Can We Make More Use of RAP? A Study of Extracted Binder Properties in NH, VT and Maine RAP Mixes

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Northeast Pavement Preservation Partnership
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Objective

- To determine what effect the increase of RAP/Millings in HMA has on the PG Binder
- Motivating Factors
  - Private customer mixes were using greater RAP percentages
  - DOT's are requiring the bumping of grades
  - Increasing cost of binders
  - Customers are looking for ways to reduce cost without jeopardizing quality

HMA Plant Protocol

- Choose a mix that was frequently produced (12.5 mm)
- Set cold feeds to produce Virgin mix and appropriate PGB content
- Produce mix and record temperatures and sample
  - 28 samples obtained for processing
- Increase RAP to 15% while maintaining temperature and PGB content
- Repeat this process for as many different percentages as required (20 %, 25%)

Sample Sources

- Pike Industries, Inc.
  - Hooksett, NH
  - Waterford, VT
  - Poland, ME
- Brox Industries
  - Rochester, NH
  - Hooksett, NH
- Continental Paving Co.
  - Londonderry, NH
  - Litchfield, NH

Testing Procedures

- Samples were allowed to cool, boxed and transported to the Pike's Belmont Central Lab* where the samples were processed according to AASHTO's relevant procedures and according to relevant DOT methodology
- NHDOT tested companion samples for most mixtures

