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PROCEEDINGS
THIRD WORKSHOP
GEOTHERMAL RESERVOIR ENGINEERING

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DISCLAIMER

THE BOISE, IDAHO GEOTHERMAL RESERVOIR

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ABSTRACT

Geothermal district space heating has been practiced in Boise over the last 85 years. The system has used two wells drilled approximately 50 ft (15 m) apart in the early 1890s. The wells have a combined maximum reported production rate of 1800 gpm (114 l/sec) at 170°F (77°C) discharge at the wellhead. The system has served as many as 400 homes and Natatorium; presently it serves approximately 200 homes and a large state laboratory and office building.

The heating district remained at the present capacity (two wells) for 85 years primarily because of the unknown nature of the reservoir and availability of other energy sources. Not until 1974 was the question of further development given serious consideration. Rising energy costs due to expanding energy demands and higher costs for foreign oil brought about a reevaluation of the resource. The INEL, Boise State University, and the Idaho Bureau of Mines and Geology began an investigation into the nature of the resource and the economics of space heating several large buildings and homes. Two deep, approximately 1250 ft (381 m), exploratory wells were drilled and tested by the INEL to determine the nature and size of the reservoir. Drilling and reservoir engineering test results have confirmed the presence of a large reservoir that can be developed further without adversely effecting the two production wells and heating system now in operation.

EXISTING PENITENTIARY WELLS

Hot water at 170°F (77°C) was first encountered in two wells drilled in early 1891 to a depth of only 394 ft (120 m) and 404 ft (123 m). The wells were only 50 ft (15 m) apart and were drilled in a swampy area formed by hot water seepage. Eventually the system evolved into two 16-in. (41 cm) production wells about 425 ft (130 m) deep with centrifugal pumps set to 160 ft (49 m). These wells will still become artesian if pumping is stopped and the wells are allowed to recover for approximately 3 or 4 days. The original artesian head of 50 ft (15 m) in these wells is still attainable by shutting in for a longer period.

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During the last year, these old production wells have been monitored for water level drawdown. During late January, 1977, the drawdown reached a maximum of 143 ft (44 m) below ground level (just above the pump bowls). High flow rates (up to 1600 gpm from both wells) caused by unusually cold weather and system leakage accounted for this extreme drawdown.

TWO EXPLORATORY WELLS

In the winter and early spring of 1976, the INEL drilled two exploratory wells 1000 ft (305 m) apart and approximately 1-1/2 mi (2.4 km) northwest of the penitentiary wells. Each of the exploratory wells were drilled within the immediate area of the main NW-SE trending Boise Front Fault and intersecting linears trending from the NE out of the mountains. The well locations are identified on Figure 1. The BEH-1 (BLM) well was drilled to a total depth of 1222 ft (372 m), has 7-in. (18 cm) production casing set to 610 ft (186 m) and a slotted 3-1/2 in. (9 cm) liner hung from the production casing to total depth. See Figure 2.

The BHW-1 (Beard) well was drilled to a total depth of 1283 ft (391 m), has 8-in. (20 cm) production casing set to 202 ft (62 m) and a slotted 4-1/2 in. (11 cm) liner with 100 ft (30 m) of screen hung from the production casing to total depth. See Figure 3.

The BEH-1 (BLM) well was drilled with water out of the production casing but encountered clay lenses (Montmorillonite) during drilling which necessitated cleanout of the pits three different times. BHW-1 (Beard) well was drilled with light mud in an attempt to stabilize the loosely-cemented sand beds encountered between 450 and 800 ft (137 and 245 m).

EXPLORATORY WELL TESTING

Reservoir engineering testing of the two exploratory wells has been as follows:

1. Temperature profiles of the wells were taken during drilling and after the well had stabilized. See Figure 4 for the temperature profile of BHW-1 (Beard). The profile on BEH-1 (BLM) is essentially identical.

2. Artesian wellhead pressure was monitored all during the 1976-77 heating season at BEH-1 (BLM). No correlatable pressure communication was observed as a result of the pumping conducted at the old penitentiary wells. A seasonal pressure decline of 2-1/2 psia was observed during the winter,but recovery began with the spring run off.

3. Artesian and pumped flow tests on each of the exploratory wells was conducted. A shaft driven pump set at approximately 185 ft (56 m) was employed for the pumped flow tests. Table I summarizes the Boise testing completed to date.

