GEOPHYSICAL PROVE OUT PLAN

Conventional Ordnance and Explosive (OE),
Removal Action,
Five Points Outlying Field,
Arlington, Texas

Contract No. DACA87-00-D-0035
Task Order 0018
Project No. K06TX002801

Prepared for:

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November 12, 2003

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INTRODUCTION

1.1 Objective:

1.1.1 ATI plans to perform a geophysical survey at the Former Five Points Outlying Field, Arlington, Texas. The overall objective of this task order is for ATI to perform a conventional Ordnance Explosive (OE) Removal Action (RA) at the site.

1.1.2 The project requires a site-specific Geophysical Prove Out (GPO) for the purpose of evaluating geophysical instruments and developing the standard response for the selected instrument(s), instrument configuration, and techniques. The GPO will be performed in accordance with DIDs OE-005-05.01 and OE-005-05A.01. All data collected (including QC data) will be submitted in Draft state to CEHNC and CESWF within 36 hours of collection (per DID OE-005-05A.01). Mobilization to begin Digital Geophysical Mapping (DGM) will not occur until the Government accepts the results and recommendations stemming from this GPO.

1.1.3 The specific Data Quality Objectives (DQO's) for the GPO will be:

- Demonstrate that the geophysical investigation systems/equipments, are operating properly.
- The ability of the geophysical systems to perform adequately in areas where trailers and single-family homes are present along with "open" areas. ("Open" areas are defined as those which interferences to the geophysical systems are minimal).
- Provide a set of isolated objects (e.g., single inert UXO items or UXO surrogates). The sensor signatures from these items will be used to determine the equipment limitations in the geologic and urbanized settings.
- Assess the operator's performance and update related procedures and assist in the development of operator measurement techniques.
- Establish a baseline of performance capabilities for the selected instruments in both "open" and urban areas.
- Establish decision parameters for target selection by the site geophysicists.
- Evaluate navigational/position systems for electronic positional accuracy for grid establishment and positioning of identified UXO in both "open" and urban areas.
- Determine average speed, minimum along track sampling, line separation distance are required to detect all target items in both open and urban areas.

- Correct Instrument latency using an appropriate correction routine that accounts for instrument latency time and sensor velocity. Corrections must be specific for all segments of data with equal sensor velocities. No "zigzag" or "chevron" effects are visible in the data maps when plotted at the scales used to detect the smallest amplitude signal for any given UXO item expected at this site.

- Perform all processing to produce final datasets (including processing to level the data) will be evaluated on a dataset by dataset basis to confirm that those routines do not significantly alter the original measured peak responses (above background) over anomalies. For producing final datasets, processing routines shall not alter the peak responses of anomalies by more than 10%. This limit will be evaluated on the GPO datasets.
- Data positioning errors in the final datasets will not exceed 20 centimeters.
- Determine the "effects" of cultural objects in the urbanized areas upon the recognition of anomalies and application of geophysical instruments.

2.0 PERSONNEL QUALIFICATIONS

2.1 Personnel

2.1.1 The geophysical investigation will be managed and performed by qualified geophysicists meeting the qualification requirements listed in DID OE-025.01. Jeffrey Leberfinger, a Senior Geophysicist with ATI, will be the Project Geophysicist. The GPO Site Geophysicists will be Colin Kennedy of ATI, and Mr. Peter Clark of Geophysical Technology Limited (G-Tek), and Mr. Marty Miele of Shaw EI. One UXO Tech II and one geophysical data collector will also be used.

3.0 TEST PLOT DESIGN

3.1 GPO Test Plots

3.1.1 ATI will construct three (3) test plots, one which is located in the area where man-made interferences are minimal (open area) and the two others where interferences are significant caused by urban dwellings (both trailers and single family dwellings) and utilities and other man-made objects. ATI will work with CEHNC to identify potential test plot locations at the site.

3.1.2 The test plot locations will be identified by ATI and approved by CEHNC and CESWF during the GPO mobilization.

3.2 Test Plot Size

3.2.1 The planned size for the "open area"_ test plot is approximately 15 meters x 30 meters. The other test plots will be located between two (2) single-family dwellings and the two (2) trailers. Size will be approximately 6 meters by 15 meters.

3.3 Test Plot Location

3.3.1 The data collection will take place at all three (3) aforementioned (Section 3.1.1) test plots at the site.

3.3.2 Coordinates for the test plots will be determined in the field after consensus is established between the District Office, CEHNC and ATI.

3.4 Planned Seeded Items

3.4.1 The test plot will be seeded by ATI prior to the initiations of the GPO, and with concurrence of the District Office and CEHNC. This activity will happen after grid set up and background survey of the grids with the Geonics MK2 EM61.

3.4.2 Ten (10) UXO surrogate items and three (3) non-UXO clutter items will be seeded in the open area test plot at varying depths and orientations. Five (5) UXO surrogate items and two (2) non-UXO clutter items will be seeded in each of the two small urbanized area test plots at varying depths and orientations. Tables 2, 3, and 4 present the known seeded item locations and type.

3.4.3 After reviewing available historical data, ATI recommends seeding surrogates for the M-47 chemical bombs, AN-MK 23 Mod I Navy, and M38 practice bombs. The location, depths, and orientation of proposed new targets to be seeded are presented in Table 2, 3, and 4.

3.4.4 The estimated maximum detection depths for the expected targets at Five Points are presented in Table 1. Based on DID OE-005-05.01, the simplified expression for maximum depth of detection is calculated as:

- Estimated Detection Depth (meters) = 11*diameter (mm) / 1000

Table 1
Calculated Maximum Detection Depths for Expected Targets

OE Type	Diameter (Inches)	Diameter (Millimeters)	Maximum Detection Depth (meters)
M-47 Chemical	8.1	205.74	2.26
AN-MK23 Mod 1 Navy	2.2	55.88	0.61
M-38 Practice	8.0	203.2	2.2

3.4.5 Figures 1, 2, and 3 presents the planned test plot in map view.

3.4.6 CEHNC may also bury blind seed items.

4.0 SITE PREPARATION

4.1.1 Minimal vegetation removal and minimal site preparation is anticipated. In areas near the single-family homes and the trailers, sod will be removed and replanted to assure minimal destruction. In addition, some surface objects that are portable may have to be relocated temporarily with the homeowner's permission.

5.0 LOCATION SURVEYING

5.1.1 All coordinates will be in Universal Transverse Mercator (UTM), meter coordinates.

5.1.2 ATI will utilize a Texas State Licensed Surveyor to survey in the coordinates of the seeded items and grid corners of the seeded items to a horizontal accuracy of 3 cm horizontally and 5 cm vertically. The surface elevation of the ground surface will also be measured after the item is seeded. Where possible a vertical piece of rebar or iron survey pin will be placed at the four corners of the grid for additional long term positioning. An ATI UXO Tech II will perform anomaly avoidance during all required activities during the surveying activities such as before placing grid corner markers in the ground.

5.1.3 Figure 1 presents the planned Open Area Test Plot in map view. Figures 2 and 3 present the two smaller Urbanized Test Plots.

