NORTH CAROLINA
Department of Transportation

NCDOT Use of Geophysics for Geotechnical Investigations

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Connecting people, products and places safely and efficiently with customer focus, accountability and environmental sensitivity to enhance the economy and vitality of North Carolina

The Geotechnical Engineering Unit of NCDOT has been contracting geophysical services to investigate sites as an alternative or supplement to traditional methods of investigation.

This presentation will discuss NCDOT's recent use of geophysics for bridge foundation subsurface investigation, retaining wall subsurface investigation, detection of voids around existing drainage, and to supplement pavement investigations.

What are the Lessons learned related to contracting the work, utilizing and confidence in the data acquired?

Bridge Investigations

B-6047, Bridge 145 over Floyd's Creek on SR 2125, Rutherford County

Reason for supplemental geophysical investigation:

- Restricted from coring through bridge deck; Prestressed Concrete Channel Beam Bridge
- Steep slope to floodplain made access difficult without creating an access road with heavy machinery.
- An idea of rock line was needed to anticipate depth to rock for two interior bent locations.

Bridge Investigations

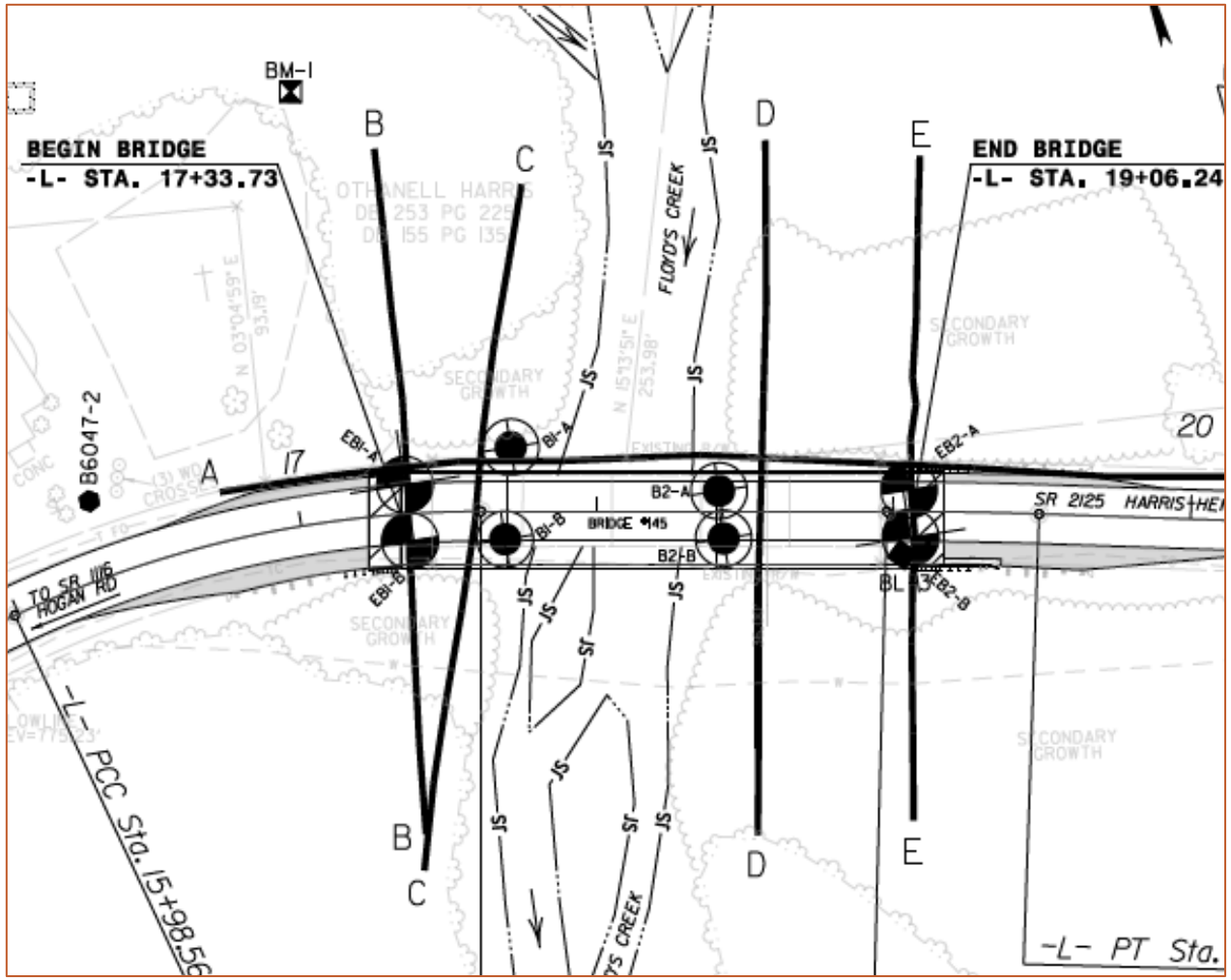
B-6047, Bridge 145 over Floyd's Creek over SR 2125, Rutherford County

Geophysical Methods Utilized:

- Seismic Refraction
- MASW

Traditional geotechnical methods employed:

- Bridge rod sounding at two locations per bent.
- End bent borings were cored to drilled shaft criteria to get a better idea of rock condition at depths below streambed elevation.



Schnabel Geophysical Survey Report, dated 2/16/2023.

Bridge Investigations

B-6047, Bridge 145 over Floyd's Creek over SR 2125, Rutherford County

Results:

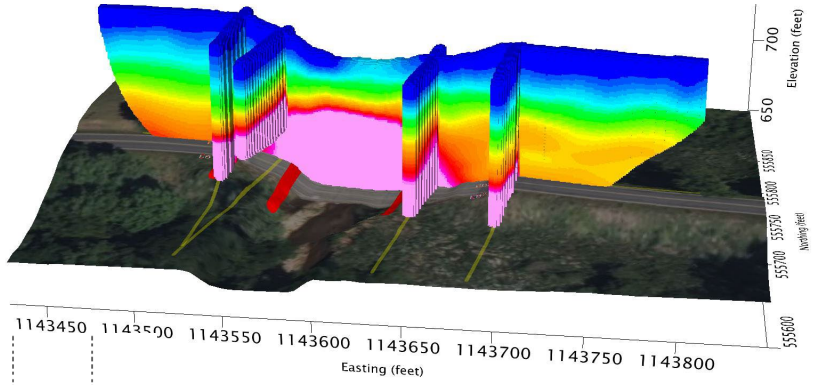
- Transitions between residual, weathered rock and crystalline rock were gradual, with less resolution.
- WR/CR was represented in P-wave velocity (ft/s) on cross section with some validation.

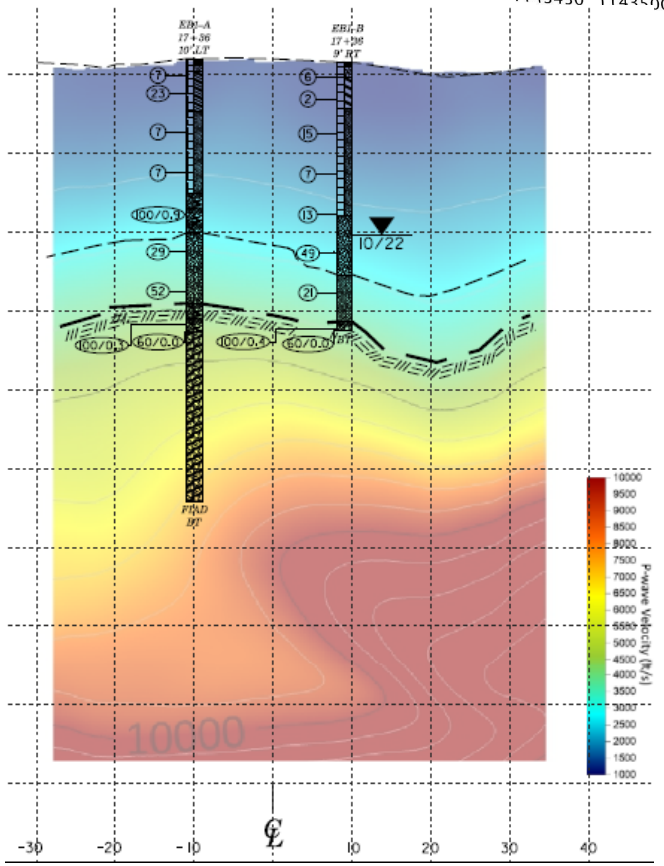
Lessons Learned:

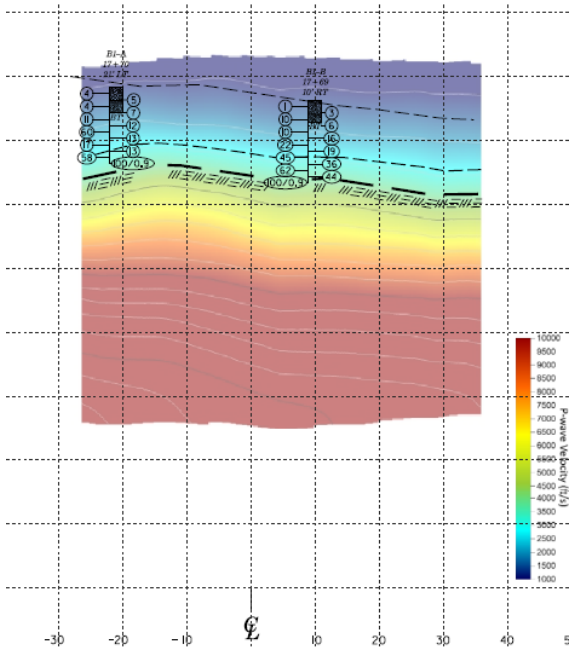
- Very little correlation to survey lines along profile.

Possible Actions:

- Post let drilling of interior bent borings.
- Future bridges may require more robust attempts to place drill rig closer to drill locations.