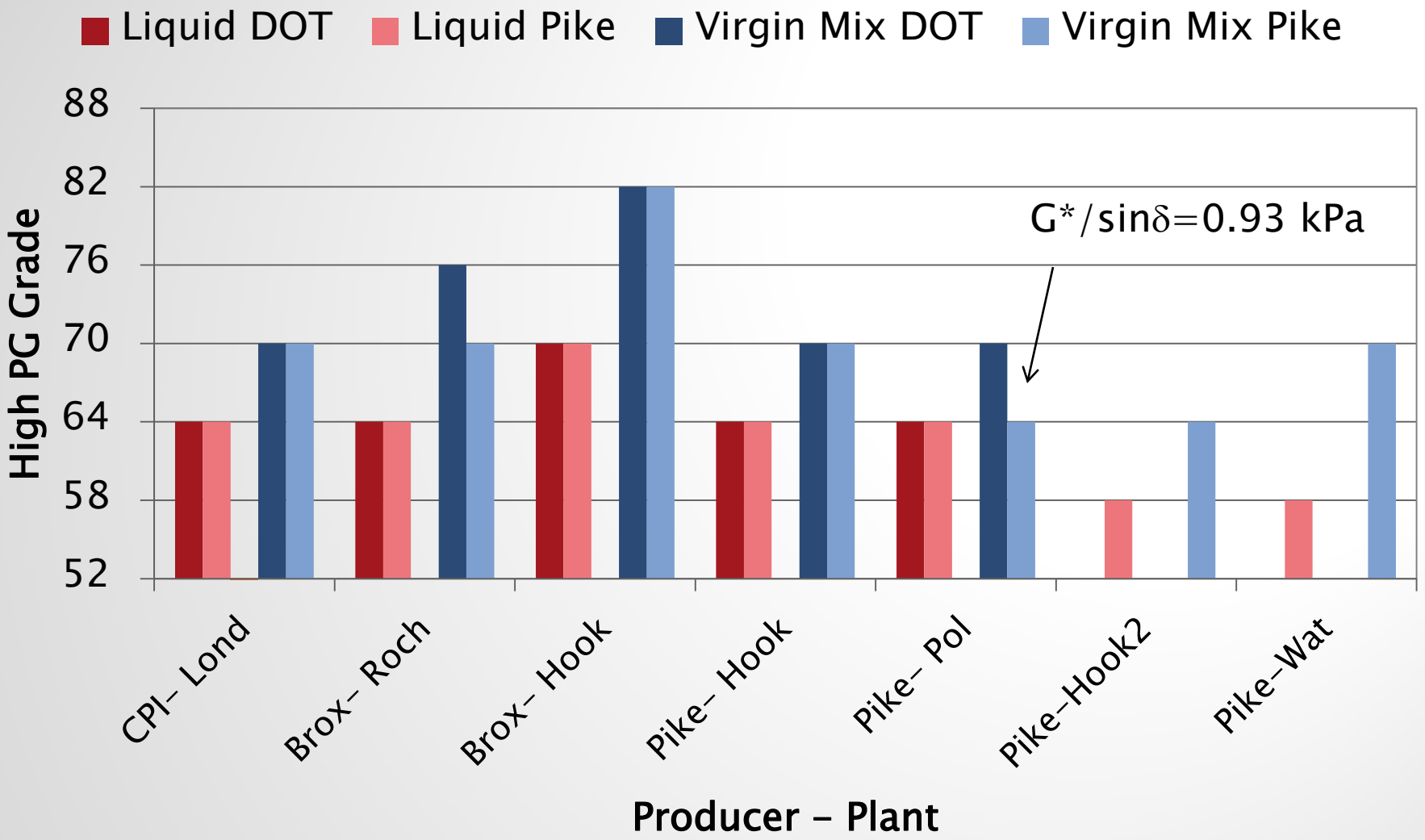
* AMRL Accredited Laboratory

Mixtures Tested

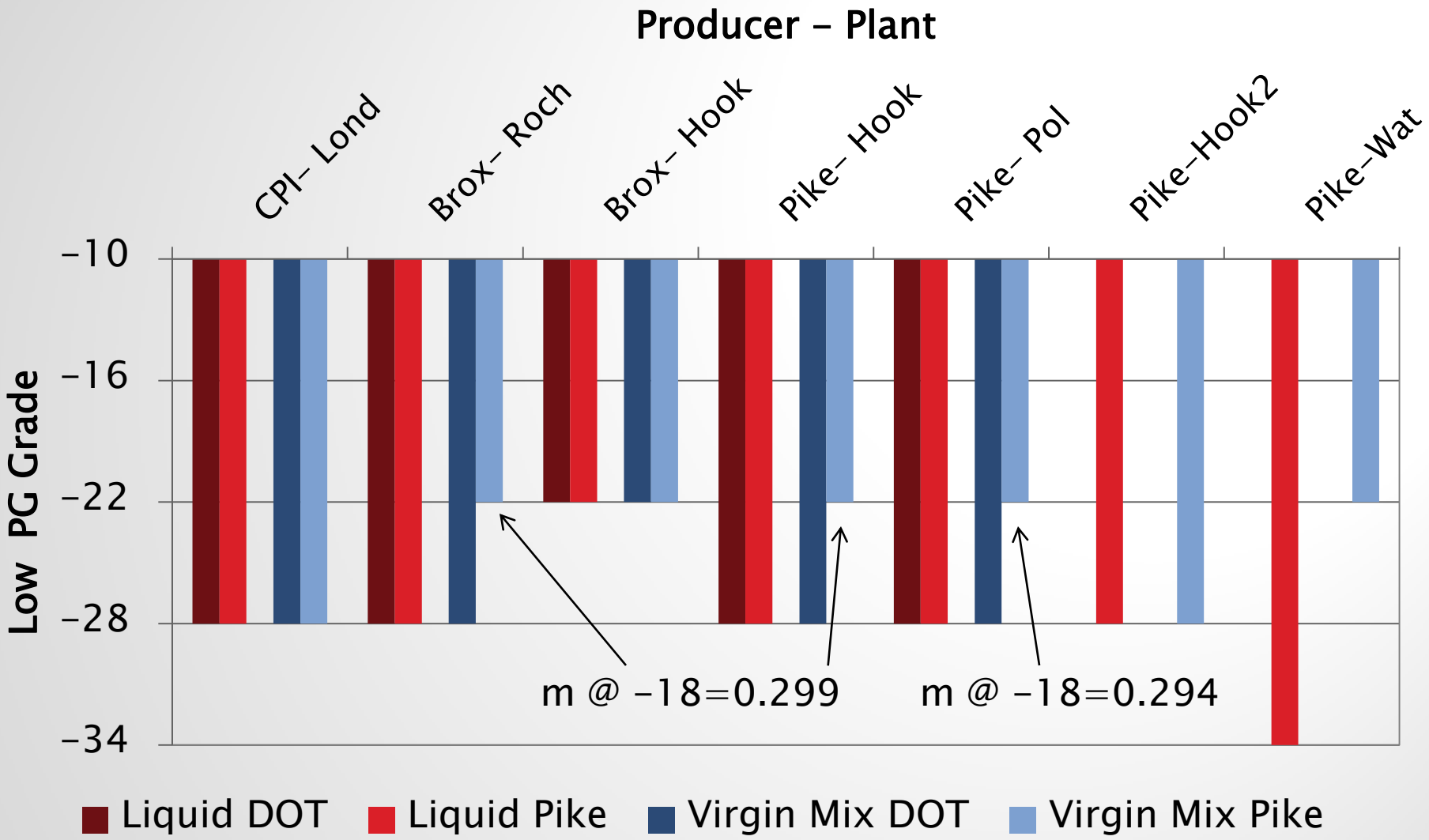
Producer	Plant	Virgin ac grade	% ac in mix	RAP percentages	RAP ac grade	% ac in RAP
Brox	Rochester, NH	PG 64-28	5.8	0, 15, 20, 25	PG 94-10	3.5
	Hooksett, NH	PG 70-22	6.0	0, 15, 20, 25	PG 88-10	3.9
CPI	Londonderry, NH	PG 64-28	6.0	0, 15, 20	PG 82-10	5.2
	Litchfield, NH	PG 64-28	6.1	15, 20	PG 88-10	4.6
Pike	Hooksett, NH	PG 64-28	5.1, 5.3, 5.4, 5.3	0, 15, 20, 25	PG 88-10	4.3
	Poland, ME*	PG 64-28	6.3, 5.8, 5.9, 6.0	0, 15, 20, 25	PG 76-22	5.0
	Hooksett, NH Mix 2	PG 58-28	5.1, 5.3, 5.4, 5.3	0, 15, 20, 25	PG 82-16	4.3
	Waterford, VT	PG 58-34	4.8, 5.2, 5.8	0, 15, 25	unknown	unknown

