Looking Below the Surface to Make Better Decisions

By

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Outline

- Discussion of Technologies
  - GPR, 3DGPR, and TSD
- Applications
  - Pavement Management
  - Rehabilitation Design
  - In-place Recycling and Density QA
  - Failure Investigations

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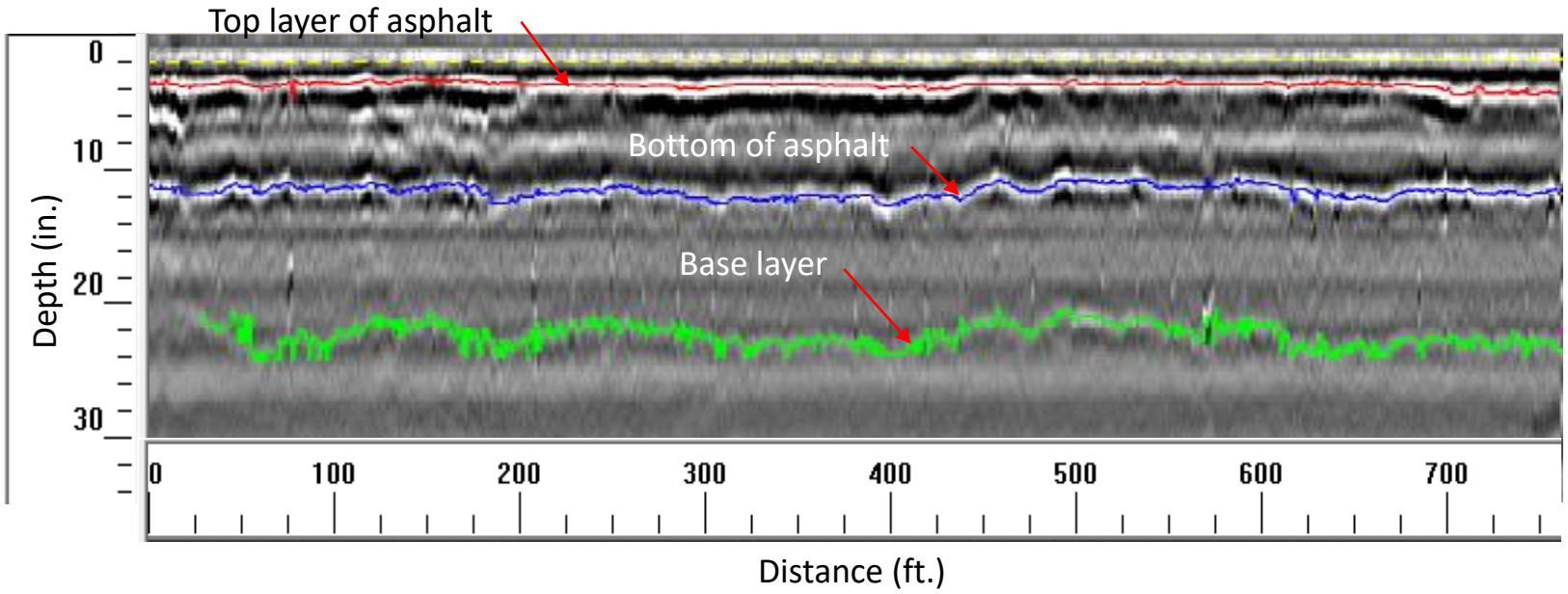
Traditional GPR



Detects

- Thickness of pavement layers
- Different pavement structures
- Stripping of asphalt layers
- Voids/moisture in base/subgrade
- Concrete deterioration under AC
- Depth of reinforcement

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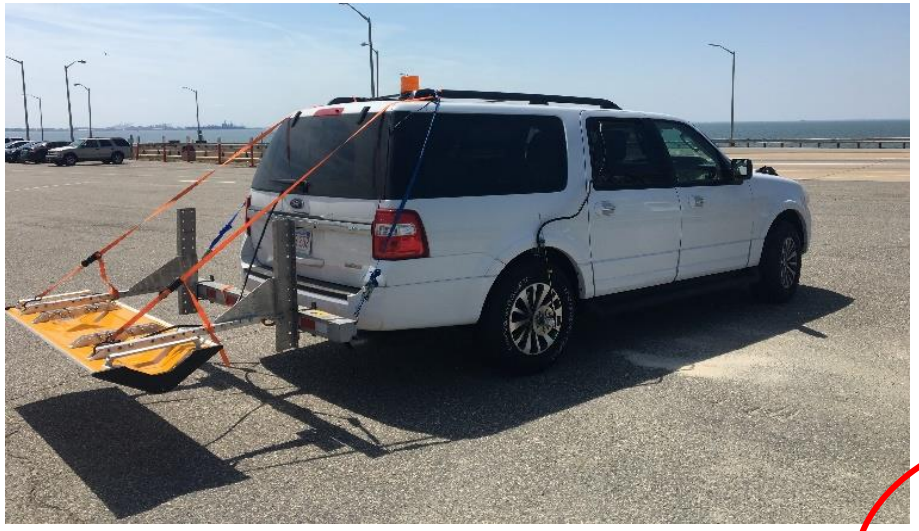
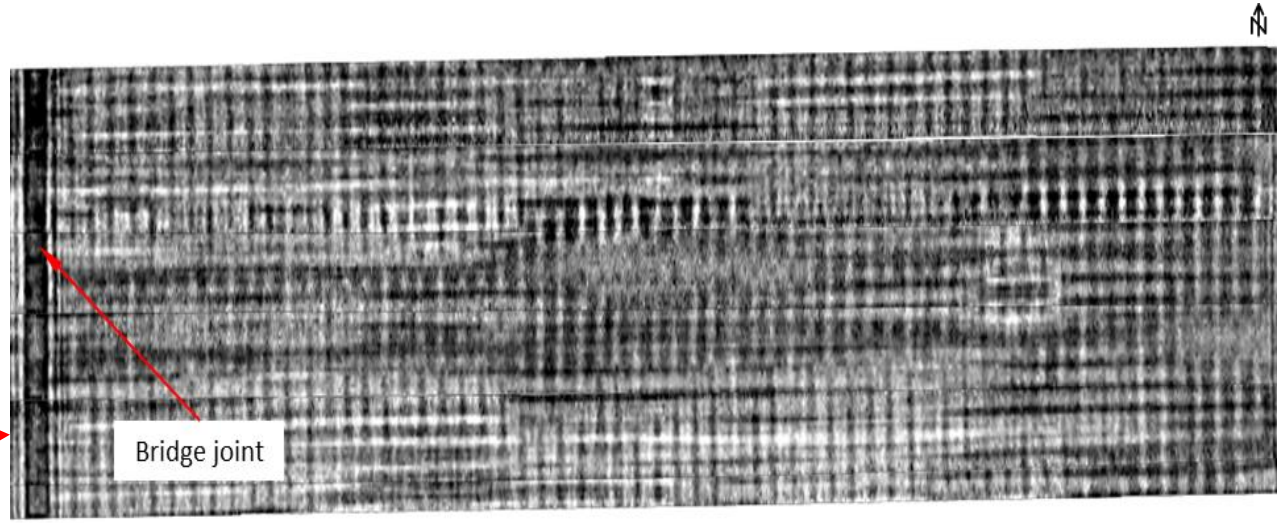
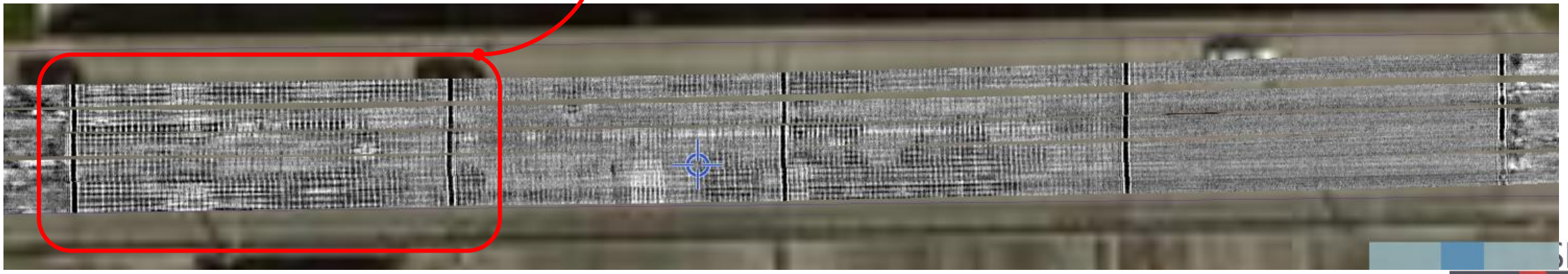
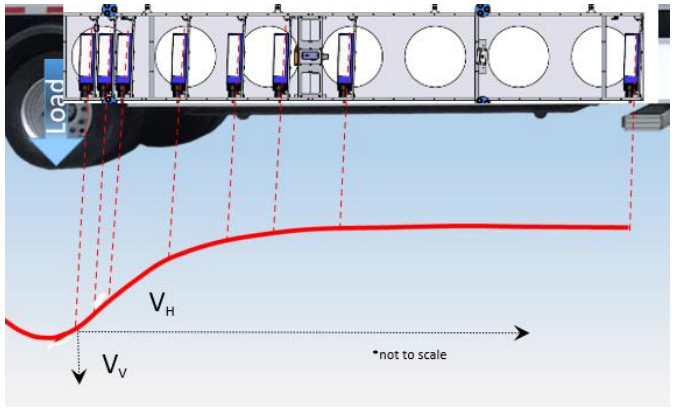
3D Radar



