# Presentation 17:
# Geophysics for Spillway and Seepage Evaluation

# Geophysics for Spillway & Seepage Evaluation

GEOPHYSICAL services

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# So what is Geophysics?

**The study of the earth (and other materials) using non-intrusive measurements of physical properties.**

**Some typical examples of parameters we measure are:**

- **Resistivity**
- **Seismic velocity**
- **Localized magnetic fields**
- **Gravity field**
- **Radar wave velocity & reflectance**

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## How is Geophysics Helpful?

- Non-Invasive "Screening" Tool
- Does not Generate Waste (Environmental)
- Supplements Subsurface Data Between Borings
- Help Subsurface Characterization by "Seeing the Big Picture"
- Quickly Search for Specific Targets
- Trace What is Not Easily Seen (Water Seepage)
- In-Situ Estimation of Engineering Properties of Subsurface Earth Materials

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## Some of Our Common Tools

- Resistivity Sounding and Imaging (2-D & 3-D)
- Electromagnetics (EM)
- Ground Penetrating Radar (GPR)
- Magnetics
- Induced Potential (IP)
- Spontaneous Potential (SP)
- Seismic Techniques
- Microgravity

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## What Can you Do with Geophysics?

- Trace Seepage through Embankment Dams/ Ponds
- Define Limits of Voids underneath Spillway Slabs
- Determine Shear Wave Velocities for Seismic Design
- Karst Investigations
- Detect Abandoned Mines
- Map Voids and Sinkhole Potential
- Subsurface Stratigraphy
- Define Depth of Fill
- Characterize Geologic Structure
- Determine Depth to Bedrock
- Determine Depth to Non-rippable Bedrock
- Map Contaminant Plumes
- Locate steel Reinforcing in Concrete Slabs
- Locate Underground Storage Tanks (USTs)
- Define Limits of Abandoned Landfills
- Confirm Fractures in Bedrock for Groundwater Well Siting
- Assess Concrete Quality
- Monitor Vibrations from Blasting/ Construction/ Demolition
- Define GW Well Capture Zones in Fractured Bedrock
- Locate Buried Metallic Debris
- .....

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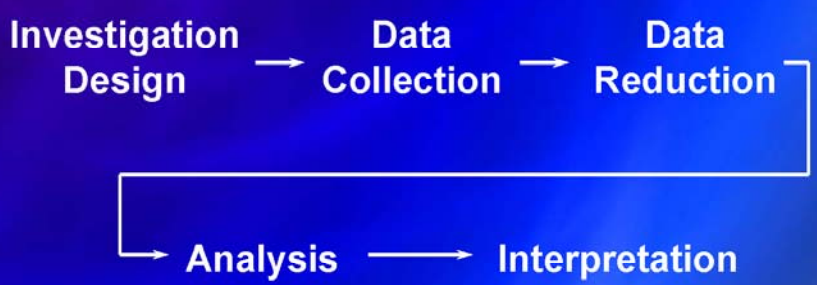
## Performing Geophysical Investigations

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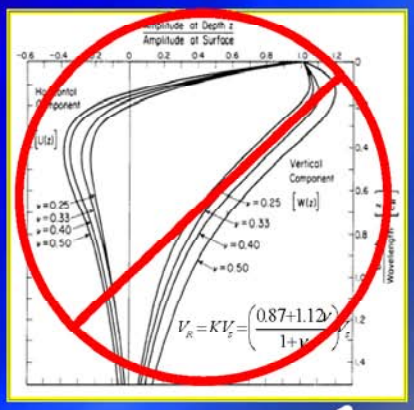
## Object of This Presentation

**NOT** to teach the theory of geophysics;

RATHER, to provide examples where geophysics is used to provide valuable information.

