Intelligent Compaction

Advances in Intelligent Compaction for HMA

NCAUPG HMA Conference

Overland Park, Ks.

Victor (Lee) Gallivan, PE
FHWA - Office of Pavement Technology
February 3, 2010

U.S. Department of Transportation
Federal Highway Administration

Intelligent Compaction

What is Intelligent Compaction Technology

An Innovation in Compaction Control and Testing

Office of Pavement Technology
Federal Highway Administration
www.fhwa.dot.gov/pavement/

----Definition----

What is "Intelligence?"

- Oxford Dictionary: *"…able to vary behavior in response to varying situations and requirements"*
- Ability to:
  - Collect information
  - Analyze information
  - Make an appropriate decision
  - Execute the decision

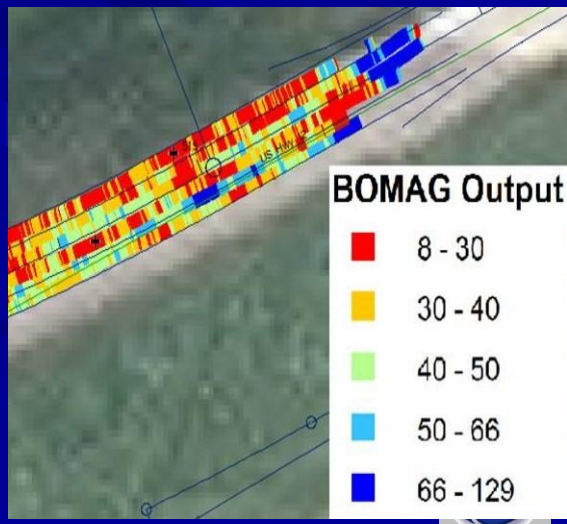
3000-4000 TIMES A MINUTE

Shortcomings Density Acceptance…

Limited Number of Locations

Benefits of IC for HMA

- Improve density….better performance
- Improve efficiency….cost savings
- Increase information…better QC/QA



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GPS Base Station

GPS Radio & Receiver

GPS Rover

Real Time Kinematic (RTK) GPS Precision

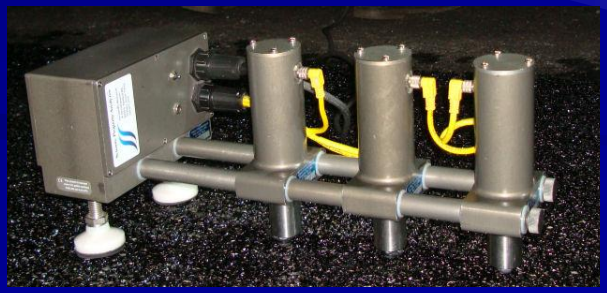
Intelligent Compaction

NG

LWD-a

NNG

PSPA



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Ammann/Case

Caterpillar

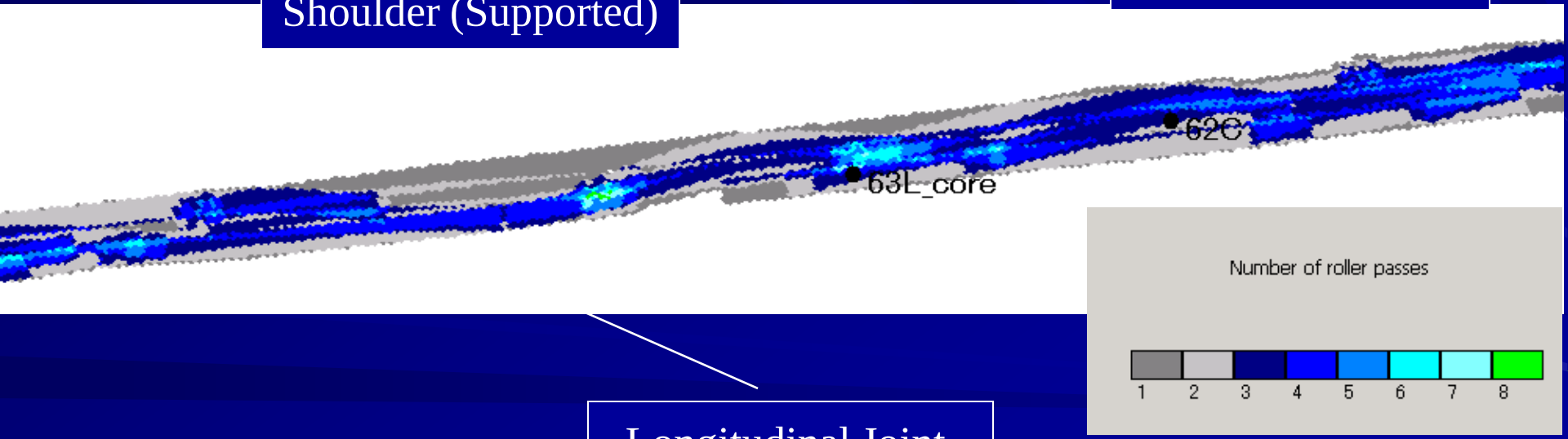
Dynapac

Bomag America

Sakai America

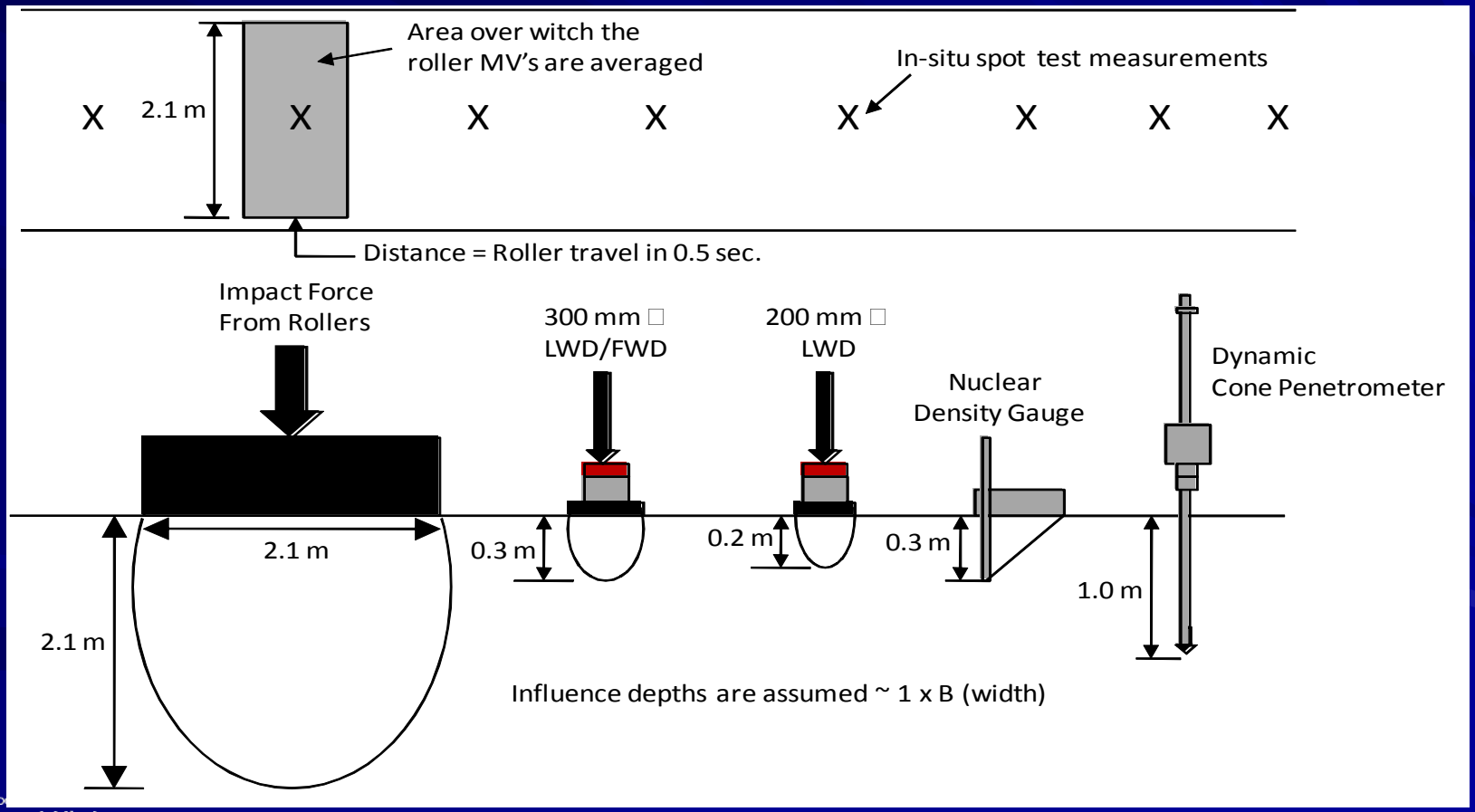
Intelligent Compaction

Mapping of Roller Passes



Courtesy Sakai America

Correlation w/ In-Situ Testing



Courtesy of Dr. David White

Intelligent Compaction

IC National Efforts

- **NCHRP 21-09** "Examining the Benefits and Adoptability of Intelligent Soil Compaction" (Completed but not published yet)
- **Transportation Pooled Fund #954** – "Accelerated Implementation of Intelligent Compaction Technology for Embankment Subgrade Soils, Aggregate Base and Asphalt Pavement Material"
  - **The Transtec, Group, Austin, Texas (George Chang- PI)**
- **Additional State IC Programs (OK, WI, etc.)**

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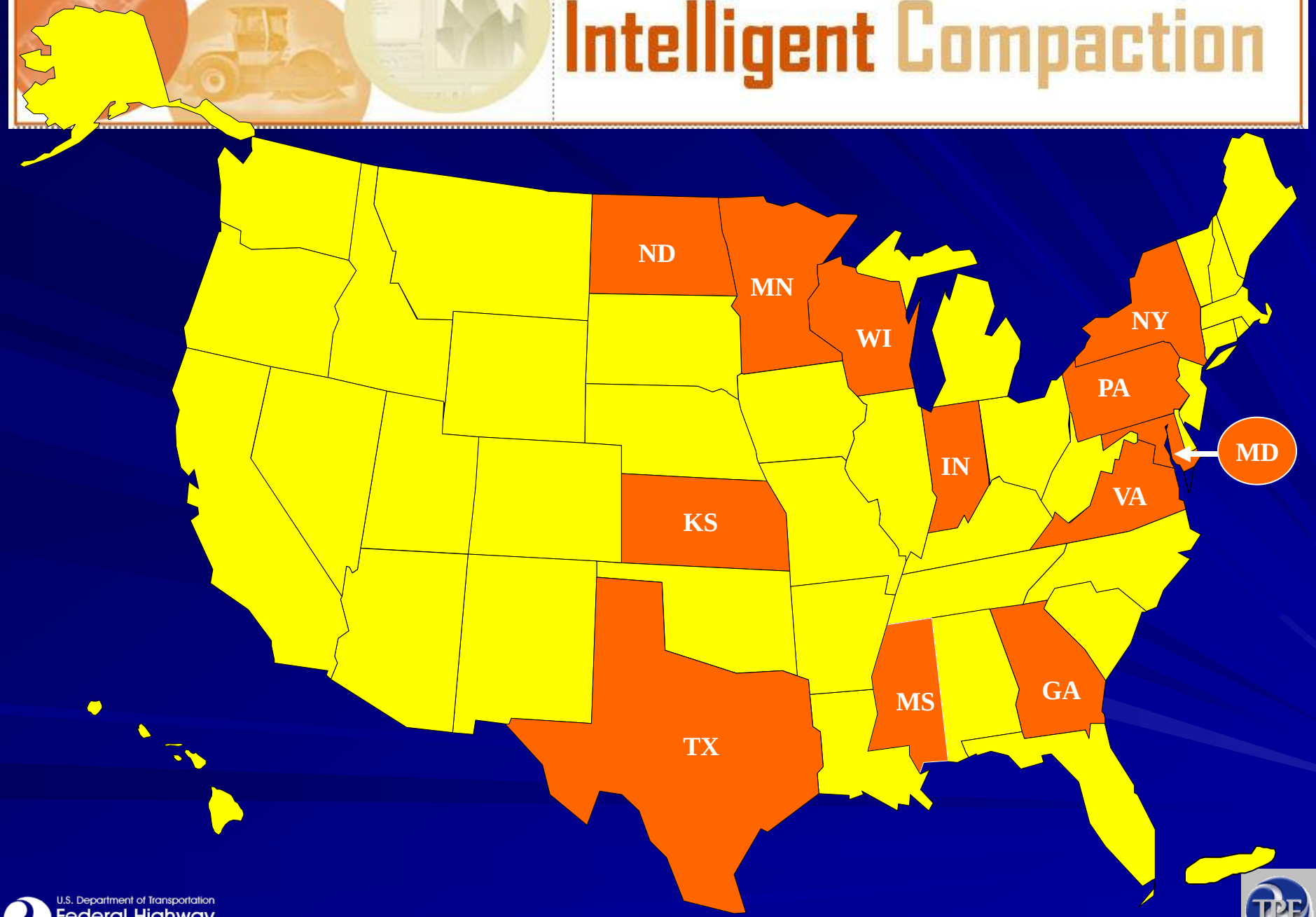

