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Virginia Transportation Research Council

We bring innovation to transportation.

Virginia Experiences with Pavement NDE Technologies = TSD

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SHRP 2 R06D Follow On - Virtual Peer Exchange
November 28, 2022

Pavements in Virginia

- VDOT maintains more than 128,000 lane miles of pavements
  - About 78% classified as secondary routes

- Annual surface condition data collected on 100% of interstate and primary routes
  - 100% annually on higher volume secondary routes
  - 20% annually on lower volume secondary routes

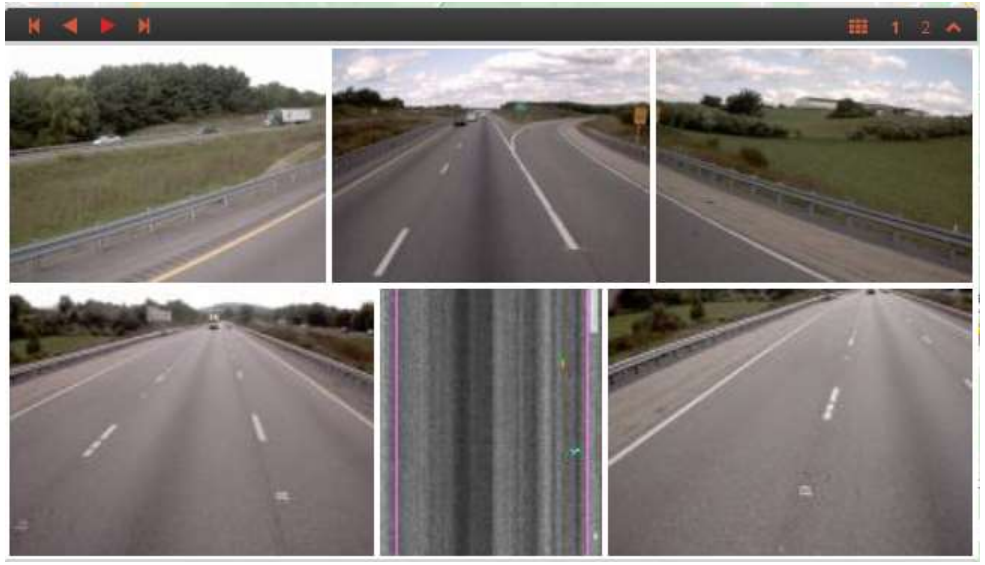
Traffic Speed Deflectometer

What is it?

- A specialized truck with a known rear axle load
- Doppler laser sensors measure instantaneous deflection velocity
- Ratio of vertical to horizontal speed gives deflection slope
- Integrating slope gives pavement deflection

