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MAGIC RESOURCE INVESTORS
P. O. BOX 1328
SUN VALLEY, IDAHO 83353

CONFIDENTIAL

September 15, 1980

Ms. Nina Ussery, SEP Secretary
Department of Energy
Idaho Operations Office
550 Second Street, Room No. 119
Idaho Falls, Idaho 83401

Re: SCAP No. DE-SC07-80ID12139, User-Coupled Confirmation Drilling Program

Dear Ms. Ussery:

Our proposal for a cooperative agreement award under the User-Coupled Confirmation Drilling Program is submitted in ten copies as required by the SCAP. Separate volumes are provided for the technical and business proposals.

We appreciate DOE's interest in involving industry in the development of energy resources. In order to assure a strong technical and management team for this effort, Magic Resource Investors proposes to subcontract most of the work to Gruy Federal, Inc., a small business firm that has performed a significant amount of geothermal work for DOE.

In submitting this proposal we have utilized the proposal check list provided with the SCAP and have fully considered amendment No. 001, dated July 16, 1980. This proposal is valid for 200 days as specified in the SCAP.

Since Gruy Federal has been involved in developing the proposal, please feel free to contact Mr. Jack Duree with technical volume questions or Mr. Gayland Daugherty with business volume questions. They may be reached at 713/785-9200.

I will be responsible for all negotiations and company commitments arising from this proposal. My telephone number is 208/726-8241.

Sincerely,

Jerold R. Kirkman
General Manager

JRK/jr

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VOLUME I - TECHNICAL PROPOSAL
SUBMITTED TO THE
DEPARTMENT OF ENERGY
IDAHO OPERATIONS OFFICE

USER-COUPLED CONFIRMATION DRILLING PROGRAM
SCAP No. DE-SC07-80ID12139

Copy No. 7 of 10

Date of Submission September 15, 1980

MAGIC RESOURCE INVESTORS
Name of Organization (principal participant if a team of organizations)

Profit (partnership)
Organizational Classifications

P.O. Box 1328, Sun Valley, Idaho 83353
Address of Organization

Magic Hot Springs Landing User-Coupled Confirmation Drilling Project
Title of Proposed Project

Maximum Funds Requested from DOE $1,088,395

Total Cost of Project Through Flow Testing $1,209,328

Location of Site Magic Hot Springs Landing, Blaine County, Idaho

Proposed Project Duration (in months) 14

Proposed Starting Date January 15, 1981

Project Manager Jack T. Duree

Position and Title Senior Managing Engineer

Telephone (w/ area code) 713/785-9200

Permission for Outside Evaluation Yes x No ____

This proposal is for drilling a(n)

Production Well x Injection Well ____ Other x

(Check other if for only testing a well).

Flow Testing is Referenced on Page 130.

Variable Cost-Share Plan is Referenced on Page 132.

Statement of Intent is Referenced on Page ii.

2. STATEMENT OF INTENT

DESCRIPTION OF PROPOSED FUTURE DEVELOPMENT

Briefly describe below your proposed end use for the geothermal resource should a successful geothermal well be drilled. Include in your description the following information:

a. Location of the utilization facility.

b. Description of the end use of the geothermal fluid and the utilization facility.

c. Whether or not you will sell the energy to other users.

Magic Resource Investors, a California partnership, with J.R. Kirkman a General Manager and Western Resource Recovery Inc. with Henry Schutte President propose to develop Magic Hot Springs, located at the north end of Magic Reservoir in Blaine County, Idaho, as follows:

A two million gallon per year ethanol plant would be constructed and put into operation. The heat requirements for the ethanol production process would be provided by geothermal fluids discovered as a result of drilling at the site. The ethanol plant would also be capable of producing a by product known as Distillers Dried Grain (DDG). Further development might include but would not be limited to greenhouses, aquaculture (catfish) and silvaculture (evergreen)

It is not contemplated that energy would be sold to other users.

If is further understood that the above proposal is contingent upon the demonstrated availability of geothermal fluids at the desired temperature (150 C), flow rate (675 GPM), and chemical composition. And also that the economic climate at the time of proving of the well is such that the development would be warrented.

Signed ______________________
Proposer
J.R. Kirkman
Magic Resource Investors

Signed ______________________
Potential User
Henry W. Schutte
Western Resource Recovery Inc.

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3. SUMMARY

The objective of the Magic Hot Springs Landing user-coupled confirmation drilling project is to establish the geothermal resource adequate to provide the energy requirement of a 2-million-gallon-per-year ethanol distillation plant. The project is located at Magic Hot Springs Landing, Blaine County, Idaho.

To be a success, the confirmation well must produce a minimum of 675 gallons per minute water at 280°F. The water will be cascaded through multiple uses in future development of an industrial park, but a single end-use ethanol plant is the basis for feasibility projections for the project.

Magic Resource Investors is joined in this proposal by two private investors, Messrs. Robert Gorham and John Wedum. All required work will be performed by Gruy Federal, Inc. under a cost-plus-a-fixed fee subcontract arrangement. Gruy Federal has an extensive background in performing contracts for DOE, including geothermal work. They will directly provide engineering, supervisory, and administrative services and provide for required field services by placement and management of subcontracts.

Magic Hot Springs was originally a thermal spring but now is an artesian well flowing 66 gal/min of 165°F water. It discharges directly into Magic Reservoir. The water quality is such that no disposal well is foreseen or included in the plan. If one becomes necessary, it will be subject to negotiation.

Geological evidence indicates that this spring and most others in the area are controlled by faults and/or fracture zones. Evidence also indicates that the Magic Hot Springs locale is the intersection of at least two fault systems.

Geochemical geothermometers indicate that the Magic Hot Springs waters have been at higher temperatures than other thermal waters in the area. Other data indicate the water may have reached temperatures as high as 392°F.

The technical plan for the project consists of an exploration program to provide field confirmation of faulting, geophysical surveys to locate the faults in the subsurface, three temperature gradient holes to provide three-dimensional heat flow data, and selection of an optimum drill site for the confirmation well. The preliminary drilling, logging, and testing programs provide for a 3,000-foot production well with downhole logging and flow testing to meet DOE specifications and provide data for determining the cost-share payment.

4. CONTENTS

NOTE: Sections of this proposal are numbered to correspond with the topics listed under "Volume I - Technical Proposal," page 7 of the SCAP.

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(continued)

FIGURES

FIGURES
(continued)

TABLES

5. RESOURCE POTENTIAL - TECHNICAL AND ECONOMIC FEASIBILITY

5.a GENERAL DESCRIPTION OF TOTAL PROJECT

The objective of the User-Coupled Confirmation Drilling Project is to prove up and prepare for commercialization the geothermal resource known to exist at the Magic Hot Springs site located on the north end of Magic Reservoir, Blaine County, Idaho.

The Magic Hot Springs area is in northwestern Blaine County, Idaho, (Fig. 1) near the center of the four-county area of Blaine, Camas, Gooding, and Lincoln counties in south central Idaho which comprises the Wood River Resource Area (WRRA).

The Hot Springs area is named for a historic artesian hot spring near the north end of Magic Reservoir (Fig. 2). It is conveniently accessible by state highways 68 and 75 (U.S. 93).

Magic Reservoir, on the Big Wood River, is located within Blaine County but supplies irrigation water for farm lands primarily in Lincoln County to the south. It is also a major recreation area which is used for boating and fishing in the spring, summer, and fall. The Hot Springs boat landing is the major access point for recreational users of the reservoir.

The land surrounding the reservoir and Hot Springs Landing is typical of high desert rangeland of the Snake River Plain. It is sparsely populated and is primarily used for grazing and recreation.

In and around Magic Hot Springs Landing, Magic Resources Investors (MRI) have assembled a block of fee land containing approximately 212 acres (Fig. 3), and have filed applications with BLM for leases on an additional 1,960 acres.

The topography at Hot Springs Landing and northward is gentle to moderately rolling, and level to rolling along the shores of Magic Reservoir to the

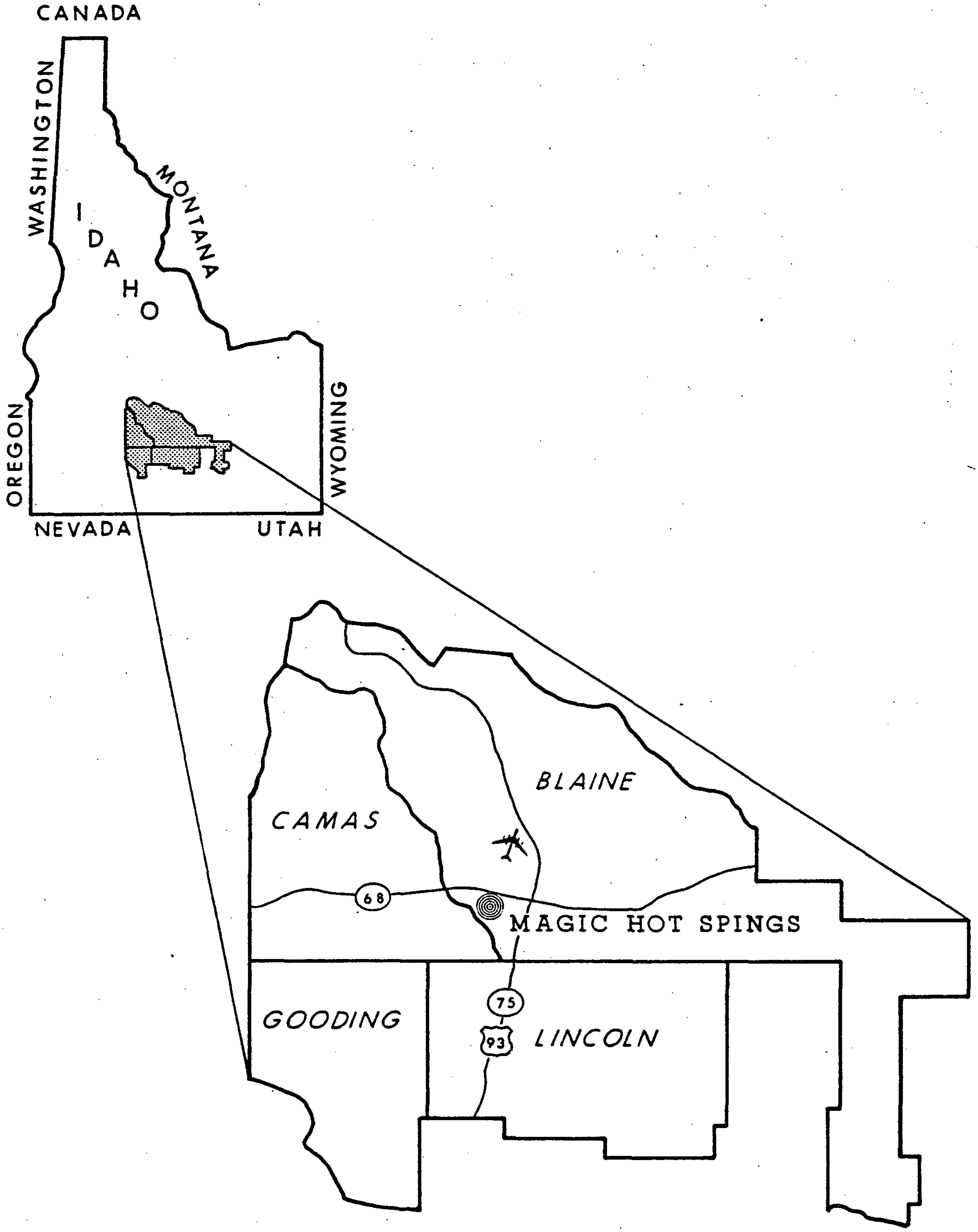


Figure 1--Location map of Magic Hot Springs in four-county Wood River Resource area, south-central Idaho.

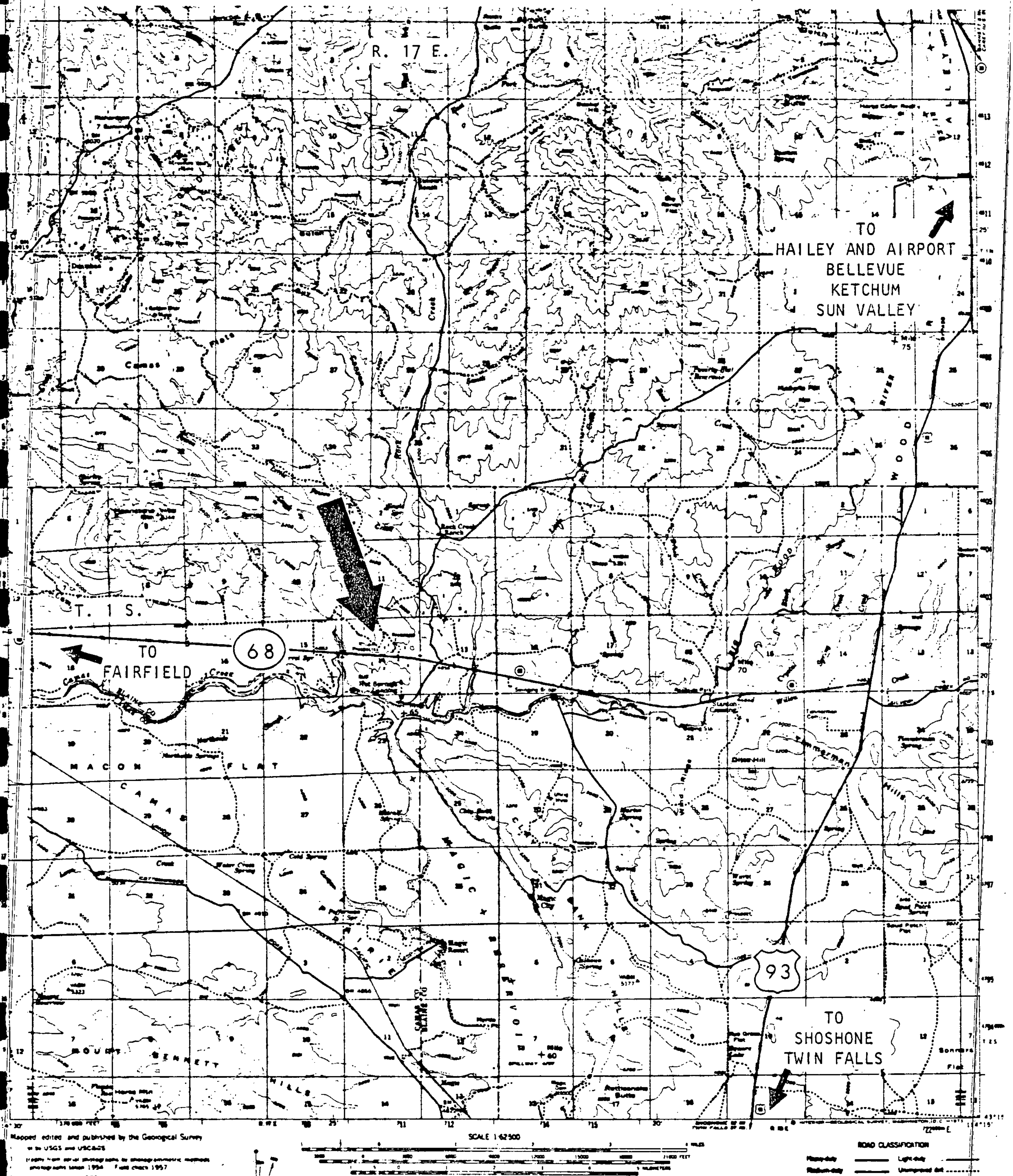


Figure 2--Location of Hot Springs Landing area of interest at north end of Magic Reservoir and confluence of Big Wood River and Camas Creek, Blaine County, Idaho.

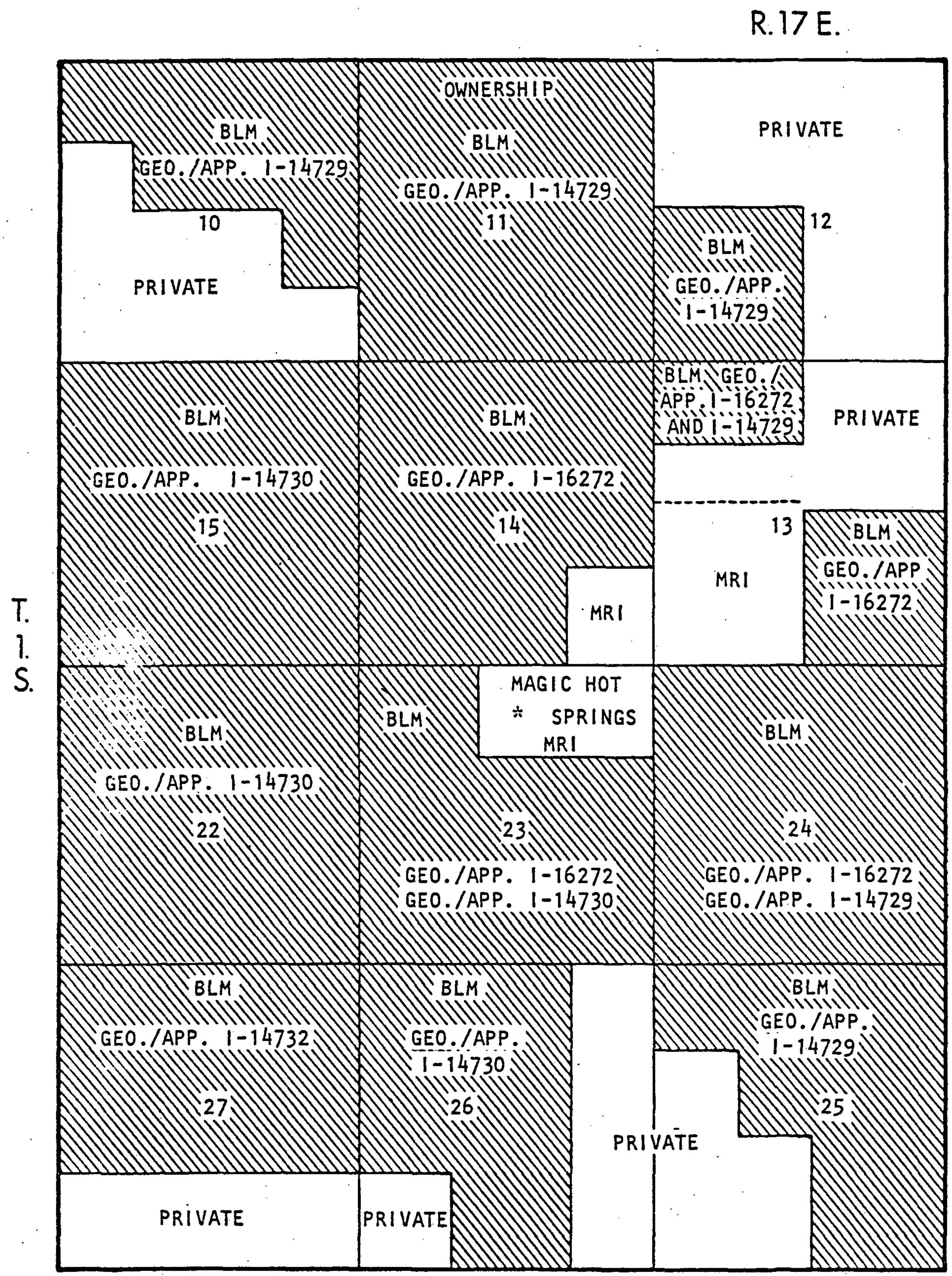


Figure 3 -- Plat of MRI applications for BLM leases and sections containing MRI fee land.

south. Elevations in the immediate area average approximately 1524 meters (5,000 feet).

As summarized in Table 1, the climate at Magic Reservoir is semi-arid with warm summers and moderate winters. Like the topography, the climate is within a transition zone between the Snake River Plain to the south and the intermountain valleys and foothills of the Smoky Mountains to the north, thence northward into the rugged Bitterroot Mountains.

The four counties immediately surrounding Magic Hot Springs have a 1980 population estimate of 23,900, of which 44 percent resides in Blaine County. Blaine County's population is concentrated along the Wood River between Ketchum and Hailey. The other counties in the Wood River area are rural in character with Gooding County accounting for 38 percent of the population, Lincoln County 14 percent, and Camas County 4 percent.

The population growth of Blaine County is greater than the other counties. Between 1960 and 1970 Blaine County gained 39 percent in population, while the other three counties lost 29 percent. Between 1970 and 1980 Blaine County had an estimated population increase of 80 percent while the other three counties have estimated increases of less than 5 percent. Population forecast for the four counties is shown in Table 2.

Table 2
Wood River Area
Population Forecast (1978)

	1970	1975	1980	1985	1990	1995	2000
Blaine	5,740	7,750	10,390	12,100	14,090	16,500	19,370
Camas	720	860	940	940	860	770	750
Gooding	8,640	8,350	9,110	9,780	10,280	10,460	10,670
Lincoln	3,050	3,020	3,460	3,320	3,160	3,170	3,250

TABLE 1

CLIMATOLOGICAL DATA FOR MAGIC RESERVOIR HOT SPRINGS

Station	Hailey	Fairfield	Richfield
Elevation (feet)	5,328	5,065	4,306
Years of record	59	20	44
Average daily temperature (°F)			
January minimum	6.7	3.21	11.1
January maximum	30.6	27.6	29.9
July minimum	49.5	46.0	50.7
July maximum	86.5	84.6	87.4
Lowest temperature of record	-36	-38	-40
Highest temperature of record	109	100	105
Average annual days			
Maximum of 90° of more	19	13	19
Minimum of 32° or less	191	211	188
Growing season*	94	68	105
Average precipitation (inches)			
Annual precipitation	14.53	15.64	9.64
Annual snowfall	88.5	83.2	35.4
January precipitation	2.11	2.91	1.41
July precipitation	0.41	0.25	0.26
Average annual number of days with precipitation			
0.10 inches or more	40	44	39
0.50 inches or more	8	10	6
Degree days	8,070	8,575	7,306

*The average number of days between mean last 32°F Temperature in spring and mean first 32°F in fall--that is, the average freeze-free period.

Source: Idaho Climatological Summary Data by Counties. National Weather Service Climatology in Cooperation with the Idaho Department of Commerce and Development, Boise, October 1971.

Agriculture is the major industry of the area. Blaine County's economy is dependent on agriculture and recreation. Camas, Gooding, and Lincoln Counties are economically dependent on agriculture. Approximately half of the cropland produces hay; most of the remainder produces grain and potatoes, with small percentages in other crops such as barley, silage, and sugar beets. Livestock and livestock products account for a large share of farm operations. Grazing permits on public lands are an important part of most ranch operations. Grazing land is primarily in federal ownership and includes approximately 82 percent of the landin the four-county area.

Hot Springs is also located within the eastern portion of an area designated as the Camas Prairie geothermal area because of the large number of hot springs and the geothermal resource potential.

With the highest surface temperature of any well in the Camas Prairie Geothermal Area, Magic Hot Springs has been the subject of several studies that document the presence and potential of the resource. Noteworthy among these is Idaho Department of Water Resources Water Information Bulletin No. 30, Part 7, Geothermal Investigations in Idaho, "Geochemistry and Geological Setting of the Thermal Waters of the Camas Prairie Area, Blaine and Camas Counties, Idaho." This study (Mitchell, 1976) reports a marked difference in chemistry between Magic Hot Springs and other thermal waters of the Camas Prairie. This chemical difference indicates that Magic Hot Springs thermal waters have been at higher temperatures than other thermal waters of the area, or that the reservoir rocks for Magic Hot Springs are chemically or mineralogically different from the thermal aquifers in the Camas Prairie. Table 3 lists the water chemistry of Magic Hot Springs.

U.S. Geological Survey Circular 790, Assessment of Geothermal Resources in the United States, 1978, (Muffler, 1978) shows that the Magic Reservoir area has significantly greater resource potential than that of other geothermal areas in the Wood River Resource Area. Circular 790 reports an estimated mean reservoir temperature of 149°C (300°F) which is of the same order of magniture as the known reservoir temperatures at the Raft River Geothermal Test Site.

TABLE 3

CHEMICAL ANALYSIS OF MAGIC HOT SPRINGS
(Chemical Constituents in milligrams per liter)

Sample Collection Date	7-21-72
Discharge (GPM)	250
Temperature (°C)	72
Silica (Si)	105
Calcium (Ca)	20.0
Magnesium (Mg)	0.10
Sodium (Na)	321
Potassium (K)	23
Bicarbonate (HCO_3)	735
Carbonate (CO_3)	0
Sulfate (SO_4)	54
Phosphate (P)	.01
Chloride (Cl)	85
Fluoride (F)	10
Nitrate (NO_3)	.56
TDS	1,213
pH	6.9

Source: Idaho Department of Water Resources
Bull. 30, Part 9, 1979.

The discharge of Magic Hot Springs well (Mitchell, 1976) is approximately 250 liters per minute (66 gal/min). Ross (1976) reports that before drilling, the original warm spring discharged approximately 492 liters per minute (130 gal/min). Reliable geochemical thermometers indicate subsurface temperatures of 115°C to 150°C (239°F to 300°F).

As shown in Table 4, Magic Hot Springs water also shows a marked difference in chemistry relative to Guyer, Clarenden, and Hailey Hot Springs to the north. The proximity of Magic Hot Springs to Magic Reservoir could mean a possibility of mixing of the thermal with nonthermal waters. Because the well at Magic Hot Springs is cased only to a depth of 12.5 meters (41 feet), leakage from Magic Reservoir is very likely entering the thermal conduit system that supplies the well. Mitchell (1976) considered this condition and developed a mixing model calculation which indicates that the hot water component of this mixed water may have reached temperatures as high as 200°C (392°F) with cold water making up 70 percent of the total.

Even if mixing is not taking place, the geochemical geothermometers listed in Table 4 indicate higher aquifer temperatures at Magic Hot Springs than at Guyer or Clarenden.

The geological center of the Hot Springs hydrothermal system remains untested in spite of the fact the location clearly has great geothermal resource potential.

The first phase in developing the full potential of this known geothermal resource, as defined by MRI's response to SCAP No. DE-SC07-80ID12139, is the design and completion of an engineering and geological program to (a) conduct a detailed exploration study of the fault systems, using field geology and supporting data such as aerial photos, a detailed geophysical survey, and a network of thermal gradient measurement holes; (b) drilling and logging of a 3000-foot confirmation test well to assess the geothermal resource at depth; and (c) flow testing of that confirmation well over a period of time and in a manner sufficient for quantitative and qualitative evaluation of the resource with respect to initial primary use.

TABLE 4

GEOTHERMOMETER TEMPERATURES

Springs or Well Identification	Discharge l/m	Known Temp. °C	Aquifer Temperature Predicted by Geochemical Thermometry, °C* T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
Guyer Hot Springs 4N 17 E 15 aac	1,000	71	128	125	9	101	88	88	64	88
Clarenden H. S. 3N 17 E 27 deb	100	47	125	122	6	97	87	45	53	87
Hailey Hot Springs 2N 18 E 18 dbb	70	59								
Magic Hot Springs Landing 1 S 17 E 23 aab	10	72	139	135	19	113	174	172	148	99

T_1 = Silica temperature assuming quartz equilibrium and conductive cooling (no steam loss)

T_2 = Silica temperature assuming quartz equilibrium and adiabatic expansion at constant enthalpy (maximum steam loss)

T_3 = Silica temperature assuming equilibrium with amorphous silica

T_4 = Silica temperature assuming equilibrium with chalcedony and conductive cooling (no steam loss)

T_5 = Na-K-Ca temperature

T_6 = Na-K-Ca temperature corrected for PCO_2

T_7 = Na-K-Ca temperature corrected for Mg

T_8 = Na-K temperature

Source: Idaho Department of Water Resources
Bull. 30, Part 9, 1979

The engineering/geological program and supporting economic data is the subject of this proposal. It is described in detail in appropriate sections herein.

The geothermal fluid will be initially utilized by an ethanol plant with a capacity of 2 million gallons per year. MRI intends to begin commercialization of the geothermal resource and initiate an industrial park development by constructing the ethanol plant with private capital. This plant could be followed by a series of secondary uses after primary users have extracted the high-temperature energy.

MRI considered other locations in the Wood River Resource Area for developing industrial park and recreational facilities, but selected the Hot Springs area because its geothermal and geological characteristics are very promising for development of a high-grade geothermal resource.

Geological evidence from all surveys indicates one or more series of faults passing through or intersecting in the area immediately north of the Magic Reservoir.

The relationship of faults and springs (including hot springs) in the hilly and mountainous regions is well recognized. Several hot springs to the north are aligned with a north-trending linear fracture that passes through Magic Hot Springs. Other linear features occur, with springs, aligned in other directions. Every indication is that these are surface expressions of fault systems that control the circulation of thermal waters.

Any possible large thermal reservoir at Magic Reservoir is probably structurally controlled by large faults. Fracture permeability may allow sufficient circulation and recharge to allow large volumes of water if the fault system can be penetrated by drilling. The thermal water geochemistry and drilling history, as well as the young volcanic geology at Magic Hot Springs, shows definite promise of hotter water with deeper drilling.

Igneous rocks from Cretaceous through Holocene age occur in and around the granitic area, providing several heat sources at various depths. These rocks range in composition from granitic to basaltic, and in texture from granitic to rhyolitic.

A heat flow of 3 HFU, which is twice the normal (1.5 HFU) for the United States, is typical of this area (Brott and others, 1976). This high heat flow is typical of the granitic Idaho batholith (Blackwell, 1973) and is high enough to indicate that thermal waters could be reaching maximum temperatures, as predicted by geochemical thermometry, through deep circulation.

The heat flow in the Magic Hot Springs area may be related to Cretaceous granitic rocks of the Idaho batholith, which are known to underlie younger volcanic rocks north of Magic Reservoir. High heat flow may also be due to the area's marginal position relative to the Snake River Plain. A buried stock or sill, perhaps related to the Holocene basalt flows south of Magic Reservoir, could conceivably underlie the area as a local high-intensity heat source (Mitchell, 1976).

Mitchell (1976) reports temperatures between 150°C and 200°C (300-392°F) might be found by deep drilling at Magic Hot Springs. Thermal waters may be circulating to depths approaching 1,800 to 2,500 meters along faults.

The MRI technical plan in this proposal includes a confirmation well (production test well) drilled to a depth of 3,000 feet at a location where it will intersect the largest number of deep fault planes or fractures. The confirmation well will be flow tested with pressure drawndown and buildup measurements sufficient to assess the geothermal potential in quantitative terms.

