CLOSURE REPORT

EAST MESA GEOTHERMAL TEST FACILITY

JULY 31,1998

UNITED STATES
DEPARTMENT OF ENERGY
Oakland Operations

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ACRONYMS AND ABBREVIATIONS

Bechtel	Bechtel Environmental, Inc.
BLM	Bureau of Land Management
Corps	United States Army Corps of Engineers
CCR	California Code of Regulations
CFR	Code of Federal Regulations
DOE	United States Department of Energy
EE	DOE Office of Energy Efficiency and Renewable Energy
EM	DOE Office of Environmental Management and Waste Management
EPA	United States Environmental Protection Agency
gpm	gallons per minute
GTF	East Mesa Geothermal Test Facility
IAG	Interagency Agreement
MDC	minimum detectable concentration
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mrem/hr	millirems per hour
NEPA	National Environmental Policy Act
NORM	naturally occurring radioactive material
OHM	OHM Remediation Services Corp.
pci/kg	picocurries per kilogram
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
STLC	Soluble Threshold Limit Concentration
TCLP	Toxicity Characteristic Leaching Procedure
TDS	total dissolved solids
TPH	total petroleum hydrocarbons
TTLC	Total Threshold Limit Concentration
μCi/ml	microcurries per milliliter
WET	Waste Extraction Test (California)
yd^3	cubic yards

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EAST MESA GEOTHERMAL TEST FACILITY
CLOSURE REPORT

Section I

INTRODUCTION

The purpose of the *East Mesa Geothermal Test Facility (GTF) Closure Report* is two fold. The first is to provide a document that validates the completion of remediation at this Department of Energy (DOE) waste cleanup project. The report's second purpose is to provide a review of the project cost and performance information and technology applications so that any experience gained can be applied to other similar cleanup projects.

