MT. HOOD GEOTHERMAL EXPLORATORY DRILLING & TESTING PLAN

OLD MAID FLAT HOLES NO. 1 & NO. 7A

MAY 1980

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**U.S. DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE
NORTHWEST GEOTHERMAL CORPORATION**

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ABSTRACT

This plan has been prepared to establish the objectives and set forth the procedures and guidelines for conducting geothermal exploratory drilling and testing operations in the Old Maid Flat area of Mt. Hood, Oregon, approximately 50 miles east of Portland. The project will be conducted on lands within the Mt. Hood National Forest, which are currently under Federal Lease OR 13994 to the Northwest Geothermal Corporation. The exploratory geothermal operations will consist of (1) testing an existing 4,000-foot temperature gradient hole to determine the quality of geothermal fluids, and (2) drilling and testing a new 5,000-foot hole to determine overall geothermal reservoir characteristics.

Drilling and testing operations will be directed by the U.S. Department of Energy (DOE), Nevada Operations Office, with technical and administrative support from Fenix & Scisson, Inc. (F&S), under Contract No. DE-AC08-76NV00038. The acquisition and analyses of scientific data will be directed by the DOE Idaho Operations Office, with technical and administrative support from the Oregon Department of Geology and Mineral Industries under Contract No. DE-FC07-79ID12044.

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I. INTRODUCTION

A. Background

Investigations by Federal, State, scientific, and industrial groups to assess and characterize the geothermal resource base in the northern High Cascade Range, and particularly in the Mt. Hood, Oregon, vicinity (see Figure 1), have been continuing for several years. The investigations, including geologic, hydrologic, geochemical, and geophysical studies plus shallow, intermediate, and deep temperature gradient hole drilling, have progressed to the current requirement for confirmatory production hole drilling to substantiate the conceptual geothermal models developed and quantify the geothermal resource potential.

Based upon measured geothermal gradients, temperatures up to 200°F can be expected at about 5,000 feet below the surface in the Old Maid Flat (OMF) vicinity of Mt. Hood. If an adequate water supply and permeable formations are associated with the expected temperature, development of the geothermal resource for direct application such as space heating at both the immediate Mt. Hood vicinity and at Portland, Oregon, can be pursued.

B. Objectives

The primary objectives of this project are to (1) confirm the existence of a hydrothermal system with temperatures of about 180°F to 200°F at depths of about 4,000 to 5,000 feet, (2) determine the quality of the hydrothermal fluids, and (3) determine reservoir productivity characteristics to support future development of the potential geothermal resource in the OMF vicinity of Mt. Hood, Oregon.

**MT. HOOD OREGON
GEOTHERMAL EXPLORATORY
DRILLING & TESTING
OLD MAID FLAT
HOLES NO. 1 & NO. 7A**

FIGURE 1 GENERAL LOCATION

C. Summary Project Description

1. General

The project will include (1) testing an existing 4,000-foot geothermal temperature gradient hole designated as OMF No. 1 (2S 8E 15 cd) and (2) drilling and testing a new 5,000-foot geothermal exploratory hole to be designated as OMF No. 7A (2S 8E 15 ac). The specific locations of the holes are shown on the vicinity map in Figure 2.

2. Testing OMF No. 1

The basic elements of the testing plan are to displace approximately 70 bbls. of existing drilling mud from the lower 1,000 feet of open hole with fresh water, remove existing 2-inch pipe, isolate the lower 800 to 1,000 feet of hole with open hole packer and tubing, swab about 100 bbls. of fluid from the hole, and, if possible, continuously pump up to 600 bbls. of fluid from the hole while measuring flow rate and borehole fluid levels. All drilling mud and produced fluid will be retained in steel tanks during the test. Upon completion of the test, all collected fluids will be injected into the borehole, and the hole will be plugged and abandoned* in accordance with applicable Federal and State requirements. An alternative to injecting into the well bore will be to haul drilling mud and produced fluids to a disposal site approved by the state of Oregon. Detailed testing procedures are included in Section IX.

*If interference testing between OMF No. 1 and OMF No. 7A is determined feasible, P&A may be delayed until OMF No. 7A operations are concluded.

FIGURE 2 VICINITY MAP

3. Drilling and Testing OMF No. 7A

The basic elements of the drilling and testing plan are to drill with a lightweight bentonite base mud to about 600 to 1,000 feet, set and cement 10 3/4-inch surface casing, continue mud drilling to about 3,200 feet, convert the mud system to fresh water, and drill to a depth of 5,000 to 6,000 feet. The hole will be evaluated with packers and swab testing and, if warranted, a 7 5/8-inch liner will be run and cemented from about 3,200 feet to 200 feet above the shoe of the 10 3/4-inch surface casing.

Further testing to consist of about 6 to 24 hours of continuous pumping will be included if feasible. All produced fluids will be retained in steel tanks until fluid quality is determined. If fluid quality is acceptable, as determined by the state of Oregon, the earthen reserve pit shall be used to contain produced fluids in excess of the 400-bbl. steel tank capacity. The maximum fluid retention capacity of the reserve pit is about 8,000 bbls. or enough to provide for up to 56 hours of production at 100 gpm. Disposal of produced fluids will be dependent upon fluid quality. Alternatives are injection into the well bore or disposal at a site approved by the state of Oregon. Plans for final disposition of the hole will be made after its producing characteristics have been determined. The detailed drilling and testing procedures are included in Section X.

4. Schedule

The field operations are scheduled to occur during the summer and early fall of 1980. An overall project schedule is contained in Appendix A.

D. Site Selection

The Old Maid Flat testing and drilling sites were approved by the Division of Geothermal Energy (DGE) after a consideration of technical, environmental, and utilization factors. The existing 4,000-foot hole, OMF No. 1, was completed by Northwest Geothermal Corporation (NGC) during the fall of 1978 and is the deepest temperature gradient hole in the Mt. Hood vicinity. The hole has a stabilized bottom-hole temperature of 180°F at 4,000 feet and the lower portions of the hole are postulated to be in relatively impermeable rock and without significant production potential. Definitive information on such a theory has not been obtained, and the OMF No. 1 site was selected for tests to obtain fluid samples from the lower portion of the hole which may be representative of the geothermal reservoir fluid. The OMF No. 7A site is approximately one-half mile from the OMF No. 1 hole and is targeted to encounter a potential fault zone at postulated reservoir depths of 4,000 to 5,000 feet.

Environmental concerns with regard to testing activities at the OMF No. 1 site are minimal since an existing cleared area with existing access road will be utilized. Drilling and testing activities at the OMF No. 7A site will involve additional environmental considerations primarily as a result of access road and site construction requirements in uncleared National Forest lands. Such considerations are addressed in subsequent portions of this plan and in an Environmental Analysis, EA No. 151-80, prepared by the USGS, Conservation Division.

It is envisioned that utilization of a geothermal resource in the Old Maid Flat vicinity of Mt. Hood could ultimately include providing hot water for space heating in the large metropolitan area of Portland, Oregon.

II. PROJECT ORGANIZATION AND MANAGEMENT CONCEPT

A. General

This section identifies the functional project participants and describes their basic authorities and responsibilities.

B. Participants

1. DOE Division of Geothermal Energy (DGE)
2. DOE Nevada Operations Office (NV)
3. DOE Idaho Operations Office (ID)
4. United States Geological Survey, Conservation Division (USGS-CD)
5. United States Forest Service (USFS)
6. Northwest Geothermal Corporation (NGC)
7. Oregon Department of Geology and Mineral Industries (DOGAMI)
8. Fenix & Scisson, Inc. (F&S)

C. Authorities and Responsibilities

1. DGE
 - a. Identify overall project technical objectives and authorize project execution.
 - b. Select drilling and testing sites.
 - c. Provide project funding.

- d. Approve project plans and major changes to plans.
- e. Monitor compliance with National Environmental Policy Act (NEPA) requirements.
- f. Maintain continual cognizance over project progress.

2. NV

- a. Develop, coordinate, and issue project operational plan.
- b. Provide a drilling support contractor, F&S, to execute the approved operational plan.
- c. Direct the activities of the drilling support contractor.
- d. Develop project cost estimates and identify operational and cost reporting practices and controls.
- e. Maintain liaison with all participating organizations.
- f. Provide an NV Project Engineer to maintain technical and administrative surveillance of project activities.

