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TECHNICAL MEMORANDUM REGARDING GEOPHYSICAL INVESTIGATION RESULTS
OPERABLE UNIT 15 (OU15) SITE 88 MCB CAMP LEJEUNE NC
10/16/2009
CH2M HILL

Geophysical Investigation Results Operable Unit 15 (Site 88) Marine Corps Base, Camp Lejeune North Carolina

PREPARED FOR: Bob Lowder/MCB Camp Lejeune
Dave Cleland/NAVFAC

PREPARED BY: CH2M HILL

COPIES: Camp Lejeune Partnering Team

DATE: October 16, 2009

The purpose of this Technical Memorandum (TM) is to present the results of a recent geophysical investigation at the former Base Dry Cleaning Facility (former Building 25), Operable Unit (OU) 15 (Site 88), Marine Corps Base (MCB) Camp Lejeune, North Carolina.

Introduction

The 1995 Work Plan for Underground Storage Tank Removals at Building 25 provided by OHM Remediation Services Corporation (OHM) prior to the removal of the former Dry Cleaner Facility underground storage tanks (USTs) indicated that five and up to nine USTs were present at the site. However, during UST closure activities only five USTs were identified and subsequently removed. It is unclear what the basis of the information is regarding the number of USTs located at the site. In 2005, the area of the former northwest corner of the building and the area behind the former building were treated using soil mixing with zero valent iron (ZVI) and clay addition. The soil mixing was conducted using 10-foot diameter augers, mixing soil and the ZVI-clay to a depth of 20 feet below ground surface.

To provide additional evidence that no additional USTs remained at Site 88 after removal and site treatment, a geophysical investigation was conducted in the vicinity of the former Base Dry Cleaning Facility (former Building 25) on June 22, 2009. The objective of the geophysical survey was to confirm that no additional USTs remain at Site 88.

This technical memorandum provides a summary and conclusion of the geophysical investigation at Site 88 - Former Base Dry Cleaning Facility (former Building 25) at MCB Camp Lejeune, North Carolina.

Site Description

The general location of Site 88 – Former Base Dry Cleaning Facility (former Building 25), shown on **Figure 1**, is located on Post Lane Road, approximately 500 ft east of the intersection of Post Lane Road and McHugh Boulevard within the Hadnot Point Industrial Area of MCB Camp Lejeune. The area surrounding Site 88 is generally developed; covered with buildings, asphalt, and large landscaped grassy areas. Ground surface elevation for the area of Site 88 is approximately 25 ft mean sea level (msl).

Site History

Site 88 is the former Base Dry Cleaning Facility (former Building 25) that operated from the 1940s to 2004. USTs were reportedly installed in the 1940s to be used in conjunction with dry cleaning operations at Building 25. Varsol™, a petroleum distillate or mineral spirit, was initially used; however, due to flammability concerns, Varsol's use was discontinued in the 1970s and was replaced with tetrachloroethene (PCE). Also in the 1970s, PCE began being stored in one 150-gallon aboveground storage tank (AST) adjacent to the north wall of Building 25, in the same vicinity as the USTs (**Figure 2**).

Five USTs at Building 25 were identified in 1994 during the 1994 Base-wide UST program inventory.

In December 1986 and again in March 1995, self-contained dry cleaning machines were installed in Building 25, eliminating the need for bulk storage of PCE.

In 1995, OHM was contracted to remove all of the USTs associated with the former Building 25 dry cleaning facility. The OHM work plan, submitted for completing the removal action, indicated that nine 500-gallon USTs were present, adjacent to the north side of Building 25 (callout **Figure 2**). During the excavation activities conducted between September 1995 to March 1996, OHM identified only five 750-gallon USTs adjacent to Building 25. OHM removed and disposed of these USTs in addition to approximately 140 tons of chlorinated volatile organic compound (CVOC) impacted soils and 3,180 gallons of liquids from within the USTs. The five 750-gallon USTs were approximately 6 feet long by 4.5 feet in diameter and were located approximately 1.5 feet below ground surface. Tanks T25-1, T25-2, and T25-3 were set vertically while tanks T25-4 and T245 were set horizontally, as shown in **Figure 1.2 of Attachment 1**.

