Box 13
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MARYSVILLE GEOTHERMAL PROJECT

PLAN AND ESTIMATE FOR PLUGGING AND ABANDONMENT OF THE DEEP WELL

July 1975

Prepared for

BATTELLE PACIFIC NORTHWEST LABORATORIES

S-73017-03

Pursuant to: Special Agreement B-776
Sponsor Agreement 211B01410
National Science Foundation

ROGERS ENGINEERING CO., INC.
ENGINEERS & ARCHITECTS
111 PINE STREET
SAN FRANCISCO, CALIF. 94111

Donated By:
Herbert Rogers Jr.
Rogers Engineering Co.

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ROGERS ENGINEERING CO., INC.
ENGINEERS & ARCHITECTS
111 PINE STREET
SAN FRANCISCO, CALIF. 94111, TEL. (415) 986-6546

In reply refer to: S-73017-03

24 July 1975

Battelle Pacific Northwest Laboratories
Battelle Boulevard
Richland, Washington 99352

Attention: Dr. William R. McSpadden

Subject: Plan and Estimate for Plugging and Abandoning Marysville Geothermal No. 1 Well and Rehabilitation of the Site

Gentlemen:

Pursuant to the letter from Dr. McSpadden dated June 16, 1975 and to his earlier verbal authorization, we are pleased to submit the enclosed plan and cost estimate for the plugging and abandonment of the Marysville Geothermal No. 1 Well, and for the restoration of the well site.

The plan and estimate are based on the following references and consultations:

1. The chart by Battelle showing the changes in flow conditions in the Marysville well through April 23, 1975, was received on June 25. This information was used in designing the plugging plan and was used as support data in the submission of the plan to the U. S. Geological Survey.

2. The U. S. Geological Survey's recent publication, "Geothermal Resources Operational Order No. 3: Plugging and Abandonment of Wells" was analyzed with reference to the conditions in the Marysville well. A plugging plan was then prepared and submitted to Mr. Reid Stone, U. S. G. S. Regional Geothermal Supervisor at Menlo Park, California, for his consideration. The comments and requirements of the Geothermal Supervisor have been incorporated into the plan as submitted herewith.

3. Verbal consultation by phone was held with Mr. Judson Sweet, State Petroleum Engineer of the Montana Oil and Gas Commission. Mr. Sweet stated that his agency will not act directly in considering a plan for plugging and abandonment, inasmuch as they did not issue the permit for the well. However, his agency will serve as advisor to the State Land Department, which did issue the permit, and in that context will be commenting on the proposed plan.

   Mr. Sweet listed the specifics of his agency's requirements, and they are in all cases either equal to, or less severe than, the U. S. G. S. requirements. We believe, therefore, that the Montana Oil and Gas Commission will recommend approval of the enclosed plan when asked for comment by the Montana Land Department, although the short time alloted for preparing this report has precluded our getting this assurance in writing.

Rogers

Battelle Pacific Northwest Laboratories
Richland, Washington 99352
Subject: Plan and Estimate for Plugging and Abandoning Marysville Geothermal No. 1 Well

17 July 1975
Rogers Ref.: S-73017-03

4. Mr. John Fields, District Manager of the U. S. Bureau of Land Management, Missoula, Montana, was asked for a listing of his agency's requirements on rehabilitation of the well site. These requirements were given verbally by phone before June 30, and confirmed in writing with a letter and list titled "Rehabilitation of Geothermal Test Well-Empire Creek", dated July 8, 1975.

   The B. L. M. requirements are incorporated in the attached plan and estimate, with one exception: It is assumed that the oil clean-up and tree removal cited in the B. L. M. letter will have been completed earlier, and the cost of that work is not included in this estimate.

5. The Montana Power Company was contacted to affirm the current status and close-out requirements with respect to the electric power service at the well site.

   Montana Power Company stated that: (1) The only charge for additional use of power during the well plugging work will be for the power used, and (2) There will be no additional charge for removal of the poles and wire back to Empire Mine when the site is abandoned.

6. Various oil well service contractors were solicited for price quotations on the requisite equipment and services in the active drilling areas closest to Marysille (Cutbank and Roundup in Montana and the Williston Basin in North Dakota).