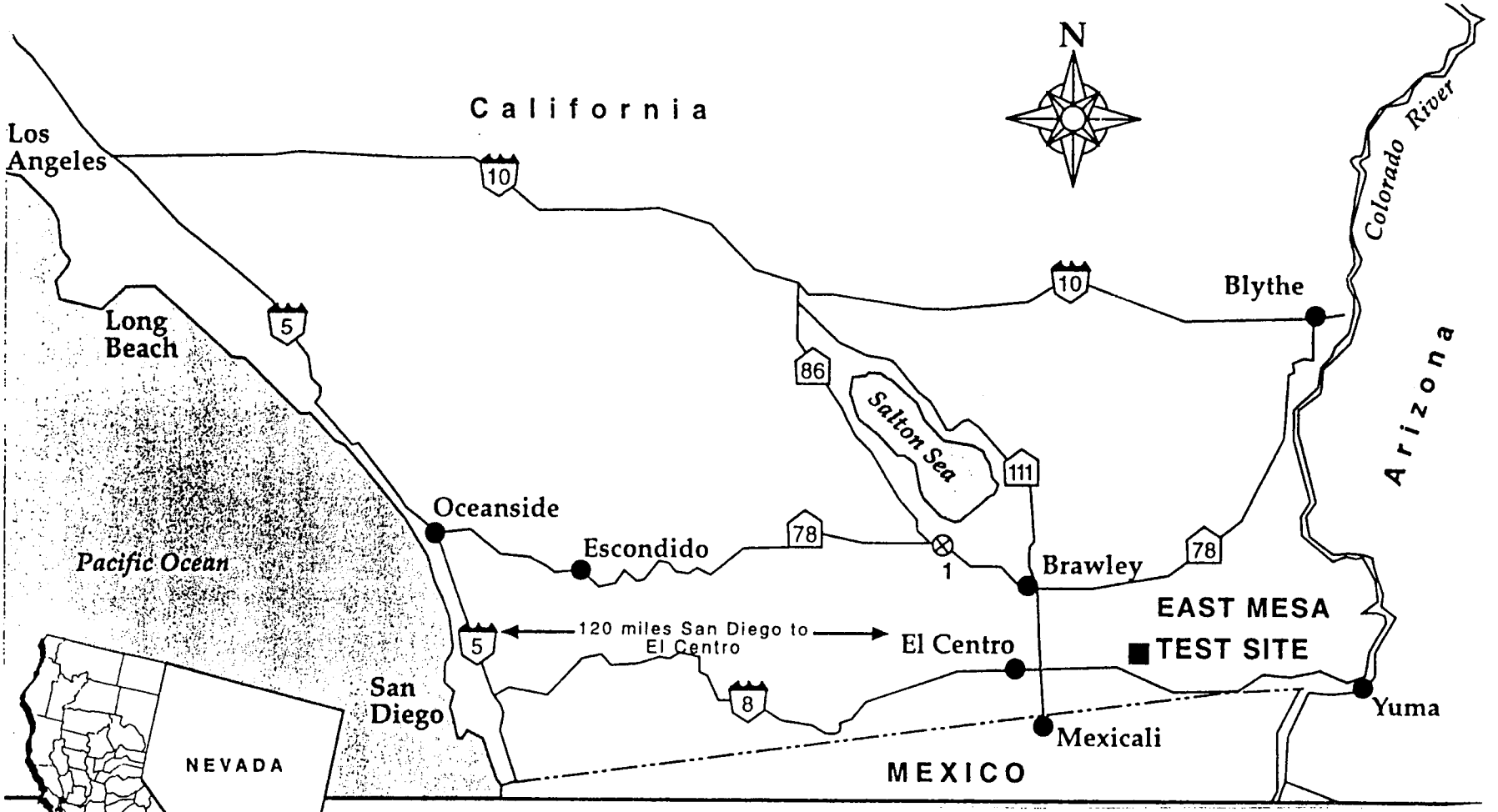
Since 1987, GTF had been a non-operational and abandoned experimental geothermal power generation and desalting facility situated on 82 acres of Bureau of Land Management (BLM) land in California's Imperial Valley. Experimental work was initiated at GTF in 1968 by the BLM. In 1978, DOE became the exclusive site operator with the DOE Office of Energy Efficiency and Renewable Energy (EE) as the operating office. DOE was granted a right-of-way agreement with the BLM to operate the site. Geothermal test activities were discontinued in 1987 and the facility was declared surplus by EE. In 1992, the issue of remediating the GTF site began to receive Congressional interest. DOE agreed in 1993 to remediate the site and return it to the BLM.

GTF consisted of a six-acre brine pond, a one-acre spray pond, two prefabricated buildings, fencing, cooling tower, septic system and drains, five production/injection wells, experimental apparatus, piping, concrete pads, and road base. From 1987 to 1997, the site was in a safe shutdown condition. Site investigation work by EE identified minimal contamination at the site. Contamination was found in the six-acre brine pond and consisted of a portion (less than one-acre) of the pond residue slightly above State of California acceptable contaminant levels for arsenic. In addition, asbestos was identified in the structures.

A Memorandum of Agreement for remediation of GTF was reached in 1995 between EE and the DOE Office of Environmental Restoration and Waste Management (EM). EE provided funding for building and legacy equipment demolition and removal activities, and for site restoration of the non-pond areas. EM provided funding for remediation and removal activities of the brine and spray ponds, and for returning the pond areas to a natural state. Four GTF geothermal wells and associated piping were transferred to adjacently located commercial geothermal companies. Environmental restoration activities were completed in 1997.

The restoration work at GTF was accelerated as a result of including GTF in the EM's Small Site Initiative. This initiative focused technical and financial resources at small DOE cleanup sites that could be completely remediated within a five year period, thereby reducing mortgage liability and overall project costs. Employing this initiative, using creative partnering and contracting approaches, recycling, and working closely with regulators and stakeholders resulted in completing the project well ahead of schedule and under budget.

