2019 PAPA/PENNDOT BUS TOUR

Radisson Lackawanna Station Hotel Scranton

July 31, 2019

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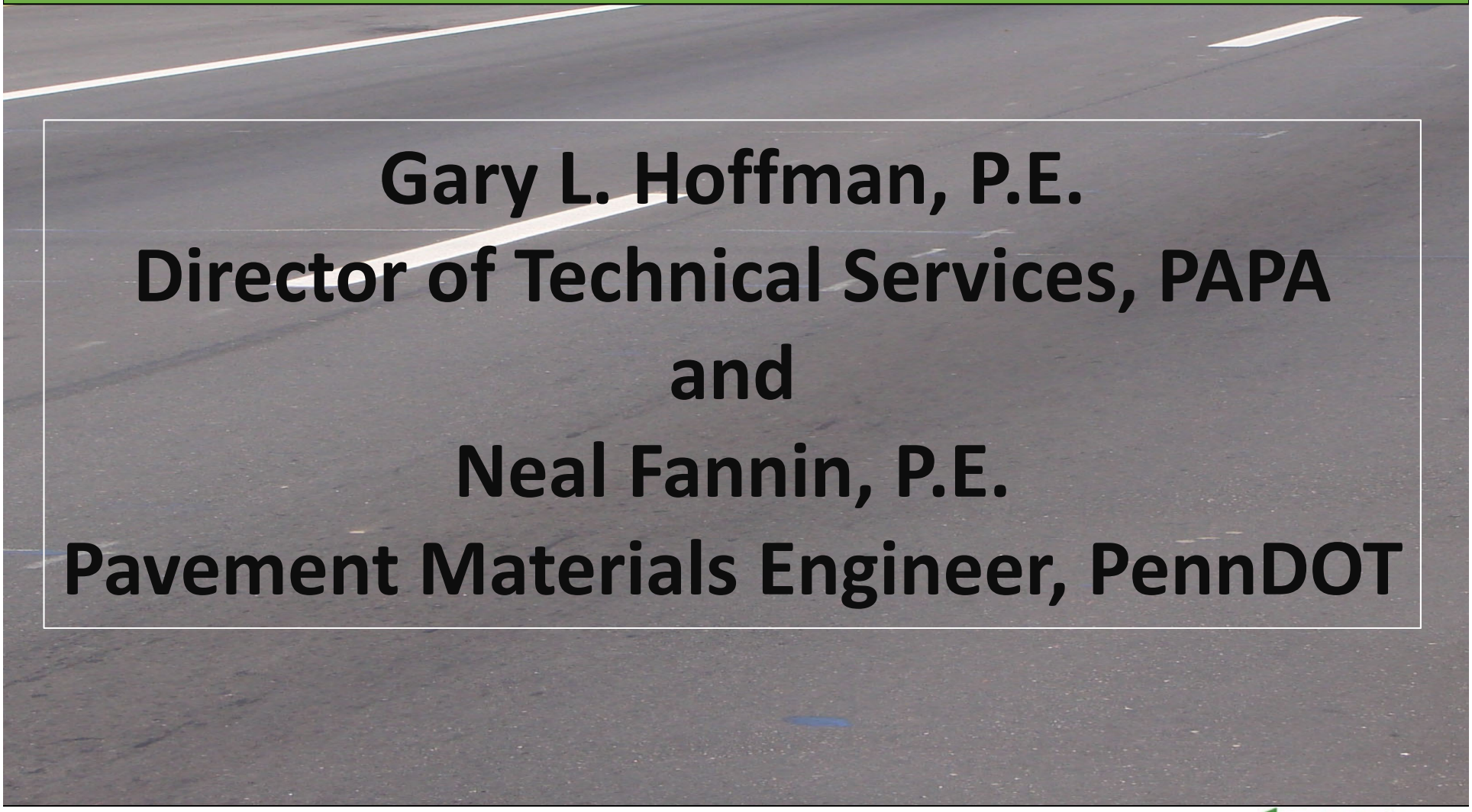
Pennsylvania Asphalt Pavement Association

3544 North Progress Avenue • Suite 100 • Harrisburg, PA 17110 Phone (717) 657-1881 FAX (717) 657-0687 www.pa-asphalt.org

THIN ASPHALT OVERLAYS
"6.33 PERFORMANCE UPDATE"



Gary L. Hoffman, P.E.
Director of Technical Services, PAPA
and
Neal Fannin, P.E.
Pavement Materials Engineer, PennDOT

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THIN ASPHALT OVERLAYS
"6.33 PERFORMANCE UPDATE"

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THIN ASPHALT OVERLAYS "6.33 PERFORMANCE UPDATE"

Outline

1. THMAO As A Pavement Preservation Strategy
2. Mix Design and Evaluation
3. Construction/Demo Projects
4. Performance Evaluations
5. Summary/findings

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THIN OVERLAYS FOR PAVEMENT PRESERVATION

Roadway Improvement Activities

			Pavement Preservation		
Activity	Re-construction	Major Rehabilitation	Minor Rehabilitation	Preventive Maintenance	Routine Maintenance
Increase Capacity	●	●			
Increase Structural Strength	●	●	?		
Improve Pavement Condition	●	●	●	●	●
Restore Serviceability	●	●	●	●	●
Extend Service Life	●	●	●	●	●

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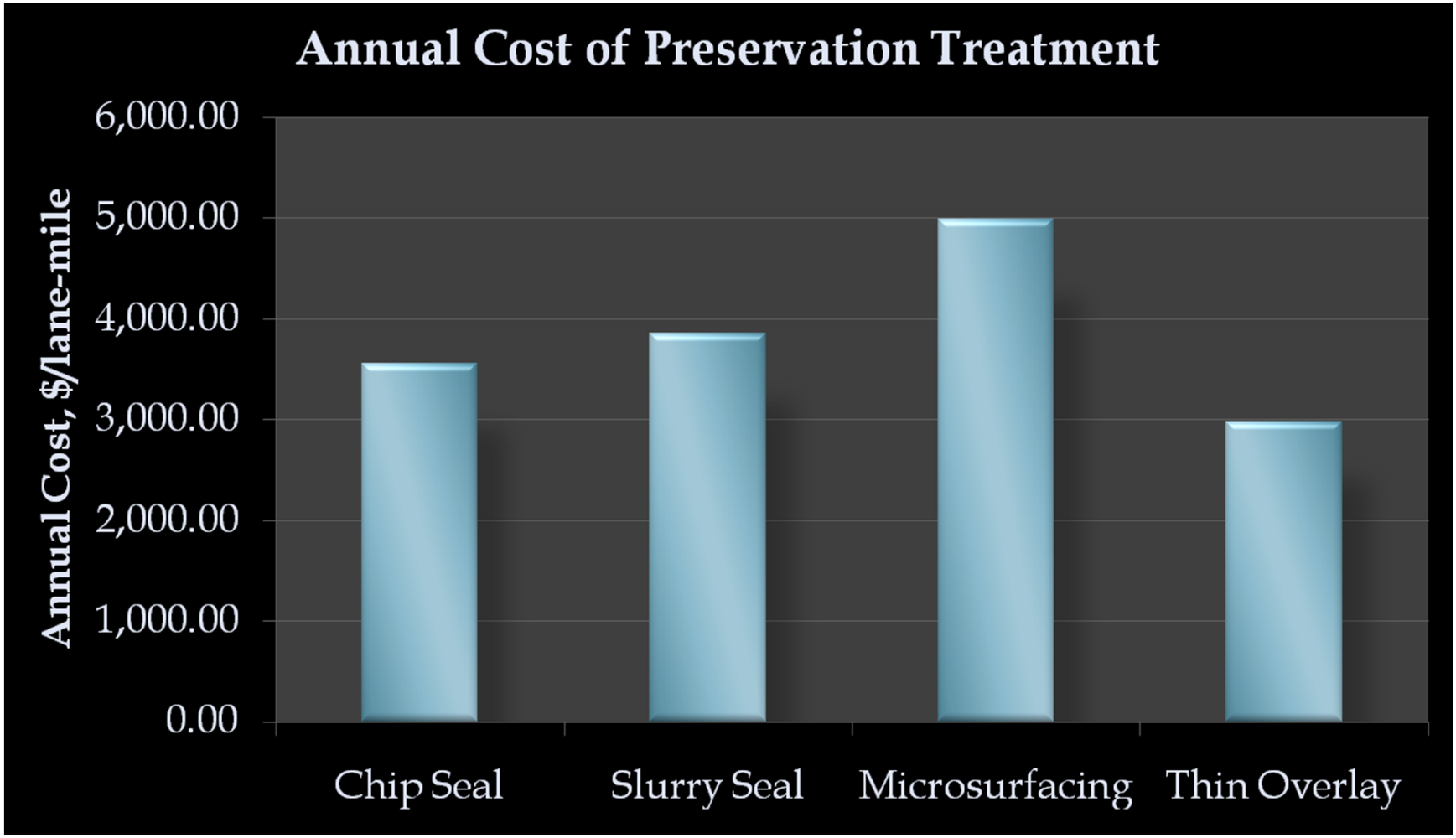
Economics