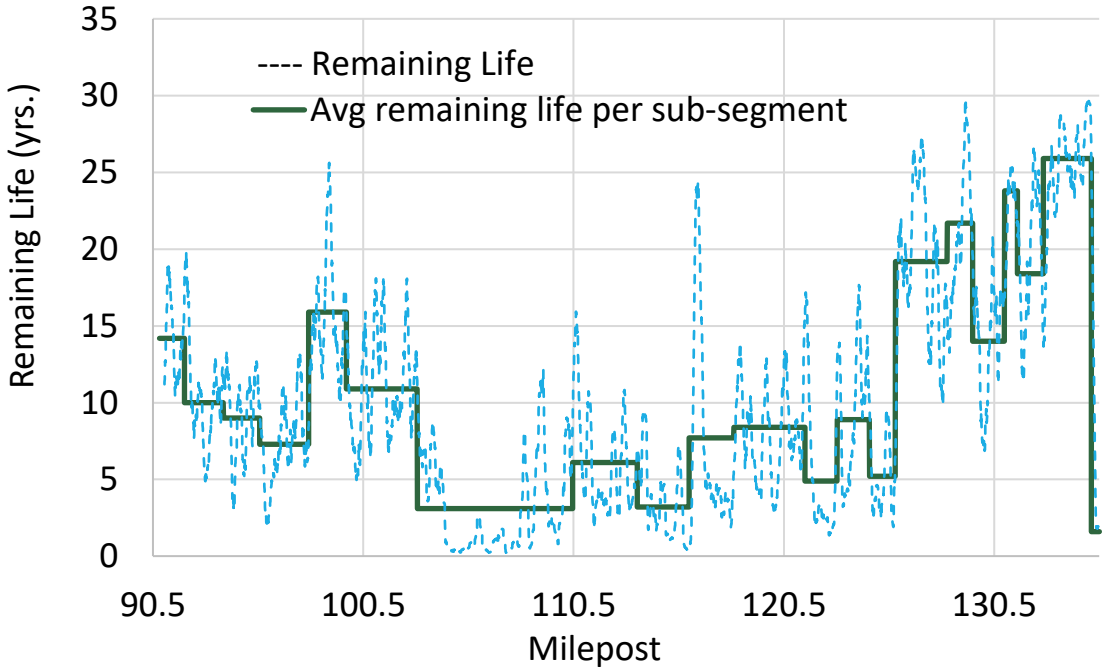




Traffic Speed Deflectometer (TSD)



- Measures pavement deflections
- With pavement thickness, determines:
  - Pavement layer moduli
  - Subgrade resilient modulus
  - Structural Number
  - Remaining Life



Supporting Decision Making

Goal

- Make the right decisions by accurately identifying the underlying conditions that cause surface distress
- Requires combining information on surface and subsurface conditions

Network-Level Pavement Management

Goal:

- Make decisions based on remaining life using pavement structure information
- Achieved by combining TSD deflection and GPR layer thickness to calculate:
  - Subgrade Modulus, Effective Structural Number
  - Remaining Life, Required Strengthening
- Example project - 2400 lanes miles evaluated in Idaho
- Results presented in geospatial database, useful for both network and project level decision making

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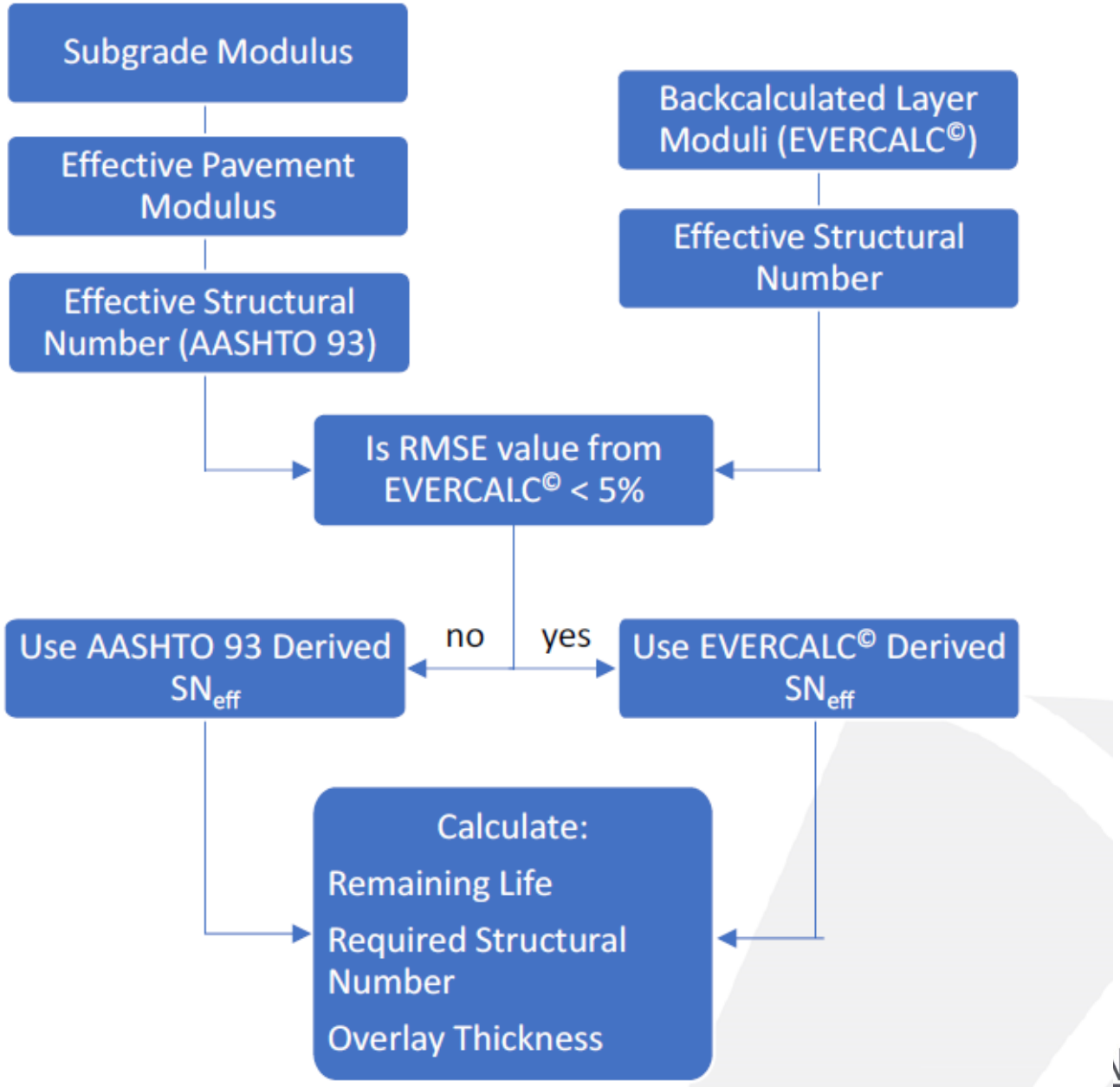
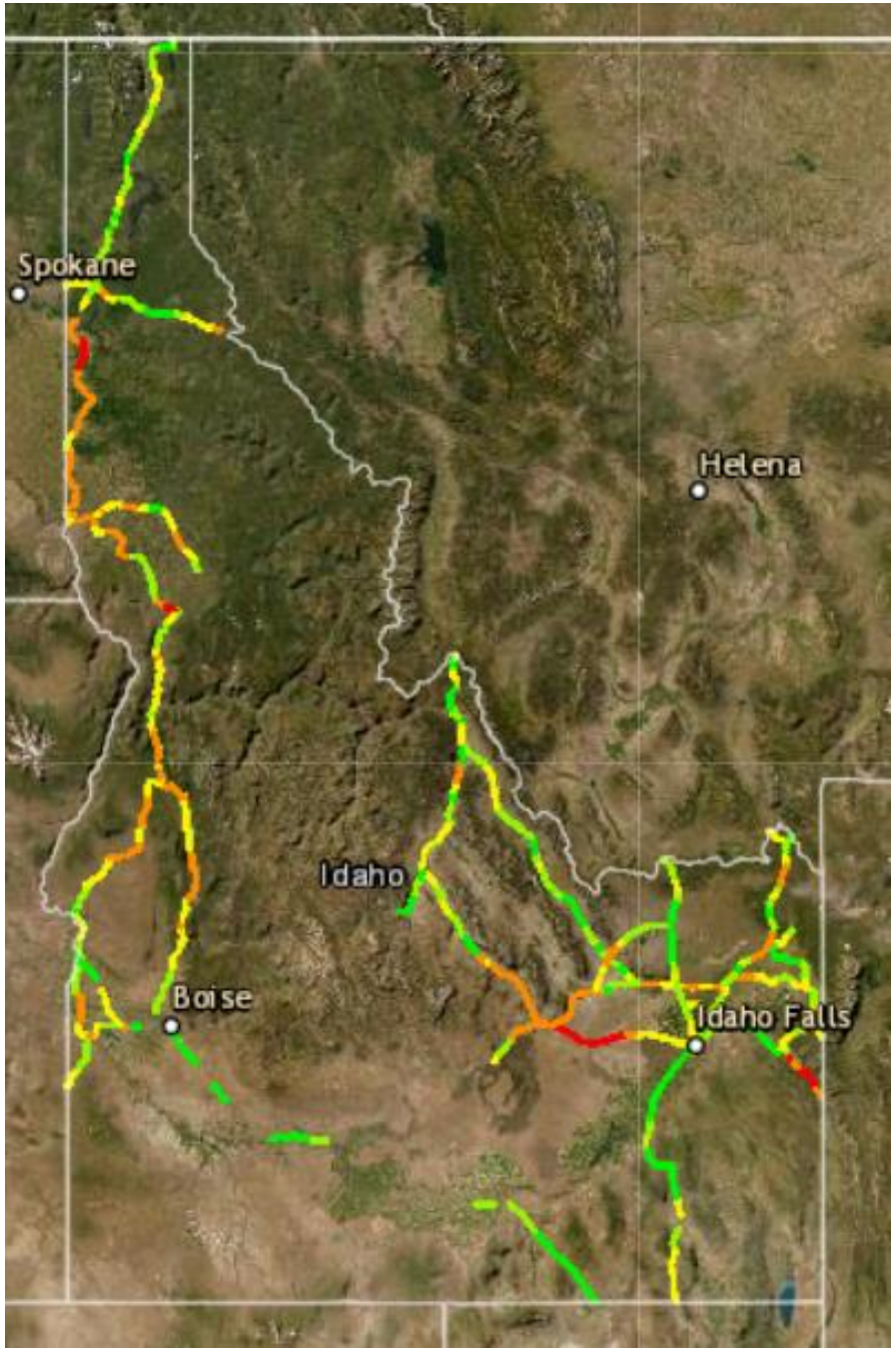
Calculation Details

