ENVIRONMENTAL ASSESSMENT OF PROPOSED SHALLOW TEMPERATURE GRADIENT HOLES NORTHERN UTAH SITES, 1978

UTAH GEOLOGICAL AND MINERAL SURVEY

OPEN-FILE REPORT 26
1978

Prepared by:

Peter J. Murphy
Geologist
Utah Geological and Mineral Survey

INTRODUCTION

Under contract with the U. S. Department of Energy the Utah Geological and Mineral Survey is presently engaged in the evaluation and confirmation of geothermal resources potentially valuable for direct heat applications. The drilling of gradient holes in the vicinity of geothermal resources is an excellent method of obtaining information pertaining to the controls of the resource. Early drilling by U.G.M.S. at Crystal Hot Springs near Point of the Mountain, and Midway Hot Springs in Heber Valley have provided valuable information on geothermal gradients, system limits, and subsurface geologic and structural data.

At the present time U.G.M.S. anticipates the drilling of approximately 13 gradient holes in the vicinity of 4 known hot springs and one warm water area in northern Utah. The sites involved with this drilling project are: the Warm Springs Fault area (Beck Hot Springs to Wasatch Hot Springs in northern Salt Lake City); the vicinity of Utah Hot Springs (near Pleasant View); Udy Hot Springs (1 mile SSW of Plymouth); the Little Mountain area (in the vicinity of Great Salt Lake Mineral Corp.); and Crystal (Madsens) Hot Springs (1 1/3 miles NNW of Honeyville).

I. DESCRIPTION OF THE PROPOSED ACTION, AND ALTERNATIVES:

The action being proposed at the above mentioned sites includes three phases: Drilling, monitoring, and abandonment. The details of each phase are described as follows:

A. Drilling and Completion:

The holes will be drilled with a conventional rotary rig with air and/or mud (as conditions warrant) to a depth of no greater than 100 meters. The drill hole will be 6 inches in diameter. Surface casing will be installed to a minimum depth of 20 ft., or deeper where conditions warrant. A one inch i.d. pipe sealed at the bottom will be placed into the hole, and the hole will be completed as appropriate for the conditions encountered. When conditions in the hole are not artesian, the annulus between the pipe and the hole wall will be filled with cuttings to no less than 2 meters below the surface. The remaining 2 meters will be filled with cement. The one inch pipe will be filled with water and capped at the surface. If artesian flow is encountered, the hole will be completed as above except that the annulus between the pipe and the hole wall will be filled with cement from the total depth to the surface.

B. Monitoring:

After the holes are drilled and completed, the temperature gradient in each hole will be measured by lowering a thermistor probe in the hole and taking measurements at approximately 2 meter intervals. The gradients will be measured periodically during a period of 6 to 12 months after the hole is completed.

C. Abandonment:

After sufficient data has been gathered, the holes will be abandoned by cutting the pipe off below the surface and plugging the hole with cement.

D. Alternatives:

There is no substitute for drilling operations of this type. The only alternative to the proposed action is not to drill, and this action would seriously impair the evaluation of the geothermal potential of the area.

II. ANALYSIS OF PROPOSED ACTION (GENERAL):

A. Drilling:

The drilling of gradient holes as described above involves some potential impacts to the environment that warrant consideration. Included in these impacts are the following:

1) Damage to vegetation caused by: vehicle traffic, human activities at the drill site, and disposal of drilling muds. Implications beyond the damaged vegetation include: destruction of animal habitats, and increased potential for erosion.

2) Damage to archaeological sites.

3) Contamination of surface waters during disposal of drilling muds.

4) Disruption of normal groundwater relationships.

5) Interference with existing wells or springs caused by the discharge of large volumes of water under artesian conditions.

6) Damages caused by the disposal of large volumes of warm, brackish artesian flows, including: soil erosion, and thermal shock and chemical alteration of existing bodies of water.

7) Explosions, electric shock or disruption of services that would be encountered when drill disturbs existing utilities.

8) Noise.

B. Monitoring and Abandonment:

Monitoring and abandonment of the gradient holes do not involve a great deal of activity or equipment. Since the impact from these activities will be minimal, there will be no further discussion of these phases of the project.

III. PRECAUTIONARY AND MITIGATING MEASURES (GENERAL):

All the above impacts need not be a problem at each site, and many of those that should be considered a possible impact can be prevented or mitigated with reasonable caution. The following comments will pertain to all sites unless otherwise indicated in the site specific discussions to follow. Damage to vegetation will be minimized by using existing road to obtain access to drill sites. No site is more than 50 meters from existing roads. The potential for increased erosion should be minimal because all sites are on flat or gently sloping terrain. Drilling mud will be contained in portable mud tanks during drilling. Disposal of mud will be done in such a manner as to minimize distruction of vegetation, and prevent impacting of surface waters as suggested in the attached letter from the Division of Wildlife Resources. No archaeological sites are known to exist in the vicinity of drilling sites. Normal groundwater relationship will be preserved as long as the driller abides by guidelines set forth in "Rules and Regulations of the Division of Water Rights for Wells Used for the Discovery and Production of Geothermal Energy in the State of Utah". Dangers posed by utilities will be avoided by contacting such utilities prior to the start of drilling operations. Noise should not be a problem since drilling is not in residential areas and will be done only during daylight hours.

The major concern that must be considered while drilling the proposed gradient holes is the encountering of large volumes of warm, brackish artesian flow. The flows are most likely to be encountered at sites closest to known springs, but need not be limited to these areas. Installation of a minimum of 20 feet of surface casing will allow controlling any large artesian flows so they will be only temporary. However, should large temporary flows be encountered, two problems may result: 1) interference with existing wells and 2) disposal of the flow until such a time as the flow can be stopped. The specifics of how temporary artesian flows will be handled will be discussed in the site specific sections to follow. However, a Division of Wildlife Resource preliminary investigation (see attached letter) indicates a minimal damage to existing fisheries would occur due to increased warm, brackish flows.