Effect of Plant Mixing

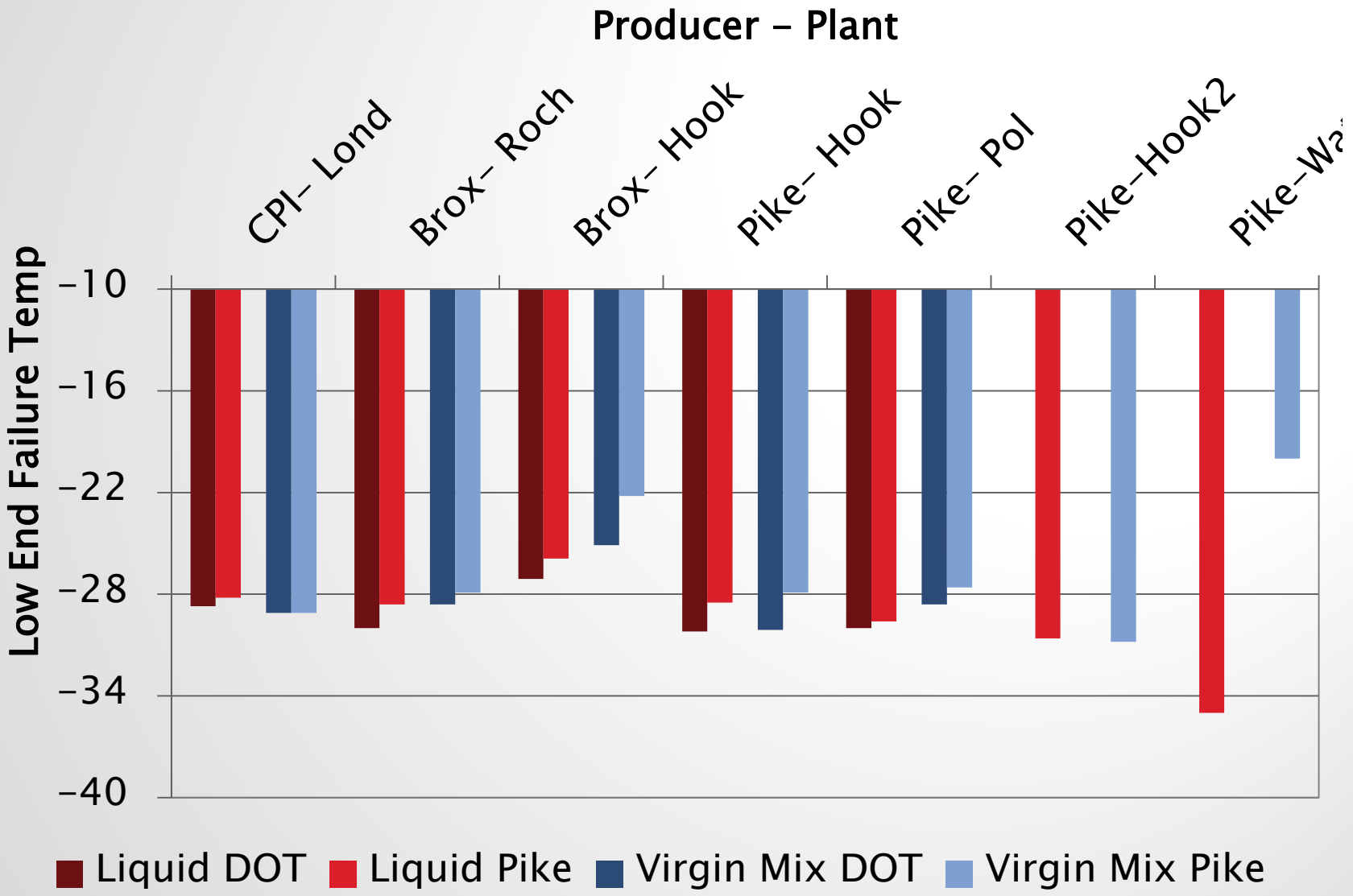
- Properties of virgin binder from tank
- Properties of extracted binder from virgin mix
- Compare:
  - High PG grade
  - Low PG grade/failure temperatures
  - Critical cracking temp

