What you Need to Know About Geophysical Surveys for Transportation Applications

Jeffrey Reid, P.G., Owner/Principal Geophysicist

Hager-Richter Geoscience, Inc.
www.hager-richter.com

HRGS
HAGER-RICHTER GEOSCIENCE, INC.
Geophysics for the Engineering & Environmental Communities

Presentation Outline

- **Benefits of geophysics and how to get the most out of geophysics**
  - **Building a project team and geophysical SOW, choosing appropriate seismic methods, contracting**
- Deliverables
- Integration of Results
- Questions

HRGS
HAGER-RICHTER GEOSCIENCE, INC.
Geophysics for the Engineering & Environmental Communities

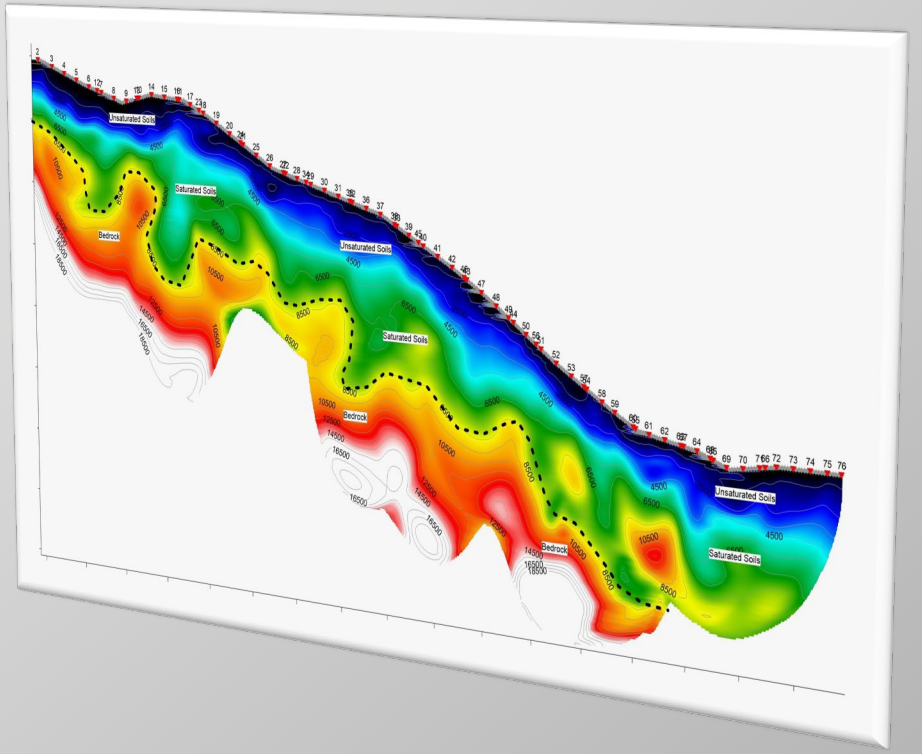
The Benefits of Geophysics for Environmental and Geotechnical Subsurface Characterization

- Reduce the Unknown!
  - Schedule and/or costs of up to 50% of major projects are significantly impacted by limited subsurface information.
  - Most of these issues are directly or indirectly related to the scope and quality of subsurface investigation/characterization.

HRGS
HAGER-RICHTER GEOSCIENCE, INC.
Geophysics for the Engineering & Environmental Communities

Why Use Geophysics

- Non and minimally invasive
- Can be used as a reconnaissance tool
- Aerial data vs point data
- Focus intrusive and more expensive methods
- Interpolate data between borings/test pits
- Generally low cost for the volume and value of data
- Reduces overall project cost and risk



HRGS

HAGER-RICHTER GEOSCIENCE, INC.

Geophysics for the Engineering & Environmental Communities

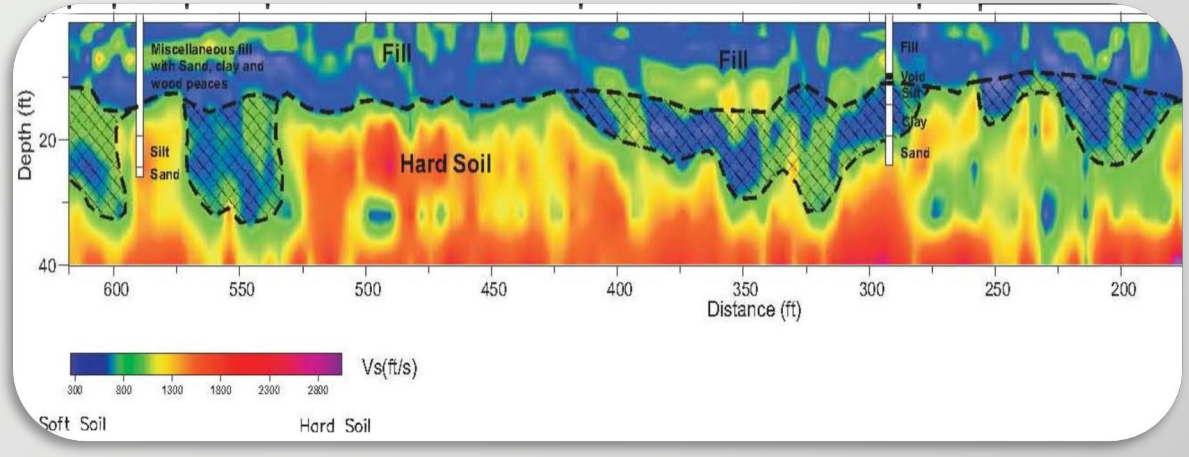
Building a Project Team

- Components of a Successful Team
  - Trust
  - Get Geophysicists Involved Early
  - Know What You Know and Don't Know
  - Setting and Managing Expectations
  - COMMUNICATION throughout the project

HRGS
HAGER-RICHTER GEOSCIENCE, INC.
Geophysics for the Engineering & Environmental Communities

How to Develop a Geophysical Scope of Work

- Are the site, project objectives, and budget suited for geophysics
- Define objectives and areas of interest
- Select the appropriate method(s)
- Set expectations and understand technical, logistical, and schedule limitations
- Outline the required deliverables and deliverable timelines



