IDAHO DEPARTMENT OF WATER RESOURCES 6/8/2020
Proof Report

Water Permit 43-7199

Owner Type	**Name and Address**
Current Owner	GEO ENERGY CORP , ZZ

Status: Cancelled

Source **Tributary**

Beneficial Use	**From**	**To**	**Diversion Rate**	**Volume**

Source and Point(s) of Diversion

Place Of Use

Conditions of Approval:

Comments:

Dates and Other Information
Water District Number: TBD
Mitigation Plan: False

Combined Use Limits
N/A

SubCase:
N/A

Water Supply Bank:
N/A

INTER-DEPARTMENT MEMO — 1

RECEIVED
FEB 27 1986
Department of Water Resources
Southern District Office

FROM Sharla

DATE 2/25/86

TO Southern

SUBJECT

Please send file 43-7199 to us since it has been voided (see attached order) so it can be filmed and destroyed.

Thanks

SIGNATURE

BEFORE THE DEPARTMENT OF WATER RESOURCES

OF THE

STATE OF IDAHO

RECEIVED
FEB 27 1986
Department of Water Resources
Southern District Office

IN THE MATTER OF WATER RIGHT APPLICATION NO. 43-7199 AND GEOTHERMAL APPLICATIONS NOS. 43-GR-1, 2, 3, 4 AND 5 IN THE NAME OF GEO ENERGY CORPORATION)

O R D E R

This matter having come before the Department of Water Resources (Department) as a result of the applicant's failure to supply required information on water right application, the Department finds as follows:

FINDINGS OF FACT

1. On July 14, 1983 Geo Energy Corporation submitted five geothermal applications (3 production and 2 injection) to the Department for development of the geothermal resource in the Raft River Geothermal Resource Area.

2. On that same day the Department advised the applicant by phone of the deficiencies of the applications.

3. On July 28, 1983 Geo Energy Corporation filed Water Right Application 43-7199 for power production in connection with the geothermal wells.

4. On August 16, 1983 the applicant was again notified by the Department of the deficiencies on the geothermal applications.

5. On September 26, 1983 a protest was received against Water Right Application 43-7199.

6. On September 30, 1983 the applicant contacted the Department in regard to the bonding requirements and appeared to be making progress in fulfilling these requirements.

7. On November 23, 1983 the applicant amended the place of use of the water right application.

8. On December 13, 1983 the Department advised the applicant of the withdrawal of the protest on the water right and requested the submittal of additional information to satisfy the requirement of Sections 42-205 and 206 of the Idaho Code.

9. On July 15, 1985 the Department advised the applicant by certified mail of the deficiencies of the geothermal applications so that processing of the applications could be completed.

10. No response was received and the letter was returned to the Department marked "No Forwarding Address".

11. On October 30, 1985 an order to show cause why Water Right Application 43-7199 and Geothermal Applications 43-GR-1, 2, 3, 4 and 5 should not be voided for failure to provide the requested information was sent by regular and certified mail to Lee Albright and Lou Esposito the two remaining Corporation officials of Geo Energy Corporation.

12. No response was received to the Order to Show Cause within the thirty days specified.

CONCLUSIONS OF LAW

1. Section 42-204, Idaho Code, provides 30 days for submission of the requested information on the water right application or the Department may void said record.

2. More than thirty days have passed since the additional information was requested for water right application 43-7199.

3. Geothermal Applications 43-GR-1, 2, 3, 4 and 5 are not complete and do not comply with the requirements of the law.

ORDER

IT IS HEREBY ORDERED that Water Right Application 43-7199 and Geothermal Applications 43-GR-1 through 5 are voided.

DATED this 7TH day of JANUARY 1986.

Norman C. Young

NORMAN C. YOUNG, Administrator
Resources Administration Division

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES
SOUTHERN REGION

John V. Evans
Governor

C. Stephen Allred
Director

1041 Blue Lakes Blvd. North
Twin Falls, Idaho 83301
(208) 734-3570

July 26, 1983

TO: Times News

South Idaho Press

FROM: Loren O. Holmes
Southern Region Supervisor

RE: GEOTHERMAL APPLICATIONS FILED IN RAFT RIVER VALLEY

NEWS RELEASE

Geo Energy Corporation, 3766 Stone Creek Way, Boise, Idaho, has filed 5 applications for permit with the Department of Water Resources to drill for geothermal resources in the Raft River Valley near Bridge, Idaho.

In its applications, the company proposes to drill 5 wells to depths of 1300 to 1600 feet to tap geothermal waters.

After energy has been extracted from the water, the applicant proposes to inject the used water into the ground at depths of 500 to 1300 feet.

Copies of the applications are on file in the Southern Region office of the Idaho Department of Water Resources, 1041 Blue Lakes Blvd. North, Twin Falls, Idaho, 83301.

Public comments or objections to the proposed permits should be filed with the Department of Water Resources by August 15, 1983.

INTER-DEPARTMENT MEMO — 1

RECEIVED
JUL 19 1983
Department of Water Resources
Southern District Office

FROM John Beal

DATE 7/15/83

TO Loren Holmes

SUBJECT 43-GR-4, 5

Since these are injection wells they will require press release per Waste Disposal Rule 6.1 Paragraph 1. Please make release as soon as possible

John E Beal
SIGNATURE

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

JOHN V. EVANS
Governor

A. KENNETH DUNN
Director

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

RECEIVED
JUL 19 1983
Department of Water Resources
Southern District Office

July 15, 1983

Loren Holmes
IDWR - Southern Region

RE: 43-GR-1, 43-GR-2, 43-GR-3, 43-GR-4 & 43-GR-5

Dear Loren:

Attached for your review and comment are applications for permit to drill 3 production wells and 2 injection wells at Raft River, Idaho, submitted by Geo Energy Corporation.

Please submit your comments to me by August 4, 1983.

Sincerely,

John

JOHN E. BEAL, Supervisor
Construction Permits Section

JEB:ldt

Enclosures

Form 4003-1
5/78

Geothermal Application No. 43-GR-1

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES

APPLICATION FOR PERMIT TO DRILL FOR GEOTHERMAL RESOURCES

1. Name of applicant Geo Energy Corporation

Post office address 3766 Stone Creek Way, Boise, Idaho 83703

If partnership, joint-venture, association, or unincorporated group, attach names and places of domicile of partners or persons. If corporation, attach list of corporate offices and their place of domicile, and the names and place of domicile of any person owning thirty percent (30%) or greater interest in the corporation. Also give:

a. Place of incorporation and date June 28, 1983

Secretary of State's Office, Boise, Idaho

b. Principal place of business Boise, Idaho

c. Location of home office 3766 Stone Creek Way

Boise, Idaho 83703

d. Is applicant making application as an agent for another person, corporation or entity? If so, state name, address, and interest of your principal.

Jerry R. Kirkman, President, Geo Energy Corporation,

3766 Stone Creek Way, Boise, Idaho 83703

e. Designation of agent residing in the State of Idaho Rick Tremblay, Vice President, Geo Energy Corporation

2. Location of proposed well Raft River, Idaho

NW ¼ - ¼, Section 23, Township 15S, Range 26E, B.M.

Well number or well name Shaun #1

3. Type of well: ☐ Exploration ☒ Production #1 ☐ Injection

4. Well construction:

Describe specifically or attach information pertinent to the proposed casing program, and well construction including casing size, thickness, length of conductor, surface and production pipes; proposed grouting procedures, safety devices, valving, and other measures designed to conserve and protect the geothermal resource and ground water of the state. 20" hole drilled to 18' depth.

16-3/4" Casing set at 18' depth, (2' above land surface) with annular space cemented solid to surface.

14" Hole drilled from 18' depth to 1,400' depth.

12-3/4" Casing set from surface to 1,400' depth with annular space cemented solid to surface.

12" Hole drilled from 1,400' depth to 1,600' depth.

9-5/8" Screen or perforated casing installed with lead swedge and set open hole from 1,400' depth to 1,600' depth. All casing standard wall 3/16".

5. If the proposed well is for exploration or production, explain the means by which you expect to contain and control the resource. (Use additional sheets if necessary.) Standard surface valving procedures with remote control extension devices. Cement, casing, surface valving, and drilling program is based on USGS drilling reports for Raft River site where no high temperatures or high pressures are known to exist at drilled depths of over 6,000'.

6. What is the character and composition of the material you expect to derive from the well? Include parameters such as phase, estimated temperatures, etc.
Refer to attached "Chemical Analysis of Thermal Water - H. S. Frazier Well" and "The Raft River, Idaho 5 MW Binary Project" report by L. L. Mink or USDOE Raft River Geoscience Case Study.

7. Is this application a part of a program for exploration or development of an already explored geothermal resource?
Development of an already explored geothermal resource.

8. What is the estimated cost of the construction of the well and related uses? Provide a validated financial statement showing the applicant has sufficient financial resources to complete the project.
$70,000: Niagra-Mohawk Power Co. - HydraCo Joint Venture

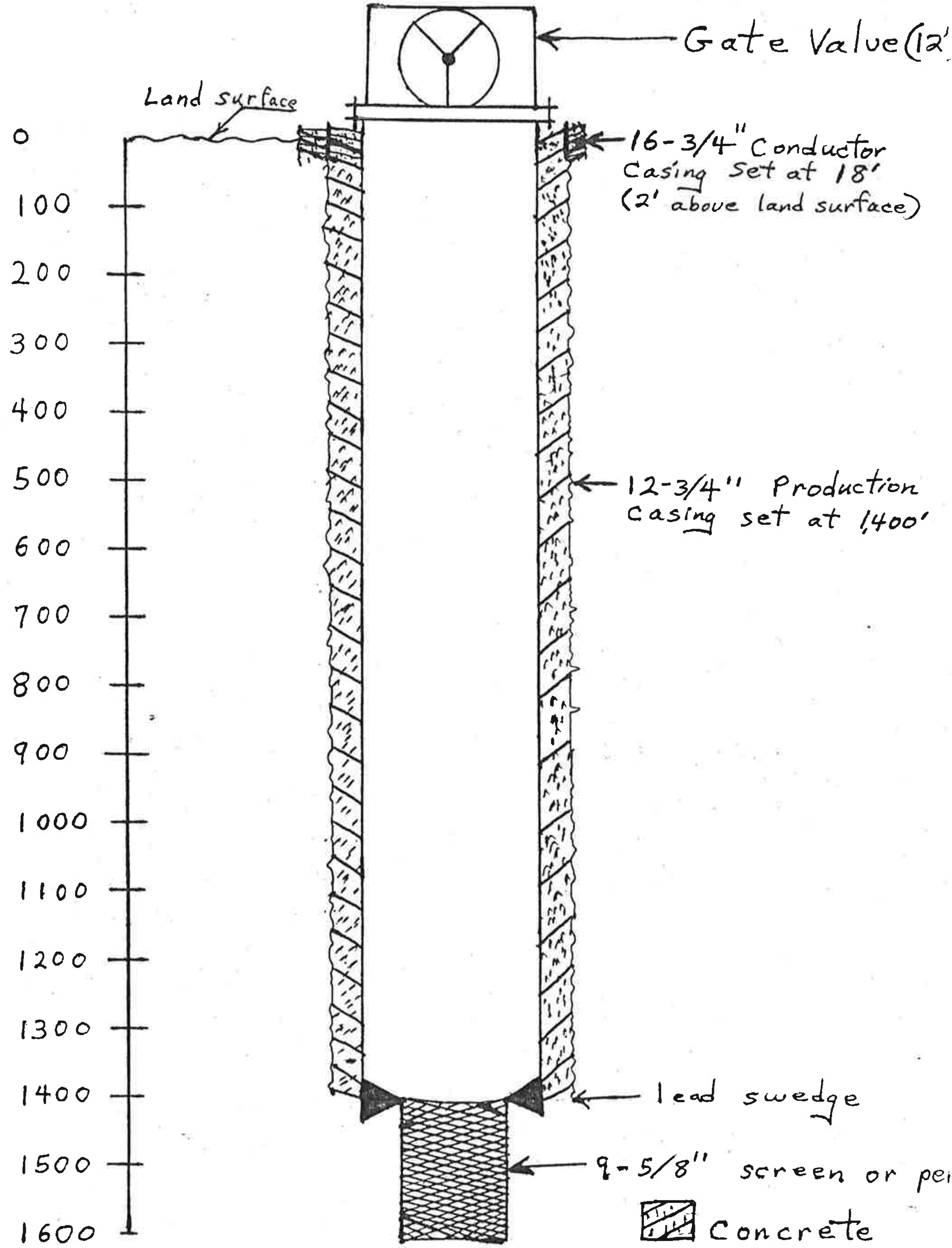
9. If the proposed development will involve the use of water for purposes other than geothermal uses, has the applicant applied for a permit to appropriate water as prescribed in Chapter 2, Title 42, Idaho Code?
Geothermal power production use

10. List in detail the applicant's previous experience in geothermal resource development.
Rick Tremblay, Vice President, Geo Energy Corporation formerly project director of Capitol Mall Geothermal Project and L. L. "Roy" Mink, Consultant to Geo Energy Corporation and former USDOE Geothermal Energy Branch Chief.

11. What does the applicant intend to do with waste products, brine or water from the well?
Reinjection into thief zone 500' to 1,300' depth.

12. Idaho law requires that a bond be filed with the Department indemnifying the State of Idaho, conditional upon the performance of the duties required by the Idaho Geothermal Resources Act and the proper abandonment of any well covered by permit of not less than $10,000 per well, the actual amount set as a condition of the permit. Identify the company that will underwrite your bond and provide confirmation that they will issue such bond upon payment of the necessary fees. A Surety Bond will be provided to the IDWR in the forthcoming drilling prospectus.

Richard B. Tremblay
Signature for application



General Production Well Const.

