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TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAVAL AIR STATION WHITING FIELD
MILTON, FLORIDA

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TECHNICAL REPORT
GEOPHYSICAL SURVEY

REMEDIAL INVESTIGATION AND FEASIBILITY STUDY

PHASE II-A

NAVAL AIR STATION, WHITING FIELD
MILTON, FLORIDA

UIC: N60508

Contract No. N62467-89-D-0317

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EXECUTIVE SUMMARY

This technical report describes the methodology and presents results and conclusions of the geophysical survey investigation conducted at the Naval Air Station (NAS) Whiting Field, Milton, Florida. The geophysical survey was one of nine field investigative tasks that comprise the Remedial Investigation (RI). The objective of the RI is to address any identified risks posed by toxic or hazardous chemicals present as a result of past waste disposal practices or spills at the facility. The entire Remedial Investigation/ Feasibility Study (RI/FS) program is being conducted at NAS Whiting Field in accordance with the Navy's Installation Restoration Program.

Geophysical surveys were completed at seven former disposal sites at NAS Whiting Field. The sites included:

- Site 1, Northwest Disposal Area,
- Site 10, Southeast Open Disposal Area A,
- Site 11, Southeast Open Disposal Area B,
- Site 13, Sanitary Landfill,
- Site 14, Short Term Sanitary Landfill,
- Site 15, Southwest Landfill, and
- Site 16, Open Disposal and Burning Area.

The purpose of the geophysical survey was to investigate the lateral and vertical extent of the waste disposal areas, identify subsurface features that may act as plume migration pathways, locate buried metallic and nonmetallic objects, and characterize landfill materials. The surveys were conducted from May 26, 1992, through June 14, 1992, and included electromagnetic induction, magnetometry, and direct current resistivity geophysical methods.

The interpreted results of the geophysical survey identified and mapped the lateral boundaries of all investigated disposal areas except Site 1. No subsurface anomalies were detected at Site 1. In addition to identifying primary disposal areas, numerous isolated metallic and non-metallic anomalies were identified and mapped. The vertical extent of the landfills was not determined nor were any contaminant plumes or possible plume migration pathways detected. A detailed summary of the geophysical results including the geophysical methods used, the results of each individual geophysical method, and the interpretation of the geophysical results is presented in Table ES-1 of this Technical Report.

The anomalies identified by the geophysical survey will be verified later by test pitting activities conducted at each of the disposal sites and the complete data set will be used to direct additional investigations at NAS Whiting Field.

Table ES-1
Summary of Geophysical Survey

Geophysical Survey, Technical Report
RI/FS Phase II-A, NAS Whiting Field
Milton, Florida

Site No.	Site Name and Type	Results			Interpretation
		Magnetometer	EM-31 Conductivity	EM-31 Inphase	
1	Northwest Disposal Area (landfill)	No anomalies	Flat across the site	Flat across the site	No landfill boundaries can be interpreted.
10	Southeast Open Disposal Area (A) (landfill)	One large scale anomaly with two isolated point features.	Consistent with magnetometer data.	Consistent with conductivity data.	Landfill is interpreted in the southern portion with definite lateral boundaries.
11	Southeast Open Disposal Area (B) (landfill)	One large scale anomaly with three isolated low amplitude anomalies.	Consistent with magnetometer data.	Consistent with conductivity data.	Landfill is interpreted with definite lateral boundaries.
13	Sanitary Landfill (landfill)	Two linear feature anomalies with a shorter parallel feature and a localized high amplitude anomaly.	Consistent with magnetometer data.	Consistent with conductivity data.	Landfill interpreted with a series of trenches. Greatest concentration of ferromagnetic metals in the southwestern corner.
14	Short-Term Sanitary Landfill (landfill)	Single linear feature anomaly trending east-west.	Consistent with magnetometer data.	Consistent with conductivity data.	Indicates signatures of metallic debris buried in trench with definite boundaries.
15	Southwest Landfill (landfill)	A feature with highest amplitude anomaly in the northern portion. Five bands of linear feature anomalies trending southwest-northeast. Extended low magnitude anomaly in the eastern portion.	Consistent with magnetometer data.	Consistent with conductivity data.	High degree of buried ferromagnetic debris in the northern portion. Parallel trenches of landfill in the central portion. Large area of landfill in the eastern portion with defined boundaries.
16	Open Disposal and Burning Area (landfill)	Two regions of extended anomalies surrounded by natural field strength. Scattered point feature anomalies trending away from the site in the easterly direction.	Consistent with magnetometer data.	Consistent with conductivity data.	Two landfill cells with definite boundaries.

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GLOSSARY

ABB-ES	ABB Environmental Services, Inc.
BGI	Blackhawk Geosciences, Inc.
bls	below land surface
DC	direct current
EM	electromagnetic induction
GPR	ground penetrating radar
MAG	Magnetometer
MD	metal detector
mmho/m	millimhos per meter
NAS	Naval Air Station
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
SOUTHNAVFAC-ENGCOM	Southern Division, Naval Facilities Engineering Command

1.0 INTRODUCTION

ABB Environmental Services, Inc. (ABB-ES), under contract to the Department of Navy, Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) is conducting the Phase II-A Remedial Investigation and Feasibility Study (RI/FS) at Naval Air Station (NAS) Whiting Field located in Milton, Florida. The RI/FS is being conducted under contract number N62467-89-D-0317.

A two-phased approach has been adopted for achieving the objectives of the RI/FS. The Phase I investigation, including subsurface geologic explanations and the sampling and analysis of surface and near surface soil, groundwater, surface water, and sediments, was carried out from December 1990 through April 1992. RI/FS Phase II is scheduled to be conducted in two parts: A and B. The Phase II-A RI field program was initiated in May 1992 with the Geophysical Survey.

The Geophysical Survey was the first field event completed in a series of tasks scheduled for the RI/FS Phase II-A program. This technical report summarizes the results and presents data gathered during the geophysical survey. A similar report will be prepared for the soil gas survey. These technical reports, along with the supporting technical memoranda, will form the basis for identifying data gaps for Phase II-B and preparing the RI report for NAS Whiting Field.

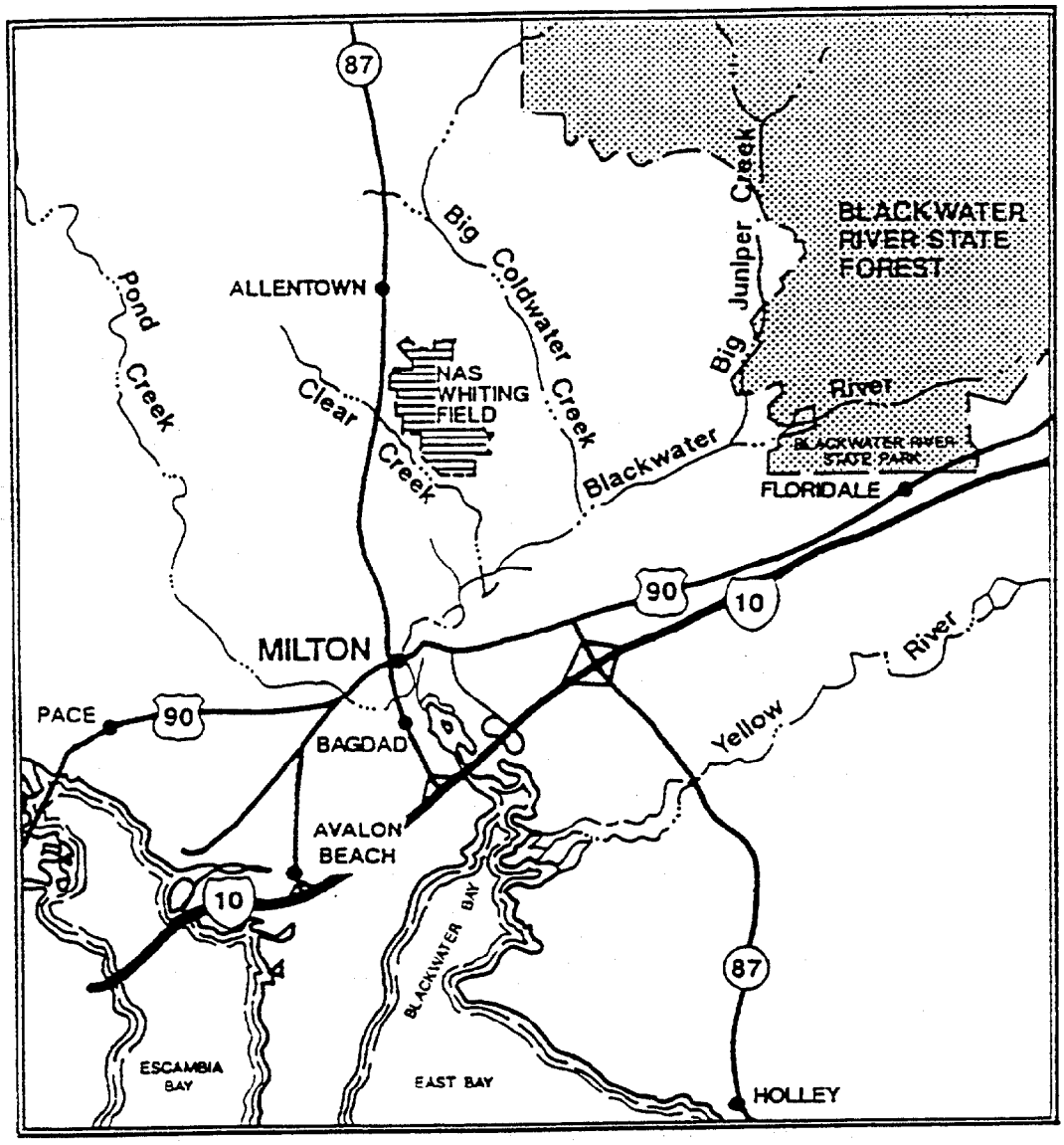
NAS Whiting Field is located in Florida's northwest coastal area approximately 7 miles north of Milton and 20 miles northeast of Pensacola (Figure 1-1). NAS Whiting Field presently consists of two air fields separated by an industrial area and covers approximately 2,560 acres in Santa Rosa County. Figure 1-2 presents the installation layout.

1.1 REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS) PROGRAM.

1.1.1 Purpose The purpose of the RI/FS Program at NAS Whiting Field is to identify a range of remedial alternatives which address any identified risks to public health and the environment posed by toxic or hazardous chemicals present as a result of past waste disposal practices or spills. To achieve this objective, the RI must collect data sufficient to assess the nature and distribution of chemicals associated with each site. The data collected in the RI will be used in the FS to screen, evaluate, and select remedial alternatives to provide permanent, feasible solutions to environmental contamination problems at NAS Whiting Field.

1.1.2 Scope of RI Phase II-A Field Program The RI Phase II-A field program activities include the following:

- geophysical surveys,
- soil gas surveys,
- soil borings and test pits,
- surface and subsurface soil sampling,
- surface water and sediment sampling,
- monitoring well installation and groundwater sampling,
- location surveys, and
- ecological and public health surveys.



SCALE IN MILES

0 5

Florida

SITE MAP

N

MAP LOCATION

SOURCE: ABB ENVIRONMENTAL SERVICES, INC. 1991

FIGURE 1-1

FACILITY LOCATION MAP

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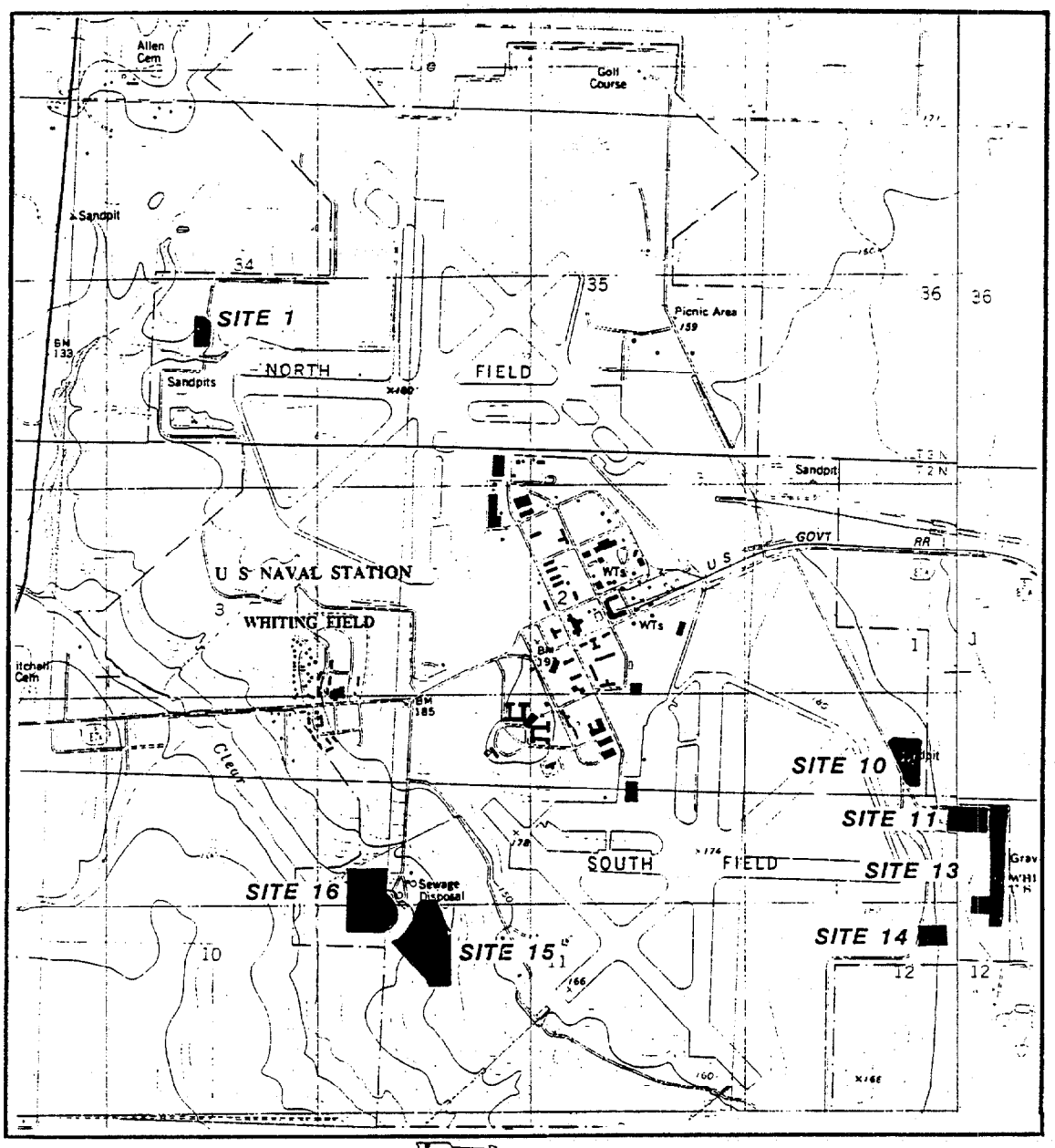

LEGEND

GEOPHYSICAL SURVEY SITE BOUNDRIES

SOURCE: BLACKHAWK GEOSCIENCES, INC. 1992

FIGURE 1-2

INSTALLATION LAYOUT

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GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA

A summary of RI Phase II-A activities is presented in Section 7.0 of Technical Memorandum No. 6 (ABB-ES, 1992c). Procedures for RI Phase II-A field explorations, including sampling and analysis, are found in Volumes I and III of the RI/FS Phase I Workplan (Jordan, 1990).

1.2 GEOPHYSICAL SURVEYS. Geophysical surveys at NAS Whiting Field were conducted during the period of May 26, 1992, through June 14, 1992. These geophysical surveys provide data that identify exploration locations to be investigated in the subsequent events of the Phase II-A RI. Geophysical surveys were performed at seven disposal areas (Sites 1, 10, 11, 13, 14, 15, and 16).

1.2.1 Purpose The purpose of the geophysical surveys at NAS Whiting Field was to investigate the lateral and vertical extent of waste disposal areas, identify subsurface structures that may act as preferential pathways for plume migration, locate buried metallic or nonmetallic objects that may indicate potential source areas, and to characterize landfill materials. In addition, geophysical methods were used to screen for possible underground utility lines, fuel distribution lines, and other obstructions that may interfere with subsurface explorations.

1.2.2 Scope Subsurface geophysical techniques proposed in the Technical Memorandum No. 6 for geophysical survey at NAS Whiting Field include the following:

- electromagnetic induction (EM),
- ground penetrating radar (GPR), and
- metal detector (MD).

However, after initial reconnaissance of the survey sites and detailed discussions with the personnel from Blackhawk Geosciences, Inc. (BGI), Golden, Colorado, a subcontracted geophysical consultant, a comprehensive plan was proposed using the following techniques:

- electromagnetic induction (EM),
- magnetometer (MAG),
- metal detector (MD), and
- direct current (DC) resistivity meter.

Although metal detecting techniques were proposed in the scope of the geophysical survey, these techniques were not incorporated during this phase of fieldwork. Metal detecting instruments will be used during later site mobilizations to screen for possible underground utility lines, fuel distribution lines, or other buried obstructions prior to drilling operations and other subsurface explorations.

Geophysical surveys were conducted at the seven known disposal areas/landfill areas at NAS Whiting Field. Table 1-1 presents both the proposed scope of work and the actual work completed at each of the sites.

1.3 SHALLOW LITHOLOGY AT STUDY AREAS. The limitations in the application of various geophysical methods are basically controlled by the characteristics of subsurface material, the ability of the corresponding signal to propagate through various materials without significant loss of information, and the extent of

Table 1-1
Scope of Geophysical Survey

Geophysical Survey Technical Report
RI/FS Phase II-A, NAS Whiting Field
Milton, Florida

Site No.	Site Name and Type	Location	Survey Area	
			Proposed	Actual
1	Northwest Disposal Area (landfill)	North Field, west side	5 acres	1 acre
10	Southeast Open Disposal Area (A) (landfill)	South Field, southeast area	4 acres	6 acres
11	Southeast Open Disposal Area (B) (landfill)	South Field, southeast area	3 acres	5 acres
13	Sanitary Landfill (landfill)	South Field, southeast area	4 acres	8 acres
14	Short-Term Sanitary Landfill (landfill)	South Field, southeast area	3 acres	3 acres
15	Southwest Landfill (landfill)	South Field, southwest area	15 acres	13 acres
16	Open Disposal and Burning Area (landfill)	South Field, southwest area	10 acres	16 acres

background noise. In order to better rationalize the effectiveness of the various methods, it is necessary to correlate the geologic information of the study areas with the behavior principles of various signals used in geophysical surveys. The relevant information extracted from Technical Memorandum No. 1 and 2 (ABB-ES, 1992a and 1992b) is presented in this section.

The lithology at NAS Whiting Field generally consists of sands and gravels with interbedded silt and clay layers, suggesting a low to moderate energy fluvial depositional environment. The sands ranged from very fine to coarse in grain size, with moderate to very high densities, and were poorly graded. The gravels were typically encountered in thicknesses of less than 1 foot or in "little to trace" amounts intermixed with coarse sands.

Clay and silt layers were found at variable depths throughout NAS Whiting Field. Commonly clays occurred with varying amounts of silts and sands. Table 1-2 presents the subsurface lithology from land surface to 30 feet below land surface (bls) at the study areas (30 feet is generally the maximum depth of exploration targeted for this investigation).

Because of the existing geological conditions including the prevalence of clay lenses throughout the study areas, GPR techniques were not incorporated in the NAS Whiting Field geophysical surveys. The electromagnetic radiation generated by the GPR instruments are rapidly attenuated in high clay content and saturated soils. The high attenuation produces a weak return signal strength which translates to decreased depth of penetration. In place of GPR techniques, terrain conductivity (EM) systems were used during the NAS Whiting Field geophysical surveys. The electromagnetic induction waves generated by terrain conductivity instruments are of lower microwave energy and are therefore not as rapidly attenuated by high clay content in area soils.

Table 1-2
Lithology at Study Areas

Geophysical Survey Technical Report
RI/FS Phase II-A, NAS Whiting Field
Milton, Florida

Site No.	Classification	Lithology (up to 30 ft bls)
Site 1	Northwestern Disposal Area	Mostly sand, and random occurrence of clay and silty clay
Sites 10, 11, 13, and 14	Southeast Disposal Areas	Clay, clayey sand, silt layers, silt and clay layers encountered more frequently than other sites
Sites 15 and 16	Southwest Disposal Areas	Clay and clayey sand layers

Notes: ft bls = feet below land surface.

2.0 DESCRIPTION OF SURFACE GEOPHYSICAL METHODS

Geophysical methods generally work on the principles of propagation of electromagnetic waves, electromagnetic induction, and use of the earth's magnetic field. These methods provide insight into subsurface conditions. The primary applications for the geophysical methods employed at NAS Whiting Field are to:

- locate and map buried waste and disposal trenches and
- locate and map man-made structures such as landfill boundaries, cables, drums and buried foundations.

Typically, multiple geophysical techniques are used when conducting an investigation so that individual anomalies detected by one method can be confirmed by a separate technique. Four surface geophysical methods were included in the scope of geophysical survey at NAS Whiting Field:

- electromagnetic induction (EM),
- direct current (DC) resistivity,
- magnetometer (MAG), and
- metal detector (MD).

The following sections describe the methodology and field procedures for each of the techniques and presents the rationale for choosing an appropriate technique. A complete copy of the raw data generated during the geophysical surveys is presented in Appendix A.

2.1 ELECTROMAGNETIC (EM) INDUCTION. Terrain conductivity refers to the relative ability of the earth to conduct electricity. Terrain conductivity can be measured using EM ground conductivity meters. As some types of leachate can alter the electrical properties of soil pore waters and groundwater, this technique can be useful in tracing ionic fractions of leachate plumes. In addition, EM instruments can detect buried metallic objects (by measuring the inphase response) and can determine changes in soil composition. These features can provide data for determining the limits of waste disposal areas or landfills.

2.1.1 Theory An EM transmitter and receiver are used with the EM technique. A primary EM field is created by passing alternating current through a coil of wire, and antenna of the transmitter. The EM field passes through the subsurface and induces a flow of EM current proportional to the combined conductivity of groundwater, sediment, and rock. The current flow induces a secondary EM field of the same frequency as the primary field but of different phase and direction. The primary and secondary EM fields are measured as a change in the potential induced in the receiver coil. The apparent conductivity of the subsurface is calculated within the receiver unit and is reported in millimhos per meter (mmhos/m). As shown on Figure 2-1, various buried objects induce changes in the apparent conductivity reported on the EM instruments. Through training, a geophysist is able to interpret apparent conductivity response and make judgements concerning the locations and types of buried materials.

The EM instrument employed in the geophysical surveys at NAS Whiting Field was the Geonics EM-31. There are two components of induced magnetic field measured by the EM-31. The first is the quadrature-phase component which indicates the ground conductivity measurement. The second is the inphase component used

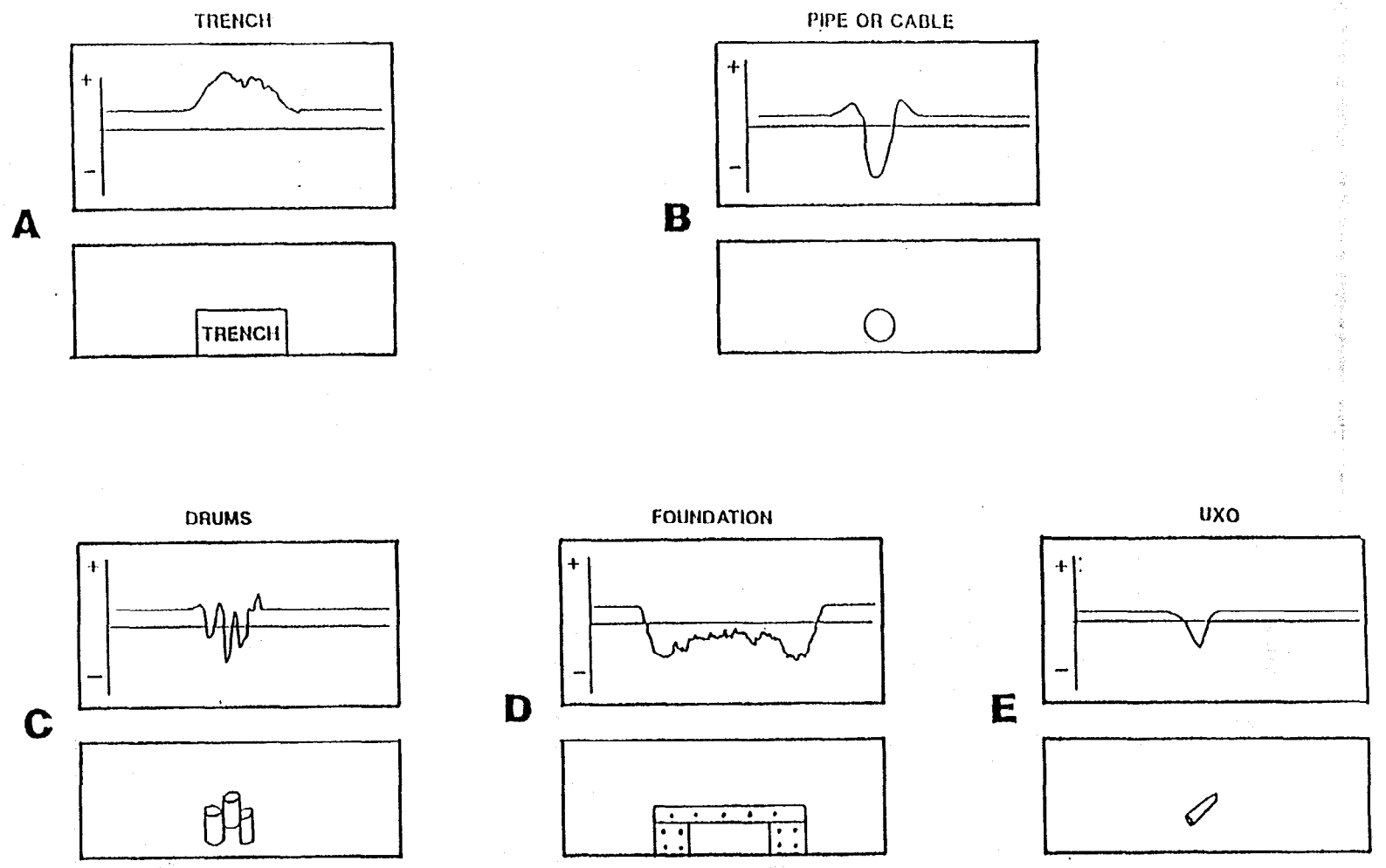

FIGURE 2-1

PRINCIPLE OF ELECTROMAGNETIC INDUCTION AS APPLIED TO GEOPHYSICAL SURVEY

SOURCE: U.S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY

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primarily for calibration purposes; however, this component is significantly more sensitive to large metallic objects and, hence, may be used to locate buried metal objects. By changing the separation distance or the orientation of the EM instrument coils, the effective exploration depth of the instrument can be changed to affect the depth of exploration. The separation distance, in the case of the EM-31, is fixed at 12 feet; however, the coil orientation can be changed. The two coil orientations considered for this investigation are horizontal-dipole and vertical-dipole configurations. A horizontal-dipole is a pair of magnetic poles that are parallel with the earth's surface. In the horizontal-dipole configuration, the two coils are placed on their edge,perpendicular to the earth's surface and coplanar. The electrical nature of the shallow subsurface is measured by use of this configuration. The effective depth of measurement typically is three fourths of the coil separation distance (approximately 9 feet). A vertical-dipole is a pair of magnetic poles that are perpendicular to the earth's surface. In the vertical-dipole configuration, the two coils are placed flat on the ground and co-planar. The deep subsurface, about 1 to 1-1/2 times the coil separation distance (approximately 18 feet), is measured by use of vertical-dipole configuration.

