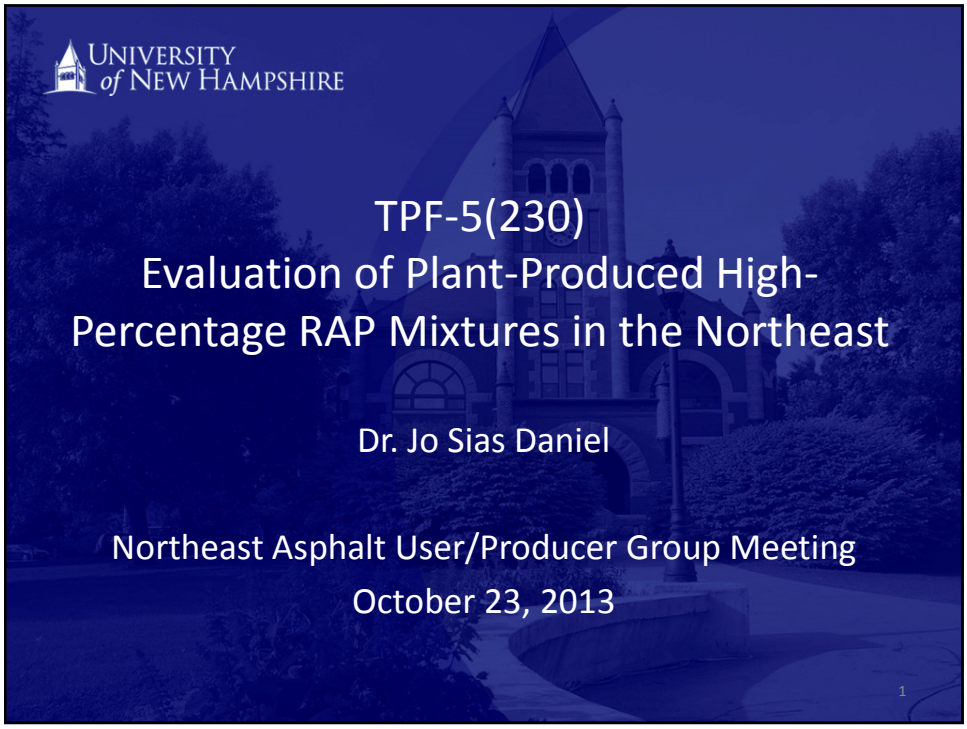
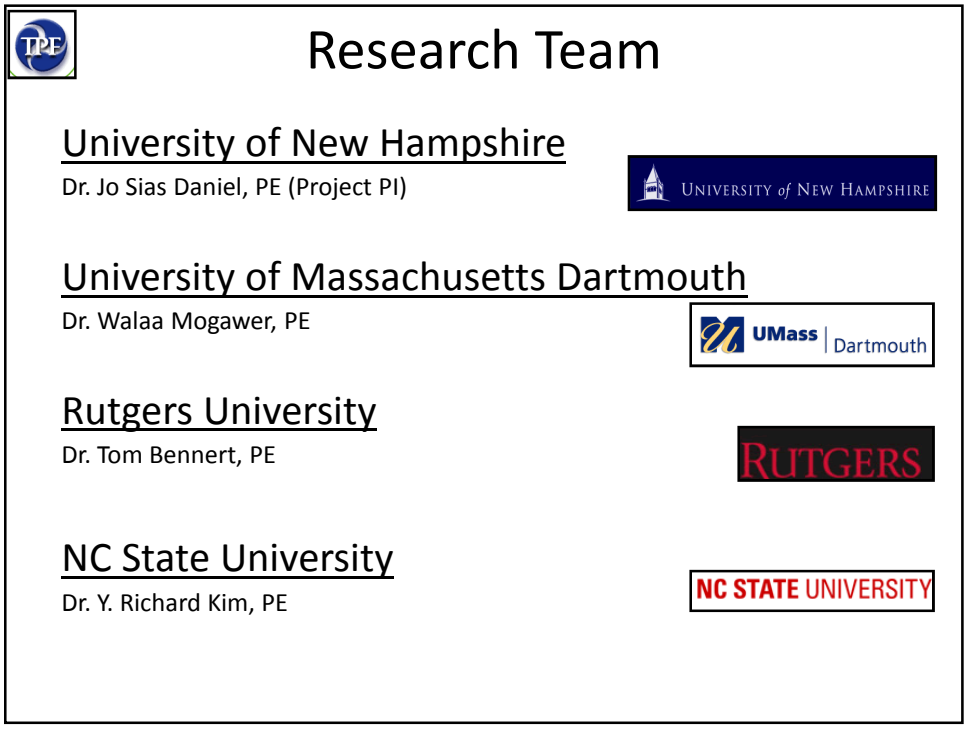

