UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Area Geothermal Supervisor's Office
Conservation Division, MS 92
345 Middlefield Road
Menlo Park, CA 94025

APR 6 1979

Department of Energy
Attn: Mr. Ray Brechbill
1333 Broadway
Oakland, California 94612

Dear Mr. Brechbill:

The Environmental Assessment (EA 125-9) for DOE's new test area at East Mesa is enclosed.

We have sent this EA exclusively to DOE, BLM, and the Regional Water Quality Control Board.

We have also included a list of Interested Parties. If you distribute the EA for comments from other agencies and individuals, this list might be helpful.

If you have any questions about the content of the EA, please call Dave Fach, Environmental & Safety Section at (415) 323-8111, Ext. 2848 or FTS 467-2848.

Sincerely,

Area Geothermal Supervisor

Enclosure

cc: Calif. Regional Water Quality
Control Board
Colorado River Basin Region

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
CONSERVATION DIVISION
OFFICE OF THE AREA GEOTHERMAL SUPERVISOR
MENLO PARK, CALIFORNIA

ENVIRONMENTAL ASSESSMENT

April 2, 1979

Prepared for one 1800m-deep production well (87-6) and an equipment test area/drill pad (about 2 ha) on public land to which DOE has the surface occupancy rights at East Mesa, Imperial Valley, California (T. 16 S., R. 17 E., Sec. 6)

Previous EA's:

28, 53, 71, 78, 88, 99-100

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Checklist Analysis

EA No. 125-9

References:
Lease No lease
EAR by BLM, East Mesa
EA's 78, 99-100
Others U.S.B.R. Env. reports for desalinization plant

Type of Operation Requested - Republic Geothermal, Inc. (RGI), operator for Sperry Research Center under contract to the U.S. Department of Energy (DOE) is proposing to construct a drilling and equipment testing pad (160m x 120m) at East Mesa, California (T. 16 S., R. 17 E., Sec. 6); drill one new 1830 m deep production well (87-6) and rework an existing injection well in Sec. 5 (well 5-1); build a geothermal fluid disposal pipeline (300 m long) from well 87-6 to DOE's existing brine-holding pond at DOE's Geothermal Component Test Facility; and install, test and remove a binary-fluid down-hole pump designed by Sperry Research Center. The two fluids are the geothermal fluid, and refrigerant R-114 which will be circulated in well 87-6 in its own closed system, and used to drive the down-hold pump. R-114 is described in the back of Appendix A. RGI also proposes to construct a tool-handling practice area at well 5-1 by putting a 76 cm diameter caisson 30 m into the ground. No new surface disturbance will be needed at the well 5-1 site for this practice area. If this down-hole pump test is successful, then Sperry intends to install a down-hold heat exchanger and small (1 to 5 Mw) surface power plant,which will be the subject of a future plan of operation and environmental assessment.

Extent of Surface Disturbance: About 2 hectares. There will be surface disturbance at the drilling pad/testing area, the pipeline path, and a small area near well 5-1 for tool-handling practice.

Extent of Subsurface Disturbance: The new well will be about 1830 m deep and at least 60 cm diameter to a depth of 730 m. From 730 m to the bottom of the well the diameter will be about 25 cm. A 76 cm diameter caisson will be put about 30 m into the ground for tool-handling practice near well 5-1.

Parameter	Impact Evaluation	Mitigating Measures
Slope Stability:	No impact. There is essentially no slope at East Mesa.	GRO Order No. 4, Sec. 5 (slope instability hazard)
Seismicity:	None anticipated - study has shown geothermal development causes insignificant seismicity changes (EA 99-100, p. 75).	GRO Order No. 4, Sec. 8 (leveling surveys as required by AGS)

Parameter	Impact Evaluation	Mitigating Measures
Subsidence:	None anticipated (EA 78, p. 72)	GRO Order No. 4, Sec. 8 (lessee cooperation with public agency)
Blow out:	No impact. Blow out prevention equipment will be used (POO)	GRO Order No. 2, Sec. 2 (blow out preventers will be used)
Air quality:	Negligible impact. All activity will be approved by Imperial County APCD (POO)	GRO Order No. 4, Sec. 9 (must meet Fed., State and local air pollution control standards)
Noise:	Minor impact. Noise levels will be within limits set by Imperial County, BLM, OSHA & AGS.	GRO Order No. 4, Sec. 11 (65dB(A) at .8 km from source)
Water quantity:	No impact. Water for drilling and testing will be from an existing well at the DOE facility. Geothermal fluids will be held in lined sumps and then reinjected in well 5-1.	GRO Order No. 4, Sec. 10 (must meet RWQCB stds.)
Water quality:	No impact. Drilling fluids will be non-toxic. All activity must be approved by the RWQCB. The salt water used to quench the well will not contaminate the ground water.	GRO Order No. 2, Sec. 1
Soil erosion:	Minor impact. Cleared areas will be susceptible to wind erosion; however, these areas will be covered with gravel and periodically watered to help keep dust down. (POO)	GRO Order No. 4, Sec. 5 (minimize soil erosion)
Waste Disposal:	Negligible impact. All potentially harmful waste will be taken to a RWQCB-approved site (POO).	GRO Order No. 4, Sec. 9 (must meet RWQCB stds.)
Vegetation:	1.9 ha will be cleared of vegetation.	GRO Order No. 4, Sec. 2 (Restoration after operations have ended.)

Parameter	Impact Evaluation	Mitigating Measures
Wildlife habitat:	1.9 ha of habitat will be temporarily lost. Cleared vegetation will be piled nearby to help replace lost habitat (POO).	GRO Order No. 4, Sec. 6 (protect natural habitat)
Endangered species:	Minor, acceptable impact. See App. B for Botanical Survey.	GRO Order No. 4, Sec. 6 (protection of endangered species)
Recreation use:	No recreation will be allowed in the immediate area during construction and testing (POO).	GRO Order No. 4, Secs. 3&4 (protection of public access/recreation)
Aesthetic value:	Minor impact. There are other buildings, holding ponds, and wells nearby	GRO Order No. 4, Sec. 1 (reduce visual impact)
Grazing:	No impact. There is no grazing in the area.	
Cultural Resource:	No impact. A survey has been done; see App. B.	GRO Order No. 4, Sec. 7 (protection of cultural resources)
Socio-economic:	Negligible impact. There is no growth-inducing impact from this proposal. Crew of 12-15 people will use existing nearby housing(POO)	
Fire:	None anticipated. All applicable fire protection standards will be observed (POO).	

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This project is proposed on BLM-administered land that DOE has surface occupancy rights for. DOE has requested the Area Geothermal Supervisor (AGS) to supervise the project. The AGS will require the operator to comply with the regulations of 30 CFR 270, Geothermal Resource Operational (GRO) Orders, and all other applicable Federal, State, and local standards. These regulations, orders, and standards all provide measures to protect the environment. No additional mitigating measures are needed.

Statement of Reasons of No Significant Impact

The quality of the human environment will not be significantly impacted by DOE's/RGI's proposal to drill this well and construct this test area. This conclusion is based on this checklist EA and the experience of field personnel and past operations in the area.

The Plan of Operation has been reviewed by the Operations, Engineering, and Environmental and Safety Sections of the Office of the Area Geothermal Supervisor.

DETERMINATION

prepared by — date 4/6/79

I (~~do not~~) concur with the above EA.

Acting Chief, Environmental & Safety Section — date 4/6/79

Based on this checklist assessment, I believe a more detailed EA (~~is~~) (is not) required.

Area Geothermal Supervisor — date 4/6/79

APPENDIX A

PLAN OF OPERATION

Environmental
FACH

PLAN OF OPERATION

SPERRY GEOTHERMAL WELL AND PUMP TEST

Section 6, T16S, R17E, SB B&M
East Mesa, Imperial County, California

Republic Geothermal, Inc., Operator
for Sperry Research Center
Under Contract to the U. S. Department of Energy

11823 E. Slauson Avenue, Suite One
Santa Fe Springs, California 90670
(213) 945-3661

Proposal to construct a location pad; drill deep resource Well No. 87-6; workover existing injection Well No. 5-1; construct production and injection test facilities; production or injection test each well as appropriate; install, test and remove a downhole binary well pump; construct a practice area for installation of a gravity head heat exchanger on existing well pad; and add approximately 250 feet of electric transmission line to tie in with an existing 34.5 kV line.

Estimated Starting Date: May, 1979

Estimated Completion Date: 1982

REPUBLIC GEOTHERMAL, INC., OPERATOR

FOR SPERRY RESEARCH CENTER
UNDER U. S. DEPARTMENT OF ENERGY CONTRACT

PLAN OF OPERATION
SPERRY GEOTHERMAL WELL AND PUMP TEST
EAST MESA, IMPERIAL COUNTY, CALIFORNIA

CONTENTS

A. PROPOSED PLAN OF OPERATION

Republic Geothermal, Inc. proposes herein to explore a specific parcel of Federally administered lands on East Mesa for geothermal resources, of sufficient quality and quantity to support the testing of a downhole binary well pump designed by the Sperry Research Center under contract to the U. S. Department of Energy (DOE). Republic Geothermal is submitting this Plan of Operation, Exploration in its capacity as field operator under subcontract to Sperry Research and at the direction of the DOE contract managers.

The proposed operation will consist of drilling one deep geothermal well on a site within 40 acres of land immediately east of the DOE Geothermal Component Test Facility (GCTF) which has been reserved from geothermal leasing. This well will be tested into a lined storage basin and worked over, if necessary, to assure an adequate quantity and quality of geothermal fluid. If the well proves satisfactory, the Sperry Research downhole binary pump will be installed in the well and operationally tested over a period of up to eight months. Effluent from this well test will be discharged via a new, temporary pipeline to the existing DOE GCTF brine holding pond. The DOE's existing waste disposal system will be utilized to dispose of this waste water, although the system will be upgraded to handle the increased volumes. This will include additional transfer and injection pumps and new filtration equipment, to be installed at the GCTF by the DOE, and an upper interval perforation and workover of the waste disposal well, Well No. 5-1, to be undertaken by Republic Geothermal.

Sperry Research has as its ultimate goal the development of a special downhole heat-exchanger to be used in connection with a small surface power plant which would utilize the heated binary fluid to drive a turbine-generator. Should both the proposed well and well pump tests prove satisfactory, it will be Sperry Research's intent to install the downhole heat-exchanger in the well, construct the necessary surface facilities on the well site to complete a small binary power plant, and generate electricity while testing this "Gravity Head Cycle Geothermal Energy Conversion System." This expanded project will be the subject of a subsequent Plan of Operation and an additional environmental review document.

