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CONSERVATION DIVISION
U.S. GEOLOGICAL SURVEY
MENLO PARK, CALIFORNIA

PLAN OF OPERATION
EXPLORATION/DRILLING

Lease Number CA-960
Section 25, T12N, R9W, MDB&M
And Section 30, T12N, R8W, MDB&M

Lease Number CA-953
Section 6, T11N, R8W

The Geysers, Lake County, California

UNION OIL COMPANY OF CALIFORNIA
Geothermal Division
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This plan proposes the improvement of existing roads, the construction of new roads, the construction of well drilling sites, and the drilling and testing of exploratory wells in the above leases. The plan is submitted as a multiple-exploratory well program to facilitate and expedite the processing, approval and execution of future plans and permits. The plan as presented thus has the flexibility necessary to determine the existence, extent, characteristics and performance of the suspected geothermal resource.

Estimated Starting Date: March 15, 1981
Estimated Completion Date: Unknown

January 3, 1980

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UNION OIL COMPANY OF CALIFORNIA
PLAN OF OPERATION: EXPLORATION/DRILLING

UNITED STATES GEOTHERMAL LEASES
CA-960 & CA-953
THE GEYSERS, LAKE COUNTY, CALIFORNIA

A. INTRODUCTION

Union Oil Company of California proposes to conduct an exploratory drilling program in Federal mineral reserves underlying Federal leases CA-960 and CA-953 in the northeast Geysers area. Both leases comprise a total of approximately 905 acres in which steam reserves have not yet been proven. In addition, this Plan of Exploration proposes improvement of existing roads and construction of new roads, as well as the construction of up to six drilling locations, and drilling and testing a sufficient number of wells to prove the existence of a usable steam resource. Union's present goal is to locate and establish steam reserves for a new power plant. If the proposed exploratory project is successful, Union will submit the subsequent Plans of Operation required for review of the proposed development and utilization of the resource and the associated environmental impacts expected.

B. DETAILS OF THE PLAN OF OPERATION

1. Location Description

Attached hereto and made a part hereof is Exhibit A, Maps. Map A-1 is a vicinity map showing the lease area with respect to The Geysers and surrounding areas. Map A-2 is a topographical map, scale 1" = 500', showing the following: The lease boundaries; the location of all existing and abandoned wells; topographic features; and all existing, improved existing and planned access roads. Map A-2 also shows the proposed locations of the following six exploratory well pads: 104-25, 108-25, 99-25, 26-30, 39-30, and a two-well pad 82-6, A.

2. Site and Access Selection and Preparation

a. General Discussion

The proposed well sites are spaced such that optimum resource information can be obtained with a minimum number of wells, as per the criteria listed in Draft GRO No. 5, 2.E (1) (a)-(g).

Attached hereto and made a part hereof is Exhibit B: "Earthwork and Construction Specifications". Exhibit B contains the specifications for drill site and road construction at Union Oil Company's drill sites at The Geysers KGRA. Also included in Exhibit B are engineering drawings for typical road construction and a typical drilling pad layout.

b. Geologic Description

The following is a general geological description of the subject Federal lease areas.

Federal leases CA-960 and CA-953 are underlain by Franciscan formation rocks. The formation is composed mainly of graywacke and greenstone (altered basic volcanic rocks) with subordinate intrusive serpentinite and minor amounts of chert, conglomerate, and various grades of metamorphic rocks. The structural grain of the Franciscan formation is generally northwest trending. An unusual characteristic of the formation is the high degree of tectonic deformation to which it has been subjected. The graywackes, cherts, conglomerates, greenstones,

and metamorphics are generally closely fractured and moderately sheared, while the softer shales and serpentinites are usually crushed and more highly sheared.

The two leases are underlain by three generally northwest trending units. A wide graywacke unit underlies the southwestern portion, an intrusive serpentinite unit underlies the central portion, and another graywacke unit underlies the northeastern portion of the leases.

Major faults in the lease area are thought to be those bounding the serpentinite. Both bounding faults appear to be steeply dipping to vertical. There is no conclusive evidence that either fault is active. U.S. Geological Survey seismic data show a few microearthquakes immediately north of the leases, but they have a nonlinear distribution.

Only a few landslides occur on the leases in this area. A large majority of the landslides that do occur are ancient and inactive with estimated ages in excess of several thousand years. None of the landslides are known to

exist within close proximity of the exploratory well sites.

c. Hydrologic Description

Both leases mainly lie between the northwesterly flowing High Valley and Kelsey Creeks, which have nearly equal drainage areas. The two streams merge immediately north of the lease area.

Meager data is available on near-surface groundwater conditions. Franciscan formation rocks similar to those beneath the leases have been known to yield very little usable groundwater in other areas. The formation is generally classified by the U. S. Geological Survey and California Department of Water Resources as being essentially non-water-bearing. Near surface groundwater in these rocks is contained in and transmitted almost entirely through fracture systems, with little interstitial storage or movement of water.