UNIVERSITY of NEW HAMPSHIRE
TPF-5(230)
Evaluation of Plant-Produced High-Percentage RAP Mixtures in the Northeast
Dr. Jo Sias Daniel
Northeast Asphalt User/Producer Group Meeting
October 23, 2013
1


Research Team
University of New Hampshire
Dr. Jo Sias Daniel, PE (Project PI)
UNIVERSITY of NEW HAMPSHIRE
University of Massachusetts Dartmouth
Dr. Walaa Mogawer, PE
UMass | Dartmouth
Rutgers University
Dr. Tom Bennert, PE
RUTGERS
NC State University
Dr. Y. Richard Kim, PE
NC STATE UNIVERSITY

Current Participants

- New Hampshire (NHDOT) - Lead Agency
- Maryland (MDOT)
- New Jersey (NJDOT)
- New York (NYSDOT)
- Pennsylvania (PennDOT)
- Rhode Island (RIDOT)
- Virginia (VDOT)
- Federal Highway Administration (FHWA)

3

Project Objectives

- Evaluate the performance of plant-produced RAP mixtures (in the laboratory and field) in terms of low temperature cracking, fatigue cracking and moisture sensitivity.
- Provide further understanding of the blending that occurs between RAP and virgin binder in plant-produced mixtures.

4

Testing

- Recovered Binder
  - PG grade
  - CCT
  - G* master curve
- Mixture
  - Dynamic Modulus
  - Hamburg & TSR
  - Low Temperature Creep & Strength
  - Fatigue (AMPT S-VECD protocol): crack initiation
  - Overlay Tester: crack propagation
  - Beam Flexure

5

Project Status

- Phase I (2010 season): All mixture testing completed. Binder testing being redone. Research team doing detailed analysis on all sets of mixtures for an interim report.
- Phase II (2011 season): Silo storage, NH field mixtures, VA mixtures. Testing and data analysis ongoing. Determination of S-VECD failure criteria.
- Phase III (2013 season): laboratory study to evaluate effect of bumping binder grade and increasing virgin asphalt content. Testing underway.
- Future Phases: based on results of Phase III, and questions remaining from Phase II

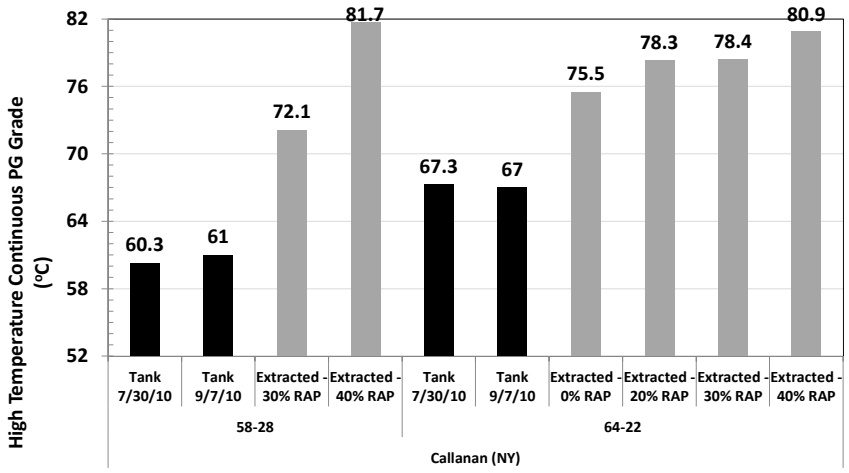
6

Phase I Mixtures: 2010 Production

Plant	NMAS (mm)	PG Grade	RAP Content (%)			
			0	20	30	40
Callanan NY (drum)	12.5	64-22	x	x	x	x
		58-28			x	x
Pike VT (batch)	9.5	58-28	x	x	x	x
		52-34	x	x	x	x
Pike NH (drum)	12.5	64-28	x	x	x	x