3. ID

- a. Provide liaison and assistance for development of the operational plan.
- b. Provide a scientific support contractor, DOGAMI, with primary responsibility for the acquisition and analyses of scientific data.
- c. Direct and coordinate the activities of the scientific support contractor.

- d. Review the operational plan and any major changes to the plan.
- e. Determine methods to be used for the public release and dissemination of scientific data and the final disposition of physical samples.

4. USGS-CD

- a. Approve the project operational plan.
- b. Coordinate with the USFS for the determination of required environmental approvals in accordance with NEPA requirements.
- c. Approve applications for permits to drill on Federal leases.
- d. Witness certain drilling activities in accordance with the Geothermal Resource Operations orders.

5. USFS

- a. Review the project operational plan.
- b. Provide advice to assure compliance with rules and regulations for operation on National Forest lands.
- c. Prepare the necessary Environmental Analysis Record (EAR).
- d. Issue required permits appropriate to lease status.
- e. Provide logistical support for operation on National Forest lands.

6. NGC

- a. Obtain lease rights and all required permits for conducting geothermal exploration on certain Federal lands within the Mt. Hood National Forest.
- b. Provide technical data for the preparation of access road and drill site construction drawings.
- c. Assist in the preparation of the project operational plan.

7. DOGAMI

- a. Assist in defining detailed scientific objectives and in data interpretations for site selection.
- b. Assist in the development of project operation plan.
- c. Direct and supervise the scientific data acquisition activities.
- d. Exercise primary responsibility for the selection of coring points and determinations for downhole fluids sampling, including aquifer testing intervals.
- e. Provide recommendations for and interpretations of geophysical logs.
- f. Prepare and print a final geologic report of scientific data obtained and interpretations derived from the holes.
- g. Execute and administer subcontracts as required for analyses of core, drill cuttings, and fluids. Such analyses shall include: rock conductivity and permeability,

petrography, petrochemistry, gas and age dates, and water chemistry.

8. F&S

- a. Provide technical specifications, schedules, and cost estimates for drilling and drilling support services subcontracts.
- b. Execute and administer subcontracts for drilling and drilling support services.
- c. Provide technical direction and on-site supervision for drilling and drilling-related operations.
- d. Provide day-to-day logistical coordination.
- e. Provide operational and cost reports as identified.

III. SITE ACCESS AND CONSTRUCTION

A. General

The proposed operations will be conducted on unimproved lands within a United States National Forest. Work will be confined to two specific areas of about 3/4 of an acre each and along a 2,200-foot access road right-of-way. Only minimal surface disturbance will occur at the OMF No. 1 site since it is an existing cleared area with existing access road. Significant surface disturbance, including clearing of trees and earth cuts and fills, will occur at the OMF No. 7A site and along the 2,200-foot access road right-of-way. A discussion of surface disturbances at each area follows.

B. OMF No. 1 Location

Access to the 150- by 175-foot existing cleared area is by existing paved road and 1.2 miles of dirt road, which is currently suitable to provide access for the required mobile well work-over equipment. Surface disturbance at the site will include excavating a 6-foot-square by 4-foot-deep area around the existing casing head flange and installing a timber-lined cellar. Four 6-foot-deep by 10-inch-diameter holes shall be augered on about a 50-foot radius from the borehole and steel guy line anchors shall be installed. An alternative to the guy line anchor holes is to use existing trees as anchors.

Upon completion of the test, the timbers shall be removed from the cellar and the cellar backfilled with the original excavated material. Guy line anchors, if used, will be cut one foot below ground level and covered with native material. Minimal grading to return the area to a generally level condition will be performed if necessary.

C. OMF No. 7A Access Road

Surface disturbance will include removal of vegetation, earth cuts and fills, and installation of steel culverts at the Sandy River and Ramona Creek crossings. The construction of the dirt access road will be generally as shown on the topographic survey drawings included in Appendix C.

The surface of the access road route is characterized by volcanic debris carried from Mt. Hood in the form of "mud" flows consisting of andesitic materials ranging from sand-sized particles to boulders up to three feet in diameter. Surface vegetation along the route includes ground cover moss, brush, and many trees of varying sizes up to 26 inches in diameter.

The route will be generally as shown in the Appendix C drawings with meandering, as necessary, to disturb the minimum number of large trees. It is planned that only three trees with diameters of 12 inches or larger will be felled. One turnout will be included at about the midway point of the road. Earth cuts will be limited to 12 inches in depth, except at the south and north banks of the Sandy River. Heavy boulder areas will be bypassed or padded with fine fill. Fill requirements will be met by hauling material from the rock quarry about 1 1/2 miles away. Drainage cuts along the road will not be necessary because of the highly permeable soil.

Dry wash crossing less than 18 inches deep will be filled. If the crossings exceed 18 inches in depth, a 12-inch steel culvert will be installed and covered with native materials or materials from the quarry.

Design criteria for the Sandy River crossing is based upon information in the Appendix C topographic survey and an opinion from the Engineering Technical Center of the Mt. Hood National Forest Service. The objective of the design is to provide a crossing with adequate flow capacity through oval culverts for normal summer and early fall runoff. If abnormal flows occur which exceed the design capacity of the culverts, the excess will bypass the crossing and pass over the normal flood plain. The crossing would then be restored with native materials from the flood plain as necessary.

Standard earthwork-type equipment to include bulldozers and front end loaders will be required to accomplish the work. Cleared brush and trees will be hauled by the earthwork subcontractor to the nearest sanitary land fill or to locations as designated by the U.S. Forest Service.

Upon completion of the drilling and testing work and demobilization at the OMF No. 7A location, all crossing culverts will be removed,

and the unnatural appearance of the bank cuts at the Sandy River crossing will be minimized. The remainder of the road will be left as is.

D. OMF No. 7A Location

Surface disturbance will include clearing and leveling an area of about 200 by 175 feet and excavating a 75- by 50-foot by 12-foot-deep unlined earthen pit in accordance with engineering drawings contained in Appendix C. Earthwork volumes were developed by the standard double end area method with a factor for compacted fill areas of 1.15. Total cut volume is about 2,264 cubic yards and fill volume is about 2,151 cubic yards, which provides a 5 percent excess for unsuitable materials. Approximately 30 cubic yards of rock from the quarry will be required to provide a 40-foot-square by 6-inch-thick compacted area for the drilling rig sub-structure.

The grading plan has been designed to preclude felling any trees of 12 inches in diameter or larger. Earthwork equipment similar to that used for the access road construction will be required. Cleared brush and trees will be hauled to the nearest disposal area or to locations as designated by the U.S. Forest Service.

Additional surface disturbance will include excavating an 8-foot-square by 6-foot-deep cellar around the conductor pipe and lining the walls and bottom with 6-inch-thick reinforced concrete.

Upon completion of the drilling and testing operations and removal of related equipment and fluids, the reserve mud pit will be backfilled and the remainder of the location left in a generally level condition.

IV. LOGISTICAL SUPPORT

A. Construction Water

Fresh water for use during testing OMF No. 1 and constructing the access road to OMF No. 1 will be obtained from the Sandy River by vacuum pump trucks. Fresh water for OMF No. 7A location preparation and drilling will be obtained by setting a diesel-driven centrifugal pump at the Sandy River and ground laying about 2,200 feet of 3-inch pipe paralleling the access road. If flowing water volumes in the Muddy Fork are adequate, the centrifugal pump will be placed there and only 200 feet of pipe will be required.

B. Potable Water

Participating organizations will provide bottled water for their personnel.

C. Electrical Power

One 80-kw diesel generator will be required for conducting pump testing at OMF No. 1 and No. 7A. An additional 40-kw generator will be required at OMF No. 7A to provide power to the office trailer.

D. Trailers

One 48- by 10-foot trailer with office furniture will be required at the OMF No. 7A site for use by DOE, F&S, and scientific support personnel. The drilling subcontractor may set up a small house trailer for drill rig supervisory personnel.

E. Vehicles

Two sedans and one pickup truck will be required for DOE and F&S personnel throughout the operational phase. Other participating organizations will provide vehicles for their personnel.

F. Communications

Two mobile phone units will be installed in the office trailer during OMF No. 7A operations.

G. Sanitary Facilities

Two chemical toilets will be provided at the appropriate locations as required and serviced as necessary.