IV. WARM SPRINGS FAULT

A. Description of the Environment:

The Warm Spring Fault region in north Salt Lake City is defined as the region between Wasatch Hot Spring on the south and Beck Hot Spring on the north. The area is approximately 2 miles long and entirely within the Salt Lake City Corporate boundary. Beck Hot Spring has a water temperature of approximately 54°C., a maximum estimated flow of 450 gpm, and a total dissolved solids content of approximately 13, 500 mg/l. Wasatch Hot Spring has a water temperature of approximately 42°C. Flows at Wasatch Hot Spring are variable, but when flows were reported at approximately 1, 000 gpm, total dissolved solids was approximately 5, 600 mg/l. Other springs, seeps, and warm water wells are known to exist between the two major springs. All springs issue through valley fill at distances no greater than 1/2 mile from the North Salt Lake Salient.

Extensive modification of natural land surfaces has occurred in the region (see Figure 1). On the salient to the east, extensive mining of sand and gravel has exposed much of the Warm Springs Fault scarp, from which the area takes its name. The area is a traffic corridor between Salt Lake City and points north. Two major roads (I-15 and state route 89) carry vehicle traffic. Two major railroads have lines paralleling the roads. There is a major switching yard for Union Pacific Railroad. An oil refinery, light to heavy industry, and a few scattered residential areas occupy the remaining land.

The hydrogeologic setting for the area can be described as a variable thickness of saturated unconsolidated sediments covering bedrock that is faulted down relative to the salient to the west. The position of the water table is variable. At the springs and in wells to the west the water level is above the land surface. In wells, used by Monroc for water to wash sand and gravel, the water level is approximately 30 feet below the surface. Old well logs indicate that the unconsolidated materials consist of alternating layers of sand and clay. No well is known to have entered bedrock. Water in this system is likely to have been derived from water moving northward from the Jordan Valley, warm water leakage from faults, and water being alternately pumped and recharged by Monroc washing operations.

All of the sites indicated in Figure 1 are located on extensively modified ground surfaces. Sites 1 and 2 are in road right-of-ways. Sites 3 and 4 are located on level areas from which sand and gravel has been removed. Depressions near sites 3 and 4 are gravel pits that are presently used as settling ponds for clays washed off sand and gravels. Site 5 is at the base of road fill below Victory Road.

B. Mitigating Measures:

Should a large volume of warm brackish artesian flow be encountered in the Warm Springs Fault area, well interferences would be limited. As stated above, only two wells are known to be active. The extent of interference is unpredicable and it may or may not be significant should it occur.

Disposal of artesian flows could be handled by a number of different methods: 1) diversion of flows into existing drainages that handle hot spring runoff; 2) diversion of flows into gravel wash pits; 3) routing of flows into storm sewer. At site 1 flows could be routed through roadside ditches into the main drainage from Beck and Hobo Hot Springs. At site 2 a combination of roadside ditches and storm sewers would be most effective. At sites 3 and 4 water could be diverted into gravel wash pits. Water produced at site 5 could be routed into the storm sewer. Using the methods described above, chemical and thermal shock to existing bodies of water should be avoided, or minimized.

V. UTAH HOT SPRINGS

A. Description of the Environment:

Utah Hot Springs issue from valley fill at the western edge of Pleasant View Salient just northwest of the town of Pleasant

View (see Figure 2). The known occurrences of warm water are confined to a limited area. The water from the springs has been repoted to flow at varying rates (900 to 3,600 gpm), at temperatures of approximately 43°C, and total dissolved solids of approximately 7,900 mg/l. Most of this area has already been somewhat modified by man. The area just west of the Pleasant View Salient is a traffic corridor. Several old and abandoned county roads are used in part for access to private lands. State Route 89 and Interstate 15 are major traffic routes presently in use. The main line of the Union Pacific Railroad is immediately adjacent to the springs. Utilities such as buried telephone cables, and overhead Utah Power and Light transmission lines are also present. The springs, that at one time drained across an area downslope from the springs, are now drained through canals and buried drainage tiles. In the past, these drainages moved water to a resort known as Ogden Hot Springs Resort, but at present time only a small amount of water is used by Allen Plant Company to heat greenhouses during the winter. The springs now drain into large swampy areas just east of I-15.

Because of the lack of nearby wells, little is known about the aquifer or aquifers present in the valley fill. However, valley fill materials are usually composed of alternating zones of sand and clay. The total depth to bedrock is unknown, but is probably variable within the area of our proposed drill sites. Major recharge to aquifers is most likely to be run off from the mountains, but some water including the hot spring water issues from faults buried in the subsurface. Major discharge from valley aquifers is in the form of springs that are common throughout the area. All of the drill sites at Utah Hot Springs are located immediately off existing roads in either road right-of-ways or private land.

B. Mitigating Measures:

Should large warm brackish artesian flows be encountered in the Utah Hot Springs area, it is not likely that any interference would be noticed in existing wells. All the known wells have been plotted on Figure 2, and no active wells are known to exist in the immediate vicinity of the springs.

Disposal of artesian flows could be handled by using existing drainage systems. Flows encountered at sites 1 and 2 could be diverted into drainages that presently drain the main springs. Flows from site 3 could be diverted into a drainage ditch and would eventually flow into the swampy area to the north. This swamp already accepts flow from the main springs, and is distant enough from the drill sites that considerable cooling would occur before waters reached the lake in the swamp. These methods of handling warm artesian flows should prevent or minimize chemical or thermal shock to existing bodies of water.