- Chou et al. (2008):
  - Thin overlays on asphalt – almost always most cost effective
  - Thin overlays on PCC – not as cost effective as on asphalt, but still cost effective
- 2008 NAPA Survey of State Asphalt Associations

Treatment	Expected Life, yrs	Range	Cost, $/SY	Range	Annual Cost, $/lane-mile
Chip Seal	4.08	2.5 - 5	2.06	0.50 – 4.25	$3,554.51
Slurry Seal	3.25	2 - 4	1.78	1.00 – 2.20	$3,855.75
Micro-surfacing	4.67	4 - 6	3.31	2.30 – 6.75	$4,989.81
Thin Surfacing	10.69	7 - 14	4.52	2.40 – 6.75	$2,976.69

Economics


Annual Cost of Preservation Treatment
Annual Cost, $/lane-mile
6,000.00
5,000.00
4,000.00
3,000.00
2,000.00
1,000.00
0.00
Chip Seal
Slurry Seal
Microsurfacing
Thin Overlay

How Thick is Thin Asphalt?

- **Placed up to 1.25 inches in thickness**

- **Ultrathin layers: between 0.75” and 1.0”**

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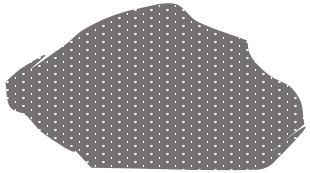
Mat Thickness/NMAS Ratio

NMAS: Nominal Max. Aggregate Size



Aggregate
NMAS

Mat Thickness
0.5 to 1.25 in

3 ≤ Ratio of Thickness to NMAS ≤ 5

Importance of NMAS in Thickness

Table shown with:

Mat Thickness:
from 1.5 inches to 0.50 inches, and

NMAS:
from 12.5 mm to 4.75 mm

- Good
- Ok
- Avoid

Mat Thickness			
In	mm	NMAS	Ratio
1.50	38.1	12.5	3.0
		9.5	4.0
		6.3	6.0
1.25	31.8	9.5	3.3
		6.3	5.0
		4.75	6.7
1.00	25.4	9.5	2.7
		6.3	4.0
		4.75	5.3
0.75	19.1	6.3	3.0
		4.75	4.0
0.50	12.7	6.3	2.0
		4.75	2.7

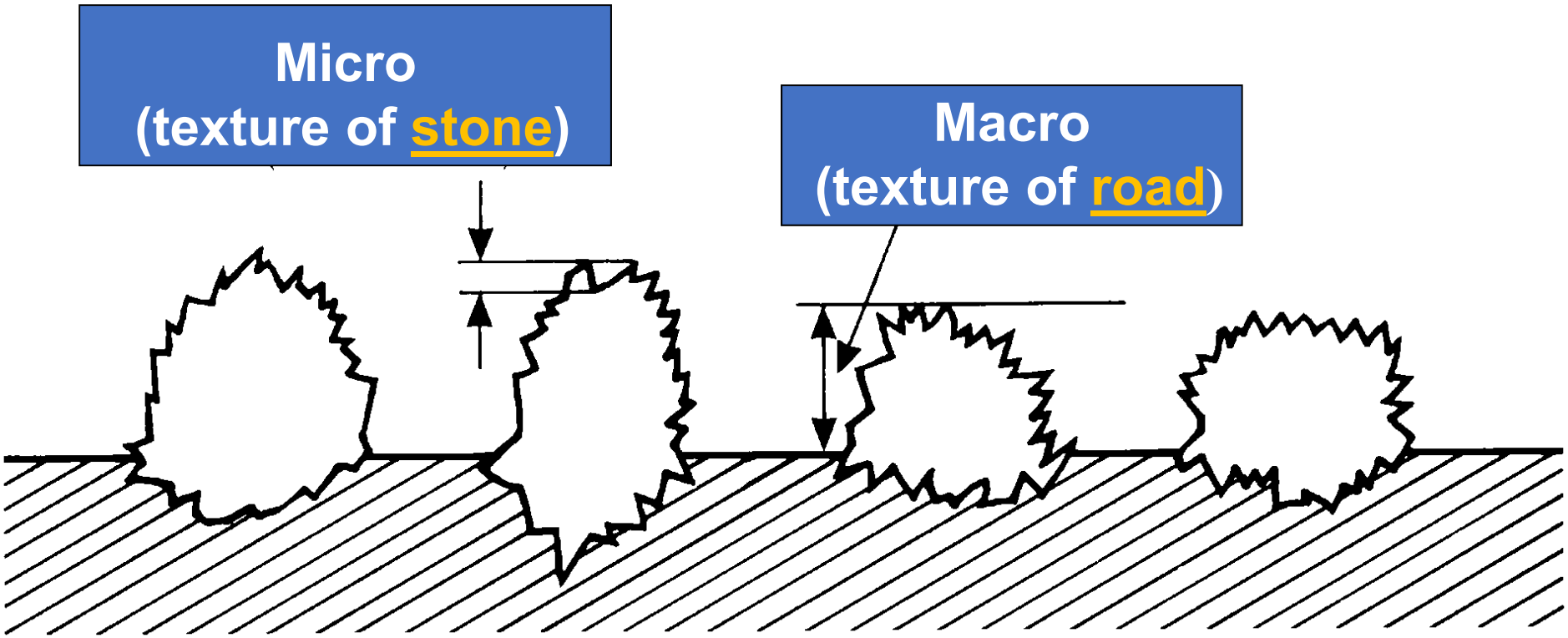
Significance of Aggregate Skid Resistance Level in Thin Asphalt

Two of the Most Important Properties Affecting Friction (Skid Resistance) Are:

1. Aggregate Microtexture

2. Pavement Macrotexture

Significance of SRL in Thin Asphalt



As NMAS & thickness gets smaller, harder to develop macro and more demand on micro.

PA
Aggregate Skid Resistance Level

ADT	SRL
20,000 & Above	E
5,000 to 20,000	H
3,000 to 5,000	G
1,000 to 3,000	M
1,000 and Below	L

MIX DESIGN AND EVALUATION

PA Thin Lift Overlay Development

BACKGROUND –

- NEPPP: Smooth Seal in Ohio, THMAO in NY
- PAPA Technical Subcommittee
  - Crafted Draft Specification
  - 6.3mm PG 76-22, Polymer modified,
  - 75 Gyrations/Virgin Mix
- PennDOT Research Project Approved