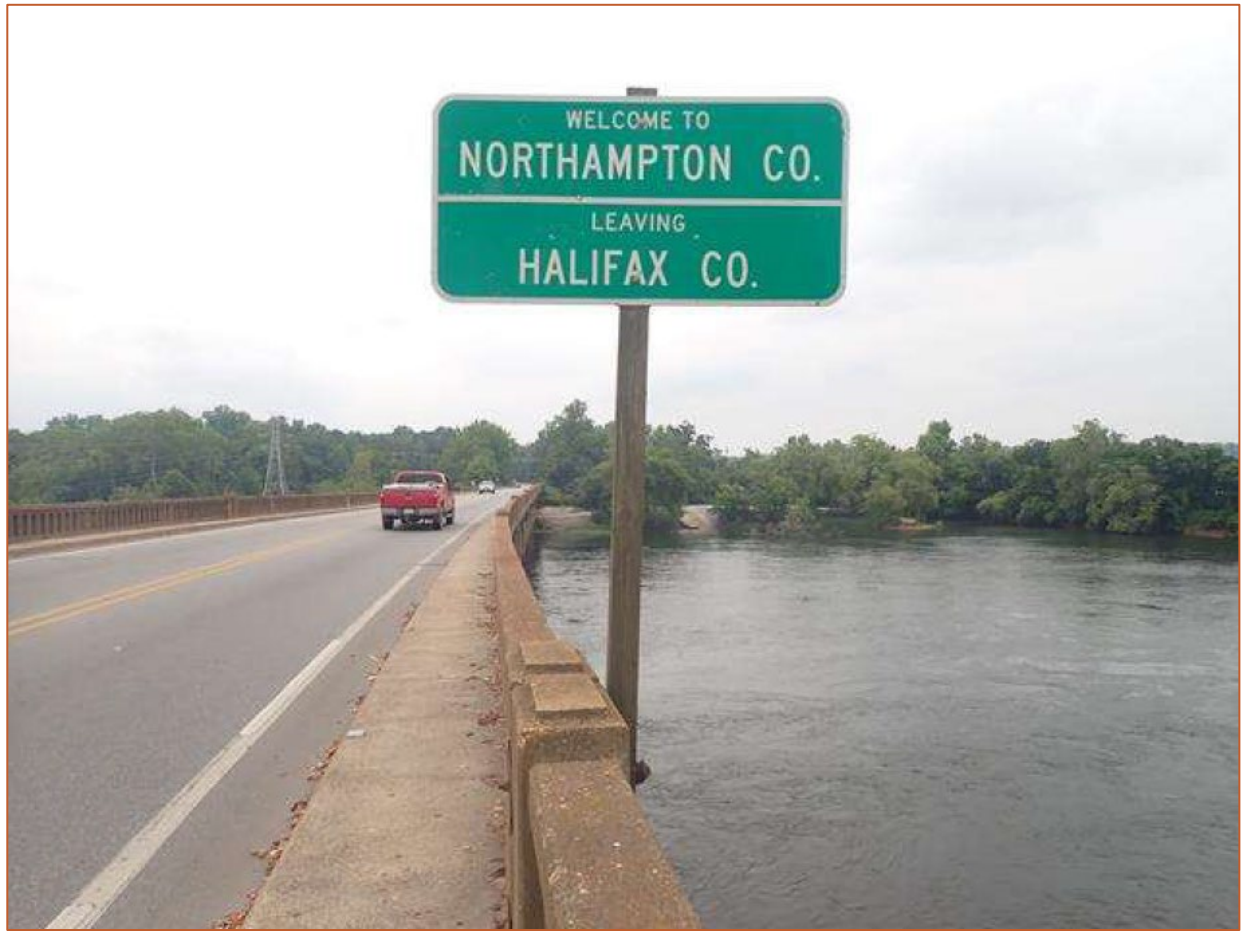
Schnabel Geophysical Survey Report, dated 2/16/2023.

Bridge Investigations

BR-0021, Bridge 51 over the Roanoke River on NC 48, Halifax County

Reason for supplemental geophysical investigation:

- New alignment, 1500-foot structure, 5 bents in Roanoke River
- Moratorium restricted barge access until November of 2023.



Bridge Investigations

BR-0021, Bridge 51 over the Roanoke River on NC 48, Halifax County

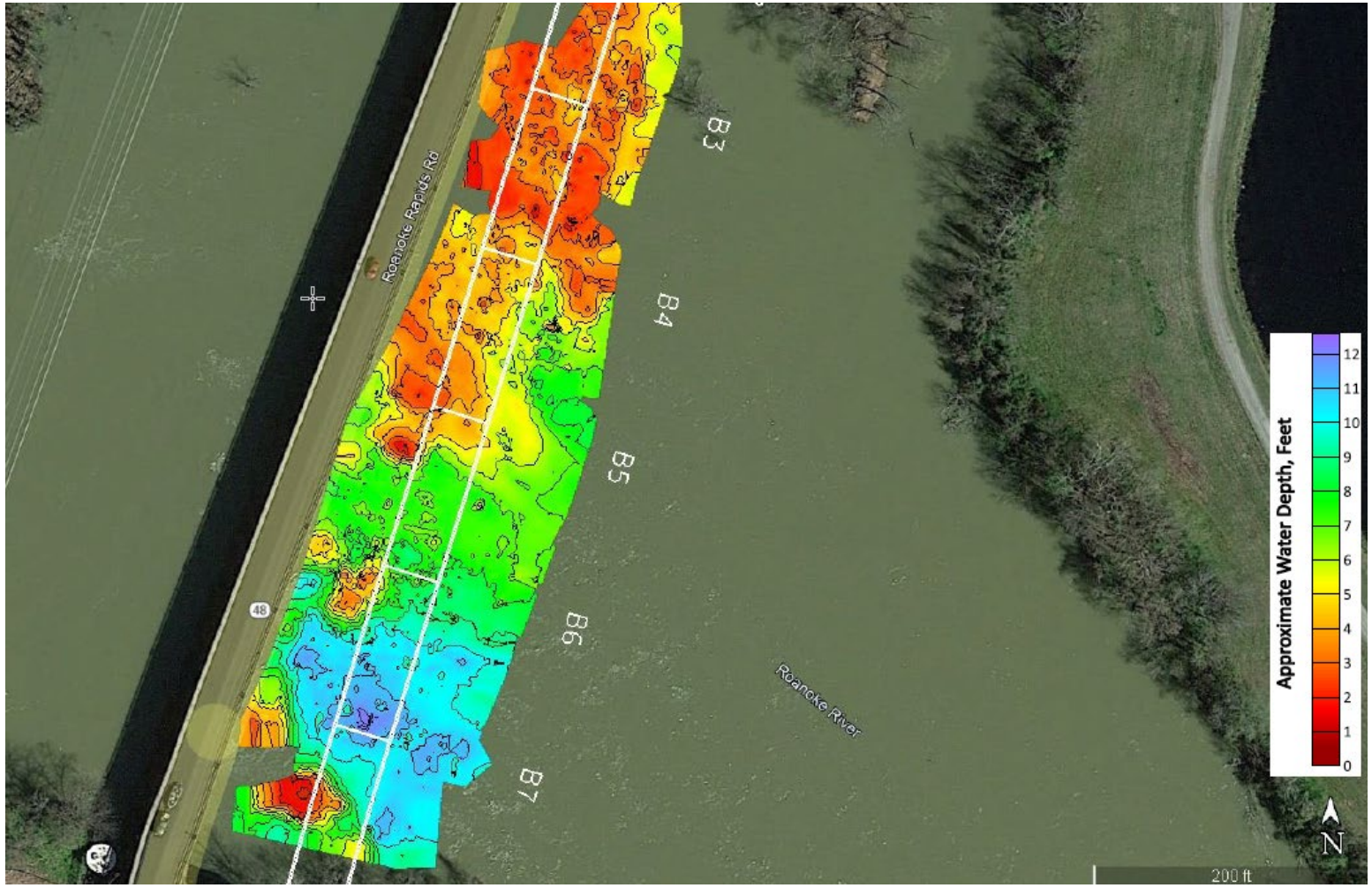
Geophysical Methods Chosen:

- GPR
- 200 MHz, 250 MHz

Seismic Refraction and Electrical Resistivity were not allowed due to potential to affect anadromous fish.

Traditional geotechnical methods employed:

- Borings will be completed using barge after Moratorium expires.

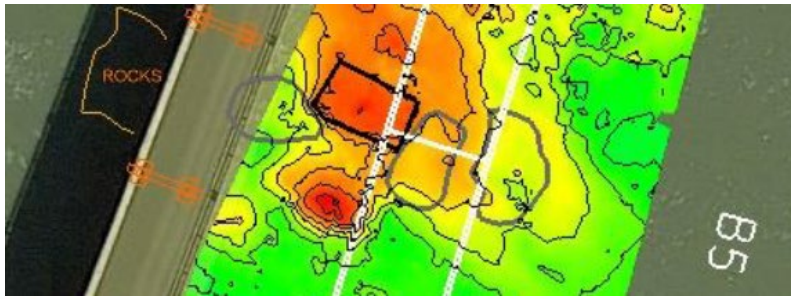


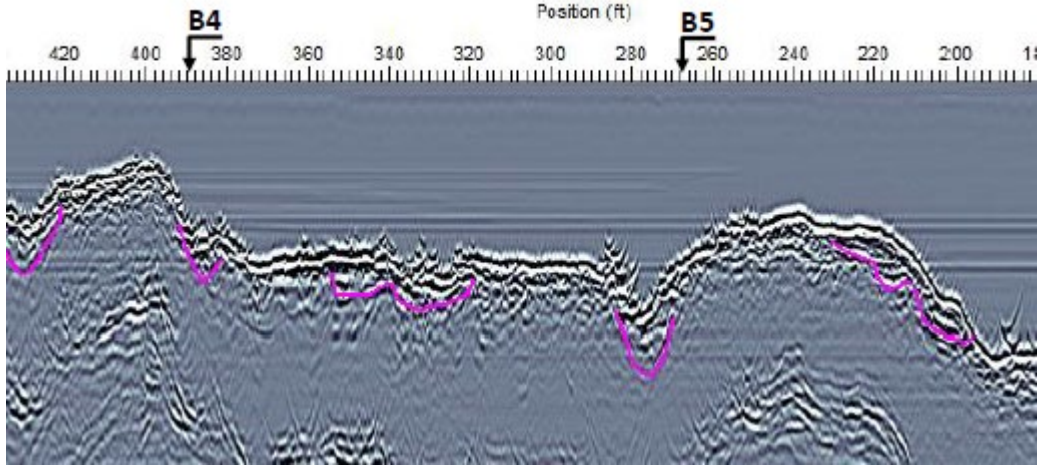
ESP Geophysical Survey Report, dated 6/15/2023.

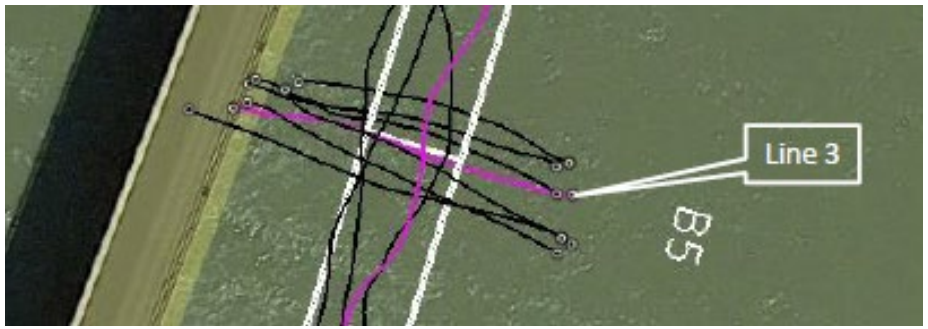
Bridge Investigations

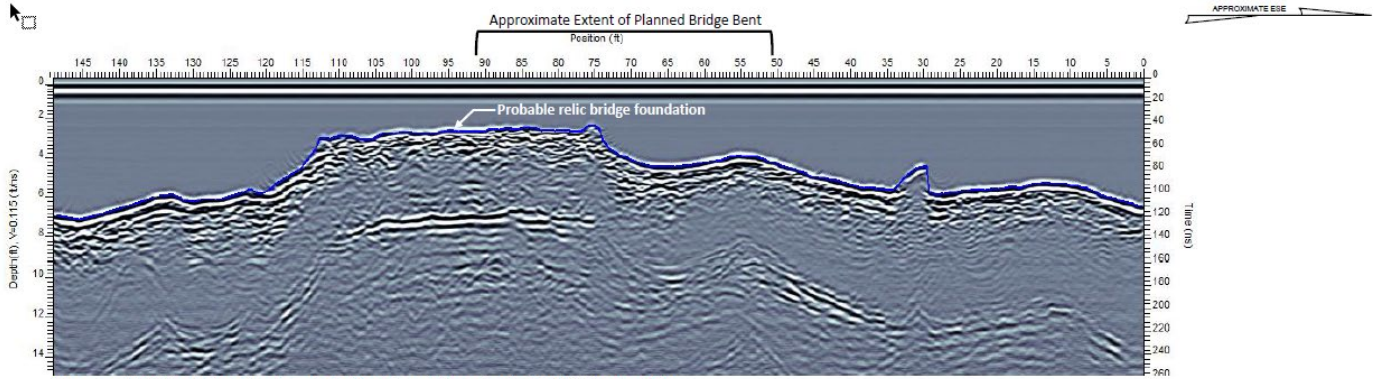
BR-0021, Bridge 51 over the Roanoke River on NC 48, Halifax County

Results:

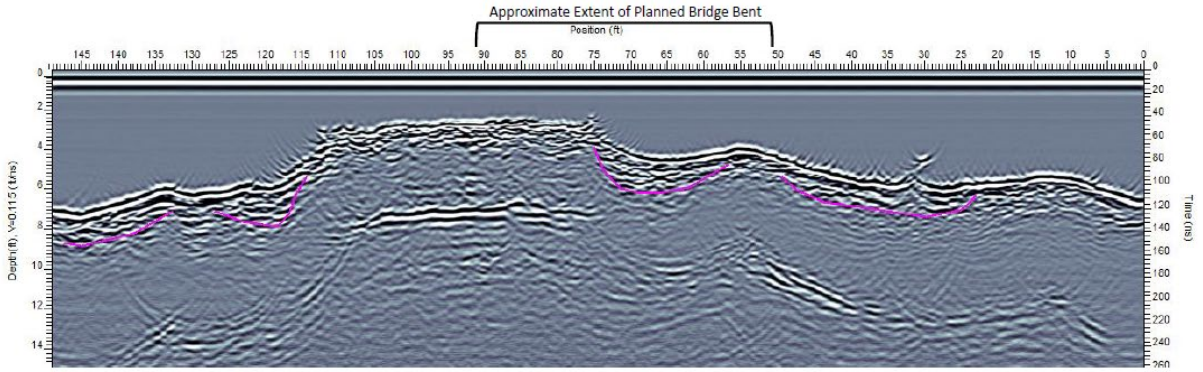








A. Processed 250 MHz GPR Line 3 showing water bottom interpretation and probable relic bridge foundation.



B. Remigrated 250 MHz GPR line 3 showing possible sediment deposits.

ESP Geophysical Survey Report, dated 6/15/2023.