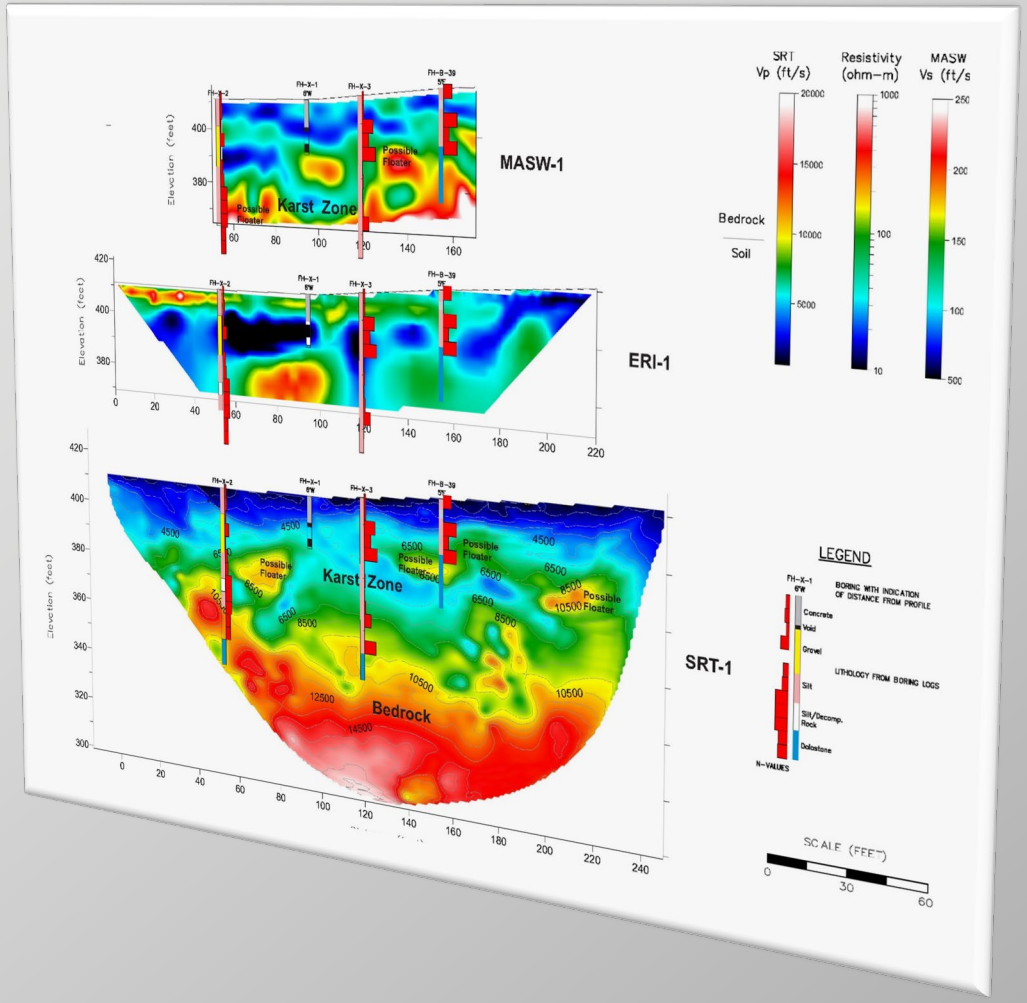
HRGS

HAGER-RICHTER GEOSCIENCE, INC.

Geophysics for the Engineering & Environmental Communities

Choosing the Appropriate Method(s)

- Project objectives
- Expected surface conditions
- Expected subsurface conditions
- Field logistics and schedule
- Expectations for survey resolution and depth of investigation
- Deliverable needs



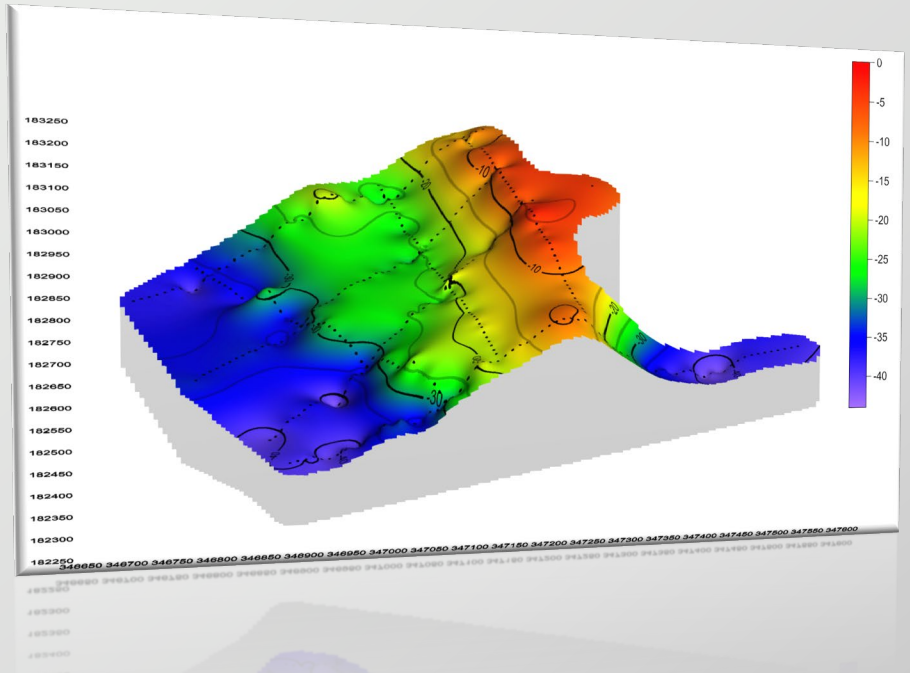
HRGS

HAGER-RICHTER GEOSCIENCE, INC.

Geophysics for the Engineering & Environmental Communities

Contracting

- Direct contracting of a geophysical consultant
- Subconsultant through geotechnical engineer or others
- Self performance
- Geophysical standby contracts (annually or multi-year)
  - Should large geotechnical and environmental standby contracts be required to have a geophysical team member?



HRGS

HAGER-RICHTER GEOSCIENCE, INC.

