KANSAS UPDATE

NCAUPG

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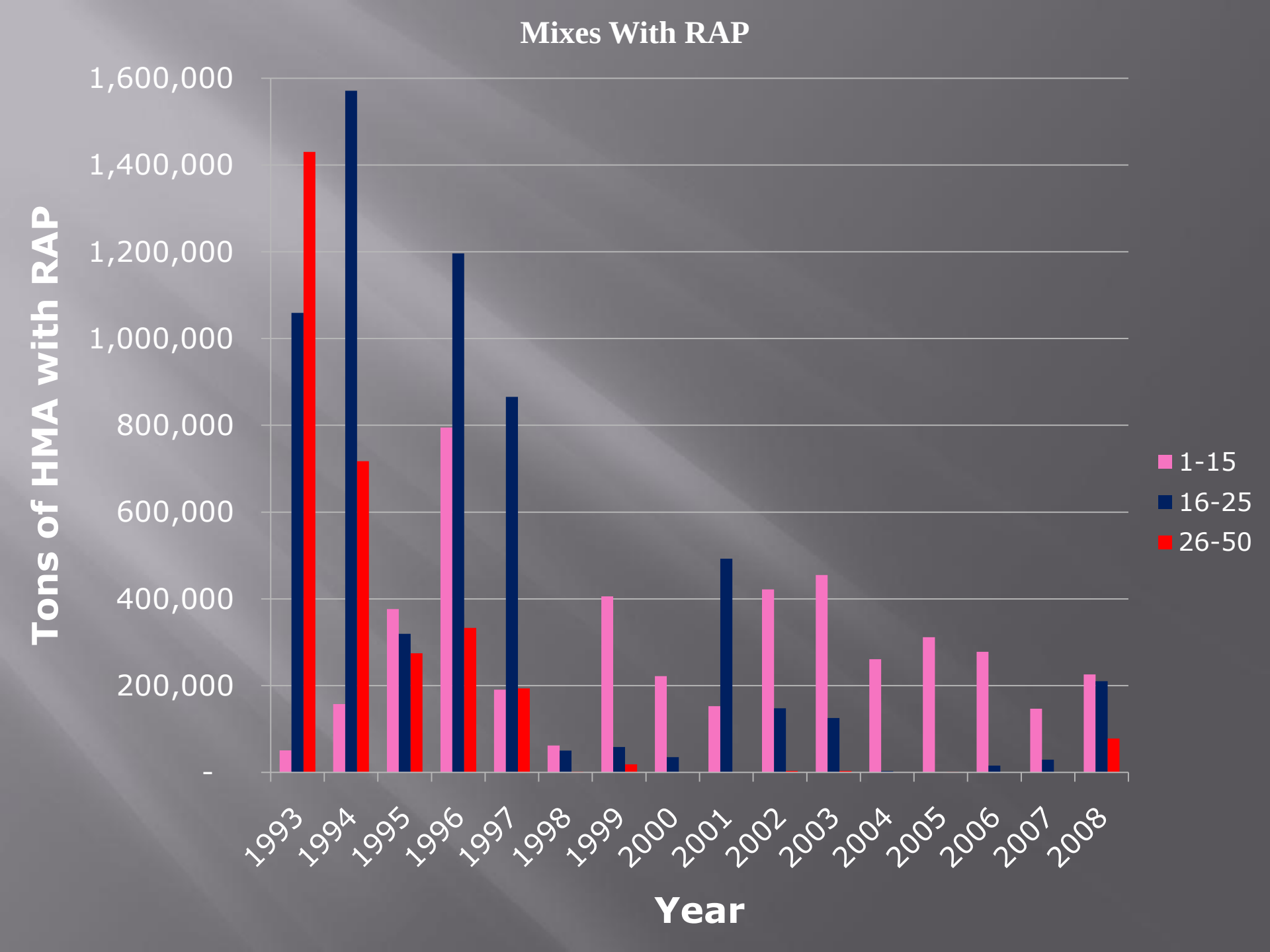
Increase Usage of RAP