The enclosed estimate of costs is based on current prices as of June 30, 1975. If the work is not to be done until the summer of 1976, it will be necessary to adjust the cost estimate to reflect whatever increment of cost inflation actually occurs in the drilling service industry over the coming year.

Six (6) copies of the Plan and Estimate are enclosed.

When testing in the well is finished and the decision is made to proceed with the plugging and abandonment work, we shall be pleased to perform any of the engineering and management tasks for which you may desire our services.

Very truly yours,

ROGERS ENGINEERING CO., INC.

Winston F. Bott

Winston F. Bott
Project Manager

WFB:bg

Enclosures: As Noted Above

Rogers

PLAN AND ESTIMATE FOR PLUGGING, ABANDONMENT AND SITE REHABILITATION OF THE MARYSVILLE (MONTANA) GEOTHERMAL WELL NO. 1

1.0 ASSUMPTIONS, CONDITIONS AND PARAMETERS

1.1 Water Flow Conditions in the Hole

1.1.1 Flow Below the Casing. The water flow history in the well through April 23, 1975 indicates that low-pressured zones deep in the hole may be gradually filling with water flowing down from the aquifers between 1,800 feet and 3,500 feet. If this action continues, the flow conditions below the 9-5/8 inch casing shoe at 4,256 feet may have completely stabilized by summer 1976. If so, this will give reasonable assurance that a good plug spanning this shoe will be obtained.

1.1.2 Flow Behind the 9-5/8 Inch Casing. The fracture zones and aquifers between 1,326 feet and 4,256 feet have been blocked off by the 9-5/8 inch casing ever since it was set, and have therefore not been observed for possible hydraulic inter-action among them during the subsequent series of tests in the hole.

Therefore it is assumed here that, after the 9-5/8 inch casing is pulled, Battelle will want to make some flow meter observations in this segment of the hole prior to setting the final plugs above. Accordingly, the cost estimate includes the cost of a run of tracer flow tests by Schlumberger.

1.2 Casing Recovery

The 9-5/8 inch casing was only "tacked" at the bottom with enough cement to fill 700 feet of the annulus, or from 4,256 feet up to about 3,500 feet. The large water flow in the hole prevented getting a competent cement job, so a check for the "free point" may show more than 3,500 feet of this casing can be recovered.

However, even if a pull on this casing showed it to be free all the way to the shoe, a stub would have to be left in the hole, since the packer shoe will not pass through the 13-3/8 inch casing above.

In the cost estimate we have assumed recovery of 3,800 feet of this 9-5/8 inch casing.

1.3 Blow-Out Preventor Requirement

The U. S. Geological Survey regulations (Reference 2 in the attached letter) require that blow-out prevention equipment be attached to the 13-3/8 inch casing head during this casing pulling and plugging operation. In view of the drilling history and the subsequent observations in the well which indicate the absence of hazardous pressures, Rogers Engineering requested a waiver of this requirement.

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However, the Geothermal Supervisor concluded that some unknown factors may still exist in the hole when this activity takes place, therefore, his office is not inclined to waive the B. O. P. requirement.

At such time in the future as the decision is made to proceed with this work, it may be useful to re-open this question with the U. S. G. S. Additional data from future observations in the well may conclusively eliminate the possibility of existence of hazardous pressure conditions to the satisfaction of the U. S. G. S., so that the added expense of the B. O. P. equipment could be saved.

The cost estimate includes allowance for rental of a double-gate blow-out preventor, including freight both ways, and the cost of blocking up the service rig high enough to accommodate the B. O. P.

1.4 Mud Plugs in the Open Hole

The U. S. G. S. regulations (reference 2 in the attached letter) require that the open hole section of the well shall be left filled with a non-setting gel type of temperature resistant mud, if possible.

Given the water flow conditions in the hole to date, the mud plugs may not be effective; however, the chance of success can be optimized by using lost-circulation materials in the mud mix.

The cost estimate provides for the required mud chemicals, and for the well service contractor to furnish the mud mixing tank and pump.

1.5 Cement Plugs

The location and sizes of the cement plugs are shown in the attached drawing "Well Profile - Plan for Plugging". The plan calls for expandable open-hole type packers under the two casing shoe plugs. These add a considerable item of cost but, since it is uncertain that the mud plugs below will resist penetrating into the thief zones, the packers are considered necessary to prevent the cement plugs from moving down the hole.