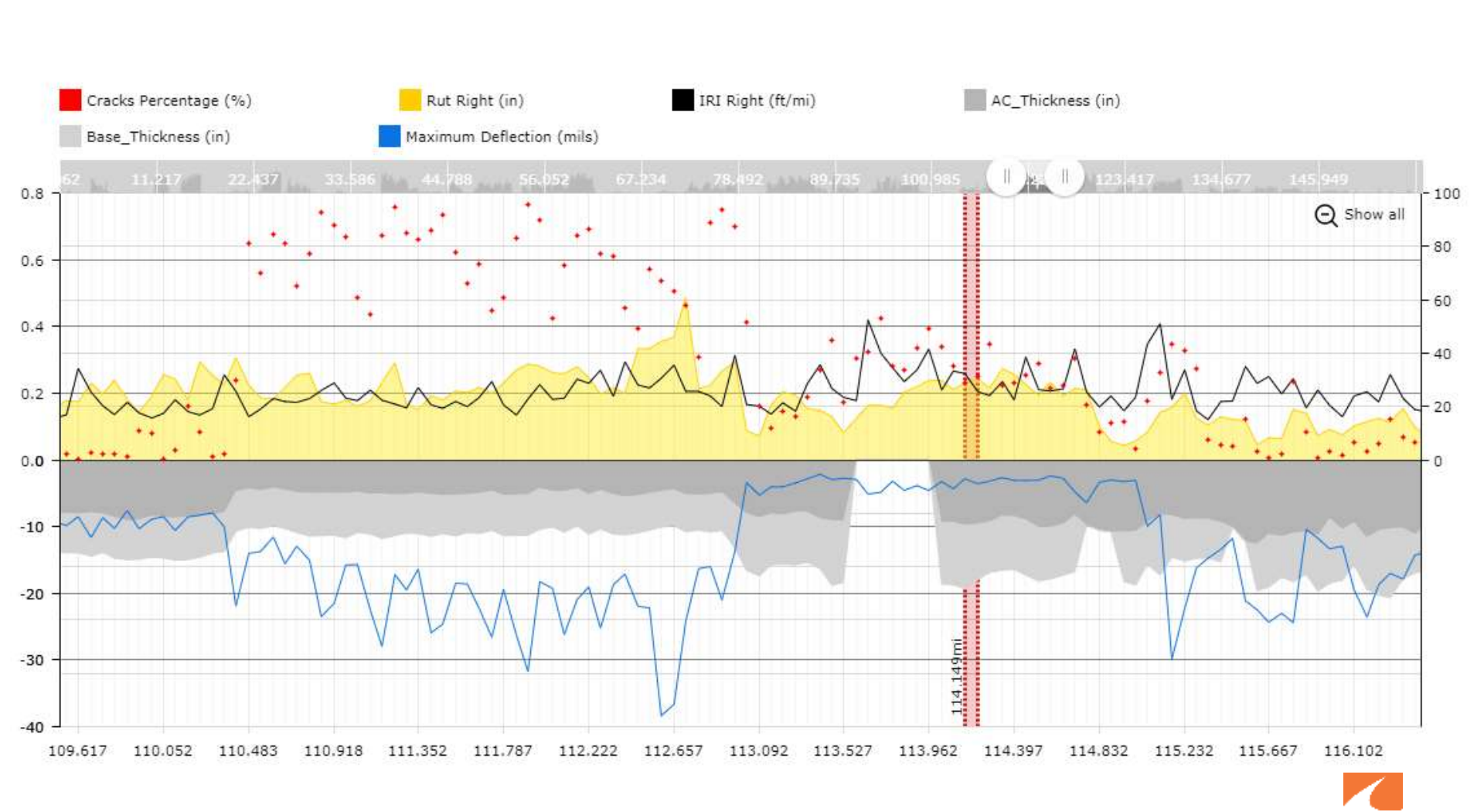
Traffic Speed Deflectometer Benefits to Agencies

- Assess structural capacity at traffic speeds
  - Also rutting, ride quality, cracking, pavement and roadway images, cross slope, etc.
- Allows for network-level structural testing with increased safety and nearly continuous measurement



Pooled Fund Study – TPF 5(385)

- 2019-2023
- 25 state agencies + FHWA
- Objectives
  - Establish a research consortium
  - Provide agencies with guidelines on how to specify data collection and use
  - Provide mechanism to conduct pilot demonstration testing
- 8,000 planned miles for 2022
  - Ranges from approx. 250 to 800 miles per agency


Cracks Percentage (%)
Rut Right (in)
IRI Right (ft/mi)
AC_Thickness (in)
Base_Thickness (in)
Maximum Deflection (mils)
Show all
114.149mi
0.8
0.6
0.4
0.2
0.0
-10
-20
-30
-40
100
80
60
40
20
0
109.617
110.052
110.483
110.918
111.352
111.787
112.222
112.657
113.092
113.527
113.962
114.397
114.832
115.232
115.667
116.102

