APPENDIX E

SUBSURFACE UTILITY SURVEY REPORT

Final Report
Subsurface Utility Survey
Three Areas
Navy and Marine Corps Reserve Center
Reading, PA
Enviroscan Project Number 010814

Prepared For: Tetra Tech NUS, Inc.
Prepared By: Enviroscan, Inc.
February 26, 2008

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February 26, 2008

Mr. Don Whalen
Tetra Tech NUS, Inc.
234 Mall Boulevard
Suite 260
King Of Prussia, PA 19406

RE: Subsurface Utility Survey
Three Areas
Navy and Marine Corps Reserve Center
Reading, PA
Enviroscan Project Number 010814

Dear Mr. Whalen:

Pursuant to our proposal written January 8, 2008, Enviroscan, Inc. completed a geophysical survey at the above-referenced site on January 23, 2008. The purpose of the survey was to locate underground metallic and non-metallic utilities (i.e. sanitary, storm, gas, telephone, water, and electric lines) within three client-designated areas adjacent at the Navy and Marine Corps Reserve Center in Reading, PA.

Methods

The utility survey was completed using standard and/or routinely accepted practices of the geophysical industry and equipment representing the best available technology, including:

- a Fisher TW-6 electromagnetic (EM) pipe and cable locator/tracer;
- a Fisher FX-3 magnetic (MAG) locator;
- a Radiodetection C.A.T. and Genny pipe and cable locator/tracer;
- a Radiodetection RD4000 Multi-Frequency pipe and cable tracer; and
- a GSSI SIR-2000 ground penetrating radar (GPR) system.

The principles of these techniques are detailed below.

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TW-6

In order to detect and trace underground utilities, Enviroscan employed a Fisher TW-6 pipe and cable locator and tracer. In pipe and cable search mode, the TW-6 is essentially a deep-sensing metal detector that detects any highly electrically conductive materials (e.g. metals) by creating an electromagnetic field with a transmitting coil. A receiving coil at a fixed separation from the transmitter measures the field strength. As the instrument is swept along the ground surface, subsurface metallic bodies distort the transmitted field. The change in field strength/orientation is sensed by the receiver, setting off an audible alarm and/or causing deflection of an analog meter. The TW-6 can nominally detect a 2-inch metal pipe to a depth of 8 feet and a 10-inch metal pipe to a depth of 14 feet.

In pipe and cable tracing mode, the TW-6 transmitter can be coupled directly (conductively) to exposed portions of a metallic pipe, cable, or wire or inductively to a subsurface metallic utility with known location and orientation. The transmitter remains stationary and energizes or excites the metallic utility to be traced with an 81.92-kilohertz signal that can be traced at the ground surface using the mobile TW-6 receiver wand or probe.

C.A.T. and Genny

The survey areas were also scanned with a Radiodetection C.A.T. and Genny pipe and cable locator and tracer. In Power mode, the C.A.T. detects the 50 to 60 Hertz (Hz) electromagnetic field generated by live power cables and other metallic utilities to which a live line is grounded. In Radio mode, the C.A.T. detects buried conductors (cables or metallic pipes) as they conduct and re-transmit commercial broadcast radio energy. In Genny mode, the C.A.T. detects signal generated by the Genny transmitter. The Genny transmitter can be coupled directly (conductively) to exposed portions of a metallic pipe, cable, or wire or inductively to a subsurface metallic utility with known location and orientation.

RD4000

Utility tracing was also conducted using a Radiodetection RD4000 digital cable and pipe tracer. Similar to the TW-6 and C.A.T./Genny, the transmitter can be directly coupled to exposed portions of a metallic pipe, cable, or wire or indirectly (inductively) to a subsurface metallic utility of known location/orientation. The transmitter remains stationary and energizes the metallic utility at a frequency selected by the operator (512 Hz, 8 kHz, 33 kHz, or 65 kHz), which is received at the ground surface by the digital locator. When the transmitter is directly coupled to the metallic utility, the digital receiver can also calculate the depth of the utility to an accuracy of ±10% of the actual depth of the utility. Please note the close proximity to bends in the traced line or poor signal strength can result in erroneous depth estimations.

FX-3

Enviroscan also employed a Fisher FX-3 magnetic locator. The FX-3 contains two sensors that measure the difference in total strength of the earth's magnetic field between two fixed heights above the ground surface (i.e. the magnetic gradient). In the absence of artificial magnetic fields or buried ferromagnetic objects, the natural gradient of the earth's field is relatively constant. Where buried magnetic or ferromagnetic objects (e.g. magnetite or iron respectively) are present, the gradient varies rapidly as the instrument is swept along the ground surface, triggering an audible alarm. The MAG instrument employed for this survey can nominally detect a 2-inch steel pipe to a depth of 4 feet.