Bridge Investigations

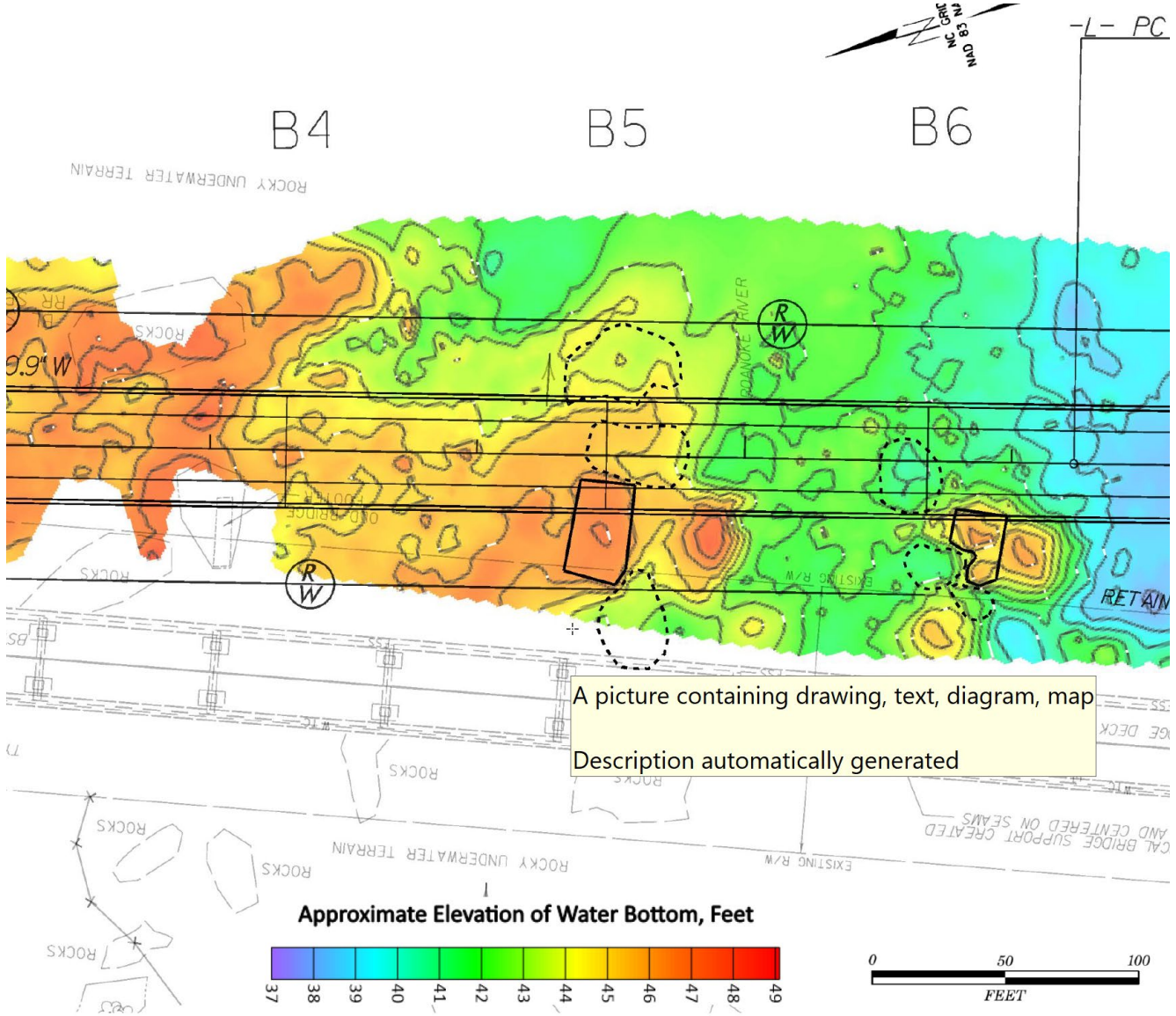
BR-0021, Bridge 51 over the Roanoke River on NC 48, Halifax County

Lessons Learned from GPR survey:

- Detected relic foundations
- Indication of sediment deposits / scour around relic foundations
- Bathymetry

Possible Actions:

- Additional geophysical surveys are planned consisting of:
  - seismic refraction
  - electrical resistivity



ESP Geophysical Survey Report, dated 6/15/2023.

Retaining Wall Investigations

R-4753, NC 107 Roadway Improvements,

Jackson County

Reason for supplemental geophysical investigation:

- Fill retaining wall construction proposed on steep slopes along Tuckasegee River.
- Multiple walls proposed with varying rock depths.

Retaining Wall Investigations

R-4753, NC 107 Roadway Improvements,

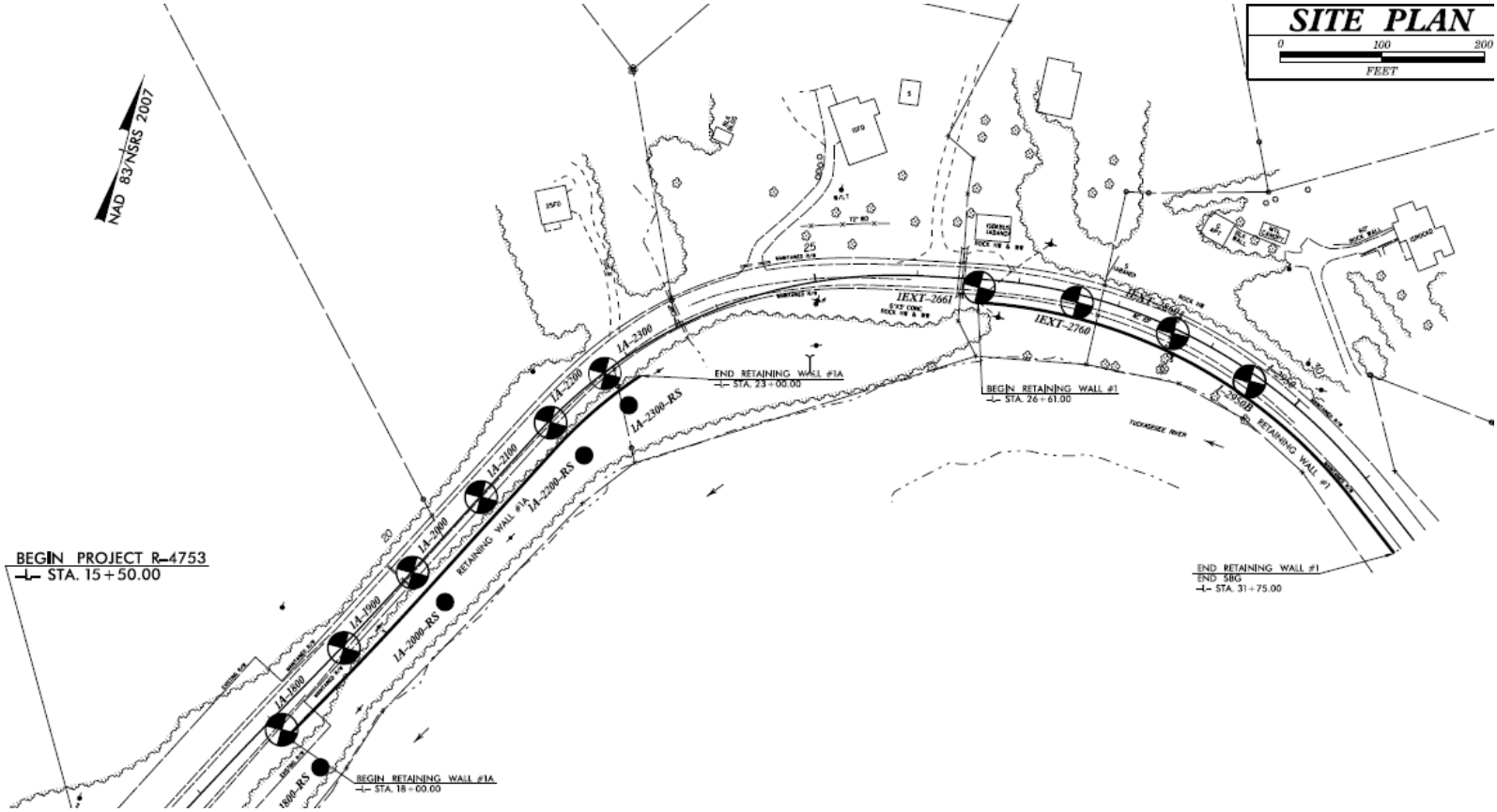
Jackson County

Geophysical Methods Chosen:

- Seismic Refraction

Traditional geotechnical methods employed:

- Borings completed in road along top of slope.
- Bridge rods advanced along wall location.

