National Center for Asphalt Technology NCAT at AUBURN UNIVERSITY

MnROAD Safer, Smarter, Sustainable Pavements Through Innovative Research

DEPARTMENT OF TRANSPORTATION

NRRA National Road Research Alliance

Introduction, Overview, and Update for NRRA (along with) Plans for the Next Phase of MnROAD Research Including 2022 Reconstruction with NCAT Additive Group

Ben Worel

SEVENTH RESEARCH CYCLE

NCAT TEST TRACK CONFERENCE

MnROAD Background

- **MnROAD Owned and Operated by Minnesota DOT**
- **Comprehensive Pavement Research**
- **30 Years of Long-Term Customer Service**
  - Minnesota Department of Transportation
  - Minnesota Local Road Research Board
  - SHRP II / NCHRP / FHWA / Partnerships
  - Pooled Funds Efforts (States) / Industry
- **Major Experiments**
  - Phase I (1994-2006)
  - Phase II (2007-2016)
  - Phase III (2017-2022) – NRRA/NCAT Efforts
  - Phase IV (2022) – NRRA/NCAT Efforts
- **MnDOT $4 million Construction**
  - Support 2022 MnROAD Mainline Interstate Partners

NRRA National Road Research Alliance

LRRB

National Center for Asphalt Technology NCAT at AUBURN UNIVERSITY

DEPARTMENT OF TRANSPORTATION

MnROAD / NCAT Partnership Updates

Formalized Partnership working on National Needs:

- Full scale accelerated test facilities
- North / South Climatic Zones / Sections
- CAPRI (NCAT Lead National HMA Consortium)

Preservation Group Experiments

- 6 year of partnership with over 20+ agencies – **Extend 2 years**
- **Requesting Participating States to fund efforts for 5 years**
- Life extending benefits of pavement preservation techniques

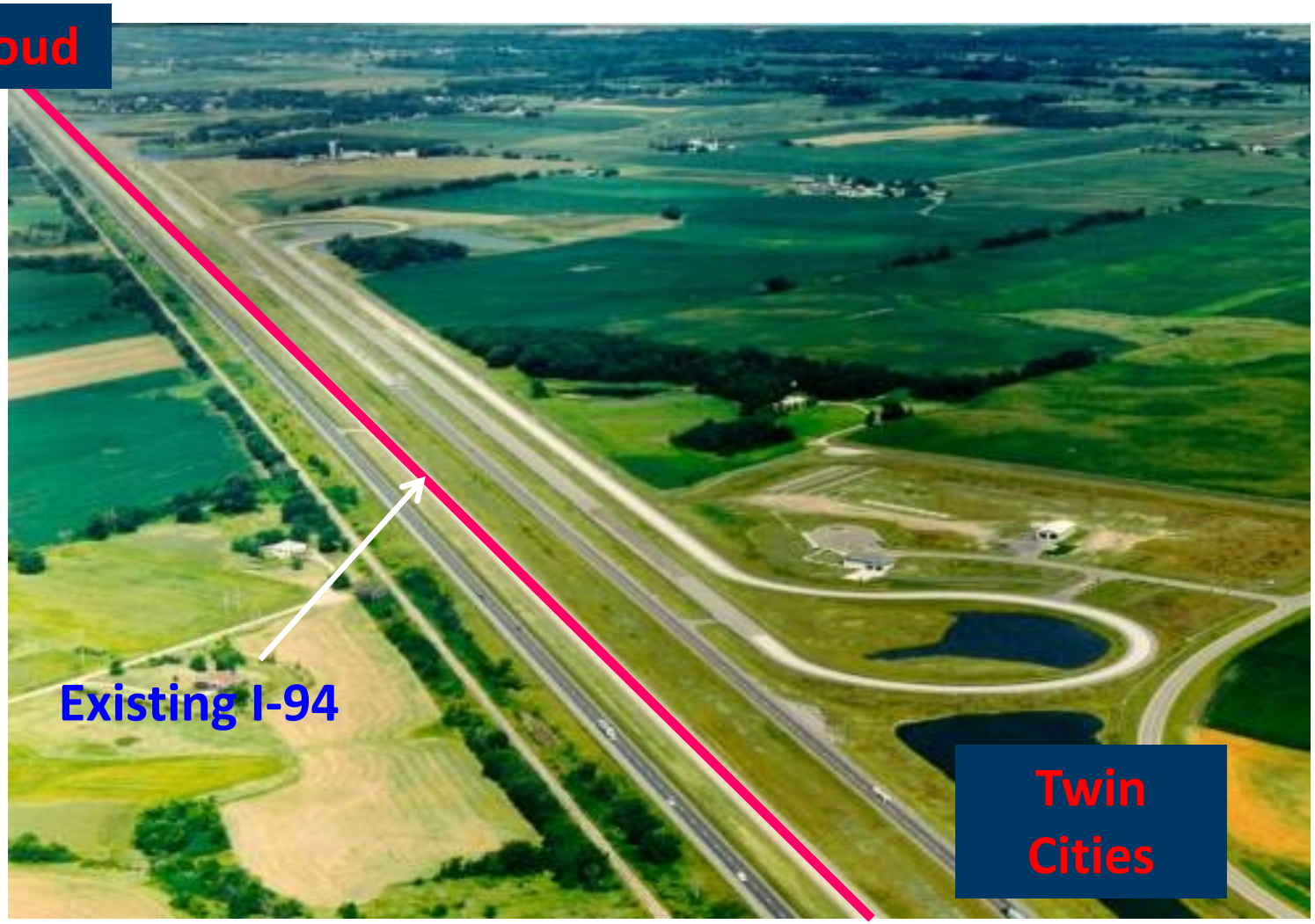
Cracking Group Experiments

- 6 year of partnership with 10 Government Agencies – **Ends 2021**
- HMA cracking test for LTC and fatigue cracking