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- **Objectives: Based on data obtained from field studies:**
  - Accelerated development of QC/QA specifications for granular and cohesive subgrade soils, aggregate base and Hot Mix Asphalt (HMA) pavement materials…
  - Short, Long and Future Term Goals
  - 3-year IC study for all the above materials
  - 12 participating States
  - 12+ field demonstration

Objectives

- Develop an experienced and knowledgeable IC expertise base within Pool Fund participating State DOTs
- Identify and prioritize needed improvements to and/or research of IC equipment and field QC/QA testing equipment

Intelligent Compaction

Short Term Goals

- Improved Density
- More Uniform Density
- More efficient compaction process
- Operator Accountability
- Correlate Measurements with Field Densities
- Real-time Density Control (QC)

Long Term Goals

- Continuous Compaction Control specifications
- Real-time Density Acceptance (QA)

Future Goals

- Tie to Design Guide (verify design)?
- Performance specifications?

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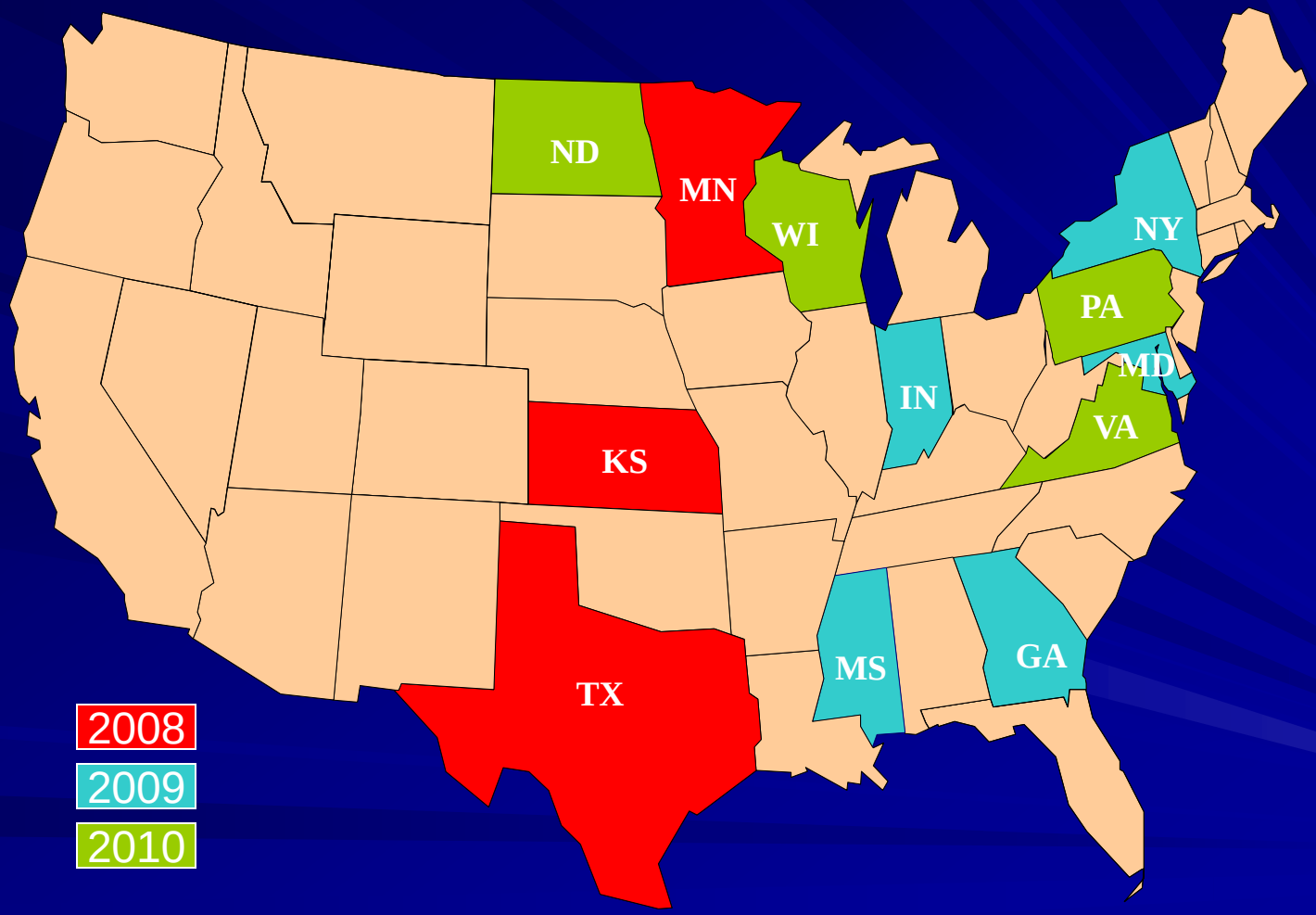

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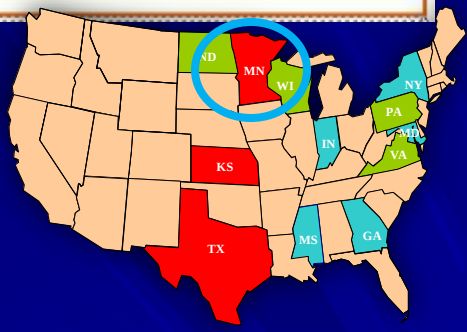
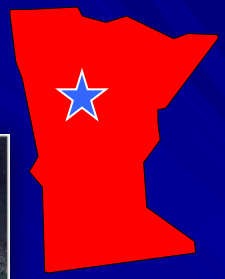
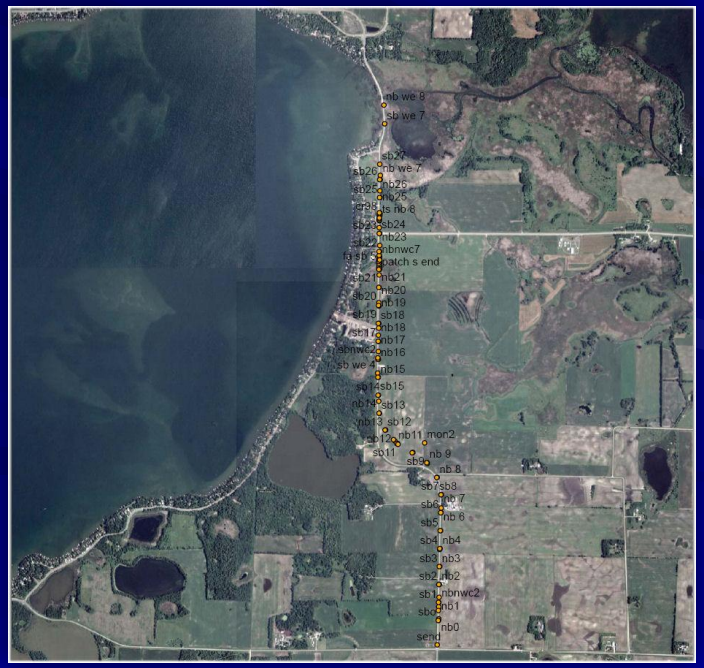
Intelligent Compaction



- Route 4, Kandiyohi County, MN
- Mapping existing subbase
- New HMA construction



