Conf-950917--1

SAND94-3188C

SUCCESSFUL REMEDIATION OF FOUR URANIUM CALIBRATION PITS AT TECHNICAL AREA II, SANDIA NATIONAL LABORATORIES, ALBUQUERQUE, NEW MEXICO, U.S.A.

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ABSTRACT

The first remediation of an Environmental Restoration (ER) Project site at Sandia National Laboratories (SNL) was successfully conducted in May and June 1994 at Technical Area II (TA-II) in Albuquerque, New Mexico (Fig. 1). The removal action involved four Uranium Calibration Pits (UCPs) filled with radioactive or hazardous materials. The concrete culvert pits were used between 1978 and 1984 by the United States Department of Energy (US DOE) to test and calibrate borehole radiometric logging tools for uranium exploration.

The UCPs were remediated as part of a voluntary corrective measure (VCM) to reduce investigation costs and accelerate regulatory cleanup schedules. The cost of the VCM to the ER Project was approximately $100,000. A cost savings of at least $180,000 was achieved by conducting the VCM instead of following the standard regulatory process.

The removal action consisted of excavating and containerizing the pit contents and contaminated soil beneath the culverts, removing the four culverts, and backfilling the excavation. Each UCP removal had unique complexities.

Sixty 208-L drums of solid radioactive waste and eight 208-L drums of liquid hazardous waste were generated during the VCM. Two of the concrete culverts will be disposed as radioactive waste and two as solid waste. Uranium-238 was detected in UCP-2 ore material at 746 pCi/g, and at 59 pCi/g in UCP-1 silica sand. UCP-4 was empty; sludge from UCP-3 contained 122 mg/L (ppm) chromium.

Place Fig. 1 here

This work was supported by the United States Department of Energy under Contract DE-AC04-94AL85000.

INTRODUCTION

The UCPs were used between 1978 and 1984 for geophysical instrument calibration. Remediation of the UCPs was conducted in the summer of 1994 as a VCM. The decision to perform the VCM was made for several reasons; the UCPs were no longer being utilized, known radiological and possibly hazardous material remained, the final remedy was obvious, and reductions in cost and schedule could be achieved. The objective was to eliminate risk to human health and the environment.

HISTORY OF THE UCPs

Construction Details of the UCPs

The UCPs were located in the western portion of TA-II (Fig. 2). The site consisted of four concrete culvert pits that were managed by the DOE. The UCPs were used to test and calibrate down-hole radiometric logging tools for the National Uranium Resource Evaluation (NURE) Program. The pits were constructed in 1978, and were used until 1984; the site has been inactive since 1984. Between 1978 and 1984, the site was enclosed with a chain link fence and contained a mobile office. The chain link fence and mobile office were removed in about 1989.

From west to east, the four UCPs were numbered sequentially 1 through 4 (Fig. 3). The distance between the centers of each pit was approximately 1.8 m. The four UCPs were constructed by excavating 1.2 m diameter pits to 2.4 m BGL. An 11.5-cm diameter borehole subsequently was drilled beneath each pit. Three of the boreholes were drilled between 4.5 and 5.8 m deep (UCPs 1 through 3). The UCP 4 borehole was drilled to an approximate depth of 64 m. Ten-centimeter diameter polyvinyl chloride (PVC) pipe was then installed into the UCP-2, -3, and -4 boreholes. A ten-centimeter diameter steel pipe was installed in the UCP-1 borehole. The pipes were not grouted in place. A 1.2 m x 2.4 m concrete culvert (i.e., hollow concrete pipe) subsequently was lowered into each of the four open pits. After the culverts were in place, a 15.2-cm concrete plug was poured at the base of UCPs -1,-3, and -4. UCP-2 did not have a concrete plug base. Although the cement plugs were poured in the culverts, a water-tight seal was apparently not created between each plug and culvert. A circular steel plate was placed upon, but was not sealed to, the top of each UCP and served as a pit cover.

Historical Use of the Uranium Calibration Pits

Although basic construction details were similar for the four UCPs, the pits were used for different calibration operations. Reported materials used at each pit are described below and are shown in Fig. 3.