Magic Resource Investors and two individual investors bring to the proposed project a net worth of about $7 million. With this substantial worth no difficulty is anticipated in obtaining loans for the non-DOE-funded cost of the exploration, drilling, and testing program. Total cost of the program through testing is estimated in the vicinity of $1.2 million.

Following the reservoir confirmation tests in this proposal, and subject to their outcome, a 2 million gal/yr ethanol plant will be constructed with private capital on MRI acreage to utilize the initial heat energy in the geothermal waters. Since the primary use will not extract all of the energy from the geothermal fluid, this plant could be followed by other users in cascading use of the resource.

Assessment of an ethanol distillation plant as initial end user of the geothermal resource is favorable with respect to attraction of private capital and commitment of that capital to this project, on the basis of market determination, feedstock supply and cost, availability of feedstocks, by-product utilization and economic return, and the area's overall ability to support and maintain an ethanol distillation facility of one and two million gallons per year capacity.

Extensive research and discussion has gone into the financial and economic feasibility aspects of this proposal. As discussed in more detail in other parts of the proposal, there is a likelihood that the geothermal resource can be cascaded for several uses. However, the principal study has been limited to an ethanol plant. Income statements, cash flow projections, and loan amortization considerations have been developed assuming 25 percent and 50 percent discounts from equivalent No. 2 fuel oil cost. Obviously the return is better with the 25 percent discount and indicates payback in the range of three to five years.

The proposed plant facility consists of prefabricated units built by Rocky Mountain ethanol Systems, Inc. The design has already been tested and proved by operations in other locales.

5.b.(1) Geological Description of Resource

Magic Hot Springs was originally an artesian thermal spring flowing 97°F water at 130 gal/min. It now is an artesian well producing 165°F water at a rate of 66 gal/min, drilled to a depth of 260 feet and cased to about 41 feet. The presence of the hot spring has been known since earliest settlement of the area.

The produced water is relatively fresh, containing 1,215 ppm total dissolved solids including 85 ppm of chlorides. It is postulated to be a mixture of deeper geothermal water and seepage from Magic Reservoir.

Although a number of geological and geothermal resource studies have included the Magic Hot Springs site and Magic Reservoir area, detailed geology of the area is not well known. The Magic Hot Springs site is the highest temperature thermal well in the area, but the origins of its water are not proved, and the controlling geological structure and conditions are not tested.

On the other hand a sufficient volume of literature exists to provide grounds for opinions and hypotheses with high probability of accuracy.

Noteworthy contributions to this proposal are the publications by Walde (1959), Walde, Powers and Marshall (1963), Smith (1966), Mitchell (September, 1976), Bennett and Remker (1979), and USGS Water-Supply Papers 1478 (Smith, 1959) and 1609 (Walton, 1962).

In addition, Mr. John Anderson, Idaho Department of Water Resources, has carefully examined the area and shared his knowledge with MRI and GFI.

A comprehensive review of the geology and geothermal potential is reported in David W. McClain and William B. Eastlake (1980), Magic Hot Springs, Idaho, Site-Specific Development Analysis, Idaho Office of Energy, Office of the Governor, under DOE grant No. DE-FG51080RA50083, Region X office, Seattle, Washington.

Material from Mitchell (1976), Anderson, and McClain/Eastlake is used freely without further credit in this proposal.

Magic Reservoir is located in the northern edge of the Snake River plain adjacent to the southern border zone of the Idaho batholith. It lies, therefore, in a region of structural, stratigraphic, volcanic, and tectonic complexity.

The Idaho batholith, has an area of more than 16,000 square miles and is located just south of the convergence of two great arcuate segments of the Nevadan orogenic belt in eastern Idaho. It is composed mainly of quartz monzonite, with marginal facies to the south and southwest of granodiorite formed by alteration of the original rock by rising solutions rich in silica, potash, feldspar, biotite, and sphene. The batholith contains many younger intrusions believed to have been emplaced either at the close of the Laramide orogeny or in mid-Tertiary time.

The Snake River plain is possibly a rim syncline to the batholith. It is a region of widespread volcanism in the Miocene-Pliocene phase of Central Rocky Mountain development, and extensive basaltic intrusion and rhyolite flows during the Pliocene.

Multiple local and regional sources of sensible heat from hot rocks and radiogenic heat from younger intrusive rocks are postulated to exist in the Magic Reservoir area, although at unknown depths.

The generalized geology of the area west of Magic Reservoir is shown in Fig. 4, from Smith (1959). The stratigraphic section of the area is shown in Fig. 5, compiled from two sources, as indicated. The Magic Hot Springs site at the north end of Magic Reservoir lies within a generally north-south and thence southeasterly belt of early Tertiary extrusive and pyroclastic rocks (Tv, ranging in composition from rhyolite to basalt but here consisting of basalt) that occurs within or locally marginal to older pre-Tertiary rocks (pre-T) of the batholith. Compare the rock symbols in sections 2, 11, 14, and 24 to those in sections 12 and 30.

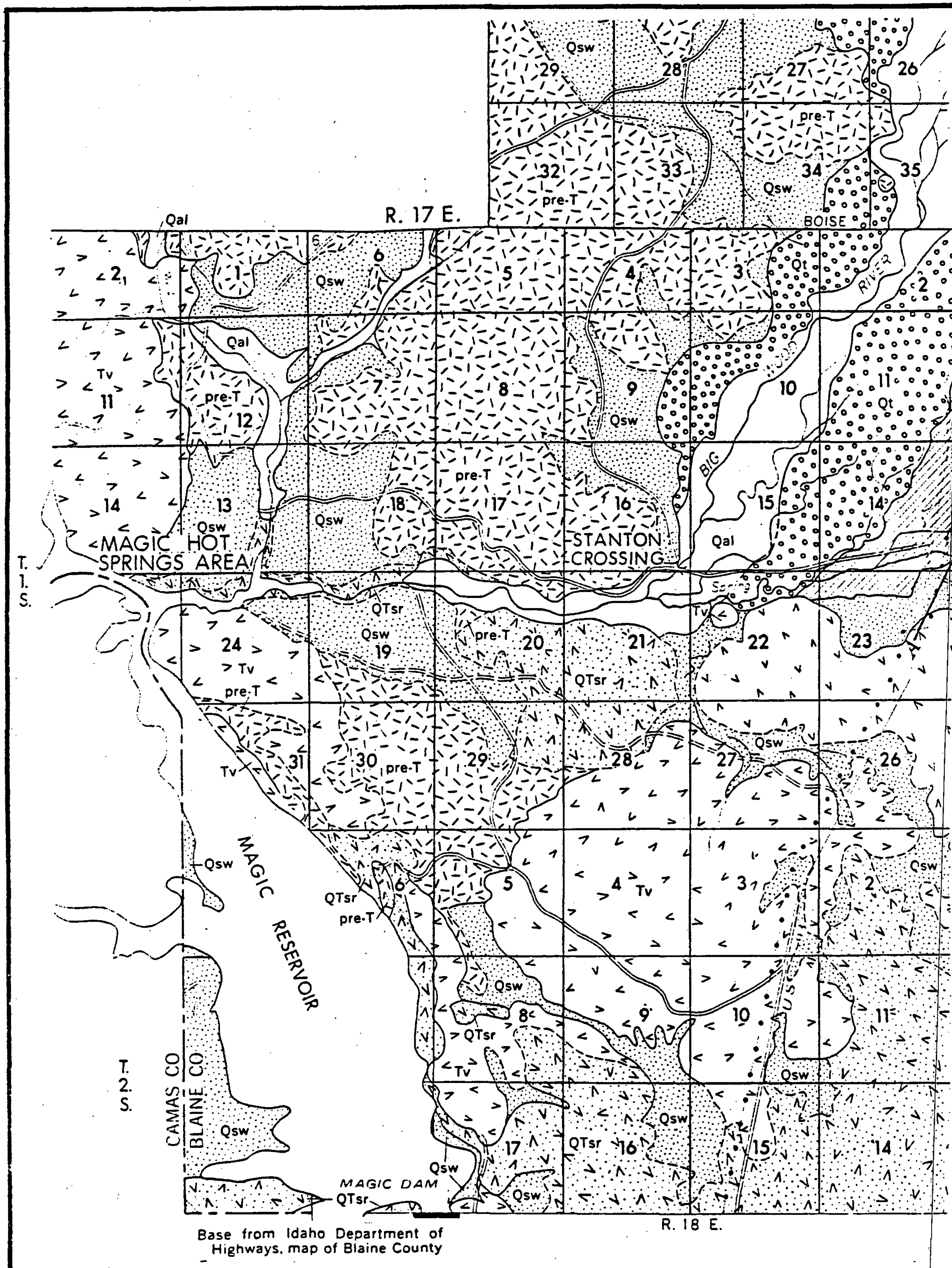


Figure 4 --Generalized geology of western portion, middle Big Wood River - Silver Creek area, Blaine County, Idaho.

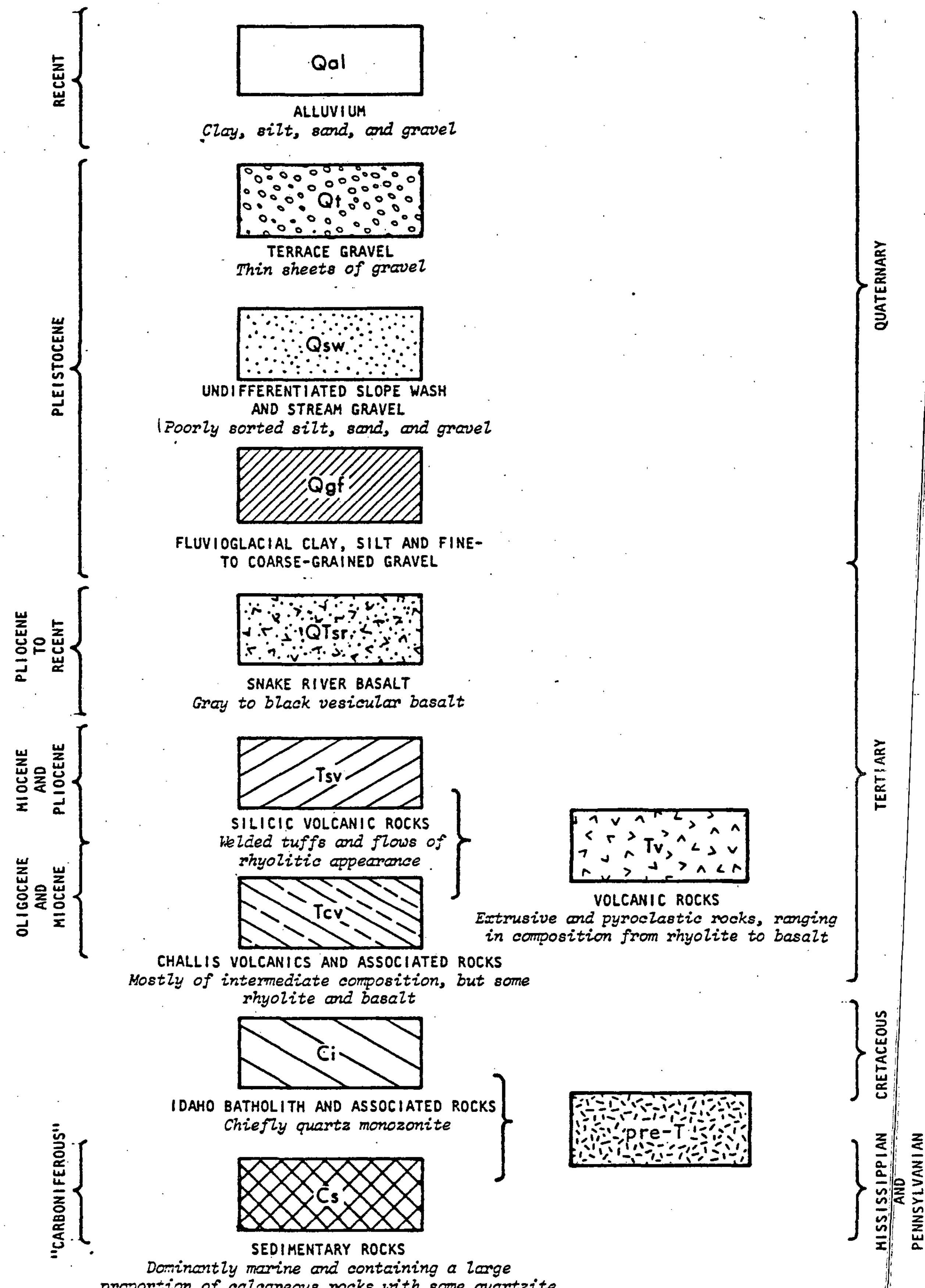


Figure 5 -- Stratigraphic units in Magic Reservoir Area, Blaine and Camas Counties, Idaho. Compiled from U.S.G.S. Water Supply Papers 1478 and 1609.

A major unconformity and weathered or altered zone that widely exists between the two rock types might provide a favorable zone of subsurface water movement.

Geological formation and their water-bearing properties are listed in Table 5. Two important shallow aquifers are the Early Pleistocene fluvioglacial sediments (Qgf) and the Snake River basalt (Qtsr). The fluvioglacial sediments are restricted to the outwash plain of the Big Wood River to the east. The Snake River basalt area of Magic Hot Springs is not recognized at the Magic Hot Springs site.

Extensive faulting is recognized in the Magic Reservoir area and is believed to be the controlling factor in the occurence of geothermal springs here and elsewhere in the southern border zone of the batholith, as at Ketchum. Other faults are believed to determine the occurrence of numerous springs north and northwest of Magic Hot Springs.

A good summary of the occurrence and importance of faulting in this area is provided by McClain and Eastlake, from Mitchell (1976) and others.

"Several major structural features are known to converge in the general area of Magic Hot Springs. The north trending Wood River Valley intersects the Snake River Plain in the general vicinity of Magic Reservoir. Also, the east-west trending Camas Prairie intersects the north trending Wood River Valley at Magic Reservoir. These major features are structurally controlled and faulting in the area has an en-echelon relationship to the Camas Prairie and Wood River Valley.

"Smith (1966) referred to the Camas Prairie Basin to the immediate west of Magic Hot Springs as a graben, and found evidence for fault control in the Mount Bennett Hills. This east-west trending range is a complexly faulted horst consisting of Cretaceous and Miocene age rocks.

"The Mount Bennett Hills (southwest of Magic Hot Springs) are tilted south and plunge eastward beneath the Pliocene and Pleistocene volcanic and

TABLE 5
GEOLOGIC FORMATIONS AND THEIR WATER-BEARING PROPERTIES
(From U.S. Geological Survey Water Paper No. 1478)

Period	Epoch	Formation and map symbol	Thickness, feet	Physical character and areal distribution	Water-bearing properties
	Recent	Alluvium Qual	0-10±	Silt, sand, and gravel underlying the channel and flood plain of the Big Wood River; chiefly of reworked fluvioglacial sediments derived from the headwater area of the Big Wood River.	Permeability generally high; gravel yields water copiously to shallow dug wells, especially where pumping induces recharge from the river.
		Terrace gravel Qt	Undetermined	Sand, gravel, cobbles, and boulders in thin deposits on stream terraces. Consists chiefly of reworked older fluvioglacial material; poorly sorted to moderately well sorted.	Contains unconfined water at shallow depth in south part of basin, but is unimportant as an aquifer because it is thin.
Quaternary		Slope wash and gravel, undifferentiated Qsw	Undetermined	Silt, sand, and gravel, poorly sorted, with angular fragments; at some places interfingers with stream gravel; elsewhere overlies old pediment slopes; occurs around border of basin and along Rock Creek.	A minor aquifer, tapped locally by domestic and stock wells; occupies small recharge areas where precipitation and surface water percolate into the ground.
	Pleistocene	Fluvioglacial sediments Qgf	300±	Clay, silt, sand, and pebble- to cobble-sized gravel deposited by streams and lakes; underlies most of the basin floor. Grades from poorly sorted coarse material on the north to interbedded clay and well-sorted sand and gravel south of the Boise baseline. Mantled at some places by topsoil.	The most productive aquifer and the immediate source of nearly all the ground water that is used in area; yields both unconfined and confined water abundantly to wells and springs; receives recharge readily north of the Boise baseline; the beds of clay beneath the southern part of the basin are confining layers over artesian aquifers.
	Pliocene	Snake River basalt QTsr	50-250±	Olivine basalt, light-gray to black, fine-grained, drusy to vesicular, jointed; contains zones of broken basalt, cinders, and interflow sediments; crops out between Gannett and Picabo and at the southeastern and southwestern outlets from the basin.	Important aquifer and the conduit through which much ground water leaves the basin by underflow; sedimentary interflow beds, especially, transmit large quantities of ground water, yields water plentifully to wells between Gannet and Picabo.
Tertiary	Miocene(?)	Volcanic rocks Tv	Undetermined	Extrusive rocks ranging in composition from rhyolite to basalt; unconformably overlie older rocks; considerably jointed. In some places individual flows are separated by thin sedimentary beds; crop out in Picabo Hills and along northeastern border of basin.	The extrusive rocks, where jointed and overlying relatively impermeable sedimentary beds, yield small amounts of water to springs; have comparatively low porosity and permeability and store little ground water except locally.
Pre-Tertiary		Sedimentary and granitic rocks pre-T	Undetermined	Sedimentary rocks, well indurated, folded and faulted; intruded by stocks of granodiorite and quartz monzonite; crop out in mountains that border the basin and extend beneath it at unknown depth.	Tightly cemented and low in permeability and porosity; generally poor water-bearing rocks except where they contain joints and other fractures; under favorable conditions ground water is transmitted through the permeable zones and is discharged through springs; important chiefly as impermeable basement rocks.

sedimentary rocks near Magic Reservoir. Smith mapped numerous northwest trending en-echelon faults in the Mount Bennett Hills and Magic Reservoir area. These faults are probably early Pleistocene age (Smith, 1966) with nearly vertical movements and generally downthrown blocks to the north. Smith reports displacement in excess of 300 meters (984 feet) in the Mount Bennett Hill area.

"Bennett and Rember (1979) mapped a major north trending fault extending from the Snake River Plain north into the Sawtooth Mountains which have an en-echelon relationship with the Wood River Valley. Malde (1963) mapped several northwest trending near vertical faults with largely dip slips down to the north. These faults have a general en-echelon relationship with the Mount Bennett Hills and Camas Prairie to the west of Magic Hot Springs.

"Mitchell's (1976) interpretation of Landsat false color infrared satellite imagery revealed several linear features near Magic Reservoir. Mitchell identified a major east-west linear at Magic Hot Springs which could represent the surface expression of a major fault. Mitchell identified this linear as the Magic Hot Springs Fault. This linear intersects the Clay Banks fault (Smith, 1966) at the location of Magic Hot Springs.

"A north trending linear feature which intersects Magic Hot Springs is aligned with several hot springs north of Magic Reservoir. This linear has an en-echelon relationship with the Wood River Valley and is a probable surface expression of major vault which could control the circulation of thermal waters as is indicated by the numerous faults.

"Both linear features intersect at Magic Hot Springs. The dip slip direction of any faults associated with these linear features is undetermined. It is probable that the east-west trending linear identified by Mitchell is a near vertical normal fault with the downthrown block to the north. This relationship would be consistent with the dip slip of the northwest trending faults of the Clay Bank Hills. The north trending linear feature is probably a near vertical fault with the downthrown block to the east. More detailed geological mapping is needed to clarify the structural relationship of these linear features.

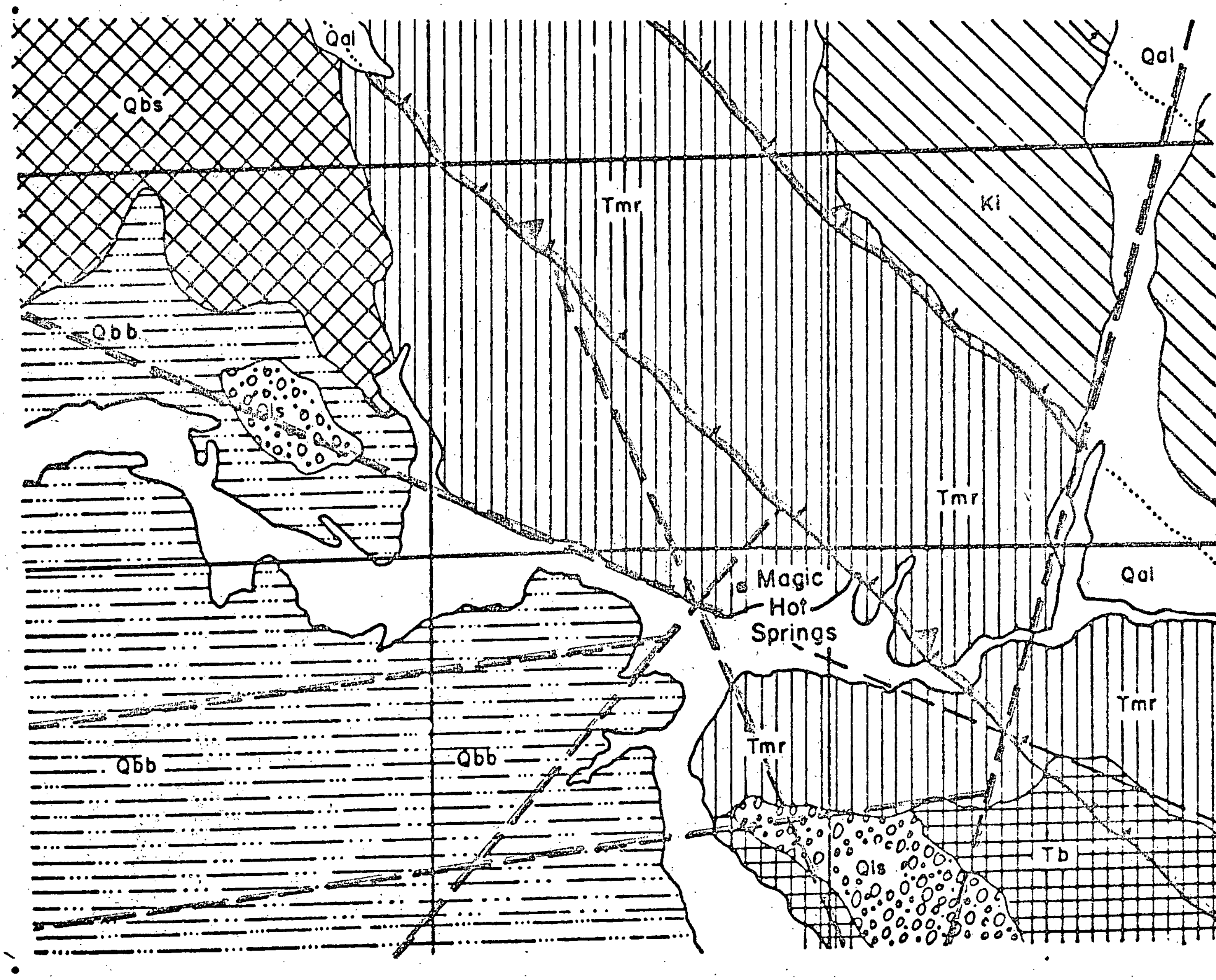
"The presence of numerous near vertical northwest trending normal faults, a major north trending linear feature and a significant east-west trending linear feature indicates a complex structural geology which is fractured and favorable for circulation of thermal fluid [emphasis added]."

John Anderson has examined Landsat imagery in the Magic Hot Springs locale and provided the interpretation of lineaments and local areal geology shown in the overlay on Fig. 6, and accompanied by the columnar section in Fig. 7. This is strong evidence that the Magic Hot Springs locale is a major intersection of several fault systems, and also that MRI acreage owned in fee (shown stippled in Fig. 6) possibly is underlain by numerous zones of fracture permeability.

Gruy Federal has also made a preliminary survey of the Magic Reservoir area, both on the ground and by interpretation of the topographic map. Figure 8 shows the GFI interpretation of the possibility that a graben extends northward from Magic Reservoir, and both an en echelon series of southwest-dipping faults extending NW-SE and a major shear zone (strikeslip faults) extending east-west pass through the Magic Hot Springs locale.

GFI postulates that the individual basaltic intrusions are associated with the graben indicated in Fig. 8 as VOL (for volcanic) and the shear zone, indicating that these faults extend to considerable depth and possibly provide fracture-zone conduits for very hot waters.

The presence of a graben is consistent with the mechanics of doming; the shear zone is consistent with differential movement of major structural elements in a tectonic belt; the subsidence of an area such as Camas Prairie to form a horst immediately west of Magic Reservoir (Smith, 1966) is consistent with removal of material from depth during times of the magmatic intrusion.



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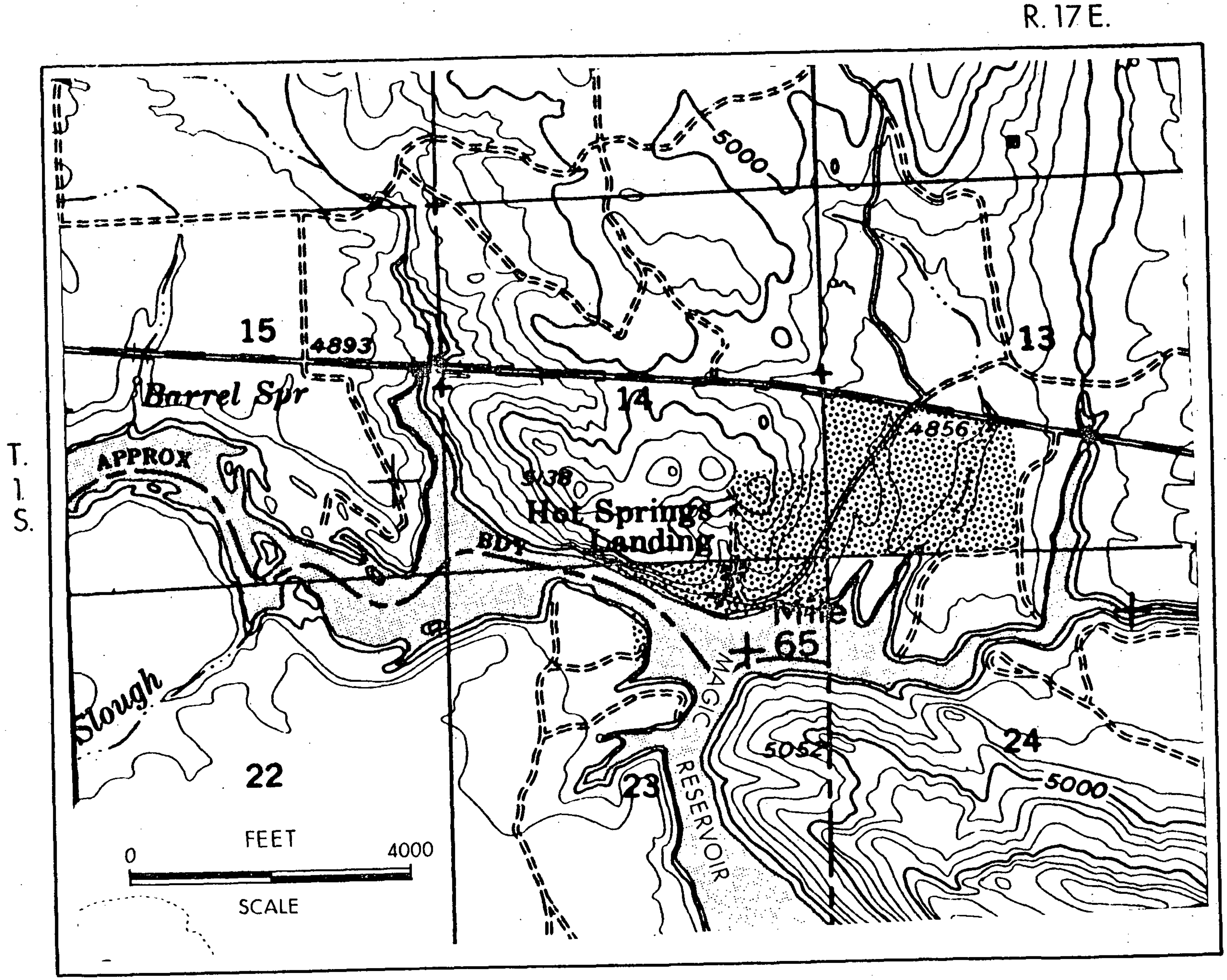

Figure 6 --Location of MRI acreage on Bellevue Quadrangle topographic base with 40-foot contour interval.