The dry cleaning operations ceased in January 2004 and the building was demolished to slab in August 2004. In 2005, the source area beneath and northwest of the former building was treated using soil mixing with zero valent iron (ZVI) and clay addition (**Figure 2**). No USTs were identified in the soil mixing area during the completion of remedial activities.

Geophysical Survey Methodology

The primary objective of geophysical investigation activities at the site was to identify metallic and non-metallic anomalies that may be related to USTs at Site 88.

The geophysical investigation was conducted over the entire area of the former dry cleaning facility and to the north and northeast of the building (**Figure 3**). An electromagnetic metal detector (Geonics EM61 Mark II time domain metal detector [EM61-MK2]), capable of detecting both ferrous and non-ferrous objects of the size of a UST up to a depth of approximately 8 feet below ground surface (ft bgs). A Trimble, Pathfinder Pro XRS differential global positioning system (DGPS) was used to integrate each EM61-MK2 reading with unique DGPS coordinates for processing and mapping purposes. The EM61-MK2 survey was conducted along five foot linear transects across the entire survey area in order provide sufficient coverage to confidently locate any anomaly that could potentially indicate USTs remaining at the site (**Figure 3**). Control points were placed on the ground using RTK DGPS.

Anomalies identified with the EM61-MK2 were further investigated with a Geophysical Survey Systems Inc. SIR-3000 cart-mounted Ground Penetrating Radar (GPR) unit with a 270 Mhz antenna, which produced a subsurface cross-sectional, two-dimensional image of the subsurface features. Vertical resolution was limited to 5 to 6 ft bgs due to the shallow water table at the site. The GPR was utilized when distinguishing between potential USTs, utilities, and other subsurface anomalies was required.

One area within the parking lot, located within the former Building 25 footprint, could not be surveyed with the EM61-MK2, as cars were present at the time the survey was conducted. As a result of this area being immediately south of the area identified by OHM as potentially containing USTs, the spaces between the cars were investigated with the GPR to assess whether any features of interest were located beneath the parked cars. No data consistent with potential USTs was noted at this location.

The geophysical investigation report can be found in **Attachment 2**. The attached report provides all details of the equipment, approach, methods, operational procedures and quality control used in performing the geophysical investigation. All geophysical survey findings are shown in the site plot **D090609-01-01** within the geophysical investigation report. Site data were mapped using a standard gridding method for the EM61-MK2. In addition, EM61-MK2 data were contoured and included for reference within the site plot.

Results

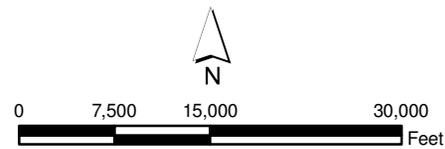
The geophysical investigation was completed on June 22, 2009. Multiple geophysical anomalies were identified in the EM61-MK2 dataset. The geophysicist was able to correlate all of the geophysical anomalies to either shallow subsurface utilities including the storm sewer system in the parking lot or surficial features including metallic covers for monitoring wells and the metallic pins in the concrete curb stops of the parking lot.

No geophysical anomalies were identified that suggest any USTs remain at the site. All anomalies identified were related to underground utilities, monitoring wells, or surface features.

