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DRAFT

RE: GPR and EM 31 Survey at Toronto Western Hospital, 339 Bathurst St.

Geophysics GPR International Inc. was requested by PCL to perform a ground penetrating radar (georadar) and EM 31 survey at the above address in Toronto. The purpose of the investigation was to identify any obstructions, foundations or facilities prior to construction planning.

The survey was performed on November 27, 2020. The approximate location of the survey is shown in Figure 1. The extents of the survey were indicated by the client on site.

The following paragraphs describe the survey design, the principles of the test method, the methodology for interpreting the data, and provide a culmination of the results in the form of an anomaly map.

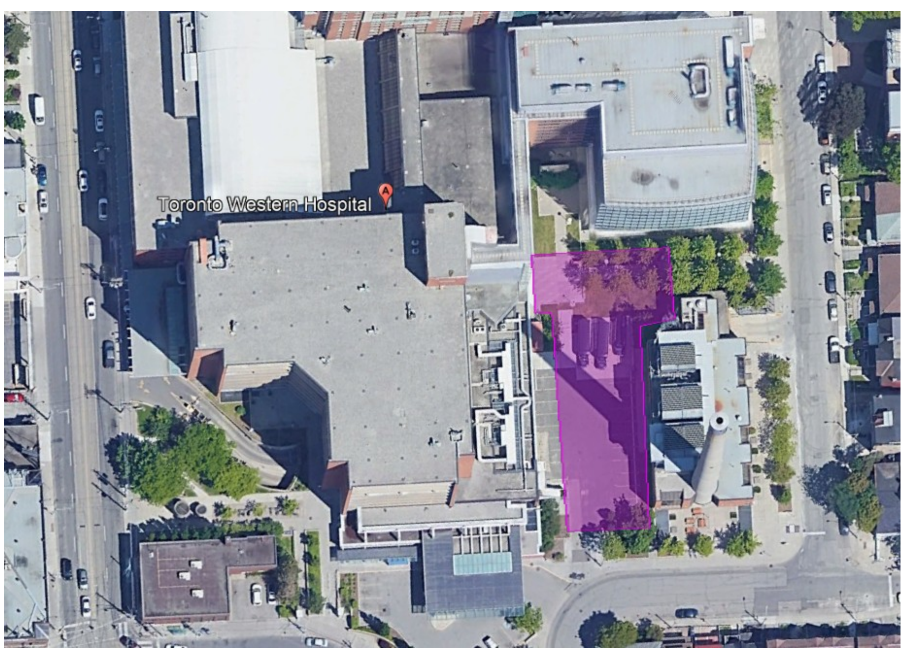

Figure 1: Approximate location of scan area highlighted with pink polygon.

Methodology

Ground Penetrating Radar

The GSSI SIR3000 was used with the GSSI 350 MHz antenna for this survey. The 350 MHz antenna generates a pseudo-cross section within the upper 2-4 m of the subsurface.

Basic Theory

Ground Penetrating Radar (or Georadar) utilizes radar technology to obtain a near-continuous profile of the subsurface. The basic principle is to emit an electromagnetic impulse into the ground. This pulse will travel through the sub-surface and reflect off the boundaries of materials with differing dielectric constants (contrasts of EM impedances). The reflected pulse returns to the surface and is recorded by a receiver. Examples of radar reflecting boundaries include air/water (water table); water/earth (bathymetry); earth/metal, PVC, or concrete (pipe locating); differing earth materials (stratigraphic profiles, including bedrock profiles).

The depth of investigation is controlled by the frequency and power of the antenna limited by attenuation and diffraction of the radar signal. Lower frequency antennas provide greater depth penetration at the expense of resolution. The radar signal is attenuated by conductive ground materials (e.g. clays, dissolved salts etc.). The radar signal is diffracted by irregular shaped material (e.g. boulders, debris etc.) that prevents the clear return of the reflected pulse.

Interpretation of georadar data is based primarily on the qualitative analysis of three characteristics of radar reflections: continuity, amplitude and shape. The interpreter then identifies reflectors and textures within the radar records that represent subsurface contacts, objects or zones. The true nature of the interpreted features can only be assumed without corroborating evidence.

Survey Design

The area was surveyed with line increments of approximately 2m in a double axis grid. Impulses are emitted at a predetermined frequency rate of 10 to 80 scans/second. Only by moving the antennas along a profile directly over the targets can the locations and depths be determined. The data was post processed off site and targets for anomalous areas were picked and plotted on a map (Figure 2).

Terrain Conductivity Electromagnetic Survey (EM-31)

Basic Theory

Electromagnetic (EM) techniques measure the terrain conductivity or resistivity of the subsurface by imparting an alternating current to a transmitter coil placed on or near the earth's surface. The current passing through the transmitter coil produces a magnetic field, which in turn induces small currents in the underlying strata. Currents within the strata produce a secondary magnetic field, which is sensed by a receiver coil. It has been shown that the ratio of the quadrature component of the electromagnetic field detected by the receiver coil to the electromagnetic field produced by the transmitter coil is directly proportional to the terrain conductivity at low induction numbers. The in-phase component of the induced magnetic field is also recorded as the ratio of the induced secondary magnetic field to the primary magnetic field in parts per thousand (ppt).