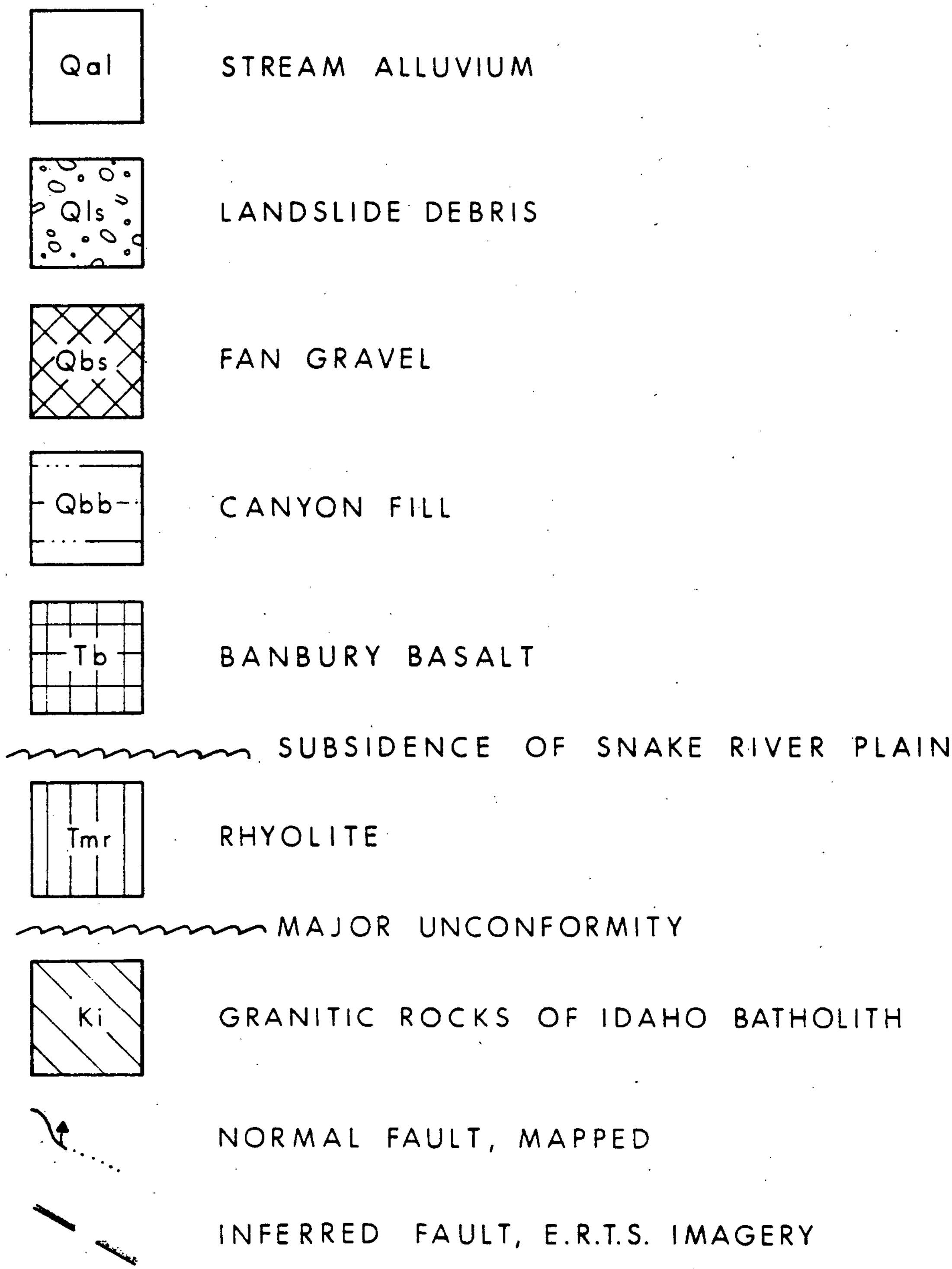

Figure 7 -- Description of Rock Units from Malde, Powers, and Marshall (1963), modified by John Anderson 1980. Accompanies Anderson geologic overlay

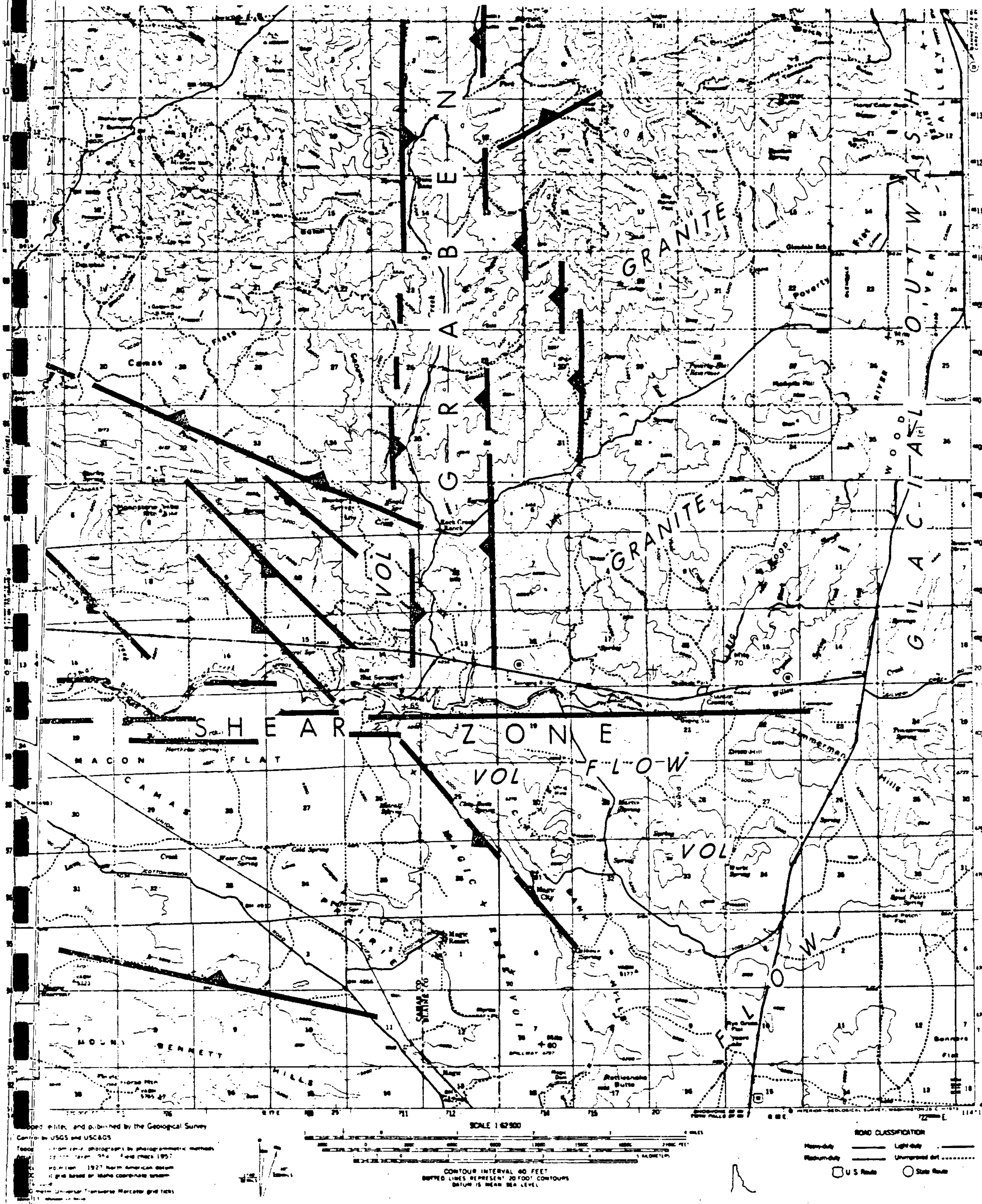

Figure 8.--Possible fault systems interpreted from reconnaissance geology, Gruy Federal, Inc.

All geological evidence indicates the presence of a high-grade geothermal resource in the Magic Hot Springs locale.

The unknown negative factor, of course, is whether the fracture permeability of the fault zones has been reduced by secondary crystallization or diagenesis.

As described elsewhere (section 5.a.), the lithology and structural geology of the area surrounding Magic Hot Springs indicate favorable conditions for the occurrence of geothermal resources. A heat flow of 3 HFU, which is twice that considered normal (1.5 HFU) for the United States, is typical of this area (Brott and others, 1976). This above normal heat flow is typical of the granitic Idaho batholith (Blackwell, 1973) and makes it reasonable to expect that thermal waters could be reaching the maximum temperatures predicted by geochemical thermometry through deep circulation.

5.b.(2) End Uses

(i) Overall Plan.

The schematic (Fig. 9) shows the overall layout for the entire proposed development including the ethanol plant. For the user-coupled proposal the only process being considered is the ethanol plant.

(ii) Energy Requirement.

The energy requirement for the ethanol process is 22.5 x 10^6 Btu per hour. The minimum temperature and flow rate required to accomplish this are 280°F and 600 gal/min. Further, the chemical composition of the resource must be such that heat required by the process can be provided by flashing the hydrothermal fluid to steam. A margin of 75 gal/min is required for heat loss and well decline, for a total of ~~615~~ 675 gal/min.

The potential greenhouses, catfish raceway, and soil-warming irrigation system shown on the schematic as potential secondary uses of geothermal energy are not part of this project. The area and heating requirements for greenhouses will depend on further economic analysis and the successful completion of the ethanol project. The construction of catfish raceways will probably depend on the successful completion of the ethanol plant. The size and flow of the raceway will be dependent on the flow rate and temperature of the shallow wells to be drilled to supply blending water. The underground soil warming/irrigiation system is meant primarily for disposal and esthetics. Any economic advantage would be only incidental.

(iii) Predicted Utilization Factor

The ethanol plant will operate 24 hours per day, 360 days per year, which gives a utilization factor of 0.986.

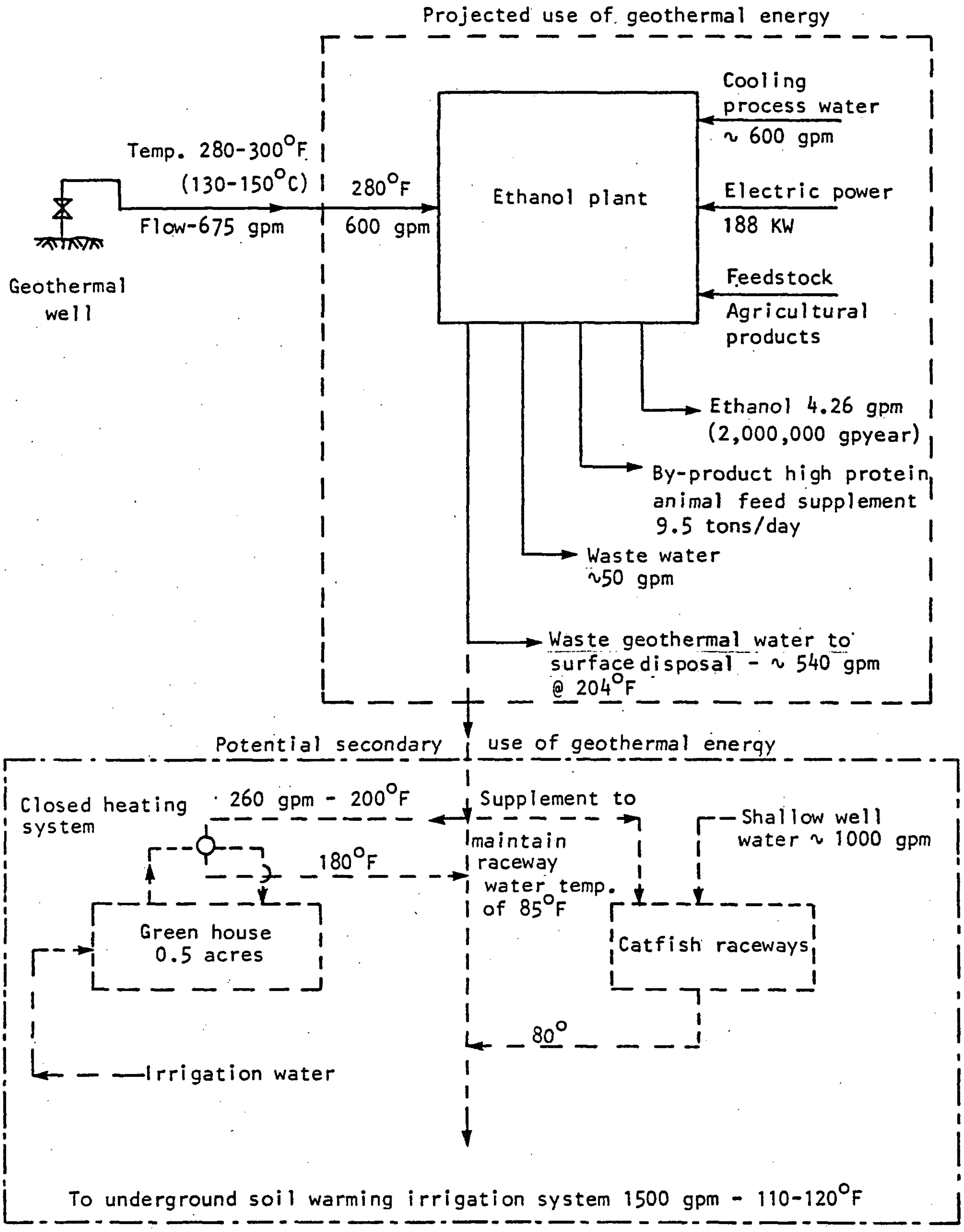

Figure 9 -- Schematic of projected end use, Magic Hot Springs geothermal well.

(iv) Gross Annual Energy Consumption

Predicted average gross annual energy consumption of the ethanol plant that will met through the use of hydrothermal energy will be 1.95×10^{11} Btu per year.

(v) Energy System Components

The major energy system components are:

1. Drilled and cased hydrothermal well, 3,000 to 4,000 feet deep, with controls.

2. Pump to supply 675 gal/min at sufficient heat.

3. Hydrothermal supply line to the ethanol plant.

(vi) Existing Energy System

The existing energy system is a 260-foot well that is cased to a reported depth of 41 feet. The well flows artesian 136 gal/min at 163°F.

If an ethanol plant is put into operation at the site, the existing well might be utilized by some of the other planned processes, such as greenhouses and fish farms.

The produced water disposal system will be subject to review when the chemical content of the produced water is known. If the water is low in mineral content, surface disposal will be feasible (natural drainage or irrigation). If the water is found to be too highly mineralized, reinjection into subsurface zones, preferably the producing interval, would be needed. The disposal system will be subject to State approval in any event.

5b.(3) FINANCIAL FEASIBILITY

Determination of the financial feasibility of the entire project through end use requires analysis of both the geothermal energy economics and the end use. The proposed geothermal system requires the siting, drilling, completion and testing of a 3,000-ft well. Assuming that the well is sufficiently successful, an ethanol distillation plant with a production capacity of approximately 2 million gallons per year will be sited adjacent to the well. Very low cost surface disposal of the geothermal fluid exiting from the ethanol plant is planned based on evaluation of available information from the present well on site.

In the future, the geothermal fluid might be cascaded from the ethanol plant through greenhouses to an aquaculture raceway and then to a nursery operation. However, these additional uses are not sufficiently certain to include them with the ethanol plant in the base load geothermal economics.

The financial feasibility of the proposed geothermal system is determined largely from income and cash flow projections for the economic life of the geothermal investment. These estimated earnings and cash flows are evaluated by themselves and also, when combined with the investment outlay, permit calculation of two other important financial measures--return on investment and payback period. We will comment on the adequacy of these four financial yardsticks--profitability, cash flow, return on investment, and payback period--for the proposed investment after developing the project financial data.

The financial representation of the proposed geothermal system as an investor might see it requires making several assumptions. The following assumptions are realistic and consistent with the proposer's financing expectations:

1. Economic life of well - 10 years (same as ethanol plant)
2. Geothermal system capitalized - $1,250,000
3. Non-exploratory well and pump capital - $750,000

4. Well flow rate - 675 gal/min
5. Wellhead temperature - 280°F or higher
6. Operating expense, labor and maintenance - 10% of non-exploratory well and pump capital
7. Overhead - 5% of non-exploratory well and pump capital
8. Depreciation - straight line
9. Interest rate - 16% for loan amortized over the 10 year life
10. Composite income tax rate - 50%
11. End user - 2 million gallon/year ethanol plant
12. Energy load - 1.94 x 10^{11} BTUs/year
13. Non-geothermal energy source - No. 2 fuel oil
14. Geothermal energy price (to be negotiated) - 25% to 50% discount off No. 2 fuel oil price of \$5.60/10^6 BTUs
15. Well cost - full cost before any cost-sharing

A few of these assumptions warrant additional discussion to make their reasonability clear. The well life assumption is tied to the ethanol facility and market. If the life were forecast based on the known geologic and hot spring data, the projected life probably would be longer. However, the ethanol plant life is estimated at 10 years, and the ethanol market and technology are not sufficiently predictable to permit inclusion of a replacement plant for a second 10-year span.

The operating and overhead expenses are based on a percentage of capital. Since the geothermal system capital includes siting and flow-testing costs, we have eliminated these exploratory items to arrive at a well and pump capital figure that is a fairer basis for estimation of expenses.

It is possible that the investors would choose to make somewhat different assumptions regarding depreciation method and intangible treatment. They also may negotiate a shorter loan life or some form of balloon repayment schedule. However, our assumptions represent a base case which other treatments would only improve.

The energy load and price are critical assumptions since they together are determinants of the geothermal revenue. The energy load is based on the energy requirements of a 2-million-gallon batch basis ethanol plant. The value of the geothermal energy is yet to be negotiated between Magic Resource Investors and Western Resource Recovery. It is anticipated that the negotiated price will result in geothermal Btu's at a 25% to 50% discount from no. 2 fuel oil. Although this range is fairly wide, it provides a basis for evaluation of the financial feasibility of the geothermal investment at the two ends of the range.

Income statements, cash flow projections, and loan amortization based on these assumptions are shown in Tables 6 and 7. Table 6 assumes that the geothermal energy is sold at a 50% discount from no. 2 fuel oil; Table 7 assumes only a 25% discount. The income statements and cash flow projections suggest that the proposed geothermal project is financially feasible. With the exception of the first year when the project is under construction and generates no income, after-tax profits and positive operating cash flow are shown in every year at both the 25% and 50% discounts. This can be seen from the lines captioned "Profit After Taxes" and "Cash Generated" on the two exhibits. In addition "Cash Generated" in each year after the first year is sufficient to pay the scheduled loan amortization that would be required for a level-payment loan. (Compare the "Cash Generated" line on each exhibit with the "Loan Amortization" line.) "Profits Before Taxes" appear to provide satisfactory coverage of interest to satisfy lenders, although at a 50% discount the interest coverage and the cash generation do not provide much of a safety margin (compare the Table 6 "Profits Before Taxes" line to the "Interest" line for years 2 through 7).

The indicated Payback Period is fully acceptable with the 25% discount but is somewhat marginal for the 50% discount level. Payback compares the cumulative cash inflow to the cumulative cash investment outlay to determine when you have your money back. Let us assume an investment outlay of about $1.5 million consisting of a $1.25 million well, $0.1 million contingency, $0.1 million loss in construction year, and $0.05 million working capital. Cumulative addition of the "Cash Generation" starting with year

TABLE 6

INCOME STATEMENT AND CASH FLOW (000s)
ASSUMING 50% DISCOUNT FROM NO. 2 FUEL OIL EQUIVALENT

Year	1	2	3	4	5	6	7	8	9	10	11
Revenue	$	$543	$543	$543	$543	$543	$543	$543	$543	$543	$543
Operating expense, labor, and maintenance		75	75	75	75	75	75	75	75	75	75
Depreciation		125	125	125	125	125	125	125	125	125	125
Overhead @ 5%		38	38	38	38	38	38	38	38	38	38
Intangibles W/O											
Interest expense	100	200	191	180	167	152	135	116	93	66	36
Profit before taxes	(100)	105	114	125	138	153	170	189	212	239	269
Income tax	(50)	53	57	62	69	76	85	95	106	120	134
Tax credits:											
Ordinary (10%)		53	57	15							
Energy (15%)				47	69	72					
Profit after taxes	(50)	105	114	125	138	149	85	94	106	119	135
Plus: non-cash charges											
Depreciation		125	125	125	125	125	125	125	125	125	125
Intangibles											
Cash generated	$(50)	$230	$239	$250	$263	$274	$210	$219	$231	$244	$260
Note:											
Loan amortization	$ -	$ 59	$ 68	$79	$91	$106	$123	$143	$166	$192	$223
Loan balance (end yr.)	1250	1191	1123	1044	953	847	724	581	415	223	-

TABLE 7

INCOME STATEMENT AND CASH FLOW (000s)
ASSUMING 25% DISCOUNT FROM NO. 2 FUEL OIL EQUIVALENT

Year	1	2	3	4	5	6	7	8	9	10	11
Revenue	$	$815	$815	$815	$815	$815	$815	$815	$815	$815	$815
Operating expense, labor, and maintenance		75	75	75	75	75	75	75	75	75	75
Depreciation		125	125	125	125	125	125	125	125	125	125
Overhead @ 5%		38	38	38	38	38	38	38	38	38	38
Intangibles W/O											
Interest Expense	100	200	191	180	167	152	135	115	93	66	36
Profit before taxes	(100)	377	386	397	410	425	442	461	484	511	541
Income tax	(50)	188	193	198	205	213	221	230	242	256	271
Tax credits											
Ordinary		125									
Energy		63	125								
Profit after taxes	(50)	377	318	199	205	212	221	231	242	255	270
Plus: non-cash charges											
Depreciation		125	125	125	125	125	125	125	125	125	125
Intangibles											
Cash generated	$(50)	$502	$443	$324	$330	$337	$346	$356	$367	$380	$395
Note:											
Loan amortization	$	$ 59	$ 68	$ 79	$ 91	$106	$123	$143	$166	$192	$223
Loan balance (end yr.)	1250	1191	1123	1044	953	847	724	581	415	223	-

2 reaches a total of $1.5 million in year 5 for the 25% discount (Table 7) and early in year 8 with the 50% discount. Thus, the payback for the former is in four years, but is six plus years for the latter. Again the 50% discount produce somewhat marginal results.

Using the discounted cash flow internal rate of return approach yields essentially the same analytic evaluation. The "Cash Generated" as shown on the exhibits is net of interest expense. Typically the internal rate of return is calculated from cash flows excluding the cost of financing, since the rate of return is presumed to cover the cost of capital. If we remove the after-tax impact of the interest expense from the "Cash Generated", we can relate the adjusted cash flows to the initial investment and determine the DCF internal rate of return (IRR). The result of these calculations for the proposed geothermal system is a 17% IRR for the 50% discount example and a 30% IRR for the 25% discount. Given the cost of money in the foreseeable future, the 17% IRR is a little low and the 30% IRR is fully adequate.

The financial feasibility of the ethanol end use depends upon many factors including availability of feedstock, an affordable source of energy, and a stable year-round market for the ethanol that will be produced. A study was prepared by Dr. Arthur C. Rathburn of Rathburn and Associates, Twin Falls, Idaho for the proposers which investigated feasibility questions including feedstock, ethanol market, ethanol technology, ethanol process cost and economics, environmental aspects and regional impacts. His conclusion was favorable to establishment of an ethanol plant in the region. This conclusion corroborates the implied business feasibility of the ethanol direct-use application that is intended by Western Resource Recovery.

(i) Feasibility of an Ethanol Plant at Magic Hot Springs Site*

A site-specific study was conducted for the Magic Hot Springs site to determine if an ethanol plant would be warranted.

1. Market Determination

A sizable market for ethanol exists outside of its use as an additive for gasoline, but that market is now adequately served by established distillation plants. Any new plant must look to outlets for "gasohol," and that outlook is favorable.

The potential volume of anhydrous ethanol that could be utilized in America (using a 10% alcohol - 90% gasoline mix) is far beyond the production capability of the country with the present technology. The 10% figure is conservative, considering that all new American automobiles are capable of burning a 20% anhydrous ethanol mixture with no carburetor adjustment. In addition, many studies are under way to produce engines that will more effectively use 100% anhydrous ethanol.

Gasohol is giving excellent customer satisfaction in Idaho, as in other areas where market tests have been carried out. Stations introducing "gasohol" can expect increases in sales volume in excess of 200 percent. Documented comments from actual users have substantiated previous performance testing (better overall performance) and again point out the desire of users to continue using the product.

This last point, increased performance, has been the conclusion of many recent studies. A study (1979) by the Nebraska Agriculture Products Industrial Utilization Committee stated, "Increased octane number, positive volume change, and reduced fuel consumption are indeed a triumvirate

*Condensed from a study by Dr. Arthur C. Rathburn of Rathburn and Associates, Twin Falls, Idaho, for MRI.

of factors that mandate alcohol in all gasoline fuels." The study further noted that "the improved volatility of gasohol fuel provides added driver satisfaction through easier starting of the vehicle, especially in cold weather."

In the region around Magic Reservoir only a few stations have tested the marketing of gasohol. These stations are pleased with customer response, even at a higher price, because of increased mileage-per-gallon performance and the fact that they are using a product that utilizes less foreign oil.

These stations were purchasing their alcohol for $2.02 per gallon and mixing it at 1 part to 10 parts unleaded gasoline. They all expressed a desire to purchase larger volumes, and felt that a price of $1.70 to $1.80 a gallon would allow them sufficient profit to install full-time gasohol pumps.

The local and regional distributors contacted for the MRI study expressed real interest in obtaining a marketing agreement with a local distillation plant. We find no reason to doubt the Iowa Development Commission's summary that "A potential market for gasohol does exist and up to 10 percent of the consumers in the market could be expected to use the product on a regular or occasional basis."

The first user to commit to the Magic Hot Springs geothermal development project is Western Resource Recovery, Inc., which intends to produce fuel-grade ethanol (180 to 190 proof) at the Magic Hot Springs site and transport this product to its facility being developed near Twin Falls for dehydration. Fuel-grade ethanol would have a value to the Western Resource Recovery, Inc. of approximately 12 cents per gallon less than anhydrous ethanol.

2. Feedstock Supply

Feedstock costs are the most critical factor indetermining feasibility.

Two major ethanol processes are in current use: cellulose and carbohydrate. The cellulose process can use any vegetable fiber, such as corn stalks or wood chips, which are inexpensive and easily available. However, the state of the art does not allow feasible operation under most situations. The production of ethanol from fruits, vegetables, or grains high in starch or sugars (carbohydrates) is as old as the making of distilled beverages, and this process is the one to be utilized.

Availability of feedstocks is somewhat limited by the remoteness of the proposed site from the lower elevations in the Snake River Plateau and the short growing season (80-85 days). Sugar beets, corn, and potatoes are not readily available in the Magic Hot Springs area. As a result, the best feedstocks are wheat, barley, oats and cheese whey.

a) Cheese whey - Two cheese plants are located in the Lincoln, Blaine, and Camas County area; one at Carey, 28 miles to the east, and the other at Richfield, about 45 miles to the southwest. Their combined production is approximately 300,000 lb of whey per day, averaging about 6 percent solids. This whey could be obtained at a very advantageous price, though it would have to be transported a considerable distance. Present contracts held by Western Resource Recovery for whey for similar plants in Southern Idaho are for one cent per hundredweight; therefore, it should be possible to deliver the whey to the Magic Hot Springs site for about $4.20 per ton. During the anticipated down time of the ethanol plant, the whey could be dumped in the desert, where much of it is now disposed of.

   The cheese whey would produce approximately 328,500 gallons of ethanol.

b) Grains - Blaine and Camas Counties are major producers of grains. The 1976 production in bushels was:

Crop	Blaine Co.	Camas Co.
Wheat	265,800	200,300
Barley	442,400	481,400

Oats grow well in the area and offer an additional potential source of feedstock.

If a straight grain plant is used, 400,000 bushels of barley would be needed. If whey is utilized, 286,600 bushels of barley would be needed annually.

The best combination of feedstocks for the area would be 54,750 tons of whey annually at a cost of $229,950 plus 268,600 bushels of barley annually at a cost of $604,350. This would result in a per-gallon cost for feedstock of $0.83.

3. By-Product Utilization

The two major by-products of ethanol production are a high-protein animal feed and CO_2. In plants of under 10 million gallons it is not feasible to try to recover the CO_2 produced. The only use foreseen for the CO_2 from this project is to vent it directly into greenhouses.

High-protein animal feed (protein percentage varies depending upon feedstocks) is a high-value product that can be used at up to 30% in beef rations and 50% for hogs. The by-product leaves the ethanol plant with a high moisture content, and it is produced in high volume.

The moisture problem could create extra expense. If the by-product is to be sold off site, it must be dewatered and dried. Drying could add approximately 13 cents per gallon of ethanol to the operating expenses. This is not a loss, however, because the expense would be recovered through the sale of the dried product. Also, the use of geothermal heat for drying the by-product almost eliminates the added operating expense, which amounts to only 2 to 3 cents per gallon.

A steadily growing market exists for high-protein supplements such as soybean meal in south central Idaho, because the dairy industry, a major user of high-protein feeds, is growing at a rapid rate. At present, soybean meal is selling for around $190 per ton in the area. This would make the DDG (distiller's dried grain by-products) from the proposed ethanol plant worth $114 per ton on an equivalent nutritional basis. Table 8 shows the typical nutrient composition of distiller's feeds.

4. Capital Costs

The most readily available and most economical ehtanol distillation facility is the prefabricated unit built by Rocky Mountain Ethanol Systems, Inc. These units also have a good history of dependability. The present basic price of a unit adequate for the needs of a 2 million gallon per year plant is approximately $1,540,000.

The Rocky Mountain Ethanol Systems units compare very favorably with other plant cost, averaging $2.50 per gallon of annual capacity, or a capital outlay of $5,000,000.

Rocky Mountain Ethanol Systems, Inc. has an operating still near Rupert, Idaho, producing 190-proof ethanol. The anhydrous tower is now being installed. The plant uses a batch process rather than continuous flow. Though more labor-intensive, this system is more widely used and field-proven. The plant is fabricated of mild steel and has a life expectancy of 10 years.

5. Availability of Services

Transportation - The site is located near Idaho State Highway 68. U.S. Highway 75 is five miles to the west. Both are maintained year-round and are rarely closed during the winter months. The site is not served by rail, but a Union Pacific rail spur (Shoshone-Fairfield spur) lies

TABLE 8

TYPICAL NUTRIENT COMPOSITION OF DISTILLERS' FEEDS

	Wheat		Barley		Corn		Potatoes
	DDG	DDGS	DDG	DDG	DDS	DDGS	D.D. residue
				percent			
Dry matter	93.4	92.5	92.0	93.8	93.3	92.5	95.7
Ash	3.0	4.1	1.8	2.2	7.5	4.6	6.7
Crude fiber	12.7	9.8	10.1	12.6	3.6	9.1	20.6
Ether extract	5.9	6.3	11.6	9.3	9.3	10.3	3.1
N-free extract	40.4	40.3	40.8	41.9	43.6	41.4	42.4
Protein (N x 6.25)	31.3	32.0	27.7	27.8	29.4	27.0	22.9
Energy:							
Cattle TDN	73.6	75.2	63.6	79.0	80.3	80.2	61.0
Sheep TDN	77.7	78.5	65.1	76.6	84.0	69.4	61.8
Swine TDN	84.1	85.2	67.7	92.5	79.7	94.3	74.6

Source: National Academy of Sciences, Atlas of Nutritional Data on United States and Canadian Feeds, 1971.

approximately 3 miles to the southwest. The railroad has recently shown increased interest in developing new industry in south central Idaho.

Electrical power - A three-phase electrical power transmission line runs east and west to the north of the site. No difficulty is seen in bringing sufficient power to the site.

Fire protection - Fire protection would have to be planned in site development facilities.

Police protection - Very little routine police protection could be expected from existing agencies. However, the plant will be operated on a 24-hour basis and personnel will be on site.

Availability of labor - The plant will not require a large labor force. A plant manager will carry out the day-to-day management functions. Most of the administrative duties will be carried on at Western Resource Recovery's corporate office in Twin Falls.

Two men per shift will operate and maintain the plant. These men will need mechanical skills. The area has an agricultural and lumbering oriented economy, and these skills are not difficult to locate.

6. Environmental Restrictions

A geothermally powered distillation plant creates no environmental hazards to the area. No air pollutants are produced to create emission problems. Only water and CO_2 are produced and water pollution could be prevented by proper planning.