Sakai double-drum IC roller



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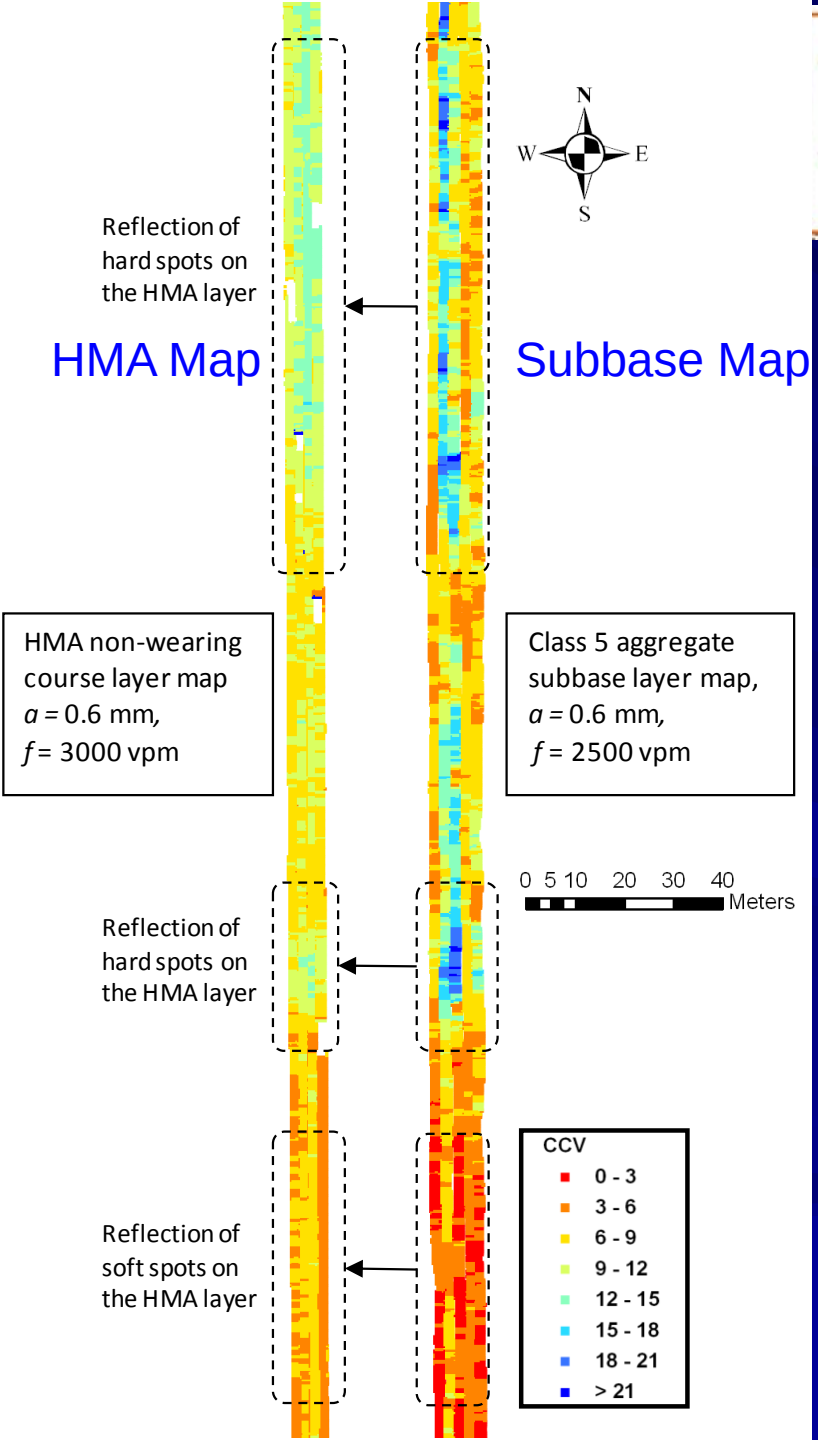
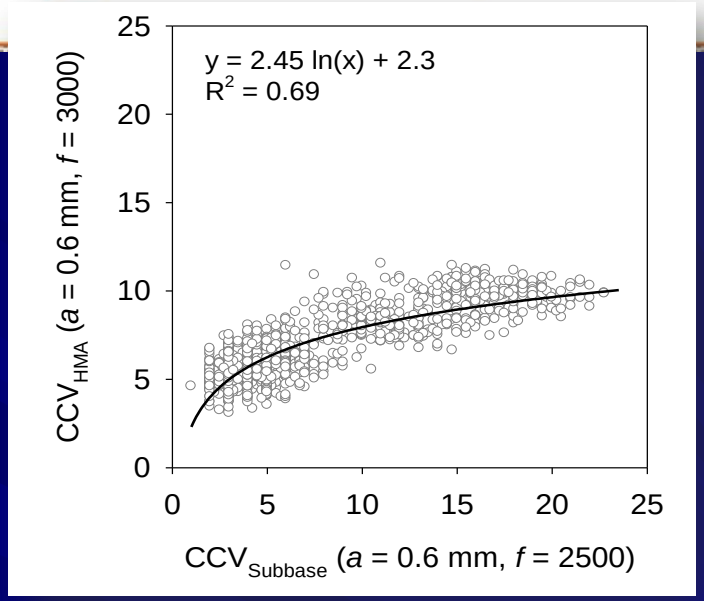
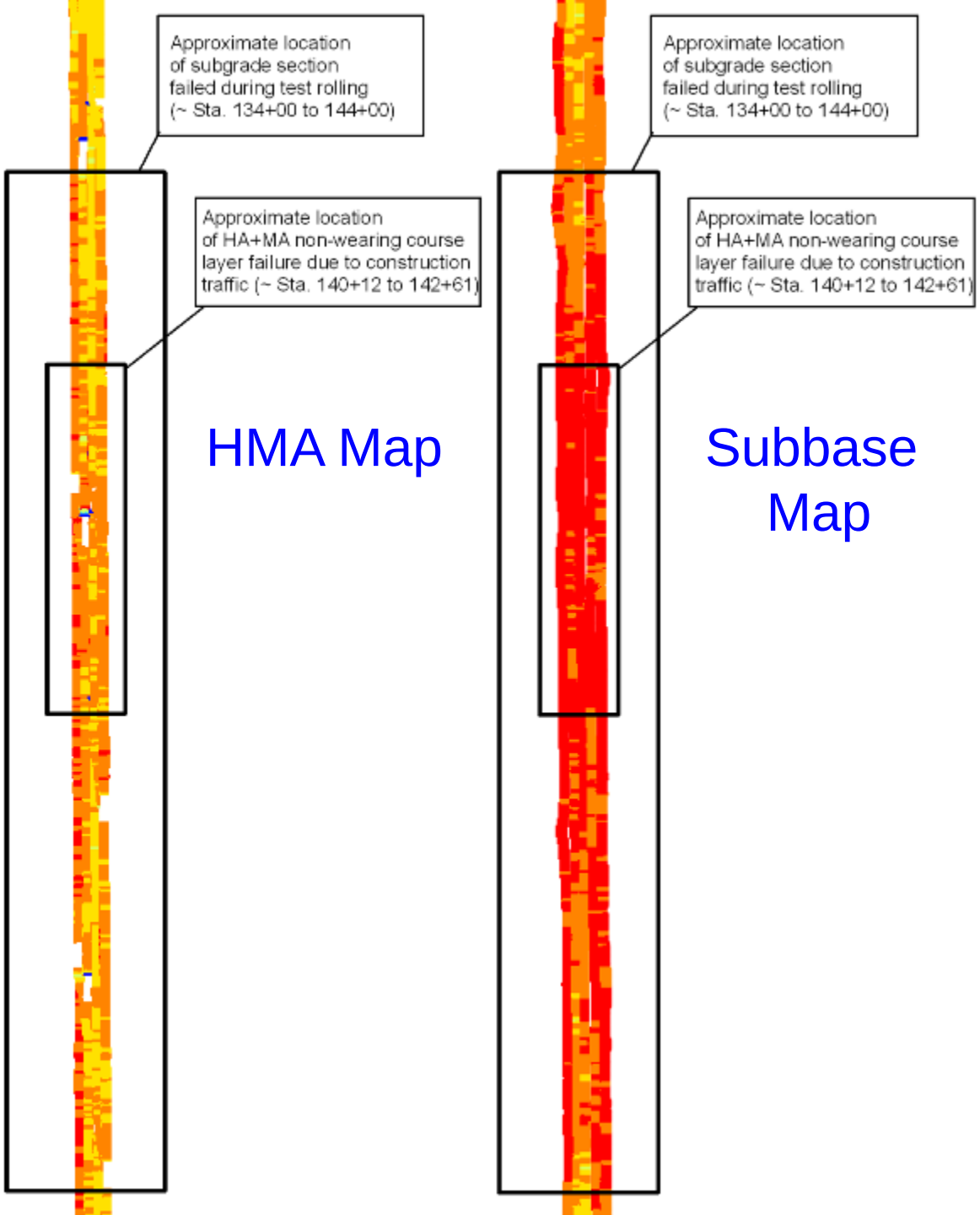


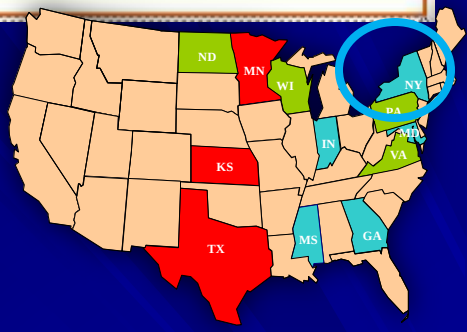


Sakai double-drum IC roller



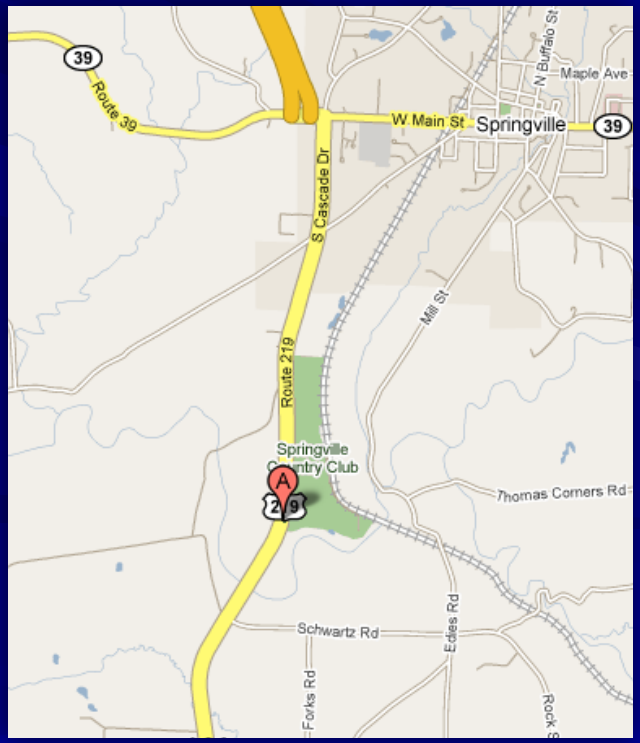
nt Compaction

Intelligent Compaction



- Peter's Road, Springville, NY
- Mapping existing subbase
- New HMA construction

Sakai double-drum IC roller



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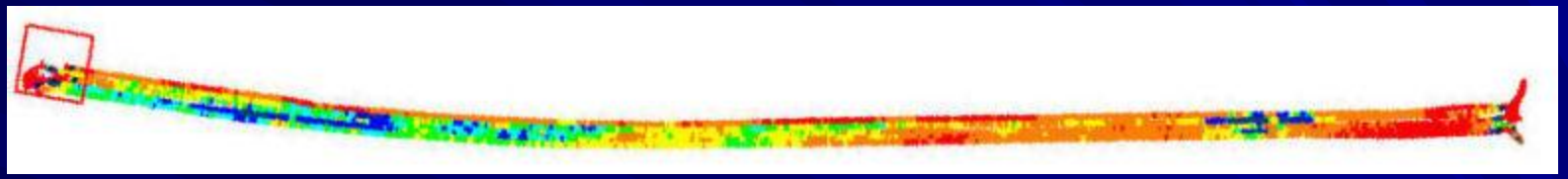
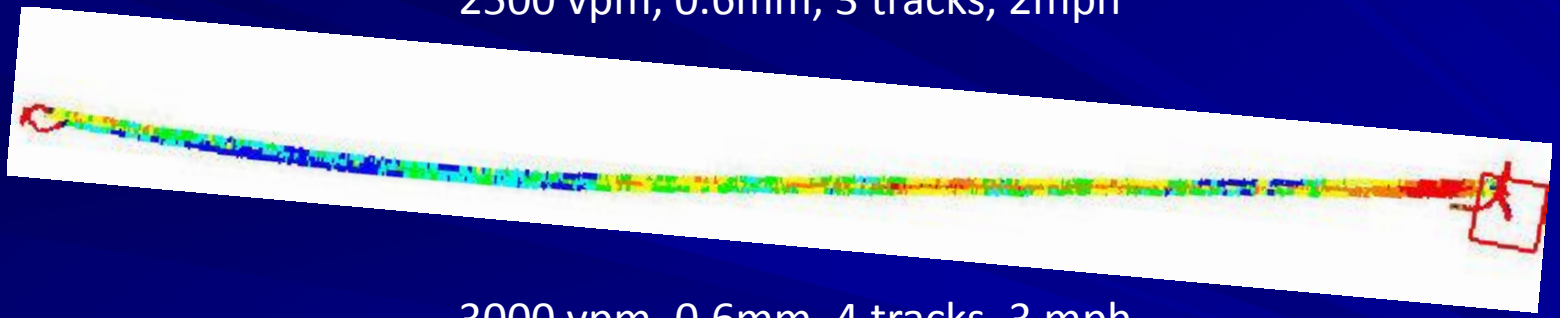
3000 vpm, 0.6mm, 5 tracks, 2mph



2500 vpm, 0.6mm, 3 tracks, 2mph



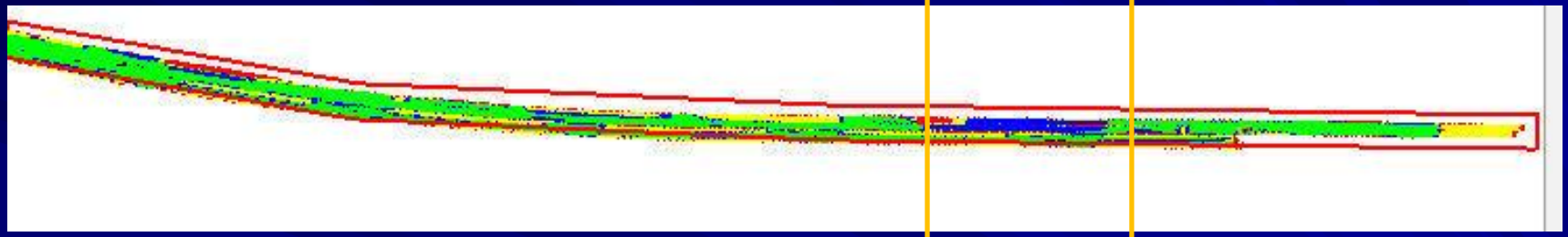
3000 vpm, 0.6mm, 4 tracks, 3 mph

Minimum Value	Maximum Value	Color
0	3	
3	6	
6	9	
9	12	
12	15	
15	18	
18	21	
21	100	