V. ENVIRONMENTAL CONSIDERATIONS

A. Fires

Exhaust stacks on all diesel- or gasoline-driven equipment will be equipped with mufflers. Smoking will be allowed in designated areas as determined by the U.S. Forest Service. Both the well work-over unit and drilling rig will have at least two UL-listed, 30-pound, CO₂ cartridge operated, dry chemical fire extinguishers for Class B and C fires. At least 200 bbls. of fresh water in a steel tank will be available at the OMF No. 7A site at all times. A centrifugal pump with a minimum rating of 100 gpm at 50 psi will be connected to the tank and a 150-foot-long 2-inch fire hose with a nozzle will be connected to the pump outlet. Burn pits will not be employed.

B. Soil Erosion

Since all fluids will be contained in steel tanks at the OMF No. 1 location, unnatural soil erosion is not expected. It is anticipated that the permeable soil and grading plan at OMF No. 7A will prevent accelerated erosion. If regrading after completion of the OMF No. 7A work is determined necessary by the U.S. Forest Service, it will be accomplished.

C. Pollution of Surface Water and Groundwaters

The grading plan for the OMF No. 7A drill site provides for drainage of working fluids into the reserve mud pit to prevent mixing with surface waters. The casing program, which includes surface pipe to 600 feet minimum and intermediate pipe to 3,200 feet minimum, will protect groundwaters against production from the geothermal zone.

D. Damage to Fish and Wildlife

All operations will be confined to well sites and access roads to minimize damage to wildlife. Additionally, a three-strand, four-foot-high barbed wire fence will be erected around the reserve mud pit. No working fluids or produced fluids will be dumped into streams or where they may find a course to streams.

E. Air and Noise Pollution

It is not anticipated that significant amounts of noncondensable gases will be encountered during drilling operations, but continuous monitoring of the drilling fluid return line will be employed to warn of possible excessive concentrations of gas.

Noise levels in the vicinity of these conventional rotary drilling rig operations are not expected to exceed OSHA limitations. F&S will periodically measure noise levels and if OSHA limitations are exceeded, hearing protection will be provided to the appropriate personnel.

F. Hazards to Public Health and Safety

All operations will be restricted to the testing and drilling sites and access roads and will be conducted using proven drilling procedures. Persons not directly involved in the operations may be restricted from the site.

G. Waste Disposal

Solid waste, such as general trash, will be placed in commercial-type trash containers and be periodically disposed of at the nearest approved sanitary landfill facility. Chemical toilets will be periodically serviced by a commercial service.

Solid waste from the drilling operation will consist of about 3,000 cubic feet of drill cuttings, which will be retained in the reserve mud pit and will ultimately be covered with native materials.

Liquid waste from the drilling operation will include drilling mud and produced geothermal fluids. The drilling mud, which is basically fresh water plus bentonite, will be hauled to a disposal site approved by the state of Oregon. The produced geothermal fluids will be injected back into the borehole if feasible. If injection is not feasible, disposal considerations will depend upon fluid quality. Estimates of mud and geothermal fluid volumes requiring disposal are highly dependent upon drilling conditions encountered. Perhaps up to 800 bbls. of drilling mud and up to 5,000 bbl. of geothermal fluid may ultimately require disposal.

Waste oil from drilling rig engines will be placed in steel drums and removed from the location during drilling subcontractor demobilization. Waste oil will not be dumped in the reserve mud pit.

H. Other

Further discussion addressing environmental considerations is provided in the previously identified EA No. 151-80. Mitigating measures to minimize adverse environmental effects will be taken to the maximum extent possible within budgetary and operational constraints after review and adoption of EA No. 151-80 by the DOE in accordance with CEQ Regulation 40 CFR, Part 1506, in order to eliminate duplication of effort between Federal agencies.

VI. OCCUPATIONAL HEALTH AND SAFETY

A. General

All operations will be conducted in accordance with current Occupational Safety & Health Act (OSHA) standards and other applicable rules and regulations for operations on United States National Forest lands.

Each participating organization will be responsible for the health and safety of its personnel and for conducting its activities in accordance with procedures that assure:

1. A safe and healthful environment for employees.
2. Control and minimization of hazards to the public and to personnel of other participants.
3. Minimization of the accidental damage to property.

B. Drilling Safety

Following is a list of the most significant requirements pertaining to personnel safety during this drilling operation:

1. All drilling equipment will be inspected by an authorized F&S representative prior to commencement of operations to assure compliance with applicable safety standards.
2. All engines will be equipped with vapor- and/or explosion-resistant or explosion-proof ignition systems.
3. All rig lighting will be vapor- and/or explosion-proof. The wellheads, blowout preventers (BOPs), and cellar will be illuminated with floodlights located as far away as possible while maintaining proper illumination.

4. The rig pumps will be connected to the standpipe and wellhead at all times, with the pits or tanks filled with appropriate mud or water. The fluid will be sufficient to fill the well bore and it will be ready for immediate use at any time.
5. The tool joints and the kelly drive bushing will be kept well doped.
6. The passageways from the rig floor will be sufficient to provide emergency escape for all personnel. These passageways will be kept open and clear at all times.
7. A sufficient amount of fire-protection equipment will be on hand and all personnel will be instructed by an authorized F&S representative in the proper use of such equipment prior to the start of operations.
8. Automotive equipment will be parked at a designated, safe distance from rig.
9. The BOPs will be checked for condition and for proper pressure rating, height, and bore. No rusted, pitted, dented, or bent ring gasket will be used. Blind rams will be cycled every trip, and pipe rams every tour. Sealing elements will be inspected for heat damage or abrasion after every trip.
10. All valves on the choke manifold will be full-opening, steel-flanged valves. They will be checked before installation for working condition and checked periodically for operating condition.
11. The choke manifold will be constructed so that the chokes can be changed without shutting in the flow.
12. The hydraulic BOPs will be equipped with two control stations-- one near the driller's position and the other at a safe

distance from well--with all lines and connections made of high-pressure steel or approved piping.

13. The BOP accumulator will be located at least 50 feet away from the well. It will be large enough to close off all of the hydraulically operated equipment when the pumps are off and have a minimum of 1,000 psi remaining in the accumulator.
14. All BOPs and lines with fluid pressure will be checked before drilling, and any leaks will be corrected.
15. Floats will be used in the drilling string, and they will be checked each trip.
16. Crew members will receive instruction in the use of BOPs, choke controls, etc. Drills will be held at least once a week to ensure all crew members are familiar with their assigned duties in a well-control situation.
17. Provisions will be made for derrickmen to escape by using a wire line and a nonspark buggy.
18. Hardhats and safety shoes will be worn by all personnel in the immediate vicinity of the drilling rig.
19. F&S will provide a supply of safety glasses which will be available to any person requiring access to the drilling rig floor.

C. Medical Services

1. F&S will assure that one OSHA-approved first aid kit is conveniently located at each drilling and testing location during the project operational phase.

2. Injuries requiring other than routine first aid treatment will be reported to the Hoodland Fire Department at Zig Zag, Oregon, approximately eight miles from the project site. The Hoodland Fire Department includes a paramedic unit with an ambulance. Additionally, helicopter ambulance service (Life Flight) is available from the Emanuel Hospital in Portland, Oregon. See telephone numbers below.

D. Emergency Contacts

<u>Service</u>	<u>Location</u>	<u>Telephone Number</u>
1. Fire/Ambulance/ Paramedics	Zig Zag, OR	(503) 622-3124 (Local 911)
2. Emanuel Hospital/ "Life Flight"	Portland, OR	(503) 280-LIFE (5433)
3. Police	Gov't. Camp, OR	(503) 272-3321
4. Sheriff	Sandy, OR	(503) 668-5234
5. Ranger Station	Zig Zag, OR	(503) 622-3191

The above list will be provided to all drilling and testing subcontractor supervisory personnel, and it shall be clearly posted in the drill rig dog house and the office trailer.

VII. INDUSTRIAL RELATIONS

Work to be performed in accordance with this plan is of a research and development nature and has therefore been determined by the NV Industrial Relations Division to be within the purview of the Service Contract Act.

VIII. PERMITS AND APPROVALS

The access road, drill site construction, and drilling and testing operations described herein have been approved in accordance with the USGS and state of Oregon permits included in Appendix B and EA No. 151-80 available from the USGS Area Geothermal Supervisor's Office, Menlo Park, California.

IX. TESTING OPERATIONS--OMF NO. 1

A. Test Objectives

The primary objective of the test is to obtain a sample of geothermal fluids from zones below about 3,200 feet in the OMF No. 1 hole and determine chemical characteristics of such fluids. Secondary objectives, if feasible, include determining zones of fluid entry and reservoir productivity characteristics.