2.1.2 **Field Procedure** A Geonics EM-31 transmitter and receiver were used for investigation at NAS Whiting Field. The data were collected on and adjacent to the seven waste disposal sites. Initially, a single base line was established at each survey area either in a due north-south or east-west direction. Parallel lines spaced at either 20 feet or 40 feet intervals were then surveyed and staked in the survey area. Data typically were collected at stations located at 10-foot intervals along each of the staked lines. The lateral boundaries of the study area were interpreted on a real time basis. At the end of each field day, EM-31 data were processed through a portable computer, data sets were gridded, contoured, and plotted, and preliminary interpretations were made. Based on these interpretations, additional base lines and stations were added to the grid until either the recovered data indicated complete coverage of the investigation area had been accomplished or physical barriers at the site limited continuation. The EM-31 was used in the vertical-dipole mode in order to gain maximum depth of exploration (1 to 1-1/2 times the distance between receiver and transmitter). Station locations were determined by pace and compass methods.

Data were collected with caution in areas of apparent interference from buildings, pipelines, overhead or underground wires, sheet piles, or metal guard rails. Interferences such as these adversely affect EM measurements. Comments were recorded where sources of interference may have been affecting the instruments. Local observed geology soil type, land use, and any other local features that could influence the apparent-conductivity readings were noted during data collection to aid in interpreting the data. At stations where there is suspected interference, the conductivity values were double-checked by rotating the instrument orientation 90 degrees from the first measurement and recording the apparent conductivity. Consistent readings at both orientations would indicate a single homogeneous unit underlying the station. Where the values were inconsistent, it was possible that the difference was the result of an isolated, highly-conductive material or object not representative of the subsurface lithology.

2.2 DIRECT CURRENT (DC) RESISTIVITY METER.

2.2.1 Theory Resistivity methods are used in conjunction with the terrain conductivity methods in order to obtain information regarding the depth of various conductive materials. Resistivity is a fundamental electrical property of rock materials related to their lithology, porosity, water content, and water quality. The determination of the subsurface distribution of resistivity from measurements on the surface yields useful information on the structure or composition of the buried formation. In resistivity methods, current is driven into the ground by galvanic contacts (such as steel probes). Four-electrode arrays are used at the surface, one pair (current pair) for introducing current into the earth, and the second pair (potential pair) for measurement of the potential associated with the current. The potential drop ratio from station to station gives the information on the resistivity variation. The depth of exploration is linearly related to the separation distance of the electrodes.

The concept behind this method is to determine the apparent resistivity at different exploration depths, and to compute from these measurements the true resistivity stratification of the ground. Because a large resistivity contrast is expected between fill and native materials, the depth of fill can be inferred from the resistivity stratification.

Various electrode configurations are available for DC resistivity soundings. The choice of the method to use is generally determined by specific data objectives and site conditions. The two most commonly used sets of surface configurations for the current and potential electrodes are the Wenner array and the Schlumberger array. In the Wenner configuration, the spacings between adjacent electrodes are kept constant with the potential electrodes at the center of the array and the current electrodes on the outside of the array. In the Schlumberger configuration, the separation of the inner potential electrodes are maintained at less than 1/3 of the half distance between the outer current electrodes.

2.2.2 Field Procedures To calculate the depth of fill, DC resistivity soundings with the Wenner array were tested. The Wenner array configuration was selected because, in general, it is less influenced by near surface variations in conductivity (including metal materials near potential electrodes) than the Schlumberger array. Data gathered during the magnetometer and EM-31 surveys indicated the potential for interference due to surface metallic materials.

A total of 4 Wenner array DC resistivity soundings were made at two of the seven investigation areas (Site 13 and Site 16) at NAS Whiting Field. Two soundings were conducted at Site 13 and two soundings at Site 16.

2.3 MAGNETOMETER.

2.3.1 Theory A magnetometer measures the intensity of the earth's magnetic field. Magnetometers are used to locate buried ferro-metallic objects by detecting the distortions in the earth's magnetic field caused by such materials. Magnetometers are not sensitive to non-ferrous metal such as aluminum, brass, and copper. A magnetometer provides a greater depth of detection than a metal detector and can generally detect smaller targets than EM systems. The earths magnetic field strength is measured either as total field strength (gammas) or as the gradient of field strength (gammas/ft).

The most commonly used magnetometers in environmental geophysical work are fluxgate and proton precession magnetometers. A fluxgate magnetometer measures a component of the earth's magnetic field (usually the vertical component). It utilizes an iron core coil which undergoes changes in its level of magnetic saturation in response to variations in the earth's magnetic field. Changes in saturation level are proportional to variations in the earth's magnetic field strength (Dobrin, 1976). A proton precession magnetometer utilizes the precession of spinning protons to measure the earth's magnetic field. These magnetometers incorporate a sensor containing a hydrocarbon fluid surrounded by a coil of wire. The coil is energized momentarily and creates a magnetic field which aligns the protons in the fluid with the magnetic axis of the coil. Once the current is removed, the protons reorient themselves in the direction of the earth's magnetic field. In the process of reorientation, protons generate a signal whose frequency is proportional to the total intensity of the earth's magnetic field (Breiner, 1973).

2.3.2 **Field Procedure** An EDA Omni-IV total fluxgate magnetometer was used for investigations at NAS Whiting Field. The data were collected on and adjacent to all seven waste disposal sites described in Chapter 1. In order to maintain the consistency in the data obtained between various geophysical methods the same grid developed for EM-31 survey was employed for this survey. Also similar to the EM-31 investigation, data were processed on a real time basis. Daily entry and evaluation of the data on a portable computer aided in the determination of complete coverage of the sites and preliminary interpretations of the data. The total field recorded by a magnetometer includes the intensity of earth's magnetic field, cultural magnetic noise, and the influence of nearby buried ferrous metal. In order to account for the time-variable changes in the earth's magnetic field, a base station magnetometer (a second stationary magnetometer) was used. The second magnetometer was used to correlate and minimize any errors due to slow natural changes of the earth's field with time (Breiner, 1973).

2.4 **METAL DETECTOR**. The use of metal detecting instruments proposed for this investigation was deferred and will be used to screen buried drums and metal objects prior to subsurface exploration activities (i.e., test pitting and drilling operations). Since a metal detector can detect both ferrous and non-ferrous metal, these can also be used before drilling at selected sites to screen for possible underground utility lines, fuel distribution lines, or other obstructions that could interfere with the completion of subsurface explorations and to prevent damage to underground equipment. Metal detectors operate on the induction principle similar to the EM method. However, metal detectors do not measure electrical conductivity as do EM systems.

3.0 RESULTS AND INTERPRETATION

3.1 GENERAL. There are four elements of exploration included in the scope of geophysical surveys at NAS Whiting Field. These elements include: determination of lateral boundaries of each disposal area, identification of the type and location of fill materials, investigation for potential high conductivity leachate plumes, and determination of the depth of fill material. The lateral boundaries of disposal areas, the type and location of fill material, and identification of leachate plumes were interpreted using the EM-31 and total magnetic field data. The depth of fill material was investigated using the DC resistivity soundings.

DC resistivity soundings with Wenner array were tested for calculating the depth of disposal areas. Calculation of depth is based on the depth versus resistivity curve generated by the DC resistivity soundings. The feasibility of interpreting DC resistivity sounding was tested at the end of EM-31 and Magnetometer surveys. Two test units (Site 13 and Site 16) were selected for this study. Figure 3-1 shows the apparent resistivity curve for sounding WENN13-2. This sounding was recorded over undisturbed ground at Site 13, well away from the landfill. The experimental data measured at different electrode spacings are indicated by points. The solid line represents the best fit computed model curve for the two layer resistivity stratification shown on the right of the figure. This model shows high resistivities throughout the section. An example of Wenner soundings over the landfills are given in Figures 3-2 and 3-3. The interpretation of this data is shown in Table 3-1 below.

Table 3-1
Interpretation of Resistivity Stratification in Terms of Landfill Depth

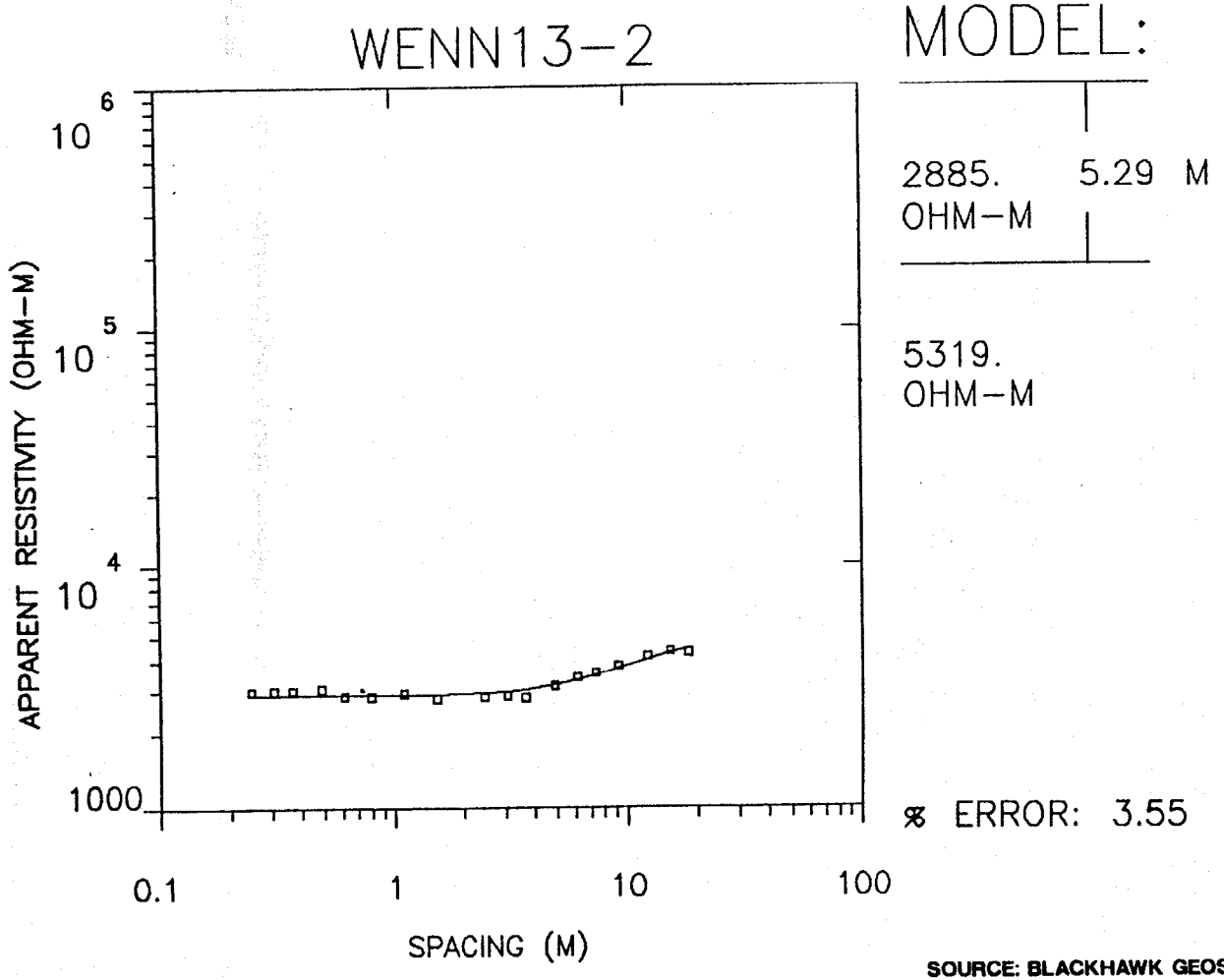
Geophysical Survey, Phase II-A
NAS Whiting Field
Milton, Florida

Layer No.	Resistivity Range (ohm-m)	Interpretation
1	>400	Surface cap
2	1 to 50	Landfill material
3	1,000	Native soil below fill

A major limitation of DC Resistivity inversions is that the solution is not unique, so that a range of resistivities and thicknesses will yield the same model curve. It has been shown that equivalence is particularly large for a thin conductive layer (landfill) overlying a highly resistive section (native soil). In such a situation only the conductance of the landfill can be determined. Conductance(s) of strata is defined as the ratio of the thickness, h, and resistivity, ρ

$$S=\frac{h}{\rho} \qquad (1)$$

Moreover, conductance can best be determined at electrode spacings greater than several times the thickness of fill. The section of the curve on the right ascending branch, at large electrode spacings, is called the S-asymptote, and its theoretical slope for a thin conductive layer overlying a highly-resistive

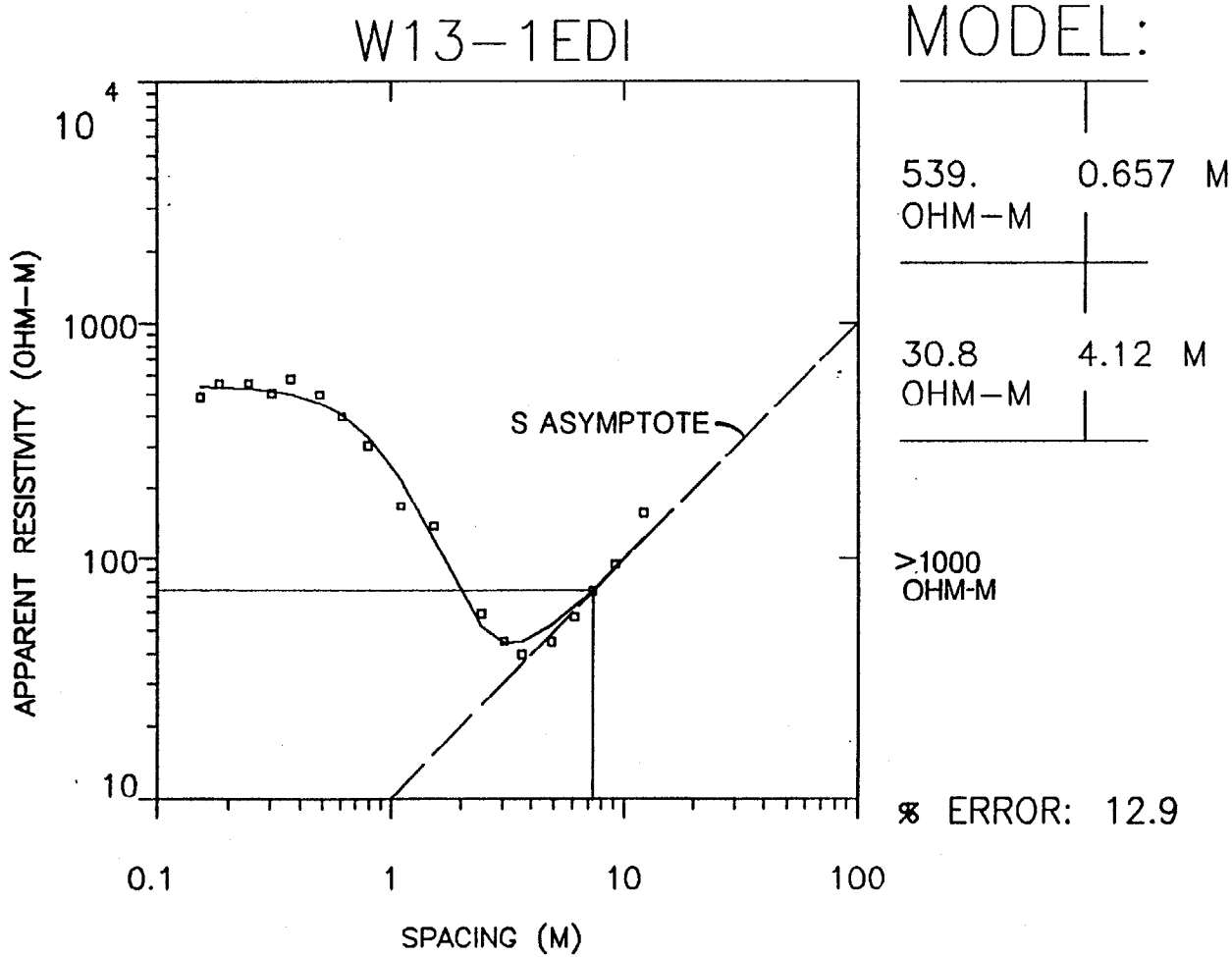


SOURCE: BLACKHAWK GEOSCIENCES, INC., 1992

FIGURE 3-1
DC SOUNDING OVER
UNDISTURBED GROUND, SITE 13

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA

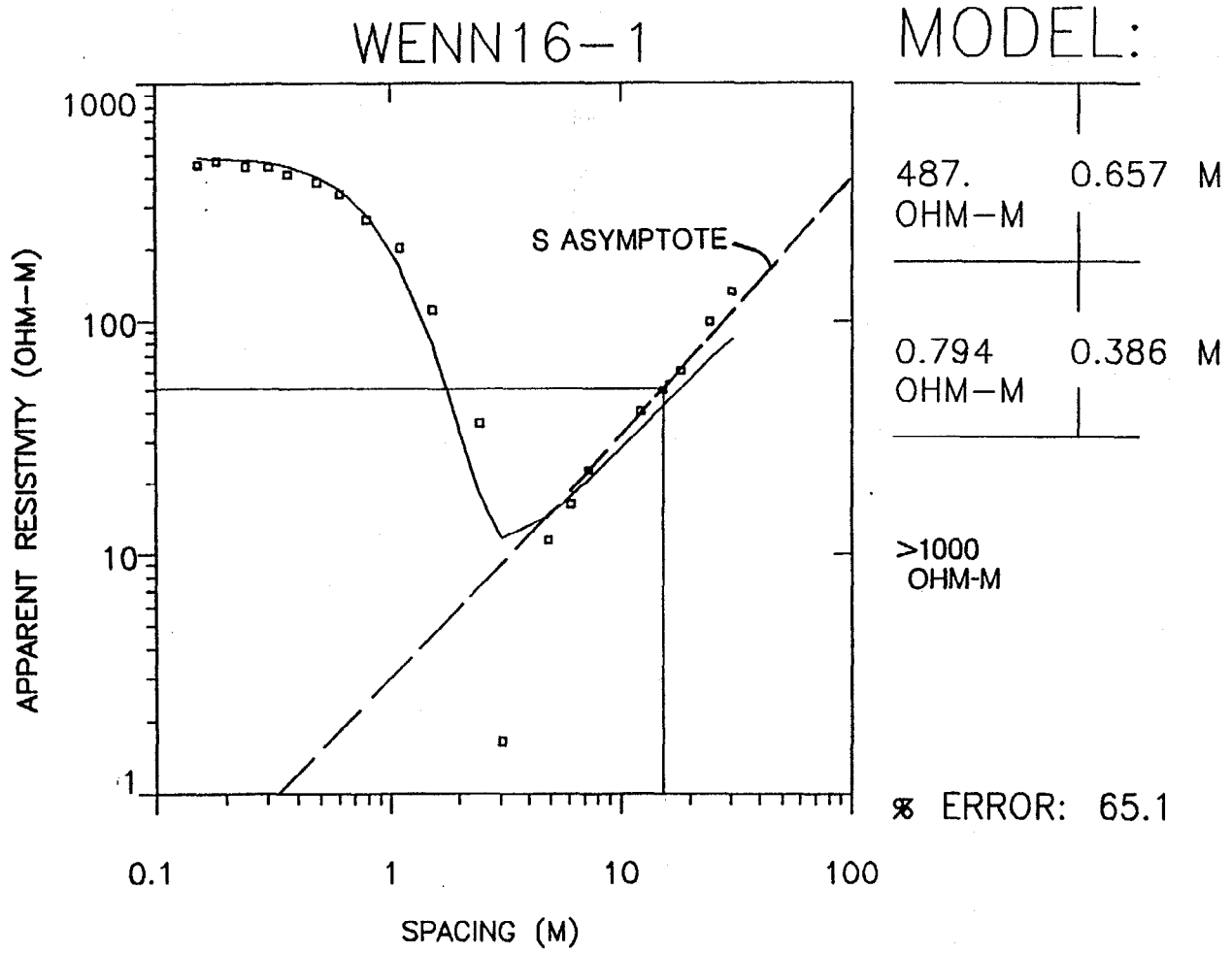


SOURCE: BLACKHAWK GEOSCIENCES, INC., 1992

FIGURE 3-2
DC SOUNDING OVER
LANDFILLED TRENCH, SITE 13

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA



SOURCE: BLACKHAWK GEOSCIENCES, INC., 1992

FIGURE 3-3
DC SOUNDING EAST-WEST TRENDING ARRAY, SITE 16

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA

section is 45°. The asymptote is shown on both Figures 3-2 and 3-3. The conductance, ρ, for points on the S-asymptote is given by

$$S=1.38\frac{a}{\rho a} \qquad (2)$$

where (a) is the electrode spacing for a point on the S-asymptote and ρa the apparent resistivity at that point. It is evident from Equation 1 that h and ρ cannot be separately determined without making certain assumptions. For example, by assuming values of 50 ohm-m (20 millimhos/m) and 20 ohm-m (50 mmhos/m) for the fill material (both are consistent with EM-31 readings at different portions of the landfills), depth of fill can be computed. This is done on Table 3-2 for DC soundings.

Table 3-2
Computation of Depth of Fill

Geophysical Survey, Phase II-A
NAS Whiting Field
Milton, Florida

Sounding No.	ρ(ohm-m)	a(m)	S(mhos)	Depth of Fill (ft)	
				ρ=50 ohm-m	ρ=2 ohm-m
W13-1ED1	73.15	7.32	.138	22.5	9.05
WENNI16-1	50.14	15.2	.419	68.7	27.5

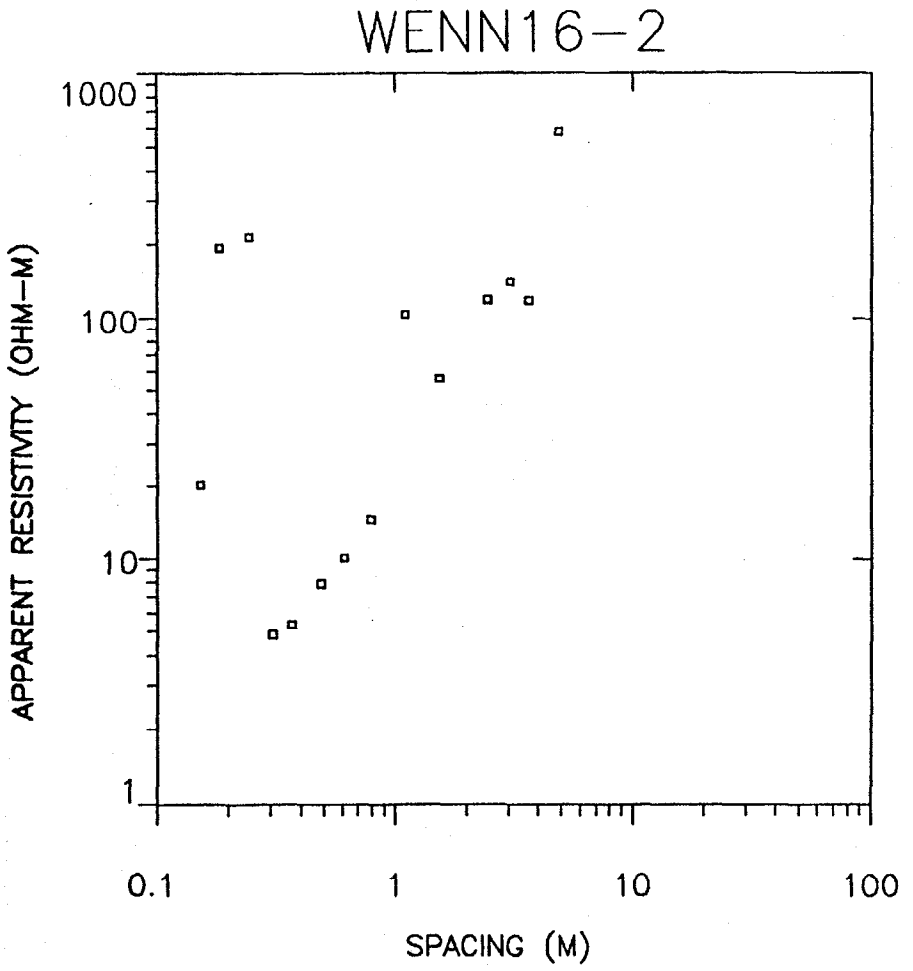
Equation 1 shows that in order to calculate the thickness of fill, the resistivity of the fill material (ρ) must be assigned a value, and Table 3-2 shows how drastically the calculated depths are affected by different resistivity values for the fill. The resistivity of fill encountered at NAS Whiting Field varied both from site to site and across individual landfills. If resistivity of fill changes laterally at a site, depth calculations will be greatly affected.

The resistivity of the fill is affected not only by the type of material in the fill, but also by the amount of metal in the fill. Metallic objects have extremely low resistivity (resistivity of iron 9.71×10^{-8} ohm-m). The low resistivity of metal not only affects resistivity of fill, but causes noise in the sounding curve when electrodes are placed near buried metal. Figure 3-4 shows a sounding that is so affected by noise that physical modeling of this data set would be meaningless.

Because of the problems associated with changes in resistivity for the fill at the NAS Whiting Field sites, Blackhawk Geosciences, Inc., decided that the depth of fill at these sites could not be accurately determined, and this phase of the geophysical surveying was discontinued.

3.2 SITE-SPECIFIC SURVEYS.

3.2.1 Site 1, Northwest Disposal Area Site 1 is located just west of the perimeter patrol road and north of the "E" drainage ditch (see Figure 1-2). Survey grid was established with survey lines running due east-west. The spacing between survey lines was 40 feet, and the survey lines were staked with labeled



SOURCE: BLACKHAWK GEOSCIENCES, INC., 1992

FIGURE 3-4
DC SOUNDING EAST-WEST TRENDING ARRAY, SITE 16

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA

stakes or flagging every 50 feet. EM-31 and total magnetic measurements were taken at 10-foot intervals along the survey lines (see Figure 3-5).

The site is bordered on the east and south by an earthen berm, and the entire site is covered with slash pines. Well WHF-1-1 lies at grid coordinates 15S, 124W. Concrete reinforcing bars were present on the surface at grid coordinates 200N, 20W.

Magnetics. As shown on Figure 3-6, no significant magnetic anomalies were found on the total magnetic field contour. The magnetic field seems to be very slightly decreasing from the northeast corner of the site (50,520 gammas) to the southwest corner of the site (50,350 gammas). Low amplitude anomalies (<50 gammas) were present along the grid line 200N at Stations 20E and 60E.

Electromagnetics. The EM-31 conductivity and inphase data sets are both flat across the site and no geophysical anomalies were interpreted based on these data sets (see Figures 3-7 and 3-8, respectively).

