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The purpose of this Geophysical Prove-Out Report is to provide a summary of field activities associated with the performance of the geophysical prove-out (GPO) and present associated correlation and quality control evaluations of the collected data. The results of the GPO will serve as the basis for the selection of appropriate equipment to perform proposed geophysical surveys for sites included under the scope of work of the task order. Geophysical data will be collected using equipment selected from the GPO for the characterization of subsurface anomalies and to estimate the munitions and explosives of concern (MEC) density over approximately 2 acres at the RVAAP-34 Sand Creek Disposal Road Landfill, 8.6 acres at the RVAAP-03 Open Demolition Area #1 (ODA1) and 6000 square feet at the RVAAP-28 Mustard Agent Burial Site (MABS). Additionally, transect surveys will be performed to delineate the Sand Creek and ODA1 boundaries. The results of the surveys will be presented in subsequent geophysical summary reports.

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Draft Geophysical Prove-Out Report for Environmental Services at RVAAP-34 Sand Creek Disposal Road Landfill, RVAAP-03 Open Demolition Area #1, and RVAAP-28 Mustard Agent Burial Site

Version 1.0

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Ravenna, Ohio 44266-9297

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CONTRACTOR'S STATEMENT OF INDEPENDENT TECHNICAL REVIEW

Shaw Environmental & Infrastructure, Inc. has completed the *Draft Geophysical Prove-Out Report for Environmental Services at RVAAP-34 Sand Creek Disposal Road Landfill, RVAAP-03 Open Demolition Area 1, and RVAAP-28 Mustard Agent Burial Site* at the Ravenna Army Ammunition Plant, Ravenna, Ohio. Notice is hereby given that an independent technical review has been conducted that is appropriate to the level of risk and complexity inherent in the project. During the independent technical review, compliance with established policy, principles and procedures, utilizing justified and valid assumptions, was verified. This included review of data quality objectives; technical assumptions; methods, procedures and materials to be used; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets customer's needs consistent with law and existing Corps policy.

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Note: The data in Appendix C are provided in electronic format on a separate compact disc. This data requires the Oasis Montaj UX Process program in order to open these files. The data provided in this appendix relates to the digitization of the information shown on Figures 6-1 through 6-12 in this report.

Acronyms and Abbreviations

AOC	Area of Concern
AS	analytic signal
cm	centimeter(s)
DGM	digital geophysical mapping
DID	Data Item Description
DQO	data quality objective
DO	Delivery Order
DoD	Department of Defense
EM	electromagnetic
EM61-MK2	Geonics EM61-MK2 TDEM metal detector
EQ	Environmental Quality Management
ESTCP	Environmental Security Technology Certification Program
G858	Geometrics G-858G cesium vapor magnetometer
GPO	Geophysical Prove-Out
GPS	global positioning system
Hz	hertz
IRP	Installation Restoration Program
ITRC	Interstate Technology and Regulatory Cooperation
MABS	RVAAP-28 Mustard Agent Burial Site
MAG	magnetic
MEC	munitions and explosives of concern
MKM	MKM Engineers, Inc.
mm	millimeter(s)
MMRP	Military Munitions Response Program
mV	millivolts
mph	mile(s) per hour
NACA	National Advisory Committee for Aeronautics
NAD83	North American Datum 1983
NMEA	National Marine Electronics Association
nT	nanoTesla(s)
nT/ft	nanoTesla(s) per foot
OB/OD	open burning/open detonation
ODA1	RVAAP-03 Open Demolition Area #1
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
QC	quality control
RI	remedial investigation
RTK	real-time kinematic
RTS	robotic total station
RVAAP	Ravenna Army Ammunition Plant
SAIC	Science Applications International Corporation
SDZ	safety danger zone
SERDP	Strategic Environmental Research and Development Program

Shaw	Shaw Environmental & Infrastructure, Inc.
SNR	signal to noise ratio
Sum4	sum of the four leveled data channels
TDEM	time-domain electromagnetic
USACE	United States Army Corps of Engineers
UXO	unexploded ordnance

1.0 Introduction

1.1 Purpose and Scope

This *Geophysical Prove-Out Report* (*GPO Report*) evaluates and documents the performance of the geophysical equipment and survey techniques that will best support the execution of digital geophysical mapping (DGM) at three Areas of Concern (AOCs) at the Ravenna Army Ammunition Plant (RVAAP). The AOCs include RVAAP-34 Sand Creek Disposal Road Landfill (Sand Creek), RVAAP-03 Open Demolition Area #1 (ODA1), and RVAAP-28 Mustard Agent Burial Site (MABS). This GPO was performed by Shaw Environmental & Infrastructure, Inc. (Shaw) on behalf of the United States Army Corps of Engineers (USACE), Louisville District under Delivery Order (DO) 0002 for Architectural and Engineering Services at RVAAP under the Indefinite Delivery/Indefinite Quantity Contract No. W912QR-08-D-0013. This DO was issued by USACE on September 22, 2008.

1.2 Geophysical Prove-Out Objectives

The GPO fieldwork was conducted at the RVAAP by Shaw from October 20 to 26, 2009 in accordance with the *Final Geophysical Prove-Out Plan for the Ravenna Army Ammunition Plant* (Shaw, 2009), hereafter referred to as the *GPO Work Plan*. The GPO was performed to validate the electromagnetic (EM), magnetic (MAG), and positioning system instrumentation for DGM surveys for munitions and explosives of concern (MEC) and other suspected buried anomalies at the three AOCs. Additionally, this GPO serves as a tool for procedural and instrumentation quality control (QC). In accordance with the *Data Item Description (DID) MR-005-05A* (USACE, 2003b) requirements, this report provides the following information:

- As-built map of the GPO plot
- Photographs of seeded items
- Color maps of the geophysical data
- Summary of the GPO results
- Target lists for GPO site
- Proposed geophysical equipment, techniques, and methodologies
- Justification for recommendations

The accompanying compact discs contain:

- Electronic copy of this report and all appendices
- Raw and processed data
- Target lists in Excel format

1.3 Site Description and Background

The RVAAP is located in northeastern Ohio within Portage and Trumbull counties, approximately 1.6 km (1 mile) northwest of the city of Newton Falls and 4.8 km (3 miles) east-northeast of the city of Ravenna (**Figure 1-1**). The facility is a parcel of property approximately 17.7 kilometers (11 miles) long and 5.6 kilometers (3.5 miles) wide bounded by State Route 5, the Michael J. Kirwan Reservoir, and the CSX System Railroad on the south; Garret, McCormick, and Berry roads on the west; the Norfolk Southern Railroad on the north; and State Route 534 on the east (**Figure 1-2**).

As of February 2006, a total of 20,403 acres of the former 21,683-acre RVAAP have been transferred to the United States Property and Fiscal Officer for Ohio and subsequently licensed to the Ohio Army National Guard (OHARNG) for use as a training site. Currently, RVAAP consists of 1,280 acres in several distinct parcels scattered throughout the confines of the Camp Ravenna Joint Military Training center (Camp Ravenna). RVAAP's remaining parcels of land are located completely within Camp Ravenna. Camp Ravenna did not exist when RVAAP was operational, and the entire 21,683-acre parcel was a government-owned, contractor-operated industrial facility.

The RVAAP Installation Restoration Program (IRP) encompasses investigation and cleanup of past activities over the entire 21,683 acres of the former RVAAP. Therefore, references to the RVAAP in this document are considered to be inclusive of the historical extent of the RVAAP, which is inclusive of the combined acreages of the current Camp Ravenna and RVAAP, unless otherwise specifically stated. The Ohio Environmental Protection Agency (Ohio EPA) is the lead regulatory agency for the investigation and remediation conducted by the Army under the U.S. Department of Defense (DoD) IRP.

1.3.1 Sand Creek

The Sand Creek Disposal Road Landfill (**Figure 1-3**) is a former construction debris dump. Materials identified in the debris include transite, concrete and brick rubble, drywall, glass, scrap metal, and wood. Previous work included the removal of the surface debris. An empty 105 millimeter (mm) projectile was previously found downstream from the Sand Creek site. 75mm casings have also been discovered in the area (MKM, 2004). The site currently receives occasional foot traffic from military, security, and maintenance personnel as well as natural resource management activities. This site will be used as part of the Safety Danger Zone (SDZ) for the small arms range complex.

The full coverage DGM area for the Sand Creek site is approximately 2.2 acres. It ranges from heavily vegetated and wooded to flat open field. The site terrain includes steep sloped areas along the banks of Sand Creek (approximately 1 acre) to flat open areas above the creek embankments (approximately 1 acre). Thick vegetation and trees less than 3 inches in diameter were removed along the banks and top of slope of the AOC in October 2009 to allow easier accessibility for the proposed DGM activities following the GPO.

1.3.2 Open Demolition Area #1

The ODA1 (**Figure 1-4**) full coverage for the proposed DGM investigation area is approximately 8.6 acres and extends beyond ODA1 into the National Advisory Committee for Aeronautics (NACA) Test Area (RVAAP-38). ODA1 was used during the 1940s for the open burning and open detonation (OB/OD) of munitions, explosives, and related debris. The material was brought to the site and burned or detonated for demolition purposes, with the resulting scrap and debris pushed to the sides. Because of these activities and the potential for munitions kickout, there is a potential for the boundaries of the ODA1 to extend beyond the current delineation into the NACA Test Area. The ODA1 site is currently not being used for training because it has been designated as a limited access area due to the potential risk for MEC. Future proposed military training activities at this site will include dismounted training and field bivouac activities.

ODA1 is relatively flat and covered with grass. Previously, fragmentation from a 90mm shell was found at ODA1. An interim removal action to remove surface and subsurface MEC scrap and debris was conducted in 2000 to address issues identified in the previous *Phase I Remedial Investigation* (*RI*) (SAIC, 2001). The *Phase I RI* was focused on the OB/OD area of ODA 1. Currently an approximately 1-foot-high earthen berm within the site surrounds the 1.5-acre former OB/OD area. The full coverage DGM area is bounded on three sides by woods and is bisected by an access road. Geophysical transect survey data will be used as an aid in determining the extent of the debris. The transect surveys will extend into the woods.

1.3.3 Mustard Agent Burial Site

The suspected MABS area to be investigated under this task order is open and flat (**Figure 1-4**). The full coverage DGM area is approximately 6,000 square feet and is located south of the former operations building. Two strips, one north and one south of the concrete crash strip, comprise the investigation site. It has been reported that steel shipping cylinders (also known as PIGs), paint cans, and 55 gallon drums may have been buried west of the current study area, although actual physical confirmation has yet to be achieved (EQ, 2008). The proposed investigation area is currently being used for military training. Future proposed military training activities will include dismounted training and field bivouac activities.

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2.0 Geophysical Prove-Out Test Grid

2.1 GPO Test Plot

Shaw constructed the GPO test grid at a centrally located area (Load Line #7) within the RVAAP (**Figure 2-1**). The GPO plot was placed in an open area approximately 300 feet north of the south entrance gate to Load Line #7. The GPO measured 100 by 100 feet to accommodate the spatial requirements for the seed item grid. The GPO area was provided by Mr. Mark Patterson, RVAAP Facility Manager, and is considered to be representative of the major types of geologic, soil, and surface terrain conditions present at the RVAAP to support the execution of DGM work at the three AOCs.

Based on our past project experience at sites with similar environmental characteristics to those at RVAAP, Shaw proposes to survey the Sand Creek Disposal Road Landfill with a G858 magnetometer and robotic total station (RTS) positioning system, as the area consists of extremely rugged terrain and large trees. The ODA1 and MABS sites can be successfully mapped with an EM61-MK2 TDEM [time-domain EM] metal detector and real-time kinematic (RTK) global positioning system (GPS), as these AOCs are "open" and generally void of rugged terrain. The intent of this GPO is to prove-out each DGM system for its proposed application at the site.

The site geology at the RVAAP is sedimentary bedrock overlain by a thin veneer of glacial sediments (tills and outwash deposits). Bedrock at the RVAAP is predominantly covered by the Wisconsin age Hiram and Kent till and is overlain by the Lavery and Hiram tills with glacial outwash deposits covering the northern corner of the site. A soils map with the location of the GPO test grid is provided in **Figure 2-2**. The geologic map provided in **Figure 2-3** shows the local geology underlying the GPO site. The resolution of **Figure 2-2** and **Figure 2-3** indicate that the GPO site appears to fall within similar soil conditions and geological regimes. To simulate actual site conditions, small trees (greater than 3 inches in diameter) located within the GPO site were not removed. Photographs of the GPO site are presented in **Appendix A**.

2.2 Background Survey

A background (pre-seeding) EM survey was performed over the GPO using the Geonics EM61-MK2 TDEM metal detector (hereafter referred to as EM61-MK2) to assess the preexisting site conditions and to locate existing ferrous and nonferrous anomalies prior to emplacing the GPO seed items. Existing subsurface anomalies were identified within the GPO site during the pre-seed EM survey. In accordance with the *GPO Work Plan* (Shaw, 2009), no anomalies were removed after assessment of the background data. Therefore, in order to use the area provided for the GPO, the existing subsurface anomalies were avoided during the placement of the seed items. The background EM61-MK2 survey map for the GPO is presented in **Figure 2-4**.

The existing anomalies are interpreted to be primarily due to metallic subsurface objects and range from approximately 20 millivolts (mV) to 500mV for the sum of the four leveled data channels (Sum4). A description regarding the use of the Sum4 is provided in **Section 3.1.2** of this report. The identification of the existing subsurface anomalies during the baseline survey resulted in having to reconfigure the GPO in the field from what was originally presented in the *GPO Work Plan* (Shaw, 2009). The GPO was reconfigured to maintain a 10-foot distance between all seed items to replicate the original design as closely as possible.

2.3 Seed Items

Inert "simulants" of the ordnance items and the PIG containers that may be encountered at the three AOCs were seeded in the GPO site test grid at varying depths and orientations. The test grid location, seed item coordinates, and survey navigation data are referenced to the North American Datum 1983 (NAD83), Ohio North State Plane coordinates, CS83 North Zone in U.S. survey feet. The seed items consisted of simulants due to the lack of availability or accessibility of inert ordnance items and PIG containers at the RVAAP, or at other similar installations from which Shaw requested them. The simulants were cut from heavy gauge (schedule 40) steel pipe with end caps (simulants with pipe diameters less than 4 inches) in an attempt to replicate the general dimensions of each ordnance type. For the simulants with pipe diameters greater than 4 inches (105mm, 155mm and PIGs), the pipe ends were welded. **Table 2-1** describes the actual size of the items and the corresponding sizes of the simulants that were buried.

The GPO contains 20 simulant seed items (three PIGs, five 90mm, two 105mm, three 155mm projectiles and seven 75mm shells) that were placed in 20 excavations. This information is presented in **Table 2-2**. The selected location for each seed item was marked with a numbered pin flag. Each location was then excavated in turn, and the appropriate seed item was placed in the excavation. Depths were confirmed with a carpenter's tape measure. Inclinations and azimuths of each item were then measured with a Brunton Pocket Transit (compass) adjusted to the local magnetic declination. The final location of each item was then acquired with the RTS. PIG items that were buried horizontal were location-surveyed at both ends of the item. Each item was then photographed in place, and the excavations were backfilled to grade. **Appendix B** contains photographs of each seed item and also presents information regarding the coordinates, depth, orientation, azimuth, and a description of each item.

2.4 GPO Test Grid As-Built Map

The as-built map for the GPO is provided in **Figure 2-5** and exhibits the GPO test grid corners, locations of each seed item and their azimuth, inclination, and depth. The seed items buried deeper than the performance metric of 11 times the diameter of the object are also indicated on the as-built map. The GPO control points are presented in **Table 2-3**.

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3.0 Instrumentation

The following sections describe the instruments used at the RVAAP during the GPO. The deployment strategies for these systems are described in more detail in **Section 4.0** of this report.

3.1 Geophysical Instruments

3.1.1 Geometrics G-858G

Gradiometer and total field MAG survey data were obtained using the Geometrics G-858G cesium vapor magnetometer (G858) carried with the shoulder-mounted harness system supplied with the instrument. The G858 is an optically pumped cesium vapor instrument that measures the intensity of the earth's magnetic field in nanoTeslas (nT). At the RVAAP, the total MAG intensity is approximately 55,700 nT, with an inclination of about 69 degrees down and a declination of about 7 degrees east.

The earth's magnetic field undergoes low-frequency diurnal variations associated with the earth's rotation, generally referred to as magnetic drift. A second stationary G858 was used to record and monitor the diurnal drift over the course of the magnetometer surveys. The MAG data recorded by the base station were used to correct the magnetic drift of the field magnetometer.

3.1.2 Geonics EM61-MK2

The EM61-MK2 was used to acquire EM data at the RVAAP GPO test grid. The EM61-MK2 is a four-channel, high-sensitivity TDEM sensor designed to detect shallow ferrous and nonferrous metallic objects with good spatial resolution and minimal interference from adjacent metallic features. The EM61-MK2 consists of two 1- by 0.5-meter rectangular coils stacked 40 centimeters (cm) apart with the source/receiver coil located below a second receiver coil. A square wave EM pulse is generated with "time on" (positive and negative) and "time off" cycles. This induces subsurface eddy currents with an associated secondary magnetic field. The decay of the secondary magnetic fields is measured during "time off" cycles and stored as a mV response. By measuring the decay at "late times" the system can distinguish between natural earth materials and buried metal (ferrous and nonferrous) because the secondary field in metallic objects decays at a much slower rate than earth materials. Although the EM61-MK2 is capable of measuring a differential, calculated as the voltage difference between the top and bottom coils, for this project, data were recorded at four time gates from the bottom coil. The time gate values are 216, 366, 600, and 1,266 microseconds for Channels 1 through Channel 4, respectively. The responses at these four specified time gates are recorded and displayed by an integrated system data logger. Unless otherwise specified, the EM61-MK2 results are presented in this report as Channel 2 and the Sum4 response, which is the sum of the four leveled data channels.

The utilization of the Sum4 response for the picking of MEC targets, rather than the standard of solely utilizing Channel 2, is primarily due to the increase in signal. The increase in signal from using the sum of the channels *may* provide better detection for some deeply buried targets (Bosnar, 2001).

3.2 Navigation Equipment

3.2.1 Leica Robotic Total Station

The Leica TPS1200 series total station is a motorized RTS that uses automatic target recognition to track the location of a 360-degree survey prism and has a distance/azimuth measurement system to produce accuracy within plus or minus 5 mm plus 2 parts per million for both lateral and vertical coordinates. Firmware used on the RTS base station to track the roving prism allows for rapid collection of data at rates up to 4 hertz (Hz) and serial output of solutions on both the base station and rover computing units. This firmware also enables the user to optimize the prism tracking parameters for rapid recovery of lock if obstructed by trees during a survey. The Leica RTS collected integrated real-time positioning data during the GPO surveys by streaming a "pseudo-NMEA [National Marine Electronics Association] data" string directly into the geophysical instrument's data logger. The data were collected using local coordinates and subsequently converted to NAD83, Ohio State Plane, North Zone coordinates when the location information became available.

3.2.2 Leica Real-Time Kinematic Global Positioning System

The RTK GPS uses a base station that is set up based on a known position. Once the base station is established, it determines its location using satellites and then applies a correction based on the offset from the known coordinates at the location. This correction is then used by a rover that is in direct communication with the base station through a radio link. The rover is usually deployed within several miles of the base station. At longer distances, line of sight is required; at shorter distances (as in this survey) line of sight is not required. RTK GPS is capable of taking survey-grade measurements in real time and providing accuracies of approximately 4 cm (horizontal). The Leica 1200 series RTK GPS was used for data collection at the GPO.

4.0 Geophysical Prove-Out Procedures

4.1 Survey Modes

Site conditions at the GPO are representative of most of the field conditions that will be encountered during the large-scale field investigation, with the exception of the steep, rugged terrain and areas of vegetation over some portions of Sand Creek.

Full coverage (2 dimensional) and transect (1 dimensional) survey modes were originally planned for the GPO evaluation using the same plot. Full coverage was achieved through deploying the sensor systems and collecting sub-parallel survey lines spaced less than 3 feet apart. Although 2D DGM protocol was proven at the GPO, the same general protocol will be used to collect 1D data, given the only difference between 2D and 1D is the distance between adjacent acquisition lines.

Both RTK GPS and RTS were used for navigation. Because survey control for the RTK GPS was not initially available, the GPO background survey was mapped using the RTS in local coordinates. Both RTK GPS and RTS were used for navigation after survey control was established. Survey paint was used to mark the instrument line paths during data acquisition.

Raw and processed instrument data are included in **Appendix C**.

4.2 Calibration Tests

An area determined to be representative of “background” was established outside of the GPO test grid and was used as a functional check area before and after data collection with both the G858 and EM61-MK2 geophysical instruments. As described in *DID MR-005-05* (USACE, 2003a), the following tests were performed:

- Static Background Test
- Static Spike Test
- Personnel Test
- Cable Shake Test
- Azimuthal Test (MAG only)
- Octant Test (MAG only)
- Height Optimization (MAG only)
- 6-Line Test

All instrumentation QC tests were performed as specified in Table 7-1 of the *GPO Work Plan* (Shaw, 2009). All metrics specified in the *GPO Work Plan* were achieved, although a higher standard deviation of measurements and were observed for static measurements from the lower

MAG sensor. One possible cause could be related to small movements of the lower sensor when it is proximal to the ground surface. **Appendix D** contains the results of the quality tests performed during the GPO.

4.3 G858 Magnetic Survey

The G858 was deployed in man-portable, vertical gradient mode using the shoulder-mounted harness system provided with the G858 unit. The vertical sensor separation between the two sensors was 2 feet with the sensors mounted at 16 and 40 inches above the ground surface, respectively. A jig was constructed prior to mobilization to allow the GPS antenna and the RTS prism to mount directly above the MAG sensors; however, it was not stable enough to collect data, and it was necessary to wear the backpack with the GPS antenna or the RTS prism attached.

The offset between the positioning system and magnetometer sensors was measured and used during data processing. Measured offset equaled 1.5 feet for ‘x’ and 3.33 feet for ‘y.’ Data were collected with both sensors in the vertical position, with the bottom sensor approximately 16 inches above the ground surface and the top sensor 40 inches above the ground surface. Sensor measurements were collected every 0.1 seconds at a line spacing that did not exceed 3 feet, and the navigation data from the RTK GPS and RTS streamed directly into the G858 logger. The MAG and navigation data were downloaded to a field computer at the end of the day.

For the purpose of this study, the MAG and gradient data were collected concurrently. Rather than covering the grids twice, the data were collected in the vertical gradient configuration, and the lower MAG sensor data were used for the total field MAG analysis.

The direction of traverses in the GPO test grid was based on the surface conditions and obstructions present. Due to obstructions caused by relatively smaller trees (that did not create an actual tree “canopy”) and the layout of the grid, it was more efficient to collect data with the traverses oriented north-south.

4.4 EM61-MK2 Electromagnetic Survey

EM61-MK2 data were collected with the GPS antenna or RTS prism centered above the coils using a non-metallic tripod supplied by Geonics. Data were collected along the same general traverses described for MAG data collection. EM61-MK2 measurements were collected every 0.1 seconds and the navigation data streamed from the RTK GPS and RTS directly into the EM61-MK2’s data logger. The four channels of the EM61 data along with the navigation data were stored in the data logger and were downloaded to the field computer following the field activities.

5.0 Geophysical Data Processing

This section presents the data processing procedures and target selection criteria that were used to complete the GPO in accordance with the *GPO Work Plan* (Shaw, 2009).

It should be noted that the simulants (i.e., pipes) utilized for the GPO were used to ensure the proposed geophysical systems can collect data of sufficient quality and quantity to meet the project objectives, and that the field protocol and data processing systems produce representative and precise results. The anomaly selection criteria is considered preliminary, and will likely be developed further with the client based primarily on the results from the government sponsored sensor evaluations at Aberdeen and Yuma Proving Grounds and nationwide GPOs, for which large volumes of data exist for actual inert UXO items (ESTCP et al., 2006).

5.1 G858 Data Processing and Target Selection

5.1.1 G858 Data Processing

The G858 MAG data, including both the survey and base station data, were downloaded to a laptop computer in the field using Geometrics Magmap 2000® software. The data were verified and backed up prior to G858 system demobilization. Magmap 2000® was used to remove drop outs and to perform the sensor offset position corrections. Data for the GPO were collected in local coordinates using RTS navigation and then translated into NAD83 Ohio State Plane North Zone coordinates. RTK GPS data were collected in geographic coordinates and translated into state plane coordinates at a later time using a combination of both Magmap and Geosoft. Geosoft was also used for additional data processing, including spike removal, lag correction, and final data leveling using a 200-point median filter. A 5-point non-linear filter was applied to the top sensor data to smooth the data and remove small amplitude dropouts prior to calculation of the vertical gradient.

The total magnetic field and vertical gradient data were interpolated using the minimum curvature routine in Geosoft at a cell size of 0.5 foot and blanking distance of 2 feet. The line path was transposed onto the color coded image, and an appropriate color scale selected based on the data statistics.

The total magnetic field, analytic Signal (AS), and magnetic gradient data for each of the configurations (RTS and RTK GPS) used with the G858G are presented in **Figures 6-1** through **6-8**.

5.1.2 G858 Target Selection

Analysis of the GPO data indicates that geologic noise, background levels, and terrain responses at the GPO did not influence the anomaly selection criteria to a large degree. These parameters were found to be best controlled through the use of picking thresholds at this early stage of the project.

Magnetic dipoles were auto-picked using UX-Process for all G858 datasets. Anomaly selection thresholds were established based on an evaluation of the noise levels and the detection of the known locations of the seed items in the GPO plot. This approach maximizes the detection ability while potentially minimizing high numbers of false positives. The total magnetic field and vertical magnetic gradient data proposed thresholds are provided in **Table 5-1**.

The results of the target lists and analyses for the total field and magnetic gradient data sets for the G858G are discussed in **Section 6.2**.

5.2 EM61-MK2 Data Processing and Target Selection

5.2.1 EM61-MK2 Data Processing

All EM61-MK2 data were downloaded to a laptop computer in the field; the data sets were reviewed for content and subsequently backed up prior to system demobilization. Data for the GPO were collected in local coordinates using RTS navigation and then translated into NAD83 Ohio State Plane North Zone coordinates. RTK GPS data were collected in geographic coordinates and translated into state plane coordinates at a later time using a combination of both Dat61MK2 and Geosoft. Geosoft was also used for additional data processing, including spike removal, lag correction, and final data leveling using a 200-point median filter.

The Channel 1, 2, and Sum4 data channels were interpolated using the minimum curvature routine in Geosoft at a cell size of 0.5 foot and blanking distance of 2 feet. The line path was transposed onto the color coded image, and an appropriate color scale selected based on the data statistics.

The response data for each of the configurations (RTS and RTK GPS) used with the EM61-MK2 in relation to the Channel 2 and Sum 4 data channels are presented in **Figures 6-9** through **6-12**.

5.2.2 EM6-MK2 Target Selection

The Sum4 along with the single time gate of Channel 2 were the primary data channels reviewed. Based on a review of the anomaly characteristics for the seed items and the background noise levels listed in **Table 5-2** a threshold value of approximately 3 mV for Channel 2 and a Sum4 threshold of 8 mV is proposed in order to detect all seed items. If seed items at or very near the 11X guideline are not of interest, the threshold should be increased to 8 mV and 16 mV for Channel 2 and the Sum4 channel, respectively. This approach maximizes the detection ability above the 11X guideline while potentially minimizing high numbers of false positives.

Target lists and analyses for the EM61-MK2 data sets are discussed in **Section 6.3**.

6.0 Results

The DGM Data Quality Objectives (DQOs) are discussed in **Section 6.1**, followed by the interpretative results for the G858 MAG and EM61-MK2 data in **Section 6.2** and **Section 6.3**, respectively. Results of the instrument function tests as described in **Section 4.2** are provided in **Appendix D**.

6.1 Data Quality Objectives

The following sections demonstrate that the data collected for the GPO meets the intent of the DQOs specified in the *GPO Work Plan* (Shaw, 2009). The DQOs for the GPO include the following metrics; background noise based on leveled survey data set, mean speed, along track sampling, across track sampling, latency correction, data leveling, anomaly selection, positioning errors, known location of QC items, and false positives. Reacquisition of anomalies will not be conducted under this DO.

6.1.1 Background Noise

The metric for background noise was determined based on the GPO data. **Table 6-1** provides the background noise levels, calculated as the standard deviation of measurements with the instrument in motion in a background area, observed during the GPO.

6.1.2 Mean Speed

Based on the results of the field GPO, a reasonable value for the mean speed metric (percent of measurements collected at less than 3 miles per hour [mph]) was determined to be a value greater than 95 percent for "wheel based" acquisition systems, such as the EM61-MK2, that is used in a flat terrain environment. A total of 97.79 percent of the measurements were acquired at a mean speed of less than 3 mph for the EM61-MK2 data using the RTS equipment, which exceeds the metric of 95 percent. A total of 96.9 percent of the measurements were acquired at a mean speed of less than 3 mph for the EM61-MK2 data using the RTK GPS equipment, which exceeds the metric of 95 percent. The velocity data for the EM61 surveys are presented in **Appendix D**.

Based on the results of the field GPO, a reasonable value for the mean speed metric (percent of measurements collected at less than 3 mph) was determined to be a value greater than 90 percent for systems where the sensor is hand carried in front of the operator in rugged terrain as will be the case for the G858 at the Sand Creek site. The velocity data for the G858 magnetometer surveys using both the RTS and RTK GPS indicate that greater than 95 percent of the measurements were acquired at a mean speed of less than 3 mph. The calculations were performed directly in Oasis Montaj using the sample to sample distance and the G858 sample rate of 0.1 seconds.

6.1.3 Along Track Sampling

The metric for along track sampling is less than 0.6 feet with cumulative gaps of less than 5 percent of the line distance. A total of 100 percent of the measurements were acquired at an along track sampling of less than 0.6 foot for the EM61-MK2 data using the RTS equipment, which exceeds the metric. A total of 100 percent of the measurements were acquired at an along track sampling of less than 0.6 foot for the EM61-MK2 data using the RTK GPS equipment, which exceeds the metric. The along track sampling data for the EM61 surveys are presented in **Appendix D**.

For the G858 data acquired with the RTS and RTK GPS greater than 98 percent of the measurements were acquired at an along track sampling of less than 0.6 foot, which achieves the metric. The calculations were performed directly in Oasis Montaj using the difference between successive measurements of the distance channel.

6.1.4 Across Track Sampling

The metric for across track sampling is that 90 percent of the measurements will be at a 3 foot line spacing or less, excluding data gaps due to trees or other obstacles that preclude the survey platform from providing complete coverage. This metric is intended to control data gaps associated with inconsistent track paths that are not associated with trees or other obstructions. Several trees present within the GPO area caused minor deviations within the path walked during data collection; however, both DGM systems achieved the cross-track spacing metric for the project. The across-track sampling metric achieved during the GPO was as follows:

- EM61 – RTK GPS: 99.82 percent
  EM61 – RTK GPS: 99.83 percent (accounting for trees with polygon)

- EM61 – RTS: 99.67 percent
  EM61 – RTS: 99.79 percent (accounting for trees with polygon)

- MAG – RTK GPS: 98.37 percent
  MAG – RTK GPS: 98.67 percent (accounting for trees with polygon)

- MAG – RTS: 97.00 percent
  MAG – RTS: 97.21 percent (accounting for trees with polygon)

Data track maps for the GPO for both the EM61-MK2 and G858 magnetometer surveys are provided in **Appendix D**.

6.1.5 Latency Correction

The metric for latency correction is no visible chevron effects in the final processed data sets used to create the color-coded images. Lag corrections were applied such that no chevron effects that could adversely affect the data interpretation are present in the processed data for the EM61-MK2 datasets. The G858 datasets were acquired with the positioning sensor located on the backpack of the instrument operator while the actual geophysical sensor was transported in front of the operator. The operator attempted to maintain a constant offset between the geophysical and position sensors during data collection; however, data artifacts resulting from small changes to the in-line and across-line offset distances are visible in the final processed MAG datasets. While this issue did not significantly impact the data interpretation of the seed items, possible solutions for this issue for the proposed survey at Sand Creek are provided in **Section 7.2** of this report.

6.1.6 Data Leveling

The metric for data leveling consists of achieving consistent processing parameters and methods for all data sets. A median filter was used in Geosoft to level the GPO data, and noise spikes in the magnetic data were deleted in Magmap. This approach resulted in DGM datasets near a background value of 0.

6.1.7 Anomaly Selection

The metric for anomaly selection is that the anomaly selections for a given data set will be reasonable and should identify all MEC or MEC-like items. Overall, the site noise from the geology, soils, and external noise sources (e.g., power lines, etc.) is small or nonexistent, and the anomaly characteristics (signal intensity, footprint and shape) from the items of interest are generally unique when compared to the anomaly characteristics from the "noise."

There were several seed items that were not selected in the total field magnetic datasets using the automatic dipole selection routines in Geosoft. These items (11, 12, 13, and 14) are within 6 to 10 feet of other large seed items, and their response is effectively "shadowed" by the larger seed items in the total magnetic field data. In order to reliably interpret anomalies with these characteristics the vertical gradient magnetic data, as well as analysis of the 1D MAG profiles, were used to further assess these anomalies during the anomaly evaluation phase.

6.1.8 Known Location Calibration Positional Check

Static position data were collected at a known location to document the repeatability of the positioning system on a daily basis and the information was logged in the on-site geophysicist's field logbook. This data was also plotted on the Oasis Map at an appropriate scale of 2.5 feet at each grid corner location to ensure the grid corners were detected within the metric from the known locations. The metric for known location calibration positional check is less than 0.5 feet.

Navigation control at known point calibration was performed on all RTS and RTK GPS setups. All were within 0.5 feet, which achieved the metric. Results for the positional check for known locations are presented in the Truth Tables in **Appendix D**.

6.1.9 Dynamic Calibration Positional Check

The metric for dynamic calibration positional check is based on cumulative errors not to exceed 2.5 feet. Related tests for this metric include the 6-Line and repeat line tests, which are summarized in **Appendix D**. Both of these tests exhibit that the metric was achieved. Interpreted anomaly "centroid" and/or peak position offsets to the mapped locations of the seed items averaged less than 2.5 feet.

6.1.10 Known Location QC Items

The metric for known location QC items is within 2.5 feet of their known locations. Assessment of the grid corner hubs anomaly pick locations at the GPO site indicates that the hubs are being located within 2.5 feet of their known location.

6.1.11 Reacquisition

The metrics for reacquisition are not applicable to this project; however, initial reacquisition recommendations based on the GPO results are discussed in **Section 7.5**. If performed during this project, anomaly reacquisition will be demonstrated and approved prior to the initiation of production surveys.

6.1.12 False Positives

The metric is for false positives to be kept to a minimum. The definition of a false positive in *DID MR-005-05* (USACE, 2003a) is "anomalies reacquired by the Contractor result(ing) in no detectable metallic material recovered during excavations, calculated as a running average for the sector." Prior to seeding the GPO plot, Shaw conducted a pre-seed survey to locate existing geophysical anomalies such that "background" locations could be selected for burial of the seed items. Numerous preexisting small to large anomalies detected by the EM61-MK2 were present as depicted on **Figure 2-4**. These anomalies were left in place during plot construction so that the plot is as representative as possible of site conditions that might be encountered during the large-scale field investigations at the three sites. A large percentage of the anomalies detected in the pre-seed DGM survey are also identified in the post-seed DGM surveys, suggesting that a significant number of them are due to buried metal objects and are not false positives.

6.2 G858 Magnetometer Results

The G858 target selections for both the total magnetic field and vertical gradient correlate well with the known seed item locations. "Shadowing" of some of the seed item anomalies in close proximity occurred in the total magnetic field data; however, the gradient data and 1D profile analysis was used to minimize this effect. Fifteen (15) of the seed items were buried at a horizontal orientation, and 6 items were oriented at or near a perpendicular azimuth to magnetic north (i.e., generally east west). Both of these factors represent a worst-case scenario in terms of the signal response characteristics for a magnetometer.

Items that were not consistently interpreted in three of the magnetic datasets include the following seed items:

- Item Number 11 (75 mm simulant at 2.5 foot depth)
- Item Numbers 12 and 13 (90mm simulant at 4 foot depth)
- Item Number 14 (75mm simulant at 2 foot depth)

All of these items with the exception of Item Number 14 are very near or exceed the 11X guideline for detection depth.

Additional anomaly selections that are not attributed to any known seed items are exhibited on the MAG figures with appropriate symbols; however, these anomalies are not presented on the truth tables or target spreadsheets as their origin (size, weight, composition, etc.) is unknown.

The seed item evaluation results are provided in **Tables 6-2** through **6-5** and presented in **Figures 6-1** through **6-8**. **Tables 6-2** and **6-3** list the targets and the locations to show the correlation with different seed items for the total magnetic field data. Summary target selection, analysis information, and target grading for magnetic gradient data sets are presented in **Tables 6-4** and **6-5**.

6.2.1 Total Field Magnetic Data

The survey results are summarized as follows:

- 17 of the 20 seed items (85 percent) were interpreted using the RTS configuration (**Figure 6-1**)
- 16 of the 20 seed items (80 percent) were interpreted using the RTK GPS configuration (**Figure 6-5**)

6.2.1.1 Total Field Magnetic Data (Analytic Signal)

The survey results are summarized as follows:

- 16 of the 20 seed items (80 percent) were interpreted using the RTS configuration (**Figure 6-2**)
- 16 of the 20 seed items (80 percent) were interpreted using the RTK GPS configuration (**Figure 6-6**)

- The AS of the total (or gradient) magnetic field is a filtering process that creates a single, positive peak for each magnetic dipole pair. In areas of low to medium anomaly density the procedure does not necessarily improve the ability of the interpreter to select candidate anomalies. However, if areas of high anomaly density are present during the large-scale field investigation at the Sand Creek Disposal Road Landfill the AS technique may be used as an additional interpretation methodology.

6.2.2 Magnetic Gradient Data

The survey results are summarized as follows:

- 16 of the 20 seed items (80 percent) were detected using the RTS configuration (**Figure 6-3**).
- 19 of the 20 seed items (95 percent) were detected using the RTK GPS configuration (**Figure 6-7**).

6.3 EM61-MK2 Electromagnetic Results

The EM61-MK2 target selections correlate well with the known seed item locations, even those that are at or exceed the 11X depth requirement for EM instrumentation. EM61 data are more successful at detecting closely-spaced items and delineating those items into their individual anomaly constituents compared to magnetic data, as the electromagnetic field diminishes at a higher rate.

Additional anomaly selections that are not attributed to any known seed items are exhibited on the EM61-MK2 figures with appropriate symbols; however, these anomalies are not presented on the truth tables or target spreadsheets as their origin (size, weight, composition, etc.) is unknown. These additional anomalies were detected during the background EM61-MK2 survey and are the result of metal objects.

The seed item evaluation results for the EM61-MK2 GPO data are provided in **Tables 6-6** through **6-9**, which list the EM61-MK2 data target pick results and their associations to the known seed items. The EM61-MK2 survey results are presented in **Figures 6-9** through **6-12** and are summarized as follows:

- 19 of the 20 (95 percent) seed items were detected with Channel 2 data using the RTS configuration (**Figure 6-9**).
- 19 of the 20 (95 percent) seed items were detected with the Sum4 data using the RTS configuration (**Figure 6-10**).
- 19 of the 20 seed items (95 percent) were detected with Channel 2 data using the RTK GPS configuration (**Figure 6-11**).

- 19 of the 20 seed items (95 percent) were detected with Sum4 data using the RTK GPS positioning system (**Figure 6-12**).
- The 11X detection depth for a 90mm is 3.3 feet. The only item that was either not detected and/or within a 3.3 foot radius of the seed item location is Item Number 13 (90mm simulant at 4 foot depth), which is located approximately 6 feet northeast of Item Number 18, a 105mm simulant at a 2 foot depth.

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7.0 Recommendations

7.1 Selected DGM Survey Equipment

For the DGM project at the RVAAP, an EM61-MK2 survey system integrated with the Leica RTK GPS in open areas (ODA1 and MABS) is recommended. For areas that contain trees or tree canopy (wooded tree line at ODA1 and portions of the Sand Creek) that may interfere with GPS equipment, the EM61-MK2 survey system integrated with the Leica RTS system is recommended. Due to the extremely steep and rugged topography at the Sand Creek Disposal Site, the G858 magnetometer is proposed, as the steep terrain will limit the safe deployment of the EM61-MK2 system. All DGM systems will be deployed by experienced Shaw personnel with the skills, capabilities, and expertise with munitions response projects with similar DQOs. The following sections present additional elements that will be considered during project execution.

7.2 Recommendations for DGM Survey Procedures

DGM data will be collected on adjacent lines separated by 2.5 feet, and the sample rate of the geophysical sensors will be 10 Hz. Position data will be acquired at a minimum rate of 1 Hz.

7.2.1 Transect Surveys

The procedures utilized during the GPO are sufficient and appropriate for transect surveying for determining the boundaries of the ODA1 and MABS sites. For transect surveys, the RTK GPS or RTS will be used to place survey lathe at predetermined locations along each transect line, or the “stakeout” program in the Leica RTS or RTK GPS will be used to maintain parallel transects. If used, the distance between the survey lathe along each transect line will be no more than 100 feet in low visibility (e.g., dense vegetation) and 200 feet in “open” areas along each proposed transect line. The survey lathe “waypoints” will be used to guide the instrument operator during data acquisition, and the RTS or RTK GPS will be used to collect position data at 1 Hz along each transect.

7.2.2 Grid Surveys

Survey paint and/or polyvinyl chloride (non-metal) pin flags will be used to mark the data acquisition lines in the field in order to maintain the necessary data coverage. The line spacing in the field will be 2.5 feet with no adjacent lines separated by more than 3.3 feet. The instrument operator will collect DGM data a minimum of 5 feet outside each grid or survey area boundary prior to turning around and preparing for the next data acquisition line.

Prior to arriving in the field, Shaw will design a non-metallic mount for the RTS prism so that the prism is directly over, or at a constant lateral offset from the G858 magnetic sensor. This procedure will eliminate changes in orientation and/or distance between the geophysical and positioning system sensors, and provide the highest quality DGM data for interpretation.

7.3 Recommendations for DGM Data Processing and Target Selection

7.3.1 Data Processing

The data processing used for the GPO effort for both DGM systems is sufficient to meet the project objectives. The quality metrics outlined in the GIP for the project will be adhered to during the processing of the data. Scripts will be used in Geosoft to process the data to minimize the occurrence of human error.

7.3.2 Target Selection

Shaw will work in conjunction with the Army and Ohio EPA to calculate anomaly density maps for each AOC based on the DGM interpretation. If requested, anomalies can be classified in terms of the likelihood of being equal to or larger than 75mm, and these data compared to the entire anomaly population.

As discussed in **Sections 6.2** and **6.3** of this report, the percent detected for the seed items is primarily based on the use of the automatic picker routines in Oasis Montaj UX Process, which only use the signal intensity component to select anomalies. An automatic picker will be used as a quality tool to ensure the data interpreter accounts for all potential anomalies during the interpretation. The Channel 2 and Sum4 channels will be the primary channels evaluated for the EM61-MK2, and the total magnetic field, vertical gradient, and 1D magnetic profile data will be used to evaluate the magnetic data for the Sand Creek Disposal Site. After the automatic target selections are transposed onto the color coded image, other anomaly attributes (e.g., footprint and shape) will be used in conjunction with the signal intensity in order to refine the automatic picker selections, if necessary. This approach has the potential to decrease the number of anomalies selected that do not have similar anomaly characteristics to the items of interest (e.g., 75mm, 90mm, 155mm, PIGs) and are most likely the result of small metal cultural debris. Representative examples of these types of items are exhibited in the color coded images as anomalies with footprints less than the seed item footprints, as well as anomalies with sinuosity. The signal response selection criteria for the G858 magnetometer and the EM61-MK2 are presented in **Table 5-1** and **Table 5-2**, respectively.

The footprint of the anomaly will also be considered during the interpretation in conjunction with the signal intensity and signal to noise ratio (SNR).

For the EM61-MK2 data, the items of interest at the site are represented by a minimum size of approximately 40 to 45 square feet for the isolated anomalies in the GPO. The minimum SNR that is anticipated for use is 3-5.

For the magnetic data, the items of interest at the site are represented by a minimum size of approximately 35 to 40 square feet (dipole response) for the isolated anomalies in the GPO. The minimum SNR that is anticipated for use is 3-5.

Shaw will also use the EM61-MK2 decay information (time constants) in an attempt to further select anomalies that are the most similar to the MEC items of interest. Non-ferrous, or largely non-ferrous items have time constants less than 150-200 microseconds, while larger ferrous items will have time constants that are a minimum of several hundred microseconds.

The proposed interpretation approach is optimum for those areas where the anomalies are "isolated" from each other and their anomaly signatures do not overlap. In areas of higher anomaly density (i.e., "cluttered" areas), there is a much lower probability of accurately characterizing each anomaly due to the interference from adjacent anomalies.

7.4 Recommendations for Target Reacquisition

Anomaly reacquisition was not performed during the GPO and is not required under this DO. If reacquisition is necessary as some time during the duration of this DO, anomalies will be reacquired using either the RTK GPS or RTS, depending on site conditions such as canopy. The EM61-MK2 (or G858 at the Sand Creek Disposal Site) will be used to locate the actual anomaly peak location in the field from the target coordinates. Any anomaly reacquisition will be demonstrated and approved prior to initiation of the production surveys.

Note that Shaw intends to use the seed items and results of this GPO in conjunction with additional work to be performed at the RVAAP by Shaw under the Military Munitions Response Program (MMRP). Reacquisition of target anomalies is required under the MMRP. Following the completion of the MMRP activities, Shaw will remove all seed items prior to demobilization.