B. Present Status

The mechanical configuration of OMF No. 1 is shown in Figure 3, and the lithology/temperature profile is shown in Figure 4.

C. Test Procedures

1. Excavate around wellhead for access to the 8 5/8-inch casing flange and install a 6-foot-square by 4-foot-deep timber cellar.
2. Auger four 10-inch-diameter anchor holes to about 6 feet in depth on a 50-foot radius around the wellhead and install steel guy line anchors. An alternative to the steel anchors is to use existing trees on the periphery of the cleared area.

OLD MAID FLAT NO. 1

PRESENT STATUS

DEPTH (FT)

FIGURE 4

3. Move in and rig up work-over unit and associated equipment. See schematic equipment layout in Figure 5.
4. Remove 2-inch valve. Pick up one joint of 2-inch black steel pipe and connect to existing 4,000 feet of 2-inch pipe. Check to see if pipe is free by pulling up to 20,000 lbs.*
5. Install an 8 5/8-inch Series 600 to 6-inch Series 900 adapter spool by stripping over the 2-inch pipe and bolting to the 8 5/8-inch casing flange. The adapter spool shall contain two 2-inch outlets with Series 600 gate valves.
6. Install a 6-inch Series 900 annular-type blowout preventer on the adapter spool.
7. Establish circulation by pumping fresh water down the 2-inch pipe and taking returns on the adapter spool outlets. Approximately 250 psi surface pressure will be required to establish circulation due to the annular mud column weight.
8. Circulate about 70 bbls. of mud out of the hole or enough to displace the lower 1,000 feet of mud with fresh water. Retain displaced mud in steel tank.
9. Pull and lay down all 2-inch pipe. Measure all pipe pulled.
10. Run a sinker bar or hole gauge mandrel and, if necessary, rig up wire line logging unit and run four-arm caliper log.

*If pipe is not free, proceed to alternate procedures in Section D.

FIGURE 5. TYPICAL EQUIPMENT ARRANGEMENT OMF NO.1

11. Pick up open hole inflatable production/injection packer with 2 7/8-inch-diameter, 10-foot-long slotted sub with restricted I.D. on bottom.
12. Run packer on 2 7/8-inch, 6.5 lbs./ft., EUE, 8RD, J-55 tubing to about 3,200 feet and set with surface pressure. Check for packer actuation by setting tubing weight on packer.
13. Install swab catcher, swab valve, and flow tee on top of 2 7/8-inch tubing and connect to steel tank via flow line which contains sampling port.
14. Using work-over unit sand line, swab about two hole volumes below the packer (approximately 100 bbls.) while measuring and retaining all quantities swabbed.
15. Periodically sample fluids and analyze in accordance with DOGAMI requirements.
16. After swabbing, rig up wire line logging unit and monitor fluid rise in 2 7/8-inch tubing to evaluate the application of pump testing and/or additional packer settings lower in the well bore.
17. If pump testing appears warranted, release packer, pull tubing and packer, and stand 3,200 feet of tubing in derrick.
18. Run a tapered 4 1/2-inch and 5 1/2-inch casing string with two external casing packers (ECPs) near bottom. Position packers at about 3,200 feet and hang off 5 1/2-inch casing on slip assembly inside 8 5/8-inch casing flange.
19. Run a retrievable bridge plug on 2 7/8-inch tubing to below the ECPs and set the bridge plug.

20. Set ECPs by pressuring inside 5 1/2-inch/4 1/2-inch casing string. Check for packer actuation by setting casing weight on packers.
21. Retrieve bridge plug and stand 1,500 feet of 2 7/8-inch tubing in derrick.
22. Run a 4-inch submersible pump on 2 7/8-inch tubing to about 1,000 feet. Nominal pump capacity shall be about 100 gpm at 1,000 feet net lift.
23. Install flow tee, throttling valve, flowmeter, sampling port, and temperature probe in discharge line to steel tank.
24. Connect pump to portable generator unit and rig up wire line logging unit for measuring fluid level* in 2 7/8-inch tubing by 5 1/2-inch casing annulus.
25. Pump well for about 4 hours (600 bbls. at 100 gpm) or until retention capacity of steel tanks is reached. Take fluid samples as directed by DOGAMI and measure flow rate, flow line temperature, and well bore fluid levels. Discontinue pumping and conduct 24-hour pressure buildup test.
26. Upon completion of pump test, pull pump and stand tubing in derrick.
27. Run final temperature log if warranted.
28. Connect flow tee and lubricator to top of 5 1/2-inch casing. Run wire line flowmeter and begin injecting collected fluids into zones below 3,200 feet to determine permeable locations.

*Alternative is to run pressure transducer for continuous downhole pressure monitoring.

29. After injection tests, rig up wire line perforating unit and perforate ECPs. Pull and lay down 5 1/2-inch and 4 1/2-inch casing.
30. Run 2 7/8-inch tubing to about 1,500 feet and place a 100-foot balanced cement plug, WOC and verify cement top by tagging with tubing, pull tubing to about 200 feet and place a 100-foot balanced cement plug across base of 8 5/8-inch casing, WOC and verify cement top, pull tubing to 20 feet and place cement plug from 20 feet to top of 8 5/8-inch casing.
31. Remove cellar timbers and backfill cellar. Move out work-over rig and equipment; restore site as described in Section III.B.

D. Alternate Procedures

A typical sequence of procedures to be used in the event the existing 2-inch pipe is stuck is as follows:

1. Locate free point with applicable specialty wire line service unit.
2. Back off pipe one joint above free point by using appropriate string shot method.
3. Run overshot and hydraulic jars. Latch onto 2-inch pipe and jar free.

If the above method is not successful, various other options will be evaluated in terms of cost effectiveness and technical requirements for obtaining a fluid sample from OMF No. 1.

E. Equipment Requirements

A general equipment arrangement for the testing operations is shown in Figure 5. A list of major equipment components is as follows:

1. Drive-in Well Pulling Unit: Approximately 200 hp nominal rating, 150,000 lbs. mast capacity, double drum draw works with 5/8-inch sand line suitable for swabbing to 4,000 feet.
2. Wire Line Logging Unit: Commercial service truck with electric logging and perforating capabilities.
3. Mud and Water Storage: Two 400-bbl. upright cylindrical tanks.
4. Fuel Storage: One 30-bbl. upright cylindrical tank.
5. Electrical Power: One 80-kw portable generator to match downhole pump requirements.
6. Pump: One 30-40-hp electrically driven, submersible centrifugal pump.
7. Pump: One 5- by 8-inch duplex positive displacement with a minimum pressure rating of 500 psi.
8. Pipe Racks: Two sets for racking a minimum of 4,000 feet of 2 7/8-inch tubing and 4,000 feet of combined 4 1/2-inch and 5 1/2-inch casing.

9. Blowout Prevention Equipment: One accumulator, one 6-inch Series 900 annular BOP, one 8- by 6-inch bolt-on adapter flange.
10. Meters: One positive displacement flowmeter with 10 to 100 gpm range.
11. Miscellaneous Valves and Fittings.
12. Tubulars
 - a. 4,000 feet: 2 7/8-inch, 6.5 lb./ft, J-55 tubing.
 - b. 2,700 feet: 4 1/2-inch, 9.5 lb./ft., J-55 casing.
 - c. 1,300 feet: 5 1/2-inch, 14 lb./ft., H-40 casing.
 - d. 1,000 feet: 3/4-inch flush joint pipe.
13. Other
 - a. Two 4 1/2-inch by 7 7/8-inch external casing packers.
 - b. Two 2 7/8-inch by 7 7/8-inch inflatable production packers.
 - c. One 4 1/2-inch retrievable bridge plug.

X. DRILLING AND TESTING OPERATIONS--OMF NO. 7A

A. Objectives

1. Verify the existence of a low- to moderate-temperature (180°F to 200°F) geothermal aquifer in a permeable fracture zone at depths from 4,000 to 5,000 feet.

2. Determine temperature, productivity, and water quality characteristics of the geothermal aquifer.
3. Obtain scientific data from subsurface formations encountered during drilling.
4. Determine design parameters for future production holes.

B. Present Status

Refer to Section III for access road and site preparation requirements and Section IX, Figure 4, for expected lithology to be encountered.