Input Parameters

- TSD Deflections
- GPR Layer Thicknesses
- Temperature
- Truck Traffic



Asphalt Thickness



AC Thickness Segment

- less than 2.5 in
- 2.5 to 4 in
- 4 to 6 in
- 6 to 8 in
- greater than 8 in

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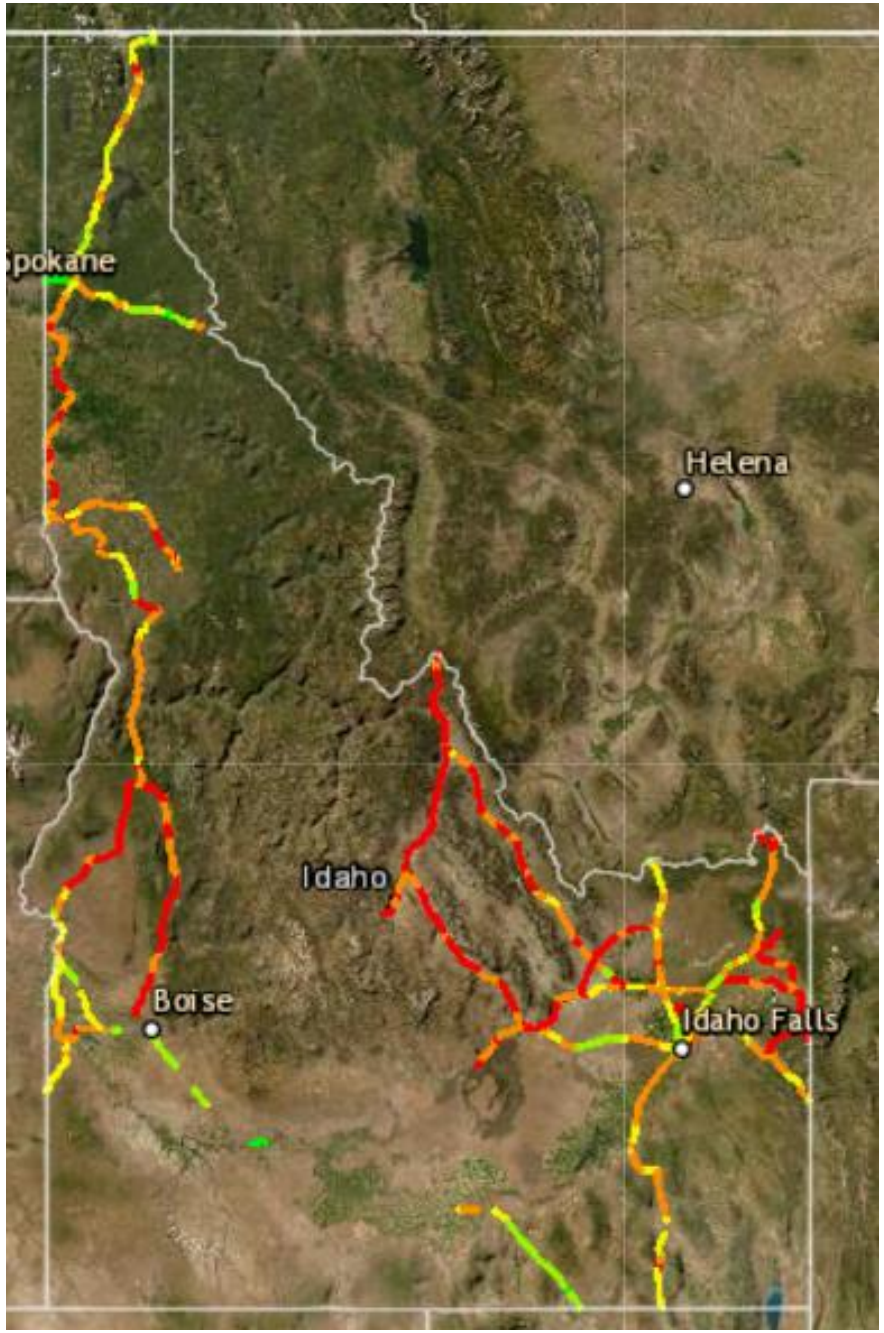
Effective Structural Number (SN_{eff})



Effective Structural Number Segment

- less than 3
- 3 to 4
- 4 to 5
- 5 to 7
- greater than 7

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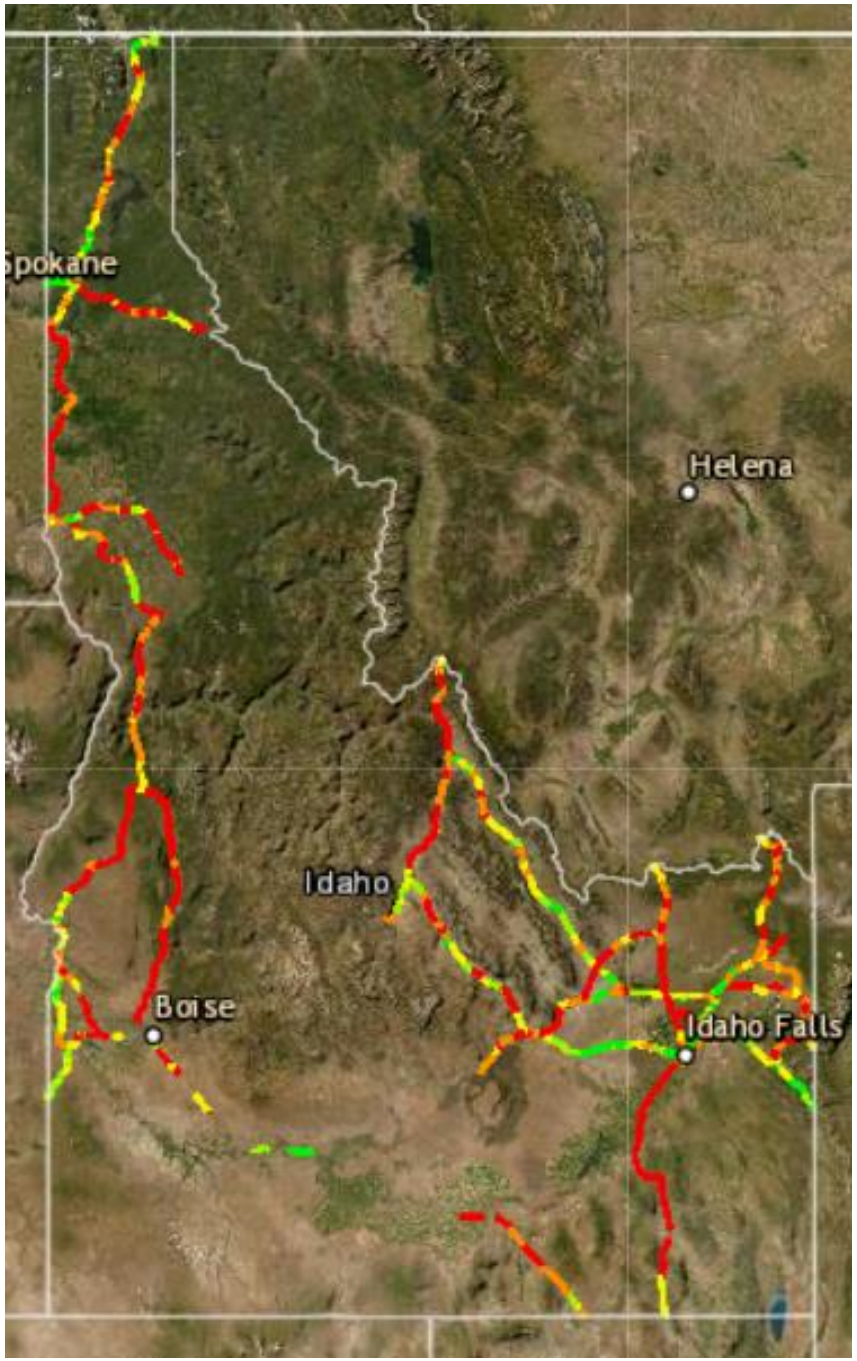
Remaining Life



Remaining Life Segment

- less than 3 years
- 3 to 7 years
- 7 to 12 years
- 12 to 17 years
- greater than 17 years