The cost estimate is based on using Halliburton's cementing service out of Roundup, Montana, and the Lynes packer service out of Billings, Montana. Other companies offering the same services are too far away to be competitive.

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1.5.1 Testing Cement Plugs

The U. S. G. S. regulations (reference 2 in the attached letter) require that the plugs at the shoe of the 9-5/8 inch casing stub and at the shoe of the 13-3/8 inch casing shall be tested after the cement has set. The procedure is to "feel" for the top of the plug by touching it with the tubing or drill pipe being used on the service rig, and then exerting 15,000 lbs. of weight to test the bond of the cement plug to the wall of the hole.

1.6 Water for Cement and Mud Plugs

The water requirement for running the mud plugs and the cement plugs can be satisfied either from Empire Creek, if permitted, or from the project's existing water well. (See the B. L. M. requirements in Reference 4).

If it is necessary to use only water from the well, Montana Power Company will restore power service upon request, and Lindsay Well Drilling of Clancy, Montana will re-install the Project's pump and pressure tank system for this purpose. The well equipment is in storage in Lindsay's yard in Clancy.

It probably will not be necessary to use the pond for storage, as a 300 bbl. water storage tank is included in the estimate for service rig costs. The service rig will not work around the clock, so the well pump can fill up the rig's storage tank overnight.

If use of Empire Creek water is permitted, the cost of pumping will be lower than the cost estimated for using the water well, unless wiers are required to measure the amount of creek water used. If wiers are required, the well should be used due to its lower cost.

1.7 Site Restoration

The requirements and standards for restoration of the site are adequately recorded in the B. L. M. letter dated July 8, 1975. (Reference 4 in the attached letter)

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2.0 PROCEDURE FOR PLUGGING WELL

(1) A service ("work-over") rig will be hired out of either Cutbank or Roundup, equipped with a minimum derrick capacity of 150,000 lbs, at least 6,500 feet of 2-7/8" tubing or drill pipe, a 300 bbl. water storage tank, and a 300 bbl. mud tank.

(2) A hydraulic casing-pulling rig and crew will be hired, probably out of Williston, North Dakota.

(3) After the service rig is in place over the hole and the B. O. P. equipment installed, tubing (or drill pipe) will be run to the bottom at 6,425 feet and a mud plug, with lost circulation material, will be spotted from 6,425 feet up to 4,700. The Halliburton pump truck can be used to pump the mud, thus the service rig does not need a mud pump.

(4) Next the open-hole packer for 7-7/8 inch hole will be set at 4,700 feet and Plug No. 1 (see attached plan) will be run from the packer to approximately 100 feet above the shoe of the 9-5/8 inch casing - a total of 550 feet.

The cement mix must have thixotropic properties to resist movement into the formations.

(5) After waiting for the cement to set, the tubing (or drill pipe) will be run back in to locate the top of cement, and 15,000 lbs. of weight will be exerted on the top of the plug for a test.

(6) The hydraulic casing-puller will then be moved in under the mast.

(7) The "free point" of the 9-5/8 inch casing will be determined, after which Halliburton's hydraulic jet cutter will be used to cut the casing just above the "free point".

(8) The hydraulic casing puller crew will raise the free string of casing and break out the collars, and the service rig will lay down the individual joints of pipe for loading out.

(9) Cement Plug No. 2 will then be run spanning the top of the casing stub as shown on the drawing. It is not necessary to "feel" for this plug.

(10) Schlumberger will then move in and run the tracer flow meter tests in the newly exposed open hole from the top of Plug No. 2 up to the shoe of the 13-3/8 inch casing.

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(11) At this time the remaining fluids in the reserve pit (sump) will be pumped into the well.

(12) Based on the flow tests, a judgment should be made at this time whether to try to place the mud plug in this upper segment of open hole. If there is substantial flow in the hole, the mud plug should not be attempted. If flow is not significant, the mud plug will then be run from the top of Plug No. 2 up to 1,426 feet (100 feet below 13-3/8" casing shoe).

(13) The open-hole packer for 17-1/2 inch hole will then be set at 1,426 feet and Cement Plug No. 3 will be run from the packer up to 100 feet above the 13-3/8 inch casing shoe.