UCP-1 was used to simulate a water-saturated, uranium-bearing sand. The pit was filled with silica sand and subsequently was saturated with a solution of uranyl nitrate. The original specifications for the uranyl nitrate solution indicated that about 9 kg of uranium oxide was planned to be used, although a memorandum indicated that only 4.5 kg of uranium oxide was actually used. The uranium oxide was dissolved with a minimal amount of nitric acid which then was diluted with distilled water to form the uranyl nitrate solution. The total volume of uranyl nitrate solution was approximately 852 L. After the UCP was filled, the solution leaked out overnight into the soil beneath the pit where it precipitated in the alkaline soil; the leak was not anticipated. Contaminated soil, which was removed during the recent VCM, was found within approximately 1.8 m beneath the bottom of the concrete plug.

Place Fig. 2 and 3 here

UCP-2 had plastic sheeting at the bottom and was filled with 1.2 m^3 of uranium ore from a mine near Grants, New Mexico. Another plastic sheet was then placed on top of the ore and 1.2 m^3 of clean fill was placed above the sheeting. The uranium ore had an estimated grade of 0.1 percent uranium oxide (U_3O_8) or "yellowcake".

UCP-3 was lined with a waterproof neoprene fabric liner that extended to the rim of the concrete culvert. The pit was filled with a solution of chromium sulfate. After calibration tests were conducted, most of the chromium sulfate solution was pumped into drums and disposed by the SNL/NM Health Physics Group. The remaining solution was pumped out in May 1994 as the first phase of the UCP VCM. The liner was also removed at this time. Vermiculite was added to the UCP to absorb the solution remaining on the bottom of the culvert.

UCP-4 was empty and was used only for background calibrations. No solutions or other material were ever placed into the culvert.

Very limited information exists about the geophysical testing conducted at the UCPs. Initial information was based on employee interviews. No testing reports, "as builts", or other engineering drawings are known to exist for the UCPs. Construction details and pit contents discussed in previous sections were verified during the VCM.

INVESTIGATION OF UCPS

In 1987, a RCRA Facility Assessment (RFA) was performed for the entire SNL/NM installation (1). At that time, the UCPs were identified as a solid waste management unit (SWMU) and described as having the potential to release hazardous materials to the environment. A more comprehensive assessment was performed under Phase 1 of the Comprehensive Environmental Assessment and Response Program (CEARP) (2), during which the UCPs were assessed and again found to require additional investigation. The scope of the Phase 1 assessment included a literature and records search, interviews with current and former employees and, in some cases, visual site inspections. No samples and limited background data were collected during either the RFA and/or the CEARP Phase 1 assessment.

Investigations Conducted Prior to the VCM

On December 5 and 6, 1991, radiation and organic vapor surveys were performed at the UCPs. No readings were detected above background. In addition, no organic vapors were detected from a passive soil vapor survey conducted in early 1994.

The objectives of the surface portion of the radiation survey were to determine both the general area gamma radiation levels and to try to detect the presence of surface contamination. The radiation levels varied from 0.02 to 0.03 milliroentgen/hour (mR/hr). Surface readings varied from 80 to 140 counts per minute (cpm), well within the range of background values. Several swipe surveys also were performed on the ground and personnel were monitored for contamination. No elevated readings were measured.

In January 1994, a second down-hole radiation survey was conducted at the four UCPs using a sodium-iodide gamma probe; background activities were measured at 14,400 cpm. Activities were measured at 0.3 m intervals in each of the UCPs:

- UCP-1 yielded readings of 74,614 cpm at 2.4 m BGL to 21,088 cpm at 4.3 m BGL, the total depth of the steel pipe.

- UCP-2 had elevated readings of 25,544 cpm near the ground surface to 23,088 cpm at 3.4 m BGL (i.e., 0.9 m below the culvert base). Total depth of the PVC pipe was 5.8 m BGL.

- UCP-3 contained no activities above background. Total depth of the PVC pipe was 5.5 m BGL.

- UCP-4 had no activities above background from the ground surface to the total surveyed depth of 15.2 m BGL. Total depth of the PVC pipe was 64 m BGL.

