UtilityScan® 4000

Training Request Form

Training Course Information

GSSI Contacts

GSSI West
Henderson, Nevada

Geophysical Survey Systems, Inc.
www.geophysical.com • sales@geophysical.com

40 Simon Street • Nashua, NH 03060-3075
Tel: 603.893.1109 • Toll Free: 800.524.3011

Training Request Form

Upcoming training dates listed at http://www.geophysical.com/training.htm

Please email completed form to training@geophysical.com or fax to 603.889.3984

Please complete the following	
Name	Phone
Company Name	Fax
Street Address	Email
City, State, Zip	

Select	Course	Cost	Date: 1st Choice	Date: 2nd Choice	Location: Nashua / Nevada
	StructureScan 3000	$800 per person			
	StructureScan 4000	$800 per person			
	StructureScan Mini	$500 per person			
	StructureScan Mini XT	$500 per person			
	UtilityScan 3000	$800 per person			
	UtilityScan 4000	$800 per person			
	UtilityScan DF / UtilityScan HS	$800 per person			
	RoadScan	$800 per person			
	BridgeScan	$800 per person			
	Profiler	$800 per person			
	RADAN 7	$800 per person			

Number of Training Attendees: ________

Please contact GSSI for more information if you need to send more than 2 people to any class.

Attendee 1:	Attendee 2:
Attendee 3:	Attendee 4:

After completed form has been received, you will be contacted to confirm date and payment information.

Signature: ______________________________ **Date: ____________________**

Form Name: Training Request Form
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UtilityScan® 4000 Training Course Outline and Info Packet

Where is class held?

Best Western Plus
1553 North Boulder Hwy
Henderson, NV 89011

http://www.bwhenderson.com/

Tel: 702.564.9200

When are the classes?

The GSSI West class schedule is on our website at http://www.geophysical.com/training.htm. Class size is limited to eight students, so reserve a spot early.

You can reserve a spot simply by contacting the Training Manager, Dan Welch at 603-893-1109 or welchd@geophysical.com.

What are the class times?

Class runs three days from 9 AM to 4 PM with approximately one hour for lunch. Breaks are given every hour.

What does it cost?

If you purchased a complete UtilityScan 4000 system, training is provided at no cost during the two year product warranty. Within the warranty period, you may select from any scheduled training course offered at GSSI. After the product warranty has expired, the tuition for a scheduled training course offered at GSSI is $800 per student.

Where should I stay?

Best Western Plus offers a reduced rate to GSSI students who elect to stay at this hotel. Reservations must be made no later than one week prior to the class start date in order to get this reduced rate.

Best Western Plus
1553 North Boulder Hwy
Henderson, NV 89011

Tel: 702.564.9200

What should I bring?

You will get as much out of the class as you put into it so, be prepared to take notes. A portion of the course requires some intensive computer work. You should be familiar with working in a Microsoft Windows environment. You should be able to:

1. Create and rename a folder in Windows.
2. Move files around your computer by 'dragging and dropping' or cutting and pasting. The instructor will not teach this, and it is your responsibility to acquire this knowledge before coming. The standard tutorials that come with Windows should be enough.

You may videotape or record the training if you wish. If you want to bring your personal equipment to work with, that is fine but not required. Students will be evaluated by class participation and oral examinations.

What if I need to cancel/reschedule?

Just contact us and let us know 48 business hours before the class. You will not be billed for the class. Failure to show without prior cancellation may result in a penalty.

Directions to Hotel from Las Vegas McCarran International Airport (LAS)

How far is GSSI from the airport?

Approximately 15.7 miles (25.26 km) from Las Vegas McCarran International Airport (LAS).

Transportation

Taxi: Taxi fare is approximately $30.00 - $40.00.
There is no shuttle from the airport.