Current VDOT Structural Pavement Data

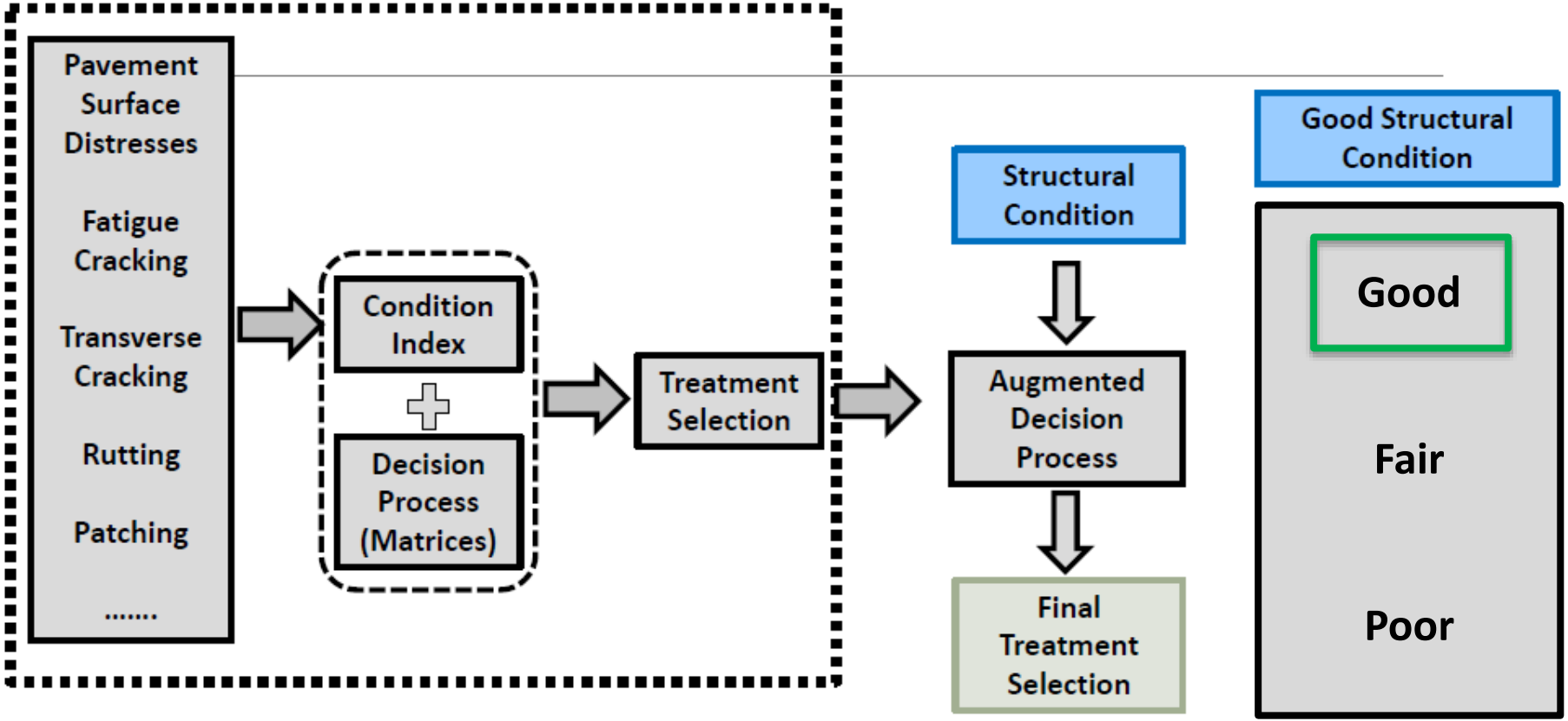
- 2006 to 2008, network-level FWD on the interstate
  - FWD + traffic level used to modify treatment decision (interstate only)

- FWD data has gaps
  - Only on the interstate (about 5% of network)
  - Now 14+ years old
  - 0.2 mile test spacing