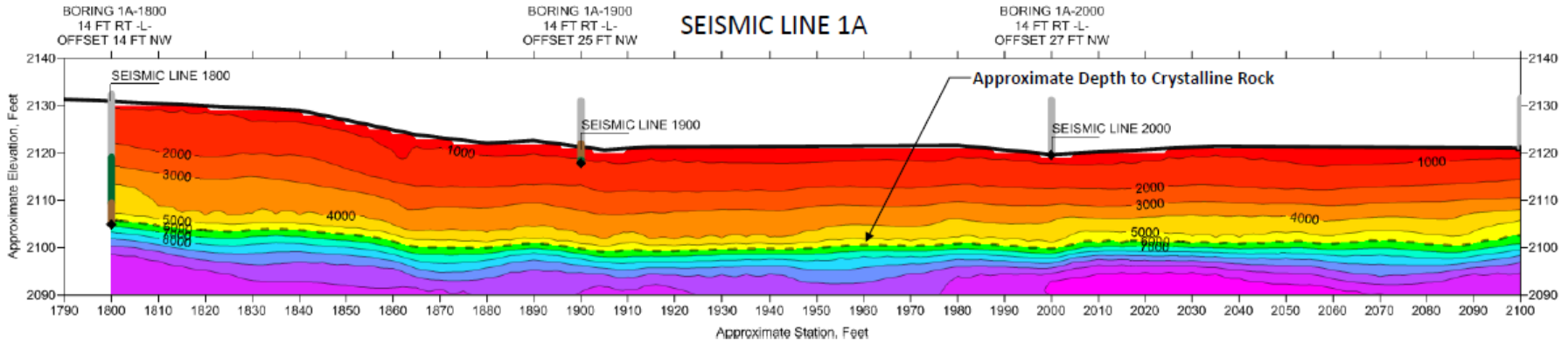


Retaining Wall Investigations

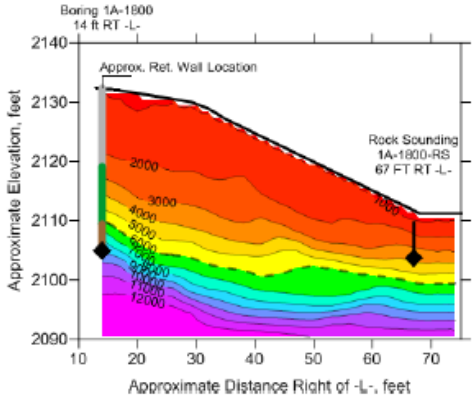
R-4753, NC 107 Roadway Improvements, Jackson County

Results:

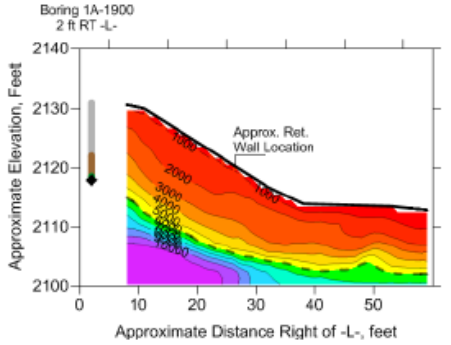
- Correlation between boring data and cross section lines tested.
- Evidence of dipping of rock structure toward the river.



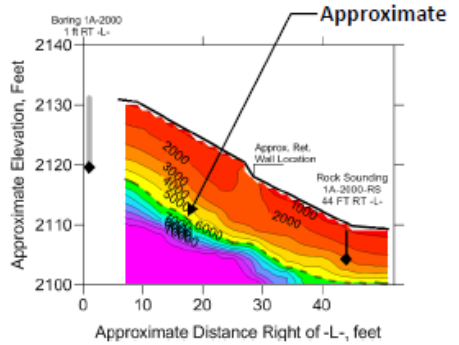
SEISMIC LINE 1800

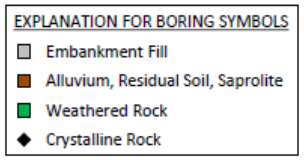


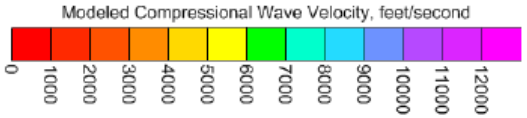
SEISMIC LINE 1900



SEISMIC LINE 2000







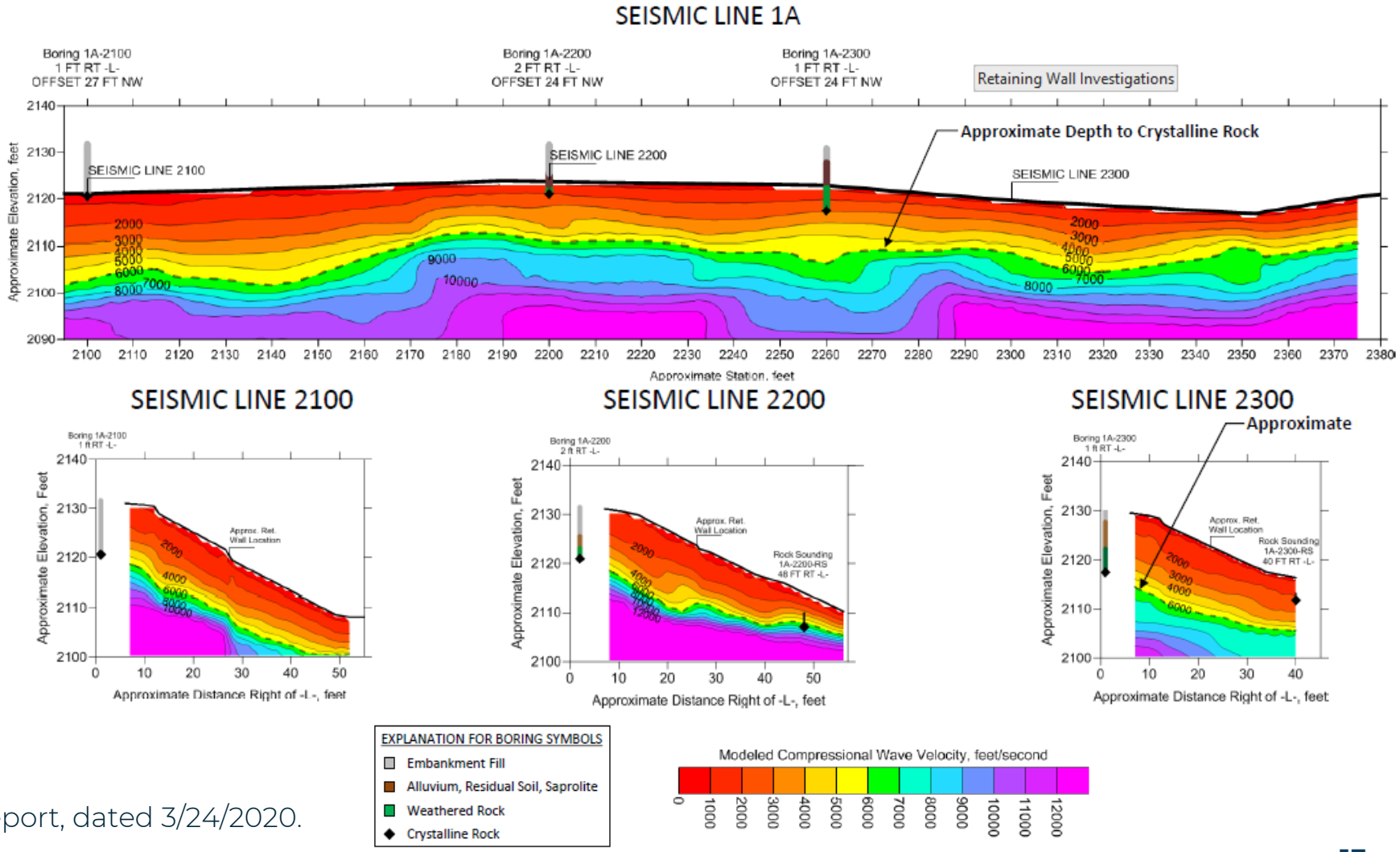
ESP Geophysical Survey Report, dated 3/24/2020.

Retaining Wall Investigations

R-4753, NC 107 Roadway Improvements, Jackson County

Results:

- Correlation between boring data and cross section lines tested.
- Evidence of dipping of rock structure toward the river.



ESP Geophysical Survey Report, dated 3/24/2020.

Retaining Wall Investigations

BR-0002, Bridge No. 8 over North Fork New River, Ashe County

Reason for supplemental geophysical investigation:

- Retaining wall construction proposed on a steep slope down to Buffalo Creek.

ESP Geophysical Survey Report, dated 3/24/2020.

Retaining Wall Investigations

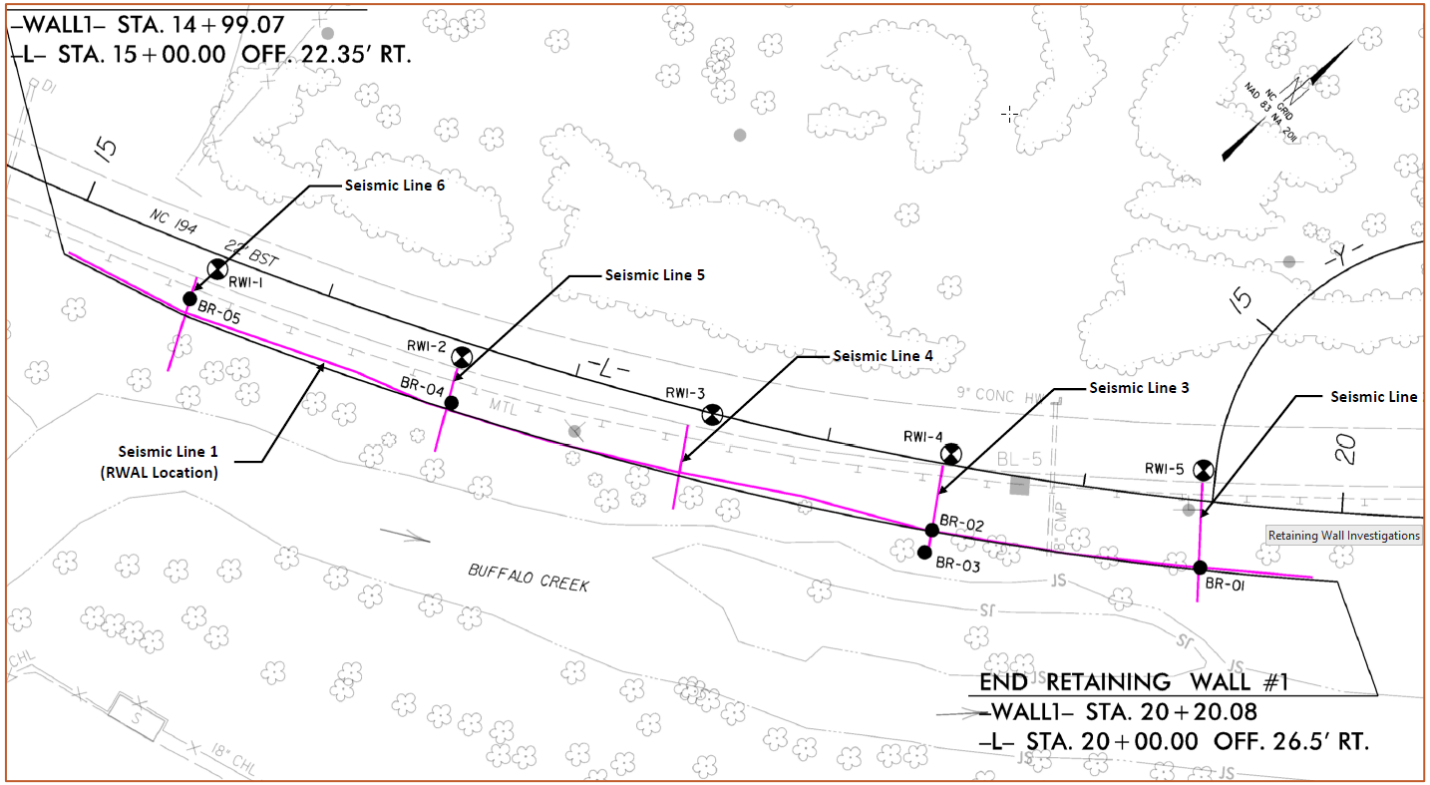
BR-0002, Bridge No. 8 on NC 194 over North Fork New River, Ashe County

Geophysical Methods Chosen:

- Seismic Refraction

Traditional geotechnical methods employed:

- Borings completed in road along top of slope.
- Bridge rods advanced along wall location.

