

Appendix J
Geophysical Prove Out Report

June 7, 2006

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Subject: Final Geophysical Prove-Out Report.
Former Trabuco Bombing Range Site
Rancho Santa Margarita, California

Dear Ms. Jorgensen-Risk:

The purpose of this report is to summarize the geophysical prove-out results of the surveys performed at the former Trabuco Bombing Range site from January 9 to 13, 2006. The Geophysical Prove-Out (GPO) was conducted in accordance with the Final Work Plan, Geophysical Prove-Out, Former Trabuco Bombing Range, December 2005, with several field-directed deviations as noted in this report. The GPO was conducted to prove the effectiveness of several geophysical instruments to detect specific munitions items at various depths and orientations on the site of the former Trabuco Bombing Range.

INTRODUCTION

The GPO was conducted by personnel from Parsons and Innovative Technical Solutions, Inc. (ITSI) on a site selected for this activity in O'Neill Regional Park, Santa Margarita CA, within the boundaries of the former Trabuco Bombing Range (see Figure 1). The GPO grid was established by planting seed items that were expected to be found on the bombing range from historical archives. The seed items were buried by both Parsons/ITSI and U.S. Army Corp of Engineers (USACE) personnel. This report contains a summary of the results obtained from the data collected using three different types of geophysical instruments. The three instruments used were a Geonics EM61-MK2 time domain metal detector, a Geometrics G-858 magnetometer, and a Schonstedt GA-52/Cx magnetometer.

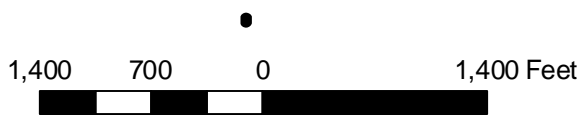


Figure 1
Geophysical Prove Out
Location

Former Trabuco Bombing Range	
Innovative Technical Solutions, Inc.	U.S. Army Corps of Engineers, Los Angeles District
PARSONS	

OBJECTIVES

The primary objective of the GPO is to demonstrate the capabilities of various items of geophysical equipment, and allow the selection of the most appropriate and effective geophysical instrument(s) for the remedial investigation (RI). In addition, the data collected during this GPO was used to:

- Verify conformance of the geophysical instruments with Data Item Description (DID) MR-005-05 (Geophysical Investigation Plan) in regards to the anomaly depth detection criteria; and
- Develop Data Quality Objectives (DQOs) and anomaly selection criteria for use in the field investigation.

PROVE-OUT GRID SET-UP

A 100-ft by 100-ft prove-out grid was constructed at a pre-selected area within the former Trabuco Bombing Range site. The grid was surveyed with both EM61-MK2 and G-858 sensors linked with the real-time kinematics (RTK) global positioning system (GPS) to map background site conditions. The number of background anomalies was considered a go-no go decision point for the viability of the selected GPO grid location. Six anomalies were identified from the background survey and these locations were avoided when seeding items. This number was considered a reasonable number to work around for conduct of the GPO at the selected grid site. The UTM coordinates of the background anomalies detected in the background survey are presented in Table A-1 of Appendix A.

The grid was seeded with 25 items designed to represent munitions and explosives of concern (MEC) in the ground. Twenty-two of the seed items were buried by Parsons/ITSI, so the locations were known to all project personnel; the last three were buried by USACE personnel and are considered blind seed items.

The Geophysical Prove-Out grid will be left in place in its current location for instrument and personnel calibration and testing during the Remedial Investigation phase of the project. After the remedial investigation is completed, the GPO grid will be removed.

Seed Items

The GPO grid was seeded with 25 items designed to represent munitions and explosives of concern (MEC) in the ground. The seed items consisted of both inert munitions debris (MD) and simulated munitions (fabricated from pipe) designed to represent specific MEC items. Twenty-two of the seed items were buried by Parsons/ITSI, so the locations were known to all project personnel; the last three were buried by USACE personnel and are considered blind seed items.

Seed items were selected from the variety of items listed in the Archive Search Report for the Former Trabuco Bombing Range. The first source of seed items was actual inert Munitions Debris (MD) provided by USACE LA District (8 MD items as shown in Table 1). A search of several commercial sources of MD yielded no additional inert MD that could be used. The last resort for seed items was to simulate the MD with pipe of similar size and material of construction. The simulated munitions and size and materials construction are listed in Table 1 and photos are presented in Appendix B. A substantial amount of time and effort was expended to locate and procure the simulated seed items.

The simulated seed items for larger rockets (3.5 and 5 in) were designed to mimic the rocket warhead only. This is a clarification to the Final GPO Work Plan, which lists the rocket but did not specify the warhead (only). The full rocket is impractical to use as seed items (at 4 feet 7 inches long for the 3.5 in rocket and 5 feet 9 inches long for the 5 in rocket), and was not the intention of the GPO Work Plan as written.

Another miniature practice bomb listed in the Archive Search Report (the 4.5 lb. MK 43) has the identical dimensions as the 3-lb Mk 23 practice bomb (2.18 in Diameter by 8.25 inches long), and is simulated by the 3-lb. practice bomb for the purposes of the Geophysical Prove-Out.

The three blind seed items were provided by the LA District and were seeded by the LA District in conjunction with the USAESCH. The three blind seed items were known to be 3 lb Mk 23 miniature practice bombs.

Seed Locations

The 25 seed items were buried at various depths and orientations to determine how the different geophysical instruments tested would respond to these factors. Every effort was made to bury these items at the depths listed in the GPO Work Plan, but the extremely hard ground resulted in some of the deeper planned seed items being placed at shallower depths. Even using an excavator, several of the deeper holes required one and a half hours to dig. The locations, depths, and orientation of the items were determined by a Professional Land Surveyor (PLS) licensed in the State of California (KDM Meridian Inc., Lake Forest CA). Table 2 shows the types, depths, and orientations of the 22 known seed items and Figure 2 shows their locations. The tip, tail and ground surface coordinates of the seed items are presented in Table A-2 in Appendix A.

GEOPHYSICAL SURVEY EQUIPMENT

EM61-MK2

The EM61-MK2 (also referred to as EM61) consists of two 0.5 by 1 meter coils, separated vertically by a distance of 30-cm, which are set on a pair of wheels and pulled by the operator. The EM61 device generates an electromagnetic pulse that triggers eddy currents in the subsurface. The eddy current decay produces a secondary magnetic field that is monitored by a receiving coil or coils. These secondary magnetic fields are

**Table 1
Seed Item Descriptions**

Item ID	Seed Item Description	Munitions Dimensions	Munitions Material of Construction	Seed Item or Simulated Item Description	Simulated Item Outside Dimension	Simulated Item Material of Construction
GPO-01	3lb Bomb; Mk23 practice	2.18in OD x 8.25in long	Steel	Inert Munition Debris	NA	NA
GPO-02	3lb Bomb; Mk23 practice	2.18in OD x 8.25in long	Steel	Inert Munition Debris	NA	NA
GPO-03	3lb Bomb; Mk23 practice	2.18in OD x 8.25in long	Steel	Inert Munition Debris	NA	NA
GPO-04	3lb Bomb; Mk23 practice	2.18in OD x 8.25in long	Steel	Inert Munition Debris	NA	NA
GPO-05	3lb Bomb; Mk5 practice	2.18in OD x 8.25in long	Zinc Alloy	Inert Munition Debris	NA	NA
GPO-06	3lb Bomb; Mk5 practice	2.18in OD x 8.25in long	Zinc Alloy	Inert Munition Debris	NA	NA
GPO-07	25lb Bomb; Mk 76 practice	4in OD x 22.5in to 27.2 in long	Steel	Inert Munition Debris	NA	NA
GPO-08	25lb Bomb; Mk 76 practice	4in OD x 22.5in to 27.2 in long	Steel	4in (ID) Sch. 40 pipe nipple x 24in long	4.5in OD x 24in	Black Steel
GPO-09	25lb Bomb; Mk 76 practice	4in OD x 22.5in to 27.2 in long	Steel	4in (ID) Sch. 40 pipe nipple x 24in long	4.5in OD x 24in	Black Steel
GPO-10	25lb Bomb; Mk 76 practice	4in OD x 22.5in to 27.2 in long	Steel	4in (ID) Sch. 40 pipe nipple x 24in long	4.5in OD x 24in	Black Steel
GPO-11	2.25in Rocket; SCAR practice	2.25in OD x 29.2 in	Cast Iron or Zinc	2in steel pipe x 30in	2.5in OD x 30in	Galvanized Steel
GPO-12	2.25in Rocket; SCAR practice	2.25in OD x 29.2 in	Cast Iron	Inert Munition Debris	NA	NA
GPO-13	2.25in Rocket; SCAR practice	2.25in OD x 29.2 in	Cast Iron or Zinc	2in steel pipe x 30in	2.5in OD x 30in	Galvanized Steel
GPO-14	2.25in Rocket; SCAR practice	2.25in OD x 29.2 in	Cast Iron or Zinc	2in steel pipe x 30in	2.5in OD x 30in	Galvanized Steel
GPO-15	3.5in Rocket; AR practice (warhead)	3.5in OD x 10.4 in	Steel	3in (ID) Sch. 40 pipe nipple x 18in long	3.5in OD x 18 in	Black Steel
GPO-16	3.5in Rocket; AR practice (warhead)	3.5in OD x 10.4 in	Steel	3in (ID) Sch. 40 pipe nipple x 18in long	3.5in OD x 18 in	Black Steel
GPO-17	3.5in Rocket; AR practice (warhead)	3.5in OD x 10.4 in	Steel	3in (ID) Sch. 40 pipe nipple x 18in long	3.5in OD x 18 in	Black Steel
GPO-18	3.5in Rocket; AR practice (warhead)	3.5in OD x 10.4 in	Steel	3in (ID) Sch. 40 pipe nipple x 18in long	3.5in OD x 18 in	Black Steel
GPO-19	5in Rocket; HVAR practice (warhead)	5in OD x 16.7 to 18.3 in	Steel	Inert Munition Debris	NA	NA
GPO-20	5in Rocket; HVAR practice (warhead)	5in OD x 16.7 to 18.3 in	Steel	4in (ID) Sch. 40 pipe nipple x 18in long	4.5in OD x 18in	Black Steel
GPO-21	5in Rocket; HVAR practice (warhead)	5in OD x 16.7 to 18.3 in	Steel	4in (ID) Sch. 40 pipe nipple x 18in long	4.5in OD x 18in	Black Steel
GPO-22	5in Rocket; HVAR practice (warhead)	5in OD x 16.7 to 18.3 in	Steel	4in (ID) Sch. 40 pipe nipple x 18in long	4.5in OD x 18in	Black Steel

NA - Not Applicable

OD - Outside Diameter

ID - Inside Diameter

In = Inches

Table 2
 Known Seed Item Locations
 Former Trabuco Bombing Range
 Geophysical Prove-Out

Item ID	Easting (ft)*	Northing (ft)*	Description (MD indicates Inert Munitions Debris, S indicates Simulated Munition)	Material Type	Orientation	Azimuth (degrees from North)	Depth (ft)
GPO-01	1451127.25	12205273.59	3lb Bomb; practice (MD)	Steel	Horizontal	272	1.06
GPO-02	1451094.48	12205295.36	3lb Bomb; practice (MD)	Steel	Vertical	N/A	0.87
GPO-03	1451126.17	12205233.87	3lb Bomb; practice (MD)	Steel	Horizontal	352	1.34
GPO-04	1451083.95	12205289.77	3lb Bomb; practice (MD)	Steel	Vertical	N/A	1.21
GPO-05	1451136.30	12205304.47	3lb Bomb; practice (MD)	Zinc	Horizontal	17	1.74
GPO-06	1451050.85	12205303.35	3lb Bomb; practice (MD)	Zinc	Vertical	N/A	2.08
GPO-07	1451084.69	12205254.33	25lb Bomb; practice (MD)	Steel	Horizontal	7	1.75
GPO-08	1451109.35	12205314.86	25lb Bomb; practice (S)	Steel	Vertical	N/A	2.08
GPO-09	1451113.09	12205252.12	25lb Bomb; practice (S)	Steel	Horizontal	281	2.83
GPO-10	1451096.39	12205228.28	25lb Bomb; practice (S)	Steel	45 deg.	295	2.72
GPO-11	1451114.85	12205293.07	2.25in Rocket; practice (S)	Steel	Horizontal	30	1.02
GPO-12	1451125.58	12205308.22	2.25in Rocket; practice (MD)	Steel	45 deg.	72	1.81
GPO-13	1451065.69	12205314.49	2.25in Rocket; practice (S)	Steel	Horizontal	78	1.71
GPO-14	1451078.95	12205309.82	2.25in Rocket; practice (S)	Steel	65 deg.	33	1.88
GPO-15	1451055.80	12205289.49	3.5in Rocket; practice (S)	Steel	Horizontal	80	1.50
GPO-16	1451102.49	12205277.06	3.5in Rocket; practice (S)	Steel	Vertical	N/A	1.66
GPO-17	1451051.76	12205245.72	3.5in Rocket; practice (S)	Steel	Horizontal	52	2.53
GPO-18	1451068.30	12205245.55	3.5in Rocket; practice (S)	Steel	45 deg.	290	2.47
GPO-19	1451142.53	12205281.64	5in Rocket; practice (MD)	Steel	Horizontal	273	1.95
GPO-20	1451054.26	12205267.08	5in Rocket; practice (S)	Steel	Horizontal	82	3.79
GPO-21	1451069.28	12205278.63	5in Rocket; practice (S)	Steel	45 deg.	277	1.87
GPO-22	1451058.68	12205222.25	5in Rocket; practice (S)	Steel	45 deg.	5	2.60

*Coordinates are NAD83 UTM Zone 11 North in U.S. Survey Feet



Figure 2 Former Trabuco Bombing Range, January 2006
GPO Grid with Seed Item Locations

received as data and stored in a data logger until it can be downloaded to a personal computer (PC) for interpretation. The EM61 data logger collects data at automatic time intervals determined by the user to about twelve times per second. The logger can also be set to record data received from either the top coil and three different time gates from the bottom coil or from four different time gates from the bottom coil. For this prove-out, data was logged at a rate of 12 hertz (Hz) and recorded from the four time gates of the lower coil. The top coil was used only as a support for the GPS receiver used to locate the data collected during the project.