B. DETAILS OF PROPOSED PLAN

1. Location and Placement of Proposed Operations

The production well, designated as Well No. 87-6, will be located at approximately 1150' N, 455' W, from S.E. corner of Section 6, T16S, R17E. A layout of the

proposed site surrounding the well is shown in Figure 1. Figure 2 shows the topography, drainage patterns and existing roads and wells.

The site is designed to accomodate all proposed operations, including well work (drilling and pump installation), the Sperry Pump System, the production and injection geothermal fluid handling system, and if feasible, the eventual operation of the Sperry Gravity Head System. As shown in Figure 1, the site layout includes a dual storage basin area 100 feet by 200 feet in size. The lined and unlined sections of the pit area will be separated by a dike. The unlined portion of this pit will be used for cuttings and drilling fluid discharge during drilling operation. The lined portion of the pit will be used for temporary geothermal fluid accumulation during clean up flow or during short flow diversion periods as required by other operations.

2. Discussion of Proposed Operations

a. Description of Drilling Program for Production Test Well

The production well will be completed in a sequence of alternating deltaic sandstones, siltstones and mudstones. The production interval will be approximately from 4700 feet to 6200 feet (all depths referenced to KB, which averages approximately 63 feet above MSL).
The casing program will be as follows:

Depth	Casing Size (O.D.)
Conductor Pipe 80'/Surface	36"
Surface Casing 1200'/Surface	30"
Intermediate Liner 2400'/1000'	24"
Production Liner 6200'/2200'	9 5/8"

Detailed casing descriptions and design criteria are included in the drilling program in the Application for Permit to Drill (APD), attached to this Plan of Operation.

FIGURE 1

SPERRY PRODUCTION WELL LOCATION AND OPERATIONS SITE

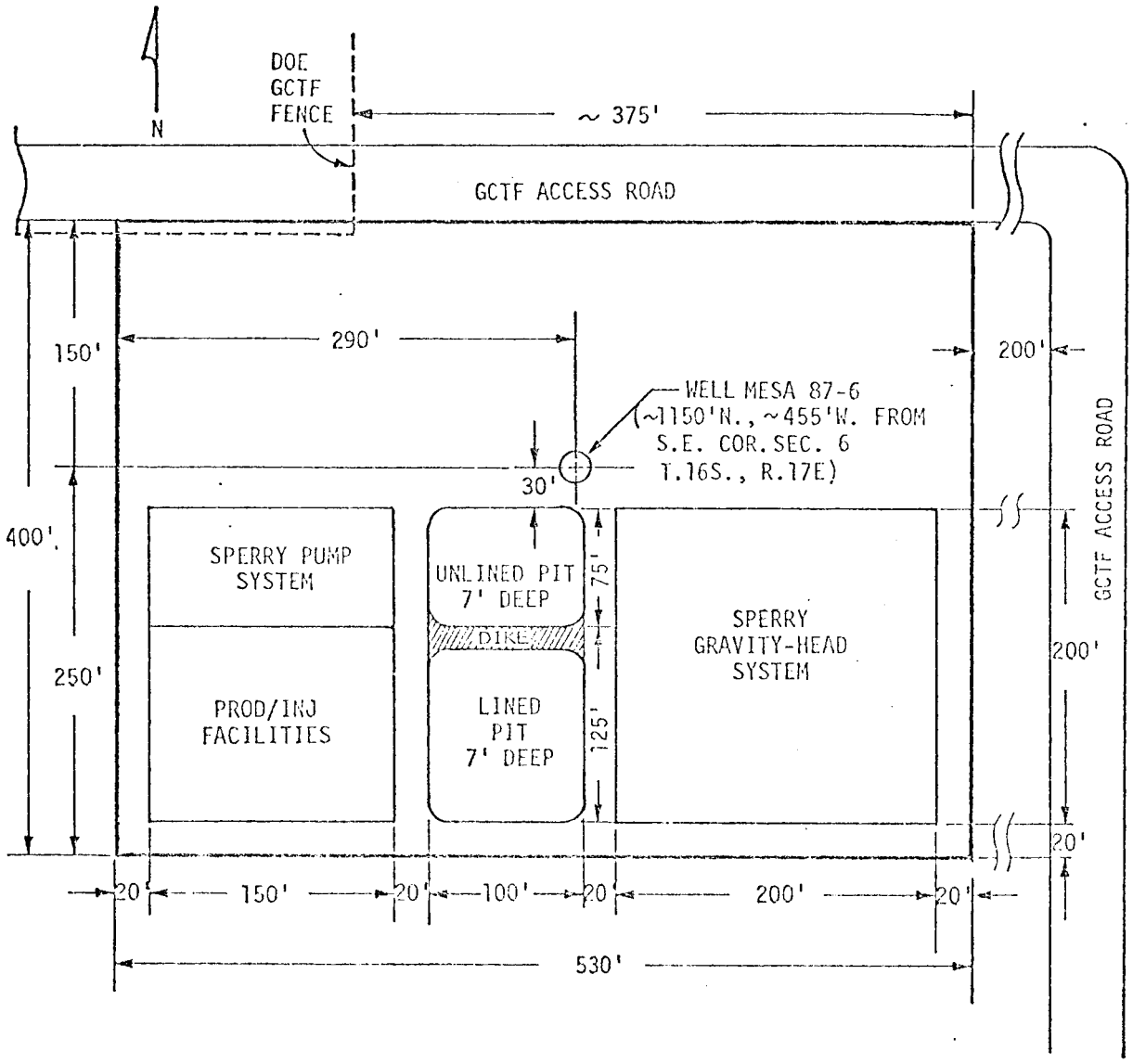

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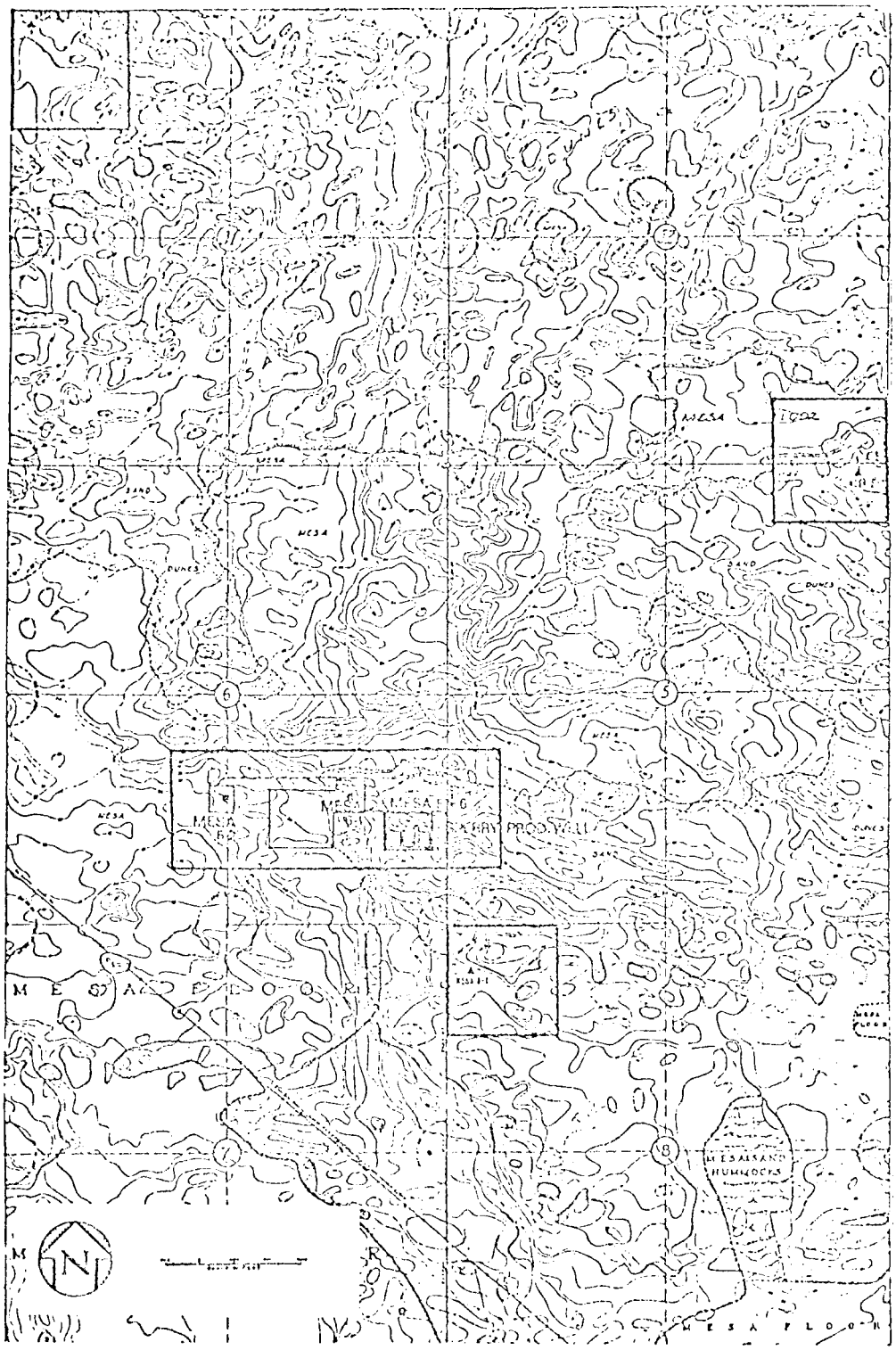
FIGURE 2

TOPO MAP OF SPERRY SITE



The wellhead configuration has been specifically designed to accomodate multiple concentric tubing strings which are required for downhole tubing operation and will be manufactured to ANSI Series 400 pressure specifications or better. A drawing and complete description of the wellhead and wellhead equipment is included in the attached APD.

The 30" surface casing will be cemented to the surface using API class "G" cement mixed 1:1 with Perlite plus 2% gel and 35% silica flour. The slurry density will be 95 lbs/ft^3. A tail slurry of 200 sacks of class "G" cement and 35% silica flour with a resulting density of 117 lbs/ft^3 will be used for additional strength around the casing shoe. The 24" intermediate casing and 9 5/8" production liner will be cemented with the same basic slurries as above; however, sufficient retarders will be added based on logging temperatures to give adequate pumping times.