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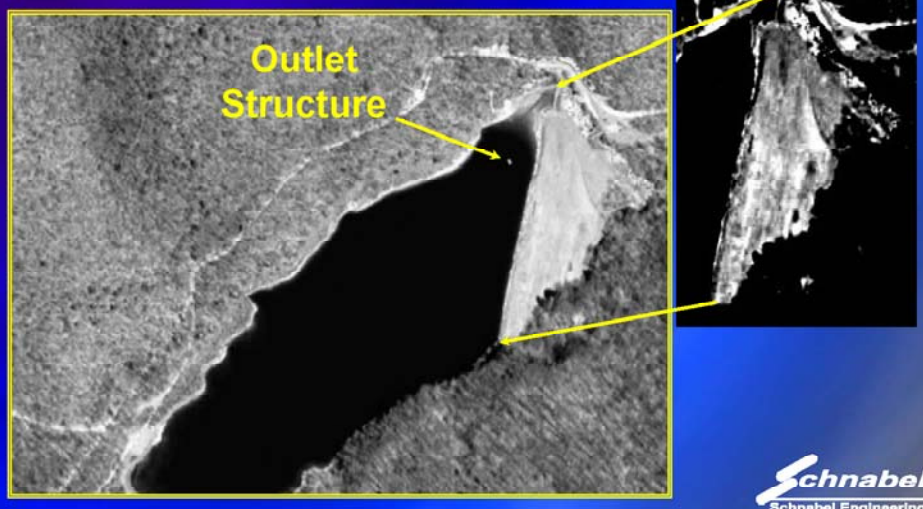
## Example 1, Moore's Creek Dam, Lexington, VA

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## *Geophysical Investigation to Define Seepage Pathways*

**Complimentary Geophysical Techniques**

- **Self Potential (SP)**
  (measures voltages from water moving through porous medium)
- **Two-Dimensional Resistivity**
  (measures low resistivity zones caused by increased water saturation)

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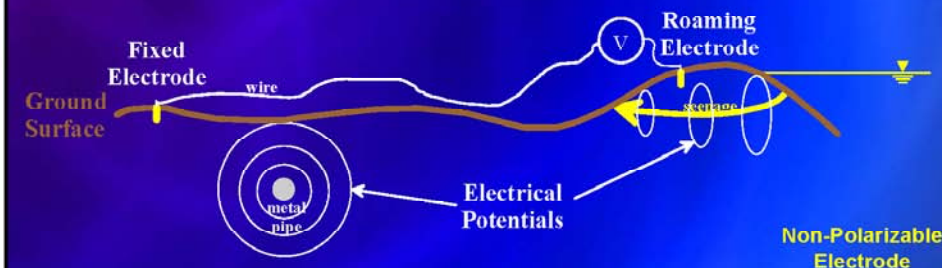
## Spontaneous Potential




Non-Polarizable Electrode

### Causes of SP Anomaly

- Mineralization
- Geothermal gradients
- Bioelectric activity
- Varying electrolytic concentrations in ground water
- Geochemical variations
- Corrosion
- Changes in topography
- Telluric currents
- Streaming

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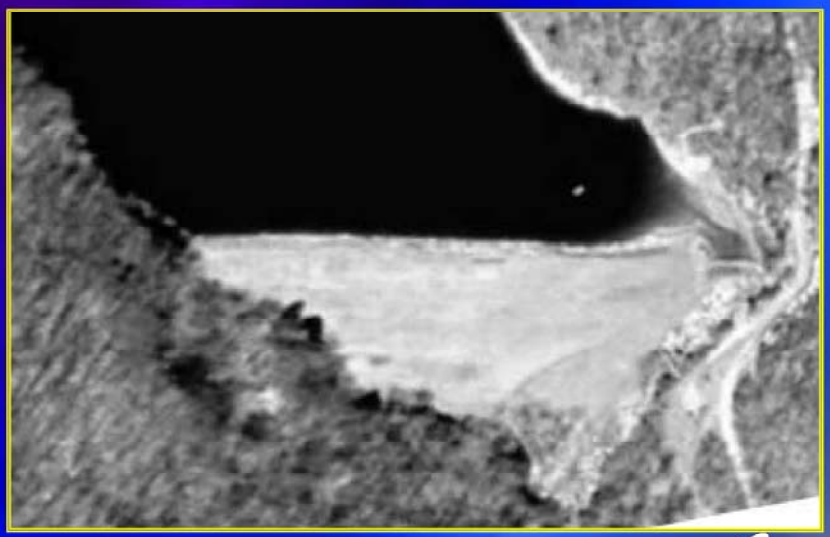
## Plan View of the Dam



