ACHIEVING DGM DATA COVERAGE IN (IN)ACCESSIBLE AREAS

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Abstract

Tetra Tech performed digital geophysical mapping (DGM) with a Geonics, Ltd. EM61-MK2 sensor along the face of a steeply-sloped berm comprised of loose soil. The innovative design included a wheeled platform coupled with a survey-grade positioning system. The entire platform was moved by a pulley system. The design facilitated digital data collection in an area otherwise considered inaccessible and of data quality to support removal of munitions-related items, including 20 millimeter (mm) projectiles.

Introduction

A common key consideration for DGM surveys is how to adapt geophysical equipment for challenging site conditions in order to obtain a permanent digital record for as much of a site as possible. Tetra Tech was tasked with performing full-coverage DGM in an area that included steep slopes with loose, sandy soil that prevented deployment of the EM61-MK2 in a person-portable configuration. In addition, adaptation of the EM61-MK2 to facilitate digital collection in these conditions also reduced risk to unexploded ordnance (UXO) personnel by limiting the need to walk the berm to completing intrusive investigation of DGM targets as opposed to full coverage required for analog clearance. As a result, the field team designed a collection platform to accommodate these site conditions and to gather an appropriate amount of data to support achievement of the project objectives. Work was conducted in the northeastern United States at a confidential site (Site) in support of an ongoing response action by Tetra Tech.

Design Considerations

As with any EM61-MK2 sensor deployment modification, sourcing non-metallic components was a primary concern in the construction process. Plywood was selected for the base of the platform in order to achieve a stable, rigid surface on which to mount the sensor and the wheels and to minimize lateral tilt over uneven terrain. A rubber mat was placed between the plywood and the sensor in order to protect the coil from excessive wear and to help minimize terrain induced noise in the data. Cut lengths of 2”x4” treated lumber were used to brace the platform and provide additional stability and heavy-duty zip ties secured all geophysical and positional equipment to the platform.

The team considered several different wheel styles, with preference to wheels that would perform well in loose, sandy soils, be durable and have enough surface area to not get stuck in small crevices and could roll over roots. The team selected a set of plastic wheels typically used as a kayak cart because they are sturdy, lightweight, composed primarily of plastic and are easy to install and maintain. The selected wheels facilitated a mounted coil of height of 30.5 centimeters (cm) above ground, resulting in a sensor ride height lower than standard EM61-MK2 wheels.
To aid in navigation, a rope bridle was attached to either side of the platform front, coming together to center the direction of pull. This design allowed for person-powered collection along sections of the berm where the pulley system could not be deployed yet where the terrain was not conducive to use of the EM61-MK2 on its standard wheels. The bridle was used to manually pull the platform up shorter sections of berm face. During machine-assisted collection (Figure 1), the bridle was integrated into the pulley system to mechanically move the platform across the berm face. Ropes were also attached to either side of the platform rear, with a person on each rope to help maintain stability across uneven terrain.

![Figure 1: Mechanical-powered Pulley Assisted Platform Collection](image)

The platform was configured with the single EM61-MK2 0.5 x 1.0 meter (m) coil centered at the front of the platform, just behind the attachment points for the rope bridle. The electronics console and Juniper Systems Allegro data logger were mounted approximately 0.6m from the coil at the rear of the platform. This placement was governed by cable length, as well as to provide ease of access for the Data Collector. A global positioning system (GPS) antenna or RTS prism was secured on a fixed tripod in the center of the coil, and all accompanying cables and positional equipment was secured towards the rear of the platform. Precautions were taken to limit the movement of any equipment and cables during collection, as that can often manifest as noise in the data.