After waiting on cement for eight hours, the casing will be slacked off and the casing pressure tested to 1,000 psi for 30 minutes, with the exception of the surface casing which will be tested to 500 psi. Liner laps will likewise be tested.

The mud program from surface to 2400' will be lightweight (8.8-9.2 PPG), low solids, fresh water, clay base drilling fluid treated with lignite for temperature stability, and bicarbonate of soda for cement combination. Desanders and and desilters will be run in order to keep the solids as low as possible. A cooling tower will be installed in the mud system and the mud pumped through this cooling tower when the return mud temperature exceeds 160°F (71.1°C). The production interval will be drilled with a sepiolite, polymer, caustic potash and lignite system as temperature and hole conditions dictate.

After setting the 24" intermediate casing, API class 2000 psi blowout preventers will be installed and tested as detailed in the drilling program in the attached APD. The casing head will have two side outlets with two flanged valves on each outlet. One side will be connected to the rig choke manifold, the other side will be connected to a pumping unit as a kill line with a back pressure valve in the line for pumping into

the well, if necessary. A fill-up line will be installed above the BOP equipment so that the hole can be filled during trips, and the amount of fluid pumped into the well while tripping will be monitored.

The hydraulic control unit for the BOP equipment will have two operating stations, one on the rig floor and one at least 50 feet from the wellhead. At all times the mud flow line temperature and the mud pit level will be monitored. A pit level warning device will be installed. Gases in the mud return will be monitored. A drill string back pressure valve along with a full opening safety valve will be maintained on the rig floor with adequate subs to fit all connections in the drill string. Each drilling crew will be instructed in blowout control procedures and the contractor will be required to have at least one pit drill per crew per week.

In the event of an emergency, the drilling contractor will have the names and telephone numbers of the appropriate company personnel to notify. Please refer to Section E, Emergency Contingency Plan, of this Plan of Operation for more detailed emergency procedures.

b. Description of Injection Well Workover

The USBR/DOE East Mesa Well No. 5-1, the current disposal injection well, has suffered injectivity impairment* and is believed to have developed fluid communication behind casing above the current completion interval. The current completion interval consists of the original slotted liner interval 5003'-6003' and jet perforated intervals to 4061'-5276' added in February, 1977. Injectivity impairment in these intervals is believed due to plugging by quartz particles and corrosion products carried in the injected water. Stimulation of the existing intervals to recover adequate injectivity for the proposed test would be expensive and is believed to carry a high risk of failure. Instead, it is proposed to recomplete the well in the interval 2600'-3977', using the procedure summarized below:

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* U. S. Bureau of Reclamation, Geothermal Resource Investigations East Mesa Site, Status Report, April 1977

1) Kill the well with salt water, move in a workover rig and install a blowout preventer.

2) Set a bridge plug at 4000' and pressure test the casing above that depth.

3) Perforate and squeeze cement behind casing in the interval 2300'-2400' to isolate zones above that point from injected water.

4) Perforate approximately 900' of sands in the interval 2600'-3977'.

5) Acid wash new perforations with approximately 500 barrels of inhibited acid and flow the well to remove plugging debris from the perforations. This cleanup flow will involve discharging 3000-5000 barrels of fluid into tanks and then transfer to the GCTF pond.

6) Test injectivity of the new completion interval and run an injection tracer survey or a shut-in temperature survey within the first thirty days of injection to confirm isolation of zones above 2300'.

c. Production and Disposal Facilities

Approximately 500,000 lbs/hr of 340° geothermal fluid will be pumped from the Sperry test well. A 10 3/4" O.D Schedule 40 welded steel water disposal pipeline will be installed from the well to the DOE GCTF fluid holding pond approximately 1000' away for later injection by the GCTF. Pressure provided by the Sperry downhole pump will be sufficient to deliver the 500,000 lbs/hr of water to the GCTF pond. Line operating pressure will be 150-250 psig, well within the disposal line design maximum operating pressure of 680 psig at 300°F. The line will be installed above ground on concrete piers and expansion loops will be installed as needed to prevent damage to the piping and equipment from thermal expansion. The pipe will be insulated in areas subject to being touched by operators.

An orifice type meter will be installed at the production wellhead to measure and record the total well flow. Pressure and temperature indicators will be installed as needed. A

chemical pump will be provided to inject any water treating chemicals found to be necessary. ANSI series 300 gate valves will be installed to close in and isolate the well.

Blowdown from the Sperry cooling system will be metered and injected into the water disposal line downstream of the well flow meter. Reinforced concrete foundations will be installed at the well site for all equipment components.

A flash tank will be installed at the GCTF pond to provide for steam flashing, two phase metering, noise and turbulence control prior to the water entering the pond. Steam will be vented into the atmosphere through an elevated stack approximately fifty feet high and the water will be dumped into the pond from the flash tank.

d. Sperry Organic Pump System

The proposed testing to be conducted by Sperry Research at East Mesa under contract to DOE involves the feasibility demonstration of a low temperature organic working fluid downhole pump. The following is a brief description of the pump operating principles, configuration and surface facilities required.

The Sperry downhole pump obtains its energy to pressurize the geothermal water directly from the well itself. The principle involved is to pump a working fluid, dichlorotetrafluoroethane ($Cl_2F_4C_2$), also known as R-114, down to the pumping unit through a downhole heat exchanger consisting of two annuli formed by the well casing and two concentric lengths of well tubing. The working fluid flows down the annulus and the hot geothermal fluid flows up the outside annulus. The heat is transferred from the geothermal fluid across the wall of the tube and into the working fluid, causing the working fluid to vaporize.

The working fluid vapor is used to drive a turbine, which in turn drives the pump impeller. Turbine exhaust is returned to the surface through the exhaust tube where it is condensed and then sent back downhole for another cycle. The working fluid is contained in its own closed loop and the geothermal fluid is excluded from the system for disposal into an injection well.

The pump and heat exchanger tubing will be installed in the test well. The surface facilities required to conduct the test will consist of the R-114 storage, pumping, condensing and monitoring equipment as shown schematically in Figure 3.

The R-114 will be transported to the well site by truck and unloaded into a 2000 gallon pressurized storage tank. The working fluid will be pumped from this vessel to initially charge the system and maintain the required volume in the system as the test progresses. Also associated with the storage vessel will be level control and filtering equipment. The equipment mentioned above in conjunction with the R-114 storage vessel will be fabricated as a single unit and referred to as the charging module.

The vaporized R-114 will flow from the wellhead into an evaporative condenser designed for $6X10^6$ BTU/hr. The condenser will circulate cooling water at the rate of 15 gpm from a supply tank located at the well site. Cooling water will be supplied to the storage tank from fresh water wells located at the DOE GCTF. Cooling water bleed-off will be pumped from the condenser at the rate of 5 gpm and injected into the water disposal line.

The R-114 will flow from the evaporative condenser into a direct contact heat exchanger, then through a dryer and filter before being pumped back into the well for another cycle. This equipment will be fabricated as a unit and referred to as the condensing module.

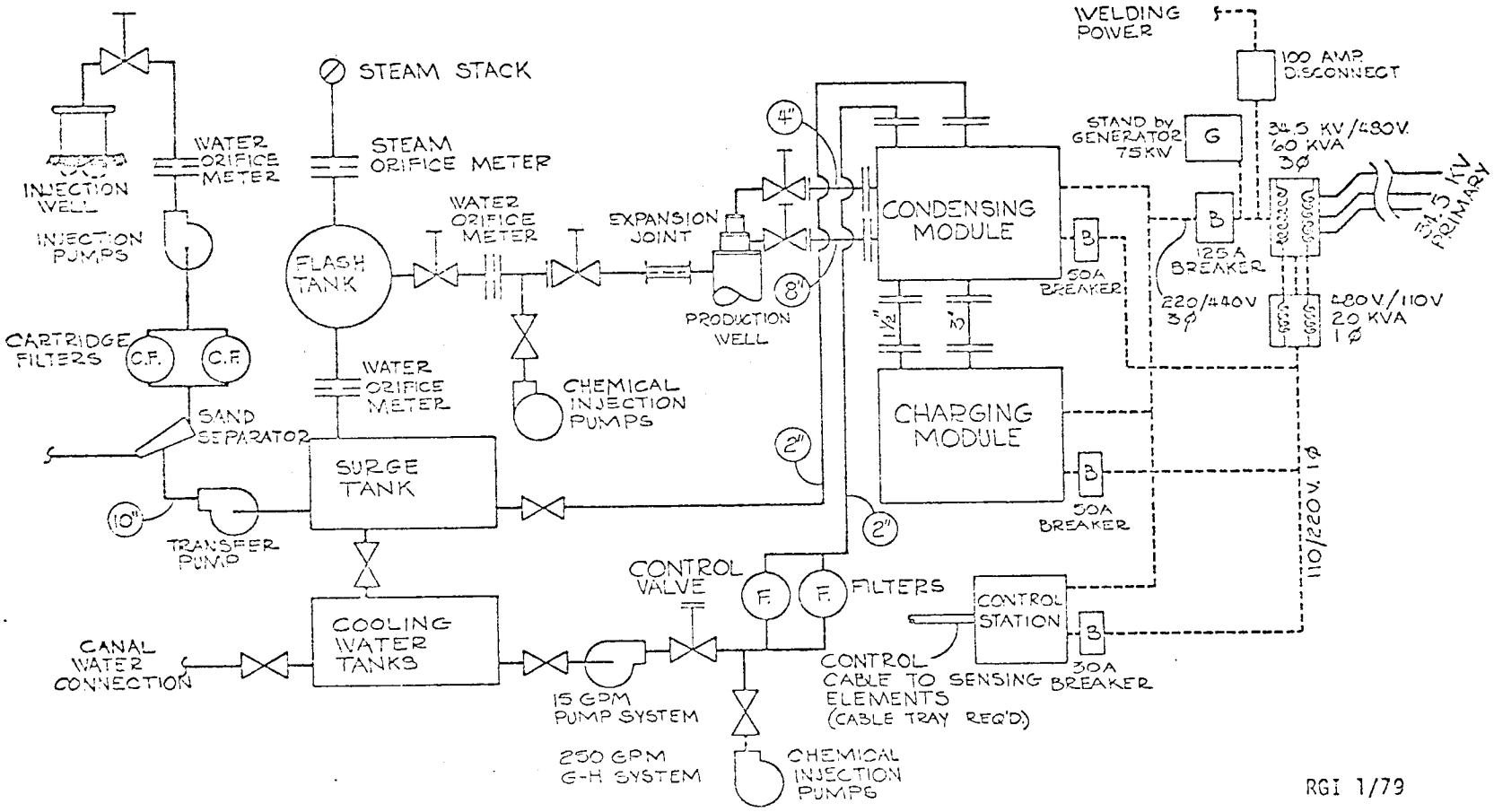
The geothermal fluid pumped to the surface by the downhole pump will be piped to the DOE GCTF pond where it will be flashed, then injected via the GCTF disposal facilities.