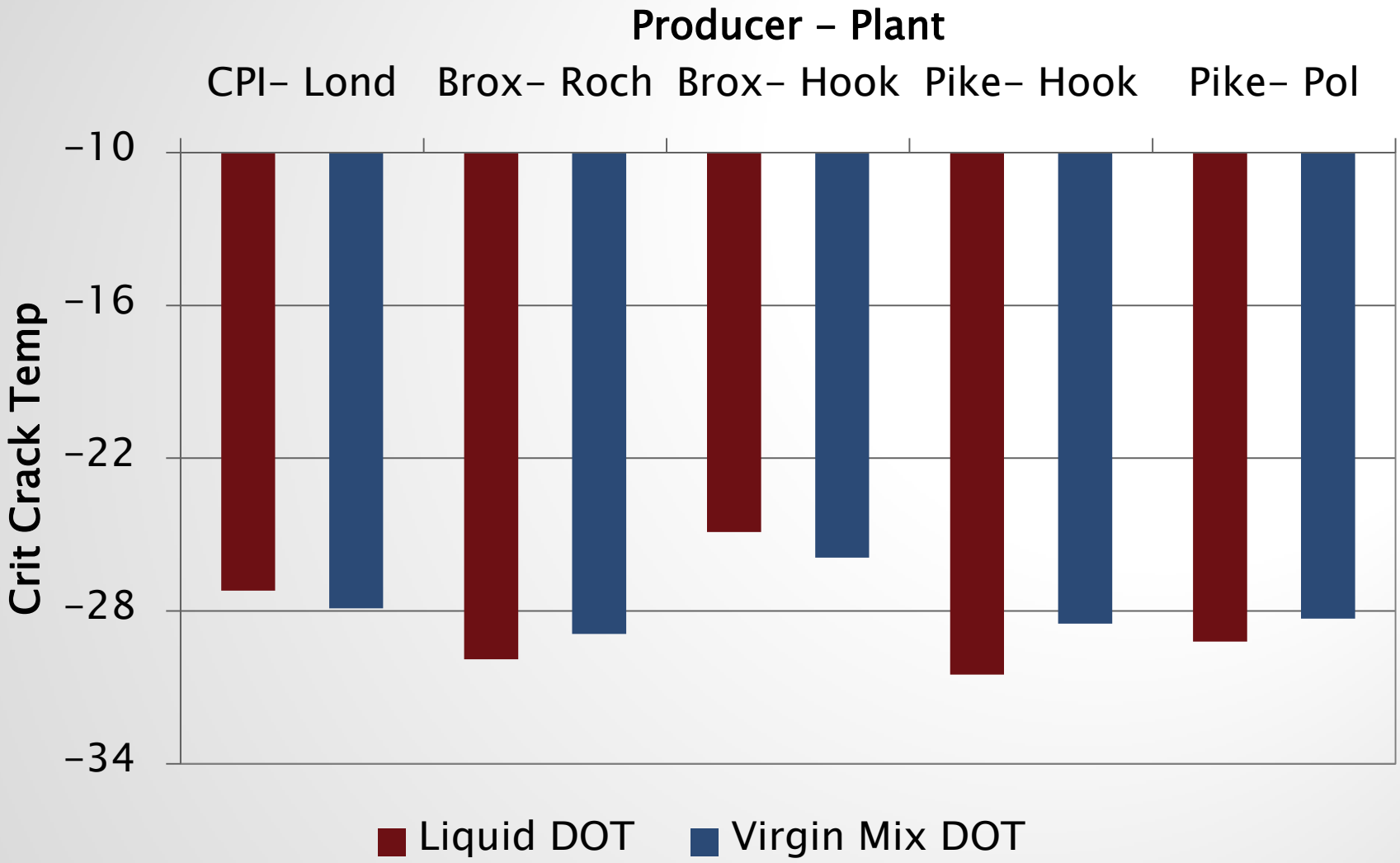


- Increase of at least one grade after mixing



- Not much change

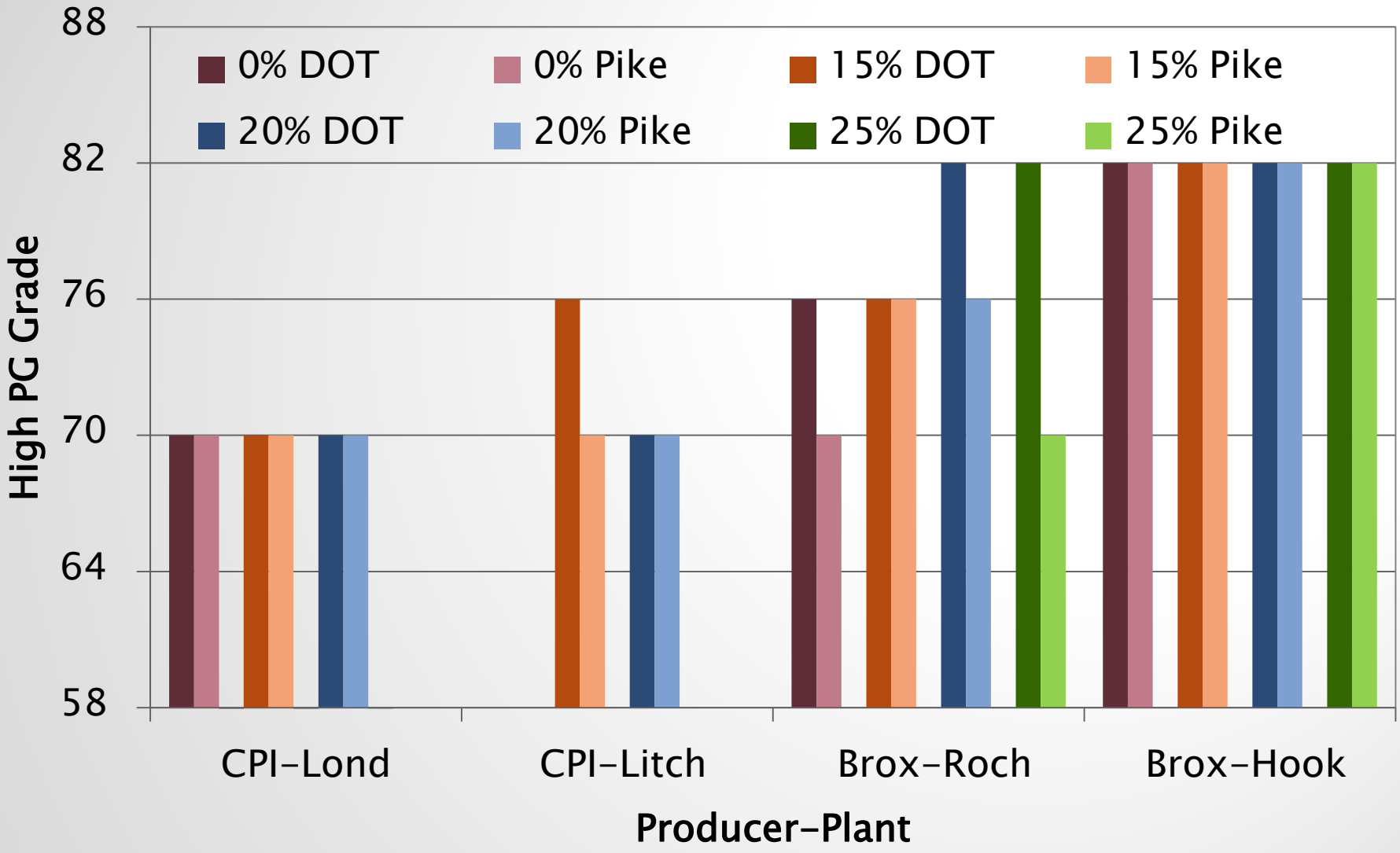

Producer – Plant
CPI– Lond
Brox– Roch
Brox– Hook
Pike– Hook
Pike– Pol
Pike–Hook2
Low End Failure Temp
-10
-16
-22
-28
-34
-40
Liquid DOT
Liquid Pike
Virgin Mix DOT
Virgin Mix Pike