J.N. 18904 DWG. NAME: 100GT1-1.DWG PLOT @ 1=100 DATE: 6-26-96 J.B.M.



⊗ Disposal Facility (Approximate Location)
1. Laidlaw Environmental

SOURCE:
URIBE & ASSOCIATES ENVIRONMENTAL CONSULTING SERVICES, 1996

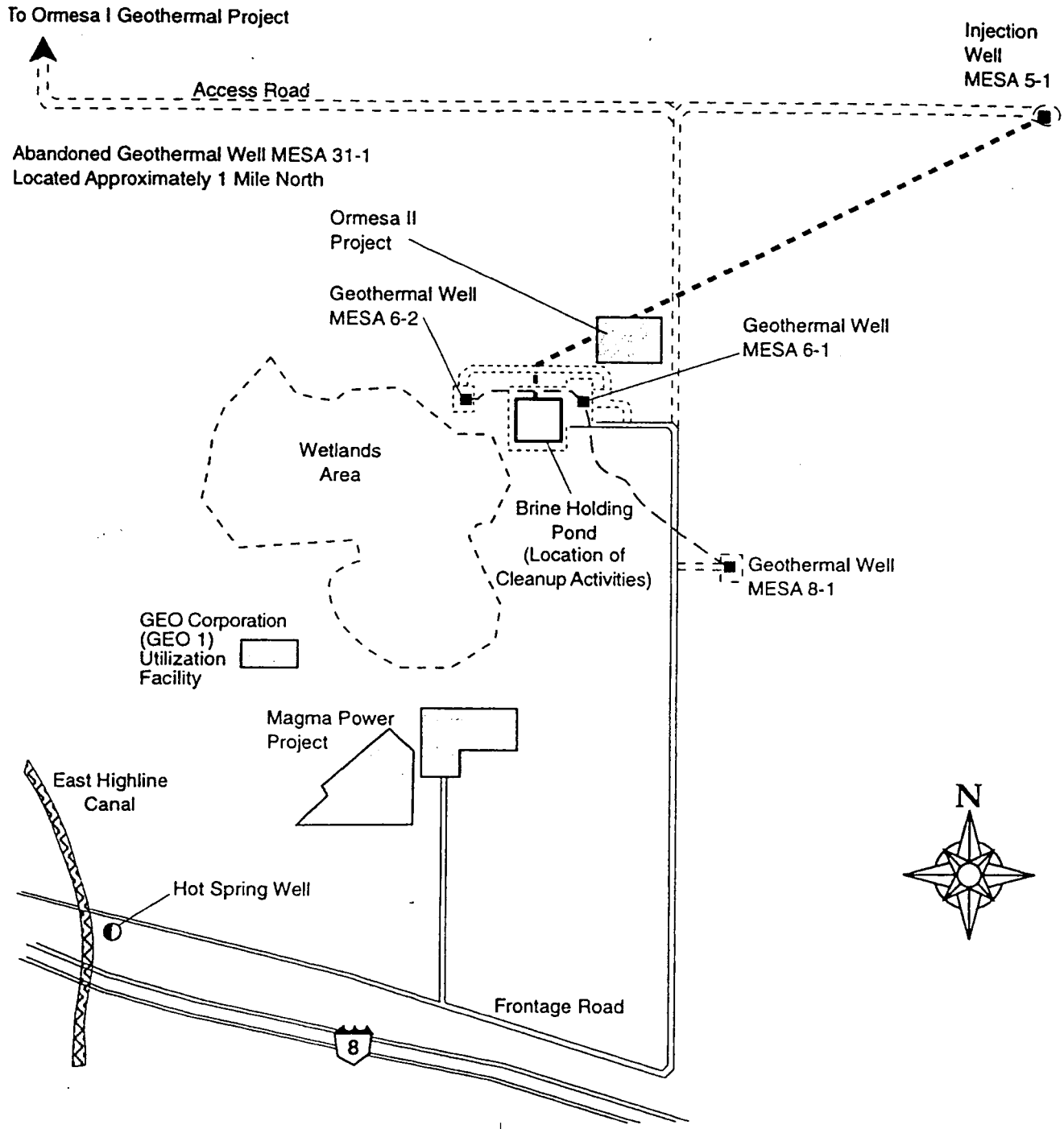
OHM Remediation Services Corp.
SAN DIEGO, CALIFORNIA