The EM-31 terrain conductivity meter records two types of data: the quadrature and in-phase components of the electromagnetic field. The quadrature component is a measure of the ground conductivity (milliSiemens per metre (mS/m)) and the in-phase component is a measure of magnetic susceptibility (parts per thousand (ppt)).

The in-phase component recorded by the EM-31 is more sensitive to the detection of buried metal than the quadrature component. Unlike the ground conductivity, the in-phase value is a relative measurement. Additional details regarding the operating principle and the type of information that can be gleaned from the data can be found at the end of this report.

Survey Design

The data were recorded with a Geonics EM-31 MK2 terrain conductivity meter (EM-31). The EM-31 lines of data were collected in two separate single axis grids. The origin for the grids is approximately 7.25m west and 3.5 m south of the southwest corner of the Emergency Department Building. Data was collected in field measured grids as a fixed GPS position could not be maintained throughout the survey area. The data were collected with an approximate spacing of approximately 2 metres.

Prior to data collection, the equipment functional checks are performed outlined in the EM-31 MK2 operating manual.

Interpretation Method and Accuracy of Results

EM-31 data are typically presented with little to no processing aside from contouring and plotting. The data were gridded, contoured and plotted using Geosoft's Oasis Montaj software package.

As discussed above, the terrain conductivity meter records two types of data: the quadrature and in-phase components of the electromagnetic field. Both data sets are contoured and presented in plan view to identify areas that deviate from what is interpreted as background levels. The background conductivity of an area can be found where there is undisturbed native soil without above ground infrastructure.

In general, the quadrature component of the signal is a measurement of the ground conductivity. This component will respond to conductive anomalies including metals and certain contaminants. The in-phase component will primarily respond to metal.

Results and Conclusions

The ground-penetrating radar data was processed and interpreted off site. Points were picked where anomalous targets were observed in the data. The points were plotted on an anomaly map. Refer to Figure 2. Example radar images are shown in Figures 4 to 8.

Ground-penetrating radar identified a reflective layer at a depth of approximately 0.30m from surface along the west side of the grid area. The footprint is approximately 15m long in the north/south orientation and 4m wide in the east/west orientation. There is a sudden change in amplitude and a ringing response throughout the data. This suggests a strong change in material in this area. Multiple reflected targets were observed below the change in material in the north/south orientation. These targets appear to continue north from the reflective layer in a linear trend at depths of 0.5m to 1.5m.

An anomalous area approximately 1m by 3m in length was identified in the southwest corner of the grid area. This target may be indicative of a previously excavated area.

An anomalous area approximately 3.5m by 3.5m was identified in the northern extents of the grid area. There appears to be a cluster of several hyperbolic or reflected point targets at depths of 0.5m to 1.5m in this area. This may only correspond to buried debris. Additional point targets were observed in the georadar data however, the targets are poor and sporadic, lacking any pattern or linear trend which would be indicative of underground conduits, obstructions, foundations or facilities.

The high conductivity values observed with the EM-31 may correspond to fences and other metallic objects at surface in some areas. Some areas are marked as anomalous as the nature of these anomalies are not known. Where possible radar profiles were recorded in areas of potential interest to help supplement EM data.

The EM-31 data plots are presented as Figures 9 and 10 for the Quadrature and In-phase data sets respectively. The interpreted EM anomaly map is presented in Figure 3.

The median conductivity level is 52 mS/m, areas shown in green in Figure 9. The EM anomaly map in Figure 3 shows areas of conductivity greater than 70 mS/m. There appears to be an overlap with conductivity and radar near the fence on the western side of the property at X,Y points 0,15 and 0,25. This is the anomaly seen in the radar data that was observed at 0.30m.

The In-phase (Magnetic Susceptibility) is often treated as a glorified metal detector. When the instrument is perfectly calibrated it will have a value of very close to 0 ppt when there are no influences from above or below ground metal. Unfortunately at this location, the In-phase provided little additional information that was not affected by above or below ground interference. The infield observations are shown on the EM anomaly map as well as some additional conductivity and In-phase anomalies. There is a somewhat large anomalous area at X,Y points 0, 5 to 0,15. This area contains multiple targets that could be running on angles to the survey lines. The nature of this zone is not known.

Additionally the EM-31 mapped two linear targets in the North East of the survey grid near X,Y points 25, 60 and 15, 60. The nature of these targets are also not known. One of the targets could be related to a light pole.

Indicated anomalies, features and targets are based on interpretations of the geophysical results. Ground-truthing is recommended to reveal the true nature of the interpreted targets. Also note, all features or targets may not be detected by the geophysical techniques employed within the investigated area, additional targets could exist and go undetected due to depth, size, interference, line spacing or characteristic geophysical properties.

The interpretation and report was written by Bryan Bolton and Carolyn Bone, P.Geo.

Carolyn Boone, P.Geo.