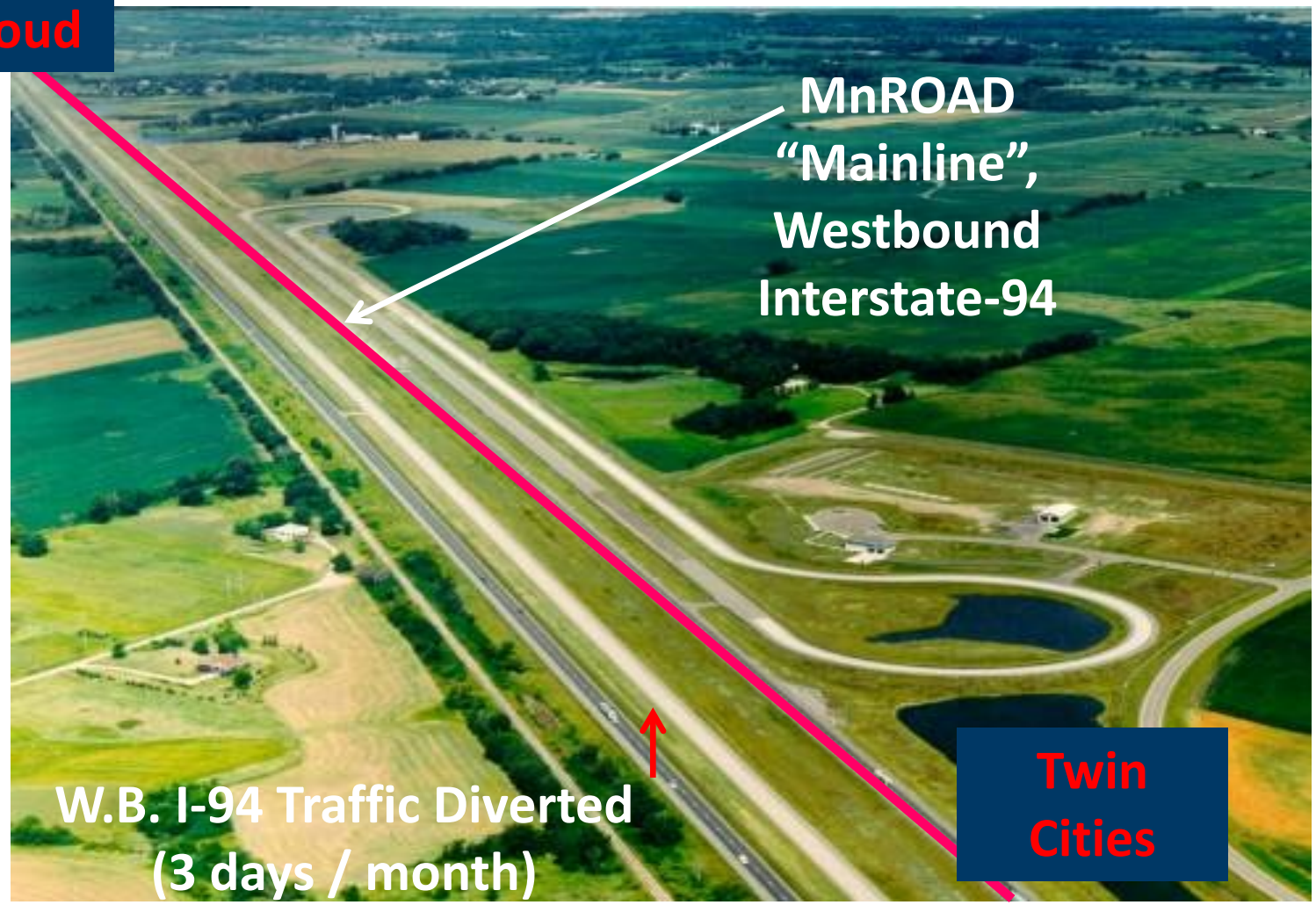
Additive Group Experiment

- Need a process to understand additive benefits
- NCAT focus on fatigue cracking
- **MnROAD focus on LTC and Reflective Cracking – Starting in 2021**
- Continued National Research Coordination

MnROAD I-94 Old Westbound (Started 2010)



MnROAD Mainline (Started 1994)



MnROAD Low Volume Road (Started 1994)

MnROAD and Minnesota Test Sections

MnROAD Overall Studies

- **39 unique ongoing studies**
- **161 unique test sections**

Interstate 94 Westbound

- **Mainline (3.5 miles)**
  - 12 ongoing studies / 44 test sections
- **Old Westbound (3.5 miles)**
  - 4 ongoing studies / 48 test sections

Low Volume Road

- Local Road Research Board
- (MN - City and Counties)
- 19 Studies / 49 test sections

Additional Offsite Test Sections

- Partnership - National Center Asphalt Technology (NCAT)
- 50 Test Sections south of Milaca – US-169 and CSAH-8
- Emily, MN

MnROAD Traffic Loading

Low Volume Road

5-axle Tractor-Trailer Truck

Inside Lane – 80K (5 days/week)

Outside Lane - Environmental

Rigid ~ 25,500 ESALs/yr

Flexible ~ 16,000 ESALs/yr

Interstate Mainline

I-94 WB Public Traffic

29,700 AADT -- 13% HCAADT

(2013)

