



TETRA TECH FW, INC.

September 17, 2003  
TTFWI-SEA-2003-GEO0010

Time Oil Company  
Mr. Scott B. Sloan  
2737 West Commodore Way  
Seattle, WA 98199-1233

Subject: Results of Ground Penetrating Radar and Electromagnetic Survey for Time Oil Company at 2737 West Commodore Way, Seattle, Washington

Dear Mr. Sloan:

On August 15, 2003, Tetra Tech FW, Incorporated (TTFW) conducted a Ground Penetrating Radar (GPR) and Electromagnetic (EM) survey at 2737 West Commodore Way, Seattle, Washington. The purpose of the GPR/EM survey was to locate potential subsurface anomalies (i.e., underground storage tank, abandoned piping) that may be contributing to the floating product frequently detected in monitoring well 01MW-05. The survey was performed by Apollo Geophysics Corporation of Bellingham, Washington, with oversight provided by TTFW.

### **Field Activities**

The GPR/EM survey was conducted by Apollo Geophysics Corporation on August 15, 2003. An area approximately 60 feet east to west and 40 feet north to south was marked on the ground near well 01MW-05. The area around the well was surveyed using an EM meter (model specified in the attached report). A magnetic object was detected approximately 6 feet south of well 01MW-05 running east to west. Following the EM survey, a GPR pulseEKKO (PE) 1000 was used to survey areas of interest. The details are provided in the Apollo report provided as Attachment 1.

### **Findings**

The GPR survey was successful in locating a buried pipe approximately 6 feet south of well 01MW-05. Based on the results of the survey, the pipe is buried approximately 2 feet below the ground surface and runs east to west, extending towards the west approximately 66 feet from well 01MW-05. The location of the pipe was not confirmed by digging. The signal for the pipe was lost at the western extent due to subsurface conditions that resembled disturbed ground. It is possible that the subsurface pipe has already been removed in this area from previous site activities or has undergone decay.



The signal of the subsurface pipe was re-established heading southwest leading directly to the New Barrel Shed. The eastern extent of the subsurface pipe could not be determined due to the interference caused by a concrete slab with rebar east of well 01MW-05. Figure 1-1 shows the approximate location of the subsurface pipe located during the GPR/EM survey.

### **Conclusions**

The condition of the subsurface pipe is not known and does not appear to be affiliated with any current site operations. During the installation of the Dual Phase Extraction (DPE) system, currently planned for the summer of 2004, the subsurface pipe could be removed when the trenching for the DPE system is conducted. Quarterly groundwater monitoring will continue to evaluate potential groundwater impacts in the area.

TTFW appreciates the opportunity to work with TOC. Should you have any questions regarding this report please contact me at (425) 482-7865.