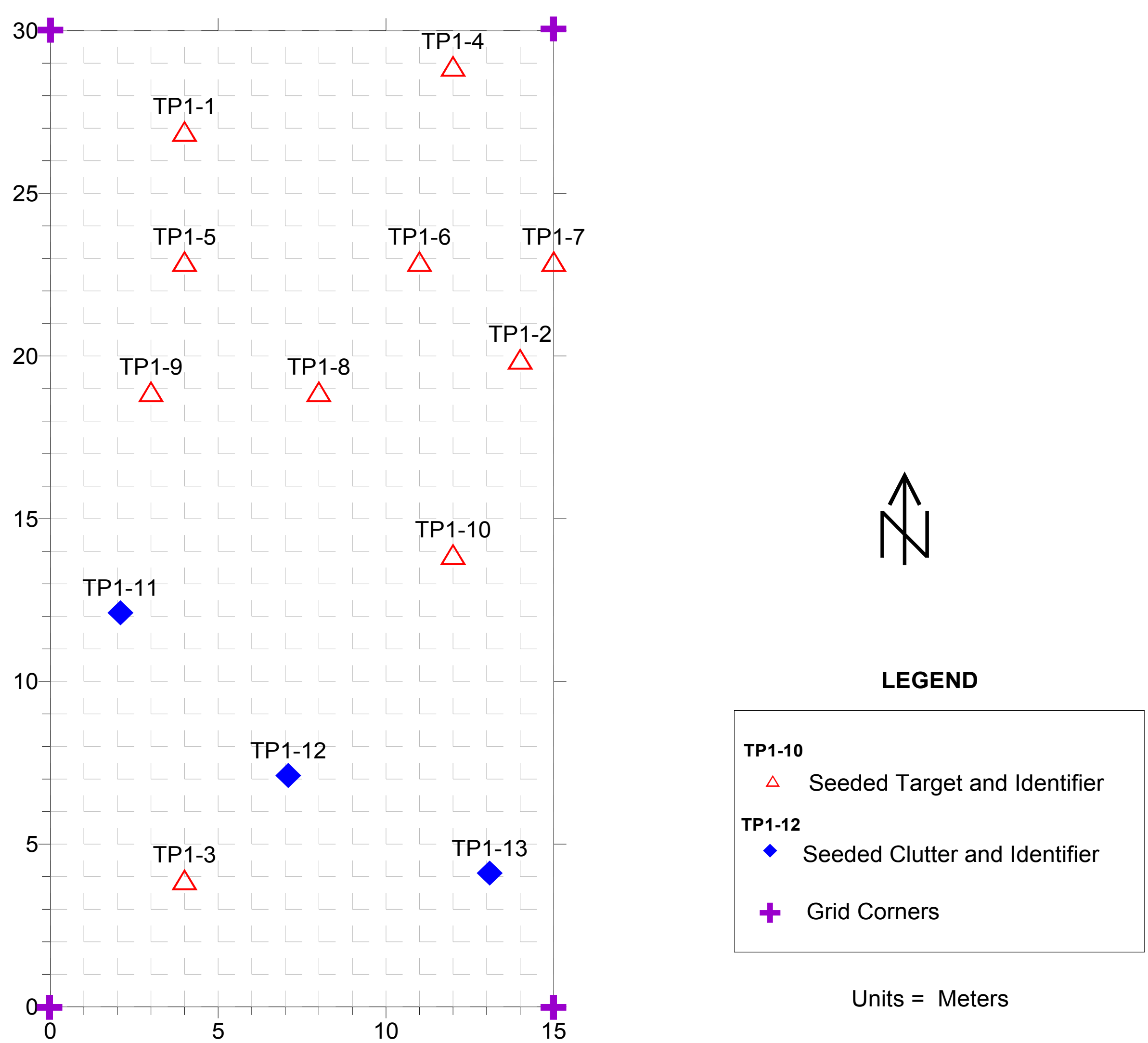

Figure 1 – Test Plot #1 Map - Open Area

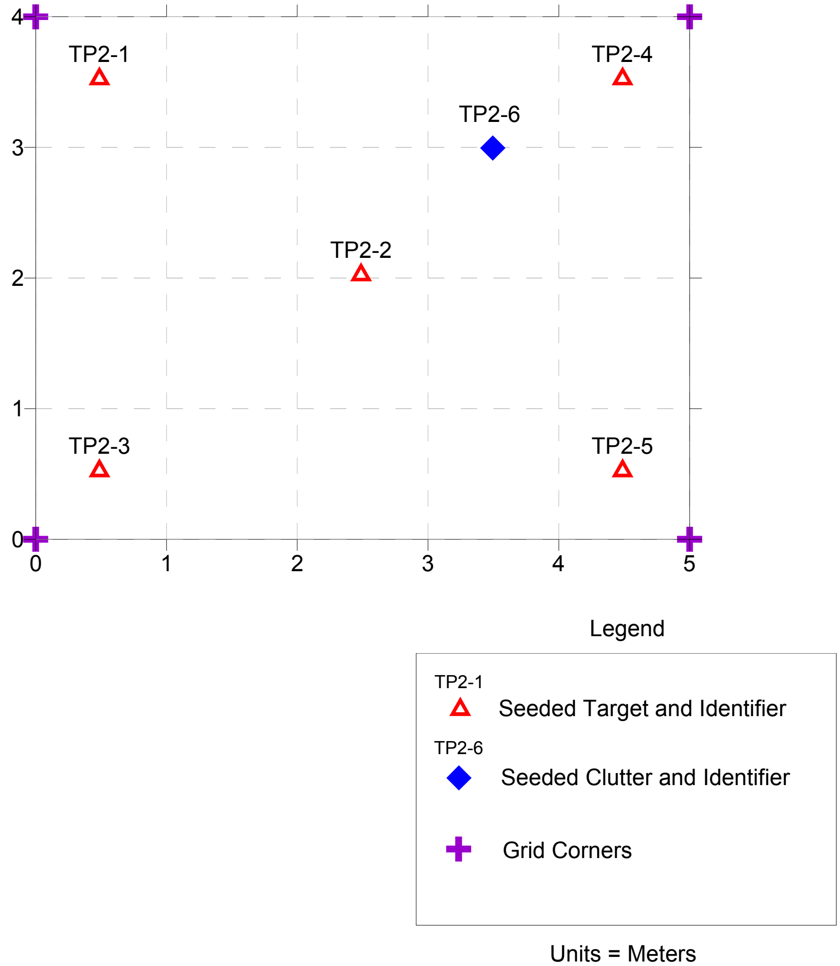

Figure 2 –Test Plot #2 - Urbanized Area

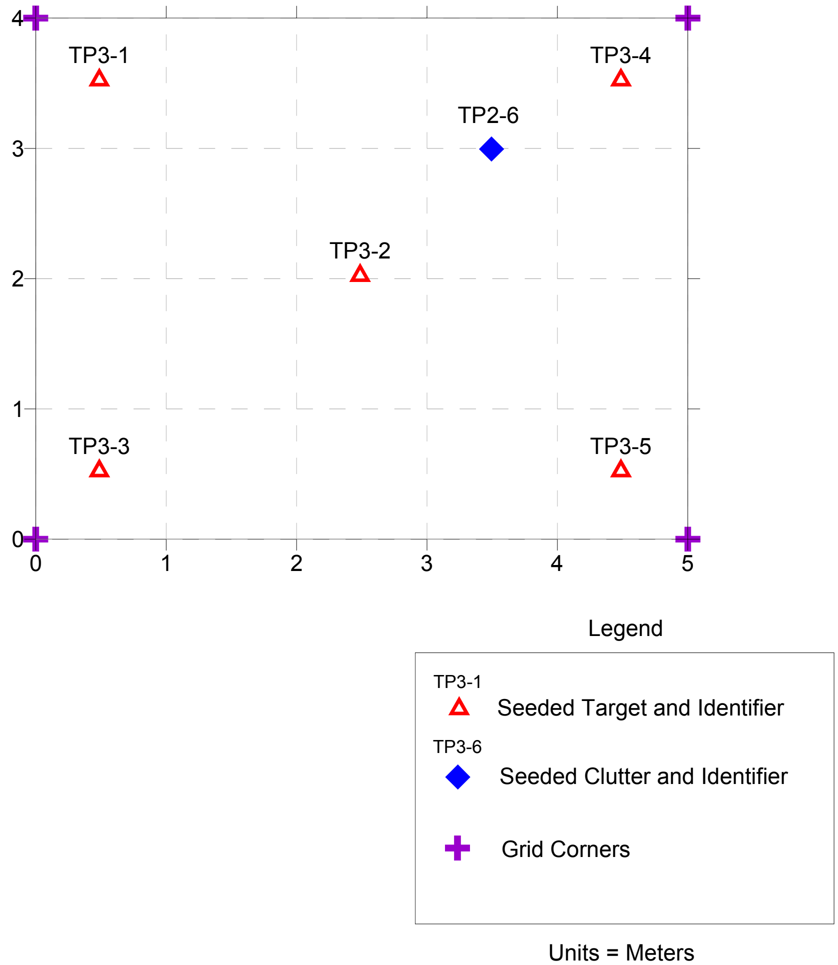

Figure 3 –Test Plot #3 - Urbanized Area

Table 2
Planned Seed Items

Test Plot #1 – Open Area

ID Number	X (meters)	Y (meters)	Target Type	Depth (meters)	Orientation (degrees)	Azimuth
TP1-1	4.0	27.0	MK-23	0.40	0	N-S
TP1-2	14.0	20.0	MK-23	0.50	0	E-W
TP1-3	4.0	4.0	M-47	0.70	0	E-W
TP1-4	12.0	29.0	M-38	0.90	45	N-S
TP1-5	4.0	23.0	MK23	0.20	90	---
TP1-6	11.0	23.0	MM-23	0.60	45	E-W
TP1-7	15.0	23.0	MK-23	0.40	90	E-W
TP1-8	8.0	19.0	MK-23	0.60	0	N-S
TP1-9	3.0	19.0	MK-23	0.30	60	N-S
TP1-10	12.0	14.0	MK23	0.50	80	E-W
TP1-11	2.0	12.0	Clutter	0.20	-----	-----
TP1-12	7.0	7.0	Clutter	0.20	-----	-----
TP1-13	13.0	4.0	Clutter	0.10	-----	-----

Table 3
Planned Seed Items
Test Plot #2 – Urbanized Area

ID Number	X (meters)	Y (meters)	Target Type	Depth (meters)	Orientation (degrees)	Azimuth
TP2-1	0.5	3.5	MK-23	0.40	45	N-S
TP2-2	2.5	2.0	MK-23	0.40	60	------
TP2-3	0.5	0.5	MK-23	0.60	0	N-S
TP2-4	4.5	3.5	MK-23	0.20	0	E-W
TP2-5	4.5	0.5	MK-23	0.30	90	------
TP2-6	3.5	3.0	Clutter	0.20	-----	-----

Table 4
Planned Seed Items
Test Plot #3 – Urbanized Area

ID Number	X (meters)	Y (meters)	Target Type	Depth (meters)	Orientation (degrees)	Azimuth
TP3-1	0.5	3.5	MK-23	0.20	45	N-S
TP3-2	2.5	2.0	MK-23	0.40	70	------
TP3-3	0.5	0.5	MK-23	0.60	0	N-S
TP3-4	4.5	3.5	MK-23	0.20	0	E-W
TP3-5	4.5	0.5	MK-23	0.50	90	------
TP3-6	3.5	3.0	Clutter	0.20	------	------

6.0 PRE-SEEDING GEOPHYSICAL MAPPING

6.1 Procedures

6.1.1 Pre-seeding geophysical surveys will be performed using geophysical survey systems appropriate to the each of the test plots.

6.1.2 The surveys will be performed with both the Geonics MK2 EM61 and the G-tek TM-5EMU's with RTK DGPS positioning (Ashtech Z extreme).

6.1.3 Lane spacing will be one meter and 0.8 meters for the EM-61 and 1 meter for the TM-5

6.1.4 Subsurface utilities detected by the geophysical instruments will be located and marked on the ground. If a utility is at a location of a planned seed item a new location will be selected with concurrence of CEHNC and CESWF. In addition, interferences caused by surface and subsurface manmade objects will be identified in the digital data set for each sensor for comparison to the post seed data sets.

6.1.5 Quality control procedures described in Section7.0 will be followed.

7.0 QUALITY CONTROL

7.1 Procedures

7.1.1 All documentation will be available to USACE personnel.

7.1.2 QC, of the instrument's data, will be achieved daily by field testing, checking the sensor and navigation system against a known target to ensure that they are operating properly. The standardization check described in Section 7.2 will be implemented to achieve QC objectives.

7.1.3 Operational and test procedures will conform to the manufacturer's standard instructions.

7.1.4 All geophysical instruments and equipment used to gather and generate field data are calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of results are consistent with the manufacturer's specifications. Calibration, repair, or replacement records will be filed and maintained by the Site Geophysicist and may be subject to audit by the QA Manager. Testing records of the field instrumentation will be filed with the CEHNC PM after the fieldwork is completed.

7.1.5 Data processing QC is required to assure data quality. Potential data problems include source data errors, data entry errors, data editing errors, data corruption errors, and user errors. ATI's data review will identify and correct any of these errors should they occur.

7.1.6 Data Loss and File Corruption. There are several programs that are used to collect and process the various files used by ATI. These files will be backed up daily.

7.1.7 Data Analysis QC Checks

7.1.7.1 Data analysis will be conducted in accordance with accepted and appropriate methods. To assure all data analysis results are reproducible and objective, 10 percent of all data will be analyzed in-house by a geophysicist, not involved with the prior analysis, to validate the accuracy of all data manipulation procedures.

7.2 Instrument Standardization

7.2.1 ATI will perform QC Steps/Tests in accordance with Attachment B of DID OE-005-05.01. The required equipment tests and frequency of testing are summarized in Table 5.

7.2.2 The following tests will be conducted:

7.2.2.1 Equipment/Electronics Warm-up

7.2.2.1.1 Purpose: Minimize sensor drift due to thermal stabilization. Most instruments need a few minutes to warm up before data collection begins. ATI will follow the manufacturer's instructions or, if none are given, observe the data readings until they stabilize.

7.2.2.1.2 Acceptance Criteria: Equipment Specific (typically 5 minutes).

Table 5: QC Test Frequency

Test #	Test Description	Specific detector	Power on	Beginning of Day	Beginning and End of Day	1st Day of Project	Repeat Last Two Lines on Each Grid
1	Equipment Warm-up		X				
2	Personnel Test			X			
3	Record Sensor Positions			X			
4	Vibration Test (Cable Shake)			X			
5	Static Background and Static Spike				X		
6	6 Line Test					X	
7	Repeat Lines						X
8	Calibration	TM5EMU		X			
9	Positioning Device Check			X			
10	Azimuthal Test	Magnetometer				X	
11	Octant Test	Magnetometer				X	
11	Height Optimization					X	
10	Ground Balance/Noise Cancel	TM5EMU		X			

7.2.2.2 Personnel Test

7.2.2.2.1 Purpose: Ensure survey personnel have removed all potential interference sources from their "bodies". Common interference sources are ballpoint pens in the operator's pocket and steel-toed boots or large metallic belt buckles, which can produce data anomalies similar to OE targets. All personnel who will be coming within close proximity of the sensor during survey operations must approach the sensor and have a second person monitor and record the results.

7.2.2.2.2 Acceptance Criteria: EM61 +/- 2mV, TM-5 EMU +/- 5emu

7.2.2.3 Record Relative Sensor Positions

7.2.2.3.1 Purpose: Document relative navigation and sensor offsets, detector separation, and detector heights above the ground surface. This will ensure that detector offset corrections and gradient calculations can be done correctly and that the surveys are repeatable.

7.2.2.3.2 Acceptance Criteria: +/- One inch (2.54 cm).

7.2.2.4 Vibration Test (Cable Shake)

7.2.2.4.1 Purpose: Identify and replace shorting cables and broken pin-outs on connectors. With the instrument held in a static position and collecting data, shake all cables to test for shorts and broken pin-outs. An assistant is helpful to observe any changes in instrument response. If shorts are found, the cable should be immediately repaired or replaced. After repair, cables need to be rigorously tested before use.

7.2.2.4.2 Acceptance Criteria: Data Profile does not exhibit data spike responses.

7.2.2.5 Static Background and Static Standard Response (Spike) Test

7.2.2.5.1 Purpose: Quantify instrument background readings, electronic drift, locate potential interference spikes in the time domain, and determine impulse response and repeatability of the instrument to a standard test item (2" diameter steel trailer ball). Improper instrument function, the presence of local sources of ambient noise (such as EM transmissions from high-voltage electric lines), and instability in the earth's magnetic field (as during a magnetic storm) are all potential causes of inconsistent, non-repeatable readings. A minimum of three (3) minutes static background collection after instrument warm-up, followed by a 1-minute standard (spike) test followed by a 1-minute static background data will be performed. The operator must review the readings to confirm their stability prior to continuing with the geophysical survey.