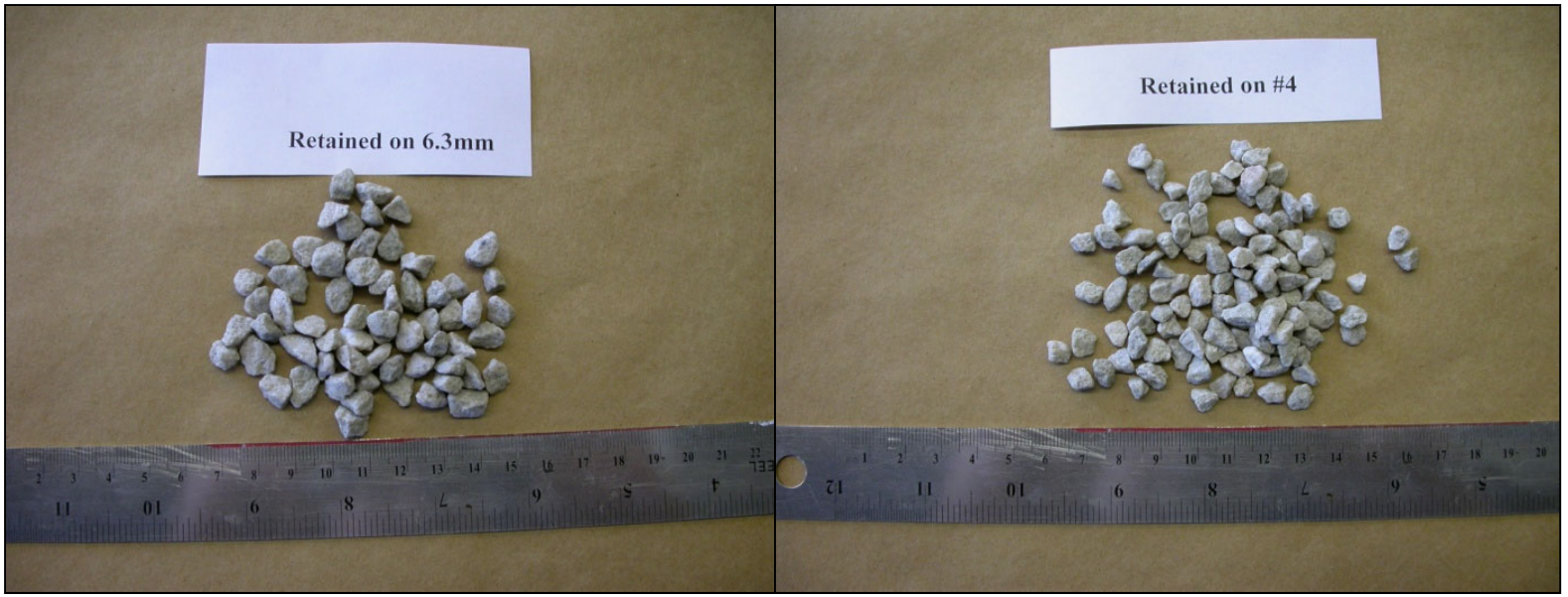
Special Provision

- 6.3 mm – 100% passing 3/8 in.
- Dense –graded (6 sieve sizes) - SRL
- PG 76-22 polymer modified
- N design = 75 gyrations
- Design voids = 4.0%
- Min. VMA = 16.5
- No RAP or RAS
- Greater than 50 F
- Optimum Rolling Pattern

Use Guidelines

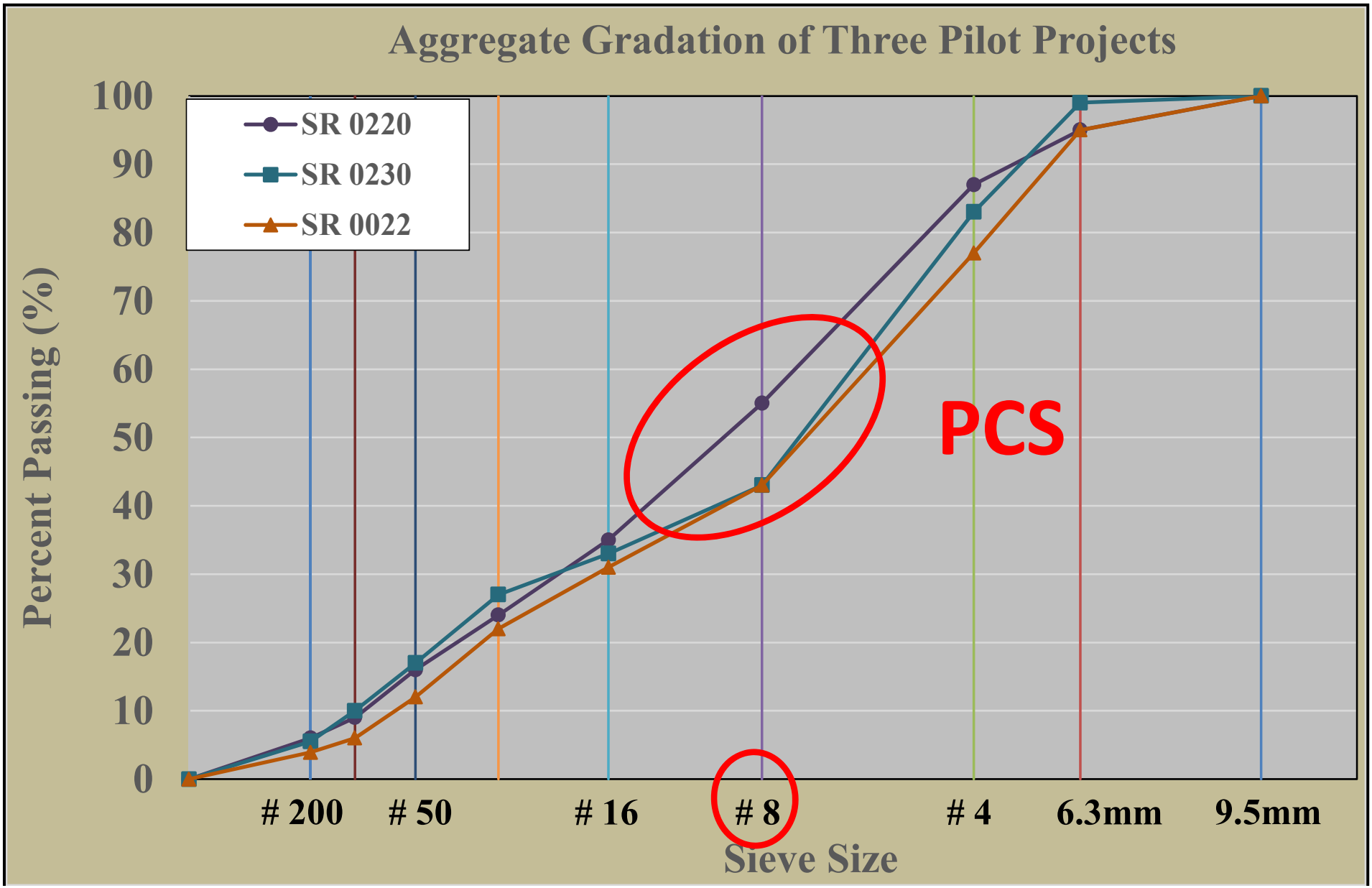
- Only on structurally sound pavement
- Same as micro-surfacing
- For correcting surface distresses only
- Consider grinding PCC first