An instrumentation control van will be located at the test site to monitor all necessary system parameters.

All vessels, pumps, and piping associated with the handling of R-114 will be constructed in accordance with the applicable ASME Codes for hydrocarbon presure vessels and piping. Safety relief valves will be provided on all vessels.

FIGURE 3

FLOW SCHEMATIC
SPERRY ORGANIC PUMP SYSTEM TEST



The working fluid will enter the wellhead at 90°F, 38 psia and at a rate of 110 gpm (1300 lb/min). The R-114 vapor will leave the wellhead at 138°F, 37 psig, 1,110 ft^3/min.

e. Transmission Line

An electrical power line will be installed from the existing IID 34.5 kV line to the well site. This will amount to approximately 250 feet of new overhead construction, to be performed by IID or a private contractor. Transformers will be installed at the well site to provide 480V, 220V, and 110V operating power. A standby generator will be provided for auxiliary power.

f. Well Evaluation

Both the production well, Well No. 87-6, and the injection well, DOE Well No. 5-1, will be evaluated prior to testing the Sperry pump system. Initial production measurements will be made by downhole instrumenting Well No. 87-6 and flowing the well, without pumping, into the adjacent lined pit. The fluid in the pit will be disposed of by trucking to the DOE GCTF pond. The reworked injection well, Well No. 5-1, will be similarly tested with the waste fluid piped back to the DOE GCTF pond through the existing disposal line between Well No. 5-1 and the DOE GCTF pond. These initial tests will take place intermittantly over a period of two to three months. After the construction of the pipeline between Well No. 87-6 and the DOE GCTF pond, production and injection testing of longer duration will take place over a period of three to four months.

g. Installation and Removal of Pump

The pump will be installled in the new producing well by the procedure summarized below:

1) Kill the well with salt water, move in a workover rig and install a blowout preventer. Have available on the rig a tubing safety valve to close in the tubing during unattended hours or in the event of an emergency.

2) Run and land the pump. Procedures for pipe makeup, seal welding and pressure testing to

be directed by Sperry representative. Move out rig.

3) Fill the tubing string with R-114 operating fluid.

The pump will be removed from the well by the procedure summarized below:

1) Exhaust the R-114 operating fluid from the downhole system into the charging module.

2) Kill the well with salt water, move in a workover rig and install a blowout preventer. Have available on the rig a tubing safety valve to close in the tubing during unattended hours or in the event of an emergency.

3) Pull and lay down the tubing and pump.

4) Remove blowout preventer and move out rig.

h. Sperry Pump System Test

After installation, the Sperry pump system will be operated for a period of six to eight months. The operation of the pump and the associated production of geothermal fluid will be monitored continuously. The pump will be removed from the well for inspection periodically during the test.

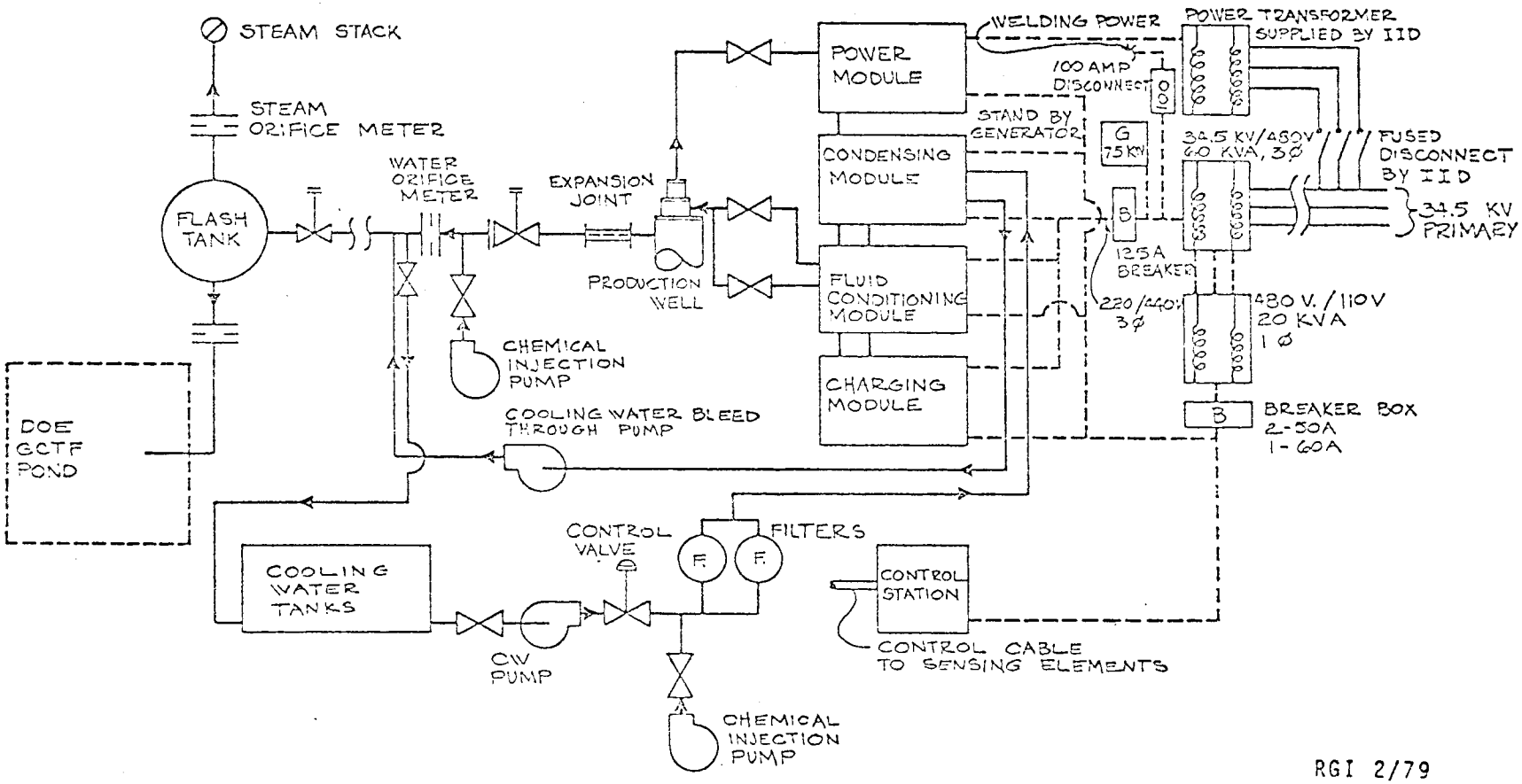
i. Description of Gravity Head Geothermal Energy Conversion System

Following the adequate demonstration of Well No. 87-6 and the Sperry Pump System, it is planned to test the Sperry Gravity Head Cycle Geothermal Energy Conversion System, a combination geothermal pump-downhole heat exchanger and wellhead electrical generating system. Although this system will be the subject of a subsequent Plan of Operation, it is briefly discussed here to provide continuity to the present program. The gravity head system is shown schematically in Figure 4.

The geothermal pump will be the same as the Sperry pump tested previously, except that the pump will be set at a depth of 2100 feet at the bottom end of the downhole (vertical) heat exchanger. By placing the pump at a depth of

FIGURE 4

FLOW SCHEMATIC
SPERRY GRAVITY HEAD SYSTEM TEST



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2100 feet the weight of the column of R-114 ("gravity head") adequately pressurizes the working fluid without the need of an energy-consuming surface feed pump. Well No. 87-6 was specifically designed to accept this downhole heat exchanger-geothermal pump by having a minimum inner diameter of 24 inches to a depth of 2400 feet.

The R-114 working fluid is heated as it moves down the well in tubes while the geothermal fluid is pumped up the well outside of the fluid-carrying tubes. A small portion of the energy in the heated R-114 is used to drive the downhole geothermal pump. The working fluid then flows under pressure up to the surface to pass through a turbine, a heat rejection unit and eventually back down the heat exchanger in a closed system. The geothermal fluid, cooled down to approximately 135°F by the time it reaches the surface, is sent off to the GCTF pond for disposal, using the same facilities as previously mentioned.

Because the system utilizes gravity to pressurize the working fluid, and because of the thermodynamic characteristics of the working fluid in the heat exchanger, the gravity head generation system should be able to convert geothermal energy to electrical energy with relatively high efficiencies. This experimental plant will be designed to produce between 1 and 5 MW of electricity (depending primarily upon the well's capabilities), some of which will be available for distribution by the IID on their 34.5 kV line.

j. Gravity Head Practice Area

The unusual configuration and large diameter of the Sperry gravity head downhole heat exchanger sections demands development of new handling methods and handling tools. To insure that tools and methods are adequate prior to handling the full load of the entire downhole system, it is proposed that the equipment be tested and personnel trained with two prototype sections of the heat exchanger early in the program. It is proposed that a practice area be set up on the western side of the injection Well No. 5-1 site. This area would require no additional roads or site construction, except that a 30" caisson would be installed approximately 100 feet into the ground in which to run the practice sections. This caisson would be cut off below ground level

and the pad area restored when the testing is completed.

The caisson for the practice wells would be installed at the same time the conductor is set for the production well. The practice period would be about thirty days in duration and would involve a small rig and approximately six people during the daylight hours.

3. Source of Water Supply and Road Building Material

During the testing of the Sperry pump, approximately 15 gpm of fresh water will be required for cooling. This water will be supplied from the water wells located at the GCTF. A 2" steel pipeline will be installed, adjacent to the 10 3/4" water disposal line, from the GCTF to the well site for cooling water. The water will be stored in a 500 barrel tank and pumped through filters to the Sperry cooling system.

No road building material will be obtained from federal lands. If any material such as gravel is needed, it will be trucked from outside commercial sources.

