Image source: NAPA

Image source: ACPA

TOPS

Targeted Overlay Pavement Solutions

A solution for extending the life of an existing pavement investment.

U.S. Department of Transportation
Federal Highway Administration

Every Day Counts
Innovation for a Nation on the Move

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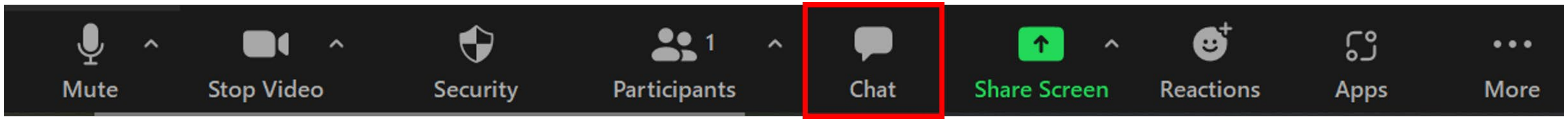
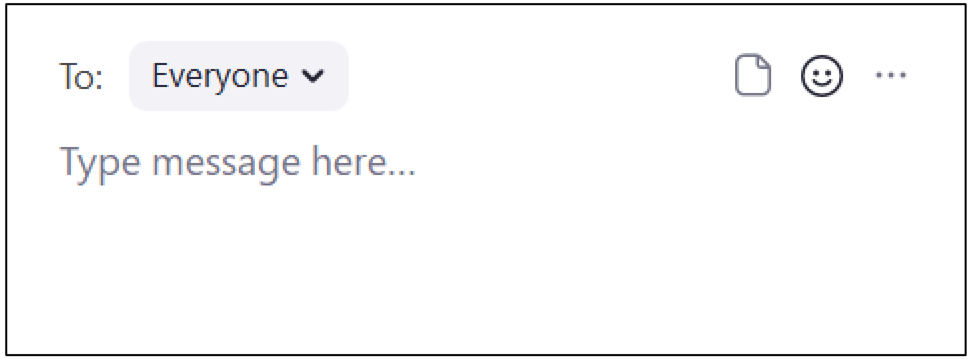
- All questions from participants will be answered during the Q&A session at the end of the webinar.





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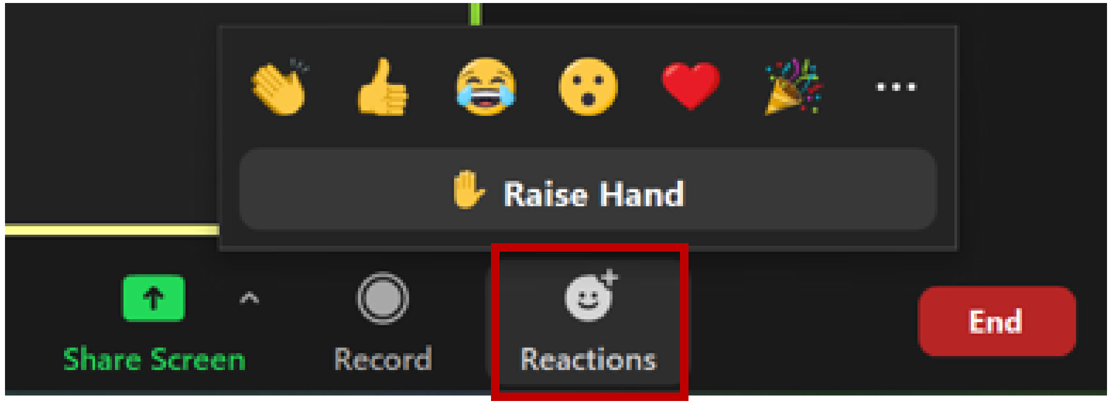

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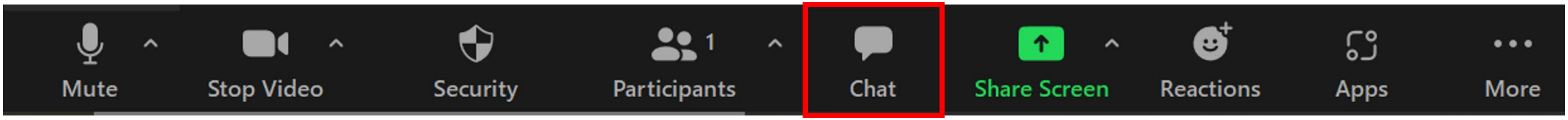
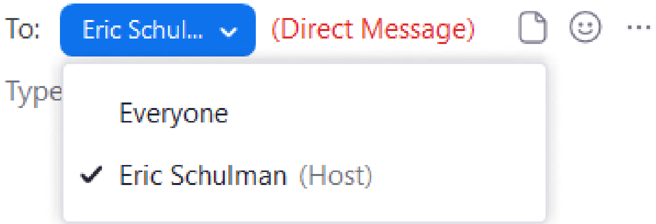




- Email eric.schulman@weris-inc.com and johan.vanrensburg@weris-inc.com

Webinar Overview

- Introduction to EDC-6 TOPS: Tim Aschenbrener, FHWA
- OGFC Overview: Kiran Mohanraj, The Transtec Group
- OGFC Agency Experience: Cliff Selkinghaus, SCDOT
- UTBWC Overview: Shila Khanal, ARA, Inc.
- UTBWC Agency Experience: Jerry Geib, MnDOT
- Q & A

FHWA TOPS EDC-6 Team

Tim Aschenbrener
FHWA Headquarters

Derek Nener-Plante
FHWA Resource Center

Bob Conway
FHWA Resource Center

Background

- Over 25% of all State DOT infrastructure funds go to pavements overlays.
- State DOT manage 2.8 million miles of pavements.

- *Information source: FHWA at https://www.fhwa.dot.gov/innovation/everydaycounts/edc_6/targeted_overlay_pavement.cfm*

Image source: Iowa State University

TOPS

U.S. Department of Transportation
Federal Highway Administration

How is this different than typical overlays?

TOPS matches treatments to high-priority, high-need locations.

Image source: Georgia DOT

TOPS EDC Mission

Image source: iStock

Extend pavement life, increase load-carrying capacity, and improve safety, mobility, and user satisfaction in a cost-effective and sustainable manner by delivering targeted pavement overlay solutions to Federal, State, and local transportation agencies.

EDC-6 Goals

- Increase the number of participating agencies that demonstrate, assess, or institutionalize an additional TOPS technology not previously institutionalized.
- Build awareness and expand TOPS usage
  - Identify a champion at each State agency
  - Share information at conferences/workshops
  - Train people (webinars/peer exchanges)

What's in the TOPS toolbox?

Asphalt overlay products:

- High-Performance Thin Overlay (HPTO)
- Crack Attenuating Mixture (CAM)
- Highly Modified Asphalt (HiMA)
- Enhanced friction overlay
- Stone matrix asphalt (SMA)
- Asphalt Rubber Gap-Graded (ARGG)
- Open-Graded Friction Course (OGFC)
- Ultra-thin bonded wearing course (UTBWC)

What's in the TOPS toolbox? Continued

Concrete overlay products:

- Concrete on Asphalt – Bonded (COA-B)
- Concrete on Asphalt – Unbonded (COA-U)
- Concrete on Concrete – Bonded (COC-B)
- Concrete on Concrete – Unbonded (COC-U)

TOPS Potential Benefits

- Improved Safety
- Improved Performance
- Retained Investments
- Cost Savings
- Environmentally Sound

Open-Graded Friction Course (OGFC)

OGFC Characteristics

- OGFCs can be used as a surface lift or as part of an entire porous pavement system
- OGFCs are primarily used for safety benefits, such as:
  - Reducing hydroplaning
  - Reducing splay and spray
  - Improving wet pavement friction
  - Reducing surface reflectivity
- OGFCs have an open-graded asphalt mixture with a high percentage of coarse aggregates almost uniform in size
- OGFCs' aggregate skeleton produces high air voids and coarse texture – improving friction and allowing water to drain
- Can reduce pavement noise, especially with newly constructed OGFCs

OGFC Terminology

- PEM: Permeable European mix
- Porous asphalt
- Plant mix seal
- Popcorn mix
- OGSC: Open-graded surface course
- PFC: Permeable/porous friction course

Newly paved OGFC

Source: SCDOT 2022

- Note: Some DOTs differentiate between these mixtures (e.g., Georgia DOT uses both OGFC and PEM. The mixes and specifications are similar but not the same.

OGFC Background

- OGFC Background
  - OGFCs have been used in the United States and worldwide for decades.
  - Some DOTs have stopped using them due to durability or maintenance issues.
- Many agencies are improving mixtures and specifications to increase durability while still achieving the safety benefits.

