Determining Layer Thickness and Understanding Moisture Related Damage of State-Owned Roads Using GPR and Capturing Such in a GIS-Based Inventory

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Abstract

The Rhode Island Department of Transportation (RIDOT) has a significant inventory of state- owned roads of which layer thickness and moisture related damage is uncertain. Discrete methods of assessment like coring and visual inspection provide limited data and are both time-consuming and costly in terms of traffic control and personnel. The objective of this study was to evaluate the efficient use of Ground Penetrating Radar (GPR) at traffic speeds to determine layer thickness and moisture content of rural state-owned roads in the State. This is accomplished through field studies of roads with both known and unknown compositions in close collaboration between University of Rhode Island (URI), Roger Williams University (RWU) and RIDOT researchers. The results are currently being incorporated into RIDOT's GIS-based inventory of roads. The ultimate goal of this effort is to establish a system for collecting and viewing pavement layer thickness and moisture related damage on a network level; information that RIDOT can use to better plan, prioritize and properly allocate funding for pavement related projects.

Data Collection with GPR

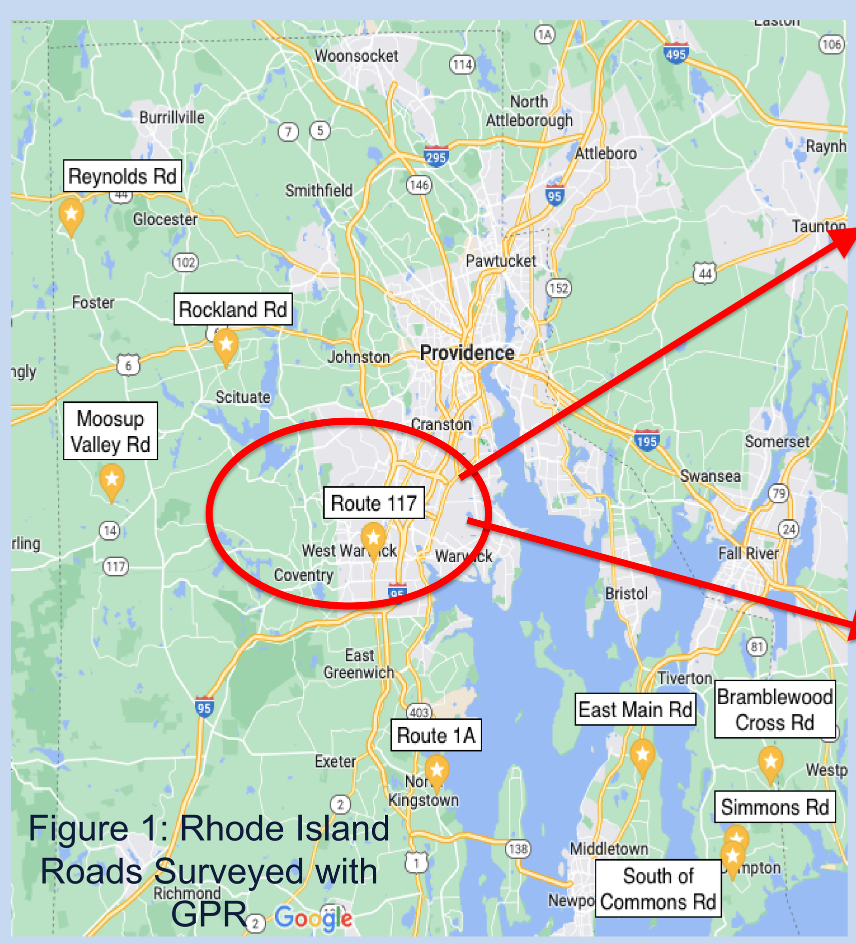


Figure 1: Rhode Island Roads Surveyed with GPR

The thickness and damage estimates of Route 117 were of particular interest because this roadway will be reconstructed soon. The RIDOT needed to know if any composite sections existed as well. The road is very old, so records were limited, and the use of GPR was critical in understanding subsurface conditions.