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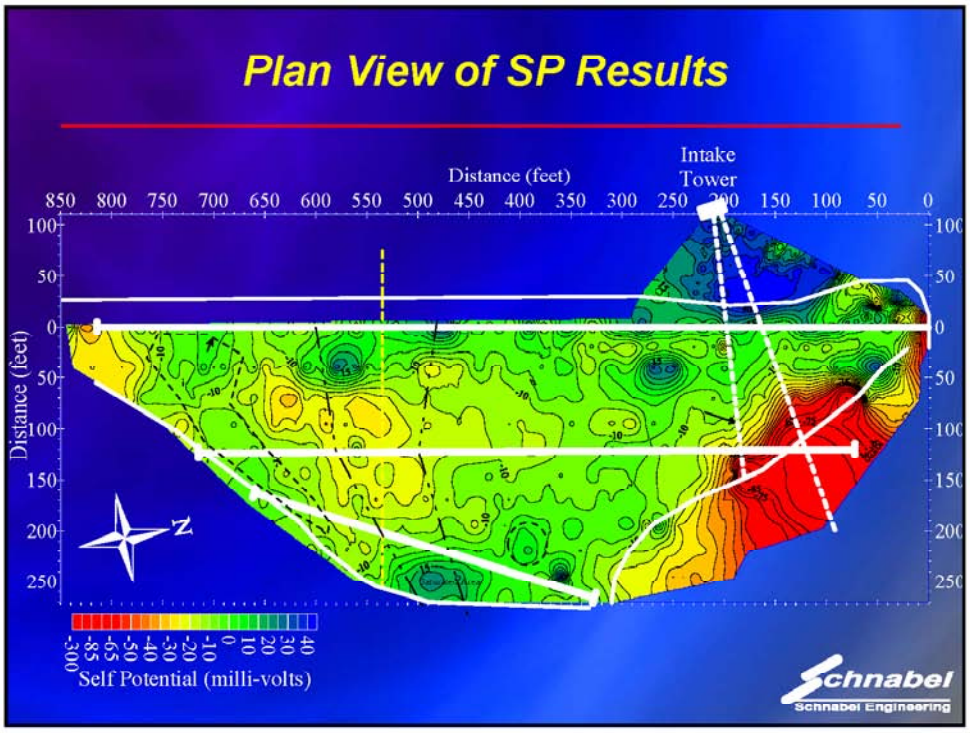
Plan View of SP Results
Distance (feet)
Intake Tower
850 800 750 700 650 600 550 500 450 400 350 300 250 200 150 100 50 0
Distance (feet)
100 50 0 50 100 150 200 250
N
-500 -85 -65 -50 -40 -30 -20 -10 0 10 20 30 40
Self Potential (milli-volts)
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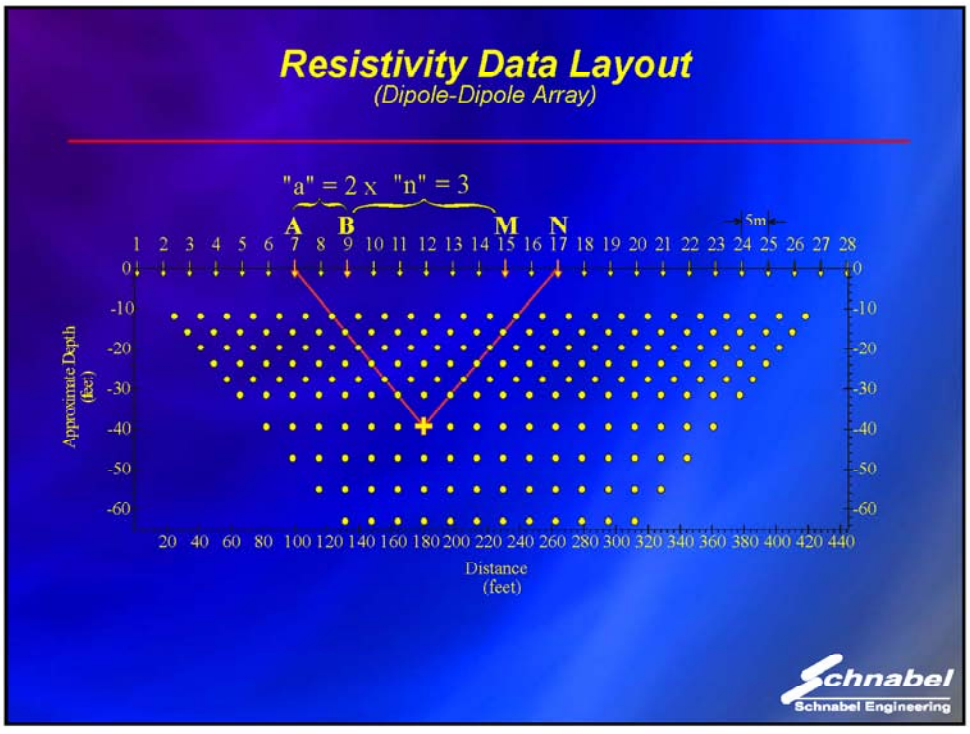
Resistivity Data Layout
(Dipole-Dipole Array)
"a" = 2 x "n" = 3
A B M N
5m
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
Approximate Depth (feet)
0 -10 -20 -30 -40 -50 -60
20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420 440
Distance (feet)
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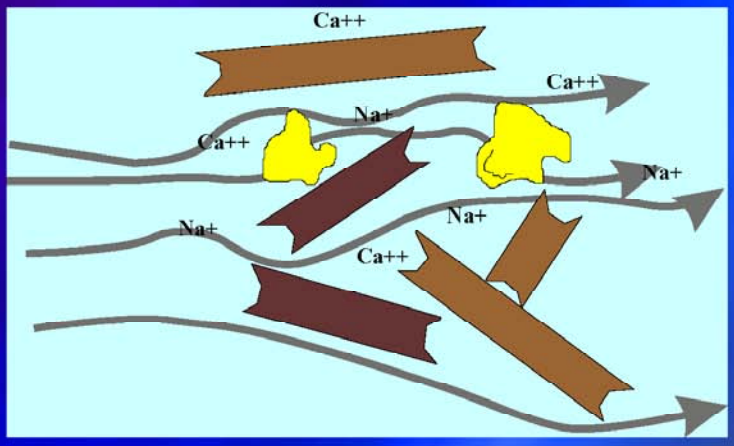
## Electrical Flow Through Earth Materials

