59982

Field Summary Report

Geophysical Investigation at FU-1, TA-73, SWMUs 73-001(b,c,d) Los Alamos Airport

Submitted to:

University of California
Los Alamos National Laboratory
Los Alamos, NM 87545

Submitted by:

Geophex, Ltd.
901 18th Street - Suite 30100
Los Alamos, NM 87544

Geophex Job Number 542
November 1995

7264

Geophex, Ltd.
901 18th Street, Suite 30100
Los Alamos, New Mexico 87544
(505) 661-6140

November 17, 1995

University of California
Los Alamos National Laboratory
Attn: Mr. Garry Allen
Ref.: 2776M0004-8N
P. O. Box 1663, MS E525
Los Alamos, NM 87545

Dear Mr. Allen:

Enclosed are three copies of our field summary report, "Geophysical Investigations at FU-1, TA-73, SWMUs 73-001(b,c,d), Los Alamos Airport." This report summarizes the geophysical surveys conducted by Geophex during August and September 1995.

We were sucessful in delineating the limits of landfill 73-001(d) even though the individual trench geometries are obscured by 20 feet of overlying fill material. We located two trenches east of the runway, which are associated with landfill 73-001(c). We could not produce an image of the waste oil pit, 73-001(b), in the area proximal to the indicated location. We suspect the pit was assimilated by the later trenching activity at 73-001(d).

We have enjoyed the opportunity of working on this project and look forward to providing you with assistance in the future.

Sincerely yours,

John W. Clough, Ph.D., PG.
Project Manager

Edward A. Hull, II
Project Geologist

Enclosure: Field Summary Report, "Geophysical Investigations at FU-1, TA-73, SWMUs 73-001(b,c,d), Los Alamos Airport" (3 copies)

cc: Larry Brown, LANL MS P274 with Enclosure (3 copies)

Executive Summary

Geophex, Ltd. conducted geophysical investigations within Field Unit (FU)-1, at Technical Area (TA)-73 Los Alamos Airport, as part of the Los Alamos National Laboratory (LANL) Environmental Restoration Program. The purpose of the surveys was to locate and map the lateral extent of several suspected small landfills proximal to the east end of the runway, Solid Waste Management Units (SWMUs) 73-001(b,c,d). This report is a complement to our preceding report covering SWMU 73-001(a), April 1995.

The 12 acre site consists of the eastern portion of the airports runway, an open grassy field, and trees and bushes scattered along the northern property fence. We conducted field investigations during August and September 1995, using magnetic total field, electromagnetic (EM), and Schlumberger vertical electrical sounding (VES) geophysical survey methods.

We integrated data from the geophysical surveys with historical records and geological observations to produce a map of suspected trenching locations. Landfill 73-001(d) is north of the runway and extends from 200 feet east of the windsock to 200 feet past the end of the runway. The landfills orientation is parallel to the runway, but the individual trench geometries are obscured by a 20-foot thick cover of debris and backfill material. Landfill 73-001(c) is 300 feet northeast of the end of the runway and extends for 400 feet east. The anomaly appears to consist of two, equal length, parallel trenches. We did not locate the 73-001(b) waste oil pit during our investigation. The inferred location of the pit places it in the center of the 73-001(d) landfill anomaly. We suspect the pit was assimilated by the later trenching activity.

To further detail the boundaries of the small landfills would require a much greater level of effort. Geophex, Ltd. recommends no further geophysical investigations at this site.

Table of Contents

Executive Summary i
List of Figures ii
List of Appendices ii
1.0 Project Introduction 1
1.1 Background Data 1
1.2 Scope of Work 1
1.3 Preliminary Evaluation 2
2.0 Geophysical Survey Results 2
2.1 Magnetic Total Field Measurement 2
2.2 Electromagnetic Survey 3
2.3 Schlumberger VES 4
3.0 Conclusions 5
4.0 References 5

List of Figures

Figure 1. Location of FU-1, TA-73, Los Alamos Airport and SWMU Groups 73-1and -2 constituents 6
Figure 2. Location of Los Alamos Airport structures, geophysical survey locations, survey grid, and other features 7
Figure 3. Residual magnetic total field data from TA-73 8
Figure 4. Oblique projection of residual magnetic total field data from TA-73 9
Figure 5. Residual EM data from 73-001(c), 7290 Hz in-phase response is shown 10
Figure 6. VES plots of data collected from two locations at TA-73 11
Figure 7. Probable landfill activity locations at TA-73 12

List of Appendices

Appendix A. Geophysical Survey Instruments and Procedures A-1

1.0 Project Introduction

Geophex, Ltd. conducted geophysical investigations at Los Alamos Airport, Field Unit (FU)-1 Technical Area (TA)-73, SWMU Groups 73-1 and -2 (Figure 1). The primary purpose of the investigation is to locate and map the position of several small landfills, SWMUs 73-001(b,c,d), located east of the main landfill. The secondary tasks were to locate septic system, SWMU 73-004(d), and the surface disposal area, SWMU 73-005.

1.1 Background Data

Los Alamos National Laboratory (LANL) operated the waste oil pit, SWMU 73-001(b), from 1947 to 1974. The pit was approximately 25 x 100 feet in size, but the depth is unknown. It was reportedly filled in with sand, but the exact location of the pit is unknown (RFI Work Plan, 1992).

The bunker debris landfill, SWMU 73-001(c), was created in 1974 for the disposal of demolition debris from four bunkers located at the east end of TA-73. The bunkers were in service from 1947 to 1973 and primarily used to store high explosive. The debris from demolition was mostly concrete rubble, since the steel doors, vent pipes, and other salvageable items were sent to the LANL salvage yard (RFI Work Plan, 1992).

The landfill debris disposal area, SWMU 73-001(d), was created in 1984 near the current east end of the runway. The disposal area was built to contain the debris excavated from the western end of the main landfill for the construction of the airplane hangars. The debris was placed in two 60 foot pits. The disposal area was used for two years, until 1986, but the exact location of the pits is unknown (RFI Work Plan, 1992).

The landfill office septic system, SWMU 73-004(d), was in service from 1960 to 1973. The system consisted of clay drainlines, a septic tank, and a leach field. It most likely handled only sanitary waste (RFI Work Plan, 1992). The system may have been demolished during subsequent landfill operations at SWMU 73-001(a).