Driving Directions:

1.	Head **southeast** on **Wayne Newton Blvd** toward **Terminal 1 Departures.**	0.3 mi
2.	Take the ramp to **Las Vegas/Henderson/I-15/I-215.**	0.3 mi
3.	Merge onto **NV-171/Paradise Rd.** Continue to follow NV-171.	1.1 mi
4.	Keep **left** at the fork, follow signs for **I-215 E/Henderson/Lake Mead** and merge onto **I-215 E.**	9.9 mi
5.	Take Exit **1** to merge onto **I-515 N/US-93 N/US-95 N.**	2.2 mi
6.	Take Exit **64A** for **Sunset Rd W.**	0.3 mi
7.	Turn **right** onto **W Sunset Rd.**	1.1 mi
8.	Turn **right** onto **NV-582 S.**	0.5 mi
9.	Turn **right** onto **W Corn St.**	200 ft
10.	Turn **left.** Destination will be on the right.	

Class Schedule

	Morning	Afternoon
Day 1	**GPR 101** An introduction to GPR method and theory as well as examples of GPR application. Topics covered include: how to read a GPR record, target ID, troubleshooting, a discussion of survey practices, factors affecting GPR signal penetration and effectiveness, and more.	**Simple Locating** Hands on locating of targets in real time and marking them on the survey surface. How to use radar to clear a location for trenching, calibrating for accurate depth estimation.
Day 2	**Simple Locating Review** A review of the previous afternoon's learned skills. **Advanced Target Recognition** Using GPR to tell the difference between metal and air-filled PVC. Noting voids and shallow geologic features such as bedrock.	**3D Data Collection and Processing** Collecting an area of 3D data for processing and imaging in 3D QuickDraw **Intro to 3D Imaging** Using 3D QuickDraw to create 3D data presentations and to answer specific questions. **Basic GPR data Processing with RADAN** **Review**

Ground-Penetrating Radar 101: Theory and Practice

Introduction

This document is designed as a basic introduction to some of the key concepts in the basic theory of operation of ground-penetrating radar (GPR). An understanding of the concepts discussed here will help make your training experience much more worthwhile and enable the trainer to spend more time preparing you for actual field situations. You are encouraged to read through this *prior* to your training class. The instructor will explain all of these concepts in much greater depth in the class, but a passing familiarity with the terms will help you. If you have any additional questions, or would like more information about a particular concept discussed here, please feel free to call Geophysical Survey Systems, Inc. at (603) 893-1109.

Equipment

A GPR system is made up of three main components: the control unit, antenna, and power supply (Figure 1).