The geothermal fluids themselves are sufficiently free of pollutants to be returned directly (after cooling) to Magic Reservoir. The stillage water, however, will be loaded with suspended solids and will need to be run through an aeration pond, which should reduce the BOD load to around 200 ppm, and then be sprayed on the adjoining rangeland. Though this may create some odors, the site is isolated from any habitation and no problem should develop.

7. Other Governmental Restrictions

The site is located in a county-zoned "Recreational District" because of the location of the hot spring and its proximity to Magic Reservoir. In the past, land developments within designated recreational areas in Blaine County have met considerable resistance to redesignation. This site, however, is far removed from the other recreational areas in the county. In addition, county planning and zoning officials and county commissioners indicate enthusiasm for the establishment of an industry in the area. At this point it appears that little opposition would be shown toward an application for rezoning.

8. Conclusion

The present situation both locally and nationally seems favorable to the establishment of an ethanol plant at Magic Hot Springs. All factors investigated in this study seem to indicate no major obstacles to the establishment of a plant.

c. REFERENCES

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6.a.(1) STATEMENT OF WORK

The following statements of work listed by task are proposed by Magic Resource Investors (MRI) in fulfillment of a cooperative agreement under the User-Coupled Confirmation Drilling Program as set forth in the Solicitation for Cooperative Agreement No. DE-SC07-80ID12139, August 15 (amended to September 15), 1980.

Task 1. Financial

Magic Resource Investors shall confirm all financial arrangements for implementation of the project and provide DOE with evidence that project financing is sufficient to complete the project. Completion of this task constitutes completion of Milestone #1.

Task 2. Environmental and Institutional

MRI shall submit an Environmental Report within 60 days of contract award, prepared in accordance with guidelines to be provided by DOE and addressing "site-specific" information relating to the project. MRI shall assist DOE in preparation of an Environmental Assessment if an Assessment is required based on the Environmental Report.

All permits, leases, and other documentation required for this geothermal project shall be acquired and provided to DOE by MRI. During the course of work under this Agreement, MRI shall coordinate with and provide information to local, state, and federal agencies, as necessary, to ensure compliance with all environmental requirements additional to the DOE guidelines. Completion of this task constitutes completion of Milestone #2.

Task 3. Exploration

A. MRI, with support from appropriate consultants, shall:

1) Conduct the following exploration work:

a. Field geology surveys and detailed site work to locate, confirm, measure, map, and project surface faults and fractures in and around the Magic Hot Springs Landing area sufficient to assess the probable existence of fault planes and/or fracture zones in the subsurface.

b. Conduct a geophysical survey of approximately 20 linear miles with methods and instrumentation best suited to identify, locate, and map subsurface faults and fractures in the Magic Hot Springs Landing area, sufficient to assess the probable existence and location of fault planes and/or fracture zones for selection of an optimum drill site to penetrate such fault planes and/or fractures within a 3,000-foot depth of the surface location.

c. Compile and analyze all available hydrologic and geochemical data from existing wells, springs, and aquifers sufficient to assess the probabilities of connected or nonconnected flow into the Magic Hot Springs Landing subterranean area, and related water qualities and quantities.

2) Analyze and interpret all exploration data and present both the data and the results to DOE.

3) Based on the exploration data:

a. Select three thermal gradient drill sites.

b. Prepare bid specifications and select a drilling subcontractor to drill the thermal gradient wells. The bid specifications and drilling subcontracts shall be submitted for DOE review and approval prior to award.

c. Obtain bids for the drilling of the thermal gradient wells.

d. Review the bids submitted and award a subcontract to the successful bidder.

e. Drill three thermal gradient wells in accordance with the bid specifications.

f. Obtain thermal gradient and lithology logs during drilling and continue gradient monitoring during the period of temperature stabilization subsequent to drilling.

B. MRI, with the support of appropriate consultants, shall:

1) Evaluate the data obtained in Tasks 3A 1-3 and other available assessment data, in order to define the hydrological and geological features of the resource with emphasis on resource location and depth. These data shall be provided to DOE as soon as they are acquired during Task 3A 1-3 in order to minimize the time required for DOE review.

2) Within ten working days of the completion of Task 3B 1, DOE and MRI shall discuss and review the data. A mutual

written agreement between DOE and MRI must be reached concerning the adequacy of the exploration data for selecting a resource confirmation drill site and the potential need for additional data prior to proceeding with the next task. Completion of this task constitutes completion of Milestone #3.

3) Concurrently with Task 3B 2; or within ten working days of the completion of this task, MRI shall discuss and review with DOE the selection of a production well drill site. A mutual written agreement between DOE and MRI must be reached concerning the location of the drill site. Completion of this task constitutes completion of Milestone #4.

Task 4. Drilling and Logging

A. MRI, with support from appropriate consultants, shall:

1) Provide for necessary drilling supervision services.

2) Update the preliminary Drilling Program, which will include well location, drilling techniques, well and wellhead design, anticipated rig type, drilling fluid program, logging requirements, etc. Temporary requirements, such as reserve pits, mud pits, equipment storage areas, noise abatement, blowout prevention, utility services, and other standard well drilling practices, shall be considered and addressed in the drilling plan. DOE shall be advised of the contents of the Drilling Program during its preparation.

3) Prepare the bid specifications and submit the Drilling Program and specification to DOE for review and approval. Within ten working days, DOE shall indicate concurrence or

request modifications to the specifications and/or program.

B. MRI, with support from appropriate consultants, shall:

1) Issue the drilling specification to drilling companies for bid.

2) Review the well bids and inspect (if necessary) the bidders' drilling equipment. MRI shall select a drilling subcontractor, with DOE concurrence. The proposed drilling subcontract shall be submitted for DOE review and approval. Within ten working days, DOE shall indicate approval or request modications to the subcontract.

3) Supervise the drilling of the production well, in accordance with the detailed Drilling Program and specifications. Periodically, MRI or its designated representative and DOE shall confer, so that decisions concerning the drilling operation can be made in a timely manner.

4) Collect fluid samples, cutting samples, well logs, bottom-hole and gradient temperature data and perform all other tests consistent with industry practice and the Drilling Program. Strata suitable for reinjection will be noted during drilling.

5) All data concerning the well shall be forwarded to DOE as soon as they are acquired in order to minimize the time required for DOE review.

6) Within ten working days of the completion of the well, DOE and MRI shall discuss and review the data. A mutual written agreement between DOE and MRI must be reached prior to proceeding with the next task. Completion of this task constitutes completion of Milestone #5.

Task 5. Flow Testing

A. MRI, with support from appropriate consultants, shall:

1) Provide for necessary flow testing services.

2) Update the Flow Test Plan and submit to DOE for review and approval; within ten working days, DOE shall indicate concurrence or request modifications to the plan.

3) Carry out a comprehensive well and reservoir test program in general accordance with the Flow Test Plan.

4) Assimilate the test data taken during the well test and estimate the well's productive capacity and production characteristics. The well testing and other available data shall be prepared and presented to DOE. Within ten working days, DOE and MRI shall discuss and review the well test results. A mutual, written agreement between DOE and MRI must be reached to determine a future course of action. This agreement constitutes project Milestone #6.

Task 6 Injection Well Drilling

A. If an injection well is deemed to be necessary by mutual agreement between DOE and MRI, a prognosis and drilling program, similar to the updated and approved Drilling Program for the initial confirmation well, shall be prepared by MRI and submitted to DOE for approval (reference Task 4A 1-3).

B. MRI shall, with appropriate consultants, conduct all operations necessary to drill the injection well and prepare it for use, including the performance of duties set forth in Task 4B 1-6 as modified in the approved injection well Drilling Program.

C. DOE and MRI explicitly recognize that an injection well is not foreseen to be necessary at initiation of the Cooperative Agreement, and that the costs, proposed budget, and proposed work schedule do not include an injection well; therefore, following a mutual agreement between DOE and MRI of the necessity to drill an injection well and prior to commencement of any work, DOE and MRI shall adjust the basis of cost-share agreement (Task 7 of the Cooperative Agreement) to include the additional costs of the injection well program and additional fee to Gruy Federal.

Task 7. Determination of Cost-Share

DOE and MRI, together with Gruy Federal, Inc. (GFI) technical participation, shall review all test results and costs and determine the DOE and MRI cost shares. The basis for the determination of the cost shares shall be the variable cost share plan contained in Section ________ (to be filled in) of the Cooperative Agreement (the basis for which is set forth in Section 8, Variable Cost-Share Plan, in this proposal) as modified, if necessary, under the terms of Task 6, Injection Well Drilling. Determination of the cost share constitutes project milestone #7.

Task 8. Project Management

MRI shall manage the project in a prudent and workmanlike manner consistent with successfully completing the Statement of Work. Management controls shall include technical assessment, budget assessment, and schedule assessment, as described in the proposal.

MRI shall maintain continuous monitoring of cost versus performance for comparison to baseline projections of each cost and performance item.

MRI shall prepare and maintain in current status, in a format acceptable to

DOE, management charts and diagrams that show all phases of overall work plan and schedule and financial plan. These diagrams will include time allowance for DOE review and approval of plans and reports, and for policy decisions. They shall also be used for coordination between Gruy Federal and other contractors and principals in the program. MRI shall maintain close coordination with DOE and shall make immediate and full disclosure of problem areas in order that corrective action may be taken with DOE support, if necessary.

Task 9. Reporting

MRI shall meet and satisfy the reporting requirements of DOE Form CR-537 in SCAP No. DE-SC07-80ID12139, consisting of the following:

Reporting Requirement	Frequency
A. PROJECT MANAGEMENT	
1. Management Plan	one time - soon after contract award
2. Contract Management Summary Report	monthly - due 15 days after end of calendar month
3. Project Status Report	monthly - due 15 days after end of calendar month
4. Conference Record	as required
B. TECHNICAL INFORMATION REPORTING	
1. Technical Progress Report	as required

Reporting Requirement	Frequency
2. Final Technical Report	final, at end of contract
C. ADDITIONAL	
1. Environmental Report	An environmental report describing the potential environmental effects of the proposed project must be submitted to DOE after execution of the agreement and prior to drilling. One time only only, submit 4 copies.
2. Milestone Schedule	A time frame schedule defining trackable milestones used to measure progress in terms of schedule. This is to be submitted upon contract execution. One time only, submit 4 copies.
3. Well Cuttings	Three sample bags (3" x 5") of well cuttings will be collected as required by DOE. The cuttings will be filed and available to the public after well completion.
4. Logs	A copy of all logs is to be transmitted to DOE as available.
5. Daily Drilling Reports	A daily record shall be kept on the IADC Official Standard Daily Drilling report or other form standard to the drilling industry. The general remarks section

Reporting Requirement	Frequency
	shall contain an accurate record of hole conditions and work performed and time required for all work to the nearest quarter hour. A copy of the Daily Drilling report shall be provided. Daily verbal communication may be required to transmit this information. An additional daily record form may be required for transmittal.
6. Test Data	A copy of test data and of the analysis of these data is to be provided to DOE for reservoir assessment. The government will use these data for an independent evaluation to determine the degree of success of the well for purposes of determining the government cost-share.
7. Final Cost Report	A cost report submitted at program completion summarizing estimated and actual costs. This report will show the DOE cost share as evaluated by the previously negotiated variable-cost-share formula criteria. Submit 4 copies.
8. Fluid Samples	as required by DOE.

9. Exploration Data — A copy of the exploration data and the analysis of these data is to be provided to DOE.

Task 10. Dissemination of Information

Throughout the project, MRI and Gruy Federal shall prepare press releases and business and technical articles for trade journals as appropriate. DOE concurrence shall be obtained on all information prepared for public release prior to the release of this information.

MRI shall design and erect a sign in good taste and of appropriate construction at the facility, which will define the project objective and parties to the project.

With regard to written and oral public information, MRI and Gruy Federal shall:

A. include appropriate recognition of the roles of the principal parties involved in work performed under this Agreement;

B. avoid statements or implications that the Department of Energy endorses any process or product arising out of the contract, without advance approval of the Contracting Officer;

C. provide DOE one copy of news releases, information folders, brochures, advertisements, technical papers, and magazine or newspaper articles pertaining to work performed under the Agreement;

D. advise the Contracting Officer of news media or public reactions to work performed under the Agreement.

Task 11. DOE Conferences

MRI and Gruy Federal shall make available any project personnel requested by DOE to attend technical meetings, and shall also encourage and strive for oral and written reports, as requested in such meetings, that merit publication in professional journals.

6.a.(2) ORGANIZATIONAL ELEMENTS

MRI and its financial associates, Robert B. Gorham and John A. Wedum, have assigned Gruy Federal, Inc. the responsibility for siting, drilling, and testing the geothermal well for the Magic Hot Springs Landing confirmation drilling program. Gruy Federal has accepted this assignment on behalf of the Gruy Companies and will assure that the resources of the Gruy Companies will be made available for this program as required.

Figure 10 shows the three Gruy operating companies under Gruy Enterprises, with their founding dates, principal officers, and office locations. The Gruy Companies employ approximately 200 full-time persons plus a varying number of consultants and contract field personnel. During the past 30 years, they have completed more than 5,000 jobs pertaining to petroleum and other earth resources in 16 nations.

All the human and technical resources of the Gruy Companies can be made available for a particular task through Mr. Lane, president of Gruy Federal, Inc.

(i) Project Management Organization

MRI thoroughly understands the necessity to conduct the User-Coupled Confirmation Drilling Program in a prudent, safe, cost-effective, and productive manner that not only achieves the technical and socioeconomic objectives of the program but also remains unencumbered by adverse political reaction and publicity that could result from careless or mediocre performance.

We do not seek this work with a casual attitude toward its performance. We have designated a team of senior individuals each of whom is a professional

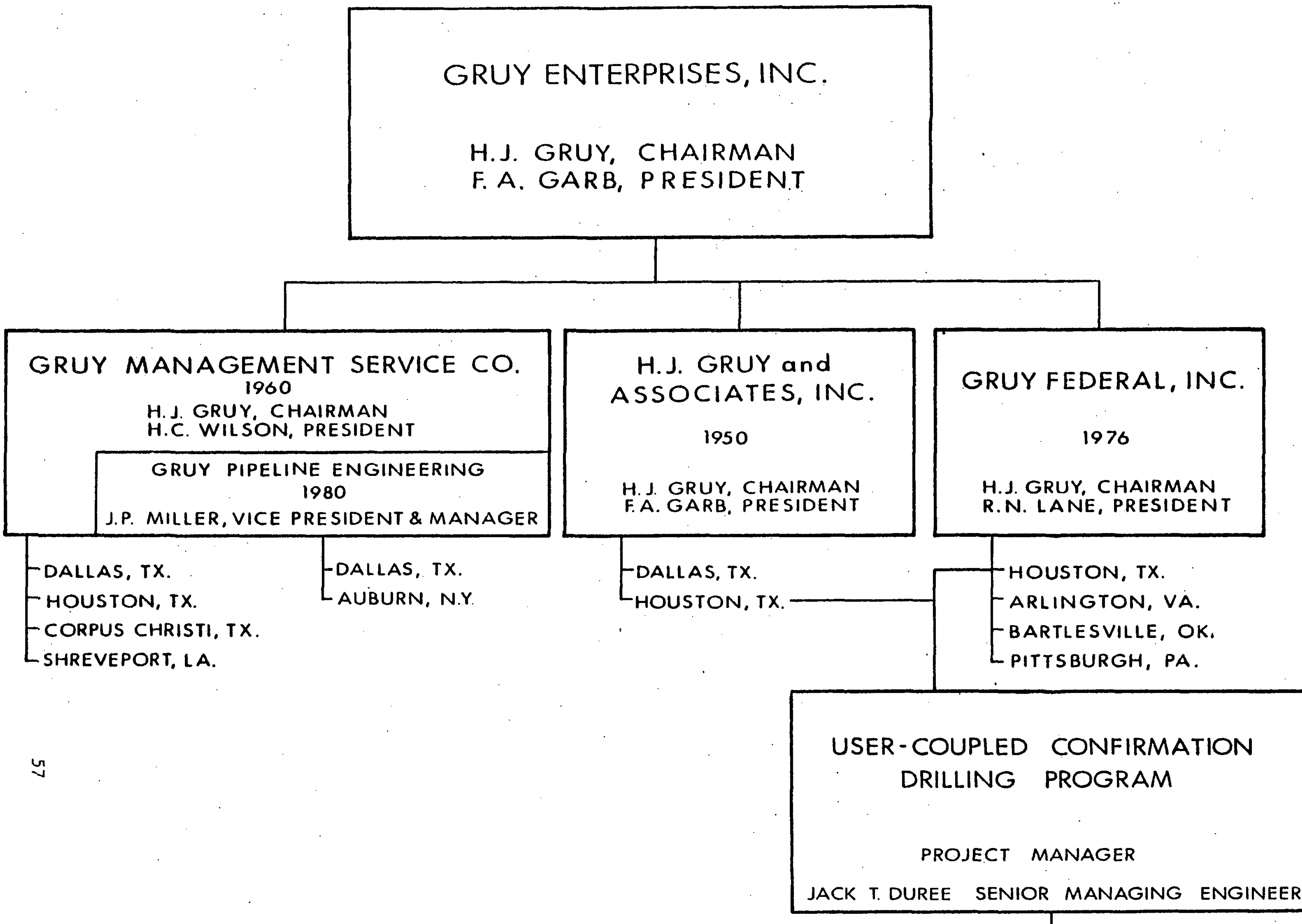


Figure 10 --Gruy Companies organization chart

See Figure 11

earth scientist or engineer who has served the Gruy Companies well on a number of relevant or related projects.

The functional management organization established by MRI and Gruy Federal, Inc. (GFI) for this geothermal confirmation drilling project is shown in Fig. 11. Mr. Duree of GFI heads a project staff under Mr. Kirkman of MRI. This staff consists of seven teams, six of which are led by senior personnel. The technical support team leader will be assigned at a later date.

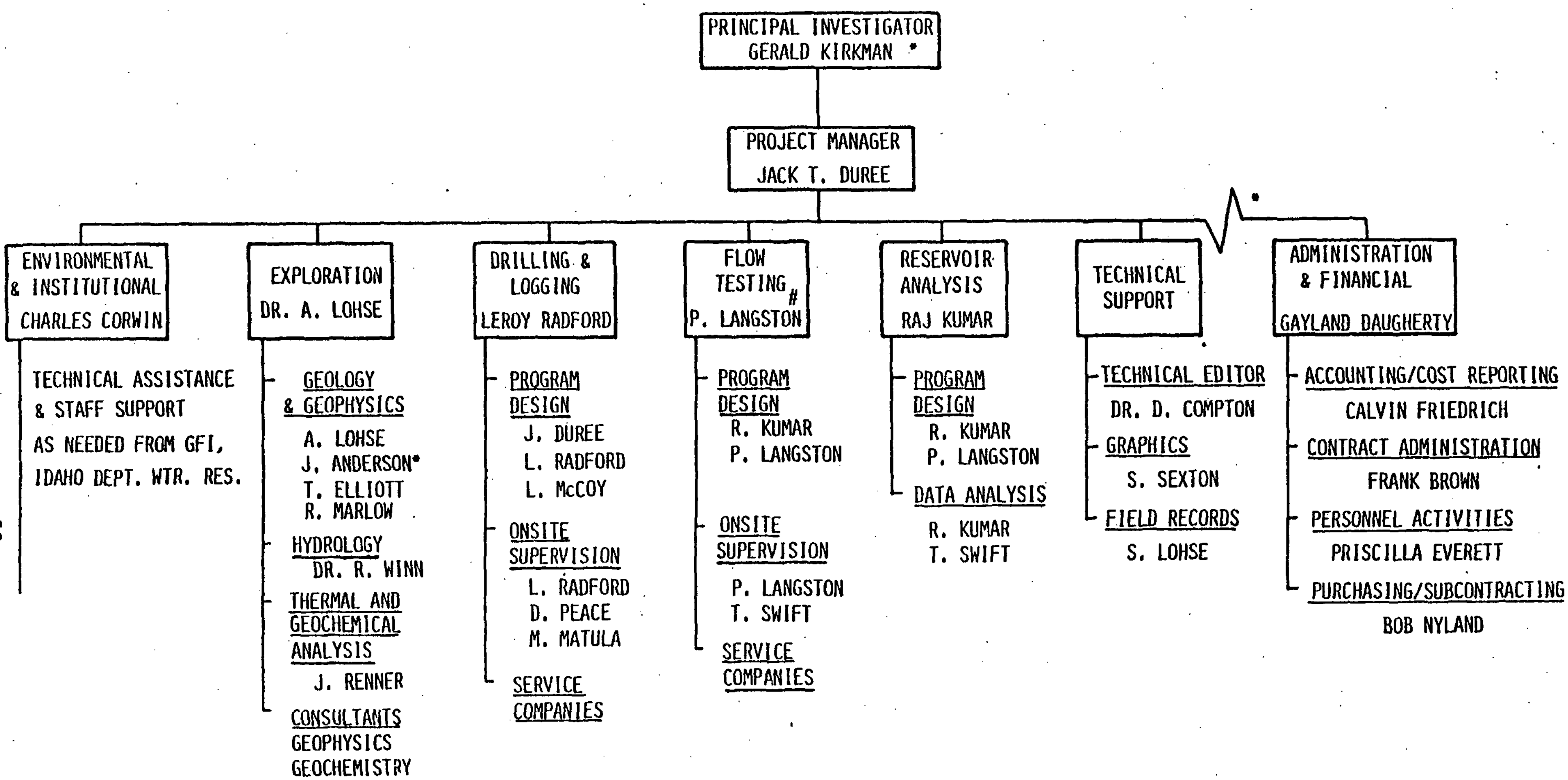
Excepting Mr. Charles Corwin, who comes to GFI's staff as a consultant for the Magic Hot Springs Landing confirmation drilling project from the position of chief engineer for Kirkman Realty Company in Ketchum, Idaho, each person in the project organization is a full-time employee of Gruy Federal. No additional persons will have to be hired.

Organization of the GFI Administrative and Financial Office for the project is shown in Fig. 12. Costs of support functions by this office are not charged directly to the project, but are covered by application of the G and A rate.

Mr. Kirkman will not receive salary or fee from this project. Mr. Corwin will be paid a standard consulting rate for the actual time he works, on the basis of a weekly time sheet approved by the Project Manager.

All key technical and support people are under the supervision of the Project Manager. They are the lead engineers or scientists: Corwin, Lohse, Radford, Langston, and Kumar. They are responsible for their individual team performance and report directly to the Project Manager; Daugherty in Administration and Finance operates independently of the project but is responsible for timely and accurate record keeping and reporting.

In the event that DOE or MRI cannot get satisfactory response from the Project Manager, appropriate contact can be made directly with R. N. Lane, president of Gruy Federal, Inc.



BACKUP PROJECT MANAGER
* NO DIRECT CHARGE

Figure 11--Magic Resource Investors and Gruy Federal management organization chart, User-Coupled Confirmation Drilling Program.

SERVICES COMPENSATED BY G & A RATE APPLICATION
EXCEPT IN FULFILLMENT OF TASK-SPECIFIC FUNCTIONS

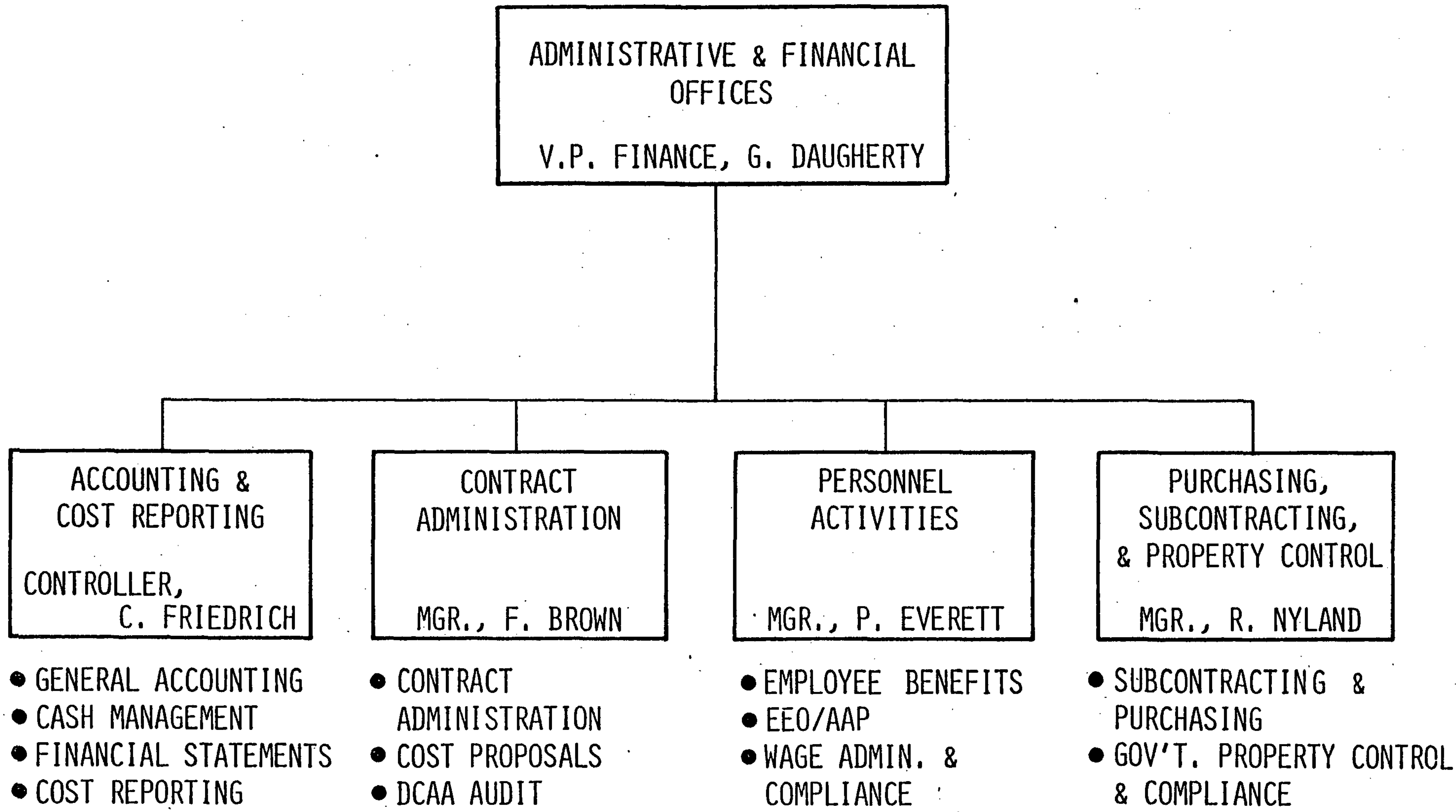


Figure 12--Organization and management, Gruy Federal administrative and financial offices.

(ii) <u>Project Manager</u>

Jack T. Duree, Senior Engineer for GFI and Senior Managing Engineer for confirmation drilling program work, is designated Project Manager, responsible for technical and administrative performance and accomplishment of all goals. This includes meeting short- and long-term work schedules, providing all reporting and deliverables, and achieving the budget. Mr. Duree will be MRI's point of contact with DOE for all technical and support work.

Mr. Duree's professional experience includes five years as manager of engineering for geothermal exploitation in the Philippines, during which time 103 geothermal wells were drilled to provide steam for four 110-megawatt generating plants. Before being assigned to the Philippines, Mr. Duree was manager for all reservoir engineering and exploitation geology for Union Oil Company's operations in Canada and Alaska.

The Project Manager will manage the project under a systems management program based upon (a) detailed technical and financial planning, control, and reporting; (b) clearly defined lateral and vertical delegation of authorities and responsibilities; and (c) accountability for individual and total performance.

This management program will include:

- time-scaled PERT/CPM network analysis of milestones to be accomplished with paths of work to be followed leading to responsible job completion;

- time-phased expenditure plan consisting of a set of baseline charts of

- projected average rate of expenditure (straight-line)
- projected average rate of commitment (stair-stepped)
- weekly/monthly incremental expenditure
- weekly/monthly incremental commitment;

- work breakdown structure comparing percent of physical progress of individual jobs between milestones with percent of allocated expenditure per job;

- job descriptions reflecting responsibilities, authorities, reporting procedures and position within overall program management;

- weekly staff meetings between work groups and/or teams and team leaders, to measure progress and coordinate future work, utilizing comparison of work progress and time-phased expenditure plan; identifying any problem areas that might require timely corrective action; and adjusting workloads or refocusing activity as necessary to maintain productivity commensurate with schedules, rates of expenditure, and fulfillment of short-term and long-term goals;

- monthly management meetings between team leaders and the Program Manager, utilizing the same procedures as the weekly meetings and open invitation always extended to other levels of MRI and GFI corporate management; and

- monthly meetings between the Program Manager and all appropriate levels of management in MRI and Gruy Federal, with lower levels of project management in attendance as requested.

Monitoring and management of the project includes weekly reports by the GFI Business Office to the Project Manager of incremental and cumulative man-hours, expenditures, and commitments.

(iii) Lead Technical Positions

Lead persons for the technical work are:

Charles Corwin, consultant to GFI, is responsible for environmental and institutional matters in fulfillment of Task 2. He will be assisted by Gruy Federal personnel and the guidelines of the Idaho Department of Water Resources. Mr. Corwin is a licensed civil engineer with 10 years' experience in construction, engineering, and environmental planning. He resides in Blaine County, Idaho.

Dr. Alan Lohse is GFI's executive vice president and principal scientist. He has more than 25 years of experience including 16 years in industry, principally with the Shell Oil and Monsanto Companies, and 9 years of directing contract research for the Corps of Engineers, U.S. Coast Guard, Energy Research and Development Administration, Environmental Protection Agency, Bureau of Mines, Department of Energy, and other Federal agencies. He has worked in all U.S. petroleum provinces, including the Rocky Mountain basins, and in many mining areas of central Mexico such as Catorce, San Luis Potosi, Charcas, and Zaragoza.

LeRoy Radford, GFI's senior engineer for drilling technology, will supervise all drilling and logging. Mr. Radford is a graduate geological engineer from the University of Oklahoma in 1941, and is a Registered Professional Engineer in Texas and Oklahoma. His experience is worldwide, including most of the continental United States and the Rocky Mountains, and includes the supervision of drilling more than 1000 wells. He was GFI's field superintendent for the Atlantic Coastal Plain geothermal drilling program.

Mr. Radford and his staff of onsite drilling supervisors, Marvin Matula and Dwight Peace, represent almost 100 years of cumulative experience in drilling, testing, and completion in all areas of the Free World, including many wells with temperatures in excess of 400°F and pressure gradients approaching 0.9 psi per foot, or approximately twice the hydrostatic gradient.