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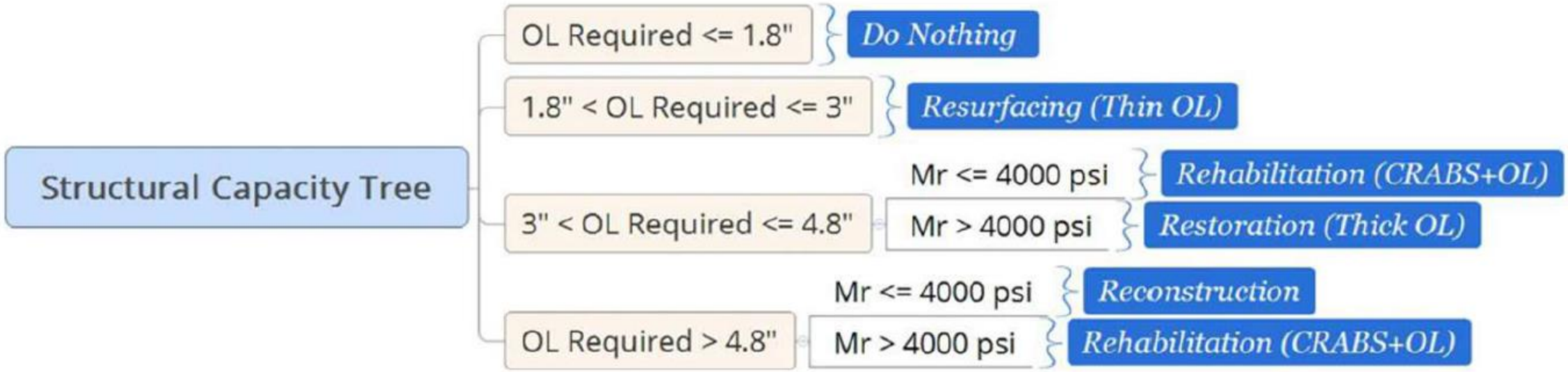
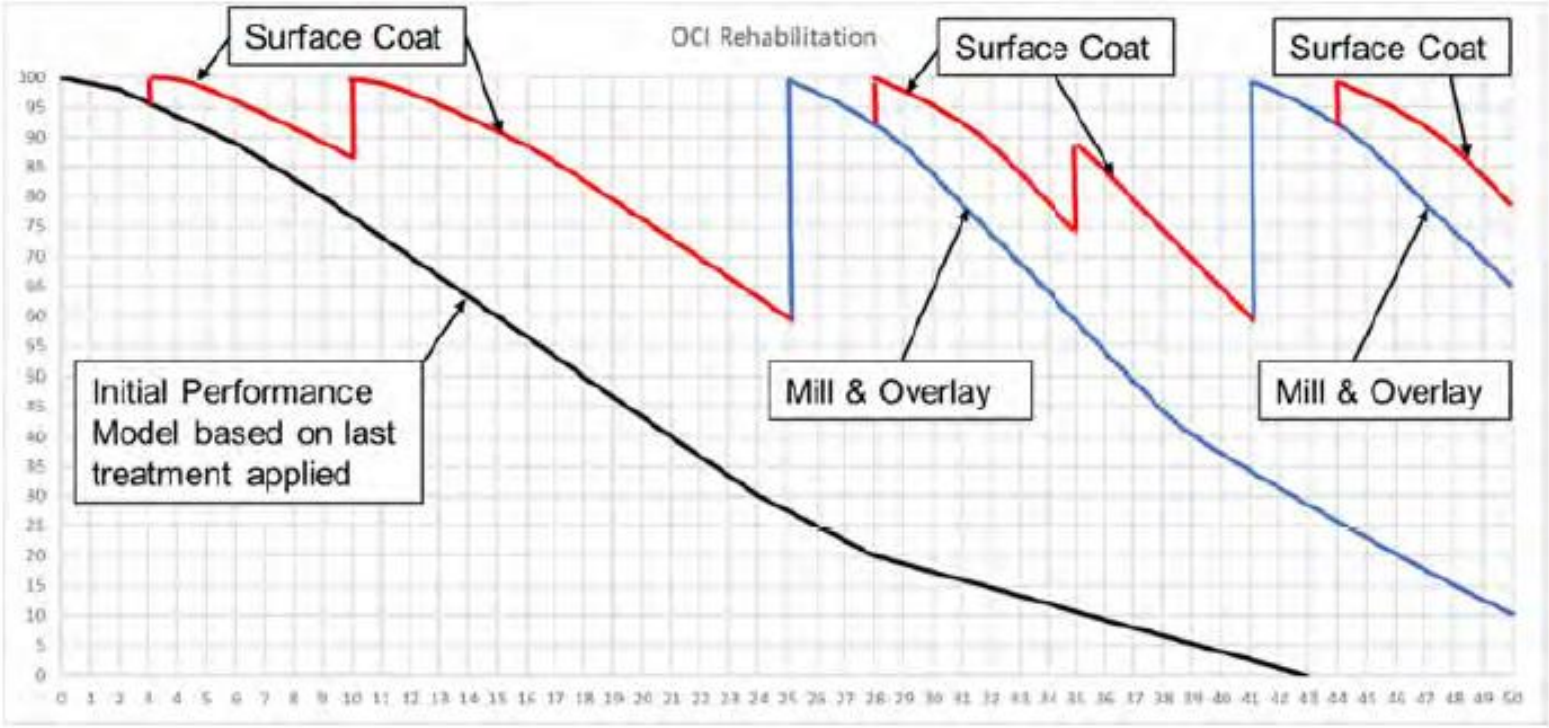
Use of Structural Data for PMS Decisions



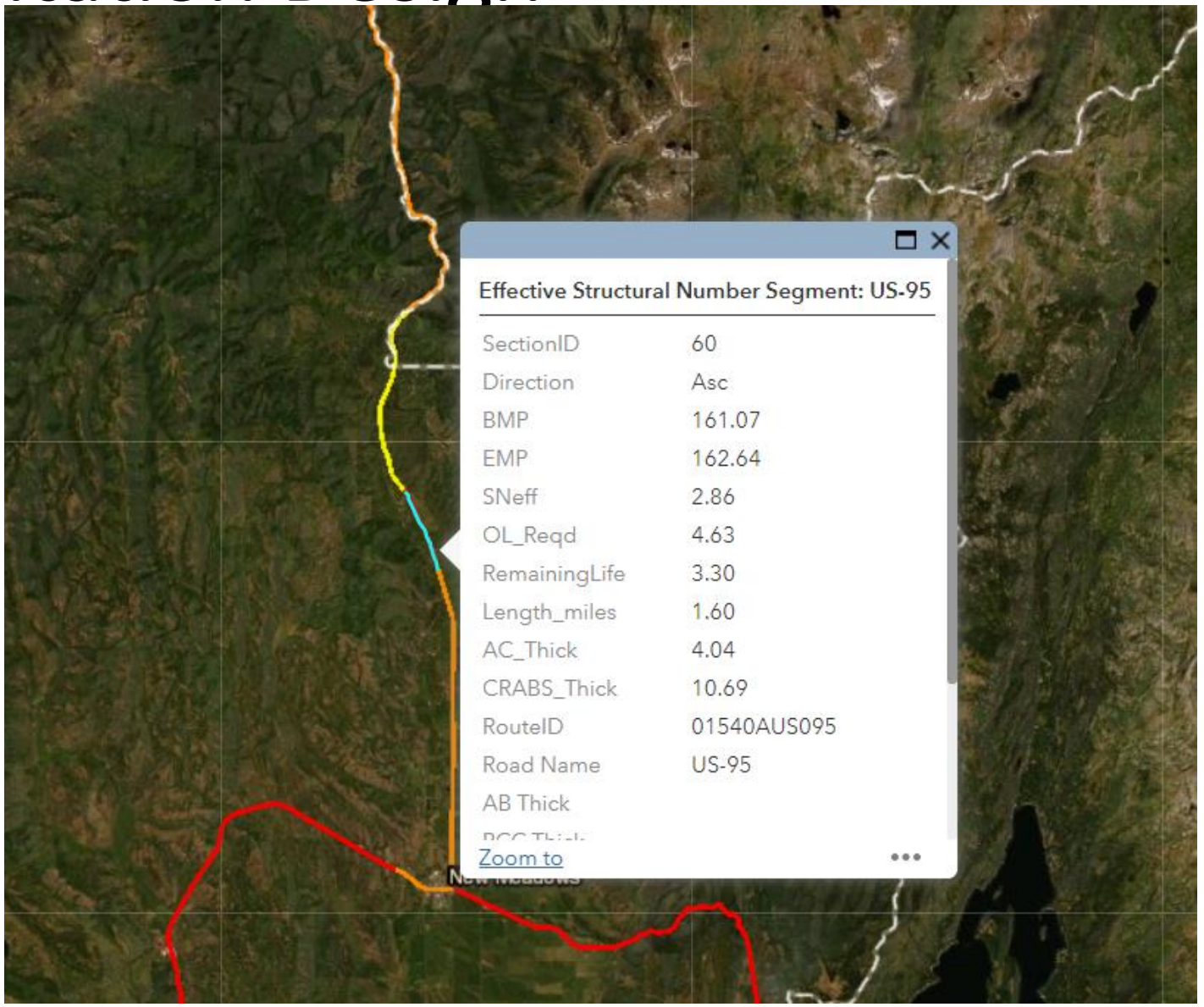
Life-Cycle Cost Savings using Accurate Structural Data



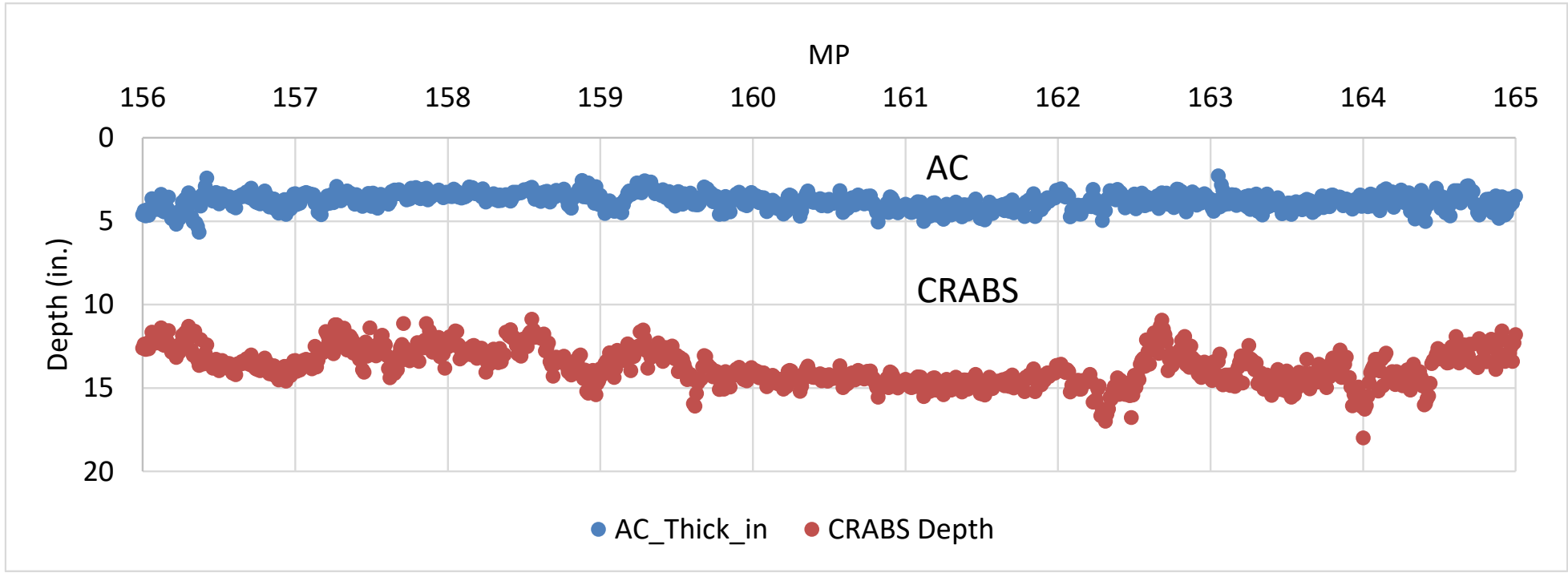
Cost Savings Using Structure Data: $15,572,100 = $21,186/mile over 50 years