**Data Collection**

The survey area along the entire berm face included zones suitable for person-powered collection with the sled and steep, distressed slopes. This necessitated the design of a pulley system that could be completely operated from the safety of the top and/or bottom of the berm and provide full coverage of the entire berm face, including the lip and the toe. The pulley was originally attached to a metal chain stretched between trees along the top of the berm and was pulled with an all-terrain vehicle (ATV). Hand-held radios were used to communicate between personnel to ensure all equipment was properly staged and secured prior to collection of each line of data. This configuration required three individuals:

- **ATV Driver** – responsible for maintaining adequate tension in rope and consistent platform speed of approximately 0.75m/second for data collection. In staging the position of the ATV, an adequate separation distance had to be maintained to prevent a metallic signature or ATV alternator-induced noise were not introduced into the data.
• Instrument Operator – responsible for monitoring geophysical data, line spacing, positional data and platform integrity. Worked as point of contact to direct the start and stop of each line collected.

• Pulley Operator – responsible for ensuring the rope was properly fed through the pulley and secured prior to use. Inspected equipment with each use, and monitored for possible safety hazards (pinch points, maintaining adequate distance from berm edge). Coordinated directly with the Instrument Operator in moving the pulley in accordance with prescribed DGM line spacing.

The nature of the berm required the collection area to originally be broken into regions based on varying degrees of slope and orientation. The chain was chosen as the preferred anchor for the pulley, as it could be modified to stretch across areas of different lengths as needed. Once the chain was properly secured to nearby trees, the pulley could be shifted the appropriate number of chain links with the completion of each line. This system, in addition to painted wheel tracks and flags placed at the toe of the berm, allowed for the Instrument Operator to maintain the required 0.6m line spacing throughout collection.

**Design Adaptations**

DGM of the berm face was performed in several phases. Intrusive investigation of derived targets was conducted between DGM data collection phases. However, over time the shape and slope of the berm face changed as a result of intrusive activities. These changes required ongoing adaptations to the use of the platform:

• Anchor Points – During the project, tree stumps along the top of the berm had to be removed to allow intrusive investigations to continue. With the elimination of these anchor points, the pulley was configured to attach to the arm of an excavator staged at the top of the berm. Eventually the ATV was also replaced with a front-end loader, which provided more torque for mapping the extended berm face (Figure 2). Additional precautions had to be taken to avoid metallic signatures in the data when introducing large pieces of heavy equipment into the collection area.

• Positional Equipment – Positioning was initially maintained using real-time kinematic GPS (RTK GPS). Use of GPS resulted in numerous data gaps from tree shadows due to the fact the top of the berm was at a higher elevation compared to the platform. Due to the pitch of the platform, the radio antenna for the GPS receiver also resulted in additional noise in Channel 4. In an effort to eliminate both of these issues, additional temporary control points were placed onsite and positioning methods were switched to RTS (Figure 2).

• Data Logger – During initial phases of data collection, the start and stop of each line was manually controlled on an Allegro data logger secured to the rear of the platform. Because of safety concerns associated with the berm face, no personnel could manually stop the data logger at the top of the line, leading to unusable extra data being collected as the platform was lowered back to the toe of the berm. This resulted in increased time spent on data processing to remove the unusable data. As a result, the hard-wired Allegro data logger was replaced with a Bluetooth-enabled model, which enabled the start and stop of each line to be controlled remotely by the Instrument Operator (Figure 2).
Results

100% coverage of the berm face was achieved. Positioning and detection performance were demonstrated through a blind seeding program using small industry standard objects (ISOs), for which all emplaced seeds were detected within required tolerance. Additional seeds were emplaced as known “data spikes” to assist with development of processing routines to correct the GPS and RTS antenna tilt during data collection. The platform was validated at an Instrument Verification Strip (IVS) constructed onsite, and daily QC checks and sensor function checks were performed in accordance with the Geophysical System Verification (GSV) process (Nelson and others, 2009).

Conclusion

In order to obtain a digital record of data collection at sites with challenging conditions and munitions-related contamination, there is often a need for innovative technology and innovative approaches using existing technology. Tetra Tech’s design at a confidential Site facilitated the use of a common geophysical sensor in challenging conditions. The use of this platform minimized risks to field personnel posed by the site conditions, met required performance criteria for the DGM survey and has facilitated the removal of munitions-related items of interest from the site in order to meet the client objectives.

References