VI. UDY HOT SPRINGS:

A. Description of the Environment:

Udy (Belmont) Hot Springs issue from the flood plain of the Malad River about 1 mile south-southwest of Plymouth (see Figure 3), shows of warm water are confined to a small area, and water issues from well-defined orifices. Most of the orifices issue directly into lakes where the water cools slightly before it is discharged into the Malad River. The total flow from the system is in excess of 1200 gpm, the TDS is approximately 7,800 mg/l, and the maximum measured temperature of the spring is 53.8°C. The owners of the property are building a resort, a trailer park, and a subdivision on property adjacent to the springs. A golf course has been constructed west and south of the springs, and the land surface has been greatly modified. Development of the springs had included the building of good roads that can be used for access to drill sites.

Very little is known about the aquifer in the vicinity of the hot springs. In a summary of the major thermal springs of Utah, Mundorff (1970) suggests that the water issues from limestones similar to those exposed two miles to the west. Major changes of the land surface by developers has buried a limestone excarpment described by Mulligan et. al. (1966). There is also evidence for an east-west trending fracture in the area.

B. Mitigating Measures:

Should large warm artesian flows be encountered at Udy Hot Springs, it is unlikely that well or spring interferences would result. The closest known wells are over one mile away. The volume of flow from the springs is so large that the flows produced from the hole would be insignificant, and should not affect the flow of the springs.

Large artesian flow at Udy Hot Springs is most likely to occur at site 2. At site 2 water could be easily diverted into lakes associated with the hot springs so that mixing and cooling could occur. At site 3 artesian flows could be diverted into a series of cool lakes located just south of the hot springs. Artesian flows are not likely to occur at site 1; however, if flow was encountered it would have to be diverted directly into the Malad River through existing drainages.

The concerns of the Division of Wildlife as expressed in the attached letter will be considered during the disposal of drilling muds.

VII. CRYSTAL (MADSEN) HOT SPRINGS:

A. Description of Environment:

The Crystal (Madsen) Hot Spring issues from valley fill at the base of an alluvial fan approximately 7 miles north of Honeyville (see Figure 4). The water comes to the surface at approximately 54°C with a total dissolved solids content of approximately 40,000 mg/l. The flow has been estimated at approximately 1,800 gpm. This spring is the most saline spring in Utah. A swimming pool has been built over the original orifice, but water flows under the pool and is drained away from the area by a stream known as Salt Creek. Not more than one hundred feet from the warm spring a cold spring issues from the alluvial fan and is drained by another stream. This cold stream was at one time used as a trout farm and some fish are still present. The warm and cold streams immerge into a long shallow impoundment on Salt Creek less than 500 feet from the hot spring.

A resort with associated buildings is in the vicinity of the springs. Areas for camping and picnicking are to the north and south.

B. Mitigating Measures:

There are no actively pumped wells in the vicinity of the springs. Therefore, there should be no well interference problems should artesian flows be encountered. Since the spring flow is so high, flows should not significantly affect the spring.

The only possible method of disposal for warm, brackish artesian flows would be to divert the flow into the drainage that currently accepts water from the hot spring. The concerns of the Division of Wildlife as expressed in the attached letter will be considered during the disposal of drilling muds.

VIII LITTLE MOUNTAIN:

A. Description of the Environment:

The Little Mountain area is approximately 7 miles WSW of Plain City, Utah. Little Mountain rises several hundred feet above the surrounding salt flat, and is essentially a partially buried mountain range (see Figure 5). Immediately to the west of the mountain is a large expanse of solar pond, used by Great Salt Lake Mineral Corporation to extract salts from Great Salt Lake brines. To the east of Little Mountain is a salt flat that extends for miles to the north and south. Although no hot springs are present, there are numerous cool to slightly warm artesian wells to the east of Little Mountain. The G.S.L.M. Corporation pumps warm water from several deep wells. The proposed drill site is located at the base of Little Mountain in the scrap yard of Great Salt Lake Mineral. Considerable modification of the original environment has already occurred due to the presence of industry in this area.

The hydrogeologic setting can be described as alternating layers of clay and sand unconformably overlaying bedrock of varying depth. This typical valley fill aquifer sequence is confirmed by a number of well logs from G.S.L.M. wells. Artesian conditions exist in the valley fill aquifer as indicated by the number of free flowing wells immediately east of Little Mountain.

B. Mitigating Measures:

There should be few problems with the proposed drilling operations at the drill site. Well interference should not be a problem because, 1) the gradient hole will be almost entirely in bedrock and, 2) any flows that might be encountered should be no greater than the flows presently observed from existing artesian wells (less than 20 gpm). Since existing flows are not exceptionally large in volume, warm, or brackish, flows encountered during drilling could be easily disposed of by drainage onto the salt flat.

IX. PERSONS, GROUPS AND GOVERNMENT AGENCIES CONSULTED:

A. State Agencies

Wildlife Resources

State Division of Health

Division of Water Rights

B. Groups and Individuals, Site Specific

1) Warm Springs Fault

Salt Lake City Engineer's Office

Salt Lake City Mayor's Office

Salt Lake City Commission

Monroc, Inc. - Mr. Steven Smith

Utah Department of Transportation, District Two

Chevron Oil Refinery

2) Utah Hot Springs

Utah Power and Light

Ogden Hot Spring & Sanitarium - Mr. Robert Clay

3) Udy Hot Springs

Belmont Hot Spring Park - Mr. Scott C. Holmgren

4) Crystal (Madsens) Hot Springs

Crystal Hot Spring Resort - Mr. Deane Platt

5) Little Mountain

Great Salt Lake Mineral Corp. - Mr. Peter Behrens

X. INTENSITY OF PUBLIC INTEREST:

There has been to date no public hostilities towards the proposed action.