Geometrics G-858 Magnetometer

The G-858 device uses cesium vapor magnetometer sensors that include a miniature atomic absorption unit from which a signal proportional to the intensity of the ambient magnetic field is derived. The sensitivity of the instrument is 0.005 nanoTesla (nT) and it can collect readings as fast as ten times per second. Two sensors were used during all of the magnetometer surveys, with the sensors separated horizontally by either two or three feet depending on the survey being conducted. Each sensor sampled the earth's magnetic field ten times per second during the surveys.

Schonstedt GA-52/Cx Magnetometer

The Schonstedt magnetometer is a hand-held unit that employs two flux-gate sensors aligned and mounted a fixed distance apart to detect changes in the earth's ambient magnetic field caused by ferrous metal. The Schonstedt magnetometer responds with an audio output and a meter deflection when either sensor is exposed to a disturbance of the earth's ambient magnetic field associated with a ferrous metal object and/or the presence of a permanent field associated with a ferrous metal object. (In most cases, it will be a combination of both circumstances.) Schonstedt magnetometers are highly portable compared to the other two instruments tested during the prove-out but do not record any digital data. They also tend to be more sensitive to small variations in the magnetic field caused by items such as nails or ferrous rocks.

Global Positioning System Equipment

A Trimble 5700/5800 RTK DGPS (differential GPS) was used to position the data collected during two of the EM61 surveys and two of the G858 magnetometer surveys. It was also used to position the locations identified during the Schonstedt survey. For the EM61-MK2 surveys, the GPS antenna was placed on a tripod above the top coil and connected to the data logger. For the GPS-located magnetic surveys, the antenna was attached to a backpack carried by the operator and data was output to the magnetometer's data logger. The Trimble 5700/5800 RTK DGPS is an integrated parallel channel GPS receiver with a built-in radio-modem communication system. A dedicated base station broadcasts real-time differential corrections to the rover units being used by the field crew. Positional data was output to the respective data loggers at 1 second intervals using a serial cable. Anomaly locations for the Schonstedt survey were recorded in the GPS data logger.

GEOPHYSICAL SURVEY PROCEDURES

Data Acquisition

EM61-MK2

The EM61 data were collected by pulling the instrument north and south across the prove-out grid until complete coverage had been obtained. Three different EM61 surveys were performed to evaluate the data collected by the instrument using different line spacing and data location methods. The EM61 data surveys included:

- One complete grid data set collected using two-foot line spacing and RTK GPS,
- One complete grid data set collected using three-foot line spacing and RTK GPS; and
- Four data lines collected using a local coordinate/fiducial data location method.

During data collection, the operator walked north and south (approximately) between two survey tapes stretched along the two end lines of the grid. Two helpers moved cones along these tapes so the EM61 operator could determine the path to be walked from one end of the grid to the other. Data collection was not stopped during the GPS-located surveys, resulting in one long string of data. The fiducial based data were collected only from one end line to the other.

At the start and end of EM61 surveying, a static test was conducted to verify the operation of the instrument. Data were first recorded from the instrument while it was stationary. Subsequently, a spray paint can was placed under the coil and additional data recorded. This verified that the instrument showed a relatively standard response over the same piece of geophysically “quiet” ground and that the instrument responded to a test item. Plots of the EM61 static test data are included in Appendix C.

Before data acquisition on the grid, the EM61 was run in two lines at 90 degree angles to each other, over one of the GPO grid’s corner spikes. This provided a measurement of GPS accuracy. Finally, a 6-line test was collected along the southern end line of the grid. The 6-line test serves to show that the data collected over the same line, including an introduced spike in four of the six lines, is repeatable at different data acquisition speeds. It is also effective in delineating the latency associated with the EM61 system. The latency is determined by finding a correction value that, when applied, results in overlapping peaks over the spike rather than the “chevron” pattern exhibited by uncorrected data. A plot of the 6-line test data is included in Appendix C.

After selecting anomalies from the EM61-MK2 datasets, the coordinates from 20 selected anomalies located closest to seed items were loaded into the GPS data logger memory to verify the reacquisition process. The GPS was used to navigate to the selected location and the EM61-MK2 operator searched the area for the peak response

location. This refined location was recorded with the GPS to be compared with the known location of the seeded item.

G-858 Magnetometer

The magnetic data were collected in the same manner as the EM61 data, with the operator traversing north and south across the prove-out grid. Similar line spacings (2 feet and 3 feet) and location methods (GPS and fiducials) were used as well. The only difference was that the two sensor configuration used for the magnetometer allowed the operator to walk lines separated by 4 feet (2-foot survey) and 6 feet (3-foot survey) rather than the 2 or 3-foot separations necessary in the EM61 surveys.

At the start and end of the G-858 surveying, a static test was conducted to verify the operation of the instruments. Data were first recorded from the magnetometer sensors while they were stationary. Subsequently a spray paint can was placed between the two sensors and additional data recorded. This verified that the instrument was responding to a test item and ensured that the sensors were connected to the correct serial ports on the computer so that they could be positioned correctly. Plots of the G858 static test data are included in Appendix C.

A 6-line test and an octant test were also collected with the magnetometer. The six line test was the same test run with the EM61. The octant test involves the collection of data in eight directions (N-S, S-N, NE-SW, SW-NE, etc.) over a geophysically “quiet” spot. The octant test is designed to determine how the direction the operator is walking affects the amplitude of the magnetometer’s response. If any differences are noted, they can be accounted for in post processing. A plot of the 6-line test is included in Appendix C.

Leveling filters were used to process diurnal variations in the earth’s magnetic field out of the data. The diurnal changes are typically fairly long term phenomena that take place over the course of hours. Since the duration of each of the GPO magnetometer survey was very short (15-20 minutes), the earth’s magnetic field was not expected to change to any significant degree during each survey. As a result, a G-856 magnetometer base station was not utilized (as specified in the Final GPO Work Plan) because the G-856 data were unnecessary and would not be used. This was a field deviation from the Work Plan directed by Parsons in consultation with the USAESCH geophysicist on site. It should be noted that the G-856 was on hand to take the data if required.

After selecting anomalies from the G-858 datasets, the coordinates from 16 anomalies located closest to seed items were loaded into the GPS data logger memory to verify the reacquisition process. The GPS was used to navigate to the selected location and the G-858 operator searched the area for the peak response location. This refined location was recorded with the GPS to be compared with the known location of the seeded item. The G-858 was reconfigured with one sensor located 2 feet above the other to allow for more accurate pinpointing of the anomaly peak.

Schonstedt Magnetometer

A complete Schonstedt magnetometer survey of the entire GPO grid was initiated in accordance with the Final GPO Work Plan but later redirected during performance of the GPO. The Schonstedt survey was initiated on the entire GPO grid with survey lines spaced at 5 feet. However, because so many small anomalies were detected in the first 3 lanes (15 feet wide by 100 feet long each or 1500 square feet), a survey of the entire grid was deemed cumbersome, impractical, and of little value. It was observed that the GPO site had a very high concentration of small (gravel-size) ferrous rocks (so-called “hot” rocks) and also small ferrous trash articles (such as nails likely due to the high population area). A field-directed deviation from the work plan was initiated by Parsons in consultation with the USAESCH geophysicist to survey only the locations that showed evidence of disturbance during burial operations at the grid. It was noted that there were a very large number of magnetic rocks (so called “hot” rocks) and other ferrous debris. This was done simply to determine which of the seed items the Schonstedt could detect, as it was already evident that the number of anomalies that would be detected by the Schonstedt was significantly greater than the number detected by either the EM61- MK2 or the G-858 magnetometer.

DATA DOWNLOADING AND PROCESSING

EM61-MK2

The EM61 data were imported into Geonics’ *Dat61MK2*TM software for pre-processing. *Dat61MK2* combines the EM61 data and the GPS data collected during the project. The resulting data set is automatically saved in Geosoft XYZ format, which can be imported into Geosoft’s *Oasis Montaj*TM software. The exceptions were the four lines collected using only survey tapes and fiducials for location purposes. The first and last data points in each of these lines were set to be 0 or 100 feet along the line, and the rest of the locations were interpolated evenly between these two points. The southwest corner of the grid was defined as the 0N, 0E coordinate of the local grid. The corrected data were then exported to an .xyz file.

The prove-out data were processed using Geosoft's *Oasis Montaj*TM software and the following procedures:

- Conversion from WGS84 latitude and longitude to NAD83 UTM Zone 11N coordinates (GPS-located data); or translation and rotation from the local grid system (fiducially-located data).
- Latency correction using the values derived from the 6-line test conducted before the survey. A 0.45-s latency correction was used for the EM61-MK2 data.
- Drift correction by subtraction of the median value from each data point in the four time gate channels. The median was calculated using a 150 point rolling statistics filter. The four leveled time gate channels were added to produce a total channel.

- Gridding using 0.25 grid node spacing and a blanking distance of 2-ft. Both the leveled channel 3 and the total channel data for the 2-foot and 3-foot line spacing surveys were gridded for evaluation following the GPO.
- Selection of anomalies that are potential Munitions and Explosives of Concern (MEC) using Geosoft's UX Detect algorithm. Various anomaly selection criteria (thresholds) were evaluated for each of the grid files created for the EM data. The final threshold for each grid file was the one that selected as many seed items as possible in the respective grid file. It should be noted that seed item GPO-06 was not detected by the 2-foot survey at the lowest threshold evaluated because the response was within the noise level.
- Calculation of the anomaly width and decay constant between Channels 1 and 4 for the anomalies selected in each data set. Finally, anomalies were eliminated from each data set based on screening values developed to keep all known seed items and to reject anomalies suspected to have been caused by geophysical noise. The criteria used to eliminate anomalies are discussed in the Results and Discussion/EM61 MK2 Section.

G-858 Magnetometer

The G-858 data were pre-processed using Geonics' *Magmap 2000*TM. Magnetic data pre-processing in Magmap includes the combination of the magnetic survey data and the GPS data collected simultaneously or the conversion of the data from time-based line lengths to distance-based lengths. If the GPS was used to position the data, the offsets from the GPS antenna to the center of each magnetometer sensor are entered into Magmap to correctly position the data collected by each sensor. Once the offsets are entered, the data can be exported into Geosoft XYZ format. Two XYZ files are created by Magmap upon export, one for each sensor. Each XYZ file contains the data recorded by the respective sensor, as well as the position of the sensor based on the location of the GPS antenna and the offsets entered for that unit. The four lines collected using fiducials were processed in a manner similar to the EM61 lines collected using fiducials, with the line limits set to 0 and 100 feet. The southwest corner of the grid was defined as the 0N, 0E coordinate of the local grid.

All of the magnetic data sets were processed using Geosoft's *Oasis Montaj*TM software. Individual Geosoft databases were created for each set of magnetic data collected. The G-858 data were processed with the following procedures:

- Conversion from WGS84 latitude and longitude to NAD 83 UTM Zone 11N coordinates (GPS-located data); or translation and rotation from the local grid system (fiducially-located data).
- Latency correction using the values derived from the 6-line test conducted before the survey. A 0.3-s latency correction was used for the line-located data and a 0.1-s latency was used for the GPS-located data.

- Drift correction of the single sensor data by subtracting the median value calculated using a 100 point rolling statistics filter.
- Gridding using 0.25-ft grid node spacing and a blanking distance of 2-ft.
- Selection of anomalies that are considered to be potential MEC was performed by the site geophysicist after running the created grid file through an analytic signal filter in Geosoft. The analytic signal filter returns only positive anomalies, making it easier to select anomalies at a consistent threshold and determine where the exact center of an anomaly should be located. Both the original grid, with the positive and negative responses shown, and the analytic signal grid were considered during selection of anomalies considered to be potential MEC.

Schonstedt Magnetometer

The Schonstedt magnetometer does not collect data during surveying by nature. However, GPS points were collected wherever the operator indicated an anomaly was located. These points were downloaded from the GPS data logger using Trimble *Geomatics Office*[™]. The points were then exported as a CSV file for comparison with the known locations of the seed items.