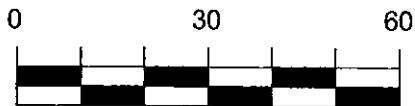
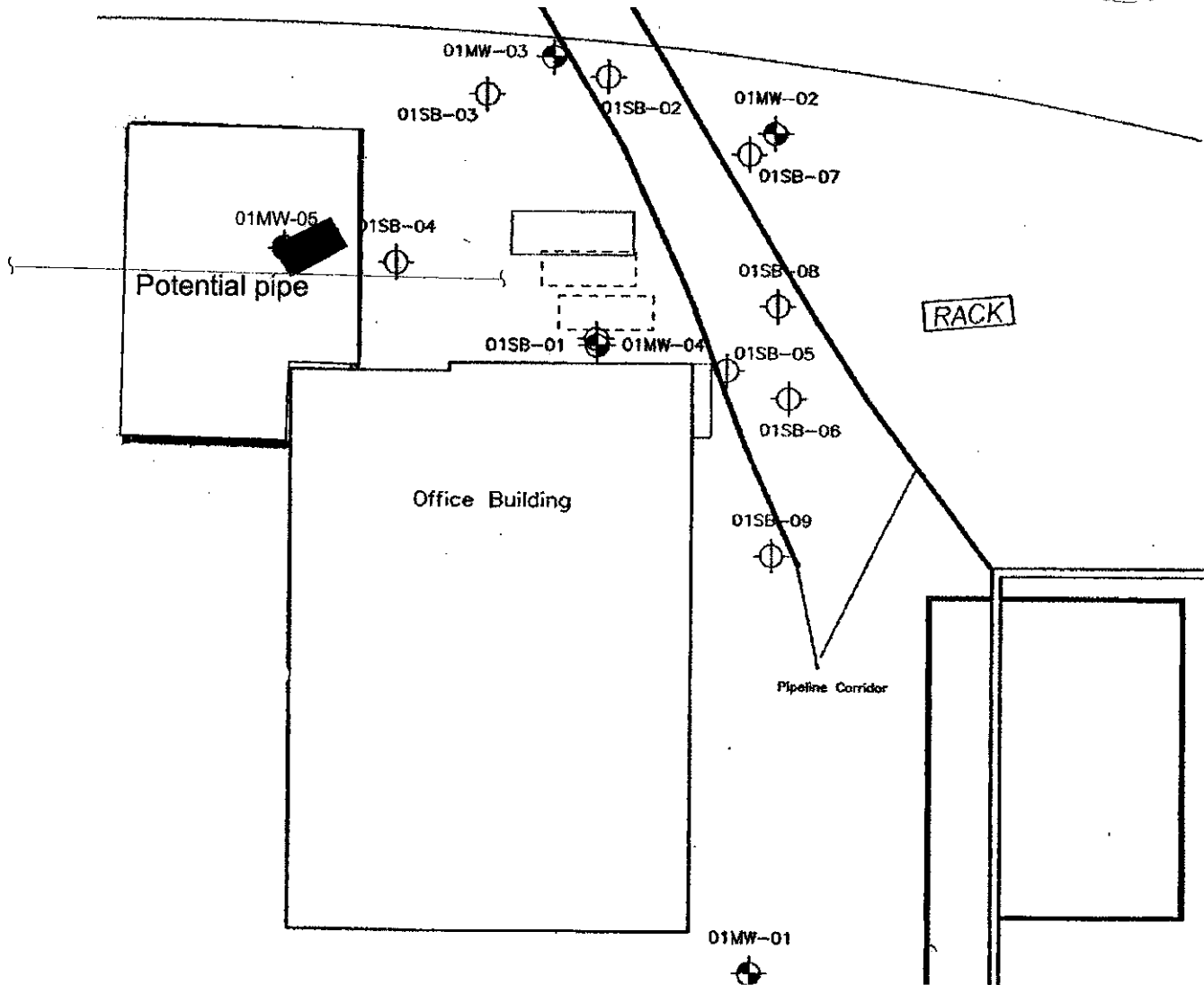
Sincerely,  
TETRA TECH FW, INC.

A handwritten signature in black ink, appearing to read 'Bryan S. Graham', with a long horizontal flourish extending to the right.

Bryan S Graham, R.G., L.Hg.  
Project Manager

Enclosure

# Site Plan



Approximate Scale 1" = 30'

## LEGEND

- Approximate area of GPR and EM exploration
- Approximate location of potential buried obstruction

Note: Site Plan created from a site map by Foster Wheeler Environmental Corporation, Inc. titled, "1999 Sampling Locations," dated July 24, 2000. The locations of all features shown are approximate.



**APOLLO GEOPHYSICS CORPORATION**

ENGINEERING, HYDRO-GEOLOGY,  
ENVIRONMENTAL & CONSTRUCTION

www.apollogeophysics.com

2737 West Commodore Way  
Seattle, Washington

**FIGURE**  
1

FILE NO.