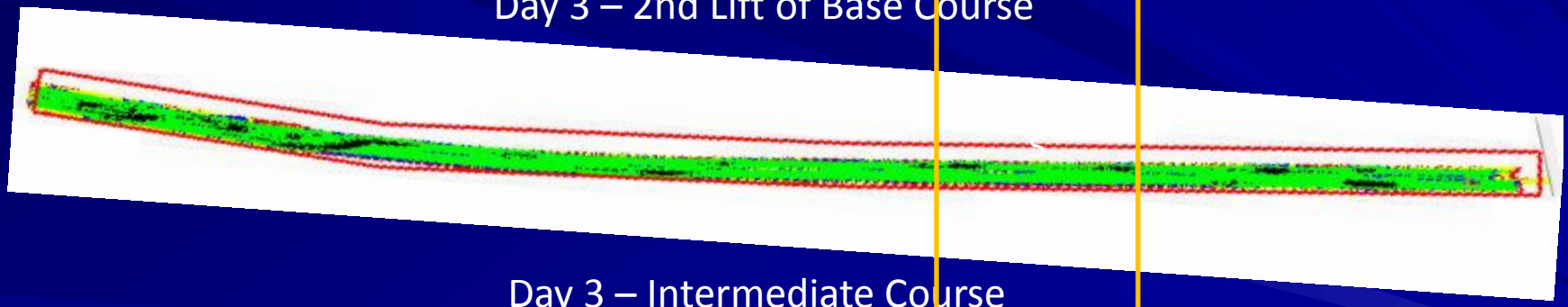
Intelligent Compaction

Minimum Value	Maximum Value	Color
1	2	
2	3	
3	4	
4	5	
5	6	
6	7	
7	8	
8	9	
9	10	
11	12	

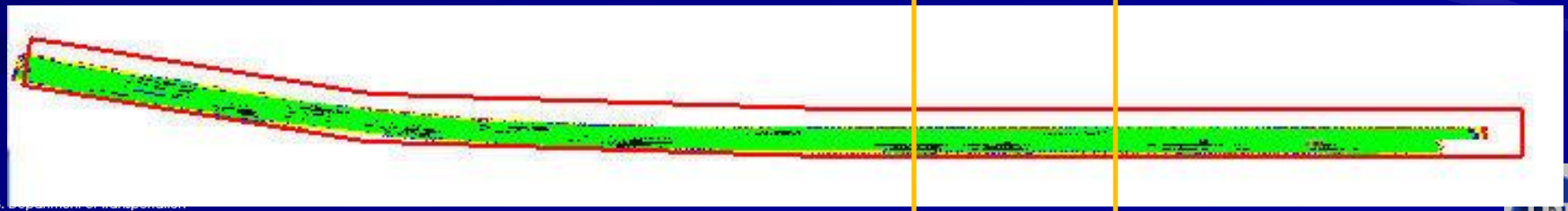
Day 2 – First Lift of Base Course



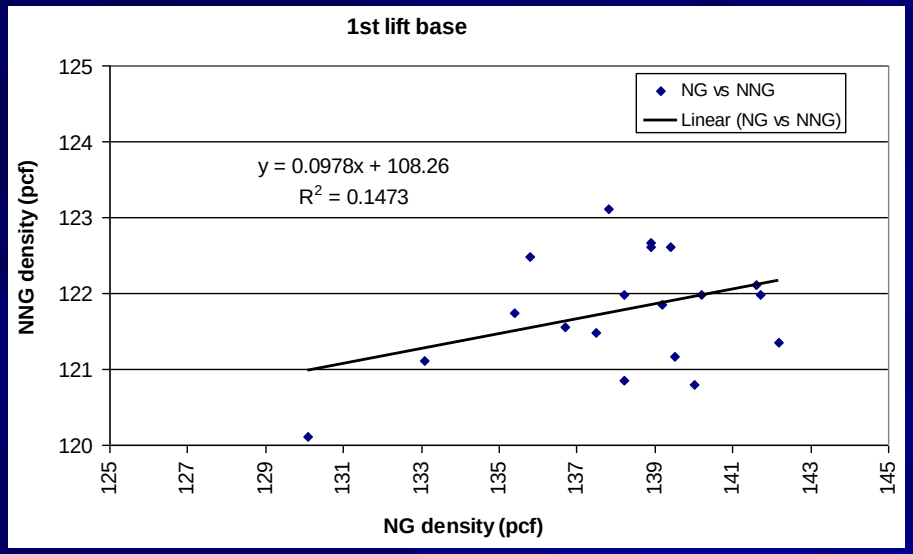
Day 3 – 2nd Lift of Base Course

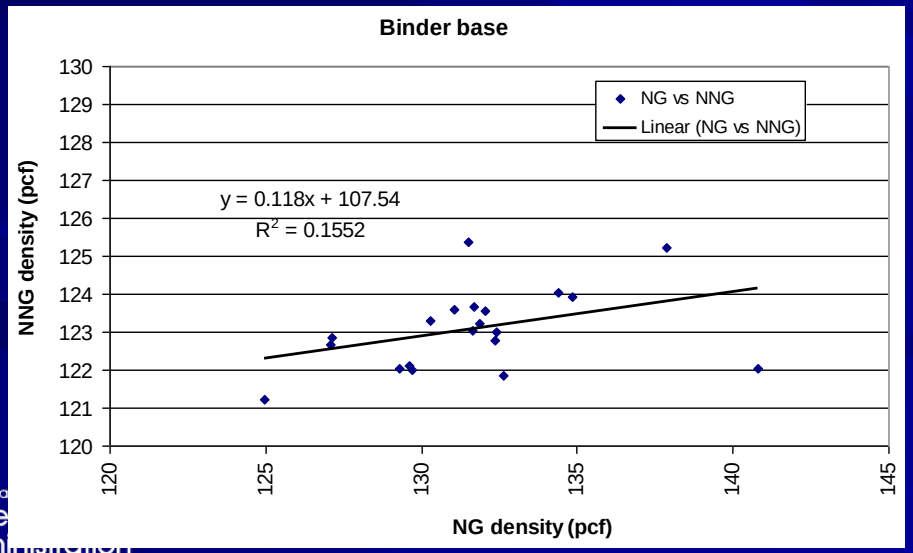


Day 3 – Intermediate Course



Intelligent Compaction

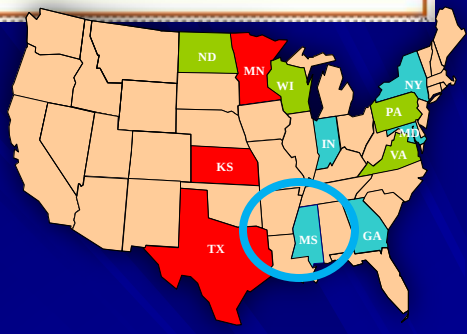




NG

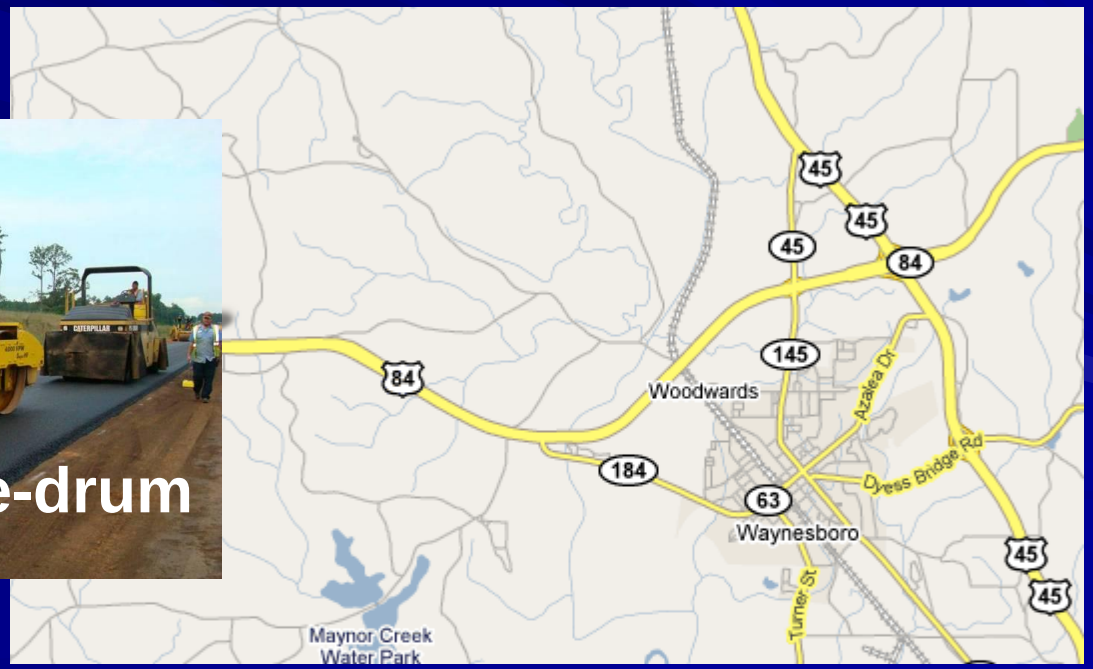
NNG (PQI)

Intelligent Compaction



- US 84, Wayne County, MS
- Mapping existing stabilized base
- New HMA Construction

Sakai double-drum IC roller



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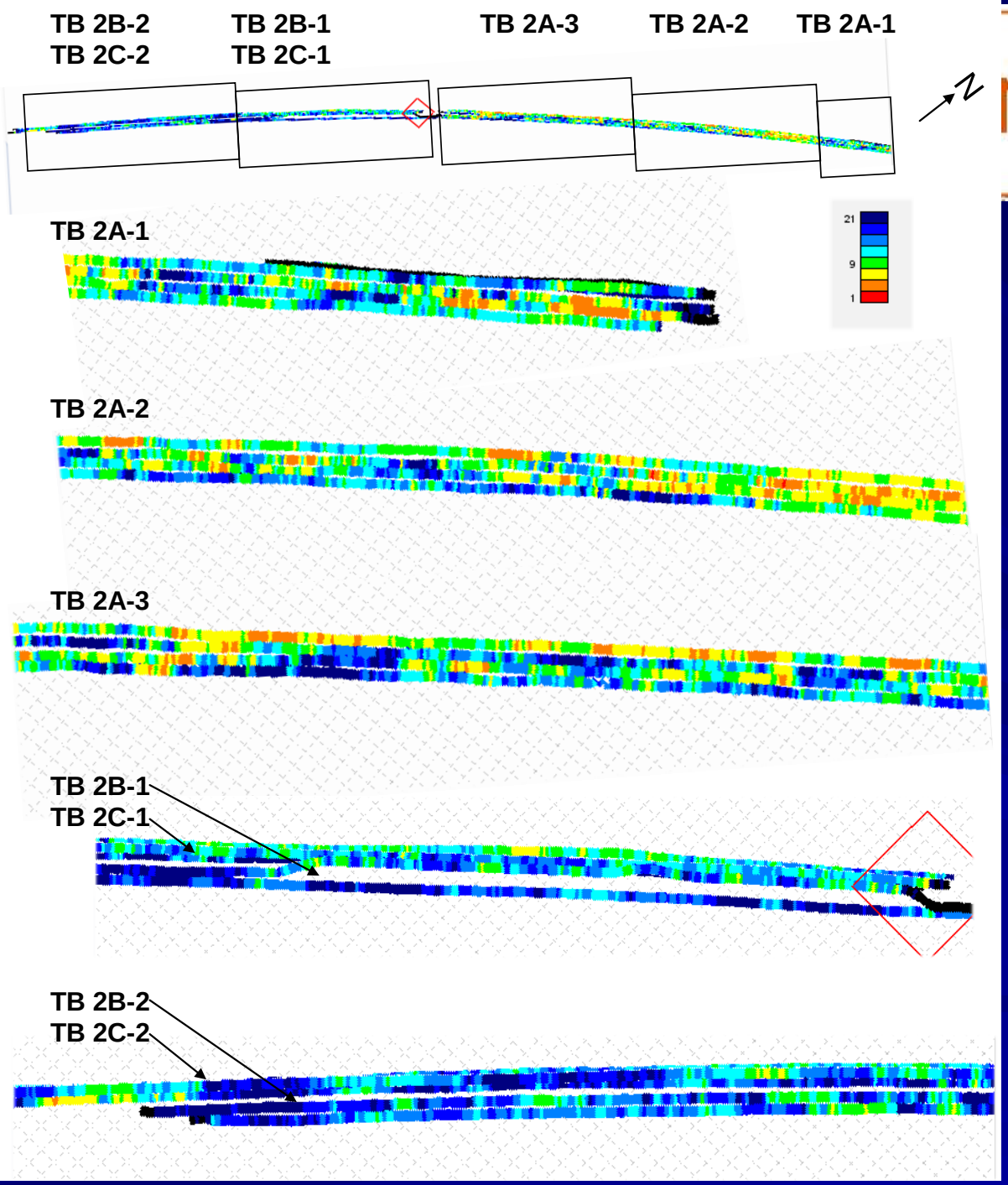