C. Drilling and Testing Procedures

1. Using cable tool or air hammer drilling methods, drill a 22- to 26-inch hole to firm formation estimated at about 30 to 100 feet. The hole will be covered with a 3/4-inch thick plywood board or equivalent whenever the drill string is not in the hole.
2. Set 18 5/8-inch, steel conductor pipe with minimum wall thickness of 0.375-inch and welded joints at total depth and anchor with ready mix grout from total depth to surface.
3. Construct an 8-foot-square by 6-foot-deep reinforced concrete cellar around the 16-inch conductor pipe and cut the pipe off at ground level (top of the cellar).
4. Move in and rig up a conventional rotary drilling rig and associated equipment. See typical equipment layout in Figure 6.
5. Install a 16-inch Series 600 rotating head on the conductor pipe with fill-up line connection to mud pump and return line connection to mud pits.

FIGURE 6. TYPICAL EQUIPMENT ARRANGEMENT OMF NO. 7A

6. Mix a lightweight bentonite-base drilling mud and begin drilling a 14 3/4-inch-diameter hole using a mill tooth bit dressed with three 1/2-inch nozzles. Drill collar diameter should be between 7 and 8 inches. After drilling about 75 feet below the base of the conductor pipe, trip out and pick up stabilized bottom-hole assembly as follows:

One 14 3/4-inch bit, one 14 3/4-inch full-gauge rotating stabilizer, one 10-foot drill collar, one 14 3/4-inch full-gauge rotating stabilizer, one 30-foot drill collar, one 14 3/4-inch full-gauge rotating stabilizer, and remainder of drill collars to equal 60,000 lbs. weight.

7. Continue 14 3/4-inch hole to about 600 to 1,000 feet, maintaining mud weight of about 9.4 lb./gal. and circulation rates of about 600 gpm. Lost circulation materials (LCM) will be used as required. If circulation cannot be maintained with LCM, the hole will be dry drilled, i.e., without returns, using fresh water and periodic high-viscosity mud sweeps. If adverse hole conditions dictate that casing be set before reaching a minimum of 500 feet, consideration will be given to reaming the 14 3/4-inch hole to 17 1/2 inches and running 13 3/8-inch casing.
8. At casing setting depth, the hole will be conditioned by circulating with mud for about one hour and a suite of geophysical logs will be run. See Section X.E.
9. After logging runs, trip to bottom and condition hole for setting and cementing 10 3/4-inch casing.
10. Run 10 3/4-inch, 40.5 lb./ft., K-55, ST&C casing with float shoe on bottom and float collar one joint above float shoe. Run one centralizer on each of the bottom five joints. Centralizers may not be used above the bottom five joints to allow for remedial cementing through 1-inch tubing.

11. Cement the casing conventionally with 450 cubic feet of lightweight (12.4-13 lb./gal.) cement followed by 200 cubic feet of Class G cement (nominal 14.8 lb./gal. slurry) with 2 percent calcium chloride. Total slurry volume (650 cubic feet) provides about 50 percent excess for 750 feet of gauge hole. If cement returns are not observed at the surface, a density log will be run to locate the cement top and a 1-inch tubing string will be run in the annulus for cementing to the surface.
12. Cut 18 5/8-inch casing at cellar floor and 10 3/4-inch casing according to blowout preventer (BOP) equipment spacing requirements. Weld 10 3/4-inch Series 600 casing head flange with two 2-inch valved outlets. Install a 10-inch Series 600 double-gate BOP with pipe rams on top and blind rams on bottom, a 10-inch Series 600 annular BOP, and a bell nipple with return line to mud pits. See typical BOP stack in Figure 7.
13. Rams, valves, and 10 3/4-inch casing will be pressure tested to 1,000 psi and the annular BOP will be pressure tested to 700 psi.
14. Begin drilling a 9 7/8-inch-diameter hole using a mill tooth or insert bit dressed with three 7/16-inch nozzles and bottom-hole assembly as described in Step 6 with 9 7/8-inch-diameter rotating stabilizers.
15. Continue hole to about 3,200 feet, maintaining mud weight of about 9.4 lb./gal. and circulation rates of at least 400 gpm.
16. At 3,200 feet, drilling mud will be replaced with fresh water, which will be used as the drilling fluid to total depth unless hole conditions dictate returning to mud. Occasional high-viscosity mud sweeps may be required during the water-drilling phase. Minimum circulation rate while drilling of water will be 500 gpm.

TYPICAL BOP STACK FOR DRILLING 9 7/8" HOLE

17. At total depth, anticipated to be from 5,000 to 6,000 feet, the hole will be conditioned for logging by circulation with water and geophysical logs will be run in accordance with Section X.E.
18. Conduct swab testing by using inflatable production/injection or straddle packers run on 2 7/8-inch, 6.5 lb./ft. J-55 tubing. Packers should have a differential pressure rating of 3,000 to 4,000 psi. Packer setting points will be selected based upon DOGAMI recommendations and caliper survey considerations.
19. Connect swab valve, flow tee, and swab catcher to 2 7/8-inch tubing and connect to steel tank via flow line with sampling port. Using rig sand line, swab sufficient volumes to obtain representative fluid sample. If feasible, monitor fluid level rise in 2 7/8-inch tubing between swab runs and obtain productivity estimate. Conduct temperature surveys as determined necessary.
20. Injection tests using downhole flowmeter may also be conducted.
21. Based upon results of swab testing, select setting point for 7 5/8-inch intermediate liner. The setting point is estimated to be below 3,200 feet.
22. Trip out of hole with packer and tubing. Mix about 20 bbls. of high-viscosity mud and spot below desired liner setting point. Spot a 50-cubic-foot (approximately 100 lineal feet in 9 7/8-inch hole), Class G cement plug below the liner setting point. WOC and verify top by tagging with drill string.
23. Run 7 5/8-inch, 26.4 lb./ft., K-55, ST&C liner to an estimated 3,200 feet with liner hanger 200 feet above shoe of 10 3/4-inch casing. Liner will contain float shoe on bottom and float

collar one joint above float shoe. Centralizers will be placed on the bottom five joints, the top three joints, and every third joint in between.

24. Cement the liner through drill pipe in one continuous stage with 700 cubic feet of lightweight (12.4-13 lb./gal.) cement containing silica flour. Actual cement volumes and composition will vary depending upon hole conditions. The liner will be circulated with a volume of cement adequate to rise about 100 feet above the liner top.
25. WOC 8 hours. Pick up 9 7/8-inch mill tooth bit dressed with three 7/16-inch nozzles and drill out cement to top of liner hanger. If cement is not tagged above liner hanger, a density log will be run to locate cement top and remedial squeeze cementing will be performed as necessary.
26. Pick up 6 1/2-inch mill tooth bit dressed with three 13/32-inch nozzles and drill out cement in liner hanger and inside liner shoe. Run bit to total depth and circulate hole with fresh water.
27. Run a 4-inch submersible pump on 2 7/8-inch tubing to about 1,000 feet. Nominal pump capacity shall be about 100 gpm at 1,000 feet net lift. Run 1-inch or 1 1/2-inch tubing string beside the 2 7/8-inch tubing for water-level* monitoring.
28. Install flow tee, throttling valve, flowmeter, sampling port, and temperature probe in flow line to steel tank.

*Alternative is to run pressure transducer for continuous downhole pressure monitoring.

-
29. Connect pump to portable generator and rig up wire line logging unit for measuring fluid levels in 1-inch or 1 1/2-inch tubing.
 30. Pump well for about three hours (400 bbls. at 100 gpm) or until retention capacity of steel tanks is reached. Take fluid samples as directed by DOGAMI and measure flow rate, flow line temperature, and well bore fluid levels. Discontinue pumping and conduct 24-hour pressure buildup test.
 31. Further pump testing up to the 8,000-bbl. retention capacity of the reserve mud pit may be conducted.
 32. Upon completion of pump testing, pull pump, lay down tubing, and run final temperature log.
 33. Remove BOP equipment.
 34. If hole is potential producer, install 4-inch gate valve on top of 10 3/4-inch casing head and cover cellar with steel plate. See Figure 8 for completion diagram.
 35. If hole is dry, plug and abandon in accordance with USGS requirements or complete it as a temperature-observation hole with plug and abandon responsibilities remaining with lessee.
 36. Move out drilling rig and equipment and restore site and access road as described in Section III.C. and D.