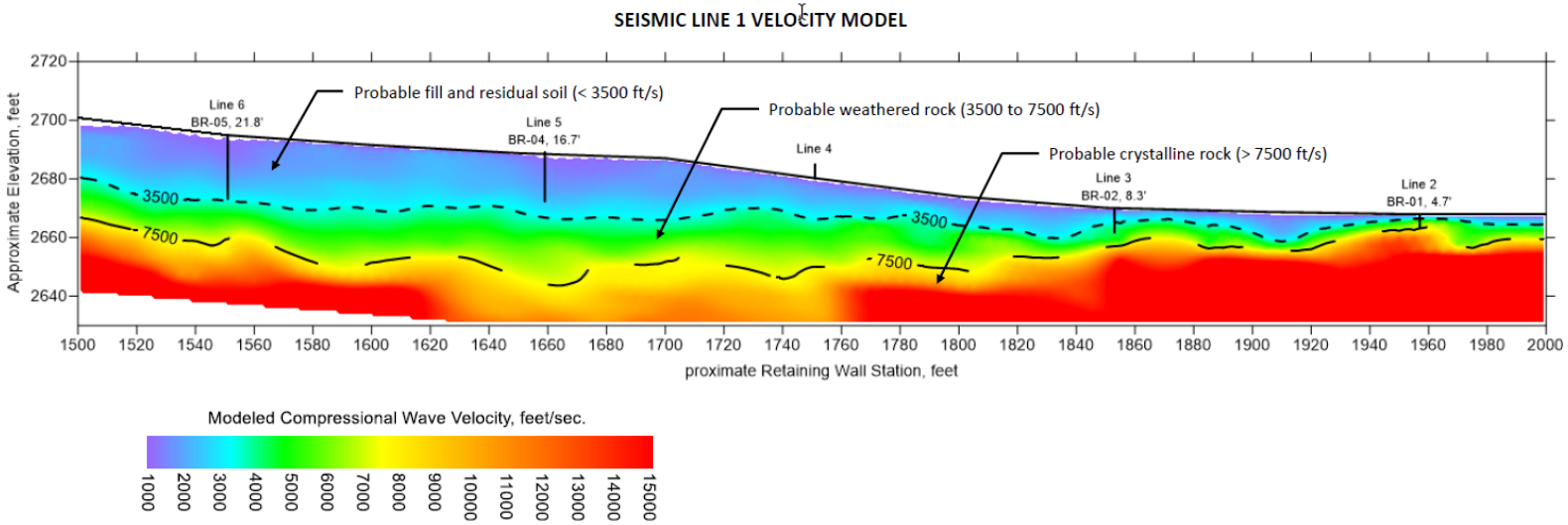


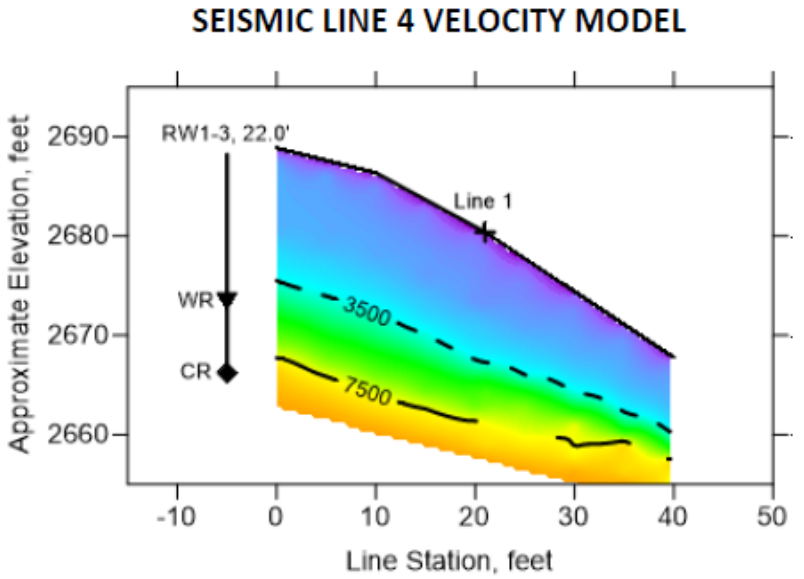
ESP Geophysical Survey Report, dated 3/24/2020.

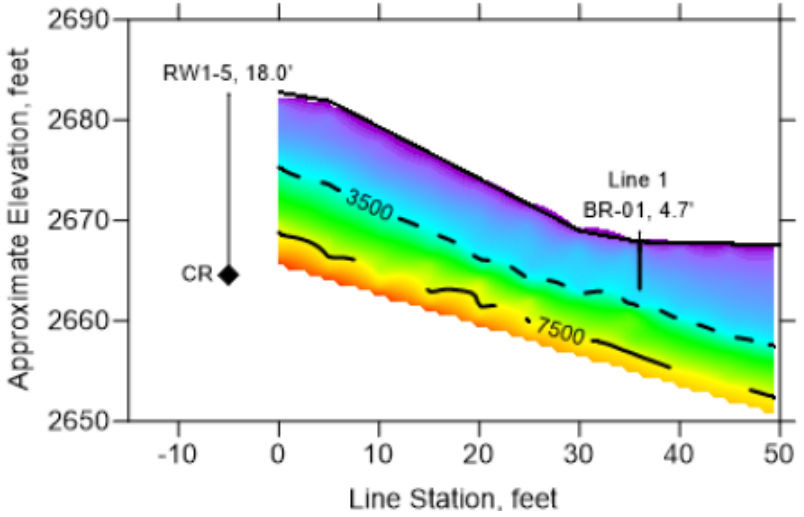
Retaining Wall Investigations

BR-0002, Bridge No. 8 on NC 194 over North Fork New River, Ashe County

Results:





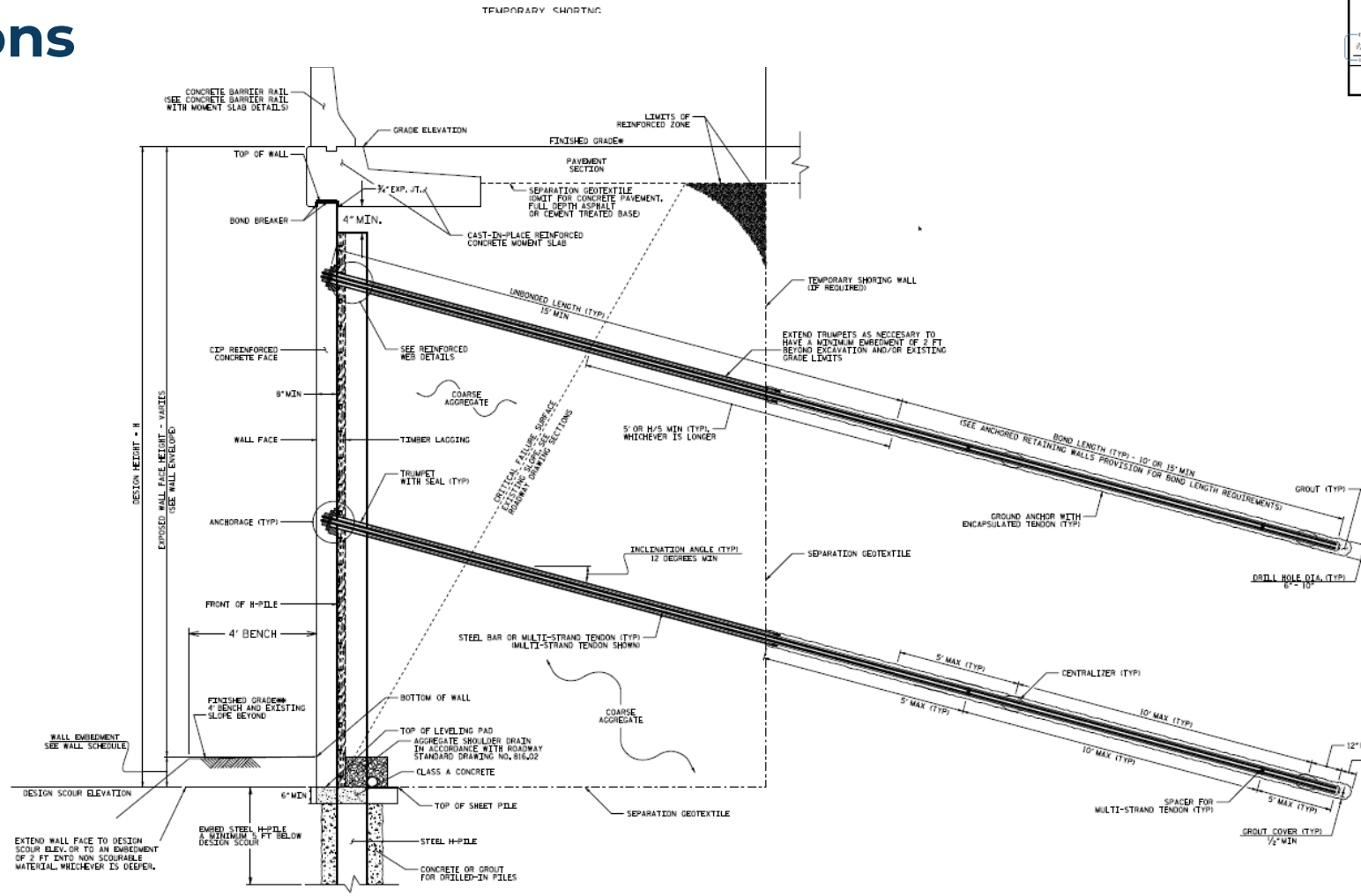


ESP Geophysical Survey Report, dated 3/24/2020.

Retaining Wall Investigations

Lessons Learned:

- Relatively solid data to correlate rock line and confirm elevations anticipated during wall construction.
- Data assisted in selection of wall type and installation



DETAIL C, TYPICAL SECTION - ANCHORED WALL PILE EXCAVATION

TYPICAL SECTION FROM STA 19+50 -L- TO STA 20+00 -L- (DOUBLE ROW OF GROUND ANCHORS SHOWN, AS NEEDED)

Sinkhole and Void Investigations

51214.01AK, Sinkhole along Pipe on I-85 Ramp, South of Parham Road at I-85 and Wesley Drive, Vance County

Reason for **supplemental** geophysical investigation:

- Attempt to identify any unseen voids.
- Determine extent of any loss of material along current drainage pipe and adjacent drainage features.

Schnabel Geophysical Survey Report, dated 6/14/2021.