- Advantages of using more RAP
  - Economics
    - Cost of Aggregates
    - Cost of Asphalt Binder
    - Transportation Costs
  - Environmental
    - Recycling Natural Resources
    - It's "Green"


Mixes With RAP
Tons of HMA with RAP
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
-
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
Year
1-15
16-25
26-50

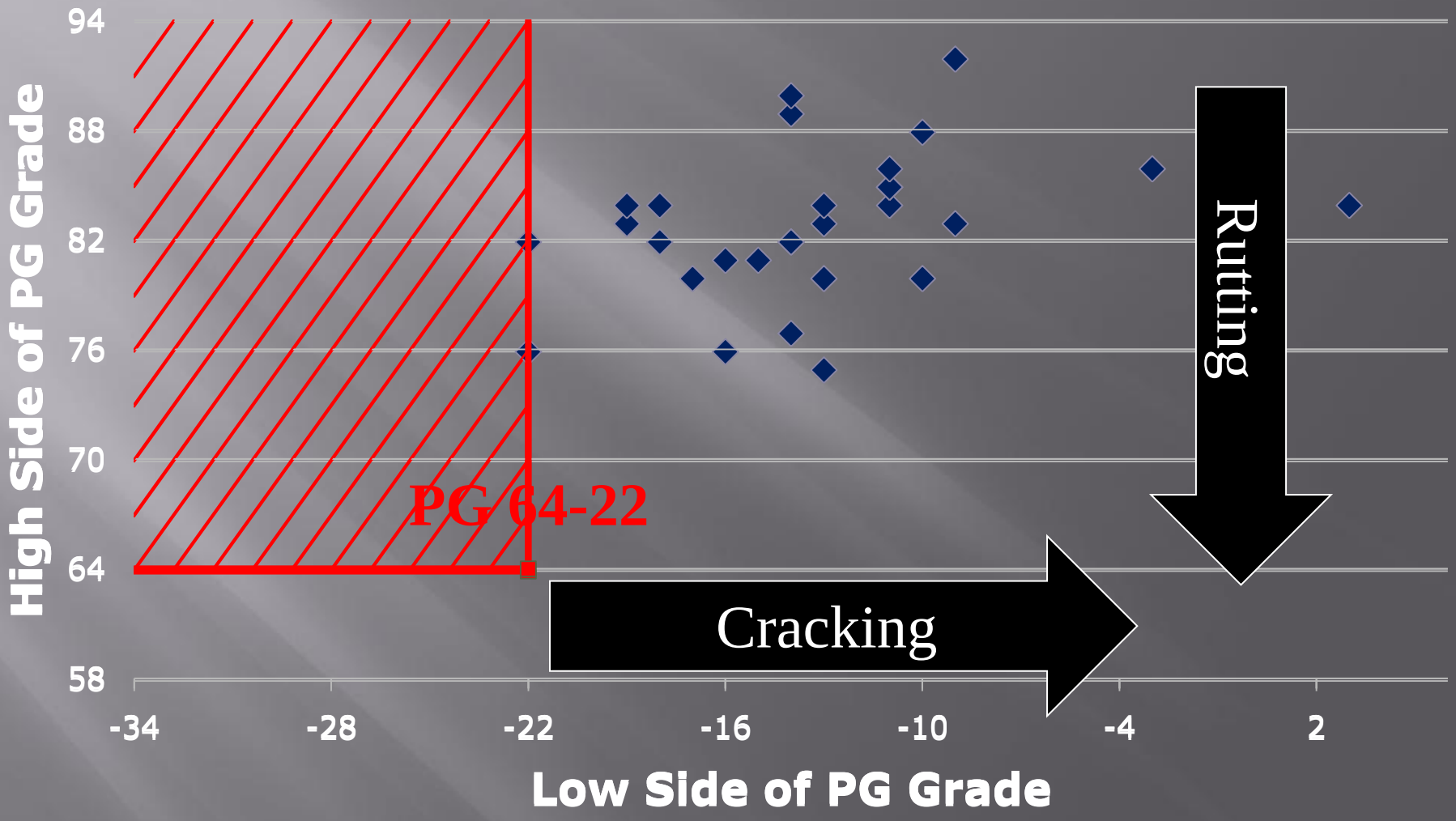
Current RAP Guidelines

- RAP < 25%
  - Millings generated from project
- RAP < 15%
  - Contractor provides millings
- FRAP
  - Increase allowable RAP by 10%
  - Fine FRAP passes ¼” screen
  - Coarse FRAP retained on ¼” screen