Reduction of splash and spray (right) compared to dense graded surface (left)

Source: Watson et al., 2018

Benefits of OGFC

- Agency interviews revealed safety benefits to be the primary reason for use of OGFC
- The macrotexture and void structure increase friction and surface drainage
- Reduced pavement noise. However, studies have shown the noise reduction becomes less effective over time

Example of OGFC (top) versus dense graded surface (bottom)

Source: Watson et al., 2018

Design and Planning

- Project selection criteria considerations:
  - High traffic
  - High speeds (many agencies use on all interstates)
  - Areas with evidence of wet-weather crashes
- Existing structural distresses to be repaired before OGFC

Placing OGFC

Source: SCDOT 2022

Design and Planning, Continued

- Thickness criteria – example agencies in table (12.5 mm mixtures)
- Typically, not considered a structural layer or assigned structural value

Agency	Specified Spread Rate or Thickness	Tolerances
GDOT	100 lb/yd^2 (approximately 1-inch thick)	±7 lb/yd^2
FDOT	0.75-inch thick	±5% of target spread rate
SCDOT	125 lb/yd^2 (approximately 1.25-inch thick)	Not specified

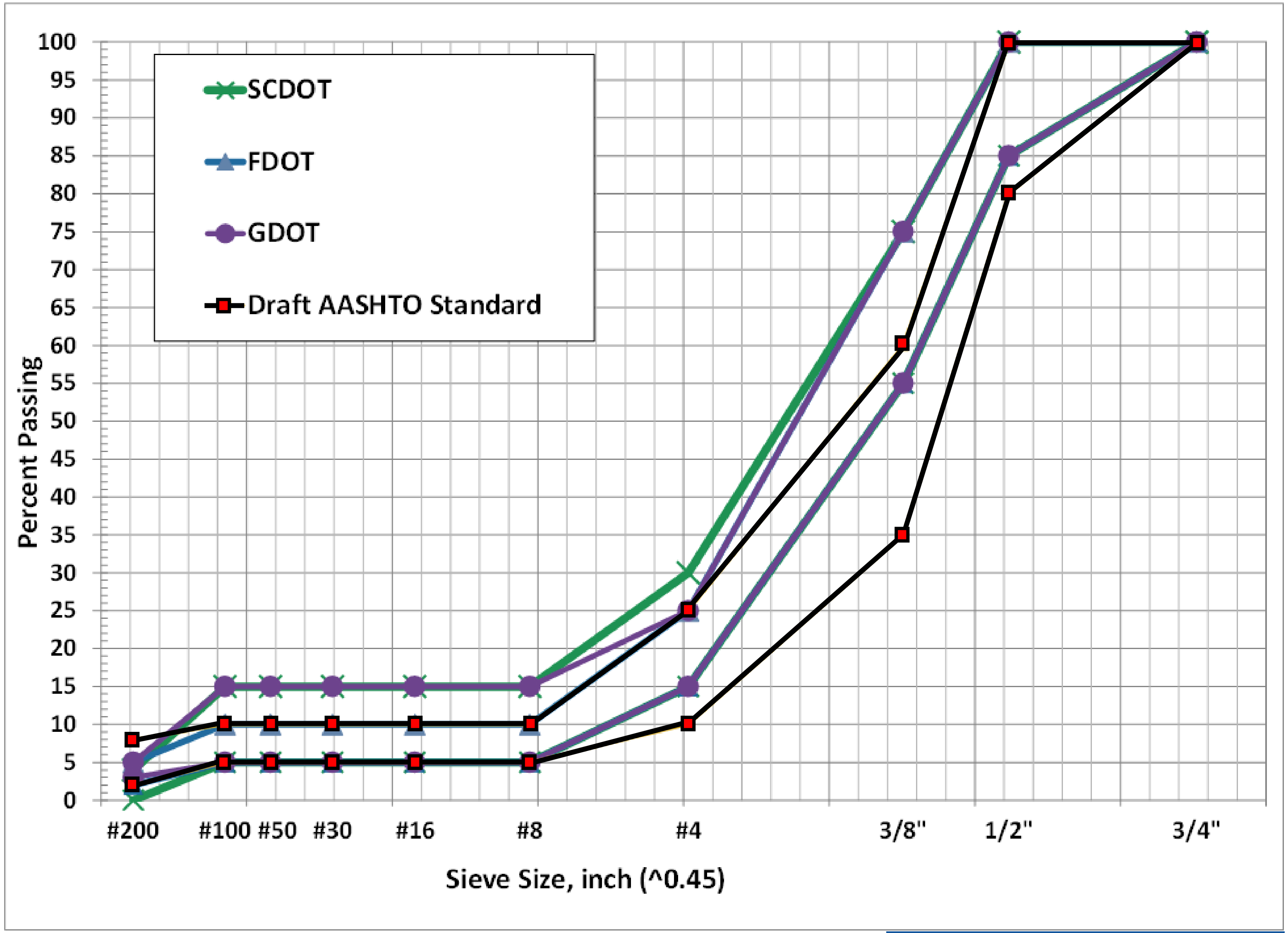
Source: FDOT, SCDOT, GDOT

Materials

- Aggregates
  - High quality aggregates meeting Los Angeles abrasion loss, soundness, fracture, or other suitability requirements
- Asphalt Binders
  - Modified binders becoming common practice for OGFC mixes – improved durability
  - Rule of thumb: stiffer binders with “high temperature” 1-2 grades stiffer (e.g., typical PG 64-XX use PG 76-XX)
- Additives
  - Anti-strip (hydrated lime)
  - Stabilizing agents
    - Fibers
    - Warm mix additives (WMA)
    - Ground tire rubber (GTR)

Materials, Continued

- Asphalt gradations
  - Coarser gradations have improved permeability and rutting resistance
  - Finer gradations (and higher binder content) have improved noise reduction and durability
  - Design for balance
  - Consider increased P#200s for increased durability



Source: FDOT, SCDOT, GDOT, NCHRP Report 887

Mixture Properties

- Asphalt content
  - Typically between 5.0-7.0 virgin and polymer binder
  - Typically between 6.0-8.0 GTR modified
- Air voids
  - Typically between 15-20%
- Cantabro loss
  - Typically 15-20% unaged – recently updated method
- Draindown at production temperatures
  - Typically 0.3-0.5%

Source: FDOT, SCDOT, GDOT, NCHRP Report 887

Cantabro Loss samples, before and after

Source: Bamunuarachchi et al., 2019

Mixture Properties, Continued

- Other specifications to consider:
  - Stripping resistance
  - Permeability/Porosity
  - Shear strength
  - Conditioned tensile strength.
  - Rut resistance testing (e.g., Hamburg Wheel Tracking Test)
  - Cracking resistance testing (e.g., I-FIT)

Source: NCHRP Report 887

9.5 mm OGFC pavement

Source: SCDOT, 2021

Construction Specifications and Successful Practices

- Proper requirements and practices for adding additives
- Mixing temperatures and storage requirements to avoid and detect draindown
- Tack or bonding layers are critical – application rates and materials may vary from dense graded mixtures
- Equipment and tools to ensure balanced paving and reduce thermal segregation
- Proper rolling pattern to seat the mix without breaking aggregate.
  - Liquid detergent in rolling water may help with pick-up
  - Static steel-wheel rollers

Maintenance

- Over time, OGFC can become “clogged”
  - Few agencies report maintenance to unclog. Still may have improved permeability compared to dense graded mixtures.
- Winter maintenance techniques may vary compared to dense graded mixtures
  - Avoid use of sand
  - Careful snowplowing techniques
  - Rates of de-icing or salting may be higher than dense-graded mixes
    - (25-50% higher, but traffic plays a role)
    - Pre-wetted salt (compared to brine or dry) can be effective
    - Anti-icing is effective (sensitive to timing since it is placed before storms)
  - Training for maintenance personnel

South Carolina DOT Case Study

About the Presenter, Cliff Selkinghaus

- **Cliff Selkinghaus** currently holds the position of Asphalt Materials Manager at the SCDOT Office of Materials and Research.
- He has worked at SCDOT for 28 Years and loves working in all areas of asphalt.

OGFC – TOPS
SCDOT

What we have done to improve our OGFC in SC………

OGFC – Lessons Learned..

Having issues with buildup in trucks?