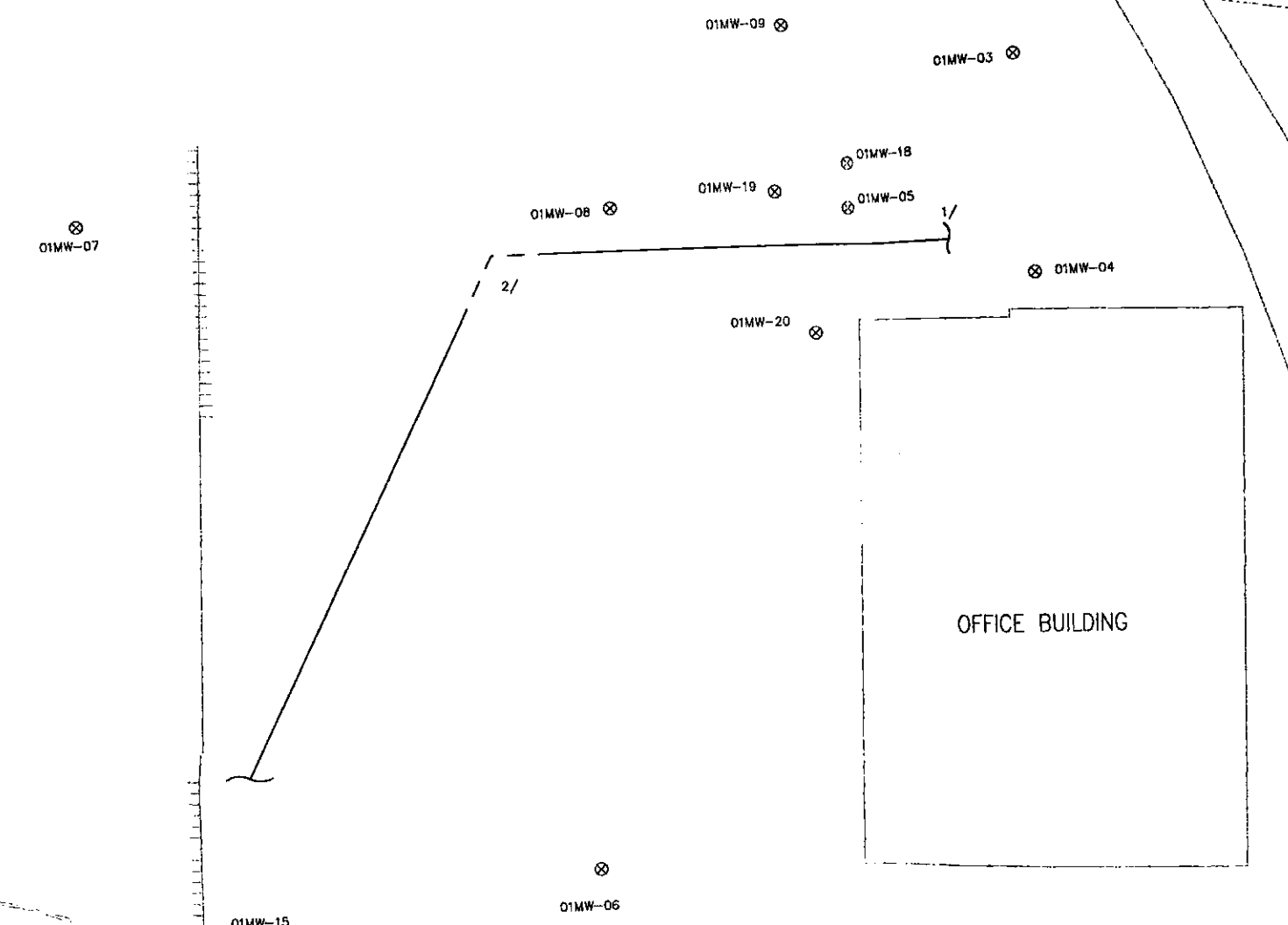
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DATE

August 2003

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WEST COMMODORE WAY

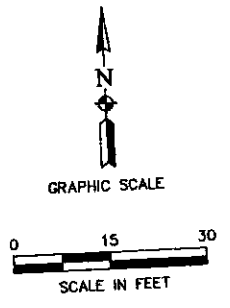


**LEGEND**

- ⊗ GROUNDWATER MONITORING WELL
- SUBSURFACE LINE

**NOTE**

- 1/ SIGNAL LOST DUE TO REBAR IN CONCRETE SLAB.
- 2/ APPROXIMATE LOCATION OF BEND BASED ON E-W TANGENT AND SW-NE TANGENT. SIGNAL LOST IN THIS AREA.