SITE LOCATION MAP

EAST MESA GEOTHERMAL TEST FACILITY EL CENTRO, CALIFORNIA

DRAWN BY	DATE	CHK'D. BY	DATE
J.B.MOSS	6-26-96	D. OLSON	6-26-96
APP'D BY	DATE	PROJECT MANAGER	DATE
P. EVERDS	6-26-96	J. PEPIN	6-26-96

PROJECT NO. 18904 FIGURE 1-1



Source: EMO Limited Feasibilty Study, August 1992

0 1000 2000 3000

SCALE IN FEET

SOURCE:
URIBE & ASSOCIATES ENVIRONMENTAL CONSULTING SERVICES, 1996

OHM Remediation Services Corp.
SAN DIEGO, CALIFORNIA

SITE VICINITY MAP
EAST MESA GEOTHERMAL TEST FACILITY EL CENTRO, CALIFORNIA

DRAWN BY	DATE	CHK'D. BY	DATE
J.B.MOSS	6-26-96	D. OLSON	6-26-96
APP'D BY	DATE	PROJECT MANAGER	DATE
P. EVERDS	6-26-96	J. PEPIN	6-26-96

PROJECT NO. 18904 | FIGURE 1-2

J.N. 18904 DWG. NAME: 100GT1-2.DWG PLOT @ 1=100 DATE: 6-26-96 J.B.M.

During site operations from 1972 to 1975, the waste brine was discharged into the holding pond. Loss rates from the pond due to evaporation were estimated to range from as high as 60 gallons per minute (gpm) in the summer to negligible amounts during the winter. The holding capacity of the pond was inadequate to handle increased site activities; consequently a waste brine injection system was installed in 1976. The holding pond was used intermittently after installation of the injection system, both to supplement the injection system, and to provide for brine disposal when the injection system was not in operation. The ponded brine was monitored monthly for dissolved oxygen, total dissolved solids, pH, and conductivity. Geothermal research activities at the site were discontinued by 1987 as commercial-scale geothermal power development matured in the region.

Field investigations and feasibility studies of the site that supply more detailed information can be obtained from the following sources:

Field Investigation Report, Bechtel Environmental, Inc., 1991. Report covering characterization of the brine pond residues and the health and safety monitoring, focusing on potential radiological concerns (Bechtel, 1991).

Limited Feasibility Study, Bechtel Environmental, Inc., 1992. Study of the development and analysis of four remedial action alternatives for remediation of the brine pond based on the Field Investigation Report (Bechtel, 1992).

Site Restoration Phase II Report, Dames and Moore, 1993. Report on the results of Phase I and Phase II site securing, safety, and sampling/analysis activities. Focused primarily on facilities and equipment (Dames and Moore, 1993).

2.3 Site Logistics/Contacts

Organization	Name	Phone No.
DOE EE Project Manger	Greg Collette	303-275-4734
DOE Headquarters EE Program Manger	Ray Fortuna	202- 586-1711
DOE EM Project Manger	Hemant Patel	510-637-1568
DOE Headquarters EM Program Manger	Rod Cummings	301- 903-7606
US Army Corps of Engineers Project Manager	Andy Winslow	402-293-2532
BLM Field Engineer	Larry Caffey	619-337-4425
Regional Water Quality Control Board Project Manager	Neal Krull	619-776-8942

2.4 Technology Application

Innovative technologies were not applied in the brine pond remediation because the excavation and off-site disposal alternative was determined to be the most cost and time effective remedial alternative.