7.2.2.5.2 Acceptance Criteria: Static Background Test: EM61 +/- 2.5 mV, TM5EMU +/- 10emu, Static Spike Test: EM61/TM5EMU, +/- 20% of standard item response, after background correction.

7.2.2.6 Six Line Test

7.2.2.6.1 Purpose: Document latency, heading effects, repeatability of response amplitude, and positional accuracy. This test will be performed in an area relatively clear of anomalous response. The test line will be well marked to facilitate data collection over the exact same line each time the test is performed. Heading effects, repeatability of response amplitude, positional accuracy, and latency are evaluated. The following procedure will be followed:

1. Lay out a 30-meter non-metallic tape in an N-S or E-W direction. Run a survey along the 30-meter line going one direction.
2. Run a survey along the 30-meter line in reverse direction.
3. Place target (trailer-hitch ball) on clean area of the line at an inline distance of 15 meters.
4. Run a survey along the 30-meter line in one direction.
5. Run a survey along the 30-meter line in opposite direction.
6. Run a survey along the 30- meter line in one direction, moving very fast.
7. Run a survey along the 30- meter line in opposite direction, moving very slow.

7.2.2.6.2 Acceptance Criteria: Repeatability of response amplitude +/-20%, Positional Accuracy +/-20cm.

7.2.2.7 Repeat Data

7.2.2.7.1 Purpose: Determine positional and geophysical data repeatability. After data collection on each grid, the last two lines will be repeated.

7.2.2.7.2 ATI will also collect two tie lines on each grid. One tie line will be collected at each 0 meter line and along the 15 meter line.

7.2.2.7.3 The data will be viewed in profile form and compared to original data as a means of evaluating the ability of the instrument to respond consistently with sufficient positional accuracy of the data.

7.2.2.7.4 The position data will be evaluated by superimposing the initial and repeat line to verify that they do not deviate by more then 20 cm.

7.2.2.7.5 The repeat data will be evaluated and accepted immediately following data download from surveys.

7.2.2.7.6 Acceptance Criteria: Repeatability of response amplitude +/-20%, Positional Accuracy +/- 20cm.

7.2.2.8 Height Optimization

7.2.2.8.1 Purpose: Determine the sensor height that optimizes the target signal-to-noise ratio and maintains adequate sensitivity. This test will be performed for the TM5-EMU instrument. A line is established with at least one test object along its length. Data is collected with the instrument using a minimum of three different sensor heights, and the height that best meets the objectives is selected. This test will be performed with the smallest detectable target object buried to the maximum depth of detection.

7.2.2.8.2 Acceptance Criteria: Maximum signal-to-noise ratio that reliably detects smallest target objective.

7.2.2.9 TM5-EMU Calibration

The TM-5 EMU will also be calibrated by a calibration device known as an “EMUlator”, which was developed by G-Tek for the purpose of establishing the integrity of the TM-5 EMU. At the beginning of each survey session the EMUlator is placed touching the rim of the sensor coil and data is recorded for a period of about 30 seconds. The EMUlator delivers a controlled response to the excitation transmitted by the TM-5 EMU.
Acceptance criteria: Response should exceed 250 emu.

7.2.2.10 Data Position Check

At the beginning of each day a known survey point shall be visited and its measured position recorded.

Acceptance criteria: Measured position should be within 5 cm.

8.0 ANOMALY AVOIDANCE

8.1.1 ATI plans to seed targets in three test plots. ATI will have a UXO Tech II onsite during the intrusive seeding operations to perform anomaly avoidance.

8.1.2 ATI will screen all seed target locations with the TM-5 EMU and EM61 metal detector.

8.1.3 The UXO Tech II will also utilize a Garrett Sea Hunter or equivalent metal detector to assist in OE avoidance.

9.0 SEEDING

9.1.1 The test plots will be seeded with known targets as presented in Tables 2, 3, and 4.

9.1.2 ATI will hand dig the holes for the items to be seeded.

9.1.3 CEHNC may also bury blind seed items.

10.0 DATA COLLECTION VARIABLES

10.1 Sensors

10.1.1 ATI will test the Geonics Mark 2 EM61, and the G-Tek $TM5_{EMU}$.

10.1.2 The EM61 MK2 is a Time Domain Electromagnetic (TDEM) system. The EM61 MK2 generates 150 electromagnetic (EM) pulses per second and measures during the off time between pulses. After each pulse, secondary EM fields are induced briefly in moderately conductive soils and for a longer time in metallic objects. Between each pulse, the EM61 MK2 waits until the response from the conductive earth dissipates and then measures the prolonged buried metal response. This response is recorded in millivolts (mV). By sensing only the buried metal response, the EM61 MK2 detects metallic targets that might otherwise be missed. The EM61 MK2 measures multiple time gates (216, 366, 660, and 1266 usec) to provide a more complete measurement of the response decay rate. The MK2 can record up to 12 records per second, four (4) time gates per record, or 3 time gates of better channel data coupled with one reading for top channel per second.

10.1.3 The **TM-5EMU** electromagnetic detector system is configured with one sensors measuring the transient electromagnetic response. The sensor is a monocoil acting as both transmitter and receiver, operated as a vertical magnetic dipole, with 16 turns, a diameter of 18 inches, inductance of 300µH and resistance of 0.7Ω. The transmitted waveform consisted of two different length pulses (200µs, 3.3A and 50µs, 830mA), repeated at the rate of approximately 1200Hz. The peak pulse amplitudes are based on an applied voltage of 5V, and at turn-off, the pulses ramp to zero in about 2-4µs (corresponding to the self-induced emf clipped to 187V). The theoretical bandwidth of about 500kHz reduces to about 300kHz after the addition of amplifiers and integrators. The detector is based on synchronous demodulation, sampling the secondary field decays over narrow integration gates. After subtracting the ground response and digitizing at approximately 60Hz, the output is decimated to 32 samples per second that are recorded with a GPS position at a Hz rate. Amplifier gains are adjusted to provide digital output between $\pm$4096 units such that background noise is set to $\pm$ 1-2 units. A low pass filter is applied at periodic intervals to reset the background signal to a zero mean. During a traverse this filter is switched out so that the filter does not attenuate target responses, and the drift is removed from the digital record in post-processing with a high-pass filter.

10.2 Positioning Systems

10.2.1 Some areas such as the single family homes and trailers may not allow the use of the GPS due to limited signal access to navigational satellites or due to the presence of the structures. ATI will test the GPS only on the open grid, and the GPS and LRTS on the two smaller urbanized grids.

10.2.2 ATI will utilize an Ashtech Z extreme RTK Global Positioning System (GPS) and Lieica Robotic Total Station (LRTS) to integrate location data with the sensors to be tested. The systems employed will have centimeter accuracy and will utilize a base station established at a known monument/control point.

10.3 Data Integration

10.3.1 ATI will utilize the Geonics data logger to obtain real-time integration between the EM61 and GPS data streams.

10.3.2 The $TM5_{EMU}$ will integrate GPS and LRTS with data in real time, using proprietary G-Tek software.

10.4 Sampling Rate

10.4.1 Sampling rates of the EM61 MK2 will be 8 times per second for the man-portable sensor.

10.4.2 Sampling rates of the $TM5_{EMU}$ will be 30 times per second for the man-portable sensor.

10.4.3 Sampling rates on the Astech GPS and LRTS will be no less frequent than one (1) time per second.

10.5 Data Density

10.5.1 Data will be collected along traverses 1 meter and 0.8-meter survey lines for the test plots.

10.6 Production Rates

10.6.1 The anticipated production rates for the digital geophysical mapping evaluation is one instrument and navigation system over the planned grids, per 10-hour day.

10.6.2 ATI plans on utilizing one two-man data collection crew.

10.7 Man-Made Interference Test

10.7.1 ATI will perform walk away tests from cultural features to document the interference caused by man-made object such as single-family dwelling, trailers and their surface utilities upon the sensors.

11.0 DATA ANALYSIS AND INTERPRETATION

11.1 Procedures

11.1.1 ATI will utilize Geosoft's UXO Detect™ and Geophysical Mapping QC Module to process the data. ATI and G-Tek will utilize proprietary G-Tek software to preprocess $TM5_{EMU}$ data. Due to the short field schedule ATI will perform daily QC and data processing of all data sets.

11.2 Initial Field Processing

11.2.1 ATI will perform data file QC review and correction of the following:

8. Grid name and location
9. Line numbers, survey direction, start and end points
10. Removal of isolated data drop-outs and spikes, if they are not related to equipment failure.
11. Identification of physical feature interference sources from survey sheets.

11.3 Standard Data Analysis

11.3.1 ATI will perform the following analysis where appropriate:

12. Positional offset correction
13. Sensor bias, background leveling and/or standardization adjustment
14. Sensor drift removal
15. Latency Correction

11.4 Quantitative Interpretation and Dig Sheet Development

11.4.1 As grids will be laid out to insure coverage of all the accessible property in the project, ATI will interpret the collected data as the grid method.

11.4.2 ATI will determine the optimum gridding method, search criteria, and contour level selection with background shading and analysis based on the data collected. ATI will discuss these parameters with CEHNC prior to beginning production of the draft report figures.

11.4.3 Colored maps will be constructed in accordance with Attachment D, DID OE-005-05.01, Geophysical Map Deliverable Format.

11.4.4 Dig sheets will be constructed in accordance with Attachment C, DID OE-005_05.01 as adapted for the sensor technologies used.

11.4.5 All drawings will be of engineering quality in drafted form. The color maps will be generated at a scale of 1 inch = 15 feet (1:180).

11.4.6 Colored contour maps and profile data will be evaluated to make appropriate picks of seeded UXO targets. ATI will compare the selected location with the known item location.

11.4.7 The TM5-EMU will be evaluated for its capability for additional discrimination. Parameters of the recorded waveforms used to classify the metal target responses include:

- magnitude (data ranges between –4096 and 4096),
- polarity (positive or negative magnitude),
- spatial wave-length (typically measured as the width of the anomaly at an amplitude corresponding to half the peak value).

12.0 REACQUISITION

12.1 Procedures

12.1.1 Targets on the test plot will be reacquired using the Geonics MK2 EM61, and $TM5_{EMU,}$ and with the Ashtech Z extreme GPS or LRTS. The distance from the reacquired target and the targets actual location will be measured and recorded to evaluate the effectiveness of the reacquisition process.

13.0 RECORDS MANAGEMENT

13.1 Procedures

13.1.1 Field data sheets shall be maintained in accordance with Attachment A of DID OE-005-05.01.

13.1.2 Data will be provided to the COE representative in the field on a CD.

13.1.3 Project documentation will be collected and managed on-site during the life of all field activities for inspection by client personnel.

13.1.4 Geophysical data will be recorded digitally and downloaded periodically to a field computer for review in the field. In addition to the copy of data placed on the field computer's hard drive, a copy of the data will be placed on a floppy or zip disk, or disks, for backup before the data are erased from the equipment.

13.1.5 As an additional means of ensuring data availability, all data will be transferred to the geophysical data processing center on a daily basis. This off-site storage of data will further reduce the likelihood that data will be lost. Transfer may be accomplished by e-mail attachment, file transfer protocol (i.e., FTP), or overnight delivery of floppy zip disks, or CD's. If possible, copies of field data collection forms and appropriate field logbooks will also be faxed.

13.1.6 The Project Geophysicist will review the uploaded geophysical data to verify the transfer system is functioning on a daily basis. This review will also serve to double-check the field data review for QA/QC purposes. The review will verify that the data is valid and useable for the intended purpose.

13.1.7 All digital data stored at the geophysical data processing center will be backed up daily and weekly. All data, reports, memorandums, spreadsheets, etc., will be maintained in a designated client/site subdirectory and transferred to the central GIS/database system.