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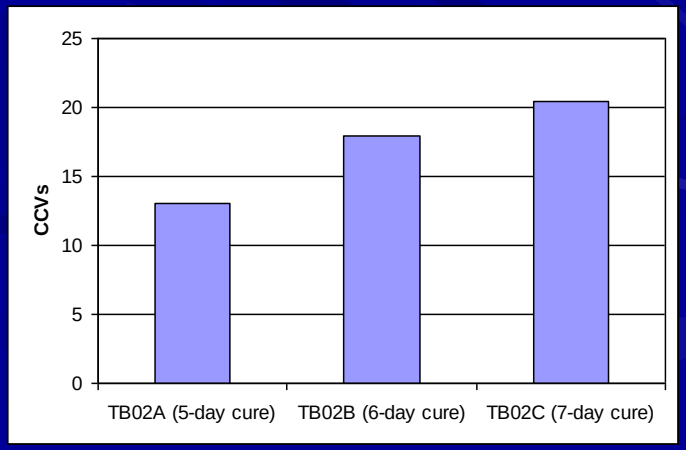
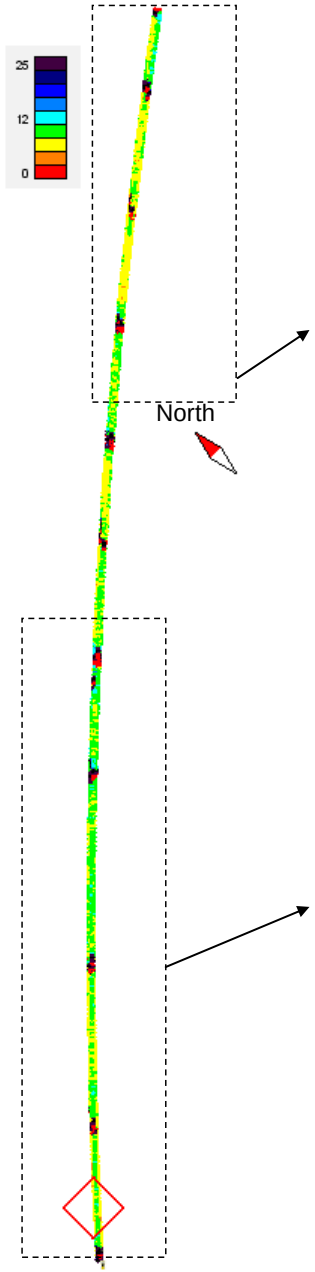
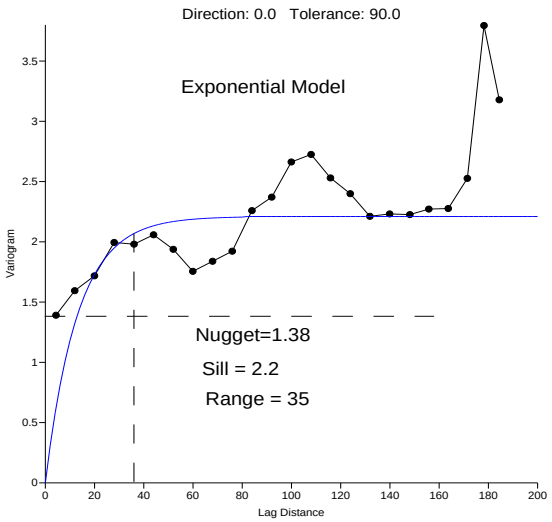


Sakai CCV

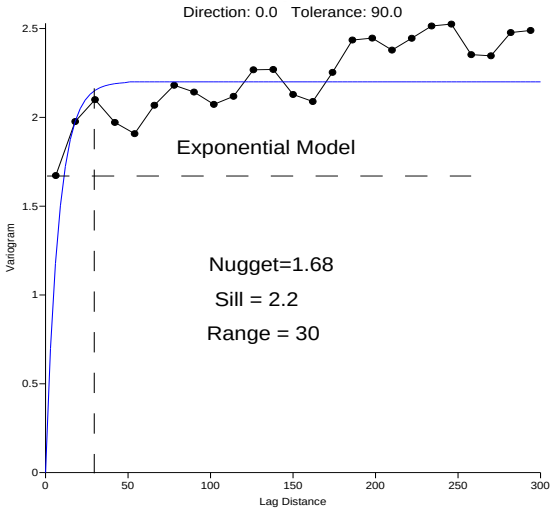


Total length of 582 m

Semi-variogram of CCV



EB Lane 1 (400 to 582 m)



EB Lane 1 (0 to 300 m)

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Sakai double-drum IC roller

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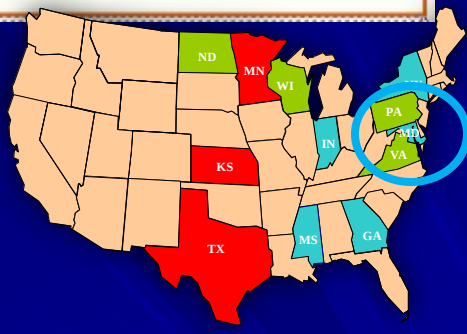
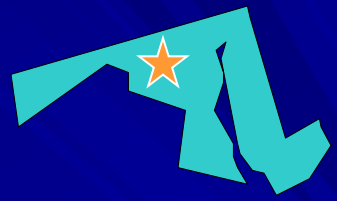


- US 340EB, Frederick, MD
- SMA overlay
- Mapping milled HMA surface



Bomag double-drum IC roller

Sakai double-drum IC roller

Test bed 02 Mapping

Bomag Sakai

t Compaction

Bomag Evib

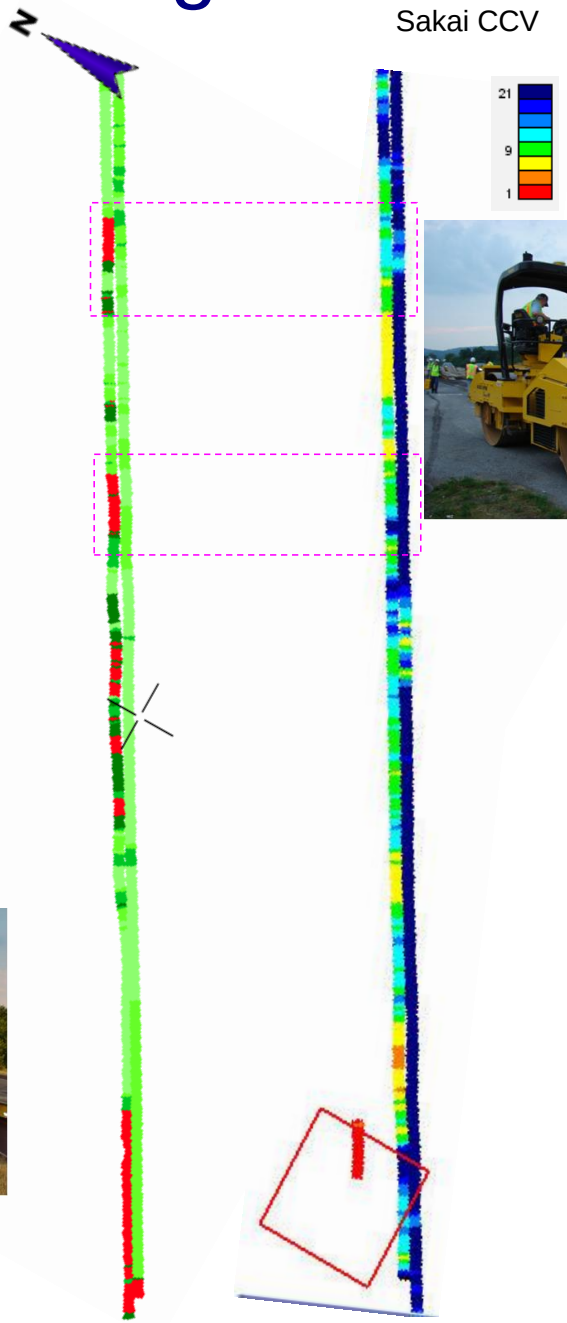
Done	650 m²
Start date	12:35:17 PM 7/21/2009
End date	12:41:51 PM 7/21/2009

	AVG	Min	Max
EVIB [MN/m²]	286	101	350
Amplitude [mm]	0.3	0.2	0.6
Frequency [Hz]	50	16	67
Speed [km/h]	5.5	1.0	6.6