Attached: EM-31 Fact sheet and Georadar

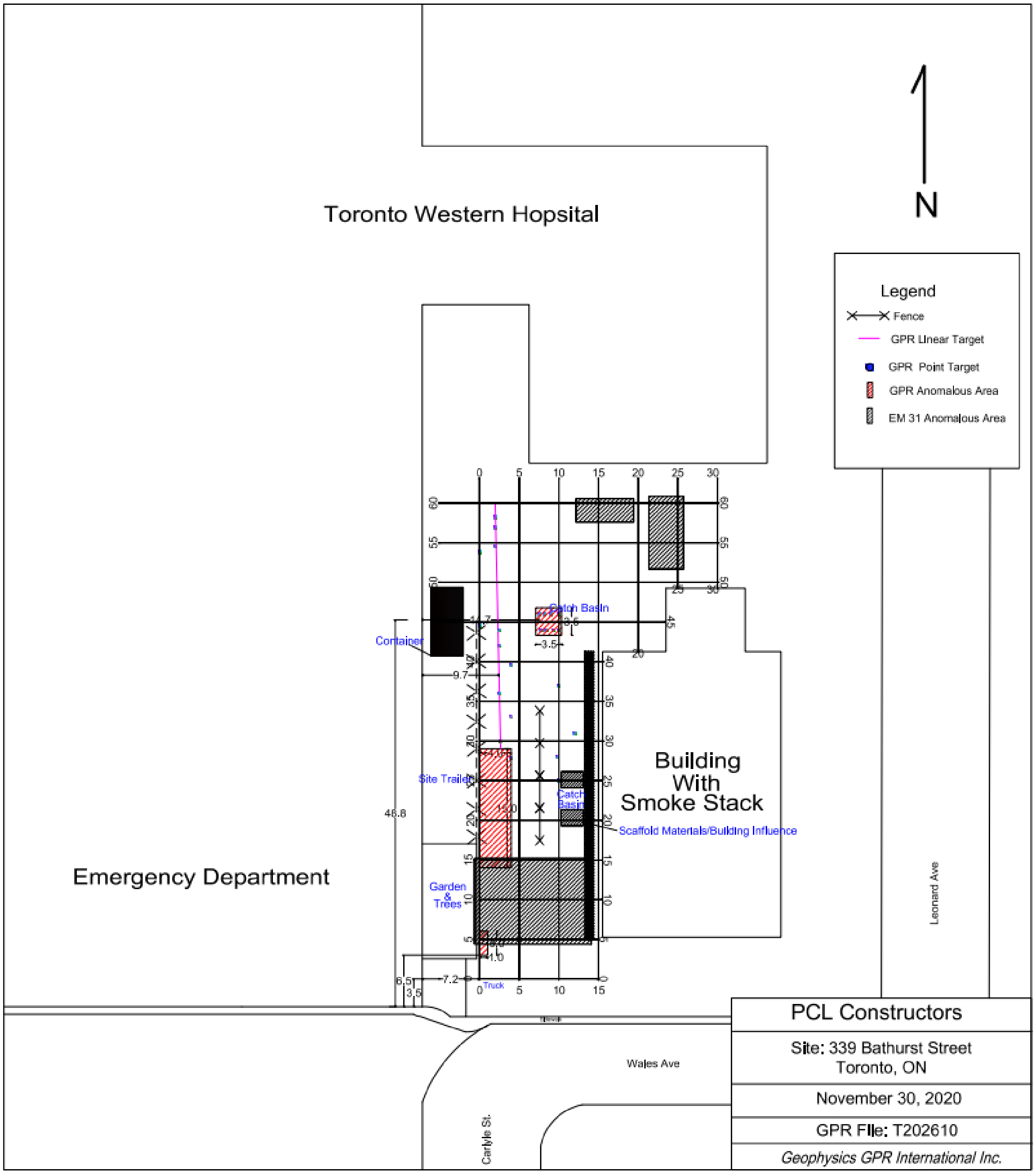

Figure 2: Anomaly map.