Sinkhole and Void Investigations

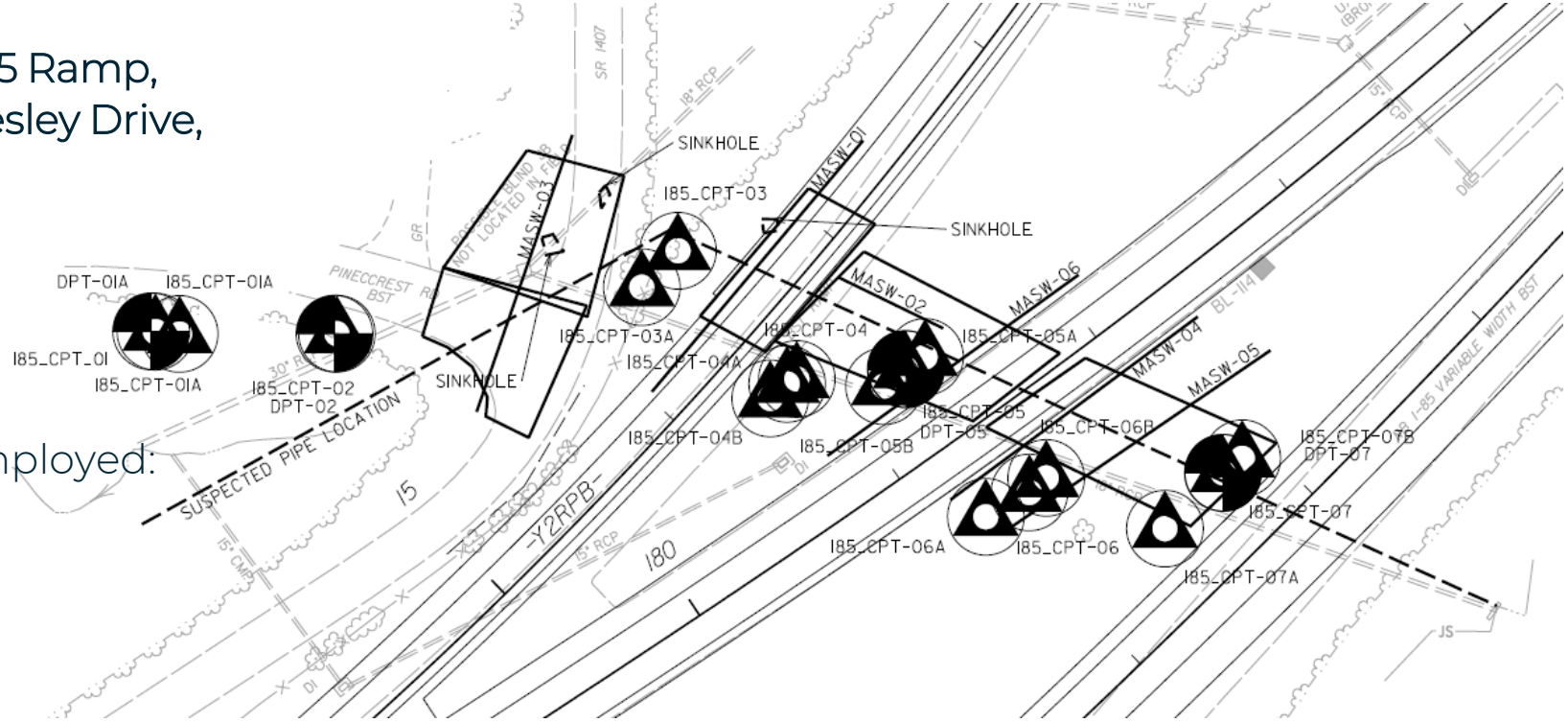
51214.01AK, Sinkhole along Pipe on I-85 Ramp, South of Parham Road at I-85 and Wesley Drive, Vance County

Geophysical Methods Chosen:

- GPR
- MASW

Traditional geotechnical methods employed:

- SPT Borings.
- Cone Penetrometer Testing (CPT).



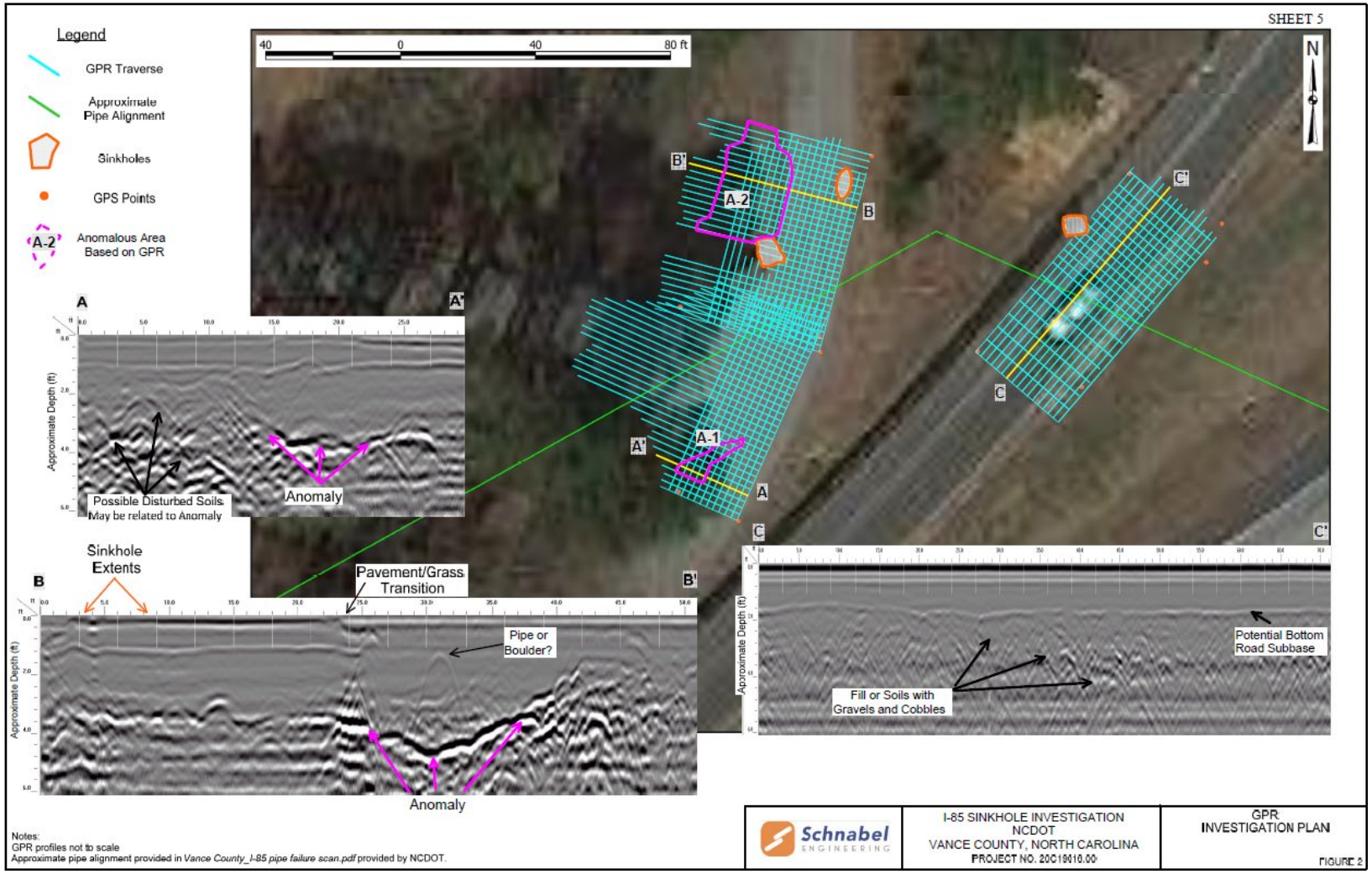
Schnabel Geophysical Survey Report, dated 6/14/2021.

Sinkhole and Void Investigations

51214.01AK, Sinkhole along Pipe on I-85 Ramp, South of Parham Road at I-85 and Wesley Drive,
Vance County

Results:

- Clear correlation of sinkholes to anomalous results.
- Indication of disturbed soils.



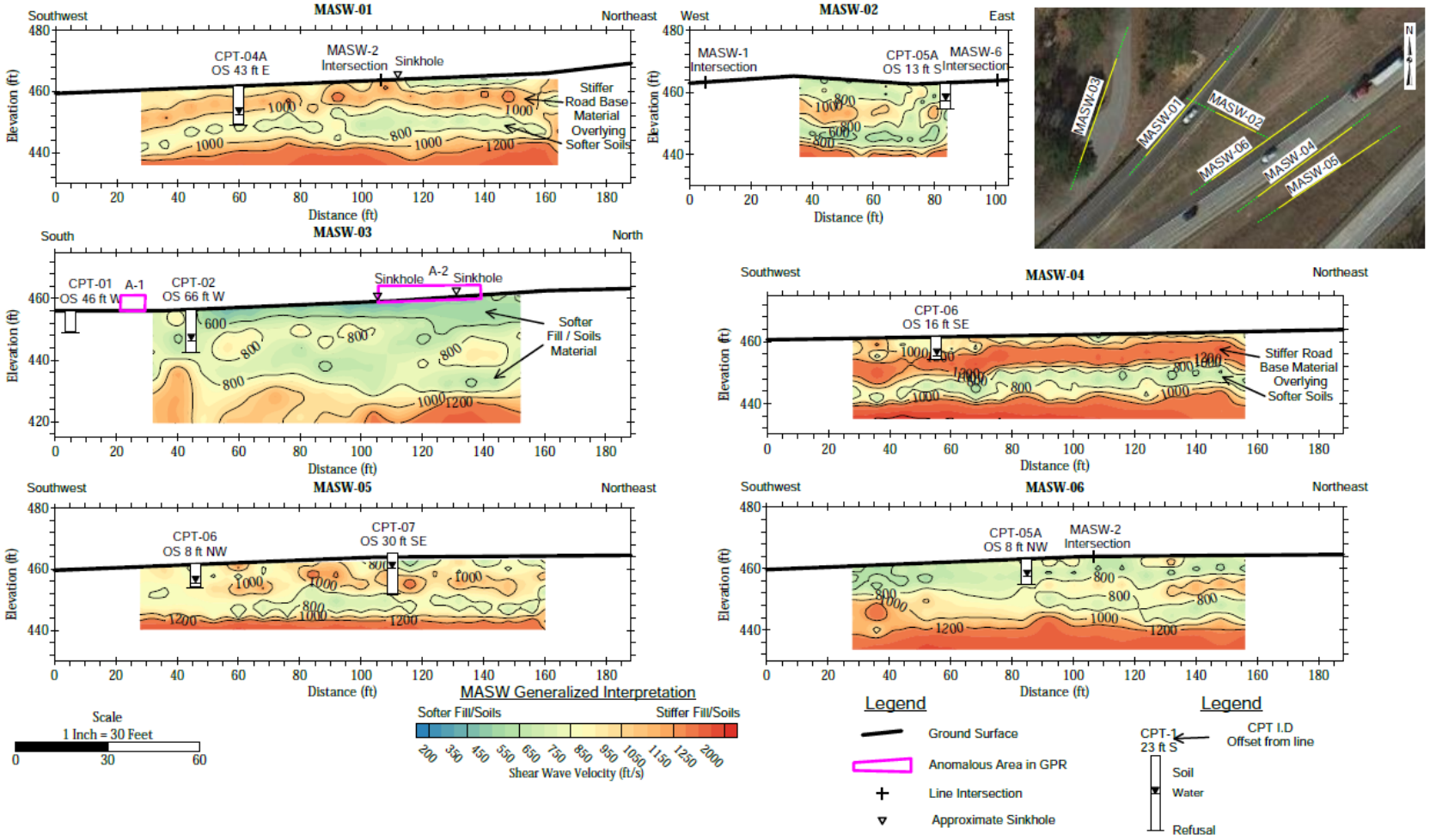
Schnabel Geophysical Survey Report, dated 6/14/2021.

Sinkhole and Void Investigations

51214.01AK, Sinkhole along Pipe on I-85 Ramp, South of Parham Road at I-85 and Wesley Drive,
Vance County

Results:

- Evidence of denser/stiffer soils and looser/softer fill material and possible alluvium.



Schnabel Geophysical Survey Report, dated 6/14/2021.

Sinkhole and Void Investigations

51214.01AK, Sinkhole along Pipe on I-85 Ramp, South of Parham Road at I-85 and Wesley Drive, Vance County

Lessons Learned:

- GPR appeared to be the strongest results in detecting anomalous areas within vicinity of known sinkhole locations.
- Use of other methods than MASW
- Electrical Resistivity may have been a good candidate for geophysical method at this site.

Schnabel Geophysical Survey Report, dated 6/14/2021.

Sinkhole and Void Investigations

R-2514C, US 17 from North of Maysville to South of NC 58, Wildlife Crossing Bridges,
Jones County

Reason for supplemental geophysical investigation:

- Overall assessment of site for voids and karst topography.