4. Approximate Crew Size, Probable Type and Location of Housing and Support Facilities

Approximately twelve to fifteen people may be working on the location at any one time during drilling and testing operations. One or two trailers will be located on-site to provide office and working space for the supervisory and engineering personnel. No housing will be required on-site during these operations due to the proximity of existing facilities.

C. ENVIRONMENTAL PROTECTION

The following measures will be taken for protection of the environment:

1. Fire

All local, state and federal fire protection standards applicable to the proposed activities will be observed. Smoking will be allowed only in designated areas. Water and fire extinguishers will be available

at the site during drilling, construction and testing activities in the unlikely event a fire should occur.

2. Soil Erosion

Due to the essentially level topography at East Mesa, the infrequent rainfall and the lack of surface water, soil erosion is not anticipated to be a problem. Off-road vehicle use will be prohibited except where necessary. Best efforts will be made to minimize disturbance of the perennial woody vegetation. The location will be covered with gravel to prevent erosion. Cleared areas around the proposed pipeline which are not required after construction will be allowed to revegetate naturally.

3. Surface and Ground Water

a. Surface Water

Surface waters in the vicinity of the proposed operations are limited to the south-north flowing East Highline Canal located approximately one and one-half miles west of the proposed wellsite. The remainder of the area of operations is devoid of obvious stream channels. The distance between the proposed operations and the East Highline Canal suggests no deleterious effect on the quality of surface waters can be expected.

b. Ground Water

There are no natural ground water sources such as seeps or springs within the proposed East Mesa area of operations. The California Regional Water Quality Control Board, Colorado River Basin Region (RWQCB) considers the ground water in the vicinity to be saline and not beneficially used.

Drilling muds and cuttings will be stored in the unlined portion of the storage pit and will ultimately be disposed of at a site approved by by the RWQCB. Geothermal fluids, well clean out fluids, and workover fluids will be allowed to flow directly into the plastic-lined portion of the storage pit or into steel tanks to permit suspended solids to settle out. The supernatant will be pumped to the existing brine holding pond at the DOE test facility and will be injected back into the geothermal reservoir via an existing injection well. Residual solids in the lined storage pit and steel tanks will be

disposed of in a dump site approved by the RWQCB.

Drilling muds will not contain toxic materials nor materials which could contaminate the ground water. All pipelines will be properly constructed and maintained to prevent leakage. The chloroflourocarbon working fluid will be contained in a closed system and will not contact the ground water in normal operations. No accidental release of the working fluid is anticipated; however, should a rupture in the system develop below ground level little ground water contamination should be expected due to the relative insolubility of the working fluid (see Section D., Environmental Concerns).

Republic has submitted a Report of Waste Discharge to the RWQCB for the proposed activities and will operate under the anticipated Waste Discharge Orders. Republic will also protect the area's ground water by complying with provisions of GRO Order No. 2 or exceptions to this Order as approved by the Area Geothermal Supervisor.

4. Fish and Wildlife

There are no fish in the area. The construction of the proposed well pad will result in some unavoidable permanent destruction of habitat. The proposed production and injection testing will not disturb additional habitat. Because of the minor amount of habitat disturbance and the homogeneous nature of the vegetation at East Mesa, it is anticipated that this disturbance will not significantly impact the area's wildlife. To help provide replacement habitat, removed vegetation and excess soil shall be stacked in several piles at a reasonable distance from the well pad. The area temporarily disturbed for the construction of the flowline from the pad to the GCTF storage pond will be allowed to revegetate.

5. Air and Noise Pollution

a. Air

Air quality should not be significantly degraded during these proposed operations. All operations will be conducted with the approval of the Imperial County Air Pollution Control District. To date, the portion of noncondensable gases in the wells drilled at East Mesa has been a small

0.05 to 0.2 percent of the total produced fluids and about 90 percent of the noncondensables is carbon dioxide. Only minute concentrations of hydrogen sulfide have been detected.

Dust from site construction activities will be suppressed by distribution of shallow ground water low salinity geothermal fluids as evaluated and approved by the Regional Water Quality Control Board.

The chloroflourocarbon working fluid (R-114) will be stored in a closed system and should not be released to the atmosphere. R-114 is a stable, nontoxic gas which is not a precurser to any pollutants for which there are natural or local ambient air quality standards (see Section D., Environmental Concerns). Thus, should an accidental release of the working fluid occur, it would not result in an air quality problem. Republic does not anticipate the proposed East Mesa operations will significantly degrade the existing ambient air qualtiy.

b. Noise

Noise is expected to be of minor concern from the proposed geothermal operations. Noise levels will be maintained within the limits prescribed by Imperial County, the Bureau of Land Management and the Occupational Safety and Health Administration. Drilling rig engines and compressors will be equipped with mufflers.

Noise impacts on wildlife at East Mesa will probably be minimal because of the relatively low intensity and steady, continuous nature of most of these noise emissions. The East Mesa area itself is also very isolated from any human receptors. The extant ambient noise levels on East Mesa are usually very low, but are frequently punctuated by the sounds of aircraft overflights and explosions from the nearby military gunnery range. Occasional off-road vehicle use of the area also adds to the ambient noise levels.

6. Public Health and Safety

Public health and safety shall be ensured through the use of appropriate equipment, operating procedures and notices. Appropriate warning signs will be posted on all pipelines and testing equipment. The proposed well site will be posted with a sign indicating the

well name, the designated operator and an emergency phone number. Supervisory personnel will be available during drilling and testing operations.

During testing activities the location pad or appropriate portions thereof will be surrounded by a chain-link fence. The well will be chained and locked when not attended. All drilling shall be conducted in accordance with all state and federal requirements, specifically GRO Order No. 2.

As discussed in Section B.2.d, all vessels, pumps, and piping associated with the handling of the organic working fluid, R-114, will be constructed in accordance with the applicable ASME Codes for hydrocarbon pressure vessel and piping. Safety relief valves will be provided on all vessels. In the event of an accidental release of the working fluid, low-pressure automatic shut-in safety valves would close in the system and minimize the volume of working fluid lost to a relatively small portion of the total system. The working fluid itself is nonflammable and relatively nontoxic; however, the vapors are heavier than air and could conceivably produce high local concentrations in enclosed areas (see Section D., Environmental Concerns). Accordingly, adequate ventilation will be provided in all areas where R-114 is stored, handled, and used , and no buildings, tanks, pits, sumps, or other enclosures will be located in the immediate vicinity of the working fluid. Ventilation will be provided to the cellar during any period when personnel may be required to enter. Precautions will be made to avoid direct contact with the liquid and safety glasses or goggles will be required when handling the liquid.

7. Methods for Disposal of Waste Materials

Portable chemical or approved septic system sanitary facilities will be provided for personnel on-site during the proposed operations. These facilities will be maintained by a local contractor and wastes will be disposed of off-site. Trash and construction debris will also be removed to an appropriate dump site.

Drilling muds and drilling cuttings will be neutralized and deposited on the surface of existing roads or trucked to a disposal site approved by the Regional Water Quality Control Board (RWQCB). Republic favors the former method of disposal.

The residual contents of the lined storage basin and steel tanks will be removed and taken to an appropriate waste facility as approved by the RWQCB. These wastes will be removed at the end of the proposed operations and as necessary during the drilling and testing activities.

8. Section 270(i), (j) and (k)

Republic is prepared to submit, upon notification to do so, any further information not included herein which the Supervisor may require. Republic anticipates that there should be only negligible environmental impacts from these proposed operations.

Republic is prepared to carry out provisions for monitoring deemed necessary by the Supervisor to ensure compliance with the regulations.

Republic is prepared to participate in the collection of data concerning the existing air and water quality, noise, seismic and land subsidence activities and ecological systems of these leases for a period of one year prior to the submission of a plan for production.

D. ENVIRONMENTAL CONCERNS

1. Environmental Considerations of the Organic Working Fluid

The proposed drilling and testing operations differ from normal geothermal activities in that the Sperry organic pump system utilizes an organic working fluid (about 2000 gallons) for its operation. The application of innovative or different technologies often raises questions regarding potential environmental constraints associated with utilizing the technology. Republic has included a list of physical properties of the proposed working fluid, dichlorotetraflouroethane, to facilitate an understanding of this fluid (Table 1). The physical properties of particular interest include the fluid's low toxicity rating (Table 2), its nonflammability and its relative inertness. In addition, the fluid is clear and colorless and has only a faint ethereal odor.

No unusual environmental or safety problems associated with the working fluid have been identified which will significantly affect the East Mesa environment or present a human-health hazard.

TABLE 1

PHYSICAL PROPERTIES OF FLOUROCARBON REFRIGERANT - 114

Flourocarbon Name	Dichlorotetraflouroethane
Formula	$CClF_2$-$CClF_2$
Molecular Weight; g/mol	170.91
Normal Boiling Point; °C	3.77
Normal Freezing Point; °C	- 94
Critical Trmperature; °C	145.7
Critical Pressure; atm	32.2
Critical Volume; cm/mol	293
Critical Density; g/cm	0.582
Density of Liquid at 25°C; g/cm	1.456
Density of Saturated Vapor at B.P.; g/l	7.83
Specific Heat of Liquid at 25°C; cal/g	0.243
Specific Heat of Vapor at 25°C and 1 atm;cal/g	0.170
Heat of Vaporization at B.P.; cal/g	32.51
Thermal Conductivity at 25°C; [liquid]	0.034
Btu/(hr)(ft)(°F) [vapor; 1 atm]	0.006
Viscosity at 25°C; [liquid]	0.38
Centipoise [vapor; 1 atm]	0.011
Surface Tension at 25°C; dyne-cm	12
Refractive Index of Liquid at 25°C	1.288
Dielectric Constant [liquid]	$2.26^{25°C}$
[vapor; 1 atm]	$1.002^{26.5°}$
Solubility in Water at 25°C and 1 atm; wt%	0.013
Solubility of Water in R-114 at 25°C; wt%	0.009
Toxicity; Group Number (See attached table for definition of group number)	6

Source: Handbook of Chemistry and Physics, 57th Edition, 1976-1977. Robert C. Weast, ed. CRC Press, Inc., Pub. Cleveland, Ohio.