Geophysics for the Engineering & Environmental Communities

Presentation Outline

- Benefits of geophysics and how to get the most out of geophysics
  - Building a project team and geophysical SOW, choosing appropriate seismic methods, contracting
- **Deliverables**
- Integration of Results
- Questions

HRGS
HAGER-RICHTER GEOSCIENCE, INC.
Geophysics for the Engineering & Environmental Communities

What Results are Needed from the Geophysical Surveys

- Bedrock depth and configuration
- Mapping soft soil layers
- Water table
- Engineering properties (rippability, Vs100)
- Identification of bedrock fracture zones and faults
- Locations of utilities and obstructions
- Identification of voids and landslide features

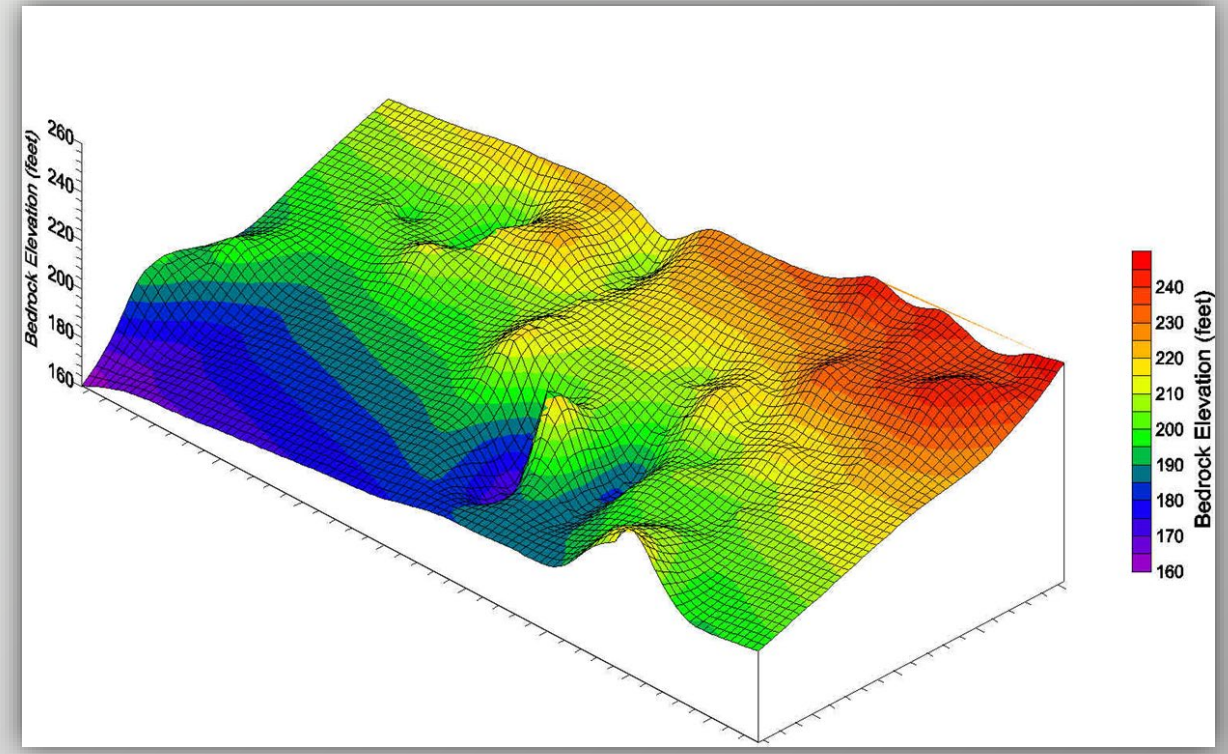
HRGS

HAGER-RICHTER GEOSCIENCE, INC.

Geophysics for the Engineering & Environmental Communities

How Can the Client Effectively Use the Geophysical Results

- Types of Deliverables
- Paper Reports
- PDF Report
- JPG/TIFF Images
- 2D/3D AutoCAD
- ArcGIS
- Excel Tables