(14) After the cement plug has set, the top will be located and tested in the same manner as for Plug No. 1.

(15) If not already full to the surface, the 13-3/8 inch casing will be filled with water. Then the surface plug, No. 4, will be run in, filling the top 50 feet of the casing, and overflowing to fill the cellar with cement up to the top of the 13-3/8 inch pipe.

(16) The service rig will be moved off and returned to base.

(17) The cellar will be prepared for abandonment as follows:

(a) Weld a steel plate across the top of the 13-3/8 inch casing.

(b) Cut a drain through the wall of the concrete cellar flush with the top of the cement inside the walls.

(c) Fill balance of cellar with dirt, plus two feet of cover, during the restoration grading of the site.

NOTE: The U. S. G. S. desires to observe the testing of the two cement plugs at the casing shoes (Plugs No. 1 and No. 3). Accordingly, the District Geothermal Supervisor in Salt Lake City, Utah, should be notified of the schedule for this work.

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3.0 COST ESTIMATE

3.1 Cost of Plugging Well

(1)	Service Rig and Crew, on Day Work	$12,000
(2)	Casing Crew and Hydraulic Pulling Rig	9,500
(3)	Blow-out Preventor, Rental and Freight	1,400
(4)	Schlumberger Flow-Meter Run	2,100
(5)	Cut Casing (Halliburton)	1,500
(6)	Open-Hole Packers (2) including Service Engineer	3,900
(7)	Halliburton Cementing Service	6,200
(8)	Cement, including freight	2,900
(9)	Mud Chemicals and Service	1,800
(10)	Pump Sump Water into Hole	500
(11)	Mixing Water for Mud and Cement	500
	Total Cost of Plugging Well	$42,300

3.2 Cost of Site Rehabilitation

(1)	Pump Out Septic Tank		$ 100
(2)	Remove Power Line - No Charge		0
(3)	Remove Plastic Sump Liner Above Fill Line		
	Removal Cost	$200	
	Salvage Value as Irrigation Ditch Liners	(200)	
	Net Cost		0
(4)	Revegetation		1,000
(5)	Fill Sump and Regrade Site per B. L. M. Letter		17,900
	Total Cost of Site Restoration		$19,000

3.3 Cost of Engineering and Management

(1)	Engineering and Management	$ 6,500
(2)	Travel Expense, per diem	1,000
(3)	On Site Auto Expense	1,200
(4)	Miscellaneous Expense	300
	Total Cost of Engineering and Management	$ 9,000

3.4 Credit from Sale of 9 5/8 Inch Casing

Net of Freight and Handling (conservative estimate) - 3,800 feet @ $8.00 per foot	($30,400)