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

The BEH-1 well production (artesian flow) will be used for space heating of a BLM warehouse this winter and the long term drawdown will be monitored.

CONCLUSIONS

1. The 170° F geothermal reservoir boundaries have not been detected and the reservoir appears to be capable of usage rates far exceeding the present rate.

2. The reservoir is proven to extend at least 1-1/2 miles along the Fault.

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

4. Test results indicate that future production wells (properly located) will have high production rates in the order of 600 to 1000 gpm for 12 to 16 in. (30 to 40 cm) wells at pump setting depths of 400 feet.

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

The authors wish to thank the geology students, faculty and especially Renald N. Guillemette of Boise State University for their assistance and help during the Boise Project.

WELL LOCATIONS IN BOISE IDAHO

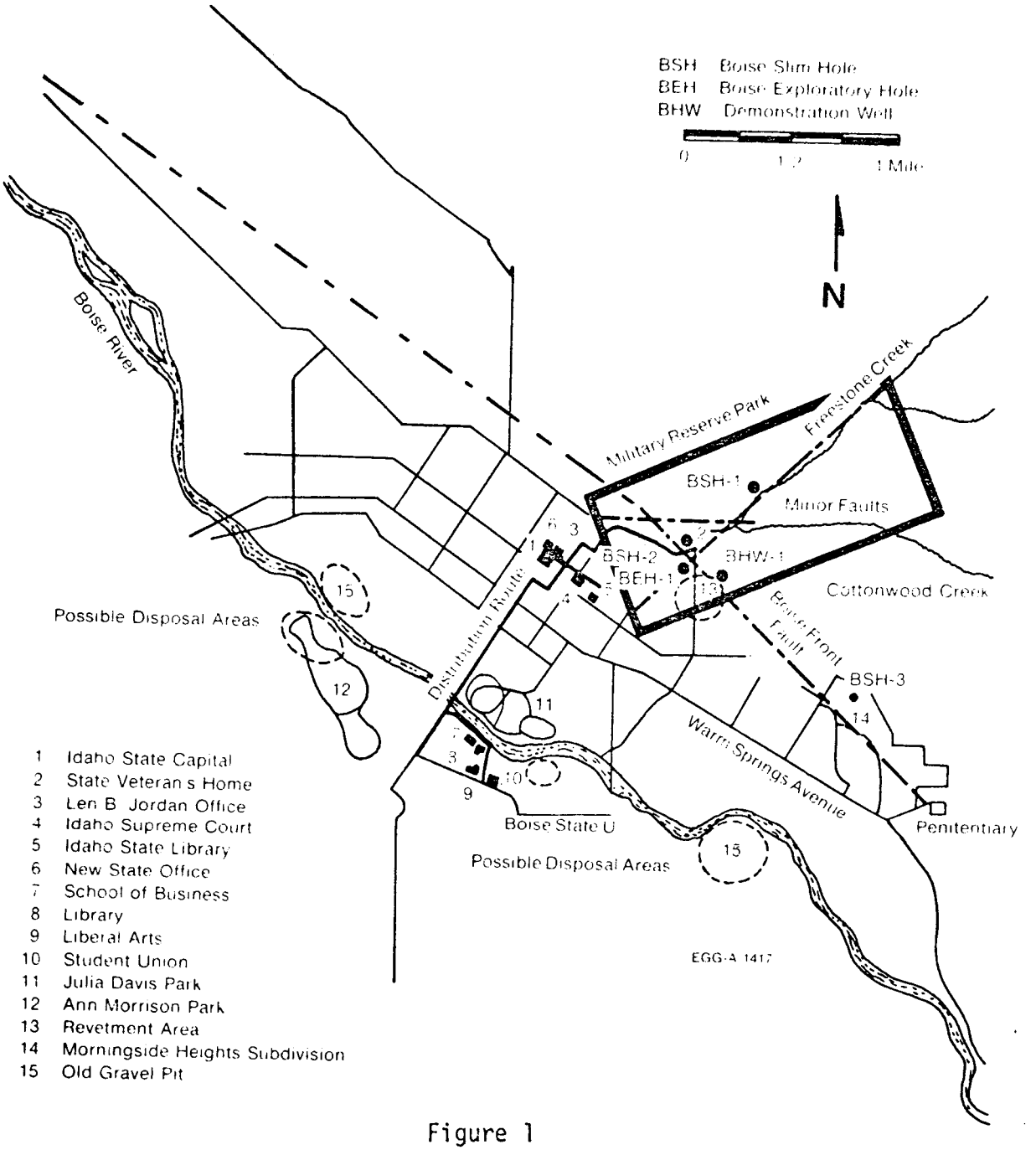

Figure 1

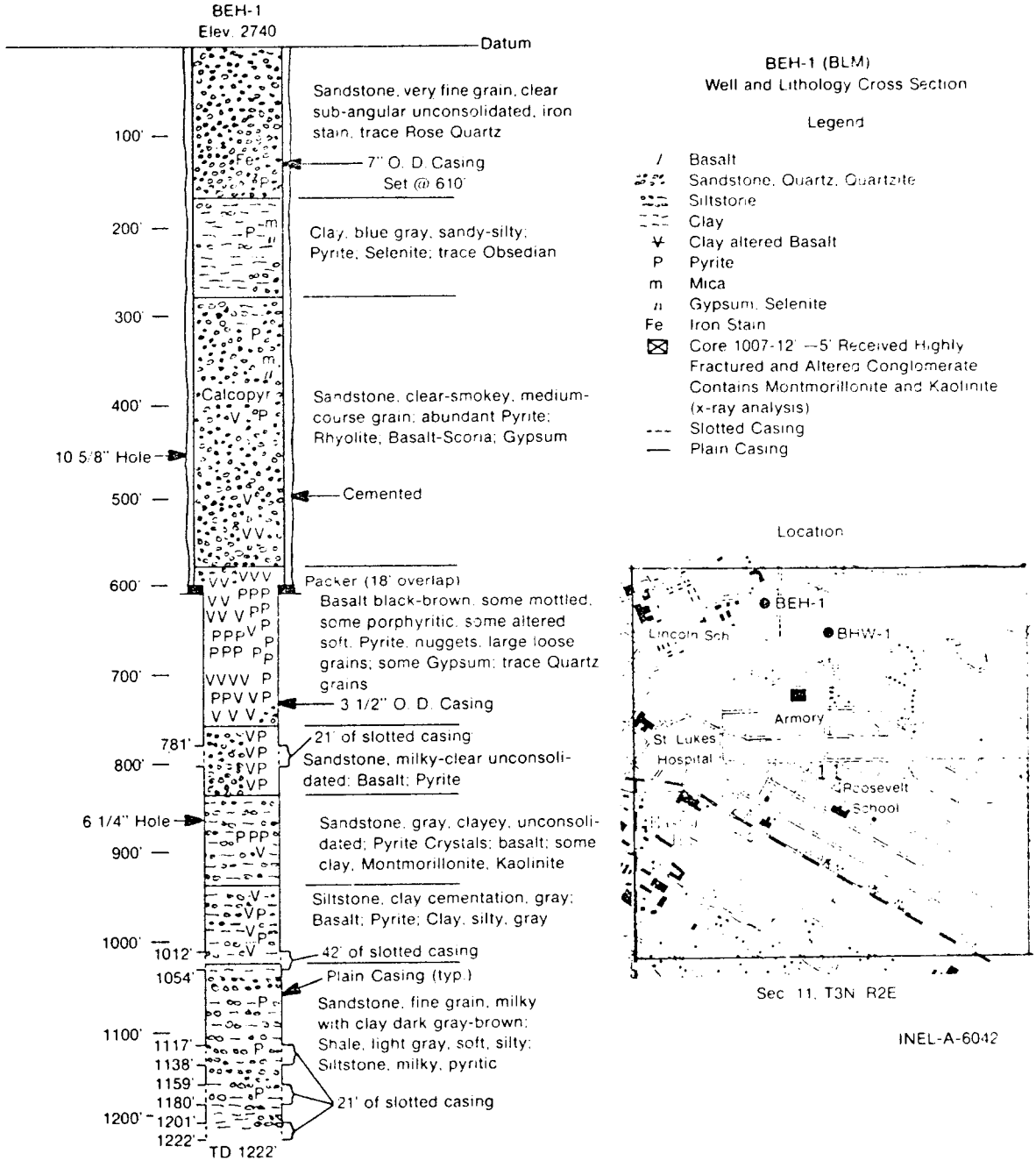
BEH-1
Elev. 2740
Datum
Sandstone, very fine grain, clear sub-angular unconsolidated, iron stain, trace Rose Quartz
7" O. D. Casing Set @ 610'
Clay, blue gray, sandy-silty; Pyrite, Selenite; trace Obsedian
Sandstone, clear-smokey, medium-course grain; abundant Pyrite; Rhyolite, Basalt-Scoria; Gypsum
10 5/8" Hole
Cemented
Packer (18' overlap)
Basalt black-brown, some mottled, some porphyritic, some altered soft, Pyrite, nuggets, large loose grains; some Gypsum; trace Quartz grains
3 1/2" O. D. Casing
21' of slotted casing
Sandstone, milky-clear unconsolidated; Basalt; Pyrite
6 1/4" Hole
Sandstone, gray, clayey, unconsolidated; Pyrite Crystals; basalt; some clay, Montmorillonite, Kaolinite
Siltstone, clay cementation, gray; Basalt; Pyrite; Clay, silty, gray
42' of slotted casing
Plain Casing (typ.)
Sandstone, fine grain, milky with clay dark gray-brown; Shale, light gray, soft, silty; Siltstone, milky, pyritic
21' of slotted casing
TD 1222'
100'
200'
300'
400'
500'
600'
700'
781'
800'
900'
1000'
1012'
1054'
1100'
1117'
1138'
1159'
1180'
1200'
1201'
1222'
BEH-1 (BLM)
Well and Lithology Cross Section
Legend
Basalt
Sandstone, Quartz, Quartzite
Siltstone
Clay
Clay altered Basalt
P Pyrite
m Mica
Gypsum, Selenite
Fe Iron Stain
Core 1007-12' —5' Received Highly Fractured and Altered Conglomerate Contains Montmorillonite and Kaolinite (x-ray analysis)
Slotted Casing
Plain Casing
Location
BEH-1
BHW-1
Lincoln Sch
Armory
St Lukes
Hospital
Roosevelt
School
Sec 11, T3N R2E
INEL-A-6042

