NCAT RAP Research

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ALDOT RAP

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ALDOT RAP

- Characterize RAP without using traditional solvents
- Develop method to select appropriate RAP/shingles and virgin material proportions and properties
- Identify method to characterize mixes with RAP and/or shingles
- Evaluate the feasibility of RAP in OGFC

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Indirect Methods

- Dynamic Modulus

- Bending Beam Rheometer

- Dynamic Shear Rheometer Torsion Bar

- Indirect Tension Relaxation Modulus

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FHWA RAP

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FHWA RAP

- Document high RAP content projects
  - RAP Percentage > 25%
- Evaluate field mix
- Evaluate the need for binder bumping
- Evaluate binder blending
- Best practices document
- Develop mix design guide
  - Identify proper RAP heating in laboratory
  - Identify most appropriate extraction method
  - Identify successful techniques for designing mixes

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Heating RAP for Mix Design

- Four heating scenarios
  - Heat virgin aggregate and RAP for same amount of time prior to blending
  - Heat virgin aggregate and RAP for 16 hours prior to blending
  - Heat virgin aggregate for three hours and RAP for minimum time and then blend
  - Superheat virgin aggregate and blend with room temperature RAP
- Extract binder and evaluate binder properties

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RAP Heating Results

Virgin Heating Time	Virgin Temperature	RAP Heating Time	RAP Temperature	Average Asphalt Content
3 hours	355 °F	3 hours	355 °F	2.11
3 hours	355 °F	30 min	355 °F	1.98
16 hours	355 °F	16 hours	355 °F	0.79
3 min	500 °F	0	Room Temp.	2.35

RAP Heating Study

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Extraction Evaluation

- Cooperative research with ARC
- Each agency is evaluating two aggregate sources
- Aggregate consensus properties before manufacturing “RAP”
- Blend aggregate and asphalt and age to create “RAP”
- Extract using centrifuge, reflux, and ignition oven
- Compare aggregate and binder properties

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NCAT Test Track RAP Study

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Test Track RAP Study

- Sponsored by Old Castle, ALDOT, and NCDOT
- 7 Sections

Virgin Binder	Control	20% RAP	45% RAP
PG 52-28			✓
PG 67-22	✓	✓	✓
PG 76-22		✓	✓
PG 76-22 + Sasobit			✓

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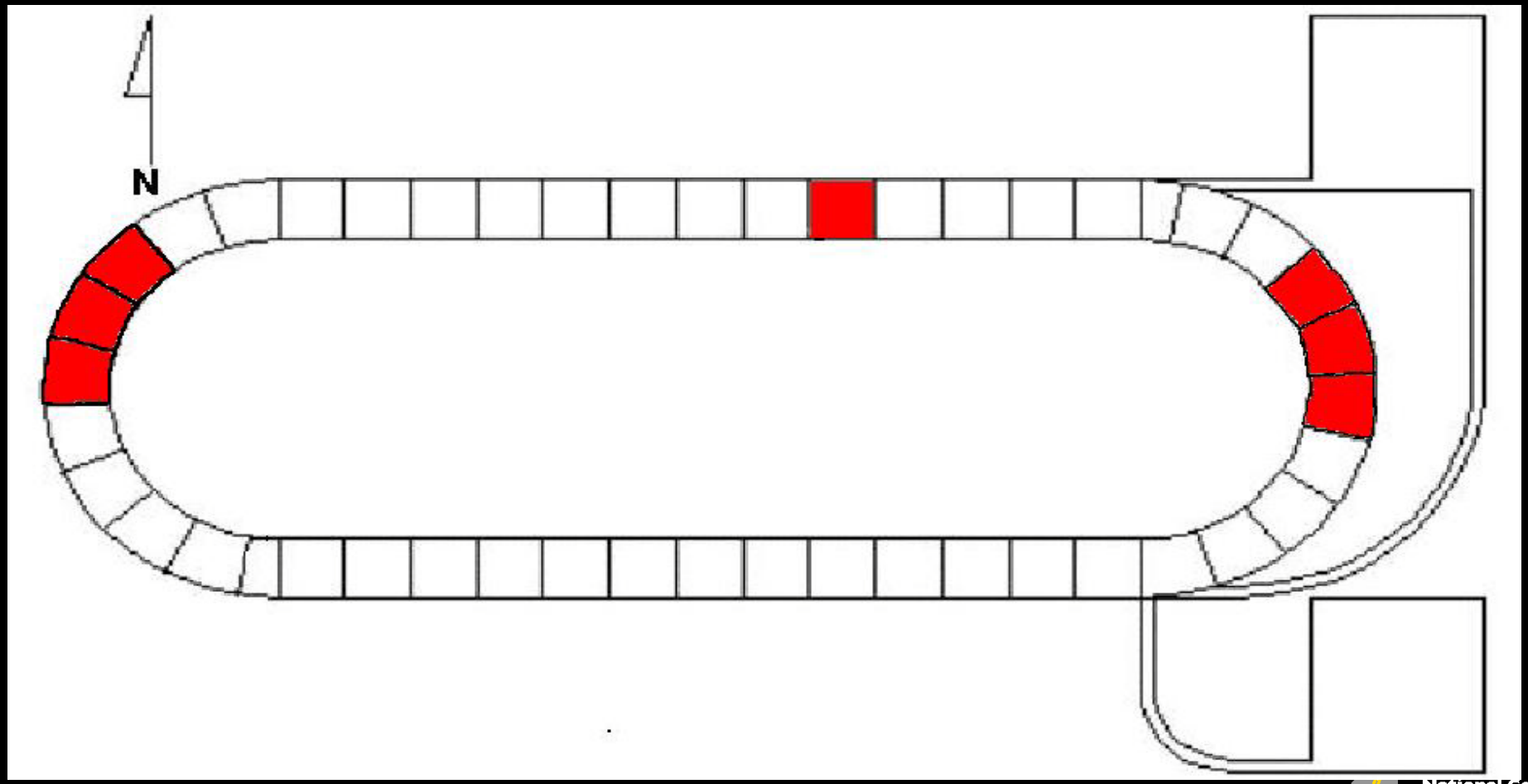
RAP Test Sections