3. Drilling Program

The wells will be drilled with a rotary drilling rig such as those used in the oil industry. It will be equipped with diesel electric generators, storage tanks, mud pumps, and other normal auxiliary equipment, in addition to geothermal modifications such as diesel driven air compressors. Total diesel consumption will be about 6,800 liters (1,800 gallons) per day.

The drilling program involves drilling a hole to the reservoir formation, including the setting and cementing of surface and intermediate casings. This part of the hole is drilled using a clay-water drilling mud to circulate the rock cuttings to the surface where they are removed by screens. The mud is then recirculated.

Pressures within the vapor-dominated reservoir at The Geysers are sub-hydrostatic and will not support the weight of drilling mud, so that drilling into the reservoir utilizes compressed air to circulate the cuttings to the surface. The air, cuttings, and any steam encountered are diverted through the blowie line to a cyclone separator/muffler. Water is injected into the blowie line to aid in removal of particulates from the steam and air.

4. Completion and Testing

Normally, the wells will be completed open-hole in the production zone with a continuous string of production casing from the top of the production zone to surface.

After completion, the wells will be put on vents large enough to prevent well bore loading and mechanical damage. Vent size is reduced to 1/4" as soon as practicable, at which the vent rate is approximately 227 kg/hr (550 lb/hr).

Tests to provide data for the reservoir evaluation will consist of flow periods up to four days at various rates averaging less than 50,000 kg/hr. The steam will be flowed to the atmosphere through a muffler. All equipment, valves, flanges, and fittings shall meet minimum ASA or API standard specifications.

C. ENVIRONMENTAL CONCERNS

1. Methods for Disposal of Waste Materials

- a. Each well's drilling mud wastes will be disposed of in a mud sump. As described in Section 7 of Exhibit B, each sump will be constructed to the requirements of a Class II-1 disposal site. The lining of the sump will be relatively impervious with a maximum permeability of 1×10^{-6} centimeters per second. The sump shall be abandoned upon completion of drilling operation at the drill site in strict accordance with Section 7.3 of Exhibit B, which is in accordance with requirements of the California Regional Water Quality Control Board, North Coast Region.
- b. Solid waste materials such as paper containers and towels, cardboard containers, metal strapping, etc. will be removed and disposed of by Union Oil at a certified public dump.
- c. Portable chemical sanitary facilities will be used by personnel on the drilling or construction sites. These will be maintained and wastes disposed of by a local contractor.

Permanent sanitary facilities are located at Union's field office.

2. Delineation of Potential Environmental Impacts

a. Physical Characteristics

Geological Hazards - Potential impacts and their mitigating measures are discussed with respect to seismicity induced by production of geothermal fluids, slope stability, and well blowouts.

Seismicity - No active faults are recognized or suspected in the lease area. The nearest known active fault in the immediate region is the Maacama fault, trending northwest through the area east of Healdsburg. The October 1, 1969, Santa Rosa earthquake (M=5.7) is thought to have had its epicenter along the Healdsburg-Rodgers Creek fault which is a southward en echelon continuation of the Maacama fault system. No damage resulted at The Geysers from this earthquake, even though it was felt there.

Several theories exist as to the relationship

between geothermal development and seismic activity. Although a general trend of increased microseismicity with continuing production of geothermal fluids has been observed at The Geysers, there is no factual basis for assuming a direct cause-effect relationship.

E. Majer and T.V. McEvilly state in "Seismological Investigations at The Geysers Geothermal Field", Lawrence Berkeley Laboratory, U.C.B, December 1977, that it is possible that microearthquake activity is related to an expanding steam zone. The presence of increased microseismicity could be construed as positive in that such activity would prevent stress build up causitive of larger earthquakes. Also, in U.S.G.S. Open-File Report 78-798 (Marks, Ludwin, Louie, Bufe, et al), it is shown that generally the seismic activity in The Geysers resembles closely that of surrounding areas in most characteristics, such as magnitude distribution. Therefore, it can be concluded that the probability of seismic environmental impact due to this project is slight.

Land Subsidence - Mr. Ben E. Lofgren, formerly of the U. S. Geological Survey, has conducted vertical and horizontal first order surveys over the Clear Lake-Geysers KGRA since 1973. His latest report, open file paper #78-597, shows cumulative subsidence. Lofgren maintains that subsidence is occurring at the rate of 2 cm/year (0.8 in) between the Collayomi and Mercuryville fault zones. Lofgren concludes that the compressive subsidence in the central production area does not appear to have any environmental implications at present. This would imply that exploratory drilling, testing, and production of wells in the prospective lease areas would not have appreciable subsidence impacts. Rather, earth movements due to landslides, down slope creep, regional and local tectonism, and temperature changes are probably of greater magnitude and importance. (Lofgren, 1973)

Site Stability - Exhibit B, Earthwork and Construction Specifications, details the construction methods that will be used in building the proposed sites and roads. A preliminary review has been made of each site which indicated each site to be free of older landslide and potential stability problems.

Before construction, a detailed site specific geotechnical investigation will be made for it is felt that the application of these methods to the specific locations will effectively mitigate or prevent any site stability problems.