MUD to 1,400' - WATER 1,400' - 1,600'

Basic Data Table 1. Chemical Analyses of Thermal Water from Selected Springs and Wells in Idaho (continued)

Spring or Well Identification Number and Name	Sample Collection Date	Measured Surface Temperature °C	Reported Well Depth below Land Surface (meters)	Discharge (l/min)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Phosphate (PO_4)	Chloride (Cl)	Flouride (F)	Nitrate (NO_3)	Boron (B)	Ammonia (NH_3)	Specific Conductance (field)	pH (field)	Total Dissolved Solids (TDS)	Hardness: Carbonate	Hardness: Non-Carbonate	Alkalinity as $CaCO_3$	Percent Sodium (%Na)	Sodium Absorption Ratio (SAR)	Cation-Anion Balance	Data Reference*
Cassia County (cont'd.)																												
SEARS SPRING 14S 25E 6BBB1S	8/ 5/75	28	0.	662.	22	29.0	7.50	15	3.30	120.	0.0	10.00	0.0	19.0	0.40	0.0	0.0	0.0	270	8.2	165	103.	5.	98.	23.3	0.6	0.365	9
GRIFFETH-WIGHT WELL 14S 26E 18DD1	0/ 0/ 0	77	1982.	378.	64	5.0	12.00	14	2.50	116.	124.00	27.00	0.01	62.0	0.0	1.20	1.00	0.0	10000	8.4	368	62.	0.	302.	31.9	0.8	-62.093	10
HAROLD WIGHT WELL 14S 26E 1CDA1	6/14/77	63	0.	0.	83	1.0	0.20	170	2.90	240.	36.00	25.00	0.0	72.0	7.30	0.50	0.0	0.08	600	9.3	515	3.	0.	257.	98.1	40.6	-3.683	12
HAROLD WARD WELL #1 14S 27E 18CCC1	7/24/75	24	0.	3399.	90	55.0	2.20	170	29.00	131.	0.0	23.00	0.0	300.0	1.10	0.0	0.0	0.0	960	7.6	734	146.	39.	107.	66.8	6.1	-0.457	9
MORRIS MITCHELL WELL #2 15S 21E 25DCC1	9/22/77	46	0.	38.	28	2.0	0.10	110	1.80	230.	11.00	21.00	0.02	17.0	2.40	0.03	0.0	0.08	475	8.7	306	5.	0.	207.	96.9	20.6	-2.673	10
HAROLD WARD WELL #2 15S 24E 22DDB1	7/25/72	38	152.	378.	44	37.0	9.30	70	3.10	169.	0.0	33.00	0.03	80.0	2.90	0.56	0.0	0.0	606	7.4	362	131.	0.	138.	53.1	2.7	-1.377	3
BLM 15S 25E 29CDC1	10/ 7/76	60	0.	0.	68	3.6	0.10	120	3.40	65.	20.00	40.00	0.0	82.0	7.60	0.0	0.0	0.0	540	8.9	376	9.	0.	87.	95.0	17.0	1.840	9
BLM 15S 26E 12ACC1	12/ 5/74	26	0.	0.	88	300.0	1.40	2000	270.00	58.	0.0	45.00	0.0	3900.0	3.90	0.0	0.0	0.88	998	7.8	6636	754.	707.	48.	79.8	31.7	-1.427	9
BLM 15S 26E 22DDD1	12/ 6/74	82	0.	189.	56	56.0	0.50	1300	14.00	63.	0.0	52.00	0.0	2000.0	5.00	0.0	0.0	0.04	6609	8.0	3514	142.	90.	52.	94.7	47.5	0.762	9
IVAN DARRINGTON WELL #1 15S 26E 23AAA1	10/23/75	85	0.	15.	140	43.0	1.00	400	37.00	63.	0.0	40.00	0.0	680.0	9.10	0.0	0.0	0.0	1879	8.1	1381	111.	60.	52.	84.6	16.5	-2.265	9
FRAZIER H S WELL 15S 26E 23BBC1	5/18/72	95	126.	220.	90	53.0	0.40	560	22.00	55.	0.0	57.00	0.0	900.0	5.70	0.54	0.0	0.0	3049	7.4	1715	134.	89.	45.	88.3	21.1	-0.381	3
HARRIAT CRANK WELL 15S 26E 23DDC1	5/18/72	90	165.	227.	97	130.0	0.40	1110	35.00	36.	0.0	61.00	0.01	1900.0	14.00	0.57	0.0	0.0	6089	7.7	3365	326.	296.	30.	86.7	26.7	-0.474	3
IVAN DARRINGTON WELL #3 15S 26E 23DDD1	7/30/75	33	0.	0.	53	140.0	8.30	450	19.00	174.	0.0	69.00	0.0	820.0	2.30	1.10	0.0	0.0	2459	7.0	1648	383.	241.	143.	70.6	10.0	0.265	12
REID STEWART WELL 15S 26E 24BAD1	7/24/75	32	0.	3399.	47	100.0	6.30	380	16.00	177.	0.0	65.00	0.0	650.0	1.90	0.0	0.0	0.0	2179	7.3	1353	275.	130.	145.	73.6	10.0	-0.596	9
IVAN DARRINGTON WELL #4 15S 26E 24DCC1	7/29/75	31	0.	3399.	55	88.0	7.10	340	16.00	161.	0.0	52.00	0.0	560.0	2.50	0.0	0.0	0.0	1839	7.5	1199	249.	117.	132.	73.3	9.4	1.293	9
BLM 15S 26E 25ACA1	1/14/75	30	0.	83.	88	35.0	3.90	370	34.00	176.	0.0	32.00	0.0	570.0	2.80	0.0	0.0	0.21	1949	7.7	1222	103.	0.	144.	84.6	15.8	-2.119	9
BLM 16S 26E 5BBA1	3/28/75	40	0.	151.	37	58.0	9.00	240	13.00	138.	0.0	44.00	0.0	380.0	4.40	0.0	0.0	0.14	1539	6.8	853	182.	69.	113.	72.5	7.7	0.971	9

Form 4003-1
5/78

Geothermal Application No. 43-GR-2

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES

APPLICATION FOR PERMIT TO DRILL FOR GEOTHERMAL RESOURCES

1. Name of applicant Geo Energy Corporation

   Post office address 3766 Stone Creek Way, Boise, Idaho 83703

   If partnership, joint-venture, association, or unincorporated group, attach names and places of domicile of partners or persons. If corporation, attach list of corporate offices and their place of domicile, and the names and place of domicile of any person owning thirty percent (30%) or greater interest in the corporation. Also give:

   a. Place of incorporation and date June 28, 1983

      Secretary of State's Office, Boise, Idaho

   b. Principal place of business Boise, Idaho

   c. Location of home office 3766 Stone Creek Way

      Boise, Idaho 83703

   d. Is applicant making application as an agent for another person, corporation or entity? If so, state name, address, and interest of your principal.

      Jerry R. Kirkman, President, Geo Energy Corporation,

      3766 Stone Creek Way, Boise, Idaho 83703

   e. Designation of agent residing in the State of Idaho Rick Tremblay, Vice President, Geo Energy Corporation

2. Location of proposed well Raft River, Idaho

   W ½ SE ¼, Section 22, Township 15S, Range 26E, B.M.

   Well number or well name Heather #2

3. Type of well: ☐ Exploration ☒ Production #2 ☐ Injection

4. Well construction:

   Describe specifically or attach information pertinent to the proposed casing program, and well construction including casing size, thickness, length of conductor, surface and production pipes; proposed grouting procedures, safety devices, valving, and other measures designed to conserve and protect the geothermal resource and ground water of the state. 20" hole drilled to 18' depth.

   16-3/4" Casing set at 18' depth, (2' above land surface) with annular space cemented solid to surface.

   14" Hole drilled from 18' depth to 1,400' depth.

   12-3/4" Casing set from surface to 1,400' depth with annular space cemented solid to surface.

   12" Hole drilled from 1,400' depth to 1,600' depth.

   9-5/8" Screen or perforated casing installed with lead swedge and set open hole from 1,400' depth to 1,600' depth. All casing standard wall 3/16".

5. If the proposed well is for exploration or production, explain the means by which you expect to contain and control the resource. (Use additional sheets if necessary.) Standard surface valving procedures with remote control extension devices. Cement, casing, surface valving, and drilling program is based on USGS drilling reports for Raft River site where no high temperatures or high pressures are known to exist at drilled depths of over 6,000'.

6. What is the character and composition of the material you expect to derive from the well? Include parameters such as phase, estimated temperatures, etc.
Refer to attached "Chemical Analysis of Thermal Water - H. S. Frazier Well" and "The Raft River, Idaho 5 MW Binary Project" report by L. L. Mink or USDOE Raft River Geoscience Case Study.

7. Is this application a part of a program for exploration or development of an already explored geothermal resource?
Development of an already explored geothermal resource.

8. What is the estimated cost of the construction of the well and related uses? Provide a validated financial statement showing the applicant has sufficient financial resources to complete the project.
$70,000: Niagra-Mohawk Power Co. - HydraCo Joint Venture

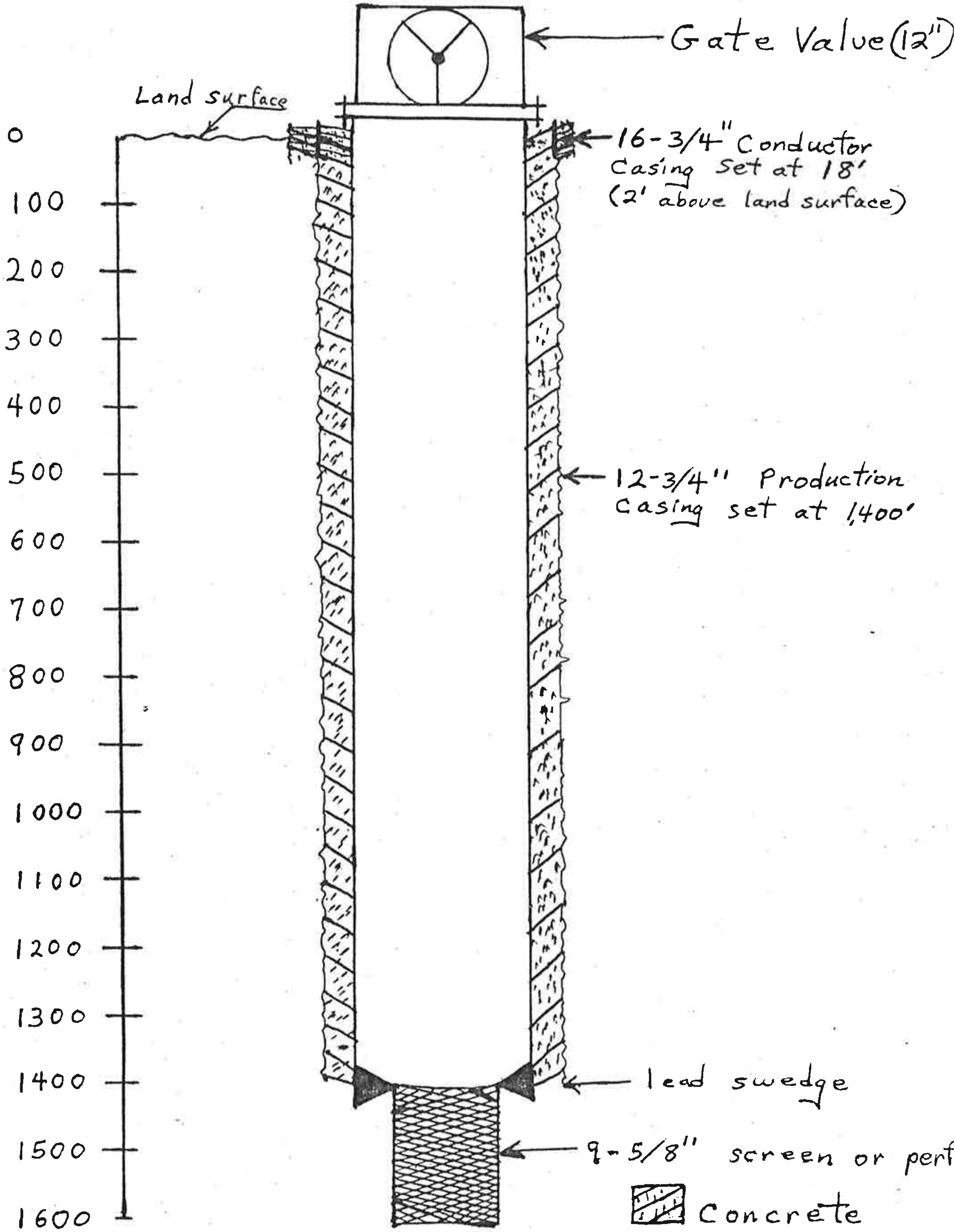
9. If the proposed development will involve the use of water for purposes other than geothermal uses, has the applicant applied for a permit to appropriate water as prescribed in Chapter 2, Title 42, Idaho Code?
Geothermal power production use

10. List in detail the applicant's previous experience in geothermal resource development.
Rick Tremblay, Vice President, Geo Energy Corporation formerly project director of Capitol Mall Geothermal Project and L. L. "Roy" Mink, Consultant to Geo Energy Corporation and former USDOE Geothermal Energy Branch Chief.

11. What does the applicant intend to do with waste products, brine or water from the well?
Reinjection into thief zone 500' to 1,300' depth.

12. Idaho law requires that a bond be filed with the Department indemnifying the State of Idaho, conditional upon the performance of the duties required by the Idaho Geothermal Resources Act and the proper abandonment of any well covered by permit of not less than $10,000 per well, the actual amount set as a condition of the permit. Identify the company that will underwrite your bond and provide confirmation that they will issue such bond upon payment of the necessary fees. A Surety Bond will be provided to the IDWR in the forthcoming drilling prospectus.

Richard F. Tremblay
Signature for application



General Production Well Const.