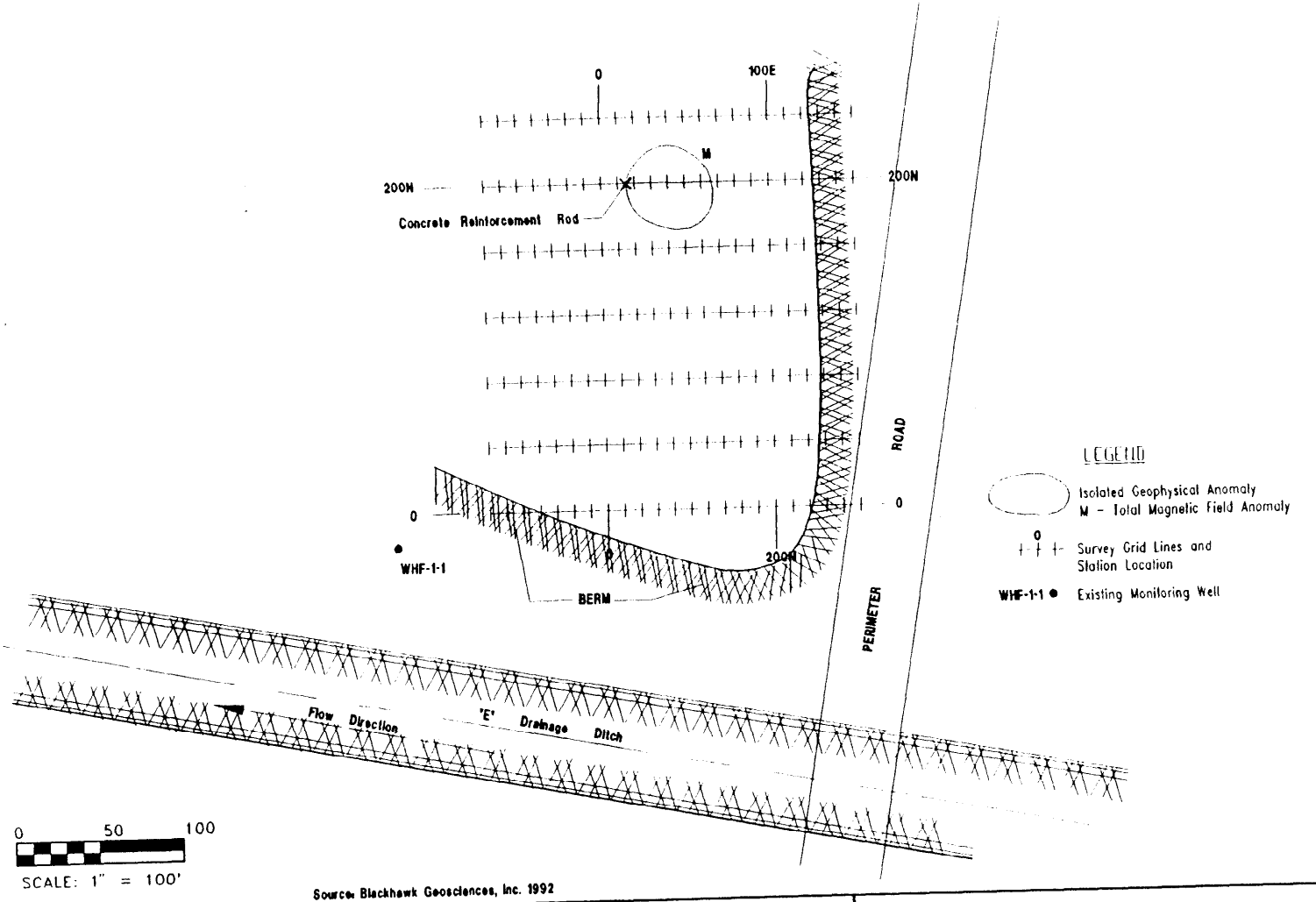
Results. Interpretations of the geophysical data sets are shown in Figure 3-5. On Figure 3-6, the magnetic low on the southwestern corner of the grid is interpreted to be caused by erosion barriers and the iron bar reinforcement in the concrete drainage ditch. It is therefore not included on the anomaly summary map (Figure 3-5). The anomalies along the line 200N occur close to the concrete reinforcing rods present on the surface, and this anomaly is interpreted to be associated with these rods. From the lack of significant geophysical anomalies, landfill boundaries could not be identified. It is inferred that only limited landfill activities occurred at this location. However, it is possible that disposal materials were restricted to fill dirt or concrete rubble which yielded 2W in similar conductivities to the native materials and therefore was not identified during the geophysical survey.

3.2.2 Site 10, Southeast Open Disposal Area Site 10 lies east of perimeter road on the east side of NAS Whiting Field (see Figure 1-2). Several piles of construction rubble were present on site 10, and a ponded area was present on the northeastern portion of the grid. A survey line spacing of 40 feet was used at Site 10, with station intervals of 10 feet. Well WHF-10-1 lies at grid coordinates 36S, 272E (see Figure 3-9).

Magnetics. As shown on Figure 3-10, the large scale total magnetic anomalies at this site extend from approximately grid coordinates 150S to 260N, and from Station 40W to 200E. A low amplitude anomaly is present at grid coordinates 440N, 90W.

Electromagnetics. Figures 3-11 and 3-12 show an apparent anomalous area in the southern portion of the conductivity and inphase grids. This area extends roughly from 260N to 100S, and from 30W to 190E. Station 480N, 130E shows an anomalous value on both data sets. Along line 280N, between 100W and 10W, there is a low amplitude, linear feature indicated on the inphase EM-31 data (Figure 3-12).

Results. The landfill disposal area shown in Figure 3-9 was based on all three geophysical method data sets (total magnetic field, EM conductivity and EM inphase). The northern and southern edges of this area also correspond to the piles of construction rubble on the surface. The amplitude of the feature on the

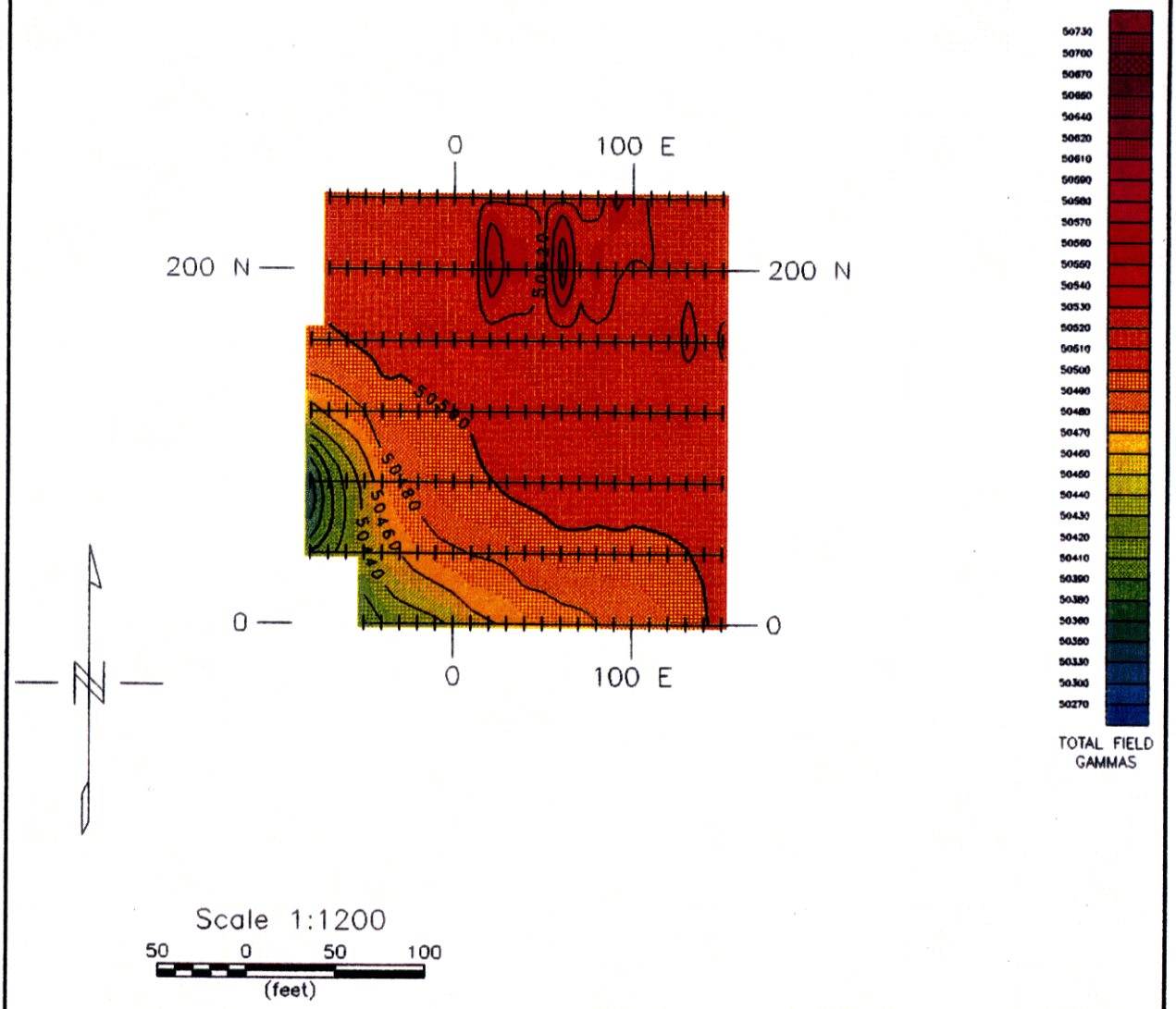


Source: Blackhawk Geosciences, Inc. 1992

FIGURE 3-5
SITE 1
GEOPHYSICAL SURVEY GRID LINES
AND INTERPRETED ANOMALY LOCATIONS

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA



SOURCE: BLACKHAWK GEOSCIENCES, INC. 1992.

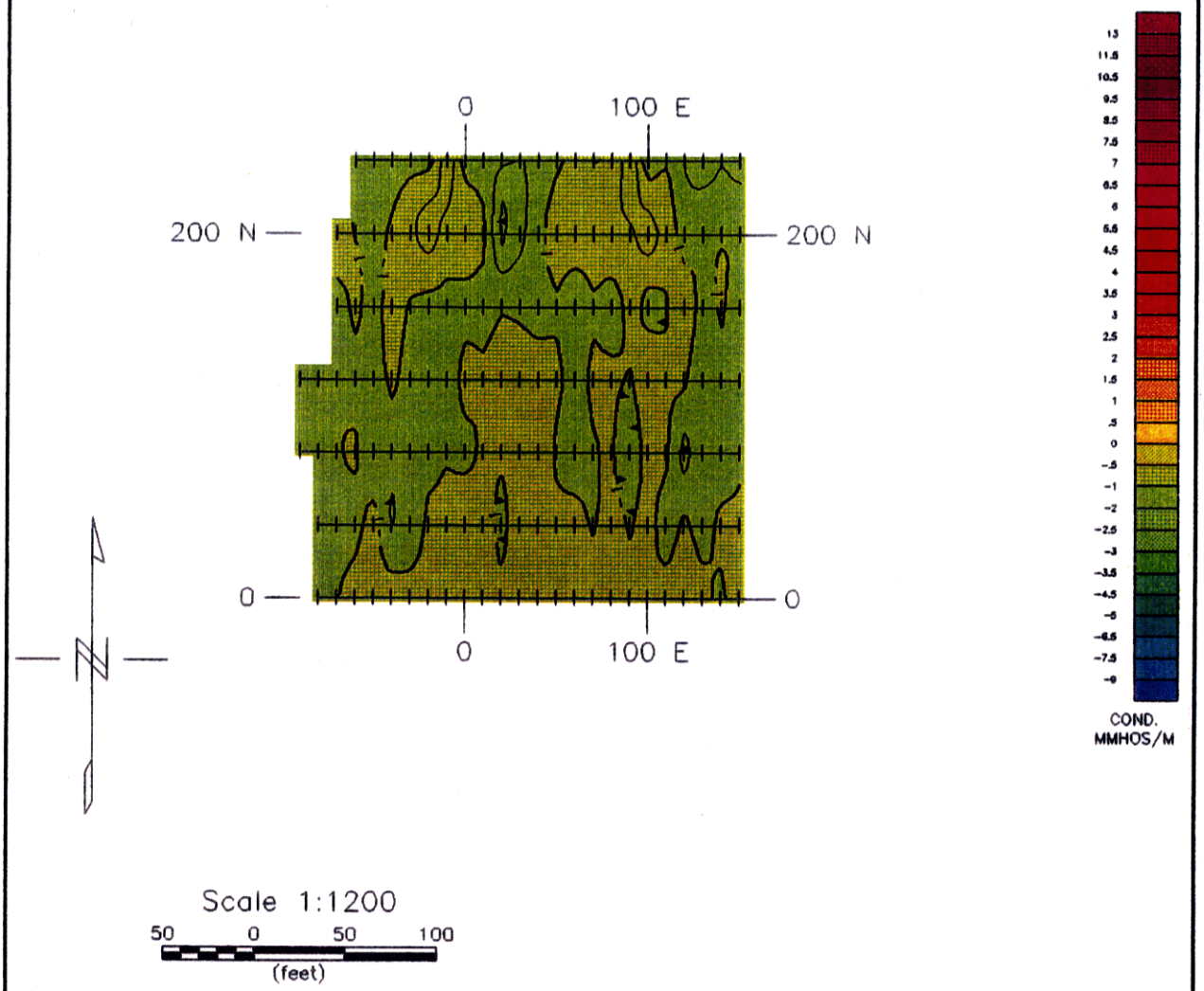
FIGURE 3-6

SITE 1
TOTAL MAGNETIC FIELD
ISOPLETH MAP

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA

00230 CBIY



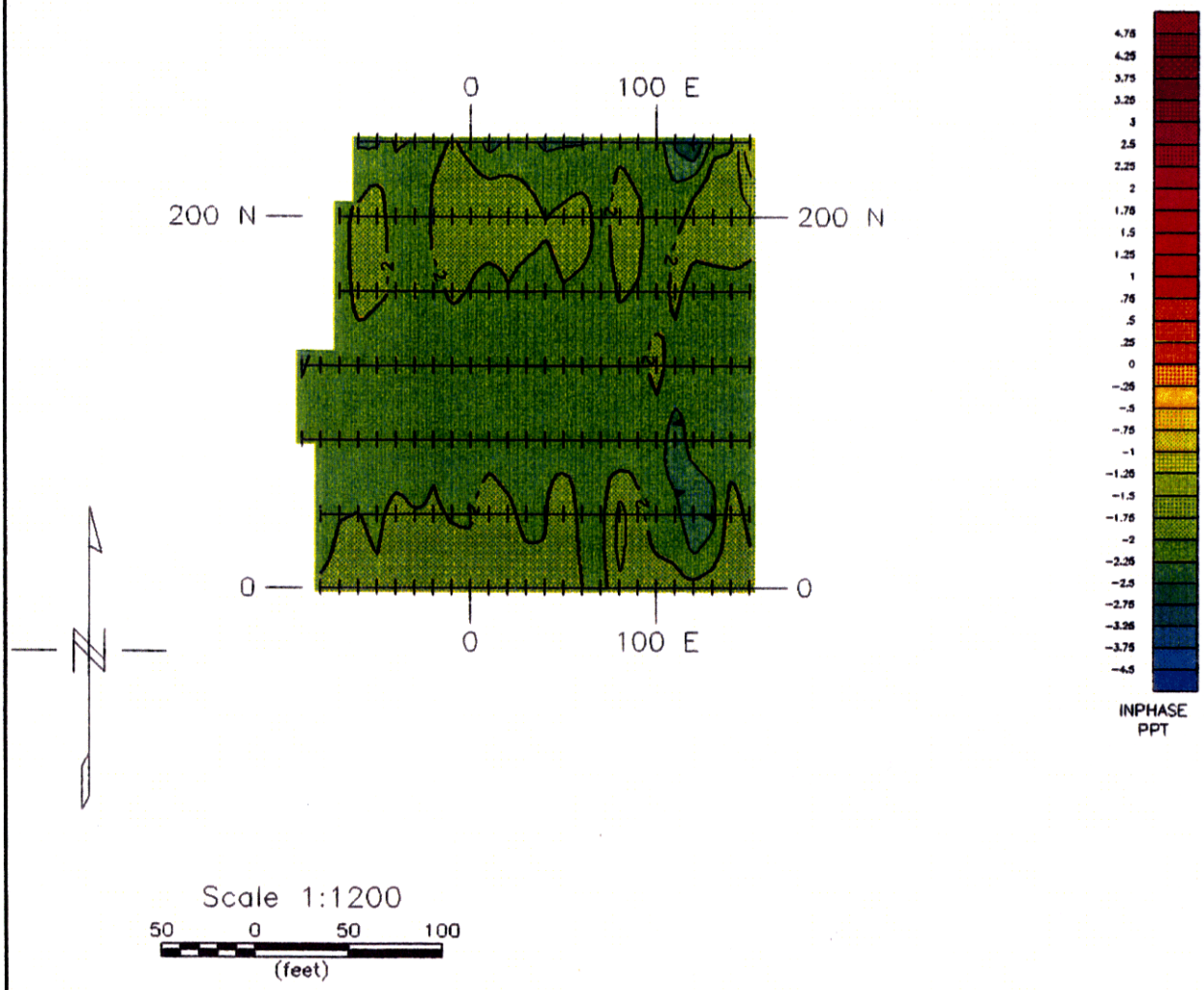
SOURCE: BLACKHAWK GEOSCIENCES, INC. 1992.

FIGURE 3-7

SITE 1
EM-31 CONDUCTIVITY
ISOPLETH MAP

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA



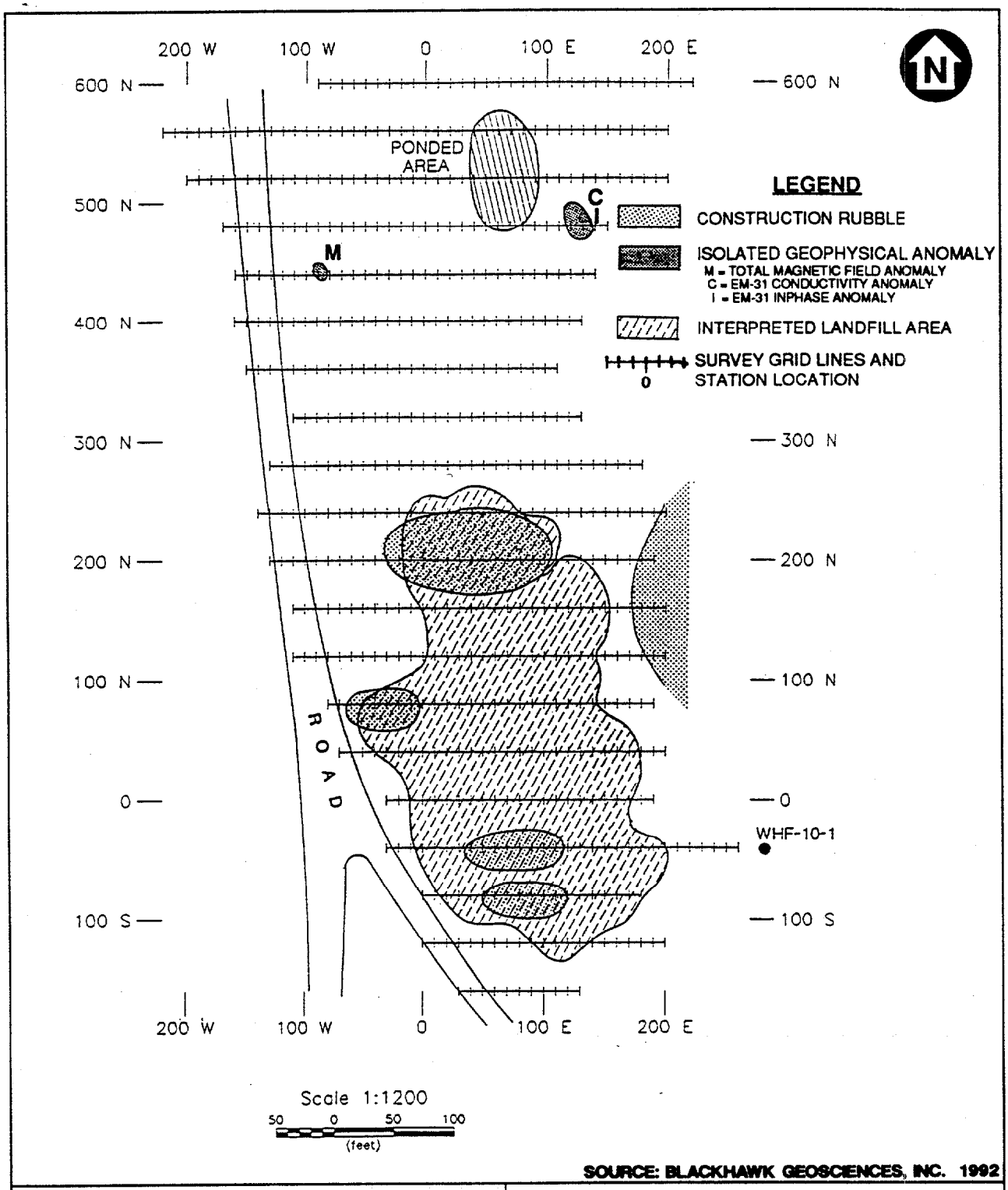
SOURCE: BLACKHAWK GEOSCIENCES, INC. 1992.

FIGURE 3-8

SITE 1
EM-31 INPHASE
ISOPLETH MAP

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA



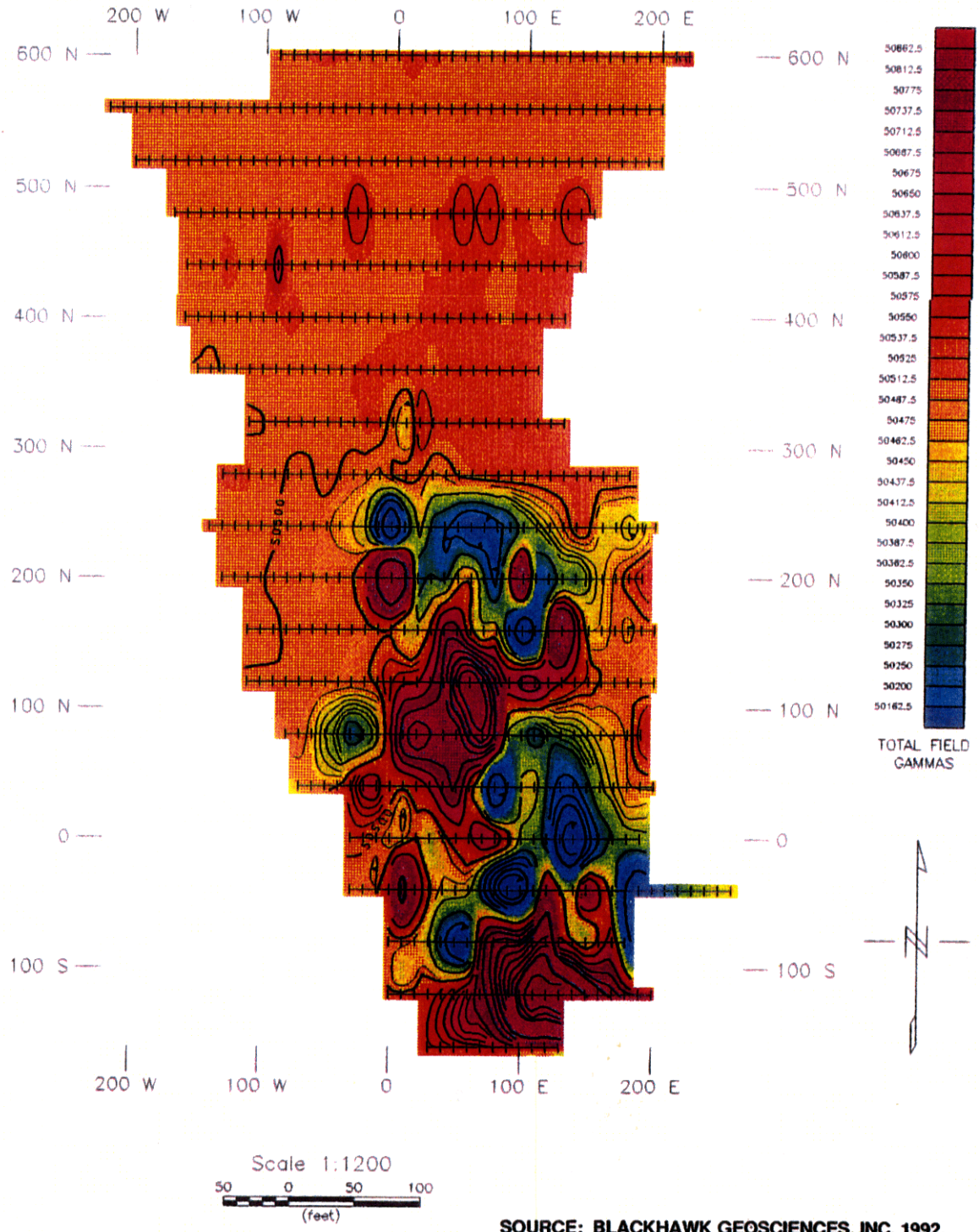
SOURCE: BLACKHAWK GEOSCIENCES, INC. 1992

FIGURE 3-9

SITE 10
GEOPHYSICAL SURVEY AND
INTERPETED ANOMALY LOCATIONS

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA



SOURCE: BLACKHAWK GEOSCIENCES, INC. 1992.