Figures



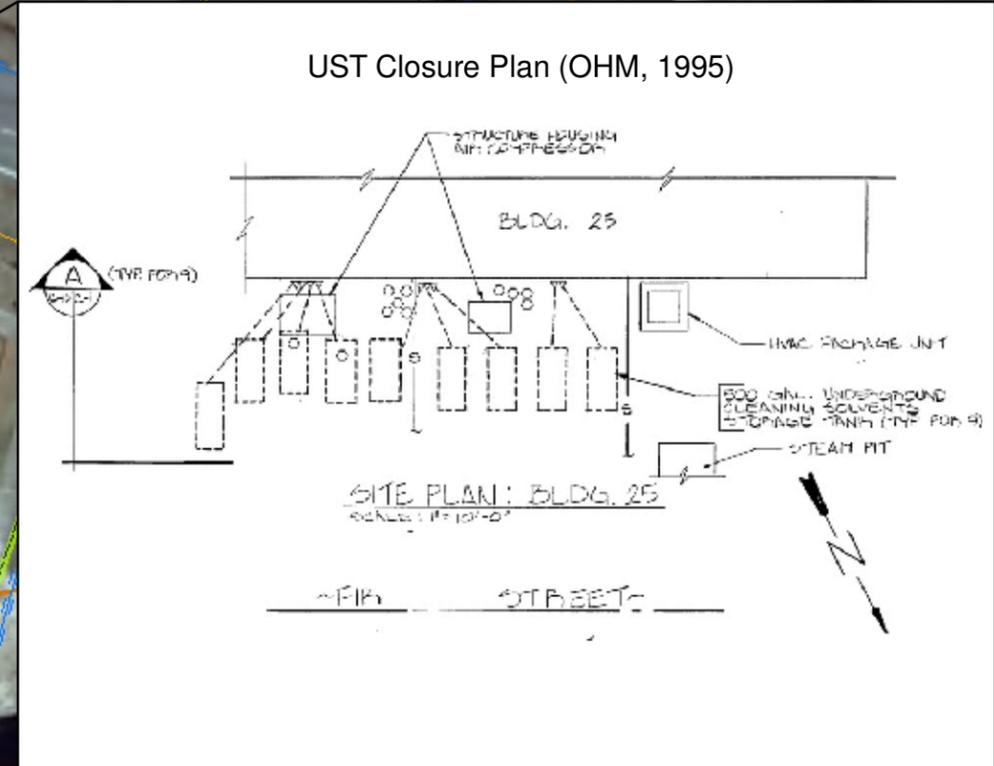
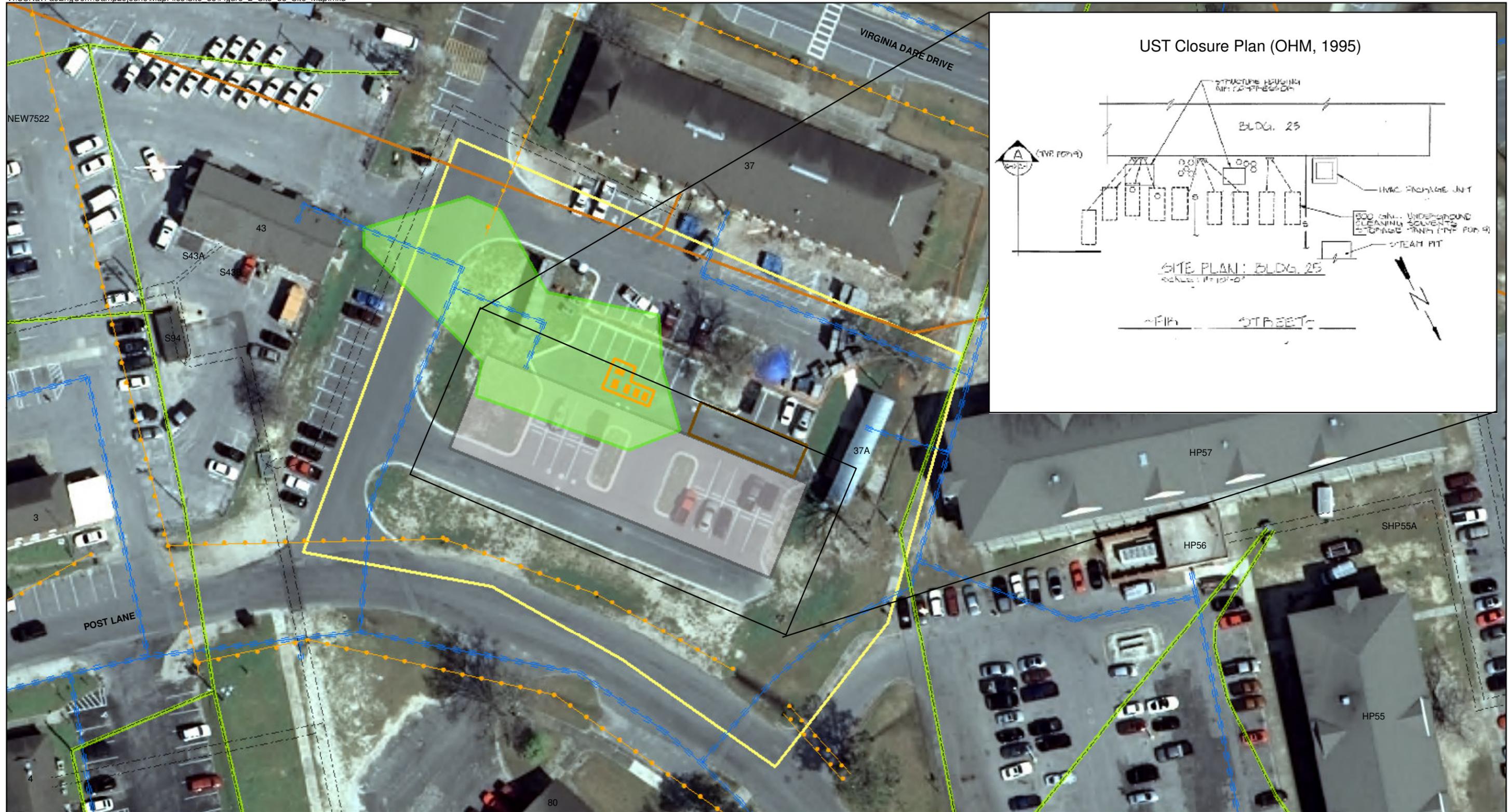
- Legend**
- Highways
 - Site 88
 - Installation Boundary