Benefit/Cost = 4.24

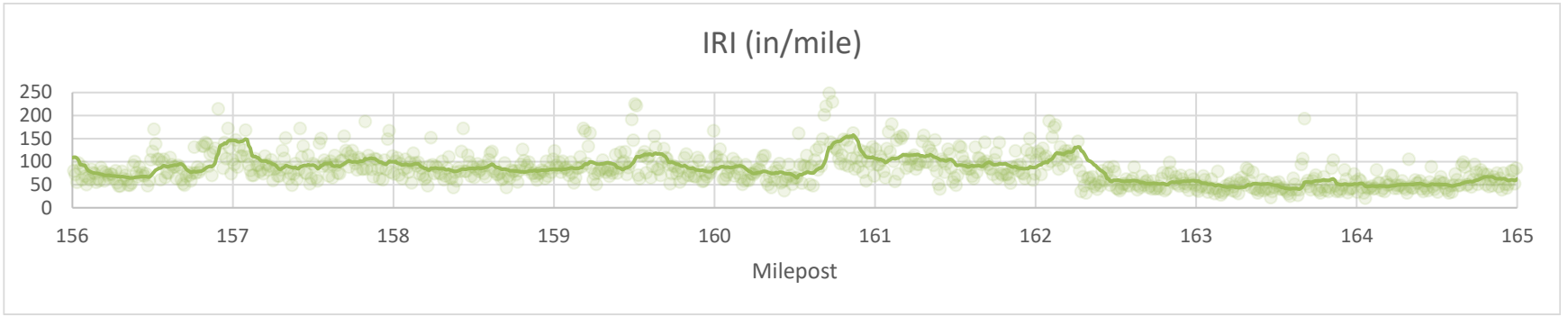
Rehabilitation Design

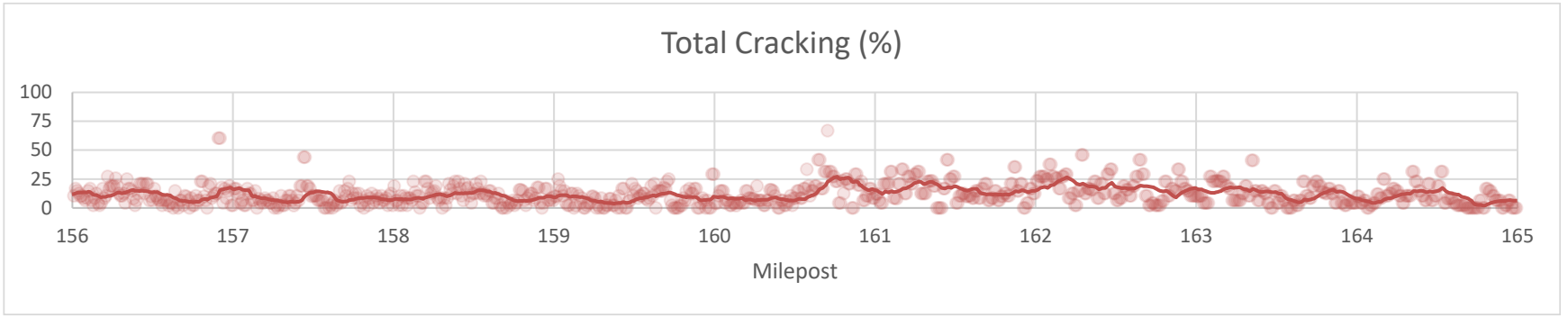


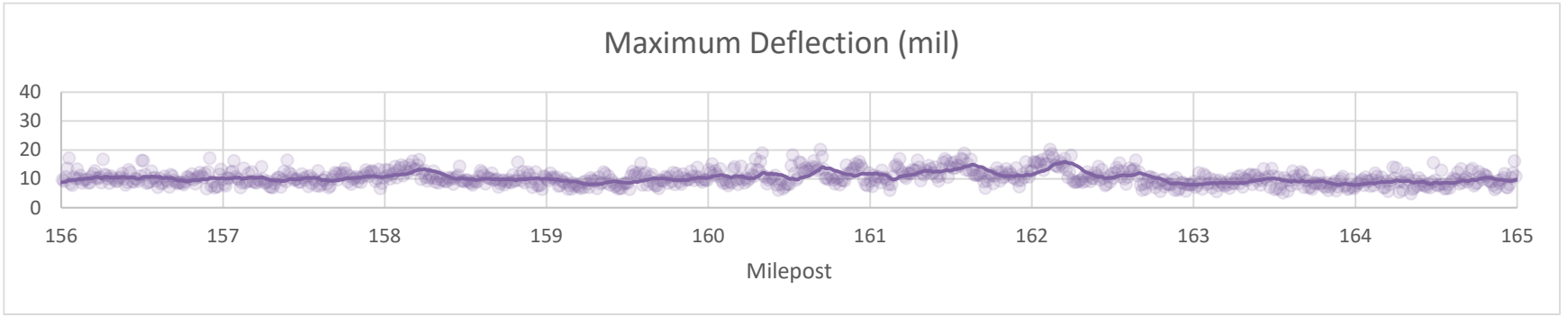
US-95 Project-Level Analysis – Pavement Structure