D. Surface Equipment and Services

A schematic equipment arrangement is shown in Figure 5. A general description of major equipment components and services is as follows:

OLD MAID FLAT NO. 7A

PLANNED COMPLETION

1. Field-Assembled Rotary Drilling Rig: Medium depth range (5,000 to 6,000 feet), 300,000-lb. mast capacity (API rating), double-drum draw works with 1-inch drilling line and 5/8-inch sand line, two mud pumps with combined nominal rating of 600 hp, drill collars for bottom-hole assembly weight of 60,000 lbs., 5,000 to 6,000 feet of 3 1/2-inch to 4 1/2-inch drill pipe, steel mud pits with about 400-bbl. combined capacity, and one 200-bbl. water storage tank, plus appropriate electrical generators and pipe racks.
2. Mud Logging Unit: Commercial service unit for continuous monitoring of flow line temperatures, gas concentrations (H_2S , CH_4 , C_2H_6 , C_3H_8 , and CO_2), and pit levels.
3. Drilling Recorder: Penetration rate, torque, weight, rotary rpm, pump strokes, and pump pressure will be continuously recorded.
4. Auxiliary Fluid Storage: One upright cylindrical 400-bbl. tank.
5. Water Supply Pump: One diesel-driven centrifugal pump capable of supplying about 500 gpm through 2,200 feet of 3-inch steel pipe.
6. Electrical Power: One 80-kw portable generator to match downhole pump requirements.
7. Blowout Prevention Equipment: One 16-inch Series 600 rotating head for drilling 14 3/4-inch hole, 10-inch Series 600 double-gate, and one 10-inch Series 600 annular preventer for drilling 9 7/8-inch hole.
8. Wellhead: One 10 3/4-inch slip-on and weld Series 600 casing head, one 10 3/4-inch by 4-inch adapter spool, one 4-inch Series 600 gate valve.

E. Subsurface Equipment and Services

1. Casing

- a. Conductor Casing: 18 5/8-inch, steel pipe with minimum wall thickness of 0.375-inch and beveled and welded joints will be set at 30 to 100 feet and cemented to surface.
- b. Surface Casing: 10 3/4-inch, 40.5 lb./ft., K-55, ST&C casing will be set at 600 to 1,000 feet and cemented to surface. Design safety factors are as follows: collapse, 2.05; burst, 4.06; tension, 11.11.
- c. Intermediate Casing: 7 5/8-inch, 26.4 lb./ft., K-55 ST&C liner will be set at a minimum depth of 3,200 feet and cemented to 200 feet above the base of the 10 3/4-inch casing. Design safety factors are as follows: collapse, 1.81; burst, 2.59; tension, 5.40.
- d. Liner Hanger: 10 3/4-inch by 7 5/8-inch mechanical set-type liner hanger with provisions for remedial cementing from above.

2. Cementing

- a. Conductor Pipe: Ready mix grout will be placed down the 22- by 18 5/8-inch annulus with fill up to the surface.
- b. Surface and Intermediate Casing: Cement systems will be selected based upon actual hole conditions encountered with appropriate additives, slurry weights, and excess volumes. All casing will be cemented to the surface or to the top of liner hanger as appropriate. Conventional well cementing commercial services will be employed.

3. Logging

A complete suite of open hole geophysical logs will be run at each casing setting point below the conductor casing and at total depth. The logs will be selected to determine the following parameters:

- a. Temperature
- b. Resistivity
- c. Spontaneous Potential
- d. Porosity
- e. Permeability
- f. Fracture Characteristics
- g. Hole Diameter and Deviation
- h. Radioactivity

In addition to the above, cement evaluation logs may be run.

4. Coring

It is anticipated that up to five cores will be obtained during the drilling operation. A 30-foot core barrel with conventional diamond coring head for cutting a 3 1/2-inch-diameter core will be used. A coring company service representative will be on site during coring operations.

5. Drill Cuttings

A minimum of one 1000-gm (about 2 lbs.) sample will be taken at 10- to 30-foot intervals from the base of the conductor pipe to total depth. Each sample will be divided into five equal portions and properly identified and contained in sample bags.

6. Directional Surveys

Hole inclination surveys will be taken with a single-shot, nondirectional instrument every 100 feet. If deviation becomes excessive (greater than 2° per 1,000 feet), a directional multishot survey will be considered to determine hole orientation.

XI. TECHNICAL AND COST REPORTING

A. Technical Reports

1. Daily Report

A daily written report will be prepared by the on-site F&S representative throughout the field operations phase. The report will be a summary of construction, testing, and/or drilling activities for a 24-hour period beginning at 0800 hours each day. The written report will be provided to the on-site NV Project Engineer by 0830 hours each day and it will be telephoned to the NV Geothermal Branch at (702) 734-3424 by 0900 hours each weekday. An acceptable report format for the drilling phase is shown in Figure 9.

2. Final Reports

- a. Testing and Drilling: F&S will prepare hole histories for OMF No. 7A and OMF No. 1 which include a summary of

DAILY DRILLING REPORT

Date: _____

Day No. _____

Location: OMF No. 7A

Present Operation _____, Hole Size _____, Formation _____
Present TD _____ ft., Drilled from _____ ft. to _____ ft.
Rotating _____ hrs., Trips _____ hrs., Down _____ hrs.,
Hole Survey _____ hrs., Logging/Testing _____ hrs.

Circ. Fluid Temps.: Max. In _____ °F, Max. Out _____ °F

REMARKS:

Rotary Speed _____ rpm, Pump Press. _____ psi, Circ. Rate _____ gpm
Pump(s) on Hole _____ 1 _____ 2, Weight on Bit _____

Mud Weight _____ ppg, Funnel Viscosity _____

Present Bit: No. _____, Type _____, Make _____, Nozzles _____,
Depth In _____, Depth Out _____,
Footage Drilled _____, Hours Run _____,
Condition _____

Drill Collars: Size _____ O.D., _____ I.D., No. in Use _____
Total Weight _____

Bottom-hole Assembly: _____

Figure 9

daily activities, tubular goods records, mud and bit records, logging records, and the "as-built" status of each hole. The report will be due 45 days after completion of the field activities.

- b. Geologic Report: DOGAMI will prepare a comprehensive report to include results and interpretations of scientific data acquired. The report will be submitted in accordance with Contract No. DE-FC07-79ID12044 requirements.

B. Cost Reports

1. Weekly Report

An unofficial written weekly report will be prepared by F&S throughout the field operations phase. It will include both weekly and cumulative costs by subcontracts category standard to the F&S reporting system. One copy of the report will be provided to the NV on-site representative on the first day of each cost-reporting week and one copy will be mailed to the NV Geothermal Branch.

2. Monthly Report

An official monthly cost report will be provided to the Director, NV Finance Division, by the 15th day of the month following the reporting period.

XII. DATA DISSEMINATION

All data acquired from this drilling and testing project will be placed in the public domain in a timely manner in accordance with accepted procedures relative to Government-funded geothermal investigations.

Physical samples such as core, cuttings, and fluids acquired during the drilling and testing project will be available for inspection at the drill site by principal project participants identified in Section II.A., the USGS Water Resources and Geologic Divisions, and certain Government laboratories or state universities as may be identified by the DOE. Portions of core, cuttings, and fluids to be analyzed will be placed in the custody of DOGAMI. Remaining portions will be available to be divided between the NGC, the USGS, the University of Utah Research Institute/Earth Science Laboratory and the Southern Methodist University.

Sufficient field copies of all geophysical logs will be available so that one copy may be provided to each principal project participant during the field operations. Additionally, final prints of all logs will be transmitted to:

Rocky Mountain Well Log Service
P.O. Box 3150
Denver, CO 80201
Telephone: (303) 825-2181

Reproductions of the logs will be available to any interested parties by contacting the above organization.

Formal geologic and drilling history reports will be distributed through the DOE Technical Information Center in Oak Ridge, Tennessee.

Any public announcements associated with this project should be coordinated with the DOE/NV Office of Public Affairs, telephone (702) 734-3521, FTS 598-3521.

APPENDICES

- A. Milestone Schedule
- B. Permits
- C. Engineering Drawings

MT. HOOD GEOTHERMAL DRILLING & TESTING PROJECT

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Approved.
Budget Bureau No. 42-R1424

SUNDRY NOTICES AND REPORTS ON WELLS

(Do not use this form for proposals to drill or to deepen or plug back to a different reservoir. Use Form 9-331-C for such proposals.)