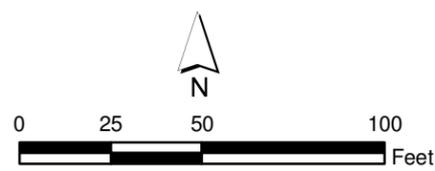
1 inch = 15,000 feet

Figure 1
Location Map
Operable Unit No. 15 (Site 88)
Marine Corps Base, Camp Lejeune
North Carolina





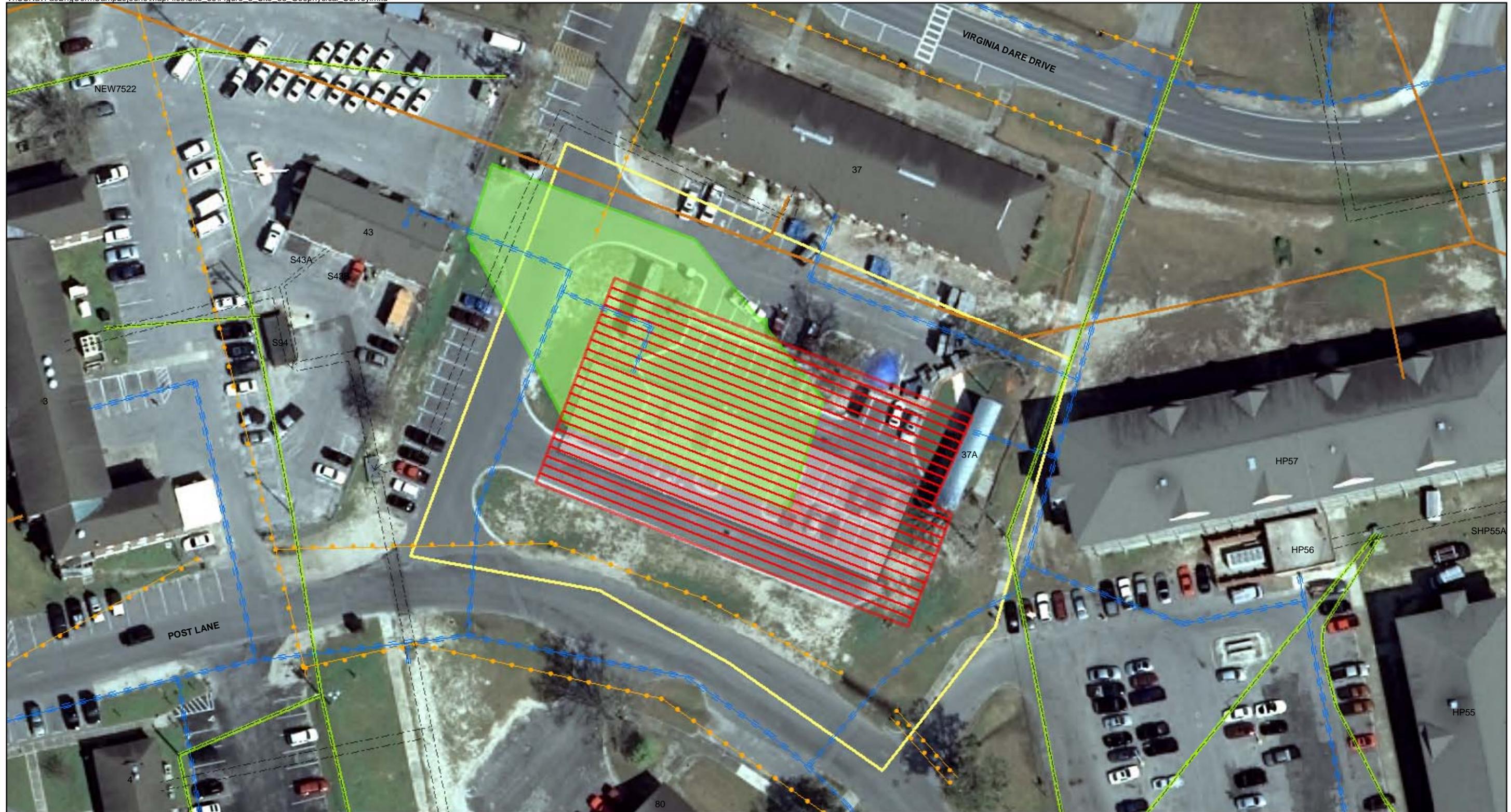
- Legend**
- Steam Line
 - Storm Sewer Drainage Line
 - Storm Sewer Utility Line
 - Electrical Utility Line
 - Water Utility Line
 - Wastewater Utility Line
 - Former UST Locations
 - UST Excavation Area
 - Suspected Area for Containing Unaccounted for USTs
 - Soil Mixing Boundary
 - Former Building 25
 - Site 88 Boundary



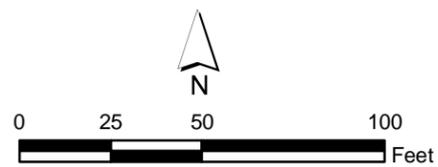
1 inch = 50 feet

Figure 2
Site Map
Operable Unit No. 15 (Site 88)
Marine Corps Base, Camp Lejeune
North Carolina





- Legend**
- Steam Line
 - Storm Sewer Drainage Line
 - Storm Sewer Utility Line
 - Electrical Utility Line
 - Water Utility Line
 - Wastewater Utility Line
 - EM61- MK2 Survey Transect
 - Geophysical Survey Area
 - Soil Mixing Boundary
 - Former Building 25
 - Site 88 Boundary