RESULTS AND DISCUSSION

EM61 MK2

The various data grids created for the prove-out area were displayed on a map along with the locations of the seed items buried in the prove-out grid. Anomaly selection thresholds were chosen for each created grid file as discussed in the Downloading and Processing Section. The results of the analyses for each grid file were then compared to determine the most effective survey spacing and processing method. Regardless of processing method (channel 3 vs. total channel), the 2-foot line spacing survey detected 21 of the 22 known seeded items and the 3-foot line spacing survey detected all 22 known seeded items.

The primary difference between the two processing methods was the relative magnitude of the anomaly selection threshold. To compare the thresholds used for each method, the standard deviation of each channel was calculated in a geophysically quiet area in the data. The standard deviations calculated for the total channel were 3.6 mV for the 2-foot spacing survey and 4.0 mV for the 3-foot spacing survey. The 20 mV threshold used to select anomalies for these two surveys was 5 times the highest standard deviation for the two survey types. The standard deviations calculated for channel 3 were 0.8 mV for the 2-foot survey and 0.9 mV for the 3-foot survey; and the thresholds necessary to detect the same seed items selected using the total channel were 5 mV and 3 mV, respectively. The 3 mV threshold used for the 3-foot survey is only 3.3 times the standard deviation of the gridded channel, suggesting that the total channel was more

effective in separating geophysical noise from actual targets. Therefore, the total channel was used to compare the results of the 2-foot and 3-foot surveys.

The maps with the EM data grids displayed are shown in Figures 3 through 5. The main difference between the two surveys was the miss of GPO-06 by the 2-foot survey. GPO-06 was a 3-lb practice bomb composed of zinc and buried vertically at a 2.08-ft depth. The anomaly from this item on the 3-foot line spacing survey was close to the 20mV threshold, suggesting that this item at this depth is barely detectable. This is especially true considering that the item was not picked on a line passing almost directly over it but was picked on a line 2.5 ft away. Tables 3 and 4 show the results of the 2 and 3-foot surveys with regard to the known seed items. For the offset calculation on these tables, the closest anomaly to the actual seed location was used in the event that more than one anomaly was selected at a location.

The third EM61 map (Figure 5), showing the fiducially-located survey, indicates that utilizing fiducials rather than GPS is an option when necessary, as the anomalies selected as potential MEC are consistent with seed items buried in the vicinity of the transect lines. It also shows that large subsurface objects may be detected by the equipment when they are further than 3 feet from the survey line. Therefore, during the actual field project, it will be necessary for the reacquisition team to follow the EM61 anomaly to its peak rather than rely on a 3-foot radius from the selected location as a stopping point. Table 5 shows the results of the fiducially-located survey with regard to the known seed items.

An additional analysis of the EM data was performed following the anomaly selection of the 2-foot line spacing data. This advanced processing looked at the decay constants and widths at amplitude of each of the anomalies detected. Figures 6 and 6a show the charted locations of each of the originally selected anomalies when these factors are taken into account. The green points represent anomalies known to be seed items; the red points represent anomalies with unknown causes or extra locations selected for known seed item anomalies. The charts show that certain anomalies can be ruled out as potential MEC based on the decay constant, the half width, or a combination of both without reducing the number of seed items detected. Based on the charts, advanced processing screening values were implemented for low amplitude (20-30mV) anomalies in each of the EM data sets collected. The screening values chosen were:

- Minimum width – 1.5 feet
- Maximum decay constant - 2000 μ s

Using this method, 5 anomalies were rejected from the 2-foot line spacing survey and 6 were rejected from the 3-foot line spacing survey. None of the selected fiducial anomalies were rejected. The location coordinates for anomalies selected as potential MEC in the EM 61 survey are presented in Table A-3 through A-5 in Appendix A for each of the respective GPO tests.

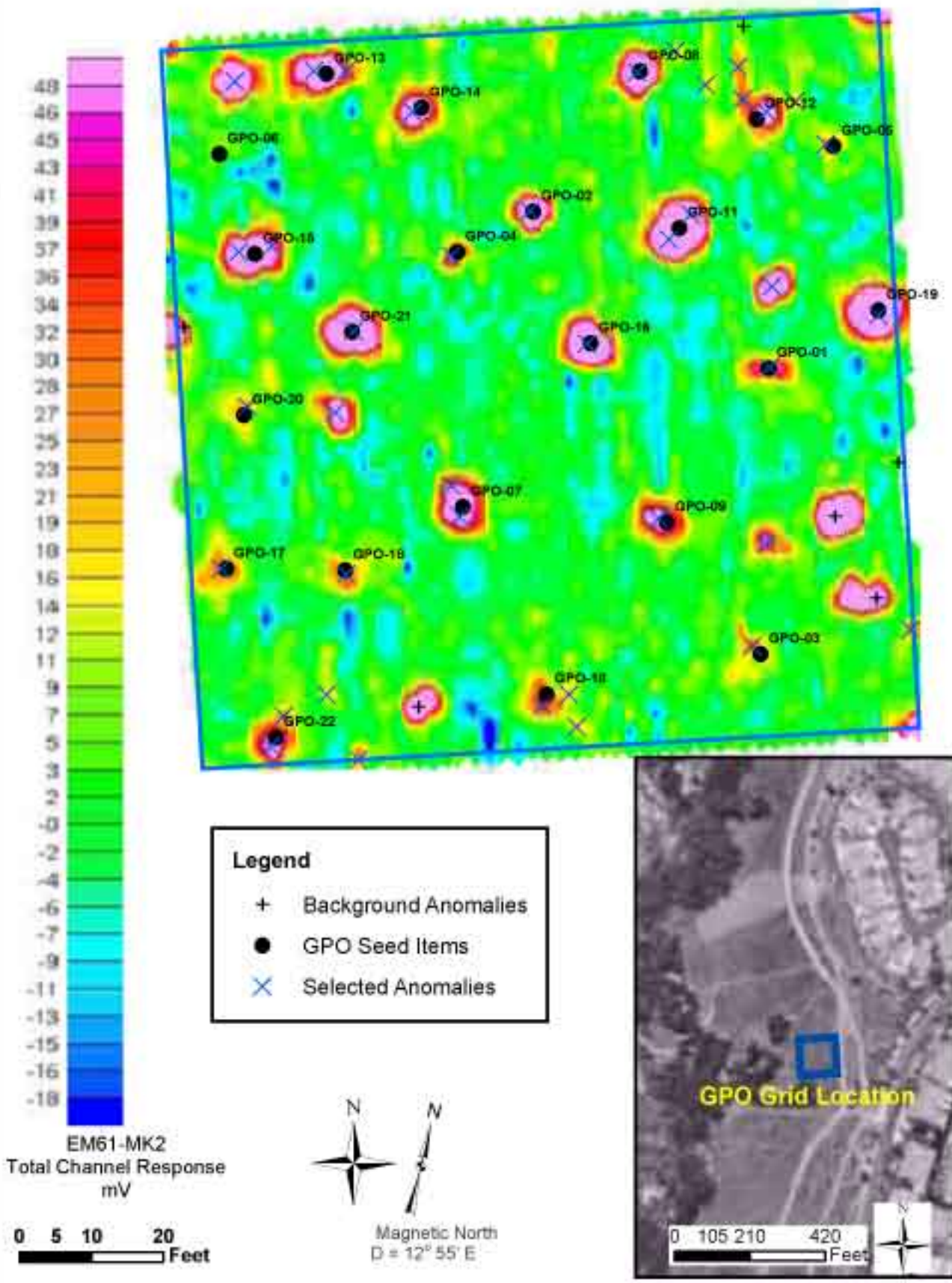


Figure 3 Former Trabuco Bombing Range, January 2006
GPO EM61-MK2 2-ft Line Spacing Results

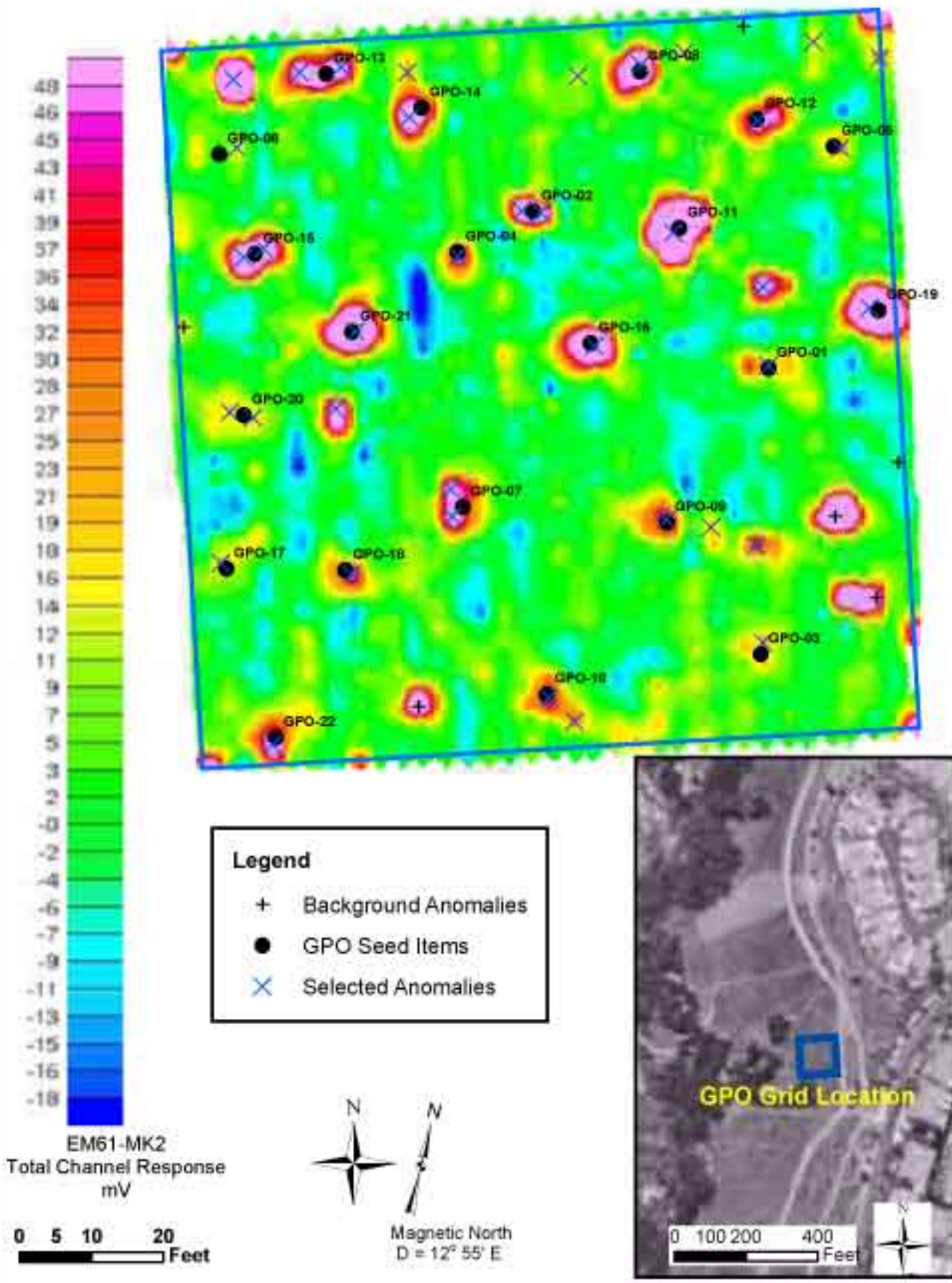


Figure 4 Former Trabuco Bombing Range, January 2006
GPO EM61-MK2 3-ft Line Spacing Results