Paul Langston, senior drilling supervisor, is in charge of flow testing and conducting the well/reservoir test designed in conjunction with Mr. Kumar and Mr. Duree. Mr. Langston is a graduate engineer with 31 years' experience in all phases of field work from roughneck to operations manager. He has worked around the world, including supervision of deep geothermal wells in Texas, Louisiana, Venezuela, Near East, Indonesia, and Norway. Mr. Langston supervised a portion of Gruy Federal's testing of geopressured-geothermal wells in the Gulf Coast.

Raj Kumar, a senior petroleum engineer with GFI, will head the reservoir analysis program. Mr. Kumar conducted reservoir and economic studies for two years with the Oil and Natural Gas Commission in India before coming to the United States to complete his M.S. in management science and engineering. He joined the Gruy Companies in 1977 after two years of applying his economic and computer programming expertise in oil and gas production. Mr. Kumar's work for Gruy includes extensive work in pressure transient analysis and reserve estimation. He is currently project manager for GFI's gas well testing using flow tests and pressure transient data to evaluate the effectiveness of stimulation techniques in Devonian shales. Mr. Kumar works closely with the Gruy Companies' Research and Development group under Dr. James H. Hartsock, Senior Vice President, in developing and applying advanced calculation and interpretative methods to reservoir testing.

Gayland Daugherty is the Financial Services Manager for the confirmation drilling program. He is vice president of finance for GFI, responsible for accounting, contract administration, subcontract procurement, and personnel administration. He works closely with the Project Manager, providing him with weekly estimates of expenditures so that funding can be controlled and reported accurately. GFI's cost control procedures are computerized and provide excellent data on a weekly basis.

(iv) Manpower Assignments by Tasks

Table 9 lists specific manpower assignments and accountabilities by Task as set forth in the Statement of Work, Section 6.a.(1).

TABLE 9

MANPOWER ASSIGNMENTS BY TASK

Task 1: Financial

- • J. Kirkman #
- G. Daugherty ∇

Task 2: Environmental and Institutional

- • C. Corwin
- J. Duree and staff
- IDWR #

Task 3: Exploration

- • A. Lohse
- J. Anderson
- T. Elliott
- R. Winn
- J. Renner
- R. Marlow
- UURI #

Task 4: Drilling and Logging

- • L. Radford
- D. Peace
- M. Matula
- L. McCoy

Task 5: Flow Testing

- • P. Langston
- R. Kumar
- T. Swift

Task 6: Injection Well Drilling

- • L. Radford
- D. Peace
- M. Matula

Task 7: Determination of Cost Share

- • J. Kirkman
- G. Daugherty ∇
- J. Duree and staff

Task 8: Project Management

- • J. Duree and staff

Task 9: Reporting

- • J. Duree and staff

Task 10: Dissemination of Information

- • J. Kirkman - news media #
- • J. Duree and staff - technical papers

no direct charge

∇ direct charge for task-specific functions

• lead

6.a.(3) Consultants and Contractors

Table 10 lists the consultants and contractors proposed to be used for the Magic Hot Springs Landing reservoir confirmation project, and their function in the project.

Mr. Corwin, as a longtime consultant to MRI, is a principal in developing the Magic Hot Springs Landing project to the present stage of readiness for the DOE reservoir confirmation program. He is thoroughly familiar with the region, the area, and all local facilities and resources. Mr. Corwin will join the MRI Project Management staff as consultant to GFI in order to work hand-in-hand with the total technical and financial support organization.

All Contractors listed in Table 10 will be obtained on the basis of best price with respect to availability and experience.

GFI is thoroughly familiar with the qualifications of each type of service contractor customary to the oil and gas and geothermal industries, and also with those extra capabilities that set apart the leaders in each type of service work. We shall strive to obtain those leading companies. We are also aware of the requirement for and shall be prepared for a post-project audit.

6.a.(4) Work Schedule

The Magic Hot Springs Landing reservoir confirmation project is expected to be completed within 14 consecutive months if the project can commence in time to avoid restrictive winter weather and conflict between our necessary housing and supportive requirements, on the one hand, and the commitment of similar services to winter visitors throughout the area, on the other.

The most suitable period for outdoor work is approximately April 1 to November 1. This period will be utilized if the contract can commence January 15, 1981, following a September 15, 1980, submittal. During that period, work is expected to proceed along the paths from milestone to

TABLE 10

CONSULTANTS AND CONTRACTORS PROPOSED FOR PROJECT

Name or Use	Position	Function
Charles Corwin	Team Leader, Environmental and Institutional. Consultant to MRI/GFI. Resident of Blaine County, Idaho.	Fulfill institutional considerations pertaining to right of access, leases, ownership, rights to use of water and related resources; prepare Environmental Report; Task 3. Further, assist all field operations as required in permits, local contractor resources, site preparation, cleanup, etc.; Tasks 3, 4, 5, 6.
Land Surveyor	Local licensed surveyor	Survey geophysical lines, test hole and production well sites.
Geophysical Survey	Contractor/consultant	Conduct geophysical surveys along preselected tracks, maintain quality control, provide completed job with interpretations. At this point we are discussing methodologies with Seiscom Delta, a major worldwide geophysical company whose work is well known to GFI.
Sign preparation	Local sign manufacturer and painter	Prepare and install appropriate sign(s) in test site area as specified by MRI.
Prepare thermal gradient holes	Drilling contractor	Drill and complete thermal gradient holes as specified.
Log thermal gradient holes	Well testing contractor	Provide equipment and operators; log thermal gradient holes with downhole equipment and methods specified by MRI; repeat each hole three times over period of monitoring; provide data satisfactory for analysis.
Site preparation	Local bulldozer operator	Provide equipment and operator to prepare sites for test holes and production well; restore all sites as prescribed, support geophysical equipment if necessary.

TABLE 10
continued

Name or Use	Position	Function
Drill and complete production test well	Drilling contractor	According to prognosis, drill and complete the reservoir confirmation well maintaining MRI environmental and safety standards; provide, maintain, and operate equipment during period of contract performance without lost time; provide satisfactory onsite supervision; other duties as specified in the contract or conventional to the industry.
Tool rental	Tool rental service company	Provide tools necessary to production well drilling and testing; deliver and service as required.
Mud logging	Mud logging service company	Provide and operate mud logging unit as specified.
Downhole logging	Wireline downhole logging service company	Provide and operate tools necessary to obtain downhole logs specified.
Water analyses	Chemical analysis service company	Conduct water analyses as specified within prescribed ranges of accuracy and tolerance; report results in conventional form or as specified, together with detailed descriptions of analytical methods sufficient for third party inquiry of methodologies and results.

milestone as shown graphically in the Project PERT/CPM* Network Plan, included in the pocket inside the back cover of this proposal.

All project schedule diagrams are time-scaled in 7-day project weeks, and all times are given in weeks.

The project work schedule is shown on three other diagrams in addition to the PERT/CPM Network Plan. These are:

- Project Milestone Schedule, Part A (Fig. 13) showing project dates for completion and reporting of Tasks and Milestones from beginning to end, without an injection (disposal) well,

- Project Milestone Schedule, Part B (Fig. 14) showing project dates for completion and reporting of Task 6, Injection Well Drilling, if Task 6 becomes necessary,

- Project Milestone Schedule, Part C (Fig. 15) showing dates for completion of Task 9, Reporting, and fulfillment of the schedule for all reporting and deliverables.

In summary, the project is expected to be conducted as shown on the PERT/CPM plan, and on Milestone Schedules A and C (without injection well) or B and C (with injection well).

As shown in the PERT chart legend, boxes on the chart represent project milestones, or work accomplished. These milestones can be cross-referenced to the proposal Table of Contents and to the Tasks in the Statement of Work. The arrows connecting the boxes represent activity necessary to achieve the milestones. Numbers on the activity arrows are the time estimates in project weeks for completing the work. These estimates are best guesses, arrived at in consultation with team members.

The PERT/CPM Network Plan is also a logic diagram of the project.

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*Project Evaluation and Review Technique/Critical Path Method

MRI MAGIC HOT SPRINGS LANDING USER-COUPLED CONFIRMATION DRILLING PROJECT
PROJECT MILESTONE SCHEDULE - PART A
PROJECT SUMMARY

TASK #	MLSTN ID#	MILESTONE DESCRIPTION
1	100	FINANCIAL ARRANGEMENTS
2		ENVIRONMENTAL/INSTITUTIONAL
2	220	ENVIRONMENTAL REPORT
2	210	PERMITS, LEASES, RIGHTS
2	200	DOE APPROVAL
3		EXPLORATION
3A2	370	GEOL/GEOPHYS DATA/ANALYSIS
3A3(A)	360	THERMAL GRADIENT SITES
3A3(B)	340	DOE APPROVAL
3A3(E)	320	THERMAL GRADIENT WELLS
3B1	310	WELL DATA/ANALYSIS
		DECISION POINT #1
3B2	300	WRITTEN AGREEMENT
3B3	410	PRODUCTION WELL SITE
		DECISION POINT #2
3D3	400	WRITTEN AGREEMENT
4		DRILLING/LOGGING (PRODUCTION WELL)
4A2	560	DRILL PROGRAM UPDATE
4A3	540	DOE APPROVAL
4B3	520	PRODUCTION WELL
4B5	510	PRODUCTION WELL DATA
		DECISION POINT #3
4B6	500	WRITTEN AGREEMENT
6		INJECTION WELL NOT NECESSARY
5		FLOW TESTING
5A2	640	TEST PLAN UPDATE
5A2	630	DOE APPROVAL
5A3	620	FLOW TEST
5A4	610	TEST DATA/ANALYSIS
		DECISION POINT #4
5A4	600	WRITTEN AGREEMENT
7	700	COST SHARE DETERMINATION
9		REPORTING (DELIVERABLES) SEE MILESTONE SCHEDULE PART C

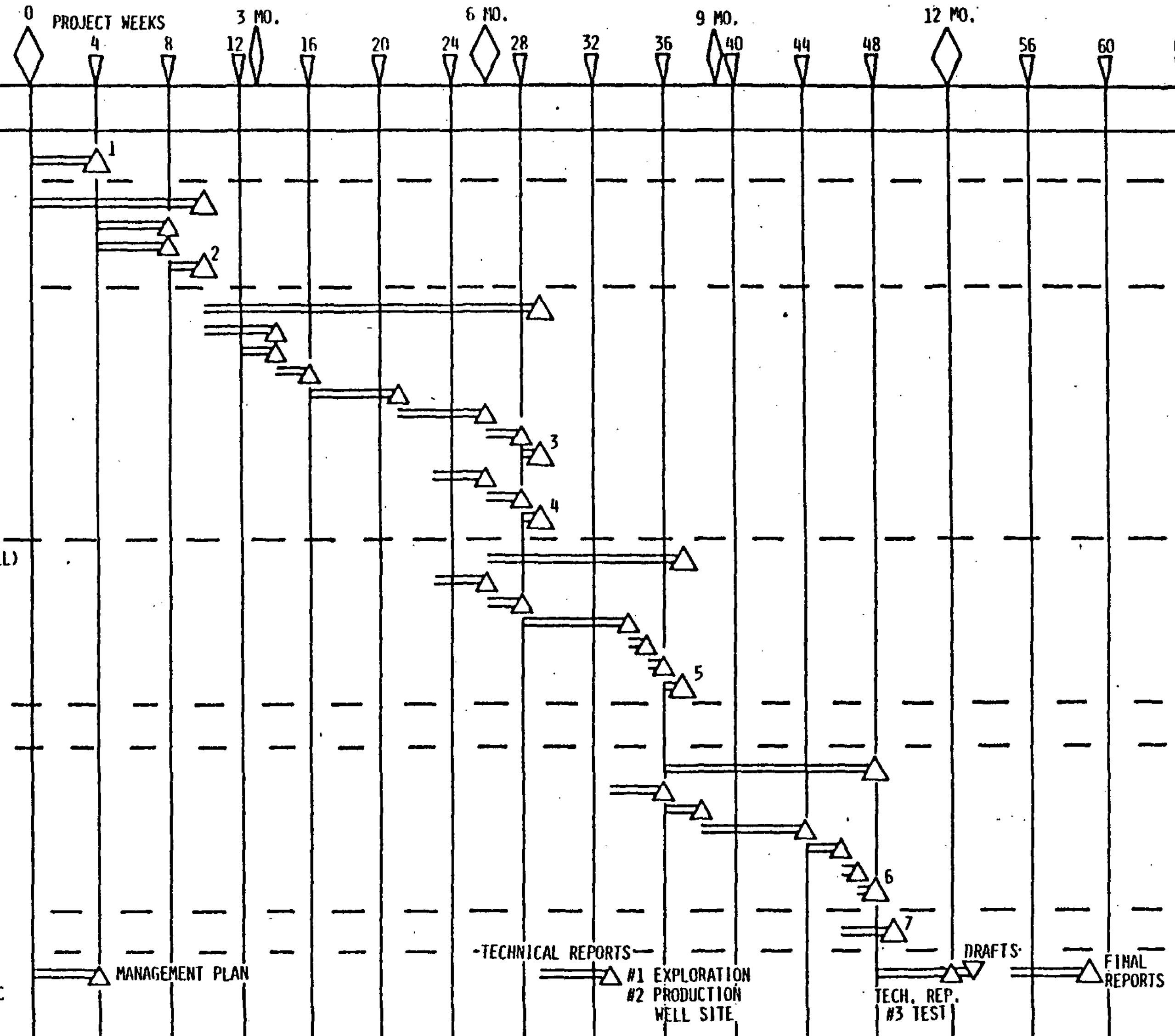

Figure 13--Project Milestone Schedule - Part A - Project Summary.

MRI MAGIC HOT SPRINGS LANDING USER-COUPLED CONFIRMATION DRILLING PROJECT
PROJECT MILESTONE SCHEDULE - PART B
TASK 6 - INJECTION WELL NECESSARY

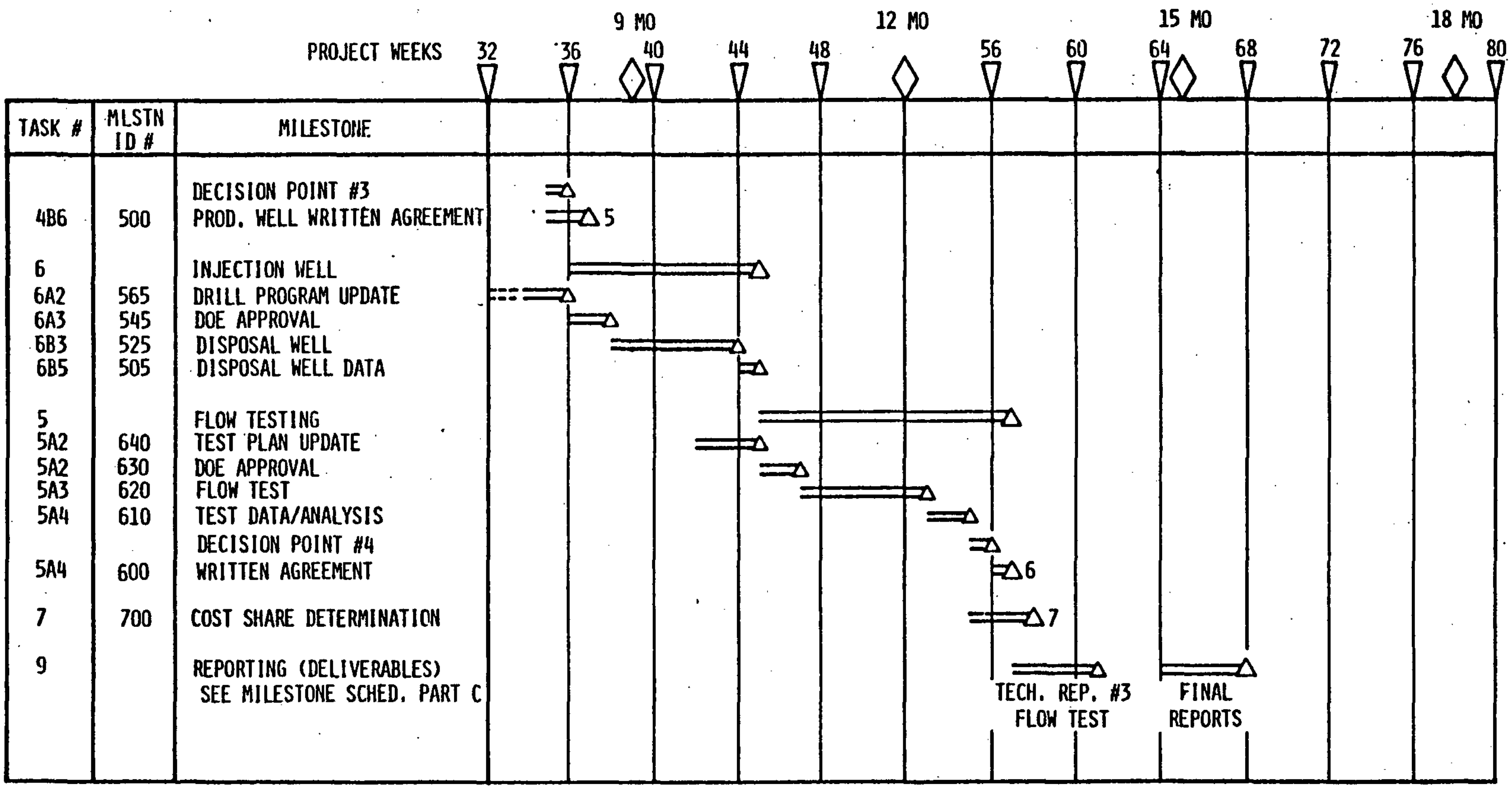

Figure 14--Project Milestone Schedule - Part B - Task 6 - Injection Well Necessary.

MRI MAGIC HOT SPRINGS LANDING USER-COUPLED CONFIRMATION DRILLING PROJECT
PROJECT MILESTONE SCHEDULE - PART C
TASK 9 - REPORTING AND DELIVERABLES

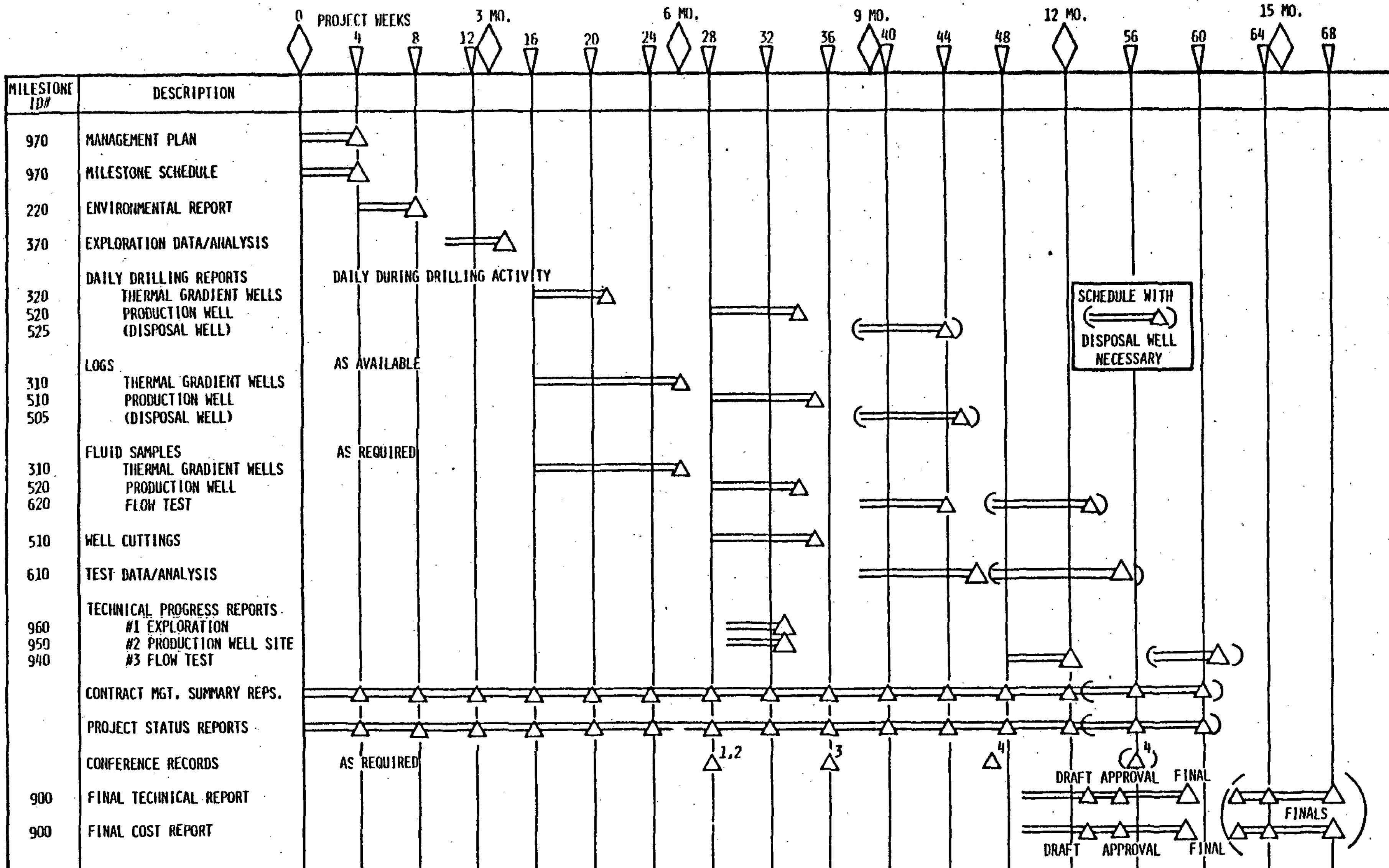

Figure 15--Project Milestone Schedule - Part C - Task 9 - Reporting and Deliverables.

Milestone triangles and activity bars on the Milestone Schedules are the equivalents of boxes and arrows on the PERT chart.

Each PERT chart milestone box contains three numbers or identifiers:

- The number in the lower right corner is the milestone identification number based on the seven major milestones described in the Statement of Work (see Section 6.2.(1)). The notation uses 100 for milestone 1, 200 for milestone 2, etc., to accommodate intermediate and minor accomplishments.

- The number at the upper right corner is the expected cumulative project time of completion of that milestone (the optimum time). From milestone #640 to project completion, the numbers below the slashes are expected later completion times for each milestone should the injection well option become necessary.

- The Milestone Schedule Part A (Fig. 13) is based on PERT chart time without the injection well option; the entire program is estimated at 59 weeks to completion, final reports delivered. Milestone Schedule Part B (Fig. 14) is based on PERT chart time with the injection well option.

- The number at the lower left corner is the Statement of Work Task number, which cross-references with the Milestone Schedules.

A brief description of the Magic Hot Springs Landing geothermal project as plotted on the PERT chart follows.

Task 1 of this project is complete with the confirmation of the Financial Arrangements, milestone #100, at 4 weeks.

Task 2, Environmental/Institutional, is complete at 10 weeks with DOE approval, milestone #200, of the Environmental Report and the lease, permit, and rights arrangements.

Task 3, Exploration, is complete at 29 weeks with the Exploration Data Adequacy Written Agreement, milestone #300, and the Production Well Site Written Agreement, milestone #400. This task includes acquiring and analyzing the exploration data, selecting the thermal gradient drill sites, and submitting these with the bid specifications and proposed subcontracts for DOE approval, milestone #340 at 16 weeks. After approval, the thermal gradient wells are drilled and monitored, the data collected, analyzed, delivered, and passed through Decision Point #1 at 28 weeks to the Exploration Written Agreement, #300.

Simultaneously, and using from the analysis of the thermal gradient data, a site will be selected for the production well, milestone #410 at 26 weeks. This selection will be passed through Decision Point #2 at 28 weeks to the Well Site Agreement, #400. Should either Decision Point result in a "no-go" decision, the agreement will be terminated at 28 weeks. Should both decisions be "yes-go", the decisions and data will input to the production well phase of the project, along with early Task 4 work.

Task 4 begins with updating the Production Well Drill Program, milestone #560 at 26 weeks, following thermal gradient data delivery and production well site selection from Task 3. The updated program, bid specifications, and proposed subcontracts are submitted for DOE approval, milestone #540 at 28 weeks. Following approval, this work, combined with Task 3 data and decisions, feeds into drilling and completion of the production well, milestone #520 at 34 weeks. The production well data are delivered into Decision Point #3 and on to the Production Well Written Agreement, milestone #500 at 37 weeks, which completes Task 4.

Following delivery of the production well data and Decision Point #3, Task 5 begins with updating the Flow Test Plan and tentatively arranging for testing services. This will be carried out simultaneously with production well completion and data delivery. This plan and the tentative arrangements are submitted for DOE approval, milestone #630 at 38 weeks. After approval, the flow test is initiated at 38 weeks and completed at 44 weeks, milestone #620. The flow test data are analyzed and delivered at 46 weeks, milestone #610, and passed through Decision Point #4 at 47 weeks to the Flow Test Written Agreement, milestone #600, at 48 weeks. This completes Task 5.

Task 6, Injection Well, is built into the project as an optional task. Should it become necessary to go to subsurface disposal, the disposal well module (see insert in PERT chart) will be inserted at 36 weeks, immediately before milestone #640. This will back up all completion dates from this point by 9 weeks. (See Milestone Schedule Part B, Fig. 14, for schedule details.)

Task 7, the Determination of Cost Shares, begins at 46 weeks with the input of the test data, the decisions from the Test Agreement, and the data and decisions from all previous tasks and Written Agreements. Task 7 should be complete by 49 weeks, milestone #700.

The Final Draft Technical and Cost Reports will synthesize the data and decisions from all previous task work, Technical Progress Reports, and the Cost Share Determination. The drafts should be delivered by 53 weeks and, following DOE approval, the final reports should be delivered at 59 weeks. With the injection well module inserted into the schedule, final reports and project completion would be at 68 weeks.

MRI will use the PERT/CPM and the Milestone Schedules for continuous monitoring and assessment of project progress, funds and labor expenditure, and reporting.

Funding and manpower estimates are coordinated with these schedules and milestones, and are easily planned and monitored along with progress. For reporting purposes a summary version of the Milestone Schedule is included with the monthly letter report; both charts are revised and updated as necessary.

6.b.(1) GRUY FEDERAL'S EXPERIENCE WITH RELEVANT OR RELATED PROJECTS

(i) Descriptions of Selected Projects

Selected projects are described in which Gruy Federal, Inc. has total responsibility, illustrative of our ability to organize and conduct large and complex projects.

1) Resource Assessment of Gulf Coast Geopressured-Geothermal Fairway

Technical Project Officer - R. T. Stearns 702/734-3424
DOE/Nevada Operations Office
Las Vegas, Nevada 89114

DOE Contracting Officer - Robert W. Taft 702/734-3251
DOE/Nevada Operations Office
Las Vegas, Nevada 89114

Contract No. DE-AC08-77ET28460
Awarded September 26, 1977 - closing April 30, 1980
Contract amount: $15,000,000
Contract type - cost plus a fixed fee

Gruy Federal was selected by DOE's Geothermal Division to undertake the identification, qualification, acquisition, planning, drilling and testing, and interpretation of wells in the geopressured-geothermal formations in the Texas and Louisiana Gulf Coast. Gruy was responsible for obtaining the support services required to accomplish all work at each well location and for all phases of the program. Two wells were completed and tested (Fairfax Foster Sutter No. 2 and Beulah Simon No. 2) and one is under joint operations by Gruy Federal and Tenneco (Tenneco Fee "N" No. 1). One wildcat exploration well was also taken over by Gruy Federal in Georgia, and drilled and cored into basement rocks for a geothermal test. This contract has more than 600 subcontractors; the major ones are shown below.

Progress Drilling Co.	$ 360,000
Ashey Enterprises	263,665
Smith Pipe & Supply	1,282,167

Oilquip	145,244
American Well Service	192,000
Weatherly Engineering	624,119
Tenneco	500,000
Gray Tool Co.	304,478
Delta Drilling	483,990
Sooner Pipe & Supply	257,203
Atlanta Pacific Marine	400,000
W-K-M	147,621
Halliburton	297,007
Schlumberger Well Services	214,932
Patterson Rental Tools	348,890

Engineering consultants: O'Brien-Goins Engineering, Inc.
Bill Laurence, Inc.

2) <u>Atlantic Coastal Plain Geothermal Drilling Program</u>

Technical Project Officer - R. T. Stearns 702/734-3424
DOE/Nevada Operations Office
Las Vegas, Nevada 89114

DOE Contracting Officer - James B. Cotter 702/734-3251
DOE/Nevada Operations Office
Las Vegas, Nevada 89114

Contract No. DE-AC08-78ET28373
Awarded April 17, 1978 - closing December 1979
Contract amount: $4,890,000

Gruy Federal completed a hydropressured geothermal exploration and evaluation project for DOE. Under this contract, Gruy supervised the drilling of fifty 1000-foot holes along the Atlantic Coastal Plain from New Jersey to northern Florida. Two 25-foot cores were taken in each test hole. Gruy Federal also did all leasing, permitting, and site-specific environmental assessment for the 50 locations. These holes were used by scientists from

Virginia Polytechnic Institute & State University to measure thermal gradients and heat conductivity, seeking to locate anomalous heat sources in the basement rocks. From results of these studies, a site was selected for a 5000-foot test well on the eastern shore of Maryland near Crisfield. This well was drilled by Gruy Federal in April 1979 to investigate possible exploitation of geothermal resources. The final report on this project was completed in October 1979.

A total of 175 subcontracts were placed by Gruy Federal. Those with a value of over $100,000 are shown below.

Energy Service Company	$ 1,071,348
Halliburton	113,000
Smith Pipe & Supply	223,589
Rowan Drilling	360,000
Oilquip	156,742

3) Palo Duro Basin Drilling Program

Technical Project Officer - Robert B. Laughon 614/424-4268
Battelle Memorial Institute
Columbus, Ohio 43201

Battelle Contracting Officer - J. W. Holcomb 614/424-4488
Officer of Nuclear Waste Isolation
Battelle Memorial Institute
Columbus, Ohio 43201

Subcontract No. E-512-01700
Awarded April 21, 1978 Completed December 1979
Contract amount: $1,740,500

Gruy Federal was selected to manage a project to drill and core two 4000-foot wells in the Palo Duro Basin. Gruy was responsible for overall project management and supervision of all services necessary to drill and core the wells from the grass roots to 4000 feet. Cores obtained from this project are to be analyzed by the Bureau of Economic Geology at The University of Texas. Approximately 8000 feet of core was delivered to the BEG under this contract.