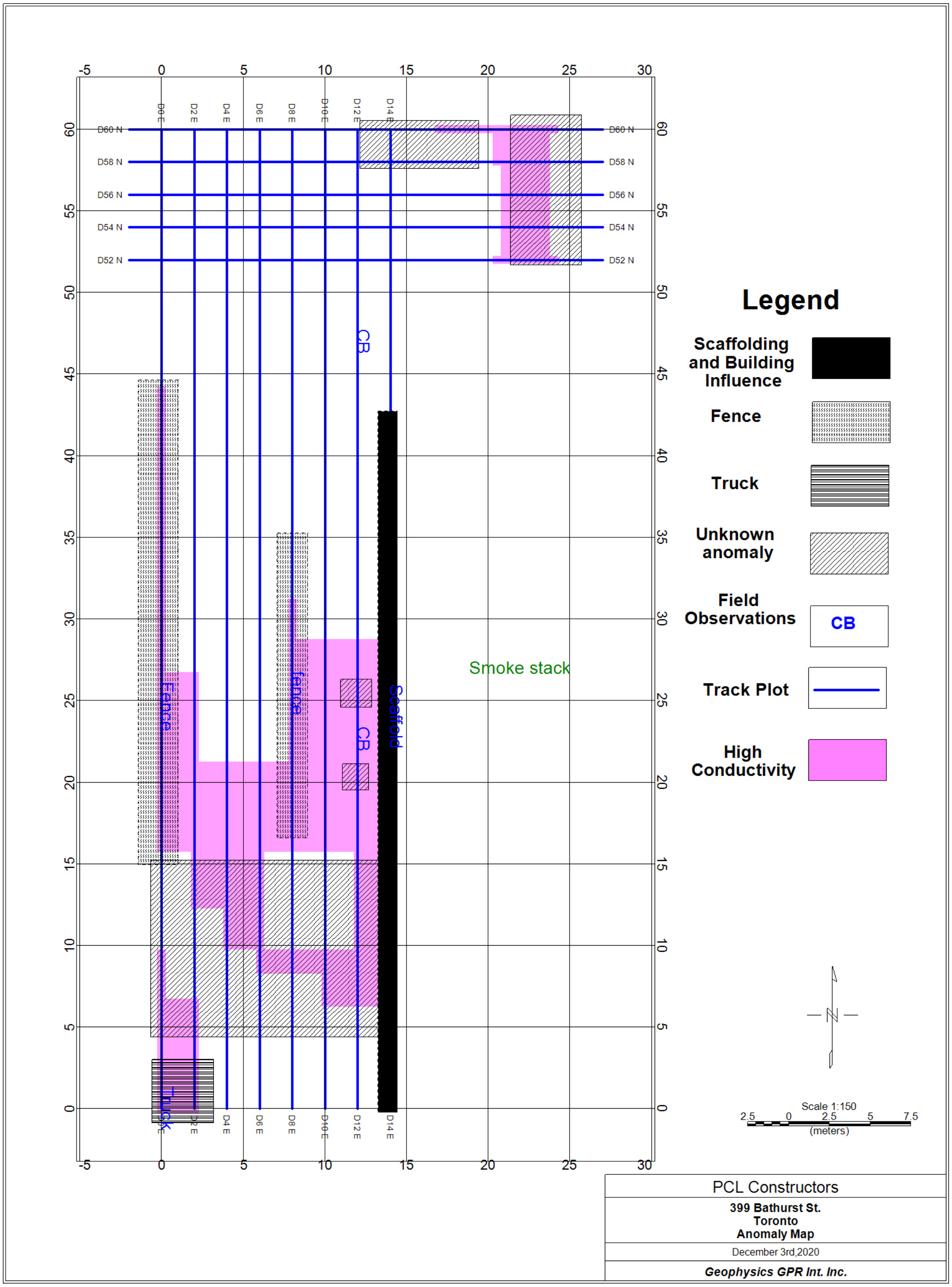

Figure 3: EM Anomaly Map

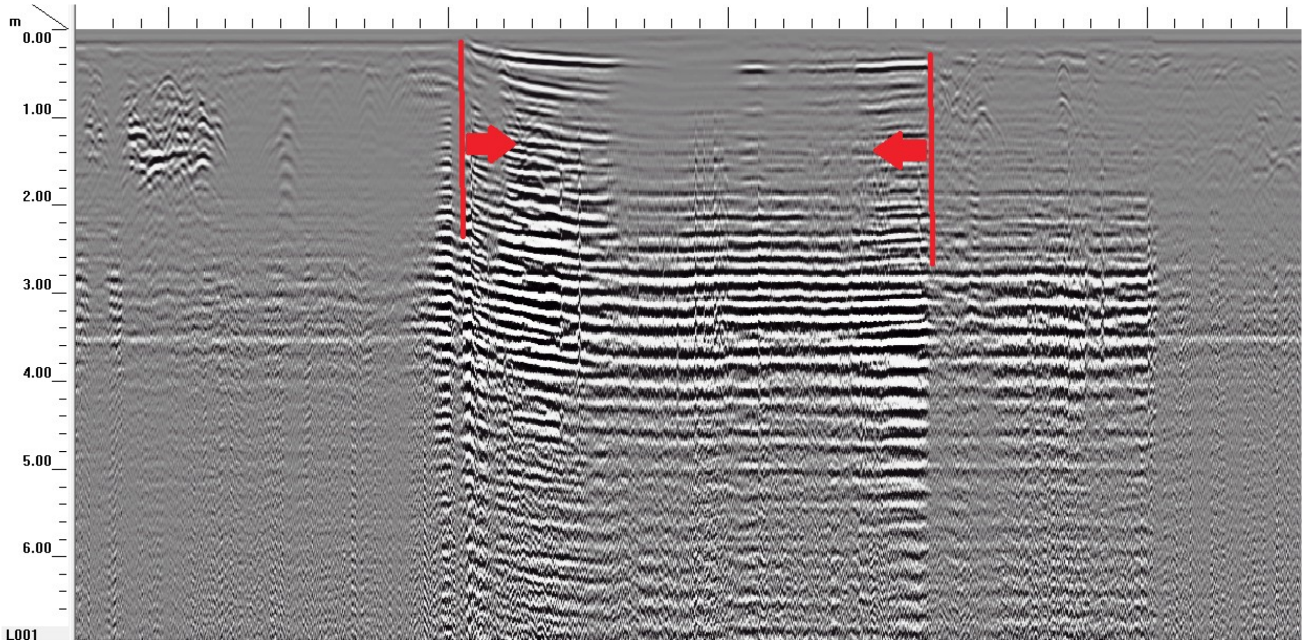

Figure 4: Example georadar line collected in north/south orientation representing the anomalous layer at 0.30m depth.

