.

* In particular, "Idaho Department of Water Administration Regulation and Minimum Well Construction Standards for Drilling for Geothermal Resources," February 1974, and as subsequently amended or modified.

If a usable geothermal resource is not encountered at either or both of the wells, or if for any other reason either site is to be abandoned, the hole will either be plugged in conformance with the Idaho Department of Water Administration standards for well abandonment, or be maintained in a standby capped condition to be used as a reinjection well for the test loop.

The following tasks will be performed to return each site to as near its original condition as possible:

1. All pits will be backfilled and levelled with soil stockpiled from site levelling and pond excavation.
2. The drill site and newly constructed access roads will be seeded with crested wheatgrass (16 lb/acre).
3. All equipment, structures, and waste materials will be removed and disposed of properly.

At the completion of the first well, a second test well will be drilled within two miles of the first site. The same drilling procedure will be followed in this case.

If one or both wells supply geothermal fluids of the appropriate temperature, a connection will be made between them and a test loop set up for operation. This will allow for the testing of geothermal system components without any consumptive use of geothermal water. The test section will consist of approximately seven branches in which corrosion, deposition, and geothermal power plant component testing will take place. Each branch will discharge into a common collection tank (60,000 gallon capacity) allowing for some additional cooling prior to the fluid being pumped back to the reinjection well. The test loop is currently in the preliminary design phase, with installation, if it is feasible, scheduled for mid-1975.

The exact location of the test section on the connection between the two wells will depend on local topography, but there is a high probability that it will be located adjacent to the producing well on the drill site clearing. All structures connected with the test loop and connection will be

above ground, requiring no excavation. The location of the collection tank (50 ft x 50 ft area) will need to be levelled, but all piping (nominally 8 in. diameter) will be supported above the ground so that no additional leveling or clearing will be required.* The hot portion of the piping will be insulated to conserve fluid temperatures and to protect man and animals from contact with hot pipe walls. The insulation will be a neutral color so as to not be conspicuous on the landscape.

* An exception to above ground location would be at places where the piping crosses roads or trails (no such roads in the area are presently paved). The piping will be installed underground at these locations.

2.0 THE EXISTING ENVIRONMENT

2.1 General Region and Drill Site Location

The area of interest is the Raft River Valley in southern Cassia County, approximately 52 miles southeast of Burley, Idaho (Figure 2). The first proposed drill site is located in the NE 1/4 SW 1/4 Section 23, T15S, R26E Boise Meridian on Federal land administered by the Burley District of the Bureau of Land Management. The location of the second well site has not been picked (pending the results of the first well) but is expected to be within two miles of the first site. The nearest population centers are Burley (population 8,279), 52 miles to the northwest, Malta (population 196) 15 miles to the north, and Almo (population 40) 12 miles to the west. The only principal road in the region is State highway 81 which runs southeast from Malta to the Utah-Idaho border.

2.2 Land

2.2.1 Topography of Drill Site Area

The drill site is located toward the southern end of the Raft River Valley near the base of the Jim Sage Mountains. The valley bottom is generally level with relief limited to small gullies and ridges. The average gradient along the course of the river is 25 ft per mile (See Figure 3).

To the northwest, the land gradient steepens as you approach the Jim Sage Mountains, which peak about 2,400 ft above the drill site (elevation 4,850 ft above sea level). Across the Raft River Valley to the south are the mountains of the Raft River Range with elevations exceeding 9,000 ft.

2.2.2 Geology

The Raft River Valley is a Basin and Range type north-south trending structural depression which has as its northern limit the Snake River Plain. It appears that recent basaltic volcanism at the north end of the valley marks the intersection of three major tectonic features: the rift zones of the eastern and western Snake River Plains, and the major north-south trending fault zones of the Raft River Valley. These faults separate the valley from the Cotterell and Jim Sage Mountains to the west and the Sublett and Black Pine Ranges on the east. The floor of the Raft River Valley is a westward-tilted, down-faulted block, whereas the Cotterell Mountains are an upfaulted block

Fig. 2. Southern Raft River Valley and Frazier Known Geothermal Resource Area (proposed drill site ⊕).

which also has a westward dip. The Jim Sage Mountains south of the Cotterells, commonly combined as the Cotterell Range, is a north-south trending anticlinal structure whose limbs have been downfaulted on both sides.