**FOSTER  WHEELER  
ENVIRONMENTAL CORPORATION**

Figure 1-1  
Location Of Subsurface Line,  
2737 West Commodore Way

**ATTACHMENT 1**

**APOLLO GEOPHYSICS CORPORATION  
REPORT**



# APOLLO GEOPHYSICS CORPORATION

Engineering, Hydro-Geology, Environmental & Construction

Mr. Bryan Graham  
Tetra Tech FW, Inc.  
12100NE 195<sup>th</sup> Street, Suite 200  
Bothell, Washington 98011

Friday, August 29, 2003

ATTN: Mr. Graham

Enclosed is a copy of our geophysical report titled, "2737 West Commodore Way – Underground Storage Tank Locate." The exploration was authorized on August 7, 2003 and was conducted in accordance with the scope of work outlined in the Tetra Tech FW, Inc. Purchase Order No.: 048754.

The attached report presents our interpretations and recommendations developed during our exploration, including Ground Penetrating Radar (GPR) Imagery presented in Figure 2 illustrating the data collected during the exploration.

We appreciate the opportunity to conduct this investigation. Please do not hesitate to contact us if you have any questions or comments. Please keep us informed on the developments pertaining to the direct exploration. If you would like us to assist you on a future project, we would definitely welcome the opportunity.

Sincerely,

Lynn M. Ringstad, Licensed Engineering Geologist  
Senior Geologist/Geophysicist

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# APOLLO GEOPHYSICS CORPORATION

Engineering, Hydro-Geology, Environmental & Construction

## 2737 West Commodore Way Underground Storage Tank Locate

AGC File No. 03.3039

Friday, August 29, 2003

This report presents the results of geophysical exploration for potential Underground Storage Tanks (USTs) at the above referenced site. The site is located at 2737 West Commodore Way in Seattle, Washington. A one-person field crew from **APOLLO GEOPHYSICS** completed the geophysical field program on Friday, August 15, 2003.

We investigated the site, as directed by Tetra Tech FW, Inc. personnel, with an Electromagnetic (EM) instrument, which locates buried metal objects. We traversed the site with the EM instrument on approximate 3- to 5-foot line spacings, which produced target areas for the Ground Penetrating Radar (GPR). We further investigated the target areas using GPR, which enabled us to determine if the targets were potential USTs. Ground Penetrating Radar established a relative depth, size and ground projection of the object (i.e. to determine if the object was indicative or was not indicative of a UST). Small objects in the near surface, 1 to 2 feet, will respond the same as a larger object (UST) at depth.

### RESULTS OF THE GEOPHYSICAL SURVEY

We traversed the site with the EM instrument. The approximate areas investigated are presented on the Site Plan in Figure 1. We did not detect anomalies near MW 01MW-05 and the asphalt patch. We did detect a potential buried pipe running east to west located approximately 16 feet from the north side of the office building. We traced the potential pipe towards 01MW-04 until we encountered a potential reinforced slab with the EM instrument. We traced the potential buried pipe with both the EM and GPR instruments towards the southwest portion of the site near existing buildings and exposed piping, which Tetra Tech FW, Inc. personnel indicated as a potential connection with the pipe.

We did not detect a potential UST near MW 01MW-05, instead we suspect from the GPR imagery that the obstruction may be remnants of a concrete slab located approximately 2 to 2.5 feet below the ground surface. We traversed the area of the suspected slab, Target #1, with the GPR instrument and it does appear to be a reinforced concrete slab. We also crossed the potential pipe in a few locations

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with the GPR instrument in an attempt to determine if the potential buried pipe connected with the exposed pipe. The potential buried pipe and the exposed piping do appear to connect.