Problematic Quarries

Quarry

Specimen	D_{avg} [cm]	Performance Grade: H_{avg} [cm]	Performance Grade: w_{dry} [g]	Performance Grade: w_{sub} [g]	V_T [cm^3]	***76-22 With Fibers: Porosity***	***76-22 WARM Evotherm: Porosity***
1	15.0	11.4	3759.5	2121.1	2021.6	*18.7*	*18.8*
2	15.0	11.5	3771.0	2129.1	2032.2	*19.0*	*19.5*

Abrasion Resistance of OGFC Mixtures

Specimen	w_1 [g]	w_2 [g]	***% Loss***	***% Loss***
1	3762.0	1768.0	*53.0*	*17.8*
2	3774.0	1616.0	*57.2*	*22.7*

Recent OGFC Designs - Porosity

Quarry	PG	Porosity
Hanson-Jefferson M0453	76-22	14.4
Hanson-Jefferson M0453	76-22	14.5

Porosity Difference: 0.1

Quarry	PG	Porosity
Martin Marietta-Cayce/N. Cola N0175	76-22	16.5
Martin Marietta-Cayce/N. Cola N0175	76-22	15.4

Porosity Difference: 1.1

Quarry	PG	Porosity
Vulcan-Columbia N0432	76-22	18.3
Vulcan-Columbia N0432	76-22	17.2

Porosity Difference: 1.1

Quarry	PG	Porosity
Martin Marietta-Rock Hill P0296	76-22	18.4
Martin Marietta-Rock Hill P0296	76-22	19.7

Porosity Difference: 1.3

Quarry	PG	Porosity
Hanson-Sandy Flats L0484	76-22	13.6
Hanson-Sandy Flats L0484	76-22	13.1

Porosity Difference: 0.5

Quarry	PG	Porosity
Buckhorn-Lynches River N0100	76-22	13.5
Buckhorn-Lynches River N0100	76-22	12.9

Porosity Difference: 0.6

Quarry	PG	***Porosity***
Martin Marietta-Augusta M0472	76-22	*20.8*
Martin Marietta-Augusta M0472	76-22	*21.2*

Porosity Difference: 0.4

OGFC Designs – Cantabro Abrasion Resistance

Quarry	PG	w_1 [g]	w_2 [g]	***% Loss***
Hanson-Jefferson M0453	76-22	4020.0	2924.0	*27.3*
Hanson-Jefferson M0453	76-22	4030.0	2782.0	*31.0*

% Loss Difference: 3.7

Quarry	PG	w_1 [g]	w_2 [g]	% Loss
Martin Marietta-Cayce/N. Cola N0175	76-22	3908.0	3152.0	19.3
Martin Marietta-Cayce/N. Cola N0175	76-22	3926.0	3136.0	20.1

% Loss Difference: 0.8

Quarry	PG	w_1 [g]	w_2 [g]	***% Loss***
Vulcan-Columbia N0432	76-22	3858.0	2740.0	*29.0*
Vulcan-Columbia N0432	76-22	3874.0	2904.0	*25.0*

% Loss Difference: 3.9

Quarry	PG	w_1 [g]	w_2 [g]	***% Loss***
Martin Marietta-Rock Hill P0296	76-22	4032.0	2836.0	*29.7*
Martin Marietta-Rock Hill P0296	76-22	3998.0	2506.0	*37.3*

% Loss Difference: 7.7

Quarry	PG	w_1 [g]	w_2 [g]	% Loss
Hanson-Sandy Flats L0484	76-22	4038.0	3338.0	17.3
Hanson-Sandy Flats L0484	76-22	4044.0	3528.0	12.8

% Loss Difference: 4.6

Quarry	PG	w_1 [g]	w_2 [g]	% Loss
Buckhorn-Lynches River N0100	76-22	4046.0	3244.0	19.8
Buckhorn-Lynches River N0100	76-22	4030.0	3310.0	17.9

% Loss Difference: 2.0

Quarry	PG	w_1 [g]	w_2 [g]	***% Loss***
Martin Marietta-Augusta M0472	76-22	3778.0	1148.0	*69.6*
Martin Marietta-Augusta M0472	76-22	3786.0	1420.0	*62.5*

% Loss Difference: 7.1


P0593W
A
B
*No Fibers
-Approved 10/13

SPR 687 – Conclusions, Part 1

Performance:

Raveling: caused by low binder content, oxidation,

Porosity: inadequate compaction, wear and tear.

Delamination: caused by inadequate tack coat, excessive cooling prior to compaction, bonding capability of tack coat, paving over pavement marking

SPR 687 – Conclusions, Part 2

Clogging: caused by sediment – deposits, fat spots – clumps of fibers, high binder content, porosity – gradation selection, over compaction

Drain down: caused by excessive binder content, inadequate fiber content, excessive production temperature, and long haul distances and high temps.

SPR 687 – Conclusions, Part 3

Mix Design:

Continue with SC-T-91 (select binder content),

Check Porosity and Abrasion Resistance with Cantabro – LA Abrasion machine (50 gyration design) – suggest 20% maximum,

Look into designs w/o fibers – use GTR or WMA

Add fines to improve durability and increase overall binder content ..

SPR 687 – Conclusions, Part 4
Dr. Putnam

Thickness Design

- minimum of 1.25 inches or two times largest aggregate (up to ¾" aggregates)
- suggest placement 1.25-1.50 inches

SPR 687 – Conclusions, Part 5
Dr. Putnam

<u>Construction:</u>

- monitor compaction temperature
- 1st load – waste to heat MTV and Paver
- provide more compaction to joints (more roller passes, but careful not to breakdown)
- possibility of increased mix temperature of first few loads, being careful of draindown.
- proper tack coat, trackless tacks?

Old OGFC Spec - Prior to 2019

Sieve	Percent Passing
¾-inch	100
½-inch	85.0 – 100.0
⅜-inch	55.0 – 75.0
No. 4	15.0 – 25.0
No.8	5.0 – 10.0
No.200	0.00 – 4.00
Range for % Binder	5.50 – 7.00

Revised Specification – 2019 to Present
12.5mm Designs- finer to allow more fines for added overall mix durability…

Sieve	Percent Passing
¾-inch	100
½-inch	85.0 - 100
⅜-inch	55.0 -75.0
No. 4	*15.0 – 30.0*
No.8	*5.0 - 15.0*
No.200	0.00 – 4.00
Range for % Binder	5.50 – 7.00

New Specification – 2019 to Present
9.5mm Designs – New to SC – more durable against future scarring and wheel-rim damage…

Sieve	Percent Passing
¾-inch	100
½-inch	95.0 - 100
⅜-inch	80.0 – 100
No. 4	20.0 - 50.0
No.8	5.0 – 20.0
No.200	0.00 – 4.00
Range for % Binder	5.50 – 7.00

Conclusions / Suggestions with OGFC

- Give choice between 9.5mm and 12.5mm
- ***Suggest adding 5-8% of washing screenings to improve durability***
- Use WMA (chemical additive) and PG 76-22
- Specify Porosity ≥ 13.0
- Specify Cantabro ≤ 15.0%
- Require a min of 55° F degree ambient to place OGFC
- Require OGFC Paving Plan – w/ trucking, etc.
- Waste ½-1 load prior to paving to preheat equipment and reduce chances of contamination
- Produce between 225-285°F (250-265° is usually ideal)
- Good tack coat - require PG 64-22 or Hot Polymer Trackless
- Do not over-roll, but ensure its seated to underlying surface
- ***Prevent paver stops at all cost !!!!!!!! Keep moving at all times!***

Ultra-Thin Bonded Wearing Coarse (UTBWC)

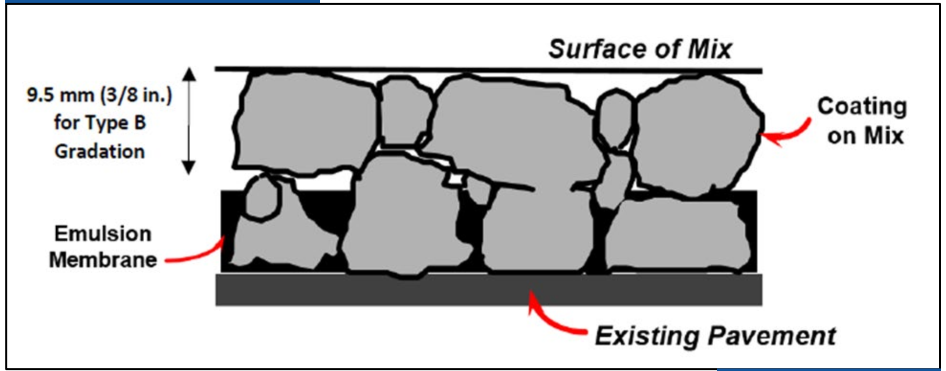
UTBWC Characteristics

- Heavy, polymer-modified asphalt emulsion membrane.
- Placed in 0.4-inch to 0.8-inch lift.
- Gap-graded polymer-modified No. 4 to ½ inch (Nominal Maximum Aggregate Size, or NMAS) hot mix asphalt (HMA).
- Placed using a spray paver in a single pass.

Newly Paved Ultra-Thin Bonded Wearing Coarse (UTBWC) Section

Source: MnDOT 2022

UTBWC Schematic



Source: MnDOT 2018

UTBWC Background

- Proprietary system originally developed in France in 1986.
- Successfully used in Europe as preventive maintenance and surface rehabilitation technique.
  - Restoring skid resistance.
  - Sealing the surface.
- First sections of UTBWC in the US were placed by Mississippi, Alabama, and Texas DOTs in the early 1990s.
- Over the years, optimized materials and construction processes.
- Several DOTs have used UTBWC (under varying names) and have a current standard or special specification.