MUD to 1,400' - WATER 1,400' - 1,600'

Basic Data Table 1. Chemical Analyses of Thermal Water from Selected Springs and Wells in Idaho (continued)

Spring or Well Identification Number and Name	Sample Collection Date	Measured Surface Temperature °C	Reported Well Depth below Land Surface (meters)	Discharge (l/min)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Phosphate (PO_4)	Chloride (Cl)	Flouride (F)	Nitrate (NO_3)	Boron (B)	Ammonia (NH_3)	Specific Conductance (field)	pH (field)	Total Dissolved Solids (TDS)	Hardness: Carbonate	Hardness: Non-Carbonate	Alkalinity as $CaCO_3$	Percent Sodium (%Na)	Sodium Absorption Ratio (SAR)	Cation-Anion Balance	Data Reference*
												Cassia County (cont'd.)																
SEARS SPRING 14S 25E 6BBB1S	8/ 5/75	28	0.	662.	22	29.0	7.50	15	3.30	120.	0.0	10.00	0.0	19.0	0.40	0.0	0.0	0.0	270	8.2	165	103.	5.	98.	23.3	0.6	0.365	9
GRIFFETH-WIGHT WELL 14S 26E 1BDD1	0/ 0/ 0	77	1982.	378.	64	5.0	12.00	14	2.50	116.	124.00	27.00	0.01	62.0	0.0	1.20	1.00	0.0	10000	8.4	368	62.	0.	302.	31.9	0.8	-62.093	10
HAROLD WIGHT WELL 14S 26E 1CDA1	6/14/77	63	0.	0.	83	1.0	0.20	170	2.90	240.	36.00	25.00	0.0	72.0	7.30	0.50	0.0	0.08	600	9.3	515	3.	0.	257.	98.1	40.6	-3.683	12
HAROLD WARD WELL #1 14S 27E 18CCC1	7/24/75	24	0.	3399.	90	55.0	2.20	170	29.00	131.	0.0	23.00	0.0	300.0	1.10	0.0	0.0	0.0	960	7.6	734	146.	39.	107.	66.8	6.1	-0.457	9
MORRIS MITCHELL WELL #2 15S 21E 25DCC1	9/22/77	46	0.	38.	28	2.0	0.10	110	1.80	230.	11.00	21.00	0.02	17.0	2.40	0.03	0.0	0.08	475	8.7	306	5.	0.	207.	96.9	20.6	-2.673	10
HAROLD WARD WELL #2 15S 24E 22DDB1	7/25/72	38	152.	378.	44	37.0	9.30	70	3.10	169.	0.0	33.00	0.03	80.0	2.90	0.56	0.0	0.0	606	7.4	362	131.	0.	138.	53.1	2.7	-1.377	3
BLM 15S 25E 29CDC1	10/ 7/76	60	0.	0.	68	3.6	0.10	120	3.40	65.	20.00	40.00	0.0	82.0	7.60	0.0	0.0	0.0	540	8.9	376	9.	0.	87.	95.0	17.0	1.840	9
BLM 15S 26E 12ACC1	12/ 5/74	26	0.	0.	88	300.0	1.40	2000	270.00	58.	0.0	45.00	0.0	3900.0	3.90	0.0	0.0	0.88	998	7.8	6636	754.	707.	48.	79.8	31.7	-1.427	9
BLM 15S 26E 22DDD1	12/ 6/74	82	0.	189.	56	56.0	0.50	1300	14.00	63.	0.0	52.00	0.0	2000.0	5.00	0.0	0.0	0.04	6609	8.0	3514	142.	90.	52.	94.7	47.5	0.762	9
IVAN DARRINGTON WELL #1 15S 26E 23AAA1	10/23/75	85	0.	15.	140	43.0	1.00	400	37.00	63.	0.0	40.00	0.0	680.0	9.10	0.0	0.0	0.0	1879	8.1	1381	111.	60.	52.	84.6	15.5	-2.265	9
FRAZIER H S WELL 15S 26E 23BBC1	5/18/72	95	126.	220.	90	53.0	0.40	560	22.00	55.	0.0	57.00	0.0	900.0	5.70	0.54	0.0	0.0	3049	7.4	1715	134.	89.	45.	88.3	21.1	-0.381	3
HARRIAT CRANK WELL 15S 26E 23DDC1	5/18/72	90	165.	227.	97	130.0	0.40	1110	35.00	36.	0.0	61.00	0.01	1900.0	14.00	0.57	0.0	0.0	6089	7.7	3365	326.	296.	30.	86.7	26.7	-0.474	3
IVAN DARRINGTON WELL #3 15S 26E 23DDD1	7/30/75	33	0.	0.	53	140.0	8.30	450	19.00	174.	0.0	69.00	0.0	820.0	2.30	1.10	0.0	0.0	2459	7.0	1648	383.	241.	143.	70.6	10.0	0.265	12
REID STEWART WELL 15S 26E 24BAD1	7/24/75	32	0.	3399.	47	100.0	6.30	380	16.00	177.	0.0	65.00	0.0	650.0	1.90	0.0	0.0	0.0	2179	7.3	1353	275.	130.	145.	73.6	10.0	-0.596	9
IVAN DARRINGTON WELL #4 15S 26E 24DCC1	7/29/75	31	0.	3399.	55	88.0	7.10	340	16.00	161.	0.0	52.00	0.0	560.0	2.50	0.0	0.0	0.0	1839	7.5	1199	249.	117.	132.	73.3	9.4	1.293	9
BLM 15S 26E 25ACA1	1/14/75	30	0.	83.	88	35.0	3.90	370	34.00	176.	0.0	32.00	0.0	570.0	2.80	0.0	0.0	0.21	1949	7.7	1222	103.	0.	144.	84.6	15.8	-2.119	9
BLM 16S 26E 5BBA1	3/28/75	40	0.	151.	37	58.0	9.00	240	13.00	138.	0.0	44.00	0.0	380.0	4.40	0.0	0.0	0.14	1539	6.8	853	182.	69.	113.	72.5	7.7	0.971	9

Form 4003-1
5/78

Geothermal Application No. 43-GR-3

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES

APPLICATION FOR PERMIT TO DRILL FOR GEOTHERMAL RESOURCES

1. Name of applicant Geo Energy Corporation

Post office address 3766 Stone Creek Way, Boise, Idaho 83703

If partnership, joint-venture, association, or unincorporated group, attach names and places of domicile of partners or persons. If corporation, attach list of corporate offices and their place of domicile, and the names and place of domicile of any person owning thirty percent (30%) or greater interest in the corporation. Also give:

a. Place of incorporation and date June 28, 1983

Secretary of State's Office, Boise, Idaho

b. Principal place of business Boise, Idaho

c. Location of home office 3766 Stone Creek Way

Boise, Idaho 83703

d. Is applicant making application as an agent for another person, corporation or entity? If so, state name, address, and interest of your principal.

Jerry R. Kirkman, President, Geo Energy Corporation,

3766 Stone Creek Way, Boise, Idaho 83703

e. Designation of agent residing in the State of Idaho Rick Tremblay, Vice President, Geo Energy Corporation

2. Location of proposed well Raft River, Idaho

NW ¼ – ¼, Section 22, Township 15S, Range 26E, B.M.

Well number or well name Bryce #3

3. Type of well: ☐ Exploration ☒ Production #3 ☐ Injection

4. Well construction:

Describe specifically or attach information pertinent to the proposed casing program, and well construction including casing size, thickness, length of conductor, surface and production pipes; proposed grouting procedures, safety devices, valving, and other measures designed to conserve and protect the geothermal resource and ground water of the state. 20" hole drilled to 18' depth.

16-3/4" Casing set at 18' depth, (2' above land surface) with annular space cemented solid to surface.

14" Hole drilled from 18' depth to 1,400' depth.

12-3/4" Casing set from surface to 1,400' depth with annular space cemented solid to surface.

12" Hole drilled from 1,400' depth to 1,600' depth.

9-5/8" Screen or perforated casing installed with lead swedge and set open hole from 1,400' depth to 1,600' depth. All casing standard wall 3/16".

5. If the proposed well is for exploration or production, explain the means by which you expect to contain and control the resource. (Use additional sheets if necessary.) Standard surface valving procedures with remote control extension devices. Cement, casing, surface valving, and drilling program is based on USGS drilling reports for Raft River site where no high temperatures or high pressures are known to exist at drilled depths of over 6,000'.

6. What is the character and composition of the material you expect to derive from the well? Include parameters such as phase, estimated temperatures, etc.
Refer to attached "Chemical Analysis of Thermal Water - H. S. Frazier Well" and "The Raft River, Idaho 5 MW Binary Project" report by L. L. Mink or USDOE Raft River Geoscience Case Study.

7. Is this application a part of a program for exploration or development of an already explored geothermal resource?
Development of an already explored geothermal resource.

8. What is the estimated cost of the construction of the well and related uses? Provide a validated financial statement showing the applicant has sufficient financial resources to complete the project.
$70,000: Niagra-Mohawk Power Co. - HydraCo Joint Venture

9. If the proposed development will involve the use of water for purposes other than geothermal uses, has the applicant applied for a permit to appropriate water as prescribed in Chapter 2, Title 42, Idaho Code?

Geothermal power production use

10. List in detail the applicant's previous experience in geothermal resource development.

Rick Tremblay, Vice President, Geo Energy Corporation formerly project director of Capitol Mall Geothermal Project and L. L. "Roy" Mink, Consultant to Geo Energy Corporation and former USDOE Geothermal Energy Branch Chief.

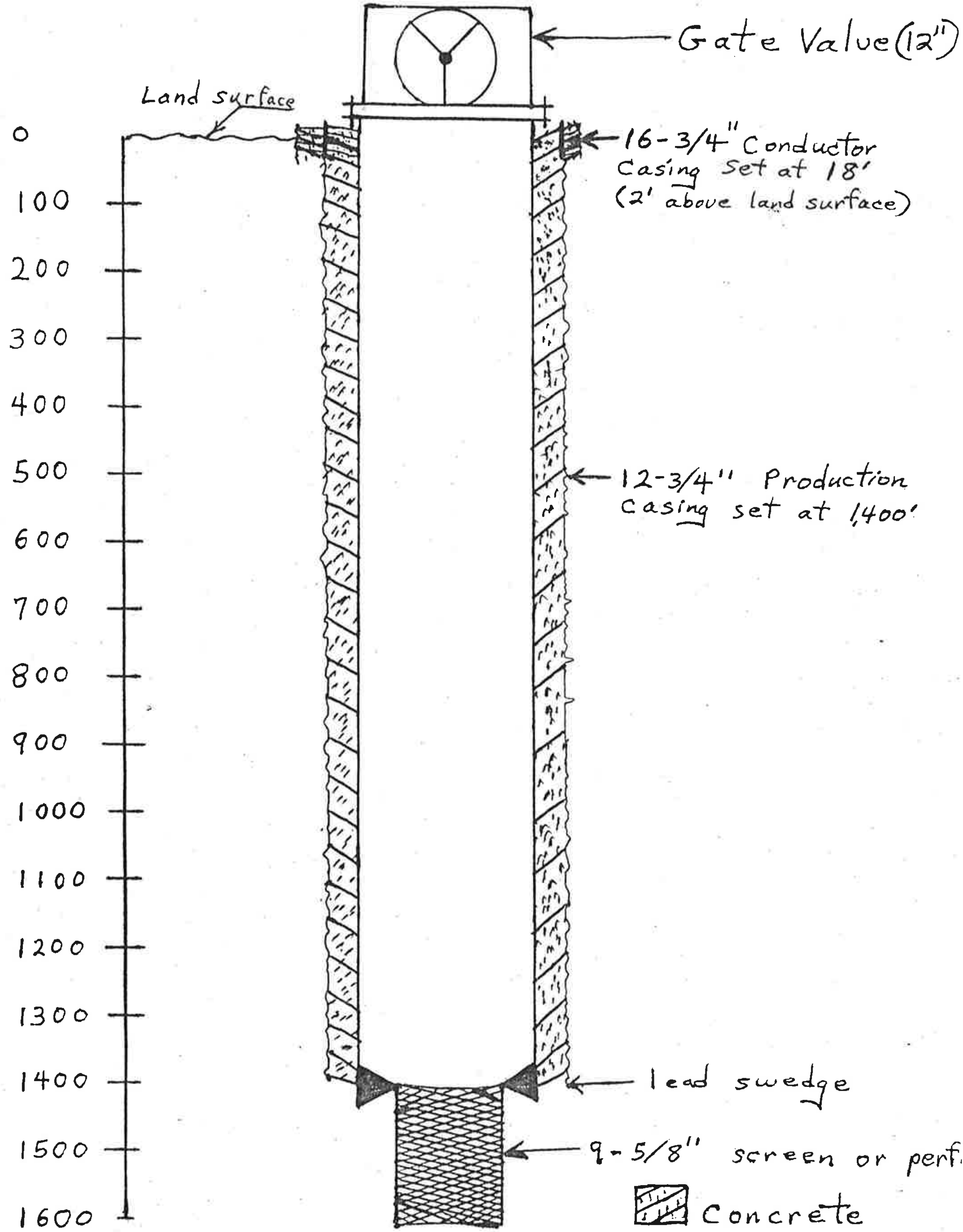
11. What does the applicant intend to do with waste products, brine or water from the well?

Reinjection into thief zone 500' to 1,300' depth.

12. Idaho law requires that a bond be filed with the Department indemnifying the State of Idaho, conditional upon the performance of the duties required by the Idaho Geothermal Resources Act and the proper abandonment of any well covered by permit of not less than $10,000 per well, the actual amount set as a condition of the permit. Identify the company that will underwrite your bond and provide confirmation that they will issue such bond upon payment of the necessary fees. A Surety Bond will be provided to the IDWR in the forthcoming drilling prospectus.

Richard F. Tremblay

Signature for application



General Production Well Const.

MUD to 1,400' - WATER 1,400' - 1,600'

Basic Data Table 1. Chemical Analyses of Thermal Water from Selected Springs and Wells in Idaho (continued)

Cassia County (cont'd.)