14.0 DATA EVALUATION

14.1 Procedures

14.1.1 ATI will evaluate and score the different geophysical approaches. Scoring Criteria will be:

- Percent of seeded items detected (by class/size, and overall)
- Number of unknown targets
- Production rate
- Cost per unit area
- Effect of man-made structures
- Equipment durability
- Safety

14.1.2 Based on ATI's evaluation, ATI will provide to the Government a listing of each target and shall include a complete description of detection characteristics to include, at a minimum, the following information:

16. Seed item ID.
17. Seed item description.
18. Seed item burial characteristics.
19. Anomaly peak response from actual data.

20. The effects of man-made objects on the data, and the removal of such effects if possible. ATI will determine which approach is likely to be most efficient and effective for the site, based on these findings.

15.0 GPO LETTER REPORT

15.1 Deliverable

15.1.1 After the GPO field work has been completed, ATI will prepare a GPO Letter Report including the following:

1) As-built drawing of the GPO plot;

2) Seed Item location spreadsheet and all control points (Microsoft Excel Format);

3) All raw and processed geophysics data;

4) Summary of the GPO results;

5) Proposed geophysical equipment, techniques, and methodologies; and

6) Sufficient supporting information to justify the project team's recommendations, including manufacturer specifications for all recommended geophysical equipment, a definition of the expected target anomalies based upon the ASR or EE/CA, and any other pertinent data/information used in decision making.

15.1.2 A CD shall be delivered with the letter report containing the following files:

1) The GPO Letter Report (Microsoft Word format);
2) All raw and processed geophysical data. All data, except raw instrument data, shall be provided in column delineated ASCII files in the format x, y, z, v1, v2, etc., where x and y are UTM Grid Plane Coordinates in Easting (meters) and Northing (meters) directions, and v1, v2, v3, etc., are the instrument readings. The last data field will be a time stamp. Each data field shall be separated by a comma or tab;
3) Geophysical maps in their native format (Geosoft Oasis montaj) and/or as raster bit-map images such as BMP, JPEG, TIFF or GIF;
4) Seed item location spreadsheet (Microsoft Excel format);
5) Spreadsheet (Microsoft Excel format) of contractor picks for each sensor type, including reacquisition; and
6) Spreadsheet (Microsoft Excel format) of all control points, survey points and benchmarks established or used during the Location Surveying task.

16.0 HEALTH AND SAFETY PLAN

16.1.1 ATI will perform the GPO work in accordance with the Health and Safety Plan presented in Appendix GPO-A.

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17.0 INTRODUCTION

American Technologies, Incorporated (ATI) performed a geophysical prove-out (GPO) survey at the former Five Points Outlying Field, Arlington, Texas. The survey was performed on November 17, 2003 through November 22, 2003. The GPO was performed to support a Conventional Ordnance and Explosive (OE) Geophysical Survey at the site. The results of the GPO will be used in determining portions of the Geophysical Work Plan and the subsequent geophysical field investigation(s).

17.1 Site Location

The Former Five Points Outlying Field (Five Points OLF) is a 162.06 acre site located at the corner of Harris Road and Matlock Road, Arlington, Texas.

17.2 Site History

The property was purchased by the U.S. Government in 1940 and used by the Dallas Naval Air Station (NAS) first as a practice landing field, then as a practice bombing range. Improvements constructed at the site included a practice landing field, a target bulls-eye consisting of two concentric rings, and a boundary fence. The Navy declared all 162.06 acres of the Five Point OLF site excess and transferred the property to the GSA for disposal. The GSA conveyed the site to Gordon and Pope Supply Company on July 19, 1956. On September 1, 1983, construction of the Twin Parks Estates mobile home park commenced on a thirty-five acre portion of the former Five Points OLF. On November 16, 1983, construction was halted due to the finding of a subsurface bomb by a city inspection (Twin Peak Estates 1984). The Jet Research Center removed approximately three thousand bombs from the thirty-five acres. Ordnance was found as deep as six feet, which may indicate that ordnance found during previous sweeps was buried in place. The 47th Ordnance Detachment at Fort Hood took possession of the ordnance recovered by Jet Research Center for proper disposal (INPR, 1996).

17.3 Site Geology

The site is located in the Osage Plains section of the Central Lowland province. Younger limestone bedrock units are exposed in sequence toward the east. Alluvium and terrace deposits overlap the bedrock along streams and rivers.

18.0 OBJECTIVE

18.1 Geophysical Prove Out

18.1.1 The specific Data Quality Objectives (DQO's) for the GPO were:

- To demonstrate that the geophysical investigation system/equipment are operating properly.
- To provide a set of isolated objects (e.g., single inert target items or target surrogates) in a grid for equipment testing. The sensor signatures from these items will be used to determine the equipment limitations in this geologic setting.
- To assess the operators performance and update related procedures and to assist in the development of operator measurement techniques.
- To establish a baseline of performance capabilities for the selected instruments.
- To establish decision parameters for target selection by the site geophysicists.
- To evaluate navigational/position systems for electronic positional accuracy.
- To determine the average speed and minimum line separation distance that would be required to detect all target items.
- To determine the instrument latency correction so that the appropriate correction routine accounting for instrument latency time and sensor velocity is used. Corrections must be specific for all segments of data with equal sensor velocities. No zigzag or chevron effects should be visible in the data maps when plotted at the scales used to detect the smallest amplitude signal for any given UXO item expected at this site.
- To produce final datasets to be evaluated, on a dataset by dataset basis, for confirmation that the processing routines do not significantly alter the original measured peak responses (above background) over anomalies. For producing final datasets, processing routines shall not alter the peak responses of anomalies by more than 10%. This limit will be evaluated on the GPO datasets.
- To ensure that the geophysical systems to perform adequately in areas where trailers and single-family homes are present, along with "open" areas ("Open" areas are defined as those which interferences to the geophysical systems are minimal).
- To determine the "effects" of cultural objects in the urbanized areas upon the recognition of anomalies and application of geophysical instruments.

19.0 SITE-SPECIFIC GEOPHYSICAL PROVE-OUT

19.1 Prove-Out Grid Location

The geophysical prove-out was conducted at three test plots constructed by ATI. The general location of the test plots are presented in Figure 1.

3.2 Grid Construction

ATI constructed 3 prove-out grids. For all three grids, the grid corners and seed item locations were surveyed by Professional Land Surveyors. Grid 1 was located between two houses in the urbanized area of K.B. Homes Development and measured approximately 15 meters on the northern side, 10 meters on the southern side and 6 meters on the east and west sides. The grid was not a perfect rectangle because of proximity to houses. Because of the irregular grid shape, not all grid corners are presented on the figures. The grid was seeded with 5 simulated UXO items and 1 clutter item (Figure 2). The depth, target type, and configuration of the seeded items are summarized in Table 1 and Appendix C.

Background data on Grid 1 was collected with the EM-61 MK2 in fiducial mode prior to seeding the grid. After seeding the items, the survey was conducted in fiducial and RTS mode with both the EM-61 MK2 and with the TM-5 EMU. Surveys were performed in both 0.8 and 1.0 meter line spacing for the EM-61 MK2 and 1.0 meters for the TM-5 EMU.

Grid 2 was located in the urbanized area of Twin Parks Estates Mobile Home Park. This grid was a parallelogram with dimensions of approximately 6 by 16 meters. A mobile home defined one side of Grid 2. Background data was surveyed in GPS and in fiducial modes with the EM-61 MK2. The grid was then seeded with 5 simulated UXO items and 1 clutter item (Figure 3). The depth, target type and