Paver placement of UTBWC

Source: Asphalt Surface Technologies Corp

UTBWC Terminology

- Minnesota DOT (MnDOT)
  - Ultra-thin bonded wearing course (UTBWC)
- Pennsylvania DOT (PennDOT)
  - Mixture: Ultra-thin wearing course (UTWC)
  - Emulsion: Ultra-thin wearing course emulsion membrane (UTWCEM).
- California DOT (Caltrans)
  - Bonded wearing course (BWC)

Placement of UTBWC

Source: MnDOT

Benefits of UTBWC

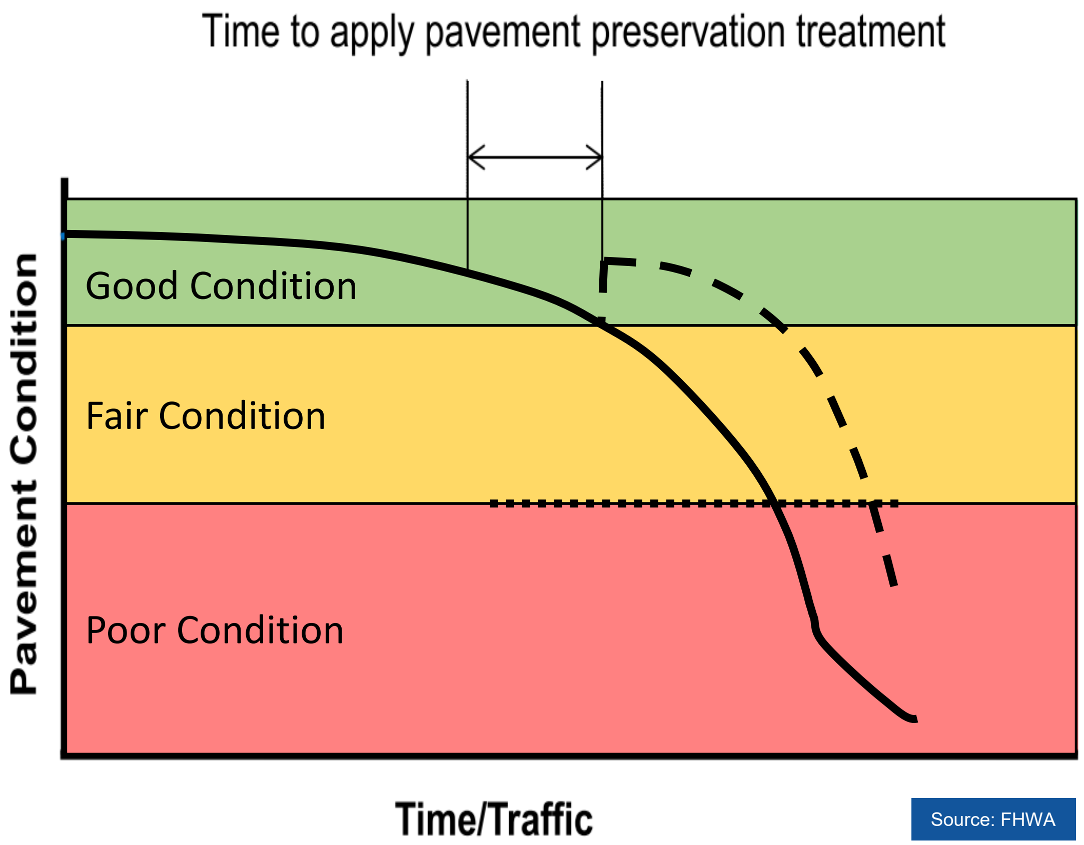
- Appropriate for State highway systems with high traffic volumes.
- Renews the road surface, provides a good surface treatment and extends pavement life.
- Minimizes impact on traffic with shorter lane closures.
- Adds service life to the pavement without a significant change in profile grade.
- Few curb and clearance adjustments needed due to thin application.
- Can be used on HMA and portland cement concrete (PCC) surfaces.

Benefits of UTBWC, Continued

- Can reduce tire-pavement noise.
- Helps maintain ride quality improvements.
- High macro-texture and open surface can improve safety and reduce back spray and splash.
- Slows down traffic and weather-related pavement deterioration.
- Resists cracking by sealing low-severity cracks.
- Resists rutting with stone-on-stone contact between aggregates.
- Improved wear resistance due to the use of high-quality aggregates.

UTBWC Design and Planning

- Project selection criteria.
- Pavement and asset evaluation.
- Pavement design, thickness criteria, and repair strategies.
- Cost and benefit-cost ratio.
- Other considerations.

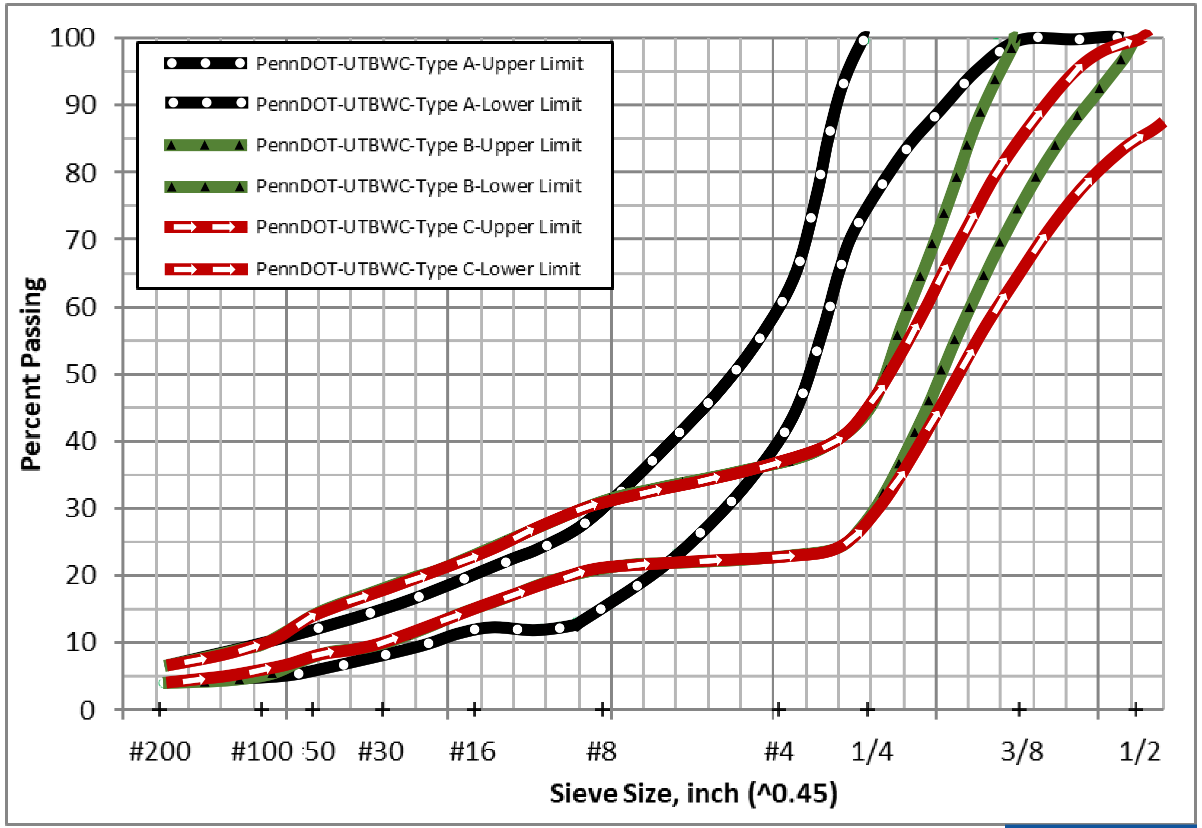


Source: FHWA

UTBWC Materials and Mixture Properties

- Asphalt emulsion membrane.
- Aggregates.
- Asphalt binder.
- Recycled materials and additives.
- Mixture design.
- Specifications.

Design Band Gradations – PennDOT



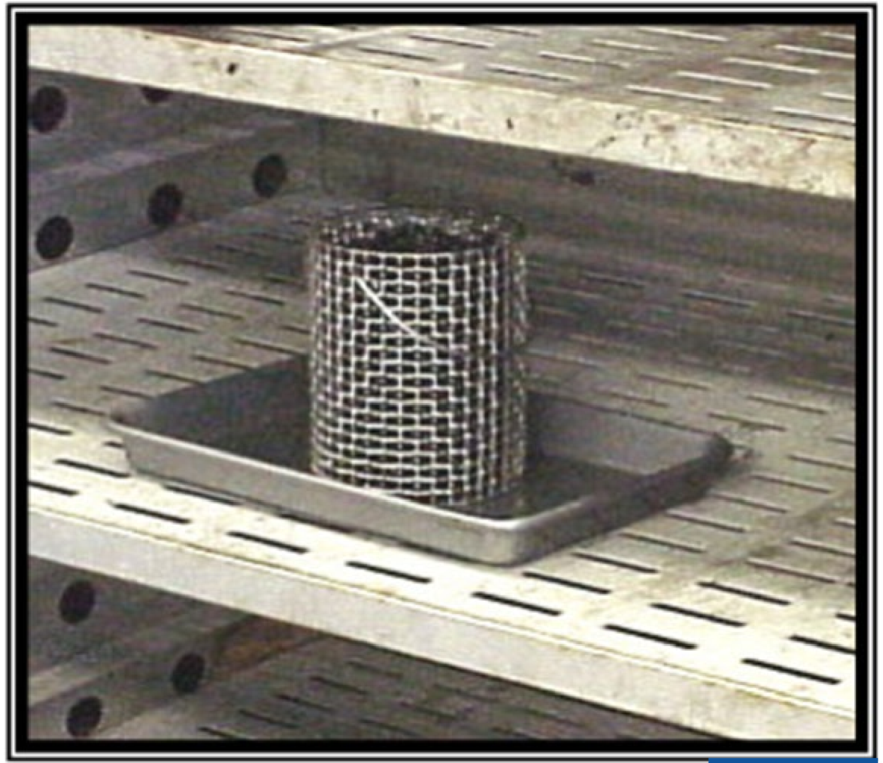
Source: PennDOT

UTBWC Materials and Mixture Properties, Continued

Processes vary by State DOT. Some State requirements include:

- Asphalt content
- Draindown test
- Lottman (tensile strength ratio, or TSR)
- Film thickness

Draindown Testing



Source: InDOT

UTBWC Production and Construction Practices

- Materials.
- Production, storage, and transportation.
- Surface preparation.
- Placement and compaction.
- Quality control (QC requirements.
- Successful practices.