The approximate locations of Targets #1 and the potential buried pipe are presented on the Site Plan in Figure 1. The GPR imagery of Target #1 is presented in Figure 2.

All EM and GPR target areas and recommended direct exploration locations were marked in the field with environmentally degradable paint. Suspected utility pipes, demolition debris, etc., were not marked in the field.

The 'GPR Imagery' presented in Figure 2 has a horizontal and vertical scale of approximately 1 inch equals 4 feet. With regard to the estimated vertical scale, the normal relationship between radar time and actual depth for the Northwest Region is approximately 4 to 4.5 nanoseconds per foot. It should be noted that this relationship holds true in a general sense. Variations of water content, silt content and other factors, such as the presence of concrete flooring, may also change this relationship. Therefore it should be expected that the vertical scale is an estimate only and may vary from the shown scale.

## **ELECTROMAGNETIC**

The electromagnetic, or EM device, transmits and receives an electromagnetic signal. The EM signal is transmitted through the ground, which in turn radiates a signal that is dependent on the ground conductivity and which is also received at the receiver. The two signals, the transmitted and ground response EM waves, are balanced for a zero response in the instrument. When the ground conditions change, for example, when the transmitted signal encounters buried metal, the balance or null point changes, and the instrument responds with an audible signal. Depending on the size of the metal object, the penetration is up to 10 feet in depth. The EM survey was limited to those areas of the Site, near the reported former UST location, where reinforcing steel was not present in concrete and/or where above ground metal objects were not present.

## **GROUND PENETRATING RADAR**

**APOLLO GEOPHYSICS** uses a PE1000 with either a 450 or 110 MHz antenna for shallow UST Locates. The radar antenna transmits an electromagnetic step-pulse at a frequency of 450/110 MHz at a selected stack rate of 32/64. When the signal encounters a change in electrical properties/permittivity, a portion of the signal energy is reflected back to the surface. The character of the reflection is used to define the source of the reflection. The reflected signal is received by the antenna, processed by a DSP radar processor with signal gain control and the raw data is recorded by the outboard 80486 computer with 16 MB RAM & 300 MB Hard Drive. The radar data is displayed by the computer on a 16.5 cm



Color Active Matrix LCD VGA screen in real-time. The radar displays the data in real-time, which enables us to review the data in the field for on the spot evaluation. The recorded raw data, as recorded by the computer, is then later processed to remove unwanted peripheral effects by proprietary GPR software.

A typical circular UST will produce, in cross-section, a hyperbolic reflection. A traverse parallel to the centerline of the UST will show a horizontal (if there is no velocity or elevation change along the traverse) reflection, with a partial hyperbolic signature at both ends of the UST. The hyperbolic signature is the result of "seeing" the tank before the center of the antenna is over the tank.

### **WARRANTY OF SERVICES**

Electromagnetic methods may define UST's constructed of non-ferrous metals, but not fiberglass or plastic materials. Ground Penetrating Radar may define fiberglass or plastic UST's or drums provided they fall within the exploration grid of the GPR.

All geophysical information presented is based upon geophysical measurements made by generally accepted methods and field procedures and **APOLLO GEOPHYSICS'** interpretation of these data. The geophysical results are, therefore, interpretative in nature and are considered to be a reasonably accurate presentation of existing conditions within the limitations of the methods employed. Services performed by **APOLLO GEOPHYSICS** under this agreement are conducted in a manner consistent with, but no less than, that level of care skill ordinarily exercised by members of the profession currently practicing under similar conditions. We cannot guarantee the accuracy or correctness of any interpretation, and we shall not be liable or responsible for any loss, cost, damages or expenses incurred or sustained by the Client resulting from any interpretation made by any of our officers, agents or employees. No other warranty, expressed or implied, is made. **APOLLO GEOPHYSICS** recognizes that subsurface conditions may vary from those encountered at the location where geophysical or other explorations are made. The data interpretations and recommendations made by **APOLLO GEOPHYSICS** are based solely on the information available to them at the time of performance; and **APOLLO GEOPHYSICS** shall not be responsible for the interpretation, by others, of the information developed.

