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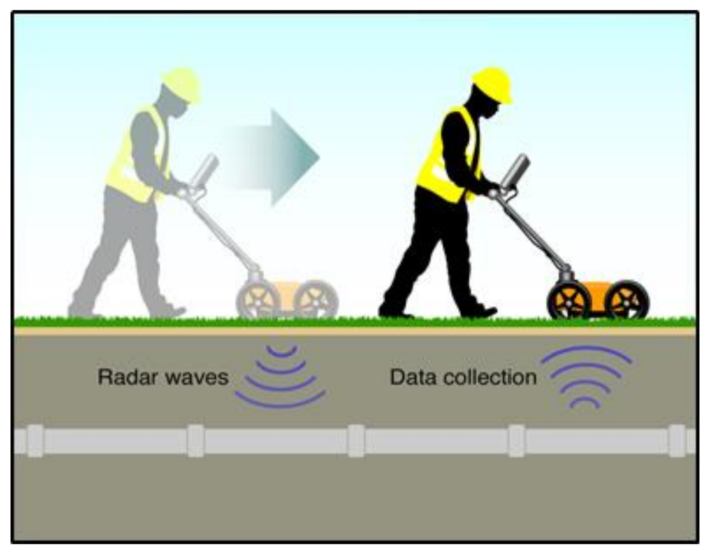
Ground Penetrating Radar for Forensic Investigation

Background

Residential schools operated in Canada between 1831 and 1996. These schools used unimaginable methods to assimilate Indigenous children into Canadian culture and suppress their own. Indigenous children often died at these schools because of the horrifying abuse they suffered and were typically buried with no grave markings. First Nations communities across the country have begun orchestrating searches around former residential schools to find these clandestine graves. NSMES proposed this project to more effectively be able to search for clandestine graves in residential school areas.

What is Ground Penetrating Radar?

Ground penetrating radar (GPR) is a geophysical locating device that uses frequency signals to image subsurface objects. GPR can detect metal and non-metal objects, as well as any underground irregularities. The GPR technician moves the device along the surface like lawnmower. The device sends out signals and receives the reflected signals that bounce off subsurface objects.



Why is GPR Important?

- GPR has several applications such as: Finding clandestine graves. Testing structural integrity of materials like concrete. Finding artifacts. Finding underground infrastructure.
- GPR is a non-invasive method that allows forensics teams to see below a surface without damaging the ground or buried objects. Thus, it can be used to find unmarked graves without disturbing those buried there.

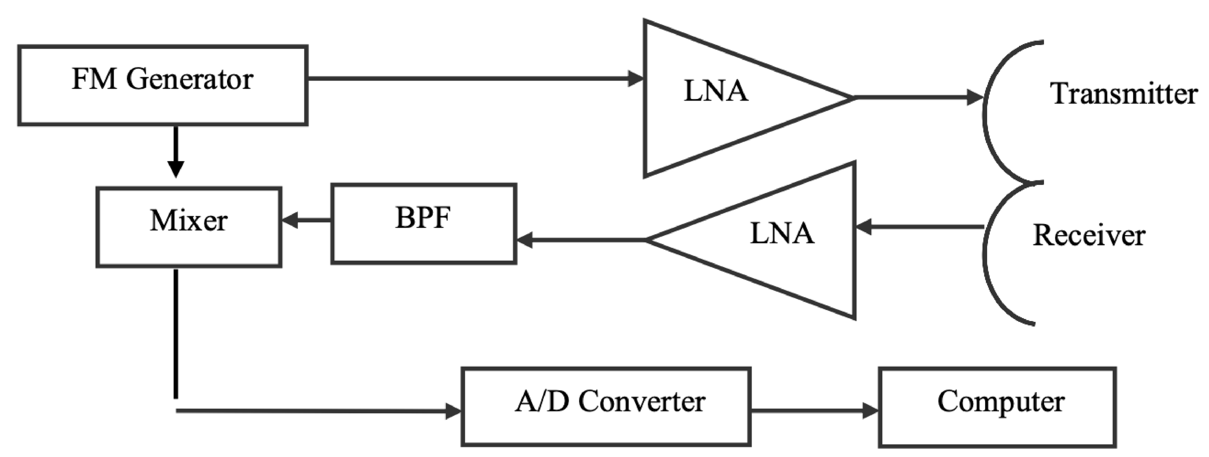
Objectives

- Give a detailed technical report on what GPR is, how it works, and how to best utilize it for forensic investigation in Nova Scotia.
- The report will provide in depth recommendations to NSMES using a wide variety of data and case studies.
- Create a checklist and rating system for using GPR in Nova Scotia.

How Does Ground Penetrating Radar Work?

Ground penetrating radars send electromagnetic pulses into the ground and examine the receiving signal for distortions or changes. A transmitting antenna first sends an electromagnetic wave into the ground. The signal (which is in the microwave band of 1 to 1000MHz) passes through the ground, getting distorted by the dielectric and conductive properties of the materials it goes through. The signal then travels back to the receiving antenna and the GPR measures variations in the signals.