Material Transfer Vehicle (MTV) and Spray Paver

Source: Asphalt Surface Technologies Corp.

Spray Paver

- Combines tack (or another bonding agent) distributer and paver.
- Bonding agent and HMA placed in one pass.
- Improved bonding since there are no opportunities to track dirt and debris onto tack/bonding or pickup tack/bonding on construction equipment.

Spray Paver – Emulsion and HMA in one pass

Source: Arrmaz (2016)

More Information About TOPS

- Stay tuned for more TOPS resources at https://www.fhwa.dot.gov/pavement/tops/
  - Asphalt resources: https://www.fhwa.dot.gov/pavement/tops/asphalt_resources.cfm
  - Concrete resources: https://www.fhwa.dot.gov/pavement/tops/concrete_resources.cfm

Minnesota DOT Case Study

About the Presenter, Jerry Geib

- **Jerry Geib** works as a Research Operations Engineer for the Minnesota Department of Transportation.
- 23-year career at MnDOT
- Research Engineer, Pavement Preservation Engineer, and Pavement Design Engineer
- Works on developing specifications and guidelines, and providing training and assistance
- Member of the Emulsion Task Force
- Jerry works on “Keeping the Good Roads – Good.”

EDC6 TOPS
UTBWC in Minnesota

MnDOT

Safer, Smarter, Sustainable Pavements through Innovative Research

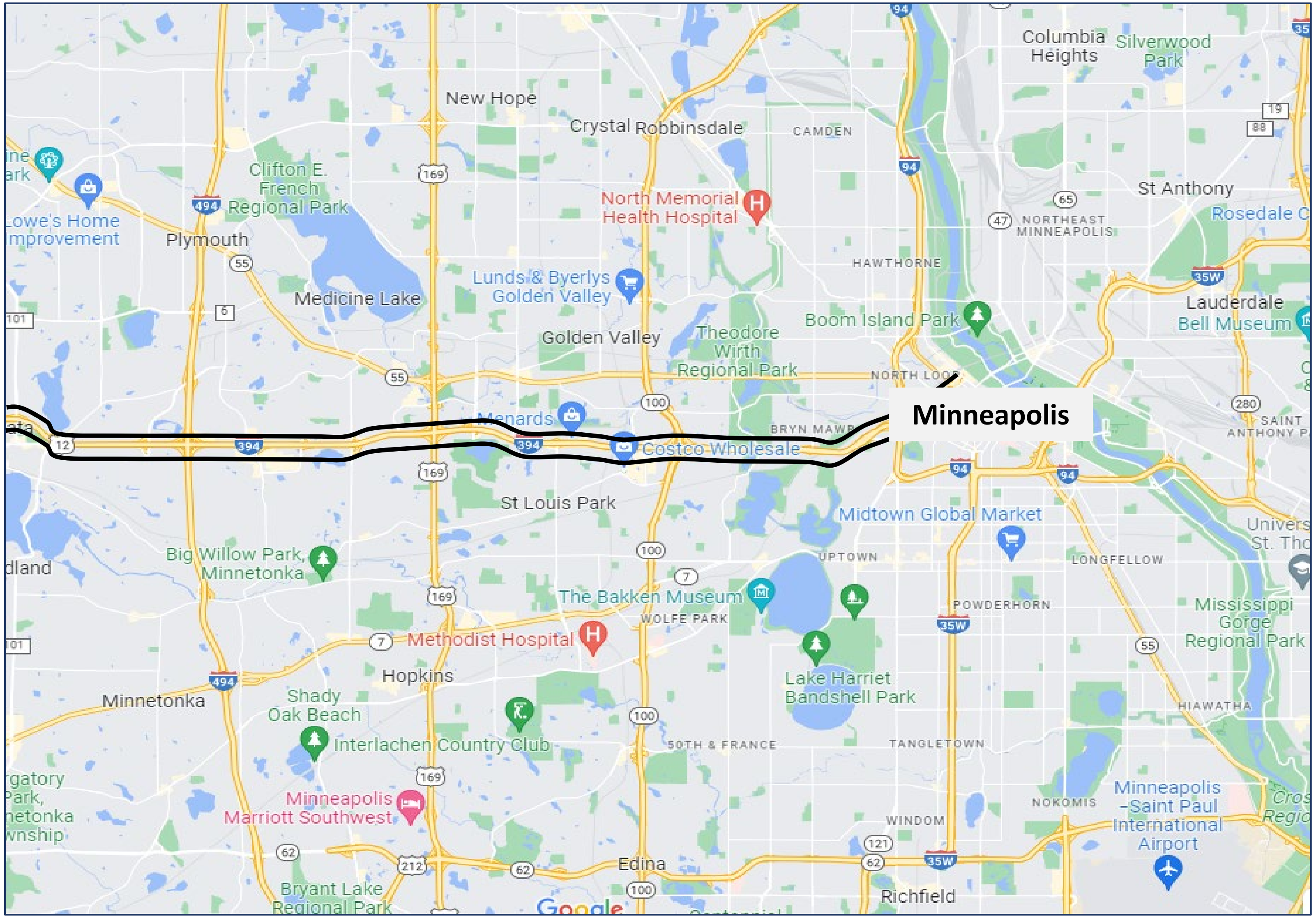
MnROAD
Safer, Smarter, Sustainable Pavements Through Innovative Research
DEPARTMENT OF TRANSPORTATION

NRRA
National Road Research Alliance
Strategic Implementation Through Cooperative Pavement Research

Purpose

- *MN UTBWC – My Favorites*
  - *I-394 - Minneapolis*
  - *MN 36 – earliest, 5 years*
  - *US 169 - oldest*
  - *MnROAD - when New*
  - *D7 (southwestern) – snow*
  - *On PCC*