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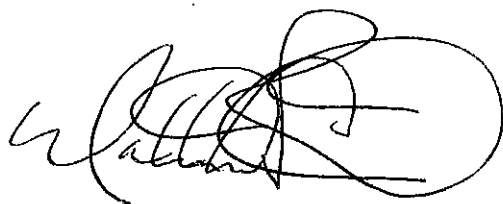
We trust this will complete your requirements for this project and look forward to working with you on future projects. If you have any further questions or need further assistance, please don't hesitate to call.

Sincerely,

**APOLLO GEOPHYSICS CORPORATION**

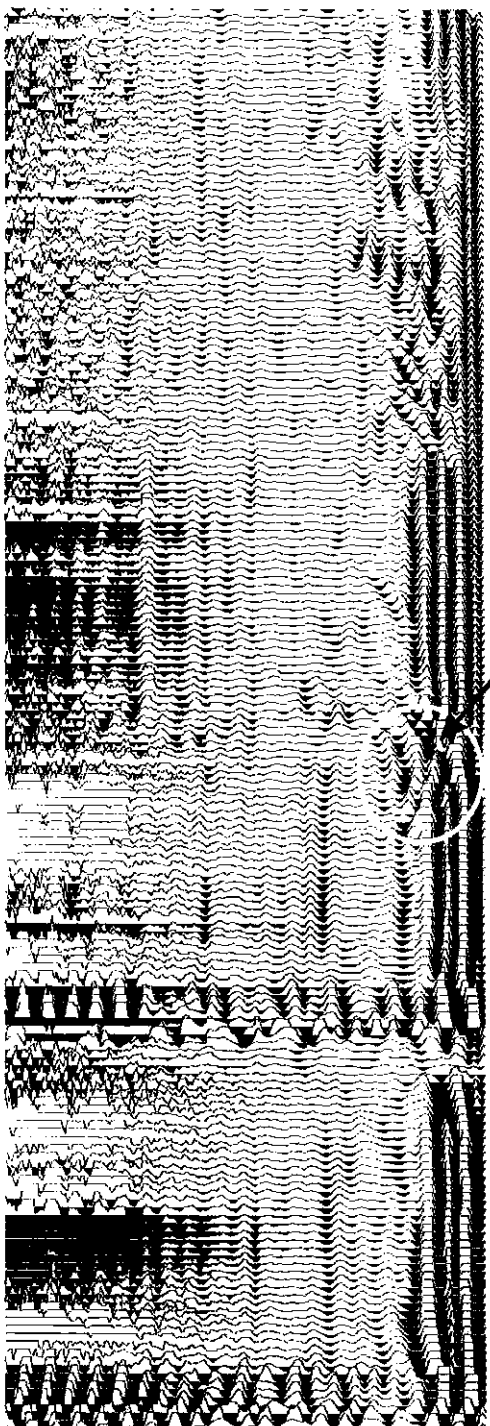
*Lynn M. Ringstad*

Lynn M. Ringstad, Licensed Engineering Geologist  
Senior Geologist/Geophysicist

A handwritten signature in black ink, appearing to read 'Matthew C. Ringstad', written in a cursive style with a large circular flourish at the end.

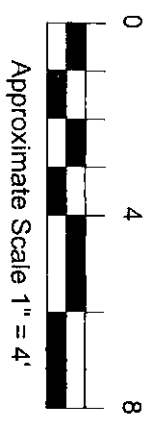
Matthew C. Ringstad  
Senior Geophysicist

# GPR Imagery - Target #1



suspected pipe

limits of  
suspected  
concrete slab



NOTE: The normal relationship between radar time and actual depth for the Northwest Region is approximately 4 to 4.5 nanoseconds per foot. It should be noted, that this relationship holds true in a general sense. Variations of water content, silt content and other factors, such as the presence of concrete flooring, may also change this relationship.



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FIGURE  
2

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