GPR

GPR systems produce cross-sectional images of subsurface features and layers by continuously emitting pulses of radar-frequency energy from a scanning antenna as it is towed along a survey profile. The radar pulses are reflected by interfaces between materials with differing dielectric properties. The reflections return to the antenna and are displayed on a video monitor as a continuous cross section in real time. Since the electrical properties of metal are distinctly different from soil and backfill materials, metallic pipes and other structures commonly produce dramatic and characteristic reflections. Fiberglass, plastic, concrete, and terra-cotta pipes and structures also produce recognizable, but less dramatic reflections. Scanning was performed using a GSSI SIR-2000 GPR controller with an internal hard drive and a color display, and both a high-frequency, high-resolution 500 megaHertz (MHz) antenna or transducer, and a lower frequency deep-penetrating 200 MHz transducer.

Survey Results

The utility survey results are depicted in Figure 1. An overview image of the site is shown in the lower right-hand corner of Figure 1. The three client-designated areas are depicted in Panels A (area adjacent to Kenhorst Boulevard.), B (Rear Courtyard Area), and C (Motor Pool Area).

Enviroscan first traced the locations of all evident utilities with visible valves, meters, or service connections within or adjacent to the survey area. These visible utilities were energized and traced using either the Fisher TW-6 or Radiodetection RD4000 equipment.

The survey areas were then scanned to locate non-evident utilities. Non-evident electric lines were scanned for using the C.A.T. in Power mode. Searches for other non-evident utilities were conducted using the TW-6, C.A.T. in Radio mode, and GPR.

In the Rear Courtyard Area (Panel B), Enviroscan also scanned for the presence of a historic fuel oil underground storage tank (UST). TW-6 and GPR scanning in the area of the UST showed no anomalies consistent with an intact UST; however, an abandoned vent pipe was traced to the approximate former UST location and remnant product lines were imaged with GPR (see Panel B, Figure 1).

Utility traces in all areas were marked in the field as the survey progressed using semi-permanent marking paint. Locations of these markings were either recorded on hand-drawn maps (Panels B and C) or digitally recorded using a backpack-mounted Topcon GMS-110 global positioning system (GPS) receiver with a nominal accuracy of better than 2 feet (+/-) (Panel A).

Recommendations and Limitations

The subsurface utility survey was completed using standard and/or routinely accepted practices of the geophysical industry and equipment representing the best available technology. Enviroscan does not accept responsibility for survey limitations due to inherent technological limitations or site-specific conditions. However, we make every effort to identify and notify the client of such limitations or conditions.

We have enjoyed and appreciated this opportunity to work with you. If you have any questions, please do not hesitate to contact me.

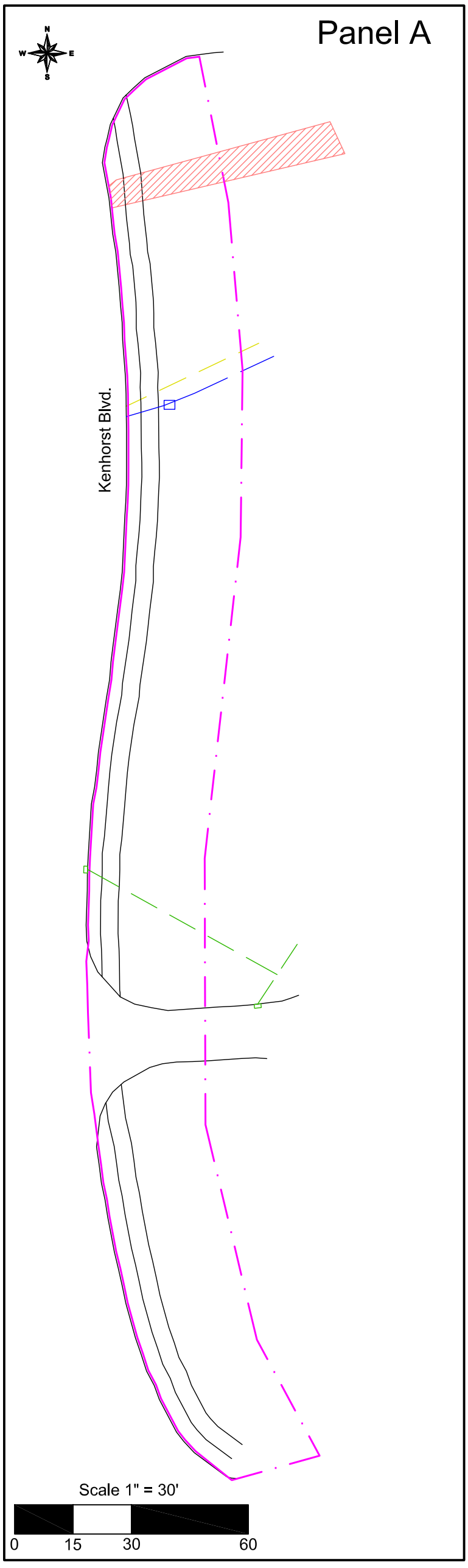
Sincerely,
Enviroscan, Inc.