Section 3

MATRIX AND CONTAMINANT DESCRIPTION

3.1 Matrix Identification

The contaminated matrix was limited to sand/residue in the six-acre brine pond. No contaminated groundwater at the site resulting from DOE operations was identified.

3.2 Regional Geology/Stratigraphy

The East Mesa Geothermal Test Facility is situated in the southern California desert on the eastern edge of the Imperial Valley. This valley is part of the topographic and structural trough (Salton Trough) in southeastern California. The Salton Trough is about 130 miles long and as much as 70 miles wide, with much of the land surface at an elevation below mean sea level. Surface drainage is north toward the lowest part of the trough which is occupied by the Salton Sea. The trough is a tectonically active feature with many faults within its boundaries, most notably the southeast-northwest trending San Andreas fault zone.

Broad alluvial fans and plains sloping to playas, creating closed dry drainage basins, are representative of the area. Frequent faulting in the area causes separation of basin-fill deposits. The basement complex consists of Precambrian to recent metamorphic and igneous rocks. The eastern shoreline of the prehistoric Lake Cahuilla is near the western boundary of the site. Surficial deposits are composed of unconsolidated deltaic sand, windblown sand, gravel, and silt.

The geographic and geologic controls that govern the occurrence, movement, and chemical quality of groundwater of the Salton Trough, specifically within the East Mesa area, vary widely. The variability of the chemical quality of the water contained in the rocks is due to differences in location with respect to the water table and opportunities for recharge, to compositional differences in sources of recharge, and to the high evaporation rate in the arid climate.

Some of the deeper groundwater in the area may be moderately altered connate ocean water. At the shallower depths, the water consists of evaporation residuals of water from prehistoric Lake Cahuilla or earlier freshwater lakes. These shallow aquifers are slightly saline because canal leakage and, to a much lesser extent, storm runoff have leached soluble evaporates from sedimentary rocks now above the water table.

3.3 Contaminant Characterization and Properties

The Bechtel Environmental, Inc. *Field Investigation Report* (Bechtel, 1991) presents a description of the field investigation and characterization activities conducted on the brine pond residues, health and safety monitoring procedures, and potential radiological concerns. The focus of the analytical work was to ascertain whether or not the residues could be considered hazardous by either the State of California or Federal regulations.

A total of one hundred samples were collected within the confines of the pond, and combined into 25 composite samples. The pond was divided into a 5 by 5 grid, and within each grid section, four samples were collected and composited. In addition, two sample duplicates were collected from the pond residues and two grab samples were collected from areas which appeared different from the bulk of the pond residues, resulting in a total of 29 samples.

The samples were analyzed for a variety of parameters including total soluble threshold limits for the seventeen metals listed under California Code of Regulations (CCR) Title 22. The soluble threshold limits for these metals were assessed using the California Waste Extraction Test (WET). Samples were tested for Resource Conservation and Recovery Act (RCRA) hazardous waste characteristics of ignitability, corrosivity, toxicity (Toxicity Characteristic Leaching Procedure [TCLP]), and reactivity. Gross alpha and gross beta radiation counts, as well as oil and grease, total petroleum hydrocarbons (TPH), and the California 96-hour static acute bioassay tests were performed.

Oil and grease and total petroleum hydrocarbons were present at negligible levels, with all values well below 100 mg/kg. At only three of the twenty seven locations examined, arsenic concentrations were at or slightly above the soluble threshold limits (5.0 mg/L for arsenic).

Naturally Occurring Radioactive Material (NORM) was also identified in the brine pond residue. In order to investigate radiological concerns, comprehensive sampling and analysis were conducted continuously during field activities. Gross alpha ranged between 8,200 and 180,000 pCi/kg, with gross beta counts between 2,300 and 170,000 pCi/kg.