UCP REMEDIATION

The removal action consisted of excavating and containerizing the pit contents and contaminated soil beneath the concrete culverts, removing the culverts, and backfilling the excavation. Soil outside the UCPs was removed with a backhoe. The soil was field-screened for beta and gamma radiation and alpha-emitting particles during the entire excavation. An RU3C was used to measure dose rate, a Bicron meter was used for gamma scintillation, and a Tennelec 5100 was used as a swipe counter. Three portable air samplers monitored potential airborne contamination.

After their contents were removed, the UCP culverts were removed one at a time by excavating approximately 2.4 m below ground level (BGL) with a backhoe and lifting each culvert with a crane. Radiological soil screening was performed during the entire excavation. After removing each UCP, the soil beneath each culvert was screened for radioisotopes. If radiological levels were at or below background, confirmatory soil samples were collected. If radiological levels were above background, contaminated soil was removed until background levels were achieved, and then a soil sample was collected at the bottom of the excavation. (Background levels were never reached at UCP-1. Excavation of the contaminated soil ceased when gamma spectroscopy results for uranium were less than the preliminary risk-based action level of 28.6 pCi/g for U-238.) Confirmatory soil samples also were collected from the backfill material as the excavation was restored to surface grade.

All drums, samples, equipment, and personal protective equipment were screened for radiological contamination, but each UCP removal had unique complexities. The chromium sulfate solution was pumped from UCP-3 and the neoprene fabric liner was removed (Fig. 4). UCP-4 was tilted on its side to break the 64-m deep PVC pipe at the base of the culvert (Fig. 5). After removing UCP-4, soil was excavated around UCP-3. A crane was then used to lift and remove UCPs -3 and -4 and the area was backfilled to the surface (Fig. 6).

Because UCP-1 and -2 contained radioactive material, a temporary building made of reinforced plastic sheeting and wood was placed over the two culverts to reduce or eliminate the potential release of airborne contaminants to TA-II (Fig. 7). Worker heat stress was a major concern since temperatures inside the building exceeded 100°F. The contaminated soil was removed by geologists wearing OSHA Level C protective equipment while health physicists monitored for exposure to radiation. Oxygen and NO_2 levels also were monitored.

Most radioactive material in the two culverts was removed with shovels and High-Efficiency Particulate Air (HEPA) vacuums (Fig. 8). Once each drum was filled and sealed, it was immediately removed to reduce the levels of radiation exposure in the building. After most radioactive material was removed and all equipment was screened, the building was moved and both culverts were sealed and removed. During the removal of the two pits, radioactive "yellowcake" was observed in the soil under UCP-1. The "yellowcake", as well as residual contamination identified at the base of

Place Fig. 4 - 8 here

UCP-2 were removed and containerized. The excavated area subsequently was backfilled and the 64 m deep PVC pipe was overdrilled and removed with a drill rig. The borehole was then sealed with bentonite cement-grout.

Sixty 208-L drums of radioactive waste and eight 208-L drums of hazardous waste were generated during the VCM. Two of the concrete culverts will be disposed as radioactive waste and two as solid waste. Sludge from UCP-3 contained 122 mg/L (ppm) chromium; U-238 activities were detected at 746 pCi/g in UCP-2 ore and at 59 pCi/g in UCP-1 sand.

EVALUATION OF RELEVANT EVIDENCE

After each UCP culvert was removed, underlying soil was screened for radioactivity using field instruments. If activity above background was observed, the soil was assumed to be radioactively contaminated, and was removed. When radioactivity was no longer detectable with field instruments, confirmatory soil samples were collected for analysis for isotopic uranium and by gamma spectroscopy (Fig. 3). Not all of the soil showing above-background radioactivity was removed from beneath UCP-1. When field instruments were no longer efficient enough to be used to distinguish between contaminated soil and background soil a soil sample was collected and analyzed by gamma spectroscopy. Excavation work was stopped when gamma spectroscopy concentrations were reported to be below the preliminary risk-based action level of 28.6 pCi/g. A confirmatory soil sample also was collected from backfill material at each removed culvert as the excavation was returned to surface grade.