I-394



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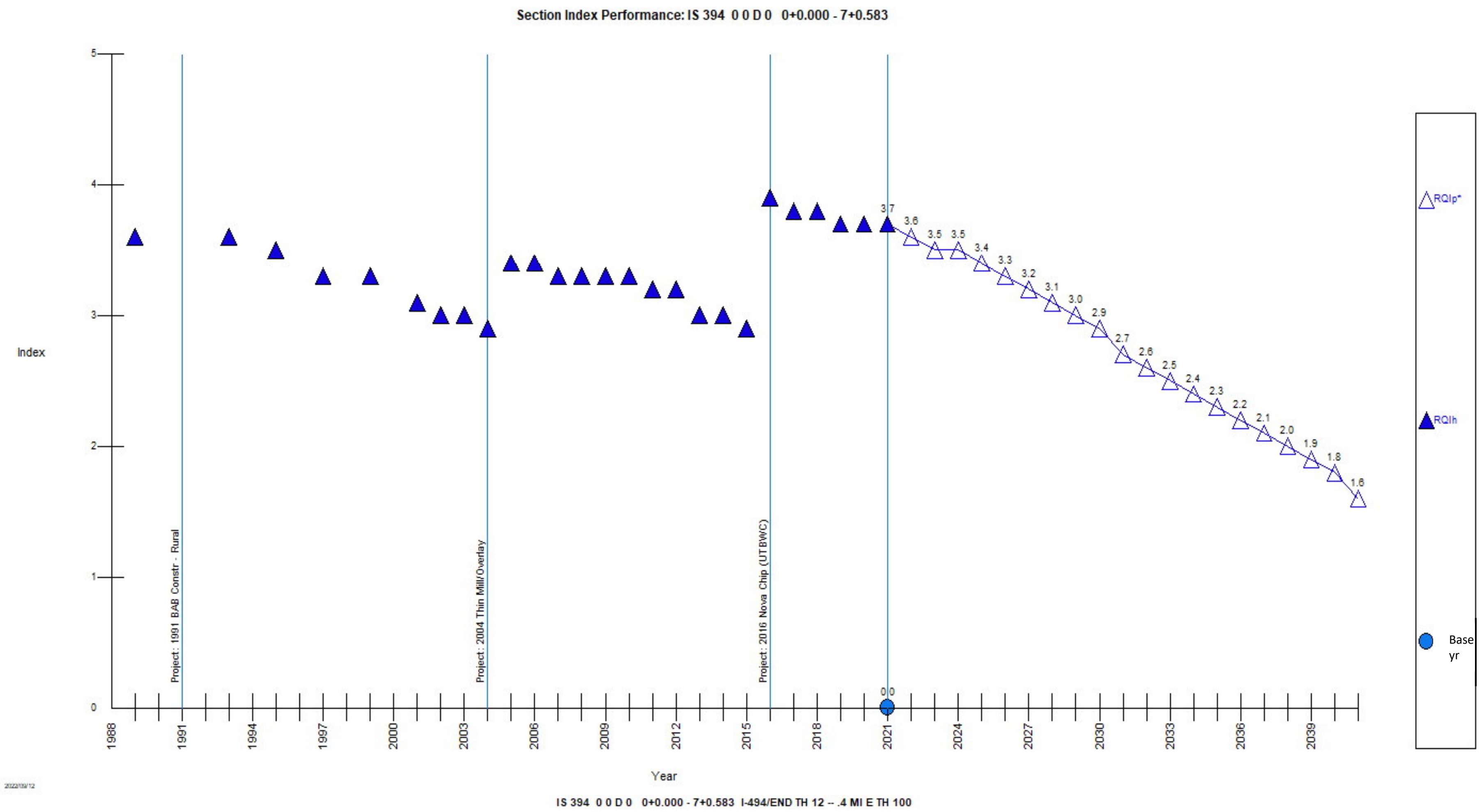
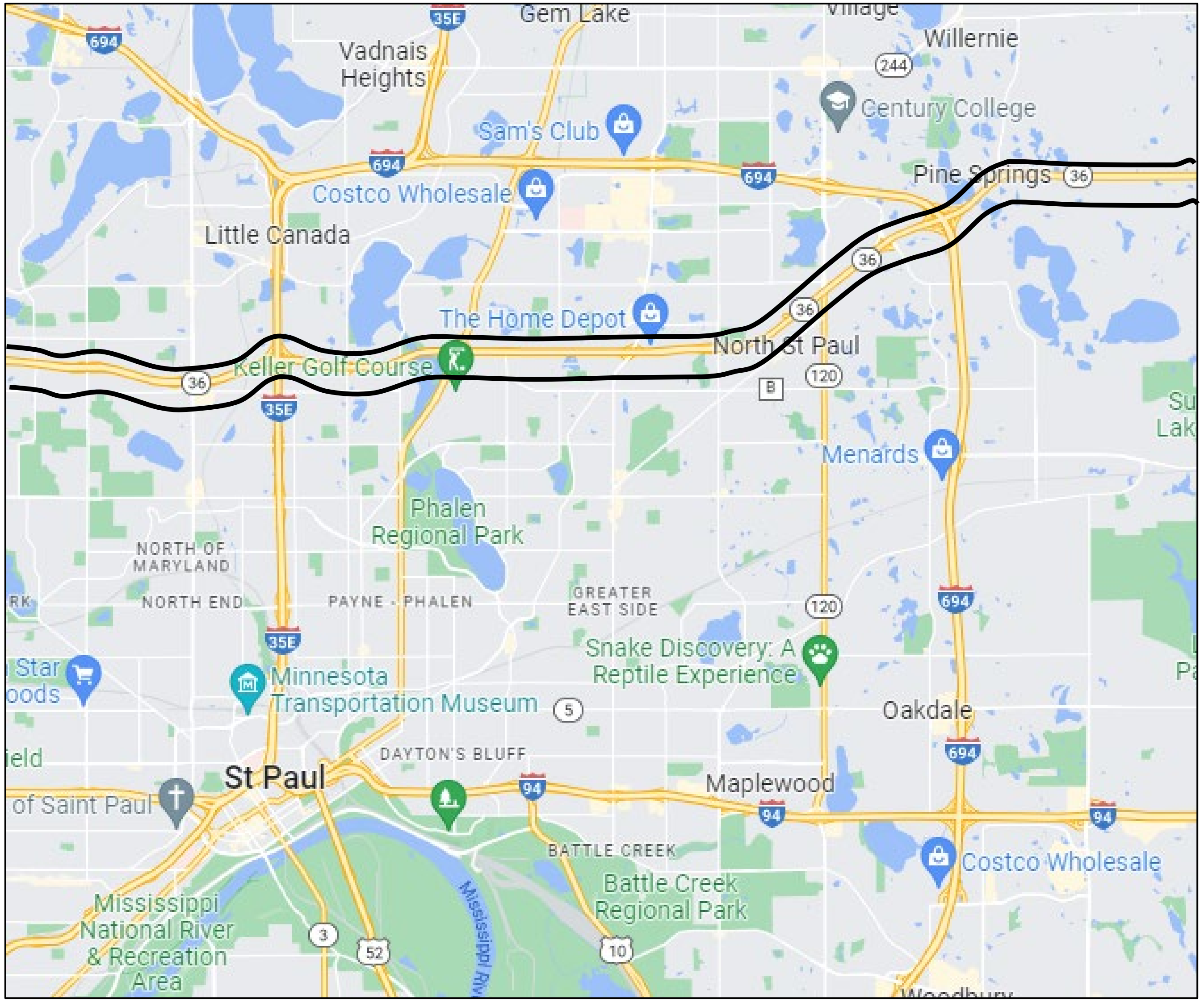
I-394, Continued