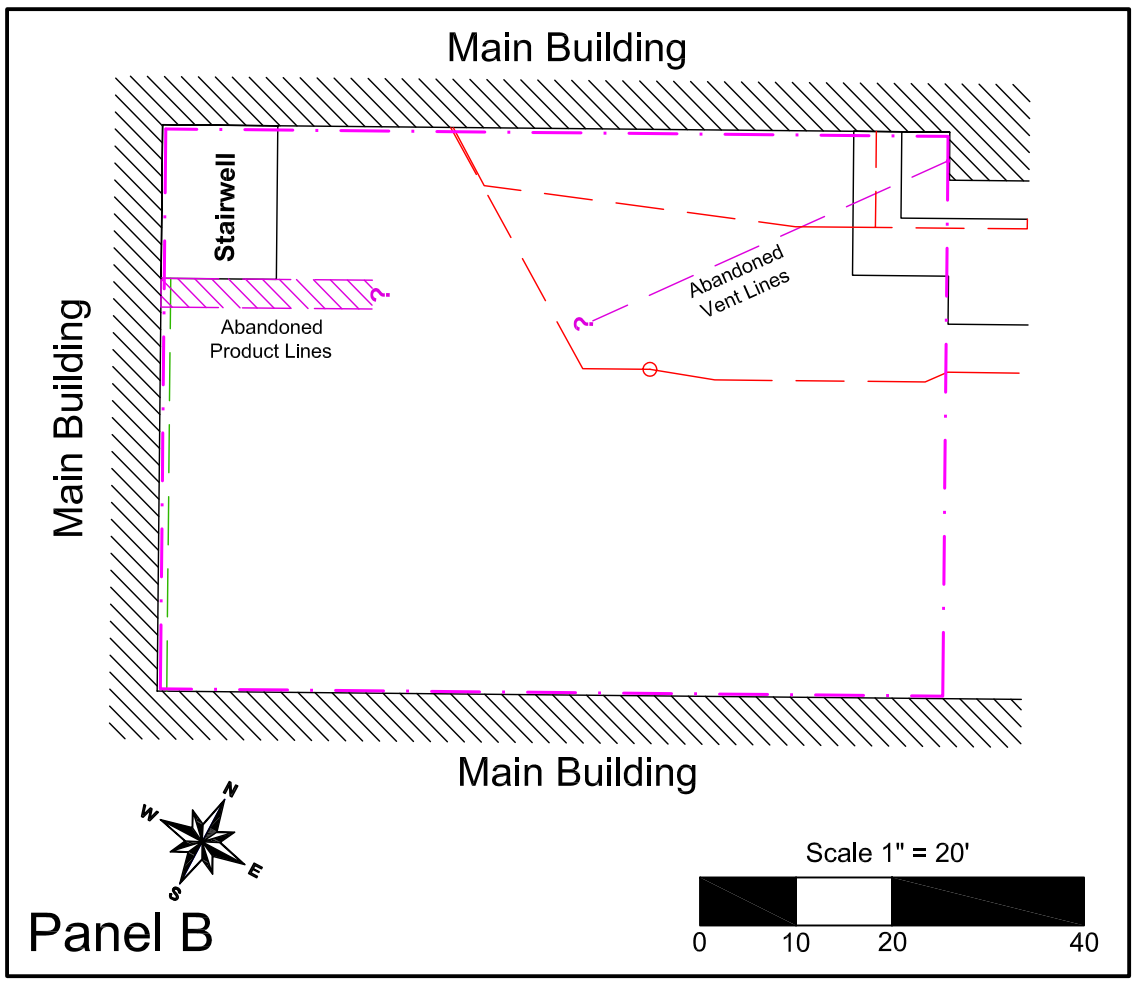
William E. Steinhart III, M.Sc., P.G.
Senior Geophysics Project Manager