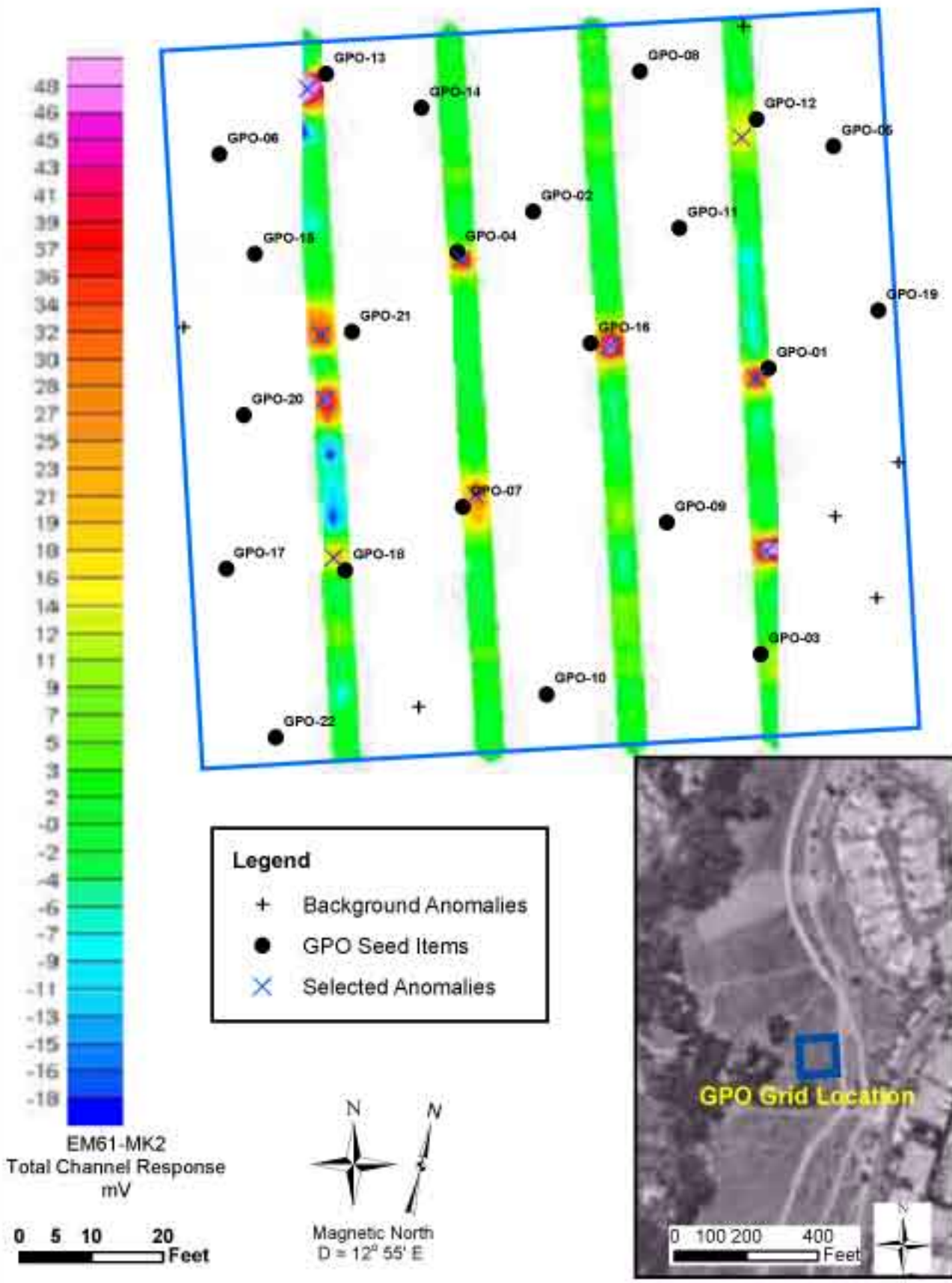


Figure 5 Former Trabuco Bombing Range, January 2006
GPO EM61-MK2 Fiducial Results

Table 3
Seed Item Detections in 2-foot Line Spacing EM61 Survey
Former Trabuco Bombing Range
Geophysical Prove-Out

Item ID	Description	Orientation	Depth (ft)	Actual Easting (ft)	Actual Northing (ft)	Target ID	Picked Easting (ft)	Picked Northing (ft)	Grid value (mV)	Offset
GPO-01	3lb Bomb; practice (steel)	Horizontal	1.06	1451127.3	12205273.6	EM2-17	1451127.4	12205273.8	26.42	0.22
GPO-02	3lb Bomb; practice (steel)	Vertical	0.87	1451094.5	12205295.4	EM2-07	1451094.0	12205295.5	184.05	0.50
GPO-03	3lb Bomb; practice (steel)	Horizontal	1.34	1451126.2	12205233.9	EM2-25	1451125.0	12205235.0	37.26	1.63
GPO-04	3lb Bomb; practice (steel)	Vertical	1.21	1451084.0	12205289.8	EM2-06	1451083.0	12205289.3	52.06	1.08
GPO-05	3lb Bomb; practice (zinc)	Horizontal	1.74	1451136.3	12205304.5	EM2-15	1451135.3	12205304.8	27.82	1.09
GPO-06	3lb Bomb; practice (zinc)	Vertical	2.08	1451050.9	12205303.4	Not Selected	N/A	N/A	N/A	N/A
GPO-07	25lb Bomb; practice	Horizontal	1.75	1451084.7	12205254.3	EM2-35	1451084.3	12205253.0	69.99	1.40
GPO-08	25lb Bomb; practice	Vertical	2.08	1451109.4	12205314.9	EM2-08	1451109.0	12205314.8	138.30	0.37
GPO-09	25lb Bomb; practice	Horizontal	2.83	1451113.1	12205252.1	EM2-22	1451112.0	12205252.8	61.69	1.26
GPO-10	25lb Bomb; practice	45 deg.	2.72	1451096.4	12205228.3	EM2-28	1451095.8	12205226.8	43.68	1.66
GPO-11	2.25in Rocket; practice	Horizontal	1.02	1451114.9	12205293.1	EM2-20	1451113.4	12205291.5	211.49	2.16
GPO-12	2.25in Rocket; practice	45 deg.	1.81	1451125.6	12205308.2	EM2-13	1451127.0	12205309.3	84.60	1.75
GPO-13	2.25in Rocket; practice	Horizontal	1.71	1451065.7	12205314.5	EM2-03	1451064.0	12205315.0	88.99	1.72
GPO-14	2.25in Rocket; practice	65 deg.	1.88	1451079.0	12205309.8	EM2-05	1451077.8	12205309.3	98.20	1.33
GPO-15	3.5in Rocket; practice	Horizontal	1.50	1451055.8	12205289.5	EM2-40	1451058.1	12205290.6	119.95	2.59
GPO-16	3.5in Rocket; practice	Vertical	1.66	1451102.5	12205277.1	EM2-21	1451102.0	12205277.0	141.14	0.52
GPO-17	3.5in Rocket; practice	Horizontal	2.53	1451051.8	12205245.7	EM2-33	1451051.0	12205245.8	34.42	0.76
GPO-18	3.5in Rocket; practice	45 deg.	2.47	1451068.3	12205245.6	EM2-34	1451068.5	12205245.0	34.92	0.59
GPO-19	5in Rocket; practice	Horizontal	1.95	1451142.5	12205281.6	EM2-16	1451142.5	12205281.0	249.54	0.64
GPO-20	5in Rocket; practice	Horizontal	3.79	1451054.3	12205267.1	EM2-38	1451054.8	12205268.3	28.49	1.27
GPO-21	5in Rocket; practice	45 deg.	1.87	1451069.3	12205278.6	EM2-39	1451069.5	12205278.8	200.92	0.25
GPO-22	5in Rocket; practice	45 deg.	2.60	1451058.7	12205222.3	EM2-30	1451058.0	12205221.0	70.57	1.42

Coordinates are NAD83 UTM Zone 11 North in U.S. Survey Feet

Average Offset: 1.15

Table 4
Seed Item Detections in 3-foot Line Spacing EM61 Survey
Former Trabuco Bombing Range
Geophysical Prove-Out

Seed Item ID	Description	Orientation	Depth	Actual Easting (ft)	Actual Northing (ft)	Target ID	Picked Easting (ft)	Picked Northing (ft)	Grid Value	Offset (ft)
GPO-01	3lb Bomb; practice (steel)	Horizontal	1.06	1451127.3	12205273.6	EM3-10	1451127.3	12205274.0	29.2	0.41
GPO-02	3lb Bomb; practice (steel)	Vertical	0.87	1451094.5	12205295.4	EM3-20	1451093.0	12205295.5	110.4	1.49
GPO-03	3lb Bomb; practice (steel)	Horizontal	1.34	1451126.2	12205233.9	EM3-03	1451126.5	12205235.5	25.5	1.66
GPO-04	3lb Bomb; practice (steel)	Vertical	1.21	1451084.0	12205289.8	EM3-21	1451084.0	12205289.3	66.6	0.52
GPO-05	3lb Bomb; practice (zinc)	Horizontal	1.74	1451136.3	12205304.5	EM3-12	1451137.3	12205304.3	26.4	0.98
GPO-06	3lb Bomb; practice (zinc)	Vertical	2.08	1451050.9	12205303.4	EM3-27	1451053.3	12205304.3	22.5	2.56
GPO-07	25lb Bomb; practice	Horizontal	1.75	1451084.7	12205254.3	EM3-38	1451083.3	12205253.0	74.8	1.96
GPO-08	25lb Bomb; practice	Vertical	2.08	1451109.4	12205314.9	EM3-17	1451109.5	12205315.8	141.1	0.90
GPO-09	25lb Bomb; practice	Horizontal	2.83	1451113.1	12205252.1	EM3-06	1451113.0	12205252.5	51.4	0.39
GPO-10	25lb Bomb; practice	45 deg.	2.72	1451096.4	12205228.3	EM3-01	1451096.8	12205227.8	48.8	0.64
GPO-11	2.25in Rocket; practice	Horizontal	1.02	1451114.9	12205293.1	EM3-08	1451114.0	12205292.5	315.0	1.02
GPO-12	2.25in Rocket; practice	45 deg.	1.81	1451125.6	12205308.2	EM3-15	1451125.8	12205308.0	75.6	0.28
GPO-13	2.25in Rocket; practice	Horizontal	1.71	1451065.7	12205314.5	EM3-24	1451067.8	12205315.5	75.8	2.29
GPO-14	2.25in Rocket; practice	65 deg.	1.88	1451079.0	12205309.8	EM3-22	1451077.3	12205308.5	105.6	2.15
GPO-15	3.5in Rocket; practice	Horizontal	1.50	1451055.8	12205289.5	EM3-28	1451054.3	12205289.0	136.5	1.63
GPO-16	3.5in Rocket; practice	Vertical	1.66	1451102.5	12205277.1	EM3-07	1451103.0	12205276.8	176.9	0.60
GPO-17	3.5in Rocket; practice	Horizontal	2.53	1451051.8	12205245.7	EM3-34	1451051.0	12205246.5	22.0	1.09
GPO-18	3.5in Rocket; practice	45 deg.	2.47	1451068.3	12205245.6	EM3-36	1451069.3	12205245.0	50.8	1.10
GPO-19	5in Rocket; practice	Horizontal	1.95	1451142.5	12205281.6	EM3-11	1451141.3	12205282.0	196.6	1.33
GPO-20	5in Rocket; practice	Horizontal	3.79	1451054.3	12205267.1	EM3-32	1451055.5	12205266.8	22.7	1.28
GPO-21	5in Rocket; practice	45 deg.	1.87	1451069.3	12205278.6	EM3-30	1451069.8	12205278.8	215.3	0.49
GPO-22	5in Rocket; practice	45 deg.	2.60	1451058.7	12205222.3	EM3-35	1451058.3	12205221.3	73.1	1.09

Coordinates are NAD83 UTM Zone 11 North in U.S. Survey Feet

Average Offset: 1.18

Table 5
Seed Item Detections in the Fiducially-Located EM61 Survey
Former Trabuco Bombing Range
Geophysical Prove-Out

Item ID	Description	Orientation	Depth (ft)	Actual Easting (ft)	Actual Northing (ft)	Target ID	Picked Easting (ft)	Picked Northing (ft)	Grid value (mV)	Offset
GPO-01	3lb Bomb; practice (steel)	Horizontal	1.06	1451127.3	12205273.6	EMFID-5	1451125.5	12205272.3	26.42	2.20
GPO-02	3lb Bomb; practice (steel)	Vertical	0.87	1451094.5	12205295.4	Not covered	-	-	-	-
GPO-03	3lb Bomb; practice (steel)	Horizontal	1.34	1451126.2	12205233.9	Not covered	-	-	-	-
GPO-04	3lb Bomb; practice (steel)	Vertical	1.21	1451084.0	12205289.8	EMFID-8	1451084.5	12205288.8	52.06	1.16
GPO-05	3lb Bomb; practice (zinc)	Horizontal	1.74	1451136.3	12205304.5	Not covered	-	-	-	-
GPO-06	3lb Bomb; practice (zinc)	Vertical	2.08	1451050.9	12205303.4	Not covered	-	-	-	-
GPO-07	25lb Bomb; practice	Horizontal	1.75	1451084.7	12205254.3	EMFID-3	1451086.5	12205256.0	69.99	2.46
GPO-08	25lb Bomb; practice	Vertical	2.08	1451109.4	12205314.9	Not covered	-	-	-	-
GPO-09	25lb Bomb; practice	Horizontal	2.83	1451113.1	12205252.1	Not covered	-	-	-	-
GPO-10	25lb Bomb; practice	45 deg.	2.72	1451096.4	12205228.3	Not covered	-	-	-	-
GPO-11	2.25in Rocket; practice	Horizontal	1.02	1451114.9	12205293.1	Not covered	-	-	-	-
GPO-12	2.25in Rocket; practice	45 deg.	1.81	1451125.6	12205308.2	EMFID-9	1451123.5	12205305.8	84.60	3.23
GPO-13	2.25in Rocket; practice	Horizontal	1.71	1451065.7	12205314.5	EMFID-10	1451063.1	12205312.5	88.99	3.27
GPO-14	2.25in Rocket; practice	65 deg.	1.88	1451079.0	12205309.8	Not covered	-	-	-	-
GPO-15	3.5in Rocket; practice	Horizontal	1.50	1451055.8	12205289.5	Not covered	-	-	-	-
GPO-16	3.5in Rocket; practice	Vertical	1.66	1451102.5	12205277.1	EMFID-6	1451105.3	12205276.8	141.14	2.78
GPO-17	3.5in Rocket; practice	Horizontal	2.53	1451051.8	12205245.7	Not covered	-	-	-	-
GPO-18	3.5in Rocket; practice	45 deg.	2.47	1451068.3	12205245.6	EMFID-1	1451066.8	12205247.3	34.92	2.30
GPO-19	5in Rocket; practice	Horizontal	1.95	1451142.5	12205281.6	Not covered	-	-	-	-
GPO-20	5in Rocket; practice	Horizontal	3.79	1451054.3	12205267.1	Not covered	-	-	-	-
GPO-21	5in Rocket; practice	45 deg.	1.87	1451069.3	12205278.6	EMFID-7	1451065.0	12205278.3	200.92	4.30
GPO-22	5in Rocket; practice	45 deg.	2.60	1451058.7	12205222.3	Not covered	-	-	-	-