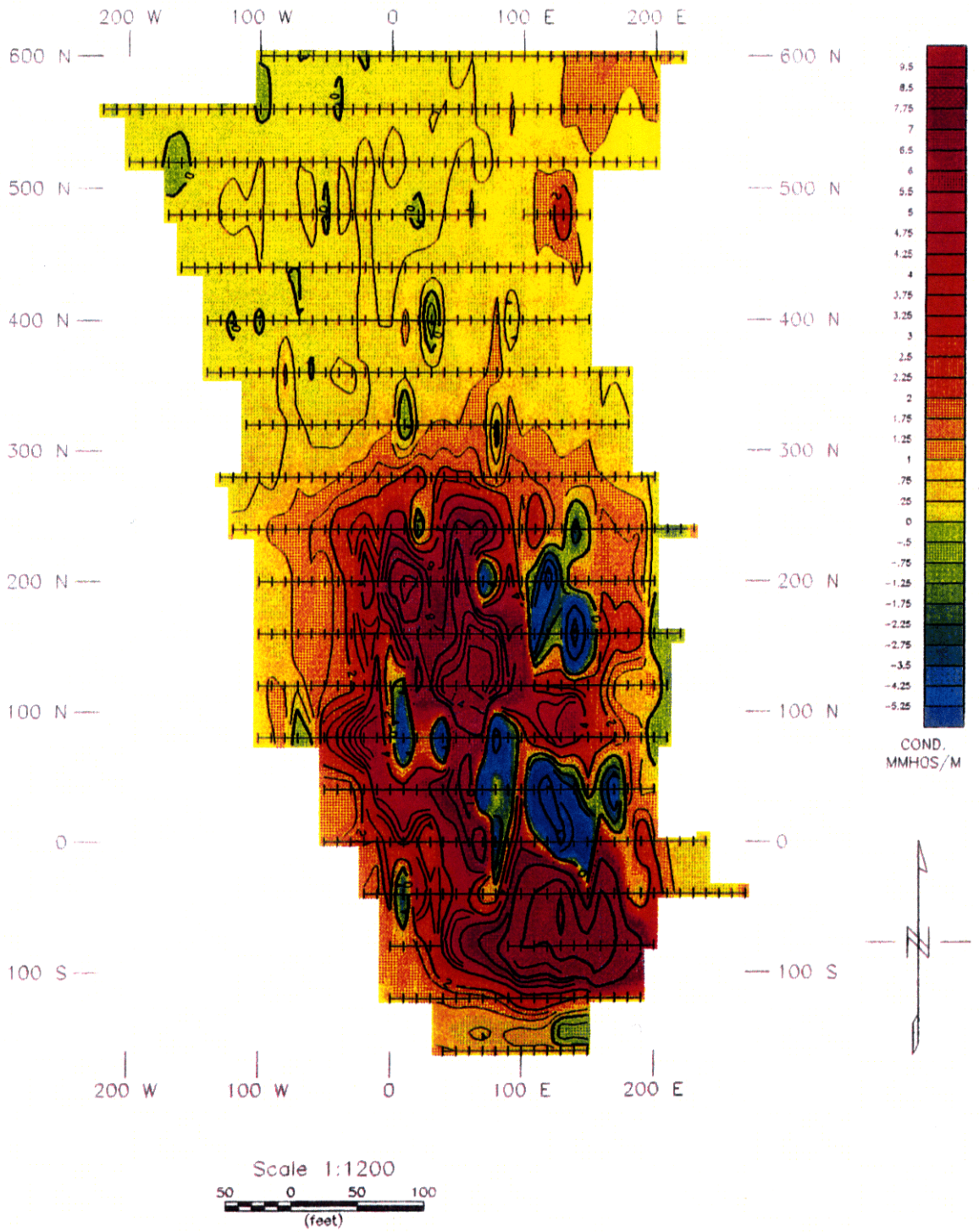
FIGURE 3-10

SITE 10
TOTAL MAGNETIC FIELD ISOPLETH MAP

TECHNICAL REPORT GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA

00230CB2Y



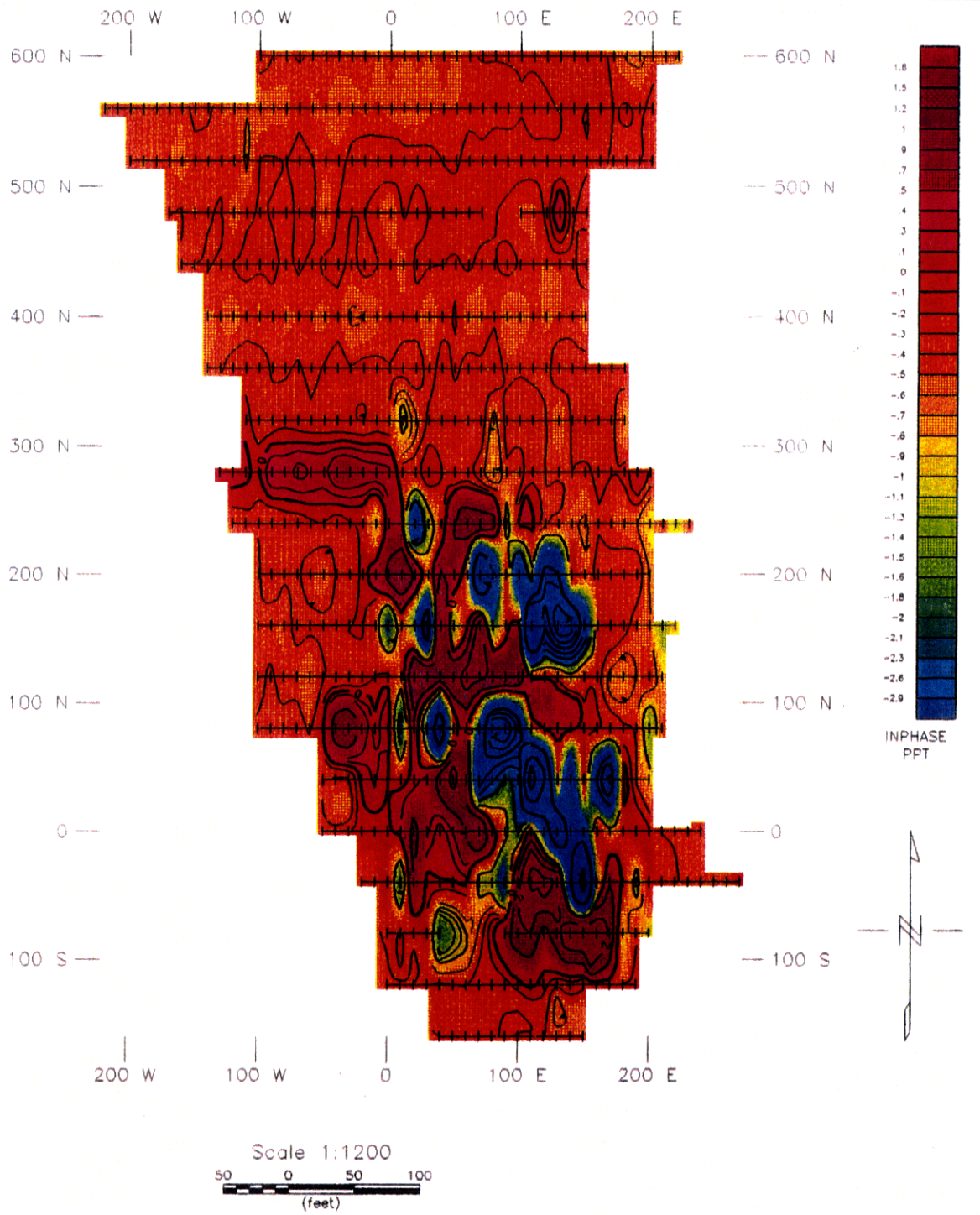
SOURCE: BLACKHAWK GEOSCIENCES, INC. 1992.

FIGURE 3-11

SITE 10
EM-31 CONDUCTIVITY
ISOPLETH MAP

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA



SOURCE: BLACKHAWK GEOSCIENCES, INC. 1992.

FIGURE 3-12

SITE 10
EM-31 INPHASE
ISOPLETH MAP

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA

inphase data between 100W and 10W along line 280N is too low to be interpreted as associated with the landfill. The anomalies at Stations 440N, 90W (total magnetics data set) and 480N, 130E (EM-31 inphase data set) are interpreted to be caused by isolated metallic objects lying at or near the surface at these locations.

3.2.3 **Site 11, Southeast Open Disposal Area** Site 11 is located in the southeastern portion of the NAS Whiting Field and near the eastern property line (see Figure 1-2). Survey lines running north-south were established at 40-foot intervals. Survey stations were located at a spacing of 10 feet. Well WHF-12-1 is located at grid coordinates 270S, 612W (see Figure 3-13).

Magnetics. The anomalous region of the magnetic data lies between grid coordinates 20S and 330S, and 560W and 20E (see Figure 3-14). Three localized anomalies are present at grid point 70S, 560W; grid point 50N, 200W; and grid point 40S, 0W.

Electromagnetics. As shown on Figure 3-15, the EM conductivity data set clearly indicates the outline of the anomalous region between grid coordinates 30S and 320S and 540W and 20E. The anomalous area on the inphase data (Figure 3-16), although not as readily apparent, lies roughly within the same boundaries. A localized anomaly is present at grid point 30S, 0W in the inphase data set.

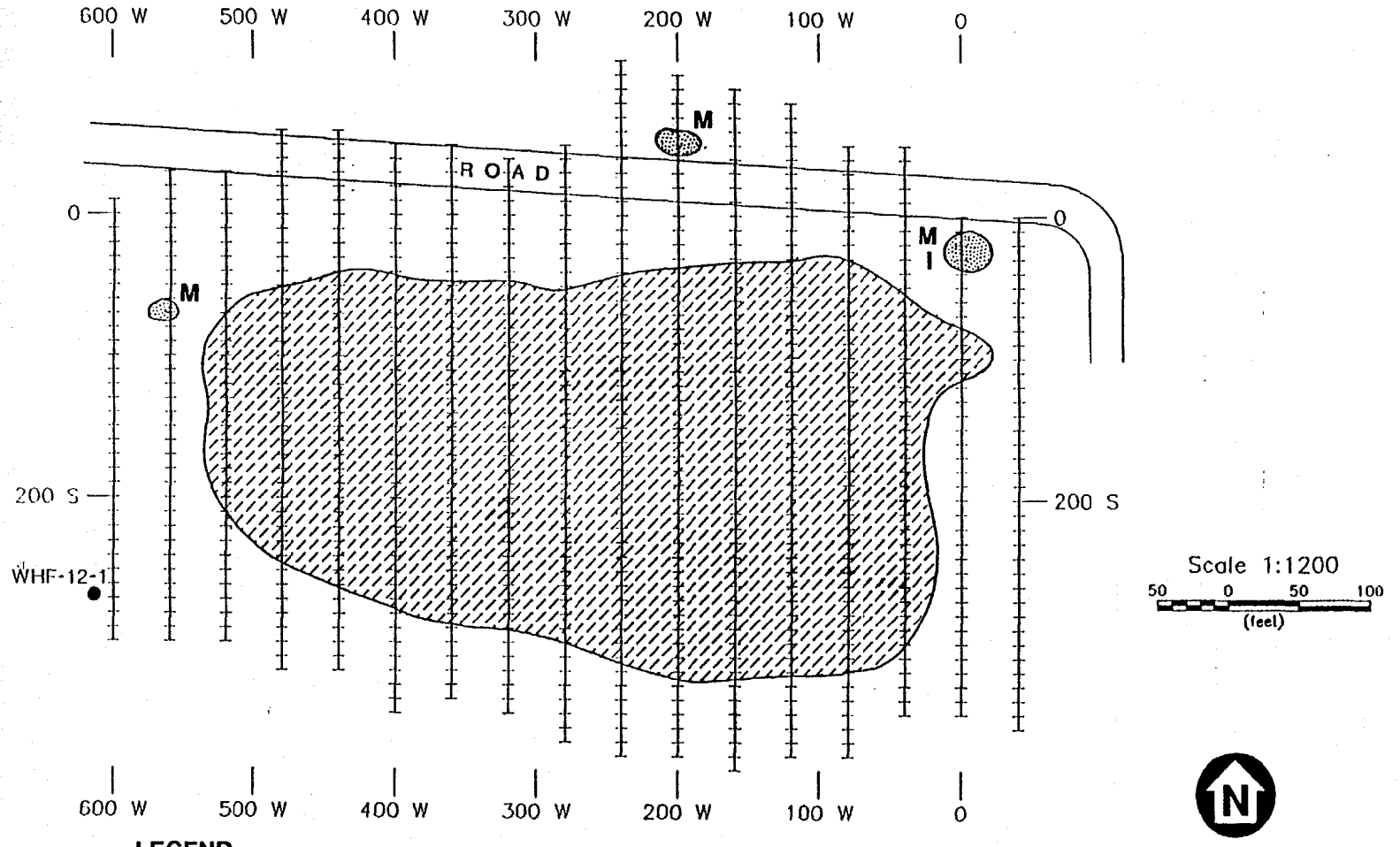
Results. The interpretation made from the total magnetic, EM-31 conductivity, and EM-31 inphase data sets is shown in Figure 3-13. All three data sets were interpreted to confirm a well defined, high contrast landfill boundary as indicated. Three geophysical total magnetic anomalies lying outside the interpreted landfill boundaries were identified at grid point 70S, 560W; grid point 50N, 200W; and grid point 30S, 0W. The last total magnetic anomaly located at grid point 30S, 0W was also confirmed by the EM-31 inphase data set. These anomalies are interpreted to be caused by ferromagnetic metal lying at or near the surface at these locations.

3.2.4 **Site 13, Sanitary Landfill** Site 13 is located on the eastern property line of the south field, and a road runs north-south along the axis of the site. The geophysical survey location map for Site 13 is shown in Figure 1-2. Survey lines were established at two different intervals running due east-west. A 20-foot line spacing was used on the lines from 0N to 1200N, and line spacing of 40 feet was used from lines 120S to 0N and lines 1200N to 1800N (see Figure 3-17). Stations were located at 10-foot intervals along each of the survey lines. This site is mostly open, with the exception of the area between 200W to 400W, and 80N to 240N, which was covered with slash pines.

Magnetics. The total magnetic field data is presented in Figure 3-18. The data shows two linear features which trend roughly north-south from approximately 80S to 1600N, with a shorter parallel feature between 700N to 1100N.

There is an anomaly of very high magnitude between 100N to 180N, and 270W to 200W. To the north, west, and south of this are other high magnitude total magnetic anomalies. At 1720N, 30E there is an isolated magnetic anomaly.

Electromagnetics. As shown on Figure 3-19, the EM-31 conductivity data shows a linear conductivity high running from approximately 80S to 1640N along 40W. Another ridge of high conductivity parallels this to the west from 740N to 1200N.



LEGEND

ISOLATED GEOPHYSICAL ANOMALY
M = TOTAL MAGNETIC FIELD ANOMALY
C = EM-31 CONDUCTIVITY ANOMALY
I = EM-31 INPHASE ANOMALY

INTERPRETED LANDFILL AREA

SURVEY GRID LINES AND
0 STATION LOCATION

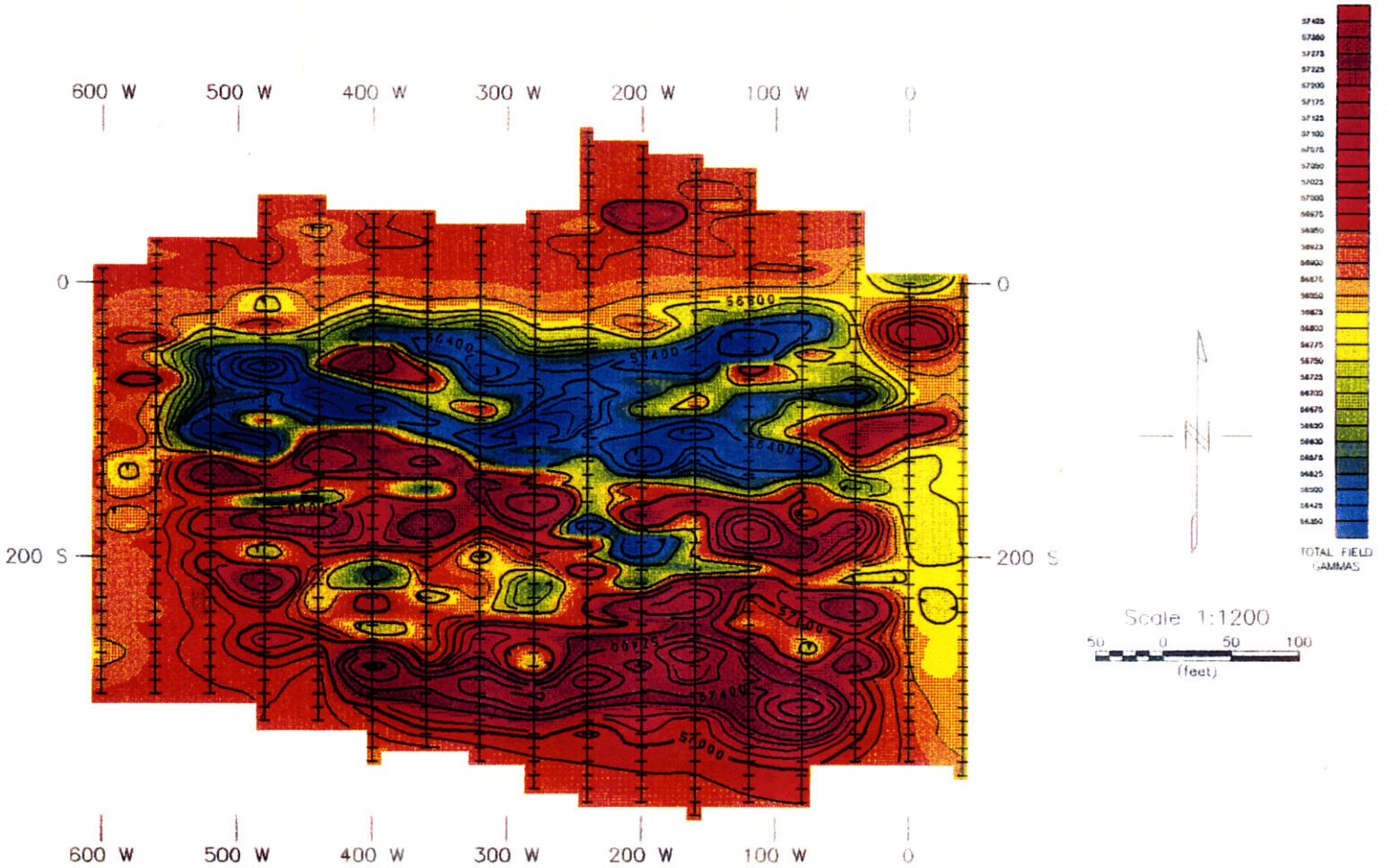
SOURCE: BLACKHAWK GEOSCIENCES, INC. 1992

FIGURE 3-13

SITE 11
GEOPHYSICAL SURVEY GRID LINES
AND INTERPETED ANOMALY LOCATIONS

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA



SOURCE: BLACKHAWK GEOSCIENCES, INC. 1992.

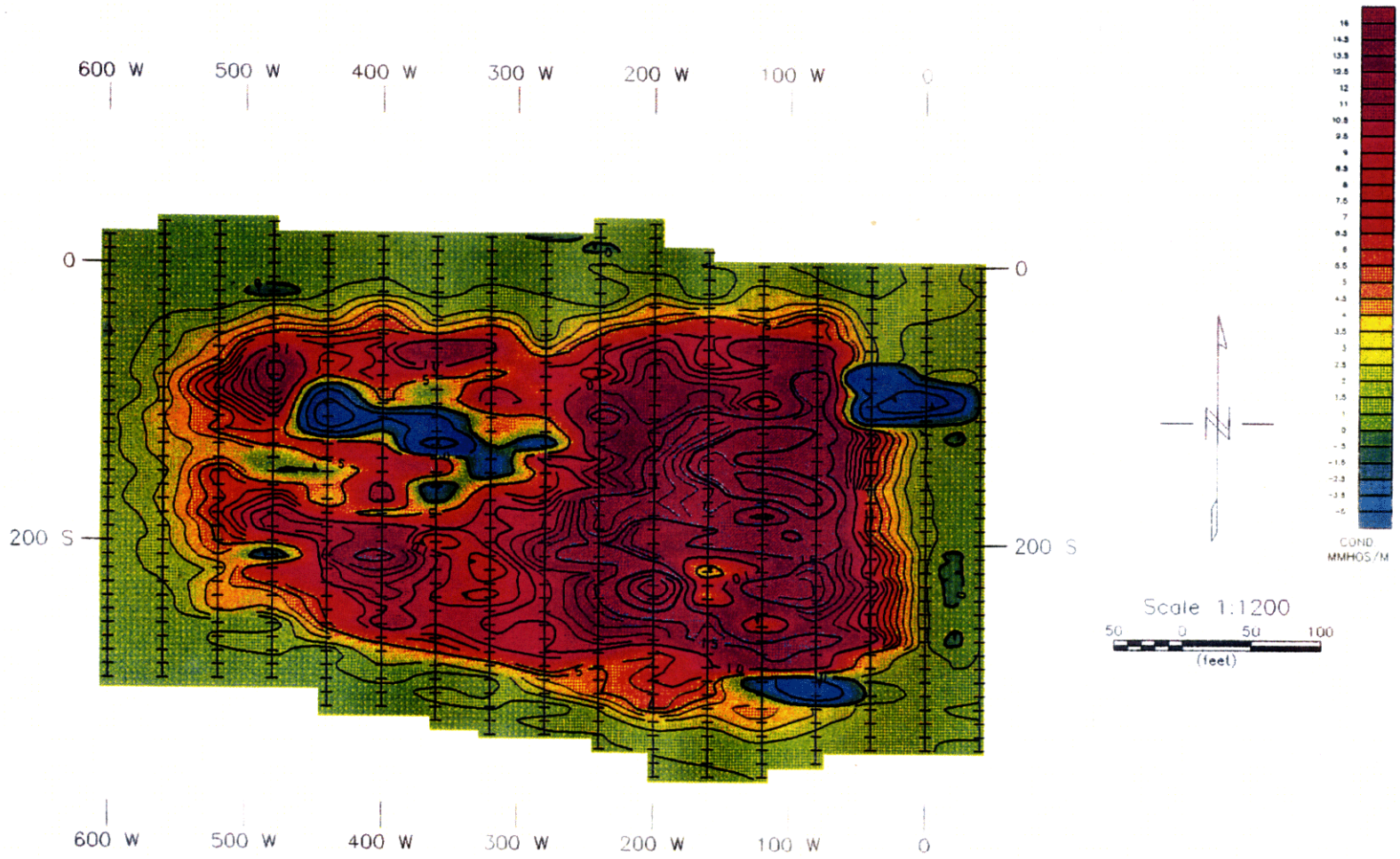
FIGURE 3-14

SITE 11
TOTAL MAGNETIC FIELD
ISOPLETH MAP

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA

00230CB3Y



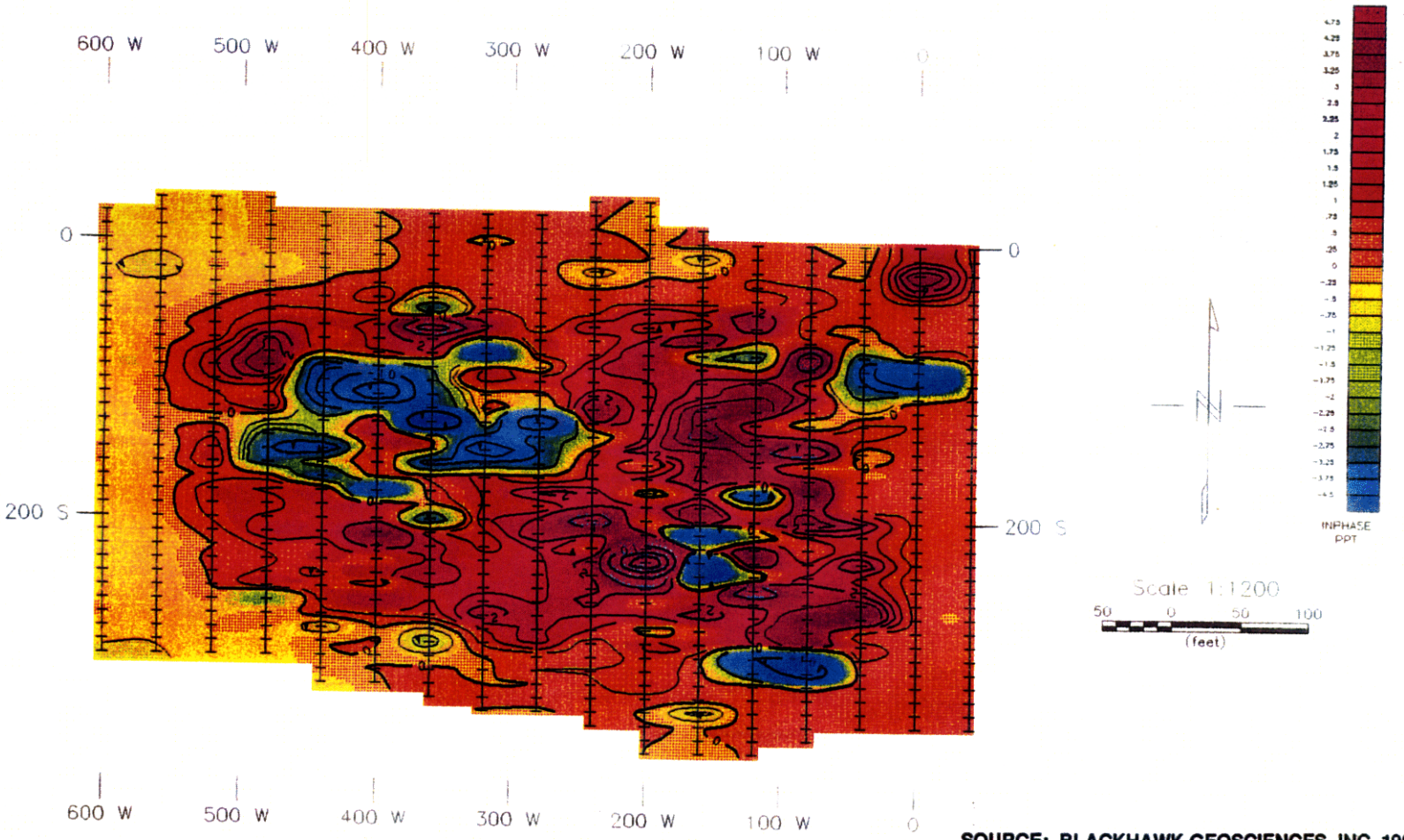
SOURCE: BLACKHAWK GEOSCIENCES, INC. 1992.

FIGURE 3-15

SITE 11
EM-31 CONDUCTIVITY
ISOPLETH MAP

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA



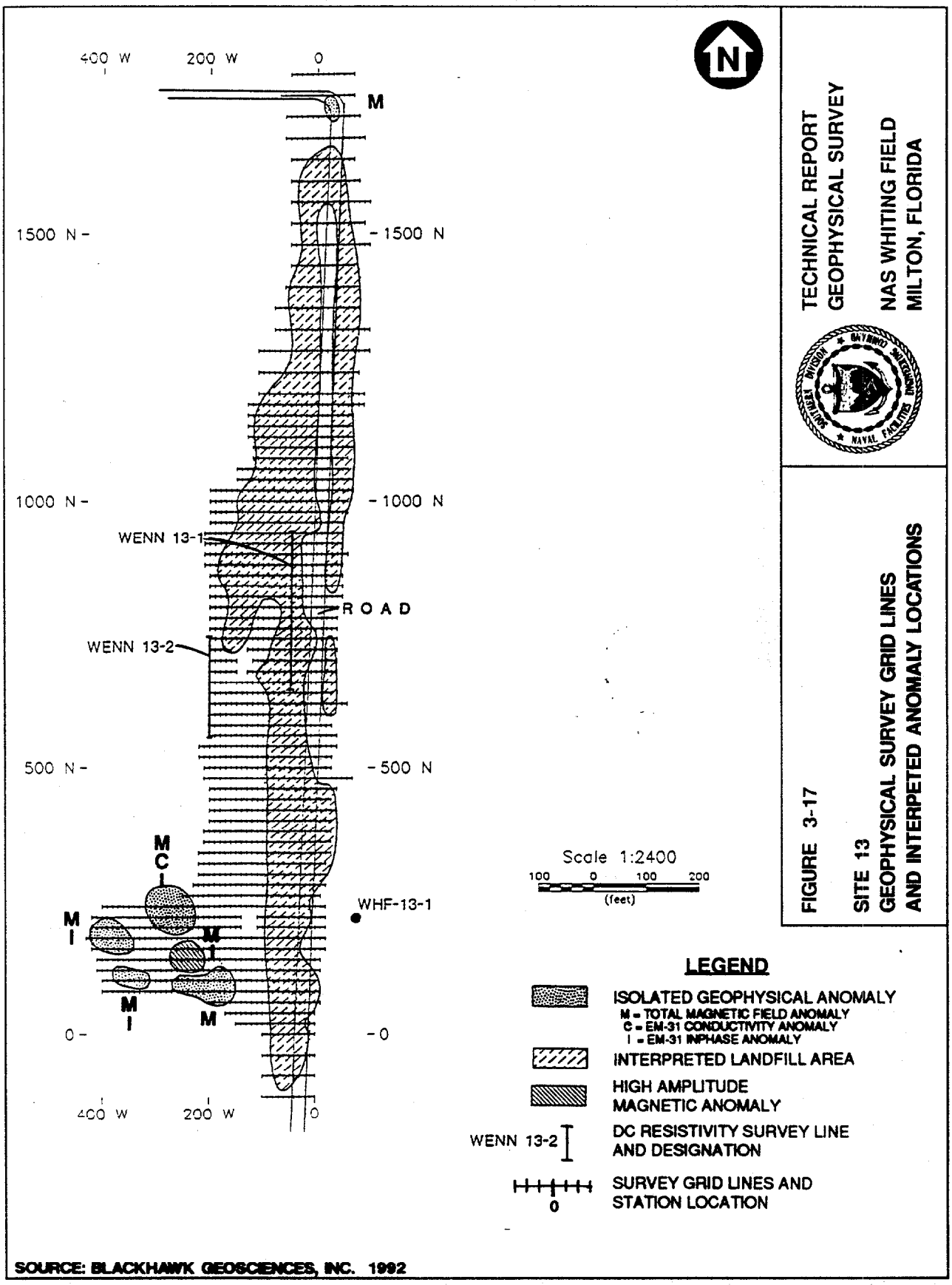
SOURCE: BLACKHAWK GEOSCIENCES, INC. 1992.