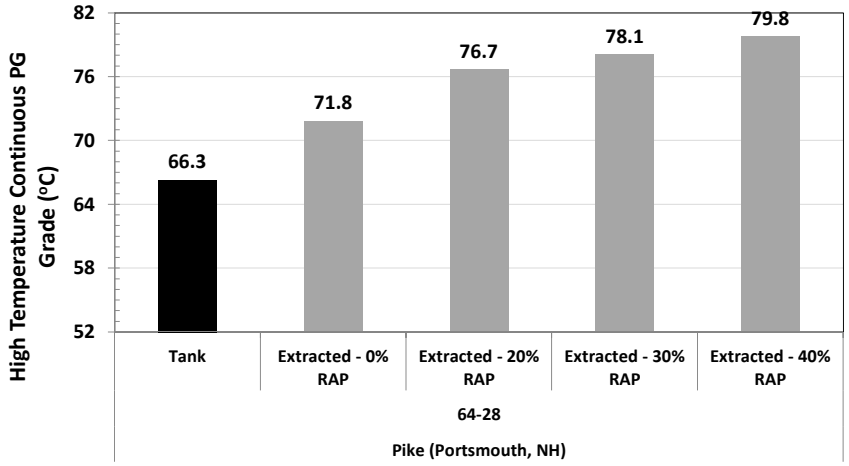
7

High PG: NY Mixtures



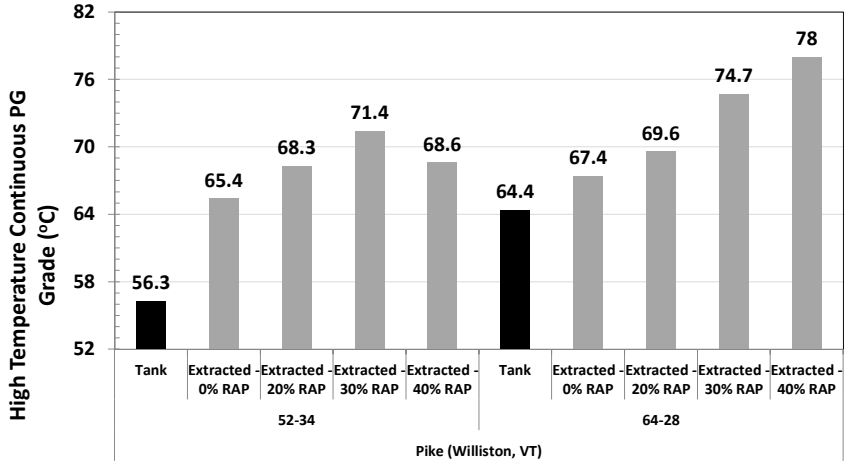
8

High PG: NH Mixtures



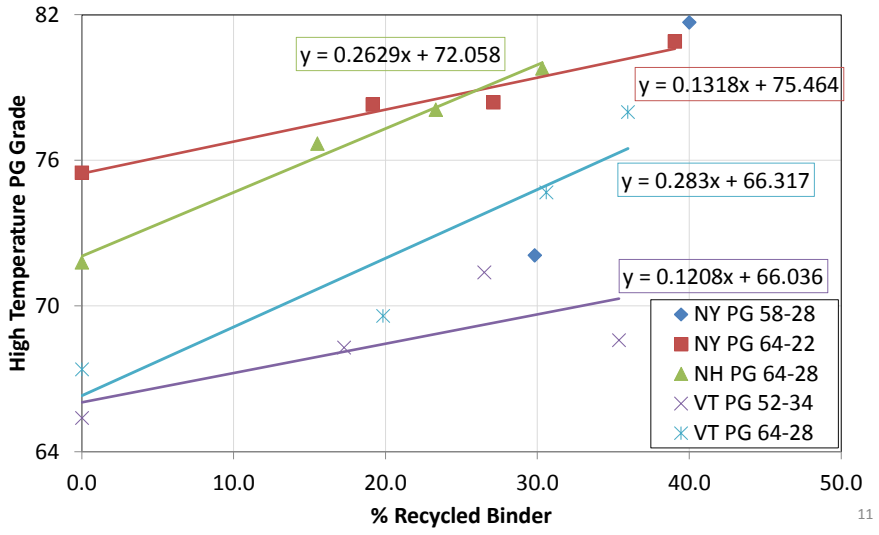
9

High PG: VT Mixtures



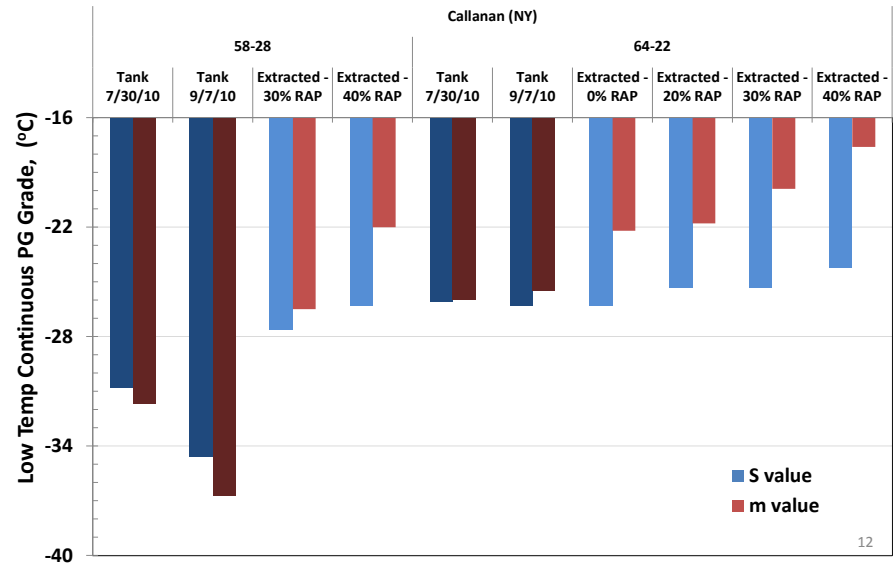
10

High PG Trend with RAP



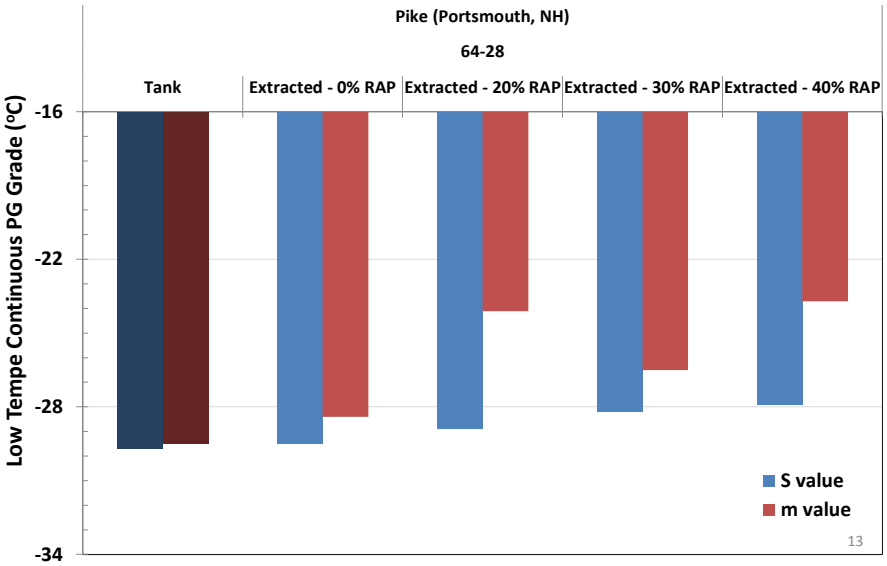
11

Low PG: NY Mixtures

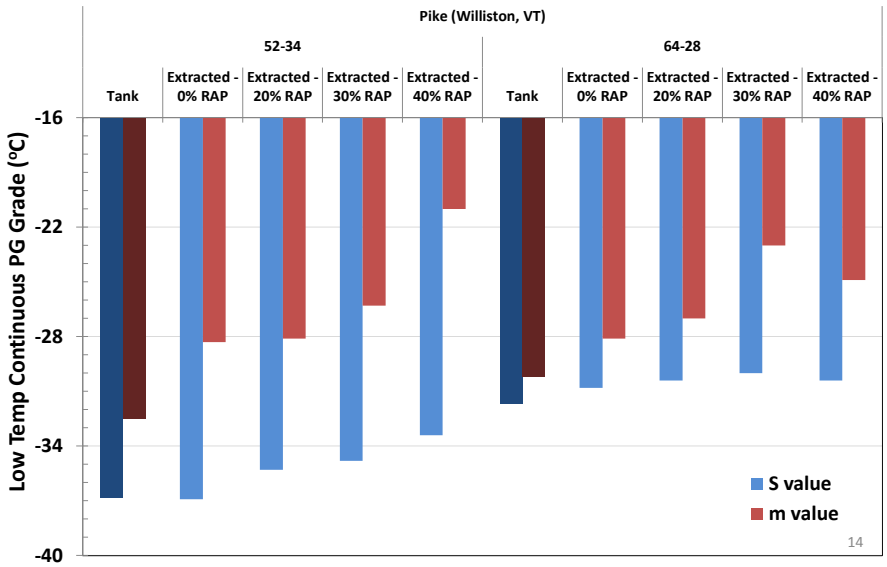


12

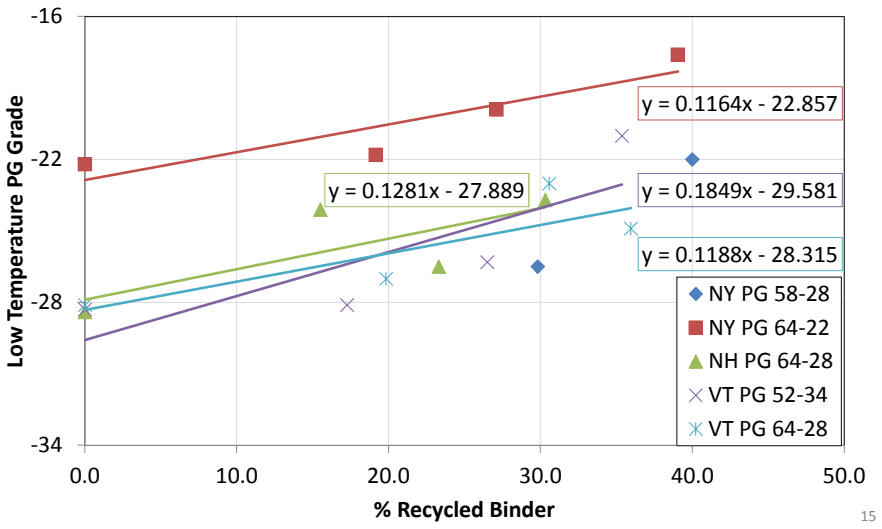
Low PG: NH Mixtures



Low PG: VT Mixtures

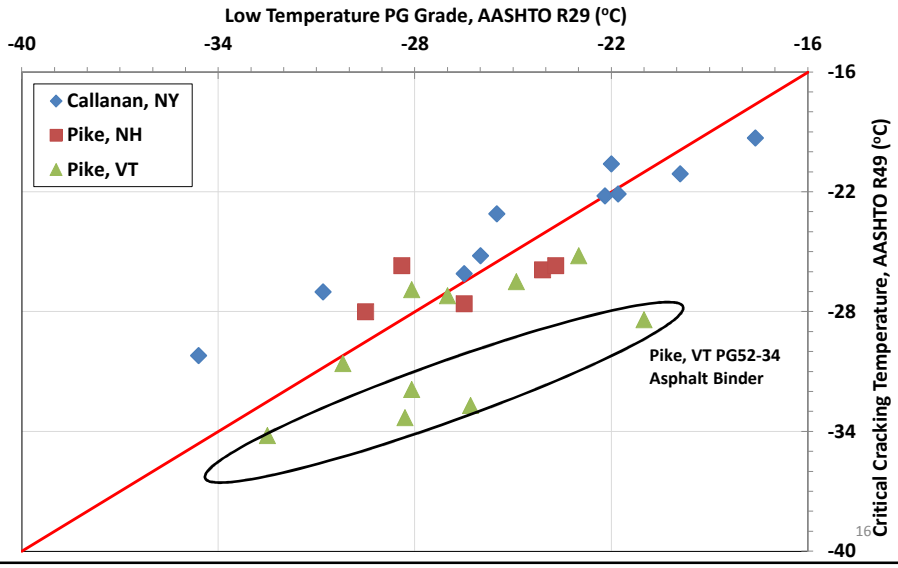


Low PG Trends