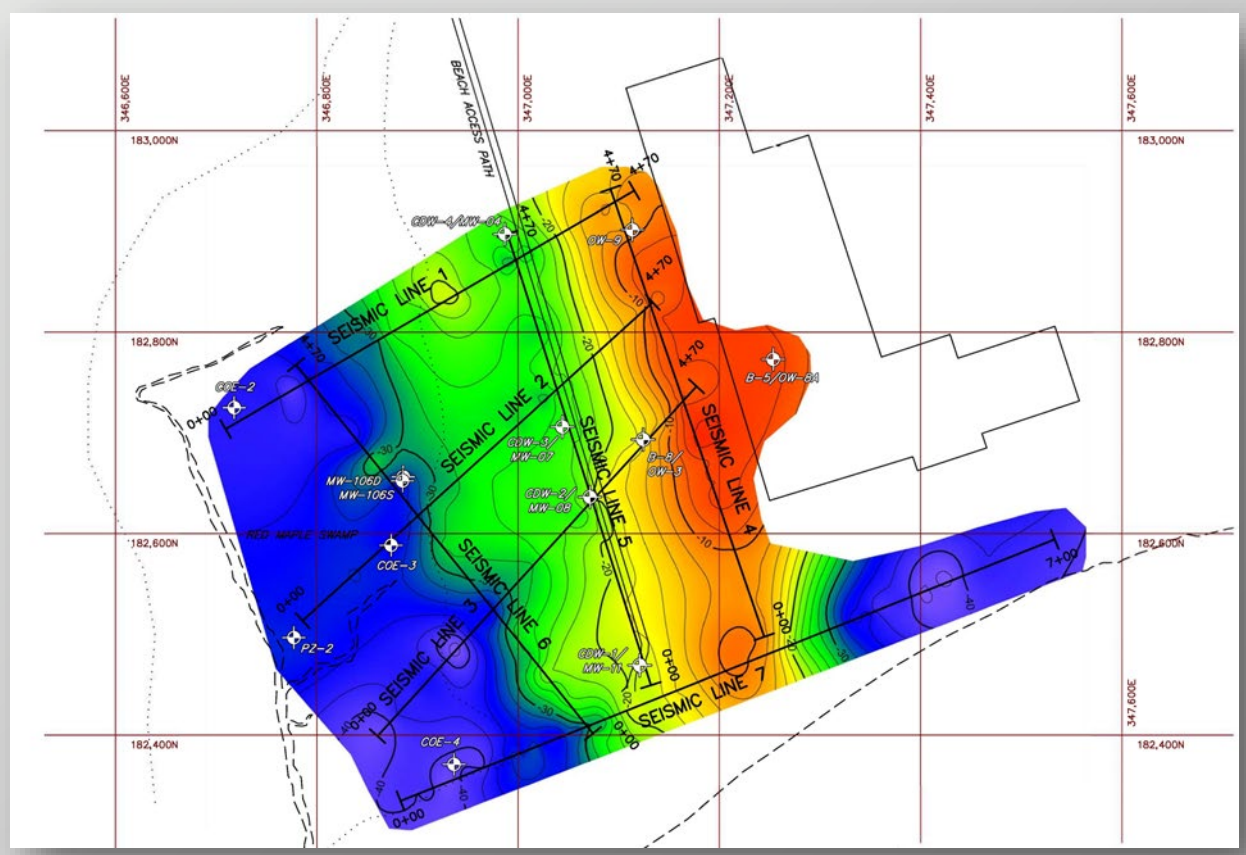
HRGS

HAGER-RICHTER GEOSCIENCE, INC.

Geophysics for the Engineering & Environmental Communities

Understanding the Deliverables

- What goes in the deliverables?
  - Results of the geophysical surveys
  - Incorporating outside data/ground truth
  - Presented in a clear and useful way
    - Depth vs Elevation
    - Data vs Interpretation
    - Stratigraphy vs Velocity
  - Meeting project objectives
  - Interpolation vs Extrapolation
  - Accuracy of the results – 2D vs 3D
  - Estimates and assumptions should be provided in the deliverables



HRGS

HAGER-RICHTER GEOSCIENCE, INC.

Geophysics for the Engineering & Environmental Communities

2D vs 3D Data Presentation

- 2D: Bedrock Profiles
  - Dense data set along each profile with bedrock elevation every 5 feet
  - Good understanding of accuracy based on comparison with nearby borings
  - Elevations of bedrock are reliant on surface elevations
- 3D: Bedrock Surface Contour Maps
  - Objectives
    - Generated from a composite data set of bedrock elevations determined from seismic refraction, borings, test pits, and outcrop observations
    - Accuracy of the model decreases with distance from hard data (interpolation/extrapolation)
    - Model can vary significantly based on gridding algorithm and grid cell size
    - Generally, the larger the grid cell size, the smoother the model at the cost of not necessarily representing the hard data points

HRGS
HAGER-RICHTER GEOSCIENCE, INC.
Geophysics for the Engineering & Environmental Communities

Digital Deliverables

- 2D: Bedrock Profiles
  - Digital profile plots in AutoCAD/MicroStation
  - Excel tables of X, Y, Z georeferenced data
  - Statements of accuracy based on comparison with nearby borings
- 3D: Bedrock Surface Contour Maps
  - Digital georeferenced surface plots in AutoCAD/MicroStation/ArcGIS/Surfer
  - Statements of relative accuracy based on comparison with nearby borings
    - Contours shown represent interpolations based on the seismic data, probe data, and reported bedrock elevations at borings. Contours shown represent non-unique models for bedrock depth (i.e., different valid models can be developed to fit the data set), and the true depth of bedrock at any location may differ significantly from that shown depending on data density and accuracy.

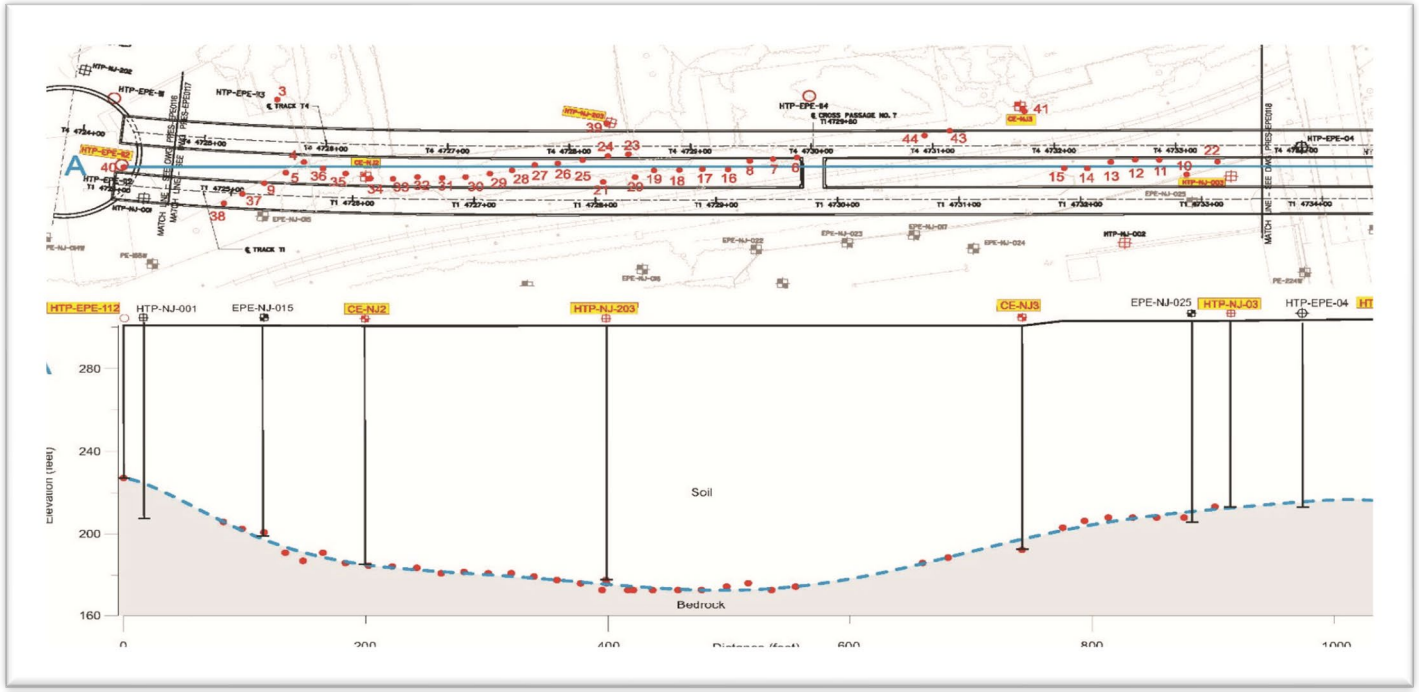
HRGS
HAGER-RICHTER GEOSCIENCE, INC.
Geophysics for the Engineering & Environmental Communities