Figure 2

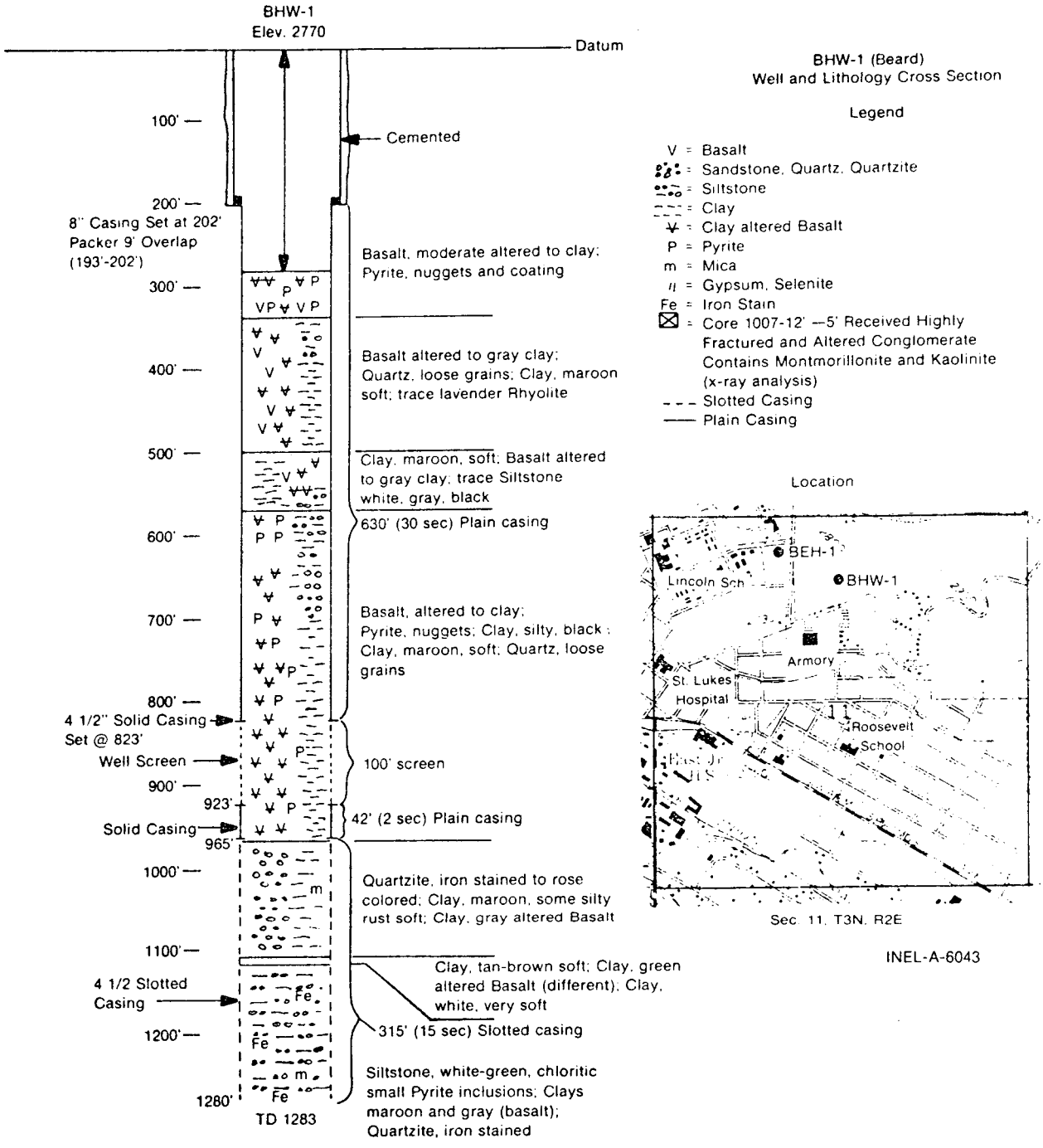
BHW-1
Elev. 2770
Datum
100'
200'
8" Casing Set at 202'
Packer 9' Overlap
(193'-202')
Cemented
300'
400'
500'
600'
700'
800'
4 1/2" Solid Casing
Set @ 823'
Well Screen
900'
923'
Solid Casing
965'
1000'
1100'
4 1/2 Slotted
Casing
1200'
1280'
TD 1283
Basalt, moderate altered to clay;
Pyrite, nuggets and coating
Basalt altered to gray clay;
Quartz, loose grains; Clay, maroon
soft; trace lavender Rhyolite
Clay, maroon, soft; Basalt altered
to gray clay; trace Siltstone
white, gray, black
630' (30 sec) Plain casing
Basalt, altered to clay;
Pyrite, nuggets; Clay, silty, black;
Clay, maroon, soft; Quartz, loose
grains
100' screen
42' (2 sec) Plain casing
Quartzite, iron stained to rose
colored; Clay, maroon, some silty
rust soft; Clay, gray altered Basalt
Clay, tan-brown soft; Clay, green
altered Basalt (different), Clay,
white, very soft
315' (15 sec) Slotted casing
Siltstone, white-green, chloritic
small Pyrite inclusions; Clays
maroon and gray (basalt);
Quartzite, iron stained
BHW-1 (Beard)
Well and Lithology Cross Section
Legend
V = Basalt
= Sandstone, Quartz, Quartzite
= Siltstone
= Clay
= Clay altered Basalt
P = Pyrite
m = Mica
= Gypsum, Selenite
Fe = Iron Stain
= Core 1007-12' —5' Received Highly
Fractured and Altered Conglomerate
Contains Montmorillonite and Kaolinite
(x-ray analysis)
Slotted Casing
Plain Casing
Location
BEH-1
BHW-1
Lincoln Sch
Armory
St. Lukes
Hospital
Rooseveit
School
Sec. 11, T3N, R2E
INEL-A-6043