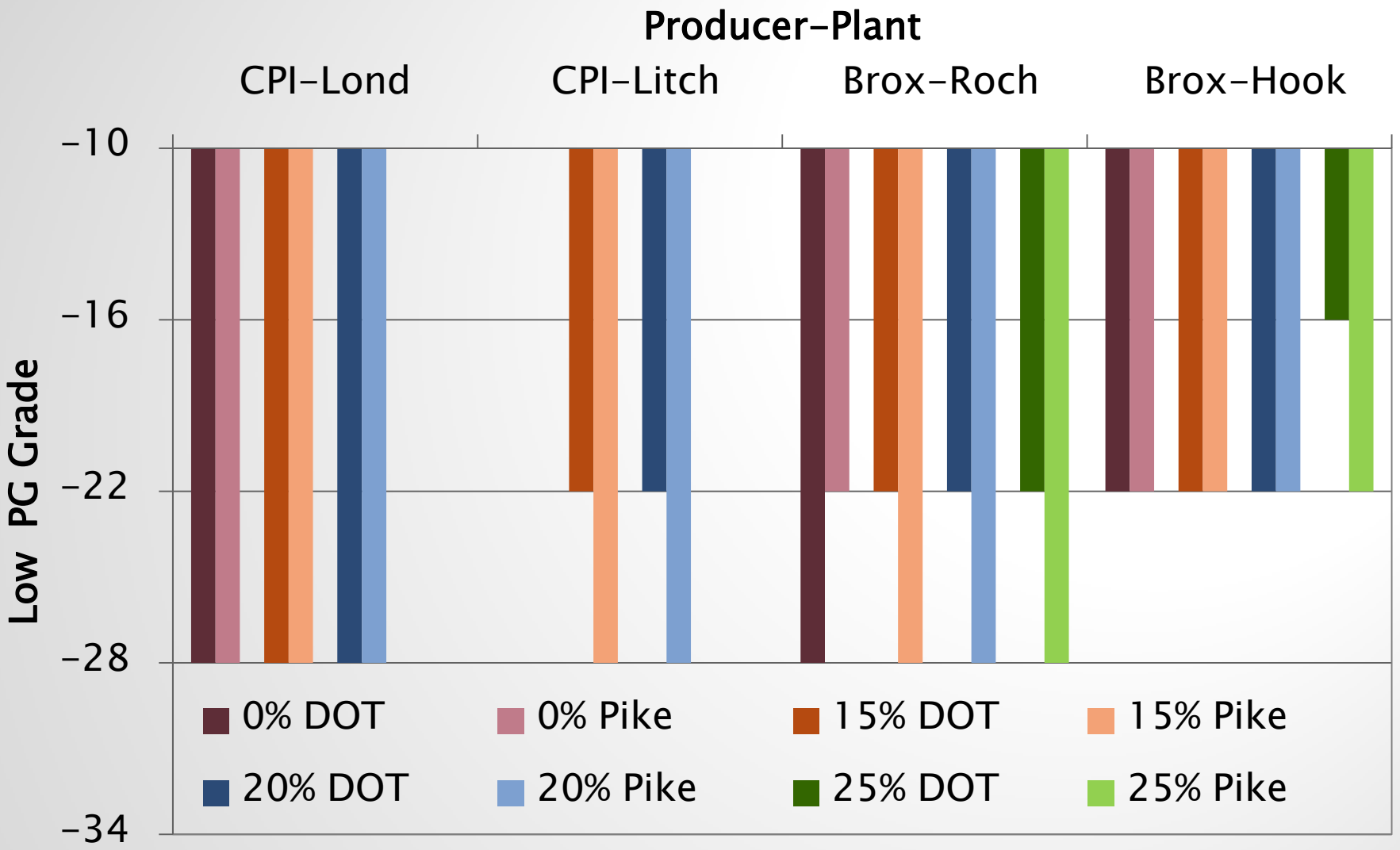
- Not much change

Comparison of RAP Mixtures

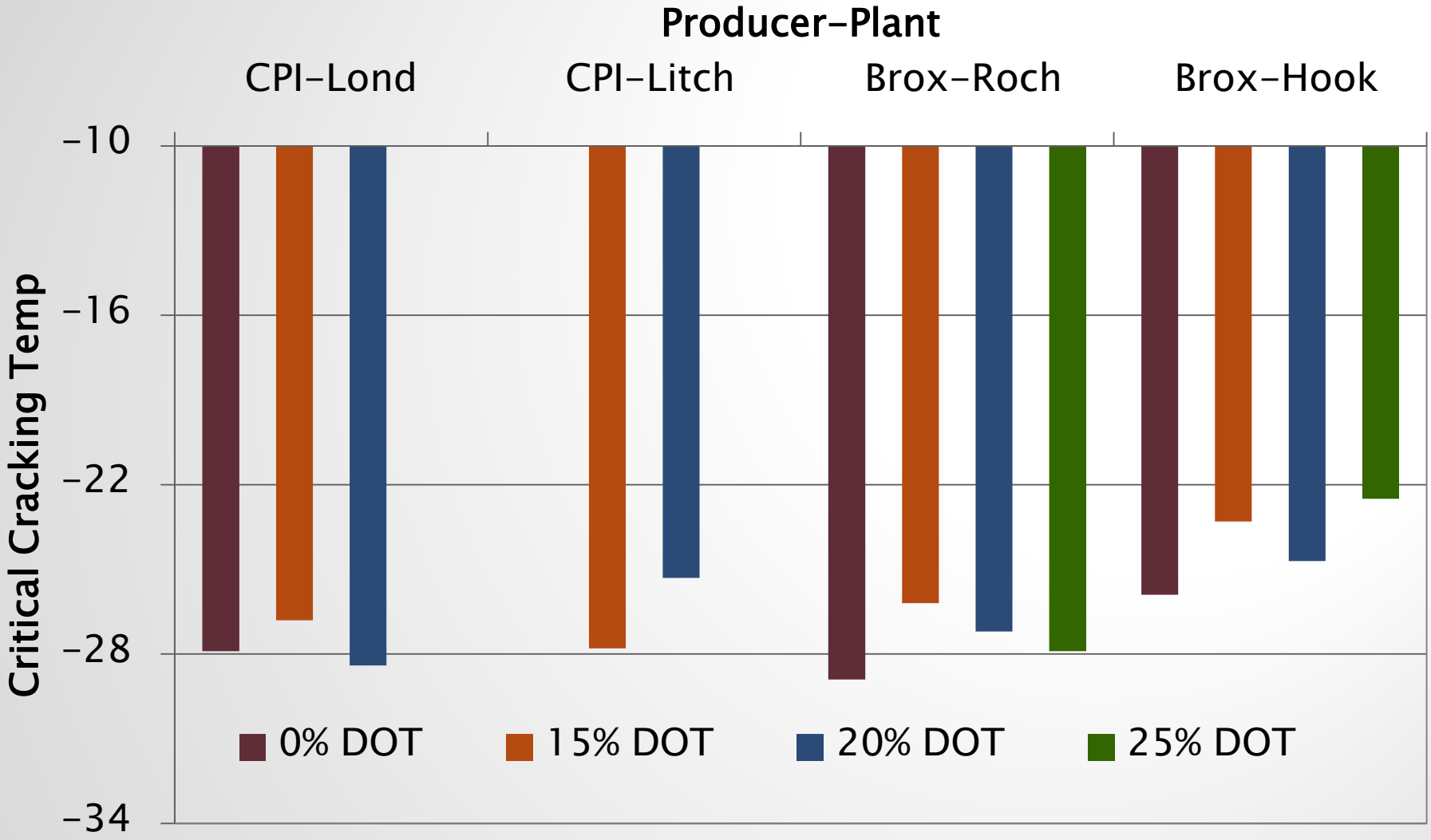
- Properties of extracted binder from virgin mix
- Properties of extracted binder from RAP mixes
- Compare:
  - High PG grade
  - Low PG grade/failure temperatures