Coordinates are NAD83 UTM Zone 11 North in U.S. Survey Feet

Average Offset: 2.71

Figure 6
Decay Constant and Anomaly Width Results
2-Foot Line Spacing EM Targets
Former Trabuco Bombing Range Geophysical Prove-Out

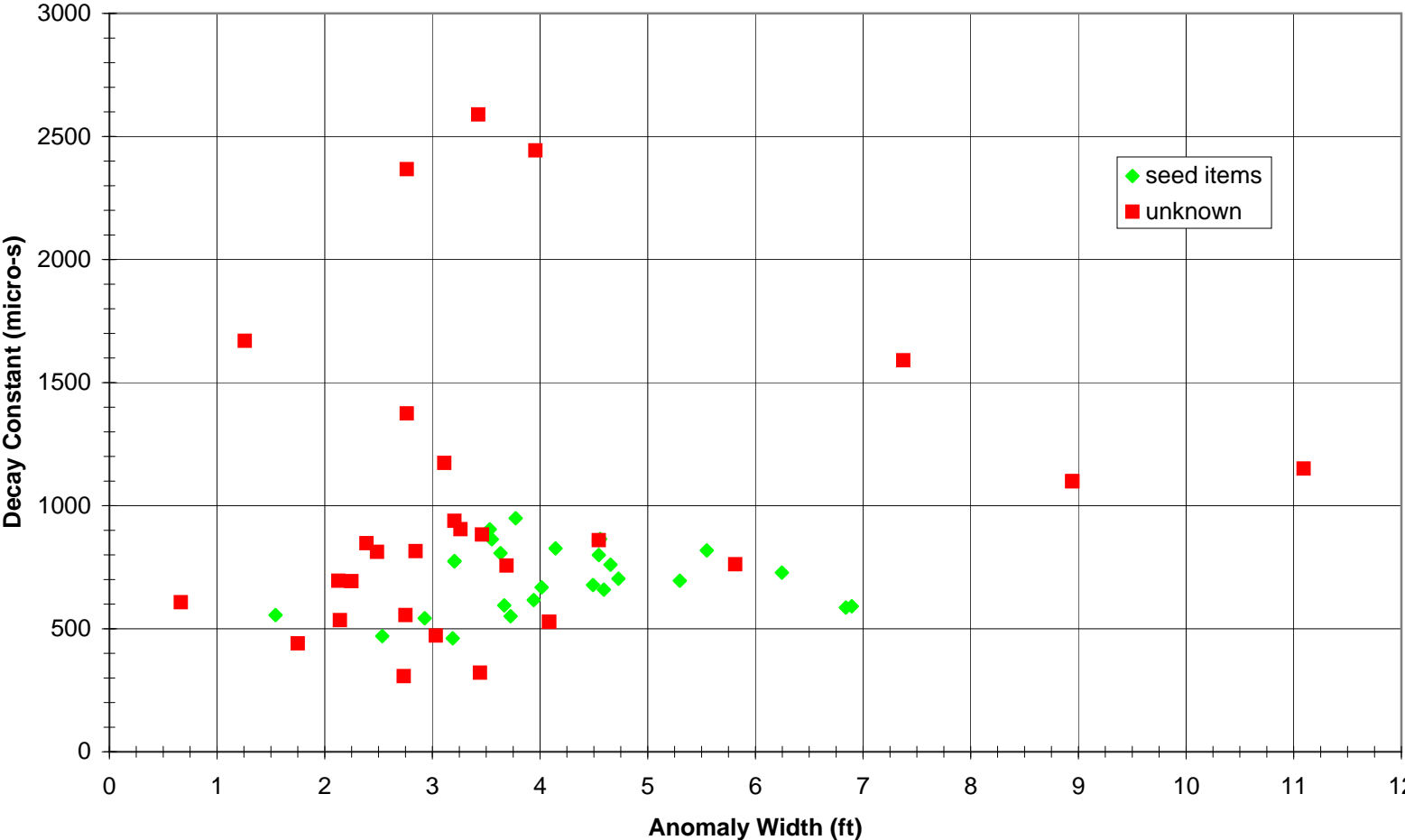
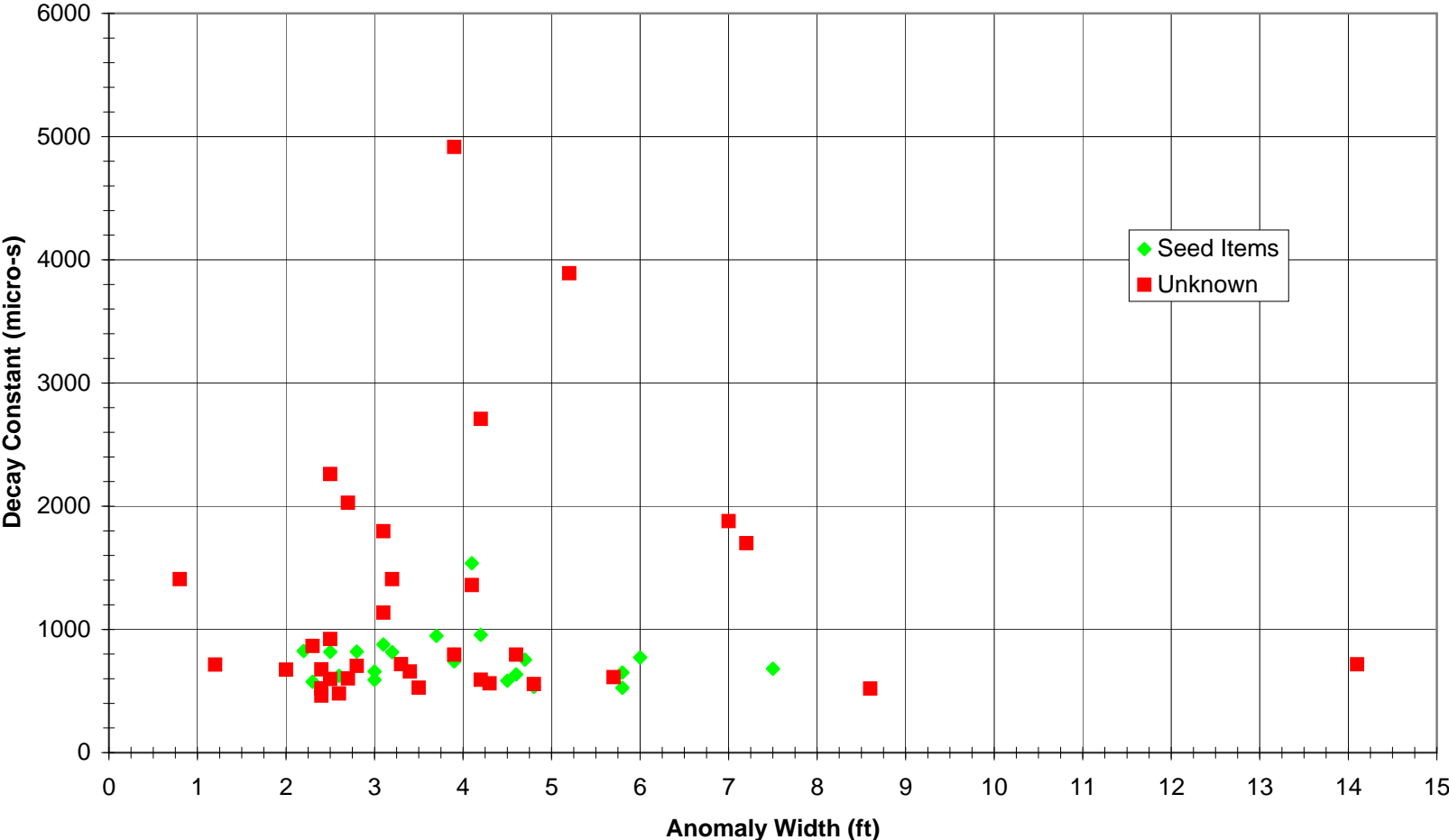


Figure 6a
Decay Constant and Anomaly Width Results
3-Foot Line Spacing EM Targets
Former Trabuco Bombing Range Geophysical Prove-Out



G-858 Magnetometer

Figures 7 through 9 show the results of the three magnetic surveys performed at the prove-out grid. The 2-ft sensor spacing survey detected 18 of the 22 seeded items (Figure 7), and the 3-ft sensor spacing survey detected 15 of the 22 items (Figure 8). The results for each of the seed items are shown in Tables 6, 7, and 8. As indicated in Table 6, all of the items missed in the 2-ft survey were 3-lb practice bombs. Any detected responses for these items appear to have been lost in the background noise of the survey, which seems to have been higher for the magnetometer surveys than it was for the EM61 surveys. This belief is supported by the large number of ferrous rocks (“hot” rocks) found during the Schonstedt survey. Small items such as “hot” rocks could add to the background noise of any magnetometer survey while remaining completely undetected by the EM61

The 3-ft sensor spacing missed two each 25-lb practice bombs and a 5-inch rocket head (Table 7). Among the items detected, the average offset for the 3-ft survey (1.67 ft) was nearly half a foot greater than that for the 2-ft survey (1.23-ft). The fiducially based G-858 survey also missed two items in the immediate vicinity of the lines collected, GPO-12 and GPO-13, which are both 2.25-in rockets.

The location coordinates for anomalies selected as potential MEC in the G-858 magnetometer survey are presented in Table A-6 through A-8 in Appendix A for each of the respective GPO tests.

Schonstedt

The Schonstedt survey was started in the southwest corner of the GPO grid with the intention of completing a full survey of the grid. However, after completing 3 lanes (15 ft) of the survey, 88 anomalies had been identified over the course of an hour and a half. Parsons/ITSI and the USAESCH geophysicist agreed that completing the full survey would not lead to a great deal of additional information regarding the Schonstedt at the site. The decision was made to survey only the disturbed locations evident across the grid in order to determine whether or not the Schonstedt was capable of detecting the seed items at the orientations and depths established for the prove-out. The results are shown in Table 9 and indicate that the Schonstedt survey missed two items, both 3-lb bombs. Three of the detected items were also found farther than 3 ft from the center of the buried seed item, although the average offset for the Schonstedt survey was only 1.40 ft.

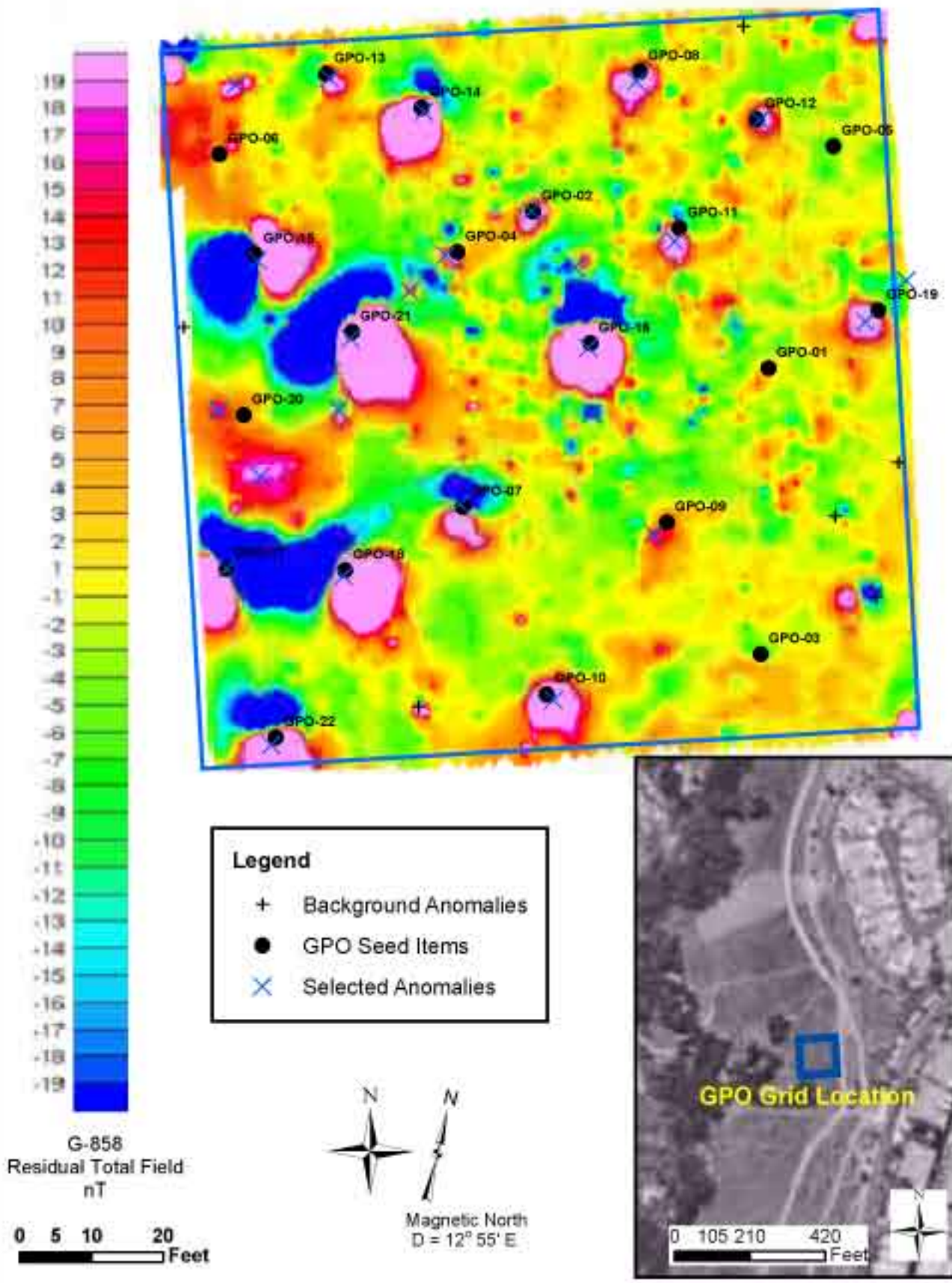


Figure 7 Former Trabuco Bombing Range, January 2006
GPO MAG 2-ft Line Spacing Results