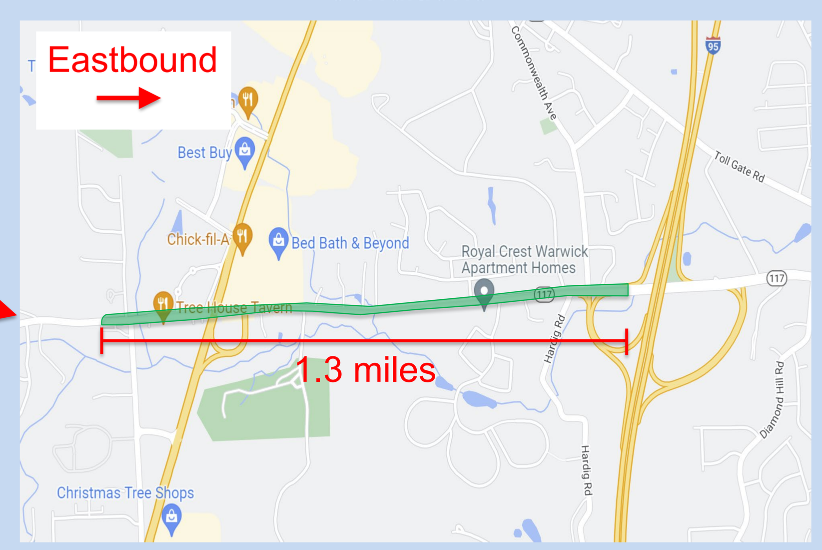
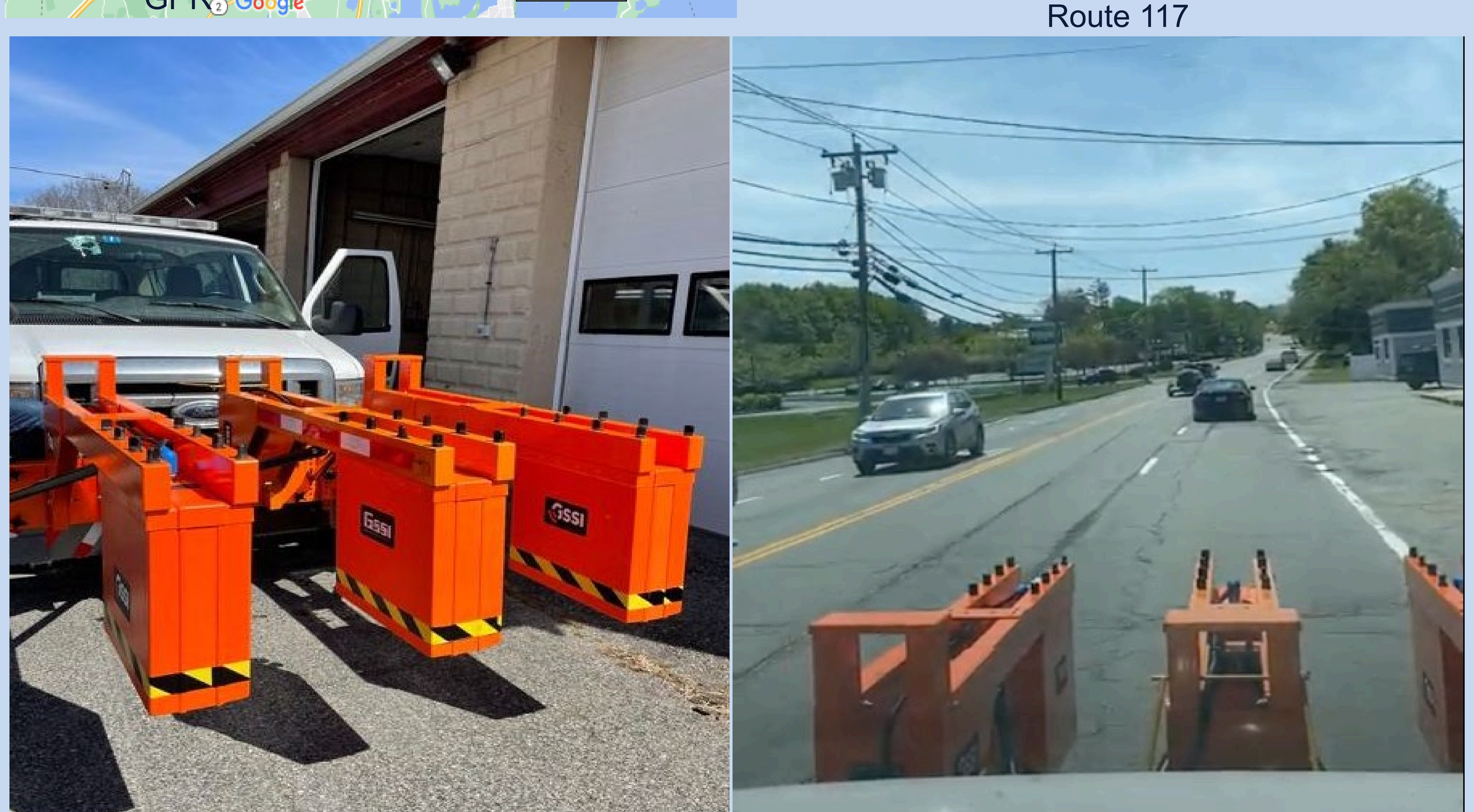