Several articles have appeared in local papers that should have alerted the public to our intent. Cooperation from property owners in the vicinity of the springs has been excellent.

XI. CONCLUSIONS:

The drilling of the proposed gradient holes should not permanently impact the existing environments. Impacts in the immediate vicinity of the drill sites should be minor and temporary. All artesian flows encountered will be temporary, and the flows can be handled in such a manner as to minimize environmental impact. Although it does not appear that interference with existing wells and springs will be a problem, it is not possible to ignore the potential problem. The installation of surface casings to contain such flows should insure that, should artesian flows cause interference, the condition will be only temporary.

XII. REFERENCES:

Milligan, J. H., Marsell, R. E., Bagley, J. M., 1966, Mineralized springs in Utah and their effect on manageable water supplies, Report WG-23-6 Utah Water Research Laboratory, Utah State University.

Mundorff, J. C., 1970, Major thermal springs of Utah, Water Resources Bulletin 13, Utah Geological and Mineralogical Survey.

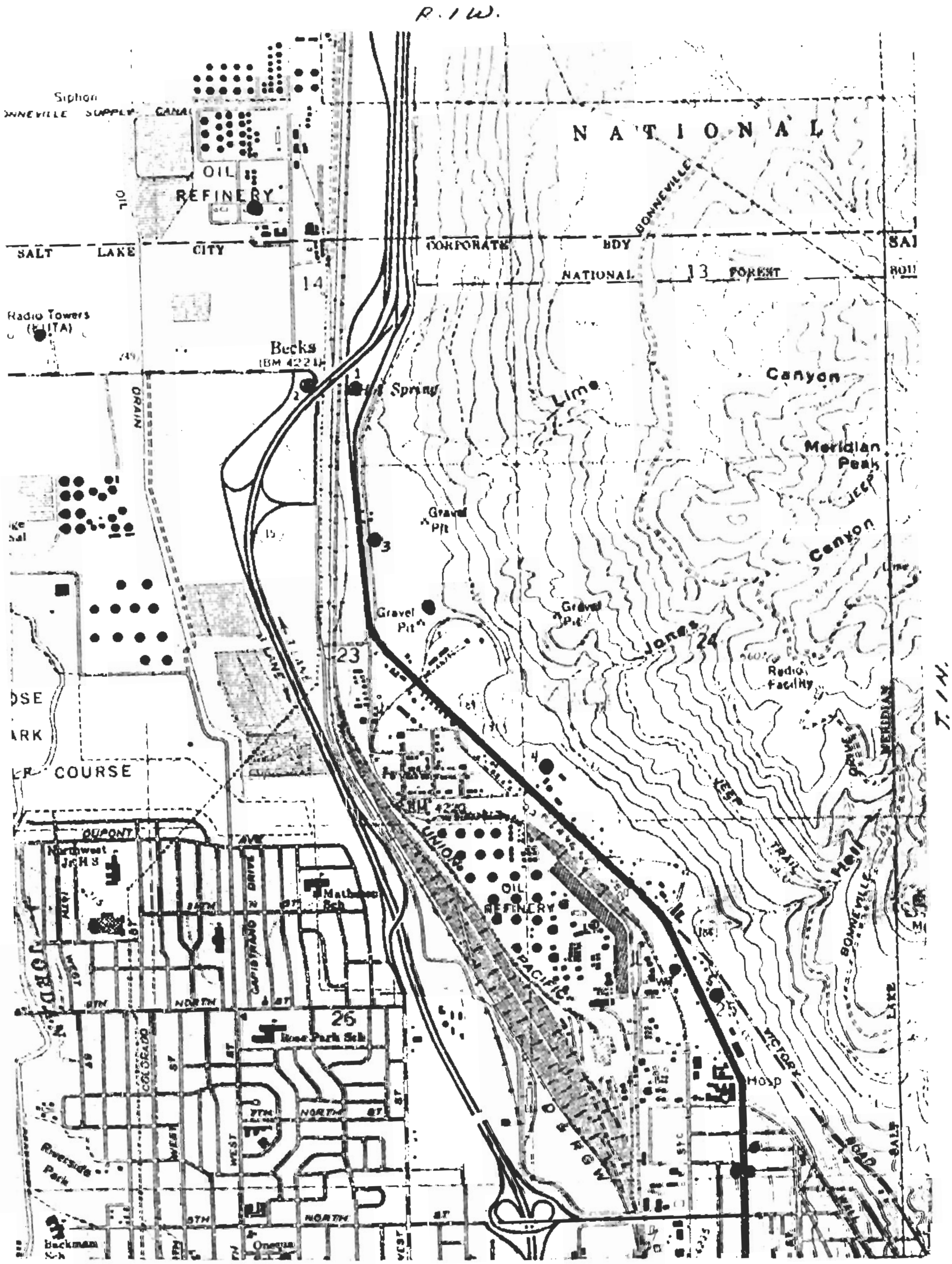

Figure 1.