A total of 62 subcontracts were placed during Gruy's management of the Palo Duro Basin Drilling program. Those with a value of over $75,000 are shown below.

Earth Sciences Company	$ 130,643
Megargel Drilling Company	340,000
Hycalog	80,730
Imco Services	83,812

4) <u>Target Reservoirs for Carbon Dioxide Flooding</u>

Technical Project Officer - Royal Watts 304/599-7218
Morgantown Energy Technology Center
Morgantown, West Virginia 26505

DOE Contracting Officer - Bill Bowser 304/599-7241
Morgantown Energy Technology Center
Morgantown, West Virginia 26505

Contract No. DE-AC21-79MC08341.
Awarded: March 5, 1979
Initial funding: $2,714,000
Contract type: cost plus a fixed fee

Gruy Federal is currently working on a DOE-funded project to select target reservoirs for tests of enhanced oil recovery by carbon dioxide flooding. The work involves evaluating the results of field tests of the method; screening carbonate reservoirs in West Texas, southeast New Mexico, and the Rocky Mountain area to select the most promising carbonate reservoirs in which to conduct additional tests; selecting specific sites for 8 to 12 test wells; supervising drilling and coring of the test wells; and interpreting the results with respect to advancing the state of the art. Pressure-coring of the first well in West Texas has been completed under this contract.

To date about 75 subcontracts have been issued during the progress of Gruy's contract. Those with a value of more than $75,000 are shown below.

Diamond Oil Well Drilling Co.	$ 124,960
Core Laboratories, Inc.	82,980

5) Collect Core Material and Log Devonian Shale Wells (EGSP)

Technical Project Officer - Charles W. Byrer 304/599-7547
Morgantown Energy Technology Center
Morgantown, West Virginia 26505

DOE Contracting Officer - Bill Bowser 304/599-7241
Morgantown Energy Technology Center
Morgantown, West Virginia 26505

Contract No. DE-AC05-79MC08382
Awarded: March 27, 1979 Estimated closing: April 1981
Current funding: $2,720,000
Contract type: cost plus a fixed fee

Gruy Federal has been awarded a contract to collect core material and geological data on the gas-bearing Devonian shales of the Appalachian region under the DOE's Eastern Gas Shales Program. The project requires the collection of cores and data from 22 wells in 11 states. Gruy Federal will be responsible for identifying specific well sites on the basis of geological and engineering data, designing each test well and the testing program, securing drilling subcontractors, supervising all drilling and coring operations, collecting and organizing the required cores and data, and synthesizing all geological, geophysical, and engineering data into a complete report on the gas potential of each test site. The objective of the project is to advance the assessment of the Devonian shales to a point where their resource potential can be utilized. The first test well under this contract has been cored and logged, the data will be available soon.

About 95 subcontracts have been placed so far. Those exceeding $75,000 are shown below.

Gordon T. Jenkins	$	172,937
Thomas W. Angerman		105,000
Falcon Drilling Co.		100,301
The Peoples Natural Gas Co.		80,140
Christensen Diamond Projects		120,334

(ii) Company Experience On Other Relevant Projects

1) Eastern Gas Shales Testing Program

The Department of Energy, Oak Ridge/Operations, and Morgantown Energy Technology Center selected Gruy Federal to perform gas well testing in Devonian shale gas reservoirs. The work is being done in two phases. In Phase I, Gruy designed and developed a practical, cost-effective field procedure for testing Devonian shale wells and analyzing the test data according to Department of Energy specifications. Gruy has completed the field testing required under Phase I. Phase II will consist of one year of gas well testing and test analyses in support of DOE's Eastern Gas Shales program. Twenty wells which have undergone stimulation by hydraulic or explosive fracturing will be tested in Phase II.

Contract No. DE-AC21-78MC08096
Awarded April 17, 1978 — Contract amount $704,200
DOE Contracting Officer: Larry Shydlosky DOE/METC 304/599-7243

2) Polymer-Enhanced Waterflood Program

Under contract to DOE/Bartlesville Energy Technology Center, Gruy Federal conducted a detailed study of the Burbank-Bartlesville sand reservoir in Osage County, Oklahoma, evaluating the results of a polymer-enhanced waterflood program for enhanced oil recovery. Gruy reviewed the geological and engineering characteristics of the Mid-Continent fields now under waterflood, determined the reservoir parameters for waterflooding, and evaluated the overall cost effectiveness of the polymer-waterflood program. Project work has been completed and the final report has been submitted.

Contract No. EW-78-C-19-0026
Awarded June 12, 1978 Contract amount $100,000
DOE Contracting Officer: Marty Lowe DOE/BETC 918/336-2400

3) <u>CO_2 Enhanced Oil Recovery</u>

DOE's Morgantown Energy Technology Center contracted with Gruy Federal to study enhanced oil recovery by carbon dioxide injection in 57 reservoirs in West Virginia. Gruy's tasks included making a detailed analysis of important reservoir parameters, evaluating potential production from these reservoirs by CO_2 injection, and interpreting the results of field tests of the method. This project is complete, and a final report was submitted in May 1979.

Contract No. EF-78-05-5602
Awarded December 12, 1977 Contract amount $100,000
DOE Contracting Officer: A. H. Frost, Jr. DOE/Oak Ridge, TN 715/483-8611

4) <u>Geothermal Direct Use Study Integration</u>

Gruy Federal has completed, under contract to DOE, a study integrating the results of 17 recently completed geothermal studies which investigated the engineering feasibility of a variety of industrial applications of geothermal energy. Gruy Federal analyzed the economics of these processes on a consistent basis and identified the geologic and thermodynamic characteristics that affect the commercial attractiveness of the various applications. The final report on the project was submitted in June 1979.

Contract No. ET-78-C-03-2072

Estimated Cost Plus Fee $72,147

DOE Contracting Officer: Robert M. Tomihiro DOE/SFO 415/273-7916

5) Resource Definition of the Eastern Geothermal Region

A Gruy Federal earth sciences team is conducting a study for the DOE aimed at defining areas of domestic geothermal potential. After completing a preliminary evaluation from available geological information, the team will identify those areas where further examination appears warranted. Gruy Federal will then conduct individual in-depth analyses of these areas to develop geologic models that could account for subsurface sources of geothermal energy and suggest specific technical approaches for verifying the models. The technical team based in Gruy Federal's Arlington office conducts this work.

Contract No. DE-AC08-78ET28373

Contract amount $350,000

DOE Contracting Officer: James B. Cotter DOE/NVO 702/734-3200

Technical Project Officer: Dr. Gerald Brophy 202/376-4898

This project continues under a new contract:

Contract No. DE-AC08-80NV/0072

Contract amount $229,204

Technical Project Officer: Joe Fione DOE/NVO

Expires October 31, 1980

(iii) Experience In Environmental Studies

Gruy Federal is familiar with environmental assessments for geothermal and many other natural resource and land use operations. We have the capability to provide either site-specific or generic information for evaluating impacts of conventional or esoteric energy-related operations. We also understand the necessity for environmental quality assurance in all field operations, and our field personnel are trained to follow the highest standards of environmental safeguard and worker safety prescribed by the International Association of Drilling Contractors, American Petroleum Institute, and the numerous state agencies with whom we have worked. We require the same standards from our contractors.

Gruy's environmental experience includes the full spectrum of data compilation, analysis, and judgment required for major energy development and commercialization programs, gained through experience in such programs as:

- site-specific environmental reports for thermal gradient measurement holes drilled and cored to approximately 1000-foot depths in eight states along the Atlantic Coastal Plain, many located in wetlands and state or federal refuges, preserves, parks, or military establishments;

- site-specific environmental report for a 5000-foot geothermal production well drilled on the Delmarva Peninsula, Maryland, adjacent to wetlands;

- site-specific environmental requirements for underground coal conversion in Wyoming, coal degasification in Pennsylvania, and tar sand in-situ combustion in Kentucky;

Gruy Federal's staff now includes personnel with experience in:

- assessment of environmental effects associated with enhanced oil recovery technologies in onshore, wetlands, and offshore provinces;

- assessment of environmental effects associated with onshore and offshore drilling;

- criteria for location of nuclear power plants;
- criteria for location of nuclear waste storage facilities;
- the Tennessee-Tombigbee Canal Project in Alabama, Tennessee, and Kentucky;
- river basin studies for flood control projects in Texas coastal environments;

Many of these programs required permitting through local county or district offices, monitoring and final reporting of field operations, and final cleanup of drill sites and other surface restoration.

The staff available within the Gruy organization and its consultants are familiar not only with basic [redacted] but with a variety of formats and regulations that have evolved for reporting environmental effects and fulfilling the requirements and the intent of NEPA, such as:

- Geothermal Steam Act of 1970,
- Clean Air Act of 1970,
- Marine Protection Research and Sanctuaries Act of 1972
- Federal Water Pollution Control Act Amendments of 1972,
- Solid Waste Disposal Act of 1972
- Noise Control Act of 1972
- Coastal Zone Management Act of 1972
- Endangered Species Act of 1973
- Geothermal Energy Research, Development, and Demonstration Act of 1974
- Archeological and Historical Preservation Act of 1974
- Federal Non-Nuclear Energy Research and Development Act of 1974
- Antiquities Act of 1906
- Historic Preservation Act of 1935
- Historic Preservation Act of 1966
- Rivers and Harbors Act of 1899 (The Refuse Act)

- Fish and Wildlife Coordination Act
- FAA regulations to prevent obstruction of air commerce.

The Gruy Federal staff includes experience as principal investigator in environmental assessments especially related to the drilling of production and injection wells, and enhanced oil recovery processes in onshore, coastal, near-shore, and continental shelf environments, including probable adverse or beneficial impacts of related activities such as transportation, storage, and field operations. A significant study involving input from major coastal and offshore oil and gas operators was conducted for the Environmental Protection Agency in 1975.

The extensive activities in project design, oil and gas field operation, and pipeline applications conducted by H. J. Gruy and Associates and Gruy Management Service Company in the states of New York, Texas, Louisiana, Oklahoma, Kansas, Colorado, and California also provide many years of direct experience with specific operational procedures that must be considered in environmental assessments.

(iv) Gruy Companies Overall Experience

The Gruy Companies consist of H. J. Gruy and Associates, Gruy Management Service Company and its subsidiary Gruy Pipeline Engineering, and Gruy Federal. These companies have performed more than 5,000 technical assignments for clients all over the world, and currently are engaged in more than 200 tasks for energy producers, transporters, utilities, and the Federal government. All of these projects are considered to be prime contracts.

Table 11 lists Gruy Company clients during the past three decades, excepting recent international work. These clients range from individual oil operators to major oil companies, state and Federal agencies, and financial institutions.

TABLE 11

GRUY COMPANIES' CLIENTS
OPERATING, PRODUCING, MANAGING COMPANIES

Ada Oil Exploration Company
The Aerospace Corporation
State of Alaska
American Natural Gas Production Company
American Petrofina, Inc.
Amoco International Oil Company
Amoco U.K. Ltd.
Apco Oil Corporation
Arabian Oil Company, Ltd.
Armco Steel Corporation
Ashland Oil, Inc.
Atlantic Richfield Company
Austral Oil Company
Aztec Oil and Gas Company
Battelle Memorial Institute
Bechtel Corporation
Bordon Company
Bradco Oil & Gas Company
R. L. Burns Corporation
Buttes Gas & Oil Company
Cabot Corporation
Cenard Oil & Gas Company
C F Industries, Inc.
Jerry Chambers
Champlin Petroleum Company
Cities Service Company
Cities Service Gas Company
Cities Service Oil Company
Cleary Petroleum Corporation
Clinton Oil Company
Coastal States Gas Company
Colorado Interstate Gas Company
Commonwealth Oil Refining Company, Inc.
Continental Oil Company
Edwin L. Cox
CRA, Inc.
Crown Central Petroleum Corporation
Damson Oil Corporation
Davis Brothers Oil Company
DeCalta International Corporation
Devon Corporation
Diamond Shamrock Oil & Gas Company
Kenneth Dunn
ELF-ERAP
Energy Sources, Inc.
Ethyl Corporation
Falcon Seaboard, Inc.
Five Resources, Inc.
Forest Oil Corporation
Four M. Properties, Ltd.
Gas Council of England
Gas and Fuel Corporation of Victoria (Australia)
Gen Oil, Inc.
General American Oil Company of Texas
Geochemical Surveys, Inc.
General Electric Company
Getty Oil Company
Goodrich Operating Company, Inc.
Gulf Oil Company
Michel T. Halbouty
Harding Oil Co.
Highland Resources, Inc.
John H. Hill
The Howard Corporation
Humble Oil & Refining Company
Hunt Oil Company
Husky Oil Company
IIAPCO
L. B. Johnson Estate
Kathol Petroleum Inc.
Kerr-McGee Corporation
Kewanee Oil Company
King Resources Company
Kirby Petroleum Company
LaCoastal Petroleum Corporation
Logue & Patterson, Inc.
Lone Star Producing Company
Longhorn Producing Company
Magellan Petroleum Corporation
McCormick Oil & Gas Corporation
John W. Mecom
Mid-American Oil Company
Mitre Corporation
Mobil Oil Corporation
Monsanto Company

TABLE 11
(continued)

Clint Murchison
Murphy Oil
Ocean Drilling & Exploration Company
Oilwell Division, U. S. Steel
Oleum, Inc.
Pend Oreille Oil and Gas Company
Phillips Petroleum Company
Pioneer Natural Gas Company
Prudential Funds, Inc.
Rockefeller Brothers
Rohm and Haas Company
Royal Resources Company
Shell Oil Company
Signal Oil & Gas Company, Ltd.
Sun Oil Company
Tenneco Oil Company
Tesoro Petroleum Corporation
Texaco, Inc.
Texas Broadcasting Corporation
Texas City Refining, Inc.
Texas Gas Exploration Corporation
Texas Gas Transmission Corporation
Texas Oil & Gas Corporation
Texas Pacific Oil Company, Inc.
Texas Utilities Fuel Company
Thurmond-McGlothlin
Tomlinson Oil Company, Inc.
Transcontinental Oil Corporation
TransOcean Oil, Inc.
Union Carbide Corporation-Nuclear Division
Union Oil Company of California
U.S. Government
- Bureau of Mines
- Department of Energy
- Department of Justice
- Department of the Interior
- Energy Research and Development Administration
- Federal Energy Administration
- U.S. Geological Survey

U.S. Natural Resources, Inc.
Van Dyke Oil Company
Weyerhauser Company
Zeigler Coal & Coke Company

TABLE 11
(continued)

GRUY COMPANIES' CLIENTS
FINANCIAL, INSTITUTIONAL, TRUSTEE COMPANIES

Bank of the Southwest, Houston
Bankers Trust Company, New York
Chemical Bank New York Trust Company
Continental Illinois National Bank and Trust Company
of Chicago
Eastman Dillon, Union Securities & Company, New York
First City National Bank of Houston
First National Bank in Dallas
First National City Bank of New York
Fort Worth National Bank
Girard Bank, Philadelphia
Houston National Bank
Loeb Rhoades & Company
Marine Midland Grace Trust Company of New York
Mercantile National Bank of Dallas
New York Life Insurance Company
Pioneer American Insurance Company
Republic National Bank of Dallas
Southland Life Insurance Company
Texas Bank & Trust of Dallas
Texas National Bank of Commerce, Houston
Union Bank of Los Angeles
Union Trust Company, New Haven

•• System Development Corporation (SDC) ORBIT System,

•• DOE/RECON Information System,

•• Lockheed DIALOG.

Gruy Federal has an extensive Information Management System that includes subscription to public and private online information retrieval systems. These include the Department of Energy Technical Information Center's RECON, System Development Corporation's ORBIT, and Lockheed's DIALOG systems.

Data files containing reservoir characteristics and well data reside on the MARK 3000 system. These files are part of the Petroleum Data System (PDS) files maintained by the Information Systems Program at the University of Oklahoma. They include the oil and gas files (OILY and TEXS), the API Master Well File (API 1 and 2), and the AAPG/CSD Exploratory File (CSD 1 and 2). Gruy Federal also accesses the Petroleum Information Well History (WHCS) file containing more than one million historical and current well records.

6.b.(2) RESUMES

Resumes of persons selected for the MRI User-Coupled Reservoir Confirmation Project are included in alphabetical order.

FRANK P. BROWN, JR.

Areas of Expertise

Proposal pricing
Cost analysis and reporting
Contract administration

Frank Brown is manager of contract administration and pricing for Gruy Federal, Inc.

He received a B.B.A. in industrial management with a minor in industrial engineering in 1963 and an M.B.A. in management in 1965 from Texas Tech University.

From 1966 to 1969 Mr. Brown was employed by LTV Electrosystems and was involved in cost and budget analysis, manpower planning, forecasting, and preparation of manhour bids for the Engineering Administration department.

In 1969 he joined Tracor, Inc., working in the areas of cost control, financial analysis, program administration, and subcontract negotiations. From 1972 to 1978 Mr. Brown worked with defense-related and commercial electronic firms with responsibilities in cost proposal preparation, cost control and variance analyses, work breakdown structure preparation and program scheduling, contract negotiations and administration, and overhead forecasting.

In 1978 he joined Martin Marietta Aerospace, Orlando Division. When he left in 1980 to join Gruy Federal, he was an estimating supervisor responsible for reviewing proposals prepared by the estimating group and for the negotiation of those proposals.

At Gruy Federal, Mr. Brown is responsible for preparation of cost proposals and administering contracts, cost planning, and preparation of cost and manpower management reports.

WM. DAVID COMPTON

Areas of Expertise

Technical editing
Preparation of reports

Dr. Compton is technical editor for Gruy Federal, Inc.

He received B.S. and M.S. degrees in chemistry from North Texas State University and the Ph.D. in chemistry from The University of Texas.

After teaching for 16 years at West Texas State University, Colorado School of Mines, and Prescott College in Arizona, Dr. Compton undertook a year of study of the history of technology at Imperial College, London, earning the M.Sc. from the University of London in 1972.

In 1974 he was awarded a contract by the National Aeronautics and Space Administration to write the official NASA history of the Skylab Program. Working with one co-author, he completed this project in 1977. A summary of this work was presented at an invited symposium at a national scientific society meeting in 1979 and has since been published.

Since joining Gruy Federal in 1978, Dr. Compton has been responsible for editing and producing all of the company's contract proposals and technical reports.

CHARLES H. CORWIN

Areas of Expertise

Civil engineering
Environmental planning
Land and lease matters

Mr. Corwin is a consultant to Gruy Federal, Inc.

He received a B.S. in applied arts from Arizona State University in 1958, a B.S. in civil engineering from the University of New Hampshire in 1965, and an M.S. in civil engineering from the University of Southern California in 1970.

From 1955 to 1975 Mr. Corwin served as an officer in the U.S. Air Force. Approximately one-half of his time was devoted to civil engineering duties, including a tour as base engineer in Southeast Asia during the Vietnam conflict.

After leaving the Air Force, Mr. Corwin worked as an engineer for the consulting firm of JVB Engineers, Inc., a civil engineering firm with several offices in the State of Idaho. During that time his principal assignment was on the design of a municipal water system.

Since 1979 Mr. Corwin has been an engineering consultant and has worked on the Magic Hot Springs project since the land was purchased by MRI. He has also served as a county commissioner for Blaine County.

Mr. Corwin is a member of the National Society of Professional Engineers and an associate member of the American Society of Civil Engineers, and is a Registered Professional Engineer in the State of New Hampshire.

GAYLAND DAUGHERTY

Areas of Expertise

Financial systems
Contract administration
Business functions

Gayland Daugherty, a Certified Public Accountant, is vice president of finance for Gruy Federal, Inc., responsible for accounting, contract administration, subcontract procurement, and personnel administration. Related activities include preparation of cost proposals and cost management reporting.

He received a B.B.A. in accounting from Texas Technological University in 1960 while employed as a senior accountant for H. D. Collings, Public Accountant. From 1960 through 1965 he served as an auditing officer in the U.S. Air Force, performing management audits of Air Force activities as well as audits of defense contractors in the Far East and NASA contractors at Cape Canaveral, Florida.

In 1966 and 1967 he was employed by Dow Chemical Company with responsibility for product cost accounting, fixed asset control, and in-house asset construction.

While with Tracor, Inc. from 1968 to 1977, Mr. Daugherty dealt with virtually all aspects of accounting and contracts business management pertaining to research, development, and manufacture of electronic equipment. In his assignment as corporate manager of government accounting services and Director of Systems and Controls for the Sciences and Systems Group, he coordinated all contractor interface with the Defense Contract Audit Agency, designed and implemented systems to assure compliance with regulations of the Cost Accounting Standards Board and Department of Defense Agencies, and participated in cost negotiations with the Department of Defense and other government agencies. Other duties included audit evaluations of, and cost negotiations with, potential subcontractors. He regularly critiqued cost accounting standards and regulations proposed to the Management Accounting Practices Committee of the National Association of Accountants and the Cost Accounting Standards Board.

Mr. Daugherty is a member of the National Association of Accountants, Beta Alpha Psi, and Beta Gamma Sigma.

JACK T. DUREE

Areas of Expertise

Geothermal energy utilization
Reservoir engineering
Enhanced oil recovery

Mr. Duree is a senior engineer with Gruy Federal, Inc.

He received B.S. degrees in petroleum engineering and mechanical engineering from Texas A&M University in 1942 and joined the Magnolia Petroleum Company as a design engineer, later becoming a field production engineer in Magnolia's west Texas region.

In 1947 he left Magnolia to become a field production engineer for The Pure Oil Company. After a year he was made chief production engineer for the Texas producing division; in 1960 he was transferred to Houston as division engineer for the company's southern division, which encompassed the Texas producing division plus the Gulf Coast onshore and offshore areas.

Mr. Duree was made division operations manager for Pure Oil Company's Alaska-Canada division in 1963. During his tenure the division increased net production from 6,300 to 11,500 barrels per day and instituted the first in-situ combustion project in Canada. When Pure Oil merged with Union Oil Company in 1965 he became joint account superintendent for Union Oil Co. of Canada Ltd., responsible for drilling and production for jointly-owned properties for which Union was not operator. In 1967 he became manager of engineering, responsible for all reservoir engineering and exploitation geology for Union's Canadian operations. Besides directing all exploitation drilling, Mr. Duree's group initiated various enhanced recovery projects. In 1973 he was made manager of heavy oil production, responsible for developing Union's tar-sand and heavy-oil reserves. He directed extensive drilling to define the productive area of these deposits and evaluated recovery methods and processes to upgrade the produced oil.

Mr. Duree entered the geothermal exploitation field in 1975 as manager of engineering (later vice president and manager of operations and production) for Philippine Geothermal, Inc., a subsidiary of Union Oil Company of California. He directed reservoir and design engineering and construction for a project that completed 103 geothermal wells in 2 fields on the island of Luzon, providing geothermal steam for four 110-megawatt generating plants. His responsibilities included reservoir and economic evaluations, conceptual bases for design of gathering systems, and operation of the completed systems and producing wells. One of these fields incorporates a subsurface disposal system which is among the largest ever built: two plants, each returning 350,000 barrels of water per day to the producing reservoir.

TERENCE J. ELLIOTT

Areas of Expertise

Geophysics
Seismic methods
Subsurface geology

Mr. Elliott is a senior geophysicist for H. J. Gruy and Associates, Inc.

After receiving his B.S. in geology from the University of Queensland (Australia) in 1963, he joined Marathon Petroleum Australia, Ltd., as a geophysical assistant. The following year he became an assistant well logging engineer for Welex in Brisbane, Australia, running logs and maintaining logging tools. In 1965 he worked for one year with the Continental Oil Company, interpreting and mapping seismic data for the North Sea field.

From 1966 through 1970 Mr. Elliott was employed by Seiscom-Delta, Inc., of Houston as a geophysicist responsible for developing and testing the company's seismic data processing system. He joined H. J. Gruy and Associates in 1971, contributing to field studies in the United States, the North Sea, and Indonesia. He joined D. R. McCord and Associates in Dallas later in 1971 and correlated seismic and subsurface geological data for major studies in Australia and Iran.

From 1973 until he rejoined H. J. Gruy and Associates in 1975 he was employed by Texas Pacific Oil Company as senior international geophysicist. He was responsible for all of the company's international seismic operations, as well as computer processing and interpretation and mapping of data to determine geological exploration prospects.

Mr. Elliott is in charge of H. J. Gruy and Associates' geophysical services, carrying out assignments throughout the United States.

He is a member of the Society of Exploration Geophysicists, the American Association of Petroleum Geologists, the Dallas Geological Society, and the Dallas Geophysical Society.

PRISCILLA EVERETT

Areas of Expertise

Personnel administration

Ms. Everett is a personnel specialist with Gruy Federal, Inc.

Since graduating from high school in 1975 she has been working part-time toward her bachelor's degree in business technology (personnel administration). She has completed a number of courses in management.

From 1975 to 1979 she was employed by Hooker Chemical Corporation in the personnel department, starting as a benefits clerk auditing and processing medical and dental claims, screening applicants for employment, and compiling data for Equal Employment Opportunity (EEO) reports. Promoted to personnel assistant, she assumed additional duties in salary and benefit administration. She was later made a corporation compensation assistant with responsibility for combining and auditing monthly wage and compliance data from four other subdivisions of the company.

At Gruy Federal, Ms. Everett develops and implements Affirmative Action and EEO programs to ensure compliance with current federal requirements, monitoring the status of the company's compliance and alerting management to any difficulties encountered. She also administers all the company's benefit and performance evaluation programs and personnel functions.

Ms. Everett is a member of the Houston Personnel Association and the American Society of Personnel Administration.

CALVIN H. FRIEDRICH

Areas of Expertise

Accounting management
Financial systems

Mr. Friedrich is controller for Gruy Federal, Inc.

He received his B.B.A. in accounting from The University of Texas at Austin in 1967 and worked for one year as an accountant for Tuloma Gas Products of Tulsa, Oklahoma.

In 1968 he joined the Southland Division of the St. Regis Paper Company and became manager of general accounting in 1974. Besides supervising the general accounting functions of the company, he was responsible for corporate, industrial, and governmental reporting functions, including SEC reports and the financial section of the annual stockholder's report. He joined Gruy Federal early in 1979.

Mr. Friedrich is responsible for maintaining and improving the accounting system, preparing the various cost and manpower reports for individual contracts, and preparing financial statements.

JEROLD R. KIRKMAN

Areas of Expertise

Developmental planning
Real estate development

Mr. Kirkman is general manager of Magic Resources Investors, president of J. R. Kirkman Development Inc., and owner of J. R. Construction Co.

He studied business administration at Idaho State University for two years in 1968 and 1969.

Mr. Kirkman has ten years' experience in business in the Sun Valley area. In 1970 he founded J. R. Construction Co., a home-building and general construction firm, which by the mid-1970s was the largest company of its kind in the Sun Valley area. Later he established J. R. Kirkman Development Inc., planning and building new subdivisions and conducting research and development in other related fields.

At present he is general manager of Magic Resources Investors, in charge of development and geothermal field research.

RAJ M. KUMAR

<u>Areas of Expertise</u>

Petroleum engineering
Economic analysis and forecasting

Mr. Kumar is a senior petroleum engineer with Gruy Federal, Inc.

He received his B.S. degree in petroleum engineering from the Indian School of Mines in 1970. Upon graduation he worked for the Oil and Natural Gas Commission in India for two years as senior technical assistant in the production section, engaged in various production activities including reservoir studies, economic studies, evaluation, and coordination in oil field operations.

In 1973 he came to the United States to work toward an M.S. in management science and engineering at Long Island University, where he completed his work in 1975 with specialty areas of accounting, economics, computer programming, and operations research.

After two years of applying his economic expertise in oil and gas production, Mr. Kumar joined the staff of H. J. Gruy and Associates, Inc. in 1977 and came to Gruy Federal later that same year.

His work with the Gruy companies has included assisting senior petroleum engineers in pressure transient analysis and reserve estimation; development of petroleum operating cost data for 24 geographic regions and six depth classes (onshore and offshore) for the Federal Energy Agency; economic analysis of proposed and interim effluent guidelines for the onshore oil and gas producing industry for the American Petroleum Institute; and forecasting reserve additions and natural gas production to the year 2000 from conventional sources for the U.S. Energy Research and Development Administration.

Mr. Kumar is a member of the Society of Petroleum Engineers of AIME.

H. P. LANGSTON

Areas of Expertise

Drilling supervision
Production supervision

Mr. Langston is a drilling supervisor with Gruy Federal, Inc.

His oil field experience spans 31 years, roughneck to operations manager, staff and line work. His safety record is his strongest recommendation.

He received his B.S. in petroleum engineering from the University of Houston in 1952, and worked for the next four years in the southwestern U.S. and in Venezuela as production foreman, petroleum engineer, and drilling supervisor, principally for the Atlantic Refining Company of Dallas.

From 1956 to 1963 Mr. Langston worked as a drilling engineer, drilling supervisor, and superintendent in Venezuela and Argentina for Creole Petroleum and Delta Drilling Company. He then took a position with Conoco as senior petroleum engineer in the south Texas area.

After five years in private business in Mexico City, Mr. Langston was an independent drilling consultant working in Asia and the Middle East on offshore drilling projects. Among his clients were ARCO, IIAPCO, British Petroleum, Elf-Erap, Phillips, and Petroswede of Norway. In 1976 he was a management consultant with Booz Allen & Hamilton International, working with Sonatrach in Algeria.

Since 1977 Mr. Langston has continued as a consultant drilling supervisor, working with Oilfield Consultants International Ltd. of London and with REMI of Houston in the Middle East, Africa, Norway, and South America.

Mr. Langston's experience in areas of deep geothermal work includes:

Onshore	South Texas	16,000 feet	0.85 psi/ft gradient
Offshore	Venezuela	15,000	0.80
Offshore	Egypt	15,000	0.84
Offshore	Oman	16,000	0.85
Offshore	Abu Dhabi	13,500	0.80
Offshore	Iran	12,500	0.75
Offshore	Indonesia	11,000	0.70
Offshore	Norway	13,000	0.74
Onshore	Algeria	12,000	0.90
Onshore	Louisiana	17,000	0.90
Offshore	Louisiana	17,000	0.90

This geothermal-geopressure work includes completion and testing of wells and disposal of high volumes of hot brine.

He is a Registered Professional Engineer in the State of Texas.

ALAN LOHSE

Areas of Expertise

Geology and geophysics
Petroleum engineering
Natural resource evaluation and production

Dr. Lohse is executive vice president and principal scientist for Gruy Federal, Inc.