FIGURE 3-16

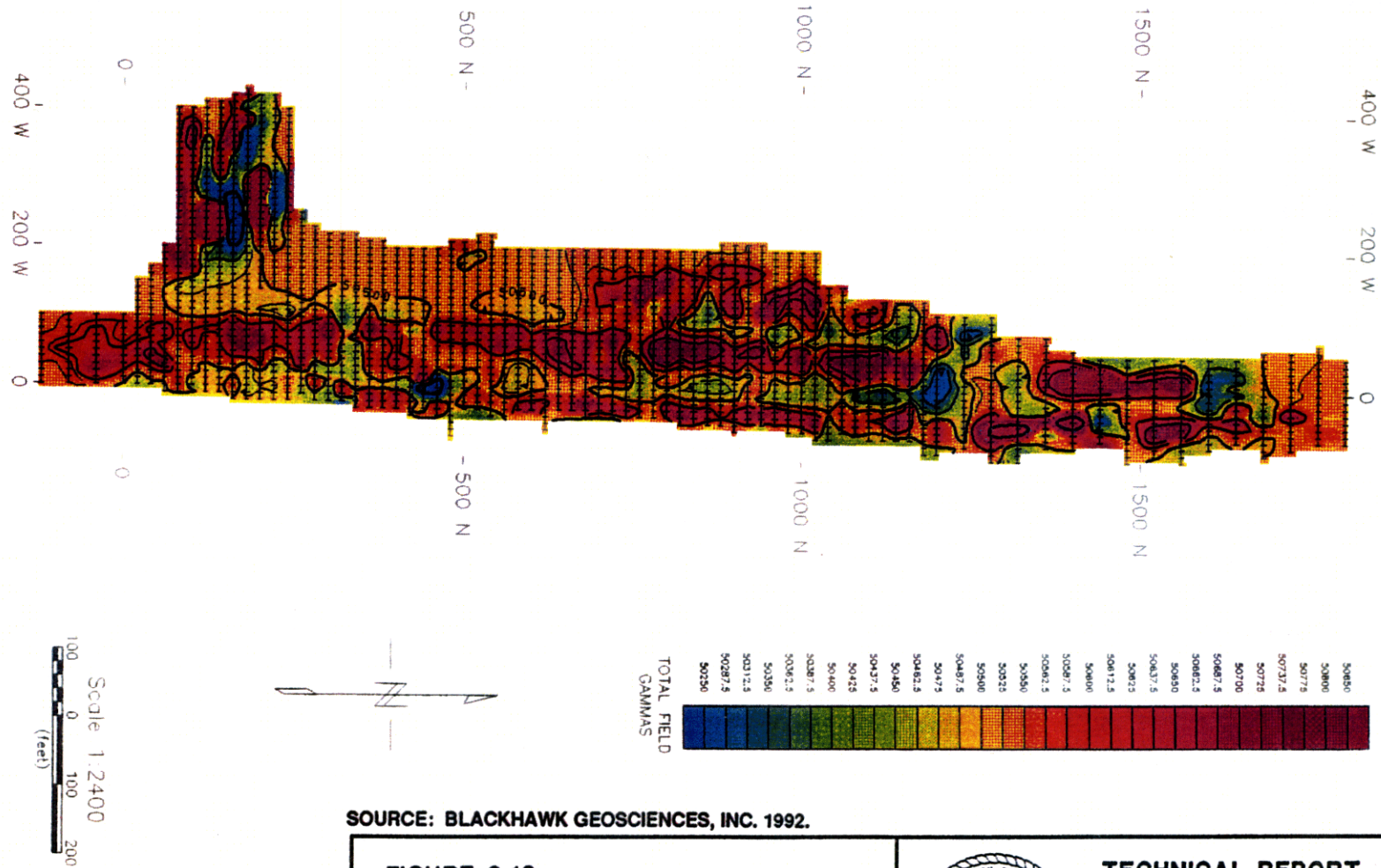
SITE 11
EM-31 INPHASE
ISOPLETH MAP

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA



SOURCE: BLACKHAWK GEOSCIENCES, INC. 1992



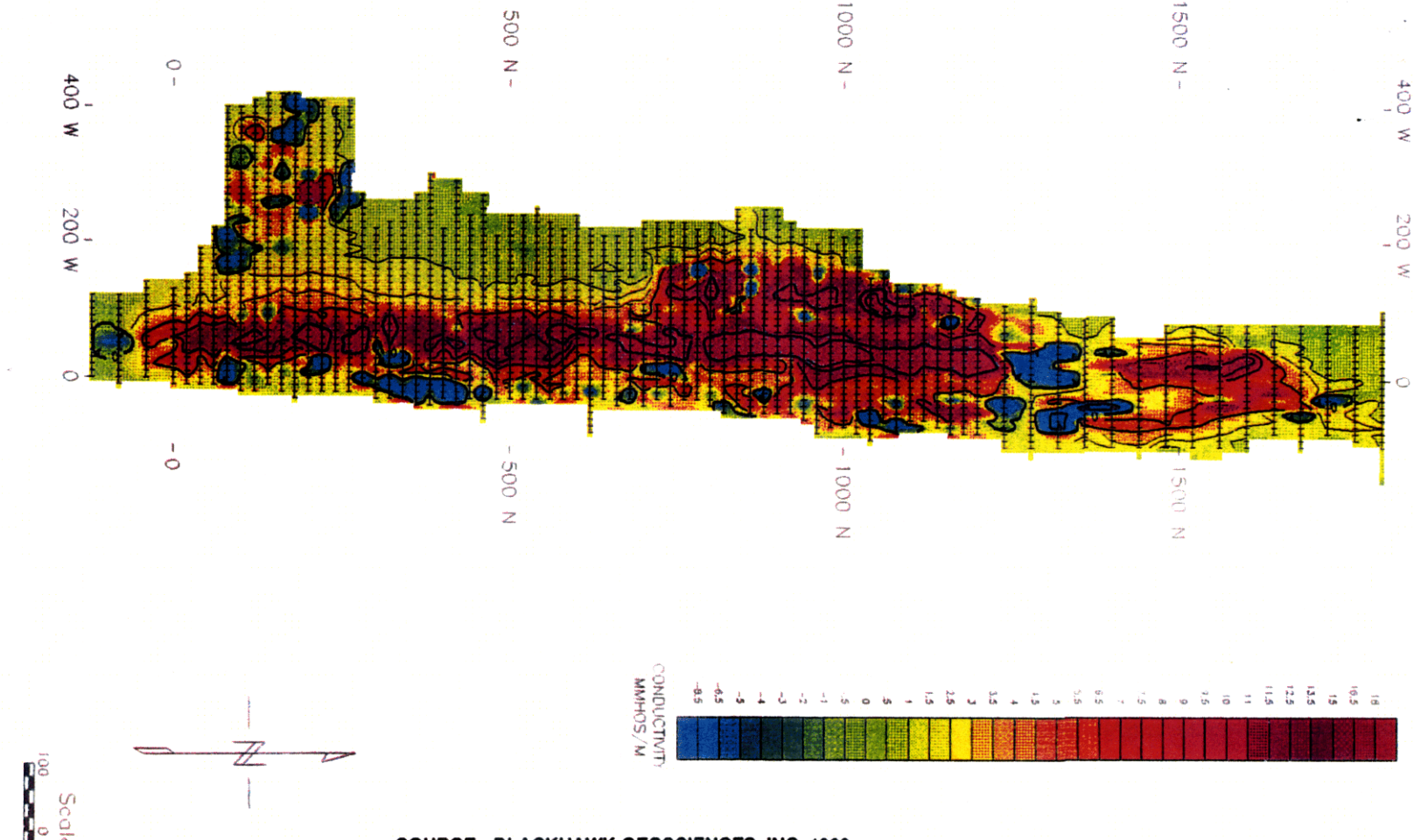
SOURCE: BLACKHAWK GEOSCIENCES, INC. 1992.

FIGURE 3-18

SITE 13
TOTAL MAGNETIC FIELD
ISOPLETH MAP

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA



SOURCE: BLACKHAWK GEOSCIENCES, INC. 1992.

FIGURE 3-19

SITE 13
EM-31 CONDUCTIVITY
ISOPLETH MAP

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA

The area between 80N to 240N, and 200W to 400W, shows scattered localized anomalies. The EM-31 inphase data set for Site 13 shows inphase anomalies consistent with those of the conductivity data (Figure 3-20).

Results. The interpreted landfill boundary is shown in Figure 3-17. The landfill appears to be a series of trenches approximately 1,750 feet long, and approximately 250 feet wide at its widest point. The trench boundaries were confirmed by all three geophysical data sets.

In the area between 80N to 240N and 20W to 400W, there are high amplitude magnetic anomalies. In this same area, the EM-31 conductivity data appears to be close to that of the background. Where there are conductivity anomalies, there are also inphase anomalies, which indicates that changes in conductivity are likely to be caused by buried metallic materials. The general character of the conductivity and total magnetic signatures in this area leads to the interpretation that large amounts of ferromagnetic metals were buried in this area. The greatest concentration of ferromagnetic metals in this area is interpreted to lie along line 140N between Stations 270W and 230W. An anomaly at grid point 1720N, 30E is present on both total magnetic and EM-31 conductivity data sets, and is believed to be caused by buried metal materials.

3.2.5 Site 14, Short-Term Sanitary Landfill Site 14, is located in the south-eastern portion of the station and is near Site 13 (see Figure 1-2). The site is covered with slash pines. The survey lines at Site 14 run north-south and were surveyed with a line interval of 40 feet and a station interval of 10 feet. Well WHF-14-1 lies at grid coordinates 175S, 37W (see Figure 3-21).

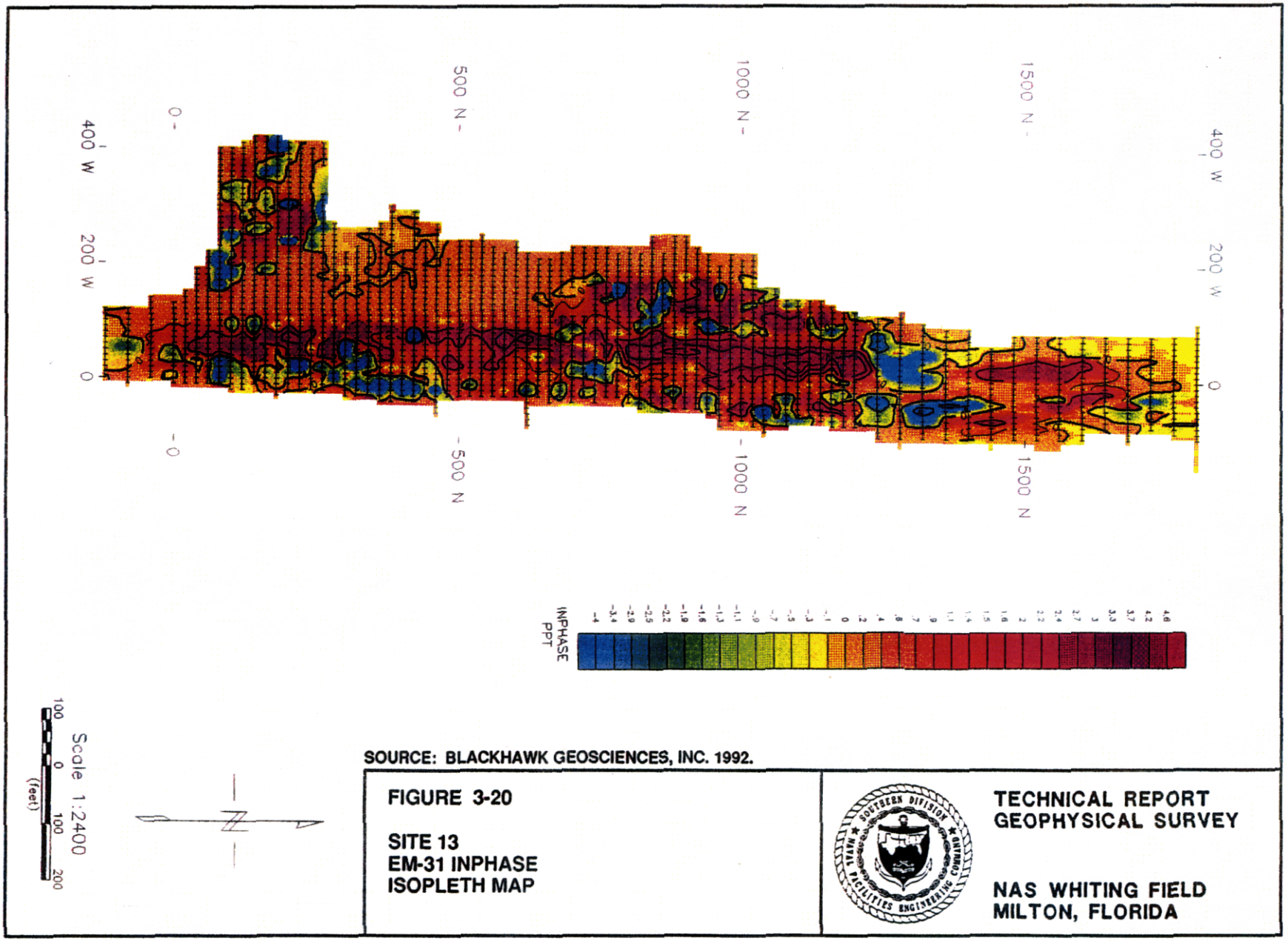
Magnetics. As shown on Figure 3-22, the total magnetic field data set indicates an anomaly that runs east-west along 180S from approximately 420W to 100W. A separate localized, low amplitude anomaly is present at grid coordinates 90S, 400W.

Electromagnetics. The EM-31 conductivity data (Figure 3-23) and inphase data (Figure 3-24) sets show a large scale anomaly centered along grid line 180S approximately 320 feet long and 60 feet wide.

Results. The anomalies on the total magnetic, EM-31 conductivity, and EM-31 inphase data sets all show signatures characteristic of fill containing metallic debris. The interpreted landfill area is shown in Figure 3-21, as is the isolated, low amplitude anomaly at 90S, 400W identified in both the total magnetic and EM-31 conductivity data sets.

3.2.6 Site 15, Southwest Landfill Site 15 is located southeast of the wastewater treatment plant in the southwestern portion of the station (see Figure 1-2). The survey lines at Site 15 were established in a east-west direction at 40-foot intervals with a station interval of 10 feet along each line. Monitoring well WHF-15-1 lies at 350N, 317W on the survey grid (see Figure 3-25).

Magnetics. As shown on Figure 3-26, there are three separate anomalous trends on the total magnetic data set. The feature with the highest magnitude lies between 800N to 1000N and 100W to 300E. In the center of the grid, there are five parallel bands of anomalous magnetic values tending north-northeast from approximately 40N to 760N. The third anomalous region is in the eastern part of



SOURCE: BLACKHAWK GEOSCIENCES, INC. 1992.

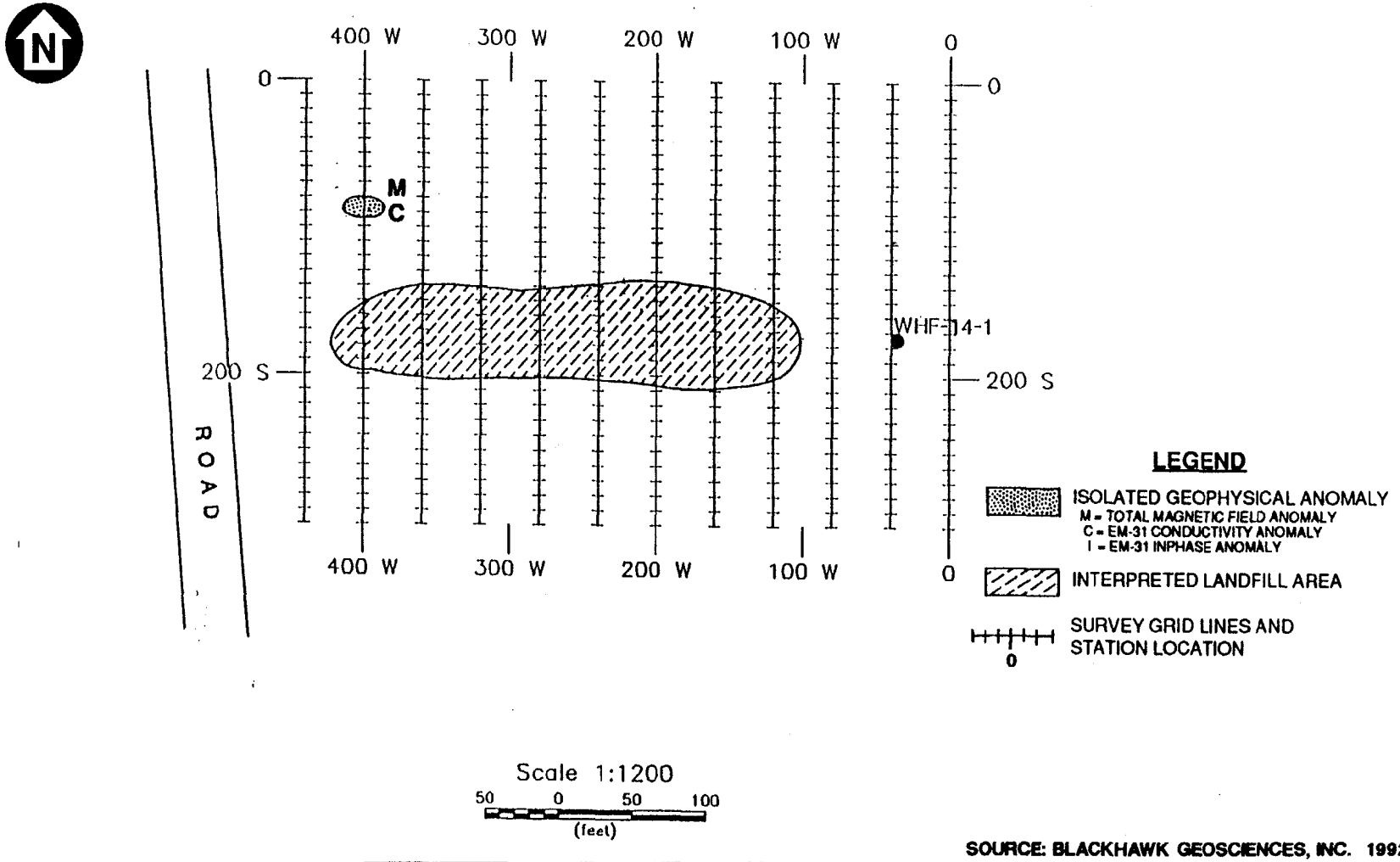
FIGURE 3-20

SITE 13
EM-31 INPHASE
ISOPLETH MAP

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA

00230505Y



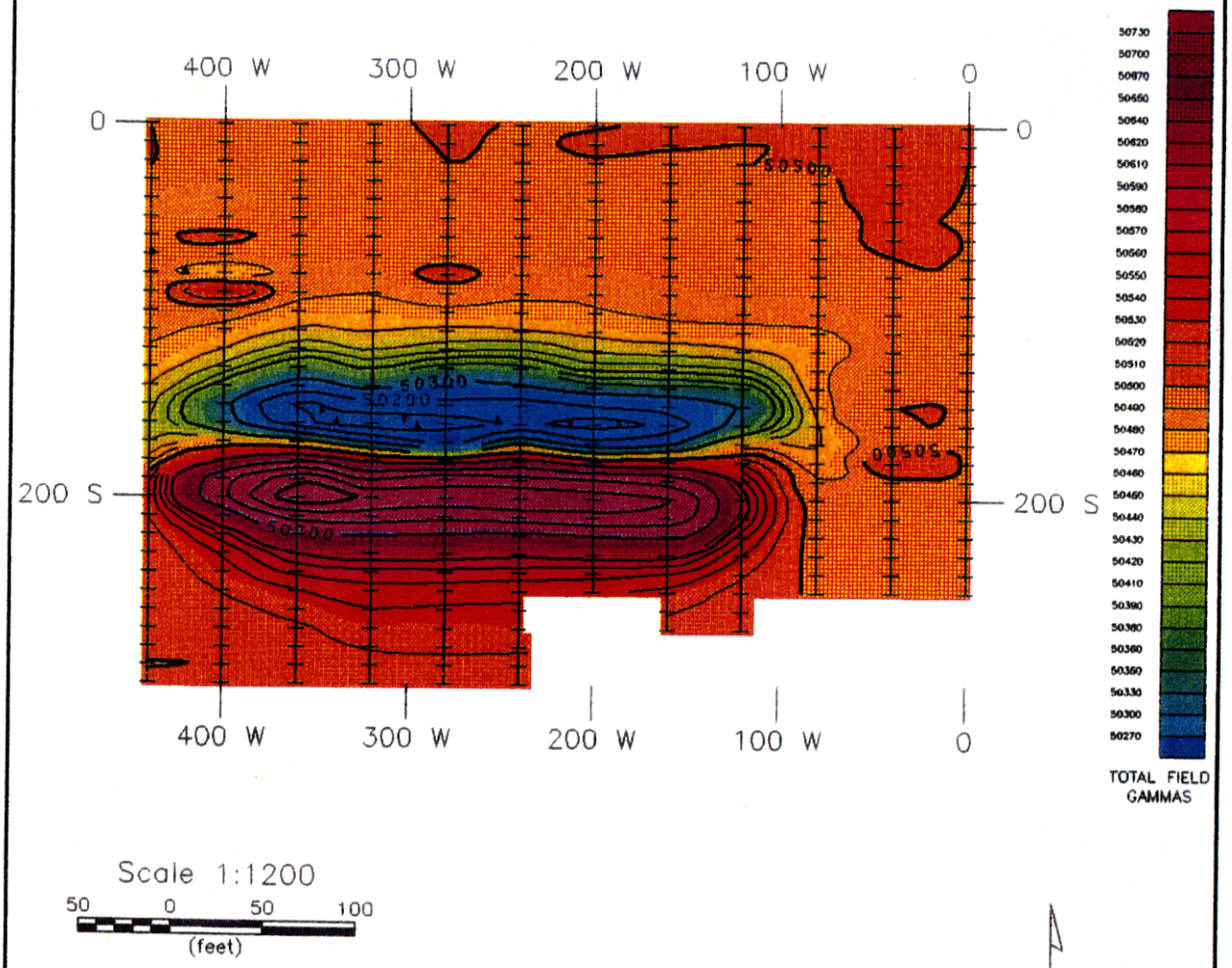
SOURCE: BLACKHAWK GEOSCIENCES, INC. 1992

FIGURE 3-21

SITE 14
GEOPHYSICAL SURVEY GRID LINES
AND INTERPETED ANOMALY LOCATIONS

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA



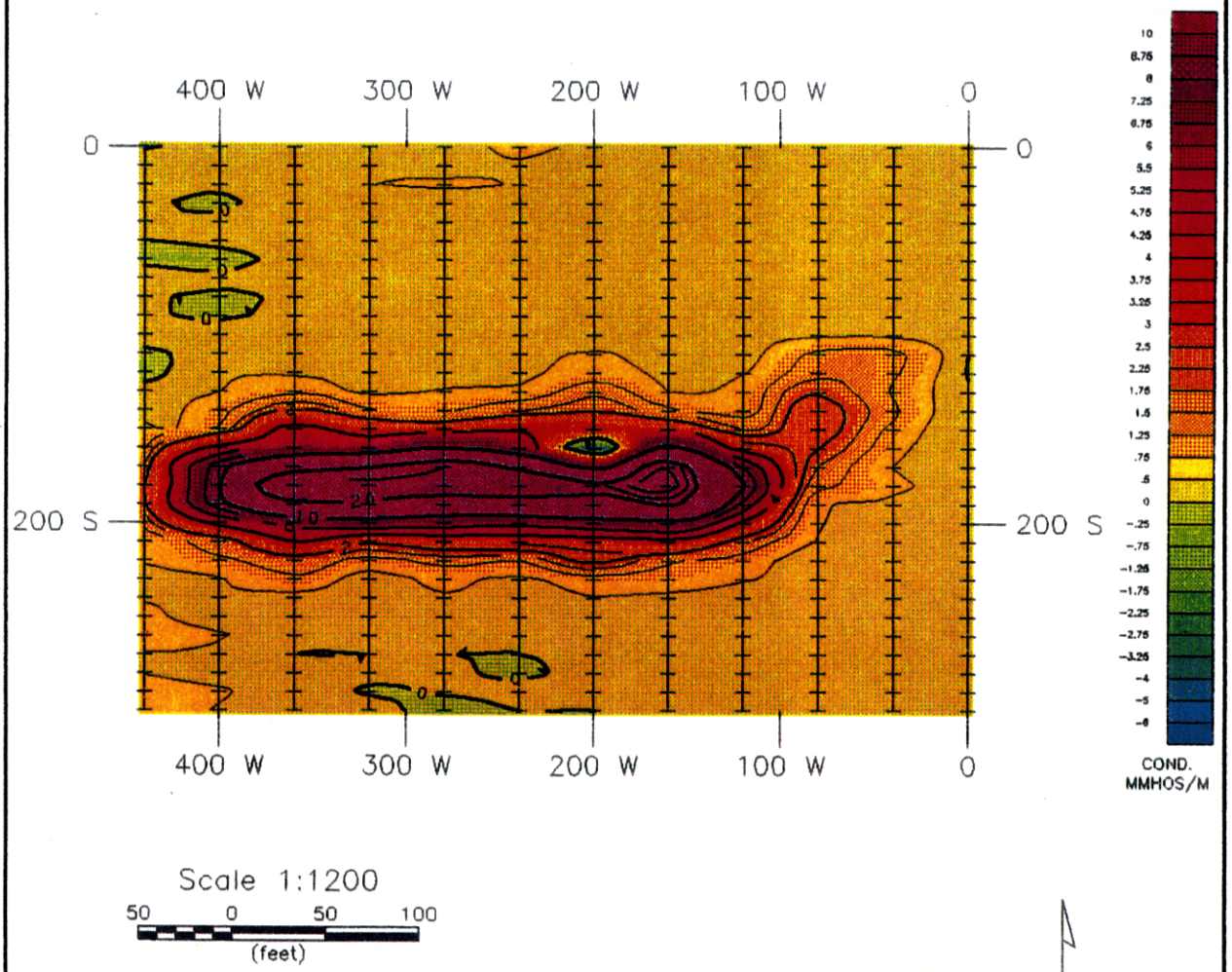
SOURCE: BLACKHAWK GEOSCIENCES, INC. 1992.