15

CCT and Low PG Comparison



16

Phase I Conclusions

- Specimen preparation matters (PMLC vs PMPC)
- Softer binder grade effective in some cases, not in others
- Impact of plant production parameters
  - Mixing temperature
  - Silo storage time

17

Phase II Mixtures: 2011 Production

- Silo Storage Study
  - NY 12.5 mm mixture with PG 64-22
  - Virgin: 0, 2.5, 5.0, 7.5 hours storage (~340 F)
  - 25% RAP: 0, 2.5, 5.0, 7.5, 10.0 hours storage (~340 F)
- NH mixtures – field sections
  - PG 58-28: 0%, 15%, 25% RAP
  - PG 52-34: 25%, 30%, 40% RAP
- VA mixtures
  - PG 76-22: 0% RAP
  - PG 70-22: 20% RAP
  - PG 64-22: 30%, 40% RAP

18

Silo Storage Study

- 25% RAP mixtures
  - Increase in stiffness with longer storage times
  - Observed in binder and mixture testing
  - Implies additional aging is occurring in silo
  - Can't separate aging vs additional blending
- Vi[illegible] m[illegible]s

19

Phase III Testing Plan

- Controlled laboratory study
- Examine impact of binder grade and total asphalt content
- Use NH mixtures from Phase I to compare with plant produced mixtures

20

Phase III Testing Plan

Mixture	Asphalt content	RAP Content (total weight)		
		0	20	40
NH Phase I	optimum	PG 64-28	PG 64-28 PG58-28	PG 64-28 PG 58-28
	+0.5%	-	PG 64-28	PG 64-28 (PG 58-28)
	+1.0%	-	-	PG 64-28 (PG 58-28)

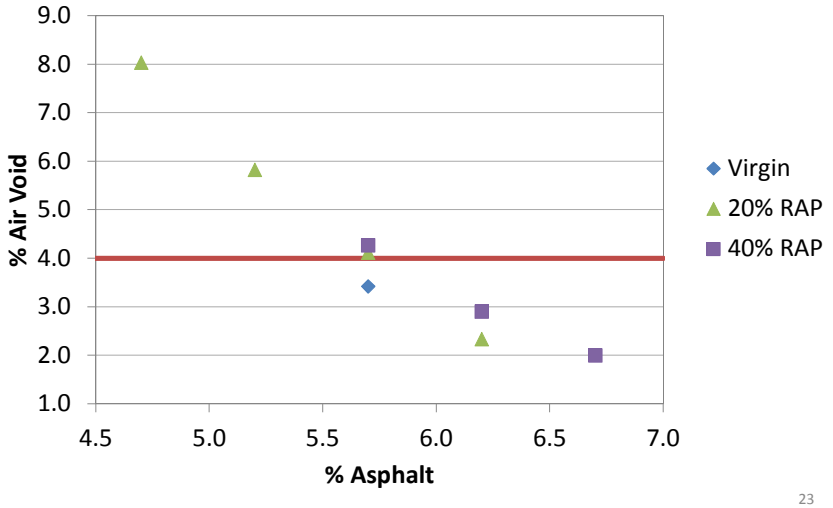
21

Phase III Testing Plan

- Binder Testing
  - PG grading including CCT
  - G* master curves
- Mixture Testing
  - Volumetrics at N_{des}
  - |E*|
  - S-VECD fatigue
  - Triaxial Stress Sweep for rutting
  - TSRST