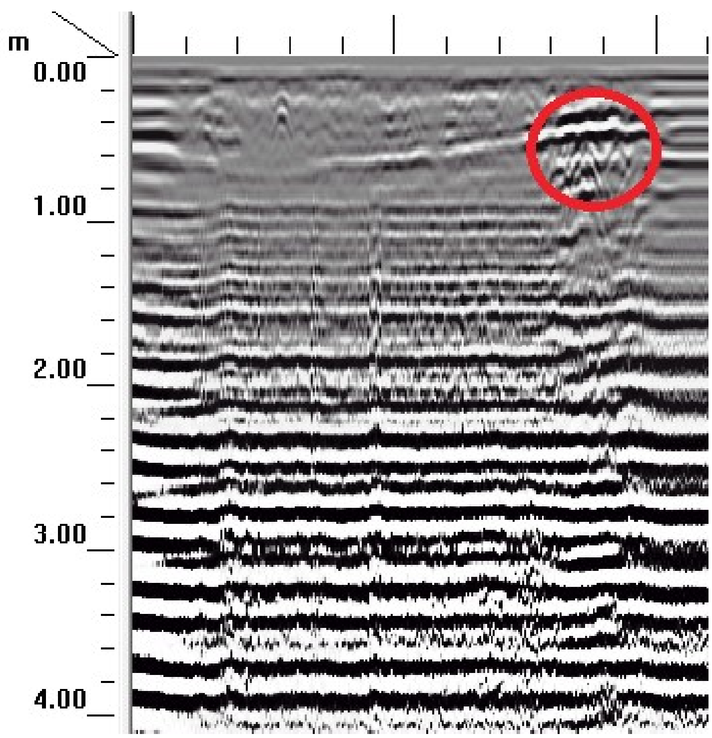

Figure 5: Example georadar line collected in east/west orientation representing the anomalous layer at 0.30m depth.

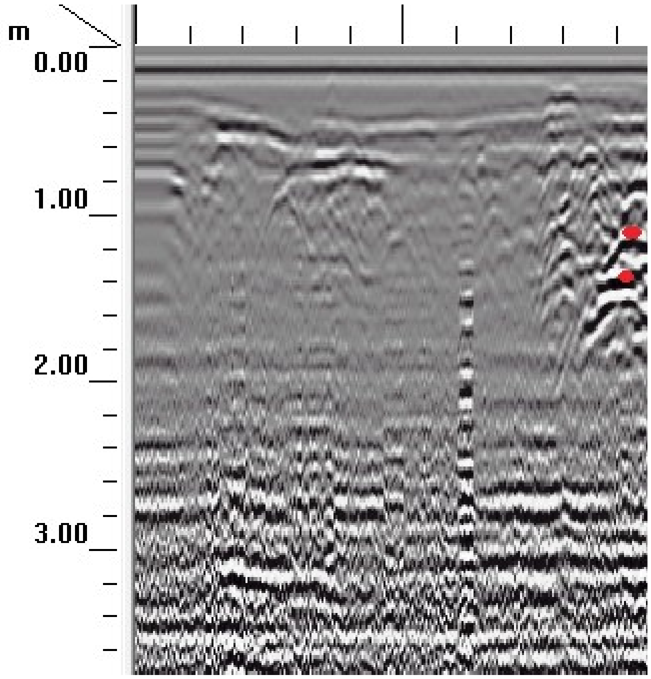

Figure 6: Example georadar line collected in east/west orientation representing the potential linear targets at 0.5m to 1.5m.