TABLE 2

UNDERWRITERS' LABORATORIES' CLASSIFICATION OF COMPARATIVE LIFE HAZARD OF GASES AND VAPORS

(Group number definition)

Group	Definition	Examples
1	Gases or vapors which in concentrations of the order of 1/2 to 1 percent for durations of exposure of the order of 5 minutes are lethal or produce serious injury.	Sulfur dioxide
2	Gases or vapors which in concentrations of the order of 1/2 to 1 percent for durations of exposure of the order of 1/2 hour are lethal or produce serious injury.	Ammonia, Methyl bromide
3	Gases or vapors which in concentrations of the order of 2 to 2 1/2 percent for durations of exposure of the order of 1 hour are lethal or produce serious injury.	Bromochloromethane, Carbon tetrachloride, Chloroform, Methyl formate
4	Gases or vapors which in concentrations of the order of 1 to 2 1/2 percent for durations of exposure of the order of 2 hours are lethal or produce serious injury.	Dichloroethylene, Methyl chloride, Ethyl bromide
Between 4 and 5	Appear to classify as somewhat less toxic than group 4.	Methylene chloride, Ethyl chloride, Refrigerant 112*
	Much less toxic than group 4 but somewhat more toxic than group 5.	Refrigerant 113 Refrigerant 21
5a	Gases or vapors much less toxic than group 4 but more toxic than group 6.	Refrigerant 11 Refrigerant 22 Refrigerant 114B2 Refrigerant 502 Carbon dioxide
5b	Gases or vapors which available data indicate would classify as either group 5a or group 6.	Ethane, Propane, Butane

TABLE 2 (Continued)

UNDERWRITERS' LABORATORIES' CLASSIFICATION OF COMPARATIVE LIFE HAZARD OF GASES AND VAPORS

(Group number definition)

Group	Definition	Examples
6	Gases or vapors which in concentrations up to at least about 20 percent by volume for durations of exposure of the order of 2 hours do not appear to produce injury.	Refrigerant 13B1 Refrigerant 12 Refrigerant 114 Refrigerant 115 Refrigerant 13* Refrigerant 14* Refrigerant 23* Refrigerant 116* Refrigerant C318*

* Not tested by U.L. but estimated to belong in group indicated.

Source: Handbook of Chemistry and Physics, 57th Edition, 1976-1977. Robert C. Weast, ed. CRC Pres, Inc., Pub. Cleveland, Ohio.

2. Cultural Resources and Botanical Surveys

Republic has contracted with the Imperial Valley College Museum for archeological and botanical surveys of the site location. The cultural resources survey is being carried out in accordance with the guidelines of the Bureau of Land Management and in consultaion with BLM archaeologists. The botanical survey report is to include a discussion of plant species present, the location of any threatened or endangered species, and any other appropriate field observations. The botanical survey is to be done in consultation with the USGS-AGS Environmental Section.

Both reports should be complete in time for incorporation in the Environmental Analysis evaluating this proposed Plan of Operation.

E. EMERGENCY CONTINGENCY PLAN

Republic's Blowout Contingency Plan is attached to the Application for Permit to Drill (APD) which is enclosed with this Plan of Operation. This Plan includes the emergency action procedures and notification lists.

APPENDIX B

CULTURAL RESOURCES REPORT
AND
BOTANICAL SURVEY REPORT

ARCHAEOLOGICAL EXAMINATIONS OF THE SPERRY-REPUBLIC GEOTHERMAL PROJECT, EAST MESA

Jay von Werlhof
for
Republic Geothermal, Inc.

with
Lorraine Pritchett
on Botany

11 March 1979
Imperial Valley College Museum
442 Main Street, in
El Centro, California 92243

CONTENTS

INTRODUCTION

The Sperry-Rand Corporation proposes to install a Low Temperature Geothermal Conversions System Program on the East Mesa, in Imperial County, California. Republic Geothermal, Inc., is functioning as consultant to Sperry-Rand on the project. In this capacity, Tawna Nicholas, Senior Environmental Planner for Republic Geothermal, requested on 23 February 1979 that Imperial Valley College Museum conduct an archaeological and botanical survey of the subject property and have a prepared report on the results by 19 March this year. She supplied IVCM with the maps and guidelines necessary to perform this work.

Specifically, the archaeological survey and report must be done in accordance with Bureau of Land Management guidelines and in consultation with the BLM Area archaeologist. In this case it would be Archaeologist Gail Egolf of the El Centro BLM Area Office. The botanical report is to include a discussion of dominant plant species, threatened and endangered plant species, and any other appropriate field observations touching the concerns. The botanist, Lorraine Pritchett, was also to enter into consultation with the USGS-AGS Environmental Section in Menlo Park assigned to the task of preparing the Environmental Assessment on the project Sperry-Rand designed.

IVCM Senior Archaeologist Jay von Werlhof scheduled, through Environmental Studies Coordinator Sherilee von Werlhof, the field work for the weekend of 10-11 March. Preliminary studies were then made, the field equipment assembled, and the field work was carried out on time.

SUMMARY OF RESULTS

1) Archaeological. One artifact--an isolate not associated with a feature--was discovered during the intensive survey.

2) Botanical. Two population scatters of buckwheat were noted within the proposed impact zone. The species is on the endangered plant lists.

PURPOSE

1) Archaeological. To discover, record, and report all cultural resources within the proposed project area and, if present, to recommend such mitigation measures as would most likely protect or preserve them.

2) Botanical. To identify all dominant plants within the project area, and to especially note the absence or presence of any plant on the lists of threatened or endangered species. Related and appropriate field observations would include the relative range of population densities.

METHODS:

1) Archaeological. Preliminary studies routinely made for all archaeological surveys include:

a) Map studies. Republic Geothermal, Inc., prepared a map of the project area on a overlay of a detailed topographic map based on two foot contours and at a scale of 47/8" = 1 mile. The project area can also be shown on the composite maps of USGS quadrangles:

> Holtville East, T16S, R17E and Glamis SW, same T R, in the west portion of the SW¼ Sec. 5, the SE¼ Sec. 6, and the east portion of SW¼ Sec. 6.

The project area is 450' NS and 880' EW, beginning at the NE corner of the CCIF Access paved road. These locations are shown on the accompanying maps.

Pertinent here, East Mesa archaeological studies have shown a close correlation to exist between contoured elevations and aboriginal land-use patterns. The sensitive elevations for site predictions occur between the 30' and 40' contours related to the ancient beachline of Lake Cahuilla. Random and isolated sites are unpatterned elsewhere except where

swales between large hummocks contain lithic resources. Flaked tools and isolates and sherds have been reported within such topographic features (von Werlhof, 1978).

Map studies thus help establish levels of prediction, useful even in an intensive survey where a 100% sample is examined for a given project.

b) Records and Literature Search. The searching through records and reports for previously reported archaeological sites is a routine and imperative aspect of field planning. IVCM maintains the largest number of archival records and reports for Imperial County known. Too, many of those have been compiled through IVCM field investigations, giving the project staff a first-hand familiarity with the East Mesa studies. All known sites are thus plotted in areal relation to the new area to be examined. It was noted that, indeed, the proposed project area had been examined before when Archaeological Research, Inc., made transects through this sector of the East Mesa while on a large-scale survey for the Bureau of Reclamation (Ellis and Crabtree, 1974). Their field records *per se* were unfortunately lost, and though the resultant field maps showed no sites discovered within the Sperry-Rand area of concern, the reviewing agencies for the current project required another field examination. Too, a botanical element had not been requisite for government surveys at the earlier time.

IVCM Environmental Botanist Lorraine Pritchett made a detailed inventory of the contiguous Section 7 immediately south of the current project. She also prepared a detailed examination of Republic Geothermal fields a mile and a half to the north. A review of her

records alerted her to the possible/probable populations of plants within the Sperry-Rand project area (von Werlhof, 1977, 1978).

c) Staffing. IVC and IVCM students and staff were drawn upon to make up the field personnel for this project. Jay von Werlhof was in overall charge, and, with Sherilee von Werlhof, devised the strategy necessary to cover all aspects of the investigation. They both worked with all crews, double-checking areas covered. Karen Smith, MA History, California State Polytechnic University (San Luis Obispo), with a minor in Archaeology, was crew leader with a survey team composed of William Hyde and Barbara Ash, both IVC students in archaeology. Margaret Keldsen, IVC second-year student in archaeology, headed the other survey crew, with archaeology students Rick Peryham and Jim Johnson. Harry Casey was assigned field photography, and Tom Murphy as assistant. Howard Pritchett, IVCM Mapper, and Wayne Keldsen, were in charge of topographic data and site locations. Botanist Lorraine Pritchett surveyed the entire parcel for preparing plant lists and distribution maps of plants. Each person kept his own field book in which field notes were made.

d) Procedures. The two survey crews lined abreast along the north arm of the GCTF Road on ten meter centers, and proceeded to the south boundary of the subject area. They then moved westward, and returned. This procedure of areal coverage was repeated until the parcel had been surveyed. Each member zig-zagged his course to make sure the total coverage was a 100% survey. Jay and Sherilee von Werlhof transected the small parcel boundary east of the NS

arm of the road to determine if any sites ancillary to the project area might exist. The results were negative here as with the main area. The von Werlhofs, Casey, and H. Pritchett also made EW sweeps as a double-check on the regular crew, with no sites noted.

2) Botanical. Lorraine Pritchett, IVCM Environmental Botanist, began her investigation in the NE corner of the parcel, and using intuitive as well as systematic examinations traversed the whole of the parcel. H. Pritchett and Sherilee von Werlhof are also knowledgeable of the endangered plants of Imperial County, and added supplemental observations to those of L. Pritchett. Buckwheat was the only species noted that was on the published lists.

TOPOGRAPHY

The topographic setting of the Sperry-Rand area is of a series of rolling sand hills which are gradually becoming stabilized. These are in contrast to the dunes east which constantly shift. This is not to say that blow sands do not influence the configurations of the area, and an examination of the topographic contours show to what general degree this occurs. The parcel slopes from a low of 16' in the SW corner to a high of 46' in the NE, attributable mainly to wind patterns. The middle belt of the subject area, following a NW to SE pattern, was of particular interest archaeologically for its conformity to the Lake Cahuilla beach line and embayment shorelines. The 40' contour marked the high of the three stages of resurgence of the lacustrine body from about 2000 years BP to approximately 1500 AD when presumably the last stand dried rapidly. The 40' line enters the subject area and follows southeasterly out of it into the NE corner of the Magma Geothermal Plant Site area where numerous cultural resources sites were discovered.