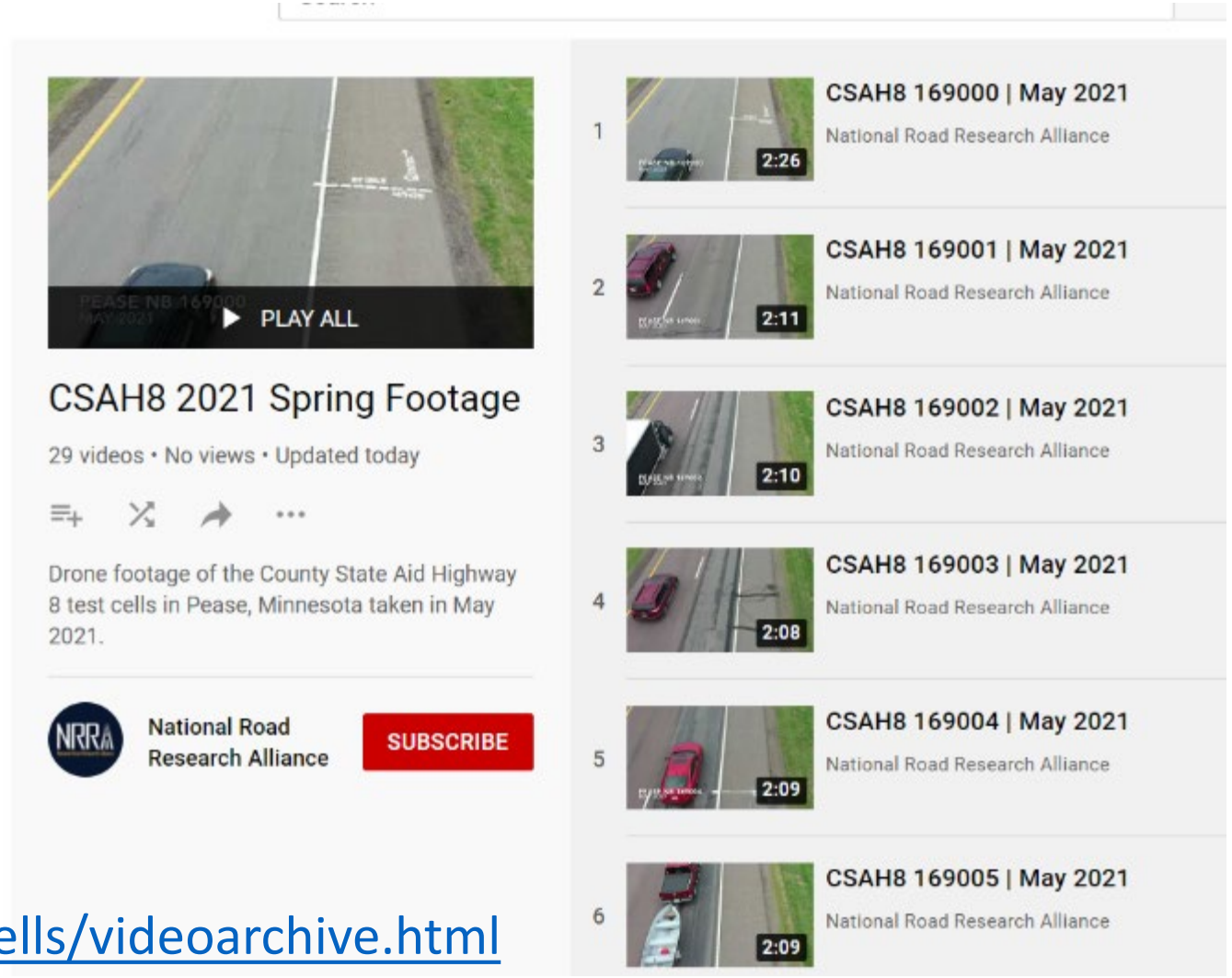
Rigid ~ 1.2 Million ESALs/yr

Flexible ~ 0.8 Million ESALs/yr

MnROAD Virtual Tours Online

MnDOT Aeronautics has begun bi-annual video recordings of all our test sections!!!

- Videos posted online
- MnROAD + Pease, TH6, & 70th Street



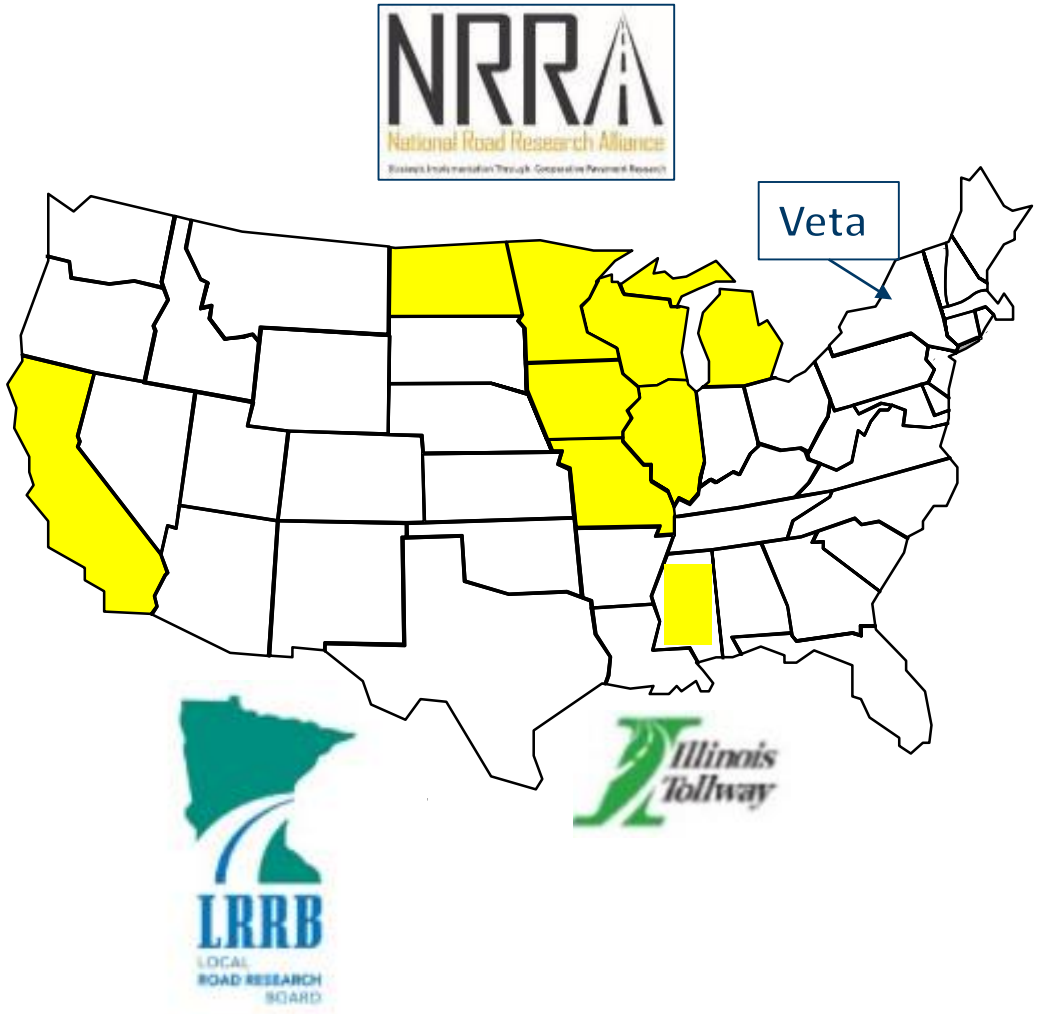
- http://www.dot.state.mn.us/mnroad/test-cells/videoarchive.html

MnROAD and Internal MnDOT Research HMA Efforts

- Coreless Asphalt Density Measurements (Dr. Shongtao Dai and Dr. Kyle Hoegh)
  - MnDOT DPS – Density Profiling System
- Road Doctor (integrated pavement monitoring vehicle)
  - Dr. Eyoab Zegeye
- Simplified Wedge Splitting Test (SWST)
  - Benefits/accuracy of DCT with simplified fab.
  - Dr. Shongtao Dai and Dr. Eshan Dave (UNH)
- Impact of moisture in granular layers
  - Dr. Raul Velasquez