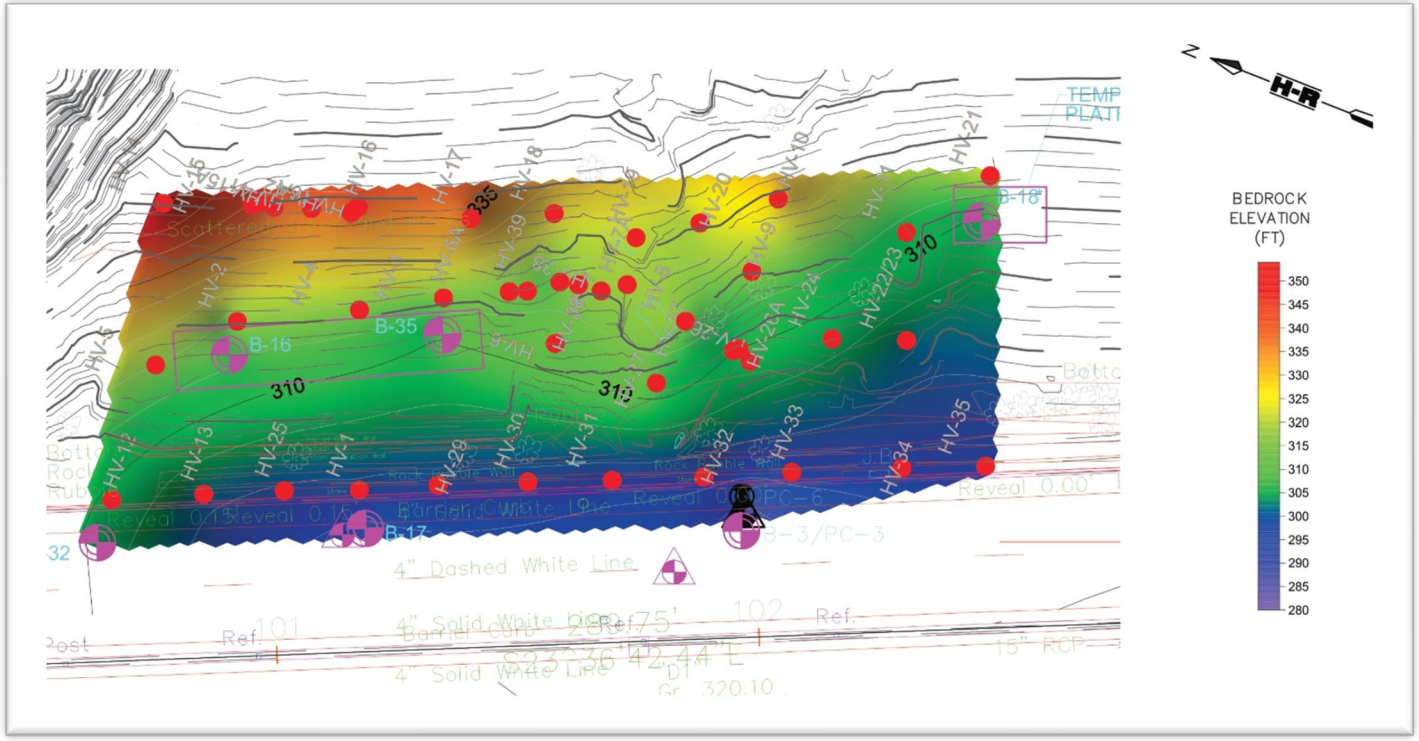
Presentation Outline

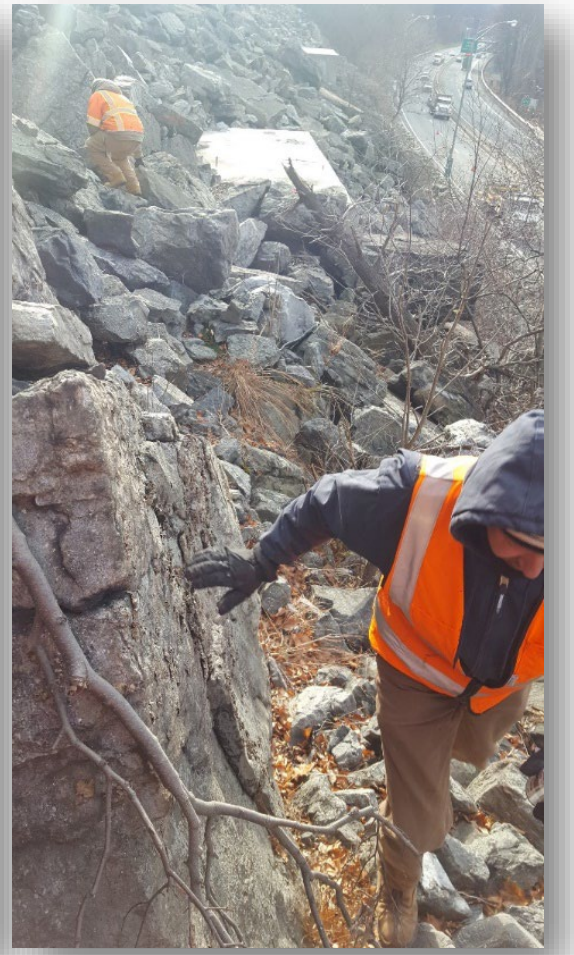
- Benefits of geophysics and how to get the most out of geophysics
  - Building a project team and geophysical SOW, choosing appropriate seismic methods, contracting
- Deliverables
- **Integration of Results**
- Questions