2008 High RAP Projects

Project Number	%RAP	HMA Tons	Mix Type
083-097/055 KA-1040-01	35%	19,094	SR-12.5A
056-005 KA-1077-01	40%	9,717	SR-12.5A
056-005 KA-1077-01	30%	4,141	SR-12.5A
004/149-064/021 KA-1034-01	30%	44,218	SR-12.5A
004/104-085 KA-1037-01	25%	6,147	SR-12.5A
025-055 KA-1009-01	25%	56,177	SR-12.5A
083/036-020/090 KA-1039-01	25%	34,226	SR-12.5A
383-074 KA-1019-01	25%	17,987	SR-12.5A
281-092 KA-1017-01	25%	18,319	SR-12.5A
075-016 K -7415-01	25%	2,359	SR-19A
075-016 K -7415-01	25%	4,753	SR-19A Sh
400-008 KA-1057-01	25%	23,843	SR-12.5A Sh
050-028 KA-1082-01	25%	8,078	SR-12.5A
083-028/086 KA-1129-01	25%	38,100	SR-12.5B Sh

PG Binder Grades



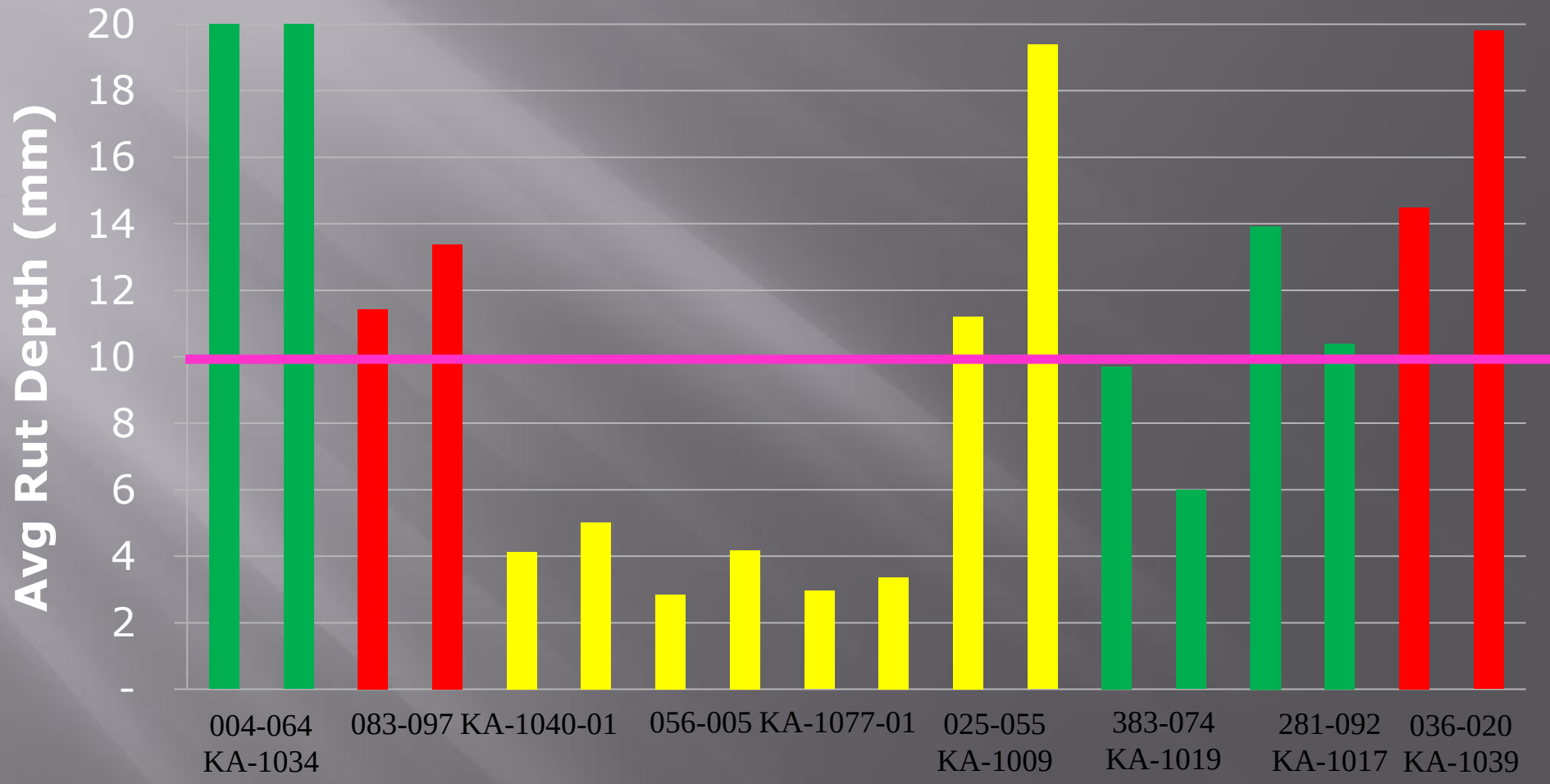
HIGH RAP USAGE
PG GRADING

Project Number	Binder	RAP	HMA		TSRST	
			Not Aged	Aged	Not Aged	Aged
025-055 KA-1009-01	62-28	76-14	72-33	72-25	-28	-28
083-097/055 KA-1040-01	63-28	83-18	73-31	72-25	-28	-24
056-005 KA-1077-01	63-25	83-12	78-26	78-18	-22	-22
004/149-064/021 KA-1034-01	60-29	80-13	66-33	66-26	-28	-24

Stripping

- 6 of the 12 High RAP mixes had at least 1 Failed Modified Lottman Test

HAMBURG WHEEL RUT TESTER



Failing Lottman Tests

Passing Lottman Tests

Borderline Lottman Tests

Air Void Results

- The 3 Projects with more than 25% RAP
  - 1 received 14% of the available incentive
  - 1 received 67% of the available incentive
  - 1 received 100% of the available incentive
- Of the 9 Projects with 25% RAP
  - 1 had a large disincentive
  - 2 received less than 50% of the available incentive
  - 3 received between 50% and 85% of the available incentive
  - 3 received 100% of the available incentive

Obstacles

- On 2 of the 3 High RAP Projects Low Voids in the Mineral Aggregate (VMA) resulted in production being suspended

High RAP Usage Conclusions

- Binder Quality and RAP Consistency are the biggest hurdles to overcome
- Blending Charts are reliable predictors of the resultant PG Grade (Virgin and RAP Binder)
- 40% RAP Mixes are achievable if
  - RAP properties are known
  - RAP is consistent (FRAP may be required)
  - Virgin Aggregates are selected to offset the shortcomings of the RAP Aggregates