Soils - Impacts of the proposed plan on the soils would be primarily from grading and compaction. Vegetative removal and soil mantle disturbance could lead to accelerated erosion.

The use of good engineering practices for earthwork, drainage, and erosion control, and preparation of drill site pad and road surfaces, as detailed in Section 3, 4, and 6 of Exhibit B, attached hereto, should satisfactorily prevent or mitigate soil erosion within the leasehold.

Air Quality - The potential impacts of the proposed operations are 1) increased suspended particulates from road construction, vegetation removal, and vehicular traffic, 2) particulates generated during air drilling, and 3) production of hydrogen sulfide (H₂S) during drilling and testing. The particulates from construction activities will be mitigated by the use of good

engineering practices as outlined in Exhibit B, and by the wetting-of-dust problem areas when necessary. Particulates generated from drilling will be abated by use of injected water and a cyclone separator/muffler, as detailed in part D5 of this report. Potential impacts from the production of H_2S will be mitigated as required by the Northern Sonoma County Air Pollution Control District. Contingency plans to mitigate the impact of any unusually high H_2S concentration are referred to in Part F of this report.

Noise - Increased noise levels from construction and drilling activities and well testing are a potential impact source. Mitigation of engine noise will be accomplished through the use of mufflers on the air compressor and drilling rig engines. Noise during air drilling will be abated by the cyclone muffler/separator described in part D5 of this report. Noise from drilling operations, even though of only 45 to 60 days duration, will be abated to a Ldn level of 65 dB(A) at a distance of 0.80 km (0.5 mile).

Water - The proposed locations are in the

drainage basin of High Valley and Kelsey Creeks. Measures to prevent or mitigate potential impacts on stream and groundwater quality are detailed in part D3 of this report.

Vegetation - The principal impact on vegetation will occur from the grading of well pad and access roads. Five of the six drilling pads will accommodate one well on Federal leases CA-960. There will be a two-well location on lease CA-953.

Environmental Impact Report for McCulloch Oil, Francisco Leasehold in 1975, and Burmah Oil, Wildhorse Leasehold in 1975, were looked at for rare and endangered plants. (Both reports found no rare or endangered plant species).

The McCulloch Oil lease will be used as an access to the drilling locations in lease CA-960 as shown on Map A-2.

The Geysers Mineral Reserve Lands - "Proposed Geothermal Leasing Environmental Assessment Record Draft", published by The Bureau of Land Management, Ukiah District, in September 1978,

was used in determining what rare, threatened and endangered plant communities might exist. This assessment mentions one rare or endangered plant (*Stephananthus batrachopus*), but it will not be affected by road improvements in this area. Prior to any ground work near these rare and endangered plant communities, Union Oil Company will contract a botanist or other vegetation expert to investigate the site and prepare an avoidance and/or mitigation plan.

Wildlife - Direct impacts to resident wildlife will be from alteration or removal of habitat for the construction of the proposed new access roads and pads. Smaller and more sedentary forms of wildlife will be most affected. The total area affected will be a small fraction of the CA-960 and CA-953 leases.

No drilling muds or other fluids associated with geothermal operations will be discharged to the surface other than to the sump, thus avoiding potential hazards to aquatic life of the High Valley or Kelsey Creek drainages.

Observations at similar drill sites (Leitner,

unpublished data) indicate that increased noise levels caused by well cleanouts, testing, and standby venting, as well as disturbance from human activity, had little obvious effect on wildlife usage of adequate habitat (Neilson, et al, 1976).

The BLM Environmental Assessment Record of September 1978 states that endangered and fully protected wildlife species sighted in The Geysers area include the golden eagle, the peregrine falcon, and the white-tailed kite. The observed use of the area for all of these birds appears to be for foraging. No nesting is known to occur on or adjacent to the subject leases.

b. Land Uses

Visual Resources - While the scenic quality of the lease may be described as moderate, the overall visual sensitivity of the area is low. From site 104-25, 2,000' to the north where High Valley Creek meets Kelsey Creek, there is a full time resident. Proper and timely revegetation

of the area would reduce visual impact of the otherwise exposed soils.

Cultural Resources - No archaeological inventories have been conducted in either CA-960 or CA-953. An archaeologist will be contacted for an on-site study of this area.

In April 1975, Ecoview Environmental Consultants conducted an EIR for Geothermal Kinetics Systems on the Francisco leasehold, Lake County, California.

The EIR indicates an archaeological site, Geysers 99 (Oak Knoll site). This site is located in the northwest corner of the study area on an oak-covered knoll on the north bank of High Valley Creek. The site takes in virtually all of the knoll and measures about 100 x 40 m. The site appears to have depth with some midden development. Abundant obsidian waste is present on the surface. The waste indicates that primary tool manufacturing occurred at the site. The major road passing through High Valley cuts across the surface of the site. It is clear that any significant

improvement or modification of this road would have an adverse effect upon the site.

The road mentioned will be used by Union for access to lease CA-960 and will need some improvements. Union will hire an archaeologist to determine whether proposed road improvements would have impact on archaeological site Geysers 99.