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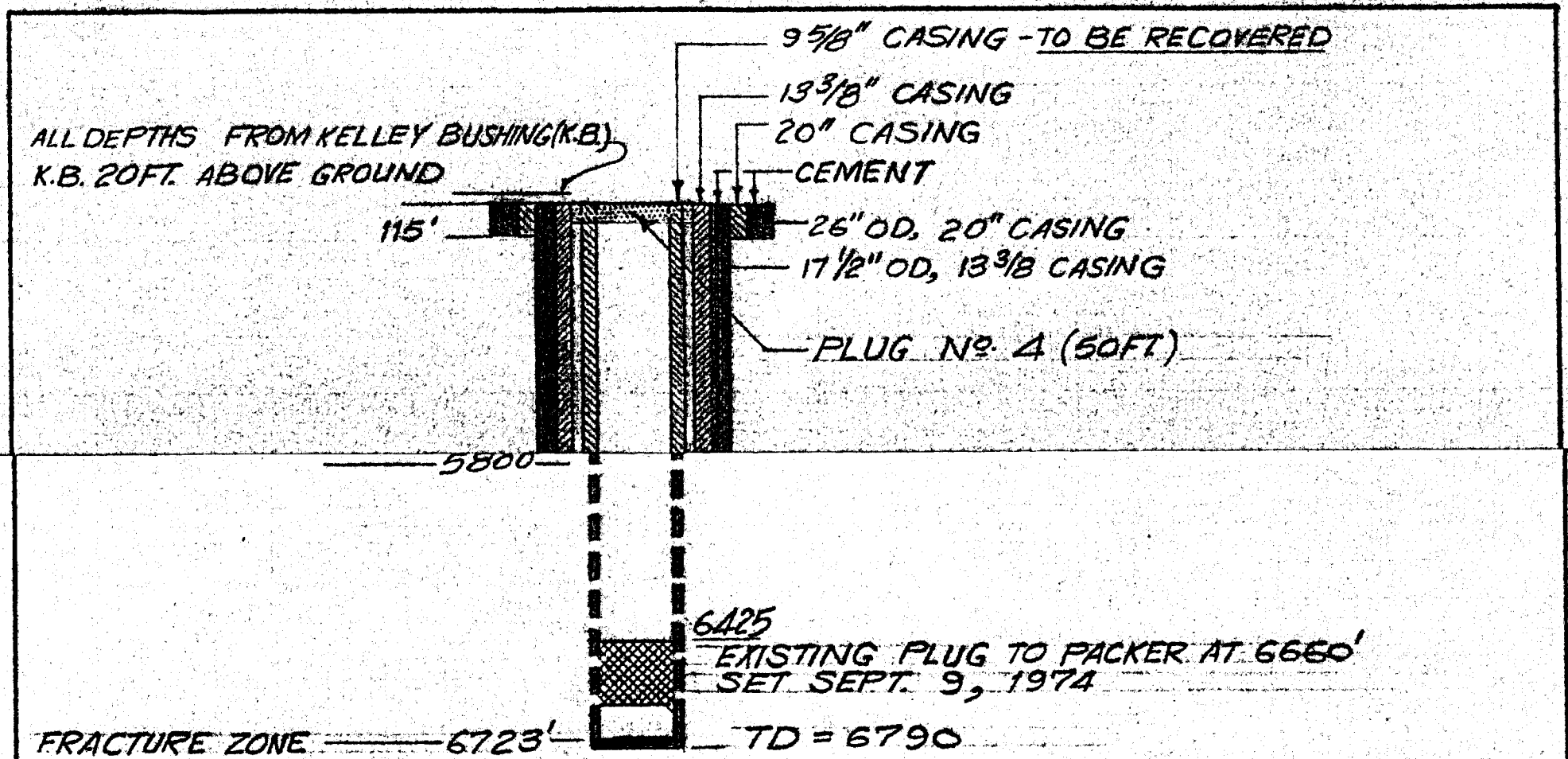
3.5 Cost Estimate Summary

Cost of Plugging Well (Paragraph 3.1)	$42,300
Cost of Site Rehabilitation (Paragraph 3.2)	19,000
Cost of Engineering and Management (Paragraph 3.3)	9,000
Total Cost	$70,300
Less Credit for Casing Sale (Paragraph 3.4)	(30,400)
Net Total Cost	$39,900



MARYSVILLE GEOTHERMAL NO. 1

WELL PROFILE - PLAN FOR PLUGGING

ROGERS ENGINEERING CO., INC.
ENGINEERS & ARCHITTCTS
111 PINE STREET
SAN FRANCISCO. CALIF. 94111

ENG. W.F.B.	PROJ. NO. S-73017-03
APPROVED	DATE. JULY/18/1975

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
CONSERVATION DIVISION

GEOTHERMAL RESOURCES OPERATIONAL ORDER NO. 3

Effective February 1, 1975

PLUGGING AND ABANDONMENT OF WELLS

This Order is established pursuant to the authority prescribed in 30 CFR 270.11 and in accordance with 30 CFR 270.14 and 270.45. The lessee shall comply with the following minimum plugging and abandonment procedures for all geothermal resources wells. Oral approvals shall be in accordance with 30 CFR 270.11. All variances from the requirements specified in this Order shall be subject to approval pursuant to 30 CFR 270.48. Each Sundry Notice (Form 9-331) shall include a notation of any proposed variances from the requirements of this Order. References in this Order to approvals, determinations or requirements are to those given or made by the Area Geothermal Supervisor (Supervisor) or his delegated representative.

The lessee shall promptly plug and abandon any well on the leased land that is not in use or demonstrated to be potentially useful. No well shall be abandoned until its lack of capacity for further profitable production of geothermal resources has been demonstrated to the satisfaction of the Supervisor. No well shall be plugged and abandoned until the manner and method of plugging have been approved or prescribed by the Supervisor.