6.3 mm NMAS Mix Placed at 1 inch Thickness

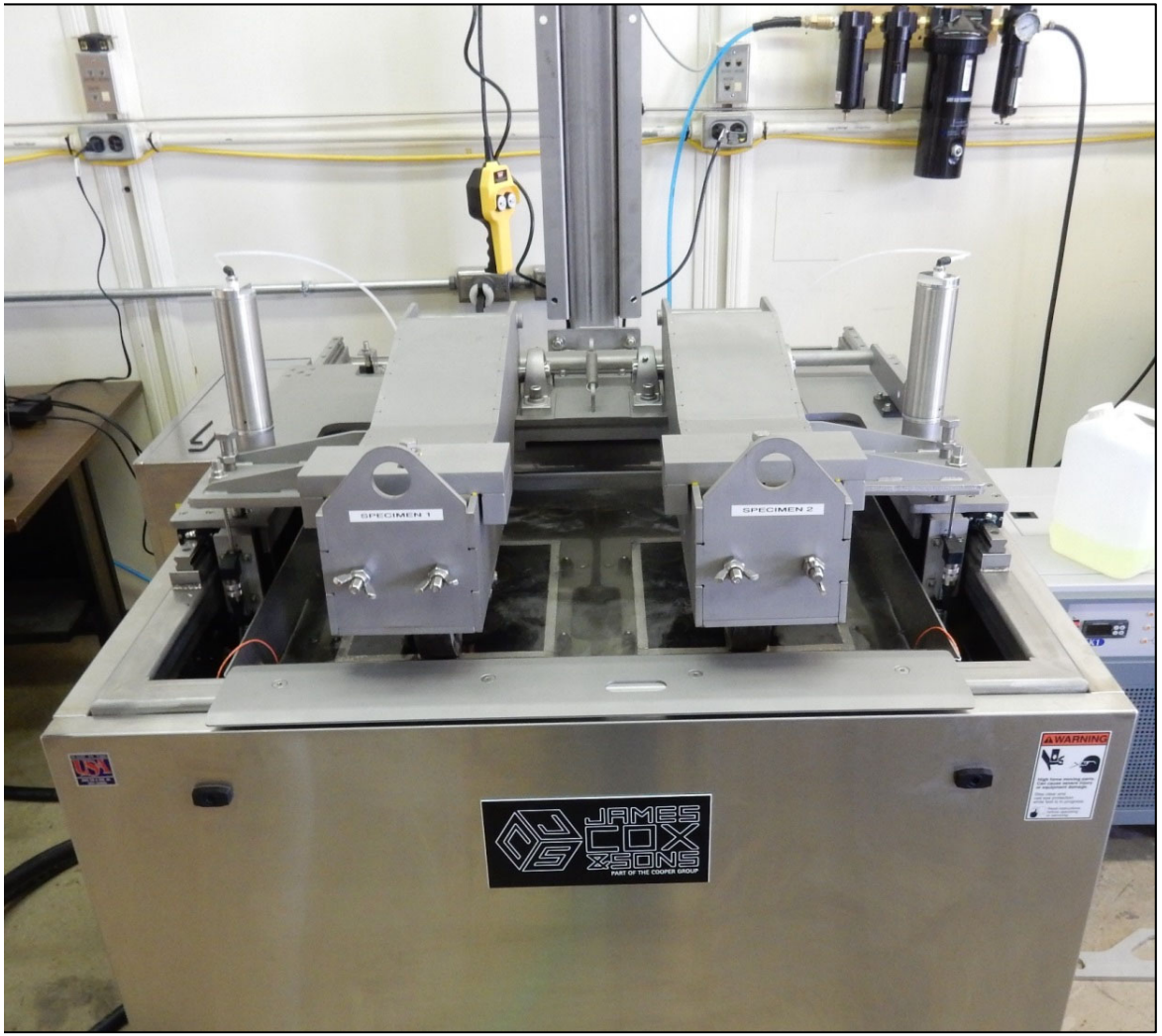


- Aggregate: Skid Resistance Level (SRL): E
- Polymer Modified Binder: PG 76-22 (for heavier traffic)
- Gyration Level: 75
- Design Air Void: 4%, Min. Design VMA: 16.5%
- Design Binder Content: 6.7%; 7.0%; 6.9%
- NO RAP/RAS

6.3 mm NMAS Mix



Performance Evaluation - HWTD



- Specimens under water
- Test Temperature: 50ºC
- 20,000 Passes
- 50 Passes per minute
- 158-lb load

RUT TEST

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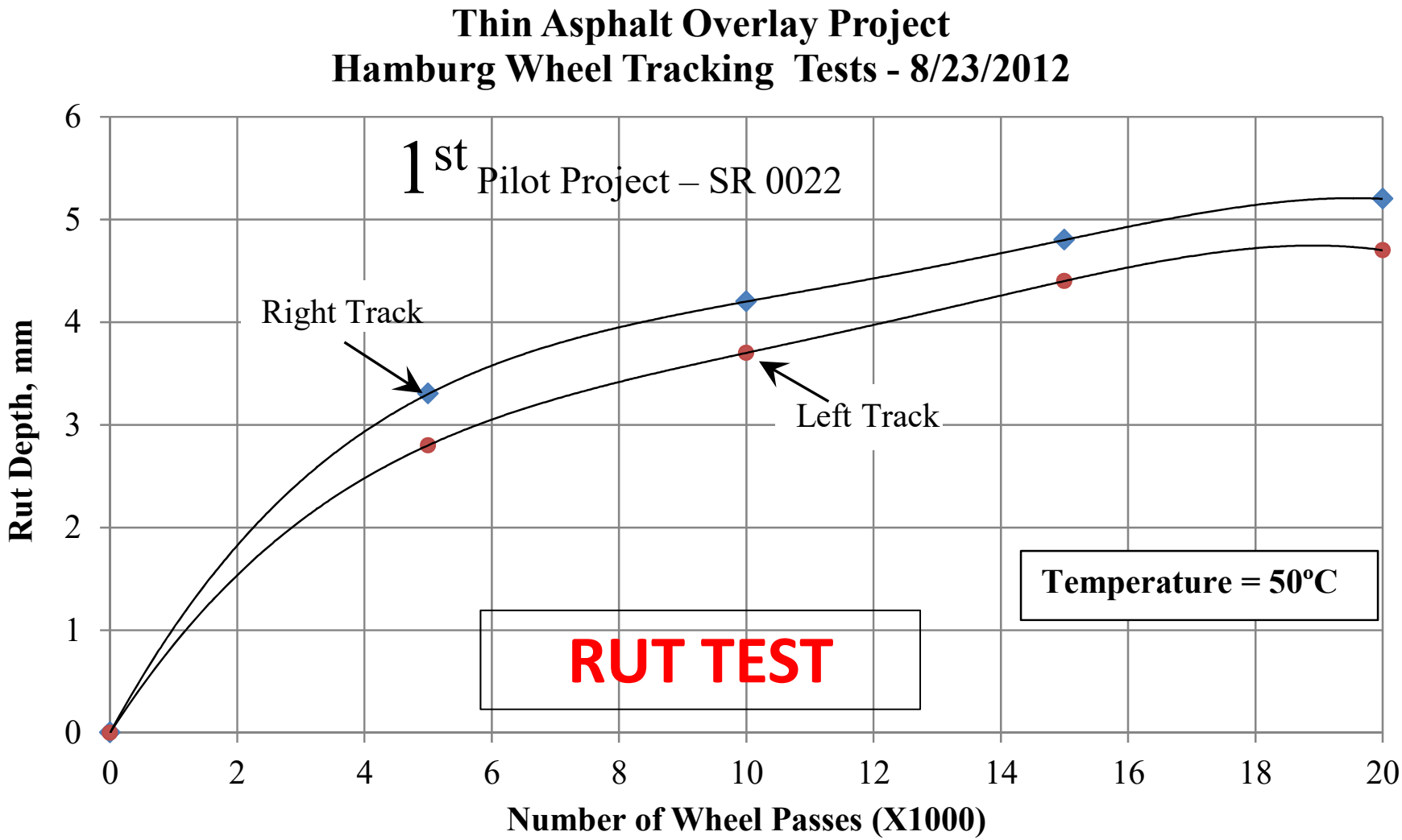
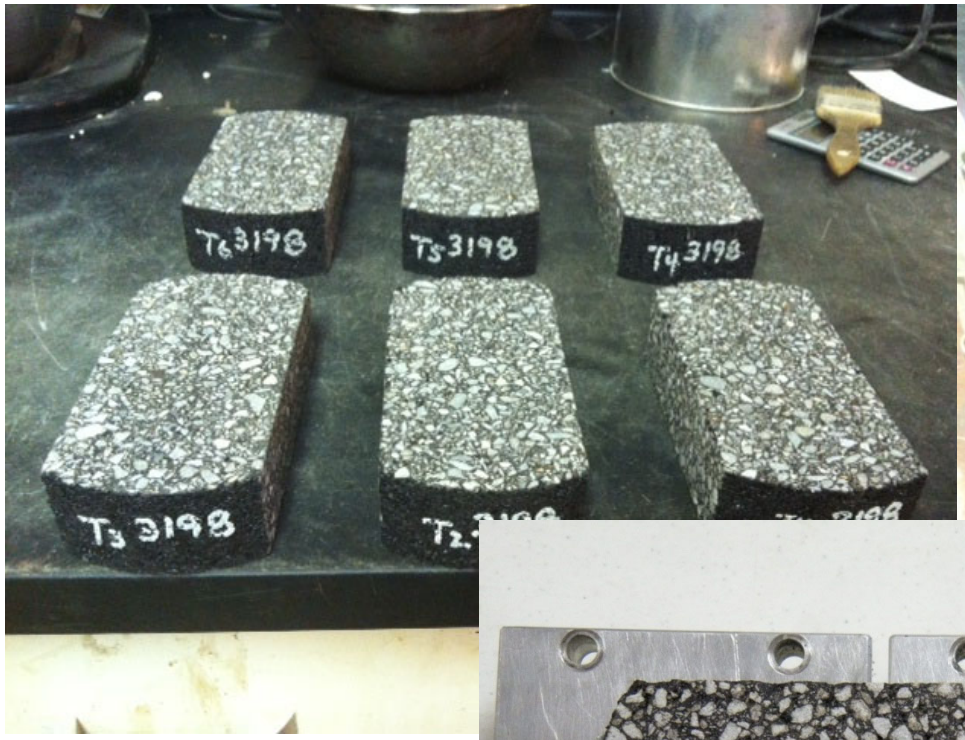
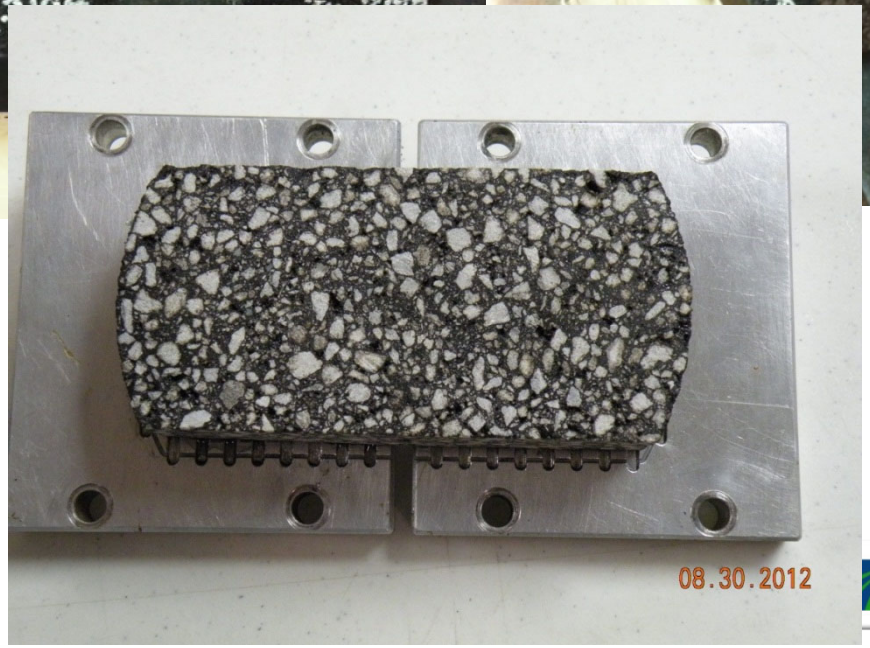
Performance Evaluation - HWTD