Historic and ethnographic inventories have not been conducted on these leases.

c. Socio-Economic Characteristics

The proposed exploratory project will not contribute significantly to the local population growth, employment or local tax revenues of the area. Only a minor increase in economic activity will be associated with the project. Approximately twelve to fifteen people may be working on the location at any one time during drilling and/or production testing operations. No housing or special support facilities will be required on site during these operations due to proximity of existing facilities.

A successful exploratory project could conceivably lead to a development program to supply steam to existing electrical generating plants, or to a new plant, which would contribute toward the nation's energy objectives. Such a project would also contribute significantly to local tax revenues.

D. PROTECTION OF THE ENVIRONMENT

This section describes the measures proposed to effectively prevent environmental damage and conduct operations in a manner consistent with rules and regulations regarding:

1. Fire Prevention Measures

- a. All vegetation on the drill site location will be cut back and maintained. Construction and drilling equipment will be equipped with exhaust spark arresters. Smoking will be allowed in designated areas only.
- b. Fire extinguisher stations will be established at strategic locations around the drilling rig. Water trucks and sprayers will be available to respond to any emergency. Drilling water stored on the site (approximately 320 cubic meters [2000 barrels]) will be available for fire fighting.

2. Soil Erosion - Prevention Measures

Please see Section 4 of Exhibit B of this Plan of Operation for an explanation of mitigative measures.

3. Protection of Surface and Groundwaters

- a. Drilling wastes, machine drippings, and rain on and around the drilling equipment will be directed into the drilling mud sump by drainage systems designed as described in Section 4 of Exhibit B of this report. This measure will assure that pollutants on the site do not enter the surface water systems.

- b. The drilling mud sumps for each multiple-well pad will be constructed with impervious liners to prevent drilling fluids or drainage from the location from contaminating surface waters. The permeability of the lining of the sumps shall not exceed 1×10^{-6} centimeters per second and shall be constructed to the requirements of the California State Water Resources Control Board for a Class II-1 disposal site. Please see Section 7 of Exhibit B of this report for the construction specifications for sumps.

- c. The well will be cased (as described in the Drilling Program section) consistent with GRO Order No. 2 to prevent contamination of ground-

water. The casing program will also satisfy those requirements set by the State of California, Department of Conservation, Division of Oil and Gas.

4. Protection of Fish and Wildlife

- a. Habitat disturbance will be confined to the described construction areas.
- b. Disturbance of natural soil or vegetation will be kept to a minimum by proper planning, earthwork and supervision, as specified in Sections 1-3 of Exhibit B.
- c. Protection of surface and groundwaters for fish and wildlife will be achieved by methods described in Sections 4, 6, and 7 in Exhibit B pertaining to drainage and erosion control, and road, site, and sump construction.
- d. Noise levels will be abated as specified in D5 below.
- e. Steam production during drilling or testing will be directed away from nearby vegetation to avoid

injury or contamination.

5. Protection From Air and Noise Pollution

- a. To abate noise pollution, mufflers will be used on all rig engines and air compressor engines.
- b. The air, rock, and steam returns during air drilling will be directed by a pipe (the blooie line) from the well to a separator/muffler to reduce noise pollution from drilling operations to a minimum.
- c. Noise levels in general will not exceed an equivalent sound level (Ldn) of 65 dB(A) at a distance of 0.80km (.5 mile). The nearest full-time residence to any of the proposed drill sites is approximately 2,000 feet away.
- d. To abate particulate air pollution during air drilling, water will be injected into the blooie at up to 0.35 cubic meters per minute (100 gallons per minute) in order to knock out rock and dust particles from the exiting returns. The resulting stream of rock, dirt, and water will be diverted to the sump.

- e. Vehicular and other traffic dust will be minimized by watering when necessary.
- f. Compliance will be maintained with conditions to be prescribed by the local Air Pollution Control District's Authorities to Construct (AC's) to be issued for the proposed wells.

6. Protection of Public Health and Safety

Hard hats will be worn by personnel during construction and drilling.

Personnel will not be allowed in trenches 5 feet or more in depth.

OSHA regulations will be followed by all personnel.

Drinking water and sanitary facilities will be provided.

The contingency plans discussed in Section E specify procedures to maximize protection of the public from fire, spills, or blow-outs.

E. EMERGENCY CONTINGENCY PLANS

If any emergency develops or is determined to be impending, appropriate control procedures will be initiated. The specific procedures will vary greatly depending on the nature of the problem. Over the years of operation, Union has developed the following Contingency Plans for The Geysers Project:

- Fire Prevention and Control Plan - Emergency Medical Response and Transport Plan - Spill Prevention Control and Countermeasure Plan - Contingency Plan for Uncontrolled Blowout - Geothermal Fluid (Water) Spill Control Plan

A copy of each Contingency Plan is available to each employee who operates in the field and copies are sent to respective local, state and federal agencies. These Plans are updated periodically and training sessions are held to acquaint the operation personnel with recent developments and improved operation procedures.