Figure 2: Google Map Image of Route 117



Figures 3a/b: Data Collected with GSSI's SIR 30 and 3, 2GHz Antennas.
Note: The antennas were setup to collect data from each vehicular wheel path and the center of the lane, at a rate of 1 scan per foot.

Data Analysis of Route 117

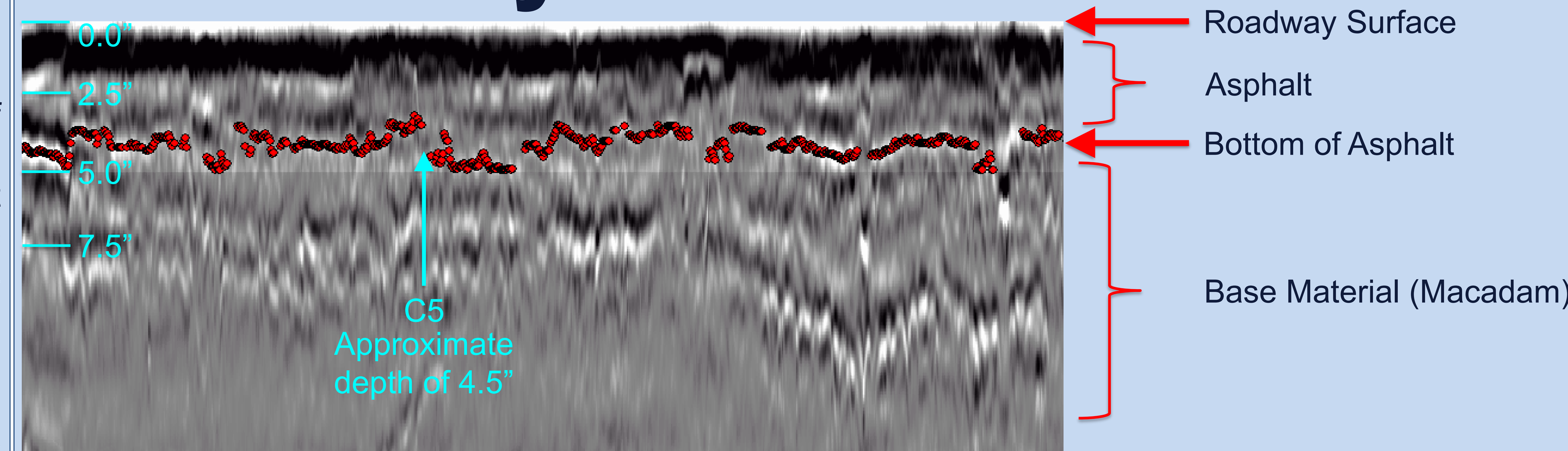


Figure 4: GPR B-Scan of Route 117

Note: The red points were manually selected using a GPR analysis software (RADAN). The **asphalt thickness, dielectric constant, and GPS coordinates** of each location were then exported into an Excel file. Cores were extracted from the roadway at selected location to verify the thickness determined from the radar data. Excellent correlation between core thickness and estimated thickness using the radar data was achieved (Figure 6).

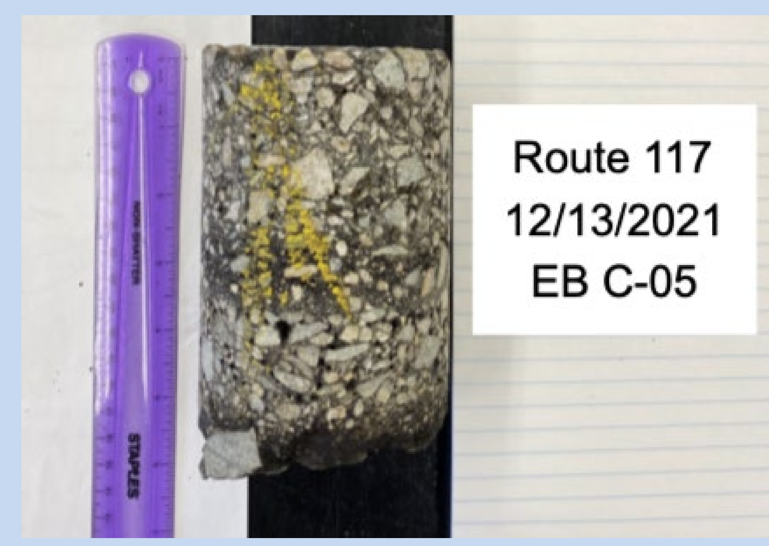


Figure 5: Core 5 with a Measured Thickness = 4.6"