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NCAT Test Track RAP Sections

1. virgin control mix with PG 67-22
2. 20% RAP with PG 67-22 virgin binder
3. 20% RAP with PG 76-22 virgin binder
4. 45% RAP with PG 52-28 virgin binder
5. 45% RAP with PG 67-22 virgin binder
6. 45% RAP with PG 76-22 virgin binder
7. 45% RAP with PG 76-22 + Sasobit

Objectives:

- Determine the appropriate grade of virgin binder needed for High RAP mixes.
- Assess constructability of high RAP mixes
  - Mix design issues
  - Plant issues
  - Paving and compaction
- Accelerated Traffic Performance
  - Compare rutting over time
  - Compare cracking and durability

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Fractionated RAP

Mix QC Summaries

Mix	Virgin Control	20% RAP	45% RAP
NMAS	12.5	12.5	12.5
Pb	5.8%	5.6 – 5.8%	4.9 – 5.1%
Va	2.9%	1.9 – 2.1%	1.7 – 3.6%
VMA	15.9%	14.2 – 14.5%	12.5 – 13.9%
In-Place Density	95%	92 – 94%	94 – 96%

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Test Section Construction

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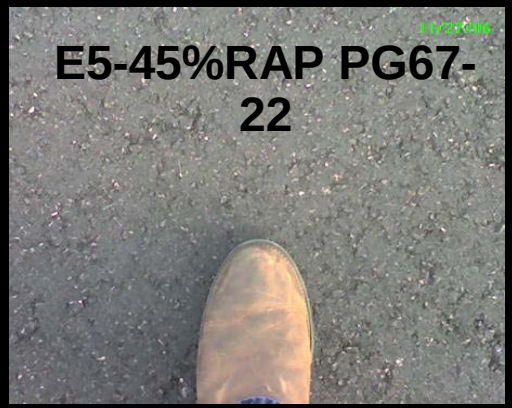
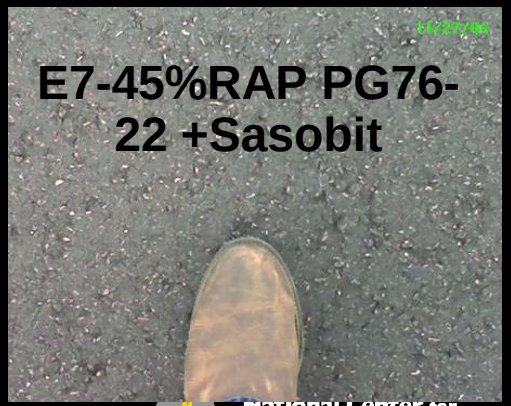
RAP Sections