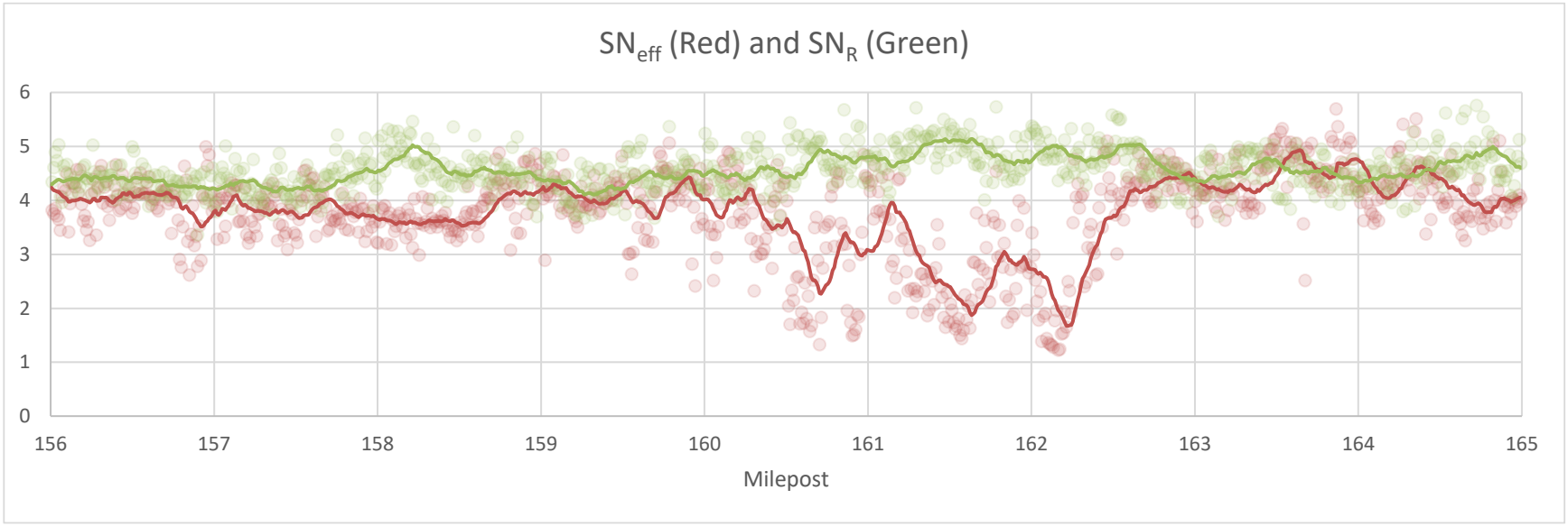
US-95 Project-Level Analysis

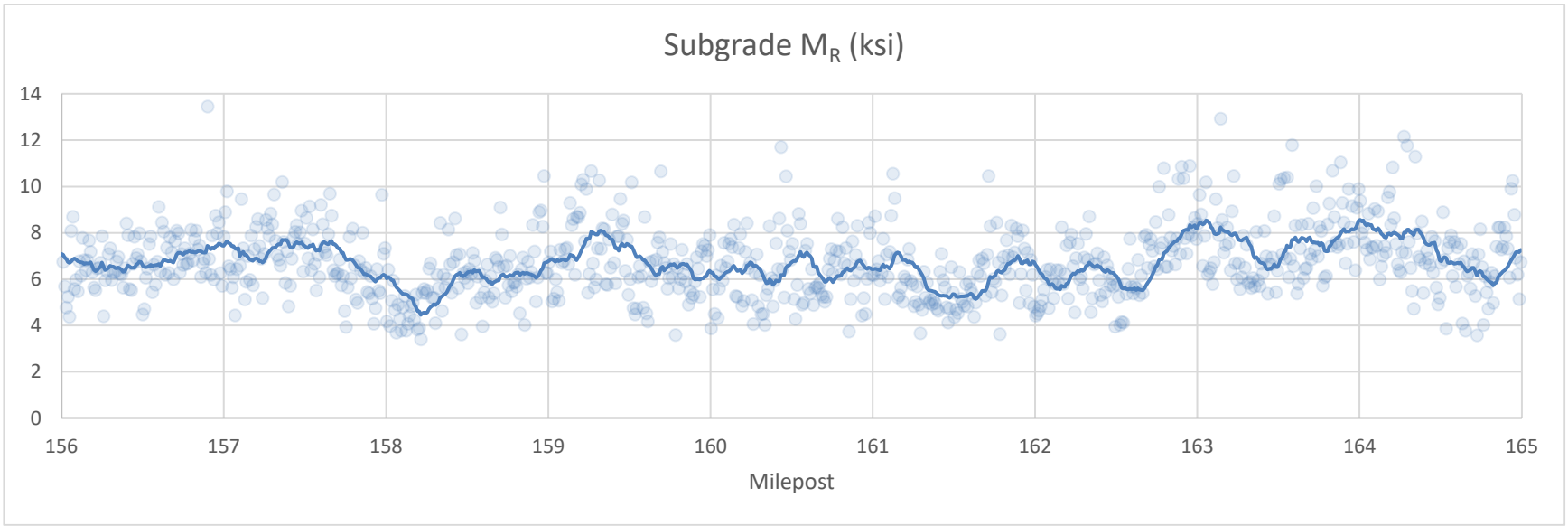




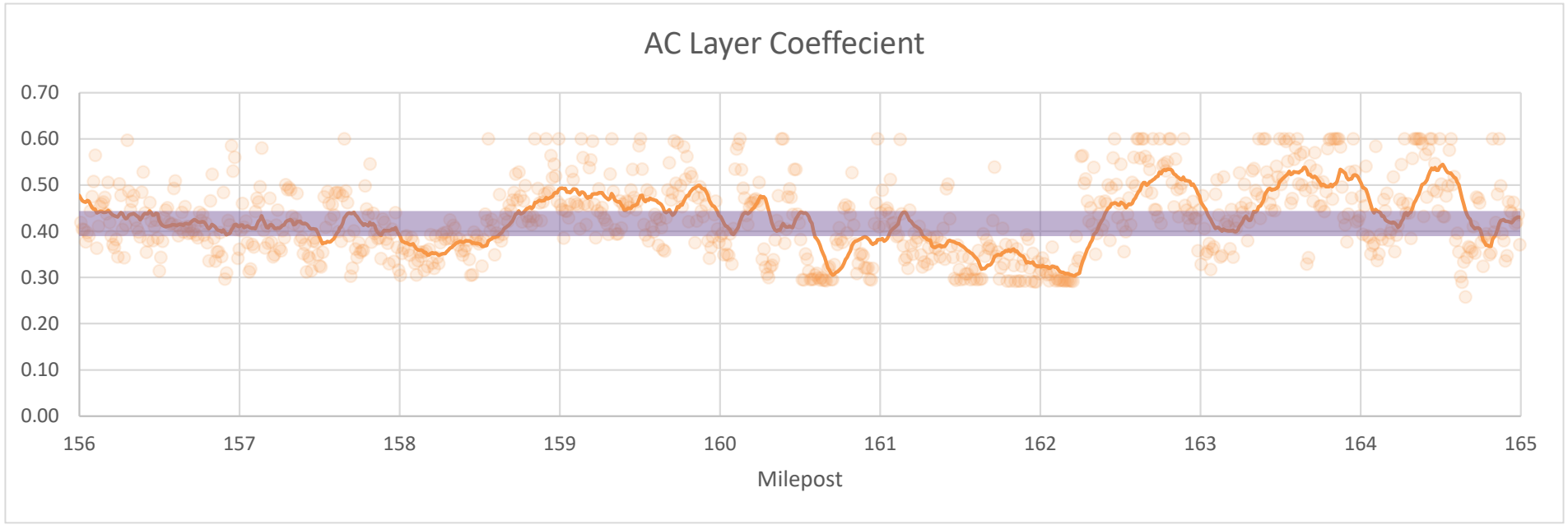


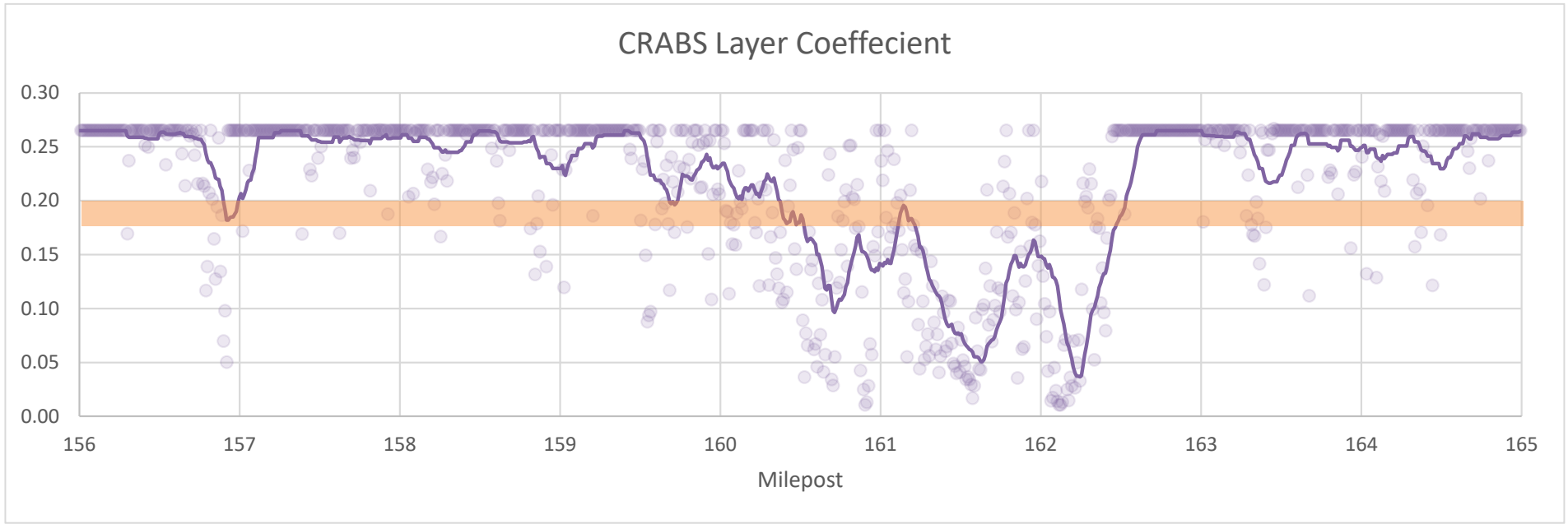
Example Project-Level Analysis – US-95





Example Project-Level Analysis – US-95





Supporting In-Place Recycling Efforts

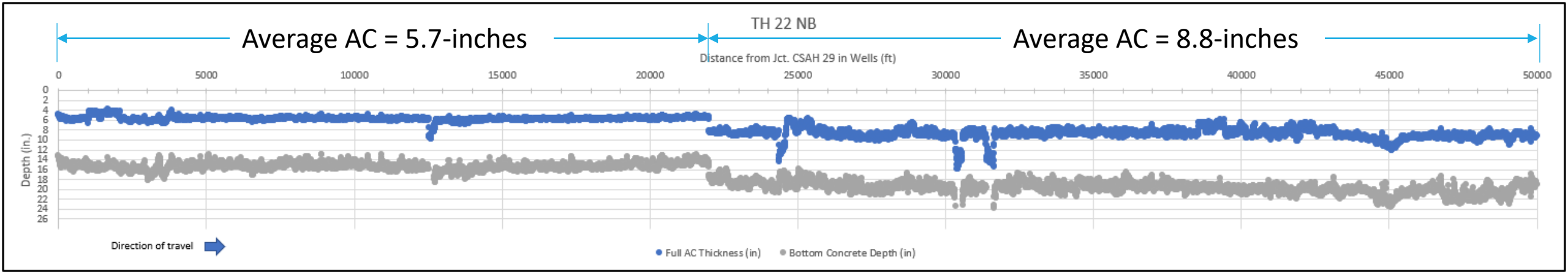
Problem:

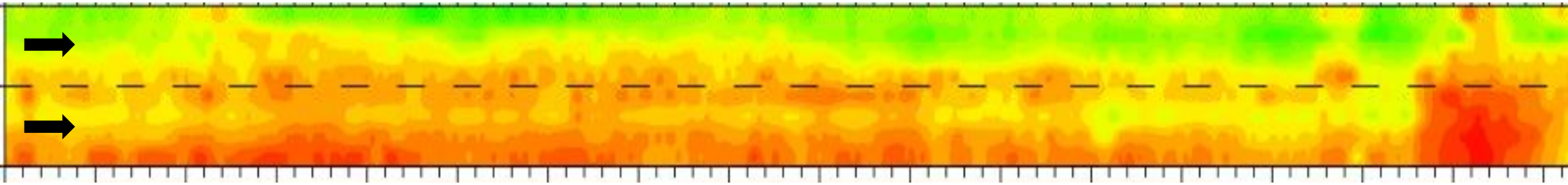
- Inaccurate/ incomplete thickness information can adversely affect the quality and resulting performance of pavements

Objective:

- Provide continuous pavement thickness information using GPR to facilitate accurate design of CIR and FDR projects