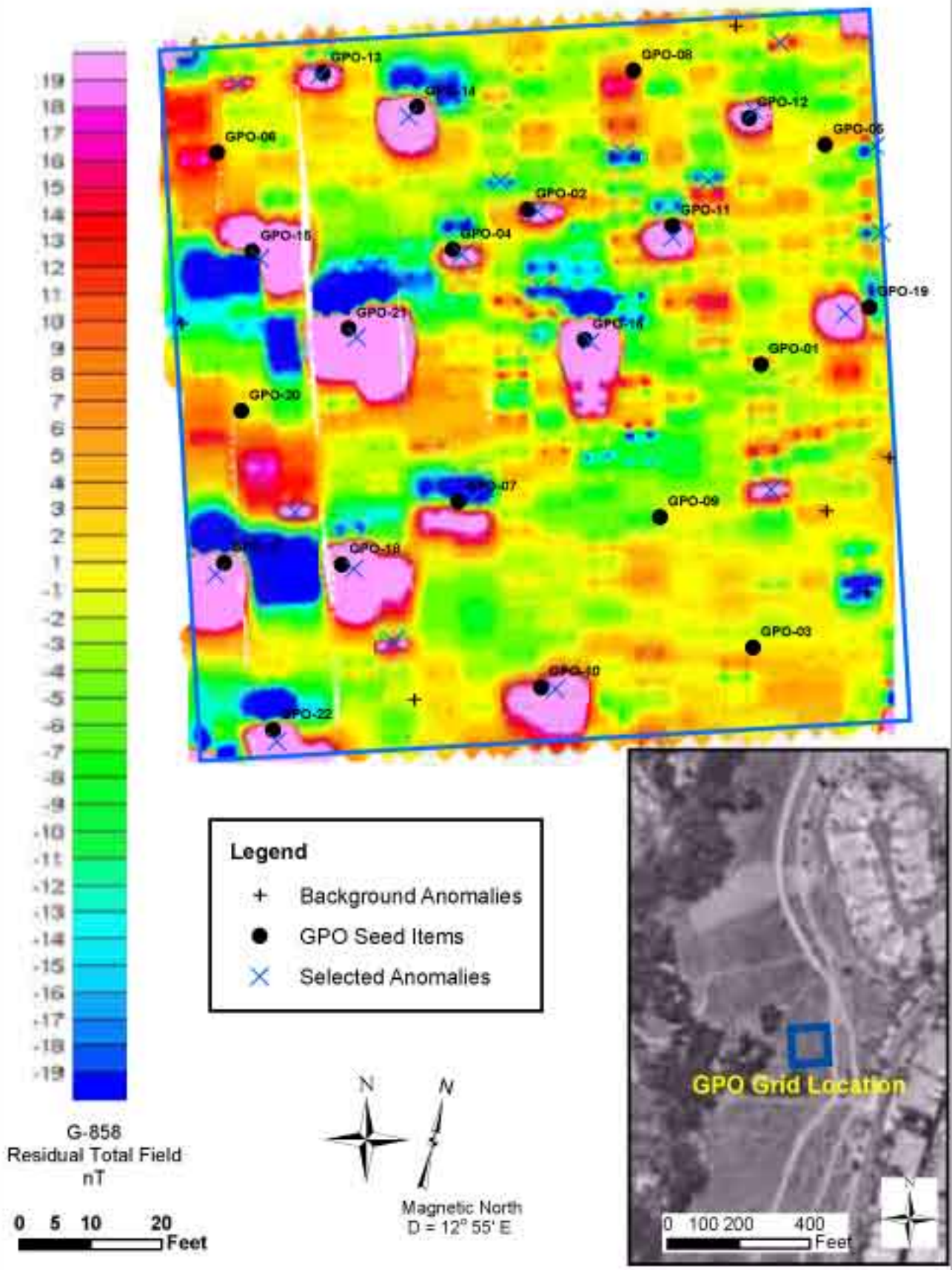


Figure 8 Former Trabuco Bombing Range, January 2006
GPO MAG 3-ft Line Spacing Results

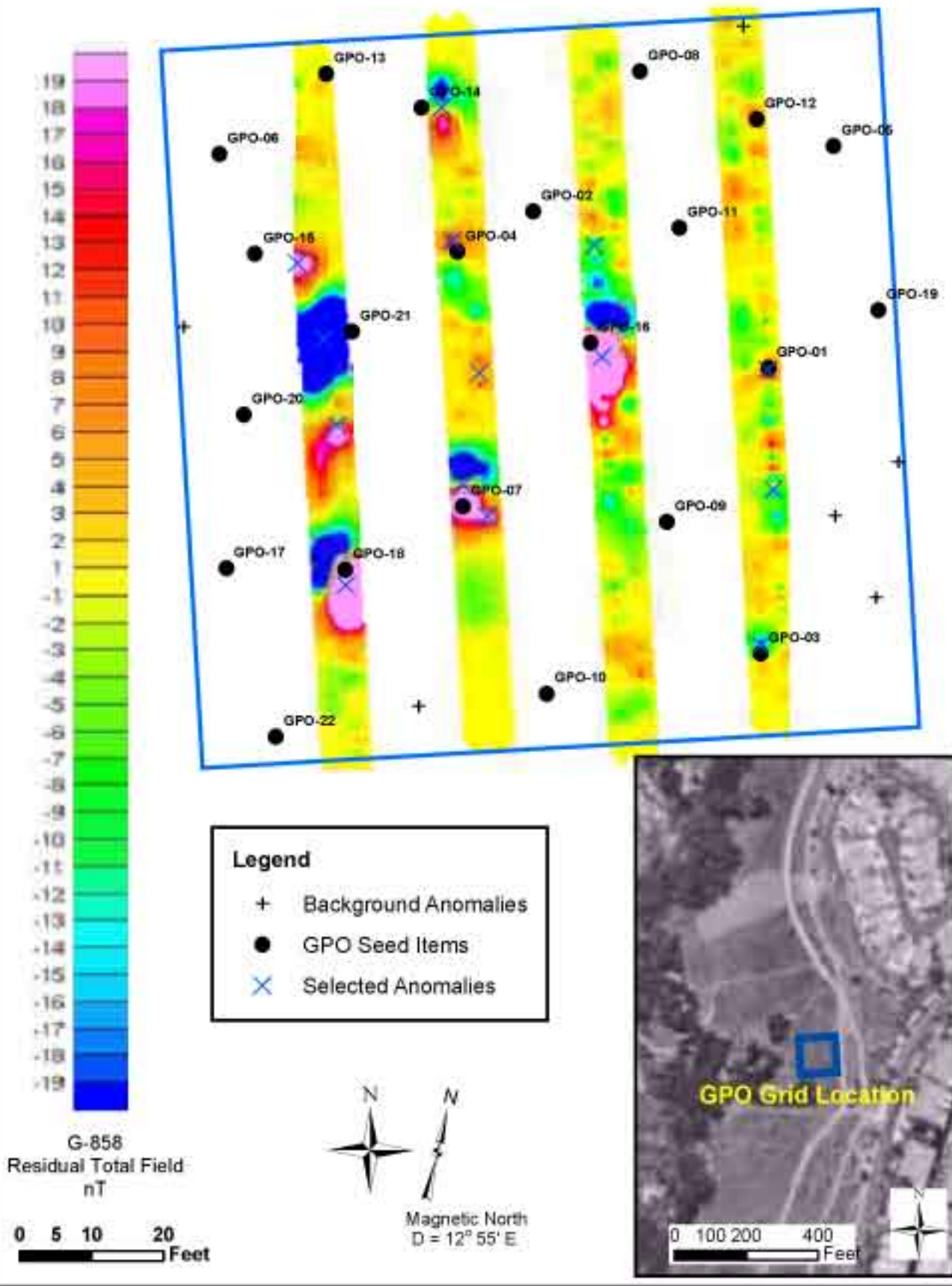


Figure 9 Former Trabuco Bombing Range, January 2006
GPO MAG Fiducial Results

Table 6
Seed Item Detections in 2-foot Line Spacing G-858 Survey
Former Trabuco Bombing Range
Geophysical Prove-Out

Item ID	Description	Orientation	Depth (ft)	Actual Easting (ft)	Actual Northing (ft)	Target ID	Picked Easting (ft)	Picked Northing (ft)	Grid value (nT)	Offset (ft)
GPO-01	3lb Bomb; practice (steel)	Horizontal	1.06	1451127.3	12205273.6	Not Selected	N/A	N/A	N/A	N/A
GPO-02	3lb Bomb; practice (steel)	Vertical	0.87	1451094.5	12205295.4	MAG2-04	1451094.2	12205295.5	28.30	0.26
GPO-03	3lb Bomb; practice (steel)	Horizontal	1.34	1451126.2	12205233.9	Not Selected	N/A	N/A	N/A	N/A
GPO-04	3lb Bomb; practice (steel)	Vertical	1.21	1451084.0	12205289.8	MAG2-03	1451082.3	12205289.3	26.77	1.69
GPO-05	3lb Bomb; practice (zinc)	Horizontal	1.74	1451136.3	12205304.5	Not Selected	N/A	N/A	N/A	N/A
GPO-06	3lb Bomb; practice (zinc)	Vertical	2.08	1451050.9	12205303.4	Not Selected	N/A	N/A	N/A	N/A
GPO-07	25lb Bomb; practice	Horizontal	1.75	1451084.7	12205254.3	MAG2-15	1451084.2	12205254.7	-20.19	0.60
GPO-08	25lb Bomb; practice	Vertical	2.08	1451109.4	12205314.9	MAG2-05	1451108.8	12205313.5	36.19	1.44
GPO-09	25lb Bomb; practice	Horizontal	2.83	1451113.1	12205252.1	MAG2-13	1451111.3	12205250.6	6.09	2.39
GPO-10	25lb Bomb; practice	45 deg.	2.72	1451096.4	12205228.3	MAG2-14	1451097.3	12205227.5	42.02	1.23
GPO-11	2.25in Rocket; practice	Horizontal	1.02	1451114.9	12205293.1	MAG2-09	1451114.2	12205291.2	58.73	1.94
GPO-12	2.25in Rocket; practice	45 deg.	1.81	1451125.6	12205308.2	MAG2-06	1451126.1	12205308.1	26.65	0.55
GPO-13	2.25in Rocket; practice	Horizontal	1.71	1451065.7	12205314.5	MAG2-25	1451066.2	12205313.9	31.74	0.78
GPO-14	2.25in Rocket; practice	65 deg.	1.88	1451079.0	12205309.8	MAG2-01	1451079.3	12205309.3	118.85	0.61
GPO-15	3.5in Rocket; practice	Horizontal	1.50	1451055.8	12205289.5	MAG2-23	1451056.2	12205288.5	51.57	1.03
GPO-16	3.5in Rocket; practice	Vertical	1.66	1451102.5	12205277.1	MAG2-11	1451102.2	12205276.4	721.42	0.69
GPO-17	3.5in Rocket; practice	Horizontal	2.53	1451051.8	12205245.7	MAG2-18	1451051.9	12205245.8	-62.64	0.12
GPO-18	3.5in Rocket; practice	45 deg.	2.47	1451068.3	12205245.6	MAG2-16	1451068.1	12205244.8	233.23	0.79
GPO-19	5in Rocket; practice	Horizontal	1.95	1451142.5	12205281.6	MAG2-08	1451140.7	12205280.1	46.70	2.38
GPO-20	5in Rocket; practice	Horizontal	3.79	1451054.3	12205267.1	MAG2-20	1451050.8	12205267.8	16.16	3.58
GPO-21	5in Rocket; practice	45 deg.	1.87	1451069.3	12205278.6	MAG2-22	1451069.1	12205277.7	723.07	0.94
GPO-22	5in Rocket; practice	45 deg.	2.60	1451058.7	12205222.3	MAG2-17	1451058.0	12205221.2	118.20	1.20