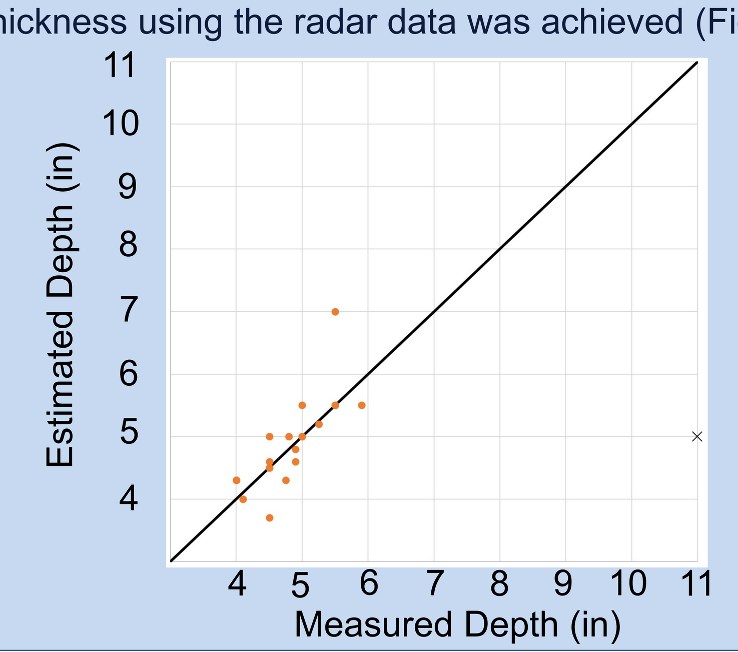
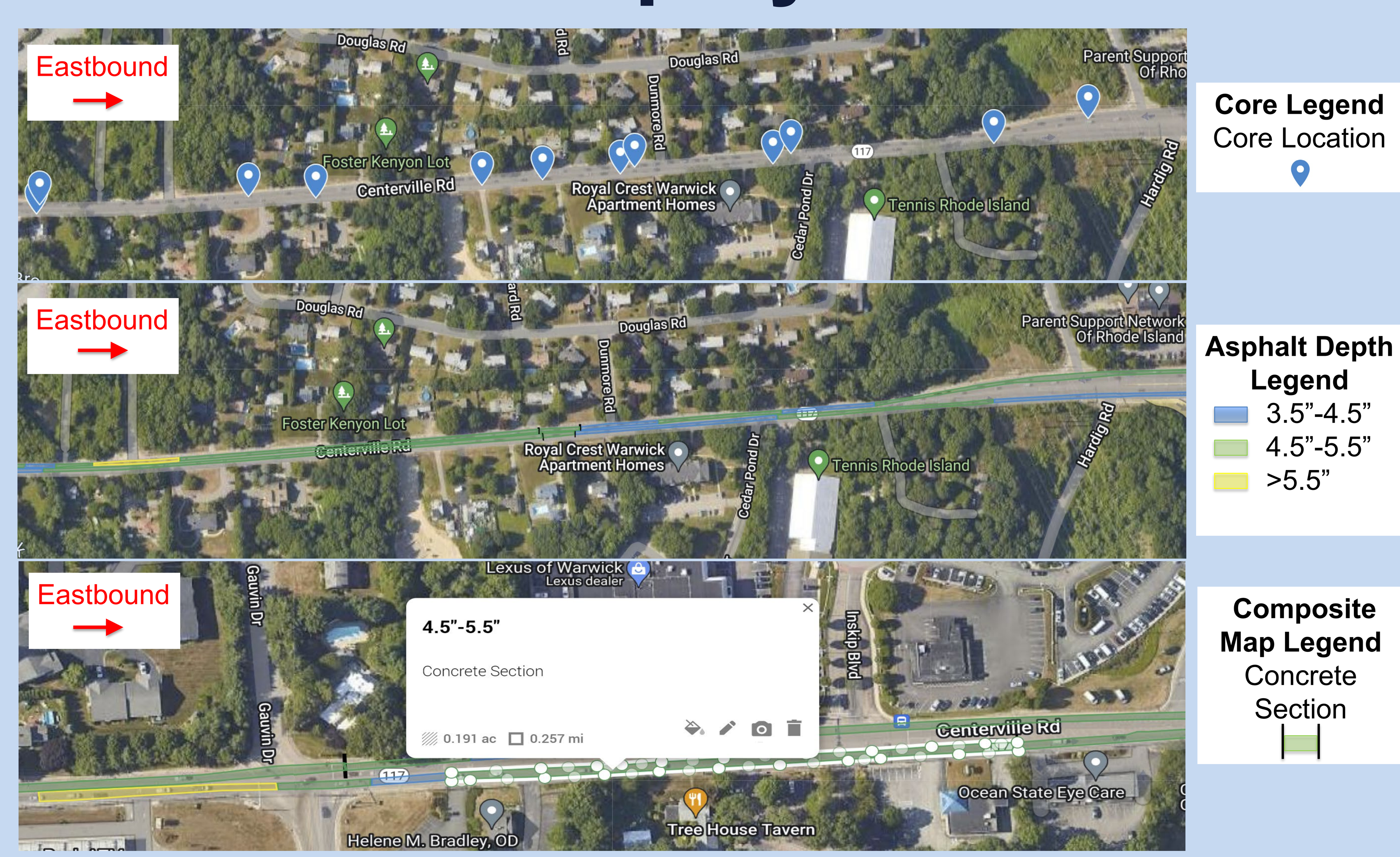


Figure 6: Estimated Core Thickness vs. Measured core Thickness

Interactive Display of Data



Figures 7a/b/c: Interactive Maps Showing Core Locations, Asphalt Depth, and Composite Sections