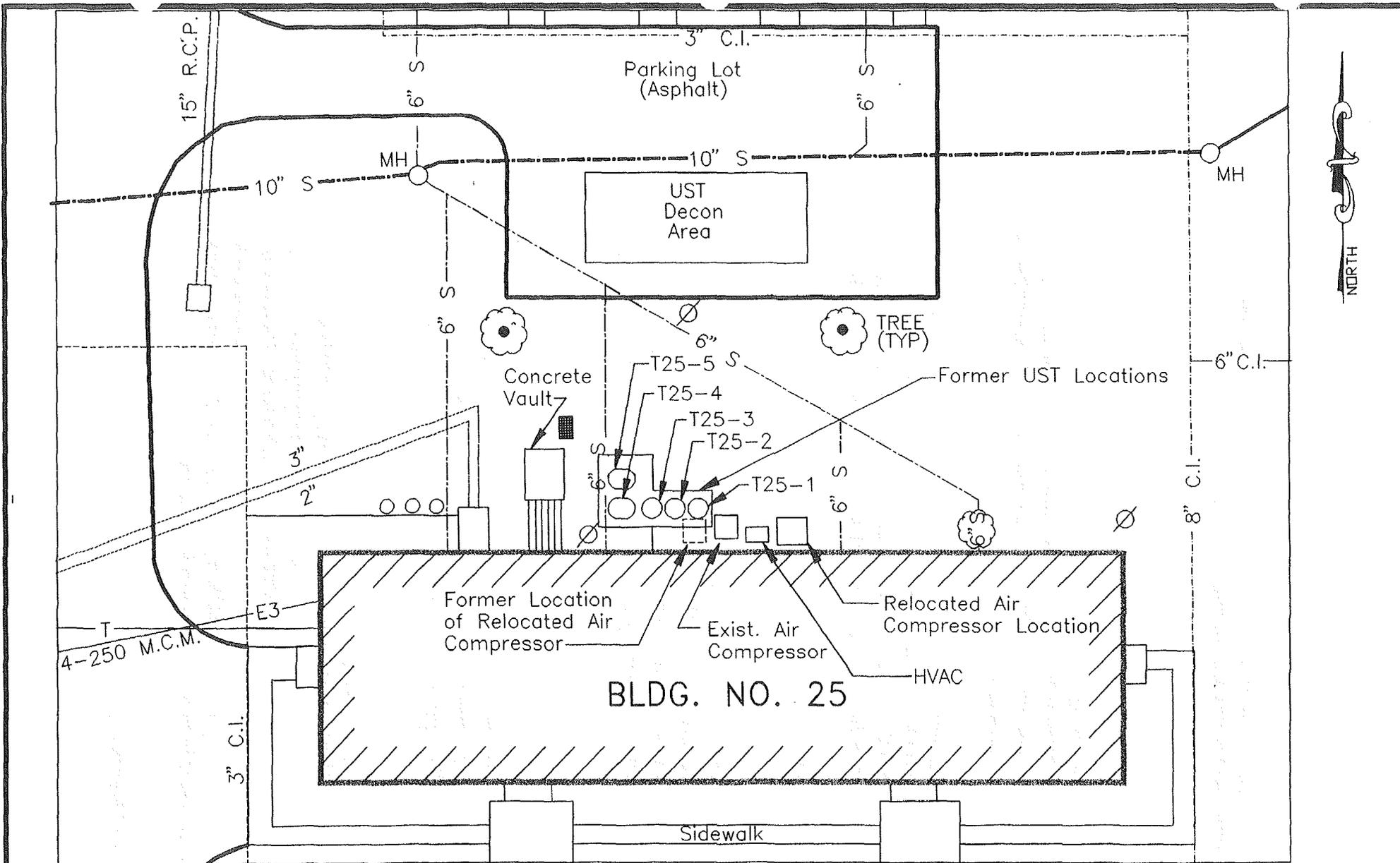
1 inch = 50 feet

Figure 3
 Geophysical Survey
 Operable Unit No. 15 (Site 88)
 Marine Corps Base, Camp Lejeune
 North Carolina