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8.0 References

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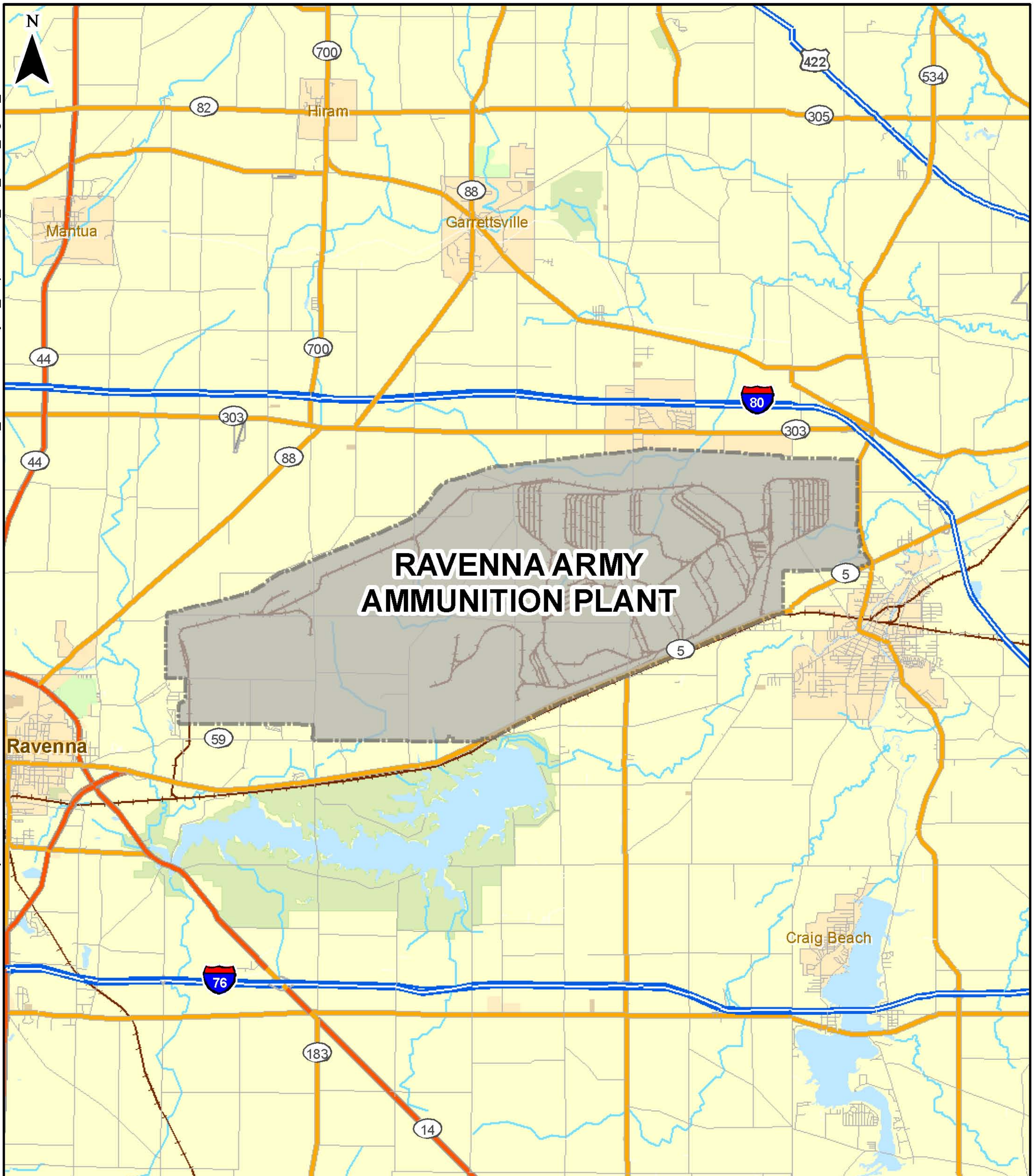
FIGURES

Figure 1-1
Location Map
Ravenna Army Ammunition Plant
Ravenna, Ohio

Project Number: 133616 Generated By: XXX Date: 02/01/10 File Path:F:\GISDATA2\MAMMS\Ravenna\GIS_Documents\Project_Maps\RVAAP_003_GPO_Fig1-2_siteBound.mxd



Legend

Facility Property Line

0 0.75 1.5 2.25 3 Miles

Projection : NAD_1983_UTM_Zone_17N

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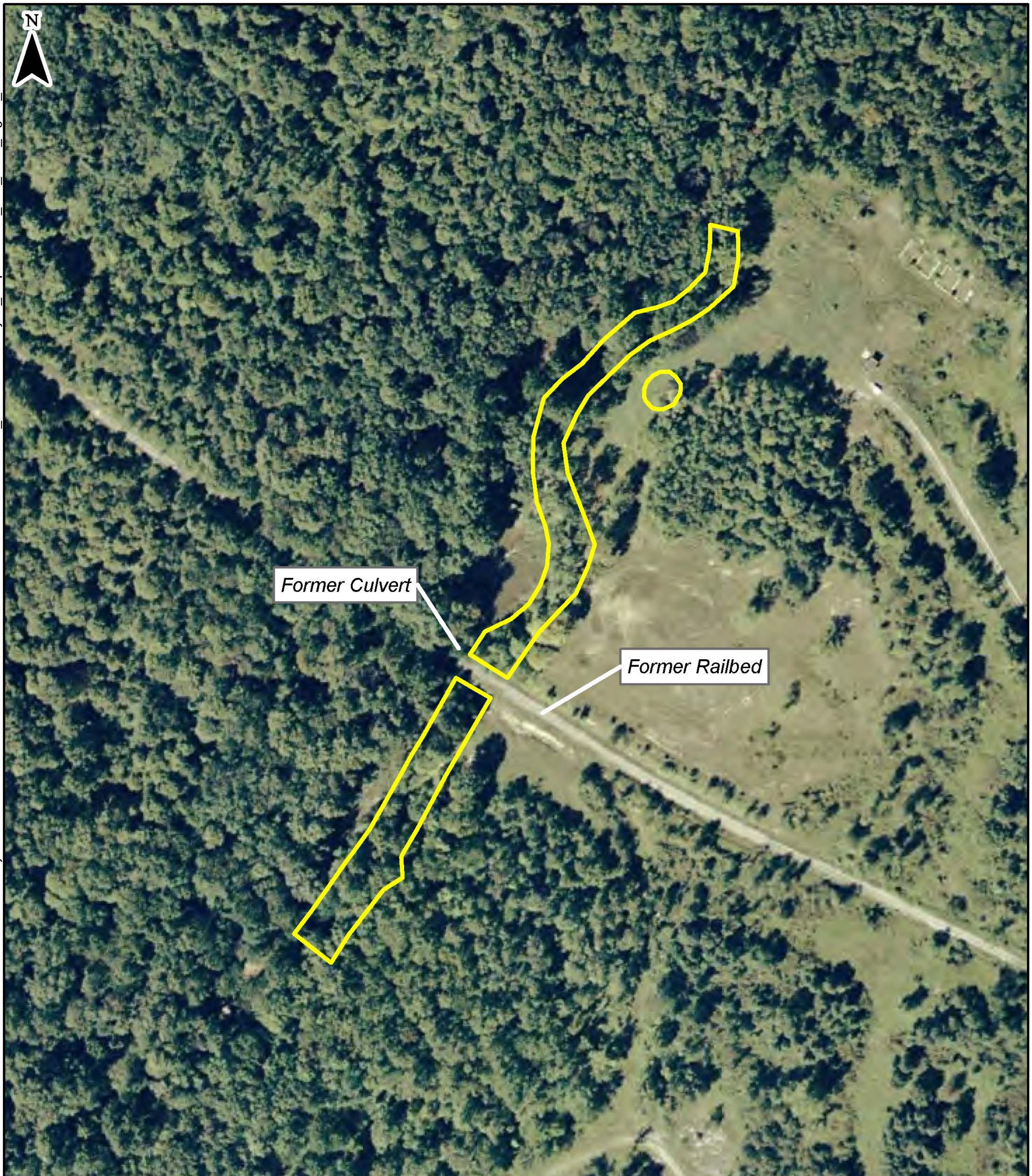
LOUISVILLE DISTRICT

MILITARY MUNITIONS RESPONSE PROGRAM

FIGURE NUMBER 1-2

FACILITY MAP
RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

Shaw Environmental & Infrastructure, Inc.



Legend

RVAAP-34 Site Boundary

0 100 200 Feet

Projection : NAD_1983_UTM_Zone_17N

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MILITARY MUNITIONS RESPONSE PROGRAM

FIGURE NUMBER 1-3

RVAAP 34
SAND CREEK DISPOSAL ROAD LANDFILL
RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

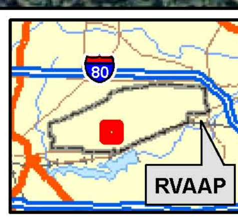
Shaw Environmental & Infrastructure, Inc.

Generated By: XXX Date: 11/12/09 File Path:F:\GISDATA2\MAMMS\Ravenna\GIS_Documents\Project_Maps\RVAAP_005_GPO_Fig1-4_RVAAP28.mxd

Legend

Open Demolition Area #1 Investigation Area (8.6 Acres)

Suspected Mustard Agent Burial Site Investigation Area (5,200 sqft)



0 100 200 Feet

Projection : NAD_1983_UTM_Zone_17N

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MILITARY MUNITIONS RESPONSE PROGRAM

FIGURE NUMBER 1-4

RVAAP-28
MABS AND RVAAP-03 ODA1
RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

Shaw Environmental & Infrastructure, Inc.

133616

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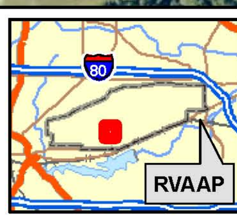
Legend

Geophysical Prove-Out Area



0 300 600 Feet

Projection : NAD_1983_UTM_Zone_17N

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CORPS OF ENGINEERS
LOUISVILLE DISTRICT

MILITARY MUNITIONS RESPONSE PROGRAM

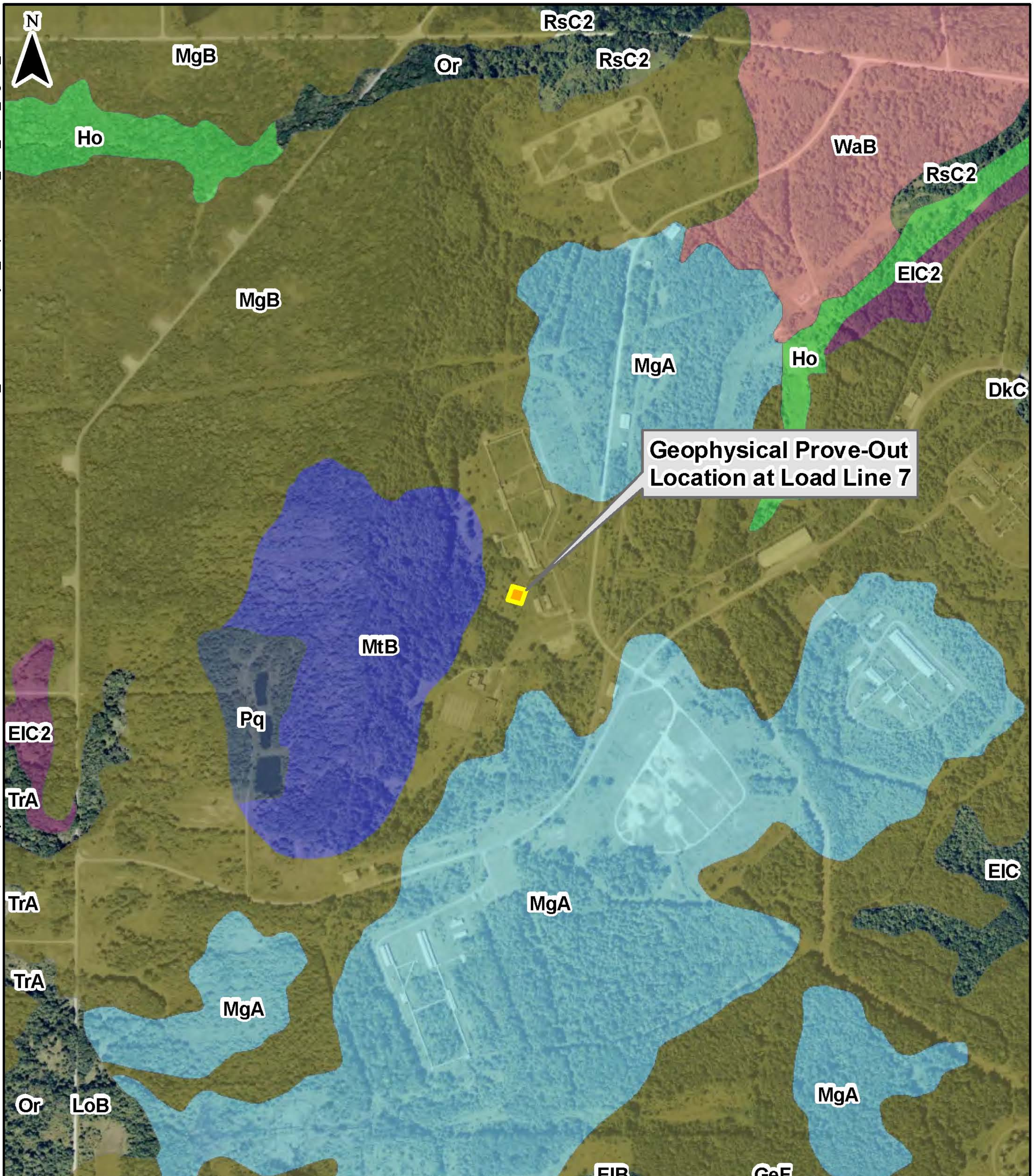
FIGURE NUMBER 2-1

AERIAL PHOTO OF
GEOPHYSICAL PROVE-OUT AREA
RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

Shaw Environmental & Infrastructure, Inc.

Project Number: 133616

Generated By: XXX Date: 02/01/10 File Path:F:\GISDATA2\MAMMS\Ravenna\GIS_Documents\Project_Maps\RVAAP_007_GPO_Fig2-2_Soil.mxd

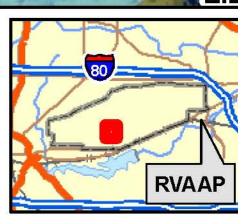


Legend

Geophysical Prove-Out Area

Soil Type

	EIC2		MgB
	Ho		MtB
	MgA		Pq
			WaB



0 500 1,000 Feet

Projection : NAD_1983_UTM_Zone_17N

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT

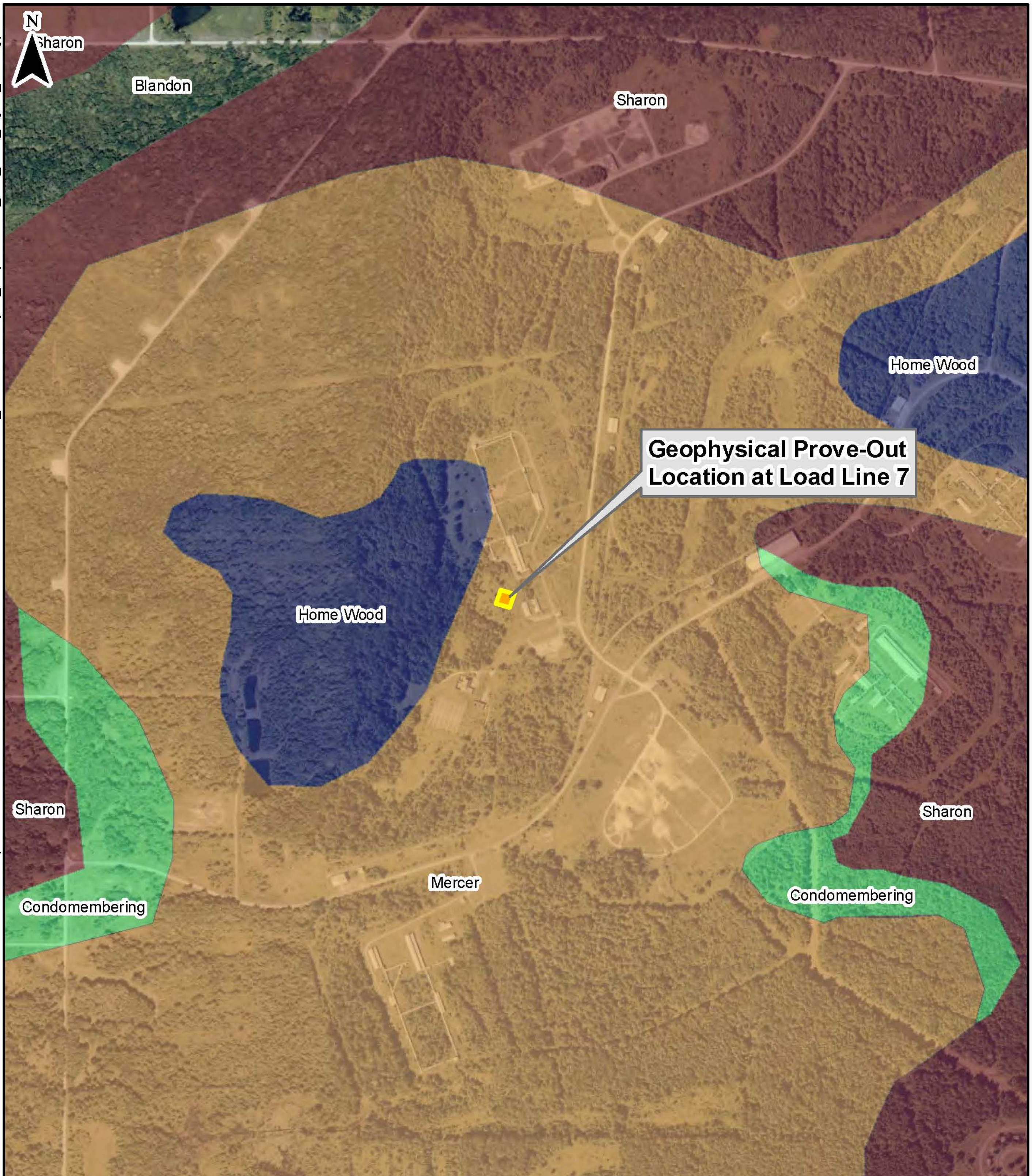
MILITARY MUNITIONS RESPONSE PROGRAM

FIGURE NUMBER 2-2

SOIL MAP AND GEOPHYSICAL PROVE-OUT AREA
RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

Shaw Environmental & Infrastructure, Inc.

Project Number: 133616

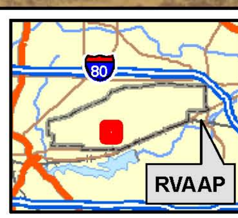


Legend

Geophysical Prove-Out Area

Geologic Formations

Connoquennissing Sandstone Member
Homewood Sandstone Member
Mercer Member
Sharon Member



0 500 1,000
Feet
Projection : NAD_1983_UTM_Zone_17N

U.S. ARMY
CORPS OF ENGINEERS
LOUISVILLE DISTRICT

MILITARY MUNITIONS RESPONSE PROGRAM

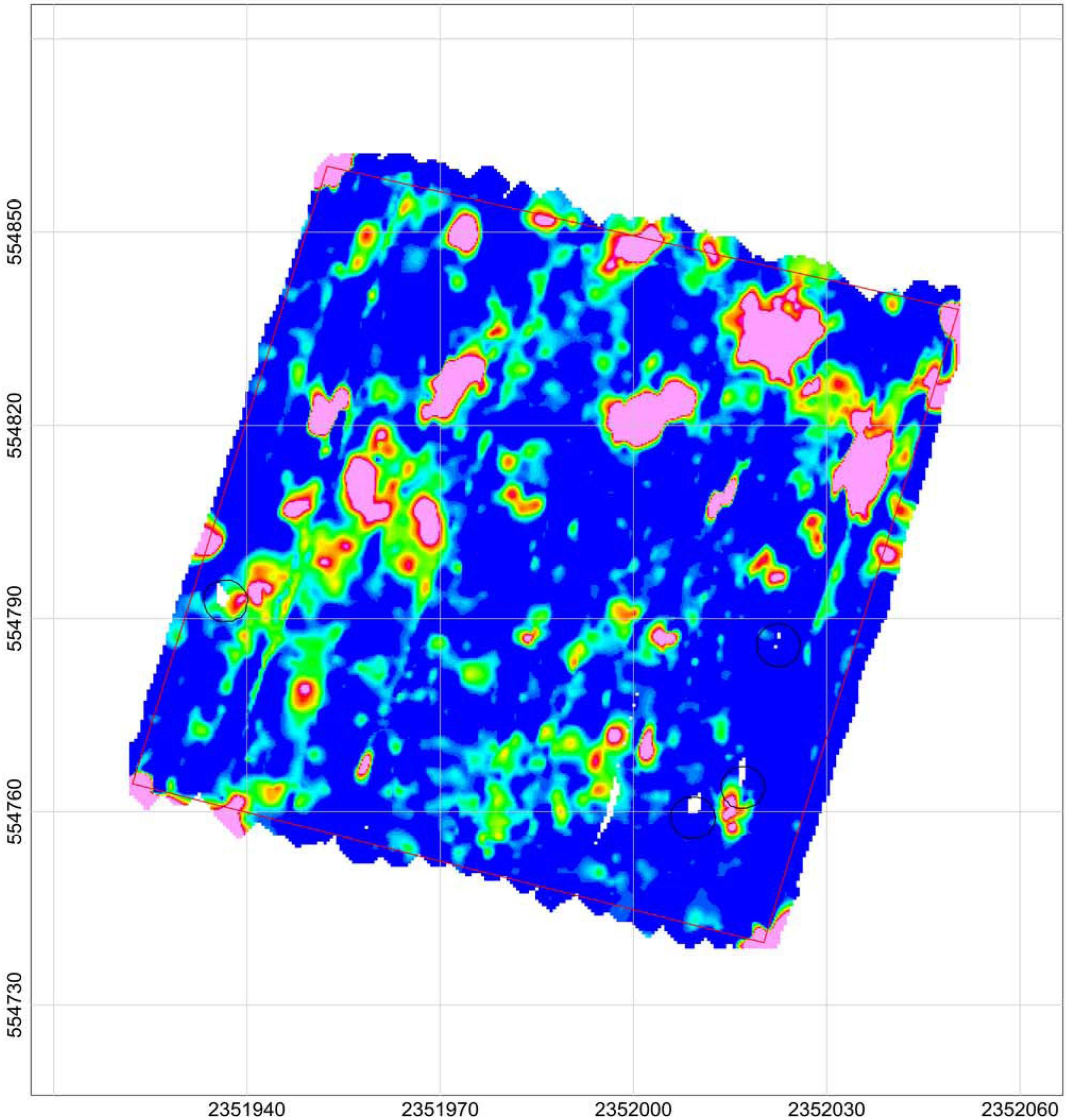
FIGURE NUMBER
2-3

GEOLOGIC MAP AND
GEOPHYSICAL PROVE-OUT AREA
RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

Shaw Environmental & Infrastructure, Inc.

Generated By: XXX Date: 02/01/10 File Path:F:\GISDATA2\MAMMS\Ravenna\GIS_Documents\Project_Maps\RVAAP_008_GPO_Fig2-3_Geology.mxd

Project Number: 133616



Geophysical Prove-Out Pre-Seeding Baseline Survey

Ravenna Army Ammunition Plant
Ravenna, Ohio

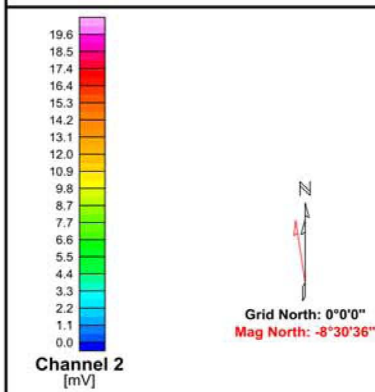
LEGEND

Location of Tree

Map Scale: Scale 1:325

25 0

US survey foot
NAD83 / Ohio CS83 North zone



Client: USACE - Louisville District

Project: Ravenna Army Ammunition Plant

Contractor: Shaw Environmental & Infrastructure, Inc.

Created by:	Verified by:
Date: 2009/10/23	File: PreSeed Final_latency
Page number:	Approved:

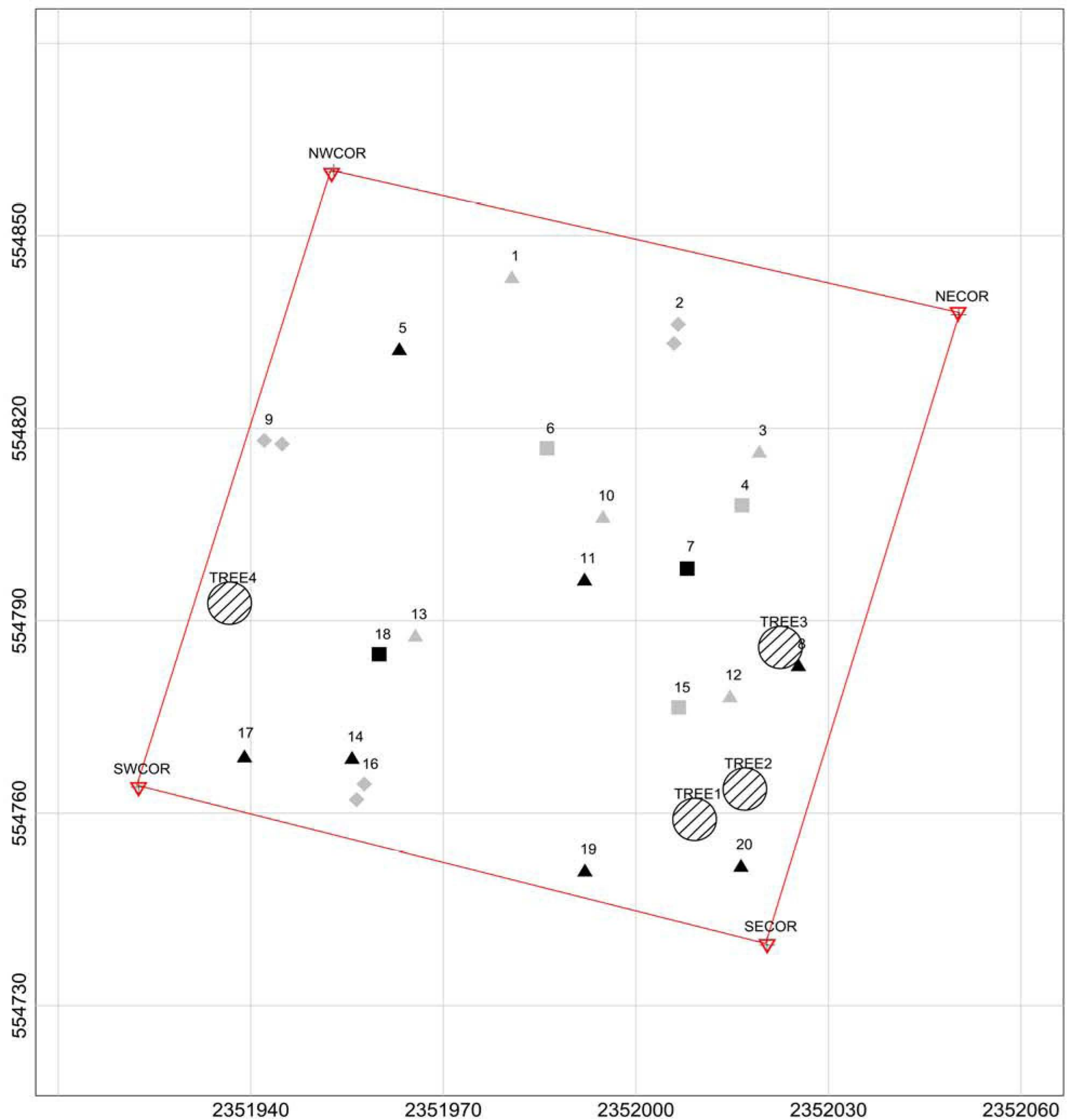
Figure 2-4

Shaw Environmental & Infrastructure, Inc.

US Army Corps of Engineers Louisville District

Geophysical Prove-Out Seed Locations

Ravenna Army Ammunition Plant
Ravenna, Ohio



LEGEND

15 Seed Item Number

Grid Corner

Seed Item Description

75 mm

90 mm

105 mm

155 mm

PIG (CAIS)

Map Scale: Scale 1:325

US survey foot

Grid North: 0°0'0"

Mag North: -8°30'36"

Client: USACE - Louisville District

Project: Ravenna Army Ammunition Plant

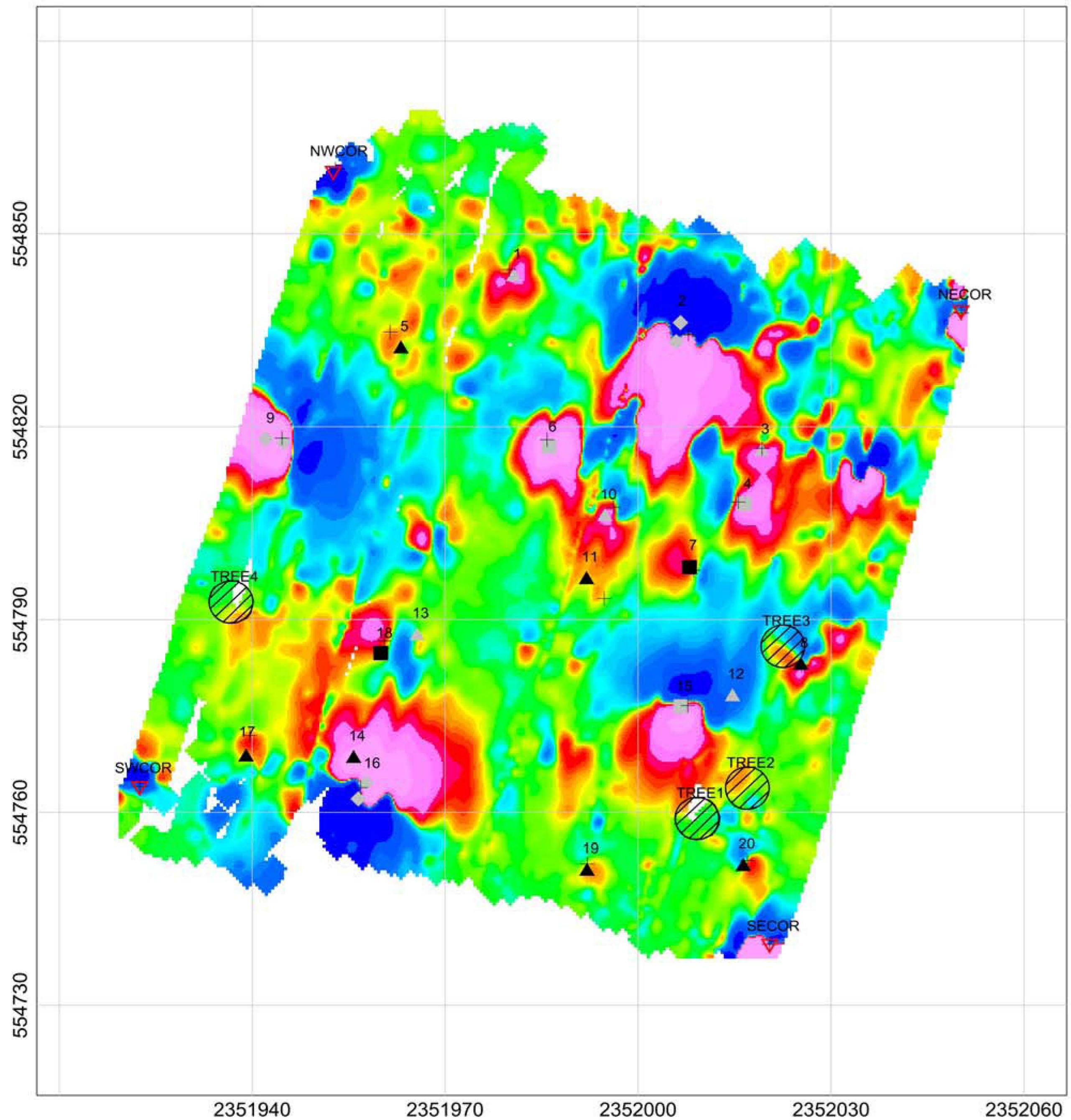
Contractor: Shaw Environmental & Infrastructure, Inc.

Created by:	Verified by:
Date: 2009/10/23	File: PreSeed Final_latency
Page number:	Approved:

Figure 2-5

Shaw Environmental & Infrastructure, Inc.

US Army Corps of Engineers Louisville District



Geophysical Prove-Out G-858G Magnetometer

RTS Positioning System
Total Field

Ravenna Army Ammunition Plant
Ravenna, Ohio

LEGEND

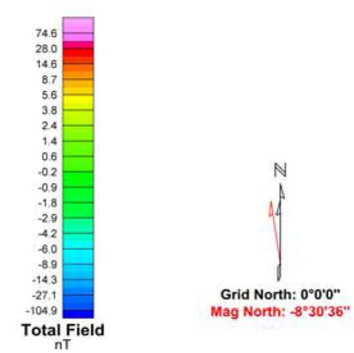
- Selected Target
- 15 Seed Item Number
- Grid Corner

Seed Item Description

- 75 mm
- 90 mm
- 105 mm
- 155 mm
- PIG (CAIS)

Map Scale: Scale 1:325

US survey foot
NAD83 / Ohio CS83 North zone



Client: USACE - Louisville District

Project: Ravenna Army Ammunition Plant

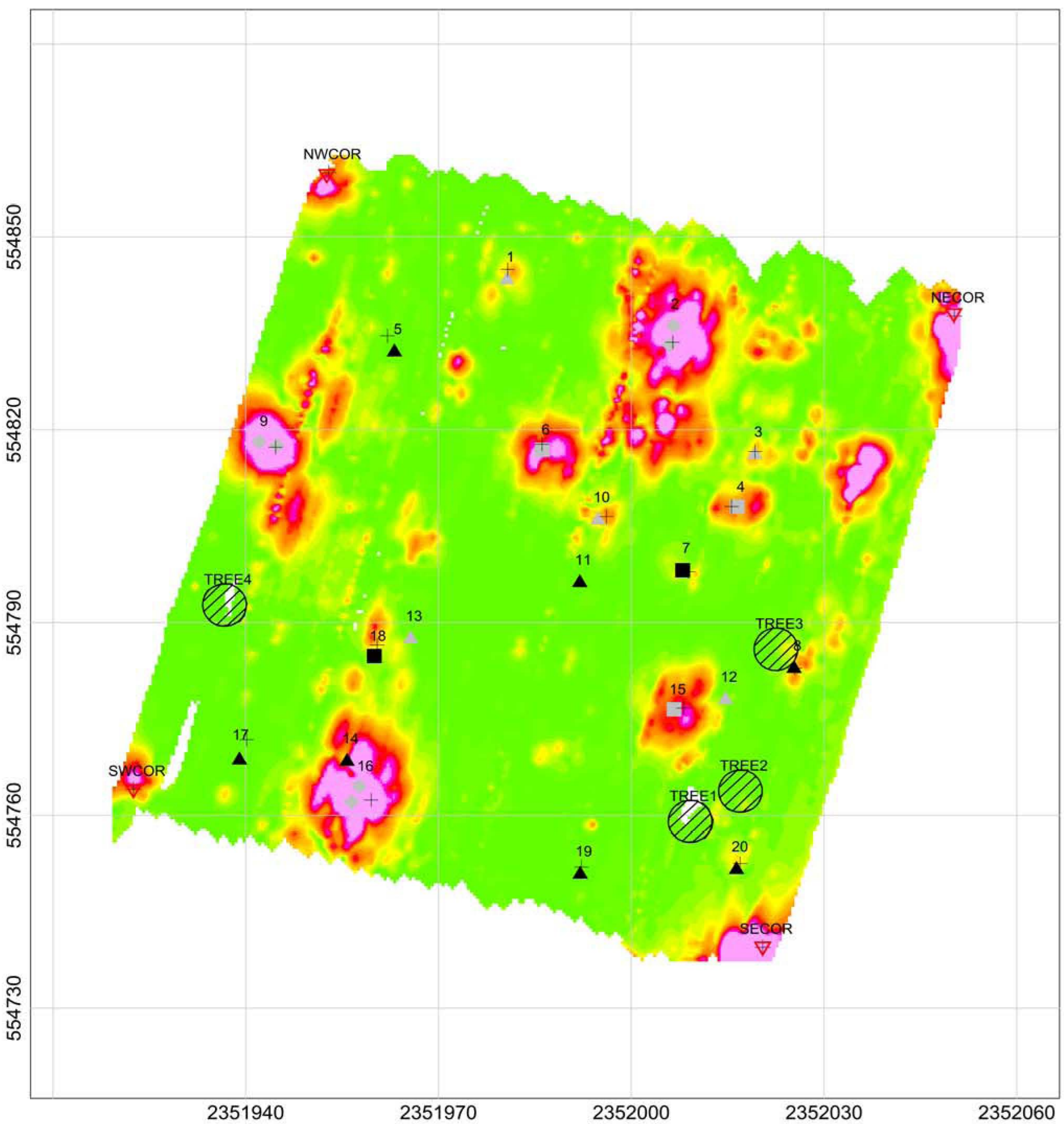
Contractor: Shaw Environmental & Infrastructure, Inc.

Created by:	Verified by:
Date: 2009/10/23	File: Mag_RTS_GPO_TF_21
Page number:	Approved:

Figure 6-1

Shaw Environmental & Infrastructure, Inc.

US Army Corps of Engineers Louisville District



Geophysical Prove-Out G-858G Magnetometer

RTS Positioning System
Total Field - Analytic Signal
Bottom Sensor

Ravenna Army Ammunition Plant
Ravenna, Ohio

LEGEND

+ Selected Target
15 Seed Item Number
▽ Grid Corner

Seed Item Description

▲ 75 mm
▲ 90 mm
■ 105 mm
■ 155 mm
◆ PIG (CAIS)

Map Scale: Scale 1:325
25 0
US survey foot
NAD83 / Ohio CS83 North zone

169.153
135.730
115.591
99.430
85.468
71.676
60.084
48.999
38.253
26.492
15.830
4.999
-6.339
-19.623
-32.823
-47.800
-65.654
-91.969
-135.800

RTS_lag_edit_B_tfas

N

Grid North: 0°0'0"
Mag North: -8°30'36"

Client: USACE - Louisville District	
Project: Ravenna Army Ammunition Plant	
Contractor: Shaw Environmental & Infrastructure, Inc.	
Created by:	**Verified by:**
Date: 2009/10/23	**File: Mag_RTS_GPO_lag_edit_B**
Page number:	**Approved:**

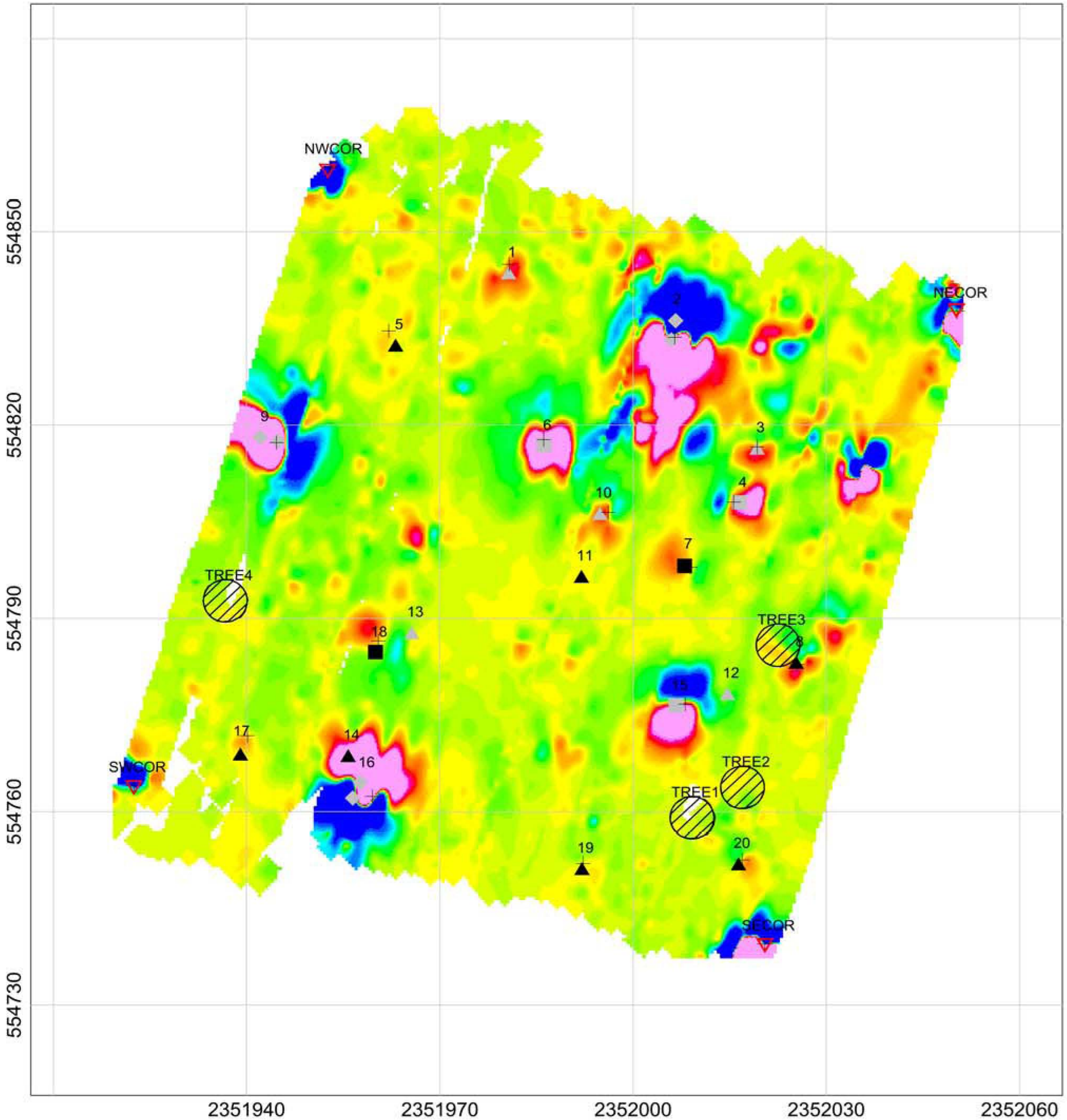
Figure 6-2

Shaw Environmental & Infrastructure, Inc.
US Army Corps of Engineers Louisville District

Geophysical Prove-Out G-858G Magnetometer

RTS Positioning System
Total Field - Gradient

Ravenna Army Ammunition Plant
Ravenna, Ohio



LEGEND

- Selected Target
- 15 Seed Item Number
- Grid Corner

Seed Item Description

- 75 mm
- 90 mm
- 105 mm
- 155 mm
- PIG (CAIS)

Map Scale: Scale 1:325

Client: USACE - Louisville District	
Project: Ravenna Army Ammunition Plant	
Contractor: Shaw Environmental & Infrastructure, Inc.	
Created by:	Verified by:
Date: 2009/10/23	File: Mag_RTS_GPO_TF_G_21
Page number:	Approved:

Figure 6-3

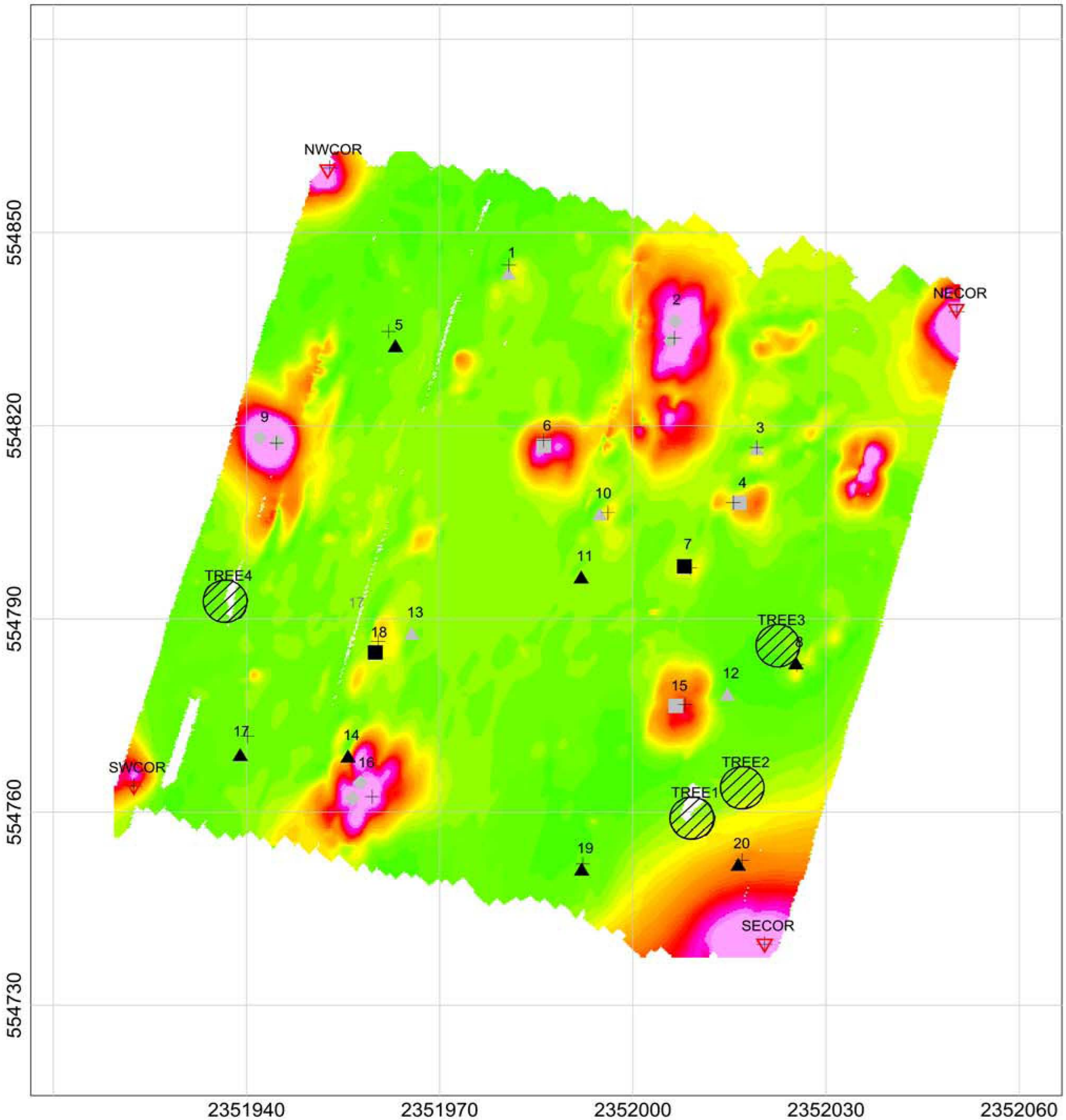
Shaw Environmental & Infrastructure, Inc.

US Army Corps of Engineers Louisville District

Geophysical Prove-Out G-858G Magnetometer

RTS Positioning System
Gradient - Analytic Signal

Ravenna Army Ammunition Plant
Ravenna, Ohio



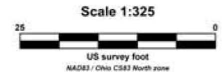
LEGEND

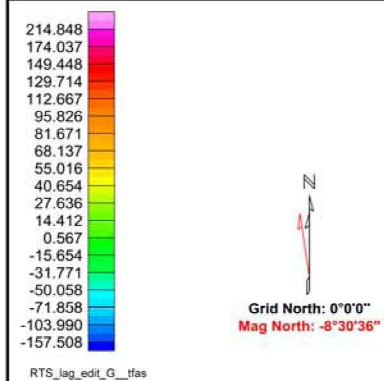
+	Selected Target
15	Seed Item Number
▽	Grid Corner

Seed Item Description

▲	75 mm
▲	90 mm
■	105 mm
■	155 mm
◆	PIG (CAIS)

Map Scale:





Client: USACE - Louisville District

Project: Ravenna Army Ammunition Plant

Contractor: Shaw Environmental & Infrastructure, Inc.