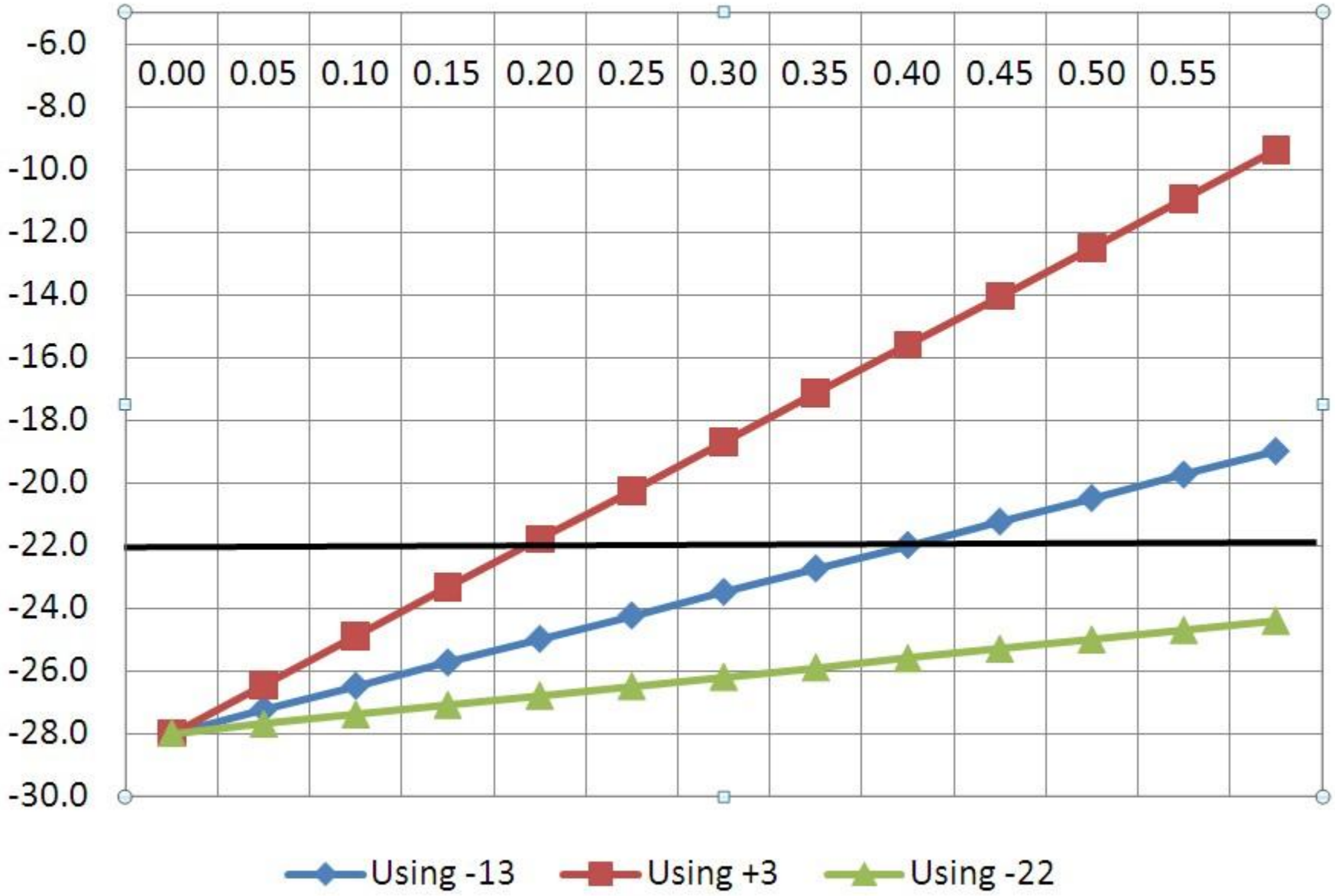
RAP/FRAP FUTURE

- Obtain millings for projects in early spring
- Send samples in to Materials Lab
  - Burn-off on RAP and Fine and Coarse FRAP
  - Determine the binder grade of the RAP
- Develop Blending Charts based on these results

Current RAP/FRAP Proposal

- Based on Blending Charts Contractor will determine the amount of RAP and FRAP to use
  - Ensure that the low side of the binder is < -23
  - Still meet the volumetric requirements
- Provide the grading of the binder that we require
  - During construction track the predicted value using the blending chart and RAP/FRAP properties.
    - Penalty for a binder at > -23

Temperature Blend



Theoretical Calculation of Blended PG Effect

Temperatures	PG_{upper}	PG_{lower}	$PG_{blend} = (\%FRAP/100)*(PG_{RAP} - PG_{virgin}) + PG_{virgin}$		
PG_{RAP}	84	-13		$PG_{blend\ upr}$ =	63.72
PG_{virgin}	52	-28		$PG_{blend\ lwr}$ =	-22.50
			% in mix	% Pb	$\%RAP_{Original\ Design}$
%RAP (MRC)				4.70	35.0
$\%FRAP_{fine}$			60.00	5.20	
$\%FRAP_{course}$			40.00	4.50	
$\%FRAP_{weighted}$		36.6	%	4.92	%