National Road Research Alliance Overview

- NRRA Phase-I (Feb 2016 – Feb 2021)
  - 40 Projects & Research @ ~$4,700,000
    - 21 Different Contractors
- Organizational Structure
  - Executive Committee (2 representatives)
  - 5 Technical Teams (Flexible, Rigid, ICT, PM, Geotechnical)
  - Monthly Research Pays off Seminars
- NRRA Phase-II (Jan 2021 – Dec 2025)
  - Pooled Fund - TPF-5(466)
    - NRRA and Veta combined
  - 11 Government Agencies
  - 65+ Associate Members
  - MnDOT utilize 4 million for 2022 MnROAD construction



NRRA | National Road Research Alliance

AGENCY MEMBERS

Caltrans · Illinois Tollway · Iowa DOT · MDOT · Minnesota Department of Transportation · LRRB · MnDOT · MoDOT · Nebraska Department of Transportation · NDDOT · Wisconsin Department of Transportation

ASSOCIATE MEMBERS

3M · Aggregate & Ready Mix Association of Minnesota · All States Materials Group · American Engineering Testing, Inc. · APA – The Engineered Wood Association · ARRA · BASF · Bioresstor · Braun Intertec · CAL STATE LA · Cargill · CAT

Collaborative · DOW · Flint Hills Resources · Geophysical Survey Systems · HeadLight · HELIX · Husky Energy · InfraSense · ingios · Iowa State University · Leica Geosystems

Liberty · Mathy Construction Co. · Michigan State University · Michigan Tech · MnDOT · Minnesota Paving & Materials · Minnesota State University · MOBA · NAPA – National Asphalt Pavement Association · National Center for Asphalt Technology – NCAT

Owens Corning · Payne & Dolan, Incorporated · RoadScanners · Surface Tech · TestQuip · Texas State University · Topcon · Trimble · UCPRC

UMD – Swenson College of Science & Engineering · University of Minnesota – Driven to Discover · University of New Hampshire · UND – North Dakota · University of Pittsburgh · University of St. Thomas · UTEP · Wirtgen Group · WCPA · wsb

National Road Research Alliance
Phase-I/Phase-II Funding Summary

		Phase-I			Phase-II	
Agency Travel		33,108	1%		50,000	1%
Construction Inspection/Sensors		324,848	7%		350,000	7%
Communication		125,000	3%		-	0%
MnROAD Data Collection		800,338	17%		800,000	16%
Research Projects						
	Regular	2,210,816	46%	74%	2,125,000	43%
	Call of Innovation	1,146,080	24%			
	State	207,677	4%			
	ICT Directed				1,375,000	28%
Database - Infopave quote					300,000	6%
		4,847,867			5,000,000	

2022 MnDOT Funding for Construction - $4 million

FHWA Partnerships (Carbon Cure and ICT Efforts)

Partnership to NCAT Additive Study

Open to other materials and study partners

Completed/Ongoing NRRA Flexible Team Projects

- Developing Best Practices for Rehabilitation of Concrete with Hot Mix Asphalt (HMA) Overlays related to Density and Reflective Cracking
  - University of New Hampshire – Dr. Eshan Dave and Katie Haslett
- HMA Mix Rejuvenator Test Sections
  - University of New Hampshire – Dr. Jo Sias
- Other NRRA research projects on:
  - CCPR, bitumen compatibility, polymers impact on IDEAL-CT/ I-FIT, rej, etc.
- Short Syntheses
  - Tack Coats, Longitudinal Construction Joints, HMA Mix Rejuvenators

http://dot.state.mn.us/mnroad/nrra/structure-teams/flexible/index.html

NRRA 2021 MnROAD Projects

- **<u>MnROAD's first "Plastic Road"</u>**

Cold-inplace-Recycling (CIR) using NEO by Technisoil https://neopave.com/

- **Unique partnership only possible through NRRA**
  - CAT- milling and paving of HMA control + prep work
  - Midstate- mix-design, CIR construction
  - MnROAD – instrumentation, monitoring (performance + environmental), and characterization (lab + structural)

Instrumented patch under future plastic CIR

NRRA 2021 MnROAD Projects

- **<u>NRRA PM Team Spray-Rejuvenator Project</u>**
- 15 test sections evaluating 12 spray rejuvenator products on local street and MnROAD LVR
  - Bio-based and petro-based
  - Untreated control, Chip Seal, Fog Seal
- **Unique partnership only possible through NRRA**
  - CAT- paving of MnROAD LVR sections
  - MnDOT partnership with city of St. Michael
    - Treatments applied to and monitored on local road
  - MnROAD – performance monitoring
  - NRRA PM Team
    - Dr. Raquel Moraes at NCAT
  - Minnesota Local Road Research Board
    - Dr. Emin Kutay at Michigan State

National Road Research Alliance
Phase-II Philosophy

Sustainability

- Minimize the impact on the climate and environment
- Reduce greenhouse gas emissions
- Improve the resilience of our transportation system
- Promote public health and healthy communities

Intelligent Construction

- Supporting Veta
- Industry and state lead innovations
- Dedicated Funding

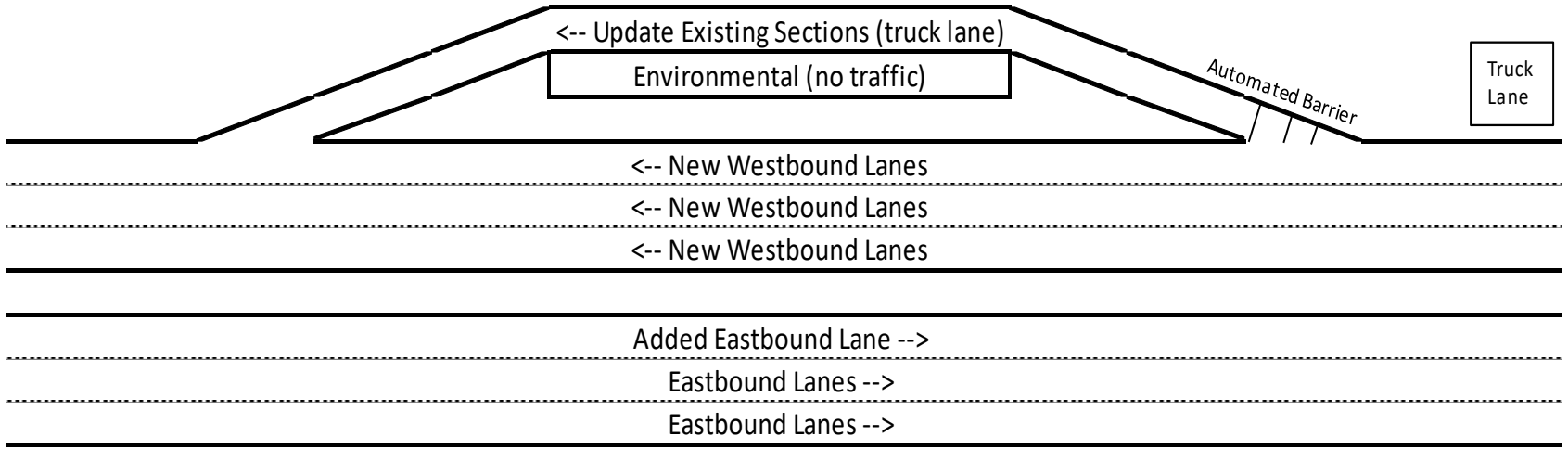
National Road Research Alliance Timeline