Coordinates are NAD83 UTM Zone 11 North in U.S. Survey Feet

Average Offset: 1.23

Table 7
Seed Item Detections in 3-foot Line Spacing G-858 Survey
Former Trabuco Bombing Range
Geophysical Prove-Out

Item ID	Description	Orientation	Depth (ft)	Actual Easting (ft)	Actual Northing (ft)	Target ID	Picked Easting (ft)	Picked Northing (ft)	Grid value (nT)	Offset (ft)
GPO-01	3lb Bomb; practice (steel)	Horizontal	1.06	1451127.3	12205273.6	Not Selected	N/A	N/A	N/A	N/A
GPO-02	3lb Bomb; practice (steel)	Vertical	0.87	1451094.5	12205295.4	MAG3-01	1451096.0	12205295.2	31.41	1.50
GPO-03	3lb Bomb; practice (steel)	Horizontal	1.34	1451126.2	12205233.9	Not Selected	N/A	N/A	N/A	N/A
GPO-04	3lb Bomb; practice (steel)	Vertical	1.21	1451084.0	12205289.8	MAG3-08	1451085.2	12205289.1	26.91	1.39
GPO-05	3lb Bomb; practice (zinc)	Horizontal	1.74	1451136.3	12205304.5	Not Selected	N/A	N/A	N/A	N/A
GPO-06	3lb Bomb; practice (zinc)	Vertical	2.08	1451050.9	12205303.4	Not Selected	N/A	N/A	N/A	N/A
GPO-07	25lb Bomb; practice	Horizontal	1.75	1451084.7	12205254.3	MAG3-11	1451086.7	12205254.8	-27.86	2.06
GPO-08	25lb Bomb; practice	Vertical	2.08	1451109.4	12205314.9	Not Selected	N/A	N/A	N/A	N/A
GPO-09	25lb Bomb; practice	Horizontal	2.83	1451113.1	12205252.1	Not Selected	N/A	N/A	N/A	N/A
GPO-10	25lb Bomb; practice	45 deg.	2.72	1451096.4	12205228.3	MAG3-17	1451098.4	12205228.1	42.36	1.97
GPO-11	2.25in Rocket; practice	Horizontal	1.02	1451114.9	12205293.1	MAG3-25	1451114.9	12205291.5	43.57	1.52
GPO-12	2.25in Rocket; practice	45 deg.	1.81	1451125.6	12205308.2	MAG3-23	1451126.3	12205309.3	40.20	1.30
GPO-13	2.25in Rocket; practice	Horizontal	1.71	1451065.7	12205314.5	MAG3-04	1451065.2	12205314.2	32.44	0.59
GPO-14	2.25in Rocket; practice	65 deg.	1.88	1451079.0	12205309.8	MAG3-03	1451077.7	12205308.4	132.01	1.87
GPO-15	3.5in Rocket; practice	Horizontal	1.50	1451055.8	12205289.5	MAG3-06	1451056.8	12205288.5	18.87	1.44
GPO-16	3.5in Rocket; practice	Vertical	1.66	1451102.5	12205277.1	MAG3-10	1451103.3	12205276.8	299.03	0.88
GPO-17	3.5in Rocket; practice	Horizontal	2.53	1451051.8	12205245.7	MAG3-14	1451050.6	12205244.1	246.93	1.95
GPO-18	3.5in Rocket; practice	45 deg.	2.47	1451068.3	12205245.6	MAG3-12	1451070.1	12205244.9	210.95	1.86
GPO-19	5in Rocket; practice	Horizontal	1.95	1451142.5	12205281.6	MAG3-19	1451139.2	12205280.7	44.30	3.48
GPO-20	5in Rocket; practice	Horizontal	3.79	1451054.3	12205267.1	Not Selected	N/A	N/A	N/A	N/A
GPO-21	5in Rocket; practice	45 deg.	1.87	1451069.3	12205278.6	MAG3-07	1451070.5	12205277.4	366.72	1.69
GPO-22	5in Rocket; practice	45 deg.	2.60	1451058.7	12205222.3	MAG3-15	1451059.2	12205220.7	114.97	1.61

Coordinates are NAD83 UTM Zone 11 North in U.S. Survey Feet

Av Offset: 1.67

Table 8
Seed Item Detections in Fiducially-Located G-858 Survey
Former Trabuco Bombing Range
Geophysical Prove-Out

Item ID	Description	Orientation	Depth (ft)	Actual Easting (ft)	Actual Northing (ft)	Target ID	Picked Easting (ft)	Picked Northing (ft)	Grid value (nT)	Offset (ft)
GPO-01	3lb Bomb; practice (steel)	Horizontal	1.06	1451127.3	12205273.6	MAGFID-01	1451127.14	12205273.33	13.40	0.28
GPO-02	3lb Bomb; practice (steel)	Vertical	0.87	1451094.5	12205295.4	Not crossed	-	-	-	-
GPO-03	3lb Bomb; practice (steel)	Horizontal	1.34	1451126.2	12205233.9	MAGFID-03	1451126.2	12205235.0	-21.70	1.12
GPO-04	3lb Bomb; practice (steel)	Vertical	1.21	1451084.0	12205289.8	Not crossed	-	-	-	-
GPO-05	3lb Bomb; practice (zinc)	Horizontal	1.74	1451136.3	12205304.5	Not crossed	-	-	-	-
GPO-06	3lb Bomb; practice (zinc)	Vertical	2.08	1451050.9	12205303.4	Not crossed	-	-	-	-
GPO-07	25lb Bomb; practice	Horizontal	1.75	1451084.7	12205254.3	MAGFID-05	1451084.6	12205257.4	1.30	3.03
GPO-08	25lb Bomb; practice	Vertical	2.08	1451109.4	12205314.9	Not crossed	-	-	-	-
GPO-09	25lb Bomb; practice	Horizontal	2.83	1451113.1	12205252.1	Not crossed	-	-	-	-
GPO-10	25lb Bomb; practice	45 deg.	2.72	1451096.4	12205228.3	Not crossed	-	-	-	-
GPO-11	2.25in Rocket; practice	Horizontal	1.02	1451114.9	12205293.1	Not crossed	-	-	-	-
GPO-12	2.25in Rocket; practice	45 deg.	1.81	1451125.6	12205308.2	Not Selected	N/A	N/A	N/A	N/A
GPO-13	2.25in Rocket; practice	Horizontal	1.71	1451065.7	12205314.5	Not Selected	N/A	N/A	N/A	N/A
GPO-14	2.25in Rocket; practice	65 deg.	1.88	1451079.0	12205309.8	MAGFID-10	1451081.8	12205309.9	-3.10	2.81
GPO-15	3.5in Rocket; practice	Horizontal	1.50	1451055.8	12205289.5	Not crossed	-	-	-	-
GPO-16	3.5in Rocket; practice	Vertical	1.66	1451102.5	12205277.1	MAGFID-14	1451104.1	12205275.1	405.30	2.49
GPO-17	3.5in Rocket; practice	Horizontal	2.53	1451051.8	12205245.7	Not crossed	-	-	-	-
GPO-18	3.5in Rocket; practice	45 deg.	2.47	1451068.3	12205245.6	MAGFID-06	1451068.4	12205243.4	208.90	2.19
GPO-19	5in Rocket; practice	Horizontal	1.95	1451142.5	12205281.6	Not crossed	-	-	-	-
GPO-20	5in Rocket; practice	Horizontal	3.79	1451054.3	12205267.1	Not crossed	-	-	-	-
GPO-21	5in Rocket; practice	45 deg.	1.87	1451069.3	12205278.6	MAGFID-08	1451065.4	12205277.6	-126.20	3.98
GPO-22	5in Rocket; practice	45 deg.	2.60	1451058.7	12205222.3	Not crossed	-	-	-	-

Coordinates are NAD83 UTM Zone 11 North in U.S. Survey Feet

Av Offset: 2.60

Reacquisition

On a preliminary basis, anomalies that could potentially be MEC were selected in the field from both the EM and magnetic data in order to determine the reacquisition capabilities of each instrument and to ensure that anomalies could be reacquired within a 1.2-ft radius of the actual location. Analysis of data was performed on the 2-foot line spacing surveys collected by both the magnetometer and the EM61-MK2. Given time demands in the field, EM61-MK2 data selection was made on a grid created from the leveled channel 3 data, rather than the total channel. Selection of anomalies from the magnetic data was performed as described in the Downloading and Processing section of this document.

The results of the reacquisition field effort are shown in Table 10. Nineteen (19) of the 20 EM anomaly locations (95%) were successfully reacquired within 1.2-ft of their actual locations from the geophysical survey. Thirteen (13) of the 16 Magnetometer anomalies were reacquired within 1.2-ft of their actual locations. It was much more difficult to determine the exact location of Magnetometer anomalies during reacquisition because the magnetometer's data logger only shows results in total field or gradient values. This means that the operator had to decide whether the peak of a high or the 0 value of a dipole should have been the location for the flag. An incorrect choice between these two possibilities could have resulted in the larger offsets seen in the magnetometer reacquisition.

False Positives

While the ability to detect MEC is the primary criteria for selecting a geophysical system, the false positive rate should also be considered. For this GPO, a false positive (FP) was defined as any anomaly that was selected at a location without either a known seed item or a known background anomaly. This definition exaggerates the FP rate because some of these anomalies may be blind seed items or pieces of metal that were not selected from the background survey data. The FP rate was calculated for all four systems that were used over the entire prove-out grid, the EM61-MK2 and G-858 at 2 and 3-foot line spacings, by calculating the percentage of selected anomalies that were false positives. Three of the four systems exhibited similar rates between 20% and 30% while the G-858 survey at 3-foot line spacing had a higher rate of 38%. Table 11 lists the FP rates for these four systems. The EM61-MK2 3-foot line spacing survey had both the best detection performance and the lowest FP rate.

Table 9
Seed Item Detections in the Schonstedt Survey
Former Trabuco Bombing Range
Geophysical Prove-Out

Item ID	Description	Orientation	Depth (ft)	Actual Easting (ft)	Actual Northing (ft)	Picked Easting (ft)	Picked Northing (ft)	Offset (ft)
GPO-01	3lb Bomb; practice (steel)	Horizontal	1.06	1451127.3	12205273.6	Not Detected	N/A	N/A
GPO-02	3lb Bomb; practice (steel)	Vertical	0.87	1451094.5	12205295.4	1451094.5	12205295.0	0.39
GPO-03	3lb Bomb; practice (steel)	Horizontal	1.34	1451126.2	12205233.9	1451127.2	12205233.8	1.00
GPO-04	3lb Bomb; practice (steel)	Vertical	1.21	1451084.0	12205289.8	1451084.0	12205290.2	0.44
GPO-05	3lb Bomb; practice (zinc)	Horizontal	1.74	1451136.3	12205304.5	Not Detected	N/A	N/A
GPO-06	3lb Bomb; practice (zinc)	Vertical	2.08	1451050.9	12205303.4	1451048.9	12205303.2	1.92
GPO-07	25lb Bomb; practice	Horizontal	1.75	1451084.7	12205254.3	1451084.7	12205254.3	0.00
GPO-08	25lb Bomb; practice	Vertical	2.08	1451109.4	12205314.9	1451109.5	12205316.3	1.42
GPO-09	25lb Bomb; practice	Horizontal	2.83	1451113.1	12205252.1	1451109.1	12205252.7	4.02
GPO-10	25lb Bomb; practice	45 deg.	2.72	1451096.4	12205228.3	1451096.3	12205228.6	0.37
GPO-11	2.25in Rocket; practice	Horizontal	1.02	1451114.9	12205293.1	1451114.5	12205293.0	0.34
GPO-12	2.25in Rocket; practice	45 deg.	1.81	1451125.6	12205308.2	1451127.1	12205309.8	2.17
GPO-13	2.25in Rocket; practice	Horizontal	1.71	1451065.7	12205314.5	1451065.9	12205311.9	2.59
GPO-14	2.25in Rocket; practice	65 deg.	1.88	1451079.0	12205309.8	1451078.3	12205309.4	0.76
GPO-15	3.5in Rocket; practice	Horizontal	1.50	1451055.8	12205289.5	1451056.3	12205290.0	0.67
GPO-16	3.5in Rocket; practice	Vertical	1.66	1451102.5	12205277.1	1451101.8	12205277.2	0.67
GPO-17	3.5in Rocket; practice	Horizontal	2.53	1451051.8	12205245.7	1451050.5	12205245.3	1.30
GPO-18	3.5in Rocket; practice	45 deg.	2.47	1451068.3	12205245.6	1451068.6	12205245.5	0.34
GPO-19	5in Rocket; practice	Horizontal	1.95	1451142.5	12205281.6	1451145.1	12205284.6	3.91
GPO-20	5in Rocket; practice	Horizontal	3.79	1451054.3	12205267.1	1451050.9	12205267.3	3.40
GPO-21	5in Rocket; practice	45 deg.	1.87	1451069.3	12205278.6	1451069.8	12205278.5	0.51
GPO-22	5in Rocket; practice	45 deg.	2.60	1451058.7	12205222.3	1451058.3	12205224.1	1.84