Figure 3

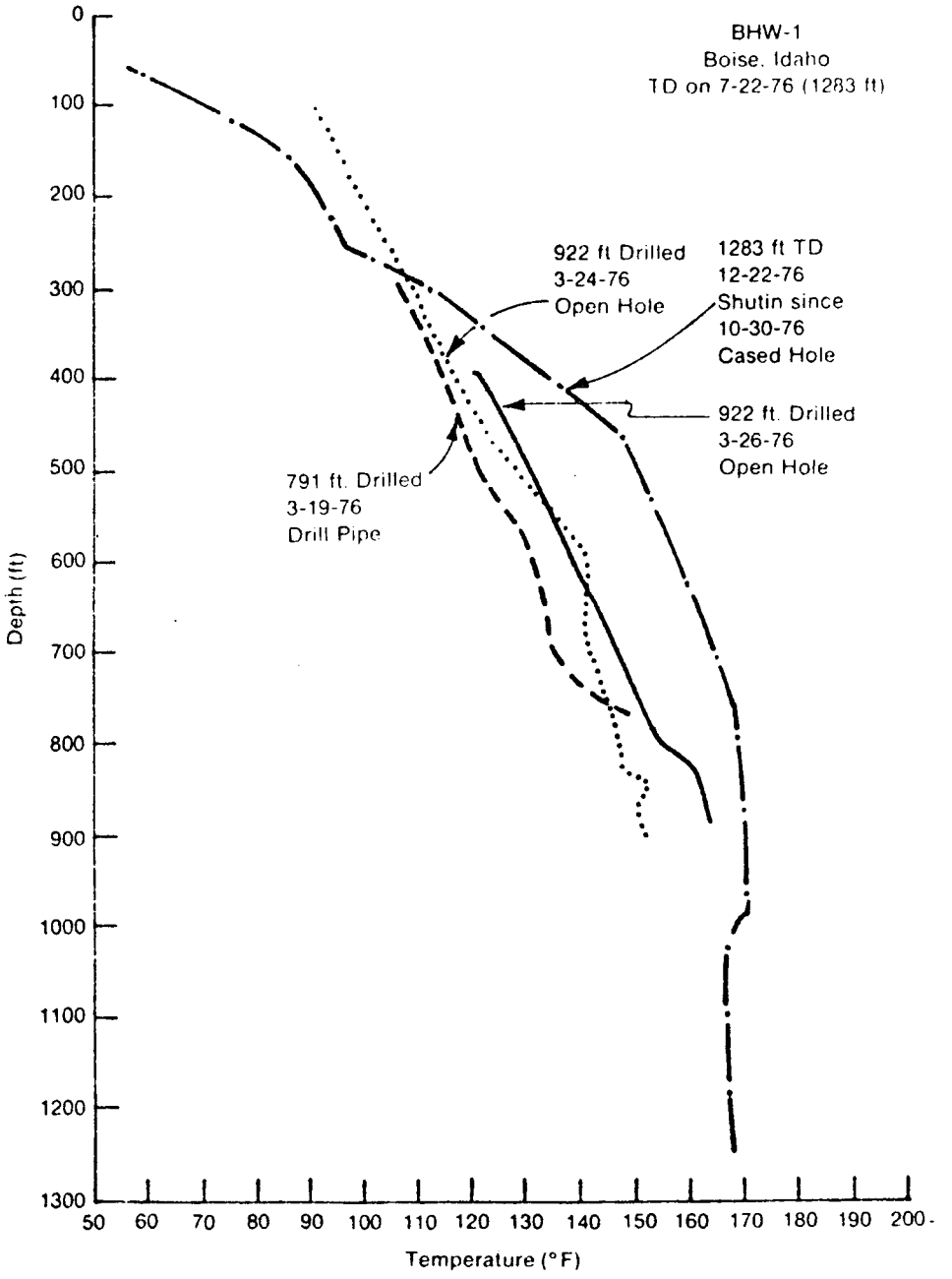
BHW-1
Boise, Idaho
TD on 7-22-76 (1283 ft)
922 ft Drilled
3-24-76
Open Hole
1283 ft TD
12-22-76
Shutin since
10-30-76
Cased Hole
922 ft. Drilled
3-26-76
Open Hole
791 ft. Drilled
3-19-76
Drill Pipe
Depth (ft)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Temperature (°F)

Figure 4

BOISE TESTING

Pumping Well	Q gpm	Date Begun	Duration	Calc. Based on Well	Kh Md. ft Drawdown	Kh Md. ft Recovery	Method	Notes
BLM	90	10-10-77	30 hrs	BLM	4.3×10^{4}	-	S/L	Questionable Poor
				Beard	1.6×10^{7}	2.2×10^{6}	S/1	Fair
				Beard	4.8×10^{6}	-	L/L	-
Beard	240	9-13-77	10 hrs	BLM	3.7×10^{6}	9.2×10^{6}	S/1	Fair
Beard	350	9-14-77	9 hrs	BLM	6.5×10^{6} 3.4×10^{6}	bef. bkpt. aft. bkpt.	S/L	R ∿ 4300' from BLM
Beard (1)	150		12 days	BLM	3.5×10^{5}	3.5×10^{6} (2)	SL	
				Beard	1.4×10^{6}	No data not fully shut in	SL	

(1) Field Plots

(2) Partial data

TABLE 1