FIGURE 3-22

SITE 14
TOTAL MAGNETIC FIELD
ISOPLETH MAP

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA



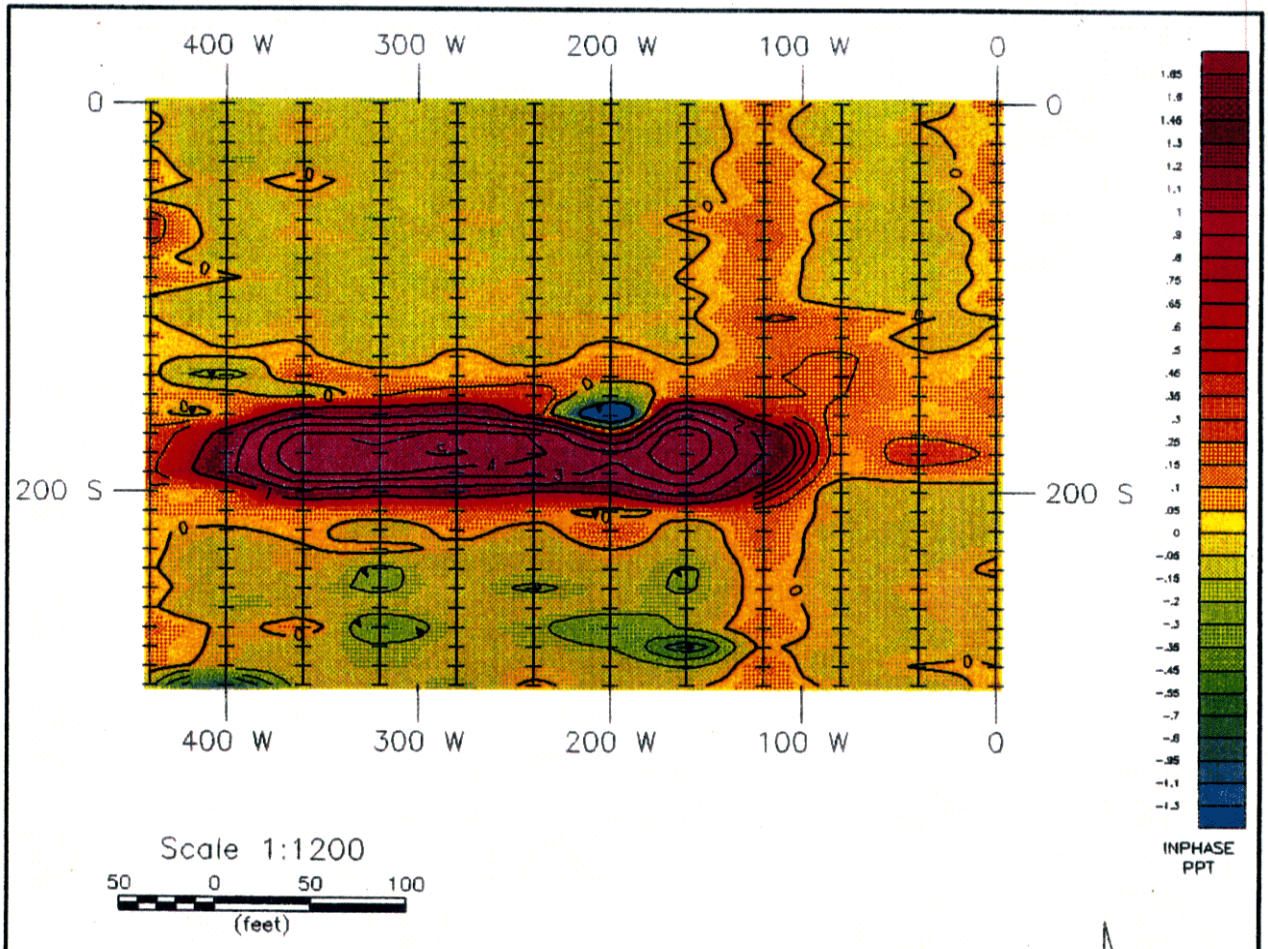
SOURCE: BLACKHAWK GEOSCIENCES, INC. 1992.

FIGURE 3-23

SITE 14
EM-31 CONDUCTIVITY
ISOPLETH MAP

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA



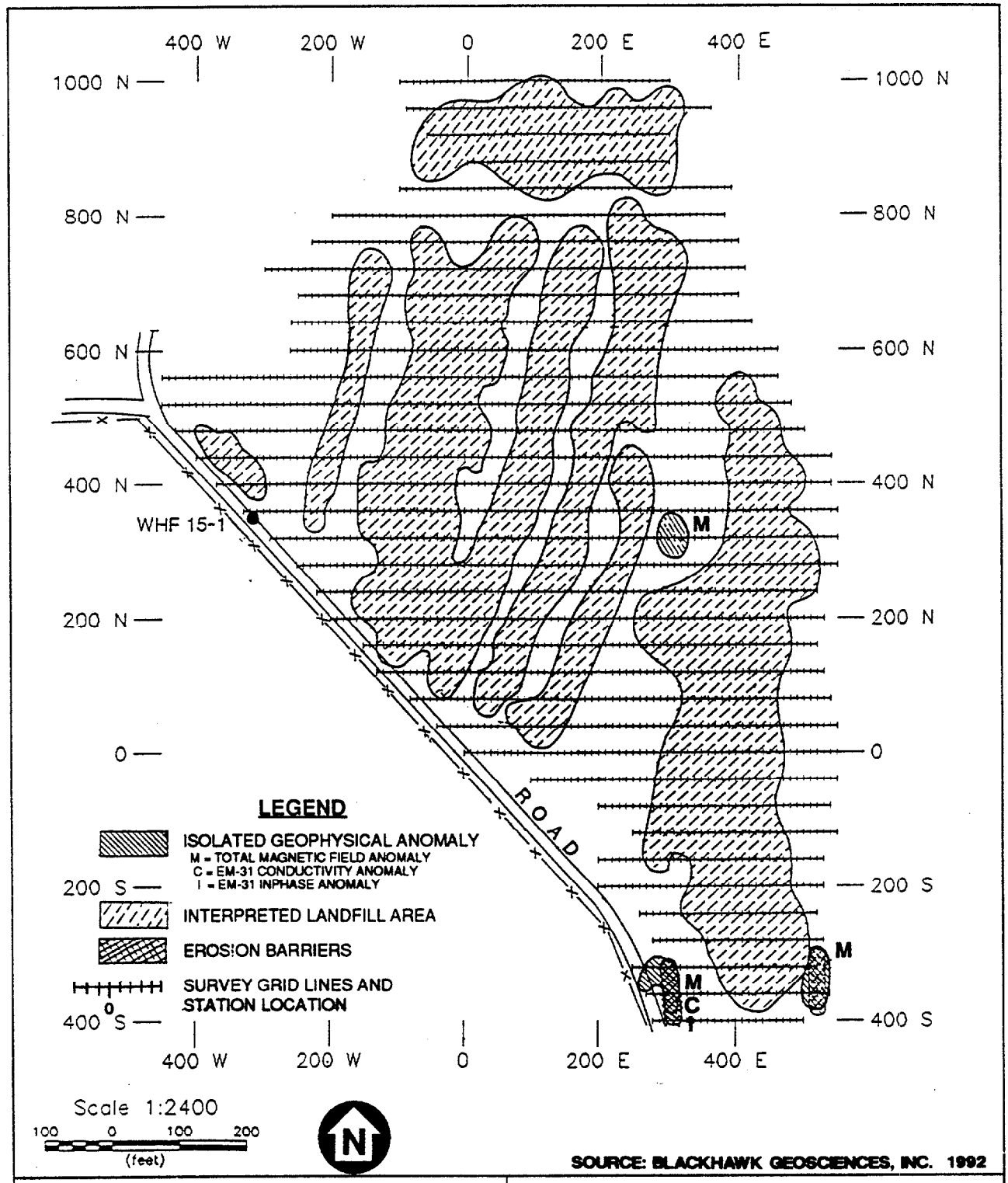
SOURCE: BLACKHAWK GEOSCIENCES, INC. 1992.

FIGURE 3-24

SITE 14
EM-31 INPHASE
ISOPLETH MAP

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA



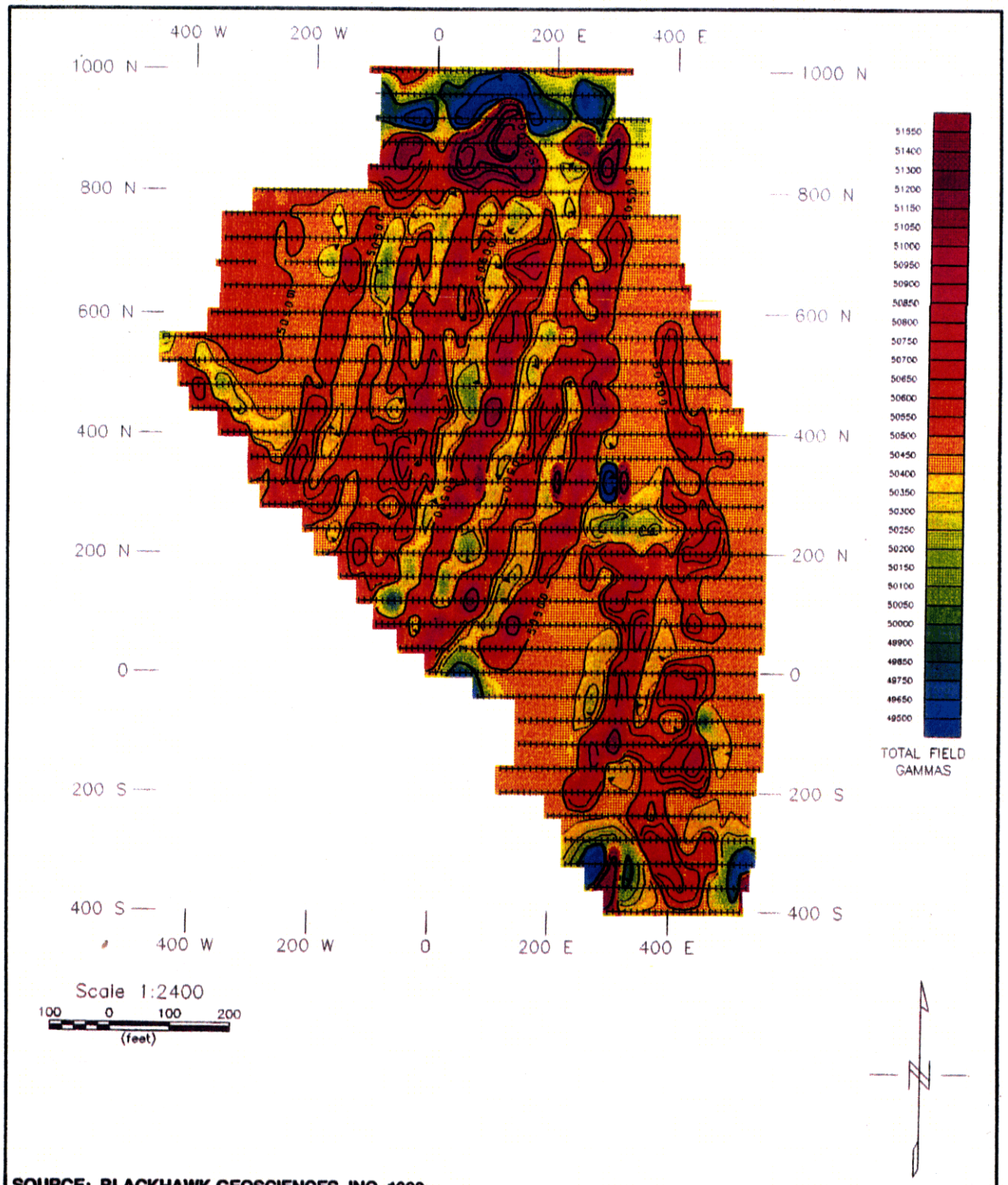
SOURCE: BLACKHAWK GEOSCIENCES, INC. 1992

FIGURE 3-25

SITE 15
GEOPHYSICAL SURVEY GRID LINES AND INTERPETED ANOMALY LOCATIONS

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA



SOURCE: BLACKHAWK GEOSCIENCES, INC. 1992.

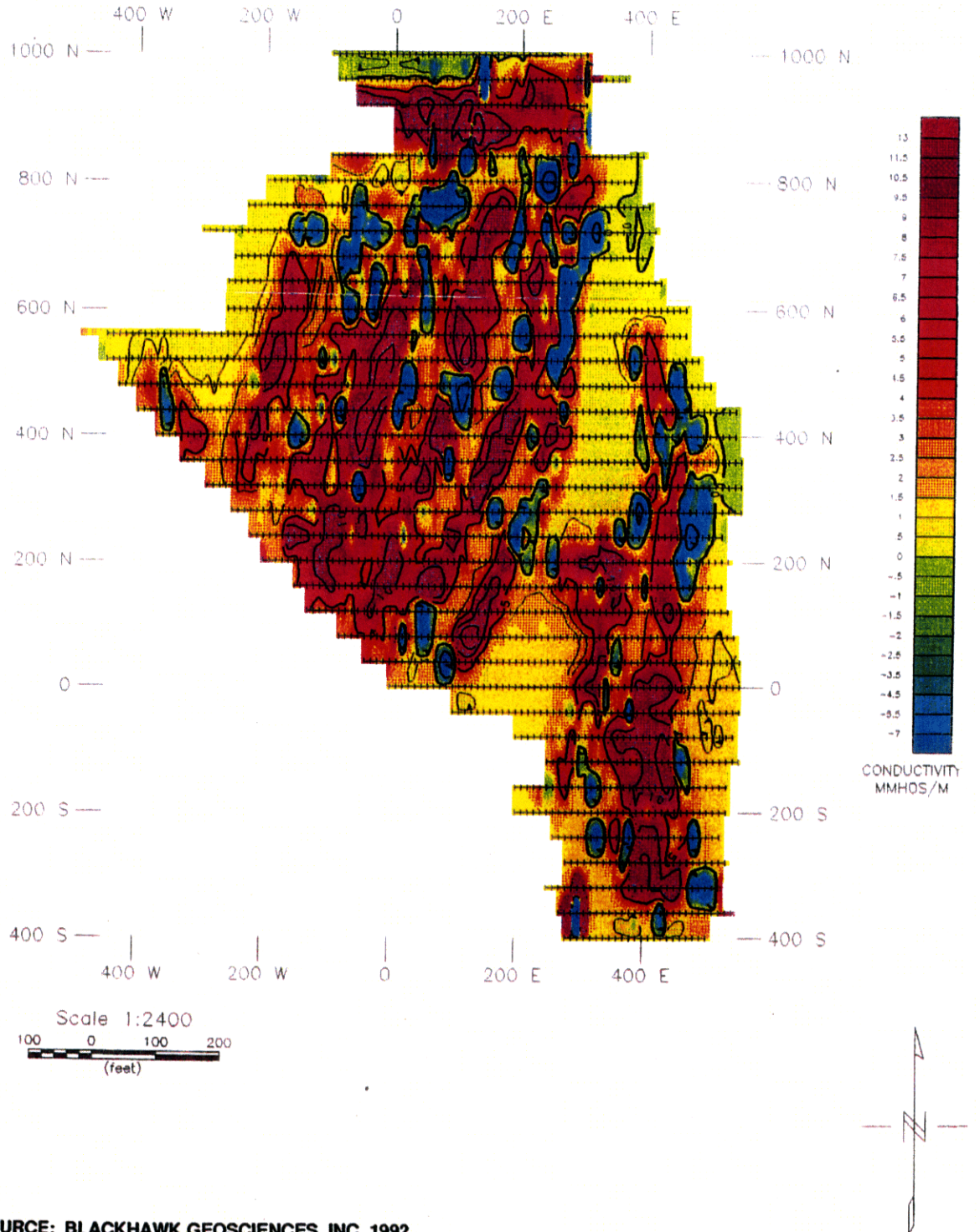
FIGURE 3-26

SITE 15
TOTAL MAGNETIC FIELD
ISOPLETH MAP

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA

00230CB7Y



SOURCE: BLACKHAWK GEOSCIENCES, INC. 1992.

FIGURE 3-27

SITE 15
EM-31 CONDUCTIVITY
ISOPLETH MAP

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA

the grid, located between 360S to 560N. Three small-scale anomalies occur at grid point 320N, 310E; grid point 360S, 520E; and grid point 360S, 290E.

Electromagnetics. The EM-31 conductivity (Figure 3-27) and EM-31 inphase data sets (Figure 3-28) show anomalous values in the same trends that were apparent on the total magnetic field data set. One anomaly present on both EM-31 induction data sets, which is not evident on the total magnetic field data, extends from 480N, 360W to 400N, 310W.

Results. The interpreted landfill areas for Site 15 are shown on Figure 3-26. The landfill area on the northern portion of the grid registered very high total magnetic field values, which indicate a high degree of buried ferromagnetic metal. The central portion of the grid has features which appear to be parallel landfilled trenches. On the eastern side of the grid is a large landfill approximately 1,000 feet long and 150 feet wide.

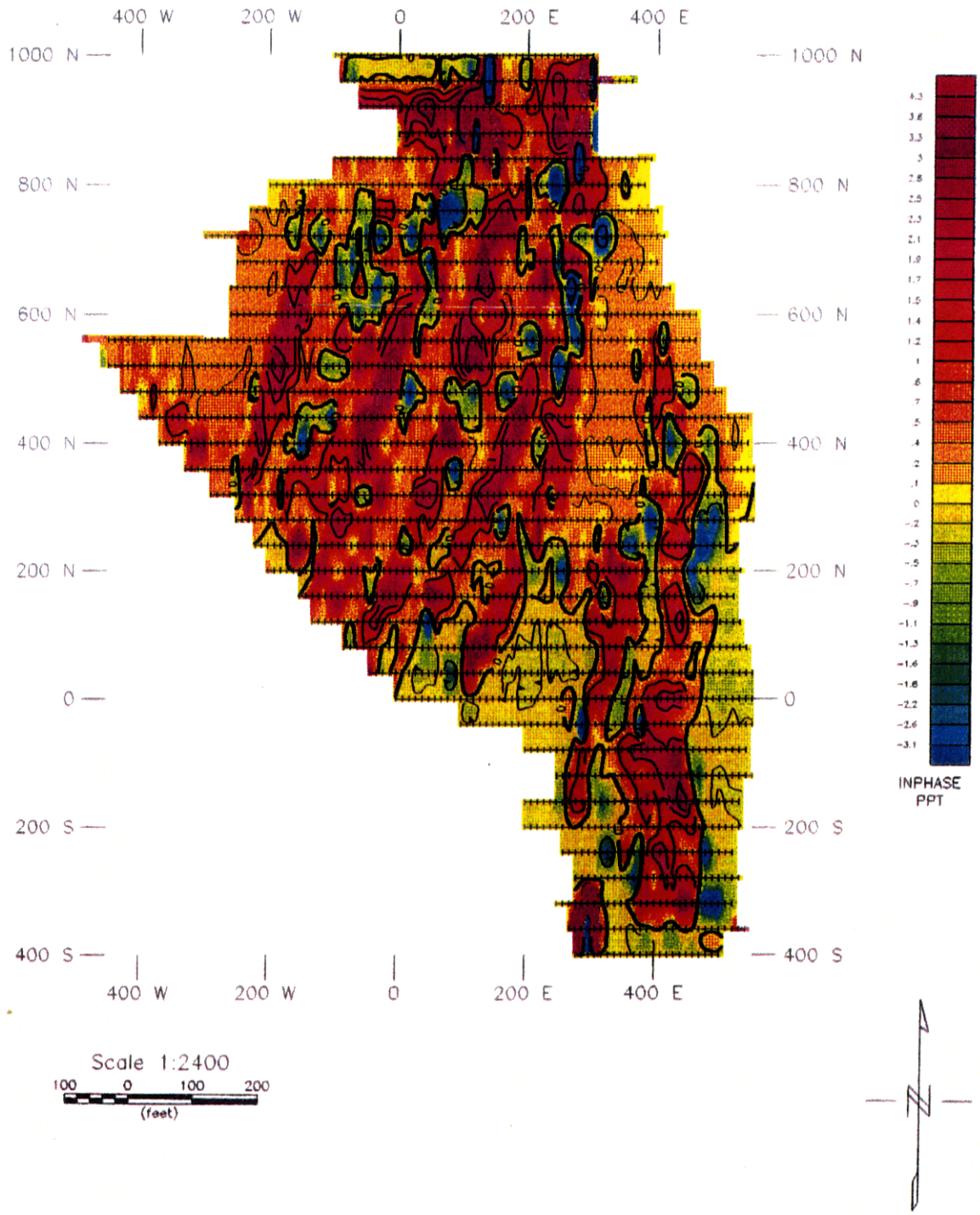
Of the three isolated high amplitude total magnetic anomalies, the two on the southern edge (grid point 360S, 520E and grid point 360S, 290E) coincide with the location of metal erosion barriers, and the anomaly at grid point 320N, 310E is interpreted to be associated with buried metals.

3.2.7 Site 16, Open Disposal and Burning Area Site 16 is located east of Clear Creek and west of the wastewater treatment plant (see Figure 1-2). The survey lines run north-south with a spacing of 40 feet, and a station spacing of 10 feet along the lines. At two areas on the site, discarded tanks were lying on the ground, and these areas are shown on the base map in Figure 3-29. Because of the fence running along grid line 0E, no EM-31 induction data could be collected along this line.

Magnetics. As indicated on Figure 3-30, the total magnetic field data set shows two major anomalies. These anomalies trend east-west and are centered around grid point 80S, 240E and grid point 400S, 120E. In addition to these major anomalies, many smaller anomalies are evident on the grid. Of note are the two large-scale anomalies located on the northern end of grid line 680E.

Electromagnetics. The EM-31 conductivity data plot shown on Figure 3-31 indicates two distinct areas of anomalous conductivities: one in the northern portion of the grid, and the second in the southern portion. The large, high conductivity area centered around grid point 50S, 260E was the area selected for DC Resistivity testing. The EM-31 inphase data (Figure 3-32) indicates anomalies consist with the EM-31 conductivity data. Both EM-31 induction plots show several small anomalies occur within the grid area but outside the main body of the large-scale anomalies.

Results. Two main landfill features were interpreted from the EM and total magnetic data sets (see Figure 3-30). The landfill interpreted in the northern portion of the grid is approximately 400 feet by 350 feet, and the interpreted landfill to the south is of more irregular shape with approximate dimensions of 370 feet by 550 feet. The western edge of both landfills are interpreted to extend to the fence, which constitutes the limit of the survey area. The presence of the chain-link fence along grid line 0E precluded the use of EM induction methods along this line, so the western boundary of these landfills can only be inferred. To the east of the interpreted southern landfill, several small geophysical anomalies exist. These are interpreted to be caused by random



SOURCE: BLACKHAWK GEOSCIENCES, INC. 1992.

FIGURE 3-28

SITE 15
EM-31 INPHASE
ISOPLETH MAP

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA

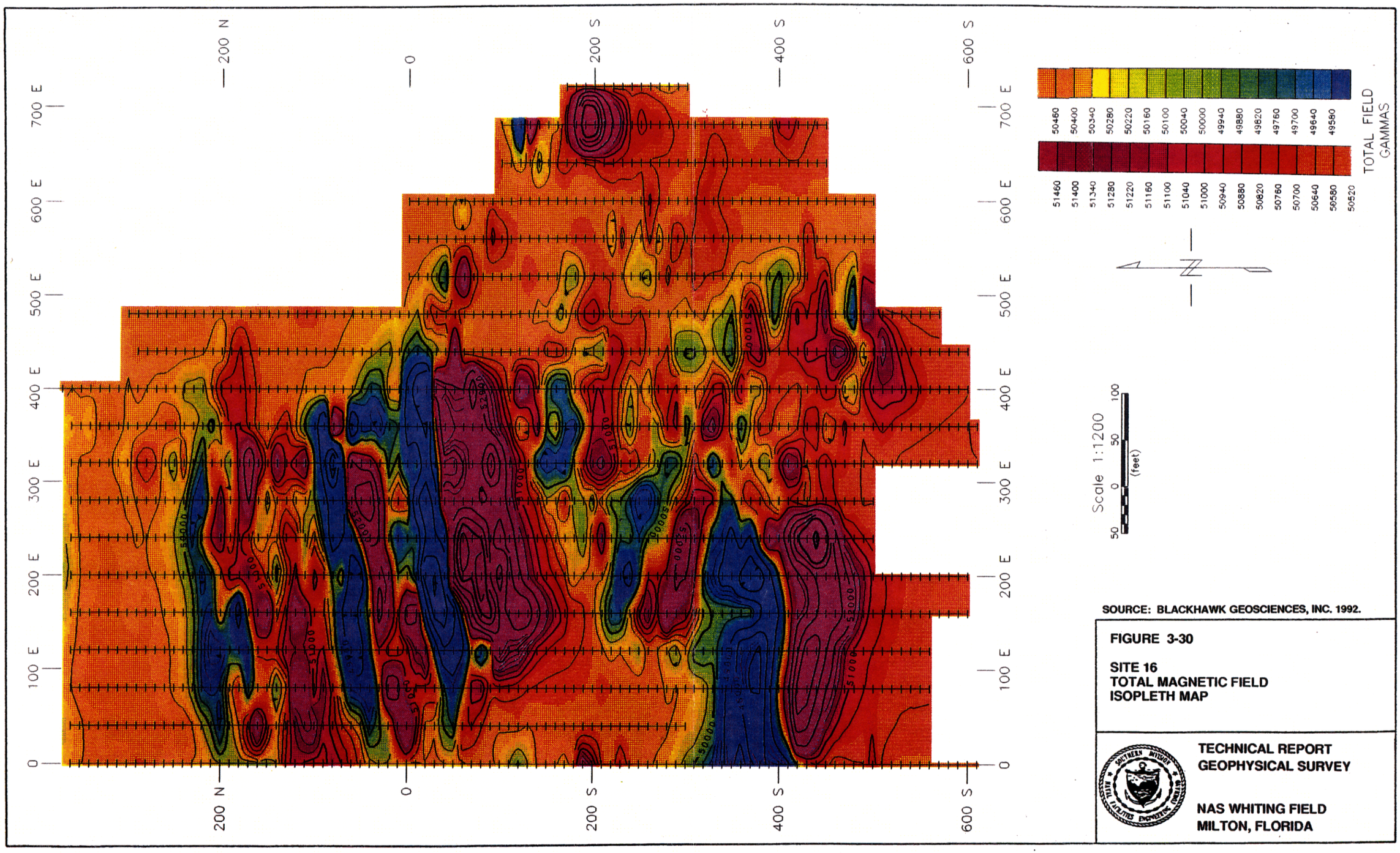
FIGURE 3-29

SITE 16
GEOPHYSICAL SURVEY GRID LINES
AND INTERPETED ANOMALY LOCATIONS

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA

00230C09Z



SOURCE: BLACKHAWK GEOSCIENCES, INC. 1992.

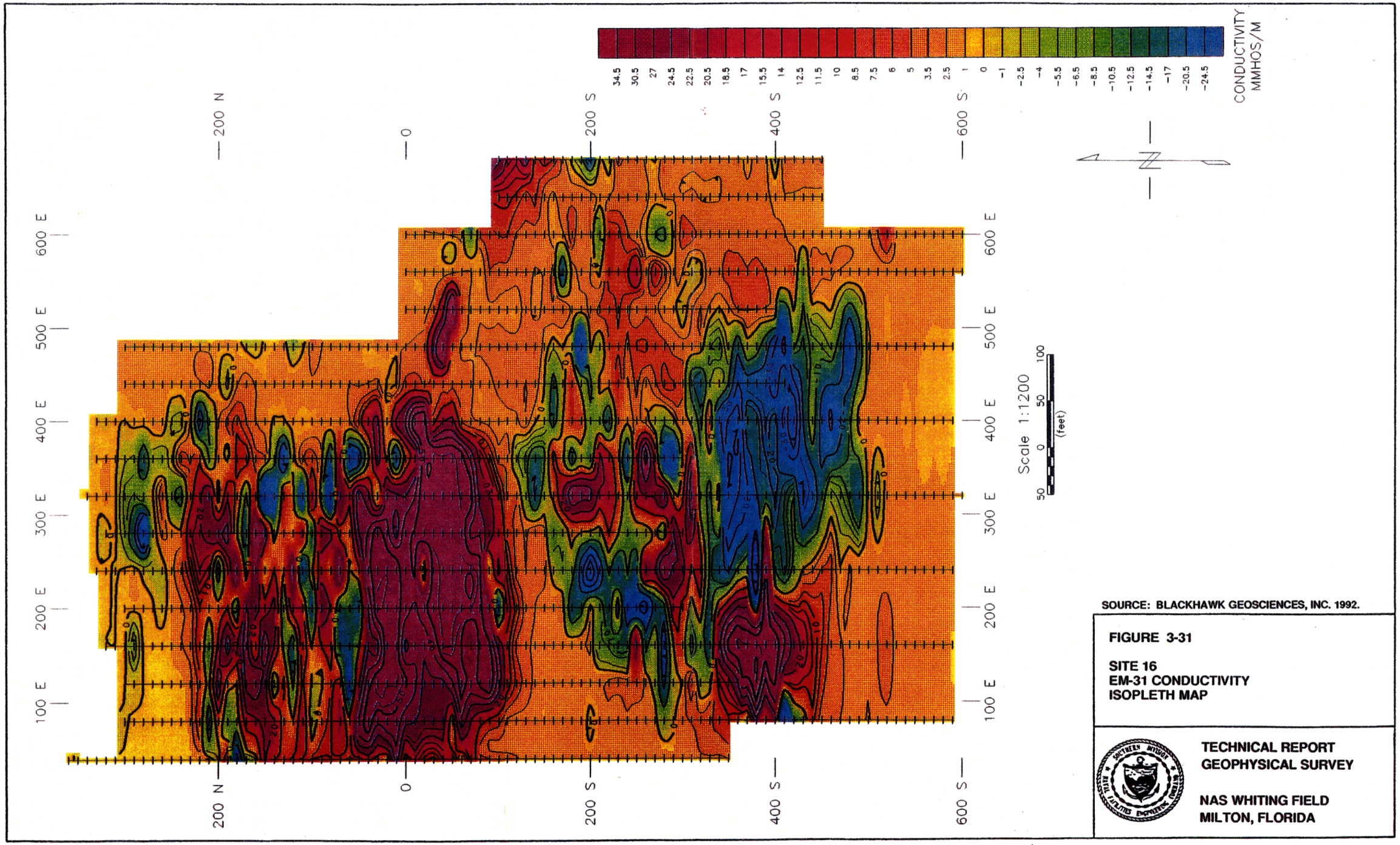
FIGURE 3-30

SITE 16
TOTAL MAGNETIC FIELD
ISOPLETH MAP

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA

00230CB104



SOURCE: BLACKHAWK GEOSCIENCES, INC. 1992.