FWD Data Implementation

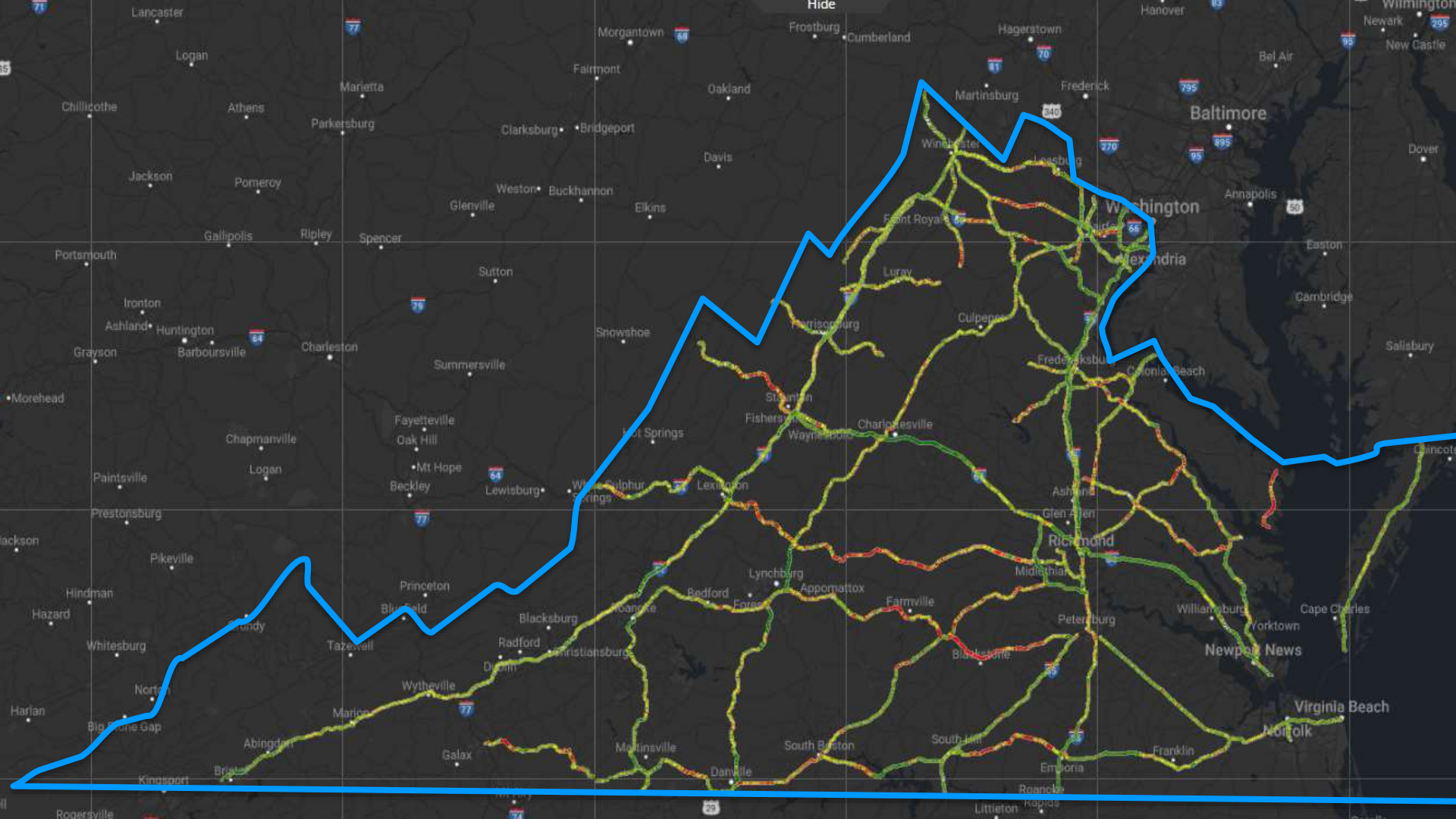
- Previous PMS practice suggests one of 5 treatment levels based on surface condition
  - Do nothing, preventive, corrective, restorative, reconstruction
- FWD values and traffic level were used to modify the treatment level
  - Increase level of treatment or keep the same

FWD Data Implementation



TSD Data Collection in Virginia

- A new opportunity
  - TSD = realistically collect structural data across the network
- Data collection efforts
  - 2017 = 4,000+ miles on cross-state corridors
  - 2018 to present = participation in PF studies
- Initial questions
  - Appropriate metrics?
  - Results similar to previous practices, etc.?
  - How often does testing need to be repeated?


