TERRAprobe
KNOW WHAT'S BELOW

Ground Penetrating Radar Survey
[redacted] Cemetery Section 2
Block 25, Lot 3, Graves 1-8
[redacted] Road
[redacted], BC

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Project No. 4980
May 22, 2020

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June 2020
Project No. TGC **#4980**

[redacted]
Attn: [redacted]
[redacted]
[redacted], BC
[redacted]

Re: GPR Survey at [redacted] Cemetery, [redacted] Road, [redacted].
Cemetery Section 2, Block 25, Lot 3, Graves 1-8

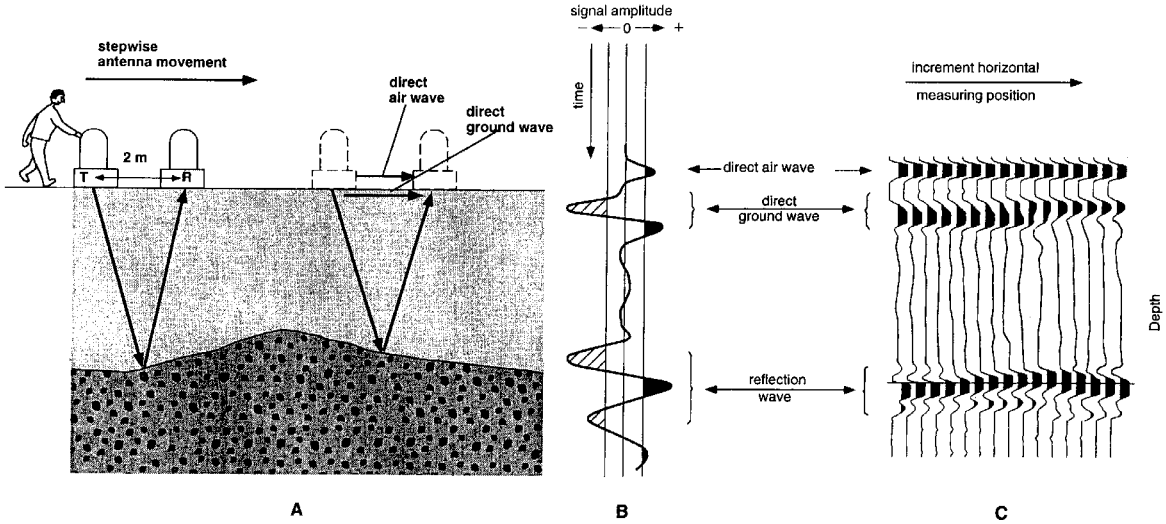
1.0 Background

On May 22, 2020, Terraprobe Geoscience Corp. (Terraprobe) was commissioned by [redacted] to undertake a high frequency Ground Penetrating Radar (GPR) survey at [redacted] Cemetery Section 2, Block 25, Lot 3.

The purpose of the GPR survey was to determine which of the eight (8) plots have remains. This report presents an overview of the GPR technology, survey methodology and interpretation of the GPR survey results.

2.0 Theory and Principles

Ground penetrating radar is the general term applied to techniques that employ radio waves to profile structures and features in the subsurface. GPR method is based on emission, reflection and detection of electromagnetic waves. A short pulse of high frequency (250-2600 MHz) electromagnetic energy is produced and transmitted into the ground. The pulse spreads into the earth materials and is affected by the properties of the surrounding material. Some of the energy is reflected at the interface between materials of different (permittivity) properties. A receiver as signal strength versus delay time records the reflected energy at the surface. Processed radar data are plotted as surveyed horizontal distance (metres) versus two-way travel time in nanoseconds.



GPR principle and reflection profiling. A: paths of the three main electromagnetic waves, B: corresponding single radar signal, C: resulting radar plot.

GPR can locate both metallic and non-metallic targets. Penetration depth and detectability of targets depend on antenna frequency, target orientation and the dielectric properties of the host material.

The interpreted radar profiles provide a two-dimensional cross section of the subsurface along the surveyed lines. The interpretation and presentation of GPR data can often be enhanced through the use of plan map displays of the data. Map view allows differentiation of targets.

3.0 Methodology

A 600 MHz frequency multi GPR antenna array system manufactured by IDS Georadar was used for the survey. The high frequency radar array was selected as the most appropriate radar equipment and frequency, settings and parameters for the optimum results.