No RAP

Moderate RAP

High RAP





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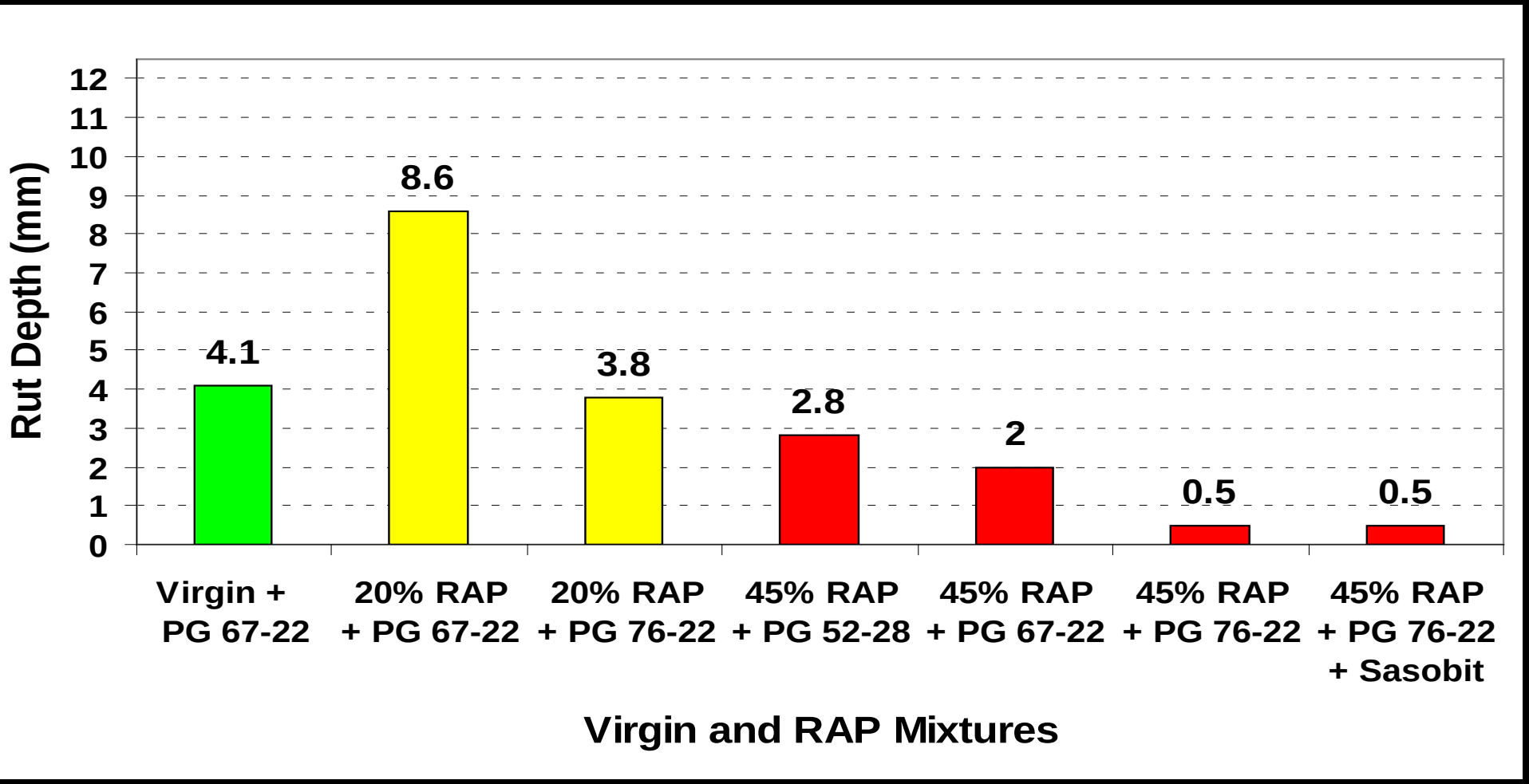
Rutting Performance @ 9.0M ESALs



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E7 45% RAP PG76-22+Sasobit

Cracking first noted in E7 in January 2008

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Recycled Mix Field Performance
E7, 45% RAP w/ PG76-22+Sasobit 1/28/08 @ 5.5M ESALs