● GRADIENT HOLES

• EXISTING WELLS

• EXISTING WELLS (ABANDONED)

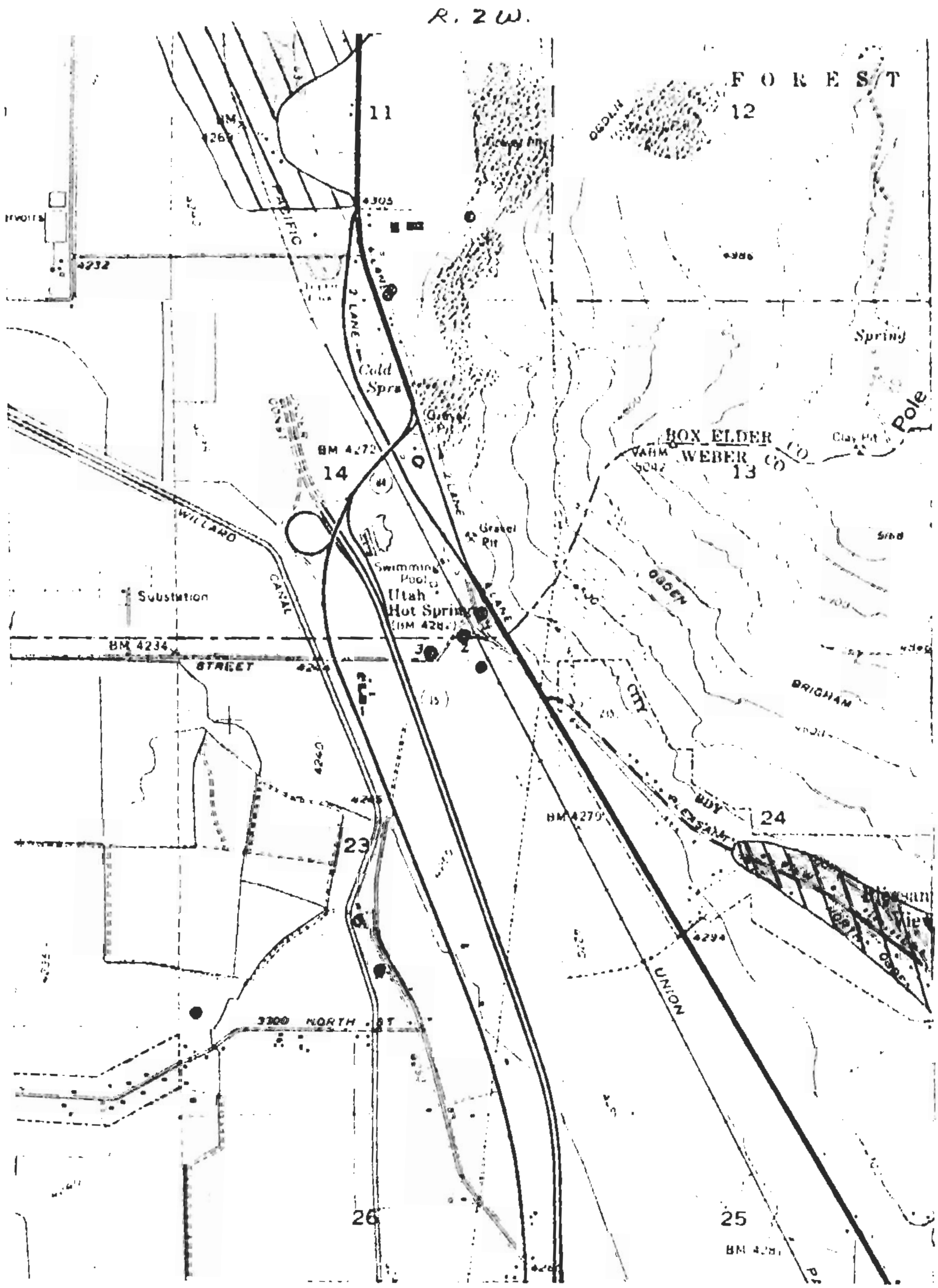

Figure 2.

- ● Gradient holes
- ○ Existing wells
- • Existing wells (abandoned)
- Areas containing many wells

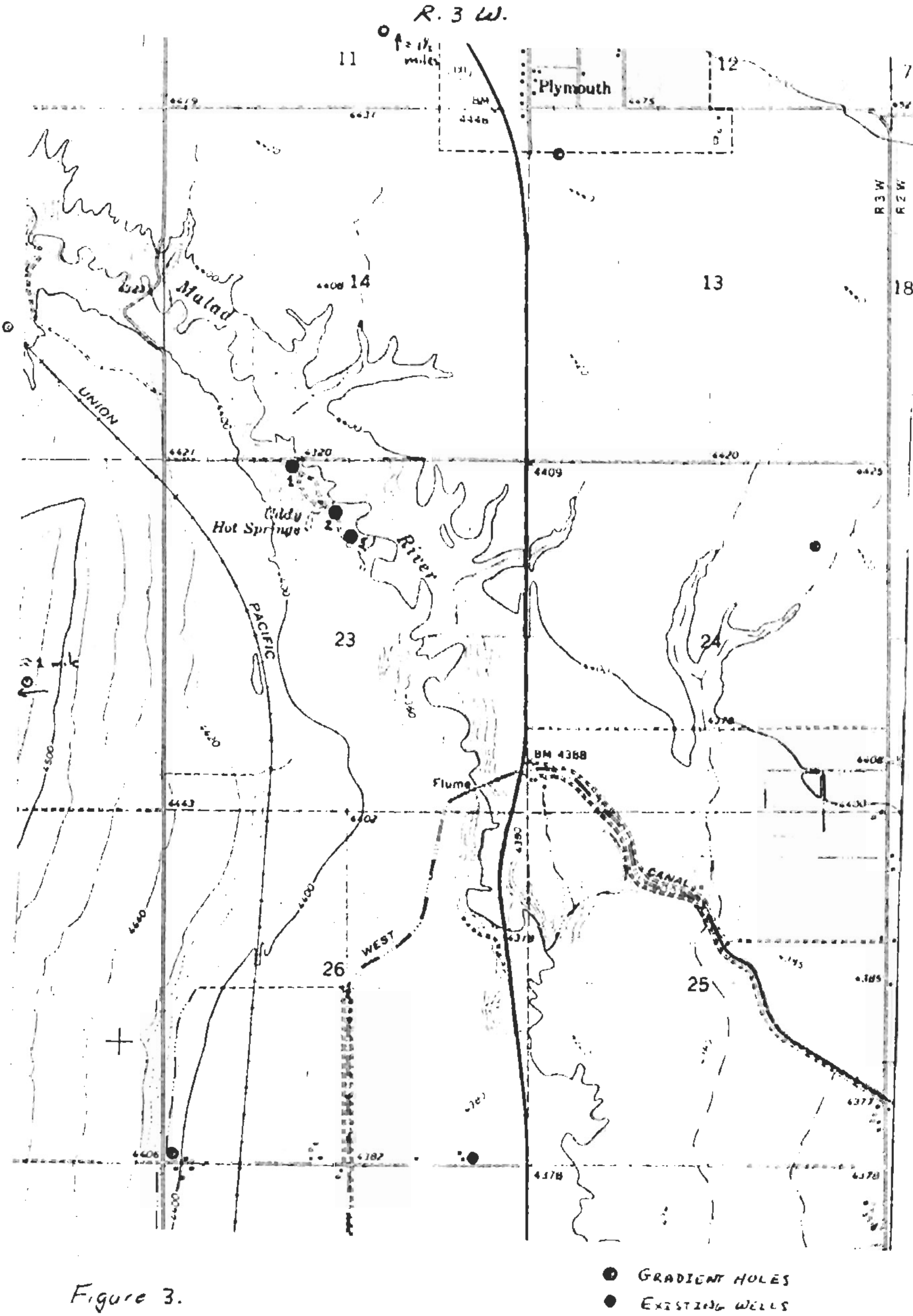
R. 3 W.
11
12
7
Plymouth
14
13
18
R 3 W
R 2 W
Malad
River
UNION
PACIFIC
Cuddy Hot Springs
23
24
T 13 N
BM 4368
Flume
CANAL
WEST
26
25
GRADIENT HOLES
EXISTING WELLS