  - Critical cracking temp



- One PG bump, mostly >20%



- One PG bump in some cases


Producer-Plant
CPI-Lond
CPI-Litch
Brox-Roch
Brox-Hook
-10
-16
-22
-28
-34
Critical Cracking Temp
0% DOT
15% DOT
20% DOT
25% DOT

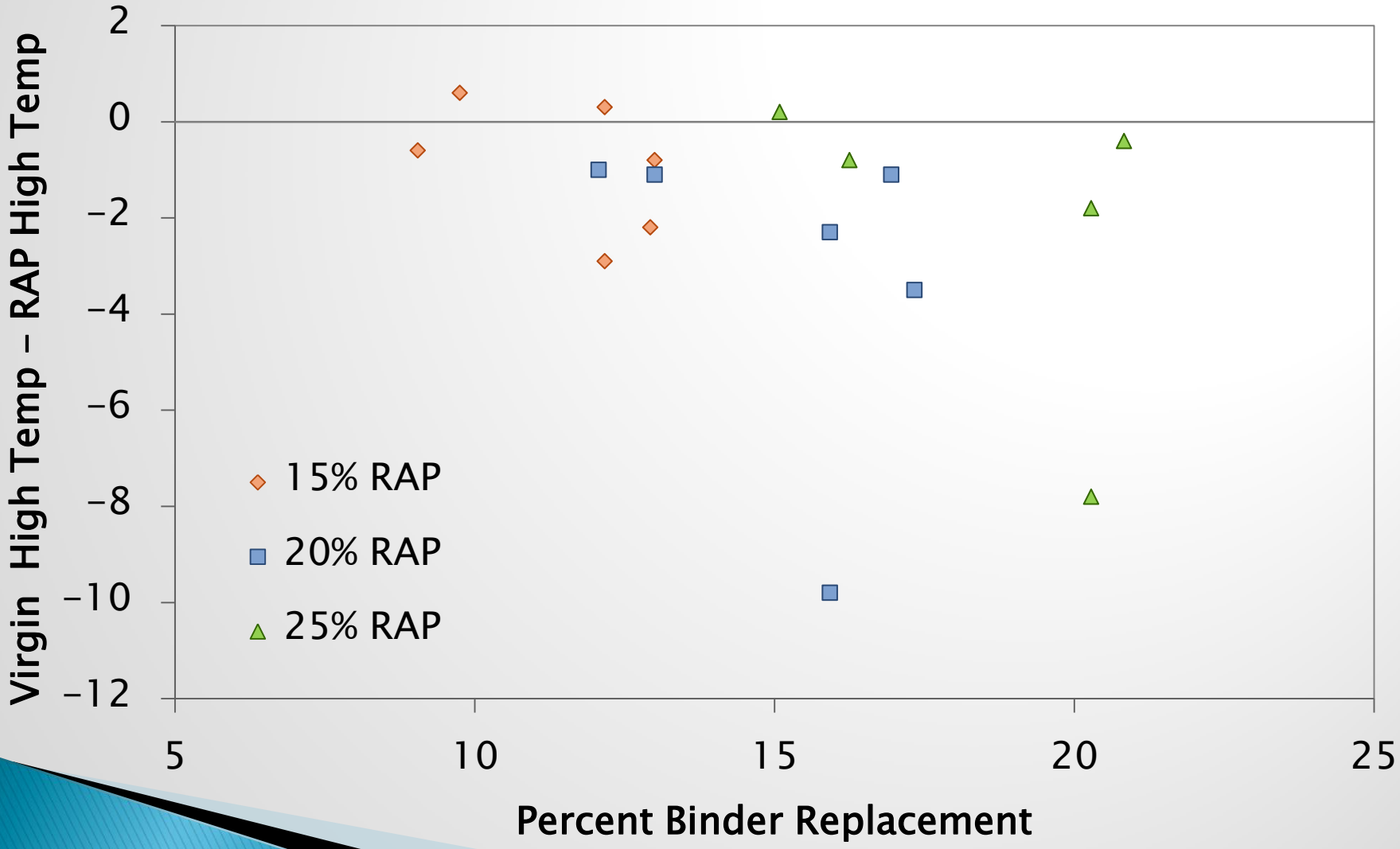
- Trends?