HRGS
HAGER-RICHTER GEOSCIENCE, INC.
Geophysics for the Engineering & Environmental Communities

Adaptability & Integration of Results





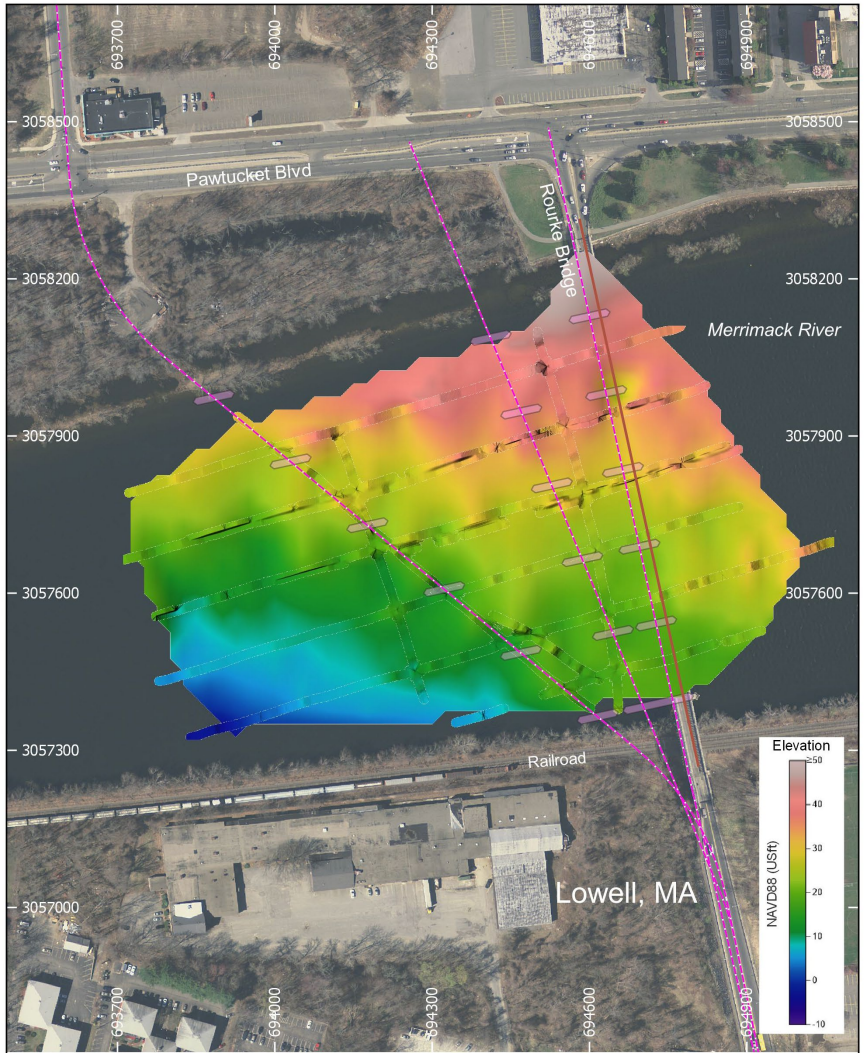


HRGS

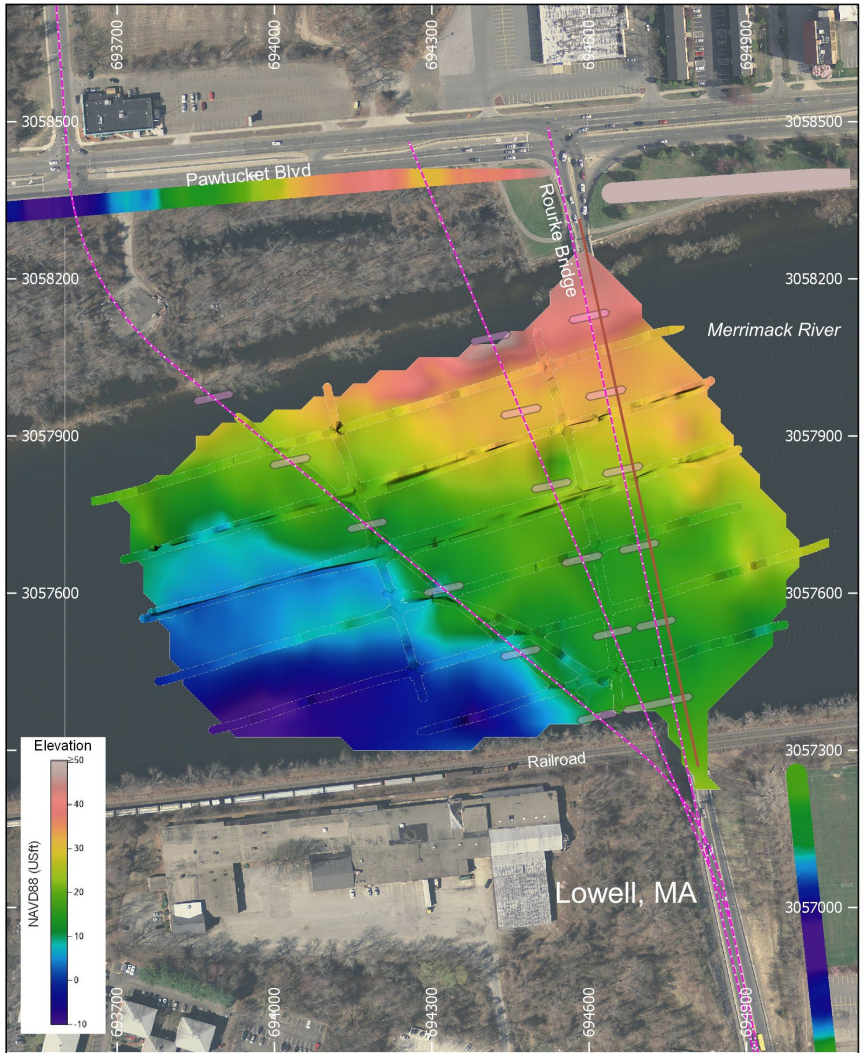
HAGER-RICHTER GEOSCIENCE, INC.