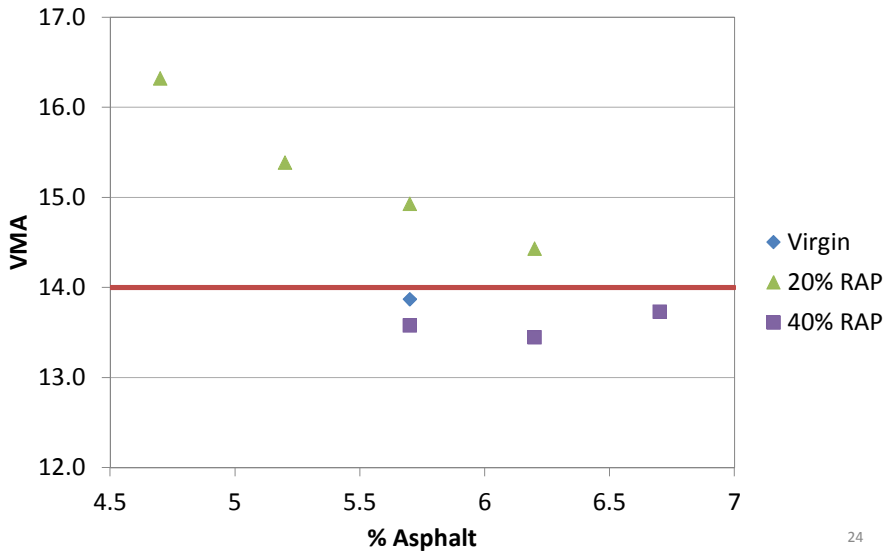
22

Phase III Air Voids



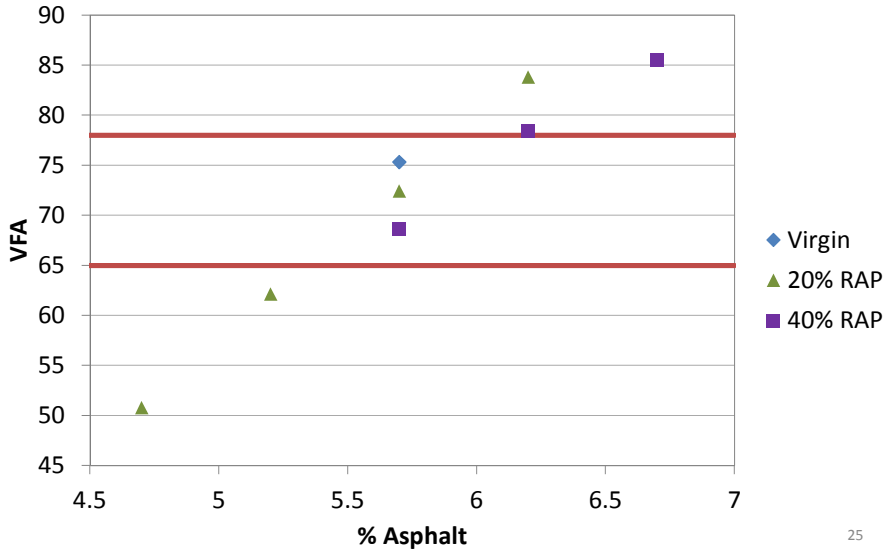
23

Phase III VMA



24

Phase III VFA



25

Additional Phases

- Additional laboratory studies on other mixtures based on results of Phase III
- Additional plant produced mixtures based on results of Phase III
- New silo storage study
- Combination of warm mix technologies and high RAP

26


Questions?