Confirmatory soil samples analyzed by gamma spectroscopy contained U-238 less than 2 pCi/g in all soil samples except for the one collected below UCP-1. The reported soil activity in this sample was 16.1 pCi/g, which was below the risk-based action level of 28.6 pCi/g.

In addition to the radiological analyses, a soil sample was collected for chromium analysis below UCP-3. The concentration of chromium from the soil sample collected below UCP-3 was 3.2 mg/kg, which is well below the risk-based action level of 80,000 mg/kg.

CONCLUSION

The reported chromium concentration from the soil sample collected below UCP-3 is well below the risk-based action level designated by the U.S. Environmental Protection Agency (EPA). All U-238 activities in soil collected below the removed culverts and in the backfill soil were below risk-based action levels. This site therefore no longer should no longer present a potential hazard to human health or the environment and has been proposed to the U.S. EPA for no further action and unrestricted future land use (Fig. 9).

The cost of the VCM to the ER Project was approximately $100,000. A cost savings of at least $180,000 was achieved by conducting the VCM instead of following the standard regulatory process which would have involved preparing a detailed workplan for review by at least four government agencies and conducting a several-month long full-scale site characterization and sampling.

Place Fig. 9 here

REFERENCES

1. EPA (U.S. Environmental Protection Agency), Region VI, "RCRA Facility Assessment Report of Solid Waste Management Units at Sandia National Laboratories," Albuquerque, New Mexico (1987).

2. DOE (U.S. Department of Energy), "Phase 1: Installation Assessment Sandia National Laboratories-Albuquerque, Comprehensive Environmental Assessment and Response Program", [DRAFT], U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, New Mexico (1987).

FIGURE CAPTIONS:

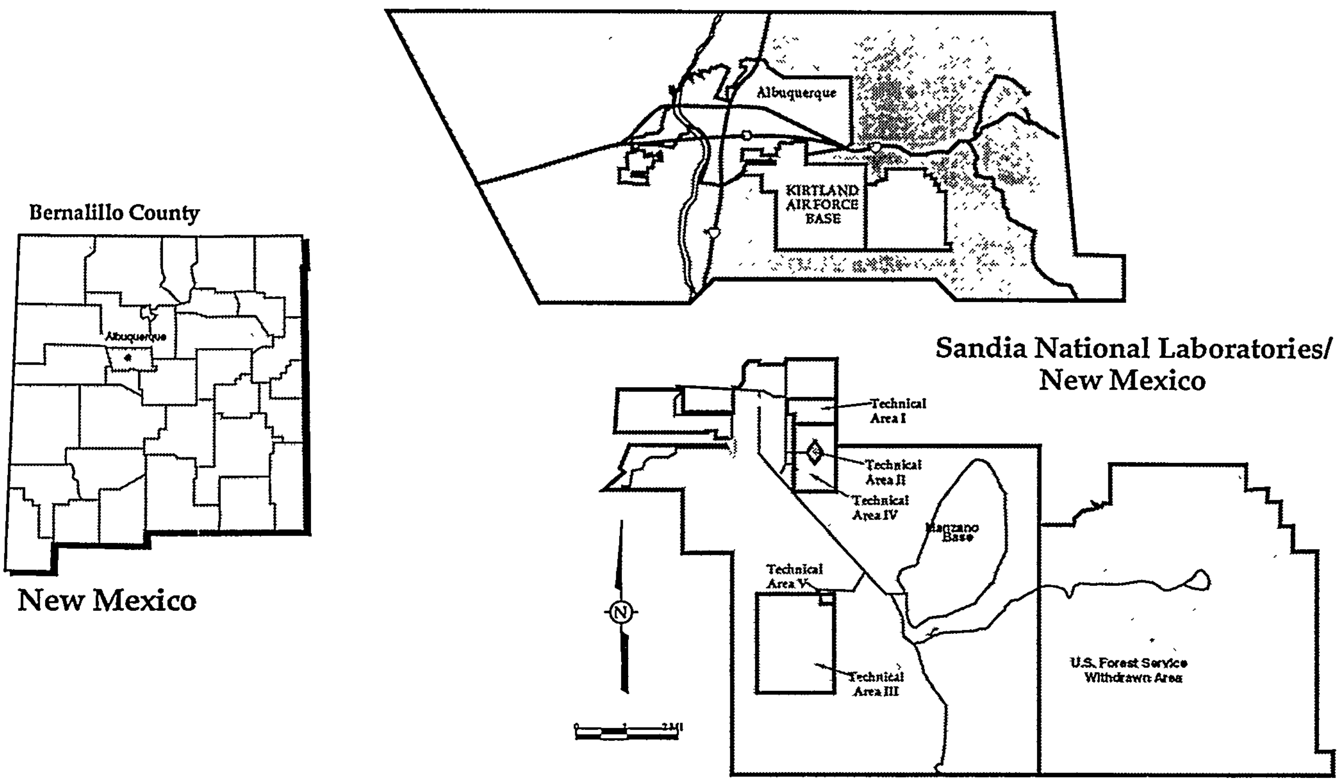

Bernalillo County
Albuquerque
New Mexico
Albuquerque
KIRTLAND AIR FORCE BASE
Sandia National Laboratories/
New Mexico
Technical Area I
Technical Area II
Technical Area IV
Manzano Base
Technical Area V
Technical Area III
U.S. Forest Service Withdrawn Area
N

Fig. 1.