Created by:	**Verified by:**
Date: 2009/10/23	**File: Mag_RTS_GPO_lag_edit_G**
Page number:	**Approved:**

Figure 6-4

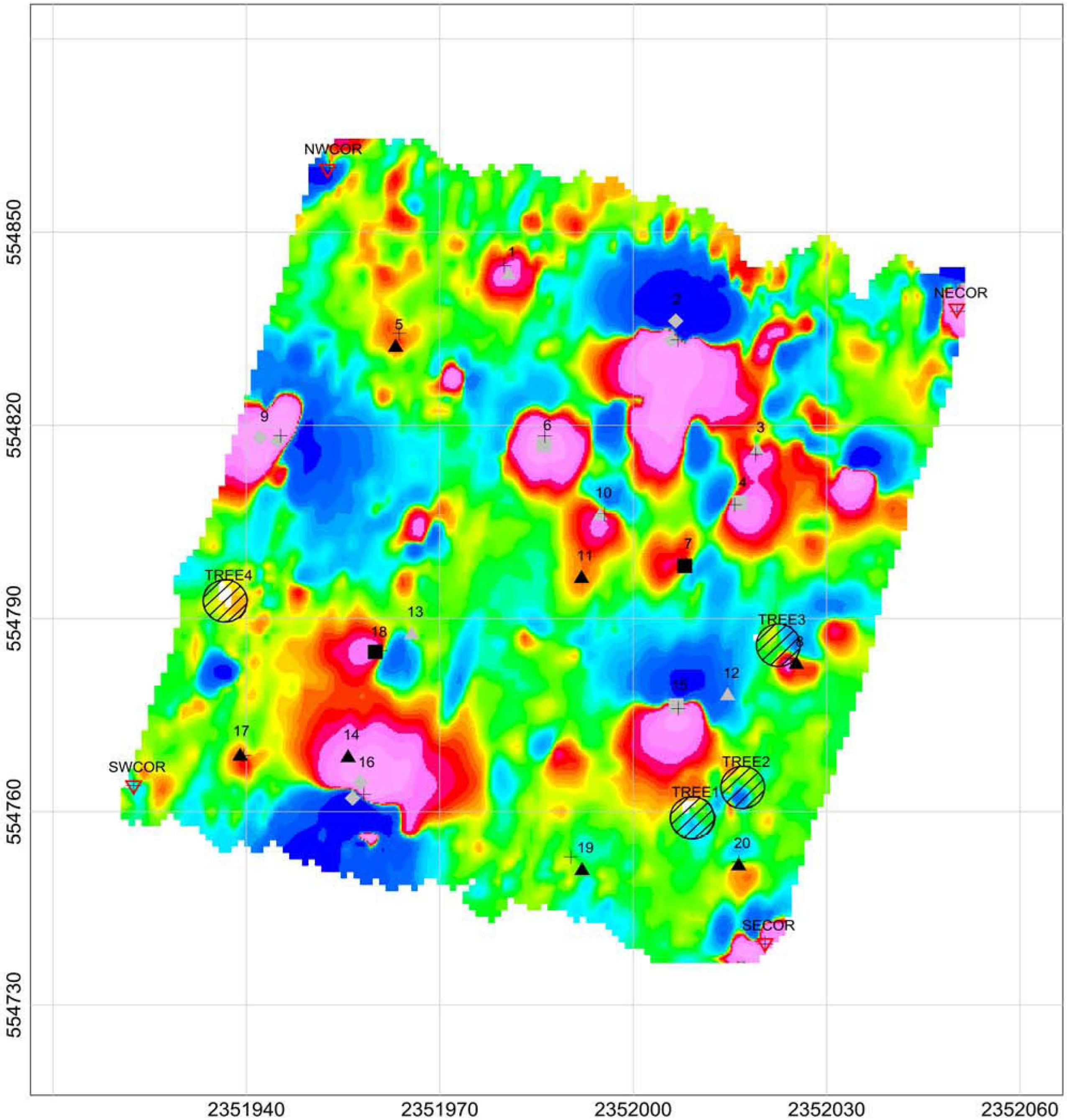
Shaw Environmental & Infrastructure, Inc.

US Army Corps of Engineers Louisville District

Geophysical Prove-Out G-858G Magnetometer

RTK GPS Positioning System
Total Field

Ravenna Army Ammunition Plant
Ravenna, Ohio



LEGEND

Selected Target

15 Seed Item Number

Grid Corner

Seed Item Description

75 mm

90 mm

105 mm

155 mm

PIG (CAIS)

Map Scale: Scale 1:325

25 0

US survey foot

NAD83 / Ohio CS83 North zone

74.6
28.0
14.6
8.7
5.6
3.8
2.4
1.4
0.6
-0.2
-0.9
-1.8
-2.9
-4.2
-6.0
-8.9
-14.3
-27.1
-104.9

Total Field
nT

N

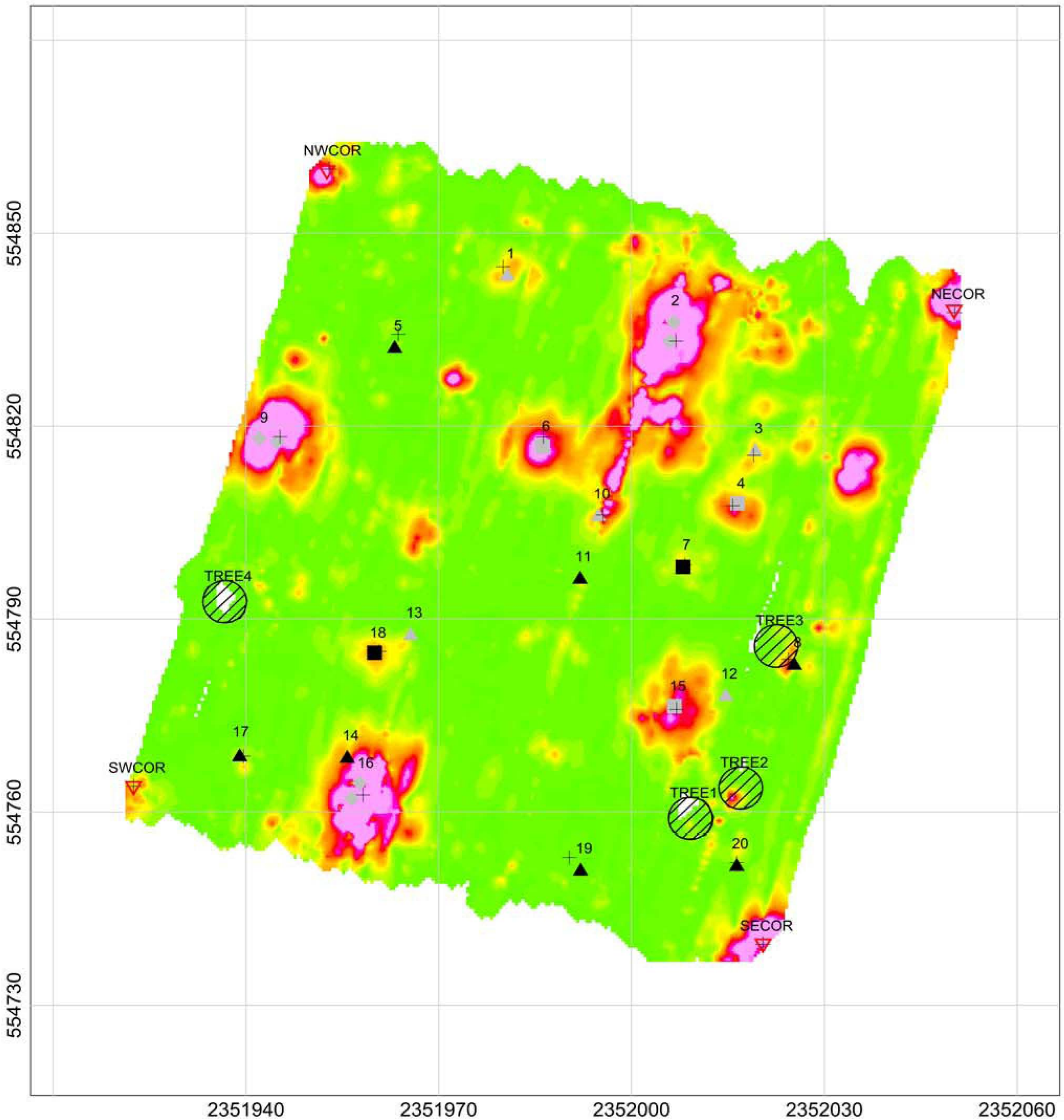
Grid North: 0°0'0"
Mag North: -8°30'36"

Client: USACE - Louisville District	
Project: Ravenna Army Ammunition Plant	
Contractor: Shaw Environmental & Infrastructure, Inc.	
Created by:	**Verified by:**
Date: 2009/10/23	**File: Mag_TF_RTK_GPS_21**
Page number:	**Approved:**

Figure 6-5

Shaw Environmental & Infrastructure, Inc.

US Army Corps of Engineers Louisville District



Geophysical Prove-Out G-858G Magnetometer

RTK Positioning System
Total Field - Analytic Signal

Ravenna Army Ammunition Plant
Ravenna, Ohio

LEGEND

- Selected Target
- 15 Seed Item Number
- Grid Corner

Seed Item Description

- 75 mm
- 90 mm
- 105 mm
- 155 mm
- PIG (CAIS)

Map Scale: Scale 1:325
25 0
US survey foot
NAD83 / Ohio CS83 North zone

175.475
140.381
119.235
102.265
87.605
73.123
60.951
49.312
38.029
25.679
14.484
3.112
-8.794
-22.743
-36.603
-52.329
-71.076
-98.708
-144.730

RTK_GPO_new_B_edit_tfas

N

Grid North: 0°0'0"
Mag North: -8°30'36"

Client: USACE - Louisville District

Project: Ravenna Army Ammunition Plant

Contractor: Shaw Environmental & Infrastructure, Inc.

Created by:	**Verified by:**
Date: 2009/10/23	**File: Mag_RTK_GPO_new_B_edit_TF_AS**
Page number:	**Approved:**

Figure 6-6

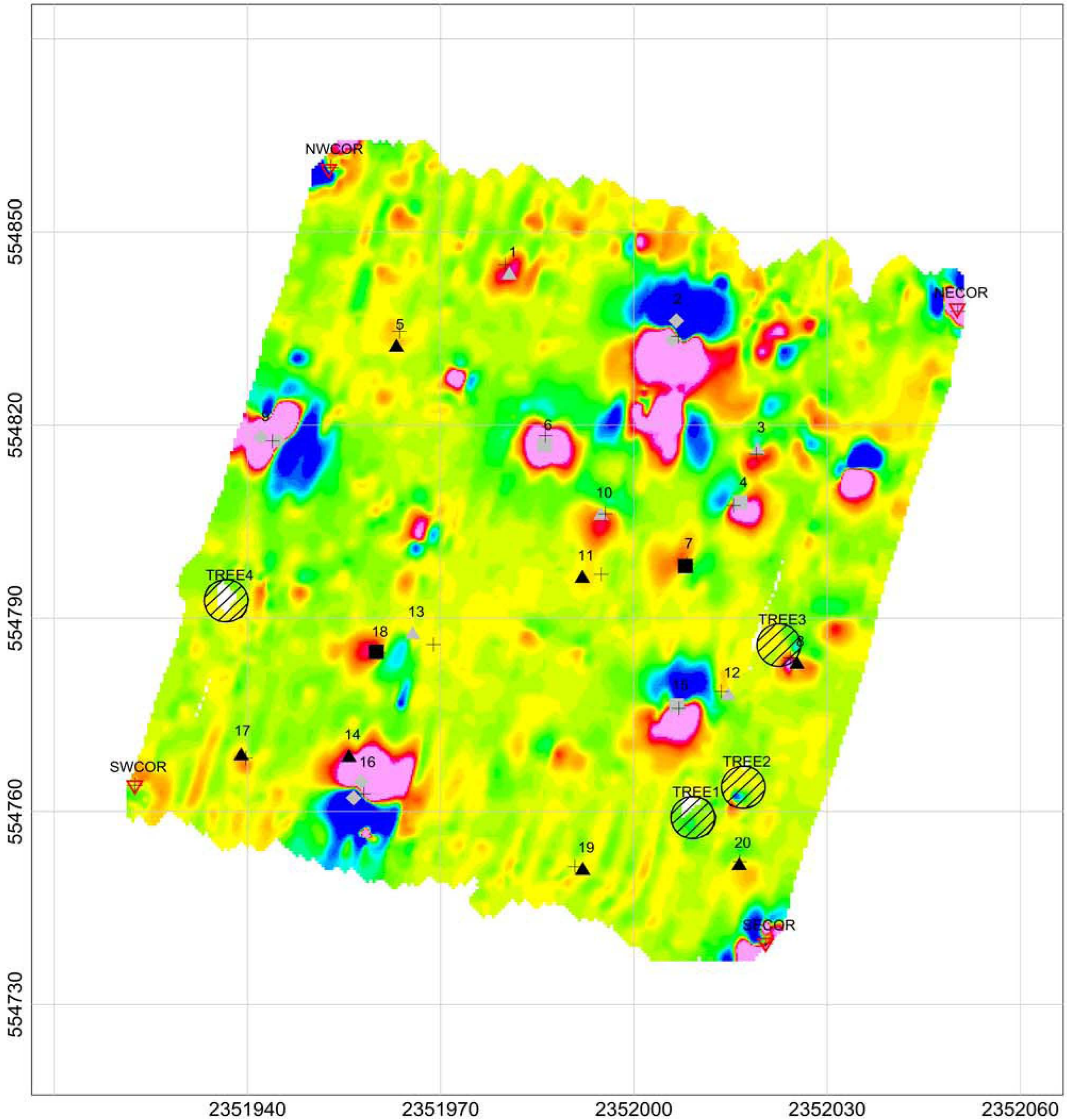
Shaw Environmental & Infrastructure, Inc.

US Army Corps of Engineers Louisville District

Geophysical Prove-Out G-858G Magnetometer

RTK GPS Positioning System
Total Field - Gradient

Ravenna Army Ammunition Plant
Ravenna, Ohio



LEGEND

+	Selected Target
15	Seed Item Number
▽	Grid Corner

Seed Item Description

▲	75 mm
▲	90 mm
■	105 mm
■	155 mm
◆	PIG (CAIS)

Map Scale: Scale 1:325

25 0
US survey foot
NAD83 / Ohio CS83 North zone

26.2
20.3
16.7
13.8
11.4
8.9
6.9
4.9
3.0
0.9
-1.0
-2.9
-4.9
-7.3
-9.6
-12.3
-15.4
-20.1
-27.9

Gradient
nT/ft

N

Grid North: 0°0'0"
Mag North: -8°30'36"

Client: USACE - Louisville District

Project: Ravenna Army Ammunition Plant

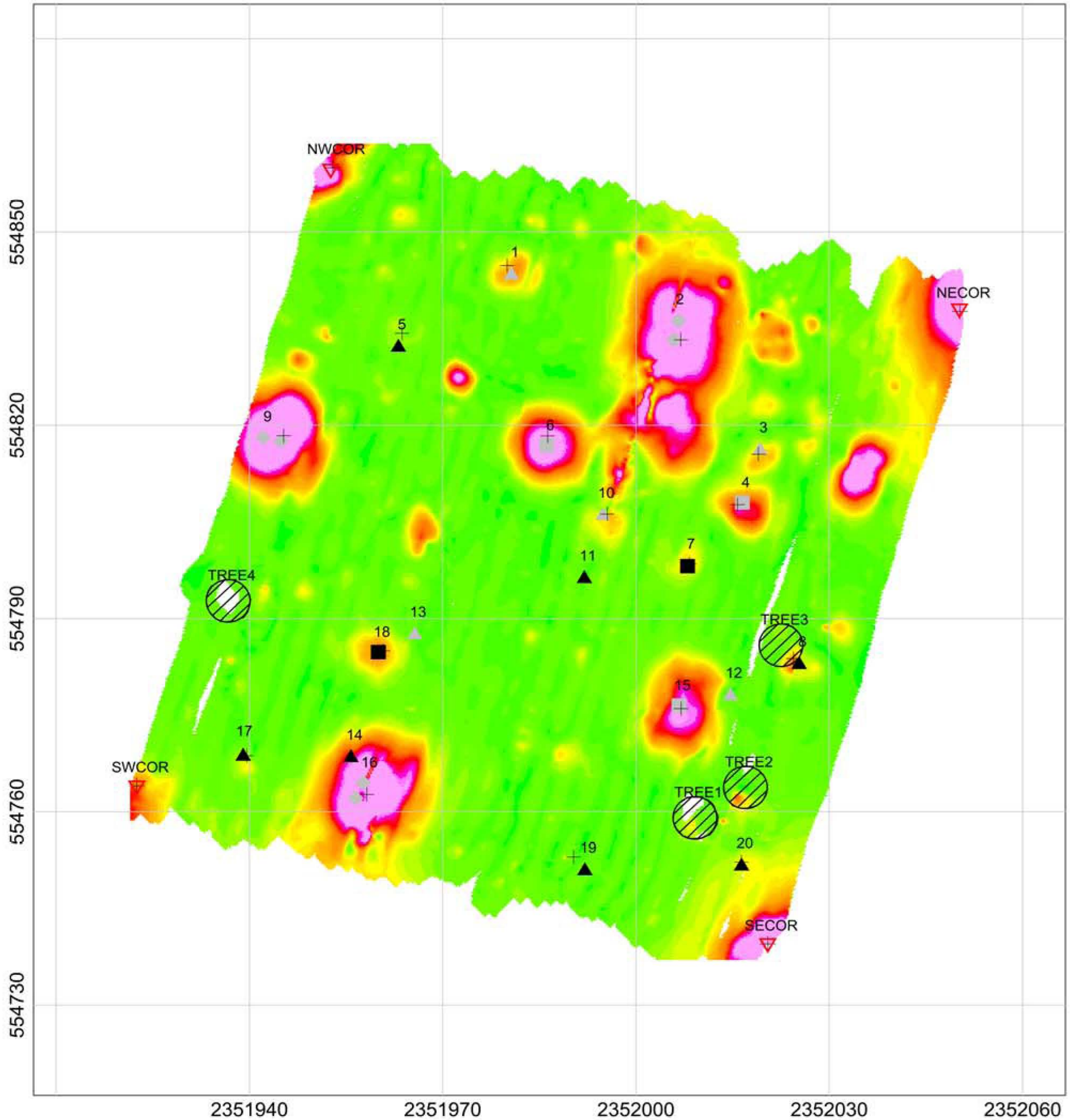
Contractor: Shaw Environmental & Infrastructure, Inc.

Created by:	Verified by:
Date: 2009/10/23	File: Mag_RTK_GPS_GPO_TF_G_2
Page number:	Approved:

Figure 6-7

Shaw Environmental & Infrastructure, Inc.

US Army Corps of Engineers Louisville District



Geophysical Prove-Out G-858G Magnetometer

RTK Positioning System
Gradient - Analytic Signal

Ravenna Army Ammunition Plant
Ravenna, Ohio

LEGEND

Selected Target
15 Seed Item Number
Grid Corner

Seed Item Description

75 mm
90 mm
105 mm
155 mm
PIG (CAIS)

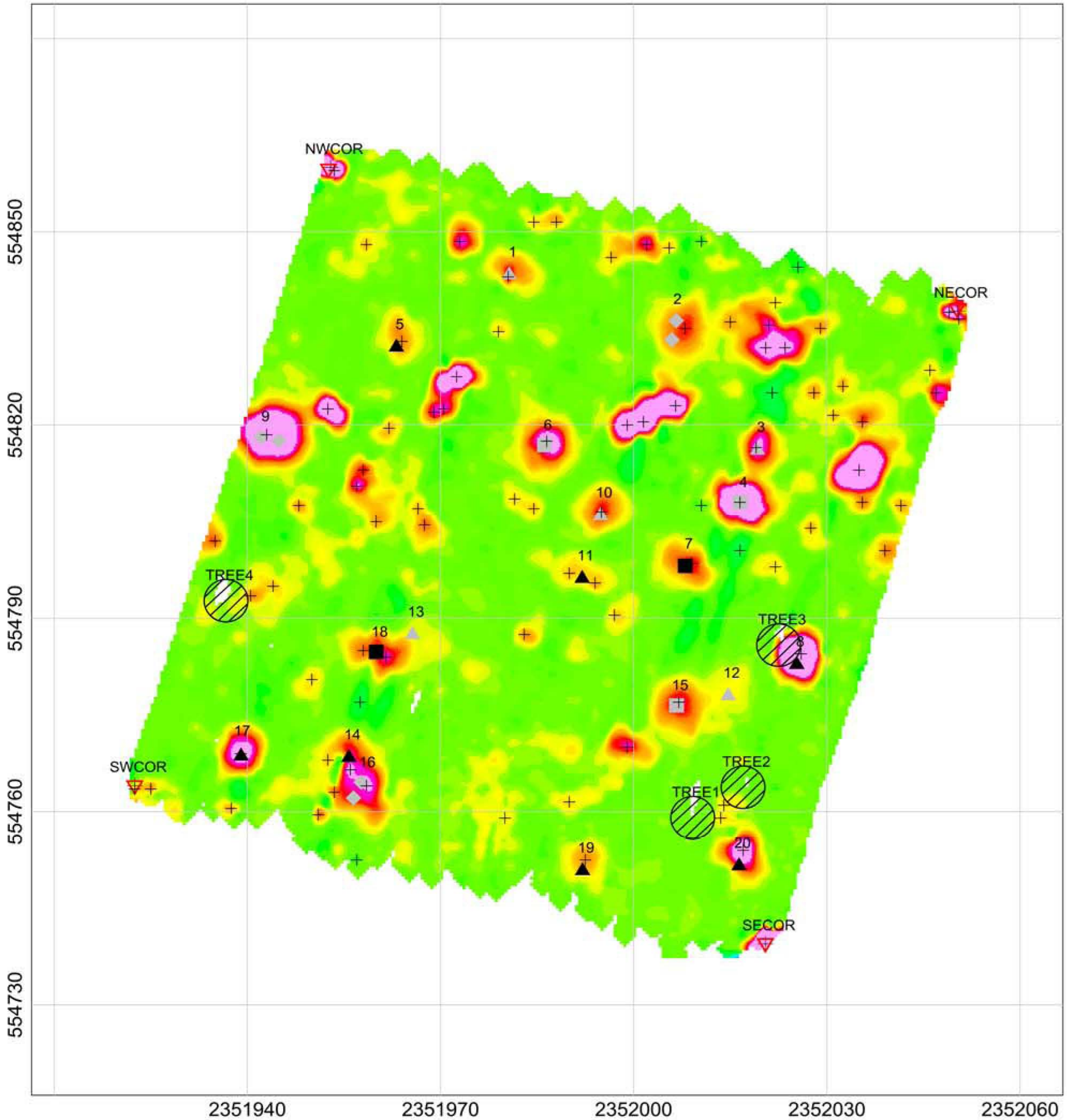
Map Scale: Scale 1:325
US survey foot
NAD83 / Ohio CS83 North zone

Grid North: 0°0'0"
Mag North: -8°30'36"

Client: USACE - Louisville District	
Project: Ravenna Army Ammunition Plant	
Contractor: Shaw Environmental & Infrastructure, Inc.	
Created by:	**Verified by:**
Date: 2009/10/23	**File: Mag_RTK_GPO_new_G**
Page number:	**Approved:**

Figure 6-8

Shaw Environmental & Infrastructure, Inc.
US Army Corps of Engineers Louisville District



Geophysical Prove-Out EM61-MK2

RTS Positioning System
Channel 2 Data

Ravenna Army Ammunition Plant
Ravenna, Ohio

LEGEND

+ Selected Target

15 Seed Item Number

▽ Grid Corner

Seed Item Description

▲ 75 mm

▲ 90 mm

■ 105 mm

■ 155 mm

◆ PIG (CAIS)

Map Scale: Scale 1:325

25 0

US survey foot

NAD83 / Ohio CS83 North zone

27.4
21.5
17.9
15.1
12.6
10.1
8.1
6.1
4.2
2.1
0.2
-1.7
-3.7
-6.0
-8.4
-11.0
-14.2
-18.9
-26.6

Sum4
[mV]

Grid North: 0°0'0"
Mag North: -8°30'36"

Client: USACE - Louisville District

Project: Ravenna Army Ammunition Plant

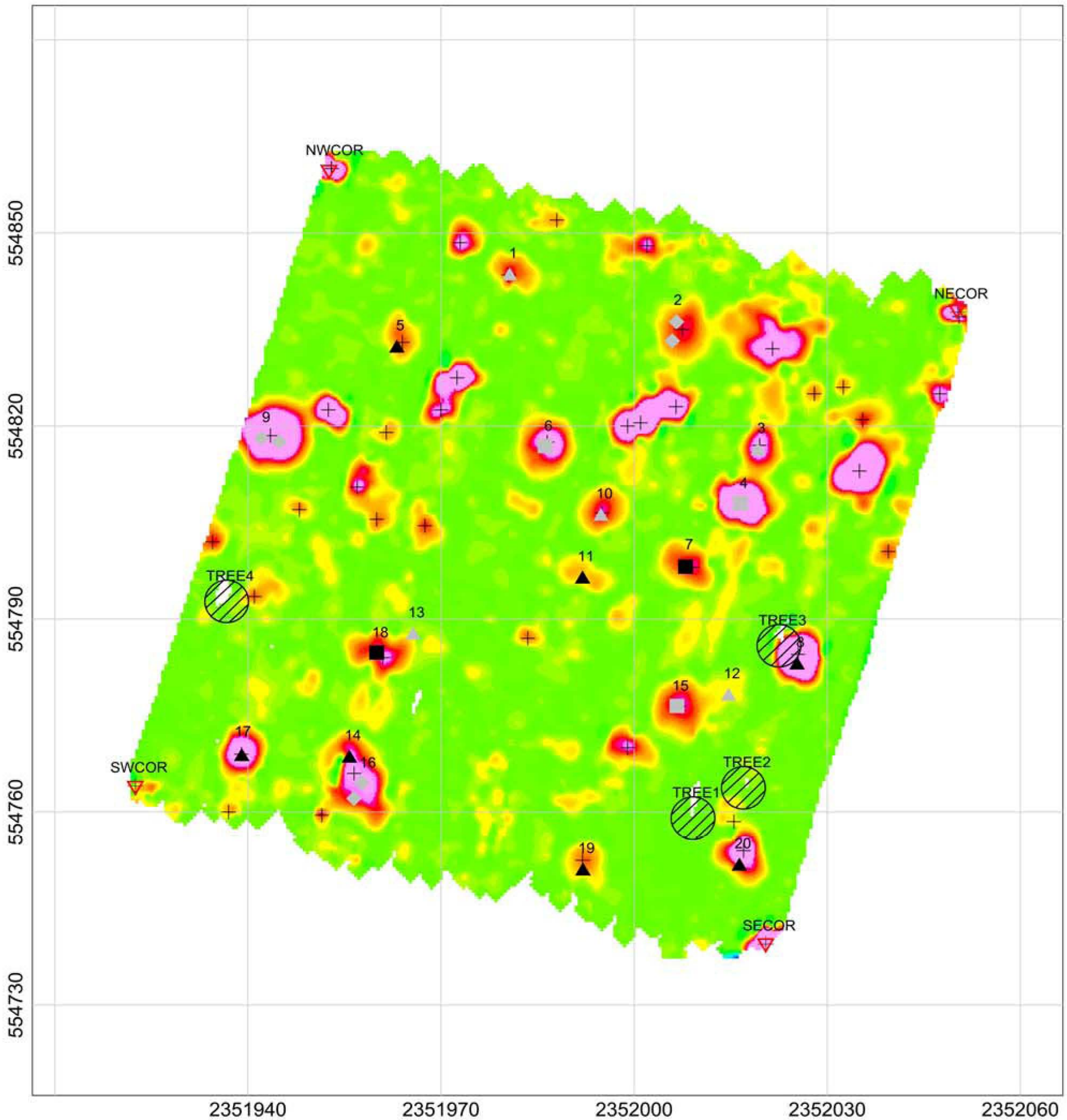
Contractor: Shaw Environmental & Infrastructure, Inc.

Created by:	**Verified by:**
Date: 2009/10/23	**File: EM61_RTS_Final_Z2_d**
Page number:	**Approved:**

Figure 6-9

Shaw Environmental & Infrastructure, Inc.

US Army Corps of Engineers Louisville District



Geophysical Prove-Out EM61-MK2

RTS Positioning System
Sum4 Data

Ravenna Army Ammunition Plant
Ravenna, Ohio

LEGEND

+ Selected Target
15 Seed Item Number
▽ Grid Corner

Seed Item Description

▲ 75 mm
▲ 90 mm
■ 105 mm
■ 155 mm
◆ PIG (CAIS)

Map Scale: Scale 1:325
25 0
US survey foot
NAD83 / Ohio CS83 North zone

41.8
33.5
28.4
24.4
20.9
17.5
14.6
11.8
9.2
6.2
3.6
0.9
-2.0
-5.3
-8.6
-12.3
-16.7
-23.3
-34.2
Sum4
[mV]

N
Grid North: 0°0'0"
Mag North: -8°30'36"

Client: USACE - Louisville District

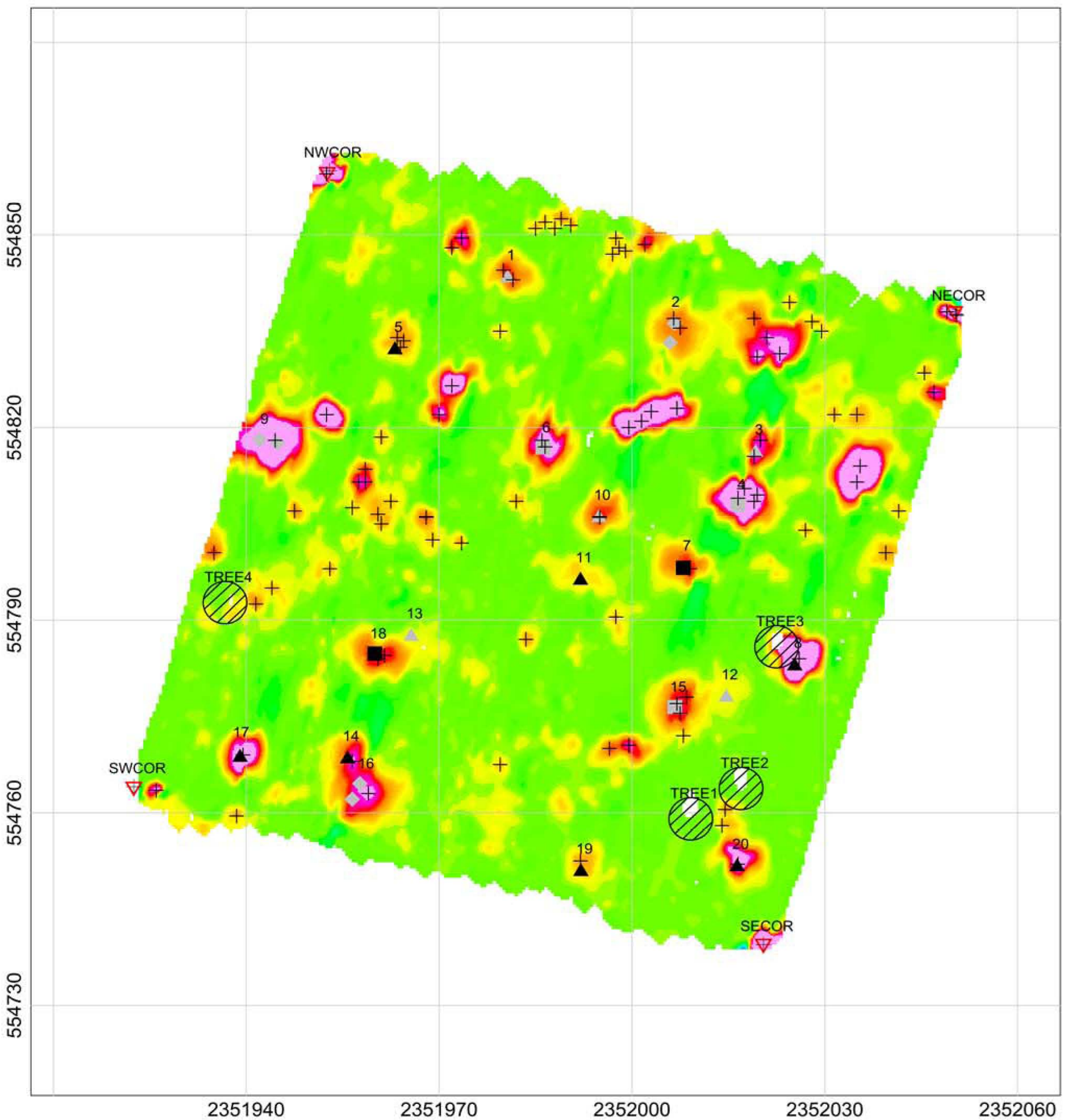
Project: Ravenna Army Ammunition Plant

Contractor: **Shaw Environmental & Infrastructure, Inc.**

Created by:	**Verified by:**
Date: 2009/10/23	**File: EM61_RTS_Final_Sum4**
Page number:	**Approved:**

Figure 6-10

Shaw Shaw Environmental & Infrastructure, Inc.
US Army Corps of Engineers Louisville District

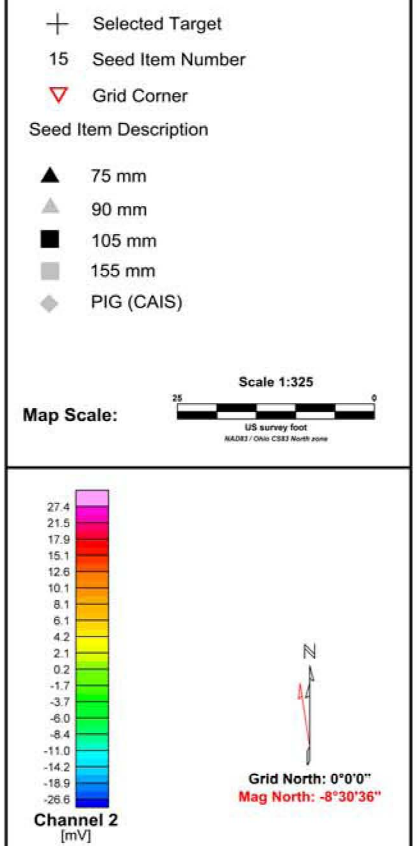


Geophysical Prove-Out EM61-MK2

RTK GPS Positioning System
Channel 2 Data

Ravenna Army Ammunition Plant
Ravenna, Ohio

LEGEND



Client: USACE - Louisville District

Project: Ravenna Army Ammunition Plant

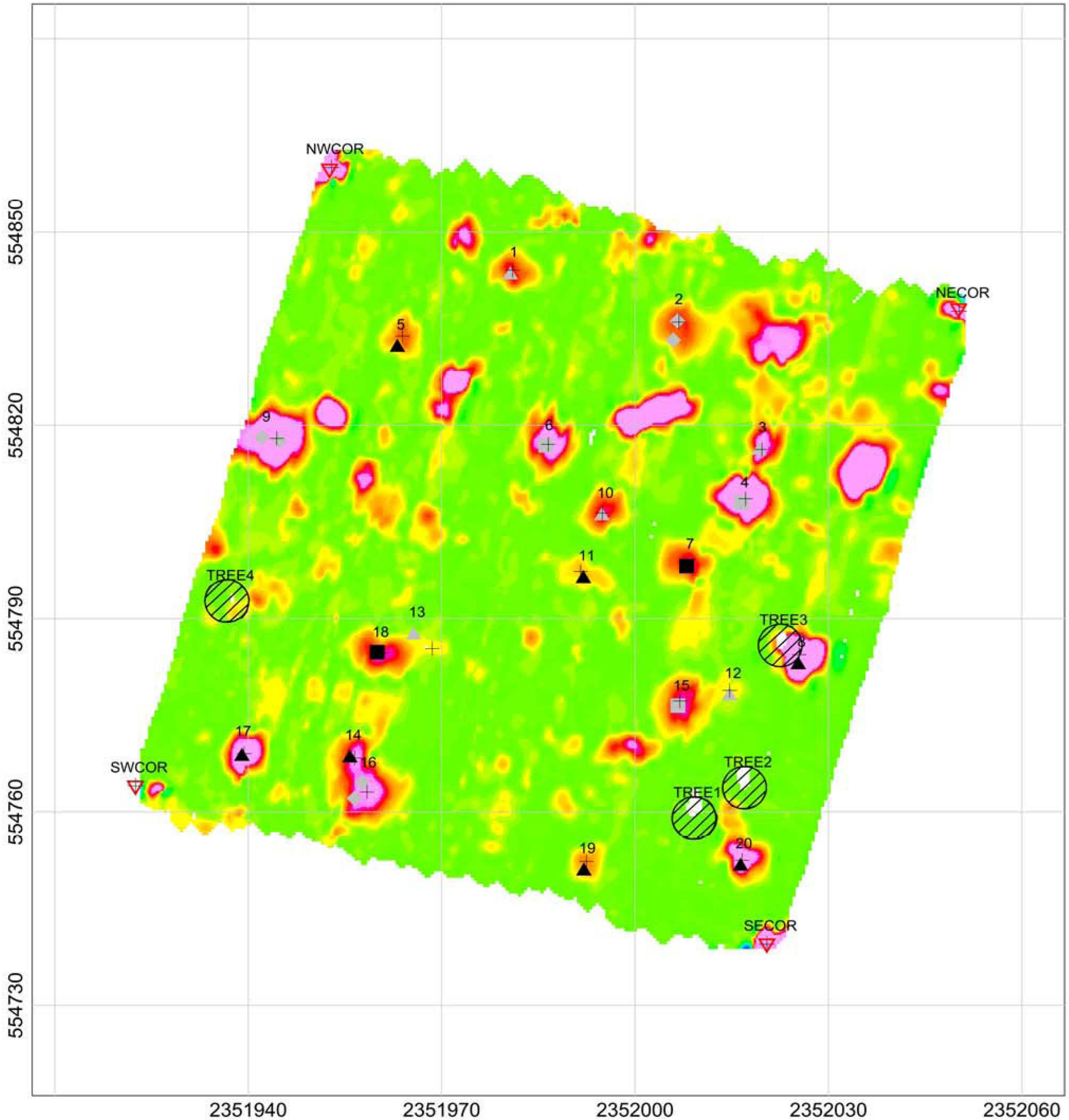
Contractor: Shaw Environmental & Infrastructure, Inc.

Created by:	Verified by:
Date: 2009/10/23	File: EM61_GPS_Final_Chan2_d_21
Page number:	Approved:

Figure 6-11

Shaw Environmental & Infrastructure, Inc.

US Army Corps of Engineers Louisville District



Geophysical Prove-Out EM61-MK2

RTK GPS Positioning System
Sum4 Data

Ravenna Army Ammunition Plant
Ravenna, Ohio

LEGEND

+ Selected Target

15

▽

Seed Item

- ▲ 75 mm
- ▲ 90 mm
- ■ 105 mm
- ■ 155 mm
- ◆ PIG (CAIS)

Map Scale: Scale 1:325
25 0
US survey foot
NAD83 / Ohio CS83 North zone

41.8
33.5
28.4
24.4
20.9
17.5
14.6
11.8
9.2
6.2
3.6
0.9
-2.0
-5.3
-8.6
-12.3
-16.7
-23.3
-34.2
Sum4
[mV]

N

Grid North: 0°0'0"
Mag North: -8°30'36"

Client: USACE - Louisville District

Project: Ravenna Army Ammunition Plant

Contractor: **Shaw Environmental & Infrastructure, Inc.**

Created by:	**Verified by:**
Date: 2009/10/23	**File: PreSeed Final_latency**
Page number:	**Approved:**

Figure 6-12

Shaw Environmental & Infrastructure, Inc.
US Army Corps of Engineers Louisville District

TABLES

1

Table 2-1
Size Comparison of Actual Items to Simulants

Seed Item	Actual Size		Simulant Size	
	Diameter (in)	Length (in)	Diameter[1] (in)	Length (in)
75mm	2.93	12	2.375	12[2]
90mm	3.54	16.25	3.5	16.25[2]
105mm	4.10	19.29	4.5	19.29
155mm	6.08	25	5.63	25
PIG	6.75	40.25	6.625	40.25

mm = millimeter
in = inches
[1] outside diameter
[2] length includes end cap

Table 2-2
Summary Table of the GPO Seed Items

Item Number	Easting (USSurvFt)	Northing (USSurvFt)	Depth (Inches)	Inclination (Degrees)	Azimuth (Degrees)	Buried Item	Simulated Projectile
1	2351980.67	554844.00	36	90	0	3.50-in Heavy Gauge Pipe	90mm
2	2352006.34	554833.48	54	0	0	6.625-in Heavy Gauge Pipe	PIG (South End)
	2352007.01	554836.45					PIG (North End) “
3	2352019.24	554816.80	24	0	0	3.50-in Heavy Gauge Pipe	90mm
4	2352016.51	554808.27	24	0	90	5.63-in Heavy Gauge Pipe	155mm
5	2351963.14	554832.78	30	0	0	2.375-in Heavy Gauge Pipe	75mm
6	2351986.16	554817.15	36	90	0	5.63-in Heavy Gauge Pipe	155mm
7	2352008.01	554798.73	42	0	300	4.50-in Heavy Gauge Pipe	105mm
8	2352025.32	554783.54	12	0	0	2.375-in Heavy Gauge Pipe	75mm
9	2351945.29	554817.81	30	45	45	6.625-in Heavy Gauge Pipe	PIG (East End)
	2351942.51	554817.81					PIG (West End)
10	2351994.85	554806.64	30	0	0	3.50-in Heavy Gauge Pipe	90mm
11	2351991.99	554796.88	30	0	90	2.375-in Heavy Gauge Pipe	75mm
12	2352014.67	554778.68	48	0	0	3.50-in Heavy Gauge Pipe	90mm
13	2351965.65	554788.15	48	0	0	3.50-in Heavy Gauge Pipe	90mm
14	2351955.77	554769.07	24	0	0	2.375-in Heavy Gauge Pipe	75mm
15	2352006.66	554776.75	48	0	0	5.63-in Heavy Gauge Pipe	155mm
16	2351956.90	554762.37	48	0	0	6.625-in Heavy Gauge Pipe	PIG (North End)
	2351958.09	554764.37					PIG (South End)
17	2351956.55	554789.66	18	0	0	2.375-in Heavy Gauge Pipe	75mm
18	2351960.01	554785.05	30	0	90	4.50-in Heavy Gauge Pipe	105mm
19	2351992.06	554751.52	36	0	0	2.375-in Heavy Gauge Pipe	75mm
20	2352016.37	554752.26	24	45	135	2.375-in Heavy Gauge Pipe	75mm

USSurvFT = United States Survey Feet
in = inches
mm = millimeter

Table 2-3
GPO Grid Corners

Grid Corner	Easting (US Survey Feet)	Northing (US Survey Feet)
NW	2351952.94	554859.99
NE	2352050.28	554837.69
SE	2352020.46	554739.47
SW	2351922.52	554764.04

North American Datum 1983 (NAD83), Ohio North State Plane coordinates, CS83 North Zone in U.S. survey feet

Table 5-1
G858 Anomaly Selection Thresholds and Background Noise Levels

G858G Magnetometer		RTS/RTK GPS
Total Field	Threshold (nT)	4
	Background noise (nT)	1.5 (standard deviation)
Vertical Gradient	Threshold (nT/ft)	3
	Background noise (nT/ft)	1 (standard deviation)

GPS = global positioning system
nT/ft = nanoTesla(s) per foot.
RTS = Robotic Total Station
RTK = real-time kinematic

Table 5-2

EM61-MK2 Anomaly Selection Thresholds and Background Noise Levels

EM61-MK2	RTS/RTK GPS
EM61-MK2 Channel 2 Threshold (mV)	3
EM61-MK2 Sum4 Threshold (mV)	8
EM61-MK2 Channel 2 Background Noise (mV)	0.97
EM61-MK2 Sum4 Background Noise (mV)	3.21

GPS = global positioning system
mV = millivolt
RTS = Robotic Total Station
RTK = real-time kinematic

Table 6-1
Calculated Background Noise Levels

Instrument	Data	GPO	Units
EM (EM61-MK2)	Channel 1	1.81	mV
	Channel 2	0.97	mV
	Channel 3	0.52	mV
	Channel 4	0.27	mV
	Sum4	3.21	mV
MAG (G858)	Total Field	1.5	nT
	Vertical Gradient	1	nT/ft

EM = electromagnetic
GPO = geophysical prove-out
MAG = magnetic
mV = millivolt
nT/ft = nanoTesla(s) per foot.

