



## ENVIRONMENTAL & EXPLORATION GEOPHYSICS

22323 East Wild Fern Lane, Brightwood, Oregon 97011 • PH (503) 622-0154 • FAX (503) 622-0526  
WEB <http://www.geopotential.biz/> E-MAIL [GeoPotential@geopotential.biz](mailto:GeoPotential@geopotential.biz)

### GROUND PENETRATING RADAR SURVEYS

Ground Penetrating Radar (GPR) can be a valuable tool to accurately locate both metallic and non-metallic UST's and utilities, buried drums and hazardous material at some sites. It may detect objects below reinforced concrete floors and slabs. GPR may delineate trenches and excavations and, under some conditions, it may be used to locate contaminant plumes. It has been used as an archaeological tool to look for buried artifacts. It may accurately profile fresh water lake bottoms either from a boat or from a frozen lake surface. GPR may be used to locate voids below roads and runways. GPR has numerous engineering applications. It can be used in non-destructive testing of engineering material, for example, locating rebar in concrete structures and determining the thickness of concrete and other structural material.

GPR uses short impulses of high frequency radio waves directed into the ground to acquire information about the subsurface. The energy radiated into the ground is reflected back to the antenna by features having different electrical properties to that of the surrounding material. The greater the contrast, the stronger the reflection. Typical reflectors include water table, bedrock, bedding, fractures, voids, contaminant plumes and man-made objects such as UST's and metal and plastic utilities. Materials having little electrical contrast like clay and concrete pipes may not produce strong reflections and may not be seen. Data are digitally recorded or downloaded to a laptop computer for filtering and processing.

The frequency of the radar signal used for a survey is a trade off. Low frequencies (250 MHz – 50 MHz) give better penetration but low resolution so that pipes and utilities may not be seen. Pipes and utilities may be seen using higher frequencies (500 MHz) but the depth of penetration may be limited to only a few feet especially in the wet, clayey soils found in many areas of the NW USA. The GPR frequency is dependent upon the antenna. Once an antenna is selected, nothing the operator can do can increase the depth of penetration.

Radar data is ambiguous. Many buried objects produce echoes that may be similar to the echo expected from the target object. Boulders and debris produce reflections that are similar to pipes and tanks. Subtle changes in the electrical properties along a traverse caused by changes in soil type, mineralogy, grain size, and moisture content all produce “noise” that can make interpretation difficult. Interpreting radargrams is an art as much as a science.

Under some conditions, although a UST itself may not be clearly visible in a GPR record, the excavation or trench in which the UST is buried is evident. Usually GPR data is used to compliment data from other “tools”. For example, a trench-like reflection but no clear UST reflection, combined with a “tank” shaped magnetic anomaly suggests the presence of a UST. Although the UST itself could not be seen using GPR, the radar showed a trench-like reflection. The magnetic data showed a large ferrous object. We would report a possible UST at that location.

GPR is often used in conjunction with magnetometer surveys. Magnetometer Surveys are very fast and large areas can be covered cost effectively. Magnetic anomalies are marked in the field, and then may be further investigated using radar.

GPR, like other geophysical tools, is excellent at detecting changes across a site, but it is poor at actually identifying the cause of the change. **The only definite way to identify buried objects is through excavation.**

#### **ADVANTAGES - General**

- When GPR data is properly interpreted subsurface objects can usually be confidently identified. This often requires the GPR data be combined with other geophysical data, surface features and historical information.
- GPR provides continuous records along traverses which, depending on the goal of the survey, may be interpreted in the field.
- At flat, open sites, for reconnaissance purposes, the antenna can be towed behind a vehicle at several mph.
- Many GPR antennas are shielded and are unaffected by surface and overhead objects and power lines.
- GPR can be used in conjunction with magnetic or EM surveys to accurately locate buried objects.

#### **ADVANTAGES – Site specific**

- With a low frequency antenna, in clean, dry, sandy soil, reflections from targets as deep as 100 feet are possible. Geologic features such as bedrock and cross bedding may be seen at some sites.
- The resolution of data is very high particularly for high frequency antennas.
- Shallow, man-made objects generally can be detected.
- Fiberglass UST's and plastic pipes can be detected using GPR.

