

Utility Locating & Mapping Survey Report

Chemical & Petroleum Bulk Storage Facilities Upgrade

**Coney Island WPCP
2591 Knapp Street
Brooklyn, NY 11235**

Prepared For Crescent Contracting Corp.

INTRODUCTION

A utility locating and mapping survey was performed by Underground Surveying, LLC of 152 Deer Hill Avenue, Danbury, CT for Crescent Contracting Corp. of 2800 Webster Avenue, Bronx, NY. The survey was performed on September 3, 4, 8, 9 and 15, 2009 at WPCP, 2591 Knapp Street, Brooklyn, NY. The purpose of the survey was to map the location and depth of underground utilities within areas A, B, C, D, E and F as shown on Drawings D1, D2, D3, D4 and D5.

The following survey was performed with cable and pipe locators and ground-penetrating radar (GPR). Before reading the full report, we advise that you read the following paragraphs to gain a basic understanding of the technology and to understand its limitations.

Cable and Pipe Locators

The science of cable and pipe locating is based on the principal that a current flowing along a conductor creates a magnetic field, and that magnetic field or signal, which is either passive or active in nature, can be detected via a receiver.

A passive signal is one that is naturally occurring around a conductor, or in this case an underground utility. Some examples of passive signals include the following:

1. Current flowing in an electric supply cable.
2. Earth return current from power systems that use metal pipes or cable sheaths as a convenient conductor.
3. Radio frequency currents from very low frequency (VLF) radio transmissions that have penetrated the ground and flow along a buried utility.

A passive sweep is performed to search for inaccessible, abandoned or unknown utilities using only a receiver. To perform a passive sweep, a survey grid is traversed in “power” mode, with the receiver blade in line with the direction of movement and at right angles to any utilities that may be crossed. When the receiver indicates the presence of a utility, it is pinpointed, traced and marked. The sweep is then continued until all detected utilities have been marked and the entire grid has been traversed in both directions. After completing the sweep, the entire process is repeated in “radio” mode to search for utilities that radiate VLF radio signals.

Passive signals enable utilities to be located, but not identified, because the same signal may appear on multiple utilities within the grid. To solve this problem, an active signal must be applied to each individual utility line.

An active signal is one that is intentionally generated by a transmitter. In this mode, the signal can be applied directly to the utility via direct connection or induction. This enables utilities to be identified, traced and their depth determined with a receiver.

Direct connection involves plugging a connection cable into a transmitter output socket and connecting directly to the target line. This can be accomplished with connection leads or with a

transmitter clamp. Connection leads are generally used to apply a signal to metallic conduits, sight lighting structures and metallic pipes. This is the preferred method for locating secondary electric, water and gas.

Many electric, telephone and cable lines are housed within plastic conduits or buried into the ground without protection. In addition, directly connecting to these lines is usually too risky or forbidden. In such instances, a transmitter clamp is used to apply a signal to the cable without interrupting service to the line. The clamp is easy to apply, but the signal may not travel as far as it does with connection leads, and works best if the target line is grounded at each end. This is the method of choice for locating primary electric, telephone and cable lines.

If an active signal cannot be applied to a line because it is inaccessible, an induction sweep must be performed. The transmitter contains an antenna, that when placed on the ground directly on top of a utility line, can induce a signal into it. The advantage of using induction is that a signal can be applied without access to the line and it is very quick and easy to use. The disadvantages are that induction efficiency is poor on deep targets, it is only useful at depths down to 6 feet and the signal can induce into lines other than the target. In addition, signal strength is often lost in the surrounding soil, the signal is shielded by reinforced concrete and a signal will not apply to a well-insulated line unless it is effectively grounded at each end. Despite its shortcomings, an induction sweep can sometimes successfully locate unknown or abandoned utilities when GPR results are inconclusive.

An active signal cannot be applied to non-conductive (non-metallic) utility lines. To combat this, a detectable duct rod or self contained transmitting sonde must be inserted into the line via a manhole, handhole, cleanout or catch basin. The disadvantages of this method are that some non-metallic utility lines do not have access points or might be obstructed by detritus. Nonetheless, this is the best method for locating fiber optics, future use lines, sanitary sewer and storm sewer.

Ground Penetrating Radar (GPR)

Quite often, non-metallic, inaccessible, unknown or abandoned utilities cannot be located with traditional cable and pipe locators. When this occurs, Ground Penetrating Radar (GPR) must be used in conjunction. GPR is a non-invasive, non-destructive geophysical surveying technique that is used to produce a cross-sectional view of objects embedded within the subsurface.

All GPR units consist of three main components: a power supply, control unit and antenna.

To understand how GPR works, we must first understand the performance of a scan is. A scan is performed by moving the antenna across the surface linearly to create a series of electromagnetic pulses over a given area. During a scan, the control unit produces and regulates a pulse of radar energy, which is amplified and transmitted into the subsurface at a specific frequency by the antenna. Antenna frequency is inversely proportional to penetration depth, which makes antenna selection the most important step in the survey design process. Below is a list of antenna frequencies, their application and maximum penetration depth.