Geophysics for the Engineering & Environmental Communities

Integrated Marine & Land Geophysical Results



Top-of-Till Interpolated Surface Map

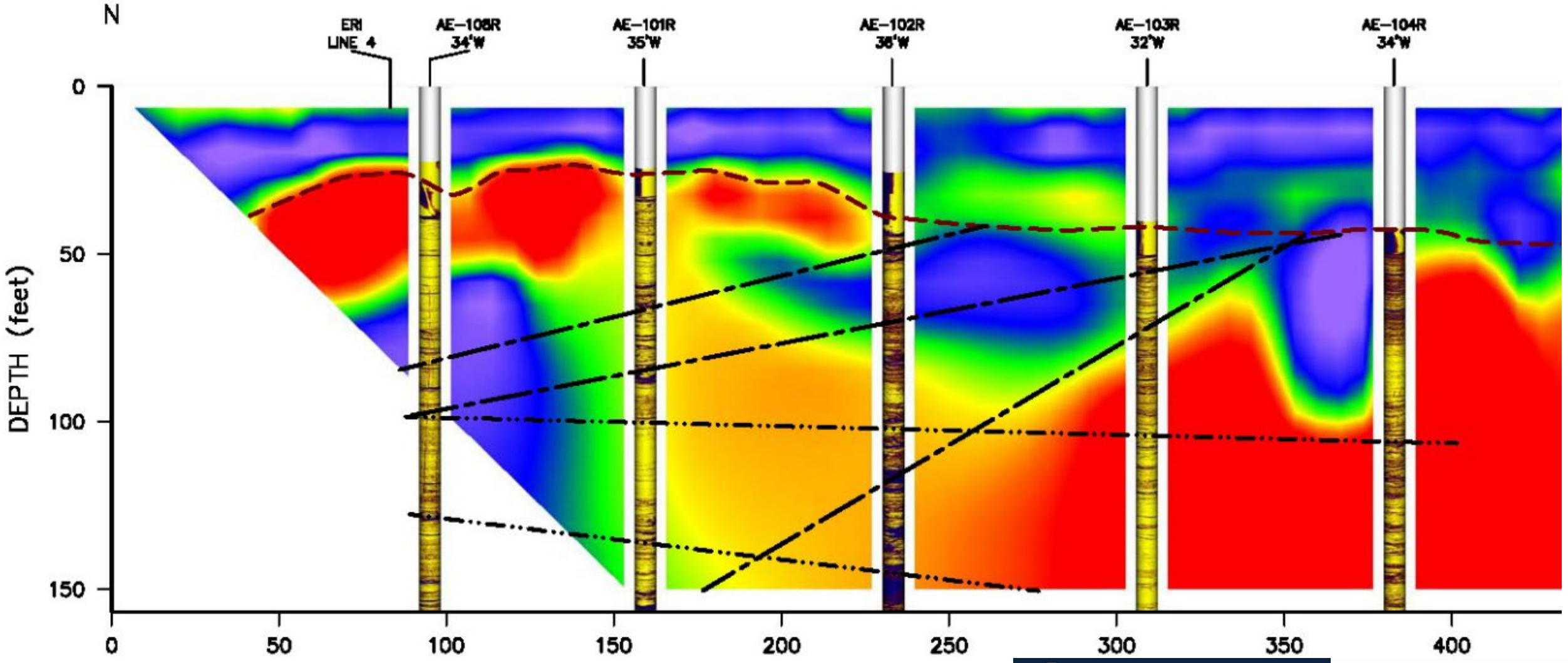


Top-of-Rock Interpolated Surface Map

Credit: Hager-Richter & e4sciences

HRGS
HAGER-RICHTER GEOSCIENCE, INC.
Geophysics for the Engineering & Environmental Communities

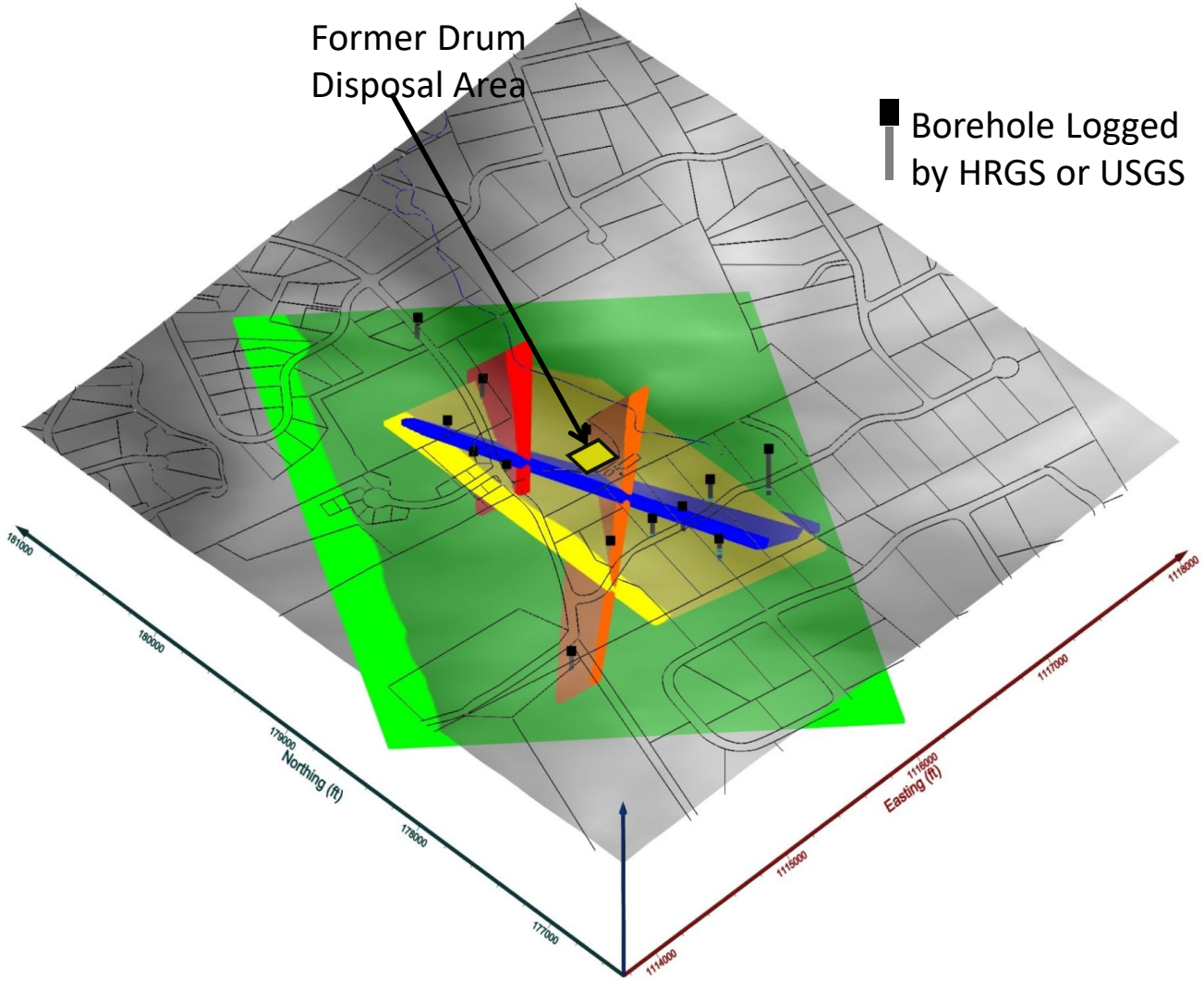
Integrated Land & Borehole Geophysical Results