Spring or Well Identification Number and Name	Sample Collection Date	Measured Surface Temperature °C	Reported Well Depth below Land Surface (meters)	Discharge (l/min)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Phosphate (PO_4)	Chloride (Cl)	Flouride (F)	Nitrate (NO_3)	Boron (B)	Ammonia (NH_3)	Specific Conductance (field)	pH (field)	Total Dissolved Solids (TDS)	Hardness: Carbonate	Hardness: Non-Carbonate	Alkalinity as $CaCO_3$	Percent Sodium (%Na)	Sodium Absorption Ratio (SAR)	Cation-Anion Balance	Data Reference*
SEARS SPRING 14S 25E 6BBB1S	8/ 5/75	28	0.	662.	22	29.0	7.50	15	3.30	120.	0.0	10.00	0.0	19.0	0.40	0.0	0.0	0.0	270	8.2	165	103.	5.	98.	23.3	0.6	0.365	9
GRIFFETH-WIGHT WELL 14S 26E 1BDD1	0/ 0/ 0	77	1982.	378.	64	5.0	12.00	14	2.50	116.	124.00	27.00	0.01	62.0	0.0	1.20	1.00	0.0	10000	8.4	368	62.	0.	302.	31.9	0.8	-62.093	10
HAROLD WIGHT WELL 14S 26E 1CDA1	6/14/77	63	0.	0.	83	1.0	0.20	170	2.90	240.	36.00	25.00	0.0	72.0	7.30	0.50	0.0	0.08	600	9.3	515	3.	0.	257.	98.1	40.6	-3.683	12
HAROLD WARD WELL #1 14S 27E 18CCC1	7/24/75	24	0.	3399.	90	55.0	2.20	170	29.00	131.	0.0	23.00	0.0	300.0	1.10	0.0	0.0	0.0	960	7.6	734	146.	39.	107.	66.8	6.1	-0.457	9
MORRIS MITCHELL WELL #2 15S 21E 25DCC1	9/22/77	46	0.	38.	28	2.0	0.10	110	1.80	230.	11.00	21.00	0.02	17.0	2.40	0.03	0.0	0.08	475	8.7	306	5.	0.	207.	96.9	20.6	-2.673	10
HAROLD WARD WELL #2 15S 24E 22DDB1	7/25/72	38	152.	378.	44	37.0	9.30	70	3.10	169.	0.0	33.00	0.03	80.0	2.90	0.56	0.0	0.0	606	7.4	362	131.	0.	138.	53.1	2.7	-1.377	3
BLM 15S 25E 29CDC1	10/ 7/76	60	0.	0.	68	3.6	0.10	120	3.40	65.	20.00	40.00	0.0	82.0	7.60	0.0	0.0	0.0	540	8.9	376	9.	0.	87.	95.0	17.0	1.840	9
BLM 15S 26E 12ACC1	12/ 5/74	26	0.	0.	88	300.0	1.40	2000	270.00	58.	0.0	45.00	0.0	3900.0	3.90	0.0	0.0	0.88	998	7.8	6636	754.	707.	48.	79.8	31.7	-1.427	9
BLM 15S 26E 22DDD1	12/ 6/74	82	0.	189.	56	56.0	0.50	1300	14.00	63.	0.0	52.00	0.0	2000.0	5.00	0.0	0.0	0.04	6609	8.0	3514	142.	90.	52.	94.7	47.5	0.762	9
IVAN DARRINGTON WELL #1 15S 26E 23AAA1	10/23/75	85	0.	15.	140	43.0	1.00	400	37.00	63.	0.0	40.00	0.0	680.0	9.10	0.0	0.0	0.0	1879	8.1	138[illegible]	111.	60.	52.	84.6	15.5	-2.265	9
FRAZIER H S WELL 15S 26E 23BBC1	5/18/72	95	126.	220.	90	53.0	0.40	560	22.00	55.	0.0	57.00	0.0	900.0	5.70	0.54	0.0	0.0	3049	7.4	1715	134.	89.	45.	88.3	21.1	-0.381	3
HARRIAT CRANK WELL 15S 26E 23DDC1	5/18/72	90	165.	227.	97	130.0	0.40	1110	35.00	36.	0.0	61.00	0.01	1900.0	14.00	0.57	0.0	0.0	6089	7.7	3365	326.	296.	30.	86.7	26.7	-0.474	3
IVAN DARRINGTON WELL #3 15S 26E 23DDD1	7/30/75	33	0.	0.	53	140.0	8.30	450	19.00	174.	0.0	69.00	0.0	820.0	2.30	1.10	0.0	0.0	2459	7.0	1648	383.	241.	143.	70.6	10.0	0.265	12
REID STEWART WELL 15S 26E 24BAD1	7/24/75	32	0.	3399.	47	100.0	6.30	380	16.00	177.	0.0	65.00	0.0	650.0	1.90	0.0	0.0	0.0	2179	7.3	1353	275.	130.	145.	73.6	10.0	-0.596	9
IVAN DARRINGTON WELL #4 15S 26E 24DCC1	7/29/75	31	0.	3399.	55	88.0	7.10	340	16.00	161.	0.0	52.00	0.0	560.0	2.50	0.0	0.0	0.0	1839	7.5	1199	249.	117.	132.	73.3	9.4	1.293	9
BLM 15S 26E 25ACA1	1/14/75	30	0.	83.	88	35.0	3.90	370	34.00	176.	0.0	32.00	0.0	570.0	2.80	0.0	0.0	0.21	1949	7.7	1222	103.	0.	144.	84.6	15.8	-2.119	9
BLM 16S 26E 5BBA1	3/28/75	40	0.	151.	37	58.0	9.00	240	13.00	138.	0.0	44.00	0.0	380.0	4.40	0.0	0.0	0.14	1539	6.8	853	182.	69.	113.	72.5	7.7	0.971	9

Form 4003-1
5/78

Geothermal Application No. 43-G-R-4

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES

APPLICATION FOR PERMIT TO DRILL FOR GEOTHERMAL RESOURCES

1. Name of applicant Geo Energy Corporation

   Post office address 3766 Stone Creek Way, Boise, Idaho 83703

   If partnership, joint-venture, association, or unincorporated group, attach names and places of domi[cile of] partners or persons. If corporation, attach list of corporate offices and their place of domicile, a[nd] names and place of domicile of any person owning thirty percent (30%) or greater interest in the [corpo]ration. Also give:

   a. Place of incorporation and date Secretary of State's Office, Boise, Idaho June 28, 1983

   b. Principal place of business Boise, Idaho

   c. Location of home office 3766 Stone Creek Way Boise, Idaho 83703

   d. Is applicant making application as an agent for another person, corporation or entity? If so name, address, and interest of your principal.
   Jerry R. Kirkman, President, Geo Energy Corporation
   3766 Stone Creek WAy, Boise, Idaho 83703

   e. Designation of agent residing in the State of Idaho Rick Tremblay, Vice President, Geo Energy Corporation

2. Location of proposed well Raft River, Idaho

   NW ¼ - ¼, Section 23, Township 15S, Range 26E, B.M.

   Well number or well name Sonja #4

3. Type of well: ☐ Exploration ☐ Production ☒ Injection #1

4. Well construction:

   Describe specifically or attach information pertinent to the proposed casing program, and well co[nstruc]tion including casing size, thickness, length of conductor, surface and production pipes; proposed g[routing] procedures, safety devices, valving, and other measures designed to conserve and protect the geot[hermal] resource and ground water of the state. 16" Hole Drilled to 18' depth.

   12-3/4" Casing set at 18' depth, (2' above land surface) with annular space cemented solid to surface.

   12" Hole drilled from 18' depth to 500' depth.

   9-5/8" Casing set from surface to 500' depth with annular space cemented solid to surface.

   9" Hole drilled from 500' depth to 1,300' depth.

   8" Slotted injection pipe set from 500' depth to 1,300' depth.

   All casing standard 3/16" wall.

5. If the proposed well is for exploration or production, explain the means by which you expect to contain and control the resource. (Use additional sheets if necessary.)

Standard surface valving procedures with remote control extension devices. Grouting, casing, valving, and drilling program is based on USGS drilling reports for Raft River Site where no high temperatures or high pressures are known to exist at drilled depths of over 6,000'.

6. What is the character and composition of the material you expect to derive from the well? Include parameters such as phase, estimated temperatures, etc.

Refer to attached "Chemical Analysis of Thermal Water - H. S. Frazier Well" and "The Raft River, Idaho 5 MW Binary Project" report by L. L. Mink, or USDOE Raft River Geoscience Case Study.

7. Is this application a part of a program for exploration or development of an already explored geothermal resource?

Development of a thoroughly explored geothermal resource.

8. What is the estimated cost of the construction of the well and related uses? Provide a validated financial statement showing the applicant has sufficient financial resources to complete the project.

$65,000: Niagra-Mohawk Power Co.HydraCo. Joint Venture

9. If the proposed development will involve the use of water for purposes other than geothermal uses, has the applicant applied for a permit to appropriate water as prescribed in Chapter 2, Title 42, Idaho Code?

Geothermal injection use

10. List in detail the applicant's previous experience in geothermal resource development.

Rick Tremblay, Vice President, Geo Energy Corporation, formerly Project Director of Capitol Mall Geothermal Project, and L. L. "Roy" Mink, Consultant to Geo Energy Corporation and former USDOE Geothermal Energy Branch Chief.

11. What does the applicant intend to do with waste products, brine or water from the well?

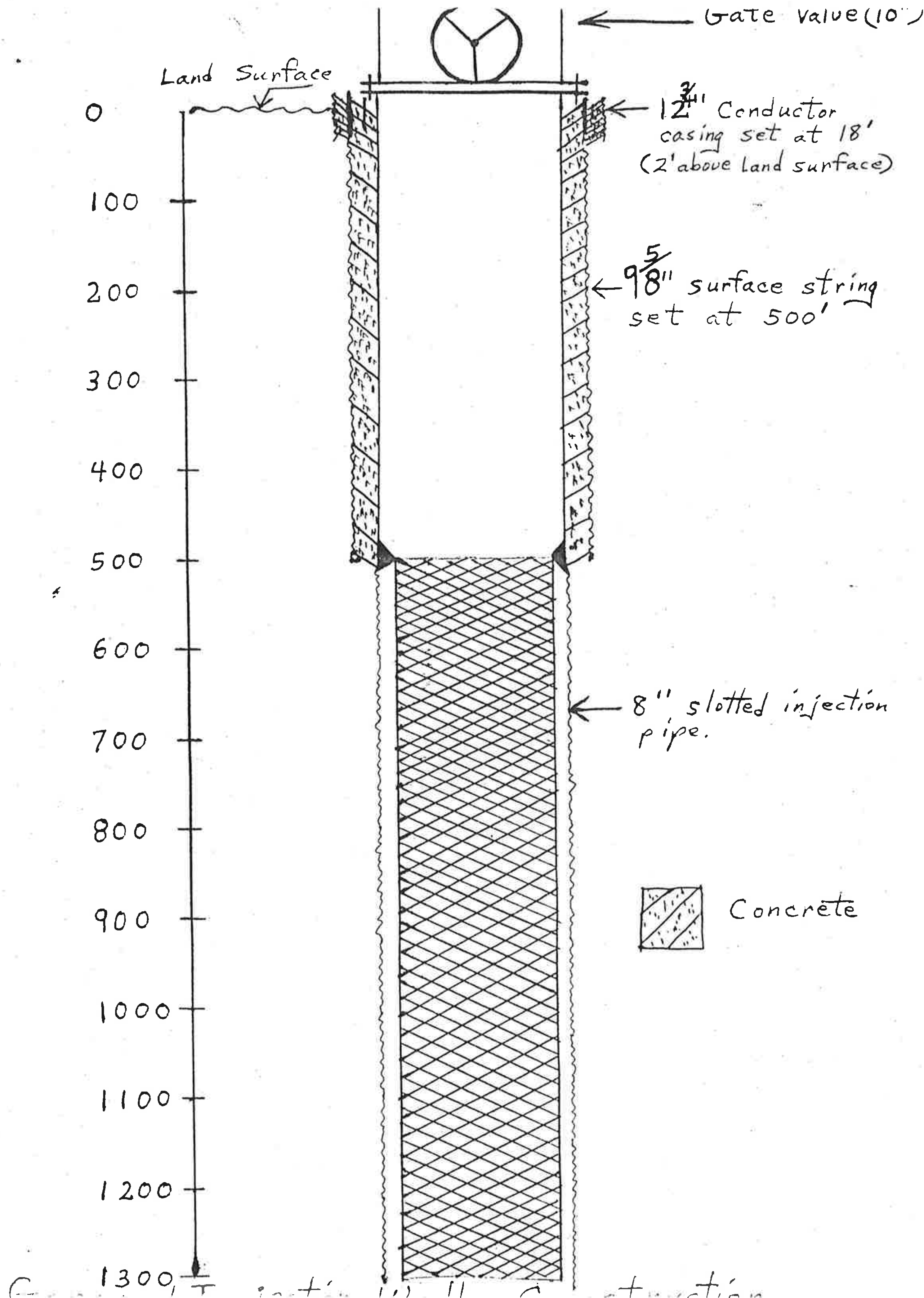
Reinjection into thief zone 500' to 1,300' depth.

12. Idaho law requires that a bond be filed with the Department indemnifying the State of Idaho, conditional upon the performance of the duties required by the Idaho Geothermal Resources Act and the proper abandonment of any well covered by permit of not less than $10,000 per well, the actual amount set as a condition of the permit. Identify the company that will underwrite your bond and provide confirmation that they will issue such bond upon payment of the necessary fees.

A Surety Bond will be provided to the IDWR inthe forthcoming drilling prospectus.

Richard Tremblay

Signature for application



Gate Value(10")
Land Surface
12¾" Conductor casing set at 18' (2' above land surface)
9⅝" surface string set at 500'
8" slotted injection pipe.
Concrete
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300

Basic Data Table 1. Chemical Analyses of Thermal Water from Selected Springs and Wells in Idaho (continued)