FIGURE 3-31

SITE 16
EM-31 CONDUCTIVITY
ISOPLETH MAP

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA

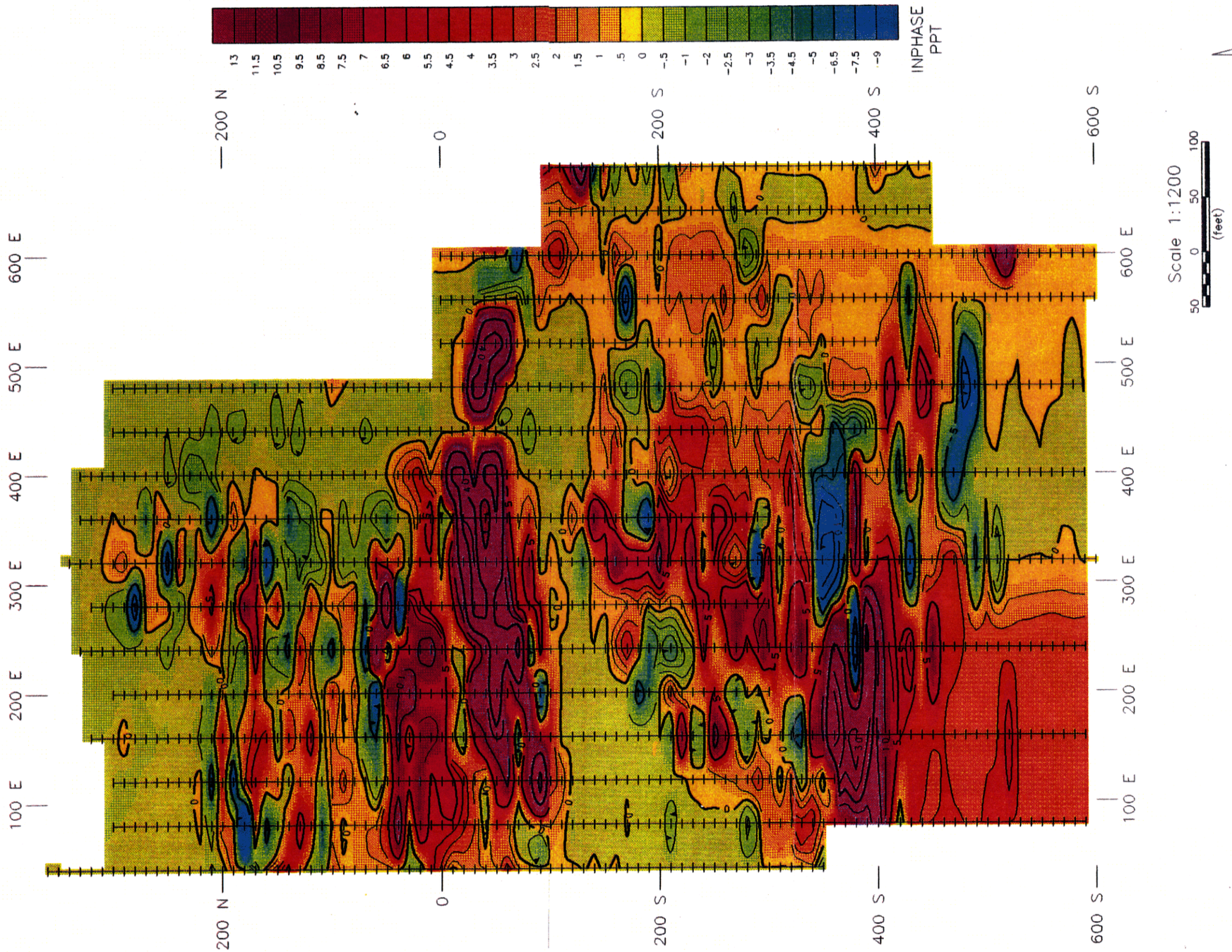


FIGURE 3-32

SITE 16
EM-31 INPHASE
ISOPLETH MAP

TECHNICAL REPORT
GEOPHYSICAL SURVEY

NAS WHITING FIELD
MILTON, FLORIDA

disposal, rather than controlled landfilling. Previously excavated large tanks are present at the site. The mound located at grid point 680E, 190S was associated with a very high amplitude total magnetic anomaly, and an EM-31 conductivity anomaly. This suggests that a pit may have been dug at this location, filled with ferromagnetic metal materials, and subsequently covered with soil. This survey grid was extended to the east three times while attempting to encompass all isolated anomalies within the grid. However, the random distribution of these anomalies did not indicate relevance to primary landfilling activities at Site 16, and therefore their locations and distribution were determined to be outside the scope of this project. Therefore, the survey was discontinued beyond these anomalies.

4.0 SUMMARY AND CONCLUSIONS

The objectives of the geophysical surveys at NAS Whiting Field were to characterize landfill materials, define the lateral and vertical extent of landfill boundaries, and to identify potential plume migration pathways. The first objectives, to characterize landfill materials and determine the lateral extent of the boundaries was accomplished with the use of the EM-31 induction tool and an EDA OMNI-IV total magnetometer. The objective of determining the vertical extent of fill at each site was not met due to resistivity variations in the landfill materials. The variable resistivities were believed to be caused by the nature of the fill material and the presence of a high metal content. These factors precluded the selection of a single value for the depth versus the resistivity curve generated by the DC sounding. Because the depth of fill measurement is largely dependent on an accurate resistivity measurement, confidence in the calculated solutions could not be obtained. Finally, no preferential plume migration pathways were identified at any of the sites.

A summary of the geophysical results and interpretations for each of the sites investigated is presented in Table 4-1. In addition, a site-by-site narrative summary of the overall findings is presented below.

Site 1. No landfill like structure was interpreted to exist. One isolated geophysical anomaly was noted.

Site 10. One landfill cell was interpreted at this site. Two small, low amplitude anomalies were present on the northern portion of the grid.

Site 11. This site contained a single interpreted landfill area. Three isolated geophysical anomalies were also interpreted.

Site 13. One landfill feature was interpreted at this site. Several additional isolated geophysical anomalies were interpreted. The anomalies located on the western portion of the grid appear to be associated with large amounts of buried ferromagnetic metal.

Site 14. One landfill feature was interpreted, along with one low amplitude isolated anomaly.

Site 15. Two large landfill cells were interpreted at this site, as well as what appears to be a series of filled trenches in the central and western portions of the grid.

Site 16. This site contained two interpreted filled areas, one in the northern portion of the grid and one in the southern portion. Several localized geophysical anomalies existed, most of which lie in the eastern portion of the grid.

As indicated on Table 4-1 and discussed above, the lateral boundaries of each of the investigated disposal areas, with the exception of one, Site 1, the Northwest Disposal Area, have been delineated and mapped. In addition to the primary disposal areas, numerous isolated metallic and non-metallic anomalies have been

Table 4-1
Summary of Geophysical Survey

Geophysical Survey, Technical Report
RI/FS Phase II-A, NAS Whiting Field
Milton, Florida

Site No.	Site Name and Type	Results			Interpretation
		Magnetometer	EM-31 Conductivity	EM-31 Inphase	
1	Northwest Disposal Area (landfill)	No anomalies	Flat across the site	Flat across the site	No landfill boundaries can be interpreted.
10	Southeast Open Disposal Area (A) (landfill)	One large scale anomaly with two isolated point features.	Consistent with magnetometer data.	Consistent with conductivity data.	Landfill is interpreted in the southern portion with definite lateral boundaries.
11	Southeast Open Disposal Area (B) (landfill)	One large scale anomaly with three isolated low amplitude anomalies.	Consistent with magnetometer data.	Consistent with conductivity data.	Landfill is interpreted with definite lateral boundaries.
13	Sanitary Landfill (landfill)	Two linear feature anomalies with a shorter parallel feature and a localized high amplitude anomaly.	Consistent with magnetometer data.	Consistent with conductivity data.	Landfill interpreted with a series of trenches. Greatest concentration of ferromagnetic metals in the southwestern corner.
14	Short-Term Sanitary Landfill (landfill)	Single linear feature anomaly trending eastwest.	Consistent with magnetometer data.	Consistent with conductivity data.	Indicates signatures of metallic debris buried in trench with definite boundaries.
15	Southwest Landfill (landfill)	A feature with highest amplitude anomaly in the northern portion. Five bands of linear feature anomalies trending southwest-northeast. Extended low magnitude anomaly in the eastern portion.	Consistent with magnetometer data.	Consistent with conductivity data.	High degree of buried ferromagnetic debris in the northern portion. Parallel trenches of landfill in the central portion. Large area of landfill in the eastern portion with defined boundaries.
16	Open Disposal and Burning Area (landfill)	Two regions of extended anomalies surrounded by natural field strength. Scattered point feature anomalies trending away from the site in the easterly direction.	Consistent with magnetometer data.	Consistent with conductivity data.	Two landfill cells with definite boundaries.

identified and mapped. However, the vertical extent of the landfills was not determined by the geophysical survey. Further, the interpreted data did not indicate the presence of contaminant plumes or possible subsurface preferential pathways for contaminant migration at any of the sites.

Anomalies identified during the geophysical survey will be verified by test pitting activities conducted at each of the disposal areas and the complete geophysical data set will be used to direct additional RI/FS investigation activities at NAS Whiting Field.

REFERENCES

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McNeill, J.D., 1980. Electromagnetic Terrain Constructivity Measurement at Low Induction Numbers. Technical Note TN-6, Geonics, Ltd., Missisauga, Ontario, Canada.