Supporting In-Place Recycling Efforts





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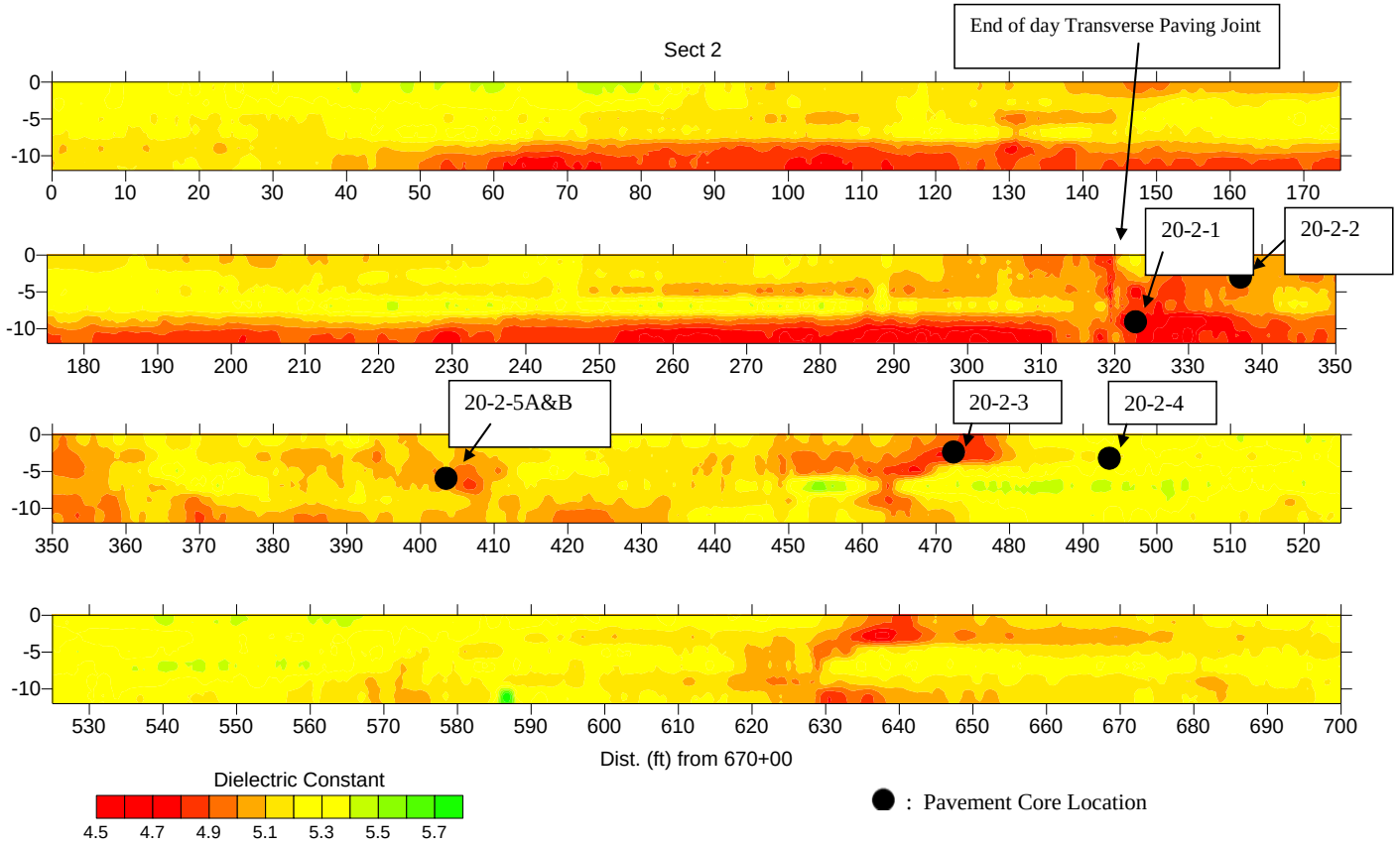
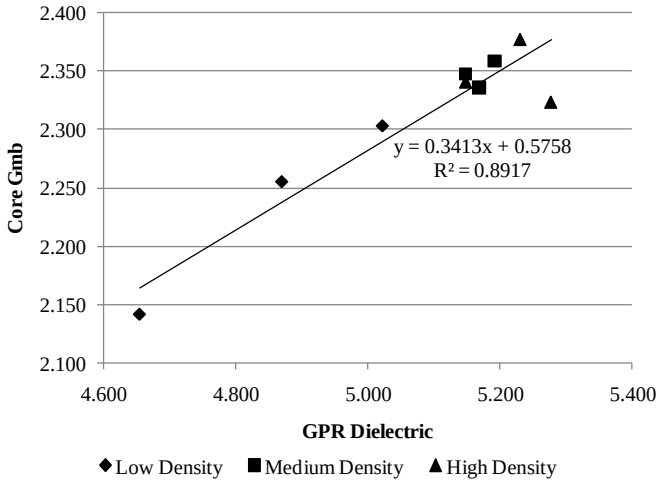
Use of GPR for Asphalt Density Determination





Results showed very good correlation between GPR dielectric constant and core densities

Failure Investigation

Goal:

- Understand nature and causes leading to pavement failures to optimize repair effectiveness

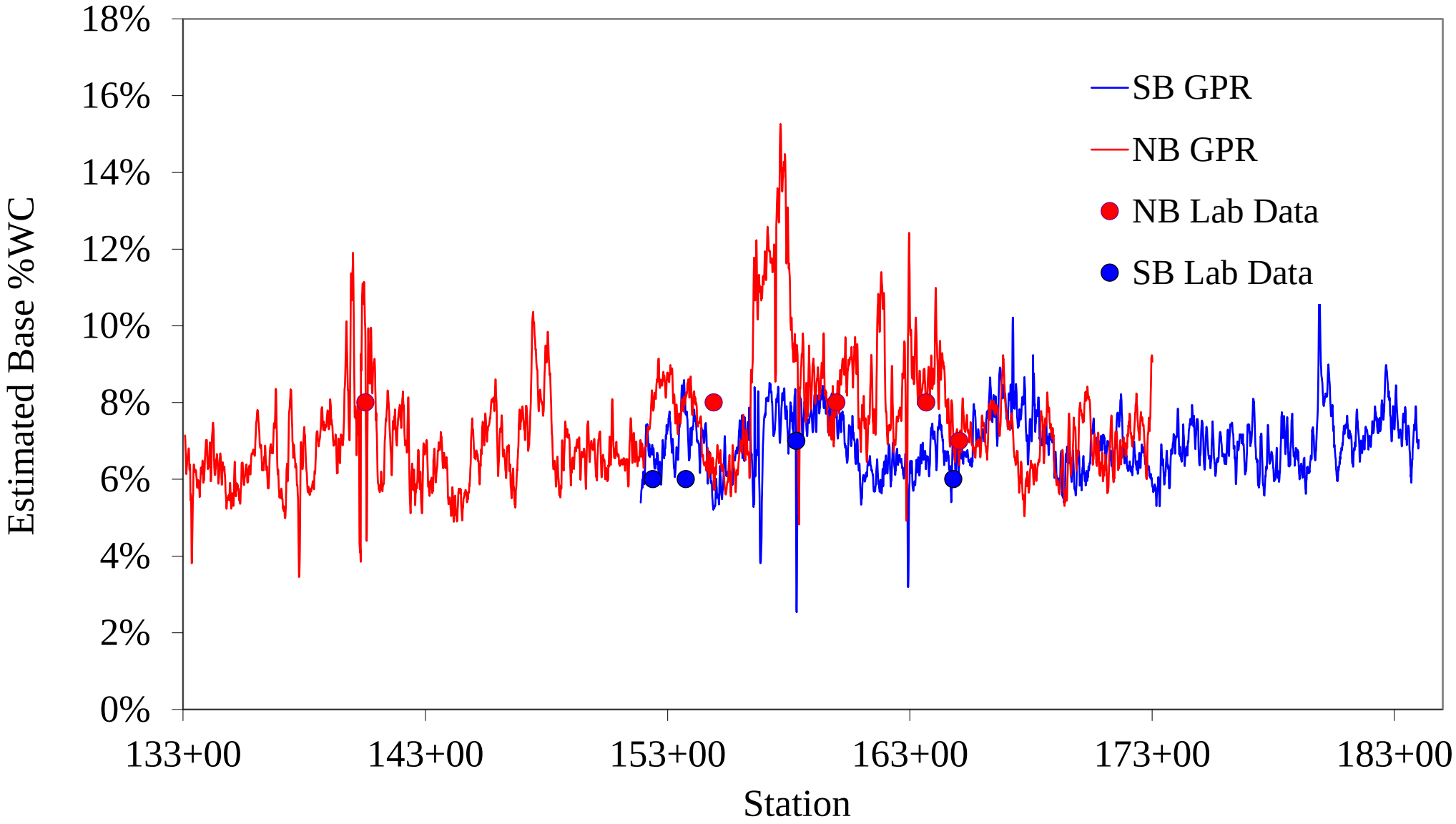
Example:

- Localized failure on a newly constructed roadway; suspected drainage issue

Objective:

- Determine the location and extent of clogged subdrains

Misalignment of Longitudinal Drainage Pipe

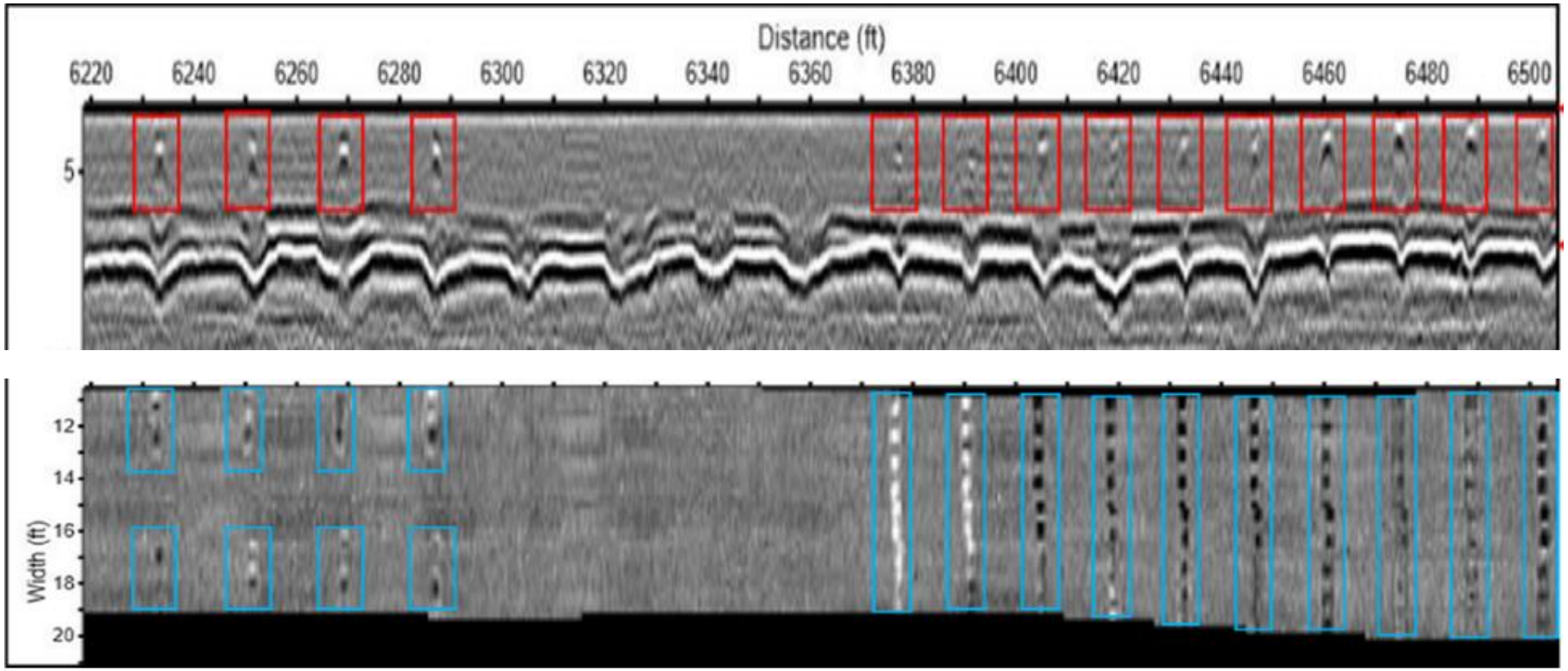


Mapping Dowel Bars in PCC Pavement

- Interest in identifying missing dowels, dowel spacing and alignment
- Advanced 3D Radar system was used - more effective than conventional GPR for this application