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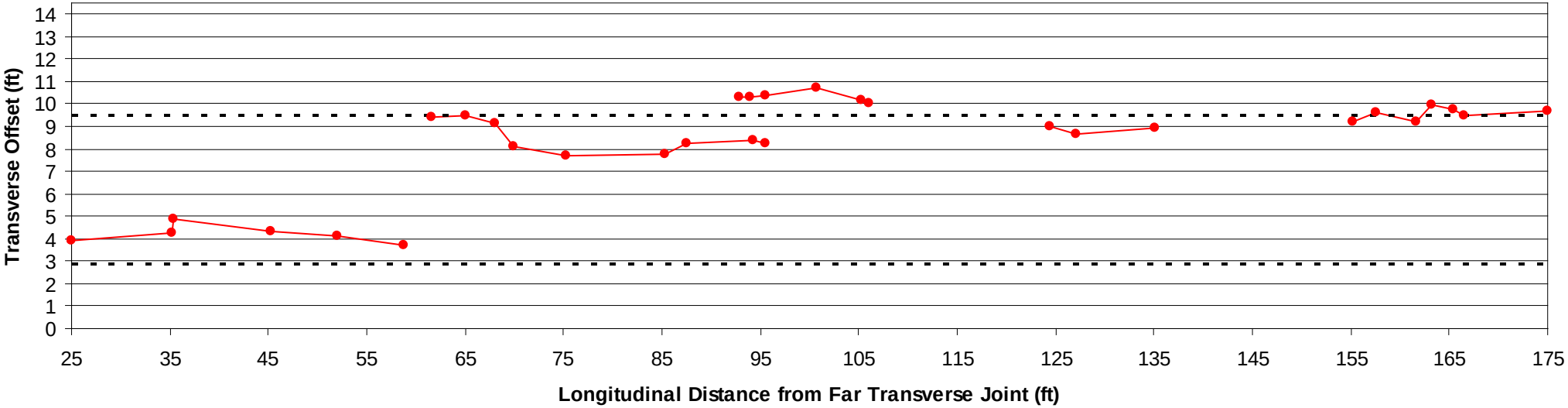
Recycled Mix Field Performance
E7, 45% RAP w/ PG76-22+Sasobit 7/21/08 @ 8.0M ESALs



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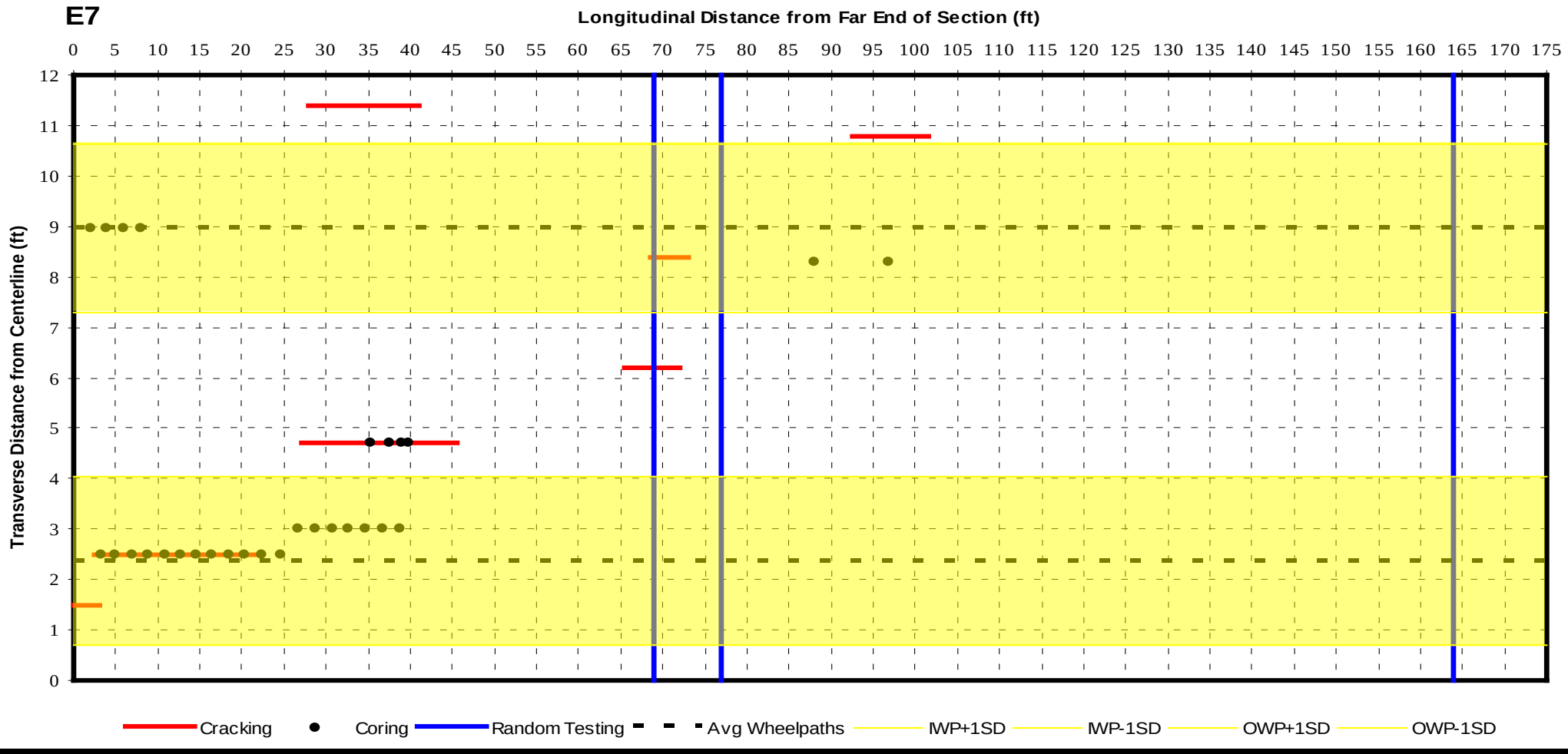
Cracking in E7 during 2003 Cycle