Hide
Lancaster
Logan
Morgantown
Frostburg
Cumberland
Hagerstown
Hanover
Newark
New Castle
Bel Air
Fairmont
Marietta
Oakland
Martinsburg
Frederick
Baltimore
Chillicothe
Athens
Parkersburg
Clarksburg
Bridgeport
Davis
Dover
Jackson
Pomeroy
Weston
Buckhannon
Glenville
Elkins
Annapolis
Gallipolis
Ripley
Spencer
Portsmouth
Sutton
Luray
Easton
Ironton
Ashland
Huntington
Grayson
Barboursville
Charleston
Snowshoe
Culpeper
Cambridge
Salisbury
Summersville
Morehead
Fayetteville
Oak Hill
Chapmanville
Mt Hope
Beckley
Lewisburg
Logan
Paintsville
Prestonsburg
Pikeville
Princeton
Hindman
Hazard
Whitesburg
Tazewell
Blacksburg
Radford
Lynchburg
Bedford
Appomattox
Farmville
Richmond
Petersburg
Williamsburg
Yorktown
Cape Charles
Newport News
Virginia Beach
Norfolk
Wytheville
Harlan
Abingdon
Galax
Martinsville
South Boston
Danville
Emporia
Franklin
Kingsport
Roanoke
Littleton

Findings From Structural Testing

- VTRC Report 21-R4 - Network Level Pavement Structural Testing with the TSD
  - Poor correlation between structural condition and surface condition
  - Structural condition affects rate of deterioration
    - Weaker areas deteriorate faster
  - Consistency in identifying weak areas was better between FWD and TSD than repeated runs of FWD

New Study = TSD Data Implementation

- Objectives
  - Identify appropriate TSD data inputs
  - Determine time between successive tests
  - Study changes in treatment recommendations
  - Investigate changes in financial impacts
- Data
  - TSD data for select locations
  - GPR-based thickness, VDOT traffic, previous day temps

TSD Data Implementation

- Structural Evaluation
  - Compare SN_{eff} with SN_{req}
  - Effective Structural Number from TSD measurements
  - Required SN at 5 and 20 years using traffic data
  - Remaining life?
- Financial Evaluation
  - Difference in cost when considering structural data?
  - It depends…

TSD Data Implementation

SN_{eff}

- Inputs
  - D_0 (temp corrected)
  - Pavement thickness
  - D_{36} to D_{72} (not temp corrected)
  - Loading area radius

SN_{req}

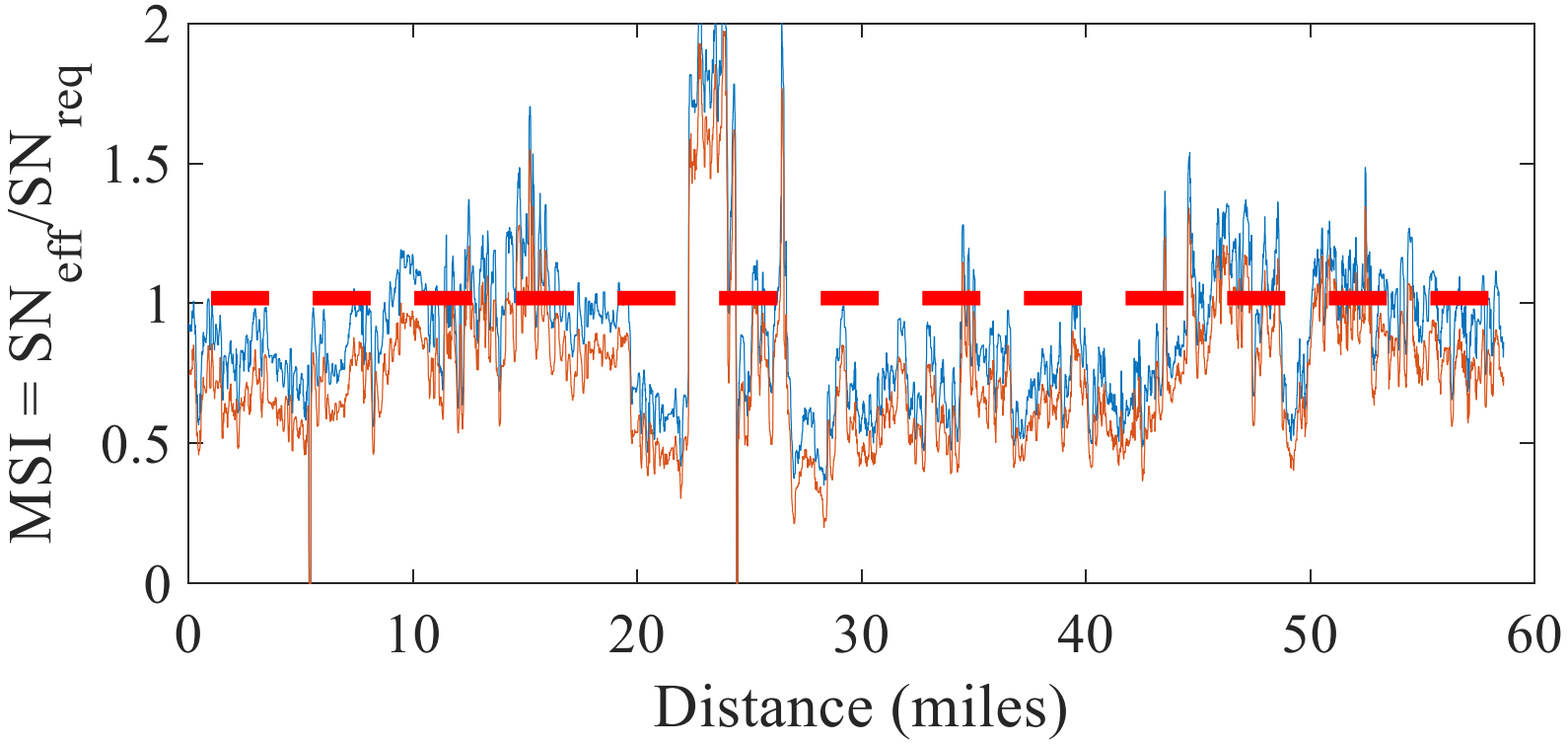
- Inputs
  - MR (0.33 correction)
  - ESALs
  - Terminal serviceability index
  - Reliability
  - Design Period