The GPR survey was performed in both line (GPS based) and grid scan mode to collect data on the area outlined by [redacted] staff. Unfortunately, due to the tree canopy the GPS did not provide the accuracy required. Henceforth swaths were collected in a preset pattern and the base line recorded off of existing features onsite. An overview of the location of the line profiles is shown in Figure 1 (appendix page 1 of 2).

Photo 1: set-up of grid data collection. Concrete curb used for position reference. Start line approx. 60cm (2ft) parallel to curb.

Photo 2: Plot #1 (in foreground, with headstone) and plot #2

4.0 GPR Data Interpretation

In the cross-sectional profiles, the first two arrivals are the direct air and ground signal arrivals. These reflections may obscure any reflections in the first 0.10m of the radar trace.

The primary response of radar to buried point like features is the hyperbolic arch, formed by the interaction between the shape of the radar beam, depth to the target and the velocity of the radar energy. Radar energy from the antenna is sent out in a cone. As the antenna approaches the target the distance decreases, forming the ascending part of the apparent hyperbola centred over the anomaly. The width of the arch is a function of the velocity and depth. The descending arch is formed as the antenna moves away.

Data processing was performed by using IDS Georadar's GRED HD processing package. The following steps were carried out: gain recovery, temporal and 3D spatial filtering, background removal and 3D migration.

Data interpretation was done manually by locating the high amplitude response GPR targets and layers and transposing that information to the drawings. Depth slices as well as all 160 individual GPR profile lines were analyzed and compared.

Material inhomogeneities, different water saturation or void space can cause change in signal amplitude. Metal object (e.g. head stone) gives a high amplitude response and signal energy loss, so that object below the metal targets may not be "visible". During the data processing the influence of the metal object and other inhomogeneities can be decreasing.

5.0 Results

The 600MHz antennae provided excellent data quality to about 3 m depth. The profiles were calibrated with an interpreted depth scale derived from the average velocity in the subsurface of 0.100 m/ns.

Unless otherwise noted, all plot numbers mentioned in this section of the report are referring to Section 2, Block 25, Lot 3.

The client provided information that plots #1, 7 and 8 are occupied and that there is a record of 2 adults and one child buried on the same day in 1937, but no record on the plot numbers used is available.

Plot #1 (1977) was used as reference to identify features that could indicate former disturbances of the ground. As the profile lines were extended past the area of interest during data collection, a second headstone was discovered in the GPR data and its presence verified during a brief second visit to the cemetery (section 2, block 25, lot 4, grave 8). GPR signal changes were very subtle, and the results therefore are strictly interpretational.

Plot #1: with headstone, burial dated 1977 as per client information, was used as reference.
Plot #2: most likely occupied.
Plot #3: potentially occupied
Plot #4: potentially empty

Plot #5: potentially empty
Plot #6: potentially occupied
Plot #7: burial site of a preemie (1949) – could not be confirmed with confidence
Plot #8: burial site of a preemie (1946) – could not be confirmed with confidence

A sample depth slice of the plotted GPR data has been included in the appendix (page 2 of 2) for reference. Lot borders in this map are based on interpretation, not measurements.

6.0 Conclusion and Recommendations

Since GPR provides indirect evidence, it is recommended to verify the interpretation e.g. by careful exposure. The adjacent graves 7 and 8 of Lot 4 were analyzed as well. Both appear to contain remains. Verifying this interpretation by comparing with official records can help evaluate the interpretation.

Signal velocity for the 600 MHz was estimated as no target was available for depth calibration; thus, we recommend the depth information be used as a guideline only.