April 27, 2021	NRRA Phase-II Items Approved
June 2021	NRRA Teams Develop Mainline Plan MnROAD will make initial suggestion
July 2021	Research Contracting Send out Research RFPs
August/September 2021	NRRA Teams Develop Sensor Plans
September 2021	MnDOT Construction Plan Development for Feb 2022 Letting
October 2021	Researchers Onboard
May 2022	MnDOT Construction Plan Development for Feb 2022 Letting

Real-Estate Available

Real-estate Available

- 3.5 Mile - Interstate Mainline
  - ~85% Open for ideas
  - ~2025 3-Lane expansion on I-94
- 2.6 Mile - Low Volume Road Loop
  - ~60% Open for ideas
  - Expect 77-79 (3 cells) for MidState CIR
- Additional Offsite Public Test Roads

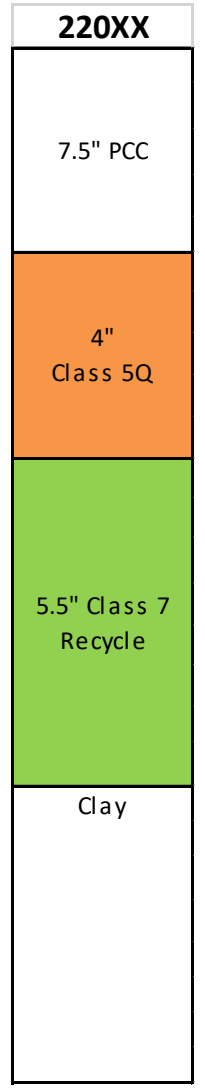


National Road Research Alliance
Phase-II Research / Test Sections (Rigid Team)

2022 MnROAD Construction

- 16 Test Sections Locations – Rigid Team working on mixes
  - 7.5” PCC / 9.5 ” granular base
  - 15’ joint spacing / 13’ wide / ~250 test sections

$760,000 Research Funding



#1 Reduced Cement Content

- How to use natural and recycled pozzolans without compromising the resiliency and durability of the concrete?

#2 Use of Carbon Dioxide for Sustainable and Resilient Concrete Pavements + FHWA Partnership

- Testing additional sustainable CO_2 utilization technologies

#3 Alternative Cementitious Materials – Geopolymer Concrete

- Geopolymer concrete involves combining an alumina-silica rich material such as fly ash, slag or calcined clay with an alkali activator such as sodium hydroxide (NaOH) to produce mixture without compromising the resiliency and durability of the concrete.

National Road Research Alliance
Phase-II Research / Test Sections (Flexible Team)

2022 MnROAD Construction

$150,000 Research Funding

- 2 Perpetual Pavement Designs in WI (Deep Strength and PerROAD)
- 2 Perpetual Pavement Designs at MnROAD
- 4 Surface Rehabilitation of an existing stabilized full depth “perpetual” pavement
- 1 Full Depth Rehabilitation of an existing stabilized full depth “perpetual” pavement
- 1 New Full Depth Rehabilitation of to achieve a “perpetual” pavement

#1 Perpetual Pavement Test Sections in Wet Freeze Climates

- Analysis of the instrumentation data collected from the perpetual pavement sections to validate existing (update transfer functions) and new PerRoad PP design philosophy (cumulative strain distribution).
- Laboratory testing to properly characterize HMA layers for PP design
- Comparison of conventional PP sections / PP sections built at MnROAD using recycling/reclamation techniques.

National Road Research Alliance
Phase-II Research / Test Sections (Flexible Team)

2022 MnROAD Construction

- No test sections in Phase-I efforts
- Use existing data around the country

$100,000
Research
Funding

#2 Validation of Loose Mix Aging Procedures for Cracking Resistance Evaluation in Balanced Mix Design

- Validate loose mix aging procedures for cracking resistance evaluation in balanced mix design.
- Mix aging should be part of the BMD process for mixture approval and perhaps initial production verification.
- Lack of consensus on mix aging is a problem for BMD implementation.
- Implementation of BMD will enable more innovative and sustainable mix designs.
- Phase I study seeks to extensively leverage the ongoing research efforts on the development, evaluation, and preliminary validation of candidate loose mix aging protocols.
- Phase II will synthesize the existing binder and mixture test results, conduct critical data review and analysis, identify research gaps, and develop an experimental plan.

National Road Research Alliance
Phase-II Research / Test Sections (FlexibleTeam)

2022 MnROAD Construction

- Expect to build test sections outside of MnROAD on existing roadways
- Could include 10-12 variables / Test sections

$200,000 Research Funding

#3 Recycled Binder Availability

- Demonstrate the benefits of adequately quantifying binder availability from recycle aggregate materials (RAM) with test sections.
- Provide guidelines for their efficient use based on laboratory and field performance comparisons.
- Currently it is assumed 100% recycled binder availability
- An adequately quantified reduced recycled binder availability with respect to balanced rutting and cracking performance and durability would provide an engineering assessment of the impact of this important consideration.
- Should DOT's assume less contribution from binder in RAP?