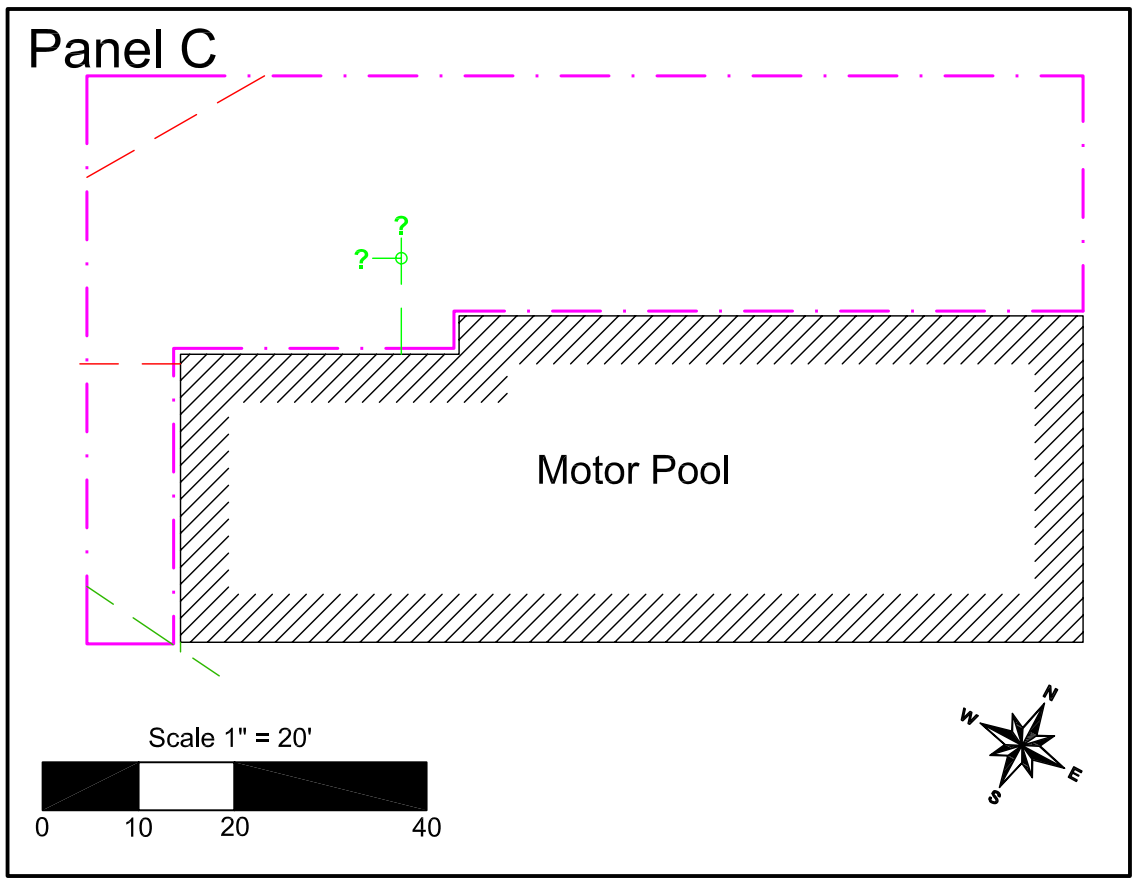
Technical Review By:
Enviroscan, Inc.

Felicia Kegel Bechtel, M.Sc., P.G.
President

enc.: Figure 1: Utility Survey Results







- Survey Boundaries
- Water Line
- Gas Line
- Sanitary Sewer Line
- Storm Sewer Line
- Lines associated with former UST
- Subsurface Metal

Notes:

Basemap from survey by Envriroscan, Inc.

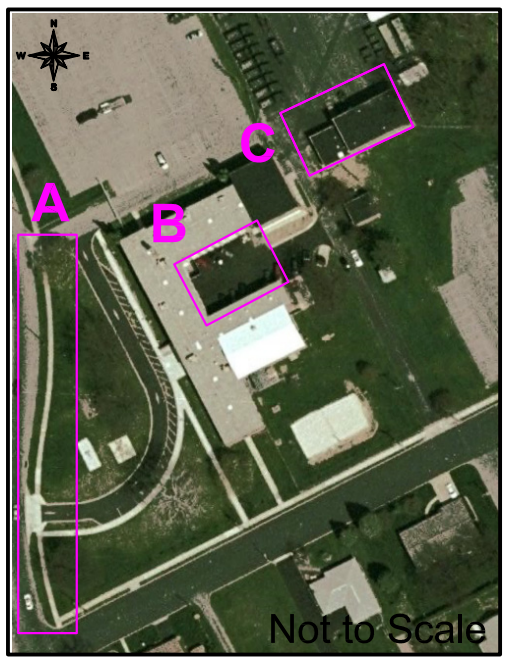


Figure 1

Utility Survey Results

Navy and Marine Corps Reserve Center Reading, PA

Enviroscan, Inc.
Project No. 010814
Rev. 02/21/09

ENVIROSCAN, INC.