Copies of these Plans have been supplied to the U.S.G.S. We will be happy to forward additional copies of each Plan upon request.

F. ENVIRONMENTAL MONITORING PROGRAM

Proposed plans for collection of baseline data will be submitted prior to or at the time of submittal of a Plan of Operation - Development. In the meantime, regional surveys of seismic activity, gravity changes, and land subsidence conducted by the U.S. Geological Survey include the discussed leaseholds and are proposed to be continued and supplemented by periodic specific studies in the area. The air quality/meteorology study run by the Stanford Research Institute (SRI), began in 1976 and continued until April 1979. This program consisted of eight sophisticated air monitoring stations of which only one is in the immediate area of the leases mentioned and was used for monitoring H₂S emissions from Unit 11. Present plans are for four additional stations to resume operation in the near future. Long-term monthly monitoring of stream water quality of PG&E will continue. A study of the effects of geothermal development on wildlife in The Geysers area has been conducted, including most of these leaseholds, during the period April 1976 to June 1977 and provides baseline data. Participants in that study included Union, PG&E, U.S. Fish and Wildlife Service, California Department of Fish and Game, UC Berkeley, St. Mary's College and Biosystems Associates.

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4. Neilson, et al, "Draft Environmental Impact Report for Geothermal Development of Union Oil Company's Leaseholds on the Upper Part of the Squaw Creek Drainage at The Geysers, Sonoma County, California"; May 15, 1974.
5. Walters, Mark, "Draft Environmental Impact Report for Union Oil Company, Northeast Geysers Unit, Geothermal Exploratory Project, Lake County, California"; 1980.
6. Department Water Resources Notice of Intention to file an Application for Certification of DWR Bottle Rock"; May 1979.
7. Neilson, et al, "Draft Environmental Impact Report for Geothermal Development by McCulloch Oil and Geothermal Kinetic Systems for the Study Area on Francisco Leasehold, Lake County, California"; 1975.
8. Neilson, et al, "Draft Environmental Impact Report for Burmah Oil and Gas Company, Wildhorse Leasehold (Part 1) on The Squaw Creek Drainage in Northeastern Sonoma and Small Parts of Mendocino and Lake Counties, California"; 1975.
9. Bureau of Land Management, Ukiah District Office, "Environmental Assessment Record for Proposed Geothermal Leasing in The Geysers Mineral Reserve Land (Five Tract)"; 1978.

EXHIBIT A

MAPS

EXHIBIT B

EARTHWORK AND CONSTRUCTION
SPECIFICATIONS

SECTION 1 - INTRODUCTION

- 1.1 General: The following specifications will be followed for drill site and road construction at Union Oil Company's drill sites at The Geysers Geothermal Area. These specifications are of a general nature and may require deviations on a case-by-case basis. Special construction requirements shall be described in the development plan for individual drill sites.
- 1.2 Supervision: Work proposed will be under the supervision of a Civil Engineer and Engineering Geologist to inspect earthwork construction and perform tests necessary to assure that suitable materials are placed to design requirements and in conformance with these specifications.

SECTION 2 - PLANNING

- 2.1 Drill Site Locations: Drill sites shall be selected utilizing natural topographic features such as ridges, benches, shoulders and valleys which provide relatively flat areas of sufficient size to accommodate the drilling facility. The site shall be engineered to balance cuts and fills, thereby minimizing changes in natural contours, excavation operations and disturbance of vegetation. Areas of both inactive and active landslides are to be avoided, or if unavoidable, engineered in such a manner to insure the safe drilling and operation of geothermal wells.
- 2.2 Road Locations: Access roads shall follow existing trails where possible, in keeping within good design and construction practices. Road widths shall be limited to the width required for use and for safe equipment operation. In general, road widths shall be 14 feet and designed to accommodate single-lane traffic. Turnouts shall be provided at strategic locations. Roads shall follow natural contours of the land, with normal grades of less than 15%. Maximum grades of 18% are allowed in specific cases for distances not to exceed 50 feet.

SECTION 3 - EARTHWORK

- 3.1 Clearing shall consist of the removal of organic growth such as brush, grass, weeds, and other vegetation and debris and the disposal of such material designated for removal,

including timber, brush, rubbish, and other matter occurring within the areas to be cleared. Construction areas for excavation and fill operations at the drill site, including berms outside the drill site area for drainage control, shall be stripped of all vegetation and organic soils. Brush and tree growth shall be stockpiled and burned, or buried in spoil areas. The topsoil may be stockpiled for later spreading over cut and fill areas to enhance revegetation.

3.2 Earth Fills: All fill areas shall be benched and keyed into undisturbed ground. Embankments shall be placed in six to eight inch lifts, moistened as required, and compacted by tamping rollers or other approved compacting equipment to 90% of ASTM D-1557-70, "Moisture Density Relations Test for Soils". Compacted fill slopes less than 30 feet in height shall not exceed 1 vertical on 1.75 horizontal and slopes over 30 feet in height should not exceed 1 vertical on 2 horizontal and shall be benched. Height between benches shall not exceed 25 feet.