ARCHAEOLOGICAL SETTING

The key to an understanding of the archaeology of the East Mesa is Lake Cahuilla, at least for the prehistoric period of the Yuman Culture. No Early Man sites have been found on the East Mesa, though it is clear that the evidence of his having been there has simply been erased. San Dieguito trails disappear as the west side of Imperial Valley is approached from the Peninsular Range, and they again pick up on the east side of the Sand Dunes and continue on to the Colorado River. By interential evidence, then, Early Man utilized the East Mesa as at least a pass-through area, and it is possible that he exploited resources there which are no longer present. This Late Pleistocene culture disappeared with the environmental change the Holocene Period ushered in, with an increased evaporation rate and a decreased precipitation rate. The San Dieguitan simply could not adjust further to the growing desertization process in which he was trapped. It is not known what happened, whether he moved out or died out, but by perhaps 7,000 BP the culture had ceased in Imperial County.

There is no evidence that the successive Amargosan Culture utilized the East Mesa. Not until the coming of the Yumans about 2,500 years ago do we find the Lower Colorado Desert of human interest once more. First establishing themselves along the river, the Yumans gradually pushed westward, first by population pressure probably, and then by attraction to Lake Cahuilla. At the time the lake arose the Yumans had spread into the Peninsular Range, and beyond to the coast. The lake divided the large group into eastern and western halves. The body of fresh water from the river backed up as far north as Indio and as far south as Mexicali Valley. It stood at the brink of East Mesa, and covered Imperial Valley and lapped at the bases of Fish Creek and Santa Rosa mountains. The sustaining waters of the lake were from the river floods which began with late Spring melting snows in the Rocky Mountains. Silts had jammed the egress of the river's normal course to the Gulf of California, forcing the entire water supply into the Imperial Valley and beyond.

Years of drought offset the annual effect of floods during the wet cycles, making the level of the lake unstable. Yet at least three high stages occurred during its career, with the 40' line being met at each.

The riverine people seasonally visited the east shore to fish, hunt small game, and gather wild foods. The fish camp that IVCM excavated at the Magma site, and the small projectile points found at Magma and the Republic site, attest to the economic base the aborigines attached to the lake. Numerous sherds have been identified, showing that some imported their pottery from the Lower Colorado River and others manufactured pottery from clays locally available. Exotic stones from the Pilot Knob Mesa have also been found along the shoreline, as well as obsidian tools quarried from the Salton Sea site at a time when lake levels exposed that volcanic source.

That the visitors worked in small bands which concentrated at group-sites rather than evenly spread along the shore is clear. Concentrations of camps occur most frequently, and artifactual isolates are uncommon. This is true of the demographic patterning along the whole East Mesa. While large concentrations were recorded at Republic and Magma, none appeared at Sperry-Rand. Other East Mesa sites, as 4-Imp-103 and 104 also have similar sizes, composition, and beach-line orientation. Carbon dating so far has placed the Republic-Magma-103/4 series at the final high stand of the lake between the Thirteenth and Fifteenth centuries, though additional materials are now being processed from successive strata between 18"-42" at 4-Imp-104. The other strata for dating have been 0"-18", the upper phases of occupation.

The recovered artifactual material from East Mesa generally shows a temporary land-use rather than long-term occupancy. Food processing equipment is generally lacking, as is such gear as for sewing, chopping, digging, playing, and conducting rituals. Though known, the general lack of cremation sites indicate that productive members of a band visited the lake rather than extended families. Hunting

gear is essentially for small game, and cutting tools are not heavy duty. There is an overall scarcity of prepared campsites, such as hearths and living floors. This also indicates that site usage was during milder or warmer periods of the year.

RESEARCH PROBLEMS

The greatest lack of information on the East Mesa archaeology can be attributed to a general lack of information on Lake Cahuilla. Portions of the lakeshores have been studied, and some dates have been prepared for different elevations. But until the whole story of the geologic past is made for the lake, our interpretive values on the archaeology will be incomplete. Here, a deficiency is now being corrected. At the present time, Mike Waters, a graduate student in geology at University of Arizona (Tucson) has a M.A. program underway which is directed to the rise and demise of Lake Cahuilla. His is a multidisciplinary approach, and such auxillary studies as palynology, organic tufa, and biology will be utilized along with hydrology, sedimentation, and climatology.

Adaptive strategies also need to be more fully studied, and here patterns of exploitation can be completed with problem-oriented excavations.

FIELD RESULTS

No archaeological sites were discovered in the field examination of the Sperry-Rand plot. One isolated hammerstone, of honey quartzite, was found on the bank of a drainway, displaying characteristic batter marks on one end. The item was collected since it was an isolate whose integrity had probably been disturbed or destroyed through downwashing. The botanical report is attached.

MITIGATION

Since nothing was discovered there is no recommendation to be made.

NATIVE AMERICAN VALUES

There are no associated cultural resources at the Sperry-Rand parcel to which this subject needs be addressed.

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1978 Archaeological Examinations of the Republic Geothermal Field, East Mesa: A Final Report. IVCM, 12 April 1978.

BOTANY

by Lorraine Pritchett

The following plants were extant on Republic's East Mesa Sperry project site:

Abronia villosa	Sand verbena
Ambrosia dumosa	White bursage
Atriplex canescens	Wingscale
Baileya pauciradiata	Lax flower
Coldenia plicata	Plicate coldenia
Dithyrea californica	Spectacle pod
Ephedra californica	California joint fir
Eriogonum deserticola	Desert buckwheat
Hesperocallis undulata	Desert lily
Larrea tridentata	Creosote bush
Oenothera decorticans var. desertorum	Woody Bottle Washer
Oenothera deltoides	Dune primrose
Oenothera pallidula	Pale yellow primrose
Palafoxia linearis	Spanish needle
Plantago insularis	Woolly Plantain
Schismus barbatus	Schismus grass
Sisymbrium irio	London rocket

The most abundant species are Larrea tridentata and Sisymbrium irio. The populations vary in size and density but have universal dispersion on the plot. Atriplex canescens, Plantago insularis and Schismus barbatus, are the next most populous species. They also have a wide distribution.

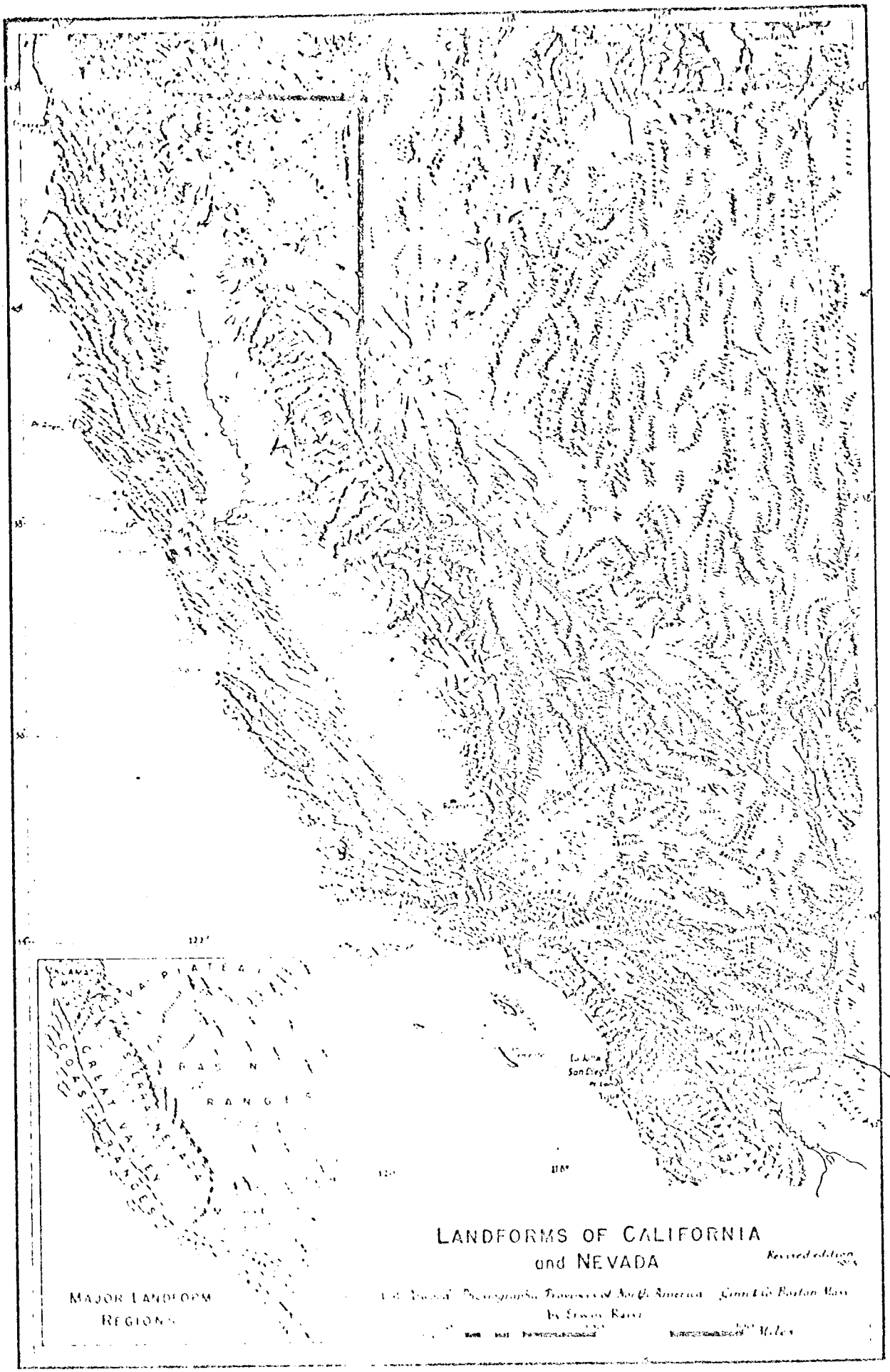
Ambrosia dumosa, Dithyrea californica and Oenothera pallidula have a medium density population with specimens found over much of the area.

There is a light population of Ephedra californica and it is confined to the Northwestern sector of the plot. Coldenia plicata is also sparsely represented.

Annuals Palafoxia linearis, Abronia villosa, Baileya pauciradiata, Hesperocallis undulata, Oenothera decorticans, and Oenothera deltoides are

present, but since it is early in the season there are relatively few specimens of each and only a few are blossoming.