1. oil ☐ well gas ☐ well other ☐ Geothermal

2. NAME OF OPERATOR
Northwest Natural Gas Co.

3. ADDRESS OF OPERATOR
123 N.W. Flanders, Portland, Oregon

4. LOCATION OF WELL (REPORT LOCATION CLEARLY. See space 17 below.)
AT SURFACE:
AT TOP PROD. INTERVAL:
AT TOTAL DEPTH:

16. CHECK APPROPRIATE BOX TO INDICATE NATURE OF NOTICE, REPORT, OR OTHER DATA

REQUEST FOR APPROVAL TO:		SUBSEQUENT REPORT OF:	
TEST WATER SHUT-OFF	☐		☐
FRACTURE TREAT	☐		☐
SHOOT OR ACIDIZE	☐		☐
REPAIR WELL	☐		☐
PULL OR ALTER CASING	☐		☐
MULTIPLE COMPLETE	☐		☐
CHANGE ZONES	☐		☐
ABANDON*	☒		☐
(other) Hydrology testing			

OR 13994
6. IF INDIAN, ALLOTTEE OR TRIBE NAME

7. UNIT AGREEMENT NAME

8. FARM OR LEASE NAME

9. WELL NO.
One

10. FIELD OR WILDCAT NAME
Old Maid Flat

11. SEC., T., R., M., OR BLK. AND SURVEY OR AREA
Sec. 15, T2S, R8E

12. COUNTY OR PARISH
Clackamas

13. STATE
Ore

14. API NO.

15. ELEVATIONS (SHOW DF, KDB, AND WD)
2750 Feet contour-photo

(NOTE: Report results of multiple completion or zone change on Form 9-330.)

17. DESCRIBE PROPOSED OR COMPLETED OPERATIONS (Clearly state all pertinent details, and give pertinent dates, including estimated date of starting any proposed work. If well is directionally drilled, give subsurface locations and measured and true vertical depths for all markers and zones pertinent to this work.)*

The basic elements of the testing plan are to displace approximately 70 Bbls. of existing drilling mud from the lower 1,000 ft. of open hole with fresh water, remove existing 2-inch pipe, isolate the lower 800 ft. to 1,000 ft. of hole with open hole packer and tubing, swab about 100 Bbls. of fluid from the hole, and, if possible, continuously pump up to 400 Bbls. of fluid from the hole while measuring flowrate and borehole fluid levels. All drilling mud and produced fluid will be retained in steel tanks during the test. Upon completion of the test all collected fluids will be injected into the borehole. An alternative to injecting into the wellbore will be to haul produced fluids to the nearby quarry in Section 21 and disperse on the ground surface if fluid quality will allow. See back for abandonment plan.

Subsurface Safety Valve: Manu. and Type _____ Set @ _____ Ft.

18. I hereby certify that the foregoing is true and correct

SIGNED [Signature] TITLE Exploration Super. DATE 2/14/80

(This space for Federal or State office use)

APPROVED BY [Signature]
CONDITIONS OF APPROVAL, IF ANY:

TITLE Dist. Super

DATE

FEB 26 '80

CONSERVATION DIVISION
GEOTHERMAL DISTRICT OFFICE

*See Instructions on Reverse Side

FEB 26 1980

SANTA ROSA, CALIFORNIA

Instructions

General: This form is designed for submitting proposals to perform certain well operations, and reports of such operations when completed, as indicated, on Federal and Indian lands pursuant to applicable Federal law and regulations, and, if approved or accepted by any State, on all lands in such State, pursuant to applicable State law and regulations. Any necessary special instructions concerning the use of this form and the number of copies to be submitted, particularly with regard to local, area, or regional procedures and practices, either are shown below or will be issued by, or may be obtained from, the local Federal and/or State office.

Item 4: If there are no applicable State requirements, locations on Federal or Indian land should be described in accordance with Federal requirements. Consult local State or Federal office for specific instructions.

Item 17: Proposals to abandon a well and subsequent reports of abandonment should include such special information as is required by local Federal and/or State offices. In addition, such proposals and reports should include reasons for the abandonment; data on any former or present productive zones, or other zones with present significant fluid contents not sealed off by cement or otherwise; depths (top and bottom) and method of placement of cement plugs; mud or other material placed below, between and above plugs; amount, size, method of parting of any casing, liner or tubing pulled and the depth to top of any left in the hole; method of closing top of well; and date well site conditioned for final inspection looking to approval of the abandonment.

GPO : 1976 O - 214-149

Plug and abandon the hole as follows:

Spot a 100 ft. cement plug from about 1500 ft. to 1400 ft., WOC and verify cement top by tagging with tubing, spot a 100 ft. cement plug from 200 ft. to 100 ft., WOC and verify top with tubing, spot a 20 ft. cement plug at the surface. Remove cellar timbers and backfill.

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

APPLICATION FOR PERMIT TO DRILL, DEEPEN, OR PLUG BACK

1a. TYPE OF WORK

DRILL ☒DEEPEN ☐PLUG BACK ☐

b. TYPE OF WELL

OIL

WELL ☐

GAS

WELL ☐

OTHER Geothermal

SINGLE

ZONE ☐

MULTIPLE

ZONE ☐

2. NAME OF OPERATOR

Northwest Natural Gas Co.

3. ADDRESS OF OPERATOR

123 N.W. Flanders, Portland, Oregon 97209

4. LOCATION OF WELL (Report location clearly and in accordance with any State requirements.)

At surface

Section 15AC, T2S,R8E (2460' south of north line, 2091' west of
At proposed prod. zone east line)

14. DISTANCE IN MILES AND DIRECTION FROM NEAREST TOWN OR POST OFFICE*

NE of Zig Zag - 8 miles

15. DISTANCE FROM PROPOSED*

LOCATION TO NEAREST

PROPERTY OR LEASE LINE, FT.

(Also to nearest drg. unit line, if any)

16. DISTANCE FROM PROPOSED LOCATION*

TO NEAREST WELL DRILLING COMPLETED

OR APPLIED FOR, ON THIS LEASE, FT.

2460' from the N.
boundary.Approx. 2200'
N.NE of OMF #1

17. NO. OF ACRES IN LEASE

2560

18. DEEPEST LIMIT

5000'

19. NO. OF ACRES ASSIGNED
TO THIS WELL

None

20. ROTARY OR CABLE TOOLS

Rotary

21. ELEVATIONS (Show whether DF, RT, GK, etc.)

2760

22. APPROX. DATE WORK WILL START*

July 15, 1980

PROPOSED CASING AND CEMENTING PROGRAM

SIZE OF HOLE	SIZE OF CASING	WEIGHT PER FOOT	SETTING DEPTH	QUANTITY OF CEMENT
26"	16"	65.0, H-40	Max. 100'	To Surface (100 cu. ft.)
14-3/4"	10-3/4"	40.5, K-55	1000'	To Surface (725 cu. ft.)
9-7/8"	7-5/8"	26.4, K-55	3200'	1,000 cu. ft.

Above quantities based upon 30% excess

1. Drill 26-in. hole to minimum depth of 40 ft. Set and cement 16-in. conductor pipe from T.D. to surface.
2. Install 16-in., series 600, rotating head, and drill 14 3/4-in. hole to a minimum depth of 600 ft. using rotary mud drilling techniques.
3. Set and cement 10 3/4-in. casing from T.D. of 14 3/4-in. hole to surface.
4. Install 10-in., series 600, double gate BOP and 10-in., series 600, annular BOP, and drill 9 7/8-in. hole to about 3,200 ft. using mud as circulating medium. Core as determined necessary.
5. Switch to water as circulating medium; continue 9 7/8-in. hole to a minimum depth of 4,000 ft. and a maximum of 6,000 ft. Core and conduct aquifer tests as determined necessary.
6. If warranted, run and cement 7 5/8-in. liner from about 3,200 ft. to 800 ft.

* ABOVE SPACE DESCRIBE PROPOSED PROGRAM: If proposal is to deepen or plug back, give main or, present productive zone and proposed new production zone. If proposal is to drill or deepen directionally, give pertinent data on subsurface location and new or old and true vertical depth. Give any casing program, if any.

SIGNED

Exploration Supervisor

(This space for Federal or State official use)

DATE

APPROVED BY

FOR DEPOSITION OF OFFICIAL USE ONLY

1069 State Office Building, Portland, Oregon 97201

APPLICATION FOR PERMIT TO DRILL A GEOTHERMAL WELL

(To be accompanied by a ~~\$25.00~~ permit fee for new wells only and a surety bond conditioned as provided by law.)