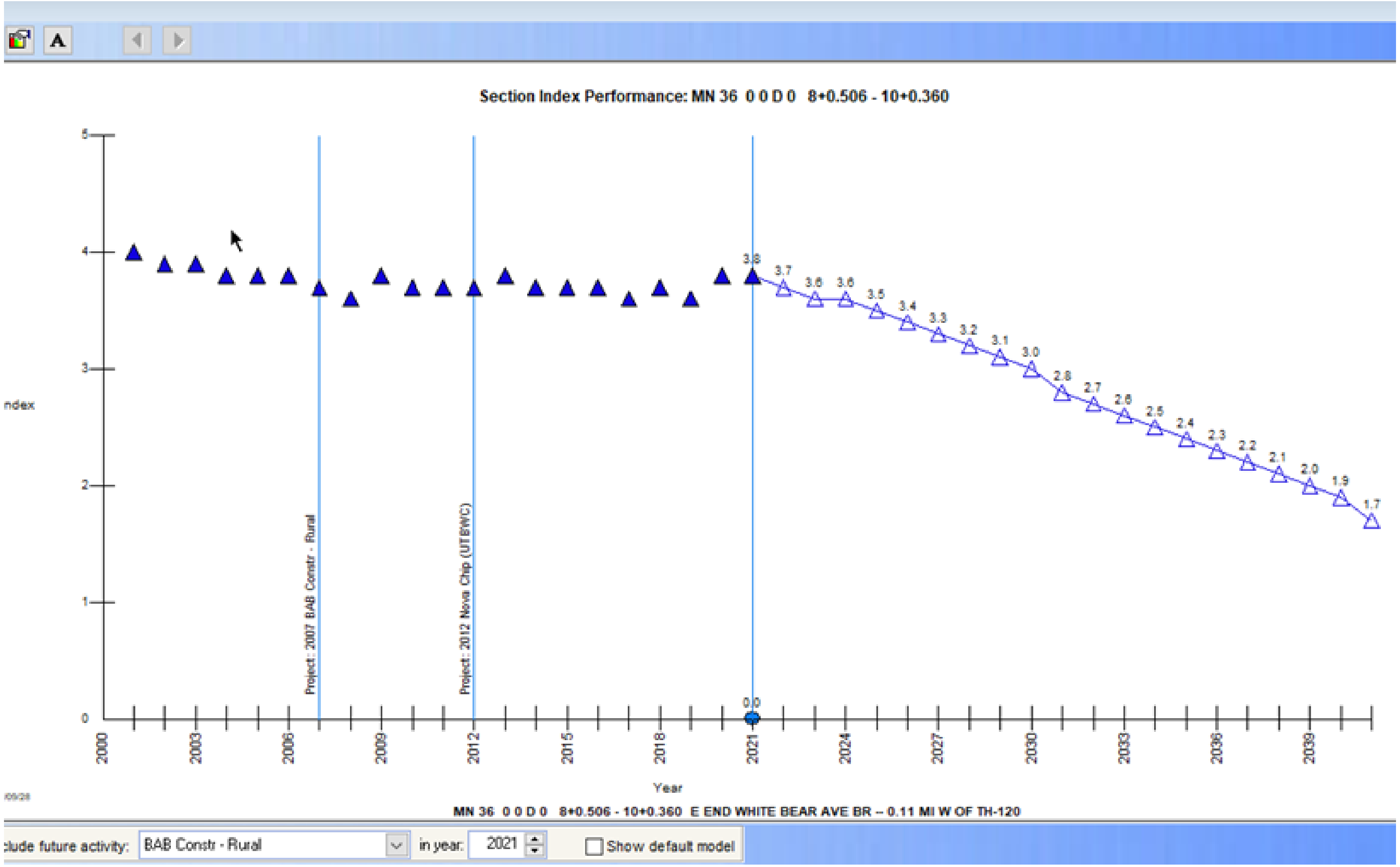


MN 36



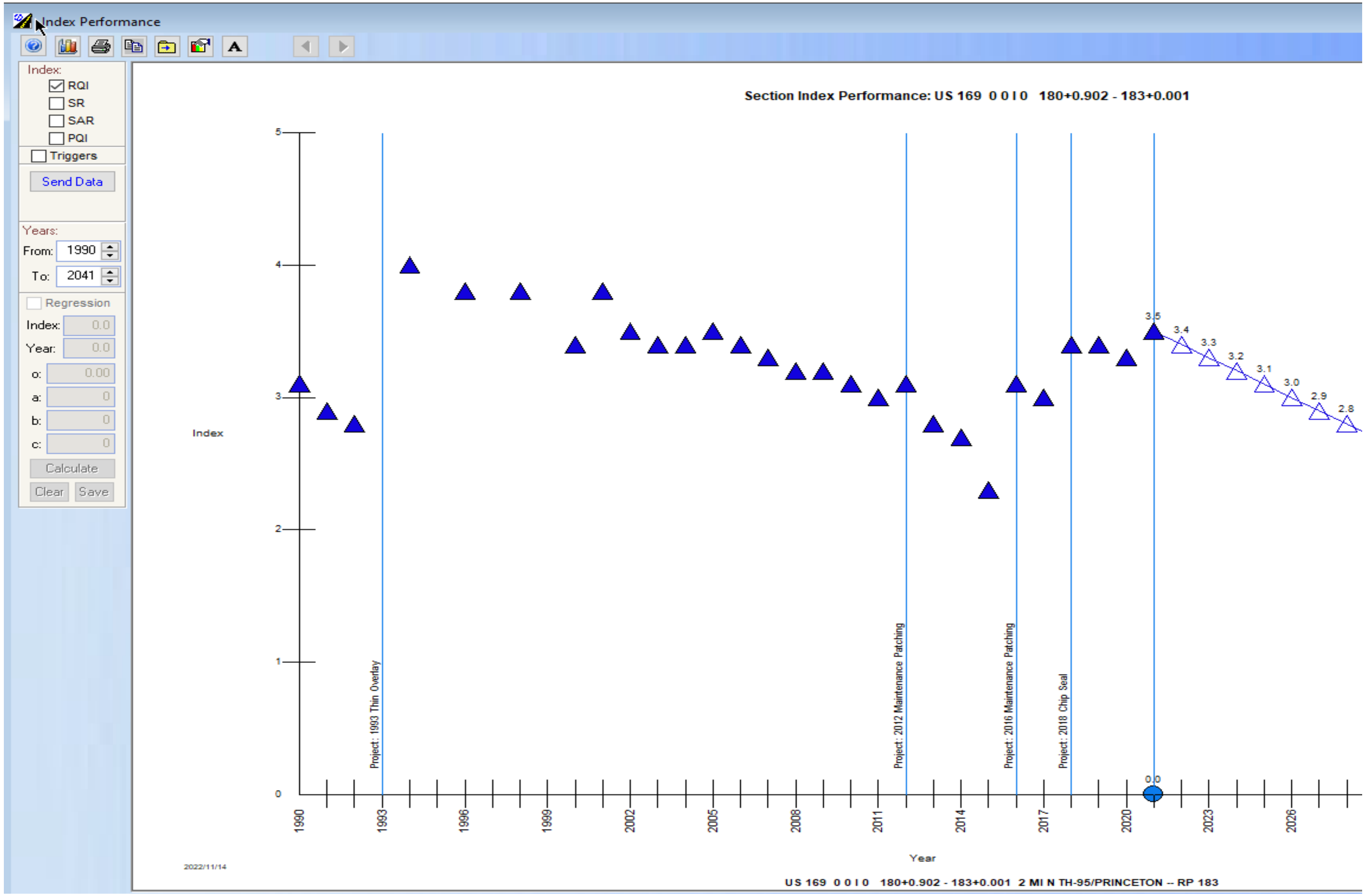
Gem Lake
Vadnais Heights
Willernie
Century College
Sam's Club
Costco Wholesale
Pine Springs
Little Canada
The Home Depot
North St Paul
Keller Golf Course
Menards
Phalen Regional Park
NORTH OF MARYLAND
NORTH END
PAYNE - PHALEN
GREATER EAST SIDE
Snake Discovery: A Reptile Experience
Minnesota Transportation Museum
Oakdale
DAYTON'S BLUFF
St Paul
Maplewood
BATTLE CREEK
Costco Wholesale
Battle Creek Regional Park
Mississippi National River & Recreation Area

MN 36, Continued



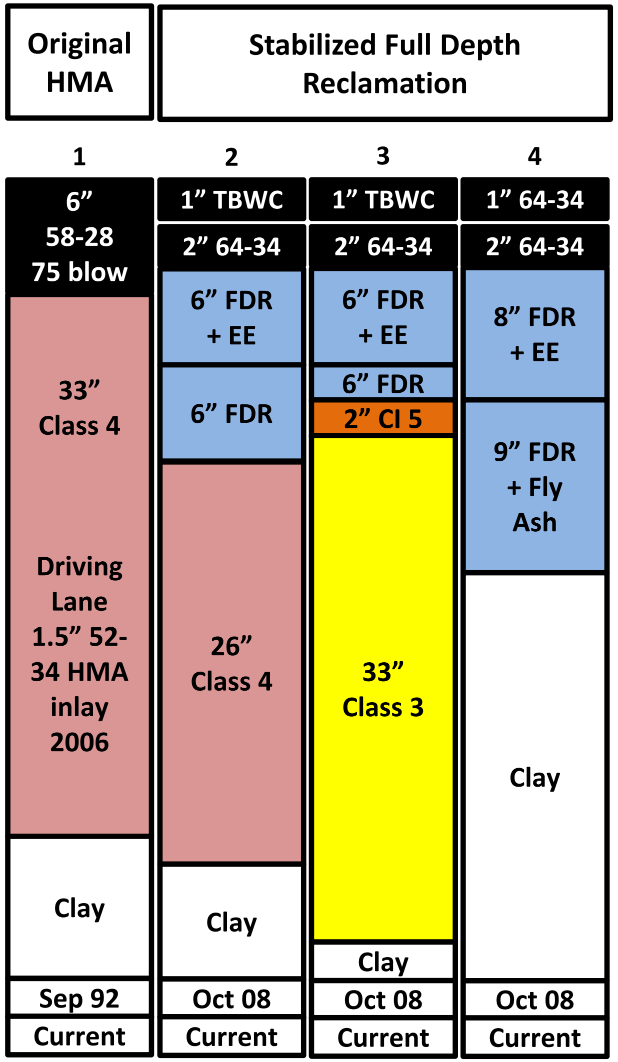
DEPARTMENT OF TRANSPORTATION

US 169



DEPARTMENT OF TRANSPORTATION

MnROAD



DEPARTMENT OF TRANSPORTATION

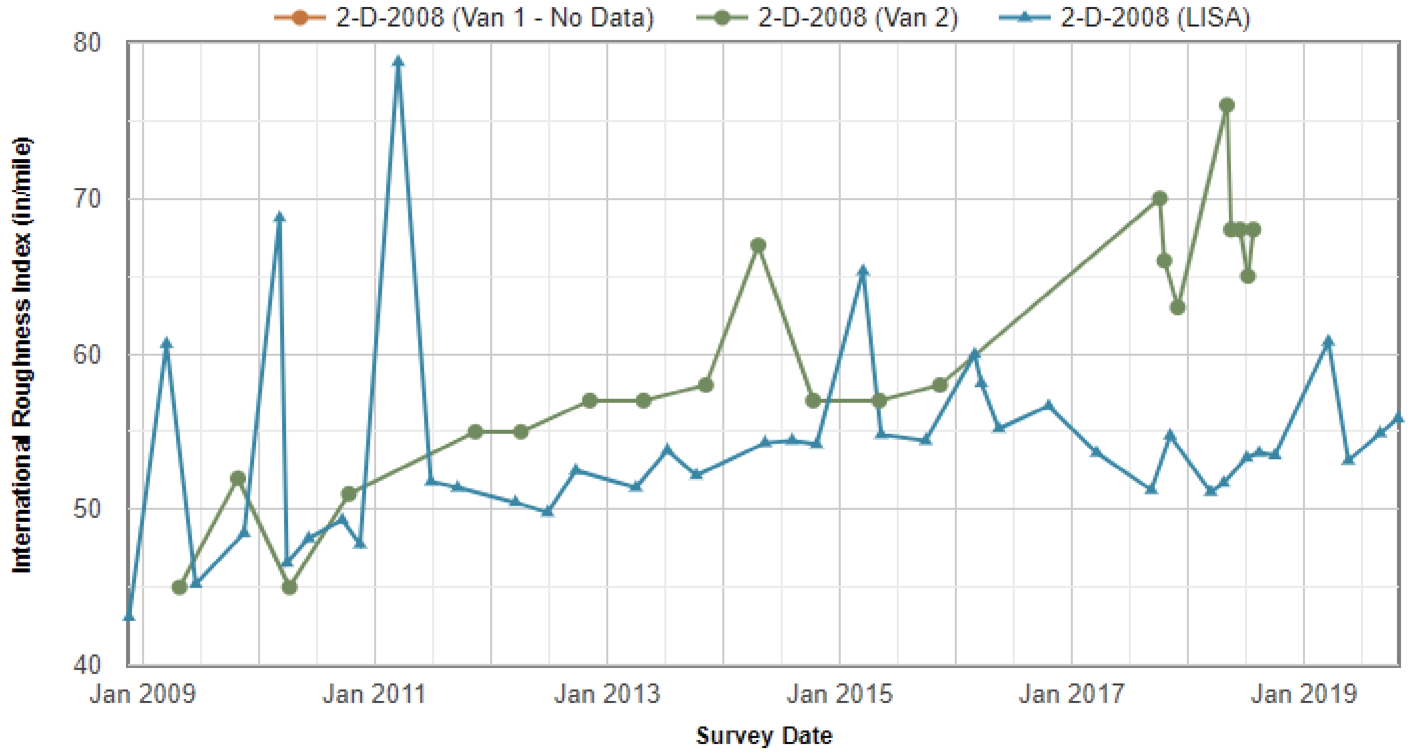
Roadway: MnROAD Mainline - Interstate 94 Section: 2-D-2008