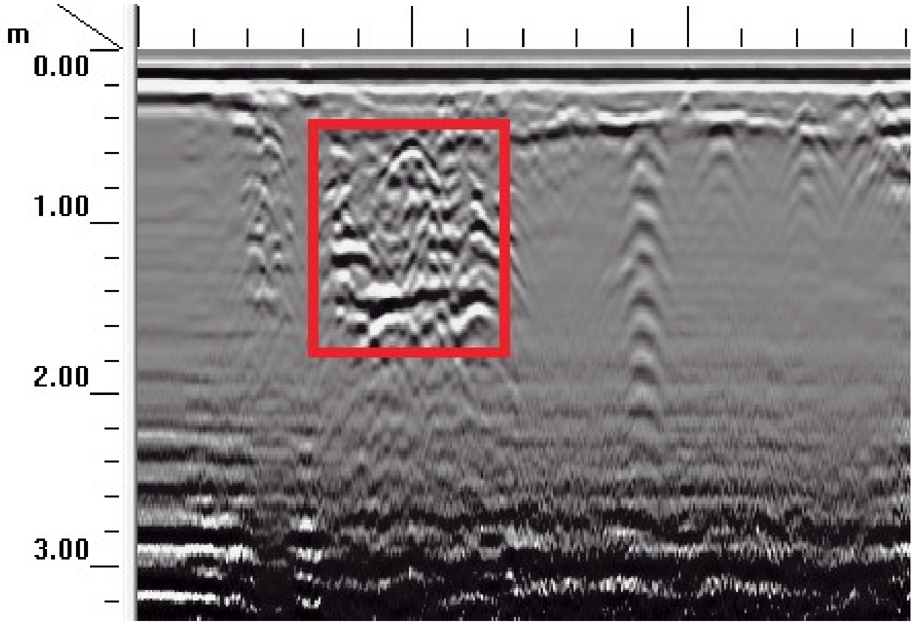

Figure 7: Example georadar image representing the anomalous area in the south-west corner of the scan area.

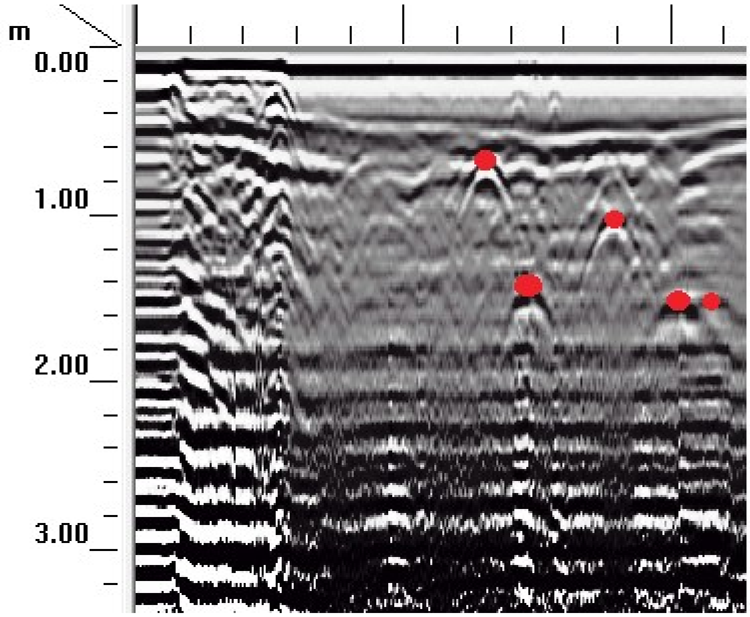

Figure 8: Example georadar image representing the anomalous area with multiple hyperbolic targets at variable depths.