Mapping Dowel Bars in PCC Pavement

Depth-Slice Showing Pavement of Dowels

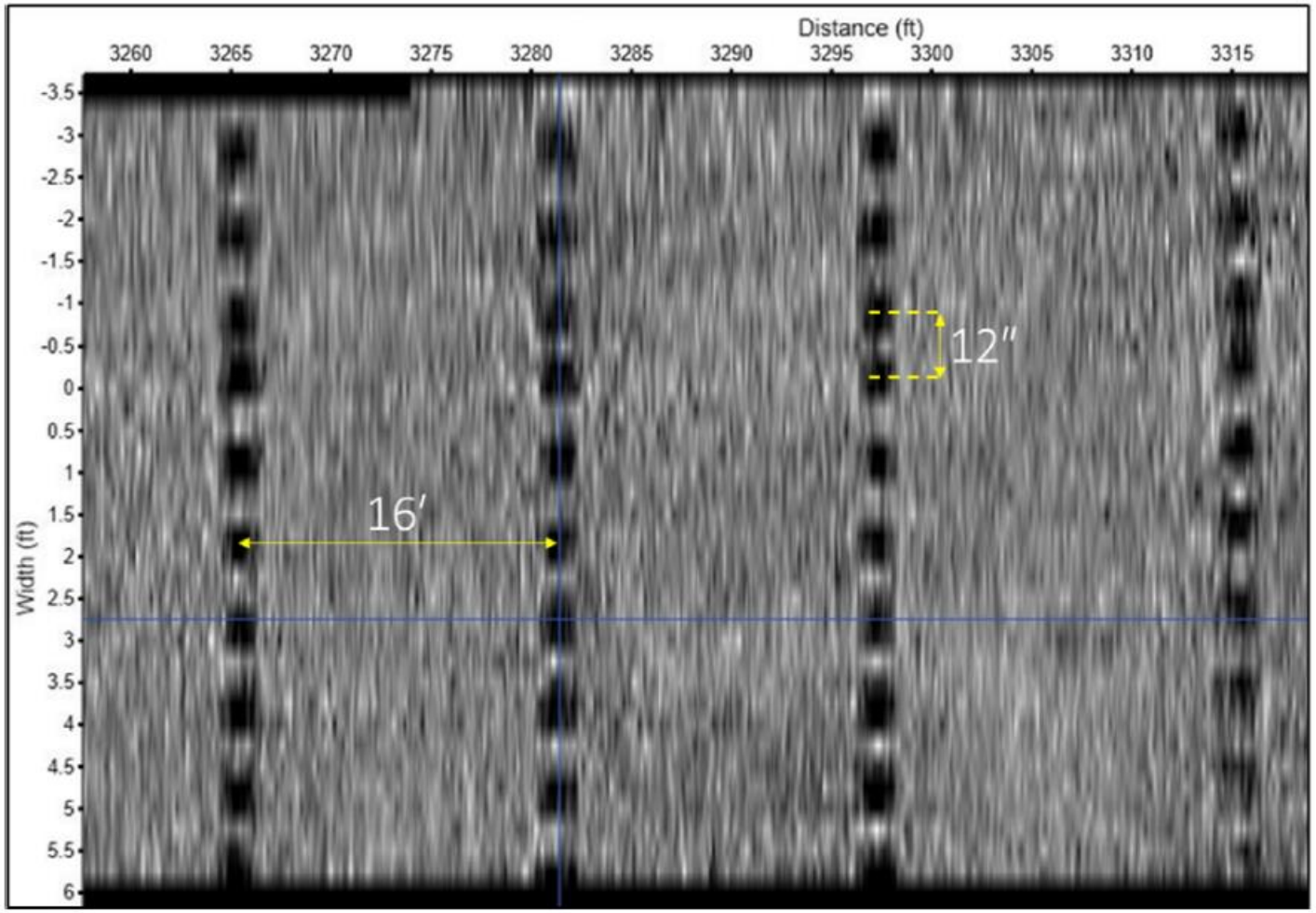


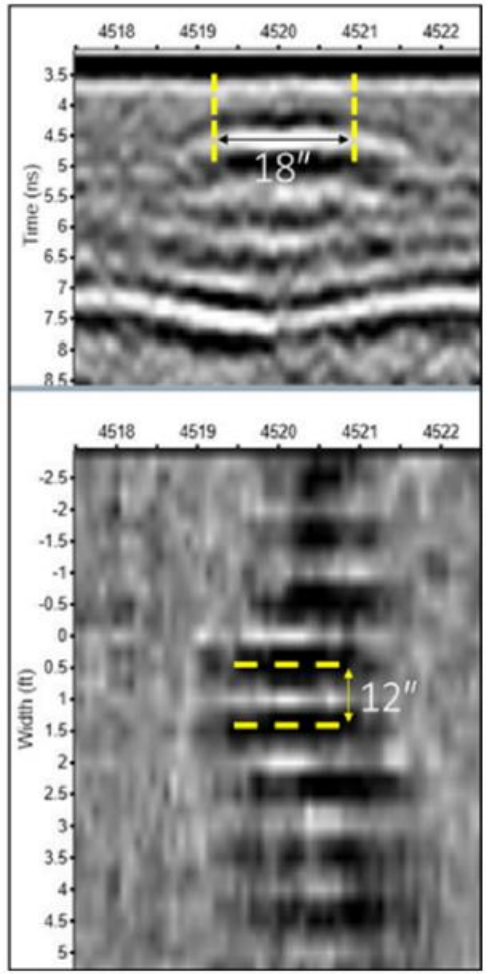
Cross Section

Depth Slice

Mapping Dowel Bars in PCC Pavement

Measured Dowels Dimensions, Spacing, and Alignment





Asphalt Stripping

Problem:

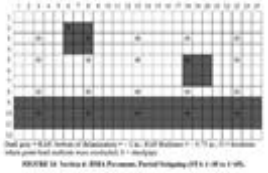
- Detect depth and extent of moisture damage (stripping) so that rehab could be properly designed to address the actual asphalt condition

Solution:

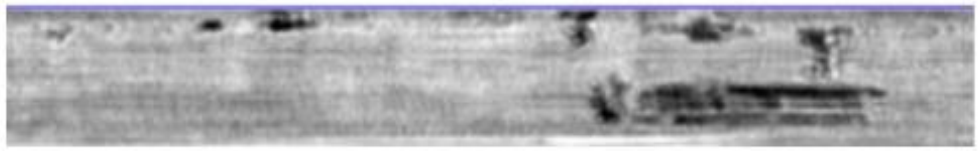
- Collected multiple lines of GPR data at driving speed
- Data analyzed to show locations, extent and depth of stripping

Initial Stripping Evaluation Test at NCAT

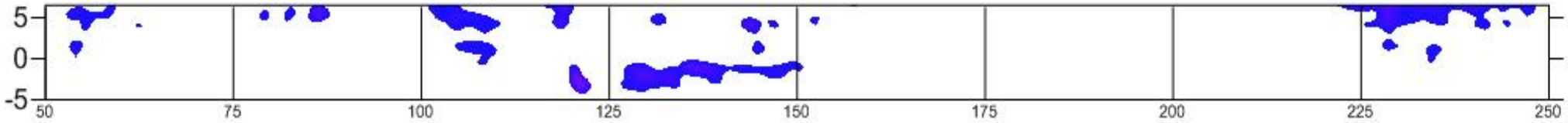
Section 6 RAP placed at 2" depth



3D GPR Depth Slice at 0.6ns.

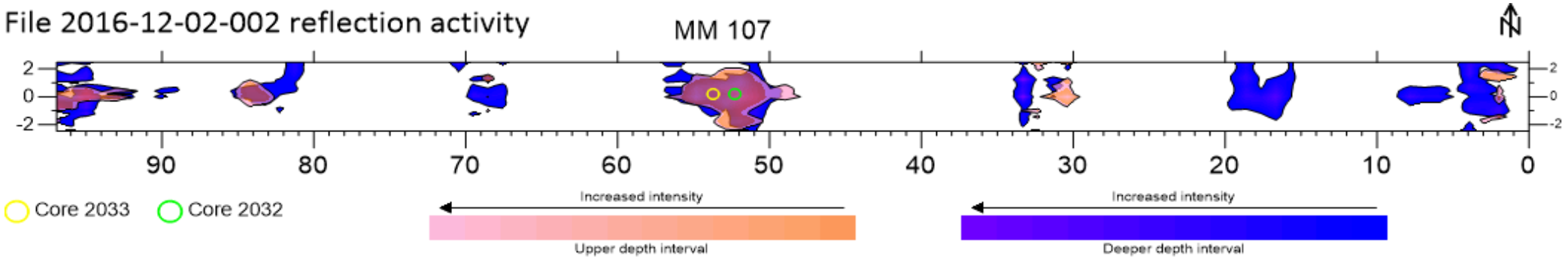


Activity Analysis (0.6 - 1.0 ns)



Asphalt Stripping Evaluation in Minnesota

Local Analysis



Combining surface and subsurface pavement data leads to the right decisions with reduced costs

- Reduce life cycle costs by making better decisions
- Increase pavement life by addressing the right needs
- Accurate thickness data avoids costly changes during construction
- Diagnose failures to allow appropriate and economical fixes