Spring or Well Identification Number and Name	Sample Collection Date	Measured Surface Temperature °C	Reported Well Depth below Land Surface (meters)	Discharge (l/min)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Phosphate (PO_4)	Chloride (Cl)	Flouride (F)	Nitrate (NO_3)	Boron (B)	Ammonia (NH_3)	Specific Conductance (field)	pH (field)	Total Dissolved Solids (TDS)	Hardness: Carbonate	Hardness: Non-Carbonate	Alkalinity as $CaCO_3$	Percent Sodium (%Na)	Sodium Absorption Ratio (SAR)	Cation-Anion Balance	Data Reference*
Cassia County (cont'd.)																												
SEARS SPRING 14S 25E 6BBB1S	8/ 5/75	28	0.	662.	22	29.0	7.50	15	3.30	120.	0.0	10.00	0.0	19.0	0.40	0.0	0.0	0.0	270	8.2	165	103.	5.	98.	23.3	0.6	0.365	9
GRIFFETH-WIGHT WELL 14S 26E 1BDD1	0/ 0/ 0	77	1982.	378.	64	5.0	12.00	14	2.50	116.	124.00	27.00	0.01	62.0	0.0	1.20	1.00	0.0	10000	8.4	368	62.	0.	302.	31.9	0.8	-62.093	10
HAROLD WIGHT WELL 14S 26E 1CDA1	6/14/77	63	0.	0.	83	1.0	0.20	170	2.90	240.	36.00	25.00	0.0	72.0	7.30	0.50	0.0	0.08	600	9.3	515	3.	0.	257.	98.1	40.6	-3.683	12
HAROLD WARD WELL #1 14S 27E 18CCC1	7/24/75	24	0.	3399.	90	55.0	2.20	170	29.00	131.	0.0	23.00	0.0	300.0	1.10	0.0	0.0	0.0	960	7.6	734	146.	39.	107.	66.8	6.1	-0.457	9
MORRIS MITCHELL WELL #2 15S 21E 25DCC1	9/22/77	46	0.	38.	28	2.0	0.10	110	1.80	230.	11.00	21.00	0.02	17.0	2.40	0.03	0.0	0.08	475	8.7	306	5.	0.	207.	96.9	20.6	-2.673	10
HAROLD WARD WELL #2 15S 24E 22DDB1	7/25/72	38	152.	378.	44	37.0	9.30	70	3.10	169.	0.0	33.00	0.03	80.0	2.90	0.56	0.0	0.0	606	7.4	362	131.	0.	138.	53.1	2.7	-1.377	3
BLM 15S 25E 29CDC1	10/ 7/76	60	0.	0.	68	3.6	0.10	120	3.40	65.	20.00	40.00	0.0	82.0	7.60	0.0	0.0	0.0	540	8.9	376	9.	0.	87.	95.0	17.0	1.840	9
BLM 15S 26E 12ACC1	12/ 5/74	26	0.	0.	88	300.0	1.40	2000	270.00	58.	0.0	45.00	0.0	3900.0	3.90	0.0	0.0	0.88	998	7.8	6636	754.	707.	48.	79.8	31.7	-1.427	9
BLM 15S 26E 22DDD1	12/ 6/74	82	0.	189.	56	56.0	0.50	1300	14.00	63.	0.0	52.00	0.0	2000.0	5.00	0.0	0.0	0.04	6609	8.0	3514	142.	90.	52.	94.7	47.5	0.762	9
IVAN DARRINGTON WELL #1 15S 26E 23AAA1	10/23/75	85	0.	15.	140	43.0	1.00	400	37.00	63.	0.0	40.00	0.0	680.0	9.10	0.0	0.0	0.0	1879	8.1	138	111.	60.	52.	84.6	15.5	-2.265	9
FRAZIER H S WELL 15S 26E 23BBC1	5/18/72	95	126.	220.	90	53.0	0.40	560	22.00	55.	0.0	57.00	0.0	900.0	5.70	0.54	0.0	0.0	3049	7.4	1715	134.	89.	45.	88.3	21.1	-0.381	3
HARRIAT CRANK WELL 15S 26E 23DDC1	5/18/72	90	165.	227.	97	130.0	0.40	1110	35.00	36.	0.0	61.00	0.01	1900.0	14.00	0.57	0.0	0.0	6089	7.7	3365	326.	296.	30.	86.7	26.7	-0.474	3
IVAN DARRINGTON WELL #3 15S 26E 23DDD1	7/30/75	33	0.	0.	53	140.0	8.30	450	19.00	174.	0.0	69.00	0.0	820.0	2.30	1.10	0.0	0.0	2459	7.0	1648	383.	241.	143.	70.6	10.0	0.265	12
REID STEWART WELL 15S 26E 24BAD1	7/24/75	32	0.	3399.	47	100.0	6.30	380	16.00	177.	0.0	65.00	0.0	650.0	1.90	0.0	0.0	0.0	2179	7.3	1353	275.	130.	145.	73.6	10.0	-0.596	9
IVAN DARRINGTON WELL #4 15S 26E 24DCC1	7/29/75	31	0.	3399.	55	88.0	7.10	340	16.00	161.	0.0	52.00	0.0	560.0	2.50	0.0	0.0	0.0	1839	7.5	1199	249.	117.	132.	73.3	9.4	1.293	9
BLM 15S 26E 25ACA1	1/14/75	30	0.	83.	88	35.0	3.90	370	34.00	176.	0.0	32.00	0.0	570.0	2.80	0.0	0.0	0.21	1949	7.7	1222	103.	0.	144.	84.6	15.8	-2.119	9
BLM 16S 26E 5BBA1	3/28/75	40	0.	151.	37	58.0	9.00	240	13.00	138.	0.0	44.00	0.0	380.0	4.40	0.0	0.0	0.14	1539	6.8	853	182.	69.	113.	72.5	7.7	0.971	9

Form 4003-1
5/78

Geothermal Application No. 43-GR-5

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES

APPLICATION FOR PERMIT TO DRILL FOR GEOTHERMAL RESOURCES

1. Name of applicant Geo Energy Corporation

Post office address 3766 Stone Creek Way, Boise, Idaho 83703

If partnership, joint-venture, association, or unincorporated group, attach names and places of domi[cile of] partners or persons. If corporation, attach list of corporate offices and their place of domicile, [and] names and place of domicile of any person owning thirty percent (30%) or greater interest in the [corpo]ration. Also give:

a. Place of incorporation and date Secretary of State's Office, Boise, Idaho June 28, 1983

b. Principal place of business Boise, Idaho

c. Location of home office 3766 Stone Creek Way
Boise, Idaho 83703

d. Is applicant making application as an agent for another person, corporation or entity? If so[,] name, address, and interest of your principal.
Jerry R. Kirkman, President, Geo Energy Corporation
3766 Stone Creek WAy, Boise, Idaho 83703

e. Designation of agent residing in the State of Idaho Rick Tremblay, Vice President, Geo Energy Corporation

2. Location of proposed well Raft River, Idaho

N ½ NW ¼, Section 27, Township 15S, Range 26E, B.M.

Well number or well name Michelle #5

3. Type of well: ☐ Exploration ☐ Production ☒ Injection #2

4. Well construction:

Describe specifically or attach information pertinent to the proposed casing program, and well co[nstruc]tion including casing size, thickness, length of conductor, surface and production pipes; proposed [drilling] procedures, safety devices, valving, and other measures designed to conserve and protect the geo[thermal] resource and ground water of the state. 16" Hole Drilled to 18' depth.

12-3/4" Casing set at 18' depth, (2' above land surface) with annular space cemented solid to surface.

12" Hole drilled from 18' depth to 500' depth.

9-5/8" Casing set from surface to 500' depth with annular space cemented solid to surface.

9" Hole drilled from 500' depth to 1,300' depth.

8" Slotted injection pipe set from 500' depth to 1,300' depth.

All casing standard 3/16" wall.

5. If the proposed well is for exploration or production, explain the means by which you expect to contain and control the resource. (Use additional sheets if necessary.)

Standard surface valving procedures with remote control extension devices. Grouting, casing, valving, and drilling program is based on USGS drilling reports for Raft River Site where no high temperatures or high pressures are known to exist at drilled depths of over 6,000'.

6. What is the character and composition of the material you expect to derive from the well? Include parameters such as phase, estimated temperatures, etc.

Refer to attached "Chemical Analysis of Thermal Water - H. S. Frazier Well" and "The Raft River, Idaho 5 MW Binary Project" report by L. L. Mink, or USDOE Raft River Geoscience Case Study.

7. Is this application a part of a program for exploration or development of an already explored geothermal resource?

Development of a thoroughly explored geothermal resource.

8. What is the estimated cost of the construction of the well and related uses? Provide a validated financial statement showing the applicant has sufficient financial resources to complete the project.

$65,000: Niagra-Mohawk Power Co.HydraCo. Joint Venture

9. If the proposed development will involve the use of water for purposes other than geothermal uses, has the applicant applied for a permit to appropriate water as prescribed in Chapter 2, Title 42, Idaho Code?

Geothermal injection use

10. List in detail the applicant's previous experience in geothermal resource development.

Rick Tremblay, Vice President, Geo Energy Corporation, formerly Project Director of Capitol Mall Geothermal Project, and L. L. "Roy" Mink, Consultant to Geo Energy Corporation and former USDOE Geothermal Energy Branch Chief.

11. What does the applicant intend to do with waste products, brine or water from the well?

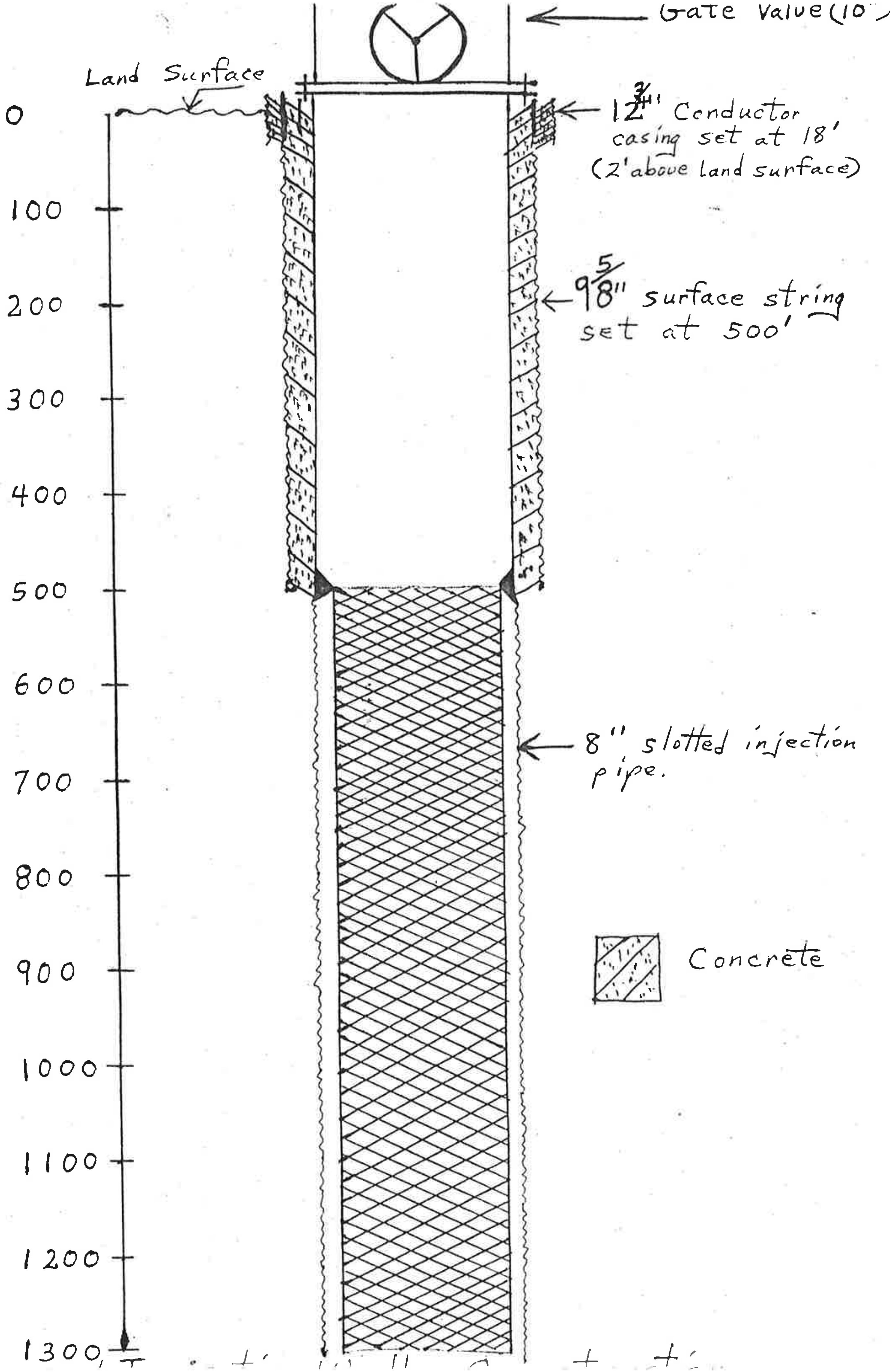
Reinjection into thief zone 500' to 1,300' depth.

12. Idaho law requires that a bond be filed with the Department indemnifying the State of Idaho, conditional upon the performance of the duties required by the Idaho Geothermal Resources Act and the proper abandonment of any well covered by permit of not less than $10,000 per well, the actual amount set as a condition of the permit. Identify the company that will underwrite your bond and provide confirmation that they will issue such bond upon payment of the necessary fees.

A Surety Bond will be provided to the IDWR inthe forthcoming drilling prospectus.

Richard Tremblay

Signature for application


Gate Value(10"
Land Surface
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
12¾" Conductor casing set at 18' (2' above land surface)
9⅝" surface string set at 500'
8" slotted injection pipe.
Concrete

Basic Data Table 1. Chemical Analyses of Thermal Water from Selected Springs and Wells in Idaho (continued)

Spring or Well Identification Number and Name	Sample Collection Date	Measured Surface Temperature °C	Reported Well Depth below Land Surface (meters)	Discharge (l/min)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Phosphate (PO_4)	Chloride (Cl)	Flouride (F)	Nitrate (NO_3)	Boron (B)	Ammonia (NH_3)	Specific Conductance (field)	pH (field)	Total Dissolved Solids (TDS)	Hardness: Carbonate	Hardness: Non-Carbonate	Alkalinity as $CaCO_3$	Percent Sodium (%Na)	Sodium Absorption Ratio (SAR)	Cation-Anion Balance	Data Reference*
Cassia County (cont'd.)																												
SEARS SPRING 14S 25E 6BBB1S	8/ 5/75	28	0.	662.	22	29.0	7.50	15	3.30	120.	0.0	10.00	0.0	19.0	0.40	0.0	0.0	0.0	270	8.2	165	103.	5.	98.	23.3	0.6	0.365	9
GRIFFETH-WIGHT WELL 14S 26E 1BDD1	0/ 0/ 0	77	1982.	378.	64	5.0	12.00	14	2.50	116.	124.00	27.00	0.01	62.0	0.0	1.20	1.00	0.0	10000	8.4	368	62.	0.	302.	31.9	0.8	-62.093	10
HAROLD WIGHT WELL 14S 26E 1CDA1	6/14/77	63	0.	0.	83	1.0	0.20	170	2.90	240.	36.00	25.00	0.0	72.0	7.30	0.50	0.0	0.08	600	9.3	515	3.	0.	257.	98.1	40.6	-3.683	12
HAROLD WARD WELL #1 14S 27E 18CCC1	7/24/75	24	0.	3399.	90	55.0	2.20	170	29.00	131.	0.0	23.00	0.0	300.0	1.10	0.0	0.0	0.0	960	7.6	734	146.	39.	107.	66.8	6.1	-0.457	9
MORRIS MITCHELL WELL #2 15S 21E 25DCC1	9/22/77	46	0.	38.	28	2.0	0.10	110	1.80	230.	11.00	21.00	0.02	17.0	2.40	0.03	0.0	0.08	475	8.7	306	5.	0.	207.	96.9	20.6	-2.673	10
HAROLD WARD WELL #2 15S 24E 22DDB1	7/25/72	38	152.	378.	44	37.0	9.30	70	3.10	169.	0.0	33.00	0.03	80.0	2.90	0.56	0.0	0.0	606	7.4	362	131.	0.	138.	53.1	2.7	-1.377	3
BLM 15S 25E 29CDC1	10/ 7/76	60	0.	0.	68	3.6	0.10	120	3.40	65.	20.00	40.00	0.0	82.0	7.60	0.0	0.0	0.0	540	8.9	376	9.	0.	87.	95.0	17.0	1.840	9
BLM 15S 26E 12ACC1	12/ 5/74	26	0.	0.	88	300.0	1.40	2000	270.00	58.	0.0	45.00	0.0	3900.0	3.90	0.0	0.0	0.88	998	7.8	6636	754.	707.	48.	79.8	31.7	-1.427	9
BLM 15S 26E 22DDD1	12/ 6/74	82	0.	189.	56	56.0	0.50	1300	14.00	63.	0.0	52.00	0.0	2000.0	5.00	0.0	0.0	0.04	6609	8.0	3514	142.	90.	52.	94.7	47.5	0.762	9
IVAN DARRINGTON WELL #1 15S 26E 23AAA1	10/23/75	85	0.	15.	140	43.0	1.00	400	37.00	63.	0.0	40.00	0.0	680.0	9.10	0.0	0.0	0.0	1879	8.1	1381	111.	60.	52.	84.6	15.5	-2.265	9
FRAZIER H S WELL 15S 26E 23BBC1	5/18/72	95	126.	220.	90	53.0	0.40	560	22.00	55.	0.0	57.00	0.0	900.0	5.70	0.54	0.0	0.0	3049	7.4	1715	134.	89.	45.	88.3	21.1	-0.381	3
HARRIAT CRANK WELL 15S 26E 23DCC1	5/18/72	90	165.	227.	97	130.0	0.40	1110	35.00	36.	0.0	61.00	0.01	1900.0	14.00	0.57	0.0	0.0	6089	7.7	3565	326.	296.	30.	86.7	26.7	-0.474	3
IVAN DARRINGTON WELL #3 15S 26E 23DDD1	7/30/75	33	0.	0.	53	140.0	8.30	450	19.00	174.	0.0	69.00	0.0	820.0	2.30	1.10	0.0	0.0	2459	7.0	1648	383.	241.	143.	70.6	10.0	0.265	12
REID STEWART WELL 15S 26E 24BAD1	7/24/75	32	0.	3399.	47	100.0	6.30	380	16.00	177.	0.0	65.00	0.0	650.0	1.90	0.0	0.0	0.0	2179	7.3	1353	275.	130.	145.	73.6	10.0	-0.596	9
IVAN DARRINGTON WELL #4 15S 26E 24DCC1	7/29/75	31	0.	3399.	55	88.0	7.10	340	16.00	161.	0.0	52.00	0.0	560.0	2.50	0.0	0.0	0.0	1839	7.5	1199	249.	117.	132.	73.3	9.4	1.293	9
BLM 15S 26E 25ACA1	1/14/75	30	0.	83.	88	35.0	3.90	370	34.00	176.	0.0	32.00	0.0	570.0	2.80	0.0	0.0	0.21	1949	7.7	1222	103.	0.	144.	84.6	15.8	-2.119	9
BLM 16S 26E 5BBA1	3/28/75	40	0.	151.	37	58.0	9.00	240	13.00	138.	0.0	44.00	0.0	380.0	4.40	0.0	0.0	0.14	1539	6.8	853	182.	69.	113.	72.5	7.7	0.971	9