Dielectric of Route 117

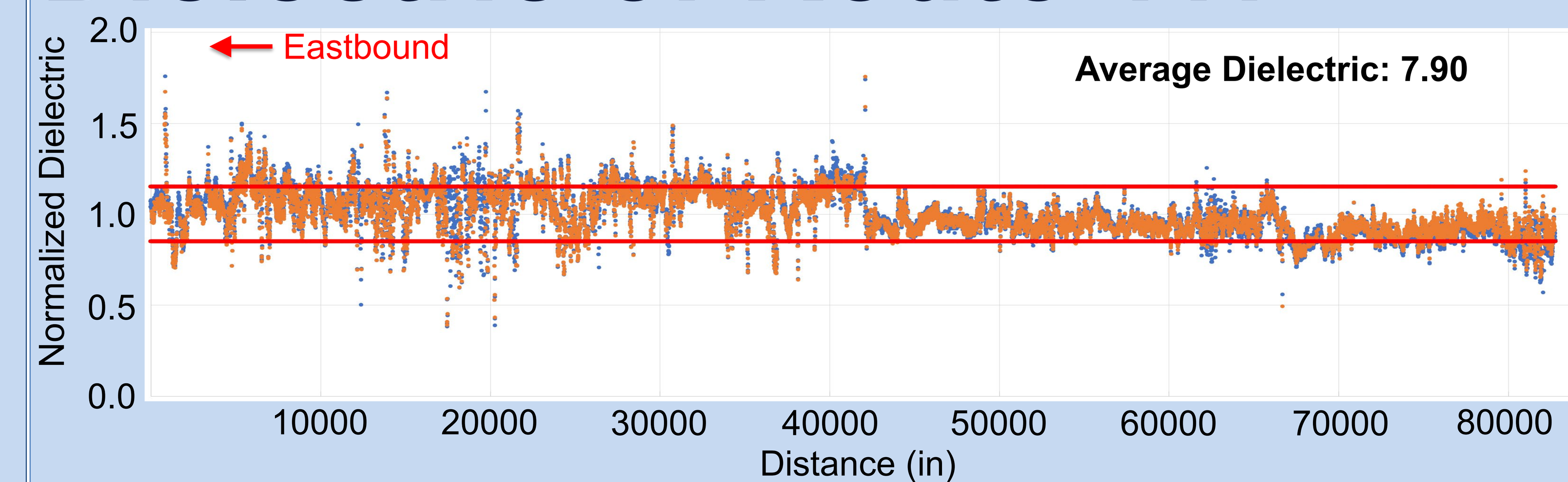


Figure 8: Eastbound Route 117 Surface and Subsurface Dielectrics
Note: The surface dielectrics are blue and subsurface dielectrics are orange. The red lines are the top and bottom limit dielectrics which are +/-0.15 from the normalized dielectric of 1.

Figure 9a/b: Interactive Dielectric Map and Route 117 Eastbound Surface Image.

Conclusions

The use of GPR allows for the estimation and interpretation of pavement thickness and dielectric constant, ultimately aiding in the determination of the condition of a road. URI, RWU, and RIDOT worked in collaboration to identify candidate roads with varying conditions and collect the data utilized for this project. The data was collected using a SIR-30 survey system and was post-processed using GSSI's software system, Radan. The accuracy of determining pavement thickness via GPR was investigated by comparing estimated pavement thickness values from GPR with cores that were collected from the roadway. Using GPR to detect moisture-related damage was also performed by calculating the dielectric constant and locating areas with abnormally high values. Google Maps was used to create user-friendly interactive maps that display the pavement depth and dielectric values along the roads. These maps allow RIDOT to locate damaged portions of the road and areas that may need restoration. This information can also be converted into RIDOT's GIS-based inventory to aid in the process of planning for reconstruction or rehabilitation. The objective of this project was to use GPR as a nondestructive process for collecting and interpreting pavement thickness and moisture related damage. The information obtained will allow RIDOT to optimize their system of planning for future pavement related projects.

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Google Map showing asphalt depth along the road