	EVIB [MN/m²]	
	> 350	19 %
	313 -350	29 %
	276 -313	21 %
	238 -276	7 %
	200 -238	8 %
	< 200	16 %
Σ	200 -350	65 %

AVG-value [MN/m²]	286
Increase	8
Standard deviation	66

Sakai CCV

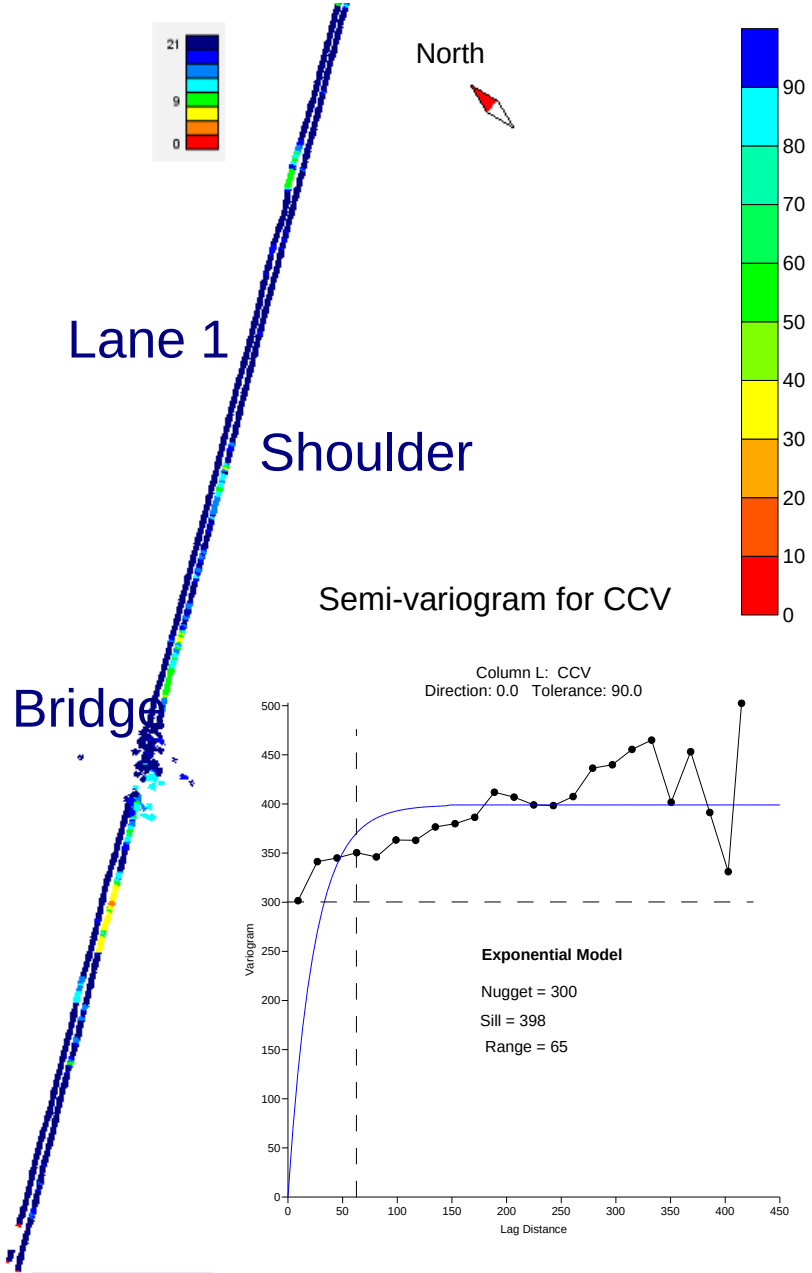


Mapping Milled HMA

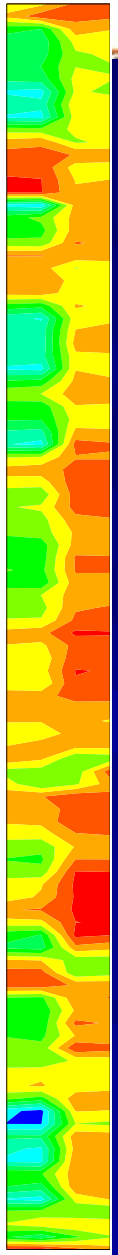
US 340 EB

TB 03A Mapping on Exiting HMA Pavement

Sakai CCV



Kridging Map



Semi-variogram for CCV

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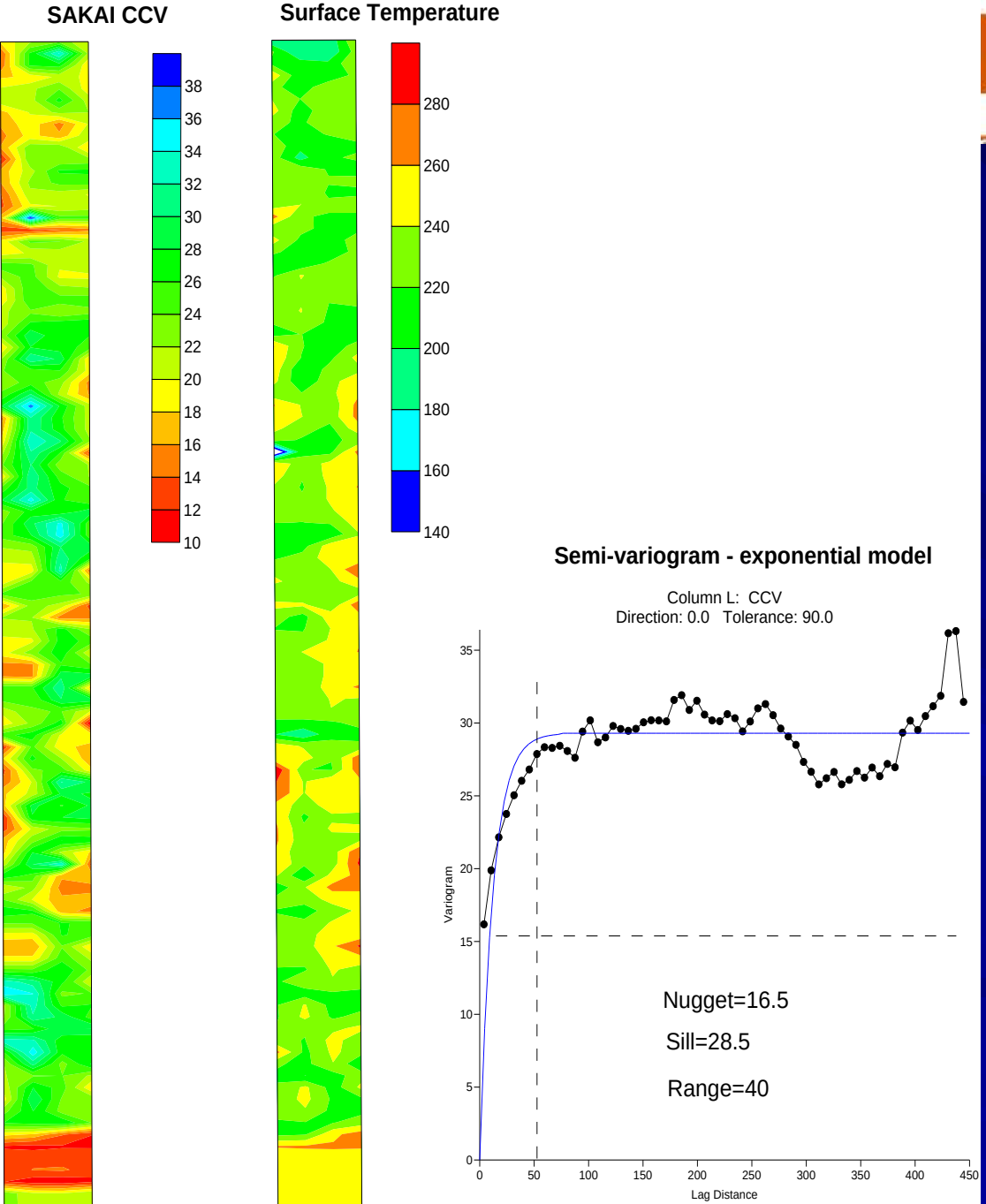
Mapping Milled HMA

Sakai double-drum IC roller

TB 03B SMA overlay (distance 0 to 684 m)



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Existing pavements

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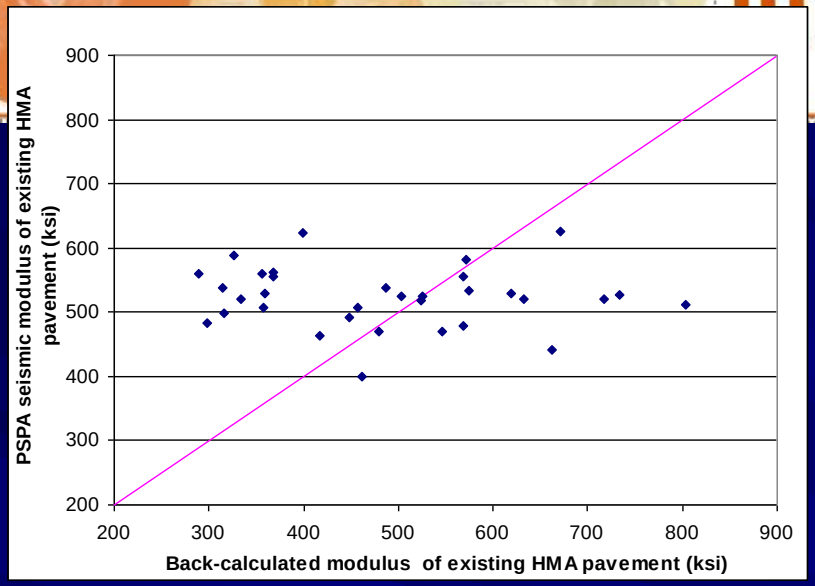
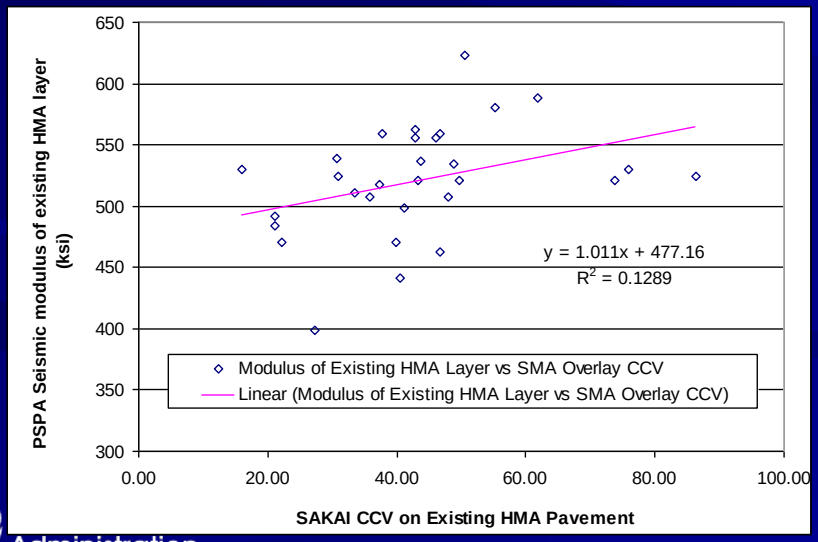