The surface disposal area, SWMU 73-005, is located south of Highway 502. The debris in this area is apparently the remains of a construction contractor's office and storage buildings from the 1940s. No LANL operations are reported in this area, but the site is on lab property (RFI Work Plan, 1992).

1.2 Scope of Work

The primary purpose of the investigation is to locate and map the lateral extent the various disposal areas, SWMUs 73-001(b,c,d), proximal to the east end of the runway and TA-73. The ancillary purpose, if feasible, is to estimate the depth of any trenches and burial pits we locate. The septic system 73-004(d), was classified as no further action required by FU-1, because the system is most likely located in the landfill 73-001(a) and presumably only handled sanitary wastes. The surface disposal area, 73-005, was classified as a low priority by FU-1, and designated for future investigation.

We conducted geophysical surveys over 12 acres using several methods. We conducted these surveys during August and September of 1995. We established a 100-foot orthogonal grid network of blue pin flags over the project area, that provided location control for our surveys (Figure 2). The area is partially bounded to the south by the runway, to the north by Pueblo Canyon, and to the east by the property fence (Figure 2). The western edge of the survey is 100 feet west of the end of our previous survey at SWMU 73-001(a), creating a 100 foot overlap in areal coverage (Geophex, 1995).

1.3 Preliminary Evaluation

We examined aerial photographs, engineering drawings, and photographs of the airport area to locate the position of the landfills described in the statement of work. We designed portions of the geophysical surveys based on these observations.

Aerial photographs taken during 1958 clearly show the waste oil pit, 73-001(b), and the four high explosive bunkers, 73-001(c), off the eastern end of the runway. They were accessible from Highway 502 via a service road, Fox Street. Fox Street was partially destroyed when the runway was extended to its current length, but a vestige is still in use south of the runway.

Photographs taken during the 1984-1986 airport renovation clearly show two parallel trenches, SWMU 73-001(d), north of the current runway. The trenches appear to be slightly offset, but close together with a narrow ridge of dirt separating them.

2.0 Geophysical Survey Results

The results of each of the geophysical methods used to characterize the landfills are summarized in this section. We include a description of the data collected and an interpretation of the results for each method. An integration and discussion of all the results is described in Section 3.0 of this report. Geophysical survey instruments and procedures are discussed in Appendix A.

2.1 Magnetic Total Field Measurement

We acquired magnetic total field data over the entire 12 acre survey area. We collected data from the edge of the runway, north to the fence line and from the 3100E line east to the 5100E line, 800 feet beyond the end of the runway. We recorded approximately 2,600 data points on a 10 x 20 foot grid. We used this data to produce a contour map of magnetic anomalies.

We produced a residual anomaly map by subtracting a background magnetic field value of 52,000 nT from all measured values before contouring. The residual map, now with a background near zero, enhances the interpretation of highs and lows. The residual map in Figure 3 shows the anomalies located by the survey. Figure 4 is an oblique projection plot of residual magnetic total field data.

Several distinct features are visible. There are no anomalies from 3100E to 3800E. We interpret this area as containing very few ferrous objects.

We attribute the large anomaly in the center of the survey area, from 3800E to 4500E, to the 1984-1986 airport renovation project that created SWMU 73-001(d). The two parallel trenches of uneven lengths are covered by 20 feet of debris and backfill material, which obscures the individual trench geometries. The chaotic pattern within the anomaly suggests a lack of segregation of the demolition debris as the trenches were being filled in and eventually covered by a layer of backfill material.

We interpret the anomaly pattern at the east end of the survey, from 4600E to 5100E, to represent two trenches. We speculate that they were excavated during the demolition of the four high explosive bunkers in 1974, SWMU 73-001(c). These trenches appear to be shallower than the two western trenches at SWMU 73-001(d). The two eastern trenches appear to be the same length, but the northern trench appears wider and shallower than the southern one. The uniformity of the anomaly pattern over the trenches suggests a systematic approach was used to backfill them.

A discrete circular anomaly at 4840E and 140N represents a small bunker. We noted a vent pipe on the top of a small earthen mound at this location. It is possibly one of the four high explosive bunkers that were presumed to be demolished in 1974. There are no magnetic anomalies or visible signs that could be associated with the other three bunkers. Based on our comparison of the description in the RFI Work Plan and the 1958 aerial photographs, the remaining bunker appears to be the second one from the east end of the site.

A small anomaly at 4460E and -60N is due to several feet of steel rebar sticking out of the ground. There is no evidence of a larger volume of buried debris at this location.

We saw no indication of the waste oil pit, SWMU 73-001(b), at the estimated location of 4200E and 70N. We speculate the pit was destroyed by the subsequent trenching and backfilling activities associated with SWMU 73-001(d).

There is very little indication of buried ferrous debris under the eastern end of the runway, as shown in Figure 1. The subtle anomaly is due to magnetic interference from a metal rack supporting runway warning lights.

2.2 Electromagnetic Survey

We conducted an EM survey over a 200 x 600 foot area from 4500E to 5100E and from -100N to 100N. This survey covered the area immediately east of the runway (Figure 2). We conducted the EM survey using the Geophex GEM-2 system operating at frequencies of 1,350- and 7,290-Hz. We used a 2.5 x 5 foot grid spacing and generated over 42,800 data points.

A contour map of the 7,950-Hz in-phase data shows several distinct anomalies (Figure 5). We interpret the anomalies to represent two, parallel, 450 foot long trenches. The long axis of each trench is aligned east-west and the trenches are positioned next to each other 25 feet apart. The

northern trench appears to be 25 feet wider and possibly shallower than the southern trench, which is 50 feet wide.

Each frequency plot produces a different response, which contributes to the overall interpretation of the target. The EM survey defined the edges of both trenches more sharply than the magnetic survey.

2.3 Schlumberger VES

We collected Schlumberger vertical electrical depth soundings at five locations within the survey area (Figure 2). A plot of the sounding results and interpretation for two locations, 3900E - 0N and 4200E - 100N, is shown as Figure 6.

In the upper plot, 3900E - 0N, the curved line through the data points is a plot of apparent resistivity versus electrode spacing. At an electrode spacing of four feet, the apparent resistivity, 200 ohm-meters, represents the true resistivity of the dry, tuff-derived soil. As the electrode spacing is increased, there is no apparent resistivity decrease, only a steady increase in the resistivity. The increasing resistivity is due to the underlying Bandelier Tuff. This response indicates there is no fill material at this location, only native soil and bedrock.