Cement used to plug any geothermal resources well, except that cement or concrete used for surface plugging, shall be placed in the hole by pumping through drill pipe or tubing. Such cement shall consist of a high temperature resistant admix, unless this requirement is waived by the Supervisor in accordance with the particular circumstances existing in that well or area.

Prior to commencing abandonment operations, the Supervisor shall be notified of all such proposed operations.

Each Sundry Notice (Form 9-331) shall include all information required under 30 CFR 270.45 and 270.72. Any bond or rider thereto covering a lease or an individual well thereon, shall remain in full force and effect until the lease or individual well is properly abandoned and the surface properly restored. Written approval of the abandonment must be obtained from the Supervisor before release of any bonds will be recommended.

1. Permanent Abandonment.

A. Uncased Hole. In uncased portions of wells, cement plugs shall be placed to protect all subsurface mineral resources including fresh water aquifers. Such plugs shall extend a minimum of 30 metres

(100 feet) below, if possible, and 30 metres (100 feet) above such aforementioned zones. Cement plugs shall be placed in a manner necessary to isolate formations and to protect the fluids in such formations from interzonal migration or contamination.

B. Open Hole. Where there is open hole (uncased and open into the casing string above), a cement plug shall be placed in the deepest casing string by either (1) or (2) below. In the event lost circulation conditions exist or are anticipated, or if the well has been drilled with air or other gaseous substance, the plug shall be placed in accordance with (3) below.

(1) A cement plug shall be placed across the shoe extending a minimum of 30 metres (100 feet) above and 30 metres (100 feet) below; or

(2) A cement retainer with effective back pressure control set approximately 30 metres (100 feet) above the casing shoe with at least 61 metres (200 feet) of cement below the retainer and 30 metres (100 feet) of cement above.

(3) A permanent bridge plug set at the casing shoe and capped with a minimum of 61 metres (200 feet) of cement.

C. Perforations, Junk, Fish and Collapsed Pipe. A cement plug shall be placed across production perforations, extending 30 metres (100 feet) below (where possible) and 30 metres (100 feet) above the perforated interval. When a cement retainer is used to squeeze cement the perforated interval, the retainer shall be set a minimum of 30 metres (100 feet) above the perforations. Where the casing contains perforations at or below fish, junk or collapsed casing, thereby perventing cleanout operations, a cement retainer shall be set at least 30 metres (100 feet) above such point, and the interval below the retainer shall be squeeze cemented.

D. Casing Shoes, Stubs, Laps, and Liners. No casing shall be cut and recovered without first obtaining the written approval of the Supervisor. A cement plug shall be placed across all casing stubs, laps, liner tops and all casing shoes not protected by an inner casing string. Such plug shall extend a minimum of 15 metres (50 feet) below and 15 metres (50 feet) above any such shoe, stub, lap or liner top.

E. Plugging of Annular Space. All open annuli extending to the surface shall be plugged with cement.

F. Surface Plug. The innermost casing string which reaches ground level shall be cemented or concreted to a minimum depth of 15 metres (50 feet)measured from 2 metres (6 feet) below ground level.

G. Testing of Plugs. The hardness and location of cement plugs placed across perforated intervals and at the top of uncased or open hole shall be verified by setting down with tubing or drill pipe a minimum of 6,803 kilograms (15,000 pounds) weight on the plug or the maximum weight of the available tubing or drill pipe string, if less than 6,803 kilograms (15,000 pounds).

H. Mud. The intervals of the hole not filled with cement shall be filled with good quality heavy mud.

1. Surface Restoration. All casing strings shall be cut off at least 2 metres (6 feet) below ground level and capped by welding a steel plate on the casing stub. Cellars, pads, structures and other facilities shall be removed. The surface area shall be restored as specified by the Supervisor in consultation with the appropriate surface management agency.

2. Temporary Abandonment. An uncompleted drilling well that is to be temporarily abandoned shall be mudded and cemented as required hereinabove for permanent abandonment except for the provisions of subparagraphs E, F, and I.