National Road Research Alliance
Phase-II Research / Test Sections (Flexible Team)

2022 MnROAD Construction

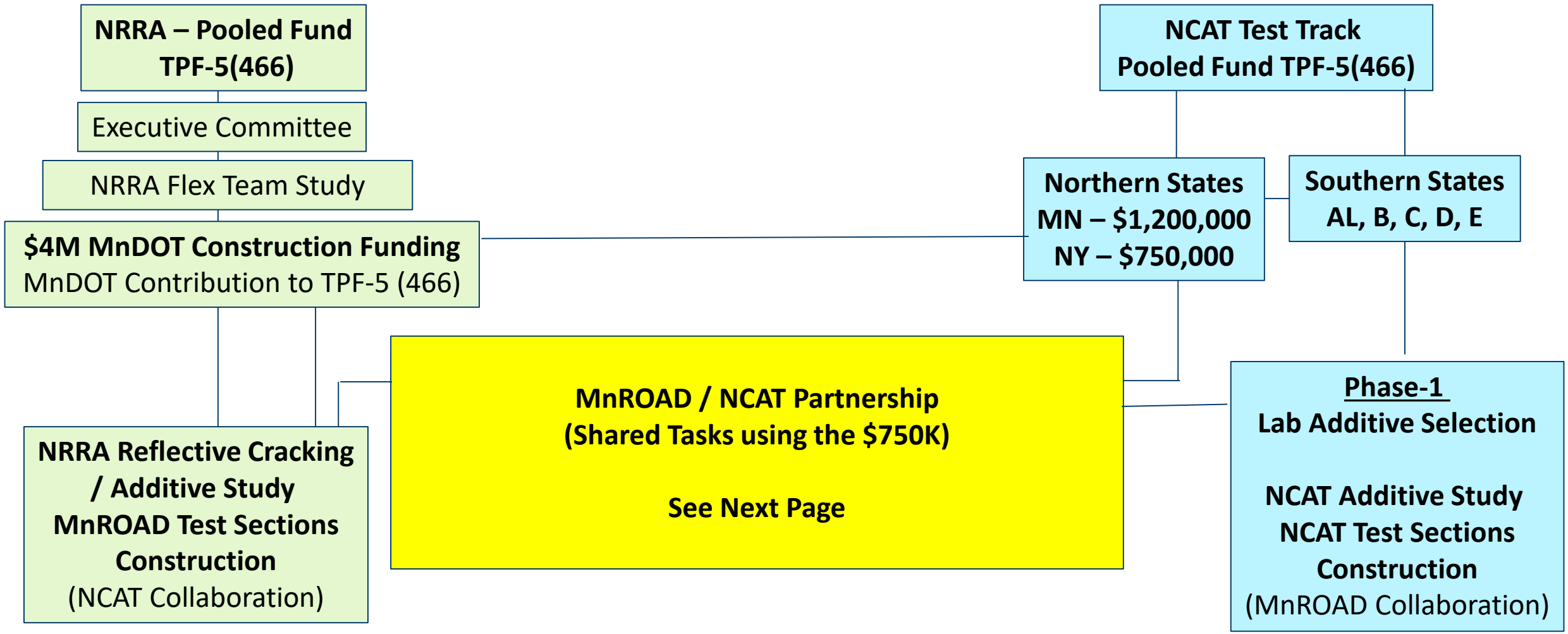
- 2021 NCAT Test sections
- 2022 MnROAD - 10 Test Sections 450’ each
- Missouri Department of Transportation and MCTI (Missouri Center for Transportation Innovation) have committed funding to develop companion test sections in Missouri

$225,000 Research Funding

#4 Reflective Cracking Challenge

- Evaluate the field performance of hot mix asphalt (HMA) surface mixes in new construction and in reflective cracking scenarios.

Additive/Reflective Cracking Challenge
Internal Partnership Relationships (NCAT/MnROAD)



Shared Products to be Developed

NRRA Deliverables (Flex Team to Discuss)

1. Low Temperature Binder Grade Reflective Cracking Potential
2. Pavement Life Impact of Included Additives
   - Layer Coefficient or Calibrated ME Model
3. Better Understanding of Reflective Cracking Mechanisms with HMA/HMA
   - Improved Modeling

NCAT Deliverables

1. Pavement Life Impact of Included Additives
   - Layer Coefficient or Calibrated ME Model
2. Validated Methodology for Evaluating Additives
   - Climatic Effects with Additives between North and Southern Mixes

Shared Tasks ~ $750K

- Phase-1 Additive Selection = paid by vendors
- Initial Mix Designs for Northern Test Sections
- NCAT Construction Support on site
- Lab Testing Plant Placed Materials
- Travel Sponsor and Communications Meetings

(No money transfer to MnDOT)

Additive Group Study – Northern Perspective
Reflective Cracking (HMA/HMA) Challenge

- **Reflective Cracking - Why this Study makes sense**
  - High percentage of our network
  - Largest activity/cost
  - Build off the cracking group study and NRRA (HMA/PCC) study
  - Manufacture's claims

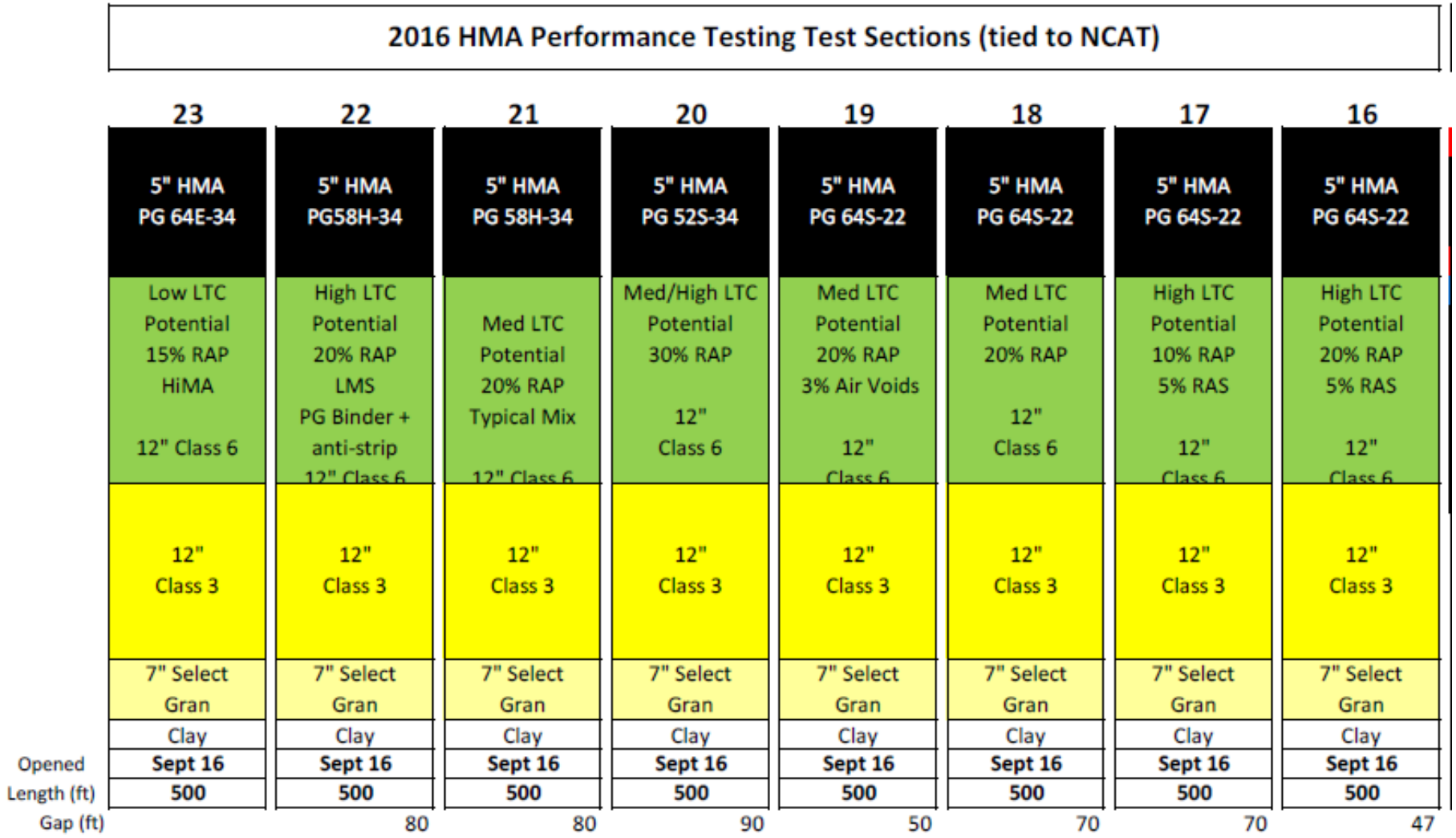
Sections 16-23 (8 test sections)