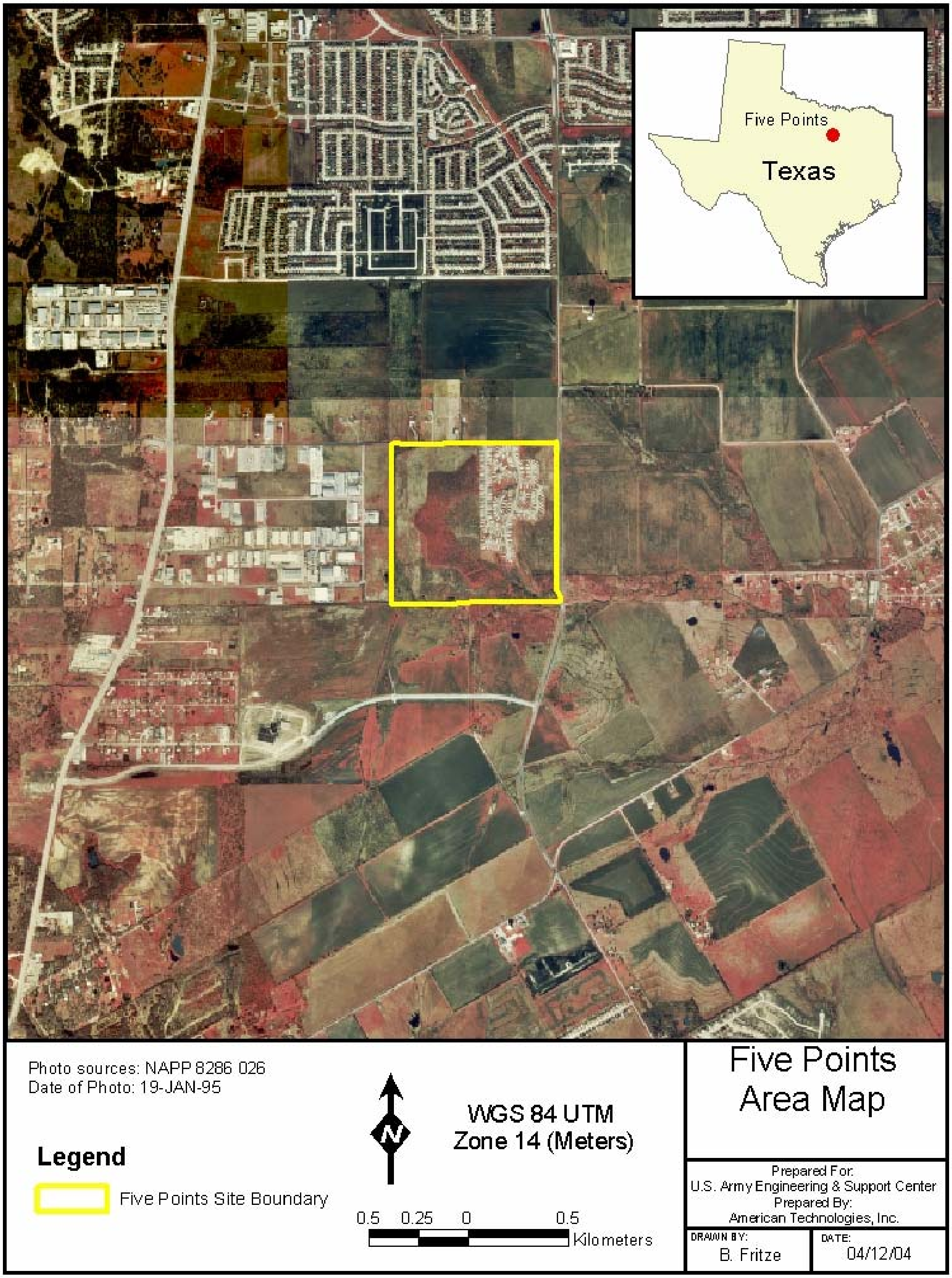

Figure 1 – Location Map

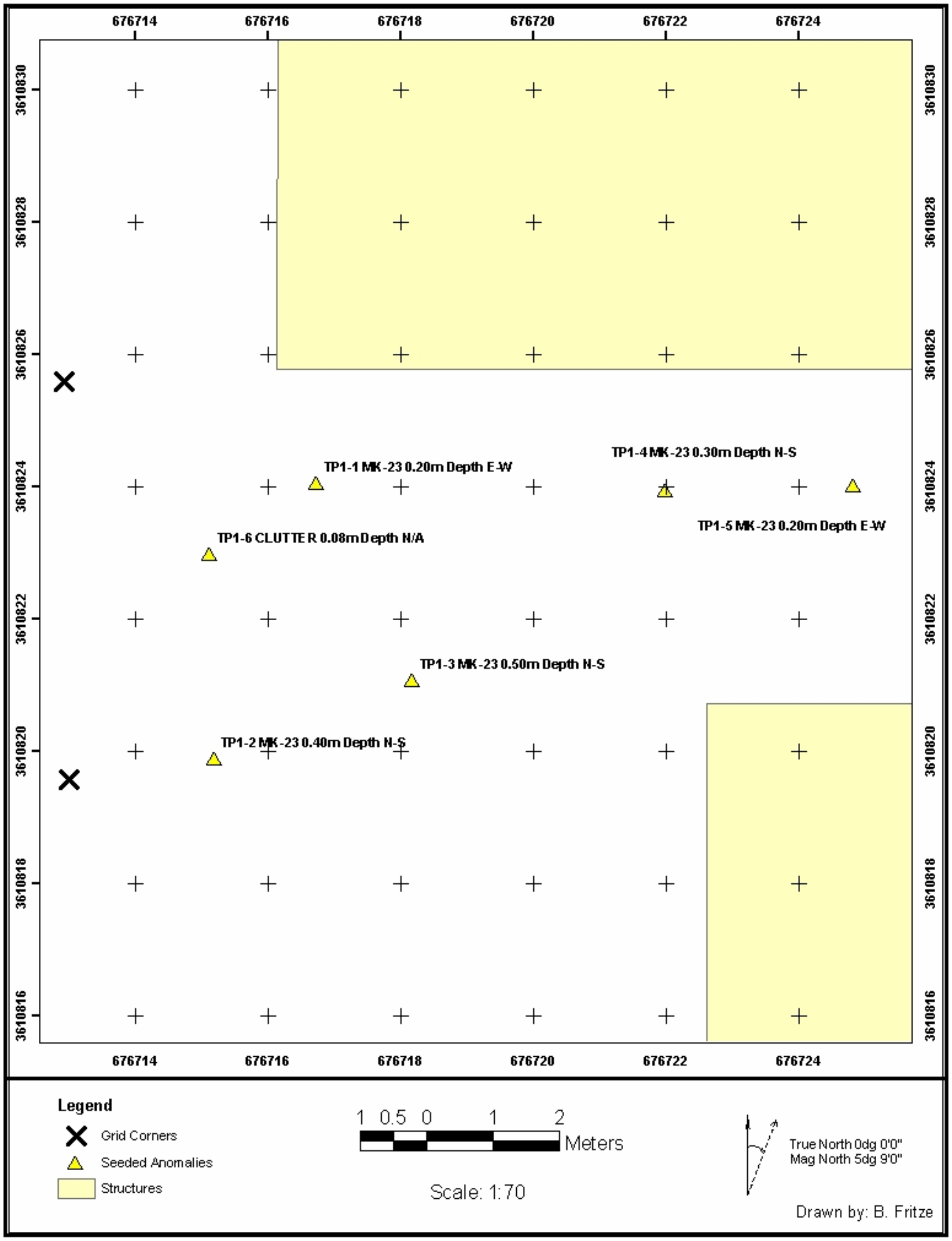

Figure 2 – Grid #1 – K.B Homes Development

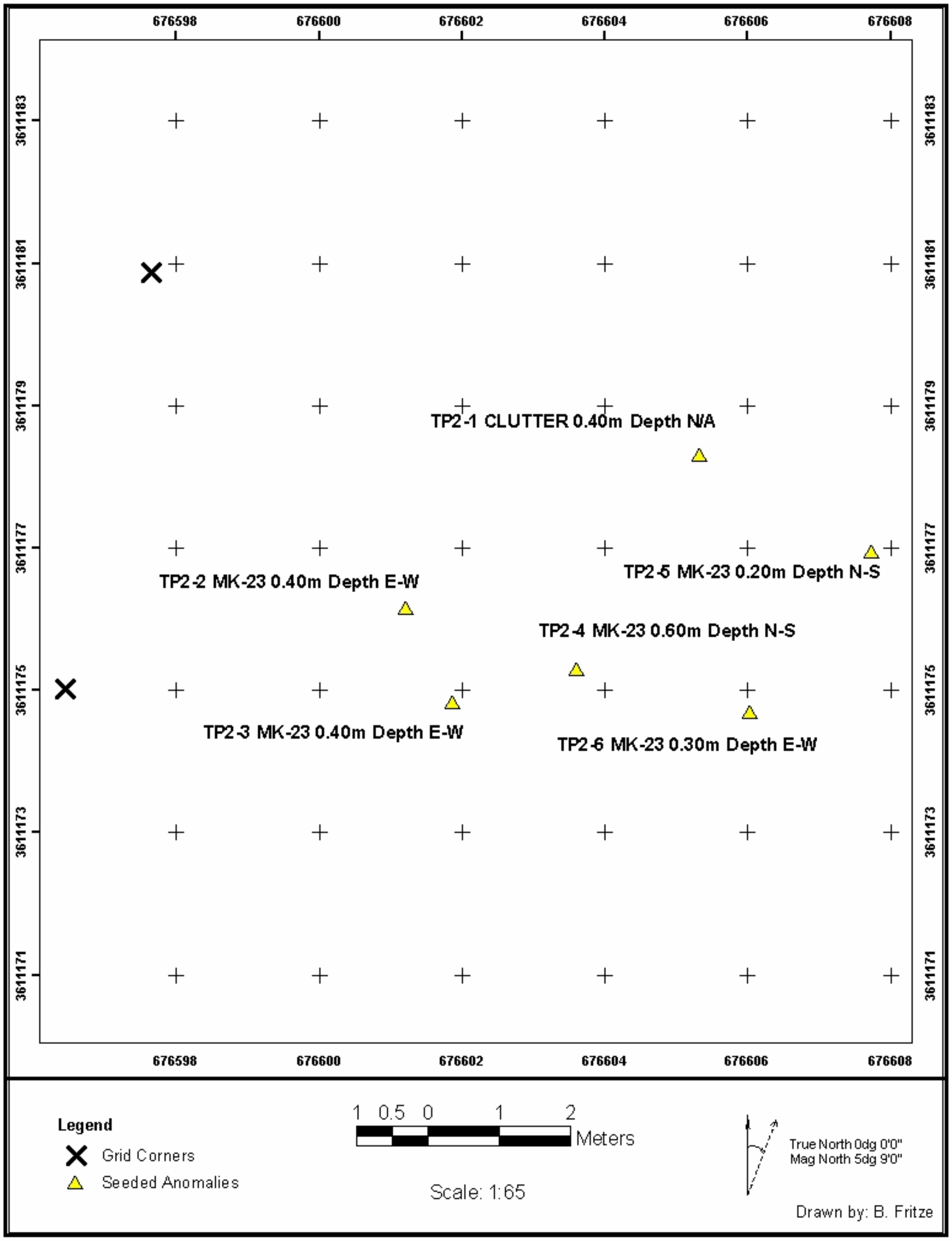

Figure 3 –Grid #2 – Twin Parks Estates Trailer Park

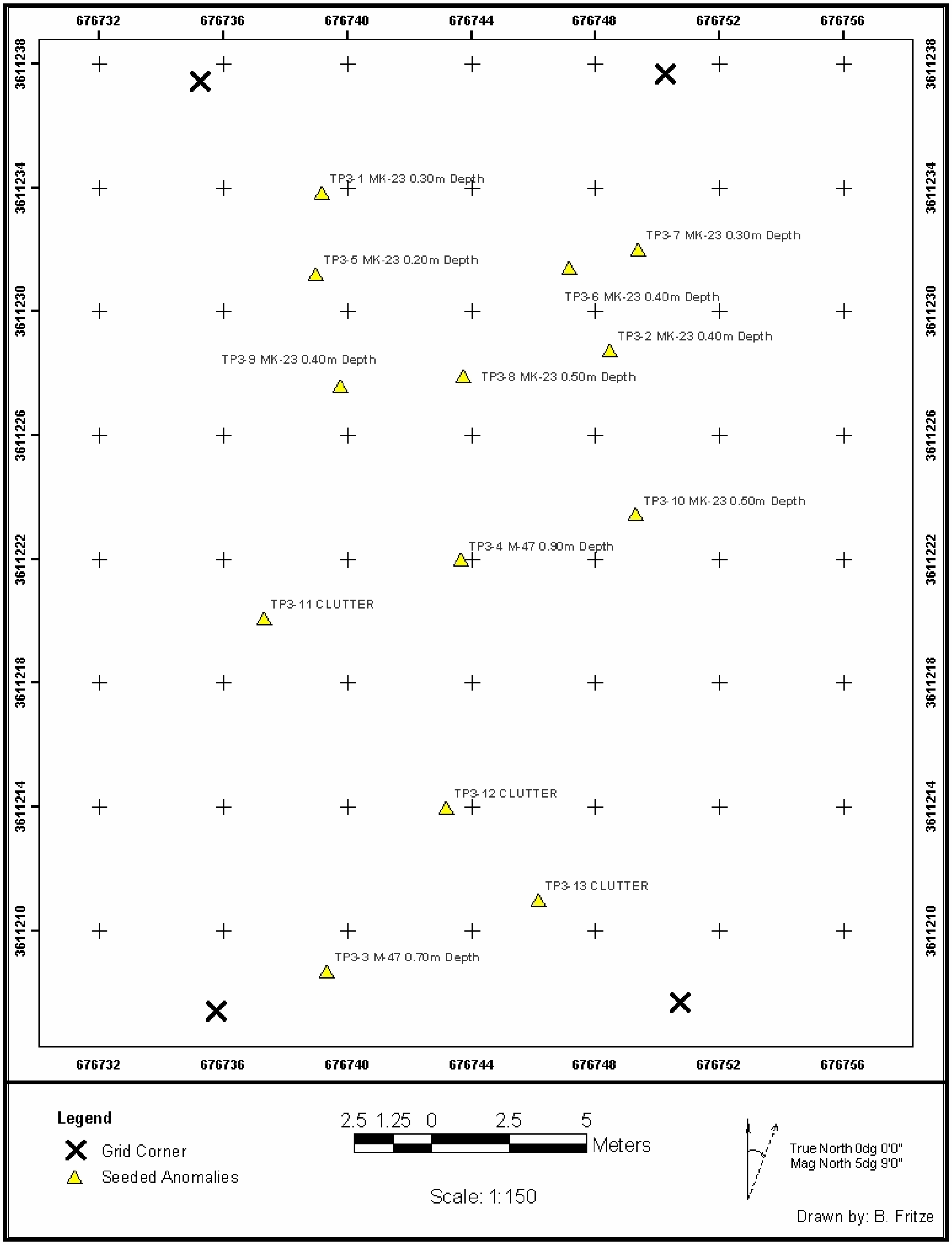

Figure 4 –Grid #3 – Open Area

configuration of the seeded items are summarized in Table 2 and Appendix C. After seeding the items, surveys were conducted in GPS and RTS modes with both the EM-61 MK2 and the TM-5 EMU. Surveys were performed in both 0.8 and 1.0 meter line spacing for the EM-61 MK2 and 1.0 meters for the TM-5 EMU.

Grid 3 was located in open area and measured 15 by 30 meters. The background was surveyed in fiducial and in GPS mode with the EM-61 MK2. The grid was seeded with 10 simulated UXO items and 3 clutter items (Figure 4). The depth and type of the seeded items are summarized in Table 3 and Appendix C. After seeding the items, the survey was conducted in GPS mode with the EM-61 MK2 and the TM-5 EMU. All surveys were performed in both 0.8 and 1.0 meter line spacing for the EM-61 MK2 and 1.0 meters for the TM-5 EMU.

The grids were seeded with surrogate items to simulate the responses of a M47, a M38, and Mark 23s. For the M47 and the M38, flue pipe made of sheet metal was cut the length of each item. For the Mark 23 simulated items, metal fence posts were cut to the appropriate length and a second, smaller diameter pipe was inserted. These items are presented in Tables 1, 2, and 3.