Attachment 1

Figure 1.2 – Former Building 25 Site Plan



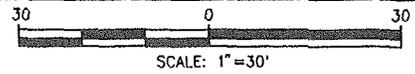
DRAWN BY	J. LANGE	6/23/95
CHECKED BY	-	DATE
APPROVED BY	-	DATE
REV.	SHEET #	CT
	17418	

FIGURE I.2
SITE PLAN

D.O. #78
 MCB CAMP LEJEUNE
 PREPARED FOR
 LANTDIV

LEGEND

- MH ○ MANHOLE
- DRAINAGE INLET
- 6" S— SEWERLINE
- ⊗ POWER POLE
- ⊗— CAST IRON PIPE



NOTES:

1. BASE MAP AND UTILITIES ARE BASED ON DRAWING PROVIDED BY LANTDIV AND ON THE SITE WALK CONDUCTED BY OHM.
2. LOCATION OF USTs NO. T25-1 THRU T25-5 IS APPROXIMATE.
3. REFER TO FIGURE 6.1 FOR LOCATIONS OF TEMPORARY MONITORING WELLS.

Attachment 2

Geophysical Investigation Report



GEOPHYSICAL INVESTIGATION REPORT

SITE LOCATION:

**MCB, Camp Lejeune
Jacksonville, NC**

PREPARED FOR:

**CH2M Hill
11301 Carmel Commons Blvd., Suite 304
Charlotte, NC 28226**

PREPARED BY:

Martin Young
Delta Geophysics Inc.
738 Front Street
Catasauqua, PA 18032

July 27, 2009

Delta Geophysics, Inc. (Delta) is pleased to provide the results of the geophysical survey conducted at the MCB Camp Lejeune site. This project was undertaken upon acceptance of Delta Proposal No. D090609-01.

1.0 INTRODUCTION

On June 22, 2009 Delta Geophysics personnel performed a limited geophysical investigation at the Camp Lejeune MCB. The subject site was an open parking lot and undeveloped land situated between buildings 37 and 37A. Surface conditions at the time of survey consisted of bituminous pavement and vegetation over soil. Subsurface conditions were unknown at the time of survey.

2.0 SCOPE OF WORK

This survey was conducted to determine the potential presence of underground storage tanks within the area of concern specified by the client representative. The area of concern was approximately ½ acre in size, bounded by buildings on the North and East sides and roads on the South and West sides. .

3.0 METHODOLOGY

Selection of survey equipment is dependent site conditions and project objectives. For this project the Senior Geophysicist utilized the following equipment to survey the area of concern:

- Geophysical Survey Systems Inc. SIR-3000 cart-mounted Ground Penetrating Radar (GPR) unit with a 270 Mhz antenna.
- Geonics EM-61 Mark II time domain metal detector.
- Trimble, GPS Pathfinder Pro XRS DGPS

Ground penetrating radar (commonly called GPR) is a geophysical method that has been developed over the past thirty years for shallow, high-resolution, subsurface investigations of the earth. GPR uses high frequency pulsed electromagnetic waves (generally 10 MHz to 1,000 MHz) to acquire subsurface information. Energy is propagated downward into the ground and is reflected back to the surface from boundaries at which there are electrical property contrasts. GPR is a method that is commonly used for environmental, engineering, archeological, and other shallow investigations.

The GSSI SIR-3000 GPR can accept a wide variety of antennas which provide various depths of penetration and levels of resolution. The 270 MHz antenna can achieve depths of penetration up to about 20 feet, but this depth may be greatly reduced due to site-specific conditions. Signal penetration decreases with increased soil conductivity. Conductive materials attenuate or absorb the GPR signal. As depth increases the return signal becomes weaker. Penetration is the greatest in unsaturated sands and fine gravels. Clayey, highly saline or saturated soils, areas covered by steel reinforced concrete, foundry slag, of other highly conductive materials significantly reduces GPR depth of penetration.