Figure 3.

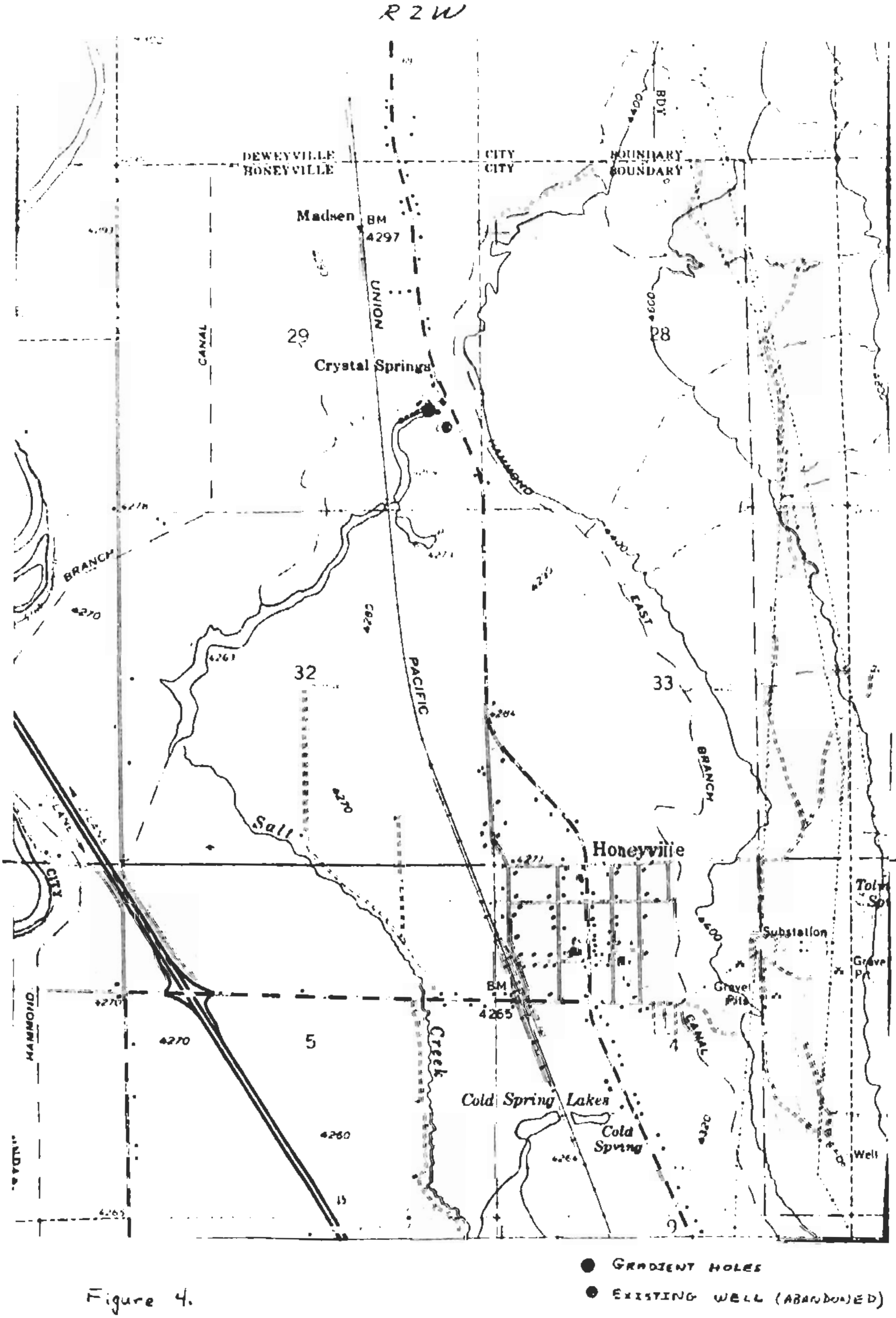
R2W
DEWEYVILLE CITY BOUNDARY
HONEYVILLE CITY BOUNDARY
Madsen
BM 4297
UNION
PACIFIC
29
28
CANAL
Crystal Springs
BRANCH
EAST
32
33
BRANCH
Salt
Creek
Honeyville
Substation
Gravel Pits
BM 4265
5
CANAL
Cold Spring Lakes
Cold Spring
Well
9
T. 11 N.
T. 10 N.
GRADIENT HOLES
EXISTING WELL (ABANDONED)

Figure 4.