ESP Geophysical Survey Report, dated 5/29/2015

Sinkhole and Void Investigations

R-2514C, US 17 from North of Maysville to South of NC 58, Wildlife Crossing Bridges, Jones County

Geophysical Methods Chosen:

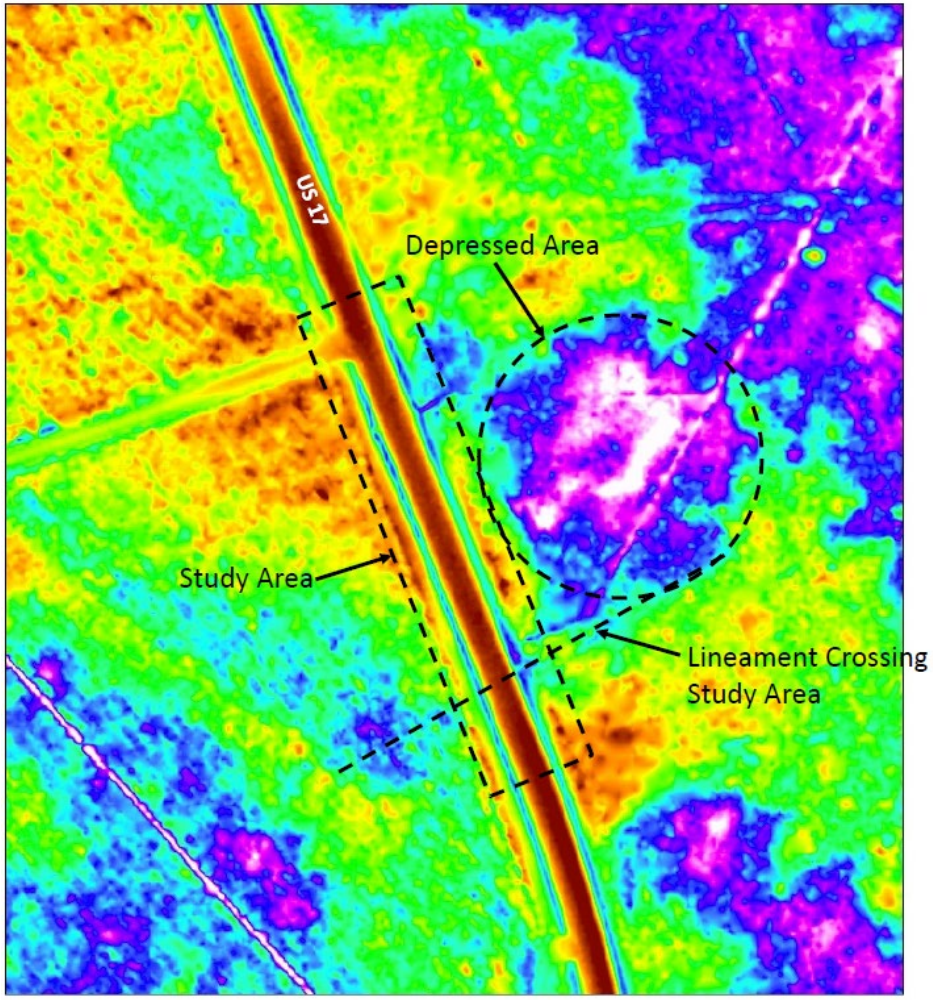
- GPR
- Electrical Resistivity Imaging
- Microgravity

Traditional geotechnical methods employed:

- SPT Borings.

Other:

- LiDAR imagery review



Note: Cooler colors indicate lower elevations

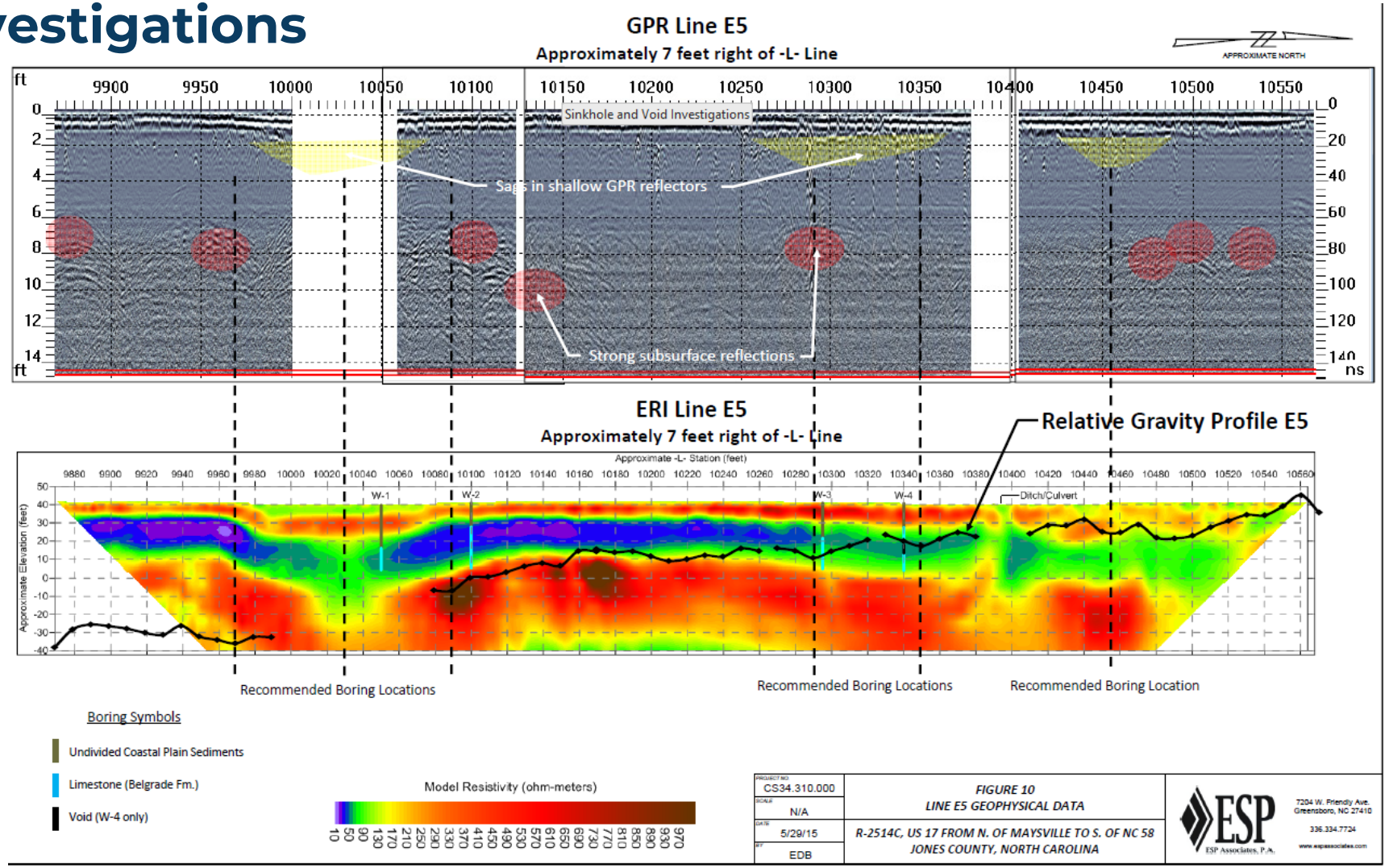
ESP Geophysical Survey Report, dated 5/29/2015

Sinkhole and Void Investigations

R-2514C, US 17 from North of Maysville to South of NC 58, Wildlife Crossing Bridges, Jones County

Results:

- Clear correlation of voids of potential karst nature between resistivity, GPR and traditional boring subsurface investigation.
- Guidance was made for additional drilling based on geophysical investigation.



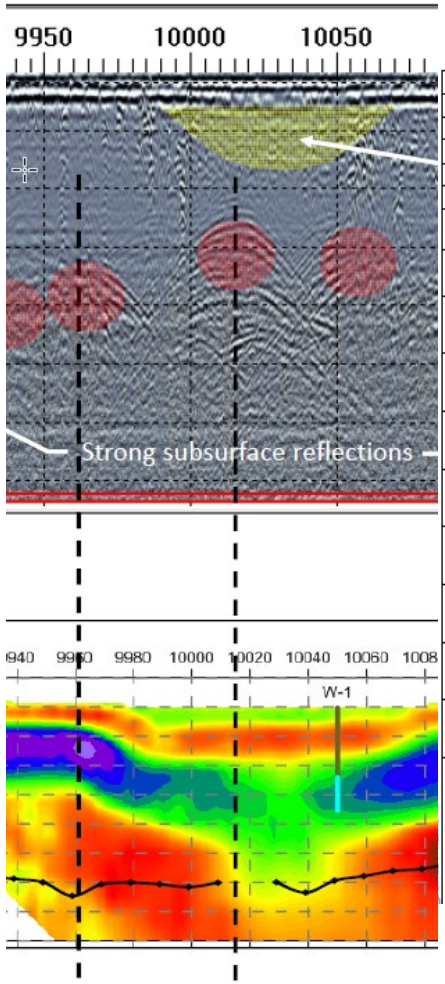
ESP Geophysical Survey Report, dated 5/29/2015

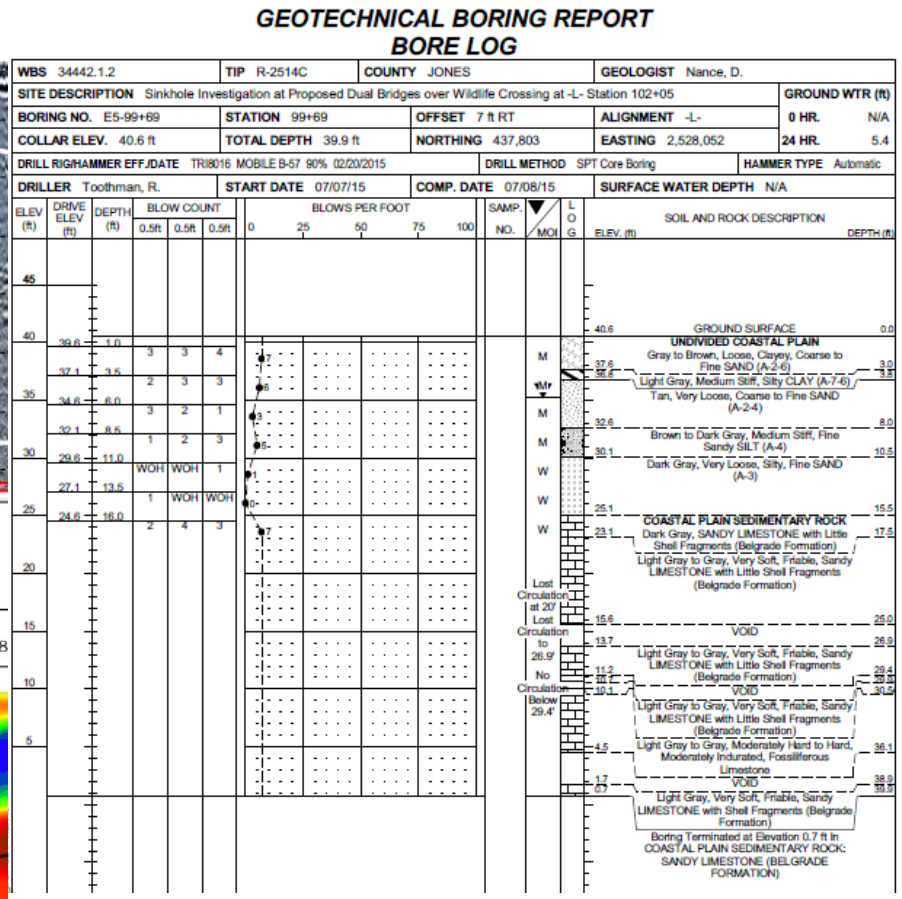
Sinkhole and Void Investigations

R-2514C, US 17 from North of Maysville to South of NC 58, Wildlife Crossing Bridges, Jones County

Lessons Learned:

Methods for geophysical survey were effective in identifying overall karst topography.





ESP Geophysical Survey Report, dated 5/29/2015,

ESP Subsurface Investigation Report dated 7/27/2015.