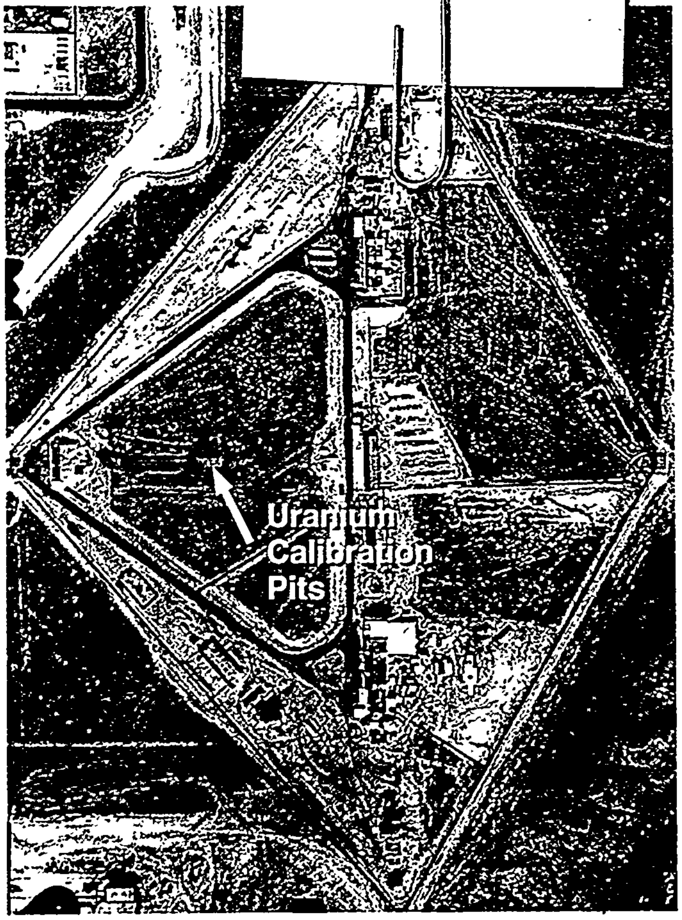


Fig. 2

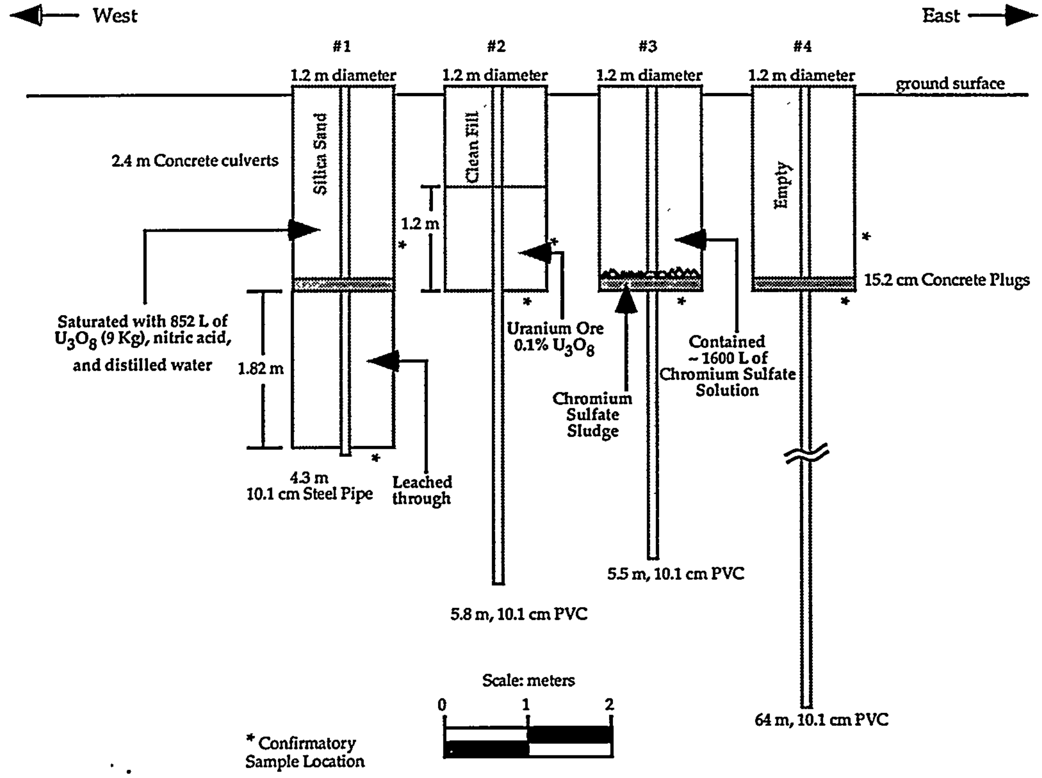

West
East
#1
#2
#3
#4
1.2 m diameter
1.2 m diameter
1.2 m diameter
1.2 m diameter
ground surface
2.4 m Concrete culverts
Silica Sand
Clean Fill
Empty
1.2 m
15.2 cm Concrete Plugs
Saturated with 852 L of U_3O_8 (9 Kg), nitric acid, and distilled water
1.82 m
Uranium Ore 0.1% U_3O_8
Contained ~ 1600 L of Chromium Sulfate Solution
Chromium Sulfate Sludge
4.3 m 10.1 cm Steel Pipe
Leached through
5.5 m, 10.1 cm PVC
5.8 m, 10.1 cm PVC
Scale: meters
0
1
2
64 m, 10.1 cm PVC
* Confirmatory Sample Location