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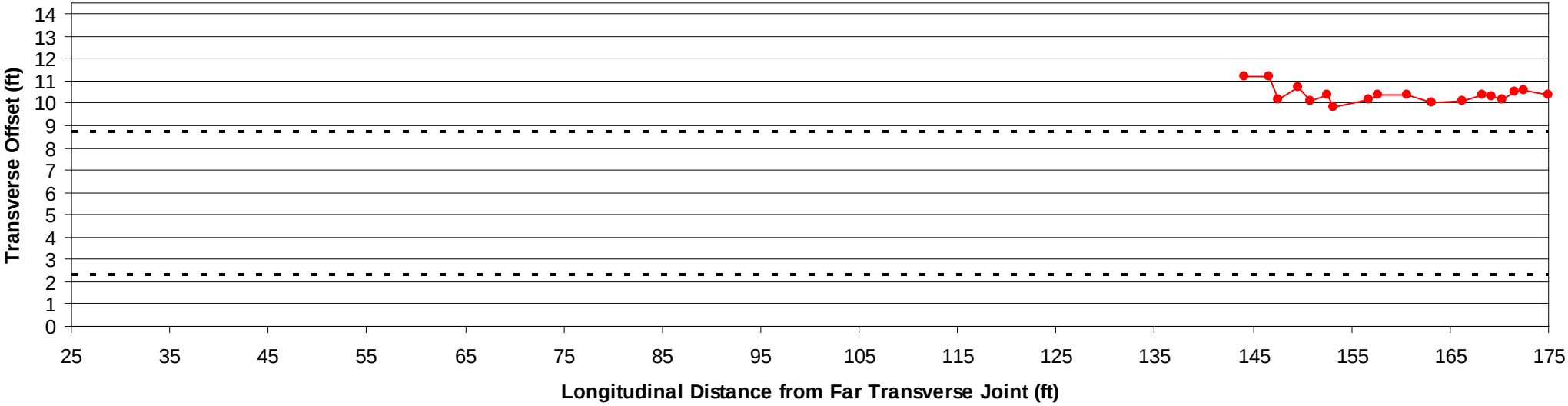
Recycled Mix Field Performance
W3, 20%RAP w/ PG76-22
4/7/08 @ 6.5M ESALs



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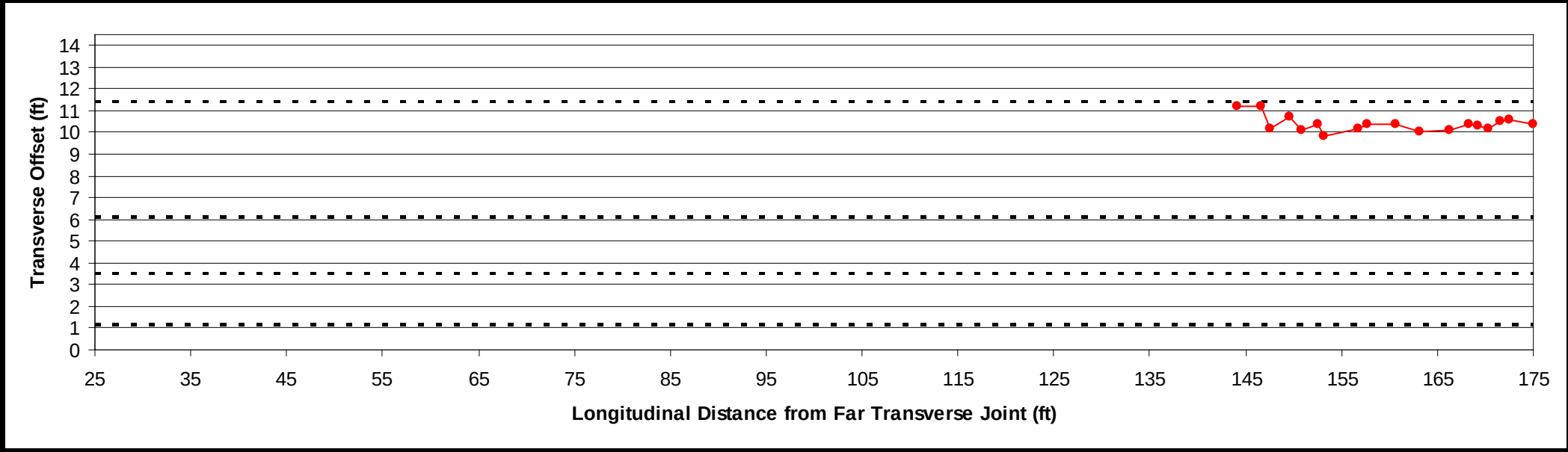
Recycled Mix Field Performance
W3, 20%RAP w/ PG76-22
7/21/08 @ 8.0M ESALs