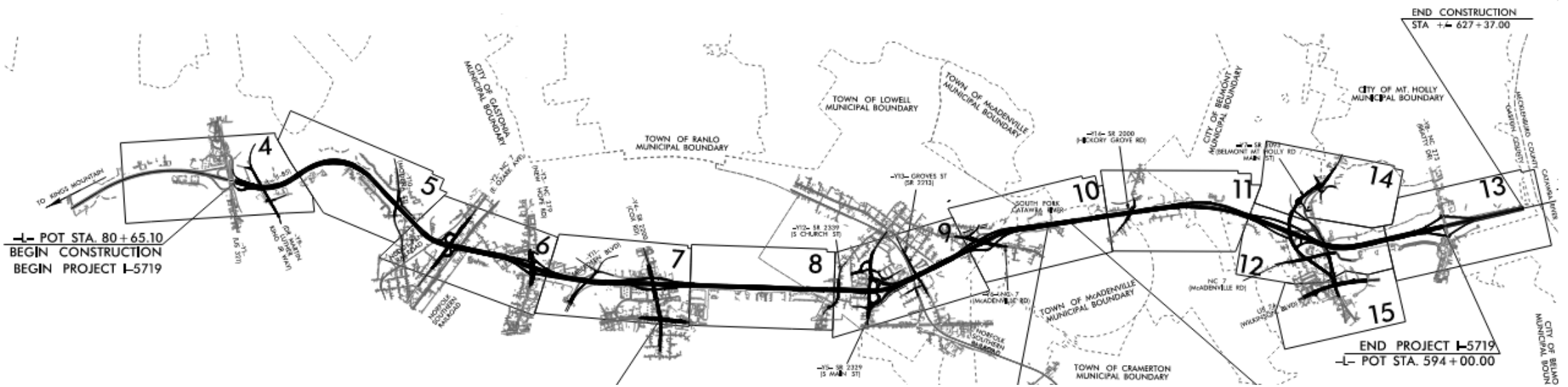
Pavement Investigations

I-5719, Widen I-85 from US 321 to NC 273, Gaston County

Reason for supplemental geophysical investigation:

- Evaluate potential for reducing traditional investigation and filling gaps in data obtained at discrete points.
- Assess rapid data acquisition claims.

Applied Research Associates 3-D GPR Preliminary Evaluation Report, dated 8/25/2023.



Pavement Investigations

I-5719, Widen I-85 from US 321 to NC 273, Gaston County

Geophysical Methods Chosen:

- 3-D GPR

Traditional geotechnical methods employed:

- Pavement coring
- Dynamic Cone Penetrometer
- Solid stem auger probe

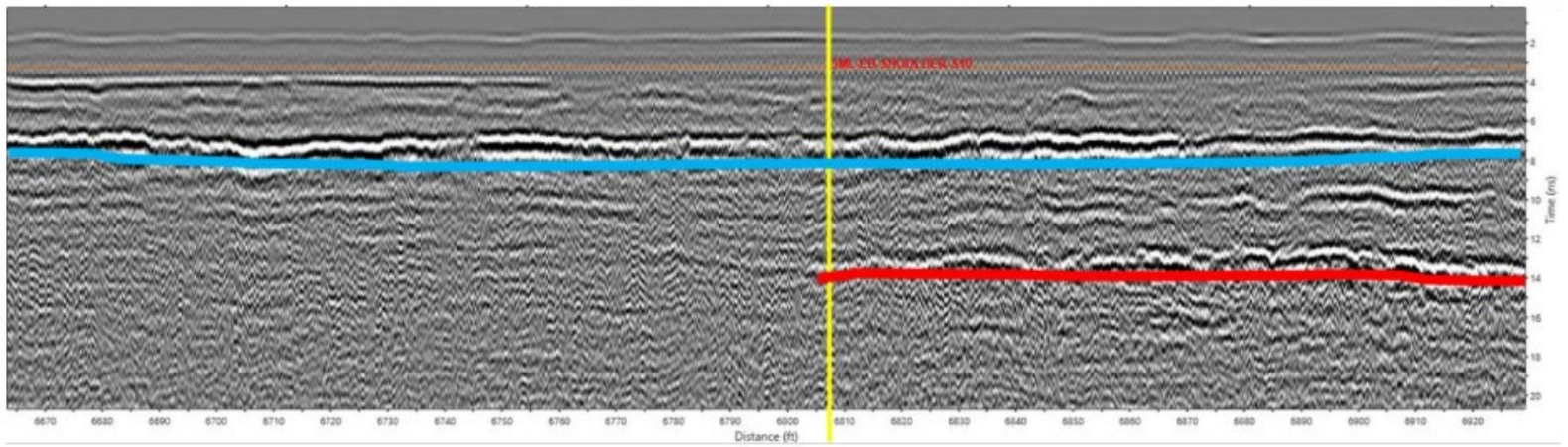


Figure 2: Potential start of new base/layer or increase in moisture content of base/layer

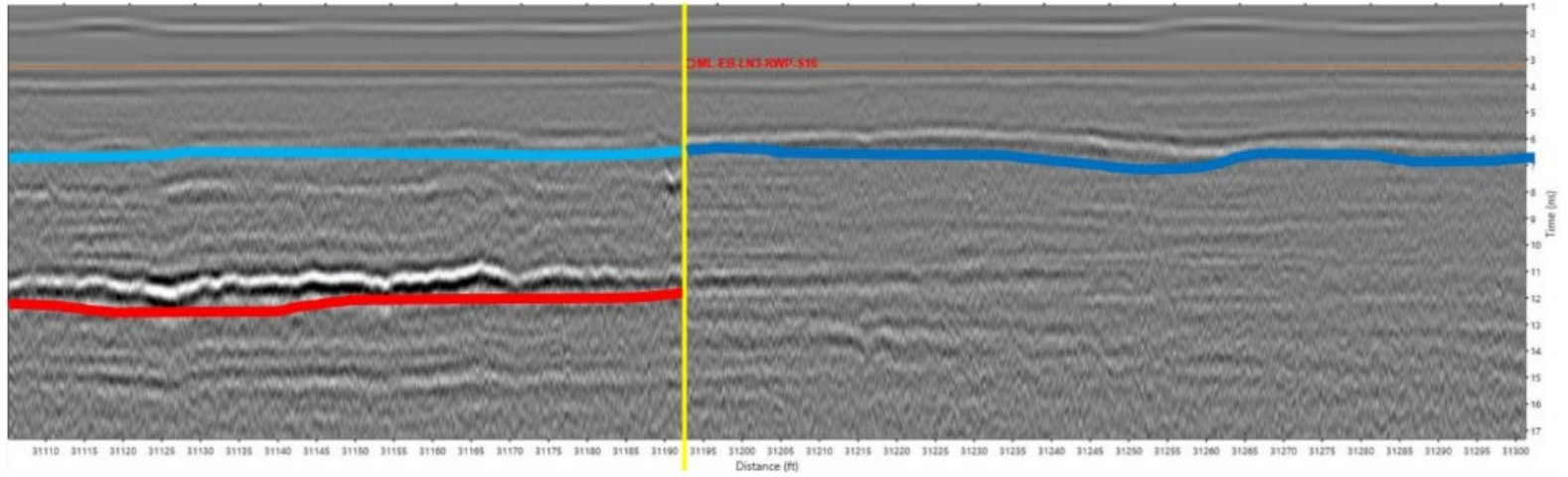


Figure 3: Potential ending of new base/layer or increase in moisture content of base/layer

Applied Research Associates 3-D GPR Preliminary Evaluation Report, dated 8/25/2023.

Pavement Investigations

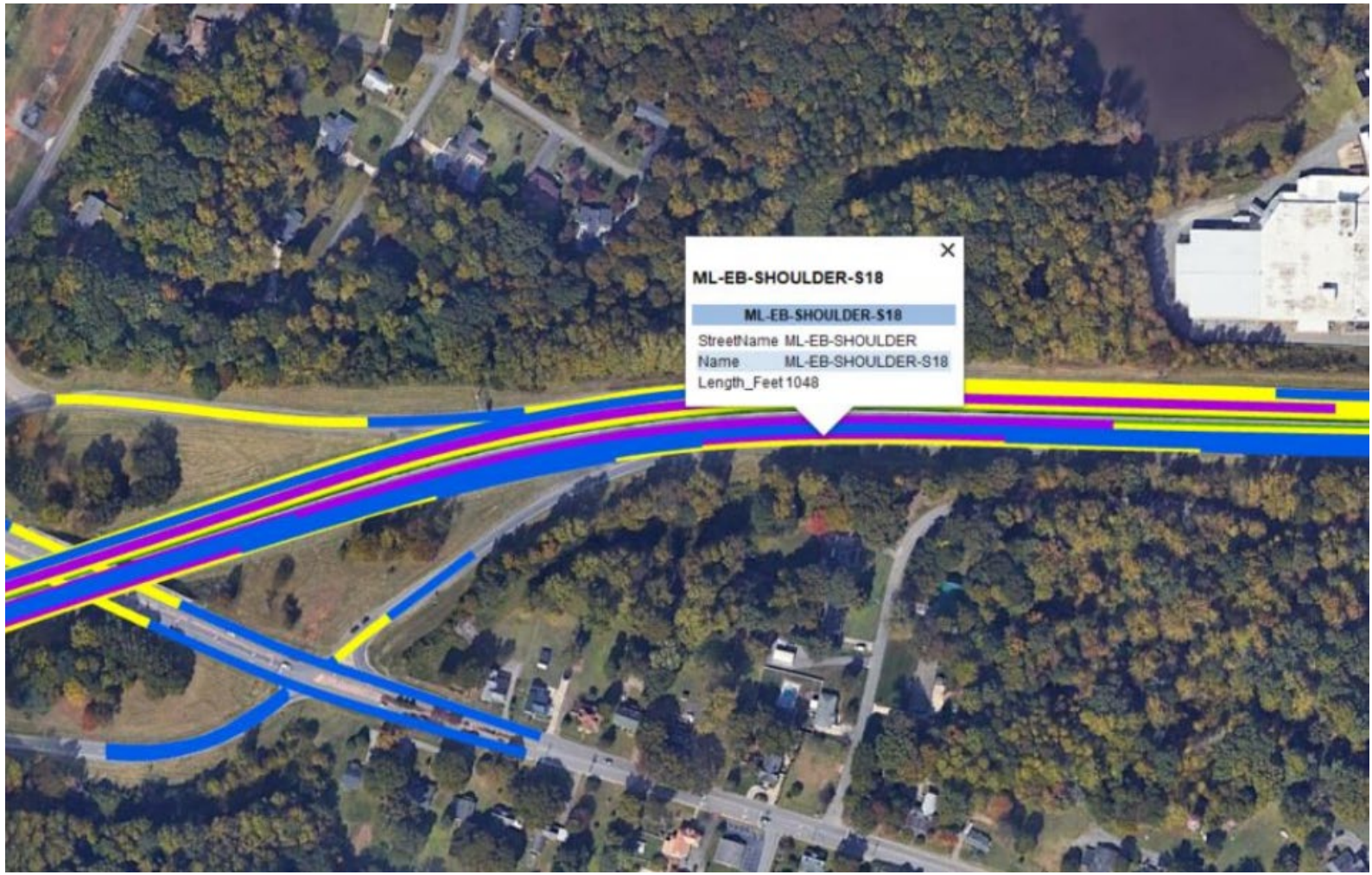
I-5719, Widen I-85 from US 321 to NC 273, Gaston County

Results:

- Data processing in progress
- Able to acquire data at approximately 45 mph
- Identified areas of different pavement sections

Lessons Learned:

- Data processing heavily reliant on pavement cores
- Best suited for variable pavement projects to group like pavements for coring or delineate areas of concern
- Use earlier in design phase



Applied Research Associates 3-D GPR Preliminary Evaluation Report, dated 8/25/2023.

Thank you!