Percent Binder Replacement

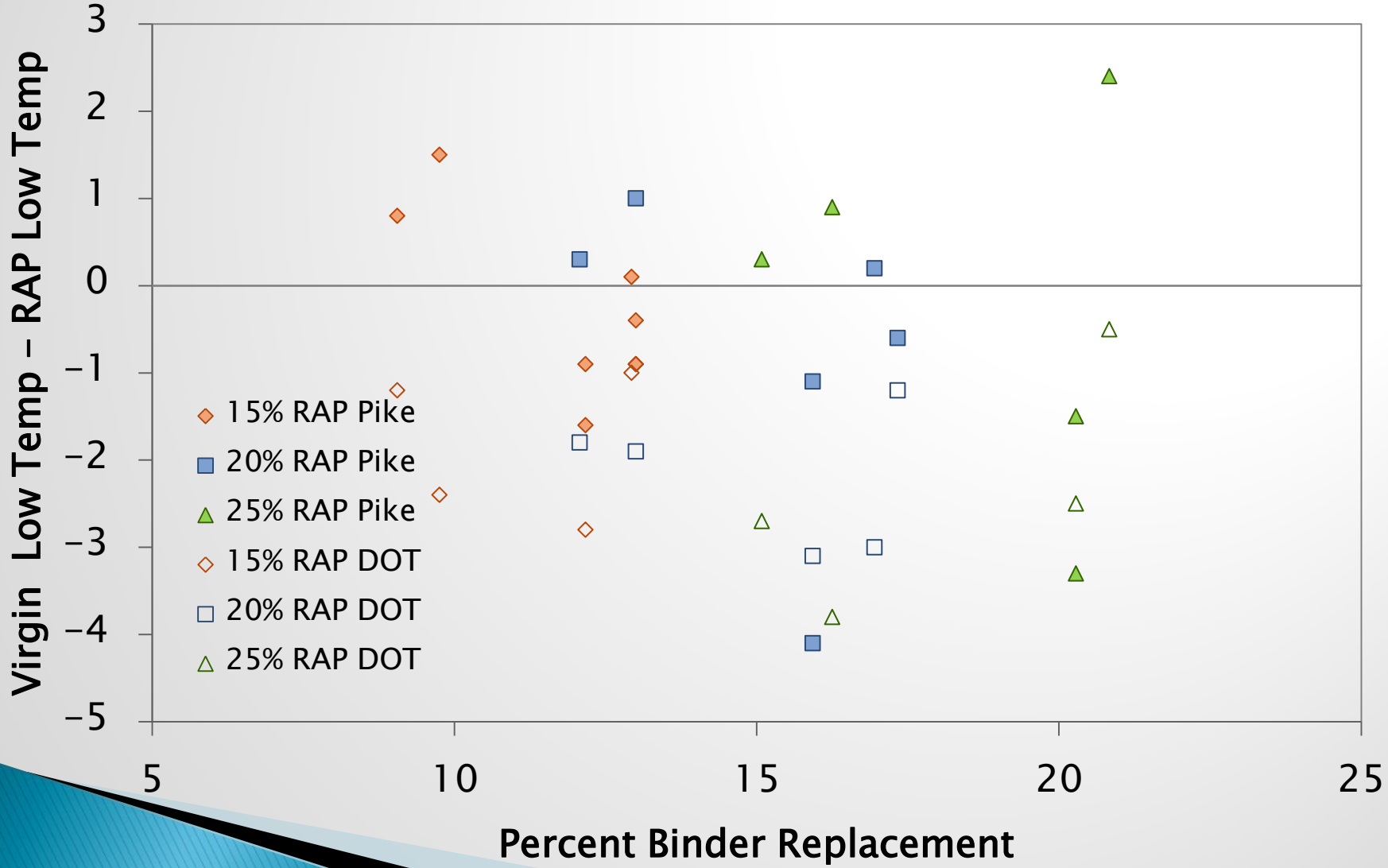
- Normalizes with respect to
  - Asphalt content in RAP
  - Asphalt content in mix

$$\%\,binder\ replacement = \frac{\%ac\ in\ RAP * \%\ RAP\ in\ mix}{\%ac\ in\ mix}$$