The solid blocky line represents interpreted resistivity versus depth derived from the apparent resistivity curve. The resistivity in the upper soil horizon is less than 200 ohm-meters while the Bandelier Tuff has an initial resistivity of approximately 600 ohm-meters. The small dip in the blocky line is probably due to increasing moisture with depth, since the decrease in resistivity (or increase in conductivity) occurs above the soil-rock interface. We conclude that there is no backfill or trench material at this location.

In the lower plot, at 4200E - 100N, the curved line through the data points is a plot of apparent resistivity versus electrode spacing. At an electrode spacing of four feet, the apparent resistivity, 200 ohm-meters, represents the true resistivity of the dry, near surface layer of the fill. As the electrode spacing is increased, the apparent resistivity decreases, to 70 ohm-meters, as the more conductive fill material is sensed. At even greater electrode spacing, the apparent resistivity increases, to 1,500 ohm-meters, as the resistive Bandelier Tuff, below the fill, influences the measured values.

The solid blocky line represents interpreted resistivity versus depth derived from the apparent resistivity curve. The resistivity in the lower part of the fill is less than 50 ohm-meters while the Bandelier Tuff has a resistivity greater than 1,000 ohm-meters. We interpret the thickness of the backfill material over the trenches to be 20 feet at this location. The VES will not sense the depth to the bottom of the trenches due to the narrow width of the trenches, less than 100 feet, relative to the VES electrode spacing, which is 100 feet at the ends of the array.

The depth interpretations from each successful VES measurement were used to corroborate the results from the magnetic and EM surveys. The narrow width and uneven terrain of the survey area prevented us from collecting additional measurements.

3.0 Conclusions

Geophysical investigations at the Los Alamos Airport provided varying degrees of assistance in locating components of SWMUs 73-001(b,c,d). We have combined all the useful geophysical data to produce a location map of suspected probable landfill activity (Figure 7).

We were unable to detect the presence of the waste oil pit, 73-001(b). We suspect the pit was destroyed by the later trenching activity associated with the landfill operations at 73-001(d).

We were able to delineate two parallel trenches east of the runway at the bunker debris area, 73-001(c). This is not the same location for the SWMU specified in the initial RFI Work Plan. The anomalies are proximal to the former bunker locations and represent buried material and apparent trenching activity. We saw no geophysical evidence to support the configuration of the 73-001(c) landfills shown in Figure 1.

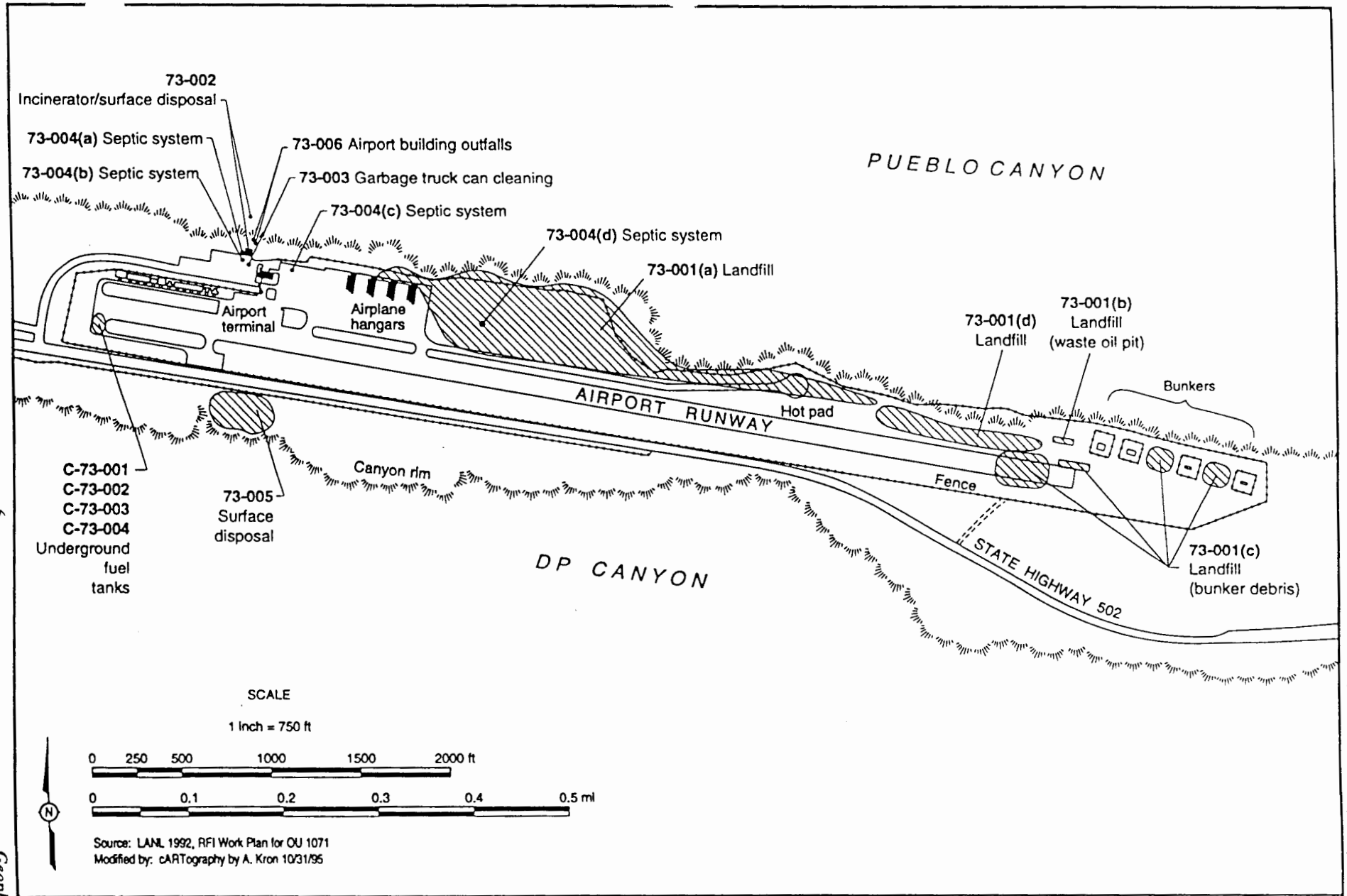
At the landfill, 73-001(d), we were able to detect a single large, linear anomaly. The individual trench geometries are obscured by 20 feet of debris and additional fill material. The orientation of our anomaly is similar to the stated configuration in Figure 1, but it lies 600 feet east of the suspected location in the RFI Work Plan.