Clutter items were scattered throughout the grids. These included soda pop cans, wire and assorted ferrous and non-ferrous items. The locations of these items were noted for later comparison to the geophysical results. These locations are presented in Figures 2, 3, and 4 for Grids 1, 2, and 3.

20.0 GEOPHYSICAL AND POSITIONING SURVEY EQUIPMENT

The ATI team evaluated two different types of sensors for the completion of the test plots. These sensors include the following: the Geonics Mark 2 EM-61 (EM-61 MK2) and the G-Tek TM-5 EMU.

20.1 EM-61MK2

The EM-61 MK2 is a Time Domain Electromagnetic (TDEM) system (Figure 5). The EM-61 MK2 generates 150 electromagnetic (EM) pulses per second and measures during the off time between pulses. After each pulse, secondary EM fields are induced briefly in moderately conductive soils and for a longer time in metallic objects. Between each pulse, the EM-61 MK2 waits until the response from the conductive earth dissipates and then measures the prolonged buried metal response. This response is recorded in millivolts (mV). By sensing only the buried metal response, the EM-61 MK2 detects metallic targets that might otherwise be missed.

Figure 5 - EM-61 MK2

Table 1

Planned Seed Items
Grid #1 – K.B. Homes Development

ID Number	Easting	Northing	Target Type	Depth (meters)	Azimuth
TP1-1	676716.35	3610824.26	MK-23	0.20	E-W
TP1-2	676714.80	3610820.09	MK-23	0.40	N-S
TP1-3	676717.79	3610821.28	MK-23	0.50	N-S
TP1-4	676721.60	3610824.15	MK-23	0.30	N-S
TP1-5	676724.44	3610824.23	MK-23	0.20	E-W
TP1-6	676714.73	3610823.19	Clutter	0.08	N/A

Table 2
Planned Seed Items
Grid #2 – Twin Estates Trailer Park

ID Number	Easting	Northing	Target Type	Depth (meters)	Azimuth
TP2-1	676605.63	3611178.41	Clutter	0.40	N/A
TP2-2	676601.52	3611176.27	MK-23	0.40	E-W
TP2-3	676602.18	3611174.95	MK-23	0.40	E-W
TP2-4	676603.91	3611175.41	MK-23	0.60	N-S
TP2-5	676608.05	3611177.06	MK-23	0.20	N-S
TP2-6	676606.34	3611174.81	MK-23	0.30	E-W

Table 3
Planned Seed Items
Grid #3 – Open Area

ID Number	Easting	Northing	Target Type	Depth (meters)
TP3-1	676739.24	3611233.64	MK-23	0.30
TP3-2	676748.56	3611228.57	MK-23	0.40
TP3-3	676739.43	3611208.51	M-47	0.70
TP3-4	676743.76	3611221.79	M-38	0.90
TP3-5	676739.07	3611231.02	MK-23	0.20
TP3-6	676747.23	3611231.20	MK-23	0.40
TP3-7	676749.46	3611231.83	MK-23	0.30
TP3-8	676743.82	3611227.71	MK-23	0.50
TP3-9	676739.86	3611227.41	MK-23	0.40
TP3-10	676749.38	3611223.27	MK-23	0.50
TP3-11	676737.40	3611219.92	Clutter	0.08
TP3-12	676743.28	3611213.80	Clutter	0.04
TP3-13	676746.25	3611210.82	Clutter	---

The EM-61 MK2 measures multiple time gates (216, 366, 660, and 1266 µs) to provide a complete measurement of the response decay rate. The MK2 can record up to 12 records per second for four (4) time gates per record. For data collection, 3 time gates and the top coil were recorded to ensure good data quality. The EM-61 MK2 was integrated with an Ashtec Z-Xtreme Differential Global Positioning System (DGPS) system and the Robotic Total Station (RTS). These are discussed in Section 4.3.

20.2 TM-5 EMU

The TM-5 EMU electromagnetic detector system (Figure 6) was configured with one and two sensors measuring the transient electromagnetic response. In dual-sensor mode, two sensors were mounted in an array oriented perpendicular to the survey direction delivering a 1.0m wide swath. In both single and dual-sensor mode the TM-5 EMU was operated by a single person.

Each sensor is a monocoil acting as both transmitter and receiver, operated as a vertical magnetic dipole, with 16 turns, a diameter of 18 inches, inductance of 300µH and resistance of 0.7Ω. During surveying, the sensor coil height was maintained at an elevation of 150mm, with the minimum HERO safe operating height calculated to be 10 cm above ground.

The transmitted waveform consisted of two different length pulses (200µs, 3.3A and 50µs, 830mA), repeated at the rate of approximately 1200Hz. The peak pulse amplitudes were based on an applied voltage of 5V, and at turn-off, the pulses ramp to zero in about

2-4μs (corresponding to the self-induced emf clipped to 187V). The theoretical bandwidth of about 500kHz reduces to about 300kHz after the addition of amplifiers and integrators. The detector is based on synchronous demodulation, sampling the secondary field decays over narrow integration gates. After subtracting the ground response and digitizing at approximately 60Hz, the output is decimated to 32 samples per second that are recorded with a DGPS position at a 2Hz rate. Amplifier gains are adjusted to provide digital output between ±4096 units such that background noise is set to ± 1-2 units. A low pass filter is applied at periodic intervals to reset the background signal to a zero mean. During a traverse this filter is switched out so that the filter does not attenuate target responses, and the drift is removed from the digital record in post-processing with a high-pass filter.

Figure 6 – TM-5 EMU

The TM-5 EMU was integrated with an Ashtech Z-XTreme RTK Differential Global Positioning System (DGPS) system and the Robotic Total Station (RTS). These are discussed in Section 4.3.

20.3 Positioning Instruments

ATI utilized an Ashtech Z-Xtreme RTK DGPS System and the Robotic Total Station (RTS) to integrate location data with the sensors tested. The RTK-DGPS system employed had centimeter accuracy and was utilized with real time base station set up on a near by survey monument.

DGPS data were collected in UTM (Zone 14N) – meters at a rate of once per second. During the data positioning check, the RTS was accurate to within +/- 5 cm.

21.0 GEOPHYSICAL SURVEY PROCEDURES

The following subsections describe the procedures used.

21.1 Pre-Survey Tests

ATI performed the Pre-Survey Standardization Tests as discussed in the GPO Plan. These QC tests for the EM-61 MK2 and the TM-5 EMU were within the acceptable criteria. Plots of the Standardization Tests are presented in Appendix D.

21.2 Seeded Test Plot Tests

21.2.1 EM-61 MK2 Survey

The EM-61 MK2 was integrated with the Ashtech RTK DGPS and the RTS in order that data points could be tagged with positions as they were collected. The survey was performed using lanes of 0.8 and 1 meter. Data were collected at 9 times per second (three bottom and the top coil time gates per second). The instrument was operated by pulling it behind the operator with the positioning antenna mounted above the center of the 1-meter x 0. 5 meter coil.

21.2.2 TM-5 EMU Survey

The TM-5 EMU survey was performed using lane spacing of 1 meter. Data were collected at 30 times per second. The instrument was operated with the positioning antenna mounted above the center of the dual sensors.

22.0 DATA DOWNLOADING AND PROCESSING

The following subsections summarize the data downloading and post-processing methods for the EM-61 MK2 and TM-5 EMU data.

22.1 Data Post-Processing

Data from the survey instruments were downloaded to an on-site laptop computer. The combined positioning/sensor data were then output to an ASCII delimited file format. Corrections for leveling, drift and instrument latency were also applied to data sets.

After post-processing and data checking were complete, geophysical data from the surveys were imported into GEOSOFT Oasis Montaj/UX Detect processing package. The data was then gridded, contoured, and analyzed for target selections.

Table 4. Pre-Survey Test Results

Test	EM-61 MKII	TM-5 EMU
Personnel Test	Slight affect to instrument response due to the position of EM 61 backpack electronics	No significant instrument response caused by personnel
Record Relative Sensor Position	GPS antenna orientation relative to sensor was directly above and centered	GPS antenna orientation relative to sensors was centered laterally for the two

		sensors
Vibration Test	No instrument response due to cable or instrument vibration	No instrument response due to cable or instrument vibration
Standard Static Test	Top Channel oscillating noise, Channels 1,2,3 stable	Sensors 1 & 2 stable
Spike Static Test	Top Channel oscillating noise, Channels 1,2,3 stable	Sensors 1 & 2 stable
Six Line Test	0.25 second latency	0.25 second latency
Repeat Data Test	Two lines of the test grid were re-surveyed and displayed repeatability as compared to those same numbered lines of full grid survey	Two lines of the test grid were re-surveyed and displayed repeatability as compared to those same numbered lines of full grid survey
Azimuthal Test	NA	NA
Height Optimization	Manufacturer suggests bottom coil 16 inches from the ground displays the best detection capability	Sensors close but not contacting ground displays the best detection capability, therefore, height should be 15 cm above ground.
Octant Test	NA	NA
TM-5 EMU Calibration	NA	Successful calibration performed during data collection initiation so as to eliminate geological affects on instrument detection readings
Data Position Check	Data positioning was accurate to +/- 5cm	Data positioning was accurate to +/- 5cm

The following is a generalized flow of the data and analysis:

- Data downloaded to in-field personal computer (PC).

- Data converted to GEOSOFT xyz format.
- The x, y location (taken originally in longitude and latitude by DGPS) was converted to UTM coordinates.
- Latency correction was performed based on instrument latency determined from transect lines of the six-line test. ATI used the UCELATENCY.GX of GEOSOFT to perform these latency corrections.
- Data was reviewed in GEOSOFT, where the grids of the surveyed areas were plotted to ensure maximum area coverage.
- The leveled data from the bottom coil (Channel 3) was gridded using minimum curvature with blanking distance of 0.8 or 1.0 meters and grid cell size 0.8 to 1. Channel 3 was used for selecting anomalies. The earlier and later time gate channel and the top channel may be evaluated in the case of anomalies that were indeterminate in Channel 3. Channel 1 or 2, when plotted, typically show noise and exaggerated anomalies that may be hard to distinguish between interference and true targets. Combining the channels for analysis typically introduces more noise and the resulting data is not leveled properly, so Channel 3 is typically used for anomaly profile selection.
- A shaded relief map was produced of the gridded data (Appendix A).
- Targets were initially selected using the Blakeley Method with cut off fiducial 5mV, then each target was carefully re-examined by analyzing the decay curve of the profile in leveled Channel 3, then comparing the signal ratio of the leveled Channel 1 and Channel 2 data to the leveled Channel 3. A threshold of 5mV was used for anomaly identification.
- After the completion of anomaly selection, the known (seeded) targets were re-projected on the produced grid map. These seeded items were surveyed in by a Texas State Licensed Surveyor. Using the locations of the seeded items, the polar distance to the known targets and the azimuth from the North to these items were calculated.
- Additional targets were selected based on the background survey results. The criteria for selecting these additional anomalies were -- if it did not appear in the background survey and the selected anomaly complied with the signature of the known/seeded items then the anomaly was added to the target selection list.
- The final target selection was exported in a GEOSOFT .xyz file format as well as a .csv file. The .csv file was imported into a GPS and a RTS to reacquire the selected targets with the initial surveying instrument. Each selected anomaly had a unique ID, which was site specific.

The TM-5 EMU data processing, which was performed by G-tek using their software and Oasis Montaj, was different in a few aspects from the processing for the EM-61 MK2. G-tek provided the following comments regarding their data interpretation and anomaly selection:

- Different amplitude thresholds and half-widths were employed for anomaly selection for the T1, T2, and T3 grids. For T1 and T2, the amplitude thresholds were 150 emu units and 130 emu units, respectively. Both employed peak half-widths of 0.3 meters. For T3, a positive and a negative amplitude threshold were selected. These were +140 and –500 emu units, respectively.