Inhalation exposures to long-lived radioactive particulate matter derived from air sampling were well below the occupational limit of 4.25×10^{-12} μCi/mL for continuous exposure. The maximum limit of detection for any sample was 9×10^{-13} μCi/mL.

External gamma radiation dose rates obtained from site surveys and absorbed dose measurements were approximately 0.03 mrem/hr. The average of the absorbed dose measurements taken during this project on the pond surface at 1 meter elevation was 0.026 mrem/hr. This is about 1 percent of the annual limit for continuous occupational exposure. As a result, no external personal dosimetry, record keeping, or access time limitations were required for work on this site based upon external exposure considerations.

Environmental monitoring results were similar to personnel sampling results. All three samples collected contained less than the minimum detectable concentration (MDC). MDCs ranged from 1.7×10^{-14} μCi/mL to 5×10^{-14} μCi/mL. The MDC for environmental samples was less than that for personnel air samples because of larger air collection volumes.

Three brine pond samples were selected at random from the 29 samples collected during the field investigation, and each sample was subjected to the California WET with the exception that deionized water was substituted for the standard citric acid reagent. The extraction test was conducted with a 1:10 ratio (weight: volume) of soil to extraction fluid. The water wash produced a total dissolved solids (TDS) content of about 16,000 mg/L, composed almost entirely of sodium chloride.

The results of the characterization of brine pond residue were:

- The brine residue was not a RCRA-defined hazardous waste based on characteristics of ignitability, corrosivity, toxicity, and reactivity.
- The brine residue was not a California-defined hazardous waste based on Total Threshold Limit Concentration (TTLC) analytical results and California 96-hour static acute bioassay tests.
- Soluble Threshold Limit Concentration (STLC) analytical results indicated soluble concentrations of the 17 California Code of Regulations (CCR) Title metals were below regulatory limits except for arsenic.
- Soluble arsenic was detected at or above the California hazardous waste regulatory limit of 5.0 mg/L in 3 composite samples.
- TPH (EPA Method 418.1) and oil and grease (EPA Method 413.2) were below California typical soil cleanup levels.
- TDS concentration of brine residue was approximately 16,000 mg/L.
- NORM levels met US Department of Transportation Hazardous Materials Transportation regulations [49 Code of Federal Register (CFR) 171-78]. At that time there were no Federal or California regulations for NORM waste.
- The State of California required off-site disposal at a Class I disposal facility because of the geothermal origin and associated concentration of NORM of the waste.

3.4 Nature and Extent of Contamination

Soil contamination was found to be contained within the perimeter of the brine pond. The brine pond was surrounded by 8-foot high soil berm. The pond was underlain by a 6- to 9- inch protective sand layer over a 10-mil PVC liner. Confirmatory sampling verified that the liner was effective in preventing the vertical migration of contaminants. The contaminant characterization is reviewed above.

No groundwater contamination was identified.

Section 4

REMEDIATION SYSTEM DESCRIPTION

The non-pond area materials were removed, recycled, and/or disposed. The project scope consisted of the following:

- Asbestos abatement of pipe insulation, transite cooling tower boards, and floor tiles
- Testing and removal of septic system
- Removal of concrete pads, floor slabs, and pipe supports
- Demolition of the shop building and office/lab building
- Demolition of storage tanks
- Demolition of piping materials
- Demolition of equipment such as cooling tower, electrical duct banks, and platforms
- Removal of asphalt paving
- Removal of boundary fencing
- Plug and abandon or transfer to local industries all geothermal or other wells
- Removal of buried construction materials

The brine pond residue was excavated using conventional equipment and loaded in dump trucks. Due to the geothermal origin of the waste and associated concentration of NORM, off-site disposal was required at a Class I disposal facility. The Westmoreland Landfill was the only disposal facility in southern California permitted to accept NORM geothermal waste streams. Disposal sites were also evaluated in Arizona, but due to permitting and transportation issues, they were not selected. The waste was transported in covered semi-end dump trucks. Transportation and disposal activities were initiated on October 1, 1996 after completion of waste profile documents. Hauling and disposal activities were completed on November 8, 1996. Appendix A shows photographs before, during, and after remediation of the brine pond residue.