4.0 References

Geophex, Ltd., April 1995, *Geophysical Investigations at FU-1, TA-73, SWMU 73-001(a), Los Alamos Airport*, Los Alamos National Laboratory, Los Alamos, New Mexico, GJN 422.

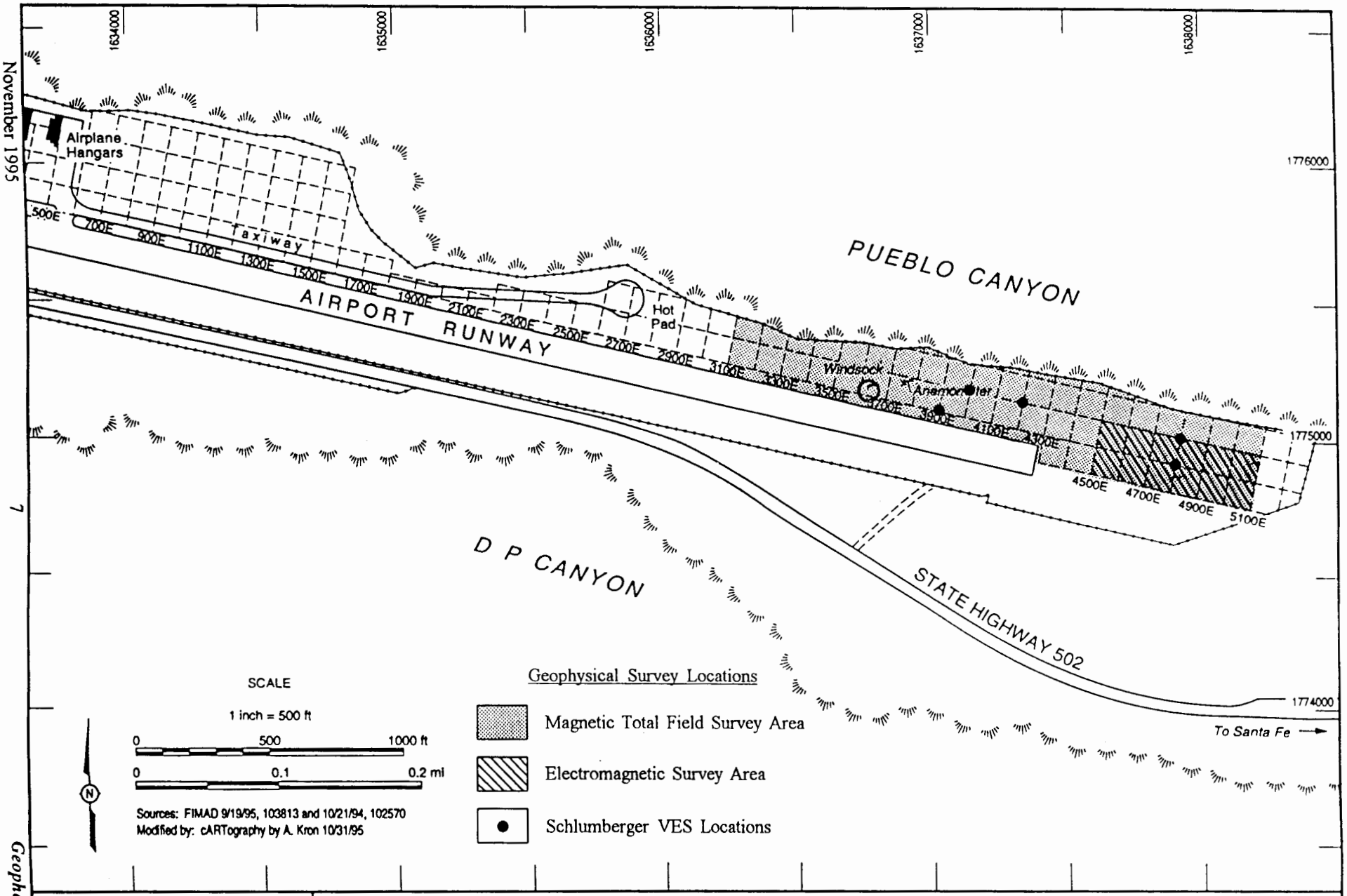
Los Alamos National Laboratory, May 1992, *RFI Work Plan for Operable Unit 1079, Environmental Restoration Program,* A Department of Energy Environmental Cleanup Program, Los Alamos, New Mexico, LA-UR-92-850.