Performance Evaluation – Texas Overlay Tester





CRACK TEST

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Performance Evaluation – Overlay Tester

Test Temperature: 25ºC
# of load cycles: 1000
Or until load reduced to 93% of original

- **Repeated loading (triangular form) under constant deformation**
- **Deformation magnitude per load cycle: 0.025 inches (0.6 mm)**
- **Duration of each load cycle: 10 seconds**

Cycles to failure > 500

Good Performance

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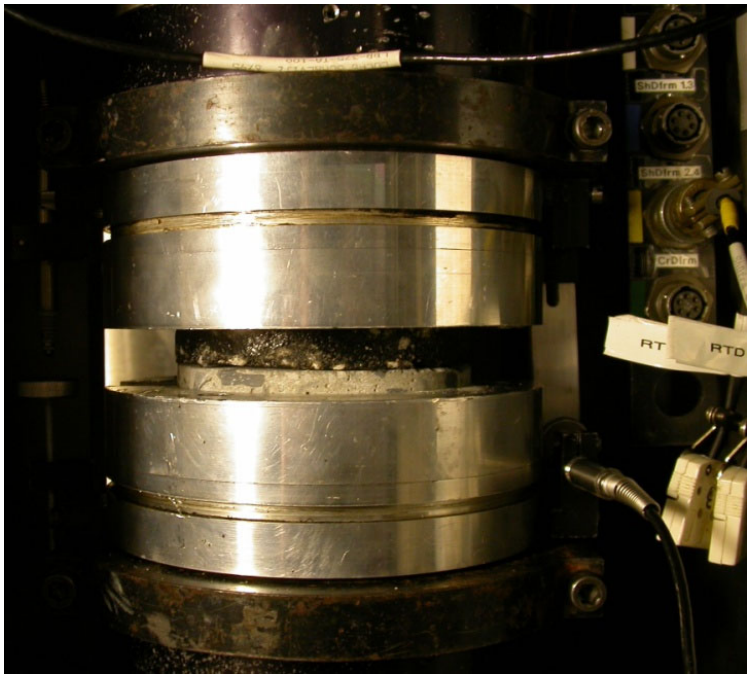
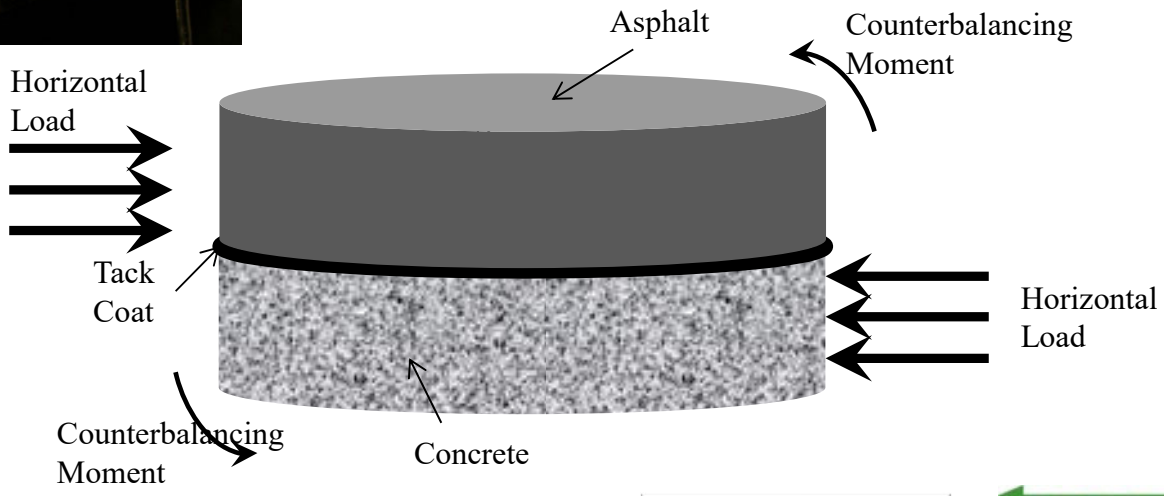
Tack Coat Evaluation