The south end of the valley is terminated by the east-west trending Raft River Range. A west-trending fault zone is suggested by topographic considerations in the vicinity of the Narrows at the southern terminus of the Jim Sage Mountains and the Raft River Valley near the locale of the hot wells and the Frazier KGRA (Known Geothermal Resource Area, Figure 2).

The Raft Formation of Quaternary Age and the Salt Lake Formation of Tertiary Age occupy the structural depression or graben of the Raft River Valley. Open file USGS gravity and seismic data indicate a total thickness of 6,000 ft of sedimentary and volcanic fill within deeper portions of the graben. The Salt Lake Formation consists of sandstones, silty sandstone, tuffs and welded tuffs with a maximum aggregate exposed thickness of 2,500 ft.

The Raft Formation consists of an exposed thickness of 1,000 ft of alluvial, fluvioglacial and lacustrine silts, sands, and gravels. The percentage of coarse-grained material in the Raft Formation in the valley increases markedly toward the south. Both the Raft Formation and Salt Lake Formation serve as major aquifers for ground water supplies in the valley.

2.2.3 Land Use and Sociocultural Patterns

The Raft River Valley is a sparsely populated (3.5 people/square mile), poorly developed area with land use limited almost exclusively to agriculture and livestock grazing. Lack of adequate demand, power, and people has hindered the growth of industry on anything more than a local scale.

The accompanying figures (Figure 4, A & B) illustrate the current land use in the Valley and give an indication of the potential of undeveloped land. Much of the land in Class VI has been reclaimed through increased sprinkler irrigation and is now capable of supporting cultivation with careful management and conservation practices (Figure 3). The major crops grown on cultivated land

Fig. 4a Land Use

Fig. 4b Land Use Capability

Class III: Significant limitations or risks of damage. Local climate conditions restrictive. Moderate to extensive soil conservation measures required.

Class IV: Requires careful management, special crop choices, and careful soil conservation practices. More suited for woodland, pasture or range use than crops.

Class VI: Too steep, stony, arid, or wet, etc. for cultivation. Limitations to forestry or grazing are moderate.

Class VII: More severe limitations. Used mainly for woodland and wildlife cover. With intensive and costly reclamation, conservation, and management measures, or under unusual circumstances, Class VI and Class VII soils may be developed for certain crops.

--from Idaho Economic Atlas

Fig. 4a and 4b Land Use and Land Use Capability in the Raft River Valley

are wheat, barley, alfalfa, and sugar beets. Nearly all of the remaining Class VI land shown in Figure 4b has been classified as potentially irrigable land, but a critical ground water situation in the Valley has effectively halted further irrigation development for the near future.

Activity in the area adjacent to the drill site itself is limited to a greenhouse operation (heated with geothermal water from hot well) about 1/2 mile to the south, some livestock grazing to the west, and the irrigation operations immediately to the east and to the south along the far side of the Raft River. County land use plans for the area predict little change in land use patterns in the near future.

2.3 Climate

The climate of the Raft River Valley typifies the semi-arid climate characteristic of Southern Idaho; however, some of the climatic extremes are moderated because of the Valley's relatively sheltered position. The mean annual precipitation at Malta is 12.2 in. (an estimated 30 year normal for the area is 9.15 in.). Temperatures average 47.6°F over the year, with extremes of 104°F (July) and -27°F (January). The prevailing wind direction is northwest and wind speeds average 8.8 mph. Calms are infrequent, occurring 2% of the time on an annual basis.

2.4 Natural Vegetation

Vegetation in the Valley is in general the sage subclimax class typical of cool deserts. The primary plant types, sagebrush and greasewood, show a characteristic spaced distribution with the "open" spaces supporting mosses, algae, and lichen. Juniper, which is almost nonexistent in the valley, becomes relatively abundant at higher elevations.

2.5 Fish and Wildlife

Animal life in the Raft River Valley is varied, including mule deer, cottontail, jack and snowshoe rabbits, coyotes, badgers, ground squirrels, pocket gophers, weasels, rattle, blueracer, and bull snakes. The mountain ranges provide the primary habitat during the summer months. As the weather becomes cooler, there is a general migration toward the valley bottom. An

expansion into the valley of antelope habitats in the Jim Sage and Raft River mountains is currently in the planning stage by the Bureau of Land Management.