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Cracking Observations

- No cracking has been detected except in E7 (45% RAP w/ PG76-22+S) and W3 (20% RAP w/ PG76-22)
- The cracks in E7 and W3 are low severity
- Cracking in E7 is likely due to reflection cracks from previous cycle

Texture Comparisons with Time/Traffic

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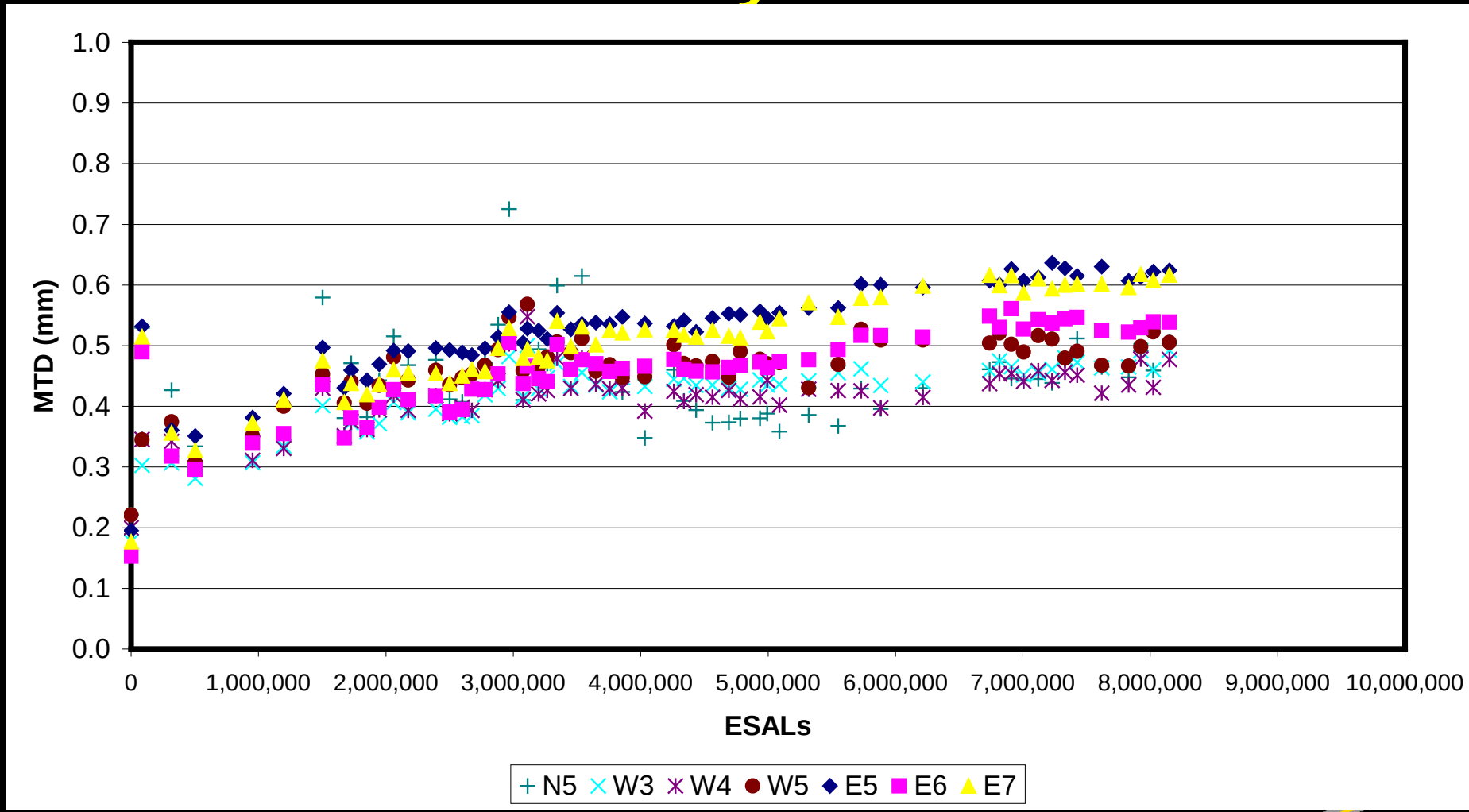
RAP Study Sections