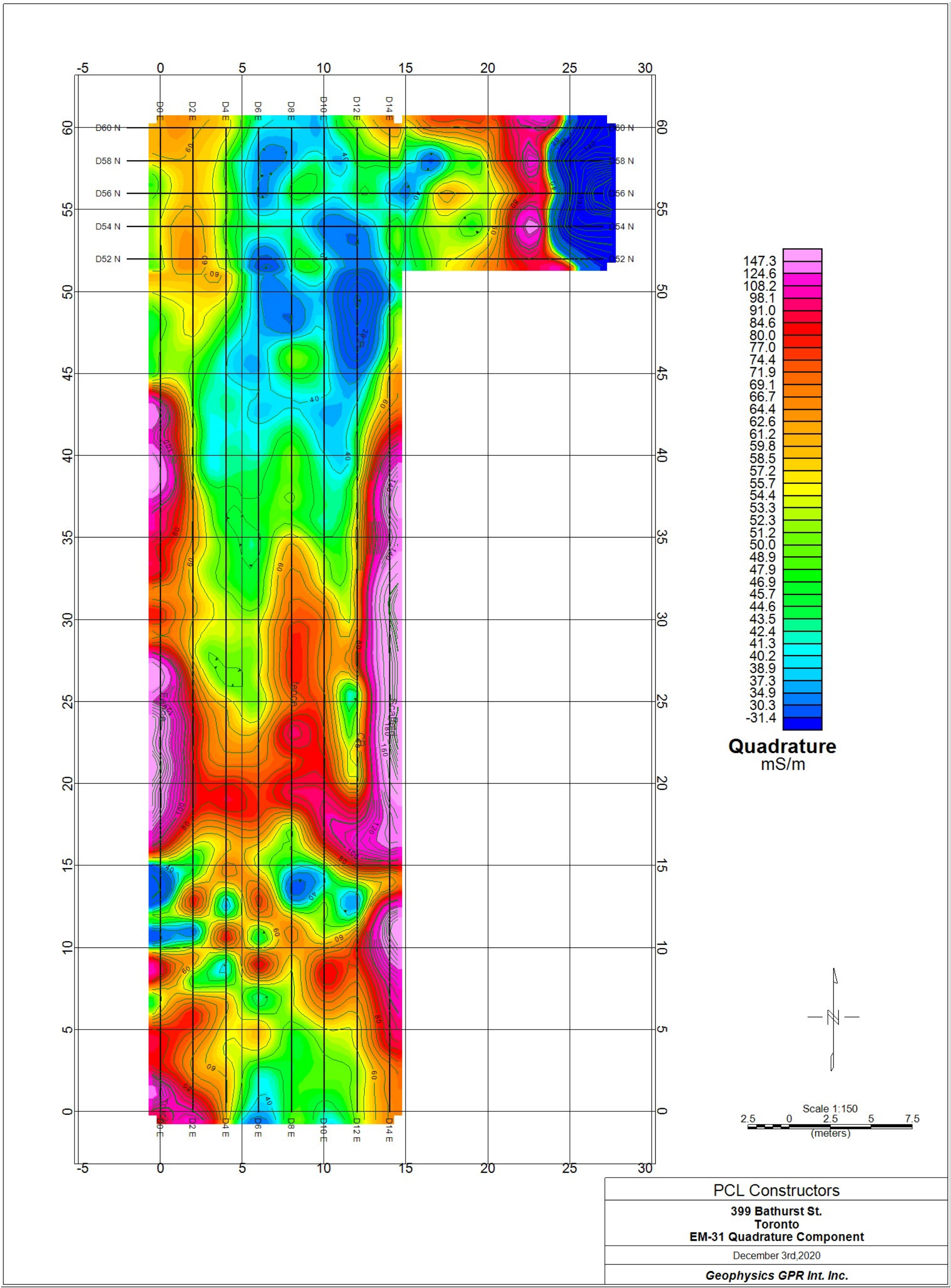

Figure 9: EM 31 Quadrature Component Map.

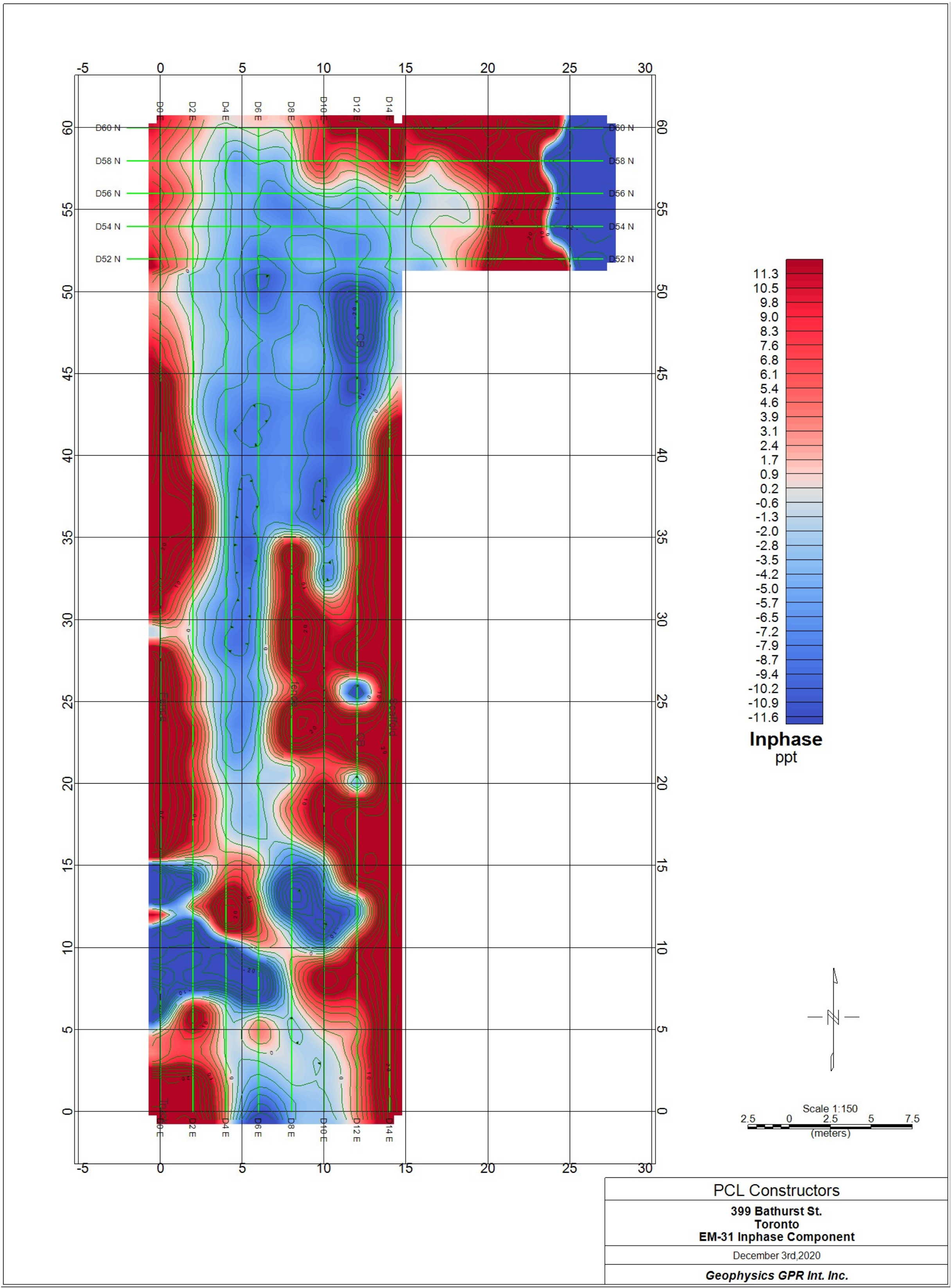

Figure 10: EM 31 Inphase Component Map.