Several species of birds inhabit the valley and adjacent bird sanctuaries in the Black Pine and Albion Mountains. Species of game birds include Hungarian Partridge, Ring-necked Pheasant, Chukar, Sage Grouse, Canadian and Snow Geese, Mourning Dove, Canvasback, Bufflehead, Pintail, Mallard, Green-winged Teal, and Wood Duck. Other birds not classified as game birds which frequent the area are Golden Eagles, Turkey Vultures, Western Meadowlarks, Barn Owls, Kestrels, Nighthawks, Cooper's Hawks, and Ferruginous Hawks.*

Fish in the Raft River are limited principally to sucker and minnow species, although Cutthroat Trout are numerous enough to support some sport fishing.

2.6 Water

Surface water in the valley occurs primarily as intermittent streams, with the Raft River being the only waterway having some flow throughout the year. Increased irrigation operations threaten the continuance of the river's existence, though at present it can still boast a measureable flow over much of its channel. Surface inflow into the Raft River Valley totals approximately 40,000 acre-ft annually, nearly all of which is diverted for irrigation purposes. Over 130,000 acre-ft of ground water was pumped for irrigation in 1966, while an estimated 80,000 acre-ft of ground water still outflows from the basin annually.

An extensive aquifer underlies much of the valley, ranging in thickness from a few feet to more than 1,500 ft. Permeability of the water-bearing formations is highly variable, but is estimated to average 300 gpd/ft² for the composite aquifer. The ground water storage capacity of the basin is large--9,000,000 acre-feet is the estimated content of the upper 200 feet of saturated deposits. However, the development of the resource has been temporarily halted

* The Ferruginous Hawk is considered a threatened species by some, though not officially classified as such under the Endangered Species Act of 1973.

by a moratorium on well drilling* imposed by the State as a result of declining ground water levels in the valley in recent years.

In general, the quality of surface and near surface ground water is good; dissolved solids in a few exceptional wells range up to more than 2,000 ppm where the temperature is high or where a substantial percentage of the water pumped was previously used for irrigation. Most of the surface and ground water is suitable for irrigation and has a dissolved solids content of less than 600 ppm, mainly calcium bicarbonate.

Two wells in the vicinity of the proposed test well site currently yield water under artesian flow with temperatures at or near boiling. Table I shows the results of chemical analyses of these two wells performed by the U.S. Geological Survey in 1972. The results of more recent analyses by the USGS are shown in Table II. A gas analysis of the Schmitt well indicates a relatively small amount of non-condensable gases present: Methane 0.25%, Carbon dioxide 0.84%, Ammonia 1 ppm.

2.7 Recreation

Developed recreation areas in the vicinity of the drill site are almost nonexistent, consisting of the Pomerelle Ski Area west of Malta in the Albion Mountains and picnic and camping areas in the mountains of the Jim Sage, Cotterell, and Raft River ranges. During the summer and fall months, hunters, hikers, and campers are fairly numerous in the valley.

2.8 Archeological and Historical Sites or Areas with Special Aesthetic Value

Only two sites in the region are listed in the National Register of Historic Sites and Monuments: the City of Rocks and Granite Pass. The latter is located in the Raft River Narrows west of the drill site. The City of Rocks, west of Almo, has just recently been designated a National Historic Site. This site can be reached by way of the Narrows road, but the main access is from Malta through Elba and south to Almo.

* In the State of Idaho, a geothermal resource is not considered a water resource and the drilling of geothermal wells is not affected by this moratorium. Furthermore, testing of the wells and operation of the test loop will generally be a non-consumptive use of water, with all the produced water being reinjected into the second well.

The Kelton Road Historic Trail travels north from the Utah-Idaho border, passes through the Narrows approximately 7 miles to the west of the drill site, and crosses the California Trail southwest of Almo. The Earncliff Post Office, a stagecoach station on the Kelton Road, was located 10 miles west of the site.

No archeological sites have been discovered to date in the vicinity of the drill site; however, as the City of Rocks was at one time an Indian ceremonial ground, there is a chance that future exploration could yield archeological information of considerable value.

There is general lack of succulent vegetation, rushing mountain streams, and lakes. Scenic vistas in the area are limited to unique geologic structures and formations. Hence, the aesthetic value of the area in the usual value sense is not rated as being extraordinary.