Portland, Oregon February 15, 1980

RECEIVED PTLD
FEB 28 1980

Department of Geology and Mineral Industries
Portland, Oregon 97201

In compliance with rules and regulations pursuant to ORS 522 (Chapter 776 OL 1971) application is hereby made for permit to drill

a (new well / prospect well): Northwest Natural Gas Co. OR 13994
(company or operator) (lease)
Well No. 7A in NE 1/4 of sec. 15, T. 2S, R. 8E W. B. & M.,
Old Maid Flat Field, Clackamas County.

This well is 2460 feet (N) (S) of the N line and 2091 feet
(E) (W) of the E line of Sect. 15.

(Give location from section or other legal subdivision lines or corners; cross out wrong directions.)

Elevation of ground above sea level is 2760 feet. All depth measurements are taken from
top of Surface csg., which is 0 above ground.

The lessee is Northwest Natural Gas Company

Address _____

Section of land
Area 640 acres

The lessor is _____

LOCATE WELL CORRECTLY Address _____

We propose to use the following strings of casing and to land or cement them as herein indicated:

Size of hole	Size of casing	Weight in pounds per foot	Grade and type	New or second hand	Depth	Landed or cemented No. sacks cement
26"	16"			New	Max. 100'	To Surface
14-3/4"	10-3/4"	40.5 #/ft	K55	New	1000'	200 ft. 3
9-3/4"					800' to 3200'	
9-3/4"	7-5/8"	26.4 #/ft	K55	Liner	800' to 3200'	W/packers

Method of drilling: rotary X, cable _____, other _____.

Proposed objectives:

Drill and test structure and fluids to 5000'. The liner will be run if required to complete testing.

Approved April 2, 1980
except as follows _____

DEPT. OF GEOLOGY & MINERAL INDUS.

By Sharon C. Newby Director

Petroleum Engineer

Northwest Natural Gas Co.

By W.F. Covert, Exploration Supervisor
position _____

Send communications regarding well to:

Name W.F. Covert

Address 123 N.W. Flanders

Portland, Oregon 97209

(Submit in triplicate)

APPENDIX C
ENGINEERING DRAWINGS

TOPOGRAPHIC MAP
GEO THERMAL DRILL
SITE 7A

GRADING PLAN

PLOT PLAN

LEGEND	
---(2772)---	EXST. CONTOUR
---(2760)---	NEW CONTOUR
---	APPROX. LIMITS OF BATH WORK
⊙	EXST. TREE
[]	DRILL PAD AREA
[]	LEVEL DRILL PAD AREA

NOTE:
FOR GENERAL NOTES SEE DRAWING No. C3
FOR PLAN & PROFILE OF ACCESS ROAD SEE DRAWING
No. 79-207-3 & 79-207-4 (NORTHWEST GEOTHERMAL
CORPORATION)

NO.	DATE	REVISIONS	BY	CK	A.E.	APP.
U.S. DEPARTMENT OF ENERGY						
NEVADA OPERATIONS OFFICE LAS VEGAS, NEVADA						
DESIGNED: C. POSTER						
DRAWN: R. COLLINS						
CHECKED: [Signature]						
PROJECT ENGINEER: [Signature]						
SUBMITTED: [Signature]						
HOLMES & NARVER INC. ENGINEERS-CONSTRUCTORS						
2753 SOUTH HIGHLAND DRIVE LAS VEGAS, NEVADA						
I.D. NO. 36200						
DRAWING NUMBER JS-095-094-C2						
SHEET 1 OF 2

SECTION A
SCALE: HORIZ. 1"=20'
VERT. 1"=5'

SECTION B
SCALE: HORIZ. 1"=20'
VERT. 1"=5'

GENERAL NOTES:

- 1- VERTICAL AND HORIZONTAL CONTROL IS BASED ON SURVEY DATA DERIVED FROM PETTIJOHN ENGINEERING CO INC. DWS. NO. 79-207-2.
- 2- REMOVE ALL VEGETATION AND KEY ALL FILL INTO ORIGINAL GROUND. OVEREXCAVATION SHALL BE APPROX. 12" WHERE REQUIRED.
- 3- SCARIFY AND RECOMPACT ALL CUT AREAS A MIN. OF 6" (RELATIVE COMPACTION OF NOT LESS THAN 90%).
- 4- ALL FILL SHALL BE COMPACTED TO A RELATIVE COMPACTION OF NOT LESS THAN 90%.
- 5- 6" THICK ROCK SURFACING SHALL BE OBTAINED FROM A LOCAL ROCK QUARRY LOCATED APPROX. 1 MILE FROM THIS SITE. MATERIAL USED SHALL BE SELECTED FROM EXISTING STOCK PILES, SHALL NOT EXCEED 1 1/2" MAX. IN SIZE AND SHALL BE COMPACTED TO A RELATIVE COMPACTION OF NOT LESS THAN 95%.

NO.	DATE	REVISIONS	BY	CHK	A.E.	APP.
U.S. DEPARTMENT OF ENERGY NEVADA OPERATIONS OFFICE LAS VEGAS, NEVADA						
DESIGNED: C. FOSTER DRAWN: R. COV CHECKED: CP PROJECT ENGINEER: C. FOSTER		GEOHERMAL WELL OLD MAID FLATS SITE WELL No. 7A SECTIONS				
SUBMITTED: [Signature] HOLMES & HARVER INC.		AGENCY APPROVAL:		BOE APPROVAL:		DATE:
HOLMES & HARVER INC. ENGINEERS-CONSTRUCTORS 2783 SOUTH MIDLAND DRIVE, LAS VEGAS, NEVADA		I.D. NO. 36200		DRAWING NUMBER JS-095-094-C3		
SHEET 2 OF 2

PLAN
SCALE - 1" = 20'

- NOTE:
1. VERTICAL DATUM (U.S.C. & G.S.) AND HORIZONTAL DATUM (OREGON GRID - NORTH ZONE) WERE DERIVED FROM BONNEVILLE POWER ADMINISTRATION TRANSMISSION LINE SURVEY FOR THE 'BIG EDDY - TROUTDALE LINE' SHOWN ON B.P.A. DRAWINGS 125062 THRU 125067 TITLED 'JOHN DAY - KEELER NO. 1.' LOCAL HORIZONTAL CONTROL FOR THIS DRAWING ORIGINATES WITH OREGON GRID COORDINATES AT B.P.A. STATION 2546+50.9. FOR OREGON GRID APPLY COMBINED FACTOR 0.9997673.
 2. VERTICAL CONTROL IS DERIVED FROM B.P.A. TOWER 43/4, STATION 2567+15' WORKING POINT ELEVATIONS BASED ON U.S.C. & G.S. DATUM.
 3. CONTOUR INTERVAL: ONE (1) FOOT & TWO (2) FOOT

REGISTERED
PROFESSIONAL
LAND SURVEYOR
R.A. Farnsworth
OREGON
R.A. FARNSWORTH
243

79-207-3

DATE	REVISION	BY

NORTHWEST GEOTHERMAL CORPORATION

TOPOGRAPHIC SURVEY

ACCESS ROAD ROUTE TO WELL 7A
SANDY RIVER - RAMONA CR. CROSSING
SECTION 15 T.25., R.B.E. N.M.
CLACKAMAS CO. OREGON

Pettijohn Engineering Co. Inc.
ENGINEERS, PLANNERS & SURVEYORS
PORTLAND, OREGON BELLEVUE, WASHINGTON

DRAWN BY: RJB CHKD BY: RAI DRW. NO. 79-207-3
SCALE AS SHOWN DATE: DEC 20 1979

REGISTERED
PROFESSIONAL
LAND SURVEYOR
R.A. Johnson
CLACKAMAS CO. OREGON

79-207-4

DATE	REVISION	BY

NORTHWEST GEOTHERMAL CORPORATION

TOPOGRAPHIC SURVEY

ACCESS ROAD ROUTE TO WELL 7A
SANDY RIVER - RAMONA CR. CROSSING
SECTION 15 T.2S., R.8E., N.M.
CLACKAMAS CO. OREGON

Pettijohn Engineering Co. Inc.
ENGINEERS, PLANNERS & SURVEYORS
PORTLAND, OREGON BELLEVUE, WASHINGTON

DRAWN BY: R.J.B.	CHECKED BY: R.A.J.	DRW NO: 79-207-4
SCALE AS SHOWN	DATE DEC 21, 1978	