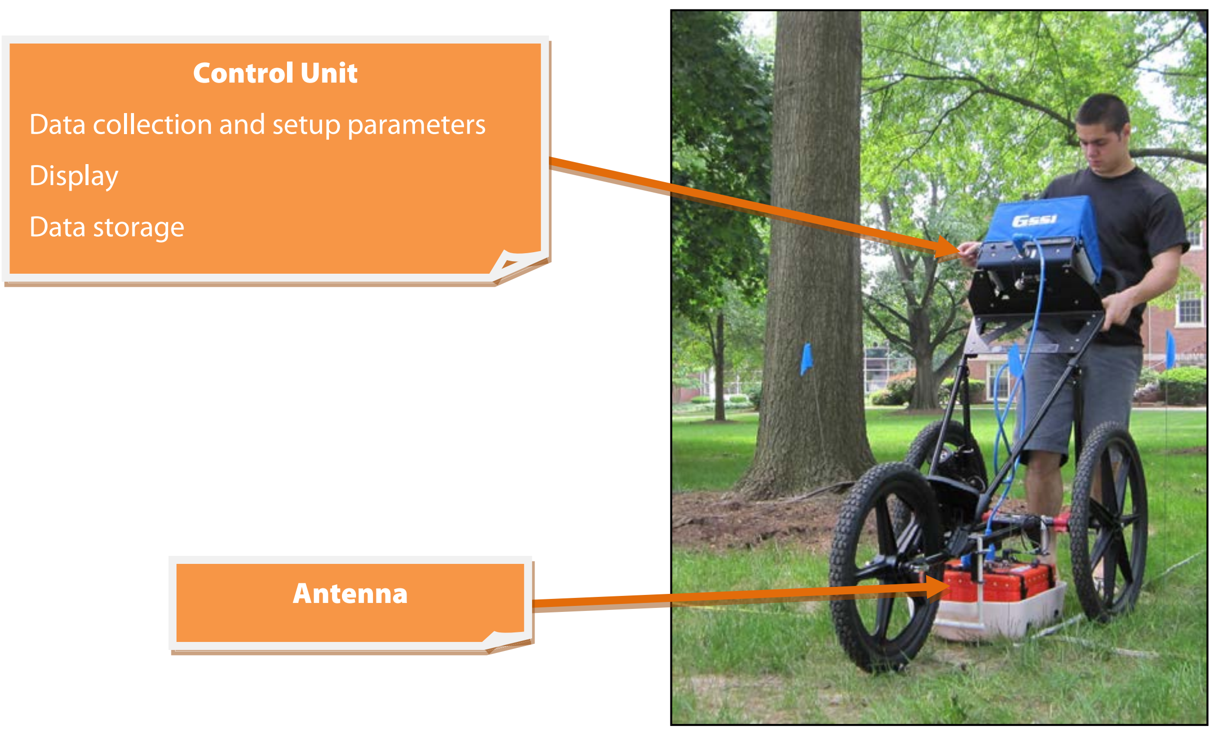

Figure 1: Complete GPR system.

Geophysical Survey Systems GPR equipment can be run with a variety of power supplies ranging from small rechargeable battery packs, to vehicle batteries, and normal 110-volt current. Connectors and adapters are available for each power source type. The unit in the photo above can run from a small internal rechargeable battery or external power.

The control unit contains electronics that produce and regulate the pulse of radar energy that the antenna sends into the ground. It also has a built in computer and hard disk to record and store data for examination after fieldwork. Some systems, such as the GSSI SIR® 20, are controlled by an attached Windows laptop computer with pre-loaded control software. This system allows data processing and interpretation without having to download radar files into another computer.

The antenna receives the electrical pulse produced by the control unit, amplifies it, and transmits it into the ground or other medium at a particular frequency. Antenna frequency is a major factor in depth penetration. The higher the frequency of the antenna, the shallower into the ground it will penetrate. A higher frequency antenna will also 'see' smaller targets. Antenna choice is one of the most important factors in survey design. Table 1 shows antenna frequency, approximate depth penetration, and appropriate application.

Depth Range (Approximate)	Primary Antenna Choice	Secondary Antenna Choice	Appropriate Application
0-1.5 ft 0-0.5 m	1500 MHz	900 MHz	Structural Concrete, Roadways, Bridge Decks
0-3 ft 0-1 m	900 MHz	400 MHz	Concrete, Shallow Soils, Archaeology
0-12 ft 0-3 m	400 MHz	200 MHz	Shallow Geology, Utilities, UST's, Archaeology
0-25 ft 0-9 m	200 MHz	100 MHz	Geology, Environmental, Utility, Archaeology
0-90 ft 0-30 m	100 MHz	Sub-Echo 40	Geologic Profiling
Greater than 90 ft, or 30 m	MLF (80, 40, 32, 20, 16 MHz)		Geologic Profiling

Table 1: Choosing the Proper Antenna.

The GPR Method: Theory of Operation

GPR works by sending a pulse of energy into a material and recording the strength and the time required for the return of any reflected signal. A series of pulses over a single area make up what is called a scan, or sometimes a trace. Reflections are produced whenever the energy pulse enters into a material with different electrical conduction properties (dielectric permittivity) from the material it left. The strength, or amplitude of the reflection is determined by the contrast in the dielectric constants of the two materials. This means that a pulse which moves from dry sand (diel of 5) to wet sand (diel of 30) will produce a very strong, brilliantly visible reflection, while one moving from dry sand (5) to limestone (7) will produce a very weak reflections.

Figure 2: Basic GPR system.

While some of the energy is reflected back to the antenna, energy also keeps traveling through the material until it either dissipates (attenuates) or the GPR control unit has closed its time window (Figure 2).