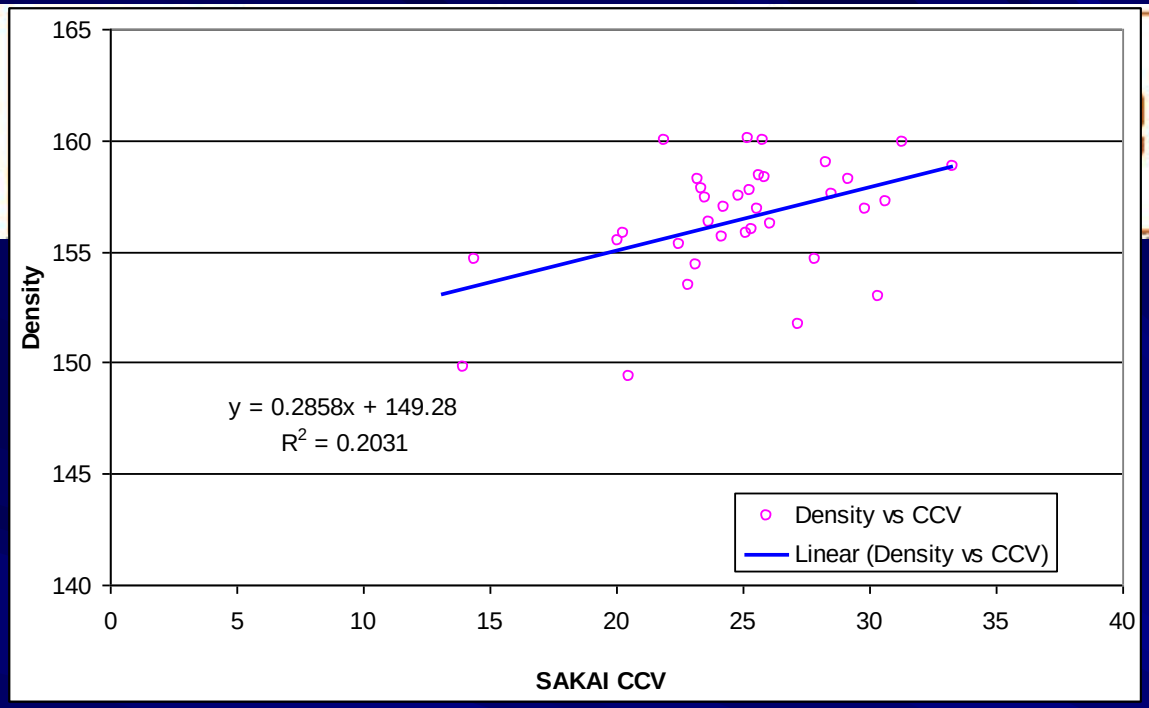
PSPA vs FWD

New SMA constrcution

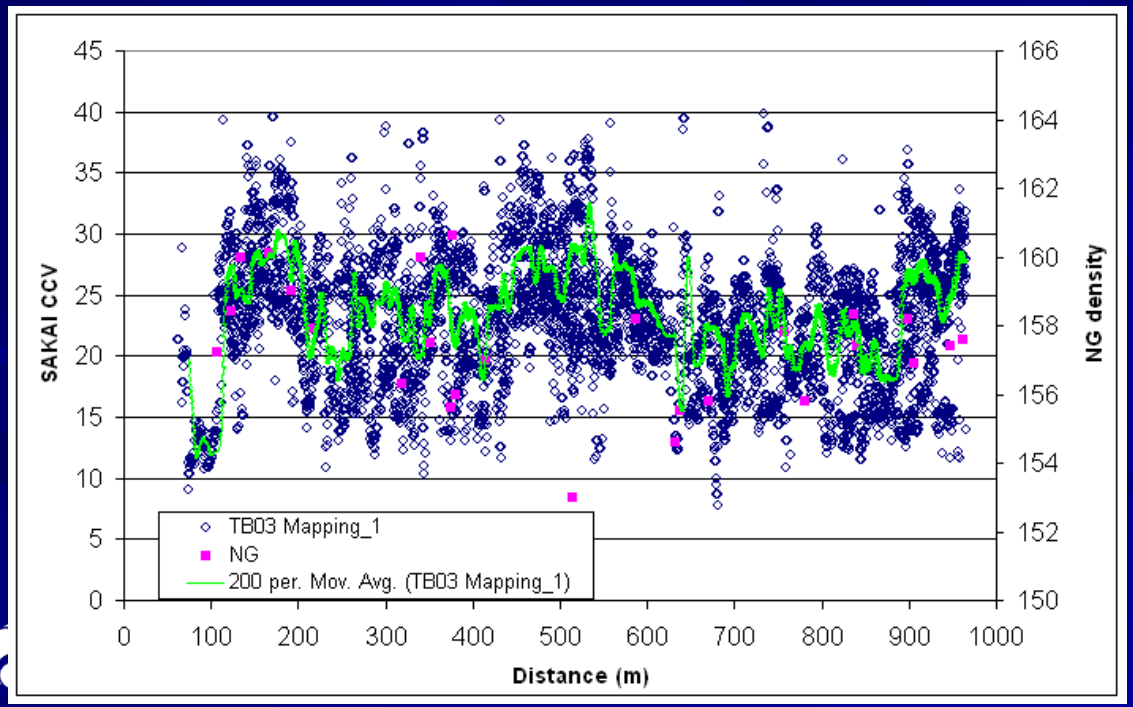


PSPA Vs IC

Administration



IC RMV vs NG



Sakai Double-drum IC roller

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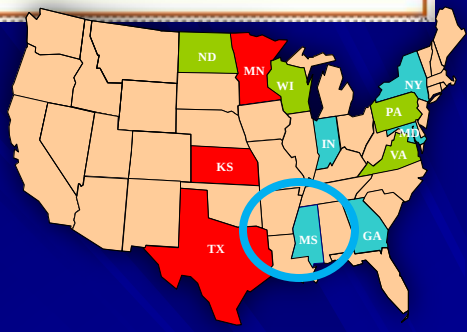
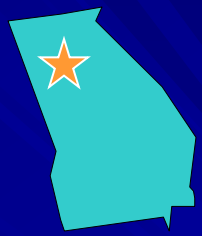
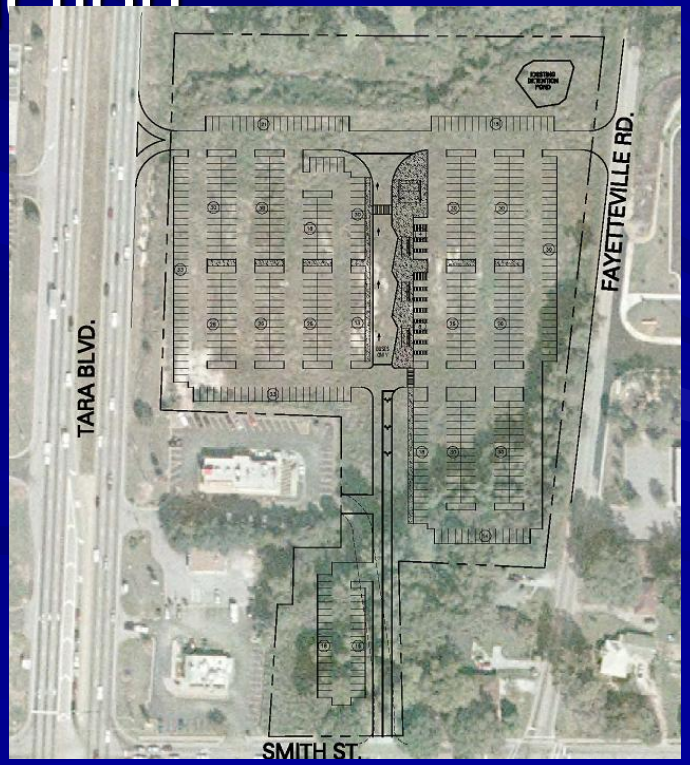


- Park&Ride, Clayton County, GA
- Mapping subbase
- New HMA construction



Sakai double-drum IC roller



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Federal Highway Administration

Sakai CCV

Minimum Value	Maximum Value	Color
0	3	
3	6	
6	9	
9	12	
12	15	
15	18	
18	21	
21	100	

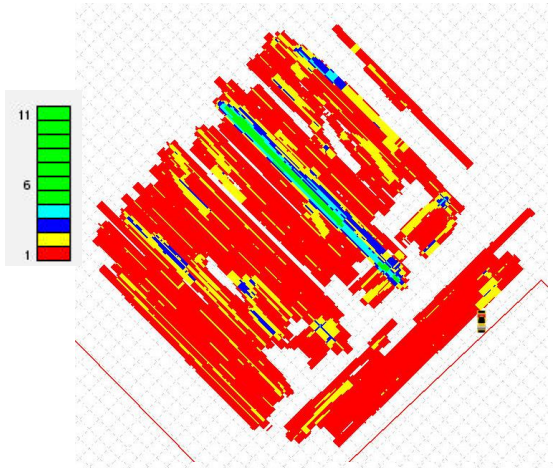
Compaction GAB

Park & Ride

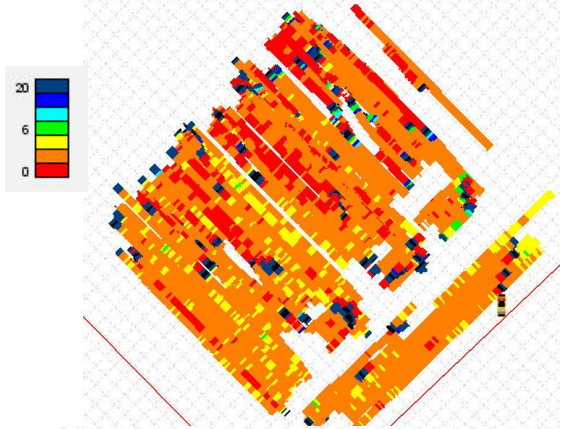
Sakai Double-drum IC roller

TB 01A Intermediate HMA Layer

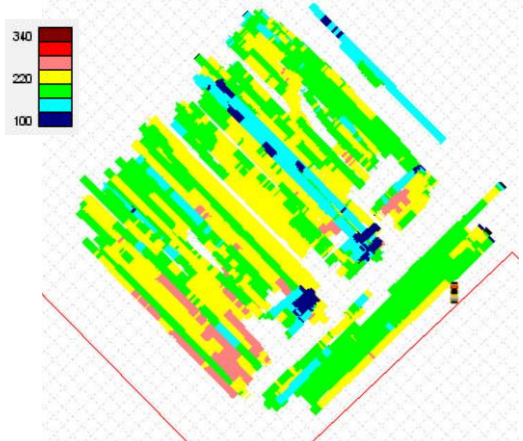
Roller pass



Sakai CCV



Surface temperature (°C)



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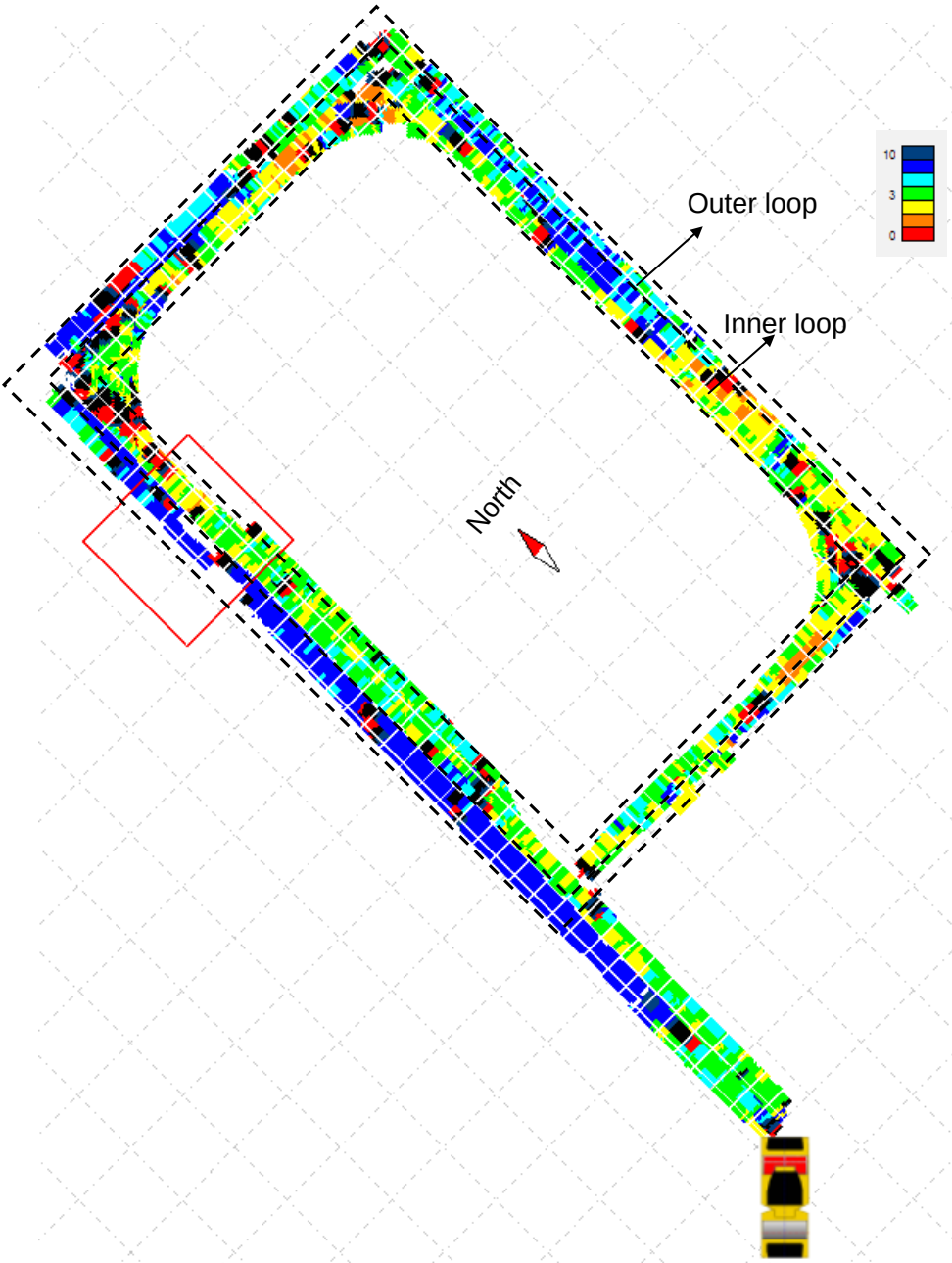
TB 05A Intermediate HMA Layer