Figures



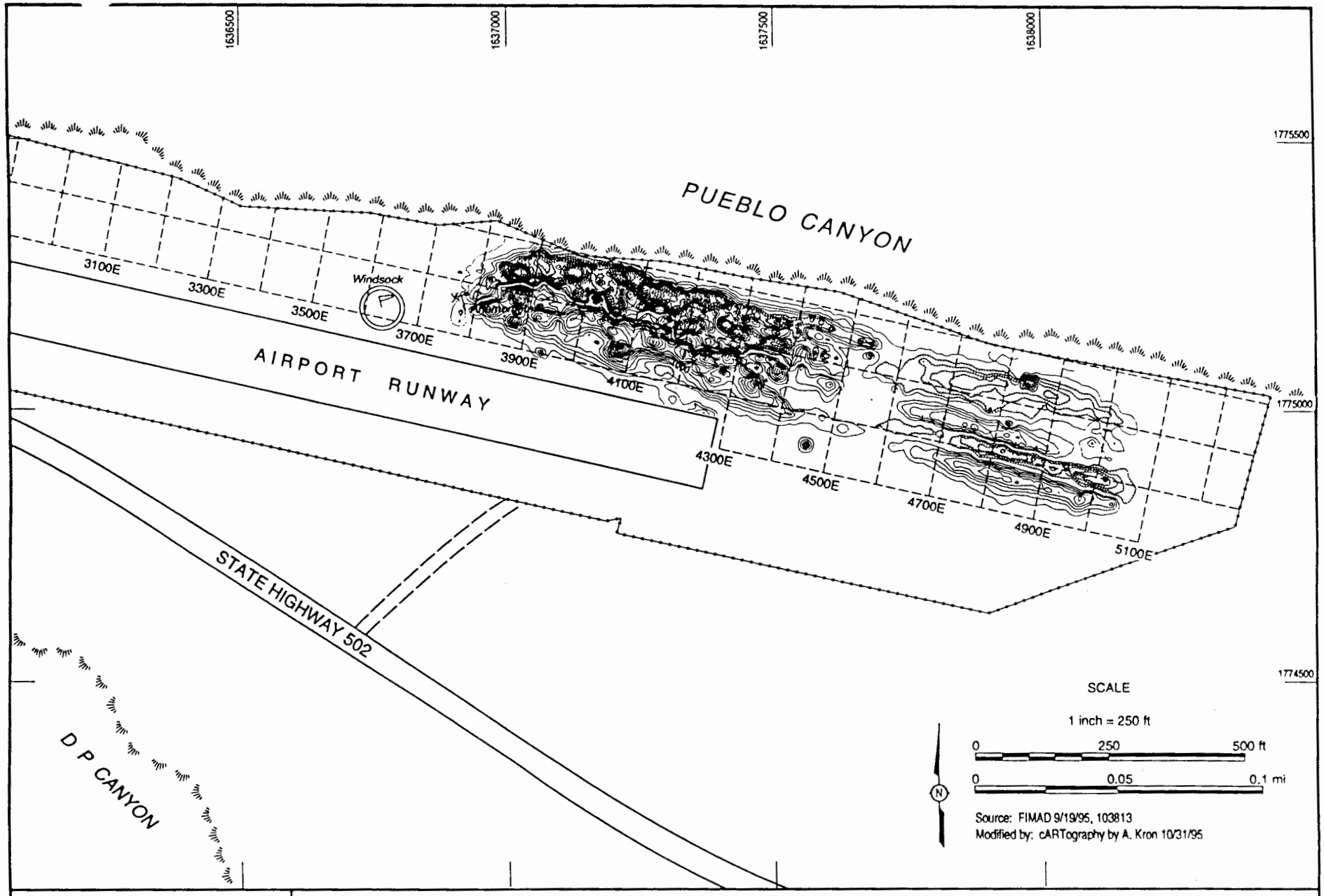
Geophex

Figure 1. Location of FU-1, TA-73, Los Alamos Airport and SWMU Groups 73-1 and 73-2 constituents.



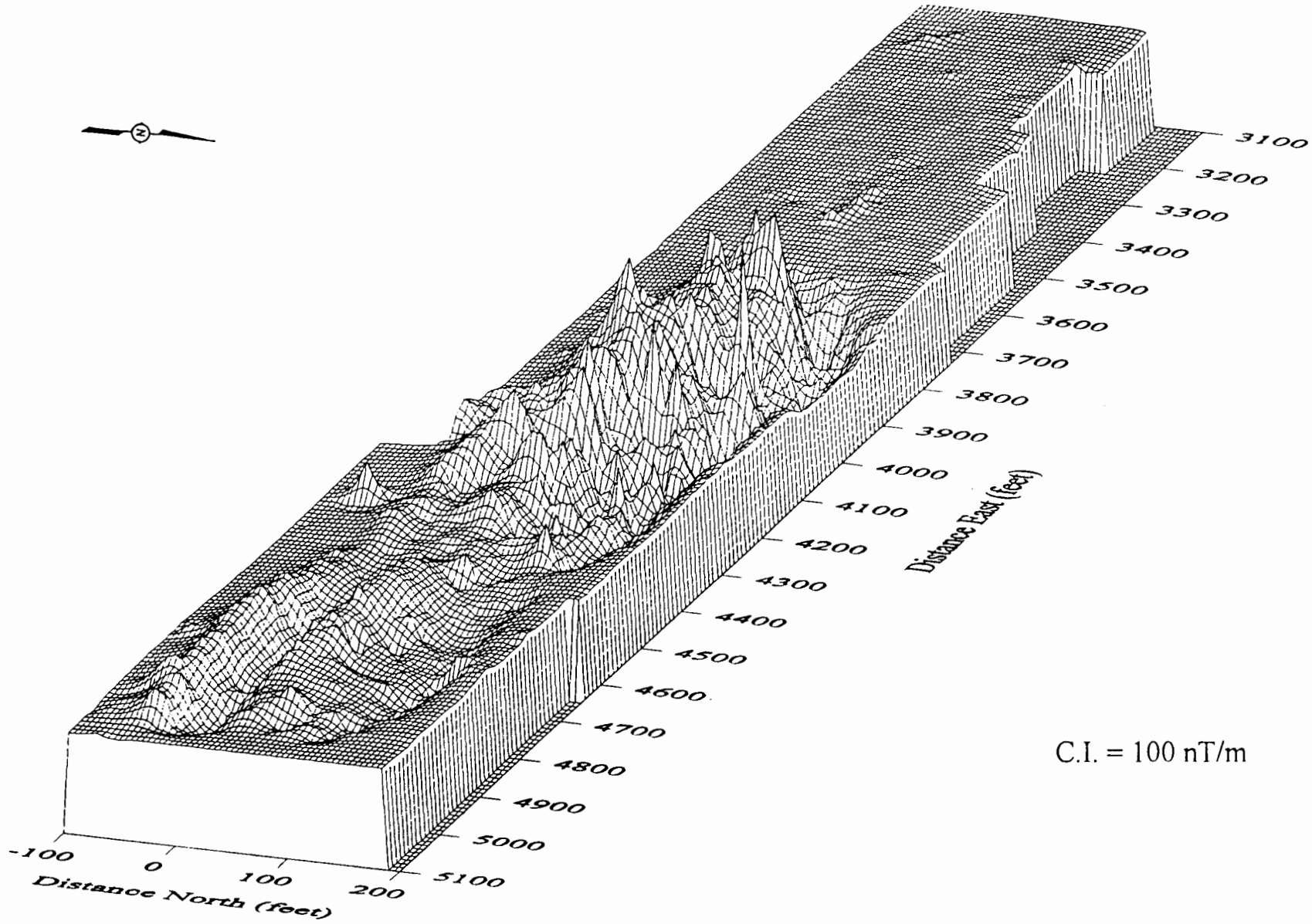
Geophex

Figure 2. Location of Los Alamos Airport structures, geophysical survey locations, survey grid, and other features.