Maximum Permissible %FRAP

$\%FRAP_{perm} = (PG_{blend} - PG_{virgin})/(PG_{RAP} - PG_{virgin})*100$

$\%FRAP_{perm}$ = 40.00

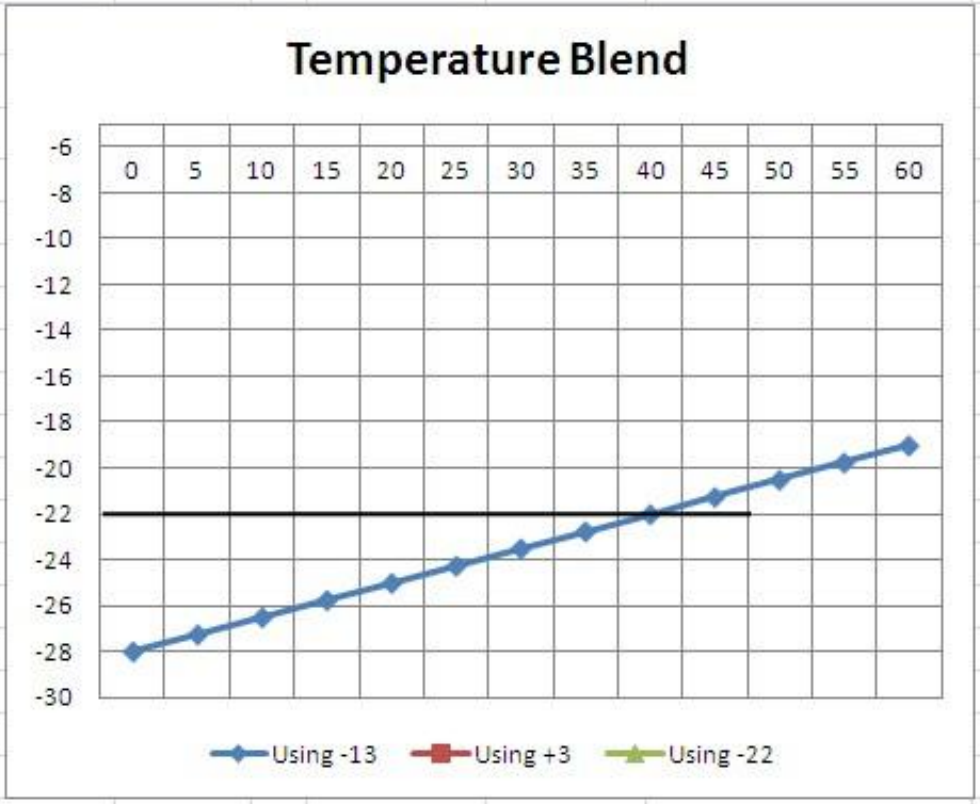
$\%FRAP_{max}$ = 38.36 %

$\%FRAP_{max} = \%FRAP_{perm} - \%FRAP_{corr}$

$\%FRAP_{corr} = \%FRAP_{weighted} - \%RAP_{Original\ Design}$

$PG_{RAP\ lwr}$	-13
$PG_{virgin\ lwr}$	-28

%FRAP	PG_{blend} =
0.00	-28.0
5.00	-27.3
10.00	-26.5
15.00	-25.8
20.00	-25.0
25.00	-24.3
30.00	-23.5
35.00	-22.8
40.00	-22.0
45.00	-21.3
50.00	-20.5
55.00	-19.8
60.00	-19.0



MRC Data				% P_b	Estimated %RAP_{max}
	PG_{upper}	PG_{lower}	RAP	5.20	
PG_{RAP}	84	-19	$FRAP_{fine}$	5.50	
PG_{virgin}	52	-28	$FRAP_{course}$	5.00	66.67