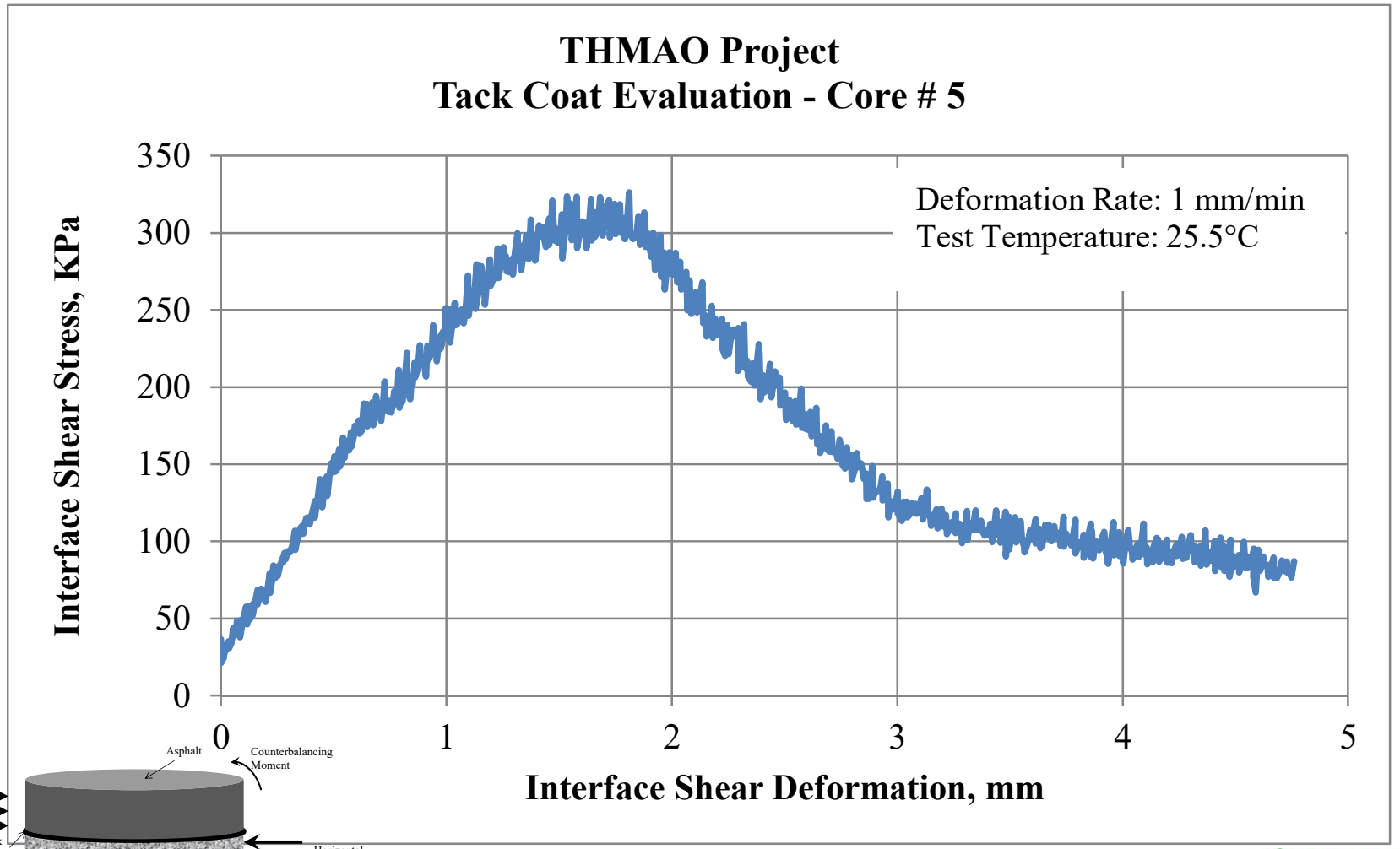


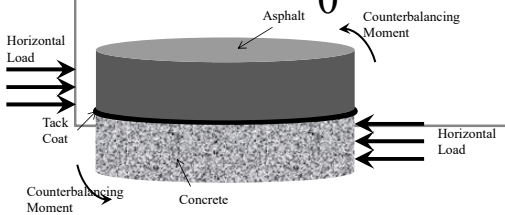
Direct Shear Applied at the Asphalt-Concrete Interface



Tack Coat Evaluation

Shear Strength = 44.5 psi - Good Performance





Recommended Requirements for Design of Asphalt Mix for Thin Lifts

Asphalt Binder

- PG 76-22 or PG 64E-22 if ESALs > 3M
- PG 64-22 if ESALS ≤ 3M
- PG 76-22 or PG 64E-22 if grade≥ 5% regardless of traffic level.

Mix Design

- 75 Gyrations
- Air Void: 4.0%
- VMA: 16.5%

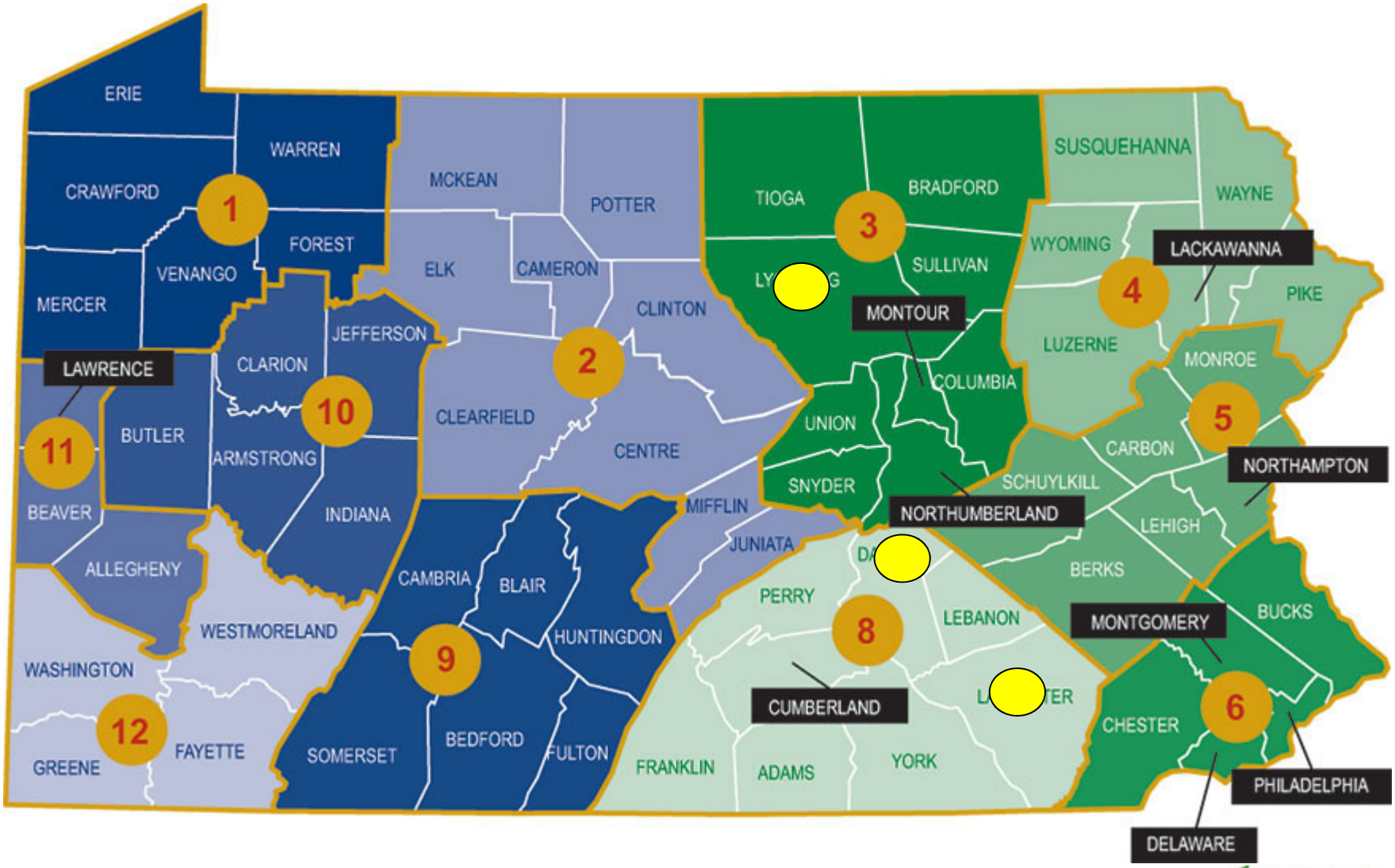
Recommended Requirements for Design of Asphalt Mix for Thin Lifts

Tack Coat, CSS-1h

Surface Type	Residual Application Rate(Gallons/SY)
New Asphalt Mixture	0.03 to 0.04
Oxidized Asphalt Mixture	0.04 to 0.06
Milled Asphalt Mixture	0.05 to 0.07
Milled PCC	0.05 to 0.07
Portland Cement Concrete	0.05 to 0.07