3.3 Excavations: The Engineer will determine in the field the disposition of excavated material, including stockpiling of certain materials excavated for later use. Excavated materials free of organic materials and debris may be used in berms and for mud sump-disposal site liners, providing such materials conform to the requirements of California State Water Resources Control Board and are approved by the Engineer.

Cut slopes less than 15 feet in height shall not exceed 1 vertical on 1.5 horizontal. Slopes with heights greater than 15 feet should not exceed 1 vertical on 1.75 horizontal. Cut slopes higher than 30 feet shall be benched. Steeper slopes may be employed on a case-by-case basis by the Engineer where sound and durable rock is encountered. The top portion of the cut shall be rounded to eliminate a sharp break between the cut and the existing vegetation. All cut slopes shall be done with a corrugated slope bar to enhance revegetation.

SECTION 4 - DRAINAGE AND EROSION CONTROL

4.1 Access Road and Drill Site Pad: Access road and drill site location surfaces shall be sloped to drain toward the cut side or up-slope side of the roadway or drill pad. The slope shall be approximately two feet per hundred feet. A drainage system designed in accordance with the "Standards" of the Division of Highways, State of California, shall be provided to adequately carry away water collected on the

surface of the roads or locations as well as water intercepted from upper slopes and natural drainage systems. The drainage system shall consist of ditches on the upslope side of roads and on the upslope perimeter of drill pads. These ditches shall be sloped to drain at a gradient between 1% and 2%, or greater with approval by the Engineer.

Sand/cement-filled bags shall be installed as energy dissipaters where required to reduce flow velocities and prevent erosion. The drainage ditches shall be conducted to culverts, sized, designed and installed in accordance with the above standards. Culverts shall be installed with sand/cement-filled sand bag headwalls at the entrance, stilling basins at the exit, and shall be extended to existing natural drainage areas. An eighteen-inch high berm shall be provided along the upper edge of all fill slopes to prevent runoff over the fill.

- 4.2 Treatment of Seepage Zones: Springs and seepage zones uncovered during excavation shall be drained by constructing "French" drains, syphon wells, or other means as determined by the Engineer, and conveyed to natural or site-constructed drainage ways for discharge.

SECTION 5 - REVEGETATION OF GRADED AREAS

- 5.1 General: Access road and drill site cut and fill slopes and other areas exposed by grading shall be revegetated with approved grasses and/or woody plants and trees. Areas to be revegetated shall be determined by the Engineer.

The revegetative effort shall be done prior to the start of the growing season in late summer or early fall in order to utilize the first light rains to germinate grass seeds.

- 5.2 Lime: As determined by a soils laboratory determination for soil pH and lime requirement and as directed by the Engineer, lime shall be broadcast over areas to be revegetated and mixed with the soil by track walking with track-laying equipment.

- 5.3 Fertilizers: For areas to be revegetated, 14-14-14 granular fertilizer shall be applied at the rate of 300 lbs. per acre.

- 5.4 Grasses: Grass seeds shall be applied at 60 lbs. per acre. The seed mix shall be as follows, depending on availability:

Blando Brome, Wymera Ryegrass or Common Ryegrass	50 lbs. per acre
Red Leafed Clover	10 lbs. per acre

- 5.5 Mulch: Chopped straw shall be blown over revegetated areas for seed protection and added erosion control when required by the Engineer. The straw shall be tacked with a tackifying agent or "punched" into place.

SECTION 6 - PREPARATION OF
DRILL SITE PAD AND ROAD SURFACES

- 6.1 Stabilization: Drill site pads and road surfaces shall be stabilized to improve trafficability and reduce soil loss during rainfall runoff. This shall be accomplished in cuts by scarifying the top 8 inches of surface. The top 8 inches of cuts and fills shall then be compacted by tamping rollers or other approved compacting equipment to 95% of ASTM D-1557-70, "Moisture Density Relations Test for Soils." Moisture contents in excess of allowable working limits may be hydrated, using approximately 10% by volume or 0.2 cubic feet per square foot surface area of either pozmix cement or quicklime. The surface shall be finished by grading and intensive rolling with a smooth steel or rubber-tired roller.
- 6.2 Surfacing: Access road surfaces shall be finished by placement of a suitable thickness of gravel or native rock or armor-coated for all-weather use, as determined by the engineer.