Table 6-2
GPO Targets from Magnetometer Data Using RTS Configuration - Total Field

GPO Targets (G-858 w/RTS)
Total Field
Threshhold:

Seed Item #	**Easting (Known)** US Survey Ft	**Northing (Known)** US Survey Ft	**Depth** Inches	**Inclination** Degrees	**Azimuth** Degrees	**Item**	**Weight** Lbs	**Simulates**	**Target Pick Total Field (nT)**	**Easting (Interpreted)** US Survey Ft	**Northing (Interpreted)** US Survey Ft	**Target Number**
1	2351980.67	554844.00	36	90	0	3.50-in Heavy Gauge Pipe	10	90mm	41.3	2351979.99	554844.46	108
2A	2352006.34	554833.48	54	0	0	6.625-in Heavy Gauge Pipe	85	PIG (CAIS) (South End)	578.9	2352007.84	554834.36	91
2B	2352007.01	554836.45	"	"	"	"	"	PIG (CAIS) (North End)	"	"	"	"
3	2352019.24	554816.80	24	0	0	3.50-in Heavy Gauge Pipe	10	90mm	72.3	2352019.27	554816.62	70
4	2352016.51	554808.27	24	0	90	5.63-in Heavy Gauge Pipe	25	155mm	168.4	2352015.60	554808.28	63
5	2351963.14	554832.78	30	0	0	2.375-in Heavy Gauge Pipe	5	75mm	13.3	2351961.45	554834.74	95
6	2351986.16	554817.15	36	90	0	5.63-in Heavy Gauge Pipe	25	155mm	398.9	2351985.84	554817.97	72
7	2352008.01	554798.73	42	0	300	4.50-in Heavy Gauge Pipe	15	105mm	36.6	2352008.67	554797.67	51
8	2352025.32	554783.54	12	0	0	2.375-in Heavy Gauge Pipe	5	75mm	53.0	2352025.46	554782.88	28
9A	2351945.29	554817.81	30	45	45	6.625-in Heavy Gauge Pipe	85	PIG (CAIS) (East End)	954.1	2351944.63	554818.24	74
9B	2351942.51	554818.37	"	"	"	"	"	PIG (CAIS) (West End)	"	"	"	
10	2351994.85	554806.64	30	0	0	3.50-in Heavy Gauge Pipe	10	90mm	56.0	2351996.18	554807.47	62
11	2351991.99	554796.88	30	0	90	2.375-in Heavy Gauge Pipe	5	75mm	9.7	2351994.74	554793.26	49
12	2352014.67	554778.68	48	0	0	3.50-in Heavy Gauge Pipe	10	90mm	N/A	N/A	N/A	NOT DETECTED
13	2351965.65	554788.15	48	0	0	3.50-in Heavy Gauge Pipe	10	90mm	N/A	N/A	N/A	NOT DETECTED
14	2351955.77	554769.07	24	0	0	2.375-in Heavy Gauge Pipe	5	75mm	N/A	N/A	N/A	NOT DETECTED
15	2352006.66	554776.75	48	0	0	5.63-in Heavy Gauge Pipe	25	155mm	223.9	2352007.74	554776.63	26
16A	2351956.9	554762.37	48	0	0	6.625-in Heavy Gauge Pipe	85	PIG (CAIS) (North End)	426.4	2351956.87	554763.87	12
16B	2351958.09	554764.81	"	"	"	"	"	PIG (CAIS) (South End)	"	"	"	"
17	2351956.55	554789.66	18	0	0	2.375-in Heavy Gauge Pipe	5	75mm	23.9	2351939.64	554771.99	23
18	2351960.01	554785.05	30	0	90	4.50-in Heavy Gauge Pipe	15	105mm	63.5	2351960.56	554786.69	40
19	2351992.06	554751.52	36	0	0	2.375-in Heavy Gauge Pipe	5	75mm	10.3	2351992.13	554751.96	2
20	2352016.37	554752.26	24	45	135	2.375-in Heavy Gauge Pipe	5	75mm	20.6	2352017.00	554752.50	3

Note: Inclination of 0 = Horizontal, 90 = Vertical

Table 6-3
GPO Targets from Magnetometer Data Using RTK GPS Configuration - Total Field

GPO Targets (G-858 w/RTK GPS)
Total Field
Threshhold:

Seed Item #	**Easting (Known)** US Survey Ft	**Northing (Known)** US Survey Ft	**Depth** Inches	**Inclination** Degrees	**Azimuth** Degrees	**Item**	**Weight** Lbs	**Simulates**	**Target Pick Total Field (nT)**	**Easting (Interpreted)** US Survey Ft	**Northing (Interpreted)** US Survey Ft	**Target Number**
1	2351980.67	554844.00	36	90	0	3.50-in Heavy Gauge Pipe	10	90mm	69.2	2351980.01	554844.79	38
2A	2352006.34	554833.48	54	0	0	6.625-in Heavy Gauge Pipe	85	PIG (CAIS) (South End)	471.5	2352006.93	554833.27	33
2B	2352007.01	554836.45	“	“	“	“	"	PIG (CAIS) (North End)	"	"	"	"
3	2352019.24	554816.80	24	0	0	3.50-in Heavy Gauge Pipe	10	90mm	62.6	2352019.00	554815.50	24
4	2352016.51	554808.27	24	0	90	5.63-in Heavy Gauge Pipe	25	155mm	143.7	2352015.75	554807.66	21
5	2351963.14	554832.78	30	0	0	2.375-in Heavy Gauge Pipe	5	75mm	15.6	2351963.71	554834.29	35
6	2351986.16	554817.15	36	90	0	5.63-in Heavy Gauge Pipe	25	155mm	451.0	2351986.29	554818.35	26
7	2352008.01	554798.73	42	0	300	4.50-in Heavy Gauge Pipe	15	105mm	31.8	2352008.27	554798.47	17
8	2352025.32	554783.54	12	0	0	2.375-in Heavy Gauge Pipe	5	75mm	53.0	2352024.44	554783.78	10
9A	2351945.29	554817.81	30	45	45	6.625-in Heavy Gauge Pipe	85	PIG (CAIS) (East End)	1065.3	2351945.31	554818.38	27
9B	2351942.51	554818.37	“	“	“	“	"	PIG (CAIS) (West End)	"	"	"	"
10	2351994.85	554806.64	30	0	0	3.50-in Heavy Gauge Pipe	10	90mm	55.8	2351995.56	554806.22	20
11	2351991.99	554796.88	30	0	90	2.375-in Heavy Gauge Pipe	5	75mm	N/A	N/A	N/A	NOT DETECTED
12	2352014.67	554778.68	48	0	0	3.50-in Heavy Gauge Pipe	10	90mm	N/A	N/A	N/A	NOT DETECTED
13	2351965.65	554788.15	48	0	0	3.50-in Heavy Gauge Pipe	10	90mm	N/A	N/A	N/A	NOT DETECTED
14	2351955.77	554769.07	24	0	0	2.375-in Heavy Gauge Pipe	5	75mm	N/A	N/A	N/A	NOT DETECTED
15	2352006.66	554776.75	48	0	0	5.63-in Heavy Gauge Pipe	25	155mm	237.5	2352007.00	554776.00	9
16A	2351956.9	554762.37	48	0	0	6.625-in Heavy Gauge Pipe	85	PIG (CAIS) (North End)	619.7	2351958.23	554762.69	4
16B	2351958.09	554764.81	“	“	“	“	"	PIG (CAIS) (South End)	"	"	"	"
17	2351956.55	554789.66	18	0	0	2.375-in Heavy Gauge Pipe	5	75mm	21.6	2351939.59	554768.71	6
18	2351960.01	554785.05	30	0	90	4.50-in Heavy Gauge Pipe	15	105mm	66.7	2351960.77	554785.00	11
19	2351992.06	554751.52	36	0	0	2.375-in Heavy Gauge Pipe	5	75mm	4.2	2351990.32	554752.98	46
20	2352016.37	554752.26	24	45	135	2.375-in Heavy Gauge Pipe	5	75mm	11.5	2352016.36	554752.18	1

Note: Inclination of 0 = Horizontal, 90 = Vertical

Table 6-4
GPO Targets from Magnetometer Data Using RTS Configuration - Gradient

GPO Targets (G-858 w/RTS)
Gradient
Threshhold:

Seed Item #	**Easting (Known)** US Survey Ft	**Northing (Known)** US Survey Ft	**Depth** Inches	**Inclination** Degrees	**Azimuth** Degrees	**Item**	**Weight** Lbs	**Simulates**	**Target Pick Gradient (nT/ft)**	**Easting (Interpreted)** US Survey Ft	**Northing (Interpreted)** US Survey Ft	**Target Number**
1	2351980.67	554844.00	36	90	0	3.50-in Heavy Gauge Pipe	10	90mm	20.4	2351980.77	554844.94	117
2A	2352006.34	554833.48	54	0	0	6.625-in Heavy Gauge Pipe	85	PIG (CAIS) (South End)	174.1	2352006.47	554833.62	97
2B	2352007.01	554836.45	“	“	“	“	"	PIG (CAIS) (North End)	"	"	"	"
3	2352019.24	554816.80	24	0	0	3.50-in Heavy Gauge Pipe	10	90mm	21.2	2352019.27	554816.62	72
4	2352016.51	554808.27	24	0	90	5.63-in Heavy Gauge Pipe	25	155mm	52.9	2352015.61	554808.06	66
5	2351963.14	554832.78	30	0	0	2.375-in Heavy Gauge Pipe	5	75mm	4.7	2351962.08	554834.61	99
6	2351986.16	554817.15	36	90	0	5.63-in Heavy Gauge Pipe	25	155mm	118.0	2351986.13	554817.74	74
7	2352008.01	554798.73	42	0	300	4.50-in Heavy Gauge Pipe	15	105mm	12.9	2352008.89	554797.92	53
8	2352025.32	554783.54	12	0	0	2.375-in Heavy Gauge Pipe	5	75mm	23.0	2352025.46	554782.88	33
9A	2351945.29	554817.81	30	45	45	6.625-in Heavy Gauge Pipe	85	PIG (CAIS) (East End)	311.7	2351944.65	554817.29	75
9B	2351942.51	554818.37	“	“	“	“	"	PIG (CAIS) (West End)	"	"	"	"
10	2351994.85	554806.64	30	0	0	3.50-in Heavy Gauge Pipe	10	90mm	16.34	2351996.14	554806.45	65
11	2351991.99	554796.88	30	0	90	2.375-in Heavy Gauge Pipe	5	75mm	N/A	N/A	N/A	NOT DETECTED
12	2352014.67	554778.68	48	0	0	3.50-in Heavy Gauge Pipe	10	90mm	N/A	N/A	N/A	NOT DETECTED
13	2351965.65	554788.15	48	0	0	3.50-in Heavy Gauge Pipe	10	90mm	N/A	N/A	N/A	NOT DETECTED
14	2351955.77	554769.07	24	0	0	2.375-in Heavy Gauge Pipe	5	75mm	N/A	N/A	N/A	NOT DETECTED
15	2352006.66	554776.75	48	0	0	5.63-in Heavy Gauge Pipe	25	155mm	69.6	2352008.13	554776.71	30
16A	2351956.9	554762.37	48	0	0	6.625-in Heavy Gauge Pipe	85	PIG (CAIS) (North End)	193.1	2351959.54	554762.38	15
16B	2351958.09	554764.81	“	“	“	“	"	PIG (CAIS) (South End)	"	"	"	"
17	2351956.55	554789.66	18	0	0	2.375-in Heavy Gauge Pipe	5	75mm	8.4	2351940.14	554771.79	26
18	2351960.01	554785.05	30	0	90	4.50-in Heavy Gauge Pipe	15	105mm	18.9	2351960.45	554786.51	42
19	2351992.06	554751.52	36	0	0	2.375-in Heavy Gauge Pipe	5	75mm	3.6	2351992.24	554751.94	2
20	2352016.37	554752.26	24	45	135	2.375-in Heavy Gauge Pipe	5	75mm	8.8	2352016.96	554752.50	3

Note: Inclination of 0 = Horizontal, 90 = Vertical

Table 6-5
GPO Targets from Magnetometer Data Using RTS Configuration - Gradient

GPO Targets (G-858 w/RTK)
Gradient
Threshhold:

Seed Item #	**Easting (Known)** US Survey Ft	**Northing (Known)** US Survey Ft	**Depth** Inches	**Inclination** Degrees	**Azimuth** Degrees	**Item**	**Weight** Lbs	**Simulates**	**Target Pick** **Gradient (nT/ft)**	**Easting (Interpreted)** US Survey Ft	**Northing (Interpreted)** US Survey Ft	**Target Number**
1	2351980.67	554844.00	36	90	0	3.50-in Heavy Gauge Pipe	10	90mm	22.4	2351980.02	554844.93	103
2A	2352006.34	554833.48	54	0	0	6.625-in Heavy Gauge Pipe	85	PIG (CAIS) (South End)	132.0	2352006.92	554833.77	92
2B	2352007.01	554836.45	“	“	“	“	"	PIG (CAIS) (North End)	"	"	"	"
3	2352019.24	554816.80	24	0	0	3.50-in Heavy Gauge Pipe	10	90mm	15.8	2352019.00	554815.50	77
4	2352016.51	554808.27	24	0	90	5.63-in Heavy Gauge Pipe	25	155mm	47.8	2352015.50	554807.52	72
5	2351963.14	554832.78	30	0	0	2.375-in Heavy Gauge Pipe	5	75mm	4.7	2351963.62	554834.58	95
6	2351986.16	554817.15	36	90	0	5.63-in Heavy Gauge Pipe	25	155mm	140.3	2351986.27	554818.36	79
7	2352008.01	554798.73	42	0	300	4.50-in Heavy Gauge Pipe	15	105mm	10.5	2352008.22	554798.44	64
8	2352025.32	554783.54	12	0	0	2.375-in Heavy Gauge Pipe	5	75mm	32.6	2352024.29	554783.86	39
9A	2351945.29	554817.81	30	45	45	6.625-in Heavy Gauge Pipe	85	PIG (CAIS) (East End)	347.9	2351943.89	554817.56	80
9B	2351942.51	554818.37	“	“	“	“	"	PIG (CAIS) (West End)	"	"	"	"
10	2351994.85	554806.64	30	0	0	3.50-in Heavy Gauge Pipe	10	90mm	20.3	2351995.56	554806.22	70
11	2351991.99	554796.88	30	0	90	2.375-in Heavy Gauge Pipe	5	75mm	3.9	2351994.92	554796.84	60
12	2352014.67	554778.68	48	0	0	3.50-in Heavy Gauge Pipe	10	90mm	6.8	2352013.57	554778.64	38
13	2351965.65	554788.15	48	0	0	3.50-in Heavy Gauge Pipe	10	90mm	2.6	2351968.87	554785.92	42
14	2351955.77	554769.07	24	0	0	2.375-in Heavy Gauge Pipe	5	75mm	N/A	N/A	N/A	NOT DETECTED
15	2352006.66	554776.75	48	0	0	5.63-in Heavy Gauge Pipe	25	155mm	76.1	2352007.00	554776.00	33
16A	2351956.9	554762.37	48	0	0	6.625-in Heavy Gauge Pipe	85	PIG (CAIS) (North End)	183.0	2351958.09	554762.73	26
16B	2351958.09	554764.81	“	“	“	“	"	PIG (CAIS) (South End)	"	"	"	"
17	2351956.55	554789.66	18	0	0	2.375-in Heavy Gauge Pipe	5	75mm	7.9	2351939.75	554768.27	27
18	2351960.01	554785.05	30	0	90	4.50-in Heavy Gauge Pipe	15	105mm	20.2	2351960.36	554784.59	41
19	2351992.06	554751.52	36	0	0	2.375-in Heavy Gauge Pipe	5	75mm	3.2	2351990.84	554751.44	5
20	2352016.37	554752.26	24	45	135	2.375-in Heavy Gauge Pipe	5	75mm	4.8	2352016.44	554752.22	6

Note: Inclination of 0 = Horizontal, 90 = Vertical

Table 6-6
GPO Targets from Electromagnetic Data Using RTS Configuration - Channel 2

GPO Targets (EM61-MK2 w/RTS)
Channel 2
Threshhold:

Seed Item #	**Easting (Known)** US Survey Ft	**Northing (Known)** US Survey Ft	**Depth** Inches	**Inclination** Degrees	**Azimuth** Degrees	**Item**	**Weight** Lbs	**Simulates**	**Target Pick Channel 2 (mV)**	**Easting (Interpreted)** US Survey Ft	**Northing (Interpreted)** US Survey Ft	**Target Number**
1	2351980.67	554844.00	36	90	0	3.50-in Heavy Gauge Pipe	10	90mm	12.7	2351981.51	554844.12	1
2A	2352006.34	554833.48	54	0	0	6.625-in Heavy Gauge Pipe	85	PIG (CAIS) (South End)	16.4	2352007.85	554835.05	2
2B	2352007.01	554836.45	"	"	"	"	"	PIG (CAIS) (North End)	"	"	"	"
3	2352019.24	554816.80	24	0	0	3.50-in Heavy Gauge Pipe	10	90mm	30.2	2352019.61	554816.61	3
4	2352016.51	554808.27	24	0	90	5.63-in Heavy Gauge Pipe	25	155mm	135.0	2352017.08	554807.82	4
5	2351963.14	554832.78	30	0	0	2.375-in Heavy Gauge Pipe	5	75mm	10.3	2351963.61	554833.78	5
6	2351986.16	554817.15	36	90	0	5.63-in Heavy Gauge Pipe	25	155mm	35.3	2351986.39	554816.87	6
7	2352008.01	554798.73	42	0	300	4.50-in Heavy Gauge Pipe	15	105mm	15.7	2352007.62	554798.49	7
8	2352025.32	554783.54	12	0	0	2.375-in Heavy Gauge Pipe	5	75mm	205.1	2352025.78	554784.28	8
9A	2351945.29	554817.81	30	45	45	6.625-in Heavy Gauge Pipe	85	PIG (CAIS) (East End)	142.8	2351943.83	554818.77	9
9B	2351942.51	554818.37	"	"	"	"	"	PIG (CAIS) (West End)	"	"	"	"
10	2351994.85	554806.64	30	0	0	3.50-in Heavy Gauge Pipe	10	90mm	16.3	2351995.35	554807.21	10
11	2351991.99	554796.88	30	0	90	2.375-in Heavy Gauge Pipe	5	75mm	5.7	2351991.46	554797.03	11
12	2352014.67	554778.68	48	0	0	3.50-in Heavy Gauge Pipe	10	90mm	3.5	2352014.51	554779.26	12
13	2351965.65	554788.15	48	0	0	3.50-in Heavy Gauge Pipe	10	90mm	3.2	2351968.70	554785.85	13
14	2351955.77	554769.07	24	0	0	2.375-in Heavy Gauge Pipe	5	75mm	17.9	2351955.79	554769.85	14
15	2352006.66	554776.75	48	0	0	5.63-in Heavy Gauge Pipe	25	155mm	20.8	2352007.13	554776.50	15
16A	2351956.90	554762.37	48	0	0	6.625-in Heavy Gauge Pipe	85	PIG (CAIS) (North End)	28.4	2351957.46	554764.94	16
16B	2351958.09	554764.81	"	"	"	"	"	PIG (CAIS) (South End)	"	"	"	"
17	2351956.55	554789.66	18	0	0	2.375-in Heavy Gauge Pipe	5	75mm	36.9	2351939.19	554769.42	17
18	2351960.01	554785.05	30	0	90	4.50-in Heavy Gauge Pipe	15	105mm	18.8	2351960.41	554784.41	18
19	2351992.06	554751.52	36	0	0	2.375-in Heavy Gauge Pipe	5	75mm	9.9	2351992.38	554752.71	19
20	2352016.37	554752.26	24	45	135	2.375-in Heavy Gauge Pipe	5	75mm	62.9	2352016.71	554753.89	20

Note: Inclination of 0 = Horizontal, 90 = Vertical

Table 6-7

GPO Targets from Electromagnetic Data Using RTS Configuration - Sum4

GPO Targets (EM61-MK2 w/ RTS)
Sum4
Threshhold:

Seed Item #	**Easting (Known)** US Survey Ft	**Northing (Known)** US Survey Ft	**Depth** Inches	**Inclination** Degrees	**Azimuth** Degrees	**Item**	**Weight** Lbs	**Simulates**	**Target Pick Sum4 (mV)**	**Easting (Interpreted)** US Survey Ft	**Northing (Interpreted)** US Survey Ft	**Target Number**
1	2351980.67	554844.00	36	90	0	3.50-in Heavy Gauge Pipe	10	90mm	23.3	2351981.51	554844.12	1
2A	2352006.34	554833.48	54	0	0	6.625-in Heavy Gauge Pipe	85	PIG (CAIS) (South End)	30.8	2352007.85	554835.05	2
2B	2352007.01	554836.45	“	“	“	“	"	PIG (CAIS) (North End)	"	"	"	"
3	2352019.24	554816.80	24	0	0	3.50-in Heavy Gauge Pipe	10	90mm	58.5	2352019.61	554816.61	3
4	2352016.51	554808.27	24	0	90	5.63-in Heavy Gauge Pipe	25	155mm	253.7	2352017.08	554807.82	4
5	2351963.14	554832.78	30	0	0	2.375-in Heavy Gauge Pipe	5	75mm	20.3	2351963.61	554833.78	5
6	2351986.16	554817.15	36	90	0	5.63-in Heavy Gauge Pipe	25	155mm	64.3	2351986.39	554816.87	6
7	2352008.01	554798.73	42	0	300	4.50-in Heavy Gauge Pipe	15	105mm	30.6	2352007.62	554798.49	7
8	2352025.32	554783.54	12	0	0	2.375-in Heavy Gauge Pipe	5	75mm	398.7	2352025.78	554784.28	8
9A	2351945.29	554817.81	30	45	45	6.625-in Heavy Gauge Pipe	85	PIG (CAIS) (East End)	263.0	2351943.83	554818.77	9
9B	2351942.51	554818.37	“	“	“	“	"	PIG (CAIS) (West End)	"	"	"	"
10	2351994.85	554806.64	30	0	0	3.50-in Heavy Gauge Pipe	10	90mm	32.5	2351995.35	554807.21	10
11	2351991.99	554796.88	30	0	90	2.375-in Heavy Gauge Pipe	5	75mm	11.3	2351991.46	554797.03	11
12	2352014.67	554778.68	48	0	0	3.50-in Heavy Gauge Pipe	10	90mm	6.2	2352014.51	554779.26	12
13	2351965.65	554788.15	48	0	0	3.50-in Heavy Gauge Pipe	10	90mm	6.4	2351968.70	554785.85	13
14	2351955.77	554769.07	24	0	0	2.375-in Heavy Gauge Pipe	5	75mm	35.6	2351955.79	554769.85	14
15	2352006.66	554776.75	48	0	0	5.63-in Heavy Gauge Pipe	25	155mm	39.0	2352007.13	554776.50	15
16A	2351956.90	554762.37	48	0	0	6.625-in Heavy Gauge Pipe	85	PIG (CAIS) (North End)	52.5	2351957.46	554764.94	16
16B	2351958.09	554764.81	“	“	“	“	"	PIG (CAIS) (South End)	"	"	"	"
17	2351956.55	554789.66	18	0	0	2.375-in Heavy Gauge Pipe	5	75mm	72.3	2351939.19	554769.42	17
18	2351960.01	554785.05	30	0	90	4.50-in Heavy Gauge Pipe	15	105mm	36.5	2351960.41	554784.41	18
19	2351992.06	554751.52	36	0	0	2.375-in Heavy Gauge Pipe	5	75mm	18.3	2351992.38	554752.71	19
20	2352016.37	554752.26	24	45	135	2.375-in Heavy Gauge Pipe	5	75mm	119.0	2352016.71	554753.89	20

Note: Inclination of 0 = Horizontal, 90 = Vertical

Table 6-8

GPO Targets from Electromagnetic Data Using RTK GPS Configuration - Channel 2

GPO Targets (EM61-MK2 w/RTK GPS)
Channel 2
Threshhold:

Seed Item #	**Easting (Known)** US Survey Ft	**Northing (Known)** US Survey Ft	**Depth** Inches	**Inclination** Degrees	**Azimuth** Degrees	**Item**	**Weight** Lbs	**Simulates**	**Target Pick Channel 2 (mV)**	**Easting (Interpreted)** US Survey Ft	**Northing (Interpreted)** US Survey Ft	**Target Number**
1	2351980.67	554844.00	36	90	0	3.50-in Heavy Gauge Pipe	10	90mm	14.5	2351981.03	554844.08	1
2A	2352006.34	554833.48	54	0	0	6.625-in Heavy Gauge Pipe	85	PIG (CAIS) (South End)	12.7	2352006.83	554836.01	2
2B	2352007.01	554836.45	“	“	“	“	"	PIG (CAIS) (North End)				
3	2352019.24	554816.80	24	0	0	3.50-in Heavy Gauge Pipe	10	90mm	25.2	2352019.69	554816.24	3
4	2352016.51	554808.27	24	0	90	5.63-in Heavy Gauge Pipe	25	155mm	119.8	2352017.15	554808.61	4
5	2351963.14	554832.78	30	0	0	2.375-in Heavy Gauge Pipe	5	75mm	9.6	2351963.94	554833.83	5
6	2351986.16	554817.15	36	90	0	5.63-in Heavy Gauge Pipe	25	155mm	39.9	2351986.55	554817.04	6
7	2352008.01	554798.73	42	0	300	4.50-in Heavy Gauge Pipe	15	105mm	13.4	2352007.92	554798.36	7
8	2352025.32	554783.54	12	0	0	2.375-in Heavy Gauge Pipe	5	75mm	177.3	2352025.48	554784.41	8
9A	2351945.29	554817.81	30	45	45	6.625-in Heavy Gauge Pipe	85	PIG (CAIS) (East End)	149.1	2351944.42	554817.97	9
9B	2351942.51	554818.37	“	“	“	“	"	PIG (CAIS) (West End)				
10	2351994.85	554806.64	30	0	0	3.50-in Heavy Gauge Pipe	10	90mm	16.2	2351994.95	554806.38	10
11	2351991.99	554796.88	30	0	90	2.375-in Heavy Gauge Pipe	5	75mm	5.6	2351991.58	554797.31	11
12	2352014.67	554778.68	48	0	0	3.50-in Heavy Gauge Pipe	10	90mm	2.7	2352014.69	554778.87	12
13	2351965.65	554788.15	48	0	0	3.50-in Heavy Gauge Pipe	10	90mm	3.4	2351968.55	554785.34	13
14	2351955.77	554769.07	24	0	0	2.375-in Heavy Gauge Pipe	5	75mm	29.8	2351956.52	554768.38	14
15	2352006.66	554776.75	48	0	0	5.63-in Heavy Gauge Pipe	25	155mm	19.4	2352006.94	554777.23	15
16A	2351956.9	554762.37	48	0	0	6.625-in Heavy Gauge Pipe	85	PIG (CAIS) (North End)	30.5	2351958.44	554763.09	16
16B	2351958.09	554764.81	“	“	“	“	"	PIG (CAIS) (South End)				
17	2351956.55	554789.66	18	0	0	2.375-in Heavy Gauge Pipe	5	75mm	53.0	2351939.34	554769.04	17
18	2351960.01	554785.05	30	0	90	4.50-in Heavy Gauge Pipe	15	105mm	16.6	2351960.75	554784.64	18
19	2351992.06	554751.52	36	0	0	2.375-in Heavy Gauge Pipe	5	75mm	8.5	2351992.48	554752.31	19
20	2352016.37	554752.26	24	45	135	2.375-in Heavy Gauge Pipe	5	75mm	46.5	2352016.63	554752.51	20

Note: Inclination of 0 = Horizontal, 90 = Vertical

Table 6-9
GPO Targets from Electromagnetic Data Using RTK GPS Configuration - Sum4

GPO Targets (EM61-MK2 w/RTK GPS)
Sum4
Threshhold:

Seed Item #	**Easting (Known)** US Survey Ft	**Northing (Known)** US Survey Ft	**Depth** Inches	**Inclination** Degrees	**Azimuth** Degrees	**Item**	**Weight** Lbs	**Simulates**	**Target Pick Sum4 (mV)**	**Easting (Interpreted)** US Survey Ft	**Northing (Interpreted)** US Survey Ft	**Target Number**
1	2351980.67	554844.00	36	90	0	3.50-in Heavy Gauge Pipe	10	90mm	26.1	2351981.03	554844.08	1
2A	2352006.34	554833.48	54	0	0	6.625-in Heavy Gauge Pipe	85	PIG (CAIS) (South End)	23.0	2352006.83	554836.01	2
2B	2352007.01	554836.45	"	"	"	"	"	PIG (CAIS) (North End)	"	"	"	"
3	2352019.24	554816.80	24	0	0	3.50-in Heavy Gauge Pipe	10	90mm	48.5	2352019.69	554816.24	3
4	2352016.51	554808.27	24	0	90	5.63-in Heavy Gauge Pipe	25	155mm	226.0	2352017.15	554808.61	4
5	2351963.14	554832.78	30	0	0	2.375-in Heavy Gauge Pipe	5	75mm	19.2	2351963.94	554833.83	5
6	2351986.16	554817.15	36	90	0	5.63-in Heavy Gauge Pipe	25	155mm	72.7	2351986.55	554817.04	6
7	2352008.01	554798.73	42	0	300	4.50-in Heavy Gauge Pipe	15	105mm	27.6	2352007.92	554798.36	7
8	2352025.32	554783.54	12	0	0	2.375-in Heavy Gauge Pipe	5	75mm	345.5	2352025.48	554784.41	8
9A	2351945.29	554817.81	30	45	45	6.625-in Heavy Gauge Pipe	85	PIG (CAIS) (East End)	274.9	2351944.42	554817.97	9
9B	2351942.51	554818.37	"	"	"	"	"	PIG (CAIS) (West End)	"	"	"	"
10	2351994.85	554806.64	30	0	0	3.50-in Heavy Gauge Pipe	10	90mm	32.4	2351994.95	554806.38	10
11	2351991.99	554796.88	30	0	90	2.375-in Heavy Gauge Pipe	5	75mm	10.8	2351991.58	554797.31	11
12	2352014.67	554778.68	48	0	0	3.50-in Heavy Gauge Pipe	10	90mm	6.6	2352014.69	554778.87	12
13	2351965.65	554788.15	48	0	0	3.50-in Heavy Gauge Pipe	10	90mm	6.7	2351968.55	554785.34	13
14	2351955.77	554769.07	24	0	0	2.375-in Heavy Gauge Pipe	5	75mm	56.1	2351956.52	554768.38	14
15	2352006.66	554776.75	48	0	0	5.63-in Heavy Gauge Pipe	25	155mm	35.7	2352006.94	554777.23	15
16A	2351956.90	554762.37	48	0	0	6.625-in Heavy Gauge Pipe	85	PIG (CAIS) (North End)	56.8	2351958.44	554763.09	16
16B	2351958.09	554764.81	"	"	"	"	"	PIG (CAIS) (South End)	"	"	"	"
17	2351956.55	554789.66	18	0	0	2.375-in Heavy Gauge Pipe	5	75mm	103.5	2351939.34	554769.04	17
18	2351960.01	554785.05	30	0	90	4.50-in Heavy Gauge Pipe	15	105mm	32.2	2351960.75	554784.64	18
19	2351992.06	554751.52	36	0	0	2.375-in Heavy Gauge Pipe	5	75mm	16.2	2351992.48	554752.31	19
20	2352016.37	554752.26	24	45	135	2.375-in Heavy Gauge Pipe	5	75mm	88.4	2352016.63	554752.51	20

Note: Inclination of 0 = Horizontal, 90 = Vertical

APPENDIX A
PHOTOGRAPHS

DESCRIPTION OF BURIED SEED ITEMS IN THE GEOPHYSICAL PROVE - OUT PLOT

RAVENNA ARMY AMMUNITION PLANT

Photograph: General site conditions of GPO area

DIGITAL IMAGE FILENAME: P1010029.JPG

DESCRIPTION OF BURIED SEED ITEMS IN THE GEOPHYSICAL PROVEOUT PLOT

RAVENNA ARMY AMMUNITION PLANT

Photograph: Excavation of seed item location

DIGITAL IMAGE FILENAME: P1010027.JPG

APPENDIX B
BURIED SEED ITEM DESCRIPTIONS

DESCRIPTION OF BURIED SEED ITEMS
IN THE GEOPHYSICAL PROVE - OUT PLOT

RAVENNA ARMY AMMUNITION PLANT

GPO Location: RVAAP

Site Geophysicist: Mark Kick 10.22.2009
Signature *Date*

COLUMN NUMBER: N/A **ROW NUMBER:** N/A

BURIED ITEM(S) IN CELL: 90mm simulant

CONDITION OF BURIED ITEM(S) (choose all that apply)**:**

■ **GOOD CONDITION**

□ **RUSTED**

□ **DENTED**

□ **PARTIAL ITEM:** ____________________

□ **CRUSHED**

■ **OTHER:** heavy gauge steel pipe

APPROXIMATE TOTAL WEIGHT OF BURIED ITEM(S): 10.0 lbs

SOIL PROFILE DESCRIPTION:

DEPTH OF BURIAL (to top of item(s))**:** 60”

NORTHING/EASTING: N 554844.00 / E 2351980.67

GENERAL INCLINATION: Vertical (90°)

GENERAL AZIMUTH: □ **N-S** □ **E-W** □ **NW-SE** □ **NE-SW** ■ **N/A**

DIGITAL IMAGE FILENAME: Item 1

DESCRIPTION OF BURIED SEED ITEMS IN THE GEOPHYSICAL PROVEOUT PLOT

RAVENNA ARMY AMMUNITION PLANT

GPO Location: RVAAP **Site Geophysicist:** Mark Kick 10.22.2009
Signature *Date*

COLUMN NUMBER: N/A **ROW NUMBER:** N/A

BURIED ITEM(S) IN CELL: PIG (CAIS) simulant

CONDITION OF BURIED ITEM(S) (choose all that apply)**:**

■ **GOOD CONDITION** □ **RUSTED**

□ **DENTED** □ **PARTIAL ITEM:** ____________________

□ **CRUSHED** ■ **OTHER:** heavy gauge steel pipe

APPROXIMATE TOTAL WEIGHT OF BURIED ITEM(S): 85.0 lbs

SOIL PROFILE DESCRIPTION:

DEPTH OF BURIAL (to top of item(s))**:** 54”

NORTHING/EASTING: N 554836.44 / E 2352007.01 (North End)
N 554833.48 / E 2352006.34 (South End)

GENERAL INCLINATION: Horizontal (0°)

GENERAL AZIMUTH: ■ **N-S** □ **E-W** □ **NW-SE** □ **NE-SW** □ **N/A**

DIGITAL IMAGE FILENAME: Item 2

DESCRIPTION OF BURIED SEED ITEMS IN THE GEOPHYSICAL PROVEOUT PLOT

RAVENNA ARMY AMMUNITION PLANT

GPO Location: RVAAP **Site Geophysicist:** Mark Kick 10.22.2009
Signature *Date*

COLUMN NUMBER: N/A **ROW NUMBER:** N/A

BURIED ITEM(S) IN CELL: 90mm simulant

CONDITION OF BURIED ITEM(S) (choose all that apply)**:**

■ **GOOD CONDITION** □ **RUSTED**

□ **DENTED** □ **PARTIAL ITEM:** __________

□ **CRUSHED** ■ **OTHER:** heavy gauge steel pipe

APPROXIMATE TOTAL WEIGHT OF BURIED ITEM(S): 10.0 lbs

SOIL PROFILE DESCRIPTION:

DEPTH OF BURIAL (to top of item(s))**:** 24”

NORTHING/EASTING: N 554816.80 / E 2352019.24

GENERAL INCLINATION: Horizontal (0°)

GENERAL AZIMUTH: ■ **N-S** □ **E-W** □ **NW-SE** □ **NE-SW** □ **N/A**

DIGITAL IMAGE FILENAME: Item 3

DESCRIPTION OF BURIED SEED ITEMS IN THE GEOPHYSICAL PROVEOUT PLOT

RAVENNA ARMY AMMUNITION PLANT

GPO Location: RVAAP

Site Geophysicist: Mark Kick 10.22.2009
Signature *Date*

COLUMN NUMBER: N/A **ROW NUMBER:** N/A

BURIED ITEM(S) IN CELL: 155mm simulant

CONDITION OF BURIED ITEM(S) (choose all that apply)**:**

■ **GOOD CONDITION** □ **RUSTED**

□ **DENTED** □ **PARTIAL ITEM:** ____________________

□ **CRUSHED** ■ **OTHER:** heavy gauge steel pipe

APPROXIMATE TOTAL WEIGHT OF BURIED ITEM(S): 25.0 lbs

SOIL PROFILE DESCRIPTION:

DEPTH OF BURIAL (to top of item(s))**:** 24”

NORTHING/EASTING: N 554808.27 / E 2352016.51

GENERAL INCLINATION: Horizontal (0°)

GENERAL AZIMUTH: □ **N-S** ■ **E-W** □ **NW-SE** □ **NE-SW** □ **N/A**

DIGITAL IMAGE FILENAME: Item 4

DESCRIPTION OF BURIED SEED ITEMS IN THE GEOPHYSICAL PROVEOUT PLOT

RAVENNA ARMY AMMUNITION PLANT

GPO Location: RVAAP

Site Geophysicist: Mark Kick 10.22.2009
Signature *Date*

COLUMN NUMBER: N/A **ROW NUMBER:** N/A

BURIED ITEM(S) IN CELL: 75mm simulant

CONDITION OF BURIED ITEM(S) (choose all that apply)**:**

■ **GOOD CONDITION** □ **RUSTED**

□ **DENTED** □ **PARTIAL ITEM:** ____________

□ **CRUSHED** ■ **OTHER:** heavy gauge steel pipe

APPROXIMATE TOTAL WEIGHT OF BURIED ITEM(S): 5.0 lbs

SOIL PROFILE DESCRIPTION:

DEPTH OF BURIAL (to top of item(s))**:** 30”

NORTHING/EASTING: N 554832.78 / E 2351963.14

GENERAL INCLINATION: Horizontal (0°)

GENERAL AZIMUTH: ■ **N-S** □ **E-W** □ **NW-SE** □ **NE-SW** □ **N/A**

DIGITAL IMAGE FILENAME: Item 5

DESCRIPTION OF BURIED SEED ITEMS IN THE GEOPHYSICAL PROVEOUT PLOT

RAVENNA ARMY AMMUNITION PLANT

GPO Location: RVAAP **Site Geophysicist:** Mark Kick 10.22.2009
Signature *Date*

COLUMN NUMBER: N/A **ROW NUMBER:** N/A

BURIED ITEM(S) IN CELL: 155mm simulant

CONDITION OF BURIED ITEM(S) (choose all that apply)**:**

■ **GOOD CONDITION** □ **RUSTED**

□ **DENTED** □ **PARTIAL ITEM:** ____________________

□ **CRUSHED** ■ **OTHER:** heavy gauge steel pipe

APPROXIMATE TOTAL WEIGHT OF BURIED ITEM(S): 25.0 lbs

SOIL PROFILE DESCRIPTION:

DEPTH OF BURIAL (to top of item(s))**:** 36"

NORTHING/EASTING: N 554817.15 / E 2351986.16

GENERAL INCLINATION: Vertical (90°)

GENERAL AZIMUTH: ■ **N-S** □ **E-W** □ **NW-SE** □ **NE-SW** □ **N/A**

DIGITAL IMAGE FILENAME: Item 6

DESCRIPTION OF BURIED SEED ITEMS IN THE GEOPHYSICAL PROVEOUT PLOT

RAVENNA ARMY AMMUNITION PLANT

GPO Location: **RVAAP** **Site Geophysicist:** Mark Kick 10.22.2009
Signature *Date*

COLUMN NUMBER: N/A **ROW NUMBER:** N/A

BURIED ITEM(S) IN CELL: 105mm simulant

CONDITION OF BURIED ITEM(S) (choose all that apply)**:**

■ **GOOD CONDITION** □ **RUSTED**

□ **DENTED** □ **PARTIAL ITEM:** ____________________

□ **CRUSHED** ■ **OTHER:** heavy gauge steel pipe

APPROXIMATE TOTAL WEIGHT OF BURIED ITEM(S): 15.0 lbs

SOIL PROFILE DESCRIPTION:

DEPTH OF BURIAL (to top of item(s))**:** 42"

NORTHING/EASTING: N 554798.73 / E 2352008.01

GENERAL INCLINATION: Horizontal (0°)

GENERAL AZIMUTH: □ **N-S** □ **E-W** ■ **NW-SE** □ **NE-SW** □ **N/A**

DIGITAL IMAGE FILENAME Item 7

DESCRIPTION OF BURIED SEED ITEMS IN THE GEOPHYSICAL PROVEOUT PLOT

RAVENNA ARMY AMMUNITION PLANT

GPO Location: RVAAP **Site Geophysicist:** Mark Kick 10.22.2009
Signature *Date*

COLUMN NUMBER: N/A **ROW NUMBER:** N/A

BURIED ITEM(S) IN CELL: 75mm simulant

CONDITION OF BURIED ITEM(S) (choose all that apply)**:**

■ **GOOD CONDITION** □ **RUSTED**

□ **DENTED** □ **PARTIAL ITEM:** __________________

□ **CRUSHED** ■ **OTHER:** heavy gauge steel pipe

APPROXIMATE TOTAL WEIGHT OF BURIED ITEM(S): 5.0 lbs

SOIL PROFILE DESCRIPTION:

DEPTH OF BURIAL (to top of item(s))**:** 12”

NORTHING/EASTING: N 554783.54 / E 2352025.32

GENERAL INCLINATION: Horizontal (0°)

GENERAL AZIMUTH: ■ **N-S** □ **E-W** □ **NW-SE** □ **NE-SW** □ **N/A**

DIGITAL IMAGE FILENAME: Item 8

DESCRIPTION OF BURIED SEED ITEMS IN THE GEOPHYSICAL PROVEOUT PLOT

RAVENNA ARMY AMMUNITION PLANT

GPO Location: RVAAP **Site Geophysicist:** Mark Kick 10.22.2009
Signature *Date*

COLUMN NUMBER: N/A **ROW NUMBER:** N/A

BURIED ITEM(S) IN CELL: PIG (CAIS)

CONDITION OF BURIED ITEM(S) (choose all that apply)**:**

■ **GOOD CONDITION** □ **RUSTED**

□ **DENTED** □ **PARTIAL ITEM:** ___________________

□ **CRUSHED** ■ **OTHER:** heavy gauge steel pipe

APPROXIMATE TOTAL WEIGHT OF BURIED ITEM(S): 85.0 lbs

SOIL PROFILE DESCRIPTION:

DEPTH OF BURIAL (to top of item(s))**:** 30”

NORTHING/EASTING: N 554818.37 / E 2351942.51 (West End)
N 554817.81 / E 2351945.29 (East End)

GENERAL INCLINATION: 45°

GENERAL AZIMUTH: □ **N-S** □ **E-W** □ **NW-SE** ■ **NE-SW** □ **N/A**

DIGITAL IMAGE FILENAME: Item 9

DESCRIPTION OF BURIED SEED ITEMS IN THE GEOPHYSICAL PROVEOUT PLOT

RAVENNA ARMY AMMUNITION PLANT

GPO Location: RVAAP

Site Geophysicist: Mark Kick 10.22.2009
Signature *Date*

COLUMN NUMBER: N/A **ROW NUMBER:** N/A

BURIED ITEM(S) IN CELL: 90mm simulant

CONDITION OF BURIED ITEM(S) (choose all that apply)**:**

■ **GOOD CONDITION** □ **RUSTED**

□ **DENTED** □ **PARTIAL ITEM:** ____________________

□ **CRUSHED** ■ **OTHER:** heavy gauge steel pipe

APPROXIMATE TOTAL WEIGHT OF BURIED ITEM(S): 10.0 lbs

SOIL PROFILE DESCRIPTION:

DEPTH OF BURIAL (to top of item(s))**:** 30”

NORTHING/EASTING: N 554806.64 / E 2351994.85

GENERAL INCLINATION: Horizontal (0°)

GENERAL AZIMUTH: ■ **N-S** □ **E-W** □ **NW-SE** □ **NE-SW** □ **N/A**

DIGITAL IMAGE FILENAME: Item 10

DESCRIPTION OF BURIED SEED ITEMS IN THE GEOPHYSICAL PROVEOUT PLOT

RAVENNA ARMY AMMUNITION PLANT

GPO Location: RVAAP **Site Geophysicist:** Mark Kick 10.22.2009
Signature *Date*

COLUMN NUMBER: N/A **ROW NUMBER:** N/A

BURIED ITEM(S) IN CELL: 75mm simulant

CONDITION OF BURIED ITEM(S) (choose all that apply)**:**

■ **GOOD CONDITION** □ **RUSTED**

□ **DENTED** □ **PARTIAL ITEM:** ____________

□ **CRUSHED** ■ **OTHER:** heavy gauge steel pipe

APPROXIMATE TOTAL WEIGHT OF BURIED ITEM(S): 5.0 lbs

SOIL PROFILE DESCRIPTION:

DEPTH OF BURIAL (to top of item(s))**:** 30”

NORTHING/EASTING: N 554796.88 / E 2351991.99

GENERAL INCLINATION: Horizontal (0°)

GENERAL AZIMUTH: □ **N-S** ■ **E-W** □ **NW-SE** □ **NE-SW** □ **N/A**

DIGITAL IMAGE FILENAME: Item 11

DESCRIPTION OF BURIED SEED ITEMS IN THE GEOPHYSICAL PROVEOUT PLOT

RAVENNA ARMY AMMUNITION PLANT

GPO Location: RVAAP

Site Geophysicist: Mark Kick 10.22.2009
Signature *Date*

COLUMN NUMBER: N/A **ROW NUMBER:** N/A

BURIED ITEM(S) IN CELL: 90mm simulant

CONDITION OF BURIED ITEM(S) (choose all that apply)**:**

■ **GOOD CONDITION** □ **RUSTED**

□ **DENTED** □ **PARTIAL ITEM:** ____________________

□ **CRUSHED** ■ **OTHER:** heavy gauge steel pipe

APPROXIMATE TOTAL WEIGHT OF BURIED ITEM(S): 10.0 lbs

SOIL PROFILE DESCRIPTION:

DEPTH OF BURIAL (to top of item(s))**:** 48"

NORTHING/EASTING: N 554778.68 / E 2352014.67

GENERAL INCLINATION: Horizontal (0°)

GENERAL AZIMUTH: ■ **N-S** □ **E-W** □ **NW-SE** □ **NE-SW** □ **N/A**

DIGITAL IMAGE FILENAME: Item 12

DESCRIPTION OF BURIED SEED ITEMS IN THE GEOPHYSICAL PROVEOUT PLOT

RAVENNA ARMY AMMUNITION PLANT

GPO Location: RVAAP **Site Geophysicist:** Mark Kick 10.22.2009
Signature *Date*

COLUMN NUMBER: N/A **ROW NUMBER:** N/A

BURIED ITEM(S) IN CELL: 90mm simulant

CONDITION OF BURIED ITEM(S) (choose all that apply)**:**

■ **GOOD CONDITION** □ **RUSTED**

□ **DENTED** □ **PARTIAL ITEM:** ____________

□ **CRUSHED** ■ **OTHER:** heavy gauge steel pipe

APPROXIMATE TOTAL WEIGHT OF BURIED ITEM(S): 10.0 lbs

SOIL PROFILE DESCRIPTION:

DEPTH OF BURIAL (to top of item(s))**:** 48”

NORTHING/EASTING: N 554788.15 / E 2351965.65

GENERAL INCLINATION: Horizontal (0°)

GENERAL AZIMUTH: ■ **N-S** □ **E-W** □ **NW-SE** □ **NE-SW** □ **N/A**

DIGITAL IMAGE FILENAME: Item 13

DESCRIPTION OF BURIED SEED ITEMS IN THE GEOPHYSICAL PROVE - OUT PLOT

RAVENNA ARMY AMMUNITION PLANT

GPO Location: RVAAP **Site Geophysicist:** Mark Kick 10.22.2009
Signature *Date*

COLUMN NUMBER: N/A **ROW NUMBER:** N/A

BURIED ITEM(S) IN CELL: 75mm simulant

CONDITION OF BURIED ITEM(S) (choose all that apply)**:**

■ **GOOD CONDITION** □ **RUSTED**

□ **DENTED** □ **PARTIAL ITEM:** ____________________

□ **CRUSHED** ■ **OTHER:** heavy gauge steel pipe

APPROXIMATE TOTAL WEIGHT OF BURIED ITEM(S): 5.0 lbs

SOIL PROFILE DESCRIPTION:

DEPTH OF BURIAL (to top of item(s))**:** 24”

NORTHING/EASTING: N 554769.07 / E 2351955.77

GENERAL INCLINATION: Horizontal (0°)

GENERAL AZIMUTH: ■ **N-S** □ **E-W** □ **NW-SE** □ **NE-SW** □ **N/A**

DIGITAL IMAGE FILENAME: Item 14

DESCRIPTION OF BURIED SEED ITEMS IN THE GEOPHYSICAL PROVEOUT PLOT

RAVENNA ARMY AMMUNITION PLANT

GPO Location: RVAAP **Site Geophysicist:** Mark Kick 10.22.2009
Signature *Date*

COLUMN NUMBER: N/A **ROW NUMBER:** N/A

BURIED ITEM(S) IN CELL: 155mm simulant

CONDITION OF BURIED ITEM(S) (choose all that apply)**:**

■ **GOOD CONDITION** □ **RUSTED**

□ **DENTED** □ **PARTIAL ITEM:** ____________

□ **CRUSHED** ■ **OTHER:** heavy gauge steel pipe

APPROXIMATE TOTAL WEIGHT OF BURIED ITEM(S): 25.0 lbs

SOIL PROFILE DESCRIPTION:

DEPTH OF BURIAL (to top of item(s))**:** 48"

NORTHING/EASTING: N 554776.75 / E 2352006.66

GENERAL INCLINATION: Horizontal (0°)

GENERAL AZIMUTH: ■ **N-S** □ **E-W** □ **NW-SE** □ **NE-SW** □ **N/A**

DIGITAL IMAGE FILENAME: Item 15

DESCRIPTION OF BURIED SEED ITEMS IN THE GEOPHYSICAL PROVEOUT PLOT

RAVENNA ARMY AMMUNITION PLANT

GPO Location: RVAAP **Site Geophysicist:** Mark Kick 10.22.2009
Signature *Date*

COLUMN NUMBER: N/A **ROW NUMBER:** N/A

BURIED ITEM(S) IN CELL: PIG (CAIS) simulant

CONDITION OF BURIED ITEM(S) (choose all that apply)**:**

■ **GOOD CONDITION** □ **RUSTED**

□ **DENTED** □ **PARTIAL ITEM:** ____________

□ **CRUSHED** ■ **OTHER:** heavy gauge steel pipe

APPROXIMATE TOTAL WEIGHT OF BURIED ITEM(S): 85.0 lbs

SOIL PROFILE DESCRIPTION:

DEPTH OF BURIAL (to top of item(s))**:** 48”

NORTHING/EASTING: N 554762.37 / E 2351956.90 (North End)
N 554764.81 / E 2351958.09 (South End)

GENERAL INCLINATION: Horizontal (0°)

GENERAL AZIMUTH: ■ **N-S** □ **E-W** □ **NW-SE** □ **NE-SW** □ **N/A**

DIGITAL IMAGE FILENAME: Item 16

DESCRIPTION OF BURIED SEED ITEMS IN THE GEOPHYSICAL PROVEOUT PLOT

RAVENNA ARMY AMMUNITION PLANT

GPO Location: RVAAP **Site Geophysicist:** Mark Kick 10.22.2009
Signature *Date*

COLUMN NUMBER: N/A **ROW NUMBER:** N/A

BURIED ITEM(S) IN CELL: 75mm simulant

CONDITION OF BURIED ITEM(S) (choose all that apply)**:**

■ **GOOD CONDITION** □ **RUSTED**

□ **DENTED** □ **PARTIAL ITEM:** ____________________

□ **CRUSHED** ■ **OTHER:** heavy gauge steel pipe

APPROXIMATE TOTAL WEIGHT OF BURIED ITEM(S): 5.0 lbs

SOIL PROFILE DESCRIPTION:

DEPTH OF BURIAL (to top of item(s))**:** 18”

NORTHING/EASTING: N 554789.66/E 2351956.55

GENERAL INCLINATION: Horizontal (0°)

GENERAL AZIMUTH: ■ **N-S** □ **E-W** □ **NW-SE** □ **NE-SW** □ **N/A**

DIGITAL IMAGE FILENAME: Item 17

DESCRIPTION OF BURIED SEED ITEMS
IN THE GEOPHYSICAL PROVEOUT PLOT

RAVENNA ARMY AMMUNITION PLANT

GPO Location: RVAAP

Site Geophysicist: Mark Kick 10.22.2009
Signature *Date*

COLUMN NUMBER: N/A **ROW NUMBER:** N/A

BURIED ITEM(S) IN CELL: 105mm simulant

CONDITION OF BURIED ITEM(S) (choose all that apply)**:**

■ **GOOD CONDITION**
□ **RUSTED**
□ **DENTED**
□ **PARTIAL ITEM:** ____________
□ **CRUSHED**
■ **OTHER:** heavy gauge steel pipe

APPROXIMATE TOTAL WEIGHT OF BURIED ITEM(S): 15.0 lbs

SOIL PROFILE DESCRIPTION:

DEPTH OF BURIAL (to top of item(s))**:** 30”

NORTHING/EASTING: N 554785.05/E 2351960.01

GENERAL INCLINATION: Horizontal (0°)

GENERAL AZIMUTH: □ **N-S** ■ **E-W** □ **NW-SE** □ **NE-SW** □ **N/A**

DIGITAL IMAGE FILENAME: Item 18

DESCRIPTION OF BURIED SEED ITEMS IN THE GEOPHYSICAL PROVEOUT PLOT

RAVENNA ARMY AMMUNITION PLANT

GPO Location: RVAAP **Site Geophysicist:** Mark Kick 10.22.2009
Signature *Date*

COLUMN NUMBER: N/A **ROW NUMBER:** N/A

BURIED ITEM(S) IN CELL: 75mm simulant

CONDITION OF BURIED ITEM(S) (choose all that apply)**:**

■ **GOOD CONDITION** □ **RUSTED**

□ **DENTED** □ **PARTIAL ITEM:** ____________________

□ **CRUSHED** ■ **OTHER:** heavy gauge steel pipe

APPROXIMATE TOTAL WEIGHT OF BURIED ITEM(S): 5.0 lbs

SOIL PROFILE DESCRIPTION:

DEPTH OF BURIAL (to top of item(s))**:** 36”

NORTHING/EASTING: N 554751.52/E 2351992.06

GENERAL INCLINATION: Horizontal (0°)

GENERAL AZIMUTH: ■ **N-S** □ **E-W** □ **NW-SE** □ **NE-SW** □ **N/A**

DIGITAL IMAGE FILENAME: Item 19

DESCRIPTION OF BURIED SEED ITEMS IN THE GEOPHYSICAL PROVEOUT PLOT

RAVENNA ARMY AMMUNITION PLANT

GPO Location: RVAAP **Site Geophysicist:** Mark Kick 10.22.2009
Signature *Date*

COLUMN NUMBER: N/A **ROW NUMBER:** N/A

BURIED ITEM(S) IN CELL: 75mm simulant

CONDITION OF BURIED ITEM(S) (choose all that apply)**:**

■ **GOOD CONDITION** □ **RUSTED**

□ **DENTED** □ **PARTIAL ITEM:** ____________

□ **CRUSHED** ■ **OTHER:** heavy gauge steel pipe

APPROXIMATE TOTAL WEIGHT OF BURIED ITEM(S): 5.0 lbs

SOIL PROFILE DESCRIPTION:

DEPTH OF BURIAL (to top of item(s))**:** 24”

NORTHING/EASTING: N 554752.26/E 2352016.37

GENERAL INCLINATION: 45°

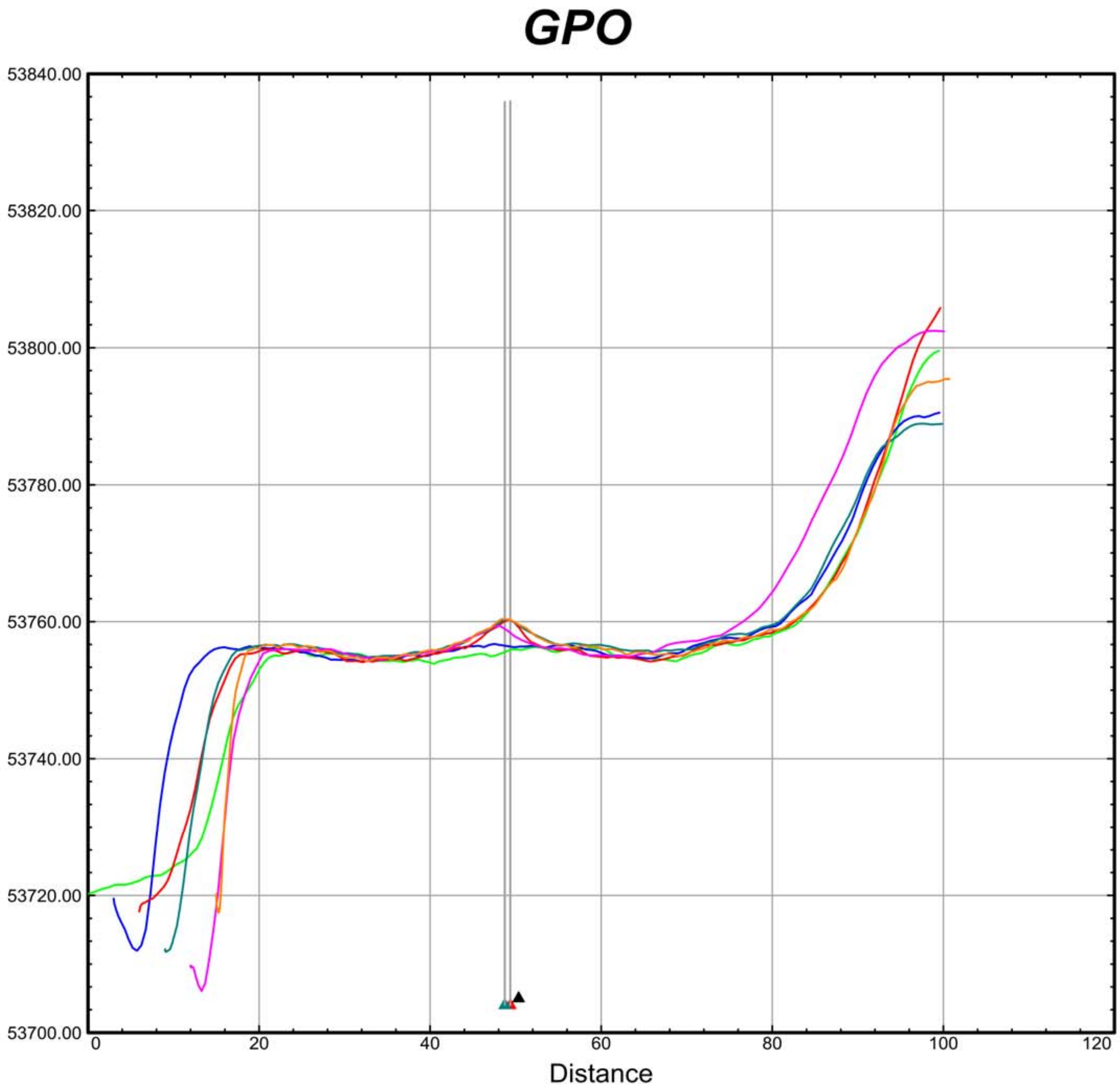
GENERAL AZIMUTH: □ **N-S** □ **E-W** ■ **NW-SE** □ **NE-SW** □ **N/A**

DIGITAL IMAGE FILENAME Item 20

APPENDIX C
GEOPHYSICAL DATA AND ELECTRONIC FILES
(submitted on compact disc)

1

APPENDIX D
QUALITY CONTROL LOGS



database: c:\shaw projects\RVAAP\field data\EM61 Data\10 22 2009\data Channel: Z1

Geophysical Prove-Out 6 Line Test

G-858G Magnetometer
Bottom Sensor

LEGEND

Proposed distance lag = -1.534
Proposed time lag = -0.254 sec

Map Scale: Scale 1:800 (meters)

Grid North: 0°0'0"
Mag North: -8°30'36"

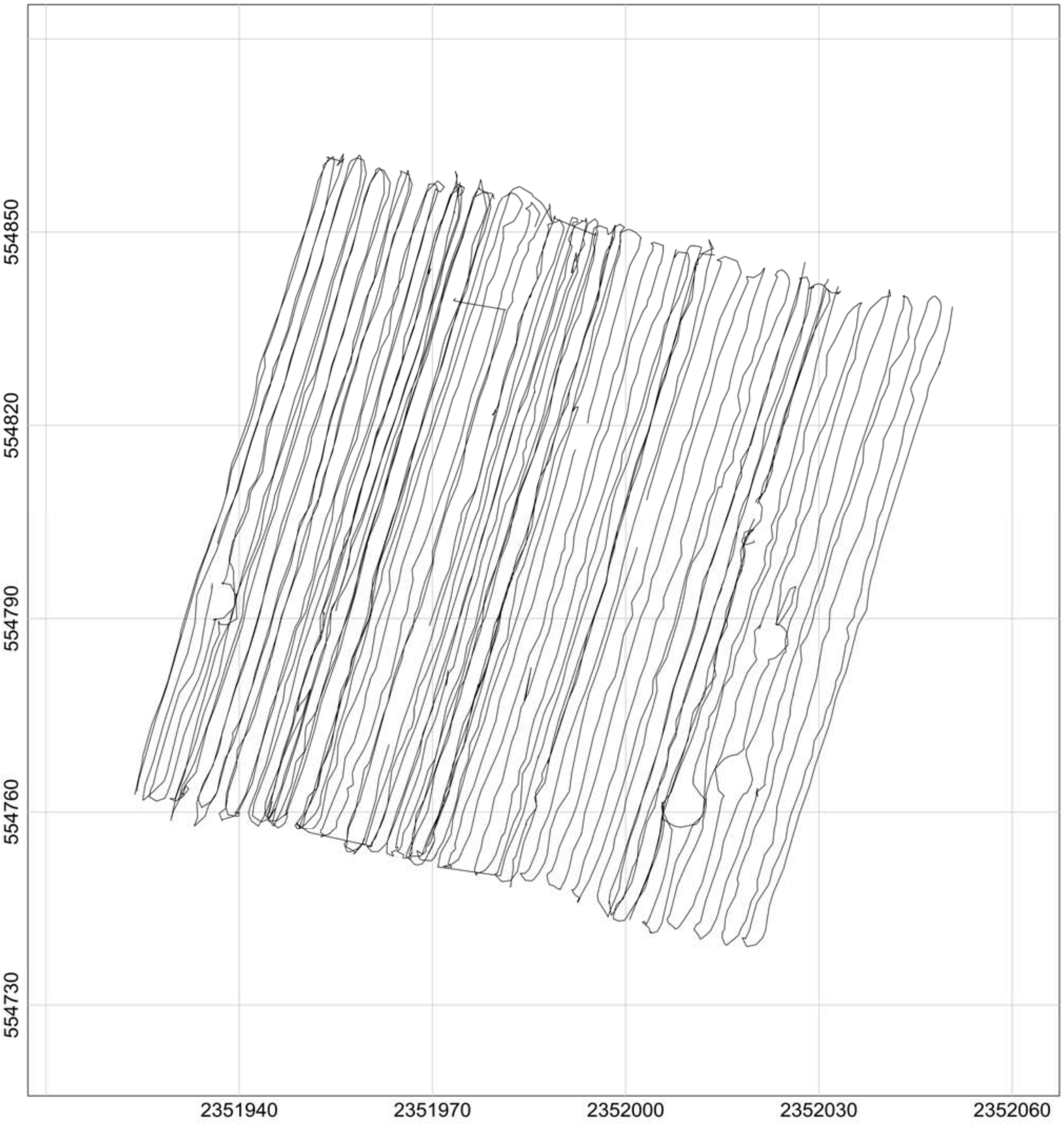
Client: USACE - Louisville District

Project: Ravenna Army Ammunition Plant

Contractor: Shaw Environmental & Infrastructure, Inc.

Created by:	Verified by:
Date: 2009/10/23	File: dataset2_edit_6LineTest
Page number:	Approved:

Shaw Environmental & Infrastructure, Inc.
US Army Corps of Engineers Louisville District



Geophysical Prove-Out EM61-MK2

RTK GPS Positioning System Track Map

Ravenna Army Ammunition Plant
Ravenna, Ohio

LEGEND

Map Scale: Scale 1:325, 25 – 0 US survey foot, NAD83 / Ohio CS83 North zone

Grid North: 0°0'0"
Mag North: -8°30'36"

Client: USACE - Louisville District

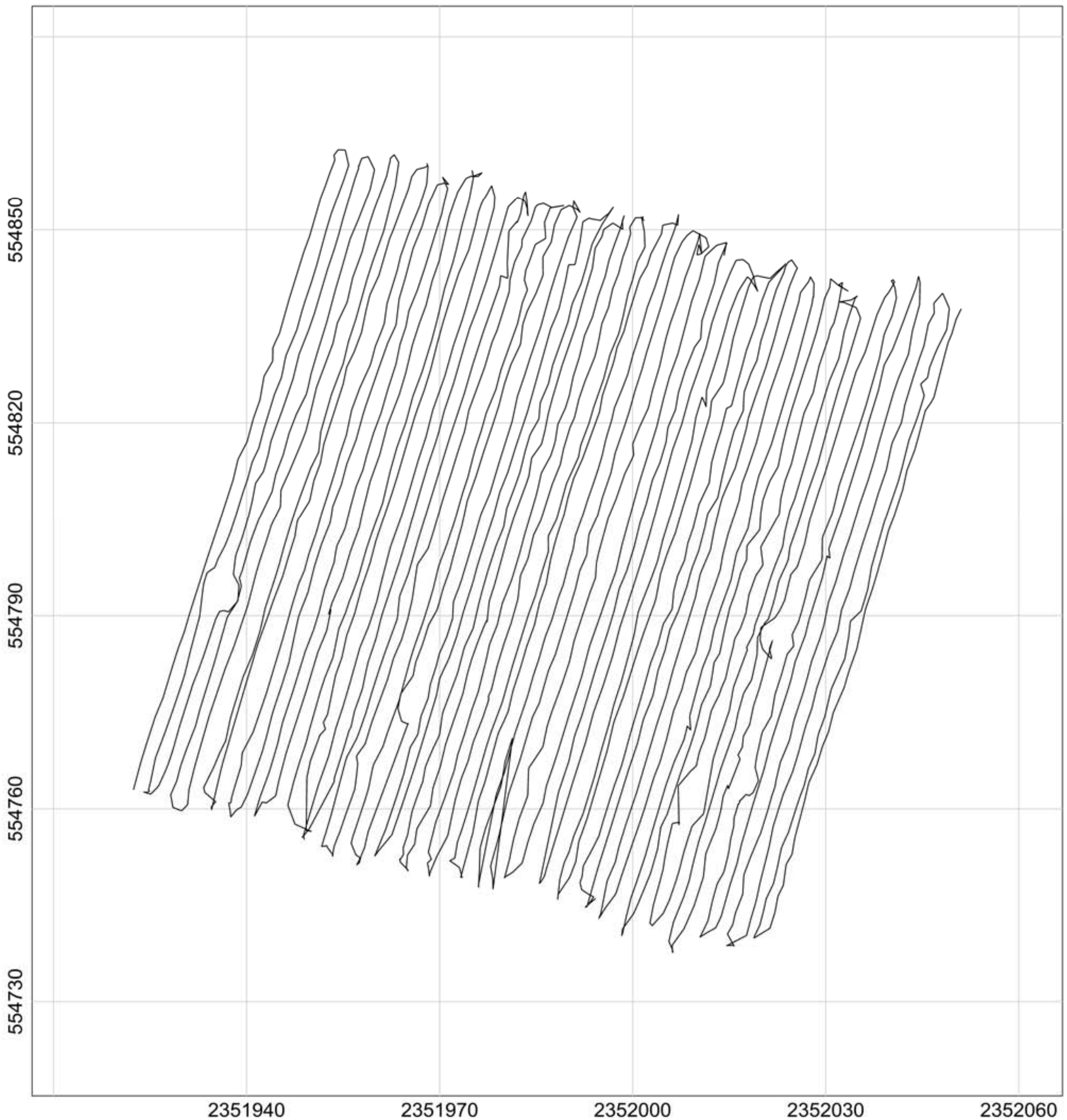
Project: Ravenna Army Ammunition Plant

Contractor: Shaw Environmental & Infrastructure, Inc.

Created by:	Verified by:
Date: 2009/10/23	File: EM61_GPS_CLMS_Track_Map
Page number:	Approved:

Shaw Environmental & Infrastructure, Inc.

US Army Corps of Engineers Louisville District



Geophysical Prove-Out EM61-MK2

RTS Positioning System
Track Map

Ravenna Army Ammunition Plant
Ravenna, Ohio

LEGEND

Map Scale:

Scale 1:325

25 0

US survey foot

NAD83 / Ohio CS83 North zone

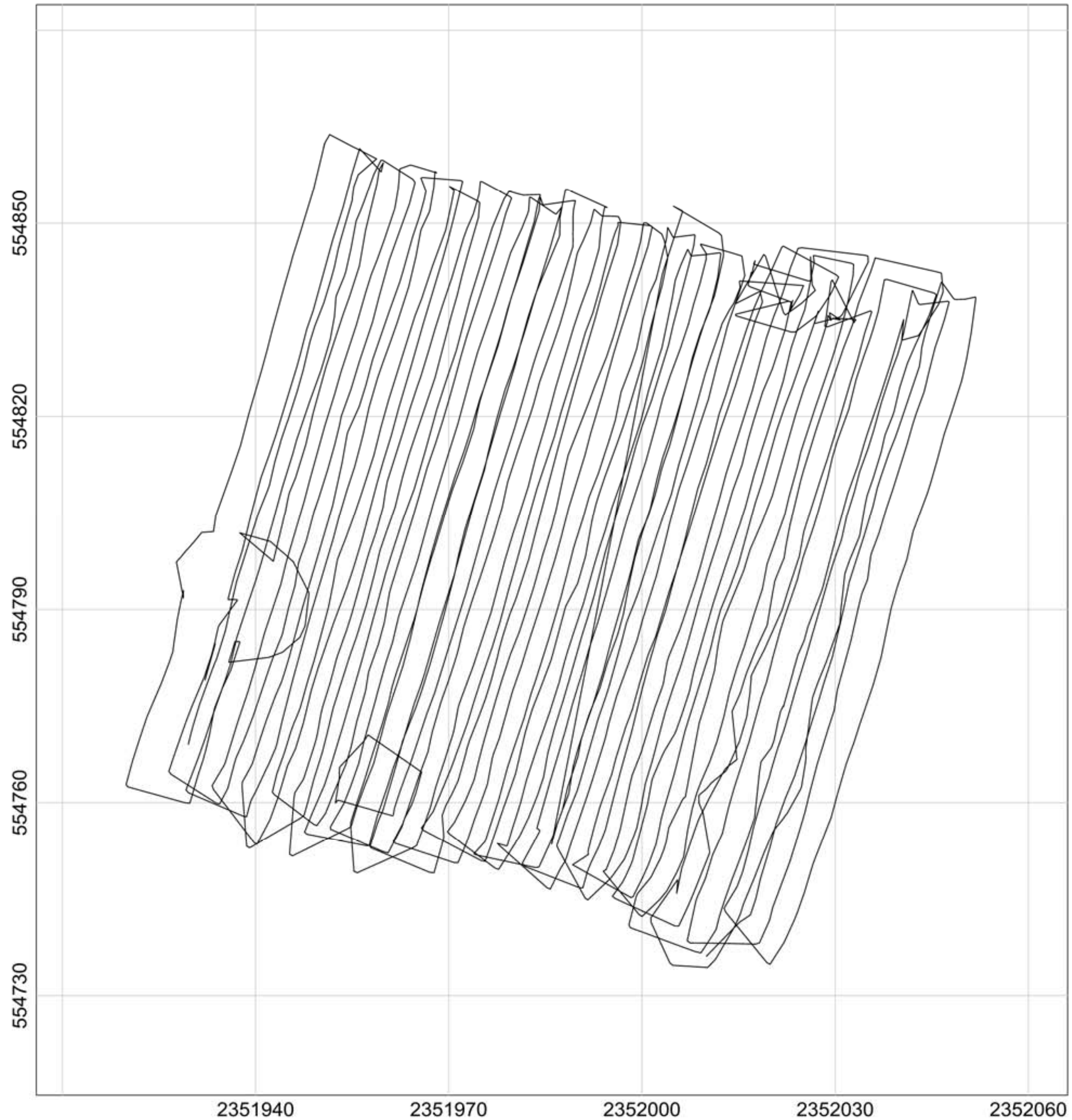
N

Grid North: 0°0'0"
Mag North: -8°30'36"

Client: USACE - Louisville District	
Project: Ravenna Army Ammunition Plant	
Contractor: Shaw Environmental & Infrastructure, Inc.	
Created by:	**Verified by:**
Date: 2009/10/23	**File:** EM61-RTS Survey_Track_Map
Page number:	**Approved:**

Shaw Environmental & Infrastructure, Inc.

US Army Corps of Engineers
Louisville District



Geophysical Prove-Out
G-858G Magnetometer

RTK GPS Positioning System
Track Map

Ravenna Army Ammunition Plant
Ravenna, Ohio

LEGEND

Map Scale: Scale 1:325
25 0
US survey foot
NAD83 / Ohio CS83 North zone

Grid North: 0°0'0"
Mag North: -8°30'36"

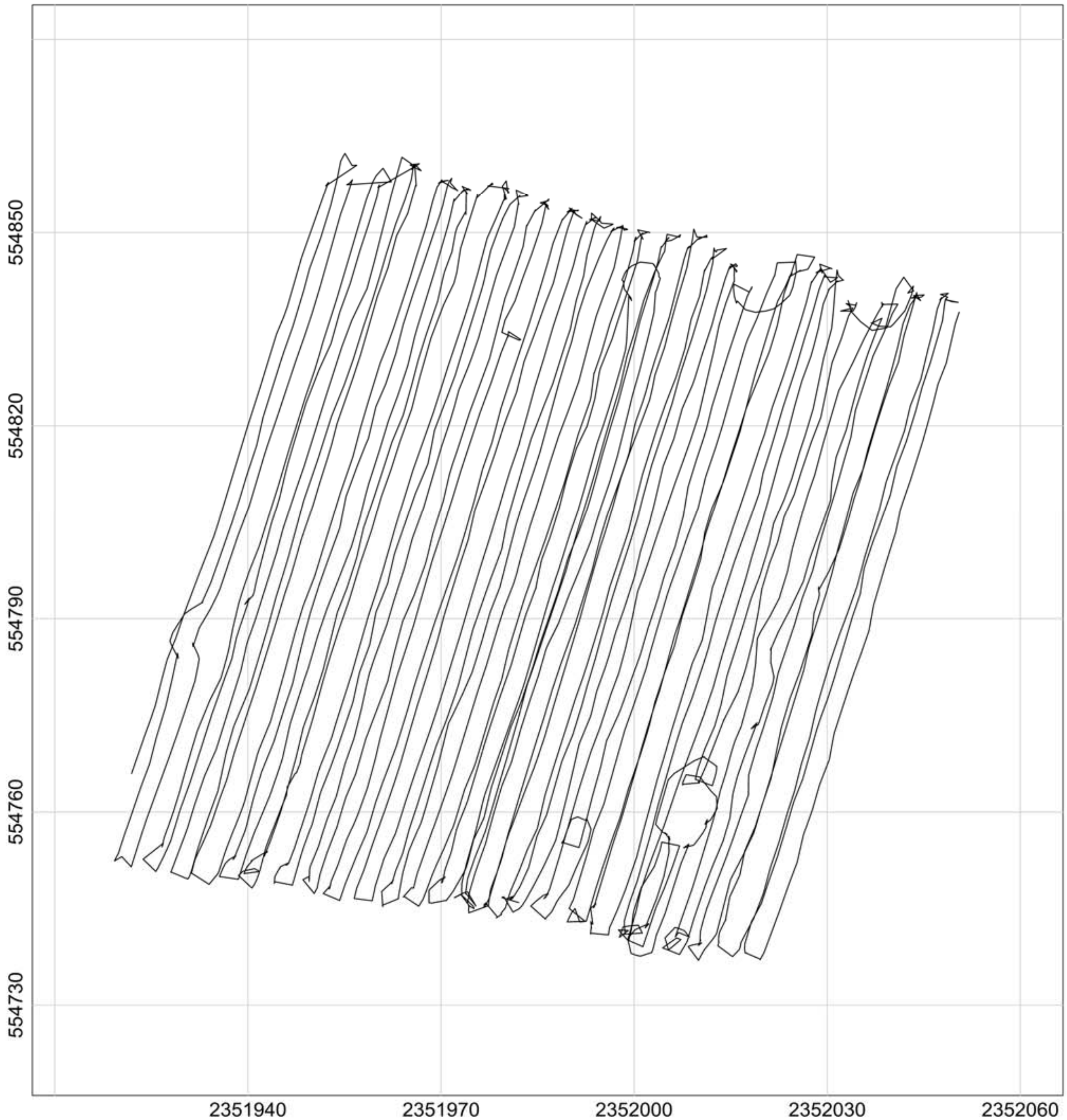
Client: USACE - Louisville District

Project: Ravenna Army Ammunition Plant

Contractor: Shaw Environmental & Infrastructure, Inc.

Created by:	Verified by:
Date: 2009/10/23	File: Mag RTK Export_edit_CLMS_Track_Map
Page number:	Approved:

Shaw Environmental & Infrastructure, Inc.
US Army Corps of Engineers Louisville District



Geophysical Prove-Out
G-858G Magnetometer

RTS Positioning System
Track Map

Ravenna Army Ammunition Plant
Ravenna, Ohio

LEGEND

Map Scale: Scale 1:325

25 0

US survey foot

NAD83 / Ohio CS83 North zone

N

Grid North: 0°0'0"

Mag North: -8°30'36"

Client: USACE - Louisville District

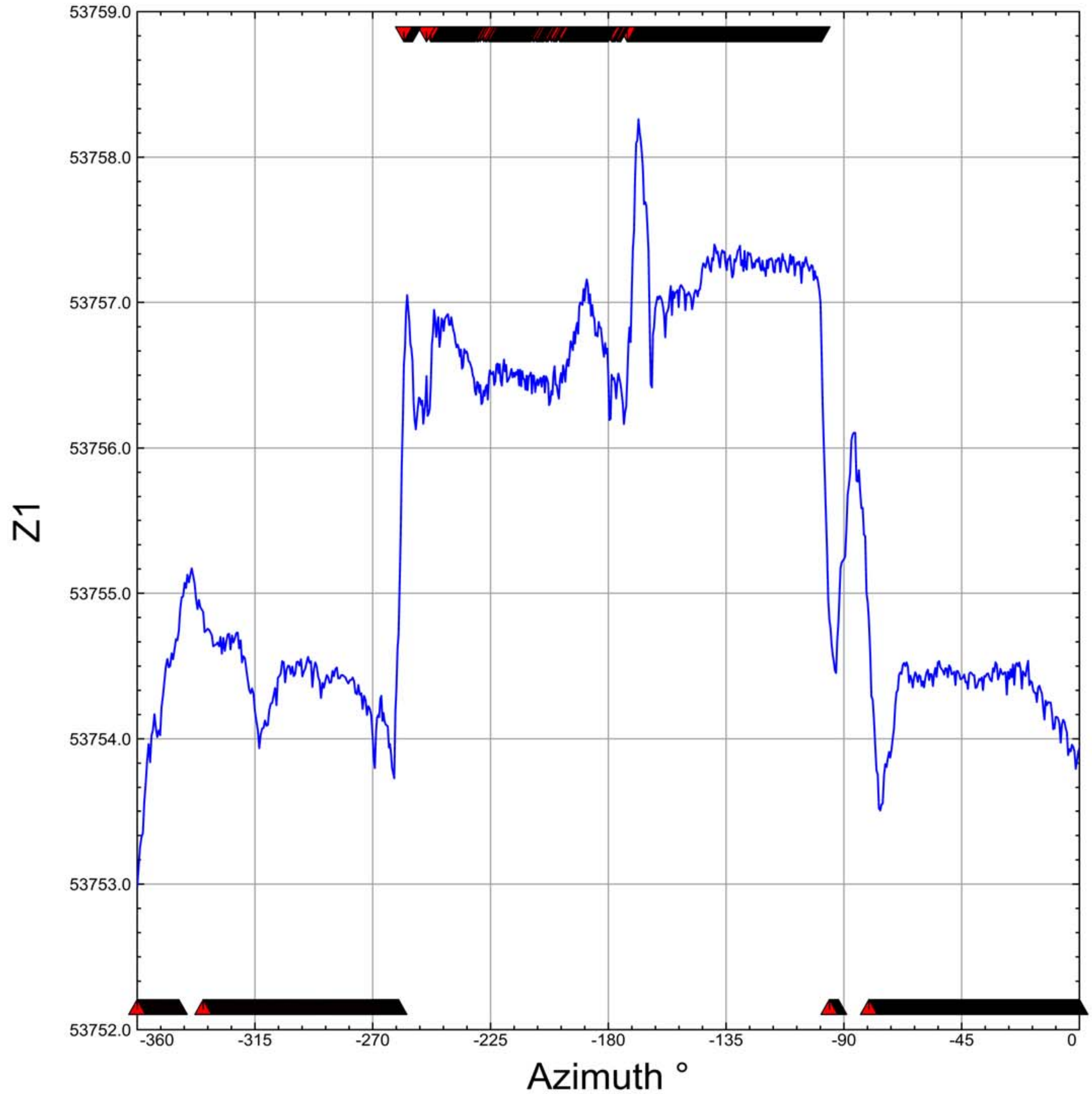
Project: Ravenna Army Ammunition Plant

Contractor: Shaw Environmental & Infrastructure, Inc.

Created by:	Verified by:
Date: 2009/10/23	File: Mag_RTS_Colin_Track_Map
Page number:	Approved:

Shaw Environmental & Infrastructure, Inc.

US Army Corps of Engineers Louisville District



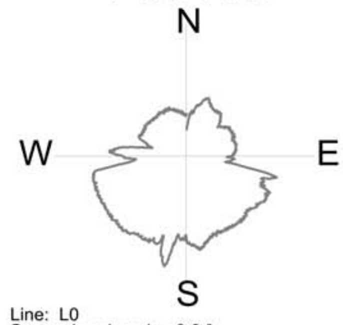
Geophysical Prove-Out Azimuth Test

G-858G Magnetometer
Bottom Sensor

Ravenna Army Ammunition Plant
Ravenna, Ohio

LEGEND

Polar Plot



Line: L0
Sensor head angle: 0.0 °

Amplitude offset exceeds tolerance.

Scale 1:2500

Map Scale: 25 0 25 (meters)

Grid North: 0°0'0"
Mag North: -8°30'36"

Client: USACE - Louisville District

Project: Ravenna Army Ammunition Plant

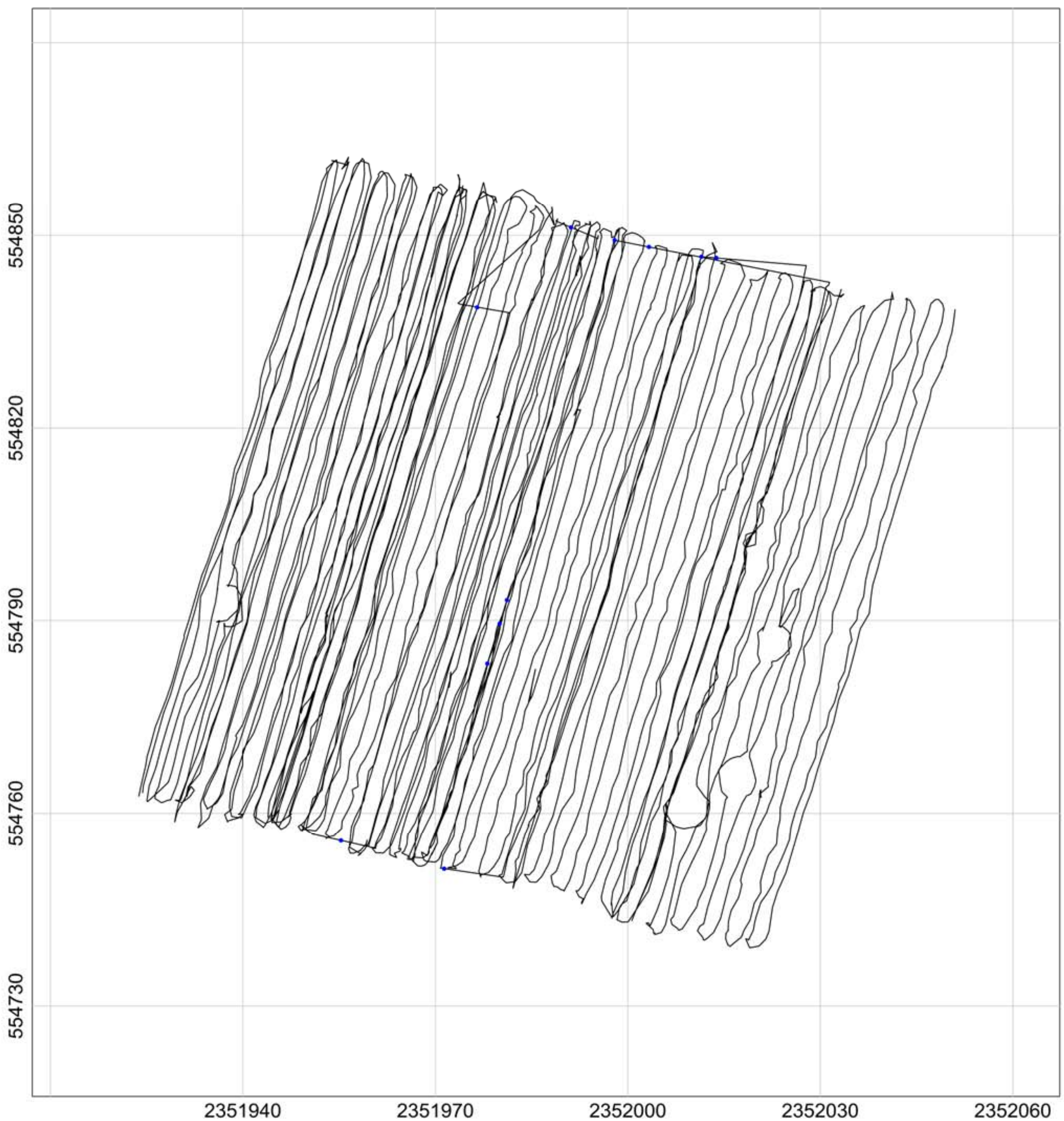
Contractor: Shaw Environmental & Infrastructure, Inc.

Created by:	Verified by:
Date: 2009/10/23	File: Azimuth_Heading
Page number:	Approved:

Shaw Environmental & Infrastructure, Inc.

US Army Corps of Engineers Louisville District

database: c:\shaw projects\RVAAP\field data\EM61 Data\10 22 2009\dataset3_edit.gdb Channel: Z1



Geophysical Prove-Out Sample Separation

EM61-MK2
w/ RTK GPS Positioning System

Ravenna Army Ammunition Plant
Ravenna, Ohio

LEGEND

Line path

Flag_Separation

Data exceeding max. data spacing: 0.0%

Map Scale: Scale 1:325

25 0

US survey foot

NAD83 / Ohio CS83 North zone

N

Grid North: 0°0'0"
Mag North: -8°30'36"

Client: USACE - Louisville District

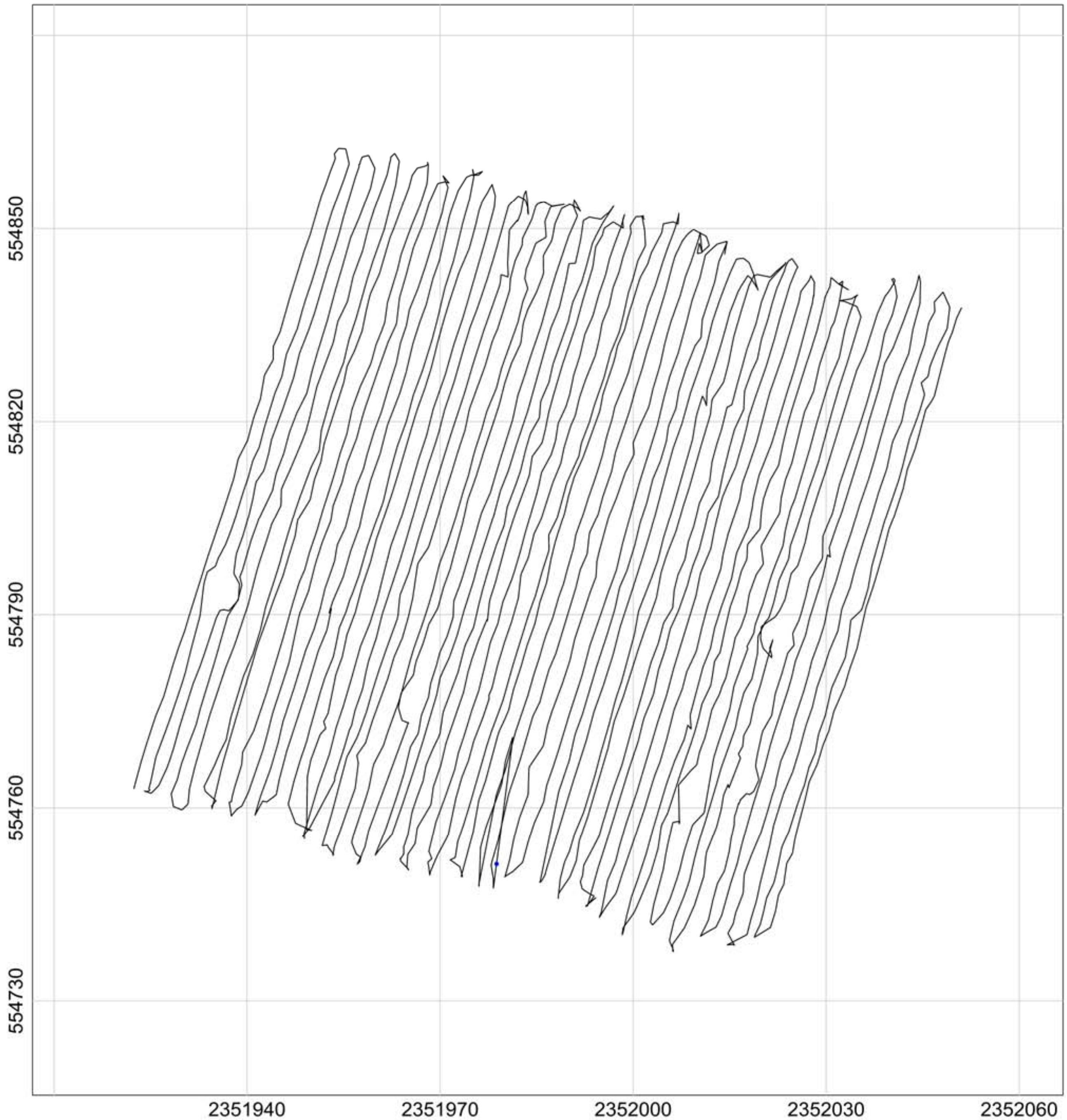
Project: Ravenna Army Ammunition Plant

Contractor: Shaw Environmental & Infrastructure, Inc.

Created by:	Verified by:
Date: 2009/10/23	File: EM61_GPS_CLMS_DATASEP
Page number:	Approved:

Shaw Environmental & Infrastructure, Inc.

US Army Corps of Engineers Louisville District



Geophysical Prove-Out Sample Separation

EM61-MK2
w/ RTS Positioning System

Ravenna Army Ammunition Plant
Ravenna, Ohio

LEGEND

Line path

Flag_Separation

Data exceeding max. data spacing: 0.0%

Map Scale: Scale 1:325

US survey foot

NAD83 / Ohio CS83 North zone

N

Grid North: 0°0'0"
Mag North: -8°30'36"

Client: USACE - Louisville District

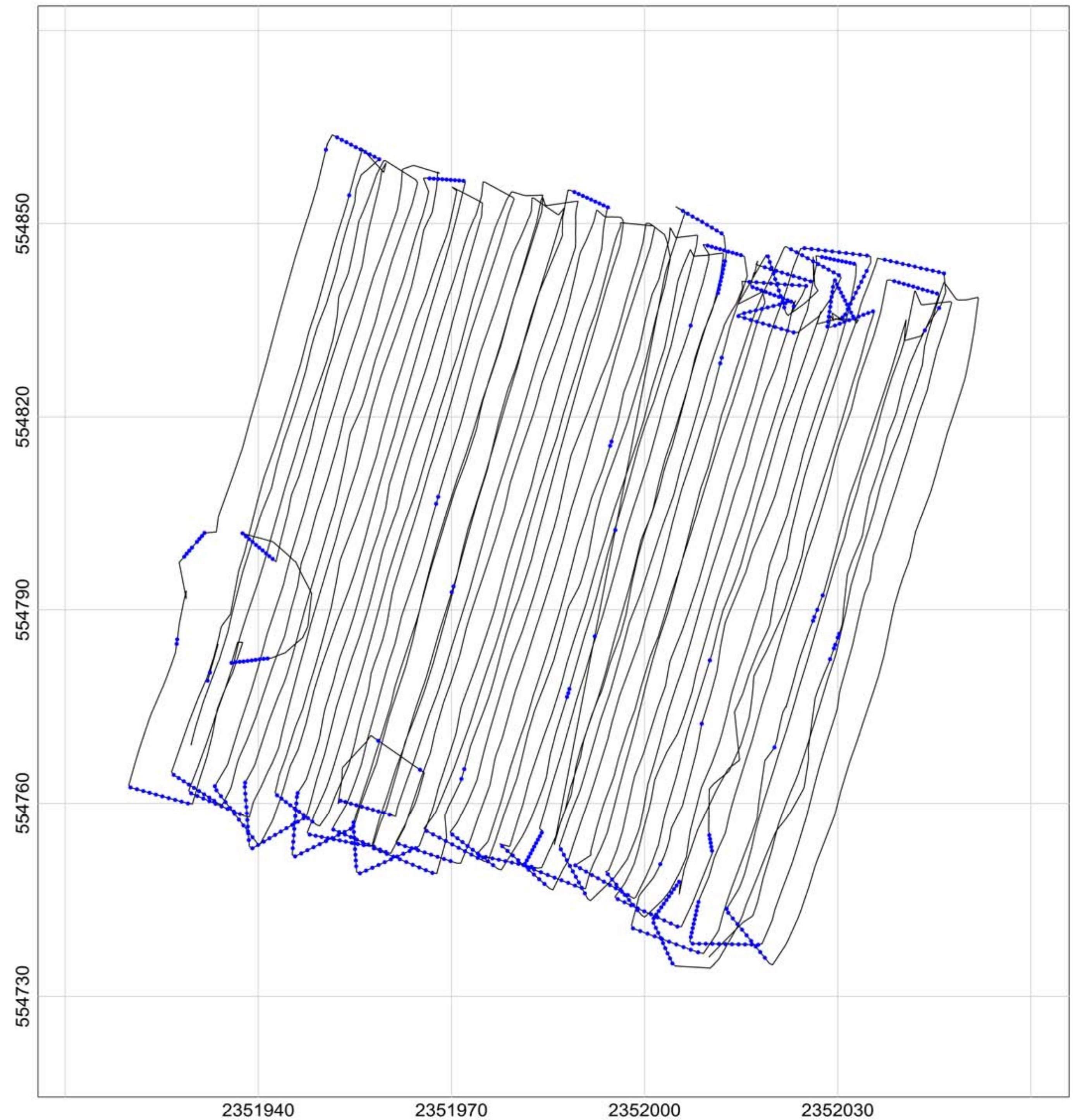
Project: Ravenna Army Ammunition Plant

Contractor: Shaw Environmental & Infrastructure, Inc.