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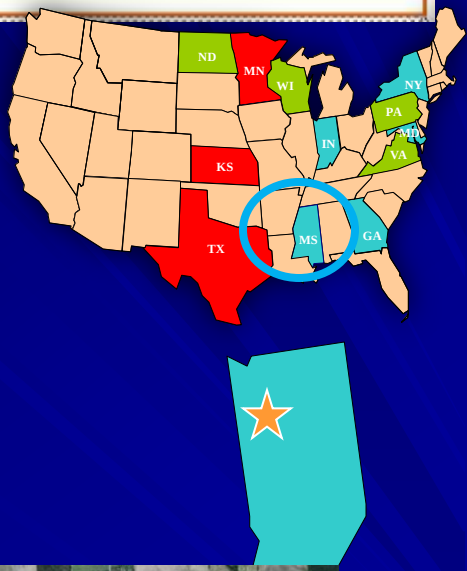
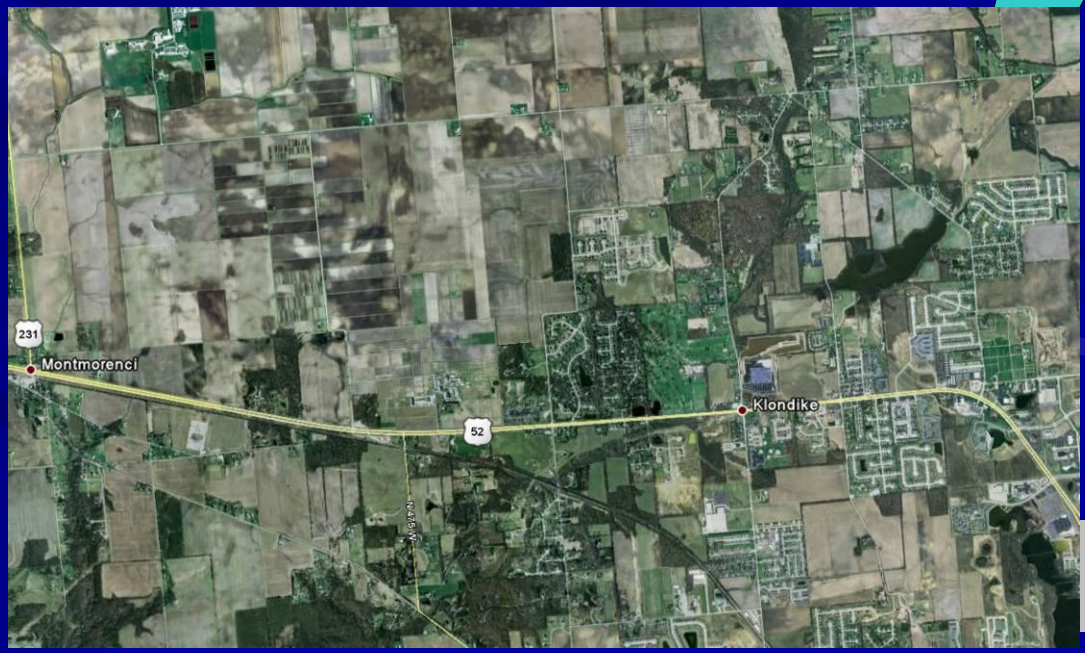
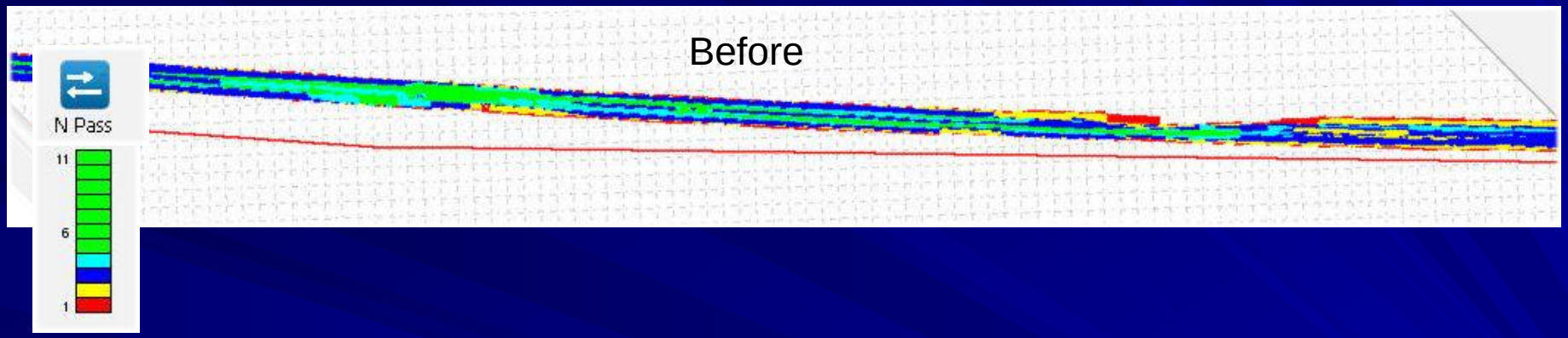
Intelligent Compaction

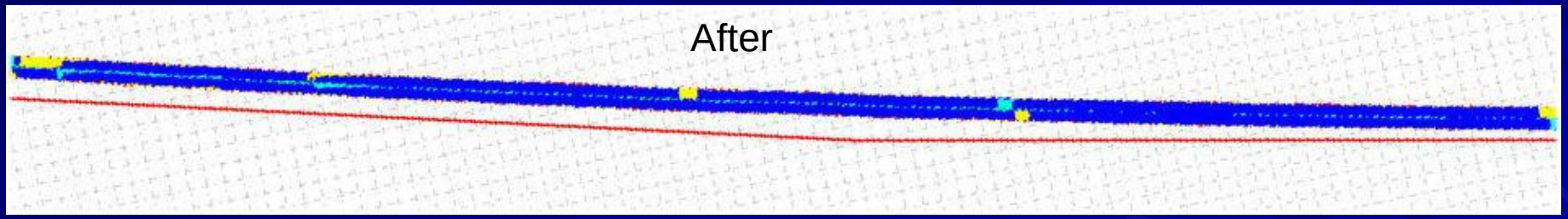


- US 52, West Lafayette, IN
- Mapping milled HMA surface
- New HMA overlay

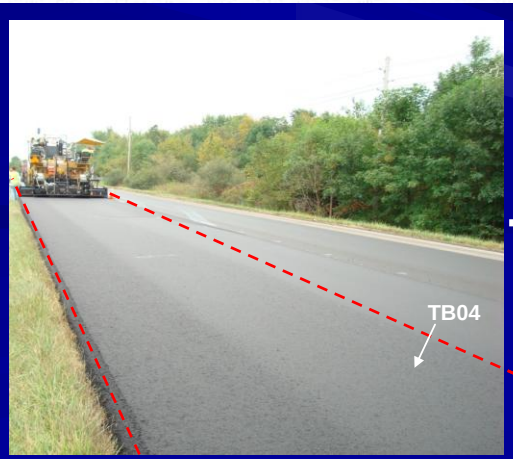


Intelligent Compaction





Sakai Double-drum IC roller



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Intelligent Compaction

- Future Initiatives:
  - Regional Conferences – that target practiti
  - Establishment of Optimum Measurement Values
  - Guidance Manual/Best Practices for both Soils and Hot Mix Asphalt Materials
  - Mini-IC Demo's: Limited support for field trials with Non-TPF States
  - Web-Page Continuation
  - 2010 Schedule

Intelligent Compaction

May	Wisconsin	HMA- Full	
May/June	Texas	HMA-Mini	
June	Virginia	HMA-Full	
June/July	North Dakota		Soils-Full
June/July	Pennsylvania	HMA-Mini	Soils-Full
June/July	Indiana		Soils-Full
June/July	Tennessee	HMA-Mini	
July/Aug	California	HMA-Mini	
August	BIA	HMA-Mini	

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Welcome

This is your one-stop shop for Intelligent Compaction (IC)! All content posted in this site is by the research team under the US FHWA research project DTFH61-07-C-R0032 "Accelerated Implementation of Intelligent Compaction Technology for Embankment Subgrade Soils, Aggregate Base, and Asphalt Pavement Materials". This project is to realize the blueprint in the FHWA IC strategic plan.

This study was initiated under Transportation Pooled Fund (TPF) Solicitation No. 954, which includes 13 participating State department of transportation (DOTs): Georgia, Indiana, Iowa, Kansas, Maryland, Minnesota, Mississippi, North Dakota, New York, Pennsylvania, Texas, Virginia, and Wisconsin. The purposes of this project are to:

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Internet

start IC Presentations Microsoft Power... Welcome | Intelli... 8:38 PM

U.S. Department of Transportation
Federal Highway Administration

www.intelligentcompaction.com

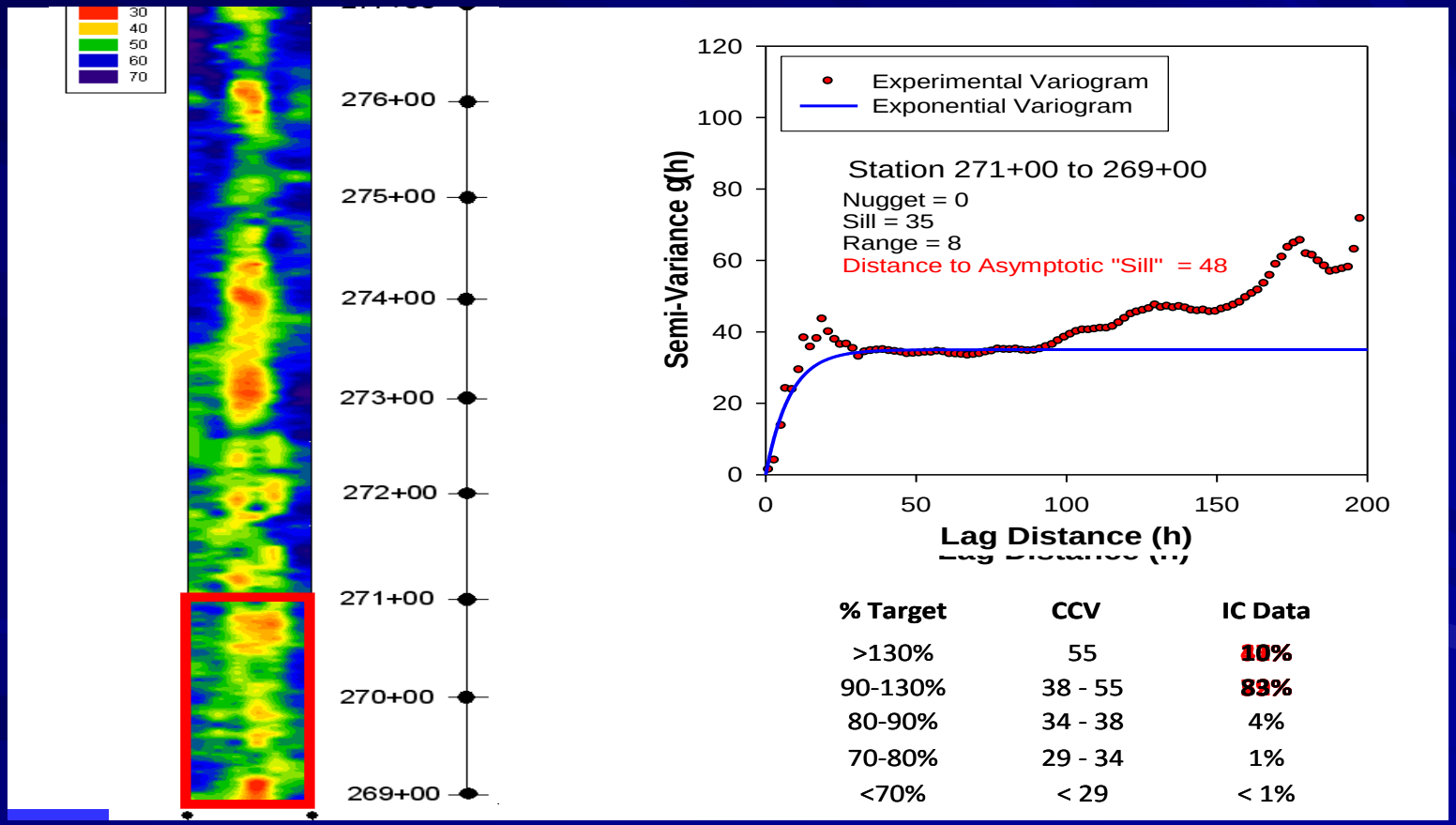
Benefits of IC

- **Improve density…**
  better performance
- **Improve efficiency…**
  cost savings
- **Increase information…**
  better QC/QA

Ultimate Goals of TPF IC

- Gain the knowledge needed to develop credible and productive **IC specifications** for future projects

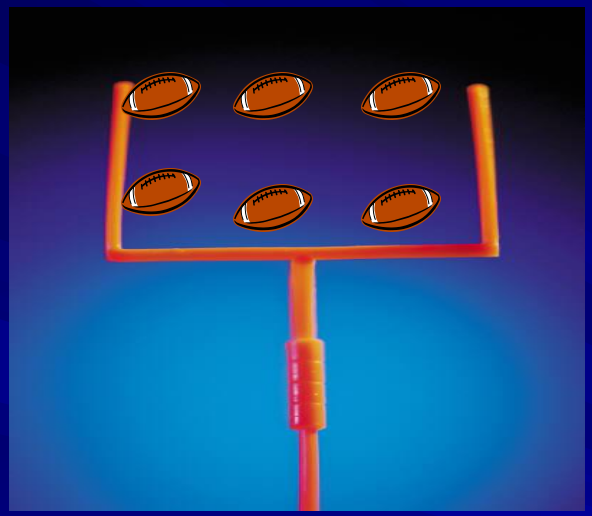
Future IC Spec



% Target	CCV	IC Data
>130%	55	10%
90-130%	38 - 55	83%
80-90%	34 - 38	4%
70-80%	29 - 34	1%
<70%	< 29	< 1%

Courtesy of Dr. David White

Indianapolis - Colts



Superbowl XLIV
Champions - 02/07/2010

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Thank you