Fig. 3

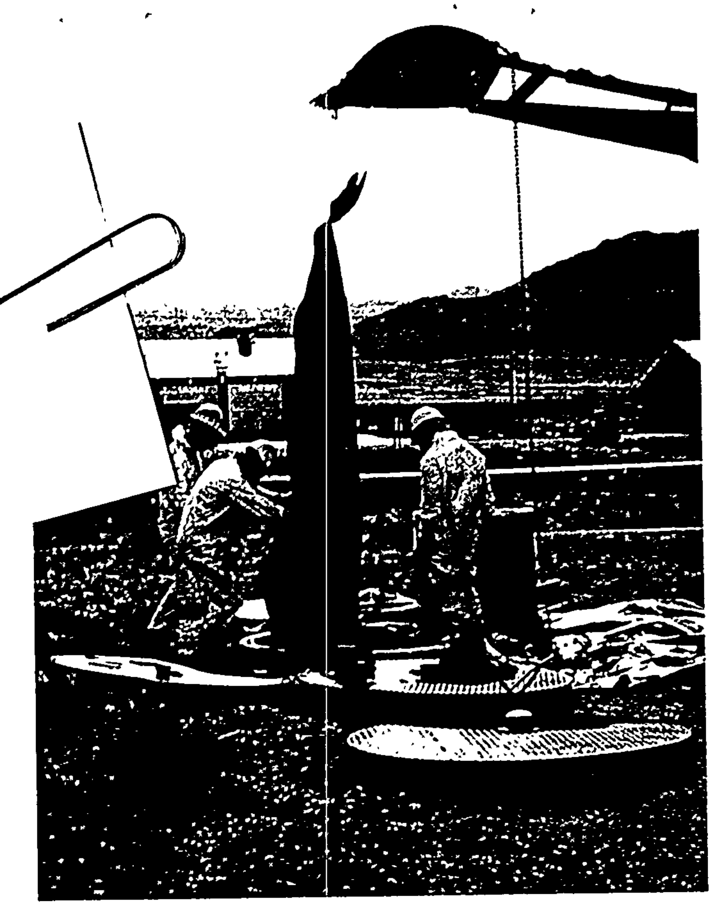
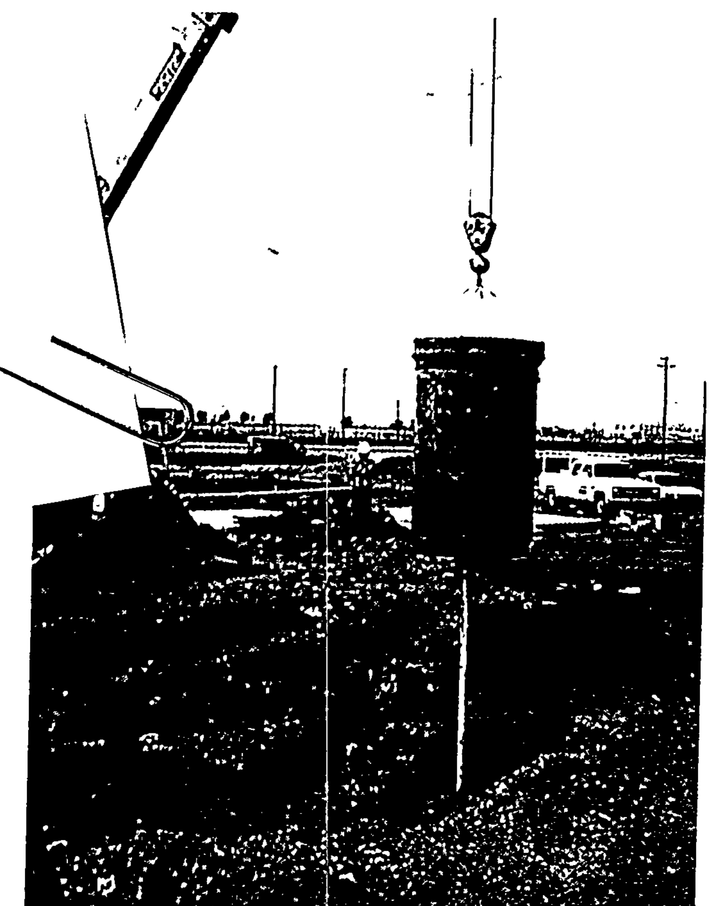