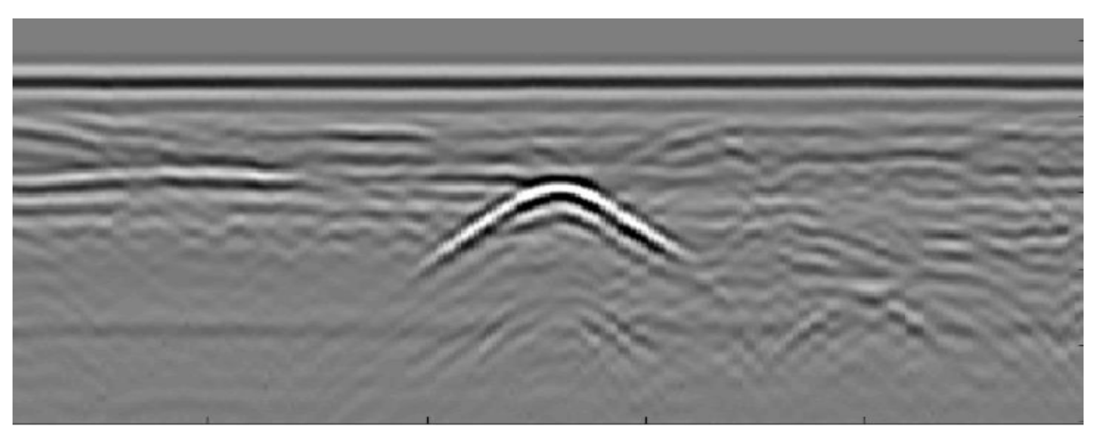
The figure below is a block diagram of a basic GPR developed by Taif University (Yahya S. H. Khraisat). The GPR system operates in the megahertz region and uses frequency modulating continuous wave technology.



The FM generator outputs a modulated continuous wave signal that is applied to the low noise amplifier (which amplifies it) and the mixer. The transmitted signal is then detected by the receiving antenna and again amplified by another low noise amplifier. The received signal is filtered using a bandpass filter, to narrow the range of frequencies and sent to the mixer. The signals are then sent through an analog to digital converter and manipulated further on the computer.

Data Interpretation

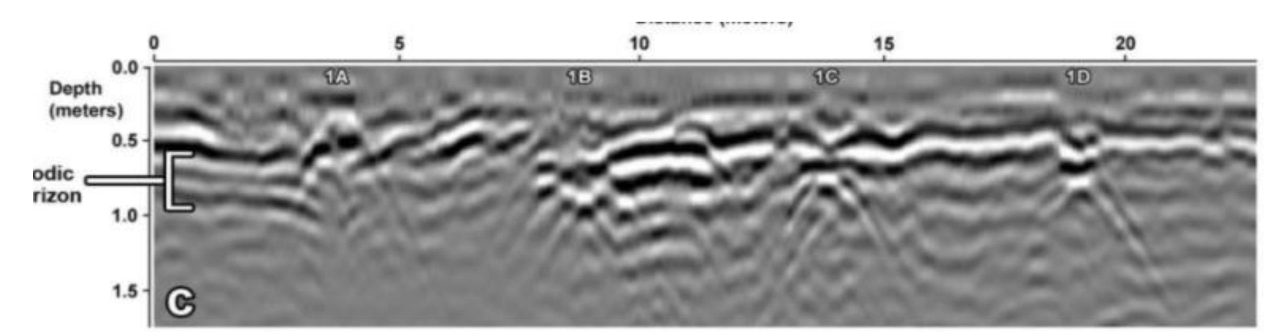
- GPR pulses travel in a cone, not a thin line. This creates a hyperbola shaped response that indicates the relative distance from the object to the GPR.
- Thus, everything the GPR picks up looks the same, which creates problems with data interpretation.



Research

There are many external factors that affect GPR detection and can hamper data gathered at a site: Some factors include decomposition, depth of burial, soil type and disturbance, any other additional items added to the grave, any past or current infrastructure on site, etc.

The picture below shows an example of a GPR scan of a subsurface from J Schultz et al. Four pig carcasses are buried in this scan, and the only subsurface obstruction is a single spodic horizon. See if you can pinpoint the location of the carcasses.



The table below shows the different soil types that can affect GPR detection:

Soil Type	GPR
High saline soil	Non-Optimal
Clay rich soil	Non-Optimal
Dense vegetation areas	Non-Optimal
Dry-sandy soil	Optimal
Sparse Vegetation	Optimal
Freshwater	Optimal
Uneven land	Non-Optimal
Flat ground	Optimal

Conclusion and Recommendations

- The best way to truly know how well the results will turn out is to go to the site and test it.
- It is essential to have prior knowledge of the site conditions.
- Preliminary data such as eye-witness accounts are crucial to maximizing efficiency and producing meaningful results.
- A contractor who specializes in GPR is ideal in most situations, as the systems are expensive and inexperienced technicians will have difficulty interpreting the data.

References

Berezowski, Victoria, et al. "Using Ground Penetrating Radar and Resistivity Methods to Locate Unmarked Graves: A Review." 23 July 2021.

Khraisat, Yahya S. H. "Design Ground Penetrating Radar." *International Journal of Engineering Research and Technology*, 2019.

Schultz, John J. *Detecting Buried Remains Using Ground Penetrating Radar*. Apr. 2012.