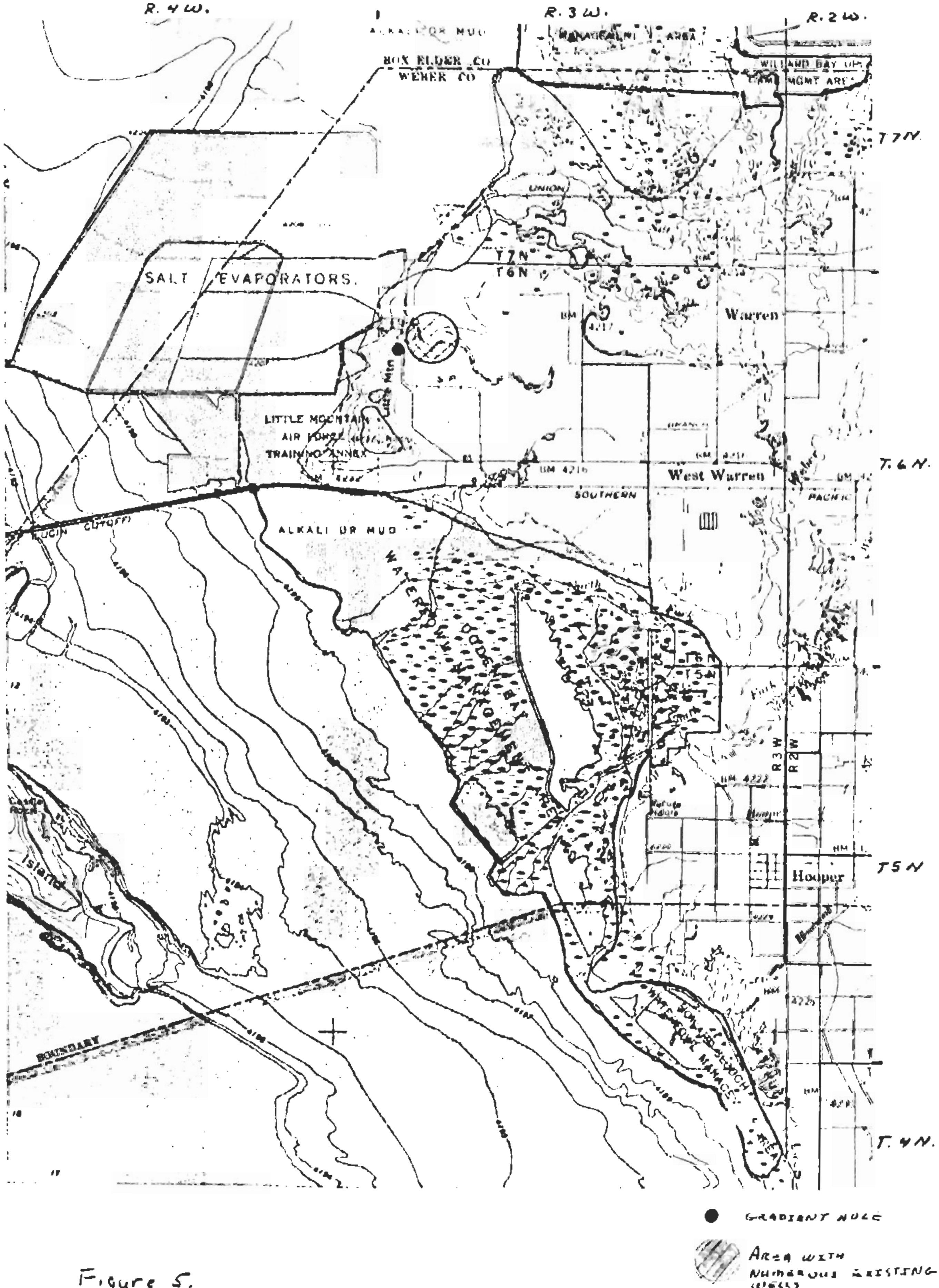
R. 4 W.
R. 3 W.
R. 2 W.
BOX ELDER CO
WEBER CO
T7N.
T. 6 N.
T5N
T. 4 N.
SALT EVAPORATORS.
LITTLE MOUNTAIN
AIR FORCE
TRAINING ANNEX
Warren
West Warren
SOUTHERN
PACIFIC
LUCIN CUTOFF
ALKALI OR MUD
T7N
T6N
T6N
T5N
R3W
R2W
Hooper
BOUNDARY
Island
GRADIENT HOLE
AREA WITH NUMEROUS EXISTING WELLS

Figure 5.

state of utah

DIVISION OF WILDLIFE RESOURCES

DOUGLAS F. DAY 1596 West North Temple/Salt Lake City, Utah 84116/801-533-9333
Director

RECEIVED
SEP 28 1978
U. G. M. S.

September 26, 1978

Mr. Peter J. Murphy
Utah Geological and Mineral Survey
606 Black Hawk Way
Salt Lake City, Utah 84108

Dear Mr. Murphy:

In answer to your letter of September 7, 1978, to Mr. Darrell Nish concerning the drilling of some 13 geothermal gradient holes in northern Utah, we have reviewed and appraised this drilling and associated activities. Following are our comments:

Increased volumes of warm, brackish water would not seriously affect the quality of existing fisheries. Current fisherman use and harvest on these areas are insignificant.