Four geothermal wells were transferred to commercial companies operating in the vicinity of the GTF project. BLM approved the transfer of the wells identified as 5-1, 6-1, 6-2, and 8-1 in a letter dated 10/4/93 (Appendix B). The transfer released DOE from the responsibility of the ultimate disposition of the four wells and from including the wells in the GTF remediation effort. The commercial companies accepted the ultimate responsibility of plugging the wells when they were no longer in operation.

Section 5

REMEDIATION SYSTEM PERFORMANCE

The non-pond area demolition and restoration project was successfully completed through EE during 1996. About 300 cubic yards of material was disposed in a local landfill. The remaining material was recycled. Recycled material included:

- 1400 cubic yards of concrete
- 550 cubic yards of asphalt
- 150 tons of scrap metal, including 2.4 miles of pipe
- Laboratory and warehouse buildings taken down and reused
- 10,000 gallon water tank
- 780 feet of chain link and barbed wire fencing
- One mile of copper wire
- Septic tank

Successful brine pond residue excavation, transportation, and off-site disposal and the subsequent site restoration of the brine pond at GTF was performed by OHM Remediation Services Corp. (OHM). EM contracted the Army Corps of Engineers (Corps) to remediate the brine pond and the Corps contracted with OHM to perform the actual remediation work.

Detailed information on the GTF remediation system performance can be obtained from the *Final Report for Geothermal Test Facility Restoration* (DOE, 1996) and the *Final Closure Report - East Mesa Geothermal Test Facility - El Centro, California* (OHM, 1996).

Section 6

REMEDIATION SYSTEM COSTS

During the 1994 appropriations process, language was added to the Senate Energy and Water Development Appropriation allowing the expenditure of up to $5M to restore GTF as an expedited response action. EE originally estimated post-1993 non-pond remediation costs to be $.6M and EM originally estimated pond remediation and associated project management costs to be $3.6M, for a total DOE remediation cost of $4.2M. EE post-1993 actual remediation costs totaled $.5M and EM actual remediation costs totaled $2.7M, for a total post-1993 DOE remediation cost of $3.2M. From 1991 through 1993, EE incurred $415K in remediation costs for pond assessments, building interior cleanups, a limited feasibility study, and Phase I and II remediation efforts.

The EE portion of the GTF Demolition Project total budget for 1996 was $620,000. The project was broken into four distinct areas; demolition and disposal, testing and sampling, travel, and State of California Water Board Annual Fee. The actual total project cost was $485,268 ($456,494 for demolition and disposal, $17,816 for testing and sampling, $6958 for travel, and $4000 for State of California Water Board Annual Fee).

Most of the non-pond area remediation cost savings can be attributed to the recycling of concrete, asphalt, and iron pipe. Disposal of the concrete and asphalt in a landfill would have cost $32 per cubic yard. Instead it was recycled at a cost of about $10 per cubic yard. The iron pipe was sold to a recycling company which included the removal of the pipe from the site.

The EM budget for remediation of the brine pond was $3.6M. Actual remediation costs totaled $2.7M for a cost saving of $909K. These cost savings were realized by utilizing local companies, proactive procurement processes, forming an Interagency Agreement (IAG) with the Corps that had programs in place to effectively remediate a site such as GTF, and the Corps Rapid Response Contract with OHM. Brine pond residue remediation cost savings are summarized below:

Activity	**Savings**
Compressed schedule from three years to one year	$325K
Completed project management requirements by DOE Project Manager	$84K
Aggressively negotiated disposal fees	$344K
Negotiated immediate use of Construction Work Plan	$5K
Eliminated requirement for imported backfill material	$50K
Negotiated deal with local operator to use their nearby water supply at no cost	$40K
Used loader and dozer for multiple purposes, reduced mobilization costs	$10K
Aggressively negotiated reduced rate for waste transportation	$40K
Utilized primarily local labor	$6K
Utilized site Supervisor and Foreman to perform multiple duties	$5K
Total:	**$909K**