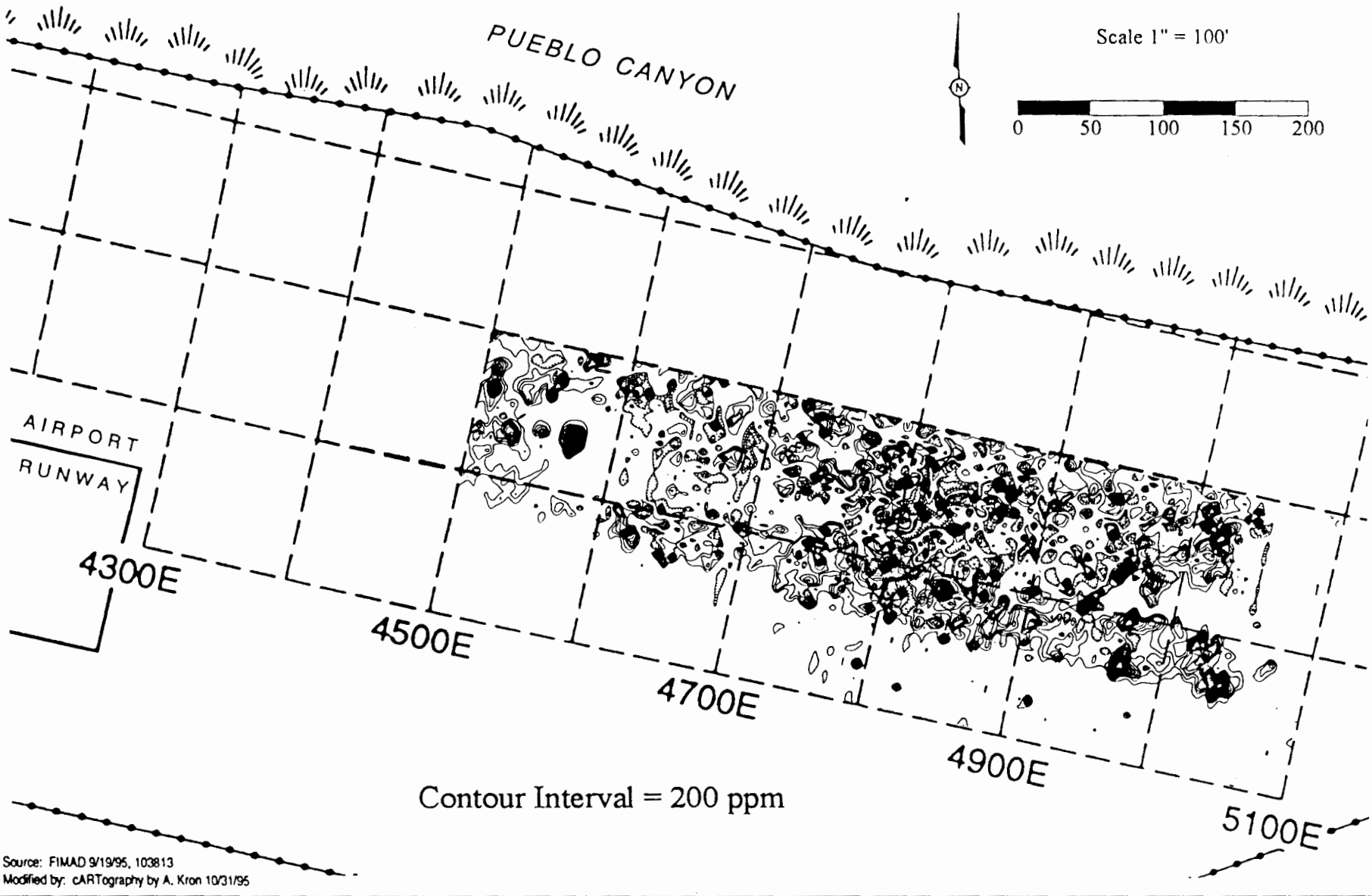
Geophex

Figure 3. Residual magnetic total field data from TA-73.