TSD Data Implementation

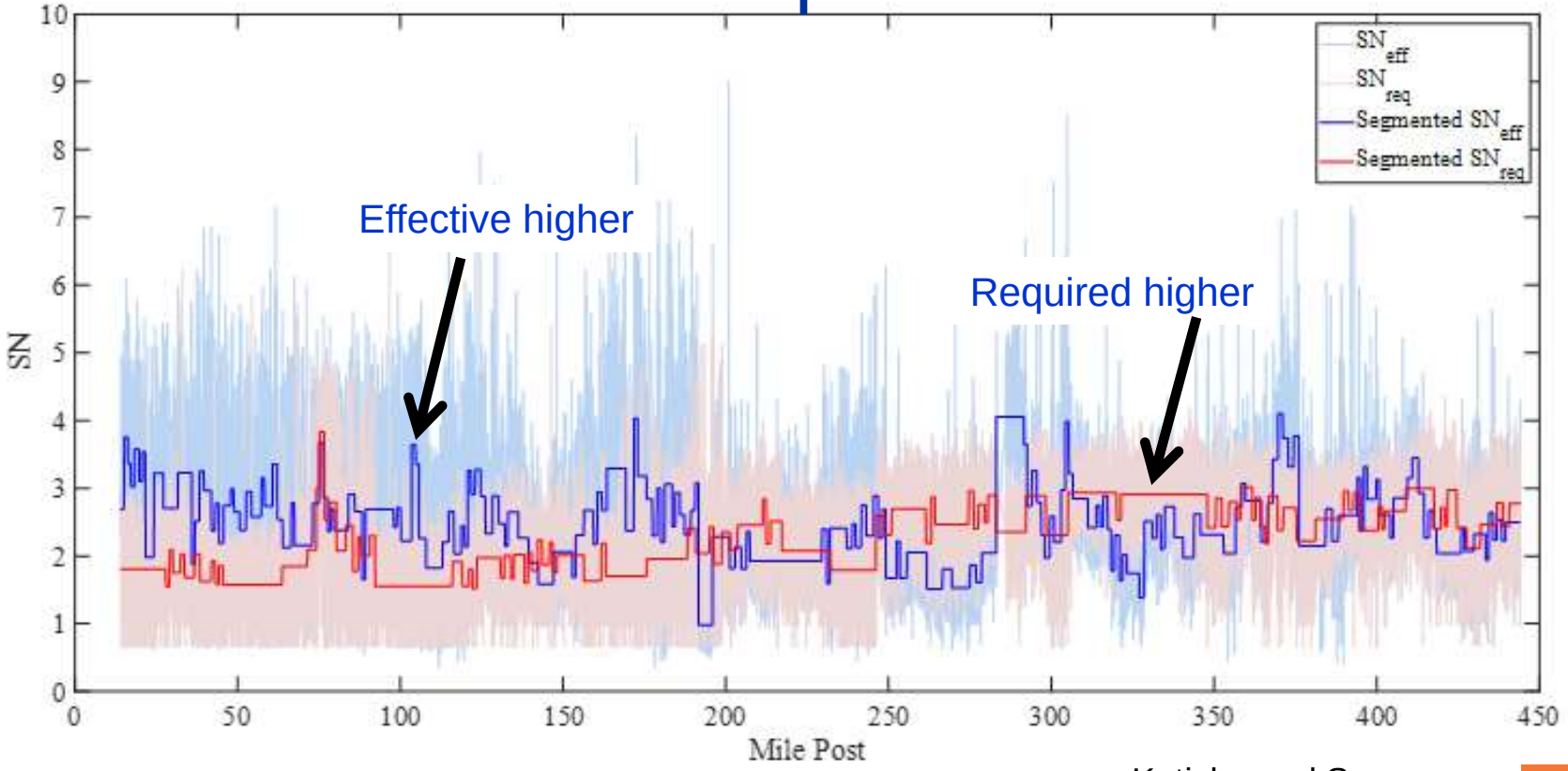
- SN_{req} calculation
  - Convert traffic data to required ESALs (5 and 20 years)
  - Default terminal serviceability, reliability, std deviation