Created by:	Verified by:
Date: 2009/10/23	File: EM61-RTS Survey_DATASEP
Page number:	Approved:

Shaw Environmental & Infrastructure, Inc.

US Army Corps of Engineers Louisville District



Geophysical Prove-Out Sample Separation

G858G Magnetometer
w/ RTK GPS Positioning System

Ravenna Army Ammunition Plant
Ravenna, Ohio

LEGEND

Line path

Flag_Separation

Data exceeding max. data spacing: 3.2%

Map Scale: Scale 1:1000 (10 0 10 metres)

N

Grid North: 0°0'0"
Mag North: 3°14'24"

Client: USACE - Louisville District

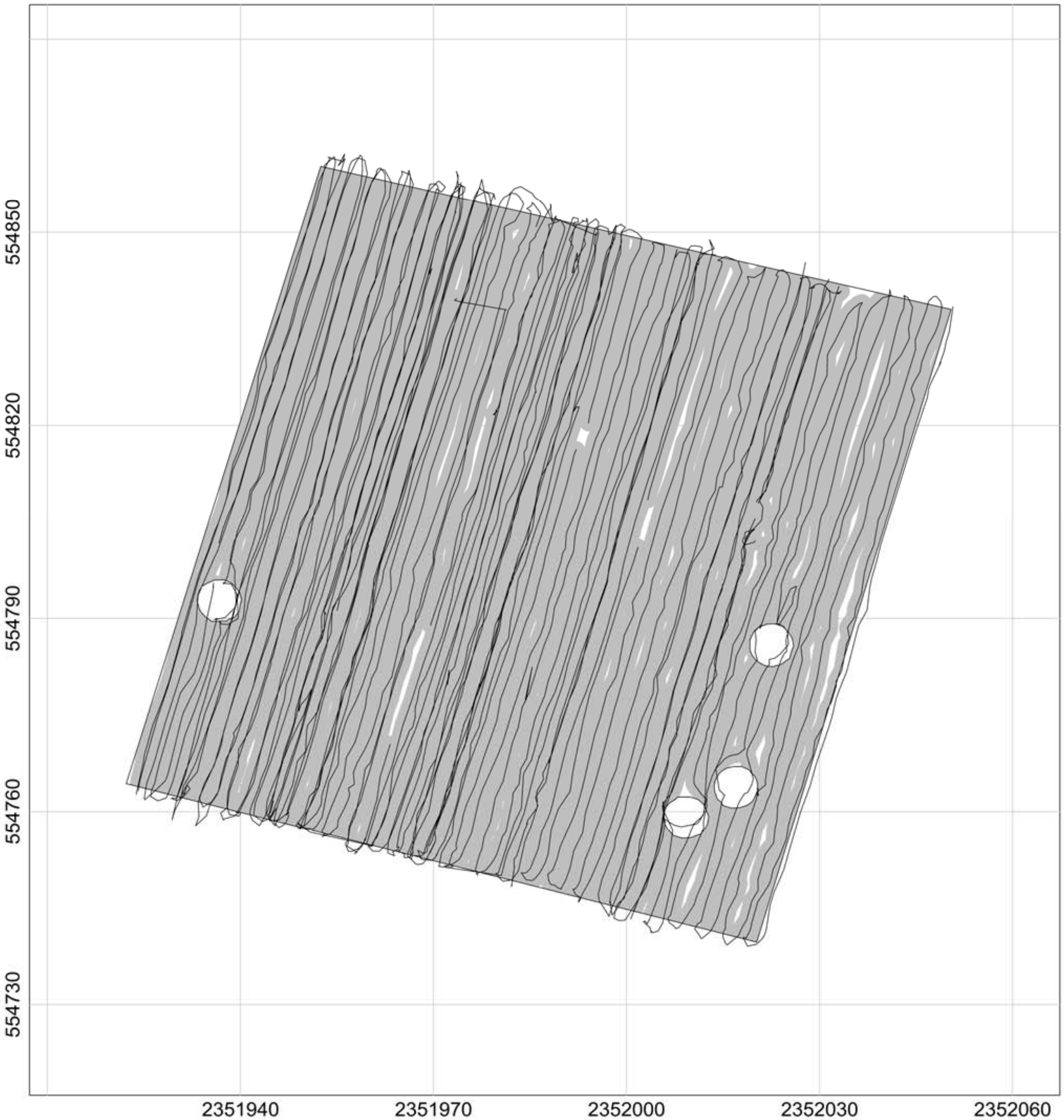
Project: Ravenna Army Ammunition Plant

Contractor: Shaw Environmental & Infrastructure, Inc

Created by:	**Verified by:**
Date: 2009/11/10	**File: Mag RTK Export_CLMS_...**
Page number:	**Approved:**

Shaw Environmental & Infrastructure, Inc.

US Army Corps of Engineers Louisville District



Geophysical Prove-Out Footprint Coverage

Ravenna Army Ammunition Plant
Ravenna, Ohio

LEGEND

Area covered: 9981.59 Feet²
Total area:10083.27 Feet²
Percentage covered: 98.99 %
Instrument foot print: 2.50 Feet
(Line Spacing)

Map Scale: Scale 1:325
25 0
US survey foot
NAD83 / Ohio CS83 North zone

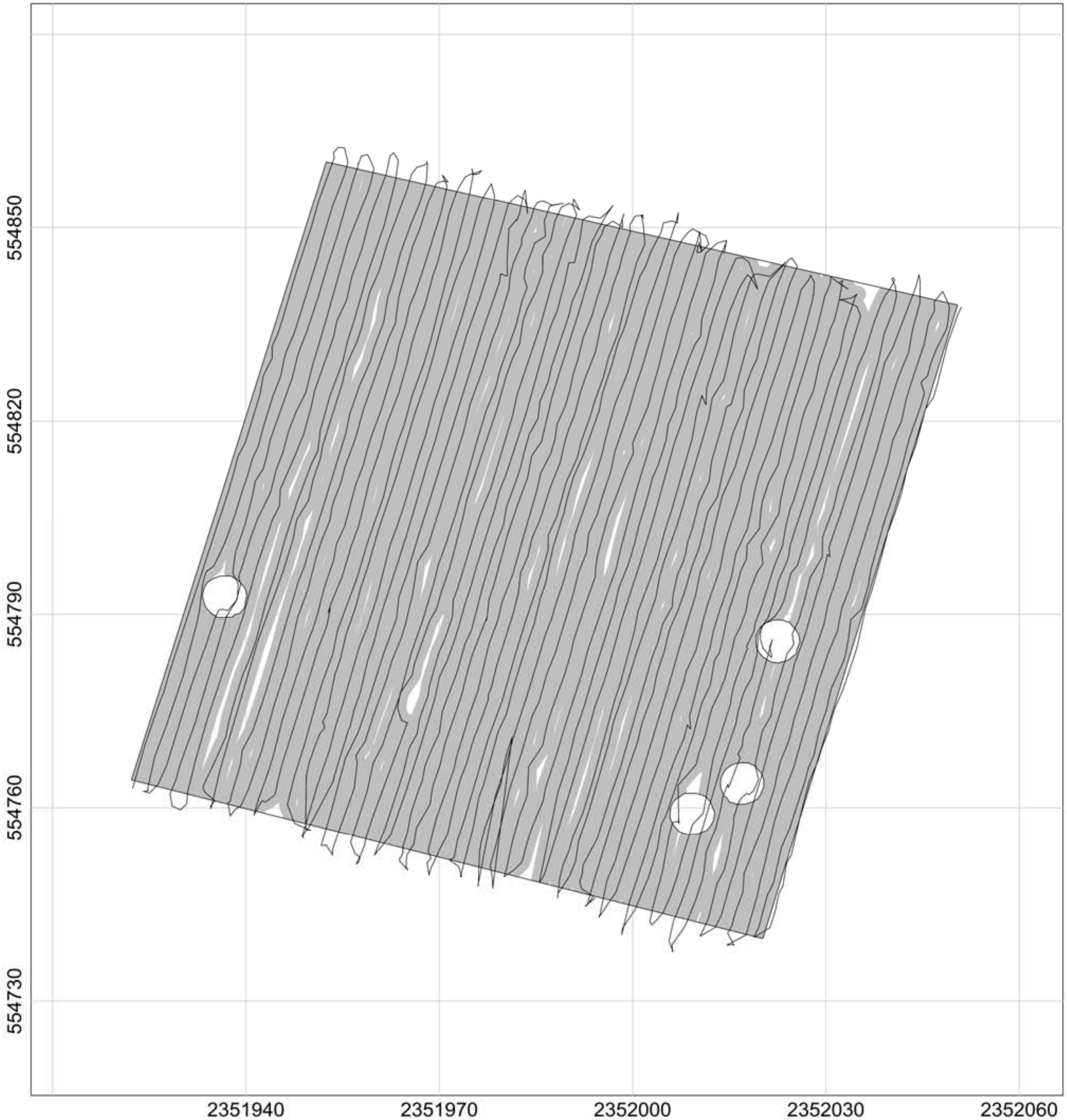
N

Grid North: 0°0'0"
Mag North: -8°30'36"

Client: USACE - Louisville District	
Project: Ravenna Army Ammunition Plant	
Contractor: Shaw Environmental & Infrastructure, Inc.	
Created by:	**Verified by:**
Date: 2009/10/23	**File: EM61_GPS_CLMS_FootPrint.**
Page number:	**Approved:**

Shaw® Shaw Environmental & Infrastructure, Inc.

US Army Corps of Engineers® Louisville District



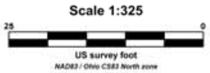
Geophysical Prove-Out Footprint Coverage

Ravenna Army Ammunition Plant
Ravenna, Ohio

LEGEND

Area covered: 9766.24 Feet²
Total area:10083.27 Feet²
Percentage covered: 96.86 %
Instrument foot print: 2.50 Feet (Line Spacing)

Map Scale:



Client: USACE - Louisville District

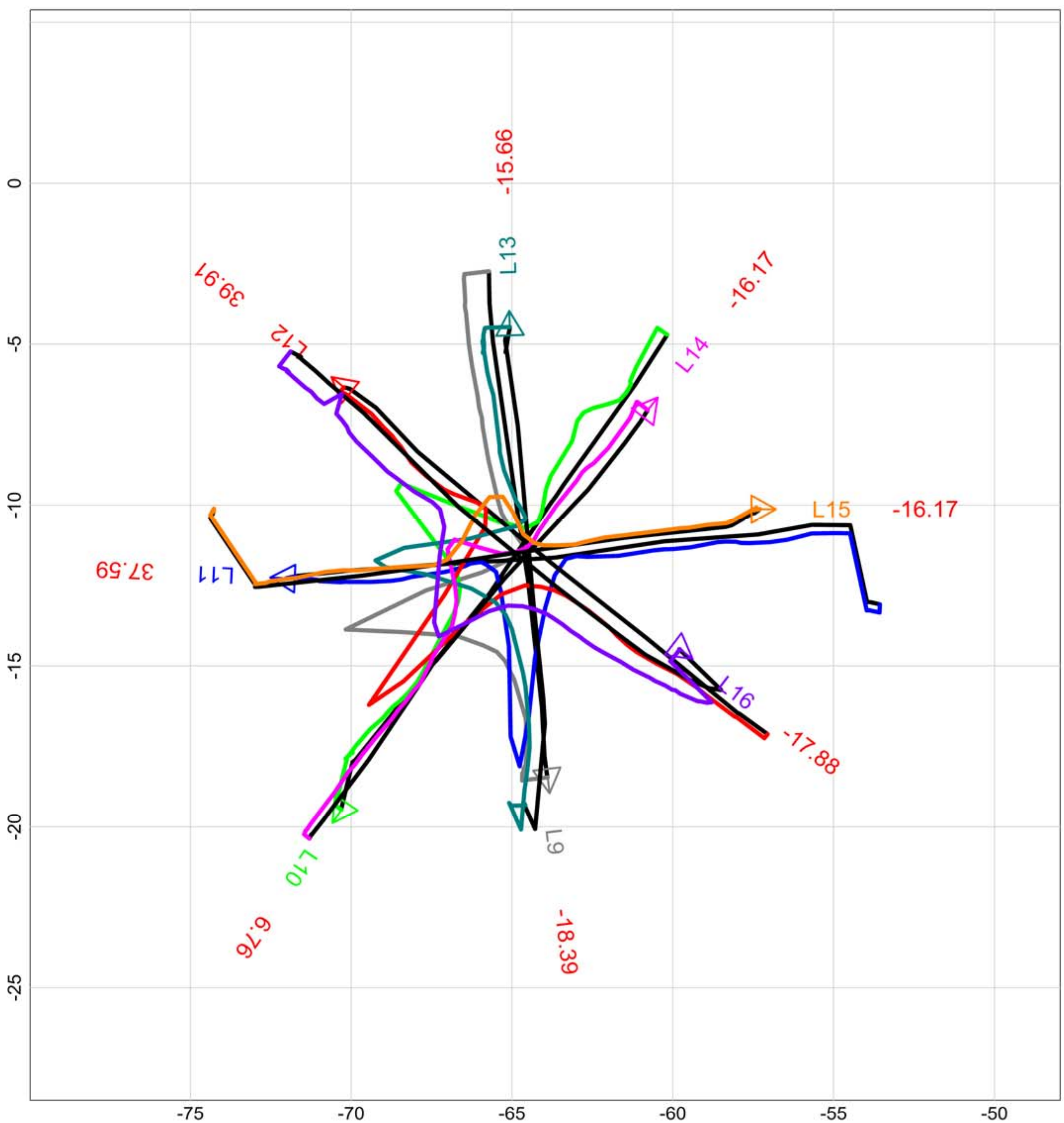
Project: Ravenna Army Ammunition Plant

Contractor Shaw Environmental & Infrastructure, Inc.

Created by:	**Verified by:**
Date: 2009/10/23	**File: EM61-RTS Survey_Foot Print**
Page number:	**Approved:**

Shaw Environmental & Infrastructure, Inc.

US Army Corps of Engineers Louisville District



Geophysical Prove-Out Octant Test

G-858G Magnetometer
Bottom Sensor
With QC Item

Ravenna Army Ammunition Plant
Ravenna, Ohio

LEGEND

Amplitudes exceeding tolerance are flagged in red

Map Scale: Scale 1:200

Grid North: 0°0'0"
Mag North: 0°0'0"

Client: USACE - Louisville District

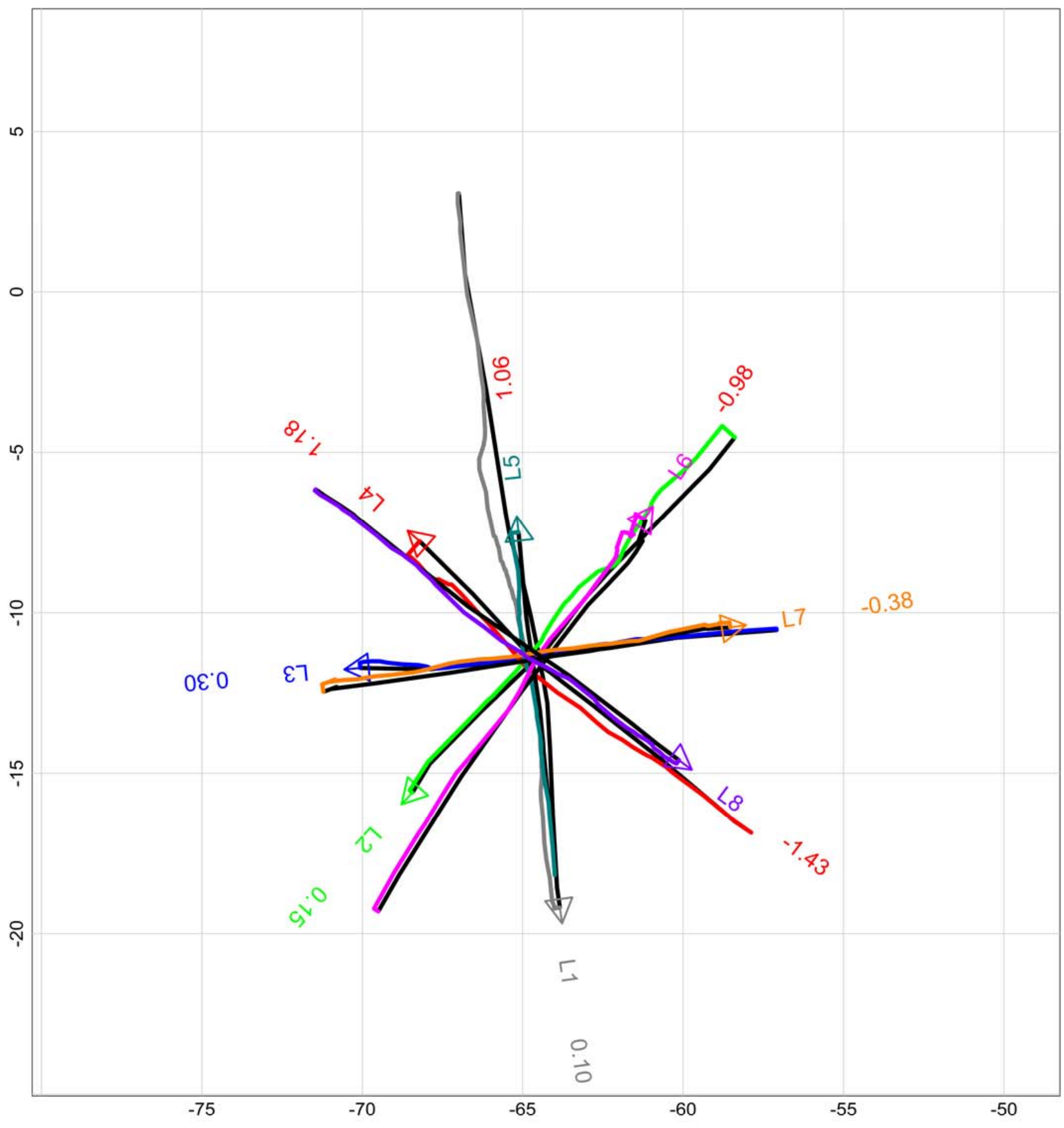
Project: Ravenna Army Ammunition Plant

Contractor: Shaw Environmental & Infrastructure, Inc.

Created by:	Verified by:
Date:	File: ___Octant
Page number:	Approved:

Shaw Environmental & Infrastructure, Inc.

US Army Corps of Engineers Louisville District



Geophysical Prove-Out
Octant Test

G-858G Magnetometer
Bottom Sensor
With QC Item

Ravenna Army Ammunition Plant
Ravenna, Ohio

LEGEND

Amplitudes exceeding tolerance are flagged in red

Map Scale: Scale 1:200

2.5 0 metres

N

Grid North: 0°0'0"
Mag North: 0°0'0"

Client: USACE - Louisville District

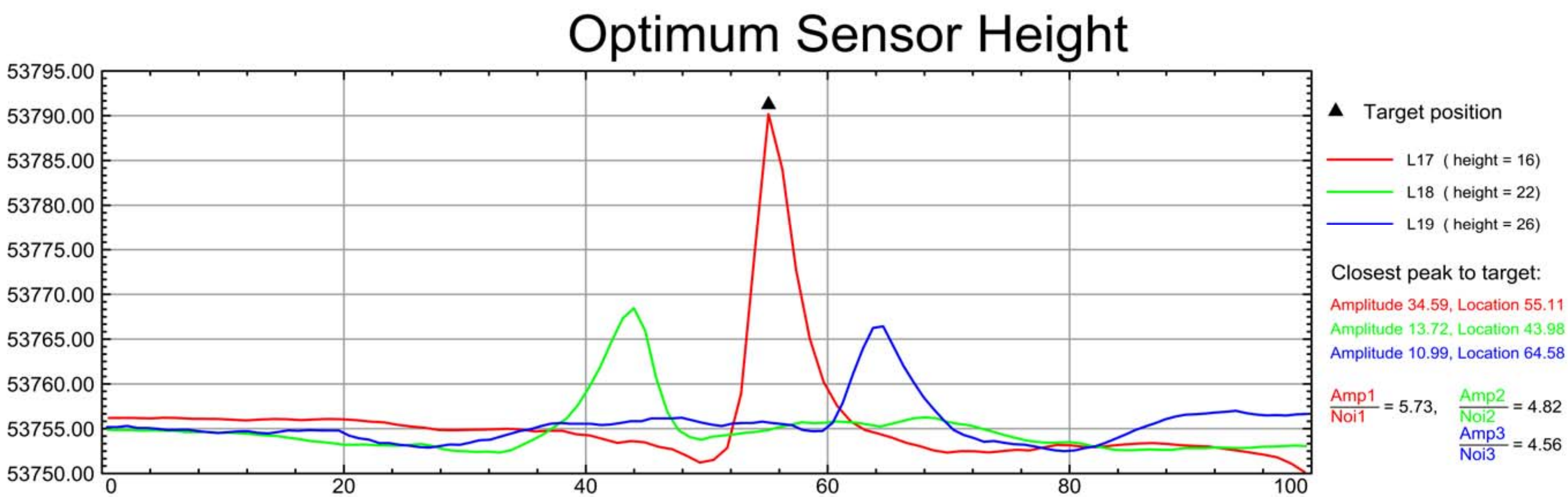
Project: Ravenna Army Ammunition Plant

Contractor: Shaw Environmental & Infrastructure, Inc.

Created by:	Verified by:
Date:	File: ___Octant
Page number:	Approved:

Shaw Environmental & Infrastructure, Inc.

US Army Corps of Engineers Louisville District



Database: c:\shaw projects\RVAAP\field data\EM61 Data\10 22 2009\dataset3_edit.gdb Channel: Z2

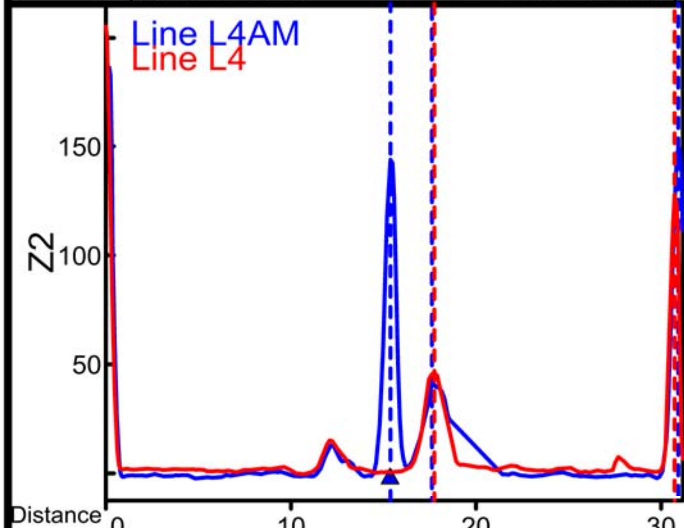
2009/10/31

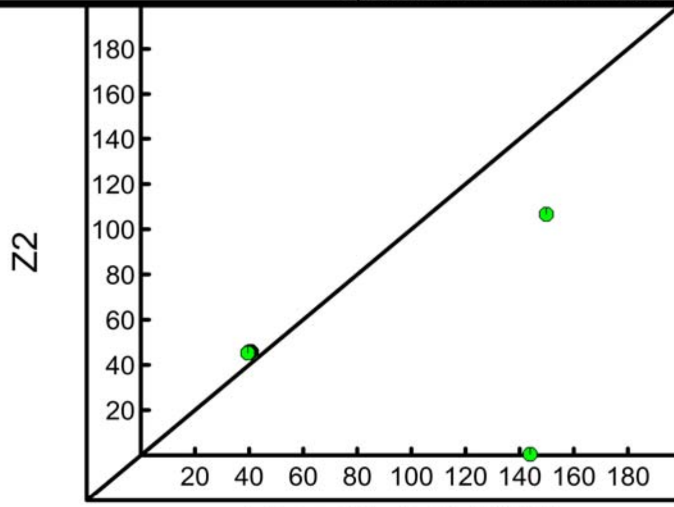
Repeatability Test

Project: RVAAP
Instrument: EM-61 (1.0x0.5m)
Tolerance (% Amplitude) :20.00
Grid name: GPO
Location: Latitude 41 Longitude -81
Operator: MK   Date: 2009/10/22

Original Profile
Repeated Profile

Lateral tolerance exceeded
Amplitude tolerance exceeded
Path Deviation tolerance exceeded
Peaks in the profiles





Fit coefficient: 0.826

Database: C:\Shaw Projects\RVAAP\Field Data\EM61 Data\10 22 2009\102309_Repeat_Lines.gdb

Site: Revenna | **Location ID:** GPO | **QC Check by:** CS
Dataset: 10/21/2009 | **Survey Date:** 10/21/2009 | **Date:** 10/27/2009

Static Test

Sensor #1

	Pre Survey					Post Survey				
	CH 1	**CH 2**	**CH 3**	**CH 4**	**G858**	**CH 1**	**CH 2**	**CH 3**	**CH 4**	**G858**
File Name:	102102A					102117A				
Line #:	L6					L6				
Min:	-1.91	-1.10	-.45	-.25		-1.91	-1.10	-.45	-.25	
Max:	1.21	.35	.32	.23		1.21	.35	.32	.23	
Mean	-.38	-.50	-.07	.01		-.38	-.50	-.07	.01	
Std:	.51	.19	.11	.07		.51	.19	.11	.07	

Comments:

Static Spike Test

Sensor #1

	Pre Survey					Post Survey				
	CH 1	**CH 2**	**CH 3**	**CH 4**	**G858**	**CH 1**	**CH 2**	**CH 3**	**CH 4**	**G858**
File Name:	102102A					102117A				
Line #:	L7					L7				
Min:	123.53	72.25	36.87	15.31		123.53	72.25	36.87	15.31	
Max:	127.16	73.90	37.76	15.78		127.16	73.90	37.76	15.78	
Mean	124.78	72.92	37.17	15.55		124.78	72.92	37.17	15.55	
Std:	.41	.27	.12	.07		.41	.27	.12	.07	

Comments:

Cable Shake Test

Sensor #1

	Pre Survey					Post Survey				
	CH 1	**CH 2**	**CH 3**	**CH 4**	**G858**	**CH 1**	**CH 2**	**CH 3**	**CH 4**	**G858**
File Name:	102102A					102117A				
Line #:	L9					L9				
Min:	-.68	-.50	-.22	-.06		-.68	-.50	-.22	-.06	
Max:	.63	.21	.17	.24		.63	.21	.17	.24	
Mean	-.05	-.12	-.06	.05		-.05	-.12	-.06	.05	
Std:	.27	.14	.08	.06		.27	.14	.08	.06	

Comments:

Site: Revenna **Location ID:** GPO **QC Check by:** CS

Dataset: 10/23/2009 **Survey Date:** 10/23/2009 **Date:** 10/27/2009

Static Test

Sensor #1

	Pre Survey					Post Survey				
	CH 1	CH 2	CH 3	CH 4	G858	CH 1	CH 2	CH 3	CH 4	G858
File Name:	102310A					102316A				
Line #:	L0AM					L0PM				
Min:	-3.64	-1.90	-.72	-.40		-33.10	-22.44	-14.52	-6.96	
Max:	.05	.34	.16	.31		-.06	.28	.11	.16	
Mean	-1.99	-.72	-.18	.00		-16.18	-10.50	-6.64	-2.72	
Std:	.71	.36	.13	.09		9.52	6.59	4.21	2.09	

Comments:

Static Spike Test

Sensor #1

	Pre Survey					Post Survey				
	CH 1	CH 2	CH 3	CH 4	G858	CH 1	CH 2	CH 3	CH 4	G858
File Name:	102310A					102316A				
Line #:	L1AM					L1PM				
Min:	138.59	79.11	37.28	14.52		125.62	69.52	30.49	10.67	
Max:	142.58	81.22	38.11	15.02		140.46	78.87	36.53	13.90	
Mean	140.24	79.91	37.68	14.76		134.58	74.85	33.85	12.40	
Std:	.72	.36	.14	.09		2.70	2.00	1.37	.86	

Comments:

Cable Shake Test

Sensor #1

	Pre Survey					Post Survey				
	CH 1	CH 2	CH 3	CH 4	G858	CH 1	CH 2	CH 3	CH 4	G858
File Name:	102310A					102316A				
Line #:	L3AM					L3PM				
Min:	-4.70	-3.38	-1.29	-.24		-34.58	-18.59	-9.56	-6.18	
Max:	.53	.29	.26	.30		19.07	17.95	14.90	11.23	
Mean	-1.09	-.72	-.20	.03		-.67	1.74	3.00	2.70	
Std:	1.43	1.02	.41	.11		13.77	10.07	7.70	5.51	

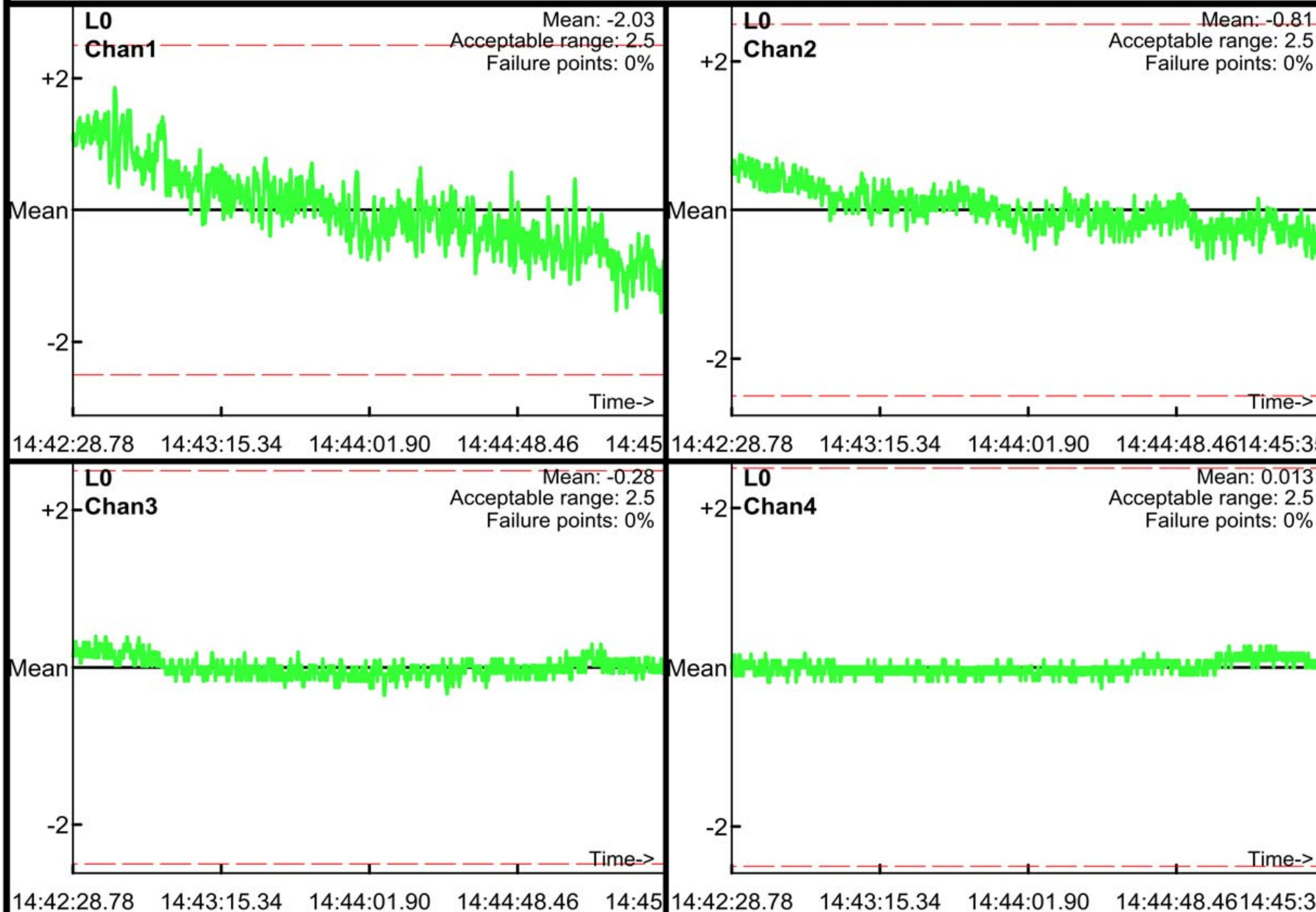
Comments:

Static Calibration Test

Project: RVAAP
Equipment: EM-61 (1.0x0.5m)
Grid/Location: GPO

Allowable failure (%): 20%
Outside range
Acceptable limits

AM test
Operator: MK
Date: 10/20/2009



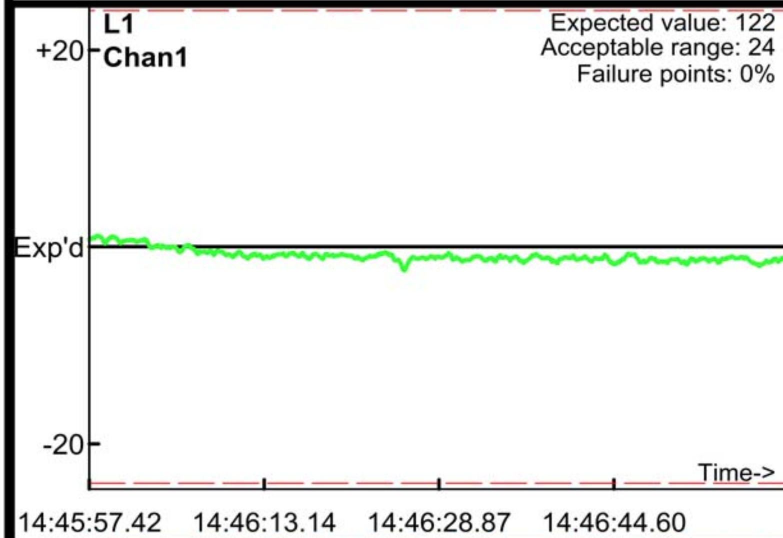
Database: C:\Shaw Projects\RVAAP\Field Data\102014A.gdb
Line Name: L0

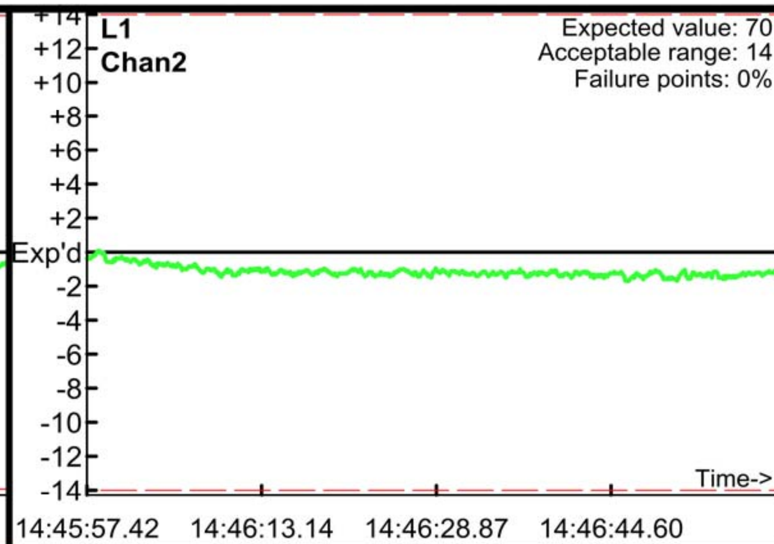
Static Calibration Test

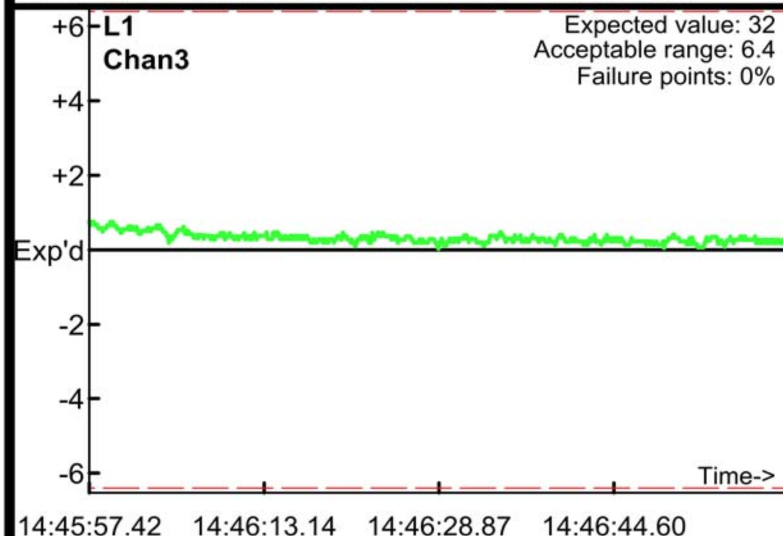
Project: RVAAP
Equipment: EM-61 (1.0x0.5m)
Grid/Location: GPO

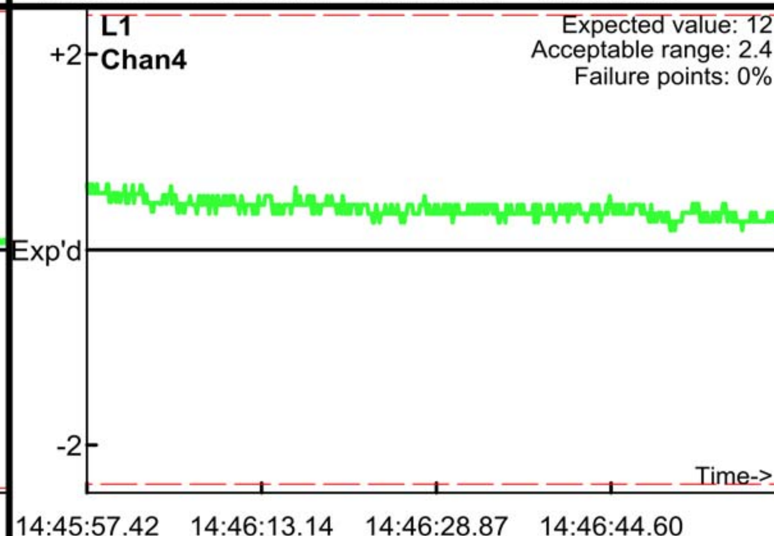
Allowable failure (%): 20%
Outside range
Acceptable limits

AM test
Operator: MK
Date: 10/20/2009









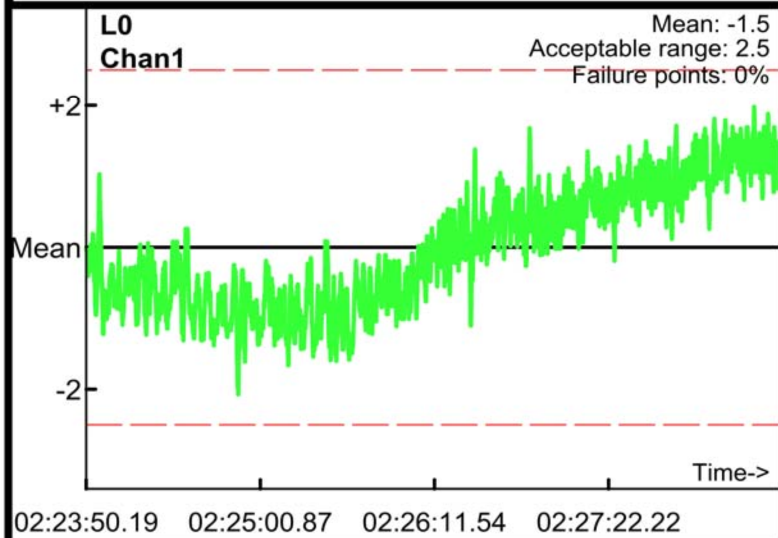
Database: C:\Shaw Projects\RVAAP\Field Data\102014A.gdb
Line Name: L1

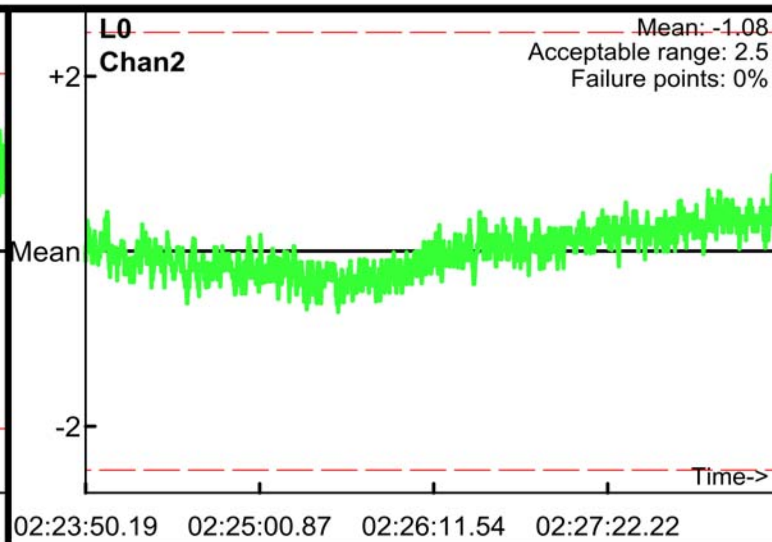
Static Calibration Test

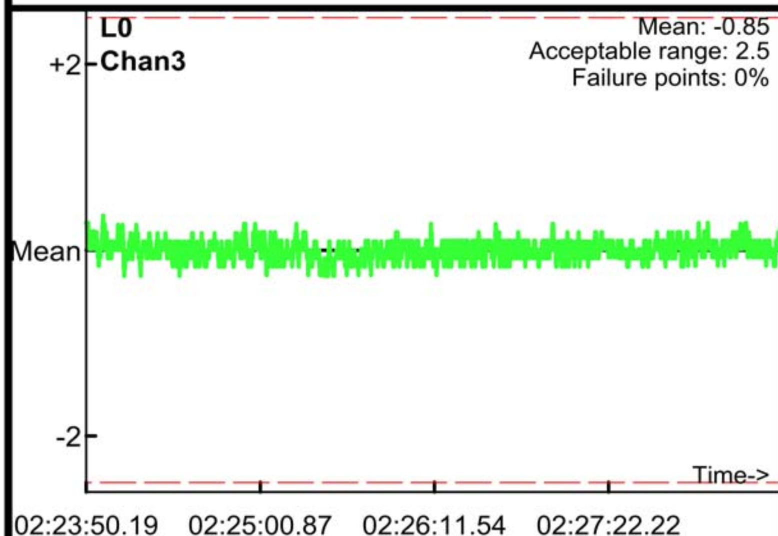
Project: RVAAP
Equipment: EM-61 (1.0x0.5m)
Grid/Location: GPO

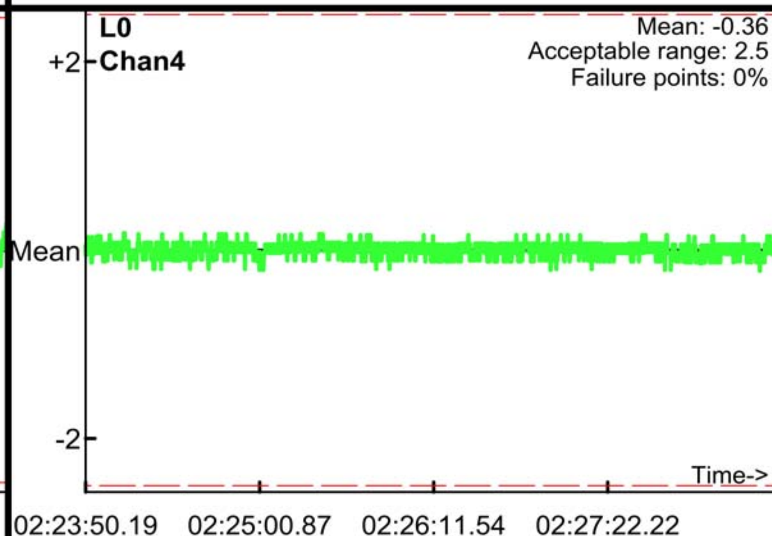
Allowable failure (%): 20%
Outside range
Acceptable limits

AM test
Operator: MK
Date: 10/21/2009









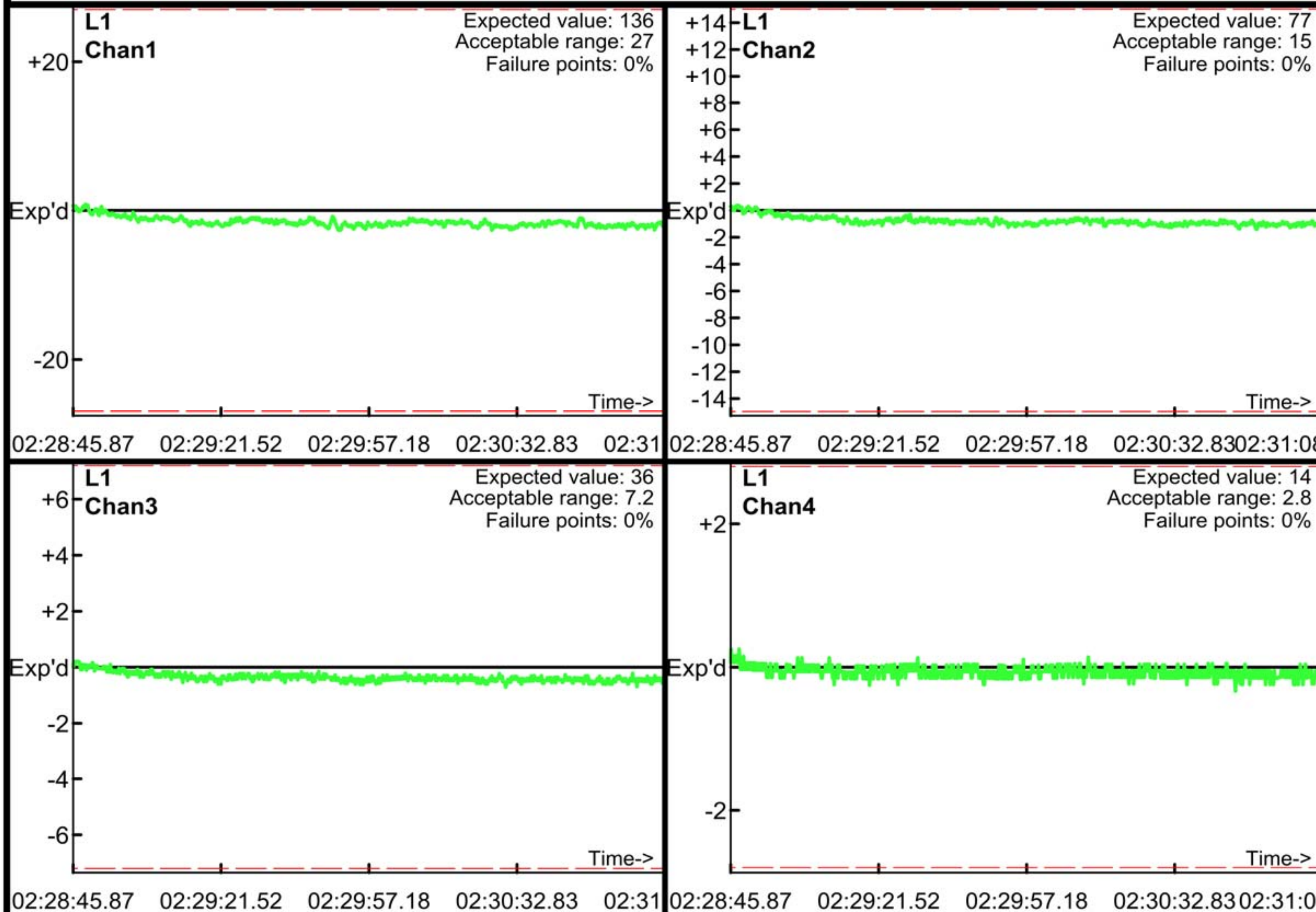
Database: C:\Shaw Projects\RVAAP\Field Data\102102A.gdb
Line Name: L0