Select Sections for Comparison

		Select	Select	Select
Roadway	MnROAD Mainline - Interstate 94			
Section	2-D-2008			

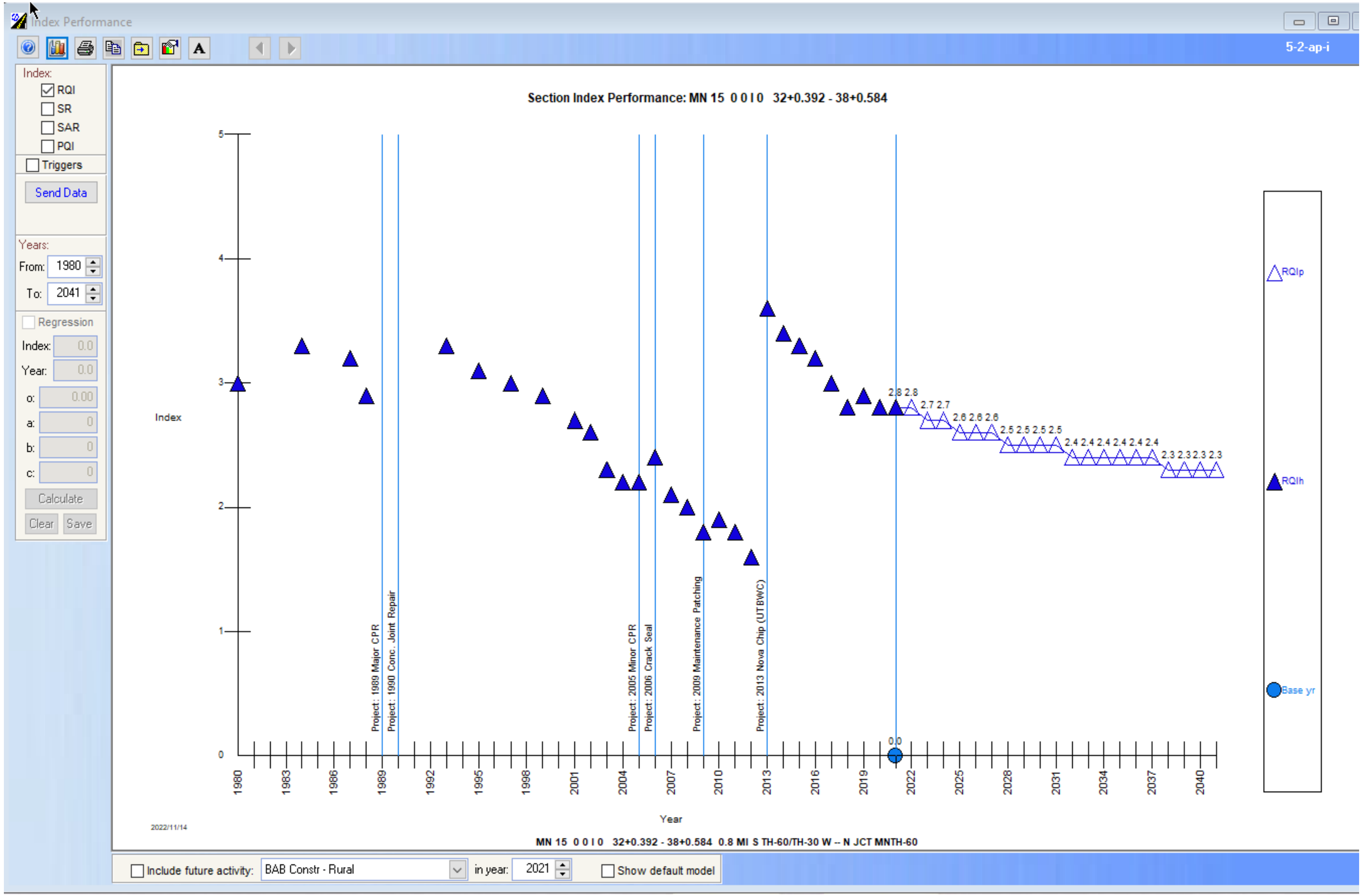
International Roughness Index (IRI)

Horizontal Axis Type: Survey Date



DEPARTMENT OF TRANSPORTATION

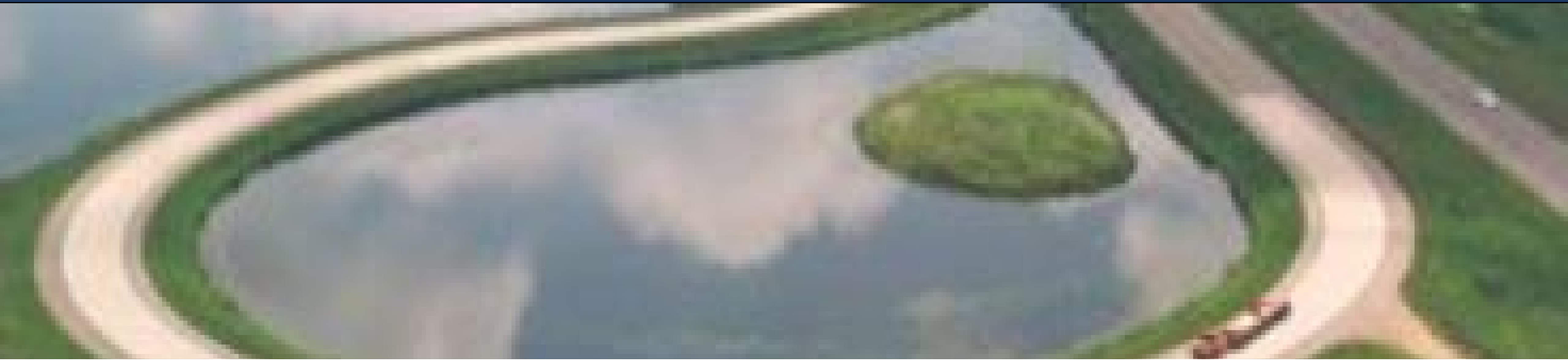
MN 15



Index Performance
5-2-ap-i
Index:
RQI
SR
SAR
PQI
Triggers
Send Data
Years:
From: 1980
To: 2041
Regression
Index: 0.0
Year: 0.0
Calculate
Clear
Save
Section Index Performance: MN 15 0 0 1 0 32+0.392 - 38+0.584
Index
Year
Project : 1989 Major CPR
Project : 1990 Conc. Joint Repair
Project : 2005 Minor CPR
Project : 2006 Crack Seal
Project : 2009 Maintenance Patching
Project : 2013 Nova Chip (UTBWC)
RQIp
RQIh
Base yr
2022/11/14
MN 15 0 0 1 0 32+0.392 - 38+0.584 0.8 MI S TH-60/TH-30 W -- N JCT MNTH-60
Include future activity: BAB Constr - Rural
in year: 2021
Show default model

“It was not our wealth that made our highways possible; rather it was our highways that made our wealth possible”,

Thomas Harris McDonald
Commissioner of Public Roads
1939 – 1953



Jerry Geib
jerry.geib@state.mn.us

NRRA National Road Research Alliance
Strategic Implementation Through Cooperative Pavement Research

MnROAD
Safer, Smarter, Sustainable Pavements Through Innovative Research
mn DEPARTMENT OF TRANSPORTATION

Q & A

Open-Graded Friction Course (OGFC)

Ultra-Thin Bonded Wearing Course (UTBWC)

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