- Structural condition index (MSI)
  - $MSI = SN_{eff} / SN_{req}$
  - MSI > 1 = structural repair not required
  - MSI < 1 = structural repair needed
    - How much? Assumptions….

Example 1



Example 2



Katicha and Scavone

TSD Data Implementation

- Examples showed differences in SN
  - Can be used to calculate treatment required
  - If $SN_{req} > SN_{eff}$, difference = needed structural capacity
- Remaining life is another way to review the data
  - "Remaining structural life"
- Remaining Structural Life, RSL
  - Calculate effective ESALs using SN_{eff} and AASHTO equation
  - RSL = effective ESALs / ESALs per year

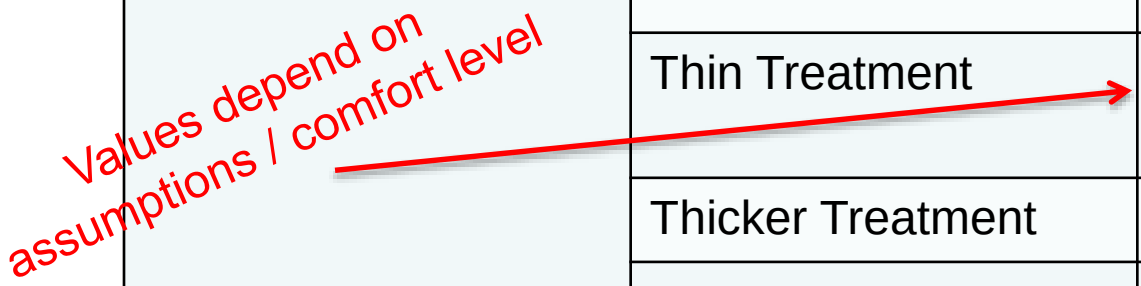
Example Using the RSL

- RSL > 20 years = do nothing
- 20 > RSL > 12 years = preventive maintenance
- 12 > RSL > 8 = thin treatment
- 8 > RSL > 3 = thicker treatment
- RSL < 3 = reconstruct

Use the above in conjunction with a functional assessment

Example Using the RSL

Functional Assessment	Structural Assessment	Modified Decision
Thicker treatment	Do Nothing	Preventive / Thin
	Preventive	Thin Treatment
	Thin Treatment	Thin Treatment
	Thicker Treatment	Thicker Treatment
	Reconstruct	Reconstruct



Summary and Outlook

- Implementing NDE techniques can help agencies make more informed treatment decisions
  - improve network performance, reduce life-cycle costs, and environmental impacts
- Research needs include:
  - Optimal measured values or calculated indices to use
  - Refinements in deflection measurement protocols
  - Calibration efforts

Thank you!

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