Static Calibration Test

Project: RVAAP
Equipment: EM-61 (1.0x0.5m)
Grid/Location: GPO

Allowable failure (%): 20%
Outside range
Acceptable limits

AM test
Operator: MK
Date: 10/21/2009



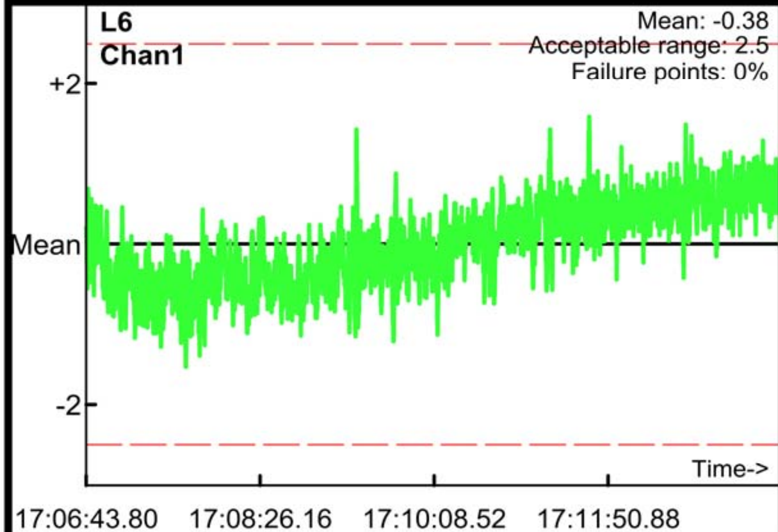
Database: C:\Shaw Projects\RVAAP\Field Data\102102A.gdb
Line Name: L1

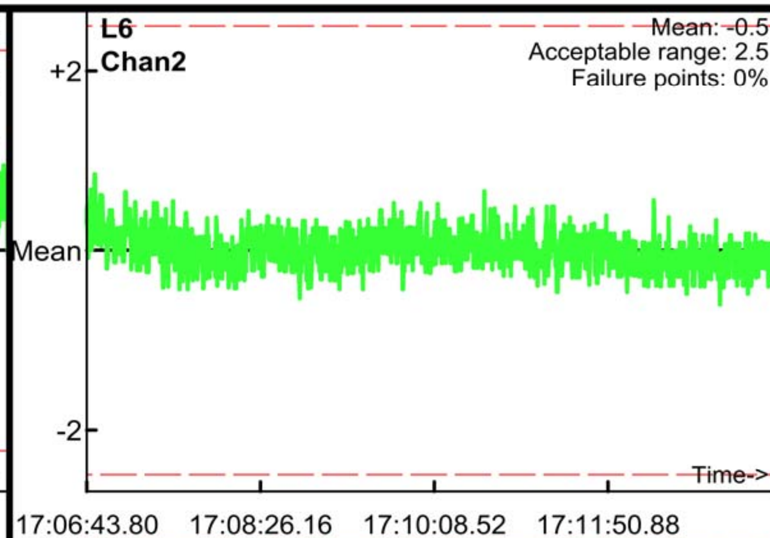
Static Calibration Test

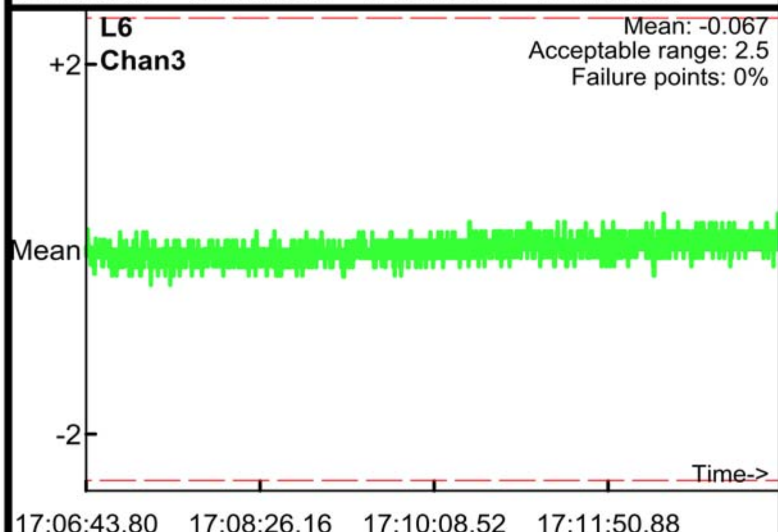
Project: RVAAP
Equipment: EM-61 (0.5x0.5m)
Grid/Location: GPO

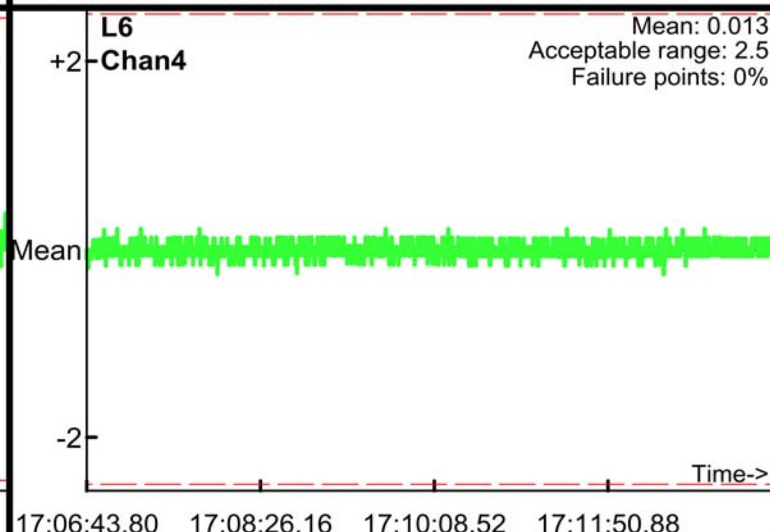
Allowable failure (%): 20%
Outside range
Acceptable limits

PM test
Operator: MK
Date: 10/21/2009









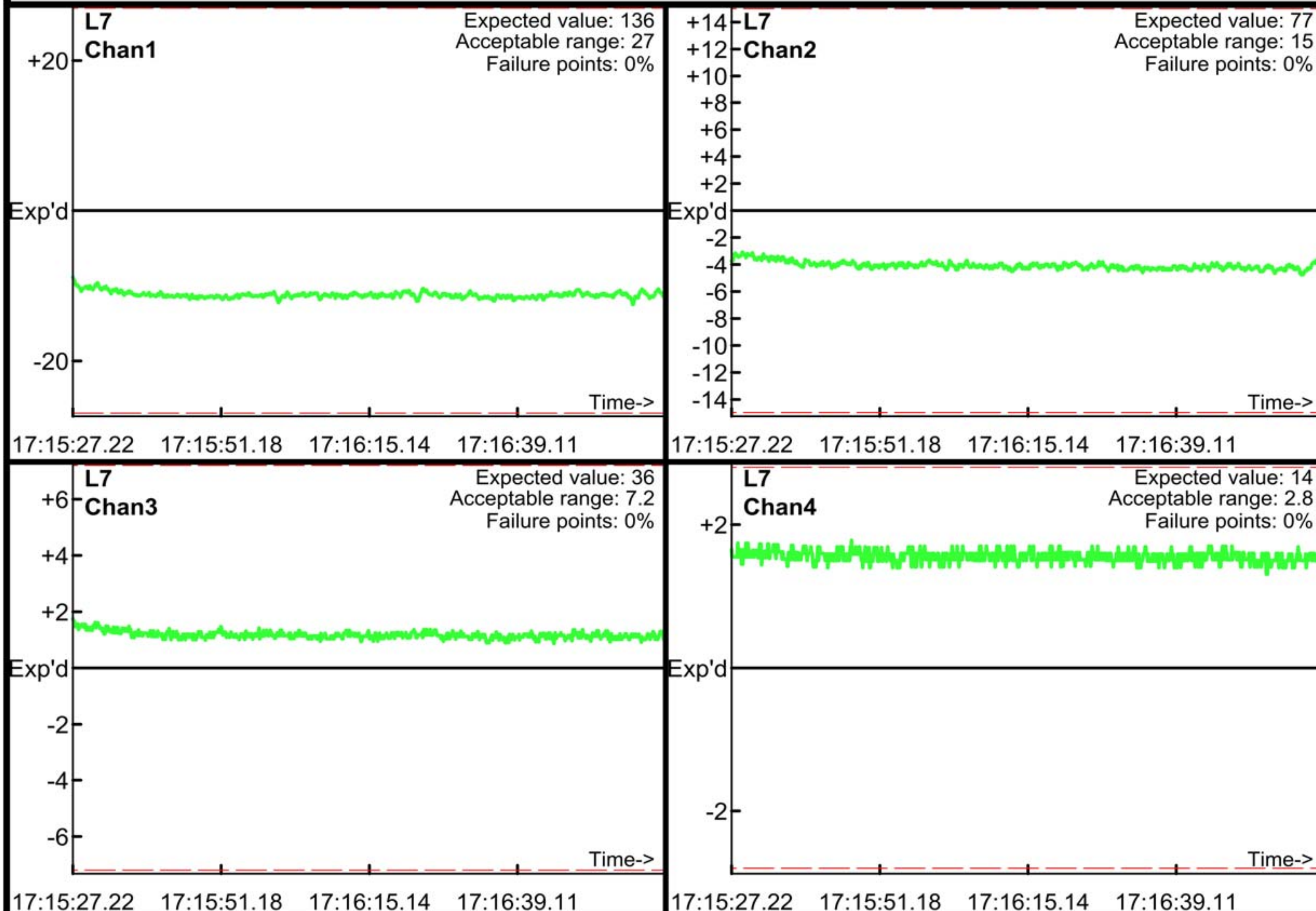
Database: C:\Shaw Projects\RVAAP\Field Data\102117A.gdb
Line Name: L6

Static Calibration Test

Project: RVAAP
Equipment: EM-61 (1.0x0.5m)
Grid/Location: GPO

Allowable failure (%): 20%
Outside range
Acceptable limits

PM test
Operator: MK
Date: 10/21/2009



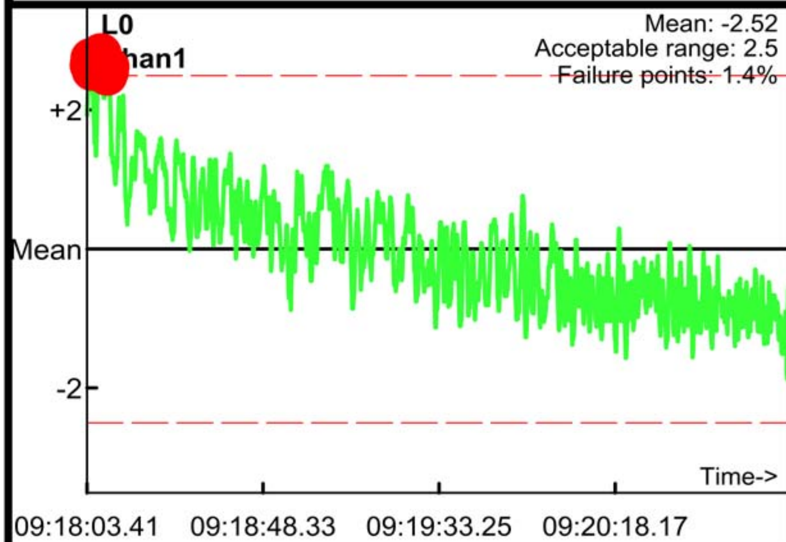
Database: C:\Shaw Projects\RVAAP\Field Data\102117A.gdb
Line Name: L7

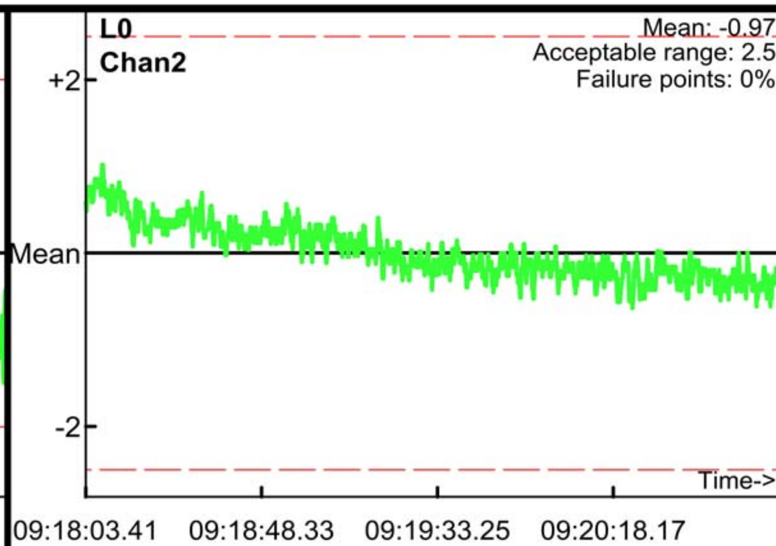
Static Calibration Test

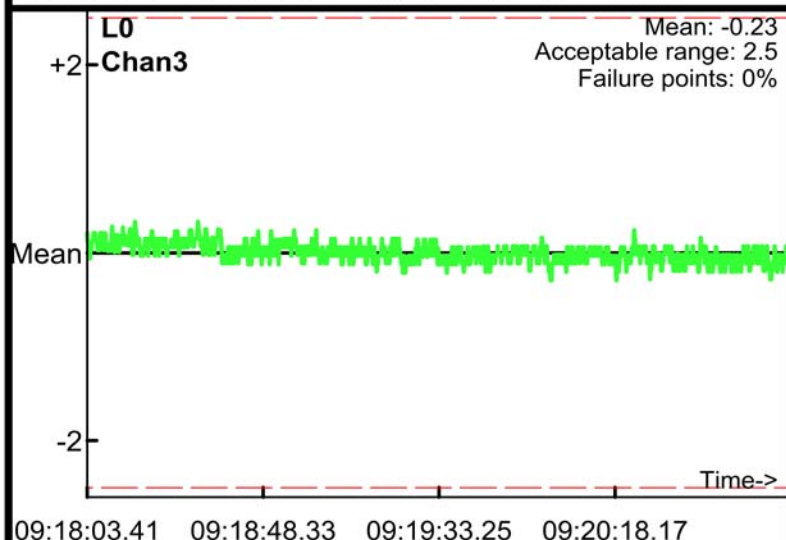
Project: RVAAP
Equipment: EM-61 (1.0x0.5m)
Grid/Location: GPO

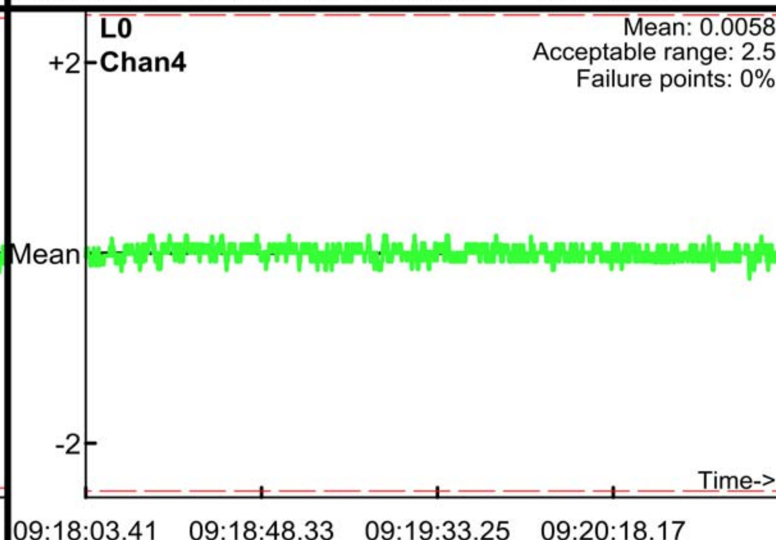
Allowable failure (%): 20%
Outside range
Acceptable limits

AM test
Operator: MK
Date: 10/22/2009









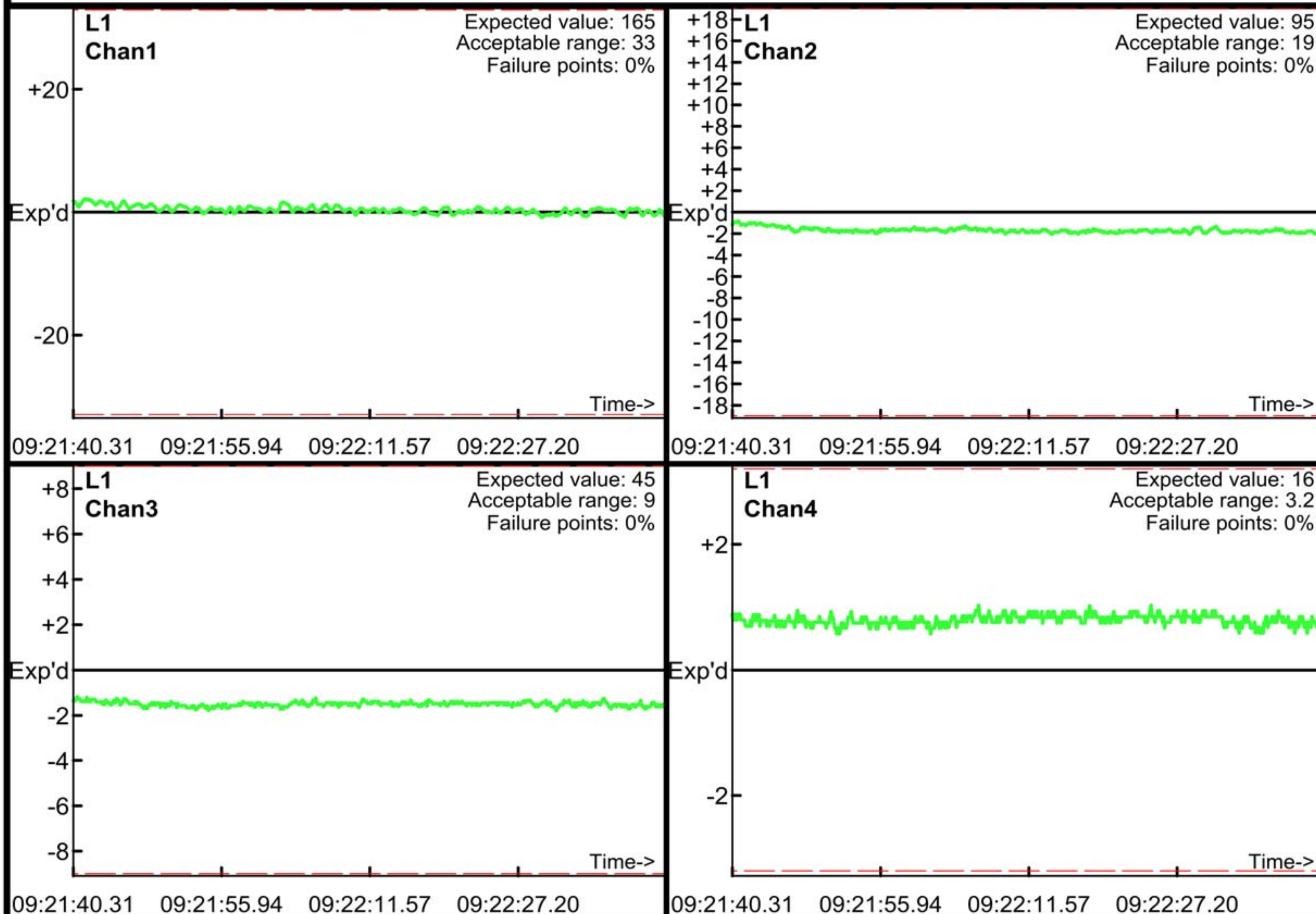
Database: c:\shaw projects\RVAAP\field data\EM61 Data\10 22 2009\102209A_edit.gdb
Line Name: L0

Static Calibration Test

Project: RVAAP
Equipment: EM-61 (1.0x0.5m)
Grid/Location: GPO

Allowable failure (%): 20%
Outside range
Acceptable limits

AM test
Operator: MK
Date: 10/22/2009



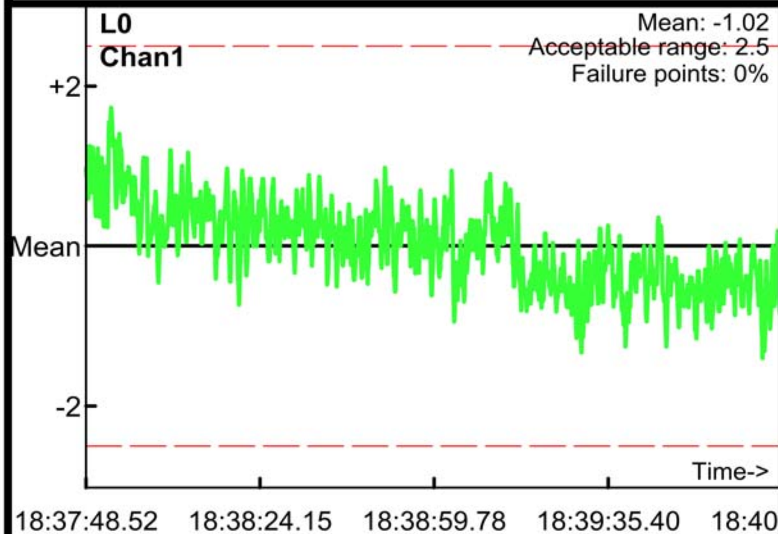
Database: c:\shaw projects\RVAAP\field data\EM61 Data\10 22 2009\102209A_edit.gdb
Line Name: L1

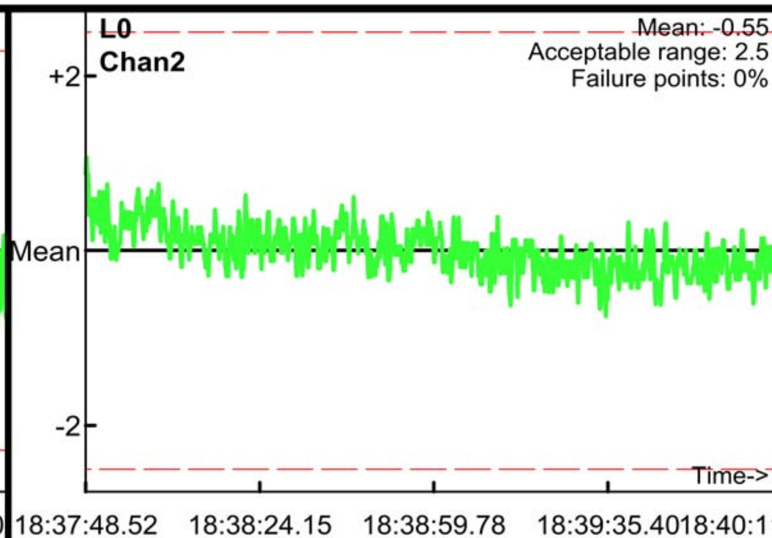
Static Calibration Test

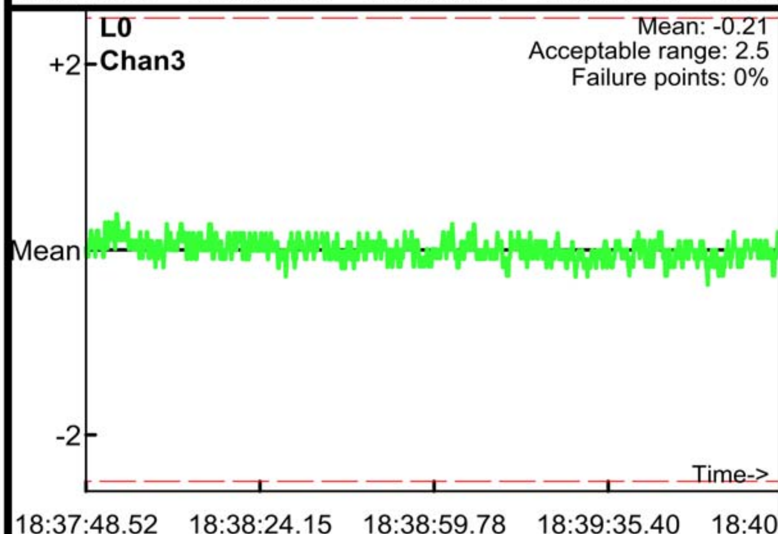
Project: RVAAP
Equipment: EM-61 (1.0x0.5m)
Grid/Location: GPO

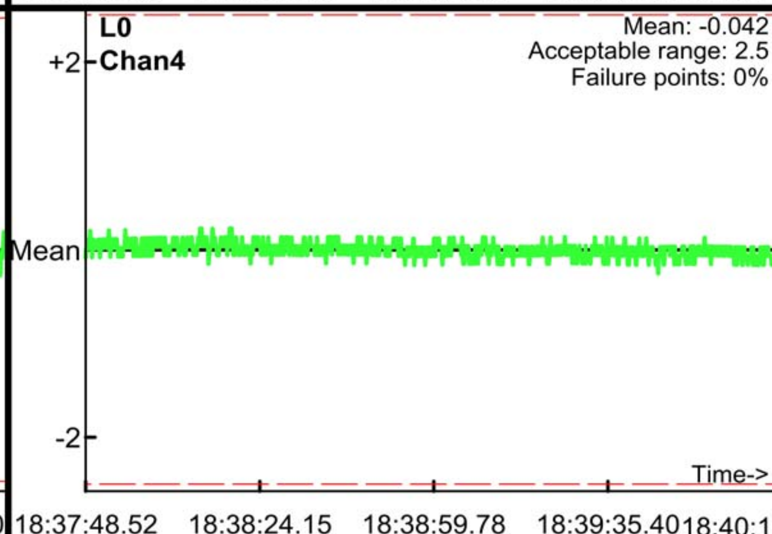
Allowable failure (%): 20%
Outside range
Acceptable limits

PM test
Operator: MK
Date: 10/22/2009









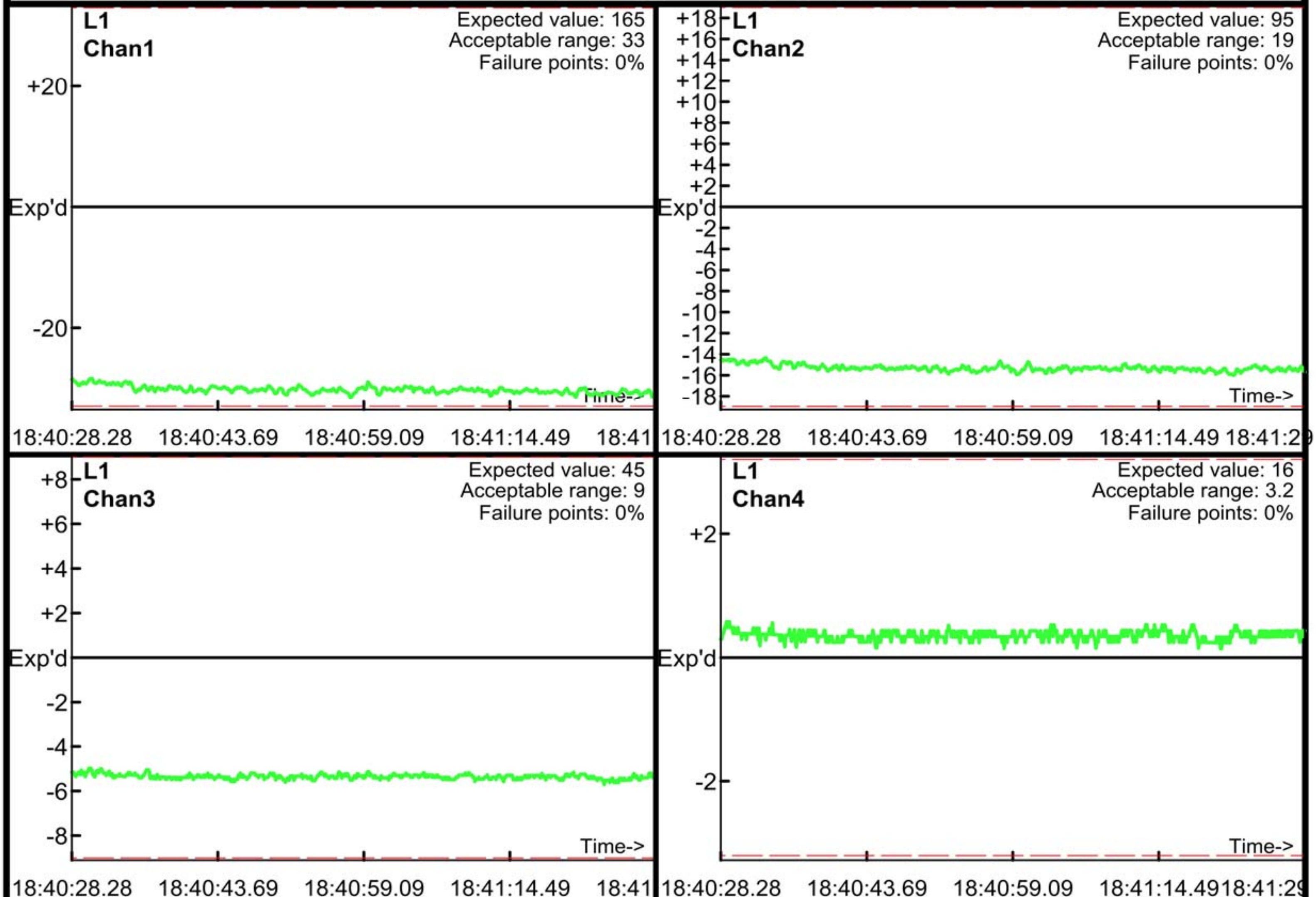
Database: C:\Shaw Projects\RVAAP\Field Data\102218B.gdb
Line Name: L0

Static Calibration Test

Project: RVAAP
Equipment: EM-61 (1.0x0.5m)
Grid/Location: GPO

Allowable failure (%): 20%
Outside range
Acceptable limits

PM test
Operator: MK
Date: 10/22/2009



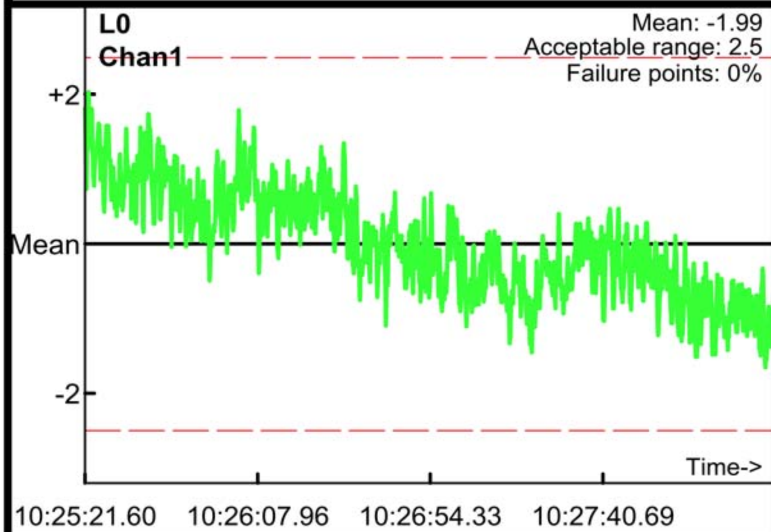
Database: C:\Shaw Projects\RVAAP\Field Data\102218B.gdb
Line Name: L1

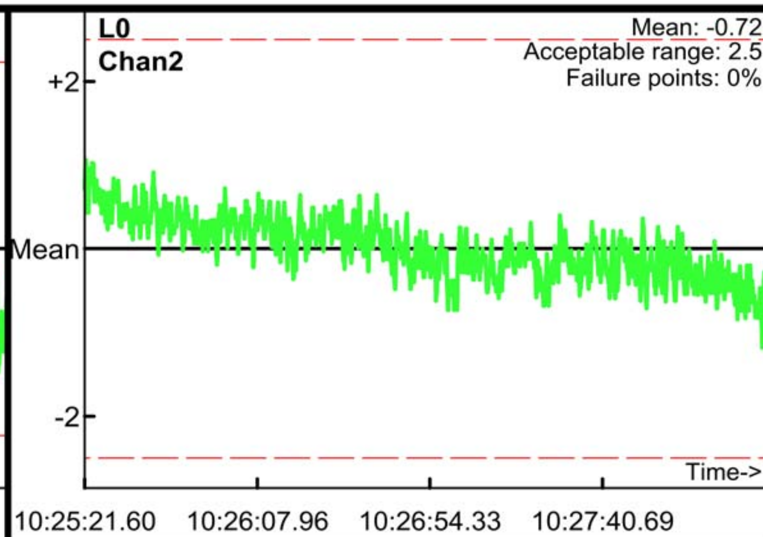
Static Calibration Test

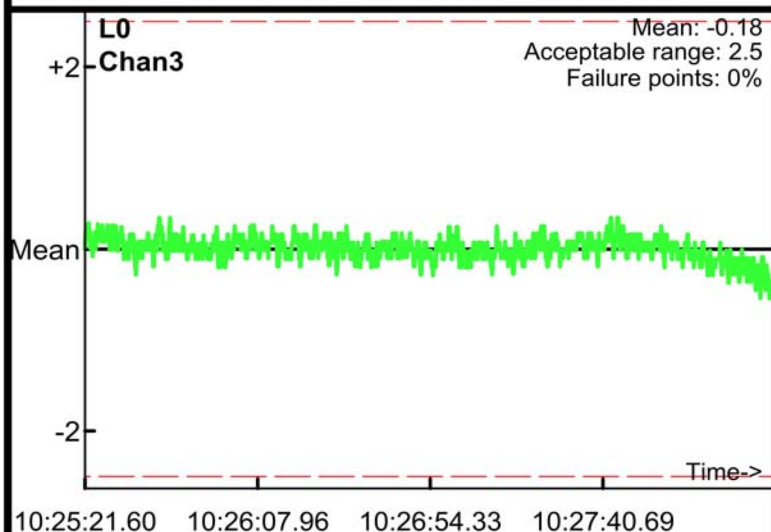
Project: RVAAP
Equipment: EM-61 (1.0x0.5m)
Grid/Location: GPO

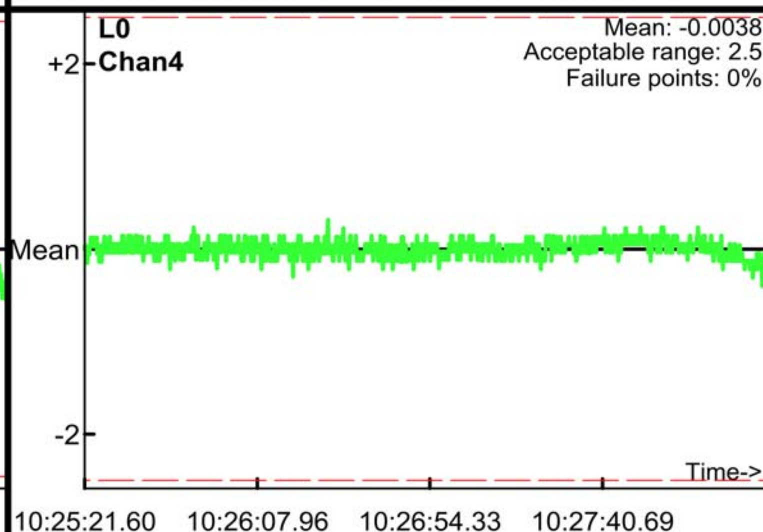
Allowable failure (%): 20%
Outside range
Acceptable limits

AM test
Operator: MK
Date: 10/23/2009









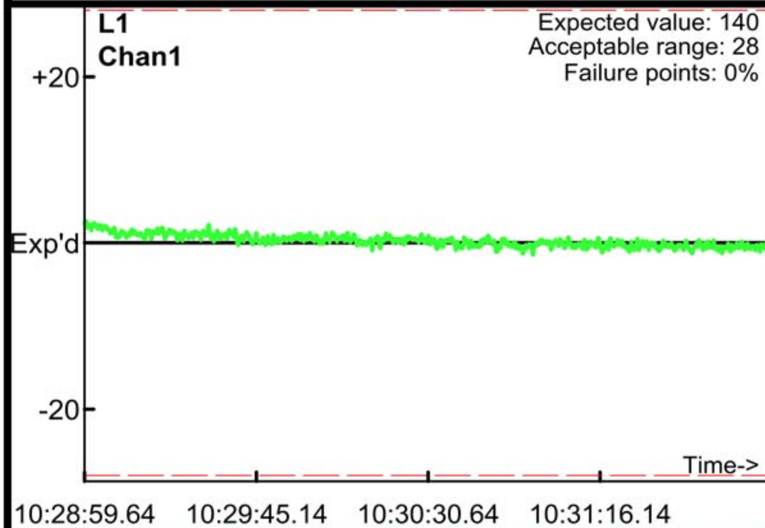
Database: C:\Shaw Projects\RVAAP\Field Data\102310A.gdb
Line Name: L0

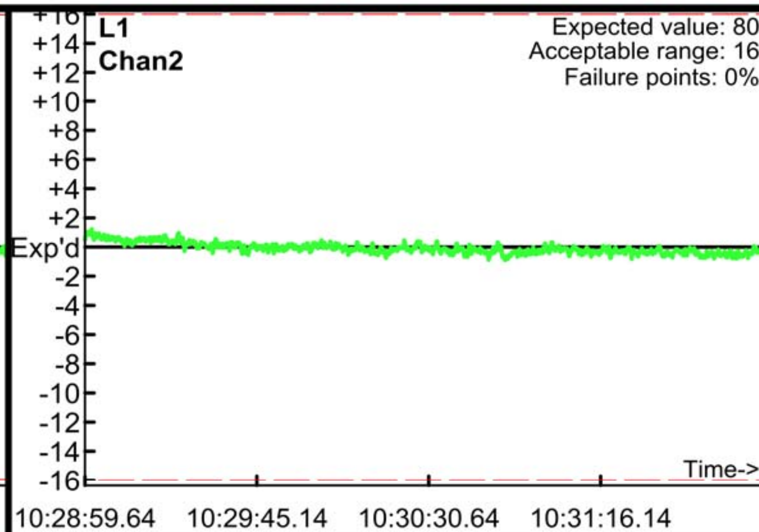
Static Calibration Test

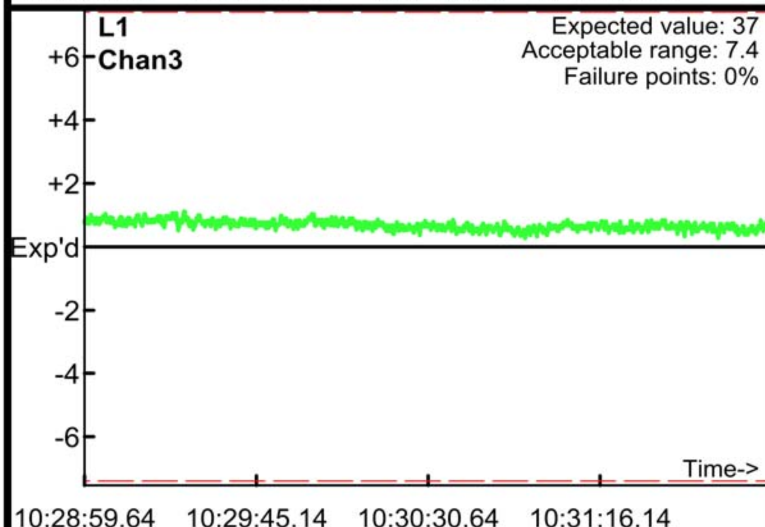
Project: RVAAP
Equipment: EM-61 (1.0x0.5m)
Grid/Location: GPO

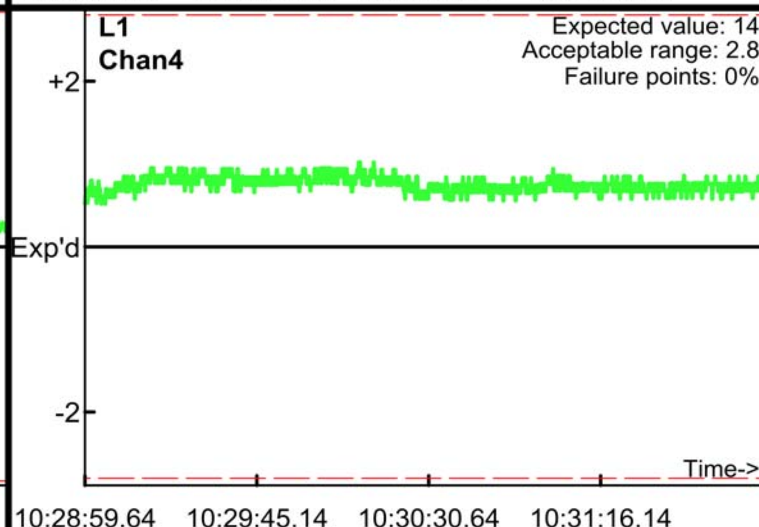
Allowable failure (%): 20%
Outside range
Acceptable limits

AM test
Operator: MK
Date: 10/23/2009









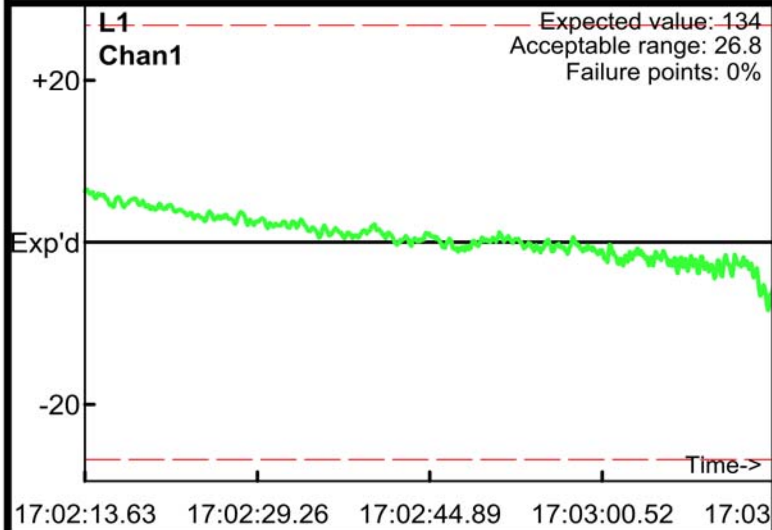
Database: C:\Shaw Projects\RVAAP\Field Data\102310A.gdb
Line Name: L1

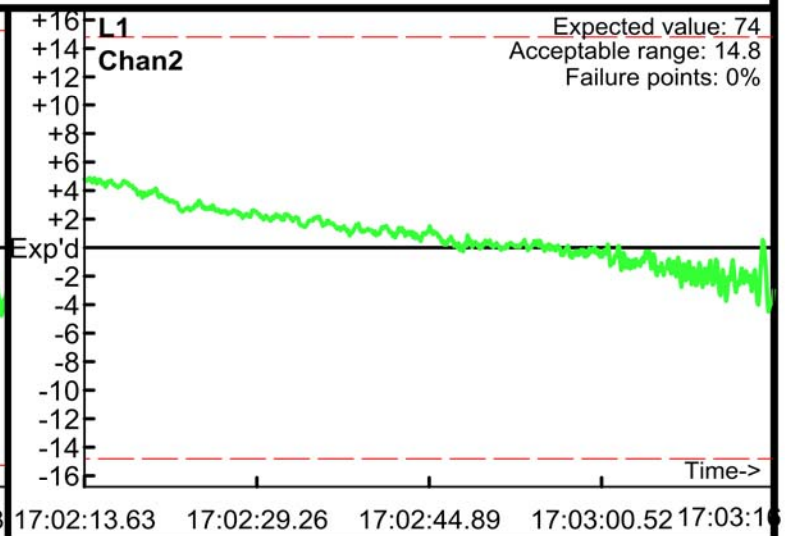
Static Calibration Test

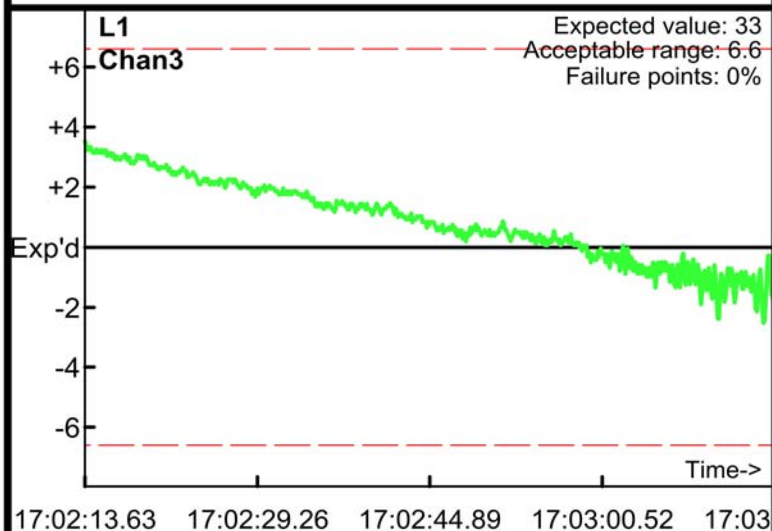
Project: RVAAP
Equipment: EM-61 (1.0x0.5m)
Grid/Location: GPO

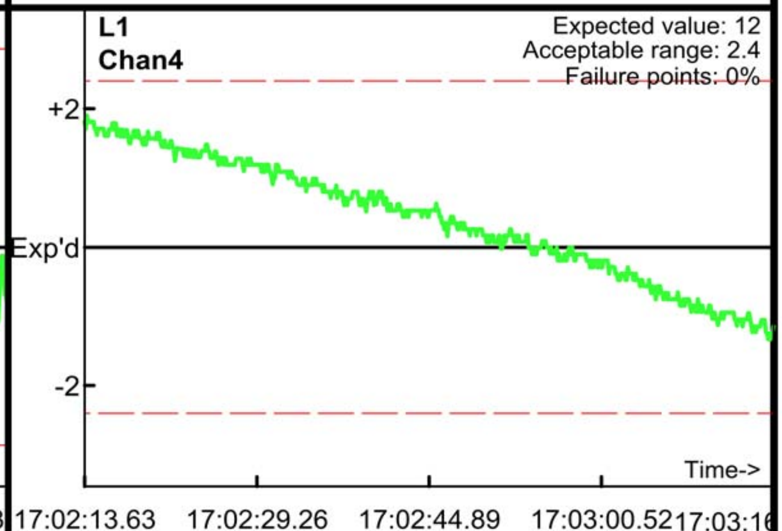
Allowable failure (%): 20%
Outside range
Acceptable limits