The GPR was configured to transmit to a depth of approximately 10 feet below the subsurface, but actual signal penetration was approximately 5 to 6 feet below ground surface (bgs). The limiting factor was signal reflection at depth due to probable shallow groundwater.

The electromagnetic (EM) method uses the principle of electromagnetic induction to measure the variability of electrical conductivity of subsurface materials. The large EM response to metal makes this technique particularly well suited to identifying buried metal objects such as underground storage tanks, buried drums, pipelines, reinforced building foundations, or other metal components of buried structures. It is, however, equally sensitive to metal objects on the ground surface, and it is important to take careful field notes that indicate the position of surface metal to avoid misinterpretation. Instruments of this type are more sensitive to near surface features i.e. reinforced concrete and this fact may sometimes mask features underneath.

The EM-61 is used to detect both ferrous and non-ferrous metals buried in the upper 8 feet of the subsurface. The EM-61 responses are recorded and displayed by an integrated data logger as two-channel information. The bottom channel is more sensitive to metallic objects in the shallow (upper few feet) subsurface, and the differential response is more sensitive to metal objects from 3 to 8 feet below ground surface. Additionally, data can be collected in passive mode. An audible tone is emitted while the EM-61 is used in passive mode, but no data is collected. This audible tone is emitted when the EM-61 is moved over any metallic objects in the subsurface.

The Pathfinder Pro XRS Mapping System is a 12 channel differential beacon GPS receiver. The Pro XRS uses an integrated differential beacon receiver and antenna to receive real-time differential corrections from a subscription-based satellite correction service. This system provides for real-time sub-meter position data collection. This system is used in a wide range of applications, including utility asset management, environmental monitoring, and natural resource and land management. Feature and attribute data are input with a hand-held Asset Surveyor data logger. The GPS Pathfinder was used to tag each EM-61 reading with geographic coordinate for processing and mapping purposes

4.0 SURVEY FINDINGS

All accessible areas within the subject site were surveyed with the EM-61. All potential features of interest detected during the EM phase of the survey were noted for later investigation with GPR.

Several subsurface utilities were noted within the EM-61 dataset. These utilities were interpreted as sewer and storm sewers.

Multiple point source metallic anomalies were present in the EM-61 dataset. Almost all are related to shallow subsurface utilities and monitoring wells. Seven of these anomalies were metallic covers for monitoring wells. Five anomalies were associated with the storm sewer system in the parking lot. Two anomalies marked as Anomaly 1 and Anomaly 2 were due to the metallic pins in the concrete curb stops of the parking lot.

One area within the parking area could not be surveyed with the EM-61 as cars were present at the time of survey. The spaces between the cars were surveyed with the GPR to determine if features of interest were below the parked cars. No data consistent with potential underground storage tanks was noted.

All survey findings are shown in the included site plot D090609-01-01. Site data were mapped using a standard gridding method for the EM-61. EM-61 data were contoured and included for reference within the site plot.

5.0 SURVEY LIMITATIONS

GPR depth of penetration was limited to approximately 5 to 6 feet below ground surface. This limitation was due primarily to possible shallow groundwater conditions.

6.0 WARRANTIES AND DISCLAIMER

As with any geophysical method, it must be stressed that caution be used during any excavation or intrusive testing in proximity to any anomalies indicated in this report. In addition, the absence of detected signatures does not preclude the possibility that targets may exist. To the extent the client desires more definitive conclusions than are warranted by the currently available facts; it is specifically Delta's intent that the conclusions stated herein will be intended as guidance.

This report is based upon the application of scientific principles and professional judgment to certain facts with resultant subjective interpretations. Professional judgments expressed herein are based on the facts currently available within the limit or scope of work, budget and schedule. Delta represents that the services were performed in a manner consistent with currently accepted professional practices employed by geophysical/geological consultants under similar circumstances. No other representations to Client, express or implied, and no warranty or guarantee is included or intended in this agreement, or in any report, document, or otherwise.

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