The rate of signal attenuation varies widely and is dependent on the dielectric properties of the material through which the pulse is passing. Another concern is conductivity. Materials which are highly conductive and thus attenuate (absorb) the signal rapidly. If the signal is absorbed, then it is not allowed to penetrate deeper into a material. Water saturation dramatically raises the dielectric (and sometimes the conductivity) of a material, so a survey area should be carefully inspected for signs of water penetration. Radar surveys should never be conducted through standing water, no matter how shallow. Depth penetration through a material with a high dielectric will not be very good. Metals are considered to be a complete reflector, and do not allow any amount of signal to pass through. Materials beneath a metal sheet, fine metal mesh, or pan decking will not be visible. It is essential to correctly estimate the dielectric constant of a material in order to get accurate depth calculations to features. In utility and concrete inspection work, this is commonly done by drilling or chipping to a known object such as a piece of rebar, measuring the depth, and calibrating that depth to the radar record. The depth accuracy of radar is extremely good if this calibration is performed. If there is a suspicion of changing conditions in the subsurface (different material, water infiltration), another depth calibration for that area should be done. Generally speaking, the more depth calibrations that are performed, the more accurate the depth estimate. If chipping or drilling is not possible, or if the survey takes place out of doors on a natural ground surface, the dielectric must be estimated. A chart of the dielectric constants of some common materials is included at the back of this booklet for reference.

Radar energy is emitted from the antenna not in a straight line, but a cone (Figure 3). The two-way travel time for energy at the leading edge of the cone is longer than for energy directly beneath the antenna.

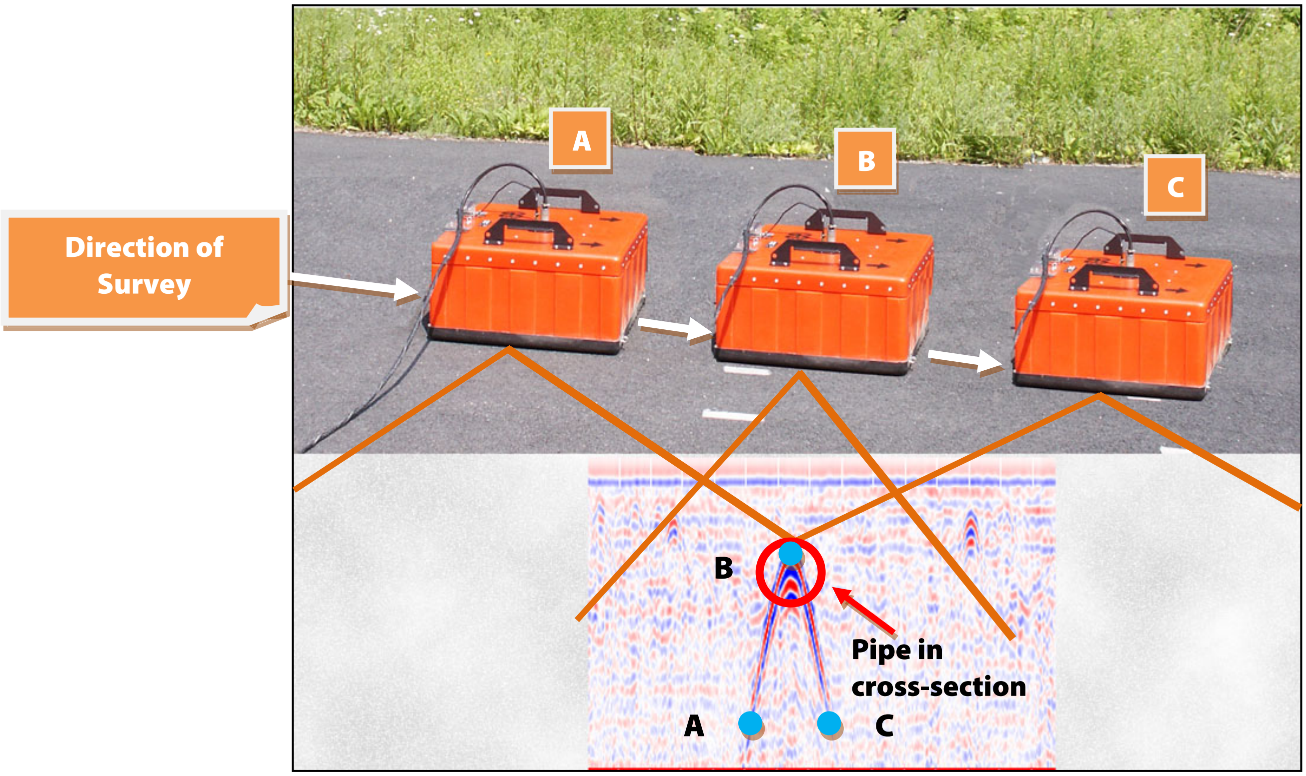

Figure 3: Hyperbola creation.