Table I

Chemical Analyses of Hot Wells in Raft River Valley
(Chemical Constituents in Milligrams per Liter)

	Schmitt	Crank
Reported Well Depth (ft.)	414	540
Discharge (gpm)-reported, and variable	58	60
Temperature (°C)	93	90*
Silica	90	97
Calcium	53	130
Magnesium	0.4	0.4
Sodium	560	1,110
Potassium	22	35
Bicarbonate	55	36
Carbonate	0	0
Sulfate	57	61
Phosphate	0	0.01
Chloride	900	1,900
Fluoride	5.7	14
Nitrate	0.54	0.57
Dissolved Solids (Calculated)	1,720	3,360
Dissolved Solids (tons per acre-ft)	2.34	4.57
Hardness (as CaCO ₃)	130	330
Hardness (Non-carbonate)	89	300
Specific Conductance	3,050	6,090
pH (field)	7.4	7.7
Alkalinity (as CaCO ₃)	45	30
Percent Sodium	88	87
Sodium Absorption Ratio	21	27

* Measured temperature is probably lower than at point of discharge

Table II
Chemical Analyses of Hot Wells - Specific Elements
(in ppm except as indicated)

	Schmitt	Crank
Mercury (ppb)	<0.1	<0.1
Silver	<0.02	<0.02
Gold	<0.01	<0.01
Cadmium	<0.01	<0.01
Cobalt	<0.05	<0.05
Copper	0.02	0.02
Nickel	<0.05	<0.05
Lead	<0.06	<0.06
Zinc	0.02	0.02
Arsenic	0.003	0.001
Antimony	<0.2	0.2
Iron	<0.02	<0.02
Manganese	0.02	0.02
Strontium	1.4	2.8

3.0 ENVIRONMENTAL IMPACTS

Due to the nature of the geothermal resource involved, the existing uncertainties about its specific characteristics and their effects on the resource development, there is ostensibly a potential for resultant deleterious impacts of sufficient magnitude to warrant general concern. However, closer examination shows that nearly all of these impacts can, through design and operational considerations, be mitigated or controlled. All feasible precautions will be taken to prevent the waste or partial destruction of either the geothermal resource or the other resources of the land involved.

The potential for contamination of either the surface or ground water is probably the most important item to be considered. Water has been termed Idaho's "lifeblood" and certainly forms the economic base for the Raft River Valley. Because of the delicate balance which exists between agricultural operations in the valley and the critical water situation, water contamination could have far-reaching effects.

The ponds constructed on the drill site for containing waste fluids and drilling muds will reduce the chances of surface water contamination resulting from contacts with these substances. The drilling mud, a kaolinite slurry, is designed so that it will not seep into the adjacent soil. Drill tailings and chemical precipitates will hinder waste fluids from seeping out of the reserve pond. In addition, the drill site will not be located at a topographic position where it might be affected by runoff which could conceivably alter holding capacity of the pond and pits. The possibility of spills of fuel resulting from tank leakage or rupture is minimal. The distance from the site to the Raft River is such that a spill would be negated before it could affect the waterway.

The collection tank and all piping connected with the proposed test loop will be designed to minimize the chance of leakage or rupture which could lead to surface water contamination from either the geothermal fluids or those secondary fluids to be used in the heat exchanger components (freons and hydrocarbon fluids have been suggested as possible secondary fluids for use in geothermal power production). In addition, all structures will be periodically

monitored to detect leakage. The test loop branches will have check and isolation valves installed to facilitate separation from the system should repair be necessary.

Surface casing will be placed and cemented for the express purpose of preventing contamination of ground water during drilling and testing of the well and subsequent operation of the production-reinjection loop. The current design calls for 900 ft of surface casing, which should effectively block off the cold water aquifer. If not, additional casing will be used. The production casing in the rest of the hole should prevent any interaction between the well and the surrounding formations.

The hazard of a blowout presents another potential environmental impact. Drilling methods and well design have advanced to a point where the chance of an uncontrolled blowout has been minimized. The well head will be fitted with a blowout preventer stack to insure control of the well during drilling operations. Casing will be securely placed and cemented to prevent a blowout created by faulty casing material. All equipment will be inspected periodically to facilitate early detection of any deficiencies which would eventually lead to well casing failure. (It should be noted that the geothermal fluid temperatures will not exceed 300°F, for which the saturation pressure is 56 psig at this elevation. Thus, the problem of pipe or equipment rupture from pressure is much less severe than is commonly considered in the operation of geothermal power plants today.)