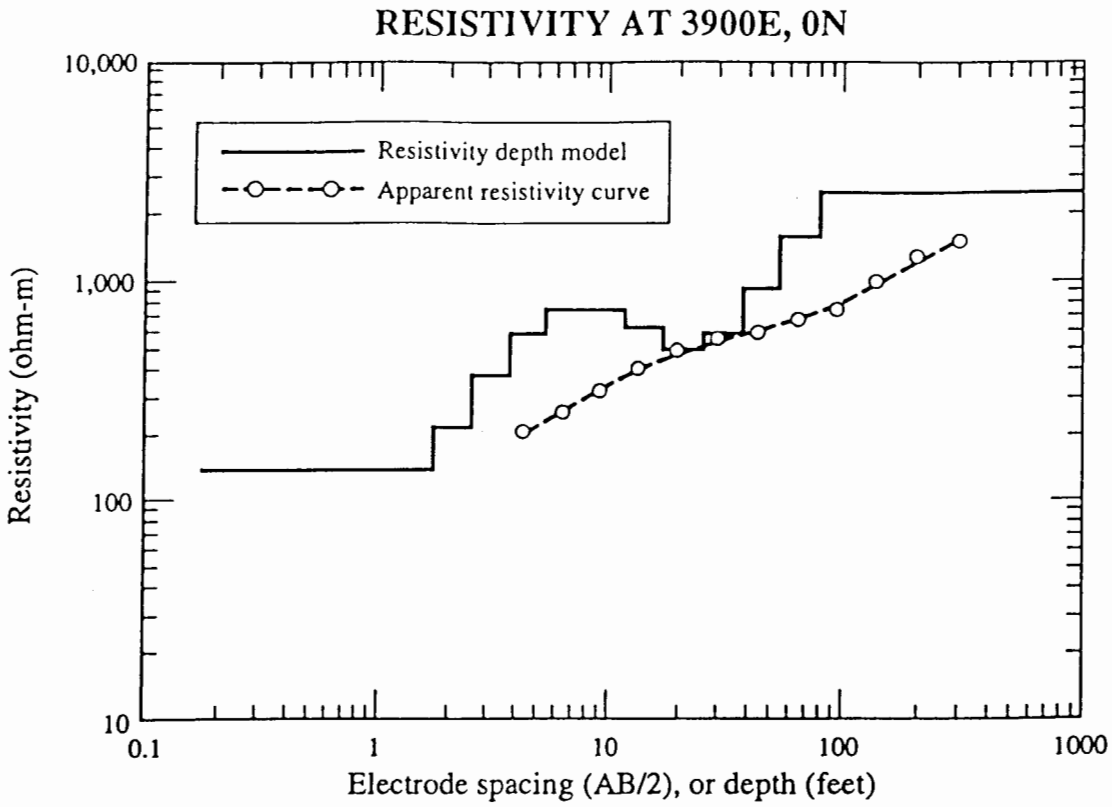
Geophex

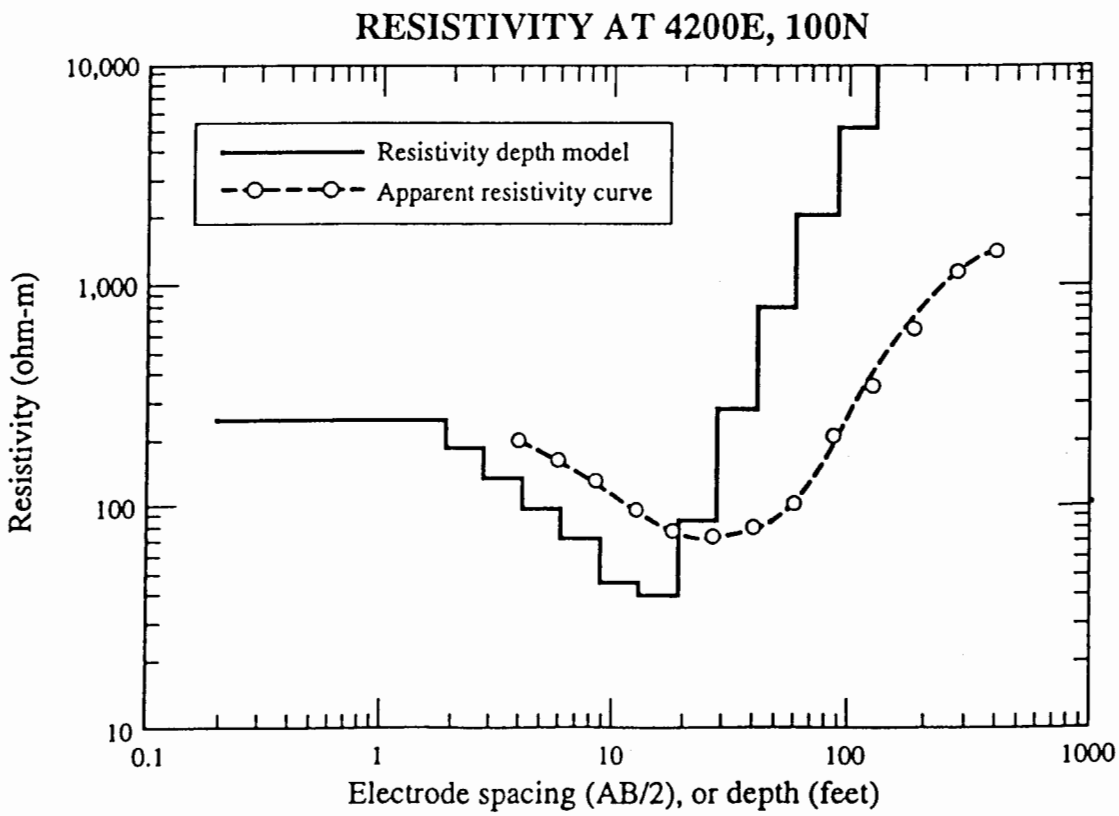
Figure 4. Oblique projection of residual magnetic total field data from TA-73.



Geophex

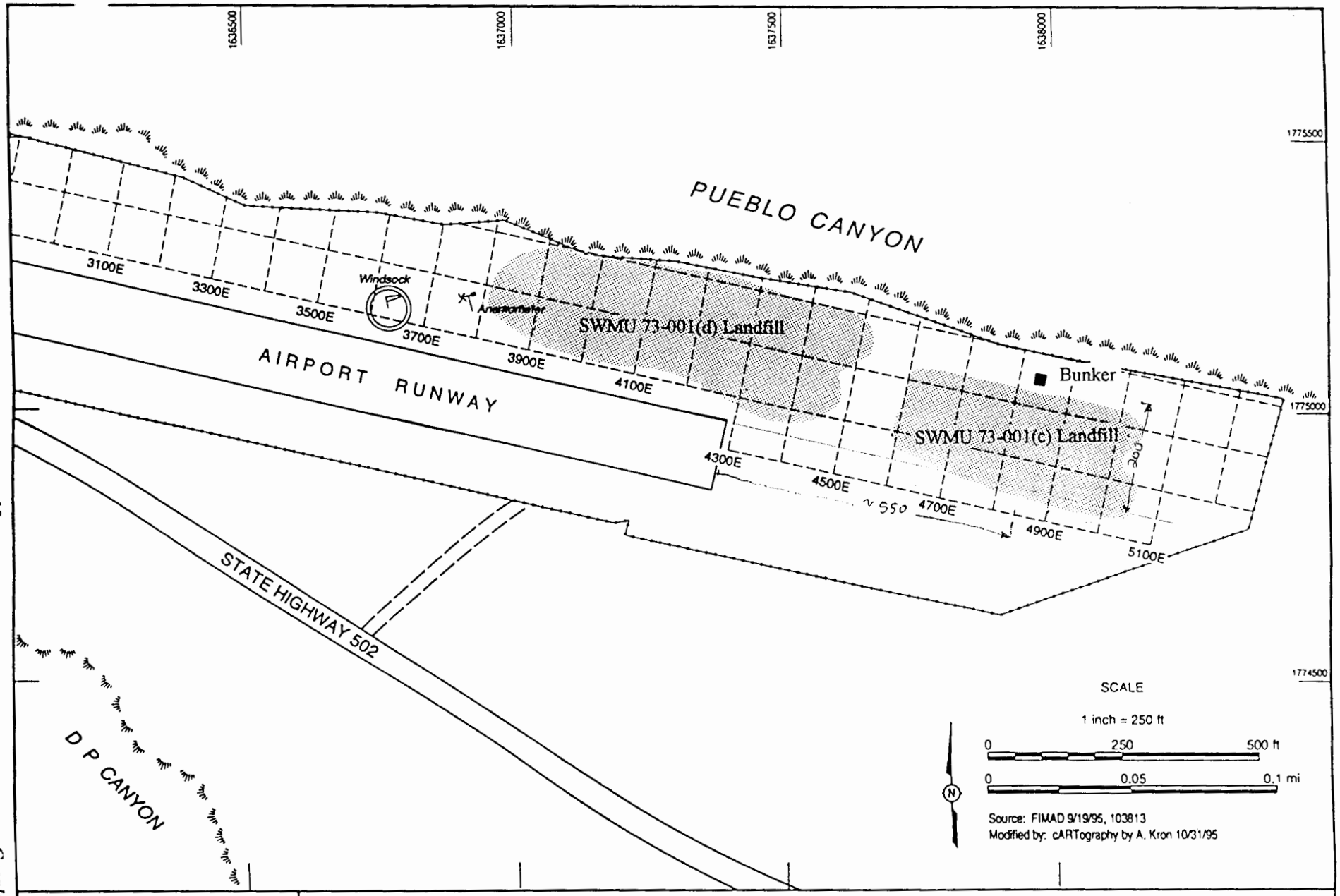
Figure 5. Residual EM data from 73-001(c), 7290 Hz in-phase response is shown.