#### **LIMITATIONS - General**

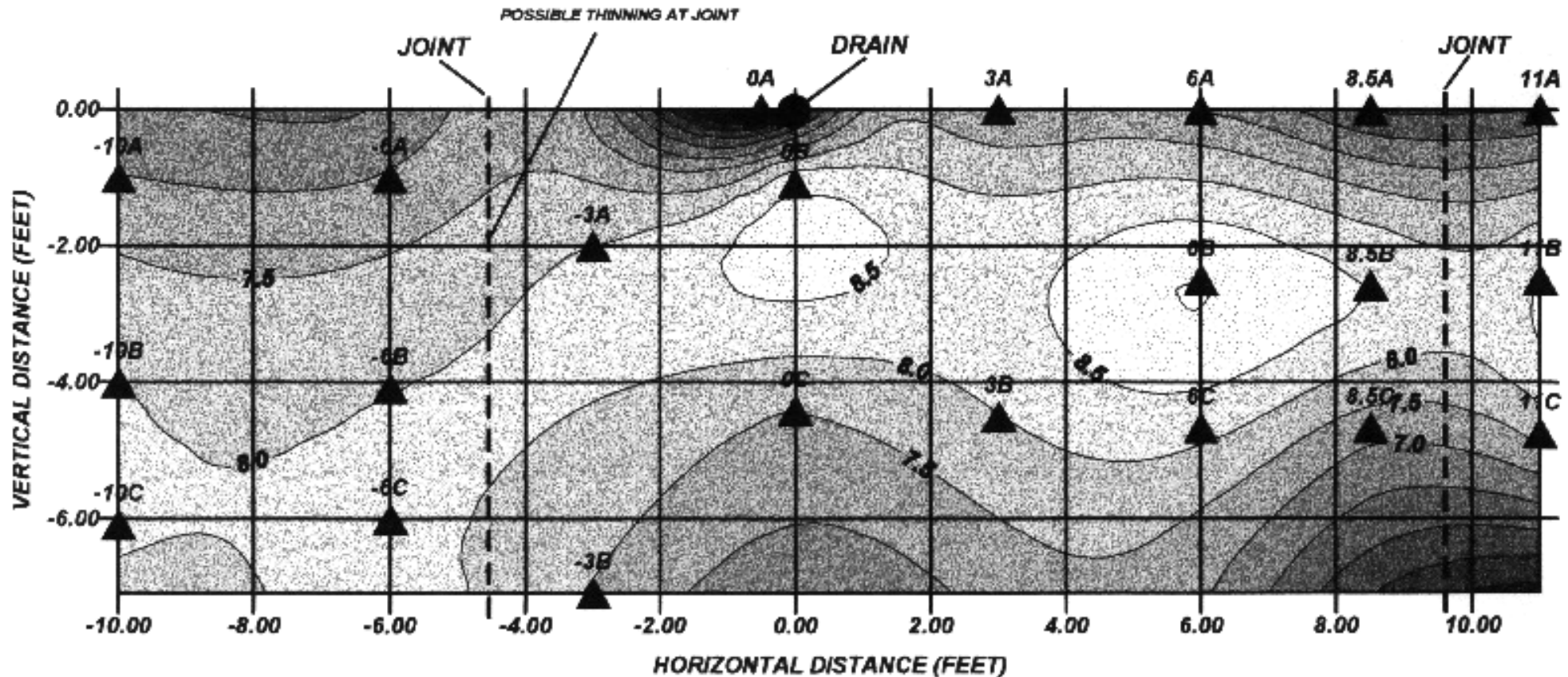
- To acquire the highest quality data, proper coupling between the antenna and the ground surface is necessary. Poor data may be obtained at sites covered with debris, an uneven surface, tall grass and brush. Objects located at curbs are difficult to see.
- Acquiring GPR data is slow. The antenna must be over the target. The signal from the antenna is cone-shaped. Reflections from objects to the side of the antenna may be seen, but their actual location relative to the antenna is not obvious.
- Penetration of the GPR signal is "site specific" and its depth of penetration at a particular site cannot be predicted ahead of time. Near surface conductive material, such as salty or contaminated ground water and wet, clay-rich soil, may attenuate the radar signal, limiting the effective depth of the survey to several feet. Reinforced concrete also can attenuate the signal. Rebar may produce reflections that look like pipes.

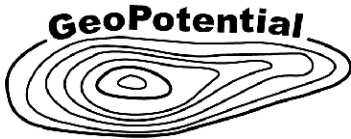
- GPR may not be cost-effective for some projects. For a detailed survey mapping underground storage tanks and utilities, it may be necessary to collect data in orthogonal directions at 5-foot line spacing.

### **LIMITATIONS – Interpretation**

- Interpretation can be difficult. Radar data are ambiguous. Subsurface objects can be detected but, in general, they cannot be identified. USTs and utilities have a characteristic reflection, however, large rocks and boulders have a similar reflection.
- The reflection visible in a GPR record is very complex and may be caused by small changes in the electrical properties of the soil. The target in mind may not produce the reflection. Due to “noise”, the target may be missed. USTs and deep utilities may be missed if they are under debris and/or other pipes.
- Other methods may be necessary to aid in the interpretation of the data (use a magnetometer to detect a large metallic mass, then GPR to determine if the object is tank-like, or a utility locator to determine if there are feed lines and fill pipes leading to the object).
- Adequate contrast between the ground and the target is required to obtain reflections. UST’s may be missed if they are badly corroded. Utilities made of “earth” materials like clay and concrete may not be detected since their electrical properties are similar to the surrounding soil.
- To determine the depth to an object without "ground truth", assumptions must be made regarding soil properties. Even with ground truth at several locations on the same site, changes in material across a site (therefore changes in signal velocity) can cause errors in depth measurements at other locations.