Statewide (All Districts)

Pavement	Percent	Miles
BIT	12%	1,682
BOB	50%	7,104
BOC	22%	3,136
CON	17%	2,377
CRCP	0%	2
All	**100%**	**14,301**

MnROAD Real Estate Available

- 4500’ total



2016 HMA Performance Testing Test Sections (tied to NCAT)

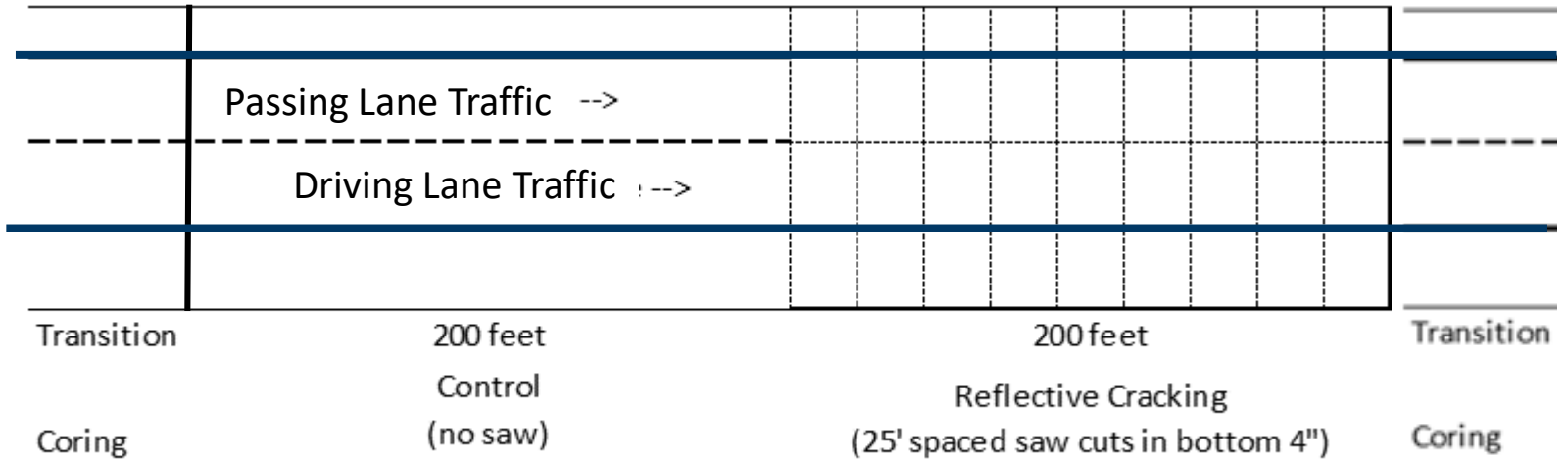
	23	22	21	20	19	18	17	16
	5" HMA PG 64E-34	5" HMA PG58H-34	5" HMA PG 58H-34	5" HMA PG 52S-34	5" HMA PG 64S-22	5" HMA PG 64S-22	5" HMA PG 64S-22	5" HMA PG 64S-22
	Low LTC Potential 15% RAP HiMA 12" Class 6	High LTC Potential 20% RAP LMS PG Binder + anti-strip 12" Class 6	Med LTC Potential 20% RAP Typical Mix 12" Class 6	Med/High LTC Potential 30% RAP 12" Class 6	Med LTC Potential 20% RAP 3% Air Voids 12" Class 6	Med LTC Potential 20% RAP 12" Class 6	High LTC Potential 10% RAP 5% RAS 12" Class 6	High LTC Potential 20% RAP 5% RAS 12" Class 6
	12" Class 3	12" Class 3	12" Class 3	12" Class 3	12" Class 3	12" Class 3	12" Class 3	12" Class 3
	7" Select Gran	7" Select Gran	7" Select Gran	7" Select Gran	7" Select Gran	7" Select Gran	7" Select Gran	7" Select Gran
	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay
Opened	Sept 16	Sept 16	Sept 16	Sept 16	Sept 16	Sept 16	Sept 16	Sept 16
Length (ft)	500	500	500	500	500	500	500	500
Gap (ft)		80	80	90	50	70	70	47

Additive Group Study – Northern Perspective
Reflective Cracking (HMA/HMA) Challenge

- **Northern Section Layout**
  - 10 Test Sections
  - 400’ test sections with 50’ coring areas

Structure (Cells 16-23)

2"	Mix / Treatment to test
2"	Common Mix / sawn
2"	Common Mix / sawn
12"	Existing Granular (Common Base)
12"	Existing Granular (Common Subbase)
	Clay subgrade