A rather widespread, medium-density population of Eriogonum deserticola is present on the tract. This Desert Buckwheat is listed on both the Federal and the California Native Plant Society lists as a Threatened specie. No other species listed as Threatened or Endangered were found.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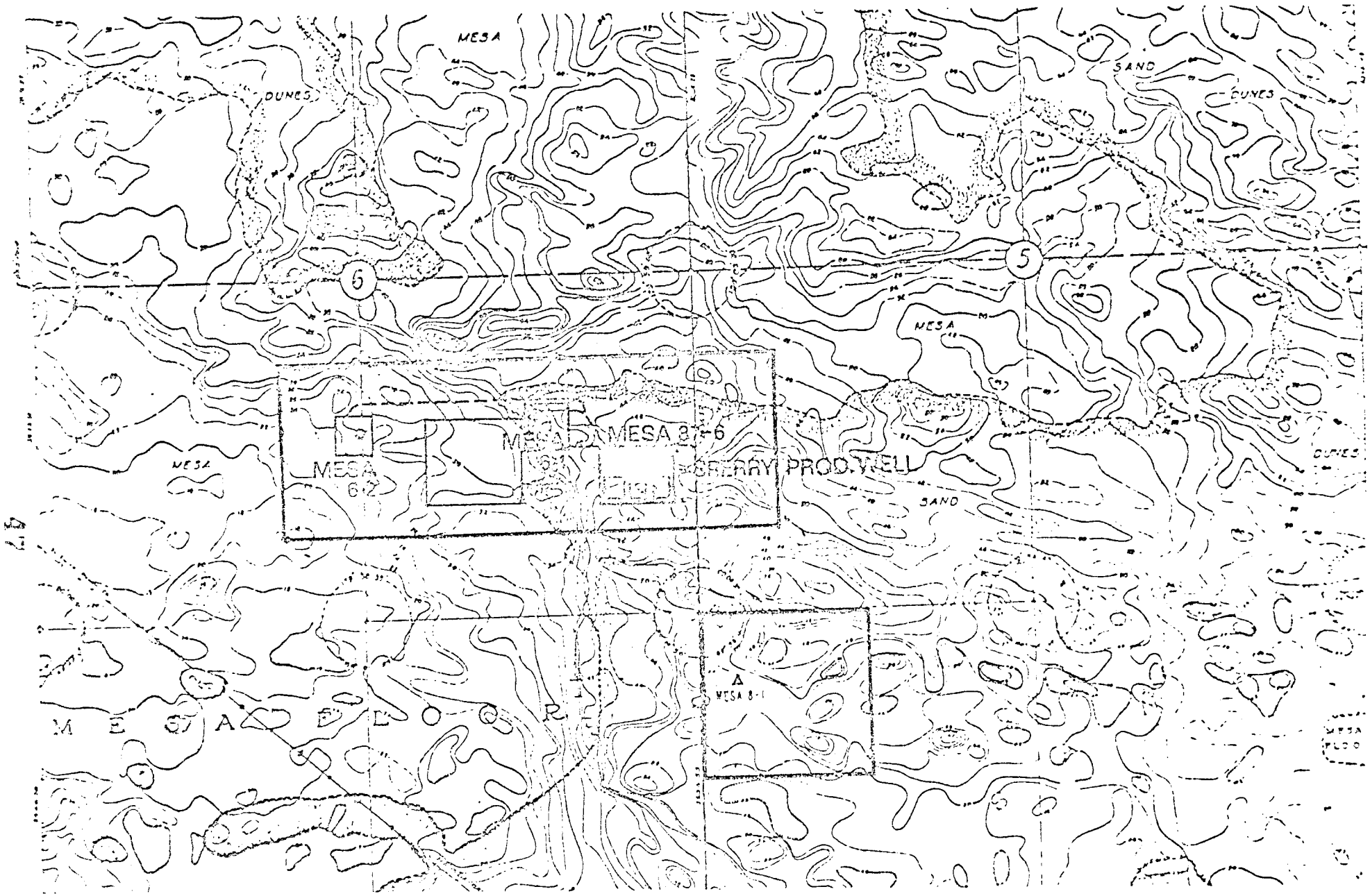
and NEVADA
MAJOR LANDFORM REGIONS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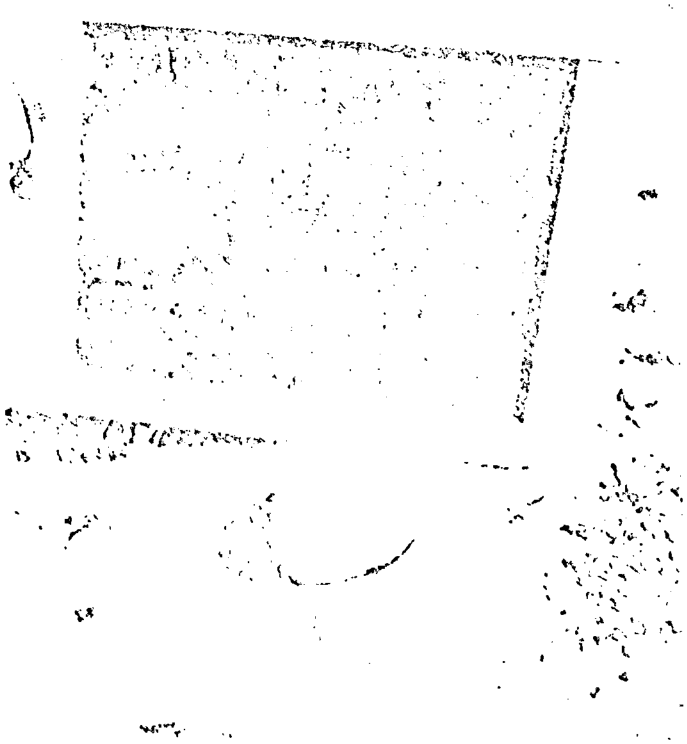

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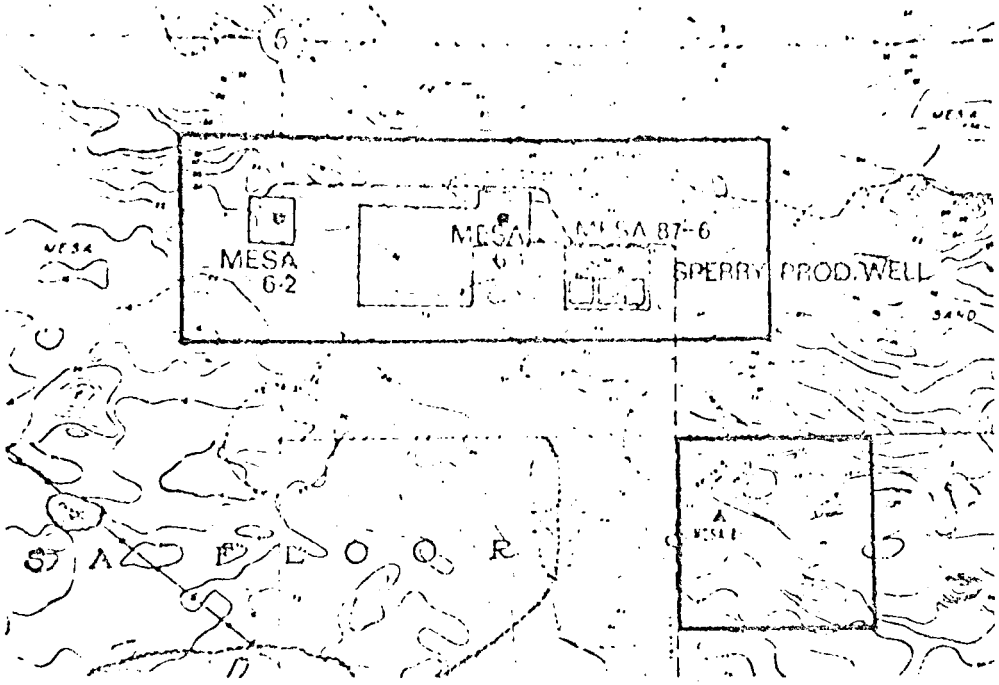
Quartzite hammerstone.



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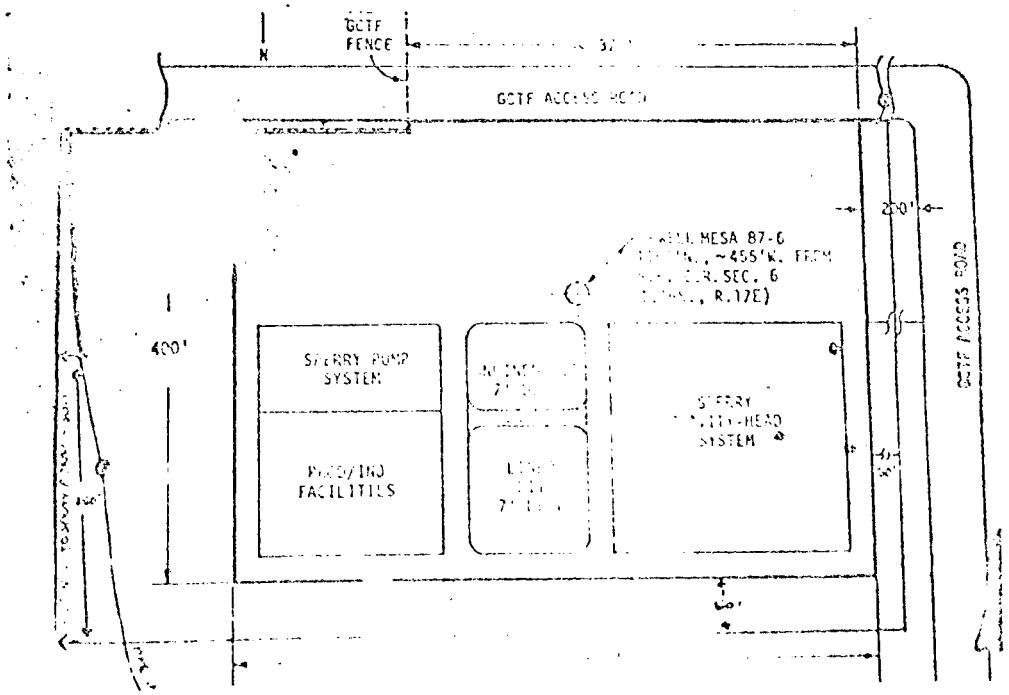
Shaded area is Project area.



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Detail shown in shaded area.