43-GR-1, 2, 3, 4 & 5

International Conference on

geothermal energy

Florence, Italy: May 11-14, 1982

PAPER H8

THE RAFT RIVER, IDAHO 5MW(e) BINARY PROJECT

L. L. Mink

Morrison-Knudsen Company, Inc., U.S.A.

R.D. Lease

U.S. Department of Energy, Idaho Falls, U.S.A.

C. R. Nichols

U.S. Department of Energy, Grand Junction, Colorado, U.S.A.

Summary

The Raft River Geothermal project, located in southern Idaho, U.S.A., has involved nearly eight years of geothermal research activities in both electric and nonelectric geothermal applications.

The geothermal resource supplying the facility is located in a fracture system found at the Contact Metamorphic Zone near the intersection of the Narrows Zone and the Bridge Fault Zone. 130°C to 145°C fluids are produced from four 1,500/2,000 m production wells and disposed of in two 1,200 m injection wells. Reservoir testing indicates the field is anisotrophic, with the major axis of hydraulic conductivity coincidental to the Bridge Fault Zone. Injected fluids will not interfere with the geothermal resource although injection over long periods of time at high pressure could affect the shallow ground water system. Further analyses of the production and injection data during plant operation will provide greater insight into this complex reservoir.

The facilities at the Raft River Site include a 60 KW(e) prototype power plant, a 5MW(e) power plant, and facilities for various types of direct applications research. These façilities are used for heat exchanger evaluations, space conditioning experiments, heat pump investigations, agriculture and aquaculture experiments, materials testing, and other miscellaneous geothermal related research.

A preliminary analysis was made of the initial start-up data taken between October 20 and November 2, 1981, for the 5MW(e) Pilot Geothermal Power Plant. This plant utilizes a dual-boiling isobutane binary cycle. Two test conditions were selected for analysis: (1) a thermal loop test with 94% of the design geofluid flow, and (2) a test at about three-fourths of the design geofluid flow in which one megawatt was generated from working fluid flow through the low-pressure stage of the turbine.

Component and system energy balances were made from initial startup data. Except for a malfunction in the high pressure turbine throttle valve system, the plant performed generally as predicted, and the testing was judged to be successful.

Held at the Centro Affari Firenze
Organised and sponsored by
BHRA Fluid Engineering, Cranfield, Bedford MK43 0AJ, England
in conjunction with Ente Nazionale per l'Energia Elettrica (ENEL), Italy

© BHRA Fluid Engineering 1982

1. INTRODUCTION

The Raft River Idaho 5MW(e) binary plant is the culmination of almost eight years of research activities in both geoscience and engineering. The Raft River geothermal project was initiated in 1973 with the U.S. Department of Energy and the U.S. Geological Survey performing an integrated geologic, geophysical, and hydrological exploration program to assist in location of the first exploration well. Since that time, seven wells have been drilled to supply and dispose of water for a 5MW(e) binary system and associated geothermal research projects. The project has been funded by the U.S. Department of Energy with EG&G Idaho, Inc., performing the research and development functions at the facility.

The Raft River Geothermal Area lies in South Central Idaho (Fig. 1) in a north trending geologic basin bounded on three sides by mountains. The valley opens to the north into the Snake River Plain. The Known Geothermal Resource Area (KGRA) is located in the south end of the valley near the Idaho-Utah border.

2. GEOLOGY

The Raft River Valley is a down-dropped sedimentary basin composed principally of tertiary siltstones, tuffaceous sandstone, and conglomerates of the Salt Lake Formation derived from the surrounding mountains. This material is overlain by several hundred meters of Quaternary alluvium and lacustrine sediments of the Pleistocene Raft Formation.

Faults in the valley are steeply dipping normal faults along range fronts and are described as having occurred as late as several hundred thousand years ago. The Bridge Fault, a principal fault lying in a north trending zone on the west side of the valley, is the principal structure thought to control the up-welling of geothermal fluids (Fig. 2). This fault was originally described as having a dip of 60-70° continuing to depth (Mabey, (1978)). Later interpretations indicate a shallowing of dip with depth flattening to nearly horizontal with no displacement of the basement (Covington (1980)) (Fig. 3). The Bridge Fault terminates north of the Raft River by an inferred basement shear structure called the Narrows Zone.

3. RESOURCE CHARACTERISTICS

The Raft River Geothermal field includes five 1,500 - 2,000 m production wells and two 1,100 - 1,200 m injection wells. Drilling was initiated in 1975 with a 1,521 m deep exploration well. This well proved the existence of a 144°C resource at a depth of 1,500 m.

With the confirmation of resource availability, plans were initiated for a binary pilot power plant to research power production at these medium temperatures. Production wells RRGE2, RRGE3, RRGP4, and RRGP5 were drilled from 1975 to 1978. Two intermediate depth injection wells RRGI6 and RRGI7, were completed in 1978 to complete the field for the 5MW(e) binary pilot plant (Table 1). One well, RRGP4, was classed as a nonproducer and is being used as a monitor well at the present time. Seven shallow monitoring wells (MW-1 through MW-7), drilled in 1978, are located near the Geothermal Injection Wells. The depth and location of each well were designed to detect any migration of injected geothermal fluids into shallow aquifers used for irrigation and drinking water supplies.

The geothermal reservoir at Raft River is a fracture dominated system. The hydraulic conductivity, coincidental with the northeast-southwest direction of the Bridge Fault Zone, is two times greater than the orthogonal direction. Tritium data indicates the fluid age is very young at sixty to seventy years old.

The fluid chemistry indicates the deep geothermal system is composed of sodium chloride type waters. Total specific conductance ranges from 2,500-2,800 uS for wells RRGE1, RRGE2, and RRGP5 to 10,800-12,000 uS for Wells RRGI6 and RRGI7. RRGE3 water quality is mid-range between the deep production wells and the intermediate depth injection wells at 8,000 uS. Fluoride is the major environmentally sensitive element with concentrations in excess of 7 mg/l in the three production wells.

The chemistry of the Raft River geothermal water suggests the existence of two waters, one of high dissolved solids moving in from the southeast at a depth of 1,200-1,600 m and one of lower dissolved solids moving in from the northwest (Figure 4). Water chemistry also indicates the deep geothermal system is hydraulically connected with the shallow ground water system of the Raft River Valley. Since the injection wells are located in the zone of higher dissolved solids, there is concern injection may cause a migration of this water into the shallower potable ground water system. Injection testing and monitoring is being conducted in conjunction with plant start-up to determine if this will occur.

4. 5MW(e) GENERAL PLANT DESCRIPTION

4.1 Plant facilities

The 5MW(e) Raft River Pilot Plant (RRPP) is a geothermal power plant designed and constructed to demonstrate the feasibility of electric power generation using moderate temperature liquid dominated geothermal resources. The plant utilizes an organic Rankine cycle method of operation. Isobutane, the working fluid, conveys the heat energy of the geothermal liquid to a turbine-generator which converts the thermal energy to mechanical and electrical energy to generate 5MW gross electric power.

The plant is composed of a tank farm, process area, pond area, and office buildings (Figure 5). The process area contains the 5MW(e) power plant including the isobutane and geothermal fluid systems. The tank farm contains the storage tanks for isobutane, propane, and nitrogen. The pond area has sludge holding ponds, a brine pond, and the isobutane flare pit. The facility offices and plant control buildings include many of the plant support systems, e.g., cooling water system, fire protection system, and plant air system.

4.2 Plant operations

The operating crew consists of a 5MW(e) plant operating crew, geothermal well operating crew, maintenance crew, and support personnel (chemists, administration, engineering, etc.). The entire crew for a three-shift, seven-day operation is approximately 50 to 55 personnel with eight to ten people on each operating crew.

4.3 Geothermal fluid supply and injection system

The supply and injection system supplies geothermal water from the production wells to the 5MW(e) plant Geothermal Fluid System and then injects the fluid into intermediate depth injection wells. The supply wells contain line shaft pumps capable of producing 32 to 70 l/s of fluid each. The exact flow rate is dependent on the drawdown characteristics of the individual wells. The injection pumps are also line shaft pumps each capable of injecting 70 l/s. The injection pumps take suction from holding ponds where the geothermal return water lines from the 5MW(e) plant terminate. These ponds act as surge vessels to relieve pressure and flow transients on the suction side of the injection pumps. All pipe for the supply and injection system is transite (asbestos cement).

The Geothermal Fluid System in the process area consists of a filter, two booster pumps, four heat exchangers, control valves, instruments, and associated piping. The primary function of the system is to transfer geothermal heat to the isobutane working fluid. The heated fluid is then converted to vapor to turn the turbine-driven generator. Secondarily, the Geothermal Fluid System is tapped for makeup cooling water, for cooling tower water basin and water tank freeze protection and to furnish building heat.

During steady-state operation, the geothermal fluid is at a flow rate of 142 l/s, a temperature of 140°C, and a pressure of 1,172 kPa at the high-pressure boiler inlet. Under steady-state conditions, the temperature at the high-pressure boiler geothermal fluid inlet is the maximum geothermal fluid temperature. However, this temperature can be regulated from the control room by means of automatic controls. The automatic control valves in the recirculation line to the suction side of the booster pumps are temperature actuated to divert cool geothermal fluid back through the heat exchanger loop to adjust system temperature.

4.4 Isobutane system

Isobutane is the primary working fluid used in a dual boiling Rankine cycle for the 5MW(e) Raft River Pilot Plant. The Isobutane System consists of two basic parts, the isobutane storage area and the process loop. The process loop is designed to extract 44MW of energy from the geothermal liquid and is capable of generating 5MW of electrical power. The isobutane flow is split at the exit of the low-pressure preheater. Approximately 34 percent of the flow is channeled to the low-pressure boiler, and the remaining 66 percent flows through the high-pressure preheater and then into the high-pressure boiler. The flow of vaporized isobutane from both boilers is directed through the turbine where thermal energy is converted to mechanical energy.

At 100 percent capacity, isobutane flow of 246 l/s is provided through two feed pumps and is maintained by an automatic control valve. Liquid isobutane is preheated in the low- and high-pressure preheaters and vaporized in the low- and high-pressure boilers. The low-pressure boiler operates at 1,393 kPa and 82°C; the high-pressure boiler operates at 2,620 kPa and 129°C. The turbine exhaust flows into the condenser where it is condensed and slightly subcooled by releasing its heat to the Cooling Water System. The liquid isobutane, at 455 kPa and 38°C, then drops into the storage tank.

4.5 Turbine generator

The turbine generator consists of a turbine, gear reducer, generator, piping, and control instrumentation. The turbine has high-pressure and low-pressure radial inflow units. The unit is designed to expand the isobutane to drive a generator that produces 5 megawatts (gross) of power and operates with exhaust pressures up to 1,586 kPa.

The isobutane is supplied to the dual pressure turbine through a 35.6 cm high-pressure header and a 30.5 cm low-pressure header that are equipped with individual throttle stop valves and flow meters. Flow control is regulated by the turbine governor. The turbine back pressure is governed by the amount of condenser pressure. The generated power of 4,160V, 1,110A ties to the 3-phase 25 KV Raft River commercial primary power lines. When the plant's turbine generator is operating, it supplies power for facility operation and delivers the surplus power to the commercial grid via a 5,000 KVA transformer substation installed at the site. When the turbine-generator is not operating, power is supplied to the site facilities from the commercial grid.

4.6 Cooling water treatment system

The Water Treatment System removes biological and chemical scale-forming impurities from geothermal water that is used as makeup feed for the Cooling Water System. Since the 5MW(e) power plant is located in a region where ground water is not readily available, cooled geothermal water is used as the makeup supply for the evaporative cooling tower. About 20% of the geothermal fluid is taken from the Geothermal Supply after passing through the plant and prior to reaching the injection system. This water is supplied to the Water Treatment System where it is initially pretreated to reduce hardness and remove silica. The water is then treated for pH, algae, corrosion, and scale control.