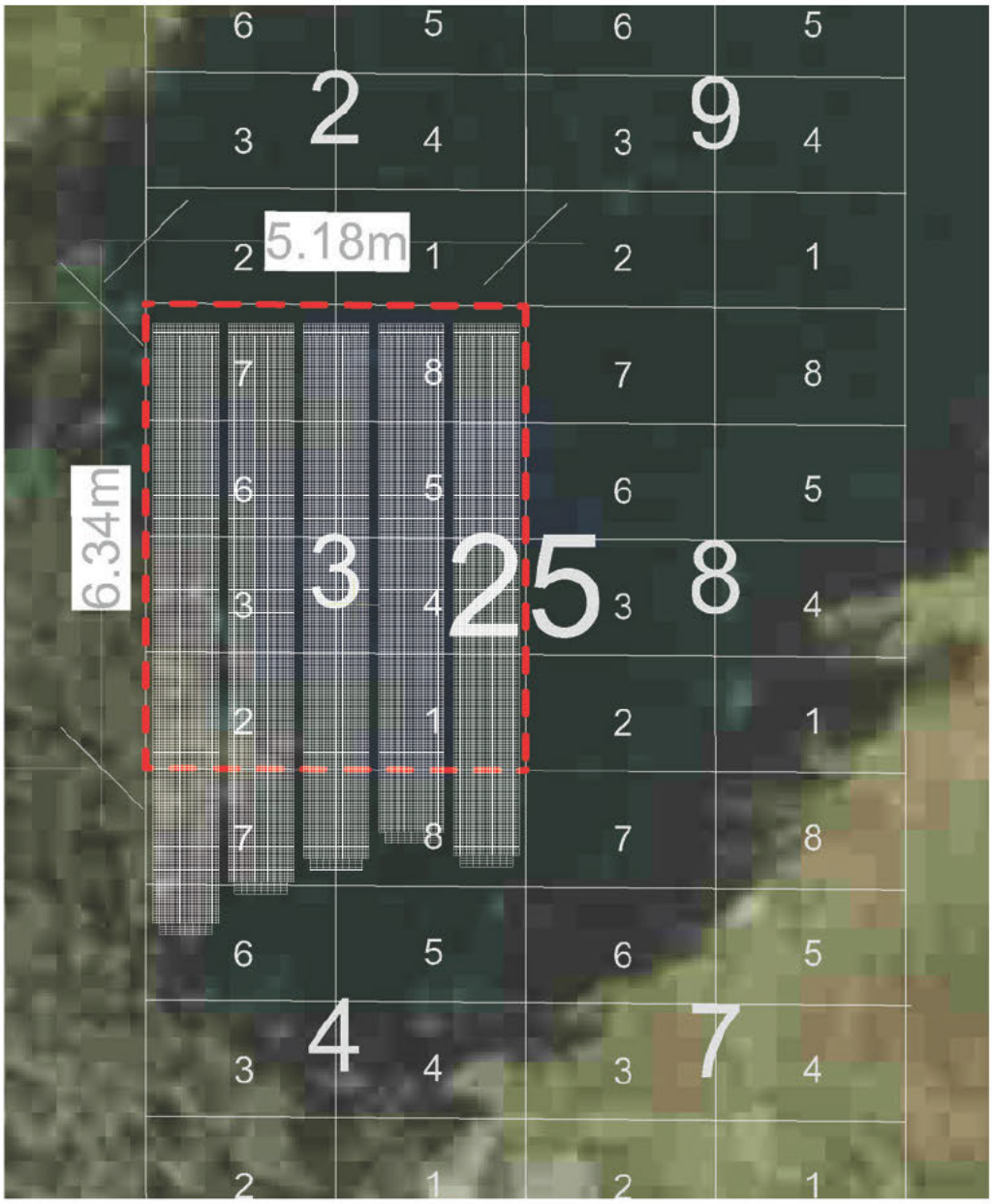
7.0 Limitations

The depth to subsurface features derived from ground penetrating radar surveys are generally accepted as accurate to within ten to twenty percent of the true depths or ± 0.1m to the boundaries. Since the depth scale was calculated using average velocities and the material is not homogeneous, it could only be used as a guideline and not as exact measurement. The results are interpretive in nature and are considered to be a reasonable accurate presentation of existing conditions within the limitations of the radar profiling method.

Thank you for choosing Terraprobe, and if you have any further questions please feel free to contact us.

Best regards,

Valesca Schaefer
Senior GPR Technician
Field Operations Supervisor
Terraprobe Geoscience Corporation



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Notes

NOT TO SCALE

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[redacted]

Page 1 of 2 - Location of GPR swaths

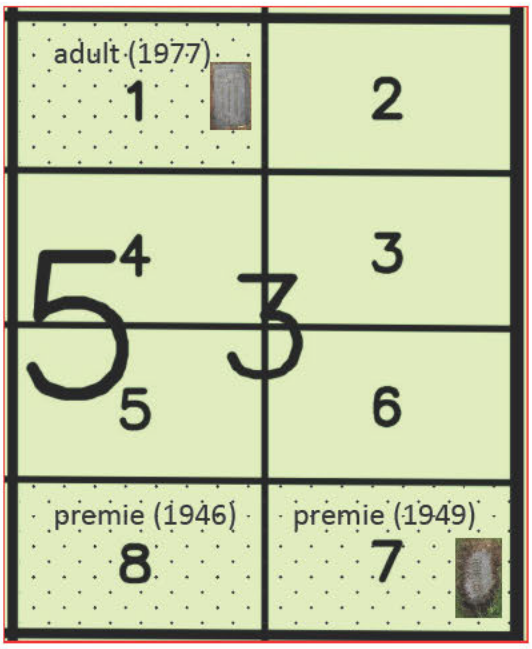
Ground Penetrating Radar Survey
[redacted] Cemetery Section 2,
Block 25, Lot 3, Graves 1-8