He received a Ph.D. in geology from The University of Texas in 1952 and also attended the University of Texas Law School from 1950 to 1952.

He was employed by Shell Oil Company in the exploration division from 1952 to 1958, with some special assignments to Shell's legal department and the Exploration and Production Research Laboratory.

From 1958 to 1962, Dr. Lohse worked as a consultant in coastal engineering and oil and gas exploration. In 1962 he joined the Monsanto Company as a staff geologist, studying new oil and gas trends and conducting technical and economic evaluations of mineral resources. He served as associate professor at the University of Houston from 1966 to 1971, where he taught courses in the geology of North America and field courses in Mexico. He also continued his engineering and geological consulting, which has included interpretation of areas in Central America, Australia, and West Africa.

From 1971 to early 1977, Dr. Lohse was senior scientist and manager for the Gulf Universities Research Consortium, where he dealt with environmental and economic studies and enhanced recovery technologies for oil and gas. During this time he conducted contract work for the Corps of Engineers, the U.S. Coast Guard, the Environmental Protection Agency, the Bureau of Mines, the Energy Research and Development Administration, and other Federal agencies.

Dr. Lohse served from 1971 to 1972 as a member of the Texas Governor's Nuclear Power Plant Task Force. From 1972 to 1974 he served on President Nixon's Air Quality Advisory Board. In 1976 he participated in a United Nations conference in Austria concerning world petroleum resources.

Dr. Lohse is a Certified Petroleum Geologist and a member of Sigma Gamma Epsilon, Sigma Xi, Phi Kappa Phi, the American Association of Petroleum Geologists, the Society of Petroleum Engineers of AIME, the Sociedad Geologica Mexicana, and the Houston Geological Society. He is listed in American Men of Science. He is the author of more than 60 publications and reports for the government and private industry, and is an Adjunct Professor of geology at the University of Houston.

STEPHEN A. LOHSE

Areas of Expertise

Technical project and systems analysis
Project coordination

Mr. Lohse is an engineering assistant with Gruy Federal, Inc.

He attended Raymond College, University of the Pacific, where he majored in liberal arts. He worked for three years in the public school system of Stockton, California, as a special education teaching assistant.

During 1975 and 1976 Mr. Lohse worked as a Research Assistant for the Gulf Universities Research Consortium, principally assisting in the compilation and computerization of an enhanced oil recovery data base covering some 800 oil fields.

Since he joined Gruy Federal in January 1979, Mr. Lohse's responsibilities have included monitoring drilling activity along the Texas and Louisiana Gulf Coast, screening prospective geopressured-geothermal test wells, and assisting in general engineering work. In late 1979 and early 1980 he was periodically assigned to the field, where he was responsible for detailed cost reporting and material handling for Gruy Federal's geopressured-geothermal drilling and testing program.

In April 1979 he attended an Advance Program Management course on the use of PERT/CPM management techniques, and he is now responsible for creating and updating the company's PERT/CPM Project Management Network Plans. He designed and conducted an in-house PERT/CPM training program for Gruy Federal personnel in June 1979.

RAYMOND MARLOW

Areas of Expertise

Well logging and log interpretation
Geological exploration

Mr. Marlow is a geologist with Gruy Federal, Inc.

He received his B.S. in geology from Lamar University, Beaumont, Texas, in 1978.

Upon graduation from Lamar, he joined the Welex company as a field engineer in south Texas, managing the activities of field crews conducting logging operations on oil and gas wells and uranium test holes. He was also responsible for collecting and interpreting the results, which included calculations using resistivity, sonic velocity, density, and radioactivity. His duties also encompassed evaluation of formation tests and sidewall cores.

Mr. Marlow joined Gruy Federal in 1980, and participates in all of the company's projects which require compilation and interpretation of geologic data and well log data.

MARVIN MATULA

Areas of Expertise

Drilling
Drilling supervision

Mr. Matula is a drilling supervisor for Gruy Federal, Inc.

He began working in the oil fields in 1956 as a driller's helper for Chiles Drilling Company of Corpus Christi, Texas. After service in the U.S. Army he took a position with Texaco, Inc., where he worked his way up to drilling foreman in Texaco's south Texas operations.

In 1976 and 1977 he worked for Gannet Offshore Company, repairing wells in the Gulf of Suez that had been destroyed during the Egypt-Israel fighting. On his return to the U.S., Mr. Matula worked as a drilling foreman and drilling superintendent for Good Hope Refineries of Laredo, Texas, and as a drilling consultant for Scarborough, Sawyer and Associates in Corpus Christi.

Since joining Gruy Federal in 1978, he has worked principally on the Gulf Coast Geopressured-Geothermal Program, supervising rig operations and coordinating all phases of field work with operations management.

R. L. McCOY

Areas of Expertise

Petrophysical Analyses
Geological Engineering
Economic Analyses

Mr. McCoy is staff petrophysicist for H. J. Gruy and Associates, Inc. in Houston.

After receiving a B.S. degree in petroleum geology from Mississippi State University in 1975, he joined Dresser Atlas. Upon completion of Dresser's comprehensive logging schools at the Houston Research Center, he was assigned to the southeast U.S. region for three years. During this period, he became familiar with the broad spectrum of services available to the industry as well as the various interpretive techniques used in mid-continent and Gulf Coast areas. He had qualified for the position of senior field engineer before leaving this field assignment.

Mr. McCoy served as a consultant for J. R. Butler and Co./Geoquest International for one year, performing various functions including geological engineering, reservoir characterization, and computer modeling (Monte Carlo) for risk analyses.

He joined Gruy Federal in 1978, and provided log analyses, geological engineering, and production engineering services for many of the company's projects, including geopressured-geothermal resource assessment and studies of possible subsidence problems. He joined H. J. Gruy and Associates in 1980.

Since 1977, McCoy has been attending the University of Houston where he is currently completing a M.S. program in petroleum engineering.

He is a member of several professional societies, including the Society of Petroleum Engineers of AIME, the American Association of Petroleum Geologists, the Society of Professional Well Log Analysts, and the Society of Exploration Geophysicists.

Mr. McCoy is the author or co-author of several technical papers which have been presented in the Journal of Petroleum Technology and Transactions of the Society of Professional Well Log Analysts.

ROBERT L. NYLAND

Areas of Expertise

Purchasing
Material management
Contract administration

Mr. Nyland is purchasing manager for Gruy Federal, Inc.

After attending the University of Texas he joined the staff of the Austin State School in 1958 as assistant supply officer where he served as buyer and supervised receiving, warehousing, shipping and inventory control. Average inventory value was in excess of $400,000 and consisted of items to support a 3000-bed residential facility. Material responsibilities included coordination between medical, plant maintenance, food service, educational, laundry, vendors, and other governmental agencies.

In 1966 he joined Tracor, Inc. as assistant purchasing agent for the Military Products Division, with responsibility for the purchase of components, raw materials and services. This included coordination efforts between engineering, production, quality control, vendors, and manufacturers. He directed a staff of buyers, expeditors, and clerks in order to support proposals and contracts.

Mr. Nyland joined Infotronics Corporation in 1969 as purchasing agent, responsible for the procurement of all components, raw materials and services required of the Austin manufacturing plant. He was also responsible for corporate purchasing agreements for the Austin and Houston plants as well as the Shannon, Ireland, plant. He developed corporate purchasing procedures, directed a staff of buyers and clerks, and ensured coordination with engineering, quality control, production, vendors, and manufacturers.

In 1970 he became purchase and supply officer for the Travis State School, responsible for purchasing, inventory control, receiving/shipping, warehousing, and supervision of a staff of 17 employees. This included the maintenance of a $500,000 inventory and coordination with vendors, plant maintenance, laundry, medical, educational, food service, and other state and federal agencies.

He joined the staff of Gruy Federal in 1978 as purchasing manager, responsible for the acquisition of all items and services required by the company. He is also responsible for government property and coordinating subcontracts with the appropriate government agency.

He was a charter member of the Austin Purchasing Management Association, serving two years on the Board of Directors and two years as Professional Development Chairman, and is a member of the Purchasing Management Association of Houston.

DWIGHT PEACE

Areas of Expertise

Drilling
Drilling Supervision

Mr. Peace is a drilling supervisor for Gruy Federal, Inc.

He has nearly 30 years of experience in drilling, and has worked in many oil-producing areas in the United States and foreign countries.

Mr. Peace began working in the oil fields in 1949 after completing two years of work at Southwest State College, Magnolia, Arkansas. From 1949 until 1967 he worked with several companies operating in southern Arkansas, east Texas, and Mississippi. In 1967 he went overseas as a driller for Loffland Brothers, working in Turkey, Libya, and Nigeria. Later he joined KCA as a rig superintendent. Before joining Gruy Federal in 1977, Mr. Peace worked for several years as a toolpusher for Helmerich and Payne.

With Gruy Federal, he has been supervisor for the company's Palo Duro Basin project, which involved drilling and continuously coring two 4,000-foot wells in West Texas.

LEROY RADFORD

Areas of Expertise

Drilling operations
Petroleum engineering

Mr. Radford is a senior drilling engineer with Gruy Federal, Inc.

He earned his B.S. degree in geological engineering from the University of Oklahoma in 1941.

After service in World War II and Korea, Mr. Radford joined the Magnolia Petroleum Company, remaining with the company for 17 years after its merger with Mobil Oil Corporation. His assignments with the company included drilling and production responsibilities in Texas, Oklahoma, Alaska, Indonesia, and Colombia.

From 1971 until he joined Gruy Federal in early 1978, he served as a drilling consultant to companies in Louisiana, the Philippine Islands, Iran, the North Sea, Algeria, and Pakistan. His experience includes contract negotiations, site selection, site preparation, and all aspects of drilling. Mr. Radford spent approximately three years on wildcat drilling programs in Indonesia, where pressure gradients approaching 0.9 psi/ft and temperatures in excess of 400°F at 10,000 feet are common. He also worked one year in Iran, where extreme drilling conditions are encountered, and one year on the Louisiana Gulf Coast, onshore and offshore.

During 1978 and 1979 Mr. Radford was in charge of the Geothermal Drilling Program on the Atlantic Coastal Plain, completing 50 temperature measurement holes of 1,000-foot depth from New Jersey to North Carolina. He was also the engineer in charge of drilling the deep geothermal test well at Crisfield, Maryland, which was completed and tested in the summer of 1979.

Mr. Radford is a member of the Society of Petroleum Engineers of AIME and is a Registered Professional Engineer in Texas and Oklahoma.

JOEL L. RENNER

Areas of Expertise

Geothermal resources
Coal geology
Mineral evaluation

Mr. Renner is a senior geologist with Gruy Federal, Inc.

He received his B.A. in mathematics from Carleton College in 1965 and his M.S. in geology from the University of Minnesota in 1969. He is currently completing his dissertation for the Ph.D. degree in applied earth sciences at Stanford University.

From 1970 to 1978, Mr. Renner worked for the U.S. Geological Survey in Menlo Park, California, and Denver, Colorado. With the Conservation Division at Menlo Park he conducted research on the tectonic and geologic controls of the occurrence of geothermal resources and was the division representative to the USGS geothermal research program. He was the senior author of the 1975 assessment of U.S. hydrothermal geothermal resources.

In Denver, Mr. Renner continued his research on geothermal resources, and was additionally involved with coal geology and evaluation. From 1977 to 1978 he was staff assistant for mineral evaluation in the Conservation Division, coordinating interdisciplinary review of problems relating to mineral development and representing the region in meetings with industry and with environmental and intergovernmental groups.

Since joining Gruy Federal in 1978, Mr. Renner has served as principal investigator on a number of technical studies, among them a review of the availability of groundwater for heat pumps and a comprehensive study of the geothermal resources potential of the eastern half of the United States. He has also evaluated the reservoir characteristics of geothermal resources in a series of studies on the direct use of hydrothermal energy. These studies were reviewed by Gruy Federal as part of DOE's geothermal resources development program.

Mr. Renner is vice president of the Mid-Atlantic Section of the Geothermal Resources Council and chairman of the subcommittee on definitions and nomenclature of the Geothermal Resources and Energy Committee of the American Society for Testing Materials. He is also a member of the Society of Mining Engineers of AIME, the American Association of Petroleum Geologists, and the Colorado Scientific Society. He has published a number of papers on geothermal resources in the eastern United States.

TERRY E. SWIFT

Areas of Expertise

Petroleum engineering
Computer applications

Mr. Swift is a petroleum engineer with Gruy Federal, Inc.

He received a B.S. in chemical engineering with a minor in petroleum engineering from the University of Houston in 1979.

While completing his undergraduate work, Mr. Swift gained practical experience in the application of computer methods to petroleum engineering problems. From 1975 to late 1978, he worked as a programming assistant for American Natural Gas, participating in the development of a comprehensive log analysis program and other programming projects related to petroleum engineering. From 1978 until he joined Gruy Federal in mid-1979, he was a strategic planning assistant at Natomas North America, assisting with the operation of Fortran economic models.

Since coming to Gruy Federal, Mr. Swift has participated in several of the company's projects. He assisted in the testing and evaluation of Gulf Coast geopressured-geothermal reservoirs. He has worked on the development and evaluation of an enhanced oil recovery (CO_2) data base, and has represented Gruy Federal on pressure-coring operations in West Texas and New Mexico in connection with a CO_2 injection project. He has assisted in the testing and evaluation of the geothermal potential of the Atlantic Coastal Plain, and has also been involved in a gas well testing program in fractured Devonian shale reservoirs.

ROBERT M. WINN

Areas of Expertise

Hydrology
Coal and lignite assessment

Dr. Winn is a senior geologist with H. J. Gruy and Associates, Inc.

He received a B.S. in geology in 1958, an M.S. in 1960, and a Ph.D. in 1973 in geology and hydrology from Texas Tech University.

From 1961 to 1966 he was employed by Mobil Oil Corporation, with responsibility for oilfield hydrogeological investigations for drilling, waterflooding, and water supplies for field operations.

After leaving Mobil, Dr. Winn joined the faculty of West Texas State University as an assistant professor of geology. His research activities included water table aquifer assessment for several water conservation districts in west Texas. During 1970 and 1971 he was on leave directing a study team assessing groundwater development potential for various areas in Algeria for the Algerian Ministry of Agriculture.

From 1974 to 1979, Dr. Winn was associated with Texas Instruments, Terra, Inc., and Environmental Consultants, Inc., conducting hydrological assessments of proposed and operating coal, lignite, and uranium mines; assessment and evaluation of surface and subsurface waters for flow regime conditions and control parameters; and studies on watershed management and downstream flood control for proposed river navigation projects.

7. TECHNICAL PLANNING

7.a EXPLORATION PLAN

The objective of the exploration plan is to obtain the data and provide the information and knowledge from which an optimum location can be selected for the confirmation well (production test well) with maximum probability of encountering multiple fault planes, fault zones, and/or fractures within the projected test well depth of 3,000 feet subsurface.

The target of the production test well is one or more subsurface zones where fracture permeability can provide circulation of geothermal waters for the well to produce sufficiently large volumes at the surface.

The exploration plan consists of six phases:

1. Detailed review of published geological data from State and Federal sources, special districts, commissions or other entities contributing to local knowledge; individual opinions, experience, and judgment of informed persons.

   Review of available literature has already commenced in the preparation of this proposal and discussion with Mr. John Anderson, Idaho Department of Water Resources, and others. It will be intensified and broadened to include all available sources and the compilation of diverse geological data and interpretations on base maps of sufficient scale to facilitate transferral of accurate locations from map to ground and vice versa.

   The work at the University of Utah Research Institute (UURI) by Strusbacker and others (1980) will be obtained as soon as posible sible. Aerial photo coverage will be obtained and analyzed.

2. Detailed field work to confirm or find, measure, and map all surface manifestations of faulting and fracturing in and around

the Magic Hot Springs area.

Two reconnaissance trips have been made into nearby locales in preparation of this proposal. Field work will be planned and conducted several miles, or as necessary, into surrounding areas to confirm or modify earlier work, discover new evidence, measure and map all criteria pertaining to faulting and fracturing and the distribution of rock types as evidence of multiple intrusions and deep fractures or vents.

3. Close-network geophysical survey through and around the area, to measure the electrical and magnetic properties of the rock and rock-fluid systems adequately to allow interpretation of the location and geometry of faults and fractures.

The dipole-dipole electrical surveys widely used by Mr. Duree for geothermal investigations in the Philippines are expected to be of limited use in the Magic Hot Springs area because water analysis indicates insufficient dissolved solids in the geothermal waters.

This matter has been discussed at length by Dr. R. E. Sheriff, Seiscom Delta senior vice president, and Dr. Alan Lohse, GFI executive vice president, and also with Mr. Leslie Denham, Seiscom Delta senior geophysicist in the Houston Operations Office.

At this point we are evaluating the overall advantages of combined electromagnetic (EM) and magnetometer surveys run simultaneously on the ground with portable equipment suitable for hilly terrain, to provide economical, close-spaced grid coverage of some miles through and beyond the Magic Hot Springs site.

Numerous methods are available for EM field work and classed according to the actual measurement made, such as polarization ellipse, intensity and phase components, dip-angle measurements, and so on.

In the final selection for the geophysical survey, we will consider all factors such as source power, reliability, speed, and simplicity for field operation, on the one hand, and depth of penetration from increased source power and larger transmitting loop, on the other. We favor the methods that measure both in-phase and quadnature components because they provide more information about the anomalies, even though they are slower and require more competent operators.

The companion ground magnetometer survey will include gadiometer measurement of vertical gradients to facilitate the quantitative determination of anomaly depth, magnetic moment, shape, and location.

Again, we favor a method that entails somewhat more field work and more care in obtaining the data (e.g., magnetic cleanliness of operator, positioning of sensors, etc.), but believe these are justified by better geological results.

4. Drilling and completion of three thermal gradient holes to depths of 1000 feet or until drilling mud returns reach 125°F; followed by three or more borehole temperature gradient surveys per hole until temperature gradient stabilization is reached.

Locations of the three temperature gradient measurement holes will be selected to complement the geological and geophysical work and to provide a reasonably uniform geometric coverage of the acreage in order that maximum interpretation can be made of isotherm patterns as the holes are monitored.

The temperature gradient wells will be drilled with a Failing 1500 or equivalent rig. The prognosis for the proposed wells is listed in Table 12 and the schematic of the proposed wells is shown in Fig. 16. The wells will be drilled through a 7-inch surface casing set at 40 feet. A 6-1/4 inch hole will be drilled to 1000 feet or until drilling fluid returns are 125°F, whichever occurs first. A 4-1/2 inch casing string will be run to bottom and cemented to the surface.

5. Plotting of temperature survey data on base maps and cross sections, contoured for analysis of heat flow, identification of aquifers and permeable zones and lateral and vertical components of subsurface water movement toward the present hot spring and well site or elsewhere within the acreage.

6. Ongoing and final integration of all data into comprehensive analyses and displays with assessment of the distribution and location of subsurface zones of fracture permeability and recommendations on the optimum location of the confirmation well. All compilations and graphic displays will be prepared, with documentation, for presentation and third-party inspection and analysis.

TABLE 12

MRI/GFI TYPICAL TEMPERATURE GRADIENT HOLE DRILLING PROGRAM

1. Prepare road and location (size of location dependent on rig obtained).

2. Drill 12-1/4 inch hole to 45 feet. If formation at this depth is adequate as a casing seat, run and set 40 feet of 7-inch 17# H40 ST&C casing and cement to surface.

3. WOC 12 hours under pressure.

4. Drill 6-1/2 inch hole to 1000 feet or until mud return reaches 125°F, whichever occurs first. This section shall be drilled with fresh water or the minimum gel mud that will permit drilling.

5. Run and set 4-1/2 inch 9.5# H40 ST&C casing at total depth. Equip casing with 4-1/2 inch float shoe and a baffle 15 - 20 feet above shoe. Use centralizers 50 and 100 feet above shoe. Displace cement with water. Bump plug and hold pressure on casing for eight hours to prevent flowback. Use a one-plug cementing head.

6. After 12 hours, release pressure, check top of plug with wire line or drill pipe. If cement has not moved, add 4-1/2 inch casing by 2-inch pipe swage, 2 inches full opening valve, tapped bull plug and bleed valve. Release rig.

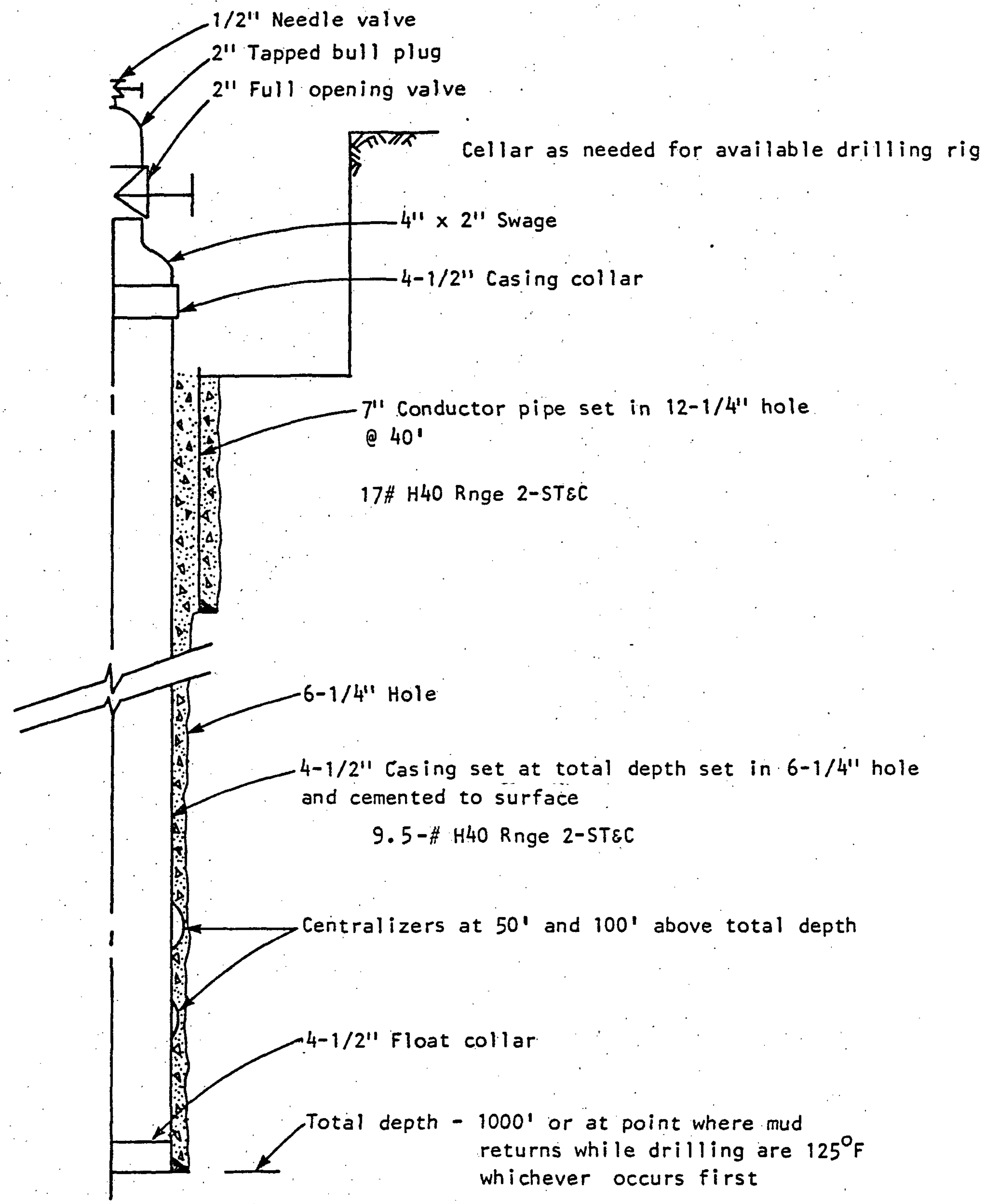

Figure 16--Schematic of typical temperature gradient hole

7.b PRELIMINARY DRILLING PROGRAM

After the exploratory program has identified a specific site and refined the drill hole conditions, a detailed drilling program will be presented, addressing the following major considerations and refined from this preliminary plan to meet all site-specific and resource-specific conditions.

Our preliminary drilling plan is presented in the production well prognosis (Table 13) and in sections 7.b 1 - 11, following.

The proposal is predicated on proving or disproving the presence of a geothermal reservoir capable of producing sufficient water to meet the energy needs of a 2,000,000 gallon per year ethanol plant. The program is designed to meet this need of 650 gal/min of water at an assumed temperature of 280°F. The 280°F water temperature is within the range predicted by geochemical thermometers, and was established as that needed to permit "cooking" of mash in the ethanol process.

The program envisions encountering a volcanic stratum sufficiently fractured to permit production equal to or exceeding this established need. The presence of fracturing is critical and the drilling program is as simple and as inexpensive as possible to determine whether such fracturing is present. The well casing program was designed to permit use of a downhole pump large enough to meet the ethanol plant needs, in the event the well does not flow naturally.

7.b.(1) Rig Selection

The production well will be drilled with a Failing 3000 or equivalent rig capable of drilling to a minimum depth of 3,000 feet. It will be equipped with a minimum of a double blowout preventer of 2,000 psi rating or higher. In addition to the blowout preventer, a 10-inch full opening 2,000-psi rated gate valve will be mounted below the blowout preventer during drilling operations. The rig will also be equipped with a rotating head

TABLE 13

DRILLING PROGRAM FOR PRODUCTION WELL

1. Build access road and location (location size and configuration will be determined by rig available).

2. Drill 17-1/2 inch hole to 100 feet with water or minimum gel mud to permit drilling.

3. Run 100 feet of 13-3/8 inch H40 48# ST&C casing and cement to surface with Portland cement.

4. WOC 12 hours under pressure.

5. Drill out cement to shoe and test with 500 psi.

6. Drill 12-1/2 inch hole to 1000 feet or mud returns at 135° whichever occurs first.

7. Run and set at total depth 9-5/8 inch J55 36# ST&C casing. Cement to surface with API grade G cement with 40% Silic's flour. Casing equipped with 9-5/8 inch guide float shoe and float collar. Centralizers 50 feet and 100 feet off bottom.

8. WOC 12 hours under pressure.

9. Set 9-5/8 inch x 10-inch flange 2000 psi casing head.

10. Drill out to shoe and test with 500 psi.

11. Drill 8-3/4 inch hole to maximum depth of 2000 feet. Anticipate lost circulation may result in a lesser depth.

12. Run and set 7-inch casing to total depth. Overlap 9-5/8 inch a minimum of 150 feet.

13. Drill 6-1/4 inch hole to 3000 feet.

14. Run and set 5-inch pre-perforated liner on bottom.

while drilling below the 9-5/8 inch casing.

7.b.(2) Borehole Configuation

The schematic of the proposed well is shown in Fig. 17. The schematic shows the well equipped with pumping equipment. A conductor string of 13-3/8 inch casing will be at 100 feet in a 17-1/2 inch hole and cemented to the surface. A 12-1/4 inch hole will be drilled to 1,000 feet or until drilling fluid returns are 135°F, whichever occurs first. A 9-5/8 inch casing string will be run to total depth and cemented to the surface. An 8-3/4 inch hole will be drilled to 2,000 feet or until drilling fluid returns are 160°F, whichever occurs first. A 7-inch liner will be set at total depth overlapping into the 9-5/8 inch casing a minimum of 150 feet and cemented in place. A 6-1/4 inch hole will be drilled ahead until a total depth of 3,000 feet is reached and a 5-inch perforated liner will be run.

This program is necessarily tentative. It is anticipated that commercial production will be found in fractured volcanic strata. Such fractured sections can present lost circulation problems, making revision of the program necessary. The program outlined here is designed to permit using a downhole pump adequate to produce 500 to 1000 gal/min. The existence of an artesian spring/well indicates that some natural flow may be expected, but whether this would be a commercial-size flow is unknown. The presence of artesian flow is considered a positive factor and a shaft-driven downhole turbine pump is projected.

7.b.(3) Drilling Fluid Programs

The well will be drilled insofar as possible with water. If artesian flow or drilling problems are encountered, minimum weight gel muds will be used. The presently produced water is not highly mineralized and no adverse effects on the prospective producing interval from use of fresh water is anticipated.

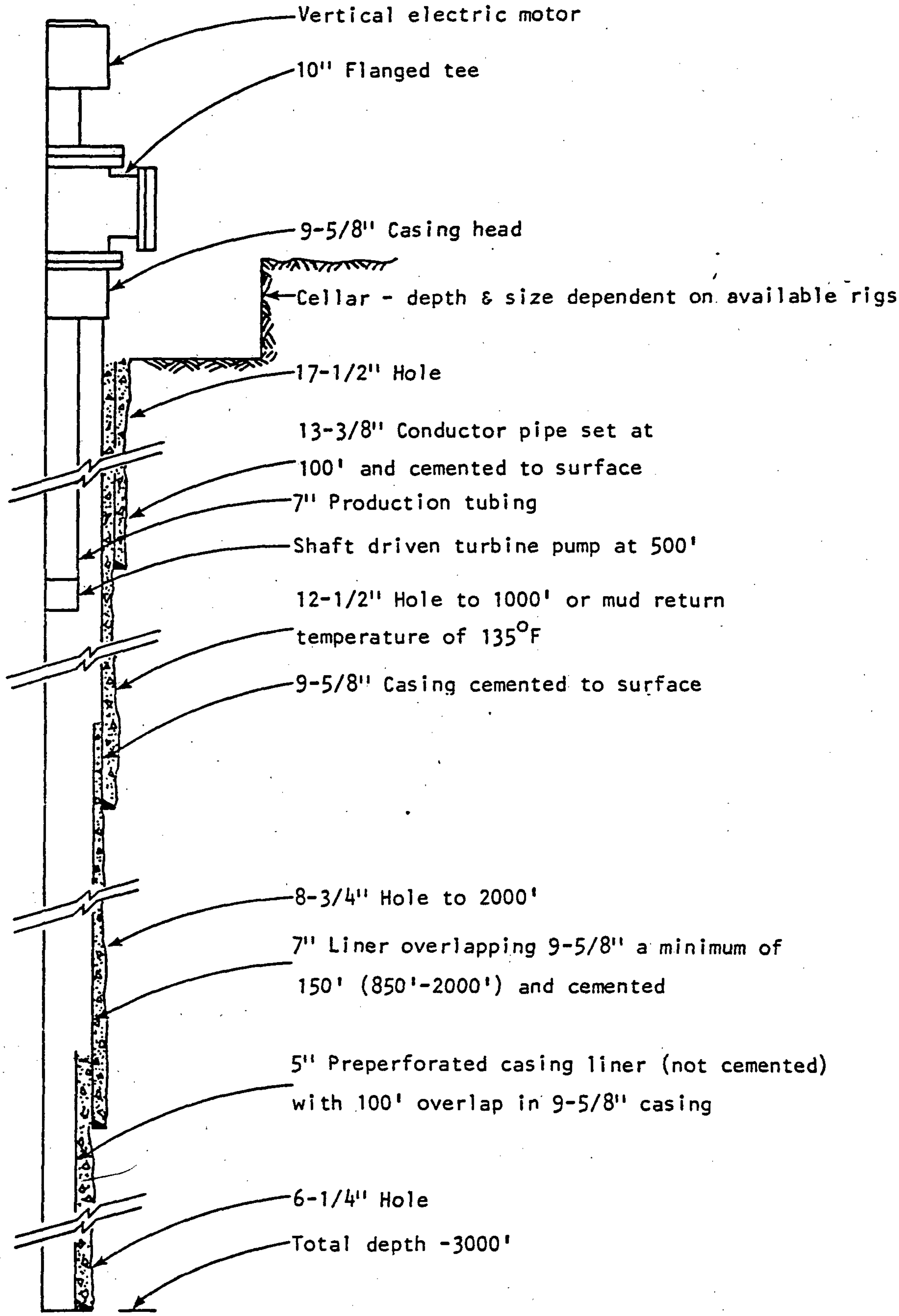

Figure 17--Schematic of planned production well.