Construction of Thin Overlays/Demo Projects

PennDOT Pilot Projects



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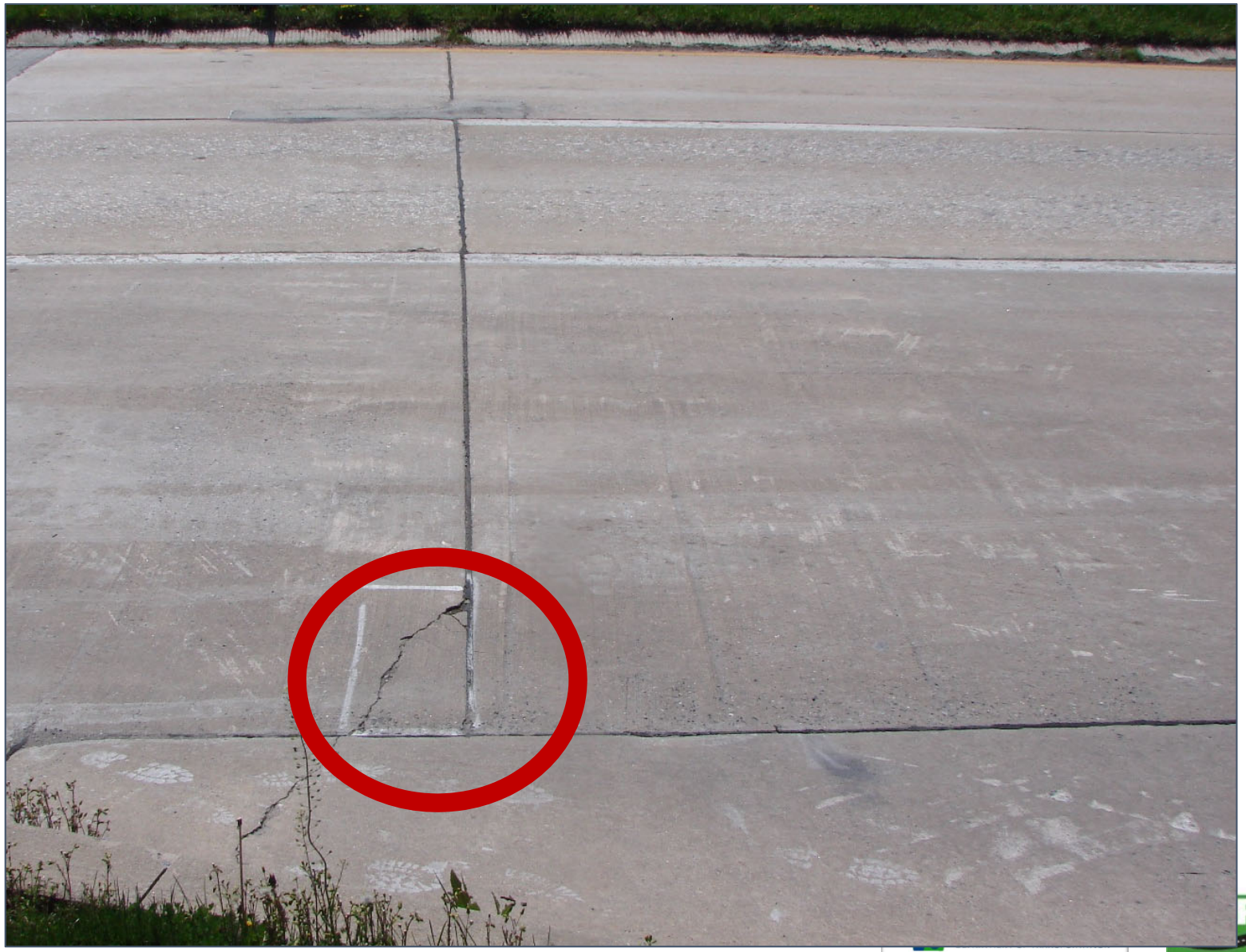
PILOT PROJECTS

STATE ROUTE	PAVEMENT SURFACE TYPE
SR 22 (Farm Show)	Diamond Ground Concrete
SR 220	Milled Asphalt
SR 230	Asphalt Overlay

Repair/Prepare the Base



Repair/Prepare the Base

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Repair/Clean Before Tacking

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Texture of the Jointed Concrete Pavement

Emulsion Tack Coat Application

NOTE: TEXTBOOK FULL COVERAGE SR 22

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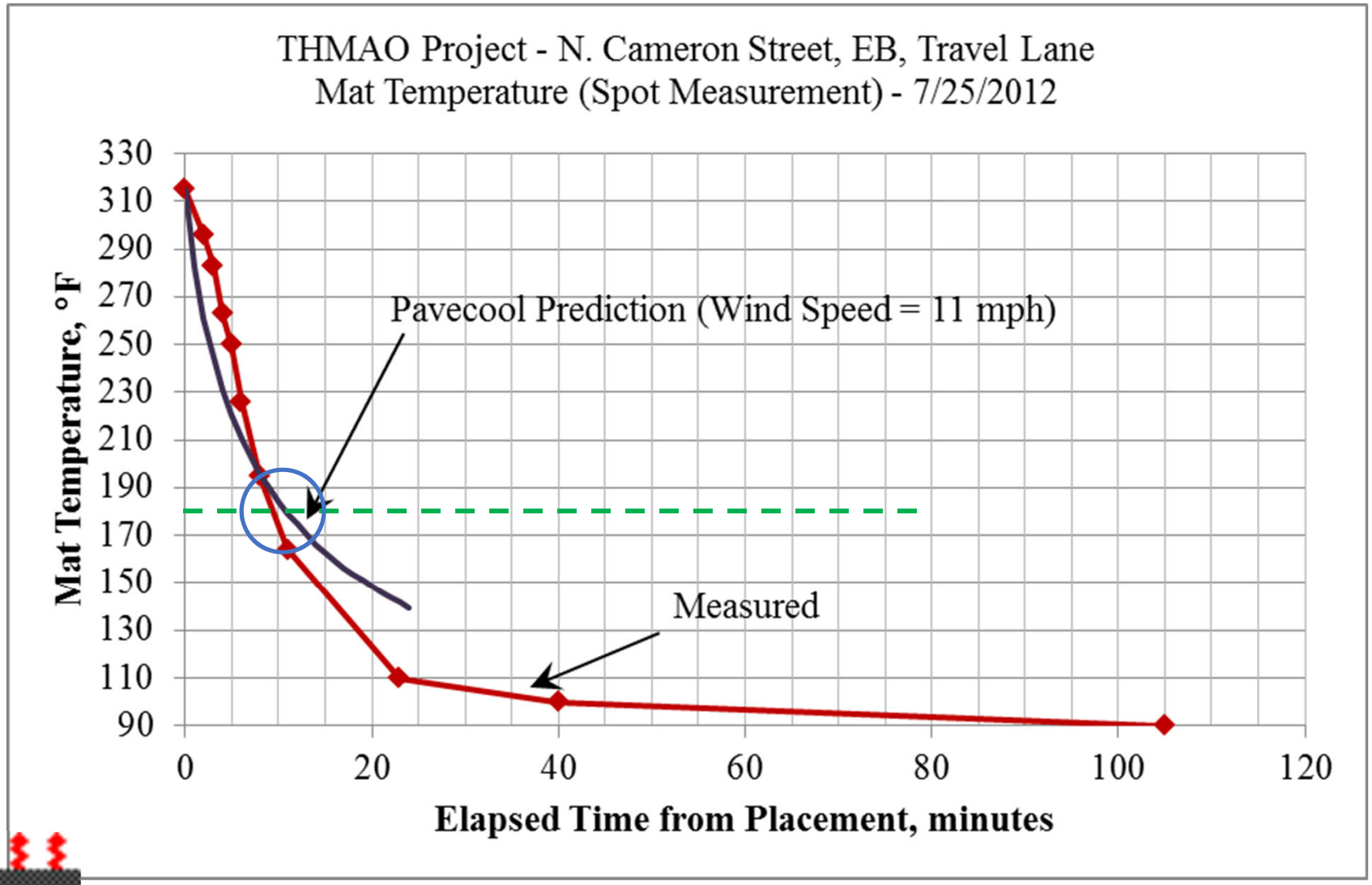
Smooth Mat Right Behind The Paver