Frequency (MHz)	Sample Applications	Max Penetration Depth (ft.)
2600	Concrete, Roadways, Bridge Decks	1
1600	Concrete, Roadways, Bridge Decks	1.5
900	Concrete, Shallow Soil, Archaeology	3
400	Shallow Geology, Utility Locating, Environmental, Archaeology	9
200	Geology, Environmental	25
100	Geology, Environmental	60

During a scan, the control unit records the strength and time required for the return of any reflected energy. Reflections are produced in the data screen profile (on the control unit) whenever the energy pulse enters and exits contrasting subsurface materials. The way it responds to each material is determined by two physical properties: **dielectric constant** and **electrical conductivity**.

The **dielectric constant** is a descriptive number that indicates how fast electromagnetic energy travels through a material. Energy always moves through a material as quickly as possible, but certain materials slow down the energy more than others. The higher the dielectric, the slower the energy will move through the material, and vice versa. Below is a list of some common materials with their corresponding dielectric constants and velocity values.

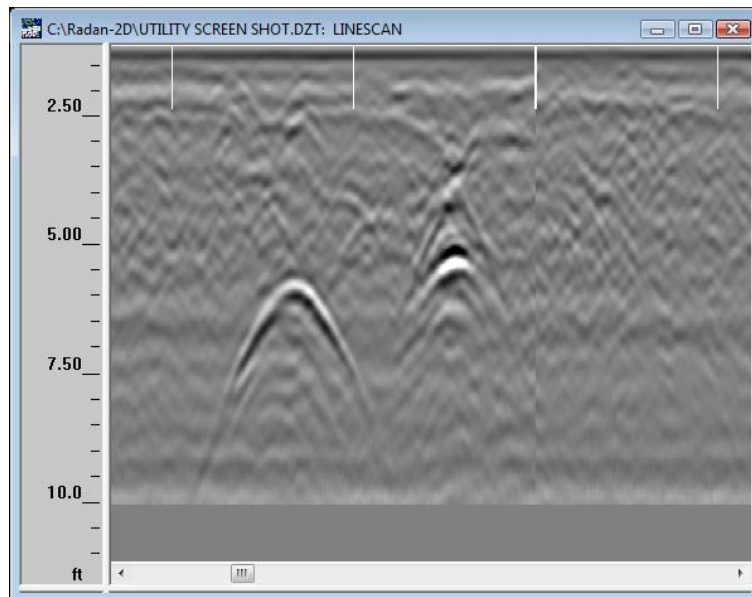
Material	Dielectric	Velocity (mm/ns)
Air	1	300
Fresh Water	81	33
Ice	3	167
Dry Sand	3 – 6	120 – 170
Wet Sand	25 – 30	55 – 60
Silt	10	95
Wet Clay	8 – 15	86 – 110
Dry Clay	3	173
Marsh	12	86
Average Soil	16	75
Granite	5 – 8	106 – 120
Limestone	7 – 9	100 – 113
Concrete	5 – 8	55 – 120
Asphalt	3 – 5	134 – 173
PVC	3	173

To determine the location of a subsurface target in the data screen profile, there must be a contrast between the dielectric values of the material one is scanning through and the target one is searching for. For example, a pulse moving from dry sand (dielectric of 5) to wet sand (dielectric of 30) will produce a strong, highly visible reflection, while moving from dry sand (5) to limestone (8) will produce a weak one. In addition, if one knows the dielectric value of the subsurface material one is scanning through, the control unit can measure the amount of time required to receive the reflected signal and convert this to depth.

Since the GPR emits electromagnetic energy, it is subject to attenuation (natural absorption) as it moves through a material. Energy moving through resistive (less conductive) materials such as dry sand, ice or dry concrete will penetrate much further than energy moving through absorptive (more conductive) materials such as salt water or wet concrete. As a result, the greater the contrast in **electrical conductivity** between the material one is scanning through and the target one is searching for, the brighter the reflection; high conductive materials such as metals produce the brightest reflections.

To understand how dielectric and electrical conductivity differences translate into visual data requires an understanding of how the antenna emits energy. Imagine the antenna scanning perpendicular to a pipe. Energy emits from the antenna in a 3-dimensional cone shape, not in a straight line as one might think. The two-way travel time for energy at the leading edge of the cone is longer than for energy directly below the antenna. Because it will take longer for energy at the leading edge to be captured, when the antenna first approaches the pipe, it will appear low

in the data screen profile. As the antenna moves closer to the pipe and the distance between them decreases, the reflections will appear higher in the profile. At the point where the antenna is located directly above the pipe, the minimum distance of separation is reached and the reflections reach their zenith. As the antenna moves away from the pipe and the distance between them increases, the reflections appear lower in the profile once again. After the scan is completed, the center of the pipe will appear in the data screen profile as an upside down U, which is referred to as a hyperbola.