Disposal of drilling muds should be planned to minimize any loss of wildlife habitat, especially riparian habitat along and adjacent to the Malad River (Udy Springs), Salt Creek (Crystal-Madsen Spring), and associated wetland and marsh areas. These habitats provide important wintering areas for pheasants and winter-resident waterfowl. It is recommended that drilling muds be deposited on arid upland sites, preferably in the greasewood habitat type.

We appreciate the opportunity to review and comment on this project.

Sincerely,

Homer D. Stapley

Douglas F. Day
Director
Acting Director

GOVERNOR
Scott M. Matheson

DEPT. OF NATURAL RESOURCES
Gordon E. Harmston
Exec. Director

WILDLIFE BOARD
Lewis C. Smith – Chairman
Roy L. Young L. S. Skaggs

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SEP 26 1978
U. G. M. S.

STATE OF UTAH

DEPARTMENT OF NATURAL RESOURCES

DIVISION OF WATER RIGHTS

DEE C. HANSEN
STATE ENGINEER

EARL M. STAKER
DEPUTY

200 EMPIRE BUILDING
231 EAST 400 SOUTH
SALT LAKE CITY, UTAH 84111
(801) 533-6071

DIRECTING ENGINEERS
HAROLD D. DONALDSON
DONALD C. NORSETH
STANLEY GREEN
ROBERT L. MORGAN

September 25, 1978

Utah Geological and Mineral Survey
606 Black Hawk Way
SALT LAKE CITY UT 84108

Issue Date: September 25, 1978
Expiration Date: March 25, 1979

Attention: Donald T. McMillan

RE: 13 Temperature Gradient Holes

Gentlemen:

Reference is made to your request for permission to drill 13 temperature gradient holes to be located at the following points: Uddy Hot Springs: (1) 1070 feet South 2700 feet West; (2) South 755 feet and West 2955 feet; (3) South 125 feet and West 3550 feet; Alternates: (1) South 1000 feet and West 3460 feet; (2) South 500 feet and West 2390 feet, all from the NE Corner of Section 23, T13N, R3W, SLB&M; Little Mountain South: Section 6, T6N, R3W, SLB&M; Crystal Springs: North 1520 feet and West 755 feet from SE Corner of Section 29, T11N, R2W, SLB&M; Wasatch/Beck's Hot Springs: (1) South 2330 feet and East 2510 feet from the NW Corner of Section 25; (2) North 820 feet and East 380 feet from the SW Corner of Section 24; (3) North 2890 feet and West 1885 feet from the SE Corner of Section 23; (4) North 850 feet and West 2955 feet from SE Corner of Section 14; (5) North 1005 feet and West 2075 feet from the SE Corner of Section 14, all in T1N, R1W, SLB&M; Utah Hot Springs: (1) North 190 feet and West 1695 feet from the SE Corner of Section 14; (2) North 500 feet and West 1350 feet from the SE Corner of Section 14; (3) North 690 feet and West 1000 feet from the SE Corner of Section 14, all in T7N, R2W, SLB&M.

By this letter you are granted permission to begin with the drilling subject to the following conditions:

1. The depth of the hole does not exceed 500 feet.

2. The wells are to be cased and sealed against the water in the formations to be drilled.

3. Return mud or air temperatures shall be monitored at, at least 30 foot intervals and should the temperature reach 125^{o} F. the drilling shall cease and the casing installed or the hole abandoned. Plastic casing may be used at temperatures under 125^{o} F.; otherwise, steel casing shall be used.

4. Upon completion of the testing program, the casings are to be capped or pulled and the holes cemented from bottom to top.

5. The driller must be bonded and have a current well driller's permit from the State Engineer. Before starting, he must give this office notice of the day he will begin drilling. Within 30 days after the wells have been completed or abandoned, he must file a well driller's report containing accurate and complete information regarding the work done.

6. Temperature data and logs of each hole surveyed are to be submitted to the State Engineer. These will be held in confidential status until released by the Company.

7. The driller shall exercise due caution in all drilling operations to prevent blowouts, explosions or fires.

8. The driller operation shall be conducted so as not to contaminate land, water or air, including the underground resources in the area. Federal and State air and water quality standards will be followed.

This is permission for the licensed driller to begin drilling your temperature gradient test wells. Note that the expiration date of this letter is March 25, 1979.

Will you please notify Ward Wagstaff, at this office, when you are going to drill the holes in sufficient time to have him or his assistant on the site when the drilling is started.

This is not permission for you to develop final test wells to be used for production purposes, but it is only intended to develop sufficient information to determine if a likely geothermal resource area does exist.

If you have any questions, please call me or Ward Wagstaff, at this office.

Yours very truly,

Stanley Green
Directing Appropriations Engineer

SG:lmv
cc: Well Driller
cc: M. Stanley Adams, Area Engineer
cc: Gerald W. Stoker, Area Engineer
cc: Edward D. Feldt, Area Engineer
cc: Rex A. Larsen, Area Engineer
cc: R. Michael Turnipseed, Area Engineer
cc: Kenneth Bull
U.S.G.S. District Geothermal Office
442 Post Office Building
Salt Lake City, Utah 84101
cc: Utah State Land Board
400 Empire Building
231 East 400 South

cc: Reed Searle
300 Empire Building
231 East 400 South
Salt Lake City, Utah 84111

cc: U.S. Bureau of Land Management
University Club Building
136 East South Temple
Salt Lake City, Utah 84111
Atten: Div. of Resources

cc: U.S. Bureau of Land Management
Cedar City, Utah 84720
Atten: Lanny Ream

cc: Don J. Christiansen
Utah Occ. Safety & Health Div.
Industrial Commission of Utah
448 South 400 East
Salt Lake City, Utah