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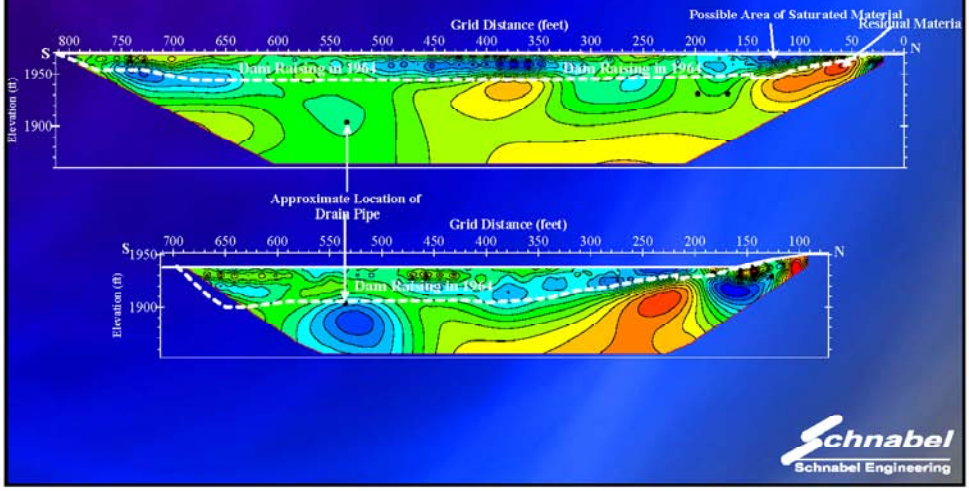
## Resistivity Results

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## Example 2: SP On Water, Chagrin Falls, OH

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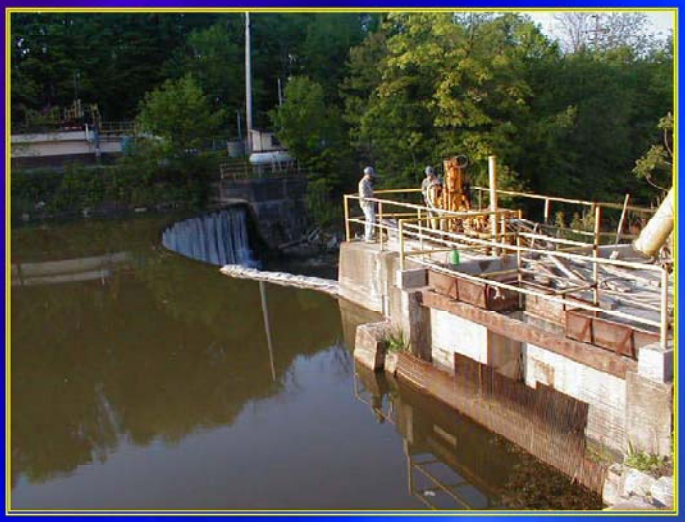
## Seepage Through or Around Spillway?