This is because that leading edge of the cone represents the hypotenuse of a right triangle. It is a longer distance than when the antenna is directly over the target. Because it takes longer for that energy to be received, it is recorded farther down in the profile. As the antenna is moved over a target, the distance between them decreases until the antenna is over the target, and increases as the antenna is moved away. It is for this reason that a single target will appear in a data as a hyperbola, or inverted "U." The target is actually at the peak amplitude of the positive wavelet (red circle in Figure 3). A mathematical function called *migration* may be performed during the data processing stage to remove the tails of the hyperbola and produce a more accurate assessment of the target location.

A reflection wave commonly has a positive and a negative wavelet. This is why hyperbolas look striped. If radar energy moves into air (dielectric of 1) from a higher dielectric medium like concrete, the signal will undergo what is called a phase reversal. A normal reflection will exhibit first a positive peak (white band) and then a negative peak (black band), while a phase-shifted signal will show a negative (black) than positive (white) peak. If energy penetrates a thin slab and continues into the air behind it, then a phase shift may indicate the back of the slab. Additionally, voids and air-filled PVC, if they are large enough, may show up as phase-shifted reflections. In some cases however, a phase shift may be falsely produced by background noise or the system's internal filters. It is therefore inadvisable to consider a phase shift alone to be indicative of a void or PVC piping.

Data are collected in parallel transects and then placed together in their appropriate locations for computer processing in a specialized software program such as GSSI's RADAN®. The computer then produces a horizontal surface at a particular depth in the record. This is referred to as a depth slice. A depth slice allows an operator to interpret a planview of the survey area.

Survey Considerations

Ground-penetrating radar, like all geophysical techniques, is most effective when as large an area as possible is surveyed. The reason for this is that effective interpretation depends on seeing contrasts within the data. Furthermore, features at the edge of the survey area may not be seen as clearly, and it is preferable to take a slightly longer time to complete the survey, then to make a costly, potentially dangerous mistake because of an inadequate survey area. If there is to be a delay between survey and any drilling or cutting, then some method of relocating the survey area and mapped features must be devised. Survey areas can be marked on the floor in permanent marker, or the survey area's location in reference to some immobile object such as drill hole or a column should be mapped.

> **Example:** A fiber optic cable is to be laid into a warehouse floor. The slab contains 8-inch on center rebar mesh and live power conduits in PVC laid on top of the mesh. The trench is to be 8 inches wide and dug to the top of the mesh. The client wants the conduit laid on top of the mesh, so accurate depth calculation to top of mesh is essential. Multiple drill cores to mesh are permitted for depth calibration. While it is possible to survey only the area that will be directly impacted, a much more effective technique would be to survey an additional 12 inches to the sides of the trench. This will help in the identification of targets at the edge of the trench. Cores should be taken down to the mesh all along the impact area.

GPR functions by transmitting and receiving electromagnetic energy at a particular frequency. Cellular phones, two-way radios, and pagers also transmit EM energy and will interfere with a GPR survey. If you must have them on, it is absolutely essential to keep these devices at least 25-30 feet away from the antenna.

Data Processing

Many situations will require the operator only to note the location of a target so that it can be avoided. For these clients, it may only be necessary to use a simple linescan format and mark the approximate area on the survey surface. Other clients may require detailed subsurface maps and depth to features. These situations will require the operator to use GSSI software to apply different mathematical functions to the data to remove background interference, migrate hyperbolas and calculate accurate depth. With some GSSI systems, such as the StructureScan concrete analysis system, this is automated. Other situations may require a greater understanding of radar processing techniques, and the operator may wish to contact GSSI for additional software training after consulting the RADAN manual.

GSSI Contacts

Geophysical Survey Systems, Inc.

General Info		
Phone Numbers	**Tel:** 603.893.1109 **Toll Free (U.S. only):** 800.524.3011 **Fax:** 603.889.3984	
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Questions about training classes or to reserve space in a training class	training@geophysical.com	
Assistance using GSSI equipment or software	applicationsupport@geophysical.com	
Technical Support		
	The GSSI Tech Support website contains a comprehensive FAQ, as well as sections for GSSI products: **https://support.geophysical.com**	
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