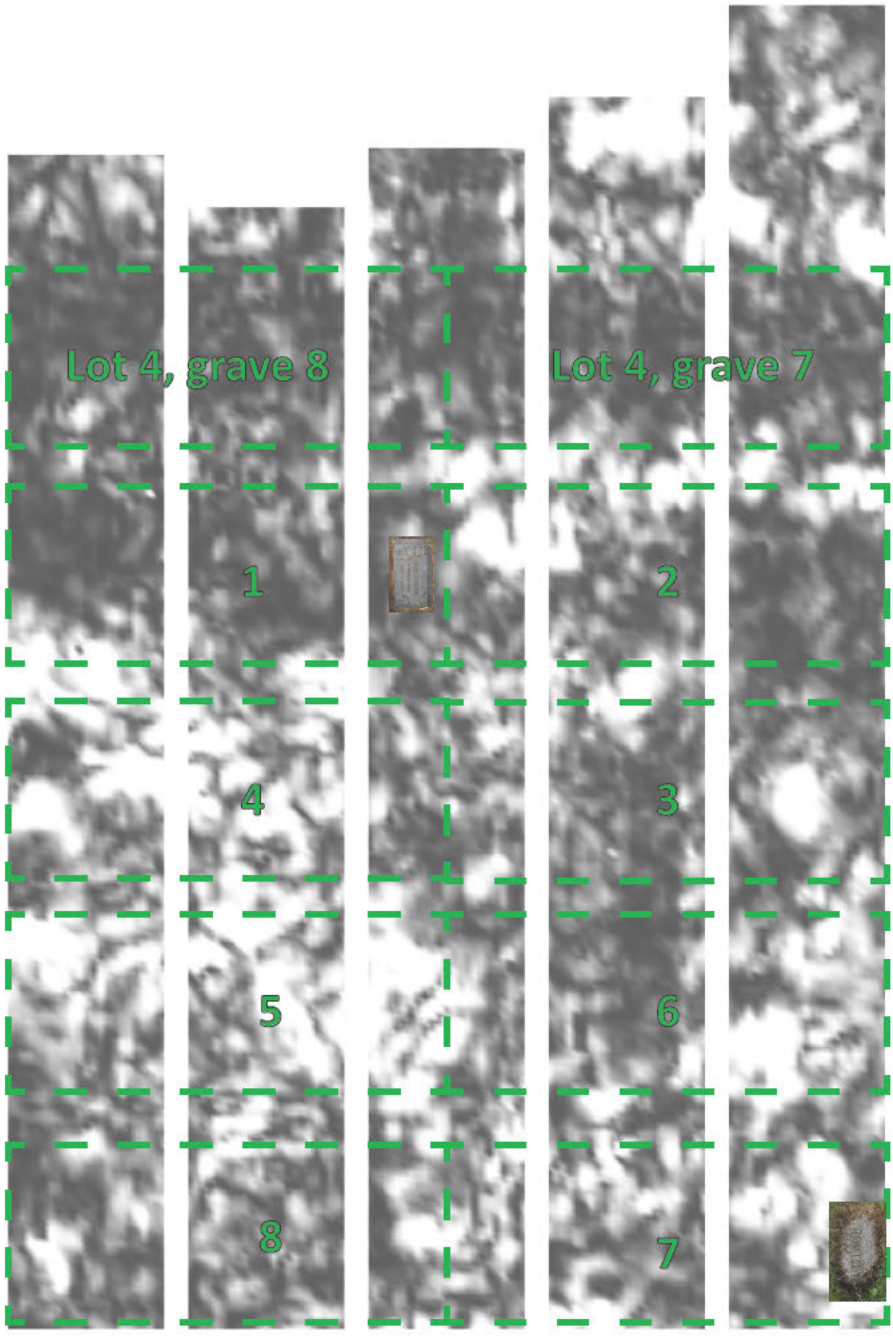
Terraprobe Geoscience Corp.

[redacted]	Jun 2020	TGC #4980

Interrment 1937:
2 adults
1 child

Location to be
determined by GPR





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Notes

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Lot borders and headstones shown on the GPR data plot are based on interpretation, not measurements and are considered approximate only.

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[redacted]

Page 2 of 2 - GPR data plot

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[redacted]	Jun 2020	TGC #4980