Section 7

REGULATORY/INSTITUTIONAL ISSUES

Regulators and stakeholders were involved directly throughout the remediation process at GTF. Remedial Actions Objectives (RAOs) were established early with all involved parties participating so cleanup activities proceeded forward expeditiously. There were no prolonged review time/decision making periods. Everyone knew what the end goal was and how to most effectively reach that goal. Through the Small Sites Initiative, sufficient funding was provided so work could keep progressing forward.

Appendix B contains a copy of the letter from the BLM that documents the transfer to commercial companies, with subsequent operation and ultimate responsibility for plugging, four geothermal wells known as 5-1, 6-1, 6-2, and 8-1. The letters from the commercial companies accepting responsibility are included. This letter also contains the acceptance of responsibility by a commercial company for the removal of cyclone fence at well site 31-1. The original well 31-1 was previously plugged and abandoned.

Appendix C contains copies of the letters from the California Regional Water Quality Control Board rescinding Cleanup and Abatement Order No. 96-023 and Waste Discharge Requirements Order No. 89-027. With the rescission of these orders, EM had completed its restoration activities at GTF.

Appendix D contains a copy of the formal relinquishment and termination by the BLM of the right-of-way reservation for GTF.

Section 8

SCHEDULE

The original schedule to complete remediation activities at GTF in 1999 was aggressive considering the site was not accepted into the EM program until 1994. With the infusion of the Small Sites Initiative funding, all remediation activities were completed by 1997. The mobilization, brine waste removal and disposal, and demobilization were completed over a three month period from August 19, 1996 to November 15, 1996.

Section 9

OBSERVATIONS AND LESSONS LEARNED

Factors that made the GTF remediation project a success are:

- Regulators and stakeholders involved directly early and throughout the remediation process at GTF.
- RAOs established activities early with all involved parties participating so cleanup activities proceeded forward expeditiously.
- Prolonged review time/decision making periods avoided.
- Sufficient funding provided (via Small Sites Initiative) so work could keep progressing forward.
- Recycled concrete, asphalt, iron pipe, and buildings.
- Transferred geothermal wells to private companies.
- Used local contractors.
- Utilized proactive procurement processes.
- Formed IAG with the Corps that had programs in place to effectively remediate a site such as GTF.
- Enacted Corps Rapid Response Contract with OHM.

Section 10

REFERENCES

Bechtel Environmental, Inc., 1991. *Field Investigation Report - Field Activities at US Department of Energy's Former Geothermal Test Facility Near El Centro, California.* November 1991.

Bechtel Environmental, Inc., 1992. *Limited Feasibility Study Remedial Activities at US Department of Energy's Former Geothermal Test Facility Near El Centro, California.* August 1991.

Dames and Moore, 1993. *El Centro Geothermal Test Component Facility Site Restoration Phase II Report.* June 1993.

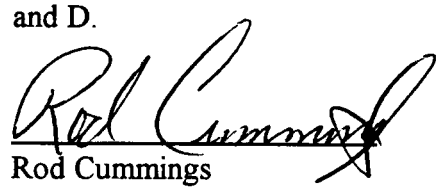
US Department of Energy, 1996. *Final Report for Geothermal Test Facility Restoration (Not Including Pond Area).* June 1996

OHM Remediation Services Corp., 1996. *Final Closure Report - East Mesa Geothermal Test Facility - El Centro, California.* December 1996.

Section 11

VALIDATION STATEMENT

This analysis accurately reflects the performance and cost of remediation at the East Mesa Geothermal Test Facility. Regulator acceptance of remediation is documented in the Appendices C and D.



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