Fig 4



← Fig. 6

Fig 5

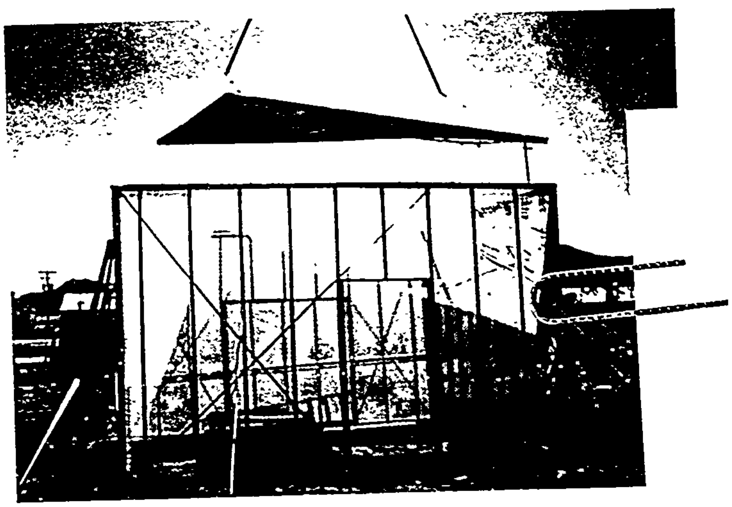


Fig. 7

Fig. 8

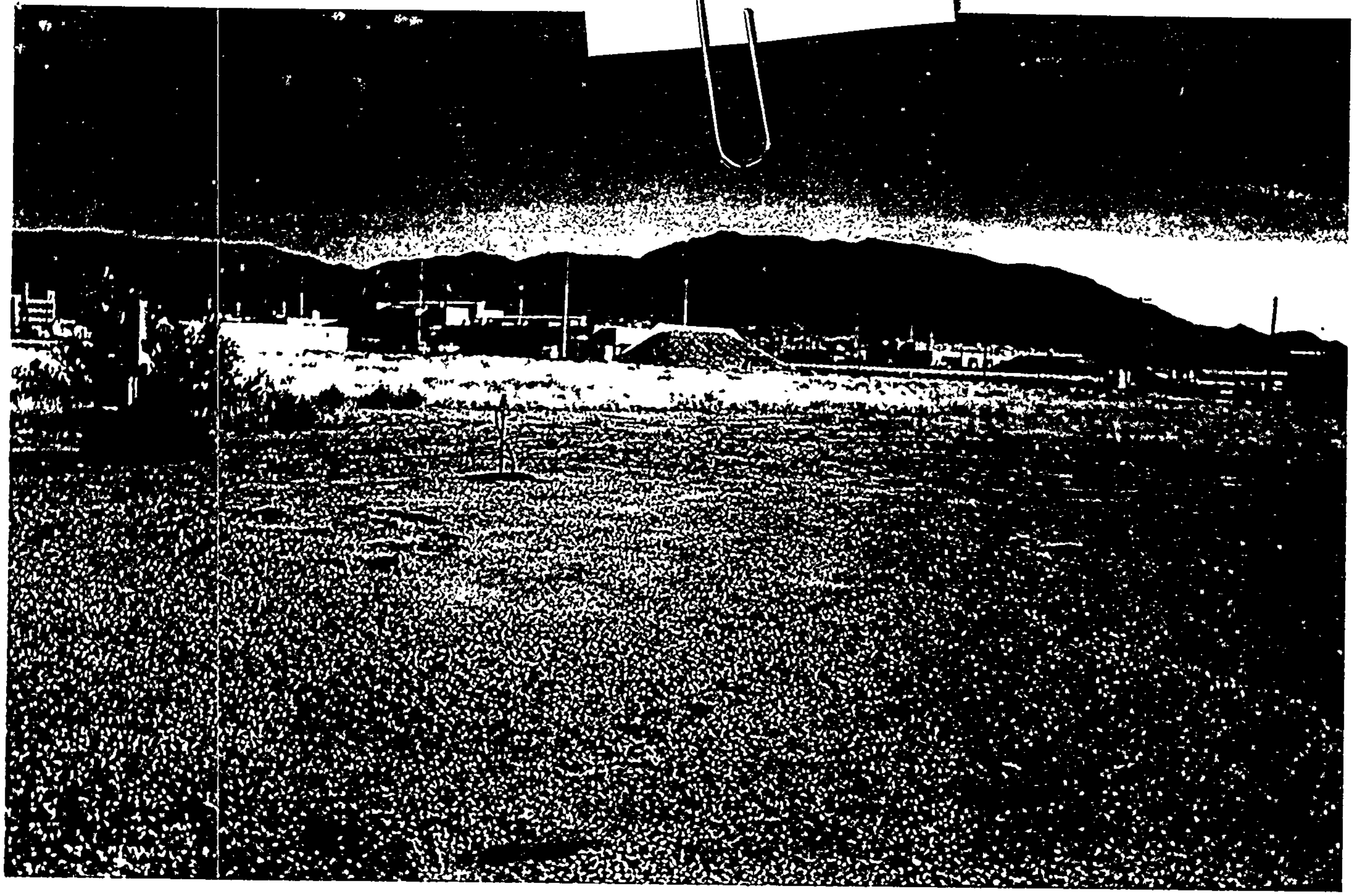


Fig. 9