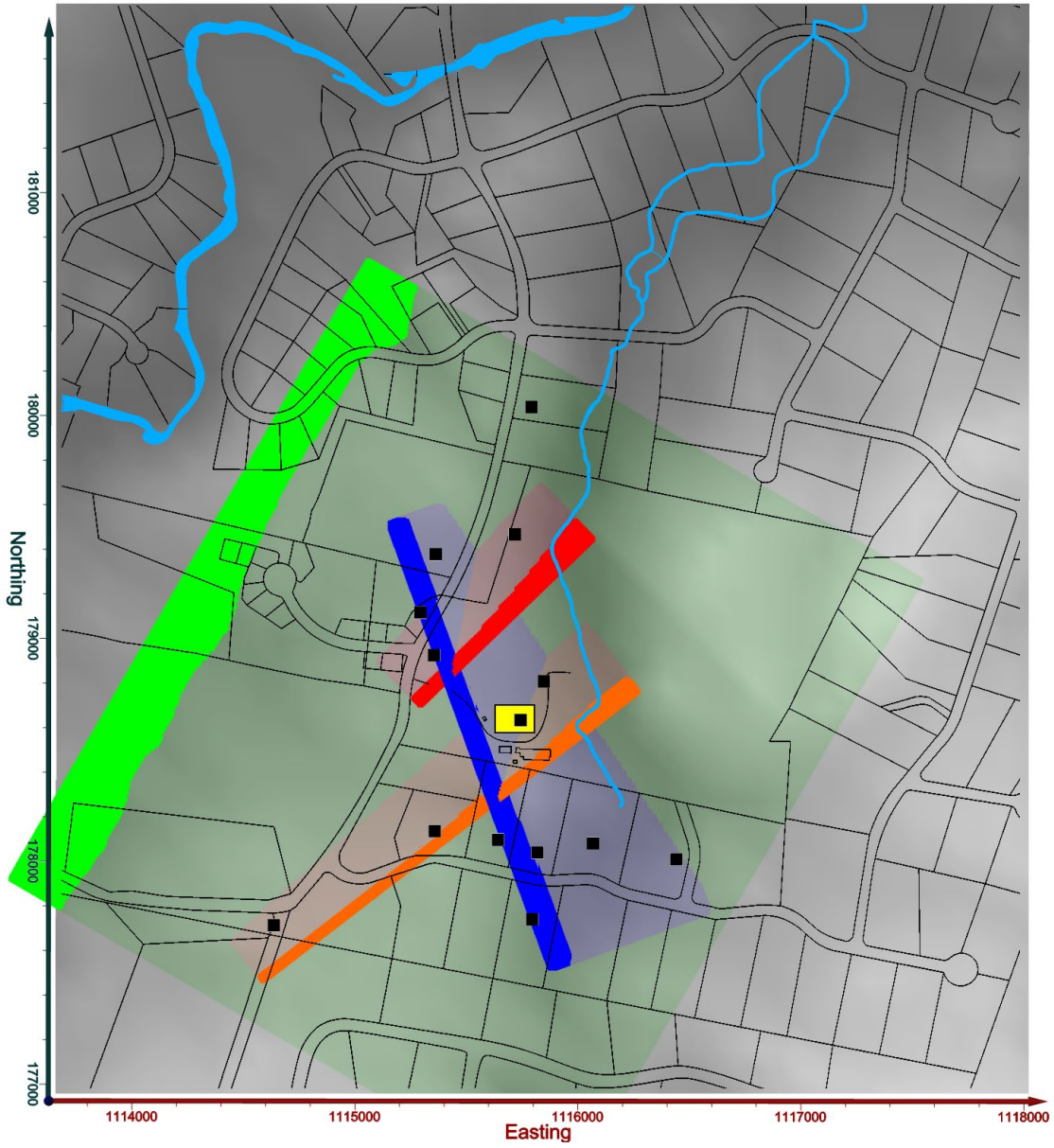


HRGS

HAGER-RICHTER GEOSCIENCE, INC.

Geophysics for the Engineering & Environmental Communities





HRGS

HAGER-RICHTER GEOSCIENCE, INC.

Geophysics for the Engineering & Environmental Communities

Presentation Outline

- Benefits of geophysics and how to get the most out of geophysics
  - Building a project team and geophysical SOW, choosing appropriate seismic methods, contracting
- Deliverables
- Integration of Results
- **Questions**

HRGS
HAGER-RICHTER GEOSCIENCE, INC.
Geophysics for the Engineering & Environmental Communities

What you Need to Know About Geophysical Surveys for Transportation Applications

Jeffrey Reid, P.G., Owner/Principal Geophysicist

Hager-Richter Geoscience, Inc.
www.hager-richter.com

HRGS
HAGER-RICHTER GEOSCIENCE, INC.
Geophysics for the Engineering & Environmental Communities