Coordinates are NAD83 UTM Zone 11 North in U.S. Survey Feet

Av Offset: 1.40

Table 10
Reacquisition Results
Former Trabuco Bombing Range
Geophysical Prove-Out

Item ID	Actual Easting (ft)	Actual Northing (ft)	Description	Orientation	Depth (ft)	Magnetic Easting (ft)	Magnetic Northing (ft)	Magnetic Offset	EM Easting (ft)	EM Northing (ft)	EM Offset
GPO-01	1451127.3	12205273.6	3lb Bomb; practice (steel)	Horizontal	1.06	N/A	N/A	N/A	1451128.5	12205273.8	1.0*
GPO-02	1451094.5	12205295.4	3lb Bomb; practice (steel)	Vertical	0.87	1451094.2	12205295.1	0.3	1451094.4	12205295.5	0.2
GPO-03	1451126.2	12205233.9	3lb Bomb; practice (steel)	Horizontal	1.34	N/A	N/A	N/A	1451125.8	12205235.3	1.1*
GPO-04	1451084.0	12205289.8	3lb Bomb; practice (steel)	Vertical	1.21	1451083.7	12205289.6	0.3	1451084.0	12205289.7	0.1
GPO-07	1451084.7	12205254.3	25lb Bomb; practice	Horizontal	1.75	1451084.1	12205254.4	0.6	1451084.6	12205253.0	0.4*
GPO-08	1451109.4	12205314.9	25lb Bomb; practice	Vertical	2.08	1451109.0	12205314.0	0.9	1451109.1	12205315.3	0.5
GPO-09	1451113.1	12205252.1	25lb Bomb; practice	Horizontal	2.83	N/A	N/A	N/A	1451112.4	12205252.2	0.1*
GPO-10	1451096.4	12205228.3	25lb Bomb; practice	45 deg.	2.72	1451094.2	12205227.7	1.9*	1451096.8	12205227.7	0.4*
GPO-11	1451114.9	12205293.1	2.25in Rocket; practice	Horizontal	1.02	1451114.1	12205291.7	0.3*	1451114.6	12205291.6	0.5*
GPO-12	1451125.6	12205308.2	2.25in Rocket; practice	45 deg.	1.81	1451126.7	12205308.1	0.4*	1451126.0	12205310.4	1.9*
GPO-13	1451065.7	12205314.5	2.25in Rocket; practice	Horizontal	1.71	1451066.6	12205314.0	0.8*	1451064.5	12205314.5	0.3*
GPO-14	1451079.0	12205309.8	2.25in Rocket; practice	65 deg.	1.88	1451079.9	12205308.6	1.5*	1451078.8	12205309.4	0.4*
GPO-15	1451055.8	12205289.5	3.5in Rocket; practice	Horizontal	1.50	1451055.5	12205289.0	0.6	1451055.5	12205289.4	0.3
GPO-16	1451102.5	12205277.1	3.5in Rocket; practice	Vertical	1.66	1451102.2	12205276.1	1.0	1451102.3	12205277.0	0.2
GPO-17	1451051.8	12205245.7	3.5in Rocket; practice	Horizontal	2.53	1451051.5	12205245.2	0.3*	1451051.7	12205245.3	0.4
GPO-18	1451068.3	12205245.6	3.5in Rocket; practice	45 deg.	2.47	1451067.2	12205245.2	0.8*	1451069.2	12205245.3	0.3*
GPO-19	1451142.5	12205281.6	5in Rocket; practice	Horizontal	1.95	1451141.7	12205280.8	0.9*	1451142.3	12205281.7	0.2
GPO-20	1451054.3	12205267.1	5in Rocket; practice	Horizontal	3.79	N/A	N/A	N/A	1451054.2	12205266.4	0.6
GPO-21	1451069.3	12205278.6	5in Rocket; practice	45 deg.	1.87	1451067.9	12205277.1	1.7*	1451069.8	12205278.3	0.3*
GPO-22	1451058.7	12205222.3	5in Rocket; practice	45 deg.	2.60	1451057.7	12205223.0	1.1*	1451057.9	12205221.2	0.7*

Coordinates are NAD83 UTM Zone 11 North in U.S. Survey Feet

Average Magnetic Offset

0.8

Average EM Offset

0.5

* Reacquired position closest to tip of item, from which offset distance was calculated.

Table 11
 False Positive Results
 Former Trabuco Bombing Range
 Geophysical Prove-Out

Geophysical Equipment	Line Spacing	Targets Selected	Targets on Seed Items Anomaly	Unexplained Anomalies	Unexplained Anomaly Rate
EM61-MK2	2-foot	40	28	12	30%
EM61-MK2	3-foot	38	30	8	21%
G-858	2-foot	25	18	7	28%
G-858	3-foot	26	16	10	38%

QUALITY CONTROL

Quality control for the former Trabuco Bombing Range geophysical prove-out data was maintained by performing instrument noise tests over a static test item with both instruments, collecting a 6-line test with both instruments, performing a GPS navigation test, and performing an octant test with the magnetometer.

INSTRUMENT QUALITY CONTROL

A 6-line test was conducted before each instrument was used to survey the grid. The test was conducted along the southern end line of the grid, and for the last 4 lines a paint can was placed at the 75E mark on this line. The results were as expected, with no significant variation in either the location or the magnitude of any evident peaks, although the magnitude was slightly lower for the fast line and slightly higher for the slow line. The 6-line tests were also used for lag correction purposes in all of the surveys conducted. The latency correction for each instrument was applied using the DOD QA/QC module in Oasis Montaj. Use of the correct latency value results in overlapping peaks when traveling in opposite directions. The results of the 6-line tests completed for each instrument are included in Appendix C.

The static tests at the beginning and end of the day showed on the order of less than ± 3 mV for the EM61-MK2. The magnetometer static tests showed peak-to-peak noise was typically less than 0.5 nT. The results of the static tests completed during the GPO are included in Appendix C.

The GPS test performed while the GPS antenna was attached to the EM61 resulted in a crossing point within 0.25 ft of the actual location of the SE corner of the grid (picked: 1451148.03E, 12205223.57N vs. actual: 1451148.26E, 12205223.61N). The octant test performed with the magnetometer did not show significant variation in signal strength in any of the 8 directions along which data were collected. There were also no dropouts in any of the 8 directions. The results of the octant test are included in Appendix C.

DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) were developed for the field portion of the project based on the results of the GPO. The DQOs for the EM61-MK2 are presented in Table 12. The DQOs based on the GPO results were based on the following parameters of the data:

- Background noise <4.0 mV – Highest standard deviation of the data between the two surveys conducted.

Table 12
EM61-MK2 DQOs
Former Trabuco Bombing Range
Geophysical Prove-out

DQO	Measure	Method of Measurement
Background Noise	Standard Deviation < 4.0 mV for a target density of 35 anomalies per acre. It is expected that this measure will increase with increased target density.	<ol style="list-style-type: none"> 1. Window the dataset to a portion of the survey area with a relatively low number of anomalies to include at least 1% of the total number of data points in the dataset 2. Use Geosoft statistics to calculate the standard deviation for windowed data
Instrument Latency	No Zig-Zag or Chevron effects.	<ol style="list-style-type: none"> 1. Observe anomalies after latency correction for zig-zag or chevron effects
Processing	Do not change anomaly amplitude by more than 5%.	<ol style="list-style-type: none"> 1. Compute the difference between leveled and raw data channels (early time gate for EM61-MK2). Differences greater than 5% will be evaluated.
Sampling Density	Maximum point-to-point separation of 0.7 ft for 98% of data.	<ol style="list-style-type: none"> 1. A Geosoft script will be used to calculate the number of point-to-point separations that exceed the 0.7 ft metric 2. The number of exceedences should be less than 2% of the total separations.
Coverage (only relevant for grid-based data)	Maximum distance between lines will not exceed the lesser of twice the line spacing (5-ft) or twice the minor axis of the anomaly produced by a horizontal Mk23 at 24 inches bgs (3.2-ft). Transect widths will be assumed to be 3-ft.	<ol style="list-style-type: none"> 1. Compute grid in Geosoft using a blanking distance of 1.6 ft. Areas in which cross-line distance exceeds criteria will be shown as blank areas in grid. Small occurrences (< 4 ft²) will be acceptable as long as they do not total more than 1% of the surveyed area.
Anomaly Selection	Proveout results indicated that a 20mV (total channel) threshold would detect all of the items seeded in the proveout grid. 20mV is at least 5 times the standard deviation of site data that does not contain anomalies	<ol style="list-style-type: none"> 1. All total channel peaks above 20mV will be selected using the Blakely test method.
Reacquisition	Horizontally 95% of all excavated items must lie within a 1.2-ft radius of the location marked in the field by the reacquisition team.	<ol style="list-style-type: none"> 1. Distances between reacquired locations and item locations will be calculated.

Sampling density of 0.7 ft for 98% of the data – The anomaly for GPO-06 included 3 data points above the 20 mV threshold used for target selection. These three points were spaced over 0.8 ft, suggesting that this spacing would be adequate to detect all of the seed items in the GPO grid. The 0.7 ft DQO gives an added measure of confidence that potential MEC would be detected. It should be noted that over 9% of the data collected in the 3-foot spacing data set were above the suggested DQO. The results discussed above suggest that a lower data collection speed would help ensure detection of all anticipated items at the site. A lower collection speed should also reduce the background noise seen during the project.

- Coverage gaps not exceeding twice the minor axis of the anomaly produced by a horizontal Mk23 at 24” (3.6 ft) – The distance between the actual location of GPO-06 and the farthest data point in the anomaly that was still above the detection threshold (20 mV).
- Anomaly Selection Threshold of 20 mV – See Recommendations section below.
- Reacquisition of 95% of the items recovered during the project within 1.2 feet of their actual locations – From the actual statistics of the EM reacquisition effort during the GPO.

CONCLUSIONS AND RECOMMENDATIONS

Buried inert Munitions Debris and simulated Munitions and Explosives of Concern (MEC) items were detected using the EM61-MK2, the G-858 magnetometer, and the Schonstedt magnetometer at a prove-out grid located at the former Trabuco Bombing Range. The results indicate that the EM61-MK2 was able to detect 4 seed items that the magnetometer surveys did not detect and 2 that the Schonstedt did not detect. The positional accuracy of both the initially selected locations and the reacquired location was higher for the EM61 than for the other two instruments. It is, therefore, recommended that the EM61-MK2 be used in favor of either the G-858 or the Schonstedt magnetometer in those areas accessible to the EM61.

There were no appreciable differences between the detections in the 2-foot line spacing survey and the 3-foot line spacing survey, although the 2-foot line spacing survey did not detect one of the items. The detection of this item, a Mk23 buried vertically at 24 inches (GPO-06), was also somewhat questionable in the 3-foot survey given that it was not detected on a survey line 0.5 feet from the item but was detected on a line 2.5 ft away. Examination of the anomaly generated by the Mk23 buried horizontally at 24 inches indicated that the item produced a 20 mV response up to 1.6 feet away. Therefore, for production survey purposes, it can be assumed that the effective footprint for EM61 data is three feet rather than two. To ensure that no gaps are left in the grid based surveys, the lines collected during these surveys will be spaced 2.5 feet apart.

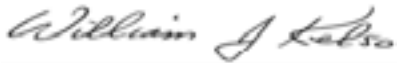
The total channel data and the 20 mV anomaly selection threshold used for the GPO are also recommended for the field project. Use of these parameters resulted in the detection of all of the seed items, a threshold that was well above the noise level for the data (5X standard deviation), and a reasonable buffer between the lowest amplitude detected for a seed item (22.5 mV) and the selection threshold. The use of advanced processing is also recommended to eliminate anomalies caused by geophysical noise. Anomalies with half widths less than 1.5 ft or decay constants greater than 2000 μ s are recommended for elimination.

Every effort was made to bury seed items down to the maximum depth of detection based on the formula in DID MR-005-05. Since the EM61-MK2 detected all known seeded items, the GPO verified that this system conforms to the depth detection criteria in DID MR-005-05.

A number of steep hillsides are within the sample area to be surveyed during the Trabuco RI. From observation during the GPO, many of these steep hillsides are not safe for personnel to operate the EM61. It is recommended that the Schonstedt magnetometer be used to survey areas that are too steep for the EM61. It is also recommended that any Schonstedt surveys should be performed as "mag and dig" surveys, with the locations of any discovered MEC or MD recorded using RTK GPS if possible. Non munitions related item locations will not be recorded.

Sincerely,

PARSONS



William J. Kelso, P.E.
Senior Project Manager