**GeoPotential**  
**SUBSURFACE MAPPING SURVEY FOR CONCRETE THICKNESSES**  
**GROUND PENETRATING RADAR STATION LOCATIONS AND**  
**THICKNESS CONTOUR MAP**  
(CONTOUR INTERVAL = 0.5 INCHES)



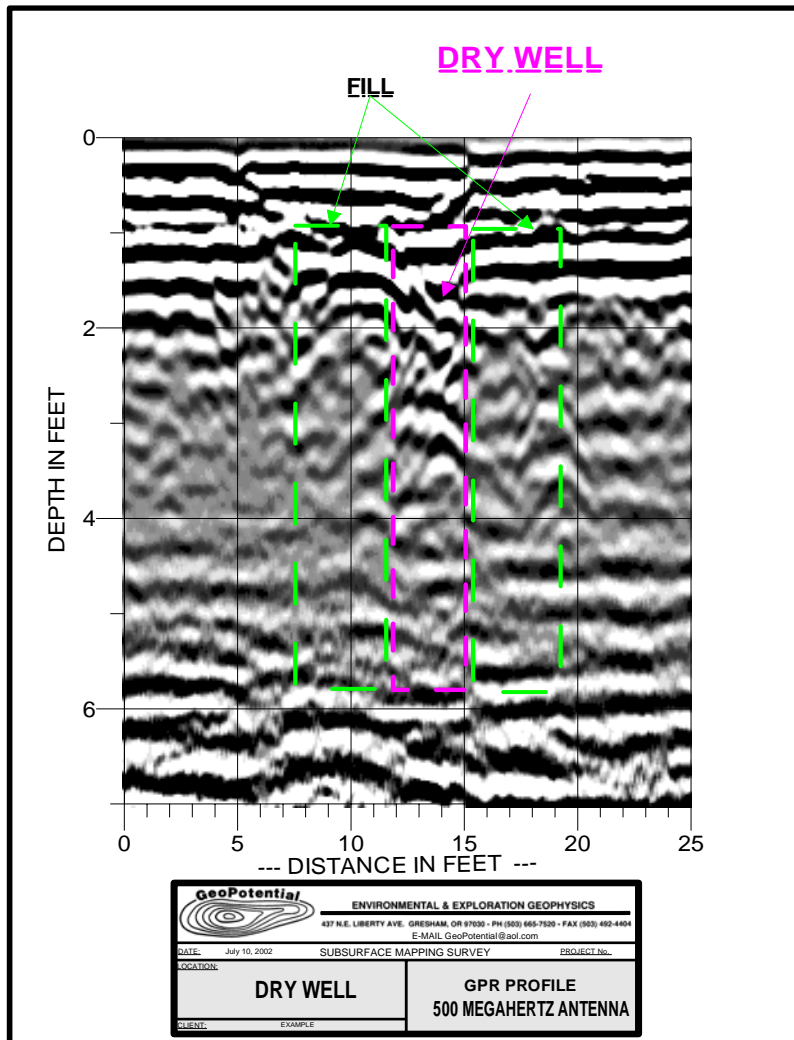



## ENVIRONMENTAL & EXPLORATION GEOPHYSICS

22323 East Wild Fern Lane, Brightwood, Oregon 97011 • PH (503) 622-0154 • FAX (503) 622-0526  
WEB <http://www.geopotential.biz/> E-MAIL [GeoPotential@geopotential.biz](mailto:GeoPotential@geopotential.biz)

### SUBSURFACE MAPPING SURVEYS FOR DRY WELLS

GeoPotential uses Ground Penetrating Radar (GPR) Surveys to map the locations of active and abandoned dry wells. The edges of the dry wells are marked on the surface along with drainpipes leading to the dry well. This provides the necessary information for environmental sampling and remediation. In addition we provide the GPS coordinates of the dry wells to satisfy the requirements of the dry well registration program. Optionally we can provide written reports and site maps for the dry well surveys. Shown below is an example of a GPR PROFILE over a dry well.



		<b>ENVIRONMENTAL &amp; EXPLORATION GEOPHYSICS</b> 437 N.E. LIBERTY AVE. GRESHAM, OR 97030 • PH (503) 665-7520 • FAX (503) 492-4404 E-MAIL: GeoPotential@aol.com	
DATE:		SUBSURFACE MAPPING SURVEY	
PROJECT No.			
UNDERGROUND STORAGE TANKS		GROUND PENETRATING RADAR PROFILE (500 MHz Antenna)	
CLIENT:			