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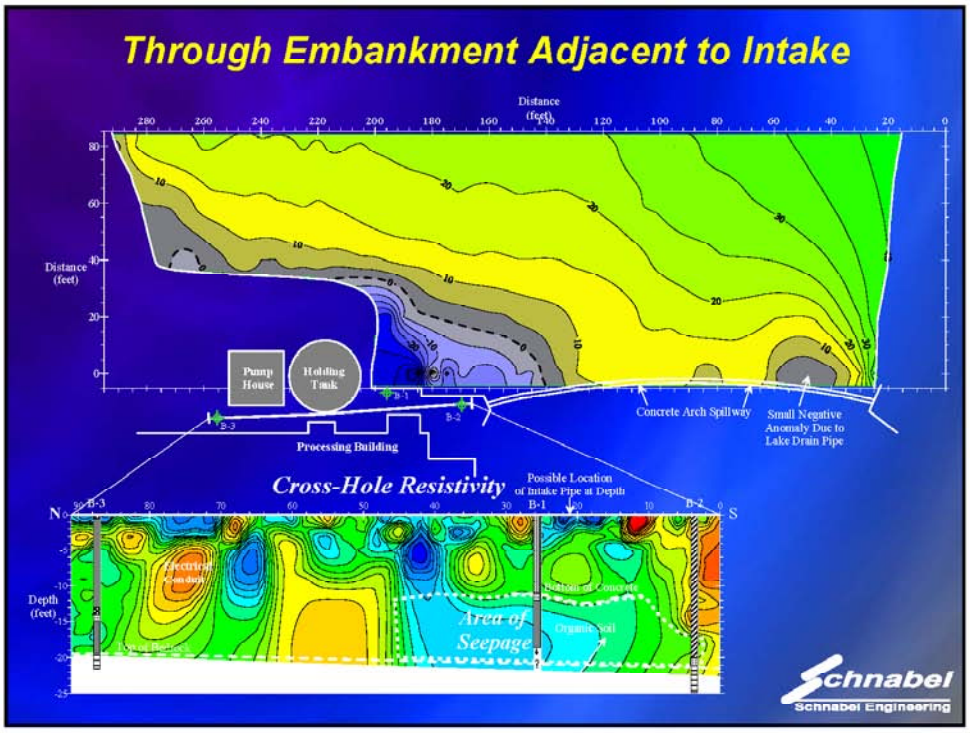
Through Embankment Adjacent to Intake
Distance (feet)
Distance (feet)
Pump House
Holding Tank
B-1
B-2
B-3
Processing Building
Concrete Arch Spillway
Small Negative Anomaly Due to Lake Drain Pipe
Cross-Hole Resistivity
Possible Location of Intake Pipe at Depth
N
S
Depth (feet)
Area of Seepage
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Example 3, Lake Logan, NC
Source
Geophones
Sonic Analysis of a Concrete Arch Spillway
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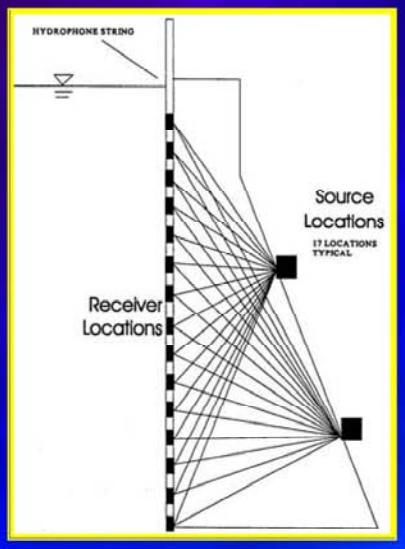
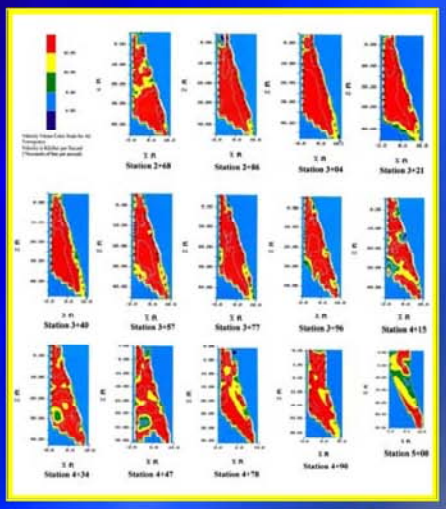
## Tomographic Analysis of the Sonic Data to Locate Poor Concrete Sections