PM test
Operator: MK
Date: 10/23/2009









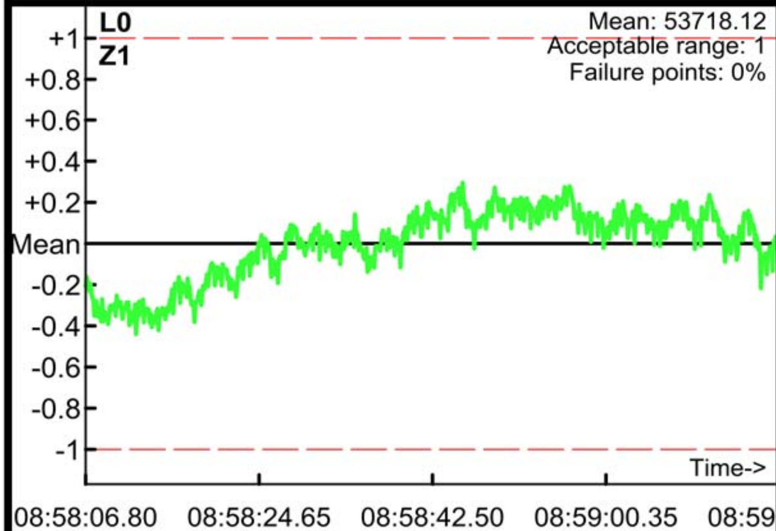
Database: C:\Shaw Projects\RVAAP\Field Data\102316A.gdb
Line Name: L1

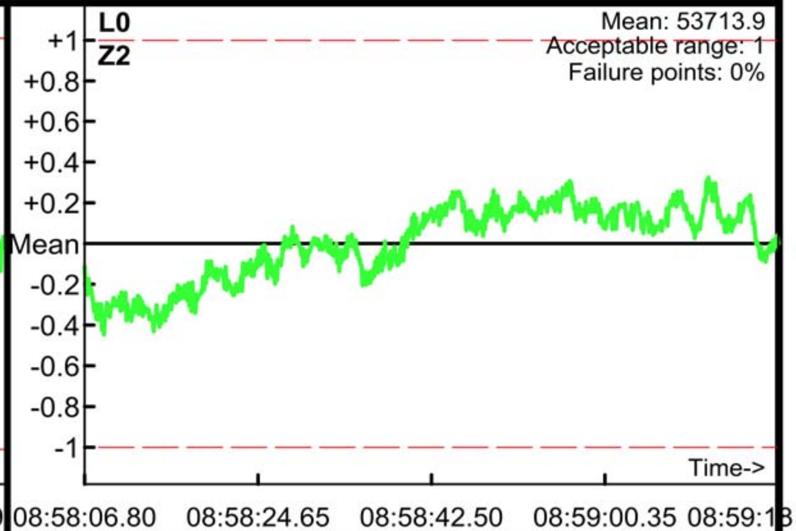
Static Calibration Test

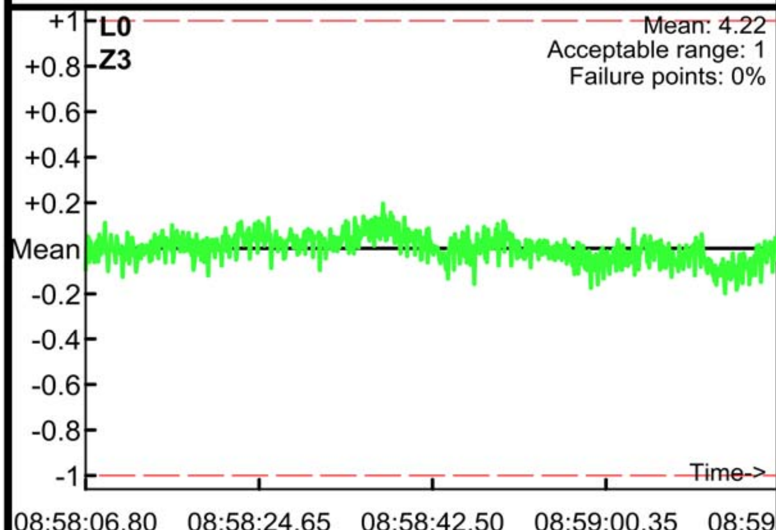
Project: RVAAP
Equipment: Magnetometers
Grid/Location: GPO

Allowable failure (%): 20%
Outside range
Acceptable limits

AM test
Operator: MK
Date: 10/26/2009







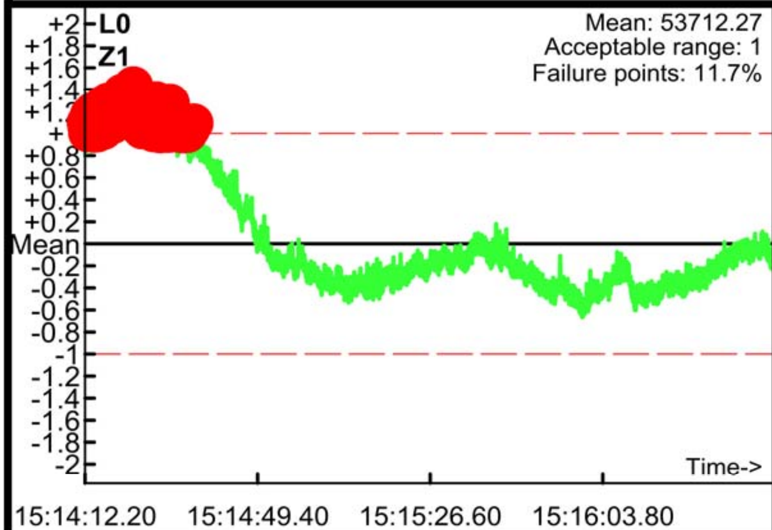
Database: C:\Shaw Projects\RVAAP\Field Data\EM61 Data\10 22 2009\dataset1_edit.gdb
Line Name: L0

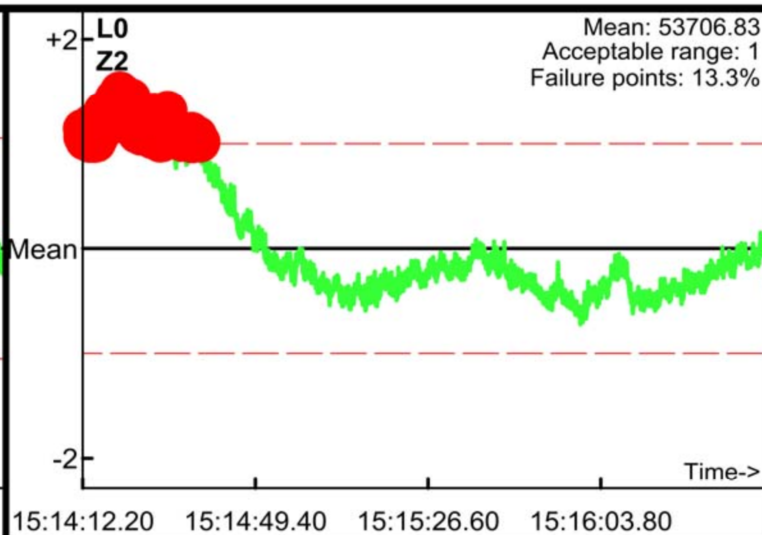
Static Calibration Test

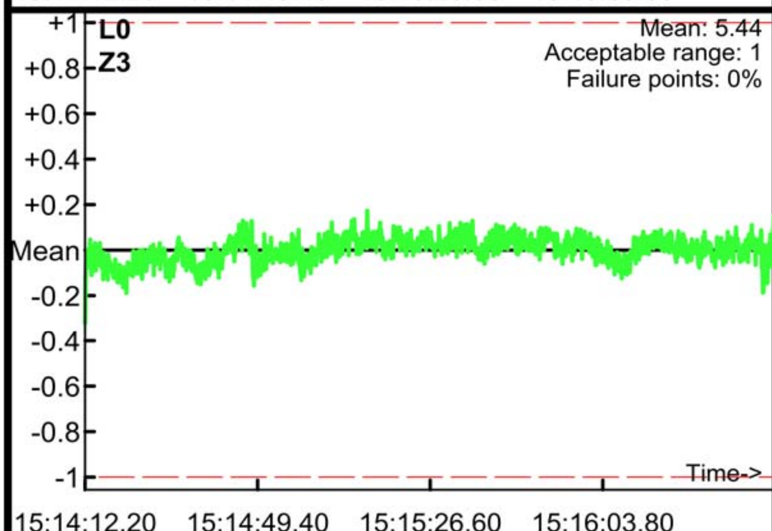
Project: RVAAP
Equipment: Magnetometers
Grid/Location: GPO

Allowable failure (%): 20%
Outside range
Acceptable limits

PM test
Operator: MK
Date: 10/26/2009







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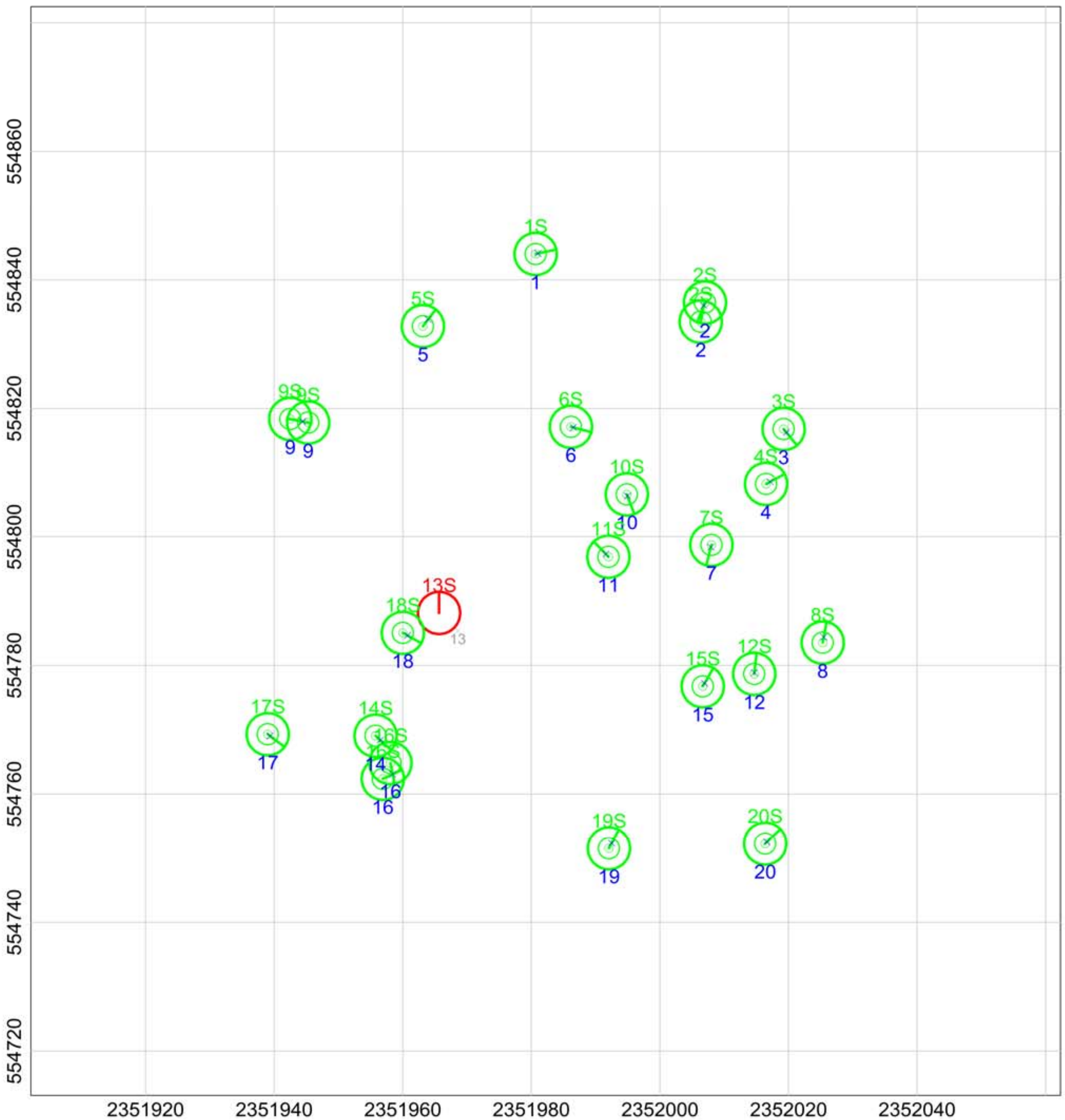
Line Name: L0



Geophysical Prove-Out Truth Table Results

EM61-MK2
RTK GPS Positioning System
Sum4

Ravenna Army Ammunition Plant
Ravenna, Ohio

LEGEND

Total number of truth targets: 23

Targets found within radius of 1.64 - 3.28 : 4

Targets found within radius of 0.66 - 1.64 : 8

Targets found within radius of 0.0 - 0.66 : 10

Number of targets reported (seeded picks): 22

Targets not found: 1

Non-seeded picks: -2

Total Score: 50

Map Scale: Scale 1:1066.271
50 0
US survey foot
NAD83 / Ohio CS83 North zone

N

Grid North: 0°0'0"
Mag North: 0°0'0"

Client: USACE - Louisville District

Project: Ravenna Army Ammunition Plant

Contractor: Shaw Environmental & Infrastructure, Inc.

Created by:	**Verified by:**
Date:	**File: EM61_GPS_CLMS_Targets**
Page number:	**Approved:**

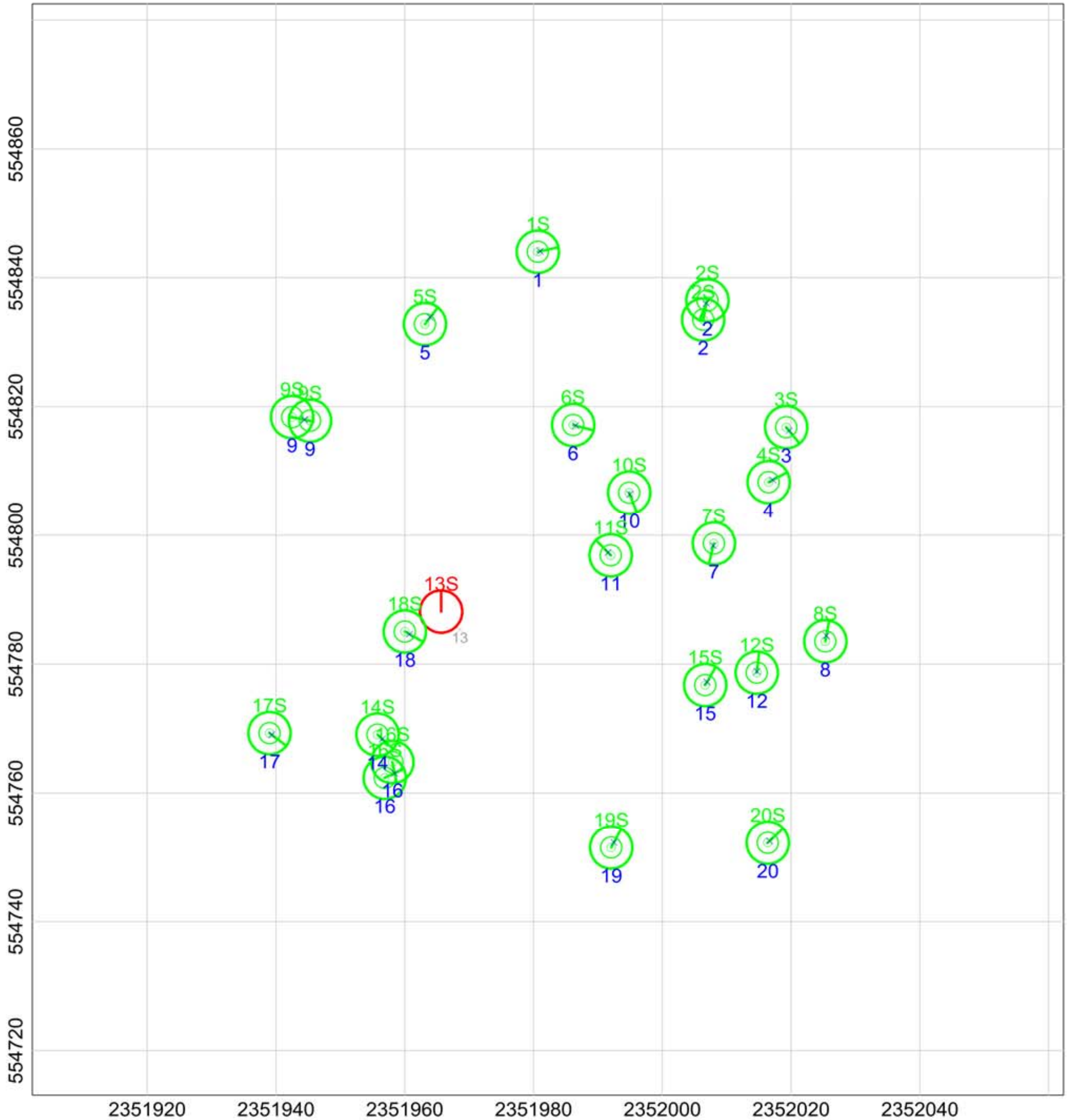
Shaw Environmental & Infrastructure, Inc.

US Army Corps of Engineers Louisville District

Geophysical Prove-Out Truth Table Results

EM61-MK2
RTK GPS Positioning System
Channel 2

Ravenna Army Ammunition Plant
Ravenna, Ohio



LEGEND

Total number of truth targets: 23

Targets found within radius of 1.64 - 3.28 : 4

Targets found within radius of 0.66 - 1.64 : 8

Targets found within radius of 0.0 - 0.66 : 10

Number of targets reported (seeded picks): 22

Targets not found: 1

Non-seeded picks: -2

Total Score: 50

Map Scale: Scale 1:1066.271

50 0

US survey foot

NAD83 / Ohio CS83 North zone

N

Grid North: 0°0'0"
Mag North: 0°0'0"

Client: USACE - Louisville District

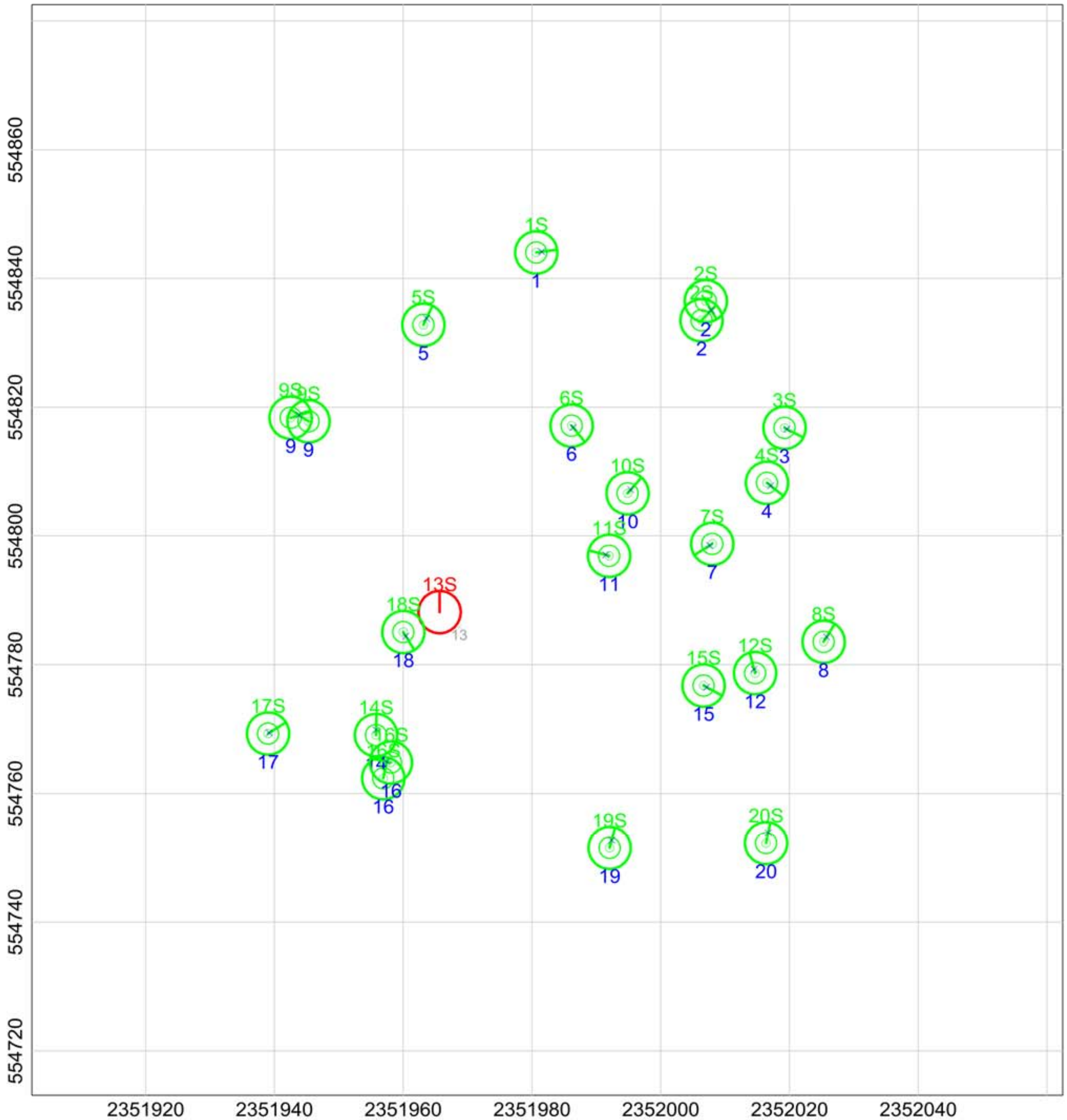
Project: Ravenna Army Ammunition Plant

Contractor: Shaw Environmental & Infrastructure, Inc.

Created by:	**Verified by:**
Date:	**File: EM61_GPS_CLMS_Targets**
Page number:	**Approved:**

Shaw Environmental & Infrastructure, Inc.

US Army Corps of Engineers Louisville District



Geophysical Prove-Out Truth Table Results

EM61-MK2
RTS Positioning System
Channel 2

Ravenna Army Ammunition Plant
Ravenna, Ohio

LEGEND

Total number of truth targets: 23

Targets found within radius of 1.64 - 3.28 : 5

Targets found within radius of 0.66 - 1.64 : 9

Targets found within radius of 0.0 - 0.66 : 8

Number of targets reported (seeded picks): 22

Targets not found: 1

Non-seeded picks: -2

Total Score: 47

Map Scale: Scale 1:1066.271

50 0

US survey foot

NAD83 / Ohio CS83 North zone

N

Grid North: 0°0'0"

Mag North: 0°0'0"

Client: USACE - Louisville District

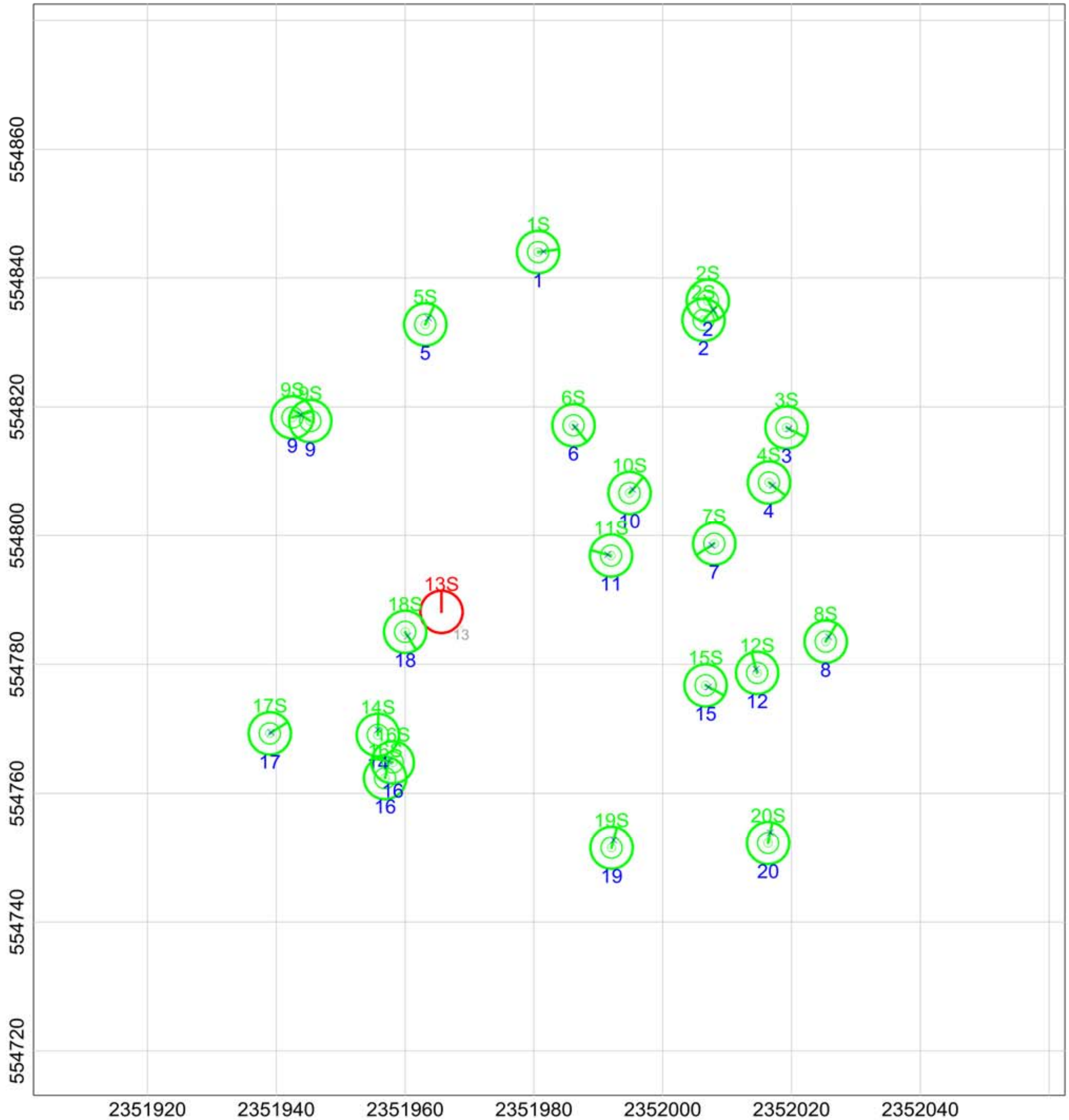
Project: Ravenna Army Ammunition Plant

Contractor: Shaw Environmental & Infrastructure, Inc.

Created by:	Verified by:
Date:	File: EM61-RTS Survey_targets
Page number:	Approved:

Shaw Environmental & Infrastructure, Inc.

US Army Corps of Engineers Louisville District



Geophysical Prove-Out Truth Table Results

EM61-MK2
RTS Positioning System
Sum4

Ravenna Army Ammunition Plant
Ravenna, Ohio

LEGEND

Total number of truth targets: 23

Targets found within radius of 1.64 - 3.28 : 5

Targets found within radius of 0.66 - 1.64 : 9

Targets found within radius of 0.0 - 0.66 : 8

Number of targets reported (seeded picks): 22

Targets not found: 1

Non-seeded picks: -2

Total Score: 47

Map Scale: Scale 1:1066.271

50 0

US survey foot

NAD83 / Ohio CS83 North zone

N

Grid North: 0°0'0"
Mag North: 0°0'0"

Client: USACE - Louisville District

Project: Ravenna Army Ammunition Plant

Contractor: Shaw Environmental & Infrastructure, Inc.

Created by:	**Verified by:**
Date:	**File: EM61-RTS Survey_targets**
Page number:	**Approved:**

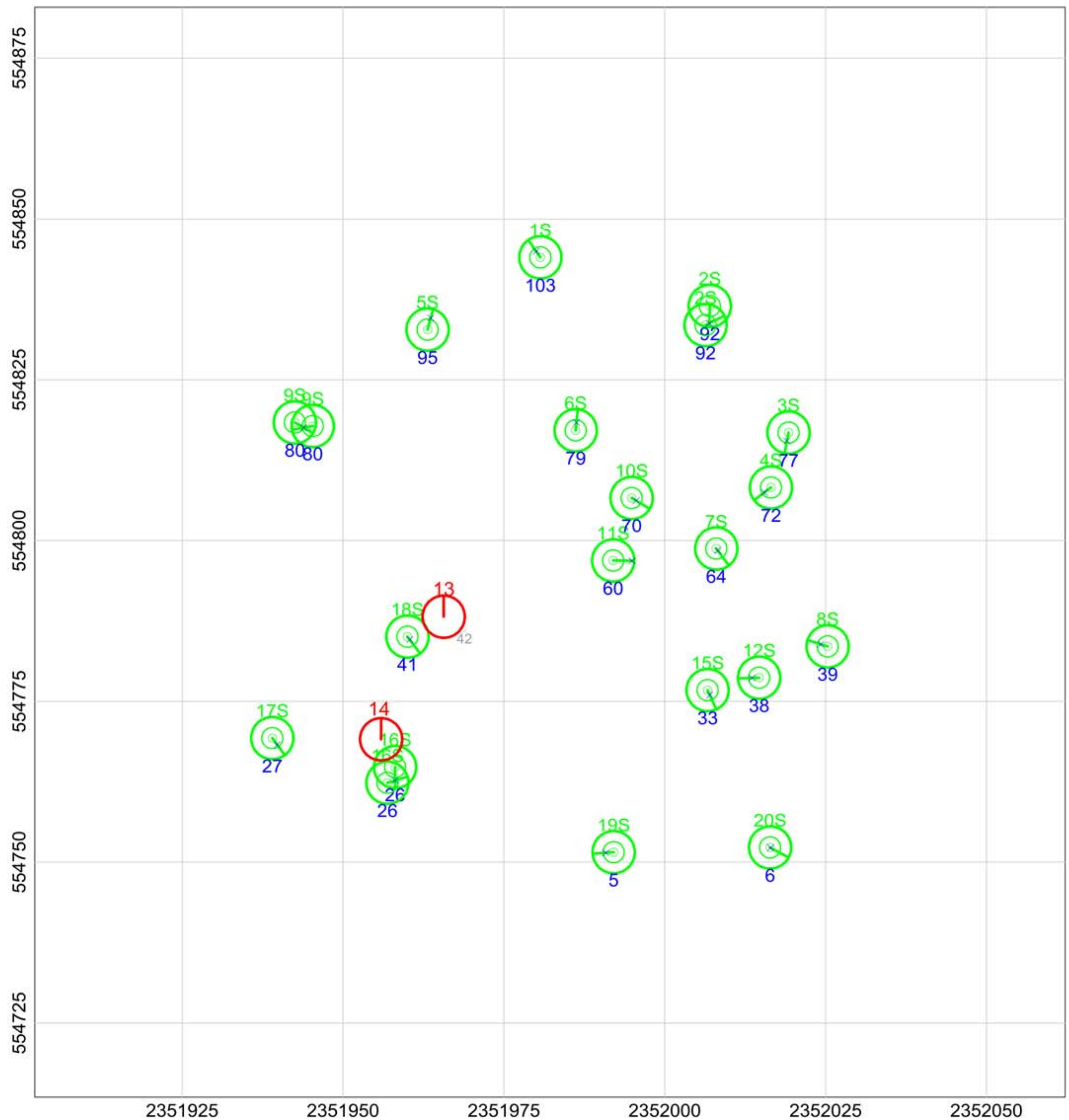
Shaw Environmental & Infrastructure, Inc.

US Army Corps of Engineers Louisville District

Geophysical Prove-Out Truth Table Results

G-858G Magnetometer
RTK GPS Positioning System
Total Field - Gradient

Ravenna Army Ammunition Plant
Ravenna, Ohio



LEGEND

Total number of truth targets: 23

Targets found within radius of 1.64 - 3.28 : 4

Targets found within radius of 0.66 - 1.64 : 13

Targets found within radius of 0.0 - 0.66 : 4

Number of targets reported (seeded picks): 21

Targets not found: 2

Non-seeded picks: -2

Total Score: 42

Map Scale: Scale 1:1000

US survey foot
NAD83 / Ohio CS83 North zone

N

Grid North: 0°0'0"
Mag North: 0°0'0"

Client: USACE - Louisville District

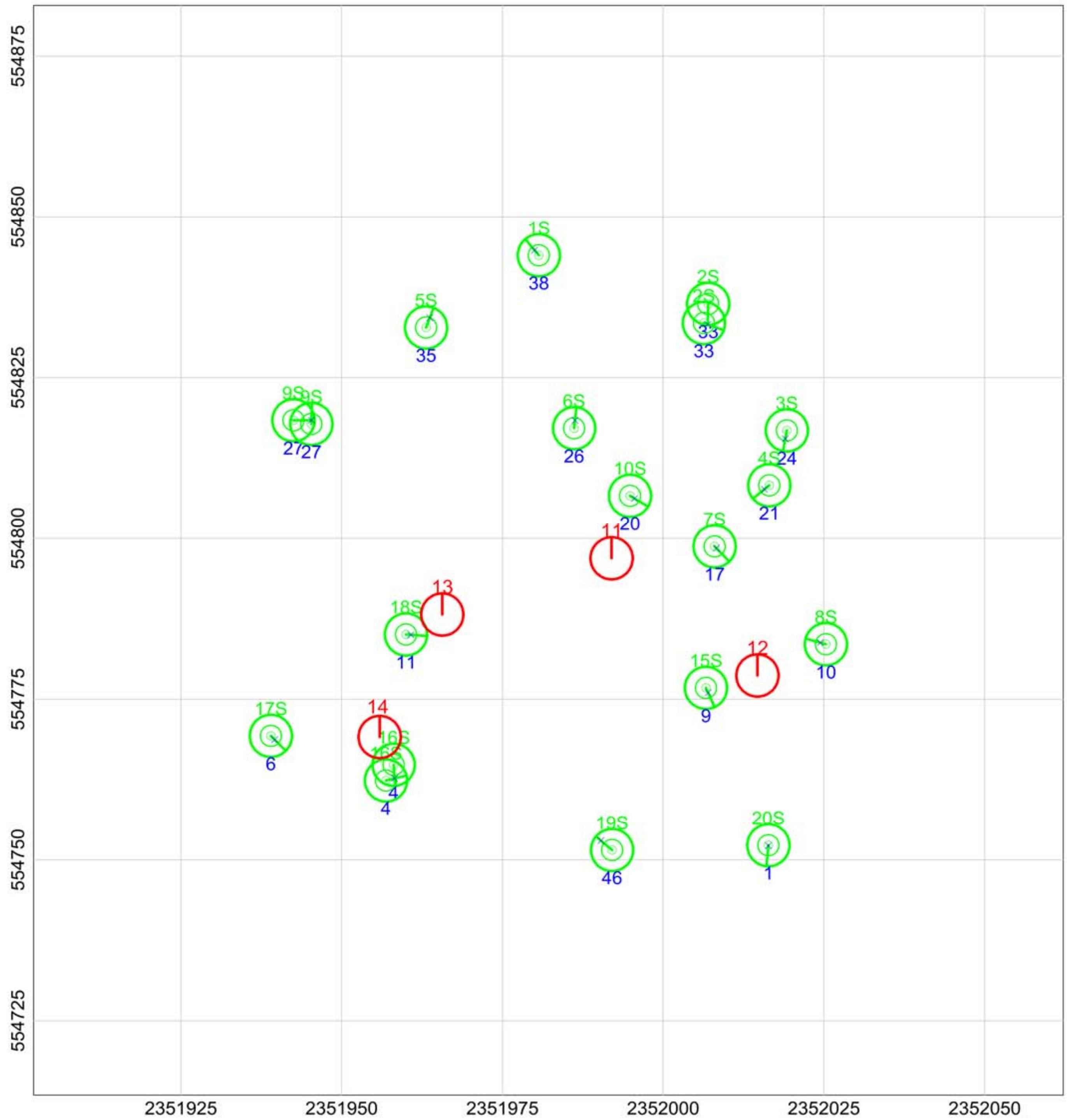
Project: Ravenna Army Ammunition Plant

Contractor: Shaw Environmental & Infrastructure, Inc.

Created by:	**Verified by:**
Date:	**File: magGRAD_gps_targets**
Page number:	**Approved:**

Shaw Environmental & Infrastructure, Inc.

US Army Corps of Engineers Louisville District



Geophysical Prove-Out Truth Table Results

G-858G Magnetometer
RTK GPS Positioning System
Total Field

Ravenna Army Ammunition Plant
Ravenna, Ohio

LEGEND

Total number of truth targets: 23
Targets found within radius of 1.64 - 3.28 : 4
Targets found within radius of 0.66 - 1.64 : 11
Targets found within radius of 0.0 - 0.66 : 4
Number of targets reported (seeded picks): 19
Targets not found: 4
Non-seeded picks: -3
Total Score: 38

Map Scale: Scale 1:1000
US survey foot
NAD83 / Ohio CS83 North zone

Grid North: 0°0'0"
Mag North: 0°0'0"

Client: USACE - Louisville District

Project: Ravenna Army Ammunition Plant

Contractor: Shaw Environmental & Infrastructure, Inc.

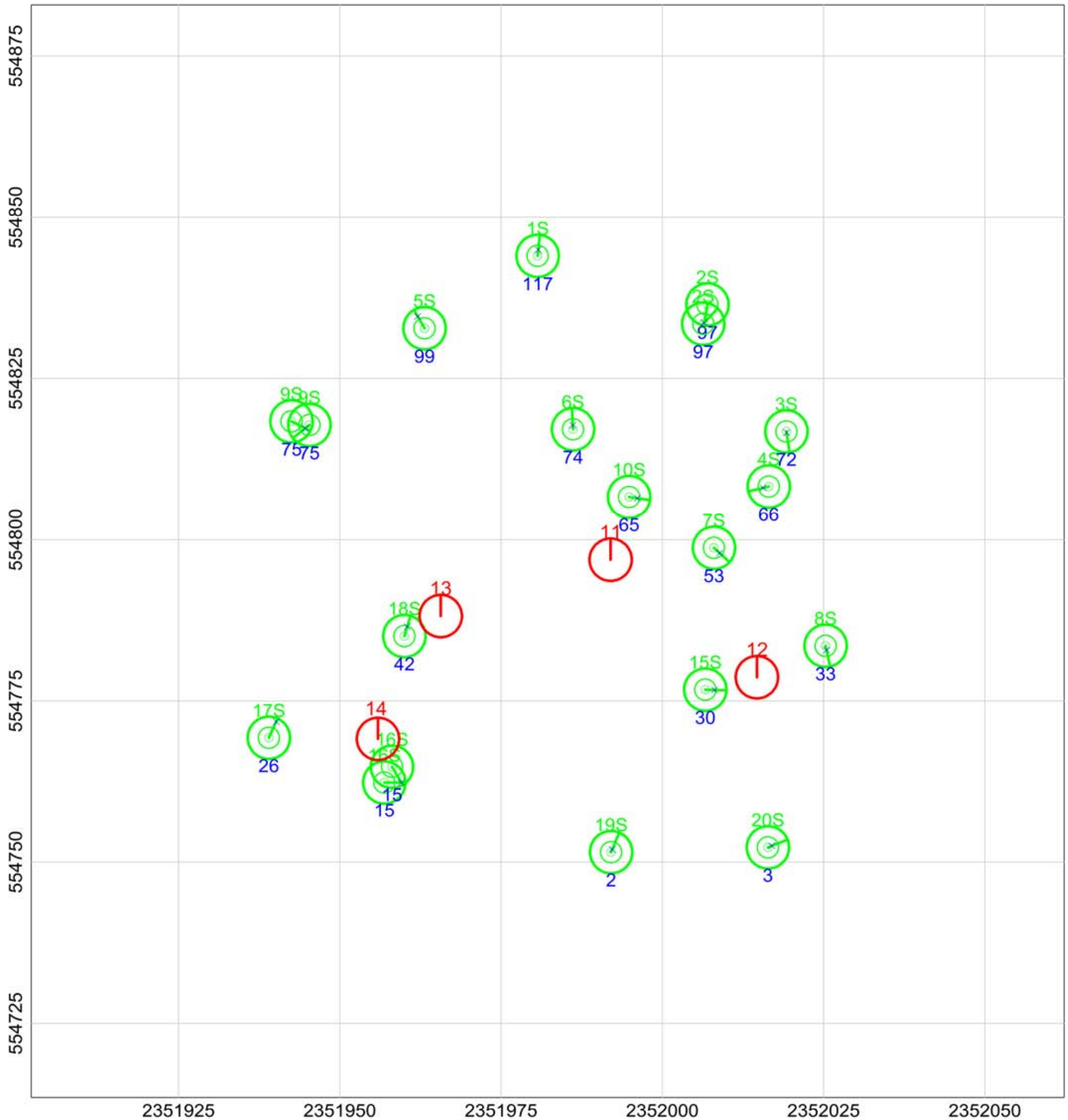
Created by:	Verified by:
Date:	File: magTF_gps_targets
Page number:	Approved:

Shaw Environmental & Infrastructure, Inc.
US Army Corps of Engineers Louisville District

Geophysical Prove-Out Truth Table Results

G-858G Magnetometer
RTS Positioning System
Total Field - Gradient

Ravenna Army Ammunition Plant
Ravenna, Ohio



LEGEND

Total number of truth targets: 23

Targets found within radius of 1.64 - 3.28 : 6

Targets found within radius of 0.66 - 1.64 : 8

Targets found within radius of 0.0 - 0.66 : 5

Number of targets reported (seeded picks): 19

Targets not found: 4

Non-seeded picks: -3

Total Score: 37

Map Scale: Scale 1:1000, 50 0, US survey foot, NAD83 / Ohio CS83 North zone

N

Grid North: 0°0'0"
Mag North: 0°0'0"

Client: USACE - Louisville District

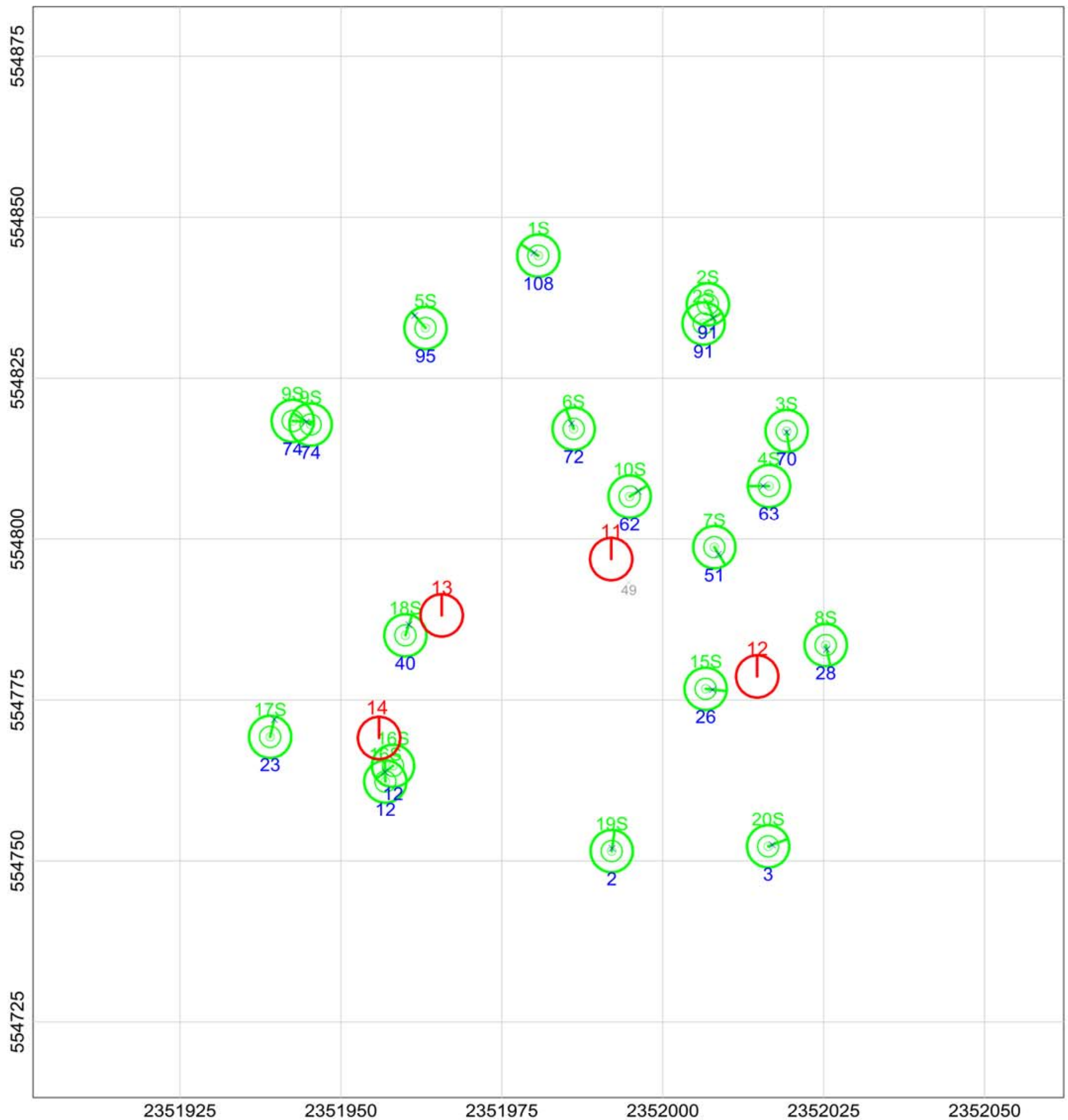
Project: Ravenna Army Ammunition Plant

Contractor: Shaw Environmental & Infrastructure, Inc.

Created by:	**Verified by:**
Date:	**File: magGRAD_rts_targets**
Page number:	**Approved:**

Shaw Environmental & Infrastructure, Inc.

US Army Corps of Engineers Louisville District



Geophysical Prove-Out Truth Table Results

G-858G Magnetometer
RTS Positioning System
Total Field

Ravenna Army Ammunition Plant
Ravenna, Ohio

LEGEND

Total number of truth targets: 23

Targets found within radius of 1.64 - 3.28 : 6

Targets found within radius of 0.66 - 1.64 : 11

Targets found within radius of 0.0 - 0.66 : 2

Number of targets reported (seeded picks): 19

Targets not found: 4

Non-seeded picks: -2

Total Score: 34

Map Scale: Scale 1:1000

50 0

US survey foot

NAD83 / Ohio CS83 North zone

N

Grid North: 0°0'0"
Mag North: 0°0'0"

Client: USACE - Louisville District

Project: Ravenna Army Ammunition Plant

Contractor: **Shaw Environmental & Infrastructure, Inc.**

Created by:	**Verified by:**
Date:	**File: magTF_rts_targets**
Page number:	**Approved:**

Shaw Environmental & Infrastructure, Inc.

US Army Corps of Engineers Louisville District