All land that is cleared or excavated in conjunction with the drilling program will be backfilled, levelled, and seeded to restore the site to as near a natural state as is possible. All materials, machines, structures, and equipment will be removed from the site and waste material disposed of at a county landfill. Chemical toilets will be serviced weekly by a commercial firm and no sewage will be disposed of at the drill site. If the well is to be used for reinjection purposes, it will also be appropriately capped, flanged, and valved.

The presence and movement of vehicles, equipment, and personnel will result in a minor disruption of normal activities, therefore presenting a hazard to people in the area. Access to the drill site itself will be limited

to authorized personnel and State and Federal safety regulations regarding well drilling and construction activities will be enforced. Precautions will be taken to insure that people on the site are not exposed to dangerous situations. The scarcity of people in the valley should minimize the effects of any hazards which do exist. However, the reserve pond for drilling fluids will be fenced with barbed wire to prevent large domestic or wild animals (or man) from inadvertently stepping into the pond.

Drilling the well with associated sounds from power sources and the racking of drill pipe will be the principal sources of noise at the site. These noise emissions will be comparable to normal construction operations and will be controlled as much as is possible. Again, because of the scarcity of inhabitants in the vicinity, this impact will be minimal.

Wildlife in the area will be disturbed due to the presence of people and equipment and the noise from the drilling operation. The Ferruginous Hawk (Section 2.5) in particular is believed to be especially vulnerable to manmade activity during its nesting period (usually between March and May). Drilling is expected to terminate in March. Bureau of Land Management wildlife habitat records indicate that the nearest Ferruginous Hawk nesting habitat is 6 miles Southeast of the site. However, if it is determined that nesting sites or mating activities may be adversely affected, steps will be attempted to mitigate the conflict. It is not expected that the overall disturbance to other forms of wildlife and their habitats will be significant, but care will be taken to minimize any disturbances which do occur.

Following well completion, testing will ensue with geothermal fluids being withdrawn. There could be a release of some obnoxious gases accompanying this withdrawal (noncondensable gases, Section 2.6). Tests previously conducted do not indicate that these gases will occur in sufficient quantities to constitute a problem. If, however, these indications are in error, efforts will be made to control the gas emissions. Vehicle exhaust emissions will constitute another source of air pollution. Due to the limited number of vehicles (6) and travel restricted to business purposes, the increase over ambient conditions will be negligible. Exhaust emissions from the drilling

rig will originate from three 500 (rated) HP engines. Typically, two engines will be operating. These exhaust emissions will persist virtually continually during the drilling operation and cease thereafter.

Whenever fluids are withdrawn and not reinjected, there is a possibility that subsidence will occur. In this case, the limited quantity of fluids to be withdrawn during initial testing of the well (about 1.5 acre-feet) makes subsidence highly unlikely. Stresses resulting from the withdrawal and reinjection of larger quantities of fluids during operation of the test loop are not expected to induce significant ground motion (under normal operation, approximately 6,000 acre-feet could be expected to be cycled through the test loop over a five year period). The area will be monitored both during drilling and during operation of the test loop, if it is installed, and any unusual ground motion will result in a halt of operations until the situation can be evaluated.

It is recognized that the remoteness of the drill site has been used in many cases as the basis for declaring impacts minimal. If, in fact, this remoteness does not minimize those impacts, controls will be instituted which will.

In summary, probable environmental alterations associated with the drilling of the deep test well may be at least partially mitigated, resulting in a minimum overall impact to the area.

4.0 ALTERNATIVES

4.1 No Action

The choice to discontinue research efforts into the utilization of geothermal resources is a feasible alternative, one that will result in no detrimental environmental effects to wildlife or to the land. However, it is one course of action that proponents of geothermal power naturally do not consider to be a wise one because it effectively stops any advancement in the field of geothermal energy. There would be a consequent environmental effect on man from not developing new energy resources.

4.2 Alternate Site

The proposed drill site was selected because it offered the best chance of attaining the resource with a minimum amount of time and effort, and maximum results. There is always the possibility that the chosen site is not in reality the best site. However, if all indications point to a given site, drilling elsewhere only increases the risk of the well not being productive and that it will have to be abandoned. Alternate sites in the area appear to have either a similar or a more significant environmental impact than that of the selected site.