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## Example 4, Concrete Spillway Slabs

Finding Voids Under Spillways

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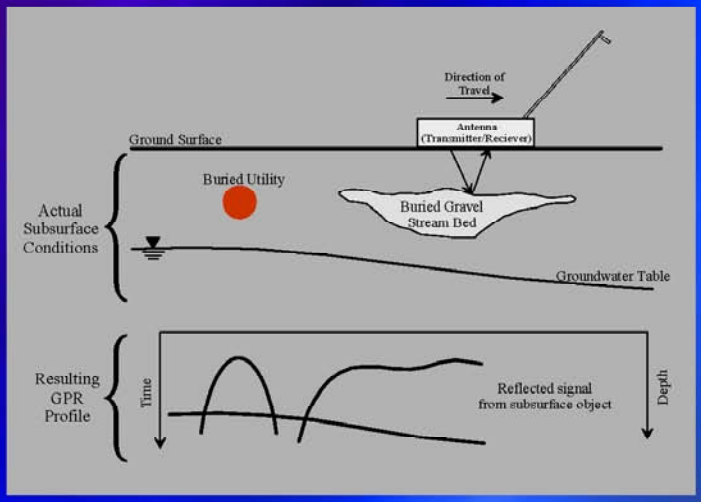
# Ground Penetrating Radar (GPR)

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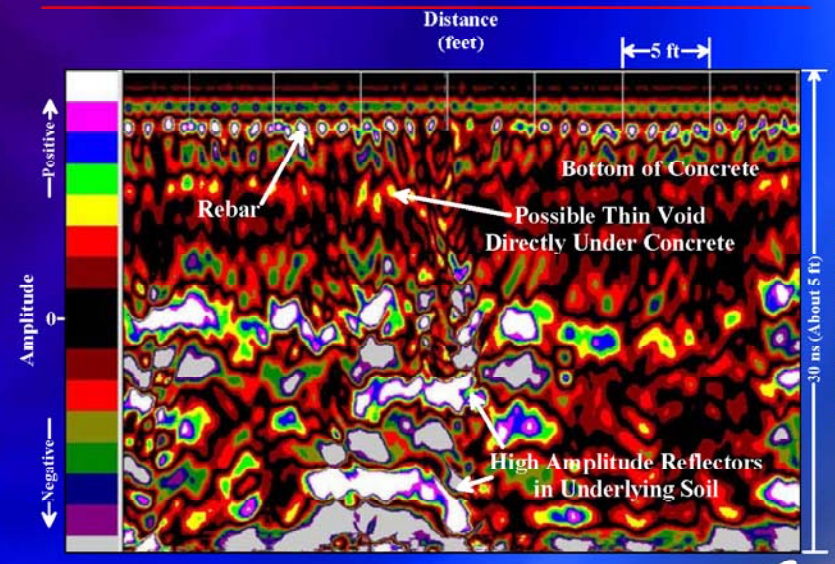
# GPR Results – "Typical" Voids