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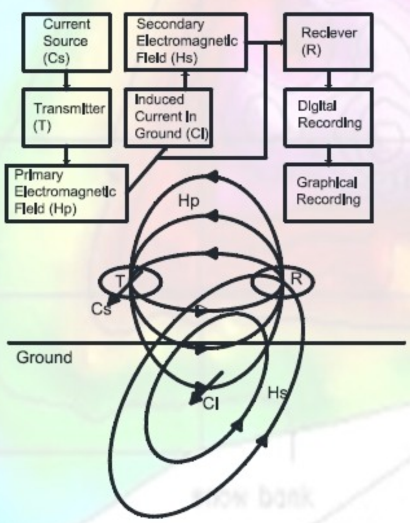
GROUND CONDUCTIVITY METER
EM31-MK2

A ground conductivity meter is an instrument that measures and records changes within ground conductivity or resistivity. Unlike traditional conductivity meters, EM31 does not require any contact with the ground. This inductive method is only possible through imparting an alternating current to a transmitter coil near Earth's surface, where a magnetic field is produced. This magnetic field will induce small currents in the underlying strata and produce a secondary magnetic field; both magnetic fields are detected by a receiver coil, resulting in am interpretable two phase colour image of the surveyed area: ground conductivity (quad-phase) and magnetic susceptibility (in-phase).

The effective depth is determined by the intercoil spacing (distance between the receiver coil and the transmitter coil). The EM-31 has an intercoil spacing of 3.66 m producing an effective investigation depth of approximately 6 m. Although the terrain conductivity value read by the instruments is an average conductivity over the effective depth of the survey, materials in the upper 2.5 m have a stronger weighting.



Principles of Ground Conductivity Meter

Features

- Surveys at walking speed
- Effective investigation depth of ~6 meters.
- Survey in continuous real-time mode
- Detection of gravel, voids in carbonate rocks, regions of permafrost, metallic conductors, pipes.
- General geological mapping (soil type, fault, etc)
- Maps bedrock topography, terrain conductivity, pollution plumes in groundwater, buried infrastructure (foundations, storage tanks, utilities)
- High resolution in conductivity.
- Precision within ±5% at 20mS/m

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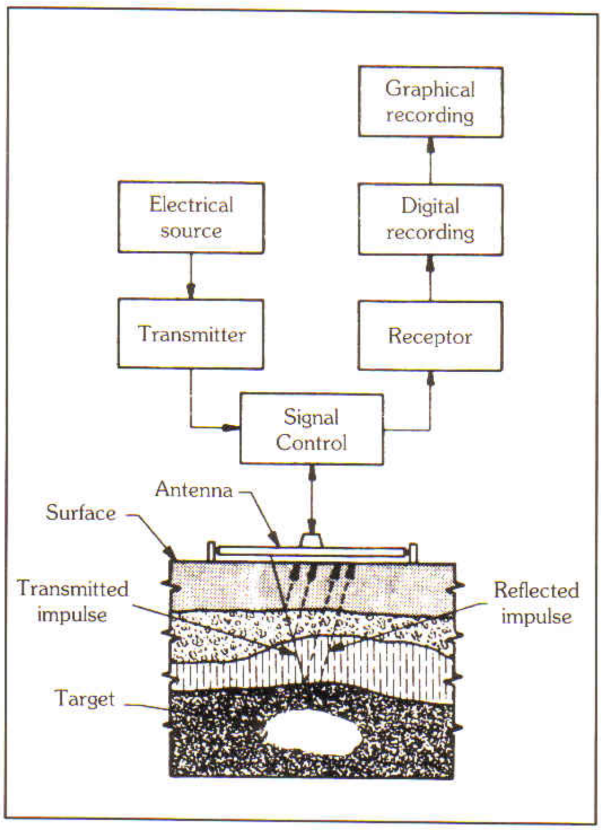
GEORADAR

As indicated by its name, georadar combines high resolution radar with geology. The underlying principle is based on the propagation of electromagnetic wave impulses (VHF) that are reflected by anomalies in the terrain (joints, irregularities, interfaces, etc.) at different depths, and then captured by the antenna. The georadar records the time taken by each transmitted signal to complete the cycle in order to calculate the depth of the anomaly. The result is similar to a seismic reflection profile where all the reflections are displayed graphically. This technique is used to solve problems for which there had previously been no practical solution.



PRINCIPLES OF GEORADAR

FEATURES

- Penetration of more than 20 metres in certain materials (penetration being inversely proportional to conductivity).
- Surveying in continuous mode.
- Identification of objects measuring only a few centimeters.
- Light and manoeuvrable equipment.
- Detection of conductivity, open spaces and/or holes (cavities).
- Detection of breaks: faults, fractures, joints, cavities.
- Results similar to seismic reflection: continuous underground profile.
- Results available immediately.
- Can be used in land, sea or airborne surveys.