SECTION 7 - PREPARATION OF
MUD SUMP-DISPOSAL AREAS

- 7.1 General: The drilling mud sump shall be constructed to the requirements of the California State Water Resources Control Board for a Class II-1 disposal site in order that spent drilling muds can be disposed of at the site. The disposal site will have the natural characteristics or will be engineered in such a manner to preclude the seepage or migration of any leached and deleterious materials contained within the sump to usable surface and ground water.
- 7.2 Impervious Liners: A soil, soil cement or lime cement, or vinyl (PVC) liner shall be constructed when native or imported soils do not meet requirements for permeabilities of less than 1×10^{-6} centimeters per second. Liner selection will be made by the Engineer depending on weather conditions and the availability of materials. The slopes of containment areas should not exceed 2 to 1 and the bottom width should not

be less than five feet regardless of which type of lining is employed. Specifications for the placement of each liner type is as follows:

1. Impervious Soil Lining

Weather conditions and availability of suitable materials permitting, an impervious clay lining shall be utilized. The soil lining shall conform to the inside pit configuration and placed in such a manner to resist accidental damage from pumping and other operations. The soil in the sump shall be thoroughly compacted to 90% of ASTM D-1557-70 prior to placement of the liner. A two-foot-thick clay lining of materials approved by the Engineer shall then be applied. The lining will be placed in six-inch layers using soil having a suitable clay content. The lining material shall be moistened to optimum moisture content and compacted to at least 95% of ASTM D-1557-70. Each layer will be compacted by means of a sheepsfoot or other suitable compacting roller. The surface of the clay lining will be finished by track-walking with a track-laying tractor. The permeability of the lining as placed shall not exceed 1×10^{-6} centimeters per second.

2. Soil Cement or Lime Cement Lining

When soil moisture content is in excess of allowable working limits, a soil cement or lime cement lining may be employed. Quick lime or pozmix cement in the amount of approximately 10% by volume shall be added and thoroughly mixed into selected soil having a suitable clay content. The mixed material shall then be spread throughout the sump area in six-inch layers and compacted to at least 95% of ASTM D-1557-70. This procedure should be repeated four times until a two-foot-thick minimum impervious lining is created. Each layer shall be compacted by means of a sheepsfoot or other suitable compacting roller. The surface of the lining shall be finished by track-walking with a track-laying tractor. The permeability of the lining as placed shall not exceed 1×10^{-6} centimeters per second.

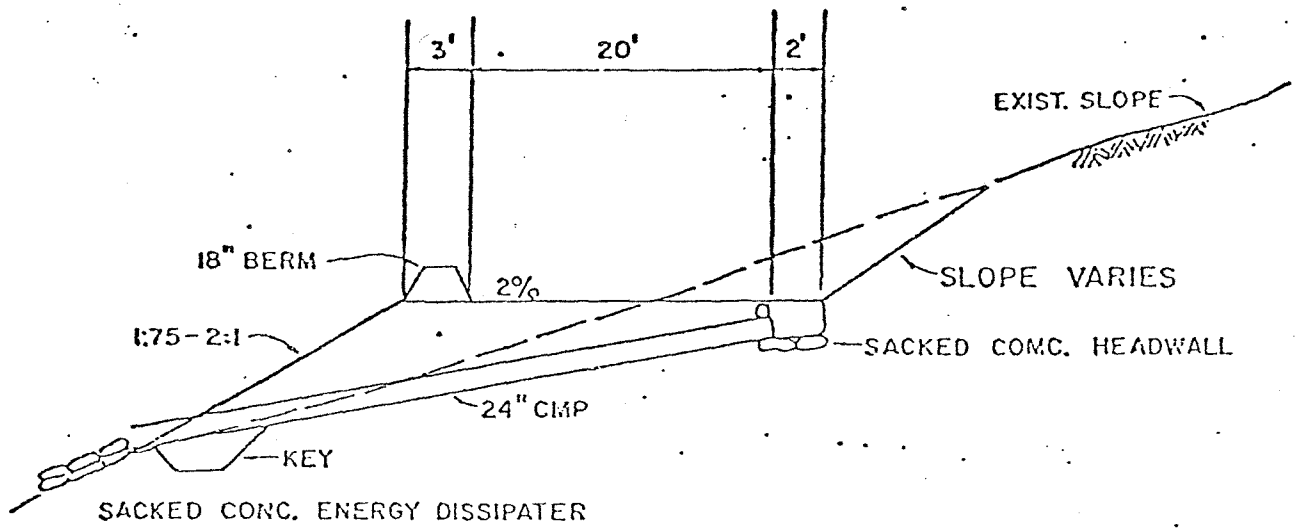
3. Vinyl (PVC) Membrane Lining

The sump area shall be carefully compacted to present a smooth surface. Rocks, rock fragments, and other material which might puncture the membrane shall be removed. A light sand or sand-cement fill, one to three inches in thickness, may be added to assist in providing a smooth surface. A vinyl membrane not less than 20 mils in thickness may be applied to assist in producing a smooth surface. A vinyl membrane not less than 20 mils in thickness shall be applied. The vinyl shall be prefabricated to meet