- For grid T3, both negative and positive anomalies were considered because the line data was integrated in the processing of this grid. This ‘unusual’ processing was required as a result of an equipment breakdown that stopped a hardware filter being switched off during surveying, as would normally occur. The hardware filter attempts to maintain a zero-mean response at all times, so acts to filter out all anomalous responses. The walking speed maintained during the 5 Points survey was such that the filter was unable to act quickly enough to fully filter out the responses from the seeded items and clutter. The integration process helped to restore the anomalies to a shape approximating that which they would have had if the filter had been switched off.

- An analysis of the GPO results and the background geological response supports the following recommendation for interpretation of TM-5 EMU data in the work to follow the GPO. Please note that this recommendation will be subjected to a review once more experience is gained in the project.
- Primary selection of anomalies should be based on an amplitude threshold on channel H > 130 emu units and a width-at-half-height > 0.3 m.

These comments are taken from the document provided by G-tek (let_USAI_Talmage_031128a_dg.doc) which is presented in the data CD for this report.

23.0 SITE SPECIFIC GEOPHYSICAL PROVE-OUT

23.1 Prove-out Results

This section describes the results of the prove-out surveys and interpretation of the data.

23.2 Instrument Surveys over the Seeded Test Grid

After the test grid seed items were buried, surveys were performed over the test plot grid with the EM-61 MK2 and the TM-5 EMU. Figures presenting the survey results are presented in Appendix A for both the EM-61 MK2 and the TM-5 EMU. The data files and figures are contained in the Data CD.

23.3 Quality Control

ATI performed the Quality Control (QC) Standardization Tests as discussed in the GPO Plan and presented in figure form in Appendix D, while the data and figures are both presented in the Data CD.

23.4 Discussion of Prove-out Results

23.4.1 Grid 1 - K.B. Homes Development

Due to the housing units on this test site, no GPS signal was attainable; therefore, the surveys were conducted in fiducial mode and using RTS with both the EM-61 MK2 and the TM-5 EMU. Due to high interference from the surrounding houses, anomaly discrimination was difficult. Because housing signals could potentially mask actual UXO signals, the housing signals were identified as anomalies. There were six seeded items buried on this test plot by ATI.

For the EM-61 MK2, targets were initially picked using GEOSOFT's Blakely method with cut off fiducial 5 mV in Channel 3. Once the picks were made, each individual anomaly has been re-examined using the profiles of the leveled bottom channel (Channel 3), the early time channel (Channel 1) and then Channel 2. The purpose of looking at these profiles were to compare the decay rate of these curves as well as the ratio between the signal amplitudes of the selected potential anomalies. G-Tek personnel processed and made the final target selections on the TM-5 EMU data.

7.4.1 GRID 1: FIDUCIAL DATA INTEGRATED WITH THE EM-61 MK2

Five out of six targets were selected from the 0.8 meter data set and four out of six for the 1.0 meter line spacing data sets using the EM-61 MK2. The single undetected target (TP1-3, a simulated MK 23 buried at 0.5 meters in a north-south orientation) fell between two survey lines in both data sets. TP1-6, a clutter item buried at 0.08 meters, was not detected by the EM-61 MK2 at 1.0 meter spacing. It should be noted that a target was selected just over 1 meter from the single missed target in the 0.8 meter data set. To help prevent missing targets and to enhance data accuracy, 0.8 meter line spacing should be implemented in future surveying of areas similar to the test plots.

In the 0.8 m data asset, an additional 10 anomalies were selected. All of these anomalies appear to be associated with cultural interferences, as evidenced by the broad anomalies present in the background plot (Figure 2, Appendix A), which are also present in the seeded plot (Figure 3, Appendix A).

In the 1.0 meter data set, 22 targets were selected in addition to the four selected targets. Based on a comparison of the background and seeded plots (Figures 1 and 4, respectively in Appendix A), most of these anomalies may be attributed to cultural interferences. Anomalies 10, 15, 6, and 12 may potentially be blind items.

It is noted that these additional targets in both data sets may also be blind items, or may mask blind items. At least one or two MK-23 and/or clutter items were buried within the test plot and their locations and depths remain unknown to ATI.

7.4.2 GRID 1: RTS DATA INTEGRATED WITH THE EM-61 MK2

Five out of six seed items were selected from the EM-61 MK2 data collected in RTS mode at both 0.8 and 1.0 meter spacing (Figures 5 and 6, Appendix A). TP1-3, which is an MK-23 buried at 0.5 meters and oriented N-S was not selected from the 0.8 meter data set, whereas, for the 1.0 meter data set, the clutter item (TP1-6) was not selected.

For the 0.8 meter data set, 12 anomalies in addition to the seed items were selected. Most of these may be attributable to cultural interference, however, items 10, 14, and 15 may instead be blind items. For the 1.0 meter data set, ten additional anomalies were identified. Like the 0.8 meter data set, most of these may be attributed to housing or cultural influences. It is noted that these 'cultural interference' targets in both data sets may also be blind items, or may mask blind items.

7.4.3 GRID 1: FIDUCIAL DATA INTEGRATED WITH THE TM5 EMU

Fiducial data collected with the TM-5 EMU resulted in the selection of all of the six known buried items, as well as an addition 30 selections (Figure 22, Appendix A). These remaining 24 anomalies may be attributable to blind items or cultural interferences.

7.4.4 GRID 1: RTS DATA INTEGRATED WITH THE TM-5 EMU

G-tek identified 32 anomalies in Grid 1 using the TM-5 EMU and RTS (Figure 21, Appendix A). Five of the six seeded items were identified within 1 meter of the seeded item. Seeded item TP1-3, which was a simulated MK 23 buried at a depth of 0.5 meters and in a north-south orientation, was not identified. The remaining 27 anomalies may be attributed to either blind items or false positive, some of which may be attributable to cultural interferences.

23.4.2 Grid 2 – Twin Estates Trailer Park

Both GPS and RTS units were utilized to compare accuracy of the positioning systems with the EM-61 MK2 and the TM-5 EMU. There were six seeded items buried on this grid, five simulated MK-23s and one clutter item, all buried at different depths and orientations by ATI.

Target selections were made on data sets with the EM-61 MK2 in conjunction with the GPS and the EM-61 MK2 with the RTS. Similarly to the previous grid, targets were initially picked using GEOSOFT's Blakely method with cut off fiducial 5 mV in Channel 3. Once the picks were made, each individual anomaly has been re-examined using the profiles of the leveled bottom channel (Channel 3), the early time channel (Channel 1) and then Channel 2. The purpose of looking at these profiles were to compare the decay rate of these curves as well as the ratio between the signal amplitudes of the selected potential anomalies.

Similarly to the aforementioned test grid, the mobile home and the utility lines on the property caused some significant data interference. Therefore, the anomaly selection process and locating anomaly peaks were difficult.

7.4.5 GRID 2: GPS DATA INTEGRATED WITH THE EM-61 MK2

Only five out of six of the seeded anomalies were detected for both the 1.0 and 0.8 m spacing (Figures 11 and 12, Appendix A). These five targets were within the acceptable polar distance from the buried items of less then 1 meter. The sixth seeded target (TP2-2, an MK 23 buried at 0.4m, oriented E-W) did not show in the 0.8 meter line spacing nor in the 1 meter line spacing because the anomaly amplitude was equivalent to the background.

For the 0.8 and 1.0 meter data sets respectively, thirteen and twelve anomalies that were not known seeded items were identified. These anomalies may correlate to cultural influences or to seed items buried at locations and depths within the test plot that were unknown to ATI (1 or 2 MK-23s and/or clutter). Anomalies selected on the east and west edges of the test plot are attributed to housing interferences.

For the 0.8 meter spacing data set, 7 anomalies could be attributed to cultural influences (anomalies 1, 6, 8, 10, 11, 13, and 19), leaving 6 potential blind items. Of these 6 items, two anomalies (# 2 and 14) are in areas that are somewhat noisy in the background plots (Figures 9 and 11, Appendix A) and therefore may potentially be cultural artifacts.

For the 1.0 meter data set, 8 selections overlap with cultural interferences, leaving four potential 'blind' items (anomalies 3, 7, 13, and 14). Of these, items 3, 13, and 14 correspond to areas that were somewhat noisy in the background plot and therefore may potentially be cultural artifacts (Figures 10 and 12, Appendix A).

It is noted that cultural anomalies were selected because they may mask smaller anomalies such as blind items in the GPO, or UXO items in the upcoming Geophysical Investigation, due to their large signals.

7.4.6 GRID 2: RTS DATA INTEGRATED WITH THE EM-61 MK2

As with the GPS data set, five out of six targets were detected within 1 meter of the buried targets for both the 1.0 meter and 0.8 meter spacing EM-61 MK2/RTS data sets (Figures 13 and 14, Appendix A). The sixth seeded target (TP2-2, an MK23 buried at 0.4m, oriented E-W) was not selected in either RTS data set because the anomaly amplitude was equivalent to the background.

For the 0.8 and 1.0 meter data sets respectively, twenty-one and thirteen anomalies were identified that were not known seeded items. These may correlate to cultural influences or to blind items buried at locations and depths within the test plot that were unknown to ATI (1 or 2 MK-23s and/or clutter).

As with the GPS data sets, anomalies selected on the east and west edges of the test plot are more likely attributed to housing interferences. For the 0.8 meter spacing data set, 13 anomalies (anomalies 2, 3, 8, 9, 12, 13, 14, 18, 21, 23, 24, and 26) could be attributed to cultural influences, leaving 9 potential blind items. Of these 9 items, five anomalies (4, 22, 19, 20, and 10) are in areas that are somewhat noisy in the background plot and may potentially be cultural artifacts.

For the 1.0 meter data set, 8 selections (anomalies 1, 2, 6, 7, 8, 10, 11, and 15) could be attributed to cultural interferences, leaving 5 potential 'blind' items. Of these 5 items, three anomalies (3,16, and 18) are in areas that are somewhat noisy in the background plot and may potentially be cultural artifacts.

It is noted that cultural anomalies were selected because they may mask smaller anomalies such as blind items in the GPO, or UXO items in the upcoming Geophysical Investigation, due to their large signals.

7.4.7 GRID 2: RTS DATA INTEGRATED WITH THE TM-5 EMU

G-Tek has performed surveys as well with the GPS unit and the TM-5 EMU and RTS with the TM-5 EMU. Processing and anomaly selection of the TM-5 EMU data has been performed by a G-Tek personal. G-Tek selected 24 instrument responses consistent with OE targets from the TM-5 EMU data (Figures 23 and 24, Appendix A). All seeded items were identified and the additional 18 targets may be attributable to either blind items or to cultural interferences.

23.4.3 Grid 3 – Open Area

This area has been surveyed using GPS with two kinds of geophysical instruments: the EM-61 MK2 and the TM-5 EMU. ATI buried 13 seeded items, out of which 10 items were simulated UXO items and 3 were clutter.

Similarly to the aforementioned two test grids, initial target selection for the EM-61 MK2 data was done by using the Blakely Method with cut off fiducial of 5 mV in Channel 3. Once the picks were made, each individual anomaly has been re-examined using the profiles of the leveled bottom channel (Channel 3), the early time channel (Channel 1) and then Channel 2. The purpose of looking at these profiles were to compare the decay rate of these curves as well as the ratio between the signal amplitudes of the selected potential anomalies.

7.4.8 GRID 3: GPS DATA INTEGRATED WITH THE EM-61 MK2

For both the 0.8 and 1.0 meter line spacing EM-61 MK2/GPS data sets, all of the 10 seeded simulated UXO targets were identified and selected as geophysical anomalies. In both cases, the 3 items corresponding with the clutter were not selected since the items signature had similar characteristics to the background values. The background and seeded plots are presented in Appendix A.

A total of 11 anomalies for the 0.8 meter data set and also 11 anomalies for the 1.0 meter data set were identified that were not known seeded items. These may correlate to cultural influences or to seed items buried at locations and depths within the test plot that were unknown to ATI (1 or 2 MK-23s and/or clutter).