4.7 Data acquisition and controls

The 5MW(e) Raft River Pilot Plant is equipped with a complete system of data acquisition and process controls consisting of four major subsystems, the Process Control Subsystem, the Process Instrumentation Subsystem, the Data Acquisition and Recording Subsystems, and the Automatic Calibration Subsystem. The function of the controls and instruments is to permit the operation and monitoring of the plant under all conditions from the control room using existing state-of-art components.

5. 5MW(e) PILOT PLANT START-UP

5.1 High geofluid flow test evaluation

System start-up testing of the Raft River 5MW(e) Pilot Geothermal Power Plant occurred between October 20 and November 2, 1981. The plant was run for two periods (October 20 through October 23; and October 28 through November 2). These tests culminated with a test in which the plant was run as a thermal loop with 94 percent of design geofluid flow and one in which the low-pressure stage of the turbine generated one megawatt of electrical power with a lower geofluid flow. The primary purpose of this testing was to check out the system and its individual components. The only significant component which did not function was the throttle valve and its control system on the high-pressure turbine stage. For this reason, the high-pressure stage could not be loaded during the power production test. Further engineering performance tests are scheduled to be performed in the spring and summer of 1982.

The High Geofluid Flow Rate Test afforded the best opportunity to establish the plant performance. During this test, the plant was operating nearest its design point. All major components except the turbine were functioning during this test.

Eight sets of complete data were taken over the time span of the test. Since variation of all important values during this time was quite small, the average measurements over this time interval were taken as the steady-state values.

Figure 6 shows a schematic of the 5MW(e) plant with various points numbered to correspond with values in Table 2. All values which were deemed to be recorded correctly are presented, although there is disagreement among several measurements. Certain redundant measurements were ignored, others were averaged, and heat balances were made for the system and individual components.

5.2 Basic data analysis

Table 2 gives the experimental values of the measurements which are used in the energy balances. The state point numbers correspond to Figure 5. For the geofluid data, the mass flow rate was taken as the averages of the two experimental measurements. The same procedure was used for all but the two lowest temperatures. For those temperatures, the lower measurement gave more consistent results. There was no redundancy in measurements for the cooling water, so the individual measurements were used. In the isobutane loop, the liquid flow rates into the boilers were taken as the best working fluid flow-rate measurements. These were used together with the preheater inlet flows to determine a consistent set of isobutane flows. The fact that the high preheater inlet flow was approximately equal to the high boiler inlet flow indicates no bypass around that preheater.

An energy balance using experimental temperature data indicated an 8.7 percent bypass. Later results indicate that the low preheater outlet temperature may be high causing the energy balance to yield a value which is too large. Temperatures were averaged utilizing the assumption that there is no bypass around the high preheater so that state points 10 and 11 are the same. Boiler and condenser pressures were derived from pressure and temperature measurements around the components.

Energy balances were calculated for each of the heat exchangers. For these calculations, both geofluid and cooling water were assumed to have the proportion of pure water as given in the steam tables (Keenan, 1969), and the isobutane proportions were taken from Starling (1973). Table 3 gives the results of these calculations. The individual differences ranged between 6.4 and 8.5 percent. An overall system energy balance is given in Table 4. The pump work is estimated from the pump characteristics knowing the flow through the pumps. The percentage difference in closure of the heat balance is smaller than that of the heat balances for the individual components.

6. BENEFICIAL USE EXPERIMENTS

Experiments related to the application of geothermal fluids, either directly from wells or after primary heat extraction from electric power generation or industrial processing, have been performed at Raft River. Uses for these fluids can impact overall economics in combined geothermal use scenarios or can influence future activities around geothermal sites such as aquaculture and agriculture. These experiments also contribute to understanding the environmental implications of geothermal development activities.

A three-year irrigation/agriculture experiment is being conducted at Raft River by the University of Idaho and the U.S. Department of Agriculture. This experiment is successfully contributing to understanding how to use geothermal fluids in crop raising activities. A highly successful aquaculture experiment was completed at the Raft River Site. Several aquatic species were raised directly in geothermal waters with the conclusion that disease problems all but disappear and growth rates are remarkably accelerated. An alternative water disposal system, geothermal wetlands, has been extensively studied at the site. This ecosystem utilized aquatic plants as bioaccumulators for water purification and the creation of waterfowl/aqua specie habitat. Successful experiments raising catfish, carp, and shrimp in geothermal water were also completed.

Several development and testing studies have been performed on equipment potentially useful in geothermal applications. The first U.S. Residential-Sized Geothermal Air Conditioner (LithiuBromide, 3-ton Arkla Unit) cooled one of the Raft River buildings.

A fluidized bed dryer was in operation for about a year, drying samples of biomass potato waste from the secondary treatment step of a local processing plant. Potato peel materials were also processed and dried. Other hardware experiments involved fluidized bed space heaters for geothermal waters that may be corrosive or have a high dissolved solids content.

A number of studies were also completed and some portions implemented for facility use at Raft River. These included integrated use/Industrial Park Geothermal complexes for Raft River or elsewhere; advanced district heating systems; advanced air conditioning using geothermal water (ammonia absorption and diaphragm); and geothermally assisted biomass-to-liquid fuel. The first geothermal powered still for fuel alcohol was successfully tested at Raft River.

7. CONCLUSIONS

The Raft River 5MW(e) Power Plant is the culmination of almost eight years of Geothermal research activities. A vast amount of knowledge has been obtained on the characteristics of a fracture-controlled geothermal system, both with respect to production and injection. Experimental data has also been collected on nonelectric experiments relating to use of geothermal fluid as the energy source. Successful experiments include agriculture, aquaculture, biomass production, wetland studies, and space conditioning.

Data on the 5MW(e) power plant was collected at the time of start-up testing during the fall of 1981. These tests indicated all components of the plant performed as predicted except the high-pressure turbine-throttle valve system. Further testing of the power plant and associated components, together with further reservoir testing, is scheduled to occur during the spring of 1982.

8. ACKNOWLEDGMENTS

The authors wish to acknowledge the assistance of EG&G Idaho in the gathering of data for the report. Special thanks goes to Larry Walrath, EG&G Project Manager, and Judd Whiebeck, EG&G Technical Branch Manager, for their efforts and support.

BIBLIOGRAPHY

Ackerman, H.D.: "Seismic refraction study of the Raft River geothermal area." Geophysics, 44, 2 Feb. 19, pp. 216-265.

Allen, C. A.: et al., "Subsurface modeling at Raft River." Geothermal Resources Council Transactions, 3, 1979, pp. 1-4.

Bliem, C. J.: "Quick look report on the start-up tests for the Raft River 5MW(e) pilot geothermal power plant." Unpublished report, EG&G Idaho Inc., Dec., 1981.

Covington, H. R.: "Subsurface geology of the Raft River geothermal area, Idaho." Geothermal Resources Council Transactions, 4 Sept. 1980.

Deviné, S. C. and Bonnichsen, B.: "Petrography of drill cores from the Raft River geothermal area, southern Idaho." Unpublished report, U.S. Department of Energy, Dec., 1979.

Goldman, D., Allman, D. W. and Mink, L. L.: "Data collection and evaluation of combined fractured and porous media flow in a fluid-dominated geothermal system." In: National Water Well Association Conference (Oklahoma City, Oklahoma: Oct., 1979).

Hoover, D. B.: "Audio-magnetotelluric apparent resistivity maps, southern Raft River area, Cassia County, Idaho." United States Geological Survey Open-File Report, 1974.

Keenan, et al.: "Steam tables (english units)." New York, John Wiley & Sons, Inc.

Mabey, D. R.: "Bouguer gravity anomaly map of the southern Raft River area, Cassia County, Idaho." United States Geological Survey Open-File Report, 1974.

Mabey, D. R. et al.: "Reconnaissance geophysical studies of the geothermal system in southern Raft River Valley, Idaho." Geophysics, 43, 7, 1978, pp. 1470-1484.

McLaughlin, T.: "Raft River geothermal project 5MW(e) power plant characterization study." Unpublished report, EG&G Idaho, Inc., Dec., 1981.

Ralston, D. R.: "Analysis of pump test results from tests conducted in the Raft River basin." Idaho Bureau of Mines and Geology, Feb., 1975.

Spencer, S. G. and Callan, D. M.: "An analysis of the response of the Raft River monitor wells to the 1979 injection tests." EG&G Idaho Inc., No. 2057, 1980.

Spencer, S. G. and Goldman D.: "Numerical simulation of the impact of fluid injection in the Raft River geothermal area." Geothermal Resources Council Transactions, 4, 1980.

Starling, K. E.: "Fluid thermodynamic properties for light petroleum systems." Houston, Texas, Gulf Publishing Co., 1973.

Williams, P. L. et al.: "Geology and geophysics of the southern Raft River Valley geothermal area, Idaho, U.S.A." Proceedings of the Second U.N. Symposium on the Development and Use of Geothermal Resources. 1976, pp. 1273-1282.

Zohdy, A. A. R., Jackson, D. B., and Bisdorf, R. J.: "Schlumberger soundings and total field measurements in the Raft River geothermal area, Idaho." United States Geological Open-File Report 75-130, 1975.

TABLE 1 - Selected Data From Raft River Wells

Well	Well Depth (m)	Casing Depth (m)	Well Head Temperature (°C)	Pumping/Injection Rate (1/s)	Specific Conductivity (uS)
Geothermal					
RRGE-1	1521	1105	137	66	2 800
RRGE-2	1994	1289	139	40	2 500
RRGE-3	1789	1293	144	40	8 000
RRGP-4	1654	1054	N/A	Nonproductive	4 050
RRGP-5	1497	1039	129	41	2 700
RRGI-6	1176	509	N/A	70	10 800
RRGI-7	1185	623	N/A	70	12 000

TABLE 2 - Experimental Values From 5MW(e) Plant Start-Up

	State Point	Experimental Value
Geofluid		
Mass Flow Rate (Kg/hr x 10^{-6})	2	.4439
	8	.4439
Temperature (°C)	4	138.7
	5	114.9
	6	98.8
	7	81.3
	8	58.0
Cooling Water		
Mass Flow Rate (Kg/hr x 10^{-6})	40	2.826
Temperature (°C)	40	18.4
	41	30.8
Isobutane		
Mass Flow Rate (Kg/hr x 10^{-6})	13	.3948
	14	.3680
	29	.1381
	19	.2567
	22	.2567
	31	.1381
Temperature (°C)	13	36.3
	14	82.6
	18,29	77.4
	21,22	113.2
	36	75.8
	37	34.2
Pressure (kPa)	24	2321.
	31	1246.
	36	403.

TABLE 3 - Component Heat Balances Using Experimental Values

Component	Heat Transfer Rate (Btu/hr x 10^{-7})			
	Into Component	Out of Component	Average	Percent Difference
Low Preheater	4.004	4.300	4.109	7.0
Low Boiler	3.195	3.432	3.314	7.2
High Preheater	2.865	3.119	2.992	8.5
High Boiler	4.267	4.002	4.135	6.4
Condenser	14.960	13.886	14.430	7.4

TABLE 4 - System Energy Balance

Rate of Heat Transfer from Geofluid	=	42.63MW(e)
Power Input to Isobutane Feed Pump	=	.69MW(e)
Rate of Energy Flow to System	=	43.32MW(e)
Rate of Heat Transfer for Cooling Water	=	42.28MW(e)
Difference	=	1.04MW(e)
		2.4%