To gather, organize and present the data, a series of scans are performed within an orthogonal survey grid. At the end of each scan, the data screen profile is reviewed for the presence of hyperbolic targets. If present, the antenna is moved backward to place a cursor (which depicts the center of the antenna) on the center of the targets. The location and depth of the targets are then marked on the surface with chalk, paint and/or flags. Once the entire survey grid has been scanned, the marks are reviewed to search for patterns similar to that of the desired targets, in this case a pipe. Any marks that run in straight line and whose hyperbolas appear to be highly conductive metal targets are then connected, thereby displaying the location and depth of the pipe.

MATERIALS

Cable and pipe locating was performed with an RD4000Rx receiver and RD4000T10 transmitter, both of which were manufactured by the Radiodetection Corp., of Bridgton ME. The GPR survey was performed with the SIR-3000, which was manufactured by Geophysical Survey Systems, Inc., of Salem, NH.

METHODS

A visual inspection was performed within each area to search for utility poles, utility vaults, manholes, handholes, catch basins, drains, conduits, cleanouts, water valves, gas valves, tank pads and vents located within or near the survey area. A visual inspection was also performed in the basement of each building surrounding each area to search for utilities exiting the basement wall. Active mode cable and pipe locating was performed within each area by directly applying a radio signal to electrical conduits, telecommunication conduits, fire hydrants, water shut off valves, ground wires and metallic drain lines. A detectable duct rod was threaded within all accessible non-metallic drains, storm sewer and sanitary sewer lines that appeared to run through the survey area at a depth of less than 6 feet. Passive mode cable and pipe locating was performed to search for inaccessible high voltage electric lines and telecommunication lines. Lastly, ground penetrating radar (GPR) scans were performed to more accurately determine the location and depth of each line and to search for non-metallic, unknown and abandoned utilities.

RESULTS

Underground utilities were marked on the ground with paint and/or flags using the standard American Public Works Association (APWA) color codes. Electric was marked with *red*, communications with *orange*, water with *blue*, drains, storm sewer and sanitary sewer with *green* and unknown lines with *pink*. The results of the survey are shown on Drawings D1, D2, D3, D4 and D5.

DISCUSSION

The results of the survey at each survey area are discussed below.

Area A

The results of the survey were fair. The following underground utilities were detected: two high voltage electrical duct banks, a communication duct bank, eight storm sewer lines, one drain line, two ground wires, an underground tunnel and two unknown lines exiting the tunnel that appear to run along the same path as the ground wires. If excavating to a depth of 5 feet or greater, we recommend that you hand dig or vacuum excavate to verify the location and depth of the unknown lines.

Area B

The results of the survey were good. The following underground utilities were detected: a high voltage electrical duct bank, sight lighting electric line, ground line and six storm sewer lines. Please note that one of the manholes could not be pulled due to corrosion, so there may be additional storm sewer lines that could not be marked.

Area C

The results of the survey were excellent. The following underground utilities were detected: an electrical duct bank, sight lighting electric, a secondary electric line, three ground wires, two drain lines, two abandoned lines and an unknown line.

Area D

The results of the survey were good. The following underground utilities were detected: a utility vault, large diameter drain line, two electric lines and three storm sewer lines.

Areas E & F

The results of the survey were poor due to signal interference from rebar embedded within the concrete slab. Many of the lines associated with the UST's located within the sidewalk could not be located due to signal interference. In addition, multiple drain lines exiting the basement of the building could not be detected as well for the same reason. The following underground utilities were detected: two electrical duct banks, four secondary electric lines, five storm sewer lines, two sanitary sewer lines, a water line and an unknown line. We recommend that you hand dig or vacuum excavate to verify the location and depth of existing utilities prior to making drainage improvements within this area.

Pump & Power House (East)

The results of the survey were inconclusive. We recommend that you hand dig or vacuum excavate prior to making drainage improvements within this area.

CONCLUSION

As emphasized earlier, GPR can only detect electrical differences in the subsurface. Any interpretations have to be considered tentative until an excavation or test-boring program can verify the existence of these features. A rule of thumb for test pits or excavations following a GPR survey is to dig first where actual echoes are shown on maps, and then extend outward from

there. Some of the targets interpreted in this report as utility lines may be portions of abandoned lines, or construction debris or cobbles in fill material that fortuitously lay in straight lines.

Again, because of the difficulties noted above in attempting to resolve all utilities, care should be taken in any test borings or soil excavations. There may be lines at depths beyond the reach of the GPR survey, and there may be non-metallic lines that were not detected by the cable and pipe locating survey.

Because of errors that can arise when transcribing survey data from maps to the field, the most reliable position of the underground utilities will be obtained by examining the markings on the ground surface. If construction is delayed, it may be advisable to refresh the marks periodically, especially in heavily trafficked areas.

If you have any questions, comments or concerns please don't hesitate to contact us at 203.312.9844 or info@undergroundsurveying.com.

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