7.b.(4) Formation Identification

A logging service will be retained on the location to record drilling operations. The following data will be recorded and plotted in graphic form:

1) drilling rate
2) bit weight
3) bit RPM
4) drilling fluid temperature
   a) into hole
   b) out of hole
5) mud return chlorides (every 50 feet)
6) mud weight
7) drilling fluid circulation rates
8) H_2S monitoring of drilling fluid (continuous)

In addition, the samples will be examined, geologically described, and plotted in graphic form.

7.b.(5) Casing Program

The casing program has been described above in the drilling section as to size and setting depth. The 13-3/8 inch conductor pipe will be API grade H40, weight 48#/foot; the 9-5/8 inch casing will be API grade J55, weight 36#/foot; the 7-inch will be grade J55, weight 20#/foot; and the 5-inch liner will be J55, weight 11.5#/foot. The water presently being produced has not caused corrosion of the surface exposed piping. The pH of the water is nearly neutral (6.9) and minimum corrosion is expected. No specific corrosion allowance has been made in the casing program; however, allowable stresses correlated into required pipe wall thickness compared to anticipated pressure would correlate to an allowance of 3/32 inches at the point of maximum pressure and greater at lesser pressures.

7.b.(6) Cementing Program

Conductor pipe in the temperature gradient holes will be cemented by the single-plug method using Portland cement. The same procedure will be used for the 4-1/2 inch casing string in the temperature gradient holes. The remaining casing strings in the production well will be cemented by the single-plug method using high temperature cement compounded from API class G cement with silica flour. Exact compounding will depend upon drilling temperatures encountered.

7.b.(7) Support Services

A mud logging unit will be used to consolidate data on drilling operations and to monitor any H_2S production, although the existing artesian hot well does not produce H_2S in noticeable quantities.

7.b.(8) Well Development

At this time no well stimulation is anticipated, in view of the geological appraisal that production in commercial quantities can be expected only if the prospective reservoir rock section is naturally fractured.

7.b.(9) Wellhead Equipment

Wellhead equipment will consist of oilfield type steel casing head or heads that will accommodate blowout preventer equipment. All will be rated at a minimum of 2,000 psi working pressure. Wellhead equipment added after completion will depend on the type of well completed. Should the well flow naturally at commercial rates, the equipment will be different from that needed for downhole pumping equipment.

7.b.(10) Description of Intended Disposal System

The produced water from the existing artesian hot well is relatively fresh (1213 ppm TDS and 85 ppm chlorides). Should the water from a deeper well exhibit the same mineral content, surface disposal should be feasible. Present artesian flow is discharging directly into Magic Reservoir.

In the event the water from a deeper well proves more highly mineralized and surface disposal is inappropriate, a disposal well would be drilled to inject this water into the producing horizon, preferably at a greater depth. The planned work reflected herein shows the drilling of a disposal well as an alternate program depending on the results obtained in drilling the producing well. An injection well would be drilled in the same manner as a producing well.

7.b.(11) Well Abandonment

Should information gathered during drilling operations show the well to be unsuccessful, it will be abandoned by placing cement plugs in the hole. Abandonment would be conducted in accordance with State requirements, to prevent migration of fluids in the well bore between permeable zones. The top 50 feet of casing would be cemented, the casing cut off below ground, and a steel plate would be welded over the top of the casing. The cellar would be filled and the site restored to the landowner's satisfaction.

7.c PRODUCTION WELL TESTING

The testing planned for a successful full-scale well can be outlined only in broad terms at this time. If the well is capable of flowing, one test procedure will be used; however, if the well does not flow and a downhole pump is required, a different procedure will be used. Even in these two postulated situations, the temperature of the produced fluid could require further changes. The following situations are discussed as illustrations and do not reflect all the testing situations that could be encountered.

1. Well flows naturally with surface temperature of produced fluid at or below 195°F. Under these conditions, water could be measured by meter, either positive displacement or orifice, or by a weir. Downhole pressure would be determined by wireline instruments.

2. Well flows naturally with surface temperature above 195°F. Flow of water would have to be measured under sufficient pressure to prevent flashing of part of the water before measurement. Measurement would be accomplished by a positive displacement or an orifice meter. Downhole pressures would be determined by wireline equipment. Should the produced water temperature be sufficiently in excess of 195°F, installation of a steam-water separator would be necessary with independent measurement of steam and water.

3. Well does not flow naturally and turbine pump installed, wellhead fluid temperature 195°F or less. Production measurement would be made with a positive displacement or orifice meter or a weir. Downhold fluid levels would be determined by an air tube run in the annulus between the pump tubing and casing.

4. Well does not flow naturally at commercial rates requiring pump installation and produces fluid with a wellhead temperature above 195°F. Production measurement would be by a positive displacement or orifice meter. This would be accomplished by holding sufficient back pressure to prevent flashing prior to measurement. Should the produced

temperature be sufficiently in excess of 195°, installation of a steam-water separator would be necessary with independent measurement of steam and water by orifice meters. Again, downhole pressure would be determined by an air tube.

The measurement instrumentation contemplated here is less accurate than would be used in a field research project. The entire project is designed to prove whether a full-scale well can be completed to meet the energy needs of an ethanol plant from geothermal water production. As noted in the drilling section, the production well is designed to do this as economically as possible and the same rationale was used in laying out this program. The data collection proposed here permits an evaluation of the well's producing characteristics and effective pay interval.

8. COST-SHARE PLAN

The proposed cost-share plan is based on two assumptions:

a. that the quality of the geothermal water is such that steam can be flashed using off-the-shelf equipment, and

b. that the well depth does not exceed 3,000 feet.

The proposed criteria for cost-sharing are shown in Table 14. These criteria were developed on an appraisal of degree of "success". The degree of success of the project is established in terms reflecting usable heat produced compared to that needed by the end user--in this case, a 2-million-gallon-per-year ethanol plant. Any secondary or cascading uses would subsequently be supplied with the same water having less available heat per unit of production, would tend to be seasonal, and could be viable only if the chemical content of the water is acceptable.

The measure of usable heat produced is a function of both volume and temperature of the water produced. The needs of the 2-million-gallon-per-year ethanol plant have been established at 600 gal/min of 280°F water. However, if the producing well exactly met this demand, no allowance would exist for possible decreasing well production capacity or decreasing water temperature. The nature of wells is to undergo decline in production rate with time. To allow for this decline we assumed that a completely successful well would produce water at 300°F or higher temperature at a rate of 675 gal/min or more. This is used in constructing the cost sharing matrix.

For a completely successful well the proposer would pay 80 percent of the cost of the project and the DOE 20 percent under the User-Coupled Confirmation Drilling Program, SCAP No. DE-SC07-80ID12139.

Should the well be capable of producing only 280°F water at a rate of 675 gal/min, some increase in the size of lines carrying the water, areas of

TABLE 14

PROPOSER'S COST SHARE MATRIX

Wellhead Temperature (°F) \ Flow Rate (gpm)	<300	300-375	375-450	450-525	525-600	600-675	>675
	Percent						
<265	10	10	10	10	10	10	10
265 - 270	10	10	10	10	10	10	10
270 - 275	10	10	10	10	10	10	10
275 - 280	10	10	10	10	10	10	35
280 - 285	10	12	18	25	30	35	76
285 - 290	10	15	22	30	35	60	77
290 - 295	10	16	26	35	40	70	78
295 - 300	10	18	30	40	50	73	79
>300	10	20	35	48	62	75	80

Percentages = proposer's share of total cost

Example: completed well produces 550 gpm of 292°F water

proposer's share = 40%

DOE's share = 60%

heat exchanger surfaces required, and possibly power consumption would be required. An allowance of 4 percent has been made for this, resulting in proposer's share decreasing to 76 percent. Intermediate temperatures (between 300°F and 280°F) are proportioned directly.

Should the temperature of the produced water be less than 280°F, the minimum for the process, it is assumed that additional heat would be supplied using fuel oil. Increasing the water temperature from 270°F to 280°F would amount to supplying 15 percent of the delivered heat from purchased fuel oil; for 260°F this figure would be 30 percent. Income for the project economics is based on receiving 50 to 75 percent of the equivalent cost for the same heat energy derived from fuel oil. Supplying 15 percent of the energy from fuel oil and receiving income equivalent to 50 percent of fuel oil costs for an all oil-fueled plant, the income would be reduced to 70 percent of that projected; if 30 percent were supplied by fuel oil on this basis, the income would be reduced 40 percent of that projected. For this reason, the cost sharing changes drastically to 35 percent MRI - 65 percent DOE for temperatures from 275°F to 280°F and to 10 percent MRI - 90 percent DOE at 270°F to 275°F while production rate is 675 gal/min or better.

Addressing the rate of production, the case of a productive capacity of only 375 gpm at 300°F was considered as the 2 million-gallon-per-year ethanol plant would consist of two parallel 1-million-gallon plants. In this case, the project investment is essentially the same and results in only one half the income considered earlier. Amortization would be longer, and schedule recognizes this by providing 35 percent MRI and 65 percent DOE funding.

The remainder of the matrix was established in a manner that generally recognizes the constraints as to temperature requirement (280°F or better) and the total heat available at different rates.

9. INSTITUTIONAL CONSIDERATIONS

In general, the MRI proposed plan for confirmation drilling and long-term development of recreational and industrial facilities in and around the Magic Hot Springs area and Magic Reservoir are singularly free of institutional problems within the concerns and intent of NEPA. What questions and potential problems might arise have already been addressed by Magic Resource Investors (MRI) prior to their substantial private investment in MRI acreage and ongoing plans for resource development, including [redacted] twelve sections of BLM lands, hiring the services of several consultants over a period of many months, and seeking out a firm such as Gruy Federal with the combination of both program design/management experience <u>and</u> hands-on field experience in oil and gas and geothermal field operations.

In addition to MRI's early assessment of institutional considerations, [redacted] brings to the team [redacted] (see Section 6.b(1) (iii)) and technical management and field experience (see Section 6.b(1)).

The basic socioeconomic concern of whether expanded primary industrial development (as in harvesting an earth resource) will overburden secondary support industries and tertiary community services is nonexistent in this reservoir project. It is very likely never to be a negative factor in long-term resource development in the sparsely populated region of south central Idaho, but a positive factor as a result of increased tax values, influx of professional persons in the work force, and creation of new schools and community services where these are generally nonexistent at present.

9.a. SITE AND ACCESS

MRI fee land of approximately 212 acres lies within sections 13, 14, and 23 of Township 1 South, Range 17 East, Boise Baseline, Boise Meridian. The area is located principally within the southwest corner of Blaine County, with a few acres in section 23 located adjacent to the upper end of Magic Reservoir. The legal description of the two parcels constituting this acreage is given in Table 15. Figure 18 shows the land and its relation to Magic Reservoir.

[redacted]

This reservoir confirmation drilling proposal is confined to [redacted] for purposes of all drilling. No problems of access, leases, or ownership of property exist.

The exploration program of Task 3 will, however, entail permission from one and possibly two private landowners to conduct surface geological surveys along specific routes such as road cuts and creek beds, and will entail similar surveys on BLM lands.

Also, Task 3 exploration will entail permits to conduct several miles of geophysical surveys on private lands. No problems are anticipated inasmuch as seismic shotholes with explosives are not planned at this time and all local landowners are hospitable to the project. Any denial of permission would result in rerouting of the survey line with minimal effect on the survey.

Ownership of the geothermal resource under MRI fee lands is construed to lie with MRI [redacted]

TABLE 15

LEGAL DESCRIPTION OF MRI LAND

Parcel I

Township 1 South, Range 17 East, Boise Meridian, Blaine County, Idaho:

Section 13: S½SW¼
NW¼SW¼ lying south of Highway 68 (also known as Highway 20)
NE¼SW¼ lying south of Highway 68 (also known as Highway 20)

Section 14: SE¼SE¼

Section 23: NE¼NE¼ excepting that portion lying below the mean high water line of Magic Reservoir
NW¼NE¼ excepting that portion deeded for Magic Reservoir, as follows:

Beginning at a point where the flow line of Magic Reservoir to the north of Camas Creek intersects the north-south center line of Section 23, said intersection being 205.9 feet south of the north quarter corner of Section 23, the flow line of the reservoir bears S. 64°56' E., 25.00 feet; thence

S. 65°35' E., 100.00 feet; thence
S. 61°23' E., 88.6 feet; thence
S. 46°44' E., 249.2 feet; thence
N. 51°42' E., 45.1 feet; thence
N. 66°48' E., 68.3 feet; thence
S. 61°59' E., 81.5 feet; thence
S. 58°14' E., 65.6 feet; thence
S. 69°51' E., 53.5 feet; thence
N. 66°28' E., 140.4 feet; thence
S. 9°21' W., 100.2 feet; thence
S. 6°52' E., 50.4 feet; thence
S. 84°06' E., 84.3 feet; thence
S. 55°51' E., 75.7 feet; thence
S. 58°47' E., 90.9 feet; thence
S. 78°52' E., 103.5 feet; thence
N. 63°48' E., 89.9 feet; thence
N. 48°09' E., 103.7 feet; thence
S. 48°52' E., 96.4 feet to the intersection of the flow line of the reservoir with the east boundary of the above-described 40-acre tract; thence following the east boundary of said 40-acre tract, S. 00°02' E., 598.6 feet to the southeast corner of said 40-acre tract, being the 16th corner; thence

S. 88°32' W., 1177.6 feet to the intersection of the south boundary of said 40-acre tract with the flow line of the reservoir west of Camas Creek; thence
N. 23°56' W., 77.1 feet; thence
N. 9°48' E., 108.7 feet; thence
N. 26°11' E., 111.8 feet; thence
N. 6°22' E., 47.5 feet; thence
N. 17°22' W., 142.8 feet; thence
N. 67°43' W., 95.6 feet; thence
N. 39°11' W., 85.7 feet to the intersection of the flow line of the reservoir with the center line of the above-described Section, and the west boundary of said 40-acre tract; thence
N. 00°00' W., 532.7 feet to the point of beginning.

Also excepting therefrom:

that portion lying below the mean high water line of Magic Reservoir.

Also excepting therefrom:

A tract of land described as commencing at the northeast corner of the NW¼NE¼ of Section 23; thence

S. 89°39' W., 280 feet to a point; thence
S. 0°34' W., 635.63 feet to a point; thence
S. 89°39' W., 100 feet to the true point of beginning; thence
N. 56° W., 125 feet to a point; thence
S. 35° W., 86 feet to a point; thence
S. 61°30' E., 175 feet to a point; thence
N. 0°34' E., 86 feet to the true point of beginning.

Parcel II

Township 1 South, Range 17 East, Boise Meridian, Blaine County, Idaho:

Section 23: Commencing at the northeast corner of the NW¼NE¼ of said Section; thence

S. 89°39' W., 280 feet to a point; thence
S. 0°34' W., 635.63 feet to a point; thence
S. 89°39' W., 100 feet to the true point of beginning; thence
N. 56° W., 125 feet to a point; thence
S. 35° W., 86 feet to a point; thence
S. 61°30' E., 175 feet to a point; thence
N. 0°34' E., 86 feet to the true point of beginning.

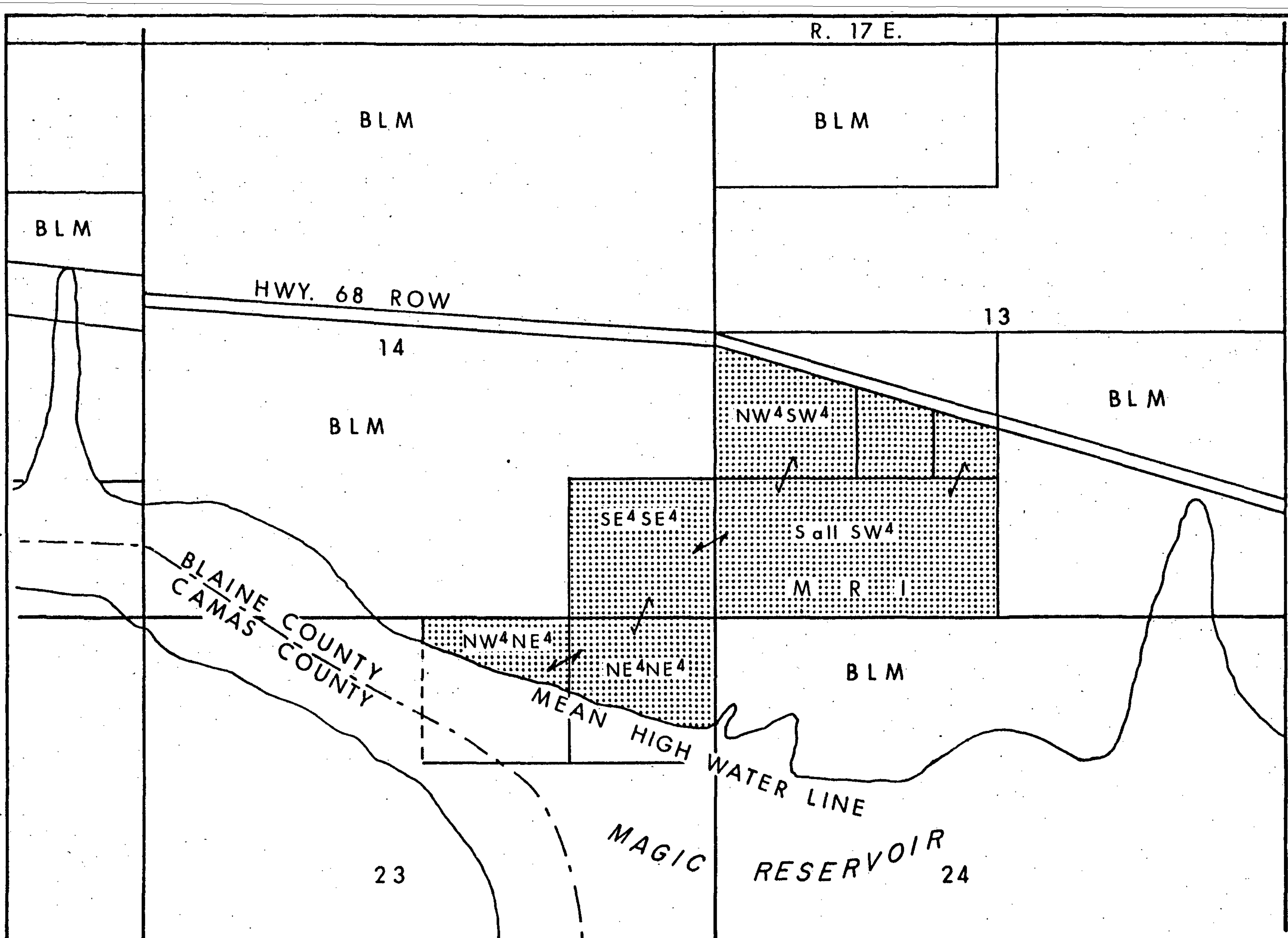

Figure 18--Map of MRI fee land, north end of Magic Reservoir, Blaine County, Idaho.

EXHIBIT 1

LAW OFFICES OF
EDWARD A. LAWSON
THE WALNUT SHELL PROFESSIONAL BUILDING
POST OFFICE BOX 1687
SUN VALLEY, IDAHO 83353
(208) 726-5657

August 27, 1980

Jerold R. Kirkman, President
J. R. Kirkman Development Company
P. O. Box 1328
Sun Valley, Idaho 83353

Re: Magic Hot Springs

Dear Mr. Kirkman:

In accordance with your request, I have examined the Magic Hot Springs property to ascertain the ownership of the [redacted] located on the property and find that they are presently owned by Magic Resource Investors. For the purposes of this letter, geothermal resources shall have the meaning set forth in Idaho Code §47-1602. As provided in Idaho Code §57-1602, geothermal resources are declared to [redacted] In view of the foregoing, and the lack of any reservation of geothermal resources by statute in the State of Idaho as has been done with mineral rights, it is my view, based upon the common law, that the [redacted] Accordingly, at the time that Magic Resource Investors acquired the Magic Hot Springs property, it concurrently acquired the geothermal resources appurtenant to that property.

In expressing our views set forth herein, we have relied on the August 22, 1980 letter from First American Title Insurance Company in addition to other information provided to me by you and such other matters as I have deemed relevant.

Very truly yours,

Edward A. Lawson

EAL:ls

9.b ENVIRONMENTAL ISSUES

No troublesome or controversial environmental issues are foreseen that cannot be alleviated by prudent operations and experienced supervision. All field procedures with respect to drill sites and associated materiel will comply with local and state regulations, and the preliminary Drilling Programs for smaller-diameter thermal gradient holes and the larger-diameter production test well (and injection well, if needed) shall also comply with these requirements/regulations.

The Drilling Programs submitted to DOE will provide safeguards against contamination of surface or subsurface waters. Preliminary plans include storage of drilling fluids in plastic-lined earthen tanks during drilling of the larger-diameter well, and in similar tanks or portable metal tanks during drilling of the smaller-diameter holes.

Drill sites will be restored to original contours and soil conditions. Abandonment will consist of plugging the casing in the abandoned holes in accordance with procedures specified by the appropriate state regulatory commission. No surface manifestation or hazard to livestock or land use will be left.

Completion procedure for the production test well (and injection well, if needed) will include a standard geothermal wellhead surrounded by an appropriate enclosure. Upon completion of the temperature gradient test well, all wellhead equipment will be contained within a 4' x 4' x 4' cellar such that no surface manifestation exists except the covering steel plate.

The concern for air quality consists of (a) dust and (b) H_2S emissions.

(a) Wind-blown dust - the topography is low hills with primary vegetation of sagebrush. The weather is frequently windy, and wind-blown dust and drifting snow characterize the area. Existing roads and numerous level areas within the MRI acreage preclude creation of any significant new bare areas to increase the blowing dust.

The drilling contractor will endeavor to disturb the existing vegetation as little as possible.

(b) Hydrogen sulfide emissions - the present Hot Springs Landing well flows artesian at approximately 135 gal/min. Most of the water is discharged just above high water level at the west end of the recreation (boat launching) area. A slight H_2S odor from this discharge is occasionally detectable but does not disturb the users of the site or users of the well water. It is unlikely that H_2S emissions during drilling will be significant, but H_2S will be monitored and controlled as necessary. How?

Noise associated with drilling, logging, and testing operations is not a problem in the open spaces of the project area. No sensitive species or habitats are present.

Water quality during and after drilling is not a problem. MRI met with the Department of Water Resources on June 19, 1980, to discuss the water quality matter. It was felt that if the chemistry of the geothermal fluid at depth is not significantly different from that of the water presently flowing, contamination would not be a problem and discharge could be made into the reservoir (see Exhibit 2).

It is presently anticipated that discharge will be utilized to considerable benefit to enhance the growth of trees.

9.c SAFETY

MRI is fully cognizant of the necessity to conduct all aspects of the reservoir confirmation drilling project in accordance with the highest industrial standards for safeguard of life, property, and environment.

EXHIBIT 2

State of Idaho
DEPARTMENT OF WATER RESOURCES
STATE OFFICE, 450 W. State Street, Boise, Idaho

JOHN V. EVANS
Governor

C. STEPHEN ALLRED
Director

Mailing address:
Statehouse
Boise, Idaho 83720
(208) 334-4440

July 17, 1980

Mr. Charles Corwin
East Fork Road
Hailey, ID 83333

Dear Mr. Corwin:

I would like to summarize my thoughts concerning the June 19, 1980, meeting we had with Mr. Al Murray, Chief of the Water Quality Bureau, Idaho Department of Health and Welfare.

Although the meeting was informal and Mr. Murray was not reacting to an [redacted] he did set several conditions which if met, would probably allow the discharge of geothermal fluids from your proposed operation directly into Magic Reservoir. The two major constraints would be that the quality of the geothermal fluids not be significantly different from that of the water presently discharging to the reservoir and that the volume of fluid not be much greater than [redacted] figure you mentioned. He also indicated that some kind of diffuser might be needed at the actual discharge point.

If you do not agree with my interpretation, please contact me. I look forward to working with you as you attempt to develop the geothermal resource at the Magic Landing site.

Sincerely,
Frank B. Sherman
FRANK B. SHERMAN, Supervisor
Geothermal and Environmental Section

FBS:cjs

cc: Al Murray, IDWR

September 10, 1980

NOTE: Mr. Charles Corwin advises that the 450 gal/min amount is increased to 750 gal/min, and a letter is forthcoming.

Alan Lohse
Alan Lohse
Executive Vice President, Gruy Federal, Inc.

Through its technical staff, provided primarily by Gruy Federal, Inc., MRI will design, apply, and maintain these standards throughout all field operations.

The experience of GFI's technical organization and project staff encompasses all phases of safety guidelines and compliance relevant to the reservoir confirmation project. The field drilling, logging, and testing supervisors are trained in standards established by the International Association of Drilling Contractors (IADC), which includes proper work procedures and equipment maintenance as set forth in the IADC Drilling Manual and other IADC operations and training manuals. GFI also is familiar with and observes all relevant OSHA regulations.

In 1978, GFI prepared two handbook, "Standard Test Procedure for Blowout Preventers, Choke Manifold and Accessory Equipment" and "Safety Inspection, Blowout Prevention and Control," that were approved by DOE for application to the geopressured-geothermal test and production wells in the Gulf Coast oil and gas province. GFI supervisors are thoroughly familiar with these handbooks.

Potential safety problems in the Magic Hot Springs Landing reservoir confirmation project include water and drilling-mud temperatures not exceeding the routine experience of GFI personnel, and borehole and wellhead pressures far less than routine GFI experience. No potential problems are foreseen that exceed or tax conventional industrial experience as long as prudent operations are conducted and experienced supervision is maintained.

9.d LEGAL, SOCIAL, INSTITUTIONAL ISSUES

These issues are all nonexistent, negligible, or favorable.

(1) Water supply - during drilling, GFI plans to use water from the Magic Reservoir through conventional surface-laid pipelines that will be removed after operations. After drilling, a significant amount of geothermal water will be used for industrial purposes.

Because contamination of the spent geothermal fluid is unlikely, the water can be reinjected into the aquifer or discharged into Magic Reservoir with appropriate State permits. This is a sparsely populated area with very little domestic water consumption.

(2) Land - no disturbance during drilling operations. No potential exists for landslides or excessive or damaging erosion.

(3) Subsidence and seismicity - neither is expected to be a problem for either the short or long term.

(4) Ecology - no short- or long-term ecological disturbance is anticipated. The project will not disturb any sensitive species or habitats, and it contains no aquatic area. Deer migrate north-south and east-west through the area but not in specific corridors. No pheasants roost or nest in the area. The Idaho Department of Fish and Game will be consulted further on any question.

(5) Socioeconomics - inasmuch as the end uses of the project will utilize or add temporily to only a small percentage of the local labor force, demands on housing, school, and other community service will be insignificant. Establishment of an industrial site will be beneficial in stabilizing the local labor market, which at present is highly seasonal.

(6) Heritage resources - since this project will require A-95 review, the State Historical Society will determine whether there are any historical or archeological impacts. If any sites exist, they will be protected.

(7) Zoning - much of the 200 acres owned by the developer is a zoned recreation development district and the remaining portion is zoned agriculture. A comprehensive plan change and rezoning will be

required to accommodate the intended industrial usage. If existing recreational uses can be guaranteed and enhanced, rezoning can be accomplished with separation and screening of industrial from recreational uses by existing topography and future trees to be irrigated by discharge waters.

Blaine County was recently awarded a grant by the State of Idaho to study ways to facilitate geothermal development in the county. As a minimum this study will produce a recommended comprehensive plan and zoning ordinance change that will recognize known geothermal locations in the county and establish permitted uses at those locations. This study is to be completed in time for this project to benefit from the findings and recommendations.

10. PROGRAM POLICY AND PREFERRED FACTORS

The Magic Hot Springs Landing project has a very large potential for expanded development and utilization of the geothermal resource. The geological evidence is very strong that a major source of exploitable heat exists in the area from both the sensible heat of hot rocks and radiogenic heat of younger igneous rocks. Also, the geochemistry of the Magic Hot Springs waters indicates water temperatures approaching 400°F may exist. The large amount of faulting in the area can provide extensive areas of water circulation, and the major faults certainly can provide zones of circulation from depths of many thousands of feet.

Alternative fluid utilization schemes and cascaded multiple uses are planned in near-future development of the industrial park, as shown in Fig. 9, Section 5.b.(2). These uses are now being designed in a geothermal management plan under preparation by Harris, Klein, and Associates working under contract with Blaine County, July 20, 1980.* The management plan includes proposals for additions to the Blaine County Comprehensive Plan and Blaine County Zoning Ordinances, as well as details such as future site access needs, etc.

The ethanol plant will require 22.5×10^6 Btu/hour. The overall project is estimated to cost $1,250,000. Assuming a complete success, the DOE cost would be $250,000, or a DOE investment of 1.1¢ per Btu/hour supplied. The proposer's cost would be 4.4¢/Btu/hour.

*Correspondence between Mr. Charles Corwin and Gruy Federal, Sept. 9, 1980.