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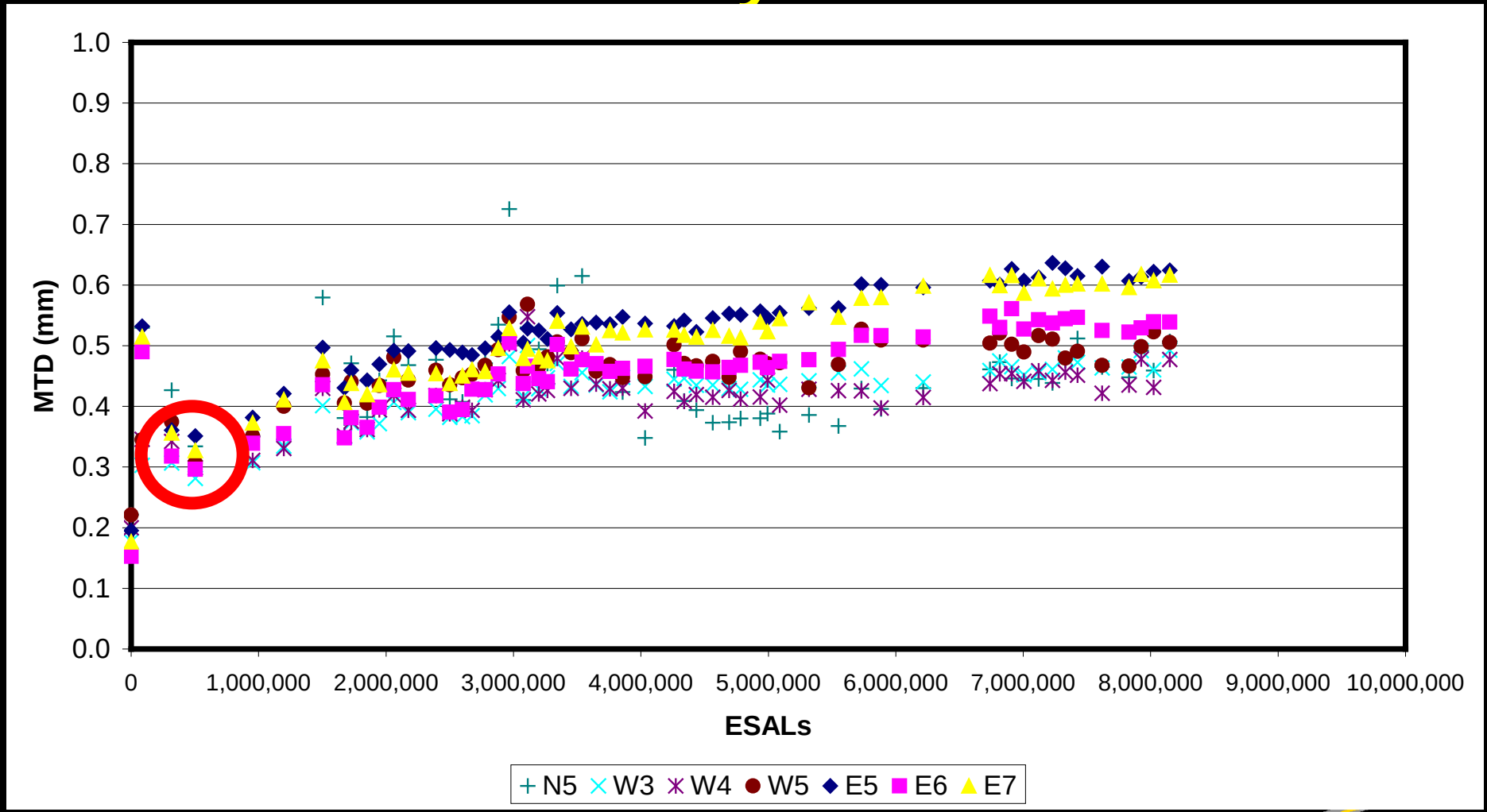
RAP Study Sections