Additive Group Study – Northern Perspective
Reflective Cracking (HMA/HMA) Challenge

Possible Test Section Mixes

1. B Oil – Control 1 (Base Oil) PG 58S-28
2. C Oil – Base Oil (Polymer Modified) PG 58H-34
3. PG52-34 binder – 2016 MnROAD Cold regions best performer
4. Superpave 5 (Using mix 1 or 2 as a basis)

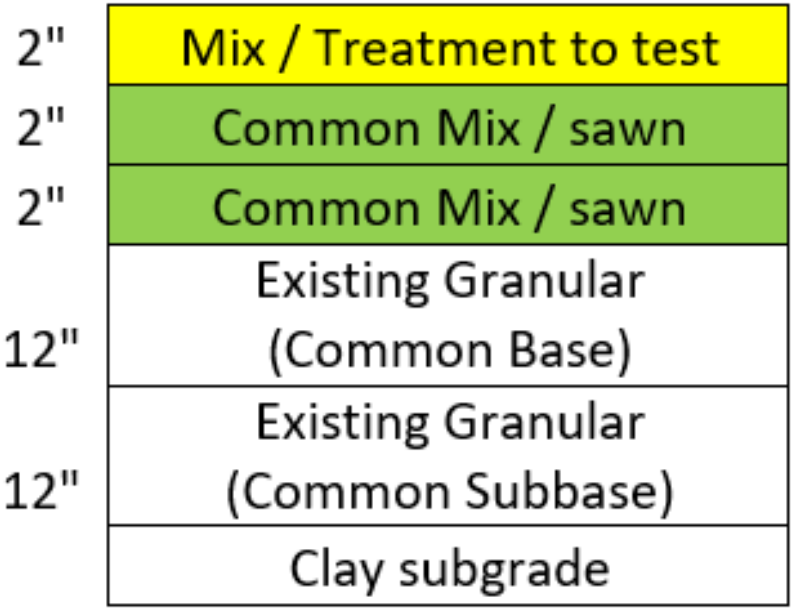
NRRA

5. Superpave 5 (Graphene Nanoplatelets from mix 4 or mix 1)
6. SMA
7. WMA
8. Regressed Air-voids
9. OGFC
10. 9.5 mm mixes
11. NCAT/NRRA Member 1 (Base Oil - Plastic)
12. NCAT/NRRA Member 2 (Base Oil - Rubber)

NCAT Tied

13. NCAT/NRRA Member 3 (Base Oil - Fibers)
14. NCAT/NRRA Member 4 (Base Oil - ?)
15. NCAT/NRRA Member 5 (Base Oil - ?)

Structure (Cells 16-23)



National Road Research Alliance
Phase-II Research / Test Sections (ICT Team)

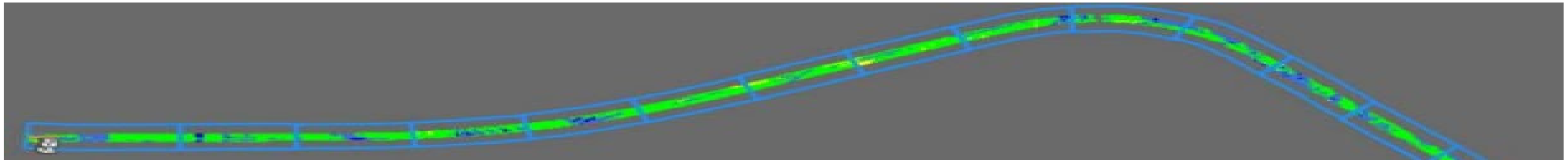
2022 MnROAD Construction

- ICT is going to work in new technologies into its construction of the subgrade, base, HMA and PCC layers
- Looking for NRRA associate support in these efforts

$987,996
Research
Funding

#1 Veta Web and Veta MDMS Standardized Platform

- Convert Veta from a desktop platform to a web-based application.
- Continuation of the work completed under TPF-5 (334) “Enhancement to the Intelligent Construction Data Management System (Veta) and Implementation” (Contract Number 1027236).
- Provide a standardized platform for the Material Delivery Management System (MDMS) – the expanded form of E-Ticketing and the ability to push MDMS data to AASHTOWare project.



National Road Research Alliance
Phase-II Research / Test Sections (PM and GeoTech Teams)

2022 MnROAD Construction

- Thinlays - 2 Test Sections Locations
- Wicking GeoTextiles – 2(+) Test Sections
- Flooded Pavements Assessment App – Future Farm Loop

$400,000 Research Funding

#1 Thinlay as a Preventive Maintenance Treatment (PM)

- Promote the continued development of thinlay mixes at MnROAD but also review of existing NRRA states efforts utilizing these mixes.

#2 Performance Evaluation of Wicking Geotextiles for Improving Drainage and Stiffness of Road Foundation

- Quantify the benefit of using wicking geosynthetics in terms of long-term performance and providing an enhanced design input parameter for pavement design engineers.

#3 Flooded Pavements Assessment App–Phase II

- Decision App for roadway closures and/or load posting to enhance the resilience of pavement systems in response to extreme events and also results in more sustainable, efficient, and cost-effect roads.

How to Get Involved

Pavement Preservation

- MnDOT Lead Study / NCAT Contractor
- TPF-5(375) - https://pooledfund.org/Details/Study/627

National Road Research Alliance NRRA

- MnDOT Lead State
- TPF-5(466) - https://pooledfund.org/Details/Study/693

Additive Group Study

- NCAT lead pooled fund
- TPF-5(469)- https://pooledfund.org/Details/Study/696

Consortium for Asphalt Pavement Research and Implementation (CAPRI)

- NCAT lead pooled fund
- TPF-5(465) - Transportation Pooled Fund - Study Details

2021 Upcoming Meeting(s)

(NRRA Annual Meeting) (MnROAD/NCAT Sponsor Meeting)

Minneapolis Minnesota
September 13-17, 2021

+

Monday 13 (starts 1 pm)

NRRA Focus Discussion (TBD)
NRRA Executive Meeting

Tuesday 14 (full day)

Phase – 1 and 2
NRRA Project Focus

Wednesday 15

"MnROAD Open House"

Tours of MnROAD (ML and LVR)
Recycling (70th Street)
Spray Rejuvenators (15th Street)
PG Tours Pease MN
(TH-169, CSAH-8)

Thursday 16 (full day)

MnROAD / NCAT Partnership Meeting

Friday 17 (ends noon)

Focus Discussion (TBD)

Thank you again!

Ben Worel

ben.worel@state.mn.us

651-358-1328