	RAP				FRAP								Contractor exceeds maximum?
LOT (Sublot)	%RAP in mix	P_b of RAP	%RAP_{corr}	%RAP_{max}	%FRAP in mix	P_b of Fine FRAP Used	% of Fine FRAP Used	P_b of Course FRAP Used	% of Course FRAP Used	$FRAP_{weighted}$	%$FRAP_{corr}$	%$FRAP_{max}$	
4A	40	4.9	5.77	72.44	40	5.5	60	5	40	5.3	-1.92	64.74	
4B	40	4.9	5.77	72.44	40	5.6	60	4.9	40	5.32	-2.31	64.36	
5B	40	5.4	-3.85	62.82	40	5.4	60	4.8	40	5.16	0.77	67.44	
5C	40	5.2	0.00	66.67	40	5.3	60	5.2	40	5.26	-1.15	65.51	

MRC Data				% P_b	Estimated %RAP_{max}
	PG_{upper}	PG_{lower}	RAP	4.70	
PG_{RAP}	84	-13	$FRAP_{fine}$	5.20	
PG_{virgin}	52	-28	$FRAP_{course}$	4.50	40.00

	RAP				FRAP								Contractor exceeds maximum?
LOT (Sublot)	%RAP in mix	P_b of RAP	%RAP_{corr}	%RAP_{max}	%FRAP in mix	P_b of Fine FRAP Used	% of Fine FRAP Used	P_b of Course FRAP Used	% of Course FRAP Used	$FRAP_{weighted}$	%$FRAP_{corr}$	%$FRAP_{max}$	
7B	35	5.3	-12.77	27.23	35	5.2	60	4.6	40	4.96	-5.53	34.47	EXCEEDS!
8C	35	5.1	-8.51	31.49	35	5.1	60	4.5	40	4.86	-3.40	36.60	
9A	35	4.9	-4.26	35.74	35	5	60	4.4	40	4.76	-1.28	38.72	

Bond Between HMA Layers

- Insufficient Bond Between layers
  - Leading to premature cracking in overlays


ROADTEC
SB-2500

Bond Test Section

- Pave test sections with a Spray Paver
  - Different Tacks
    - Eastbound – EBL (Emulsion Bonding Liquid)
    - Westbound – CSS-1H (Normal Tack Emulsion)
  - Different Rates
    - No Tack – up to 0.20 gal/sq yd


PASS
WITH
CARE
1800 SF


SUPER

Bond Test

- Goal: Have a pull-off test to ensure sufficient bonding HMA layers
  - Specify a certain bond strength to be met
  - Have a performance spec for the bond strength
- Starting this Spring visit multiple projects to start developing bond strength charts and relationships between type of surface and temperature
  - Various surface
  - Various temperatures

Kansas Test Method KT-70

- Test Method to determine the Tensile Rupture Strength for Polymer Bridge Overlays
  - Modify the test method to determine the Tensile Rupture Strength between HMA layers


DILLON
DYNAMOMETER


DILLON
DYNAMOMETER
0
1
2
3
4
5
6
7
8
9

WMA Benefits

- Compaction Aid
- Pave in cooler weather
- Green Benefits
  - Reduced emissions
  - Reduced fuel consumption
- Improvement in fatigue life of mix
  - Less oxidized and less absorption

Current Spec

- The Contractor is allowed to use Warm Mix unless otherwise shown on plans.
- Achieve Max density WMA > 165°F
- When mat temp falls below 165°F
  - Roller Marks may be removed from mat with self-propelled static steel roller

Approved list of Warm Mix Asphalt Additives

Table 602-A: APPROVED WARM MIX ASPHALT ADDITIVES			
WMA Technology	**Process Type**	**Supplier**	**Max Mix Temp Reduction[1]**
Advera	Foaming	PQ Corporation	30°F
Aquablack Solutions	Foaming	Maxam Equipment	30°F
Aspha-Min	Foaming	Aspha-Min	30°F
Double Barrel Green	Foaming	Astec Industries Inc.	30°F
Evotherm	Chemical Additive	MeadWestvaco Asphalt Innovations	70°F
Redi-Set WMX	Chemical Additive	Akzo Nobel Surfactants	70°F
Sasobit	Organic Additive	Sasol Wax Americas, Inc.	70°F

[1] Mixing temperature range is provided by the Asphalt Binder Supplier. When using WMA, the mixing temperature may be reduced no more than that shown for the specific WMA technology. The minimum mixing temperature for WMA is 220°F.

Questions?