APPENDIX A

GEOPHYSICAL SURVEY RAW DATA

1 EM DAT

```
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130 240 -1.44 -2.114
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100 240 -1.26 -2.053
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80 240 -0.96 -2.065
70 240 -1.02 -2.114
60 240 -0.84 -2.294
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40 40 -0.84 -2.01

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10	40	-0.84	-1.914
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1 MAG DAT

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-440.000	-240.000	6.600	0.361
-440.000	-250.000	6.300	0.770
-440.000	-260.000	6.120	0.650
-440.000	-270.000	3.240	0.349
-440.000	-280.000	0.120	-0.903
-440.000	-290.000	1.020	-0.024
-440.000	-300.000	0.720	-0.048
-440.000	-310.000	0.660	-0.060
-440.000	-320.000	0.480	-0.409
-400.000	-320.000	0.480	-0.060
-400.000	-310.000	0.720	0.012
-400.000	-300.000	1.140	-0.036
-400.000	-290.000	1.980	0.036
-400.000	-280.000	3.000	-0.060
-400.000	-270.000	6.480	0.445
-400.000	-260.000	11.760	2.697
-400.000	-250.000	9.300	-0.132
-400.000	-240.000	11.460	1.661
-400.000	-230.000	10.980	0.000
-400.000	-220.000	13.200	2.396
-400.000	-210.000	16.560	4.058
-400.000	-200.000	12.420	1.192
-400.000	-190.000	12.660	1.770
-400.000	-180.000	2.880	-8.369
-400.000	-170.000	11.760	0.553
-400.000	-160.000	10.860	0.999
-400.000	-150.000	7.980	0.879
-400.000	-140.000	9.660	1.734
-400.000	-130.000	5.580	1.432
-400.000	-120.000	0.720	-1.986
-400.000	-110.000	-7.380	-32.296
-400.000	-100.000	5.340	-16.870
-400.000	-90.000	5.460	-1.746
-400.000	-80.000	9.000	1.119
-400.000	-70.000	8.160	1.204

-400.000	-60.000	9.240	1.565
-400.000	-50.000	6.120	-0.048
-400.000	-40.000	5.640	1.011
-400.000	-30.000	3.960	0.325
-400.000	-20.000	1.380	-0.048
-400.000	-10.000	0.960	-0.108
-400.000	0.000	0.480	-0.012
-400.000	10.000	0.420	-0.084
-400.000	20.000	0.660	-0.012
-360.000	20.000	0.420	0.132
-360.000	10.000	0.480	0.084
-360.000	0.000	0.540	0.084
-360.000	-10.000	0.540	0.228
-360.000	-20.000	0.480	0.180
-360.000	-30.000	1.620	0.301
-360.000	-40.000	1.980	-1.047
-360.000	-50.000	4.080	-3.961
-360.000	-60.000	16.440	8.453
-360.000	-70.000	11.760	2.552
-360.000	-80.000	6.600	1.914
-360.000	-90.000	-0.660	-2.167
-360.000	-100.000	3.000	-2.420
-360.000	-110.000	-6.840	-4.070
-360.000	-120.000	-8.340	-3.841
-360.000	-130.000	-32.760	-25.878
-360.000	-140.000	8.940	0.421
-360.000	-150.000	8.460	0.264
-360.000	-160.000	-3.660	-4.925
-360.000	-170.000	-1.440	0.590
-360.000	-180.000	6.060	0.252
-360.000	-190.000	9.360	0.096
-360.000	-200.000	6.360	-3.684
-360.000	-210.000	10.200	1.180
-360.000	-220.000	9.840	1.878
-360.000	-230.000	9.420	1.372
-360.000	-240.000	8.460	2.227
-360.000	-250.000	9.599	1.336
-360.000	-260.000	9.120	0.939
-360.000	-270.000	7.620	0.830
-360.000	-280.000	5.460	-0.469
-360.000	-290.000	1.380	-1.457
-360.000	-300.000	0.600	-0.349
-360.000	-310.000	1.260	0.108
-360.000	-320.000	0.900	0.144
-360.000	-330.000	0.480	0.108
-320.000	-340.000	0.360	-0.024
-320.000	-330.000	0.720	0.132
-320.000	-320.000	1.080	-0.012
-320.000	-310.000	0.960	-0.084
-320.000	-300.000	0.600	-0.036
-320.000	-290.000	3.660	0.686
-320.000	-280.000	8.280	0.854
-320.000	-270.000	9.780	2.516
-320.000	-260.000	10.260	1.758
-320.000	-250.000	9.840	1.336
-320.000	-240.000	7.560	1.071
-320.000	-230.000	8.280	1.156
-320.000	-220.000	7.080	0.867
-320.000	-210.000	8.100	0.879
-320.000	-200.000	9.900	1.384
-320.000	-190.000	9.420	0.987
-320.000	-180.000	9.900	1.059
-320.000	-170.000	9.660	1.107
-320.000	-160.000	5.820	-3.251
-320.000	-150.000	-4.080	-8.188
-320.000	-140.000	-4.740	-4.419

-320.000	-130.000	0.780	-0.301
-320.000	-120.000	5.580	0.361
-320.000	-110.000	3.180	-0.325
-320.000	-100.000	9.840	1.324
-320.000	-90.000	10.800	1.228
-320.000	-80.000	3.120	-8.646
-320.000	-70.000	7.080	-0.385
-320.000	-60.000	11.640	2.661
-320.000	-50.000	8.340	0.409
-320.000	-40.000	3.300	0.565
-320.000	-30.000	1.440	0.132
-320.000	-20.000	1.380	0.180
-320.000	-10.000	0.720	0.168
-320.000	0.000	0.180	-0.048
-320.000	10.000	0.540	0.048
-320.000	20.000	0.660	0.024
-280.000	20.000	-0.180	0.024
-280.000	10.000	0.660	0.096
-280.000	0.000	0.600	0.072
-280.000	-10.000	0.480	0.000
-280.000	-20.000	0.840	0.180
-280.000	-30.000	1.440	0.216
-280.000	-40.000	1.680	0.228
-280.000	-50.000	1.080	0.337
-280.000	-60.000	2.760	0.120
-280.000	-70.000	6.900	0.999
-280.000	-80.000	10.560	0.734
-280.000	-90.000	4.920	-0.722
-280.000	-100.000	9.420	1.252
-280.000	-110.000	4.740	-0.373
-280.000	-120.000	2.220	-1.059
-280.000	-130.000	-4.740	-18.652
-280.000	-140.000	12.660	-2.300
-280.000	-150.000	6.300	-4.070
-280.000	-160.000	7.260	-3.227
-280.000	-170.000	8.700	0.445
-280.000	-180.000	11.040	2.119
-280.000	-190.000	10.980	0.999
-280.000	-200.000	13.560	2.143
-280.000	-210.000	14.580	2.613
-280.000	-220.000	11.460	1.553
-280.000	-230.000	10.620	1.420
-280.000	-240.000	10.500	1.432
-280.000	-250.000	11.340	1.445
-280.000	-260.000	9.540	1.432
-280.000	-270.000	9.720	1.673
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-280.000	-290.000	7.440	1.721
-280.000	-300.000	4.080	0.012
-280.000	-310.000	2.640	0.553
-280.000	-320.000	0.180	0.000
-280.000	-330.000	1.380	0.120
-280.000	-340.000	0.840	-0.048
-240.000	-350.000	0.780	0.072
-240.000	-340.000	0.960	0.168
-240.000	-330.000	1.440	0.385
-240.000	-320.000	2.100	0.421
-240.000	-310.000	4.920	0.553
-240.000	-300.000	4.740	0.180
-240.000	-290.000	4.620	0.216
-240.000	-280.000	9.599	1.047
-240.000	-270.000	11.700	1.384
-240.000	-260.000	13.140	2.300
-240.000	-250.000	13.920	1.806
-240.000	-240.000	15.180	1.998
-240.000	-230.000	15.660	2.661

-240.000	-220.000	11.520	0.216
-240.000	-210.000	18.420	2.059
-240.000	-200.000	14.640	5.756
-240.000	-190.000	17.760	1.794
-240.000	-180.000	16.920	1.782
-240.000	-170.000	17.700	1.047
-240.000	-160.000	10.440	1.336
-240.000	-150.000	12.840	0.686
-240.000	-140.000	9.900	-1.432
-240.000	-130.000	13.860	1.950
-240.000	-120.000	11.460	2.733
-240.000	-110.000	16.920	1.758
-240.000	-100.000	13.800	1.156
-240.000	-90.000	13.260	1.553
-240.000	-80.000	6.480	0.710
-240.000	-70.000	9.059	0.409
-240.000	-60.000	8.639	1.589
-240.000	-50.000	4.680	0.313
-240.000	-40.000	3.360	0.517
-240.000	-30.000	0.900	-0.168
-240.000	-20.000	0.060	-0.758
-240.000	-10.000	0.960	0.204
-240.000	0.000	1.140	0.301
-240.000	10.000	-0.180	-0.012
-240.000	20.000	0.120	0.060
-240.000	30.000	0.060	0.192
-200.000	30.000	0.420	-0.156
-200.000	20.000	0.300	-0.349
-200.000	10.000	0.420	-0.180
-200.000	0.000	0.300	-0.060
-200.000	-10.000	1.500	0.000
-200.000	-20.000	1.860	-0.060
-200.000	-30.000	3.540	0.084
-200.000	-40.000	4.020	0.120
-200.000	-50.000	9.360	1.589
-200.000	-60.000	10.920	0.650
-200.000	-70.000	12.420	1.721
-200.000	-80.000	12.540	2.047
-200.000	-90.000	12.420	1.902
-200.000	-100.000	11.760	1.420
-200.000	-110.000	12.240	1.360
-200.000	-120.000	14.700	1.420
-200.000	-130.000	13.920	1.505
-200.000	-140.000	16.080	1.746
-200.000	-150.000	15.960	2.408
-200.000	-160.000	15.720	0.276
-200.000	-170.000	17.040	1.709
-200.000	-180.000	15.840	-0.722
-200.000	-190.000	11.220	1.962
-200.000	-200.000	11.940	0.180
-200.000	-210.000	13.380	2.047
-200.000	-220.000	19.560	10.500
-200.000	-230.000	36.540	45.783
-200.000	-240.000	29.160	10.187
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-200.000	-260.000	12.300	-0.373
-200.000	-270.000	11.820	2.059
-200.000	-280.000	5.820	-0.686
-200.000	-290.000	6.180	1.276
-200.000	-300.000	7.260	0.674
-200.000	-310.000	5.880	0.662
-200.000	-320.000	6.300	0.806
-200.000	-330.000	2.700	0.313
-200.000	-340.000	1.620	-0.096
-200.000	-350.000	1.140	0.048
-200.000	-360.000	0.840	0.012

-200.000	-370.000	0.720	-0.012
-160.000	-370.000	0.780	-0.144
-160.000	-360.000	1.080	-0.012
-160.000	-350.000	1.380	-0.012
-160.000	-340.000	1.380	-1.252
-160.000	-330.000	2.460	0.264
-160.000	-320.000	3.480	0.252
-160.000	-310.000	5.460	0.132
-160.000	-300.000	5.640	0.036
-160.000	-290.000	9.780	1.180
-160.000	-280.000	9.780	0.144
-160.000	-270.000	16.860	2.528
-160.000	-260.000	16.080	1.625
-160.000	-250.000	15.960	0.806
-160.000	-240.000	3.120	-7.333
-160.000	-230.000	8.580	-13.161
-160.000	-220.000	1.620	2.275
-160.000	-210.000	9.000	-11.680
-160.000	-200.000	17.880	3.612
-160.000	-190.000	13.740	2.841
-160.000	-180.000	19.200	1.866
-160.000	-170.000	19.140	2.589
-160.000	-160.000	18.360	2.516
-160.000	-150.000	21.660	2.384
-160.000	-140.000	21.960	3.793
-160.000	-130.000	20.280	3.383
-160.000	-120.000	17.100	3.853
-160.000	-110.000	16.980	2.283
-160.000	-100.000	13.500	2.167
-160.000	-90.000	13.500	1.001
-160.000	-80.000	10.800	-2.564
-160.000	-70.000	8.100	3.889
-160.000	-60.000	8.820	0.529
-160.000	-50.000	9.000	1.252
-160.000	-40.000	6.660	0.180
-160.000	-30.000	2.520	0.168
-160.000	-20.000	0.120	-0.168
-160.000	-10.000	0.120	-0.867
-160.000	0.000	1.080	0.289
-160.000	10.000	0.720	0.192
-120.000	0.000	1.140	0.289
-120.000	-10.000	1.620	0.433
-120.000	-20.000	2.820	0.421
-120.000	-30.000	2.700	0.650
-120.000	-40.000	4.140	-0.096
-120.000	-50.000	8.760	2.757
-120.000	-60.000	15.840	2.685
-120.000	-70.000	9.300	-0.108
-120.000	-80.000	11.820	-3.263
-120.000	-90.000	11.040	0.000
-120.000	-100.000	6.780	3.046
-120.000	-110.000	15.420	2.914
-120.000	-120.000	23.940	3.865
-120.000	-130.000	23.760	0.867
-120.000	-140.000	13.440	2.589
-120.000	-150.000	26.940	3.431
-120.000	-160.000	28.560	2.805
-120.000	-170.000	17.820	2.817
-120.000	-180.000	7.320	-5.912
-120.000	-190.000	19.080	-0.024
-120.000	-200.000	19.440	1.998
-120.000	-210.000	12.960	-1.926
-120.000	-220.000	8.820	3.371
-120.000	-230.000	20.940	3.600
-120.000	-240.000	14.940	-2.552
-120.000	-250.000	10.860	6.695

-120.000	-260.000	5.040	1.806
-120.000	-270.000	15.720	1.661
-120.000	-280.000	15.360	2.396
-120.000	-290.000	13.800	1.938
-120.000	-300.000	-6.060	-11.259
-120.000	-310.000	0.480	-4.600
-120.000	-320.000	4.680	0.698
-120.000	-330.000	3.780	0.325
-120.000	-340.000	2.520	0.240
-120.000	-350.000	1.440	0.192
-120.000	-360.000	1.260	0.036
-120.000	-370.000	1.080	0.096
-80.000	-360.000	1.140	0.036
-80.000	-350.000	1.380	0.084
-80.000	-340.000	1.740	0.120
-80.000	-330.000	2.280	0.301
-80.000	-320.000	3.540	0.289
-80.000	-310.000	-10.920	-15.570
-80.000	-300.000	-7.260	-10.777
-80.000	-290.000	12.600	3.010
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-80.000	-270.000	17.880	3.913
-80.000	-260.000	12.540	2.107
-80.000	-250.000	13.620	2.432
-80.000	-240.000	16.740	1.625
-80.000	-230.000	16.800	1.059
-80.000	-220.000	16.380	0.313
-80.000	-210.000	14.760	1.071
-80.000	-200.000	19.980	2.853
-80.000	-190.000	18.540	2.348
-80.000	-180.000	20.340	3.913
-80.000	-170.000	26.220	3.203
-80.000	-160.000	24.300	-0.276
-80.000	-150.000	16.620	6.382
-80.000	-140.000	18.240	2.215
-80.000	-130.000	16.200	-0.927
-80.000	-120.000	20.280	0.782
-80.000	-110.000	17.100	2.360
-80.000	-100.000	15.360	0.349
-80.000	-90.000	18.000	4.226
-80.000	-80.000	21.000	5.840
-80.000	-70.000	10.620	0.698
-80.000	-60.000	14.400	0.000
-80.000	-50.000	5.820	0.361
-80.000	-40.000	6.960	0.891
-80.000	-30.000	3.720	0.553
-80.000	-20.000	1.560	0.036
-80.000	-10.000	1.020	0.144
-80.000	0.000	0.840	0.012
-40.000	0.000	0.600	-0.216
-40.000	-10.000	0.420	-0.060
-40.000	-20.000	0.900	-0.048
-40.000	-30.000	1.260	0.024
-40.000	-40.000	1.500	0.084
-40.000	-50.000	2.040	0.180
-40.000	-60.000	2.340	-0.108
-40.000	-70.000	2.160	0.012
-40.000	-80.000	-23.880	-3.142
-40.000	-90.000	-2.700	-5.298
-40.000	-100.000	-10.500	-3.696
-40.000	-110.000	-5.580	-1.950
-40.000	-120.000	9.840	-0.433
-40.000	-130.000	7.560	0.650
-40.000	-140.000	6.780	0.553
-40.000	-150.000	7.020	-0.553
-40.000	-160.000	5.100	0.012

-40.000	-170.000	5.820	0.048
-40.000	-180.000	6.480	0.072
-40.000	-190.000	5.640	0.084
-40.000	-200.000	7.680	2.167
-40.000	-210.000	10.020	1.180
-40.000	-220.000	7.920	1.228
-40.000	-230.000	11.820	2.589
-40.000	-240.000	9.599	1.204
-40.000	-250.000	8.700	1.770
-40.000	-260.000	8.760	2.950
-40.000	-270.000	12.360	3.757
-40.000	-280.000	3.180	-0.048
-40.000	-290.000	3.000	0.758
-40.000	-300.000	0.840	0.529
-40.000	-310.000	0.120	0.096
-40.000	-320.000	1.800	0.397
-40.000	-330.000	1.260	0.276
-40.000	-340.000	1.200	0.397
-40.000	-350.000	1.140	0.373
0.000	-350.000	1.020	0.180
0.000	-340.000	1.020	0.240
0.000	-330.000	1.080	0.313
0.000	-320.000	1.080	0.385
0.000	-310.000	1.140	0.361
0.000	-300.000	1.140	0.313
0.000	-290.000	1.140	0.325
0.000	-280.000	1.200	0.313
0.000	-270.000	1.260	0.397
0.000	-260.000	1.260	0.337
0.000	-250.000	1.260	0.301
0.000	-240.000	1.200	0.204
0.000	-230.000	1.200	0.457
0.000	-220.000	1.080	0.216
0.000	-210.000	1.260	0.433
0.000	-200.000	1.440	0.373
0.000	-190.000	1.320	0.397
0.000	-180.000	1.200	0.361
0.000	-170.000	1.200	0.385
0.000	-160.000	1.080	0.337
0.000	-150.000	0.960	0.228
0.000	-140.000	0.900	0.373
0.000	-130.000	1.080	0.457
0.000	-120.000	1.080	0.349
0.000	-110.000	-0.300	0.517
0.000	-100.000	-14.700	-7.562
0.000	-90.000	-11.400	-11.247
0.000	-80.000	1.320	0.782
0.000	-70.000	0.600	0.289
0.000	-60.000	0.660	0.192
0.000	-50.000	0.480	0.132
0.000	-40.000	0.840	0.541
0.000	-30.000	1.800	2.239
0.000	-20.000	2.040	3.094
0.000	-10.000	1.260	1.396
0.000	0.000	1.440	1.541
40.000	-350.000	0.900	0.301
40.000	-340.000	1.020	0.361
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13 MAG DAT

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-80	-200	50493.9
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-80	-150	50465.8
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-80	-130	50476.7
-80	-120	50470.6
-80	-110	50477.7
-80	-100	50485.5
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-80	-70	50494.7
-80	-60	50496.5
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-80	-40	50499.1
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-80	-20	50500.1
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-40	0	50504.1
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-40	-20	50503.5
-40	-30	50502.5
-40	-40	50501.9
-40	-50	50500.6
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-40	-80	50499.4
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0	-100	50498.5
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0	0	50500.7

15 EM DAT

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530	400	-0.12	0.144
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510	400	0.06	0.048
500	400	0.72	0.553
490	400	-0.72	-0.433
480	400	-12.84	-1.541
470	400	-8.94	-0.373
460	400	2.46	0.144
450	400	-3.42	0.397
440	400	-1.2	-0.59
430	400	-2.64	-1.396
420	400	-12.48	-2.938
410	400	3.72	0.529
400	400	1.14	0.084
390	400	-3.06	-0.313
380	400	0.9	0.337
370	400	0.12	0.192
360	400	0.06	0.204
350	400	0	0.168
340	400	0.12	0.397
330	400	0.06	0.144
320	400	0.18	0.204
310	400	0.15	0.204
300	400	0.54	0.132
290	400	2.34	0.204
280	400	6.66	0.927
270	400	8.4	3.287
260	400	10.98	2.700
250	400	12.66	1.998
240	400	9.36	1.541
230	400	-2.04	-0.541
220	400	-4.44	-0.927
210	400	2.82	-0.024
200	400	5.04	0.939
190	400	9.84	2.769
180	400	12.24	2.552
170	400	10.62	3.034
160	400	11.28	1.42
150	400	8.3	0.927
140	400	2.4	0.228
130	400	1.08	-0.072
120	400	1.38	0.276
110	400	2.46	0.409
100	400	7.5	1.276
90	400	13.68	3.817
80	400	16.42	3.516
70	400	16.02	2.829
60	400	10.2	1.673
50	400	4.5	0.602
40	400	3.48	0.541
30	400	3.24	0.457
20	400	3.54	0.505
10	400	2.22	0.349
0	400	4.5	1.529
-10	400	2.46	0.228
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-30	400	12.42	1.986
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-90	400	4.2	1.818

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-190	400	3.42	0.156
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-270	400	1.44	0.686
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-150	360	8.58	1.481
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-130	360	5.94	0.361
-120	360	6.84	0.818
-110	360	8.1	1.914
-100	360	6	0.469
-90	360	1.14	0.891
-80	360	7.86	0.565
-70	360	5.1	1.312
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-50	360	13.44	3.058
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10	360	4.98	0.192
20	360	3.72	0.349
30	360	5.28	0.565
40	360	3.96	0.18

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60 360 9.18 1.469
70 360 3.9 0.951
80 360 9.12 -1.216
90 330 -25.56 -3.913
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120 360 1.92 0.096
130 360 3.24 0.264
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150 360 10.14 1.914
160 360 12.36 1.938
170 360 13.02 3.287
180 360 10.26 2.227
190 360 3.96 0.421
200 360 2.16 0.192
210 360 2.46 0.228
220 360 3.18 0.072
230 360 7.14 1.372
240 360 10.56 2.89
250 360 2.88 1.24
260 360 -3.18 1.601
270 360 3.36 1.422
280 360 2.16 0.204
290 360 1.14 0.222
300 360 0.54 0.168
310 360 0.18 0.108
320 360 0.24 0.084
330 360 0.06 0.096
340 360 0.12 0.084
350 360 0.16 0.06
360 360 0.06 0.072
370 360 0.18 0.108
380 360 0.3 0.072
390 360 0.36 0.024
400 360 -1.8 0.012
410 360 2.34 0.036
420 360 4.20 0.036
430 360 -5.52 -0.12
440 360 1.98 0.927
450 360 6 1.275
460 360 8.54 1.974
470 360 1.8 1.42
480 360 4.38 0.144
490 360 2.4 -0.349
500 360 2.52 0.65
510 360 1.56 0.397
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490 320 -4.68 -0.108
480 320 -1.38 -0.541
470 320 -8.219 0.337
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440 320 6.3 0.794
430 320 -1.38 0.228
420 320 3 1.011
410 320 9.059 1.168

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390 320 1.68 0.301
380 320 0.54 -0.216
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360 320 0.18 0.18
350 320 0.18 0.204
340 320 0.36 0.264
330 320 0.06 0.216
320 320 0.06 0.301
310 320 0.24 0.216
300 320 0.3 0.216
290 320 0.48 0.192
280 320 0.78 0.276
270 320 3.18 0.24
260 320 6.42 1.324
250 320 1.44 1.794
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180 320 2.76 0.421
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110 320 5.64 0.541
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70 320 2.94 0.818
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30 320 5.64 2.263
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-20 320 8.34 2.769
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-190 320 1.14 1.469
-200 320 0.36 -0.24
-210 320 4.56 0.794
-220 320 4.86 -0.072
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-270	320	1.44	0.325
-280	320	1.86	0.349
-290	320	5.16	0.541
-250	280	2.04	0.325
-240	280	1.5	0.228
-230	280	1.56	0.361
-220	280	2.04	0.445
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-140	280	3.54	0.084
-130	280	1.32	-0.024
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-110	280	8.82	0.445
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20	280	7.92	1.709
30	280	11.04	1.24
40	280	2.16	0.541
50	280	-1.86	1.565
60	280	0.6	1.059
70	280	3.9	0.264
80	280	1.74	0.264
90	280	2.4	0.325
100	280	3.78	0.433
110	280	4.8	1.168
120	280	7.22	1.806
130	280	9.96	1.276
140	280	9.599	2.143
150	280	1.5	0.553
160	280	-7.98	-3.227
170	280	-7.26	-0.421
180	280	2.56	0.541
190	280	2.58	-0.409
200	280	0.54	1.42
210	280	-8.1	0.445
220	280	-3	2.878
230	280	-2.7	0.867
240	280	7.68	0.602
250	280	2.46	0.517
260	280	1.02	0.313
270	280	0.54	0.18
280	280	0.66	0.156
290	280	0.6	0.156
300	280	0.54	0.156
310	280	0.3	0.048
320	280	0.36	-0.012
330	280	0.54	0.156
340	280	0.54	0.276
350	280	0.66	0.192
360	280	1.08	0.204

370	280	1.38	0.192
380	280	-1.32	-0.192
390	280	-33.36	-4.828
400	280	-12.12	-3.203
410	280	2.82	-0.024
420	280	5.1	0.529
430	280	6.12	1.047
440	280	7.38	1.3
450	280	6.42	0.409
460	280	-21.66	-0.204
470	280	-2.64	-2.191
480	280	-4.44	-1.095
490	280	-25.14	-3.407
500	280	-7.98	-1.818
510	280	0.9	0.06
520	280	0.06	0.06
530	280	0.06	0
540	280	0	-0.012
550	280	-0.12	-0.072
520	240	-0.06	0.036
510	240	0.3	0.12
500	240	-1.74	-0.758
490	240	-12.84	-1.902
480	240	-24.72	-3.841
470	240	-45.12	-6.141
460	240	-4.44	0.216
450	240	8.16	2.468
440	240	8.16	2.3
430	240	5.76	1.517
420	240	5.94	1.703
410	240	4.08	1.052
400	240	0.3	-0.337
390	240	-6.18	-1.553
380	240	-4.38	0.072
370	240	0.9	-2.456
360	240	-7.30	-2.738
350	240	0.6	-1.818
340	240	5.54	1.372
330	240	6.76	2.601
320	240	0.24	0.252
310	240	2.22	-0.192
300	240	1.92	0.24
290	240	3.42	-0.06
280	240	2.34	0.361
270	240	1.02	0.204
260	240	-0.18	-0.228
250	240	0.12	-0.096
240	240	2.4	-0.409
230	240	-0.18	-0.602
220	240	-0.48	3.106
210	240	4.02	1.204
200	240	-17.04	-1.264
190	240	-4.74	-0.397
180	240	6.06	1.89
170	240	4.2	0.421
160	240	2.82	0.421
150	240	1.8	0.493
140	240	1.8	0.409
130	240	1.8	0.313
120	240	3.48	0.409
110	240	10.44	1.613
100	240	10.56	2.215
90	240	11.52	1.95
80	240	2.28	-0.746
70	240	3.06	-0.18
60	240	2.82	-0.12

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-160 200 2.88 -0.012
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140 200 2.52 -0.06
150 200 2.58 -0.156
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170 200 6.3 0.505

180	200	12.42	2.372
190	200	10.02	2.384
200	200	3.9	0.156
210	200	-2.1	-1.192
220	200	-2.94	-0.578
230	200	2.58	-0.144
240	200	4.2	0.373
250	200	-3.12	-2.131
260	200	-9.599	-3.431
270	200	7.68	0.638
280	200	7.32	0.361
290	200	7.38	0.096
300	200	10.92	1.637
310	200	10.38	1.264
320	200	12.6	0.674
330	200	9.66	2.54
340	200	12.66	2.336
350	200	17.82	3.6
360	200	15.72	2.203
370	200	7.14	1.432
380	200	6.54	0.927
390	200	3.06	-0.517
400	200	3.9	-0.084
410	200	4.44	0.662
420	200	6.48	-0.264
430	200	6.00	0.614
440	200	6	0.349
450	200	-6.3	-1.77
460	200	-9.90	-3.6
470	200	2.76	0.24
480	200	-2.7	-0.579
490	200	2.22	-0.132
500	200	1.62	-0.264
510	200	1.14	-0.201
520	200	1.02	-0.349
530	200	1.02	-0.228
520	160	1.14	-0.24
510	160	1.08	-0.24
500	160	1.08	-0.156
490	160	1.98	-0.108
480	160	1.8	-0.59
470	160	-6.24	-1.649
460	160	-8.04	-1.469
450	160	3.96	-0.156
440	160	6.66	1.131
430	160	8.58	1.637
420	160	8.88	1.3
410	160	5.76	0.342
400	160	-4.56	-0.674
390	160	5.4	-0.216
380	160	1.38	-1.131
370	160	3.66	1.589
360	160	13.98	1.601
350	160	8.00	1.553
340	160	3.54	0.999
330	160	-6.6	-0.132
320	160	5.64	-1.613
310	160	1.8	0.903
300	160	5.46	-0.662
290	160	4.38	0.096
280	160	3.66	0.036
270	160	6	0.698
260	160	3.78	0.204
250	160	2.7	-0.084
240	160	2.16	0.072
230	160	2.1	0.036

220	160	2.16	0
210	160	2.22	0
200	160	2.88	-0.012
190	160	4.74	0.349
180	160	5.64	1.054
170	160	11.4	1.577
160	160	11.52	1.758
150	160	7.5	1.589
140	160	4.62	-0.541
130	160	3	0.216
120	160	2.4	0.024
110	160	2.7	0.06
100	160	4.74	0.048
90	160	7.2	0.891
80	160	14.04	1.926
70	160	18	2.516
60	160	22.38	2.974
50	160	17.76	4.503
40	160	8.82	0.409
30	160	7.56	0.963
20	160	5.46	0.228
10	160	9.36	1.469
0	160	11.28	3.022
-10	160	11.4	2.817
-20	160	13.08	3.353
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-100	160	9.9	2.348
-110	160	7.44	0.409
-120	160	7.32	0.900
-130	160	8.04	1.613
-140	160	6	0.553
-150	160	3.84	0.012
-130	120	6.78	0.204
-120	120	3.66	0.072
-110	120	2.82	0.132
-100	120	3	0.078
-90	120	3.84	0.228
-80	120	3.9	0.228
-70	120	4.74	-0.06
-60	120	2.94	0.349
-50	120	7.14	1.071
-40	120	9.42	2.063
-30	120	11.34	2.468
-20	120	8.4	1.168
-10	120	4.86	0.24
0	120	3.84	0.096
10	120	4.2	0.204
20	120	6.42	0.385
30	120	4.26	0.397
40	120	0.18	-0.722
50	120	-12.96	-4.744
60	120	-5.82	1.011
70	120	-1.14	-0.18
80	120	2.28	-0.036
90	120	1.98	-0.108
100	120	1.98	-0.156
110	120	2.52	-0.048
120	120	4.08	-0.096
130	120	5.53	0.313
140	120	13.2	2.251

150	120	13.56	1.517
160	120	7.92	1.878
170	120	6.96	1.493
180	120	5.22	0.204
190	120	2.52	-0.048
200	120	1.86	-0.096
210	120	1.86	-0.18
220	120	1.56	-0.216
230	120	1.74	-0.156
240	120	1.5	-0.228
250	120	1.68	-0.168
260	120	1.74	-0.168
270	120	1.8	-0.132
280	120	2.7	-0.072
290	120	4.2	-0.469
300	120	5.7	1.746
310	120	9.12	2.637
320	120	7.14	1.276
330	120	6.96	0.614
340	120	7.74	1.216
350	120	9.78	1.709
360	120	8.16	1.469
370	120	6.84	1.709
380	120	4.98	0.132
390	120	2.58	-0.048
400	120	2.82	-0.18
410	120	3.12	-0.156
420	120	7.08	1.011
430	120	10.32	1.782
440	120	11.94	2.589
450	120	6.52	1.276
460	120	4.2	0.036
470	120	4.2	0.228
480	120	4.02	0.289
490	120	3.3	0.228
500	120	1.44	-0.228
510	120	1.08	-0.337
520	120	1.08	-0.337
530	120	1.2	-0.228
540	80	1.14	-0.289
530	80	1.14	-0.264
520	80	0.90	-0.216
510	80	1.02	-0.276
500	80	1.26	-0.24
490	80	1.5	-0.228
480	80	1.92	0.252
470	80	2.4	-0.012
460	80	2.46	-0.012
450	80	4.14	0.349
440	80	6.18	0.951
430	80	4.2	0.903
420	80	1.2	0.469
410	80	3.9	-0.072
400	80	3.06	-0.048
390	80	2.04	-0.084
380	80	1.92	-0.12
370	80	3.66	-0.036
360	80	-0.06	-0.867
350	80	2.16	1.216
340	80	5.46	1.661
330	80	9.48	1.938
320	80	4.14	0.867
310	80	3.06	-0.385
300	80	2.22	-0.313
290	80	1.44	-0.192
280	80	1.44	-0.096

270 80 1.62 -0.144
260 80 1.5 -0.264
250 80 1.38 -0.337
240 80 1.44 -0.276
230 80 1.5 -0.156
220 80 1.56 -0.24
210 80 1.38 -0.204
200 80 1.32 -0.228
190 80 0.93 -0.325
180 80 1.74 -0.084
170 80 2.1 -0.12
160 80 3.36 0
150 80 8.76 1.685
140 80 14.16 3.708
130 80 22.68 4.479
120 80 19.14 3.925
110 80 13.92 1.854
100 80 5.46 -0.83
90 80 2.88 0.132
80 80 1.92 -0.072
70 80 2.04 -0.132
60 80 -6.12 -0.216
50 80 -8.28 -0.638
40 80 1.08 -0.086
30 80 4.92 0.144
20 80 -8.76 0.024
10 80 9.36 1.758
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-10 80 5.46 -0.036
-20 80 4.68 -0.06
-30 80 4.74 0.565
-40 80 4.68 0.794
-50 80 4.5 0.915
-60 80 4.32 0.397
-70 80 2.58 -1.541
-80 80 3.36 0.461
-40 40 6.06 4.238
-30 40 4.98 0.349
-20 40 3.54 -0.421
-10 40 2.22 -0.156
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20 40 1.8 -0.072
30 40 1.26 -0.313
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50 40 1.14 -0.445
60 40 1.26 -0.289
70 40 2.1 -0.084
80 40 -5.16 -1.83
90 40 -12 -1.661
100 40 -4.62 -0.156
110 40 6.9 2.492
120 40 8.28 2.745
130 40 6.72 0.24
140 40 3.3 -0.06
150 40 1.8 -0.072
160 40 1.14 -0.192
170 40 1.2 -0.216
180 40 1.26 -0.289
190 40 1.26 -0.156
200 40 1.26 -0.289
210 40 1.14 -0.204
220 40 1.2 -0.276
230 40 1.2 -0.144
240 40 0.96 -0.252
250 40 1.32 -0.168

260	40	1.26	-0.325
270	40	1.14	-0.264
280	40	1.5	-0.252
290	40	1.98	-0.144
300	40	2.82	-0.385
310	40	3.96	0.252
320	40	5.64	0.553
330	40	10.2	1.89
340	40	10.98	2.36
350	40	-2.4	0.048
360	40	-3.48	-1.011
370	40	4.68	0.096
380	40	2.1	-0.12
390	40	2.16	-0.18
400	40	4.08	0.216
410	40	5.3	0.517
420	40	6.60	0.65
430	40	6.24	0.204
440	40	5.4	0.373
450	40	4.08	-0.108
460	40	3.18	-0.084
470	40	2.58	0.216
480	40	2.22	-0.325
490	40	1.56	-0.397
500	40	1.14	-0.204
510	40	0.96	-0.325
520	40	0.78	-0.409
530	40	0.9	-0.192
540	40	1.02	-0.264
550	40	0.9	-0.301
550	0	1.02	-0.349
540	0	1.06	-0.325
530	0	1.06	-0.313
520	0	1.14	-0.276
510	0	0.96	-0.397
500	0	1.02	-0.349
490	0	1.08	-0.264
480	0	1.02	-0.276
470	0	2.4	0.144
460	0	5.1	0.385
450	0	6.06	0.854
440	0	11.58	2.805
430	0	13.62	2.155
420	0	15.06	2.348
410	0	10.56	2.324
400	0	10.86	1.854
390	0	13.14	2.396
380	0	4.8	0.433
370	0	4.56	0.325
360	0	2.76	0.036
350	0	4.56	-1.204
340	0	-4.98	-0.505
330	0	12.36	0.638
320	0	10.98	2.492
310	0	10.8	1.77
300	0	6.54	1.324
290	0	4.68	-0.072
280	0	1.98	-0.036
270	0	1.86	0.252
260	0	1.5	0.036
250	0	1.2	-0.072
240	0	1.2	-0.144
230	0	1.14	-0.192
220	0	1.14	-0.18
210	0	1.38	-0.264
200	0	1.2	-0.24

190	0	1.11	-0.252
180	0	1.2	0.024
170	0	1.2	-0.216
160	0	1.02	-0.144
150	0	1.02	-0.12
140	0	1.32	-0.048
130	0	1.36	-0.204
120	0	1.62	-0.012
110	0	1.5	-0.192
100	0	1.62	-0.132
90	0	1.86	0.048
80	0	1.08	-0.156
70	0	1.32	0.06
60	0	1.14	-0.096
50	0	1.2	0.192
40	0	1.26	-0.144
30	0	1.2	-0.108
20	0	1.32	-0.12
10	0	1.44	-0.156
0	0	1.38	-0.156
100	-40	1.2	-0.096
110	-40	1.2	-0.144
120	-40	1.14	-0.108
130	-40	1.14	-0.012
140	-40	1.14	-0.06
150	-40	1.14	-0.06
160	-40	1.2	-0.06
170	-40	1.02	-0.072
180	-40	1.02	-0.12
190	-40	1.14	-0.084
200	-40	1.26	-0.12
210	-40	1.14	-0.084
220	-40	1.26	-0.072
230	-40	1.2	-0.012
240	-40	1.14	-0.036
250	-40	1.02	0
260	-40	1.56	-0.072
270	-40	2.64	0.108
280	-40	0.84	-0.276
290	-40	-2.4	-7.586
300	-40	6.6	0.722
310	-40	0.3	-0.048
320	-40	0.48	0.65
330	-40	8.98	-0.445
340	-40	-0.84	-0.578
350	-40	2.1	-0.602
360	-40	4.5	0.385
370	-40	4.08	0.108
380	-40	-11.22	-3.648
390	-40	9.78	1.938
400	-40	12.12	1.661
410	-40	10.02	1.42
420	-40	8.34	1.661
430	-40	7.14	0.806
440	-40	5.94	0.301
450	-40	2.82	0.036
460	-40	1.86	-0.048
470	-40	1.26	-0.132
480	-40	1.08	-0.024
490	-40	0.96	-0.276
500	-40	1.02	-0.24
510	-40	1.02	-0.216
520	-40	1.14	-0.072
530	-40	1.08	-0.216
540	-40	1.02	-0.156
550	-40	1.02	-0.18

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420 -120 15 2.456
430 -120 16.32 2.745
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480 -160 2.52 -0.036
470 -160 -1.62 -0.734
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390 -160 10.2 2.938
380 -160 9.84 1.685
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360 -160 2.28 0.072
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460 -200 4.44 1.552
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410 -280 8.32 1.493
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440 -280 3.06 1.553
450 -280 7.44 1.661
460 -280 9.12 1.156
470 -280 7.44 0.529
480 -280 2.28 -0.517
490 -280 1.92 -0.361
500 -280 1.2 -0.24
510 -280 1.56 -0.349
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500 -320 -16.14 -4.78
490 -320 -8.94 -3.504
480 -320 -9.24 -3.516
470 -320 2.64 -0.915
460 -320 11.22 2.601
450 -320 15.9 2.878
440 -320 15.42 3.179
430 -320 10.2 1.24
420 -320 11.34 1.348

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400	-320	8.94	1.613
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380	-320	7.2	2.01
370	-320	5.7	0.072
360	-320	3.54	0.06
350	-320	0.9	-0.289
340	-320	1.38	-0.12
330	-320	1.26	-0.216
320	-320	1.52	0.072
310	-320	12.18	12.439
300	-320	24.06	24.059
290	-320	3.9	2.601
280	-320	2.22	0.818
270	-320	1.32	-0.132
260	-320	1.38	-0.168
250	-320	1.2	-0.192
270	-360	1.92	0.24
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320	-360	2.34	1.131
330	-360	1.2	-0.012
340	-360	1.2	-0.096
350	-360	1.18	-0.072
360	-360	1.14	-0.216
370	-360	1.14	-0.228
380	-360	1.5	-0.06
390	-360	0.78	-0.421
400	-360	2.28	-0.024
410	-360	2.88	0.276
420	-360	-0.12	-0.59
430	-360	-7.02	-1.055
440	-360	3.32	0.12
450	-360	2.46	0.216
460	-360	1.8	0
470	-360	1.38	-0.036
480	-360	1.32	-0.12
490	-360	1.5	-0.036
500	-360	1.1	-0.168
510	-360	1.5	-0.144
520	-360	1.44	0.06
530	-360	4.32	2.649
540	-360	57.06	45.987
500	-400	1.32	-0.252
490	-400	1.14	-0.192
480	-400	1.14	-0.289
470	-400	1.2	-0.24
460	-400	1.26	-0.216
450	-400	1.26	-0.216
440	-400	1.14	-0.204
430	-400	1.26	-0.12
420	-400	1.26	-0.168
410	-400	1.2	-0.132
400	-400	1.26	-0.144
390	-400	1.14	-0.228
380	-400	1.14	-0.252
370	-400	1.32	-0.216
360	-400	1.2	-0.156
350	-400	1.14	-0.216
340	-400	1.26	-0.18
330	-400	1.56	-0.24
320	-400	1.14	-0.156
310	-400	1.32	-0.168
300	-400	1.26	-0.276

290 -400 1.08 -0.132
280 -400 1.26 -0.048
540 440 -0.06 0.192
530 440 -0.06 0.156
520 440 0 0.192
510 440 0 0.18
500 440 0.06 0.216
490 440 0.06 0.289
480 440 0.48 0.325
470 440 1.62 0.24
460 440 -7.2 0.481
450 440 -2.64 0.445
440 440 8.34 2.781
430 440 6.84 0.698
420 440 0.42 -0.759
410 440 6.48 0.614
400 440 4.08 1.601
390 440 -1.38 -0.891
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320 440 0.54 0.301
310 440 0.54 0.361
300 440 0.72 0.373
290 440 2.34 0.505
280 440 2.64 -0.481
270 440 -9.9 1.252
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240 440 8.04 2.155
230 440 8.1 2.167
220 440 4.74 0.553
210 440 4.5 0.818
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140 440 3.36 0.602
130 440 5.46 0.096
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16 EM DAT

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120	-330	-2.88	-1.625
120	-340	12.24	1.481
120	-350	16.26	-0.614
120	-360	28.2	5.045
160	-300	10.5	0.144
160	-290	-1.14	0.758
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160	-260	-13.62	7.309
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160	-30	41.22	5.683
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160	-10	35.22	0.626
160	0	26.88	7.309
160	10	57.40	9.103
160	20	57.3	9.79
160	30	25.82	1.95
160	40	28.98	11.62
160	50	-3.84	1.577
160	60	-16.02	-5.117
160	70	18.48	-2.901
160	80	15.6	1.011
160	90	10.08	-0.024
160	100	-0.06	1.432
160	110	17.22	-0.83
160	120	-17.22	7.068
160	130	-2.64	1.095
160	140	20.16	3.443
160	150	38.16	-1.998
160	160	6.24	4.527
160	170	34.98	3.588
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160	200	13.38	4.937
160	210	-11.76	-1.601
160	220	10.74	-1.264
160	230	3.24	-0.168
160	240	2.34	-0.421
160	250	1.02	-0.505
160	260	0.66	-0.505
160	270	0.24	-0.698
160	280	0.54	-0.614
160	290	-7.32	0.403

160	300	1.32	-0.385
160	310	0	-0.493
160	320	0	-0.578
200	300	0.36	-0.83
200	290	0.3	-0.529
200	280	0.66	-0.553
200	270	0.36	-0.457
200	260	-1.38	-0.252
200	250	1.38	-0.409
200	240	2.16	-0.132
200	230	3.36	-0.225
200	220	9.6	-0.313
200	210	2.82	-3.588
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200	190	10.32	-3.154
200	180	-11.7	-0.915
200	170	30.78	3.335
200	160	22.88	-0.903
200	150	13.98	-0.313
200	140	24.48	0.734
200	130	-8.62	1.77
200	120	17.18	1.131
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320	140	-25.22	-2.143
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320	210	25.16	2.071
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80	-360	7.56	6.37
80	-370	-6	5.539
80	-380	27.96	9.175

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16 MAG.DAT

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