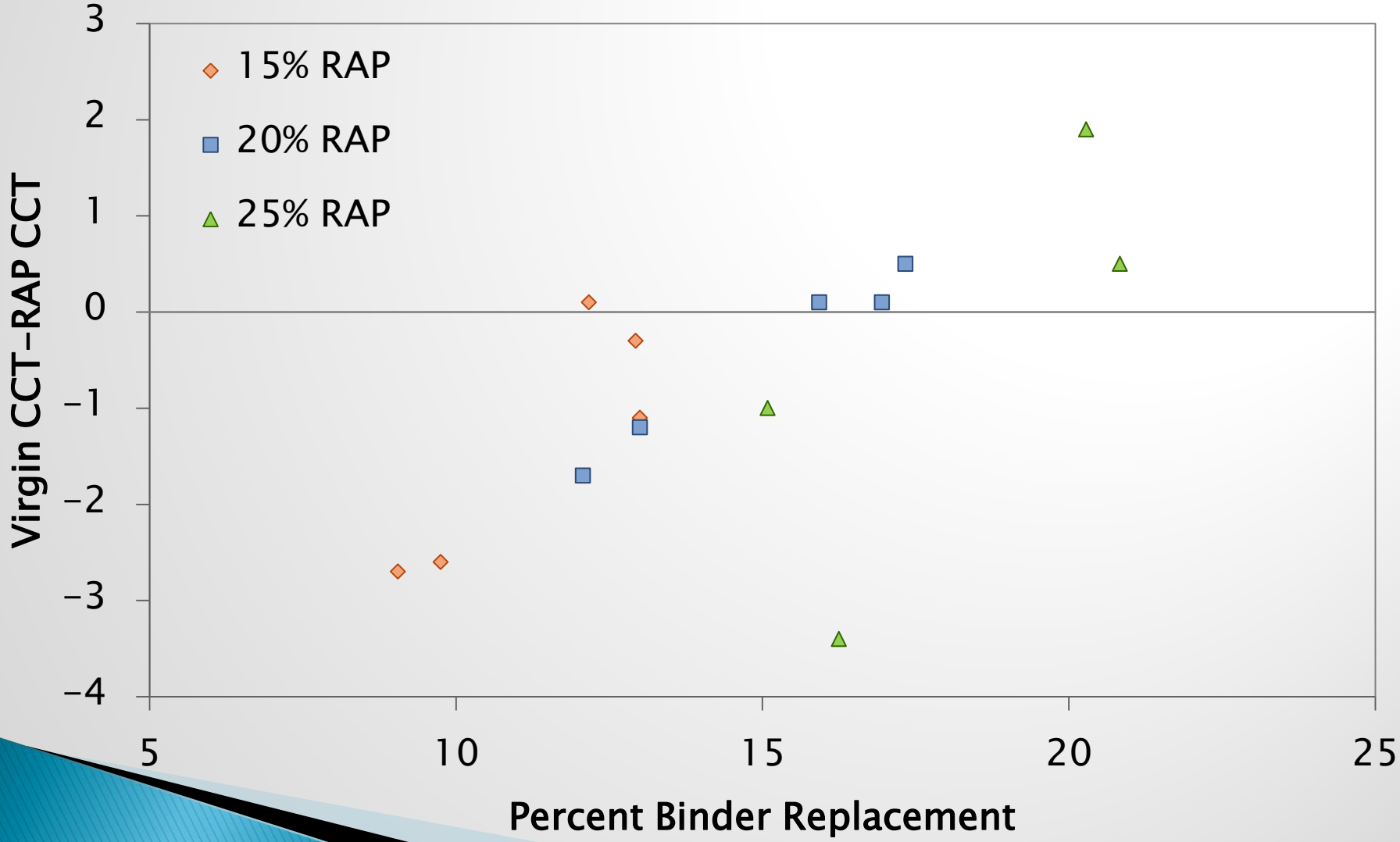
Change in High PG Grade



Change in Low PG Grade



Change in T_{cr}



Conclusions

- The high PG grade up to one grade increase
- The low PG grade stays same or only one grade increase
- Failure temps/T_{cr} only change a few degrees
- Change in high/low failure temp has decreasing trend with % binder replacement
- This data shows increasing trend of T_{cr} with % binder replacement

Future Work

- NEAUPG RAP Task Force developed scope of work for expanded mixture & binder testing study on plant produced mixtures ~$750,000
- Scope of work to include 60 mixtures
- Pooled Fund Study initiated

Current Participants

- NHDOT lead agency
- States: MD, NH, NJ, NY, PA, and VA ($90k each over 3 years)
- FHWA at $150k
- Full funding for Phase I
- Phase II not completely funded – need at least one more state for full 60 mixtures
- Research Team: UNH, Rutgers, UMass Dartmouth, NC State
- Pike doing extraction & recovery for Phase I

High RAP Pooled Fund Study

- Producers have volunteered to produce mixtures at different RAP contents
- Mixtures sampled and taken to lab for testing
- SGC specimens compacted at time of production
- Data collected on plant operations, raw material info, placement location & conditions (field cores if possible)

Testing

- Recovered Binder
  - PG grade
  - CCT
  - ABCD
- Mixture
  - Dynamic Modulus
  - Hamburg & TSR
  - Low Temperature Creep & Strength
  - Fatigue (S-VECD protocol)
- Additional testing

Phase I

- 18 Mixtures
- Focus on evaluating effect of binder grade and plant type

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)	12.5	58-28	x	x	x	x
		52-34	x	x	x	x
Pike NH (drum)	9.5	64-28	x	x	x	x

Schedule/Progress

- Callanan mixtures have been produced and delivered to research group
- Testing starting on these mixtures
- Pike NH mixtures have been produced
- Pike VT mixtures will be produced in next few weeks
- Phase I testing completed over winter/spring
- Plan for Phase II developed in early 2011
- Phase II mix production & testing 2011-2013

Acknowledgements

- Associate Researchers
  - Jeff Pochily, Pike Ind. Inc
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  - Peter Moore, Pike Ind. Inc
  - Alan Lugg & Melissa Sytek, NHDOT


Questions?
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