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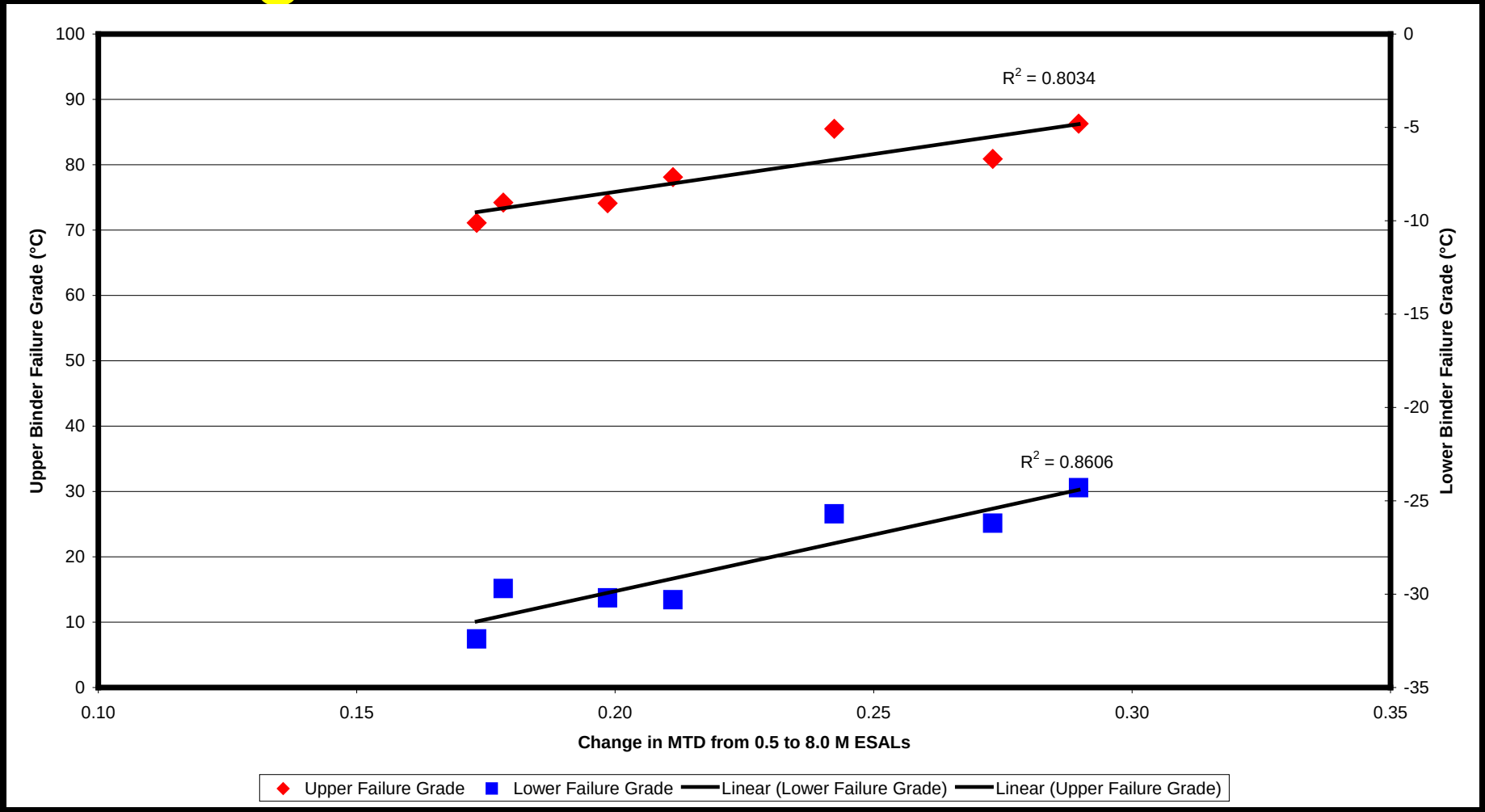
Change in MTD and Binder Grade



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Preliminary Observations

- Constructability of all RAP sections was very good. No problems encountered with compaction. The Sasobit did not appear to help compactability.
- Volumetric QC results (low Va, high VFA) were marginal for some sections.

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Preliminary Observations

- Rutting performance on the track has been good.
- Low severity cracking near edge of wheelpaths in section E7 (45% RAP w/ PG76-22+S) is progressing in extent. This cracking is likely reflection cracking from the previous cycle.
- Single longitudinal wheel path crack in W3 (20% RAP w/ PG76-22) is progressing at much slower rate.

Preliminary Observations

- Changes in pavement macro-textures appear to be related to binder failure grade. The texture changes of the RAP sections are within typical ranges.

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NCHRP 09-46

- Mix design procedure for high RAP content mixes
  - 25% or more
- Maintain current procedure with minor changes
- Standard PG during mix design
- Mix test evaluate stiffness
  - Circumvent binder blending issue
- Recommend performance test
- Assess moisture susceptibility and durability

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Questions?

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