4.3 Alternate Methods of Exploration

One of the goals of the geothermal effort in the Raft River Valley is to find out as much about the existence of the geothermal resource as possible using available proven exploration techniques. Surface geophysical and geochemical exploration techniques and extensive geological surveying have been carried out more fully than is customary in a developmental program for harnessing a geothermal resource. Even techniques of limited or unproven value have been employed on the chance that later some of this information may yield useful conclusions. Surface exploration in the immediate area has hence been carried to the nominal scientific limit for current state-of-the-art. Deep drilling is the only known method to expand the information and test its reliability.

In this instance, at least half of the research efforts have goals which extend beyond the existence or nonexistence of a resource. For these efforts, access to the resource, if it exists, is necessary and this can only be accomplished by drilling a well.

5.0 ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

The primary unavoidable adverse effect of the drilling program will be the disruption of normal human and wildlife activities in the area by the presence of the drilling operation itself, the movement of people and equipment, and noise associated with the operation. Proper program management and control should alleviate many of the conflicts which may arise, although maximal efforts would not be successful in totally integrating the drilling operation into the current setting of the area. Due to the short time estimated for the completion of the exploratory drilling project, the disruptions should not be extensive nor have a lasting effect on the area or its inhabitants.

The construction of access roads, the clearing and grading of the drill site, and the excavation of the reserve and mud pits constitute a change in the landscape which cannot feasibly be avoided. However, this change can be partially counteracted through efforts to restore the site following completion of the drilling program or abandonment of the well.

The other effects covered in Section 3.0 will not be considered here because they are capable of being mitigated to minimize or avoid their impact.

6.0 RELATIONSHIPS BETWEEN THE SHORT-TERM USE OF THE ENVIRONMENT AND
THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The development of geothermal resources is still a relatively new science, thus geothermal research efforts can, in that sense, be considered beneficial and productive. As such, the drilling program and operation of the test loop will not only provide information about the geothermal resource in the Raft River Valley, but will also serve as an evaluation of the feasibility of current hydrologic and geologic exploration methods and provide a means by which to test existing components and to design for more applicable ones.

Commitments of labor, capital, and equipment plus nearly all impacts associated with the project are short-term in nature, occurring only until completion of said project. Therefore, with the exception of the land disturbance, there will be no long-term detrimental impacts which need to be weighed against the benefits to be derived from either the well drilling or the test loop operation.

Much could be said here about the need for development of new power sources to supplement or replace existing energy sources and boost general productivity. However, since this document does not address the environmental impact of power production, similarly neither the need for development nor its benefits will be used to support the drilling program in this document.

7.0 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Besides the construction materials, manpower, and power used during drilling, all of which are in a broad sense renewable, the only irretrievable commitments of resources would be the heat (the actual geothermal resource) lost in the disposal of fluids during testing of the well and the consumptive use of ground water. In both cases the quantities involved will be small.

As revegetation is a very slow process in this type of desert environment, scarring of the land is almost impossible to avoid. Therefore, any change in the natural characteristics of the land surface either through clearing or through grading and excavation can be construed as irreversible, since it will be impossible to return the site exactly to its original natural condition. The wells themselves could be considered an irreversible impact because it would be impractical to return that ground to its original condition.

8.0 COST-BENEFIT ANALYSIS

The total cost of drilling the two deep test wells and associated activities is expected to be approximately \$1,250,000. The current projected cost for the design, installation, and operation of the test loop for five years is \$300,000. For these expenditures, it is felt that the cost to the environment of the Raft River Valley will be minimal.

A significant portion of the money involved in both the test well and test loop projects will be funneled into the economy of the Raft River Valley through increased jobs and services to be provided. Drilling of the test wells will provide a means for evaluating the results of the hydrological, geophysical, and geochemical surveys which have been performed in an attempt to construct a model of the geothermal resource and will also provide the access to the resource which is the prerequisite to the long-range program goal of demonstrating the feasibility of developing and using low-temperature geothermal resources for power production and non-electric purposes. The test loop will provide a means by which to test existing component design and function in a "geothermal environment" and to collect data on which to base new designs.