3. Suspended Wells. The drilling equipment shall not be removed on any geothermal resources well where drilling operations have been suspended, either temporarily or indefinitely, without prior approval of the Supervisor and after approved measures have been taken to close the well and to protect all subsurface resources, including fresh water aquifers.

Reid T. Stone
Area Geothermal Supervisor

Approved:

Russell G. Wayland,
Chief, Conservation Division

REFERENCE NO. 4

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
DISTRICT OFFICE
P. O. Box 4427
Missoula, Montana 59801

Mr. Winston Bott
Rogers Engineering Col, Inc.
16 Beale Street
San Francisco, California 94105

Dear Mr. Bott:

The rehabilitation plan for the Empire Creek Geothermal Well Site is enclosed. You should arrange to do the final oil cleanup as soon as possible. This will include removal of all oil-filled absorbant pads now on the site and use additional pads, as necessary, to remove the remaining traces of oil. Several large trees next to the fence on the upstream side of the site have fallen into the creek and should be removed. Some minor repairs are needed on the fence, and should require only some barbed wire and steel fence posts.

We expect that all the work, other than the plugging of the well and removal of the power line, would be accomplished prior by the fall of 1976. It appears that all of the other items could be done if some work was ongoing on the well (USGS study).

Let us know when the work on the oil pads, fencing, etc., is complete.

Sincerely yours,

John F Fields

District Manager

Enclosure - 1
Enc - Rehab. plan

cc: Battelle Northwest Laboratories

Rogers Engineering Co., Inc.
SAN FRANCISCO
RECEIVED
JUL 14 1975

PROJ. MGR._____
JOB NO._____

CONSERVE AMERICA'S ENERGY

Save Energy and You Serve America!

REHABILITATION OF GEOTHERMAL TEST WELL - EMPIRE CREEK

1. Sewage Vaults - Pump dry, replace lids, and cover lids with minimum of two (2) feet of dirt. Revegetate along with rest of site.

2. Fence - Leave in place. Fence will be removed by BLM depending on future management of the area.

3. Utilities - Leave buried phone line in. Remove power line (including poles) back to Empire Mine.

4. Sump Water Disposal - Water remaining in the sump and on the pad next to the sump will be pumped back into the well or used to mix concrete for well-plugging operations. If the concrete work is not to be done before sump burial and regrading, the water must be put into the well.

5. Sump Burial & Grading - After the water is removed, all exposed butyl pit lining is to be cut loose and removed from the site. Then material from the drill pad area will be graded across the sump area so that a minimum of two (2) feet of material covers the cuttings in the sump. This depth will be increased on the back (south) side of the sump to reduce the present 1:1 slope on the south side to at least 1½:1. This material will be taken from the pad area in such a way as to keep slopes on the drill pad under 10 percent. If extra material is required, it can be obtained from old dredging piles east of the drill site. Grading will allow vehicle use to the well casing via both culverts across Empire Creek.

6. Revegetation - All disturbed areas will be scarified to a depth of 10 inches and harrowed until material is friable with no large clods present. Soil testing for fertilizer needs will be done, and fertilizer will be applied as needed. Grass seed will be applied at 24 pounds/A in the following mixture:

Timothy	-	10 lbs/A
Alsike Clover	-	1 lb /A
Orchard Grass	-	7 lbs/A
Hard Fescue	-	6 lbs/A

Mulching should not be necessary. Timing of harrowing and seeding is critical and will be specified by BLM (late fall probably the best.) Revegetation will be accepted if there is at least 30 percent vegetative cover one growing season after seeding.

7. Plugging of Test Well - Cementing to be done to USGS specifications. Entire collar around casing to be filled with concrete. If water from pump area is not used, other sources are Empire Creek or the domestic well on the site. If Empire Creek is used, it must be during a period when all adjucated water rights in Little Prickly Pear Creek are being satisfied (generally prior to June 15 or after September 15.) Advance notice should be given to Mr. William Peppy (Canyon Creek Store owner) who is the water commissioner. If use of creek water will cause a turmoil with creek users, the pond above the site can be used to store water pumped from the domestic well. Weirs will have to be installed above and below the pond to insure normal stream flow.

8. Pond - Leave in present state except for hand scarification and seeding of both slopes, with the same rate of application and seed mixture specified in item #6.

9. Domestic Well - Install threaded cap so that well is readily available for future use.