Geophex

Figure 6. VES plots of data collected from two locations at TA-73.



Geophex

Figure 7. Probable landfill activity locations at TA-73.

Appendix A

Geophysical Survey Instruments and Procedures

Magnetic Total Field Measurement A-1
Electromagnetic Survey A-1
Schlumberger Vertical Electrical Sounding A-2

Geophysical Survey Instruments and Procedures

We conducted the following geophysical surveys at TA-73, Los Alamos Airport: magnetic total field measurement, electromagnetic (EM) survey, and Schlumberger vertical electric sounding (VES) resistivity measurement. In this appendix, we briefly describe the methodology of the techniques used. Interpretation of an area usually requires the integration of data from more than one geophysical method, combined with available engineering and geological data.

Magnetic Total Field Measurement

The earth's magnetic field would be spatially smooth and slowly varying, except for the presence of ferrous materials (containing iron) within and on the surface of the earth. Ferrous materials cause deviations of the earth's magnetic field. The identification of these deviations, or anomalies, is used to detect and locate the causative ferrous object.

Two types of magnetic surveys are frequently conducted to locate buried ferrous objects: measurement of the total magnetic field, or measurement of the vertical gradient of the magnetic field. A hand-held magnetometer is used to measure the strength of the prevailing magnetic field at equal spatial increments. Total field surveys are best used when searching for large or deeply buried ferrous objects. Surveys of the vertical magnetic gradient are used to detect and locate small shallow objects.

In a landfill, with many anomaly-producing bodies, the total field measurement can be used to map the areal distribution of ferrous objects and to some extent their depth. The total magnetic field survey method allows for rapid data collection and is inexpensive. The total field instrument used for this project is a proton precession magnetometer (EG&G, Geometrics G846).

Electromagnetic Survey

The EM survey method is based on measuring the response of an electromagnetic field induced into the earth. Low frequency signals, one to ten kilohertz, are transmitted by a small coil. The low frequency, very long wavelength electromagnetic fields produced by the transmitter, induce current flow in electrically conductive media in the earth. This induced current flow produces secondary electromagnetic fields which will radiate back to the surface. A receiving coil detects the secondary field and measures it's strength and phase, relative to the transmitted signal. The data is presented as the relative amplitude of the secondary signal, in parts per million (ppm). The system records the signals that are both in-phase and 90 degrees out of phase (quadrature) with the transmitted signal.

The depth of penetration of the transmitted field is a function of the frequency of operation. Lower frequencies penetrate deeper, while higher frequencies are attenuated more rapidly. This frequency dependent penetration depth provides the opportunity to interpret multifrequency EM data to evaluate the depth, and size, of targets.

The instrument used for this survey is the GEM-2 developed by Geophex, Ltd. The instrument acquires both in-phase and quadrature data at two frequencies simultaneously. Frequencies may be selected in the range from 300 to 20,000 Hz. The instrument has a self-contained digital data recording system. The system typically records data at one-half second intervals. At this sampling rate data is collected at two to three foot intervals while the operator moves continuously at a brisk walk. Results from many environmental sites have established that the mutifrequency GEM-2 is superior to conventional single-frequency EM units or magnetic surveys alone in ability to characterize metallic and non-metallic targets.

For this survey, we used a digital transmitter waveform composed of 1,350 Hz and 7,290 Hz sinusoids.

Schlumberger Vertical Electrical Sounding

The Schlumberger VES method is a specific type of earth resistivity measurement. In earth resistivity measurements, an electrical current is introduced into the ground through metal electrodes. Separate electrodes are used to measure the electrical potential, or voltage, produced by the induced current. The electrical resistivity of geologic materials and their included fluids are determined from the current and voltage measurements.

Vertical electrical sounding methods are obtained by increasing the separation of the current electrodes about a fixed central point on the ground surface. As the electrode spacing is increased, the method senses deeper into the ground. The measured resistivity, referred to as apparent resistivity, is equal to the true resistivity of the earth material for the case of a uniform homogeneous half-space. In the case of a layered earth, the true resistivity and thickness of the layers can be determined by mathematical modeling of the observed data.

Apparent resistivity is plotted as a function of electrode spacing. The apparent resistivity curve is used to calculate true resistivity versus depth. The end-product of the survey produces a vertical profile of resistivity beneath the survey point. The profile resembles, and is interpreted similarly to a down-hole resistivity log. The method is useful for mapping changes, with depth, of lithology, moisture content, salinity or any other factor which will cause changes in the conductivity of the sampled material.

Data acquisition is relatively rapid and data processing and interpretation is very quick and inexpensive. The method normally provides good depth penetration. The depth is generally limited only by the total length of the array, which is 1,000 feet in our current configuration. VES has the poorest resolution of the methods described here; therefore the resulting interpretation has the least detail.

We used the ABEM Terrameter 300B instrument to conduct this survey. Geophex uses a proprietary cable system that consists of two spools containing 500 feet of cable, fixed electrode clip positions along the cables, and a center switching box. Our system increases the speed and accuracy of data collection.