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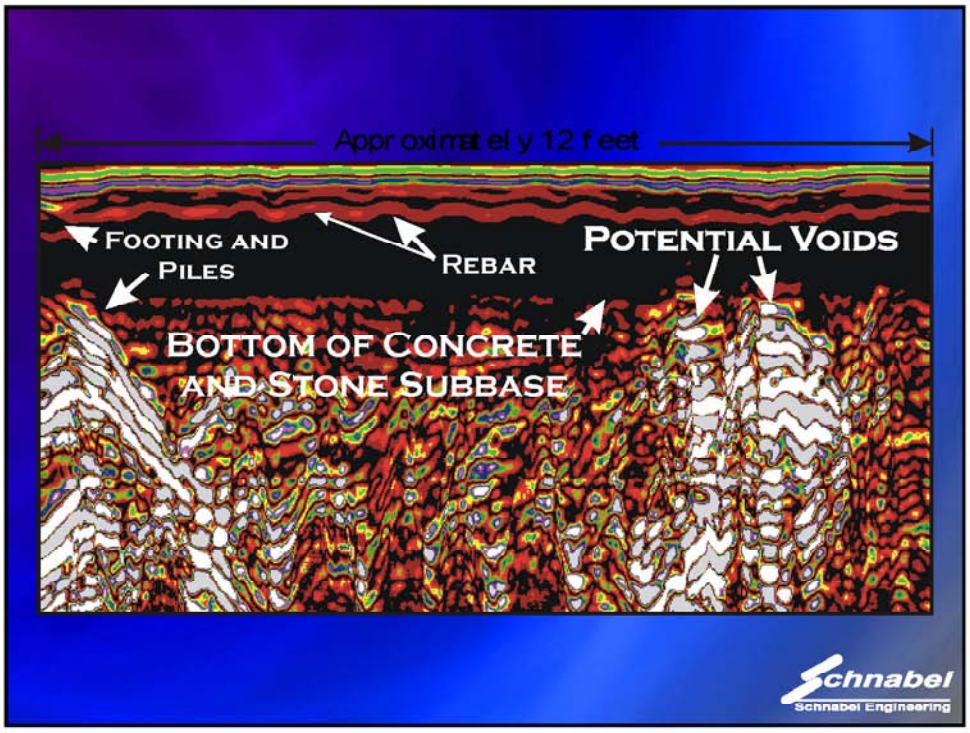
Approximately 12 feet
Footing and Piles
Rebar
Potential Voids
Bottom of Concrete and Stone Subbase
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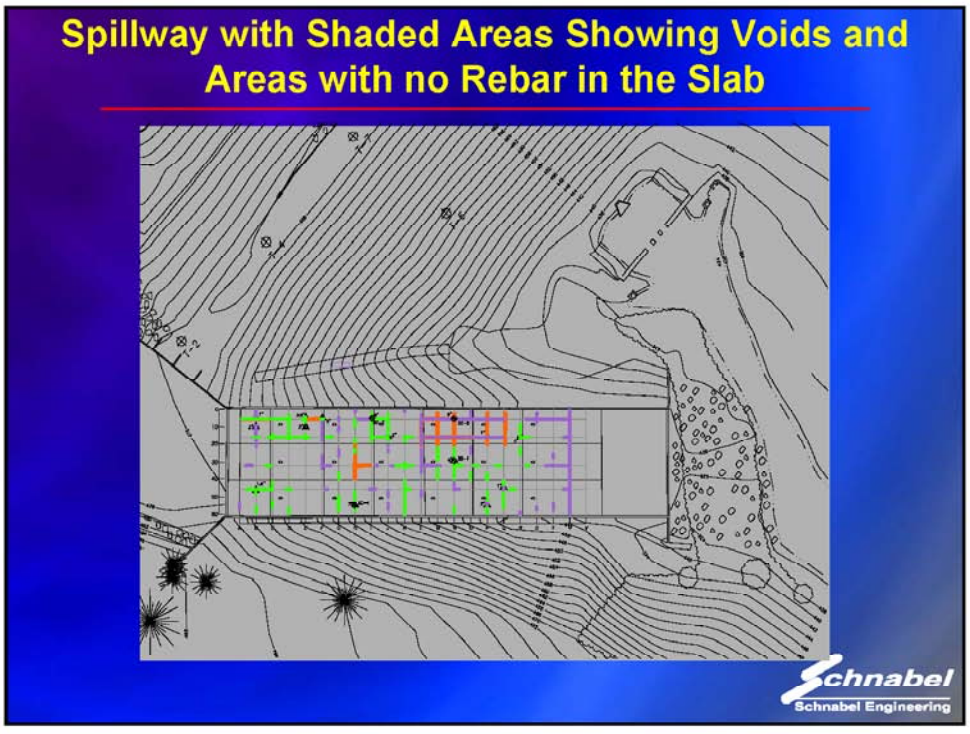
Spillway with Shaded Areas Showing Voids and Areas with no Rebar in the Slab
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# GEOPHYSICS

- Will NOT solve every problem.
- Each method has strong and weak points, therefore often best when several complimentary methods are used.
- Can be extremely useful and cost effective if used properly to "see the big picture", or to search for "targets".
- Necessary to understand geophysical principles, geology, construction methods and design, and what the client wants in order to provide USEFUL interpretations and subsurface characterization.

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