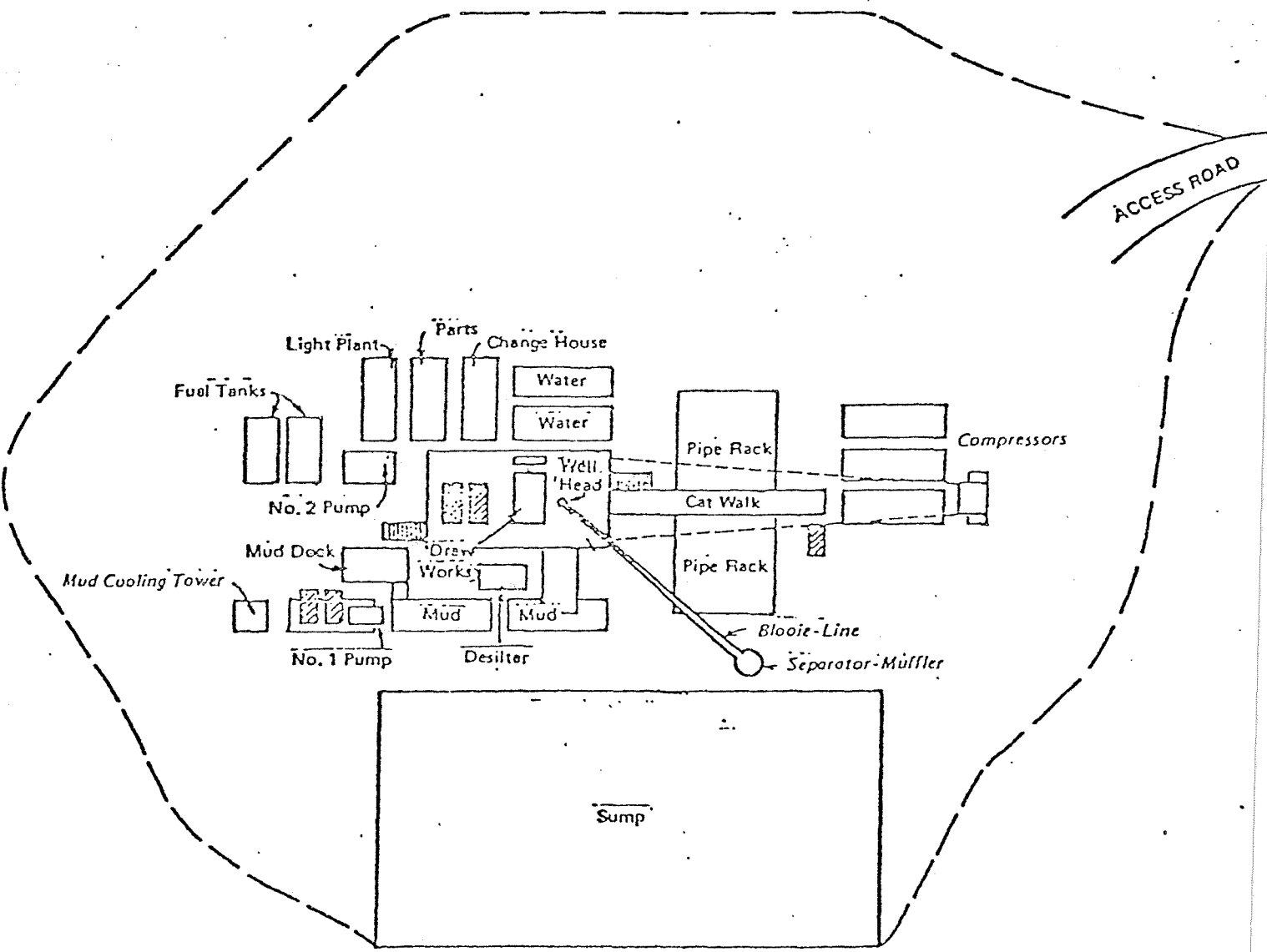
the requirements of the individual ponds and shall be packaged so that it may be unfolded into place without the necessity of pulling or dragging the membrane. The membrane shall be spread with sufficient slack to accommodate temperature changes. A ditch approximately 12 inches deep shall be excavated at the perimeter of the sump.

After placement of the vinyl lining, an earth fill, approximately 12 inches in thickness and composed of fine sand, silt and clay, free from coarse sand and rock fragments, shall be placed to hold the lining in place and to protect it. To prevent damage to the lining during drilling operations, it is recommended that supports be provided for suction and discharge lines. After filling the sump, the edges of the lining shall be buried in the 12-inch-deep perimeter ditch and the ditch backfilled.

- 7.3 Drill Site Disposal Area Abandonment: Upon completion of drilling operations at drill site locations, the mud sump-waste disposal area shall be dewatered by solar evaporation or by pumping with the final drying of the waste material by solar evaporation. When the moisture content of the waste material is reduced to 30% or less, the sump contents shall be mixed with native soils and the sump back-filled. A two-foot-high compacted berm shall be installed between the sump area and the drill site location pad to prevent water from running off the pad onto the sump. The surface of the disposal area shall be sloped to drain, graded for an attractive appearance, and revegetated.



TYPICAL CROSS SECTION &
INTERCEPTOR CULVERT



Notes:

- Used for Steam Only
- Blooie-Line
- Separator-Muffler
- Compressors

General Composite Layout of Typical Geothermal Well Drilling Facility for Steam

EXHIBIT C

SPECIFIC LOCATION
GEOLOGICAL DESCRIPTIONS

CA-960

CA-953

The Geysers, Lake County, California

DATA TO FOLLOW AT LATER DATE