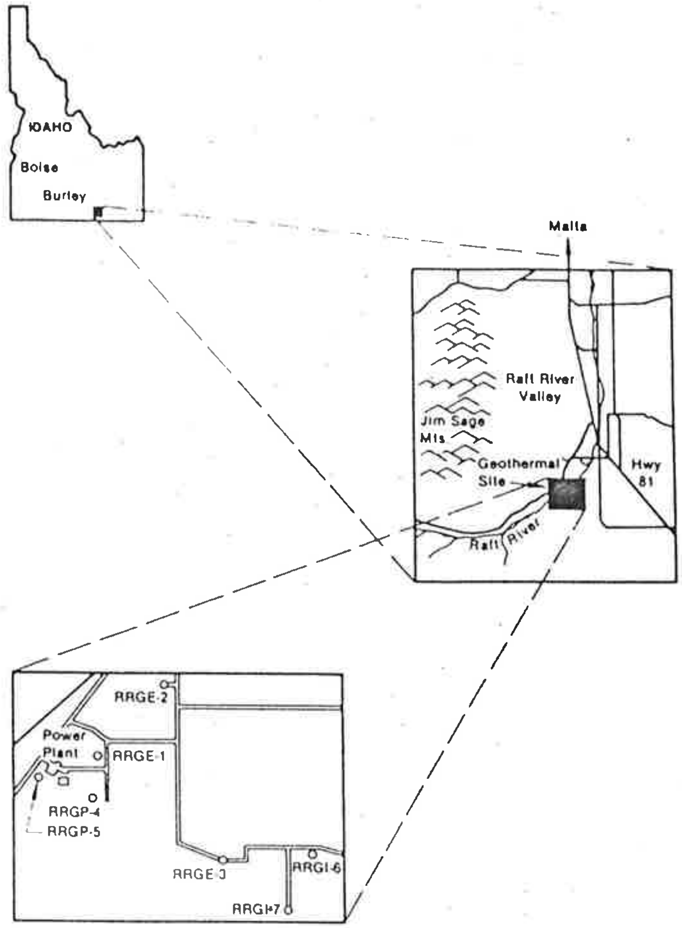


Figure 1 - Raft River Geothermal Site

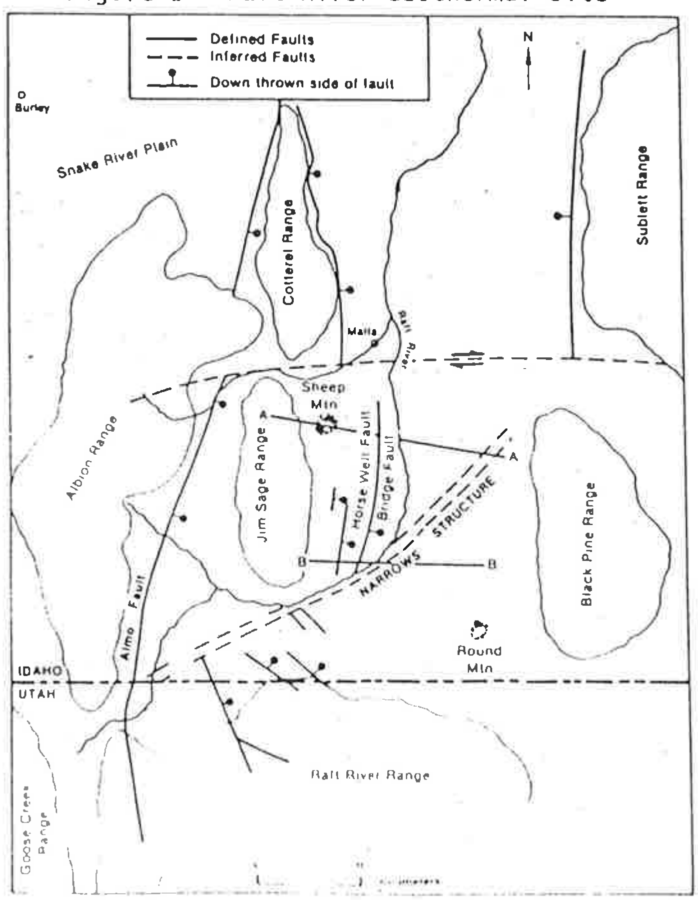


Figure 2 - Structural Setting of the Raft River Geothermal Area

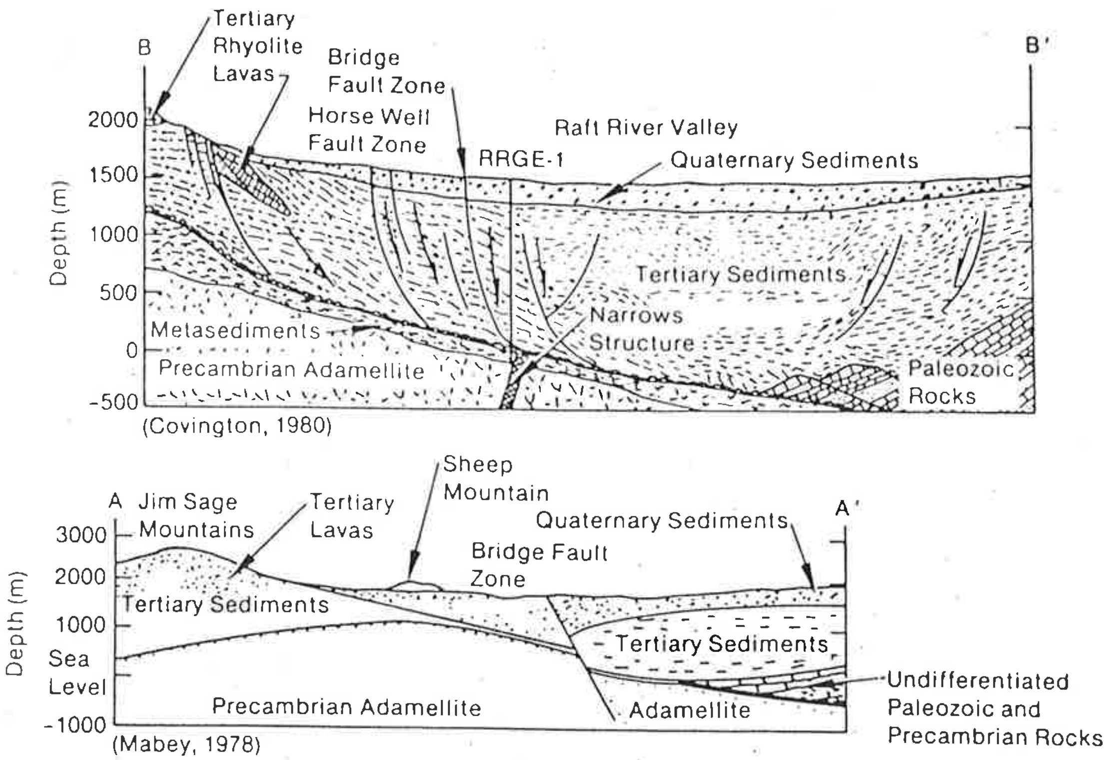


Figure 3 - Geologic Cross Sections of the Raft River Geothermal Area

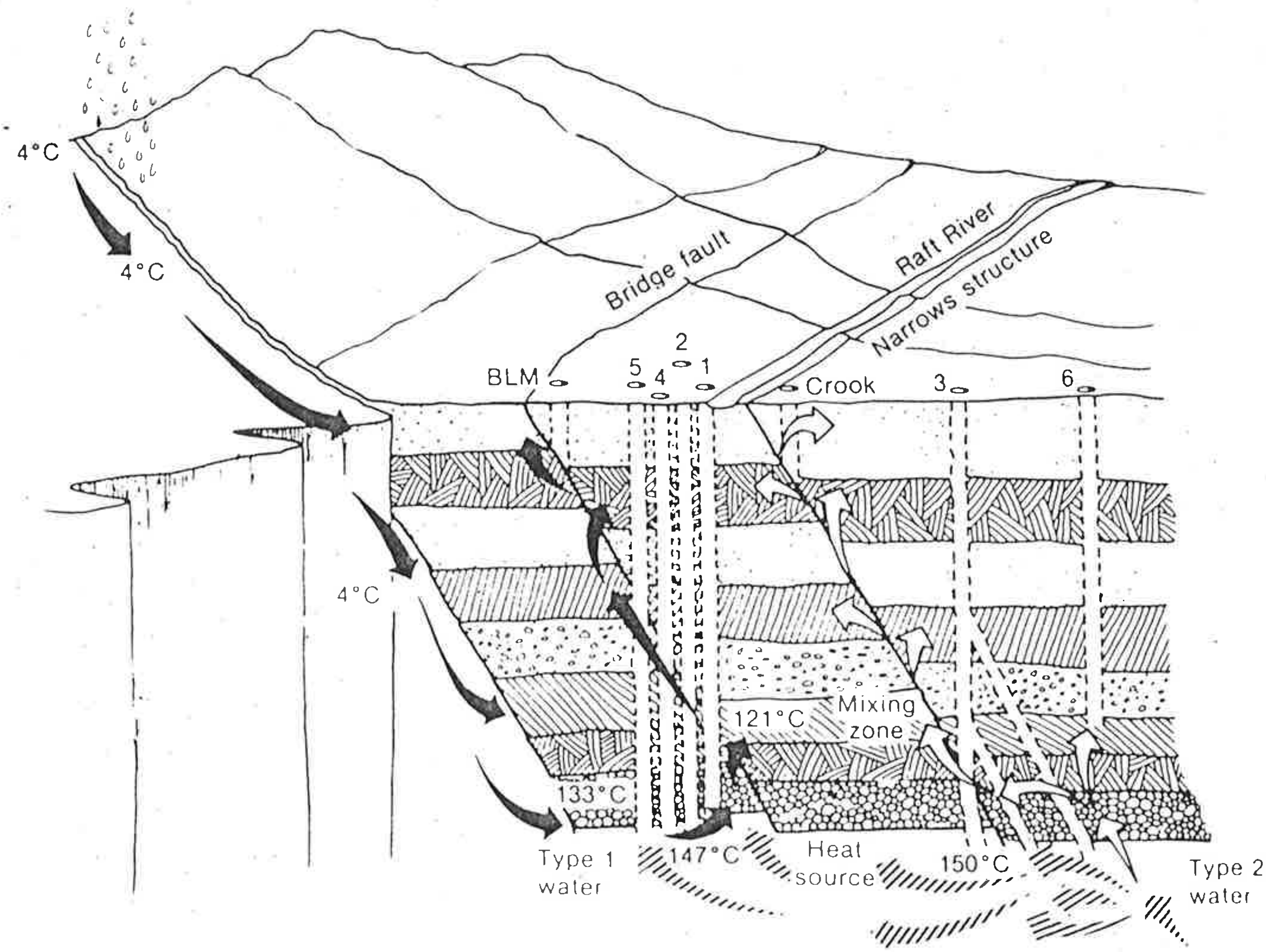


Figure 4 - Conceptual Model for Raft River Geothermal System

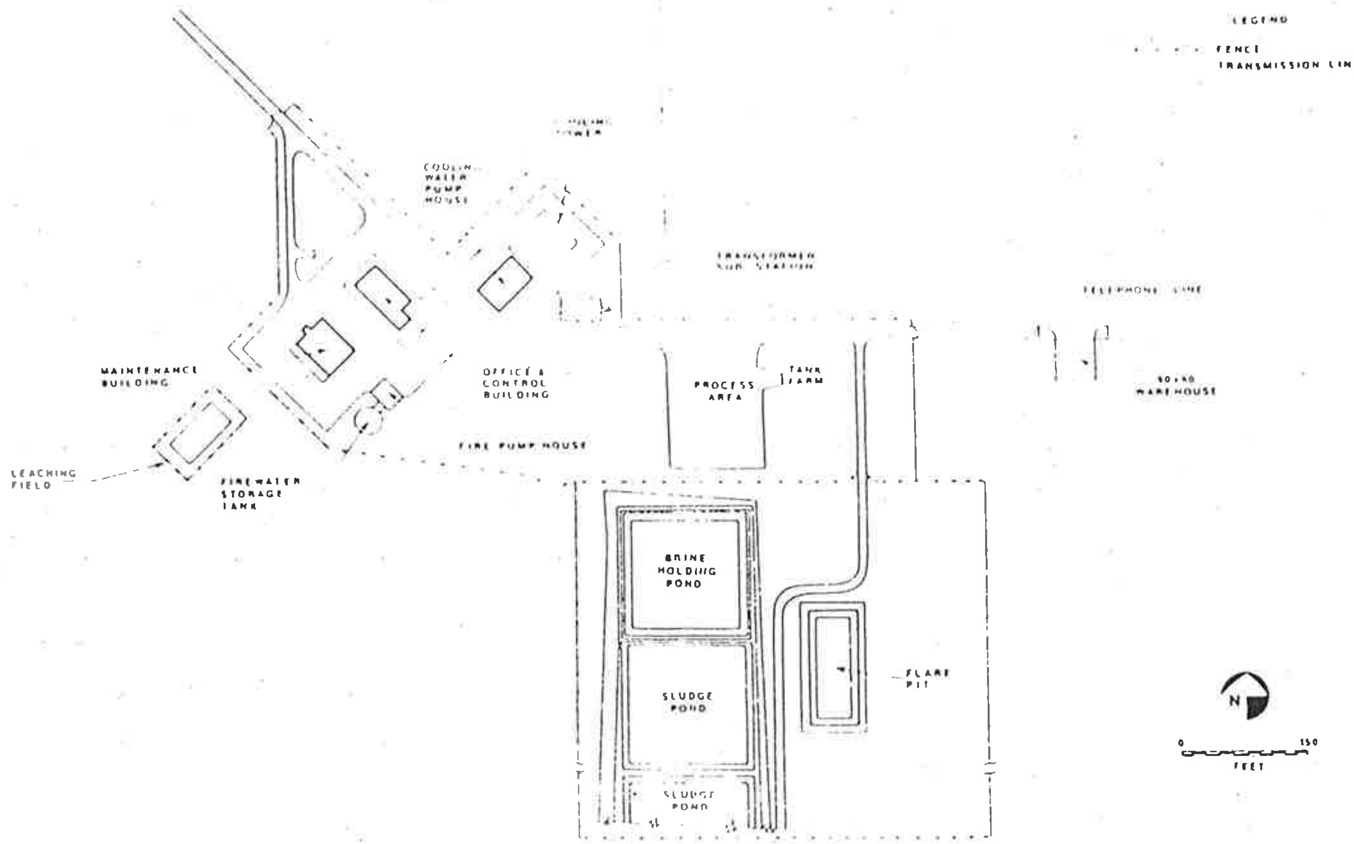


Figure 5 - Plot Plan - 5MW(e) Power Plant

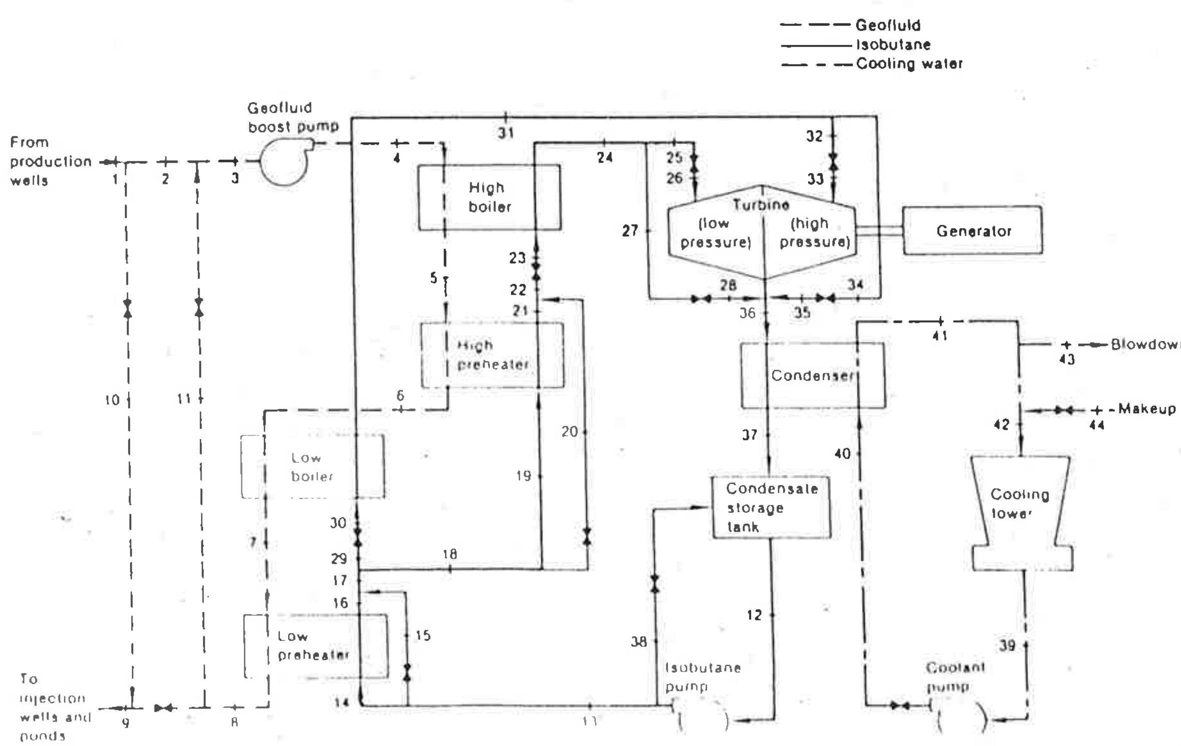


Figure 6 - Schematic Diagram of the Raft River 5MW(e) Geothermal Power Plant