A comparison of the background and seeded plots (Figures 17 and 19 in Appendix A) revealed that 10 of the 11 anomalies in the 0.8 meter data set (anomalies 3, 4, 5, 7, 9, 11, 12, 14, 18, and 21) occur near or on areas that were noisy in the background plot. Anomaly 22 did not overlap with anything on the background plot. For the 1.0 meter data set, anomalies 11 and 22 did not overlap with noisier areas of the background plot (Figures 18 and 20 of Appendix A).

7.4.9 GRID 3: GPS DATA INTEGRATED WITH THE TM-5 EMU

Processing and target selection of the TM-5 EMU and GPS system at test grid 3 has been completed by G-Tek personnel. With the TM-5 EMU, forty-six (46) instrument responses were selected that were consistent with OE targets.

Out of the 10 seeded simulated UXO targets, 7 simulated UXO items and all three clutter items were identified as anomalies. Simulated UXO items TP3-1, -8, and –10 were not identified within 1 meter of the seeded item location, although an anomaly was identified just over 1 meter from TP3-10. These three items were all MK 23s buried no deeper than 0.5 meters.

24.0 PROVE-OUT CONCLUSIONS

24.1 Instrument Selection

Open Areas

After reviewing the data from the prove-out surveys, it was determined that the EM-61 MK2 will be effective for open areas, such as those found in test grid 3, because it produced far less false positives than the TM-5 EMU. A line spacing of 0.8 meters is recommended for EM-61 MK2 data collection for sufficient resolution and to help discriminate between UXO items and cultural interferences.

Housing Areas

In close proximity to houses, such as in Test Grid 1, the EM-61 MK2 performed better than the TM-5 EMU and is the recommended instrumentation. Fewer false positives were selected with the EM-61 MK2 than with the TM-5 EMU in all grids, although both instruments recorded false positives. However, because even with the EM-61 MK2, some housing anomalies were sufficiently large to potentially mask UXO anomalies, in these areas, a different approach to anomaly identification should be adopted.

Cultural interferences due to the proximity of housing and housing related items to the test plots may potentially mask UXO signatures. The affected areas may be large in some cases, yet the potential for UXO in these areas cannot be ignored. To reduce the probability of missed anomalies during the Geophysical Investigation, the areas where the EM-61 MK2 and TM-5 EMU are ineffective will require a different approach to ensure that UXO can be removed from them. Alternative approaches are discussed below.

Positioning Systems

The TM-5 EMU did not merge well with the Robotic Total Station, therefore positioning was not as accurate as it was using a GPS unit. Hence, using the TM-5 EMU in conjunction with RTS in areas like test grid 1 where there is no GPS signal due to interference from the nearby housings the TM-5 EMU with the RTS is not an effective way of surveying; further experimentation to enhance the merging of the TM-5 EMU with the RTS is required.

The Ashtech Z-Xtreme DGPS and the Leica Robotic Total Station worked well in open areas; however there were no GPS signal attainable between housing units, therefore the Robotic Total Station became more efficient to use. The accuracy of the RTS data is within the acceptable level of +/- 5 cm. However, it is noted that the RTS system, when used in close proximity to the base station, has difficulty in positional tracking. This is attributed to the fact that the collected positional data is used to predict velocity and position. Moving the RTS by, for example, 1 meter, near the base station is more difficult for the base to track than a 1 meter movement far from the base station. For the near case, the base station predicts movement poorly and consumes more time searching for the RTS. Setting the base station as far away from the grid as possible will aid in reducing this problem.

Alternative Technologies

For the GPO, ATI selected what was expected to be the most effective instruments for the environment at Five Points. However, the GPO results indicate that the DGM instrumentation tested did not provide adequate discrimination between UXO-like anomalies and housing/cultural interferences. This is particularly demonstrated in test grid 1. For this reason, ATI discusses what other instrumentation is available, and why it may or may not provide a potential solution to mapping 'noisy' areas.

The following approaches have not demonstrated good discrimination in environments similar to those in the Five Points housing areas:

- *858 Magnetometer:* The 858, which can be used for DGM, indicates ferrous metals and does not discriminate cultural interferences and UXO-like anomalies well. Because of this, it is expected that the 858 would be very sensitive to items such as wire, nails, air conditioning units, and rebar, all of which will be common near the houses at Five Points,
- *Schonstedt*: DGM is not possible with a Schonstedt. The Schonstedt locates only ferrous metals and has been demonstrated to be very sensitive to cultural items such as wire, nails, air conditioning units, and rebar, all of which are expected to be found in the vicinity of these newly built houses.
- *Ground Penetrating Radar*, which is a geophysical method for imaging the near subsurface, does not provide sufficient resolution for small UXO items, nor does it provide the high resolution maps that are required.
- *Utility Mapper:* This is a handheld device that cannot be integrated with DGM, and will not provide superior discrimination between cultural effects and UXO items. It would prove useful in reducing the number of false positives due to utility lines, however, utility maps have been provided, and it is not anticipated that this would be a cost or time saving device.

The following approaches may provide more effective discrimination between UXO-like anomalies and houses and cultural interferences at Five Points than the EM-61 MK2 does:

- *Hand-held EM-61:* This instrument may be used for DGM and, because it is significantly smaller than the EM-61, will be able to access more areas. In addition, because the hand held version is smaller and therefore averages its signal over a smaller area, it may collect better quality closer to the housing/cultural interferences. This will potentially reduce the overall area in which discrimination between cultural interferences and UXO-like items is not possible.
- *Whites Metal Detectors:* The Whites detectors are hand held all-metal detectors that cannot be used for DGM, but may be useful in a 'detect and flag' investigation. However, it is possible to discriminate between different metals, although sensitivity to

small items may be lost. Increasing the detector head size allows for greater depths of detection, but less accuracy in depth prediction.

- *Minelab Explorer:* This instrument cannot be used for DGM, however, like the Whites, it may be effective in a 'detect and flag' operation. The Minelab Explorer generally can sense items deeper than the Whites detectors, and allows for discrimination between metals. Sensitivity to smaller items will be lost as discrimination factors are increased. Further, the Minelab Explorer can be 'programmed' to learn to discriminate certain items. As with the Whites metal detectors, increasing the detector head size allows for greater depths of detection, but less accuracy in depth prediction.

General Planned Approach

Because of the difficulties presented by data interpretation during the GPO, the following procedures are recommended for the Geophysical Investigation:

- Extensive field documentation. Cultural interferences (housing, air conditioning units, sprinklers, driveways, etc) should be noted in field maps and notes, and recorded with a positioning system as needed. Photographic documentation of the site may help in determining the location of cultural objects, as well as the condition of the site prior to mapping.
- The EM-61 tested in the GPO will be used in the open areas, and, as much as possible, in the housing areas.
- Data interpretation for the EM-61 will identify areas close to cultural influences where the housing interferences are too large and potentially mask UXO signatures. These areas can be blocked off and investigated with another instrument.
- The hand held EM-61 will be used near cultural influences to further reduce the area that cannot be digitally mapped, if the hand held EM-61 is demonstrated to be useful by testing it in the GPO.
- A 'detect and dig' technique will be used in the remaining areas near housing. The Minelab Explorer II and Whites metal detectors are the primary choices for this, and will be tested in the GPO.

24.2 Anomaly Selection Criteria

Any UXO-like anomaly having an amplitude above background of at least 5 mV within the post processed EM-61 MK2 data sets will be selected.

25.0 REACQUISITION TEST

The following subsection describes the reacquisition test.

25.1 Procedures

Target selections for all the test plots were made during the field effort, and the reacquisition procedures were testing using these selections. It is noted that the targets were later re-evaluated, and the anomaly selections presented in Appendix A are the later selections, not those selected for testing reacquisition. The anomaly selections made for reacquisition are presented in Appendix B.

Target selections for the test plot 1 were made for 8 anomalies detected within the post-processed data sets of the EM-61 MK2. Target reacquisition was performed by utilizing the stake out option of the Robotic Total Station. The RTS operator used the RTS rover receiver to reacquire and flag the location of those eight selected targets as selected from each instrument's data set. The locations of the selected anomaly locations were then compared to the location of instrument peak response.

The same process took place with the TM-5 EMU on test plot 1, where the selected anomalies were reacquired with a single sensor using the RTS.

Test plot 2 was reacquired with EM-61 MK2 and TM-5 EMU using an Ashtech Z-Xtreme DGPS as well as a Leica Robotic Total Station.

Test plot 3 was reacquired with an EM-61 MK2 and TM-5 EMU using only the Ashtech Z-Xtreme DGPS.

25.2 Results

The measured GPS offsets and performance of the GPS were less than 20 centimeters for all eight targets, as demonstrated in the tables in Appendix B. To clarify, the peak instrument response locations were within 20 centimeters of the selected anomaly locations for the eight targets of reacquisition in test site one.

10.0 OVERALL CONCLUSIONS

The data quality objective presented in Section 2.1 have met in the Geophysical Prove Out, as described below:

- The geophysical equipment was demonstrated to perform adequately in open areas, but data interpretation proved difficult near houses, due to cultural influences. Each piece of equipment was not demonstrated to be effective in all types of environments. Housing/cultural interferences were identified for test plots near housing units.
- A grid containing isolated test objects was provided in order to test the geophysical equipment.
- The field techniques, and field procedures were tested and field operators demonstrated proficiency.
- Baseline performance capabilities for the selected instruments were determined.
- Decision parameters for target selection by the site geophysicists were determined.
- Navigational systems (RTS, GPS, Fiducial mode) were tested for the best positional accuracy and applicability.
- The average speed and minimum line separation were determined in order to select all targets.
- Instrument latency corrections were determined.
- Geophysical systems performed adequately in open areas, and although anomaly discrimination was not possible close to houses, an alternative solution has been developed.

- Confirmation that the processing routines did not affect peak anomaly responses by more than 10% was achieved.
- The influence of cultural objects on geophysical data collection was determined for the instrumentation tested.

The following overall conclusions were reached during the prove-out survey:

- The EM-61 MK2 was selected from the prove-out for use in more open areas, such as in the trailer parks, as well as near housing, because of the equipment's superior detection capability compared to the TM-5 EMU. However, it is anticipated that the EM-61 MK2 will probably not produce quiet enough data in near proximity to houses to identify buried UXO items.
- In noisy areas close to houses, a potential solution is to reduce this noisy area by collecting data there with a handheld EM61. The remaining noisy area may then be boxed off based on all geophysical mapping to allow for "detect and dig' investigations.
- Detect and dig operations may be done with a Minelab Explorer II or a Whites metal detector.
- It was determined that the criteria for anomaly selection for the EM-61 would be a minimum amplitude of 5 mV above background on Channel 3 within the post-processed EM-61 MK2 data sets.
- Traverse spacing of 0.8 meters for the EM-61 MK2 will be appropriate to identify the expected targets in grid areas.
- GEOSOFT Oasis Montaj/UX Detect processing package will be used to level the EM-61 data, create grids to visually and further analyze the data, and to aid in anomaly selection.
- The reacquisition test indicated the GPS and RTS are able to relocate the expected OE items within required accuracy.

11.0 REFERENCES

25.2.1 ATI, 2003, Final Geophysical Prove-Out Plan, Conventional OE Geophysical survey at Former Five Points Outlying Field, Arlington, Texas

LIST OF ACRONYMS

ATI	American Technologies, Incorporated
CEHNC	Corps of Engineers, Huntsville Center
CESWF	Corps of Engineers, Fort Worth District
DGPS	Differential Global Positioning System
DQO	Data Quality Objective
EM	Electromagnetic
EE/CA	Engineering Evaluation/Cost Analysis
GPO	Geophysical Prove-Out
GPS	Global Positioning System
GSA	General Services Administrtaion
HH	Hand Held
MV	Millivolts
NA	Not Applicable
NAS	Naval Air Station
NS	Not Seeded
OE	Ordnance and Explosives
OLF	Outlying Field
PPM	Parts Per Million
QC	Quality Control
RTS	Robotic Total Station
TDEM	Time Domain Electromagnetics
USACE	United States Army Corps of Engineers
USFS	United States Forest Service
UTM	Universal Transverse Mercator
UXO	Unexploded Ordnance