Rollers Follow Paver Closely

Concern with Mat Temperature

Mat Temperature

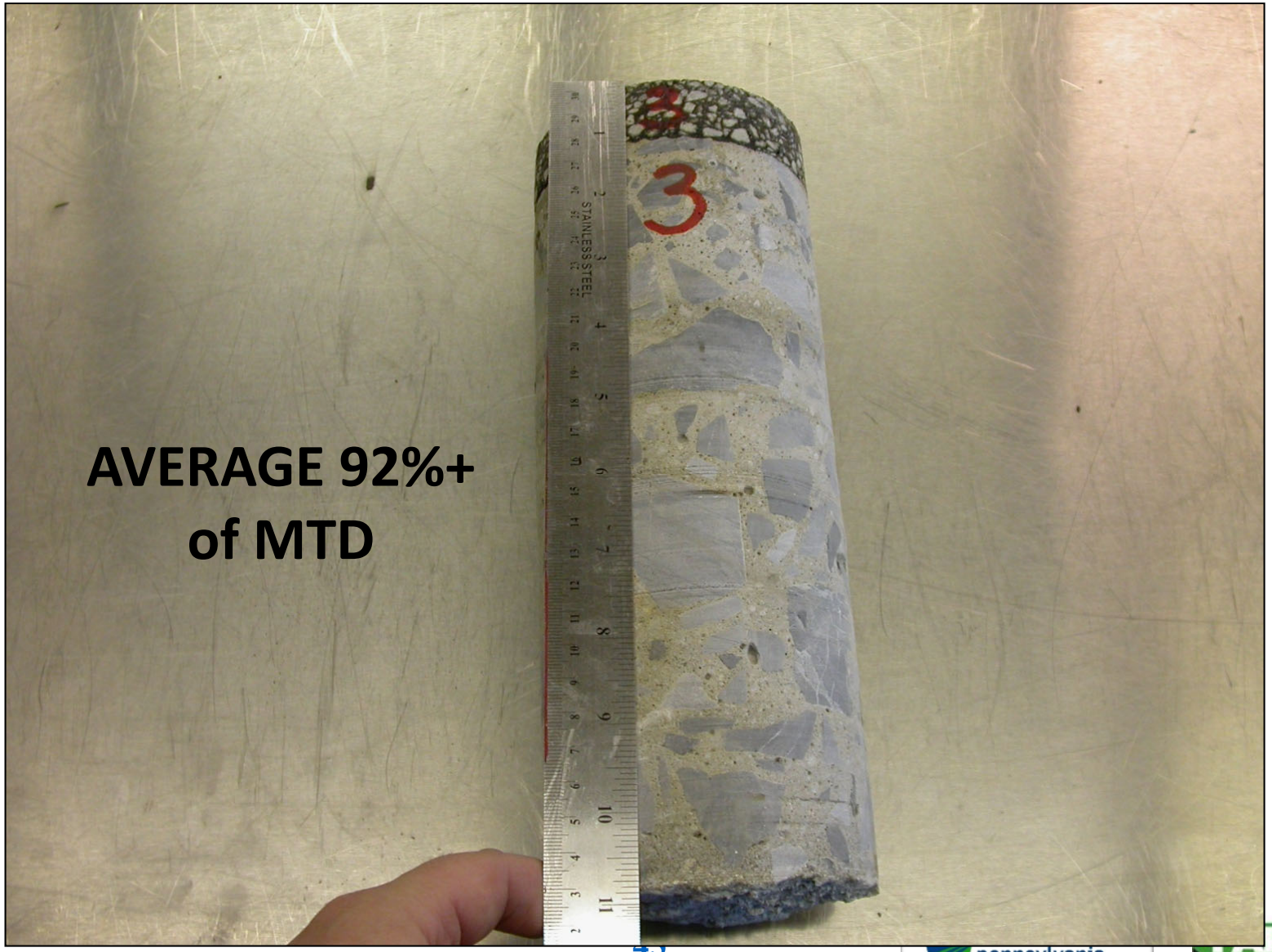


Finished Overlay – SR 0022

SR 230 – Finished Overlay

SR 220 – Finished Overlay

Coring for Density & Lab Testing



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Performance Evaluation of Thin Overlays

Performance – SR 0022

Performance – SR 0022

Performance – SR 0022

SR 220 – Performance

32 months after paving

SR 220 – Performance

SR 220 – Performance

June 2019 – 72 Months After Paving

SR 230 – Before THMAO

SR 230 – Performance

SR 230 – Performance

Skid Resistance Results

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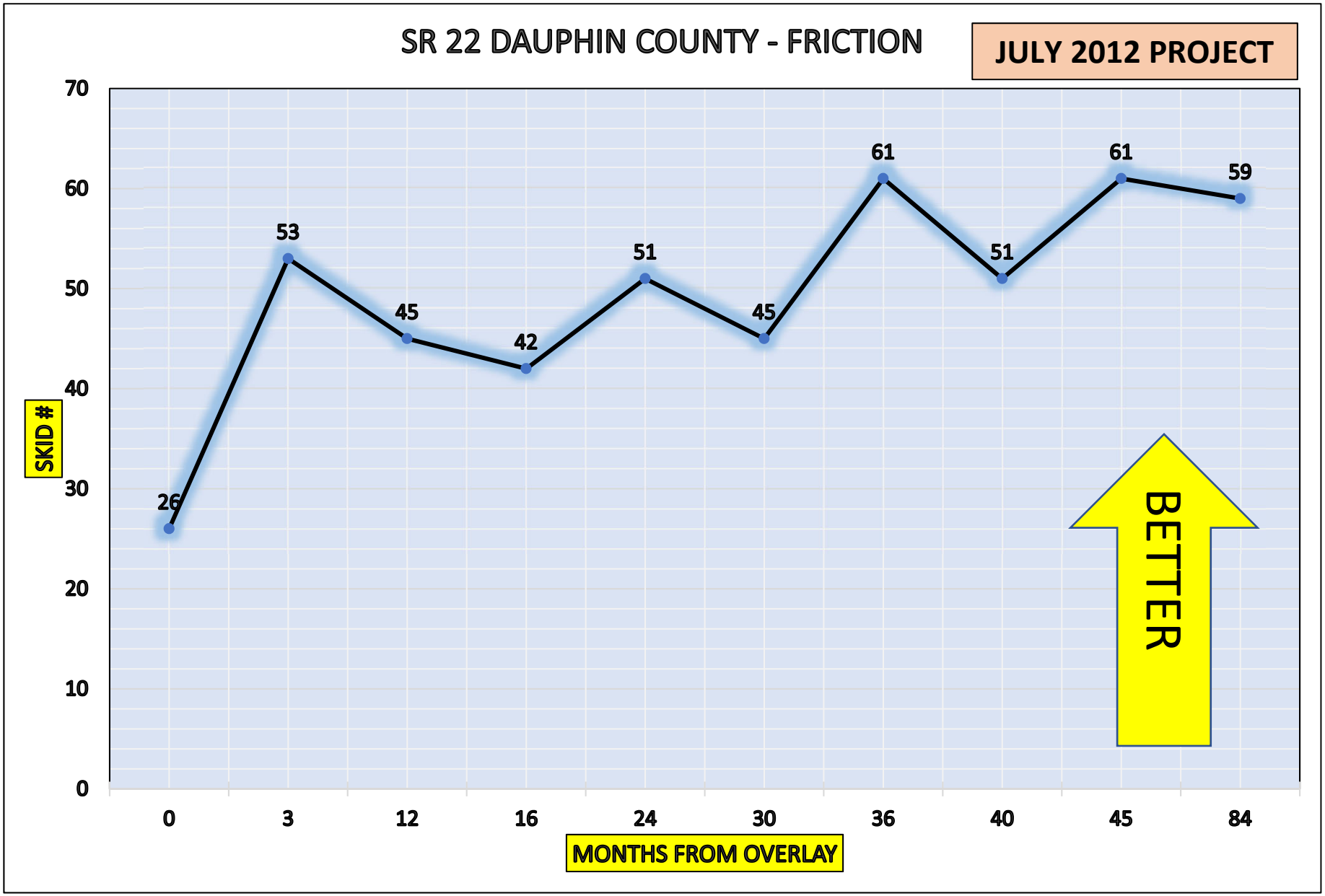
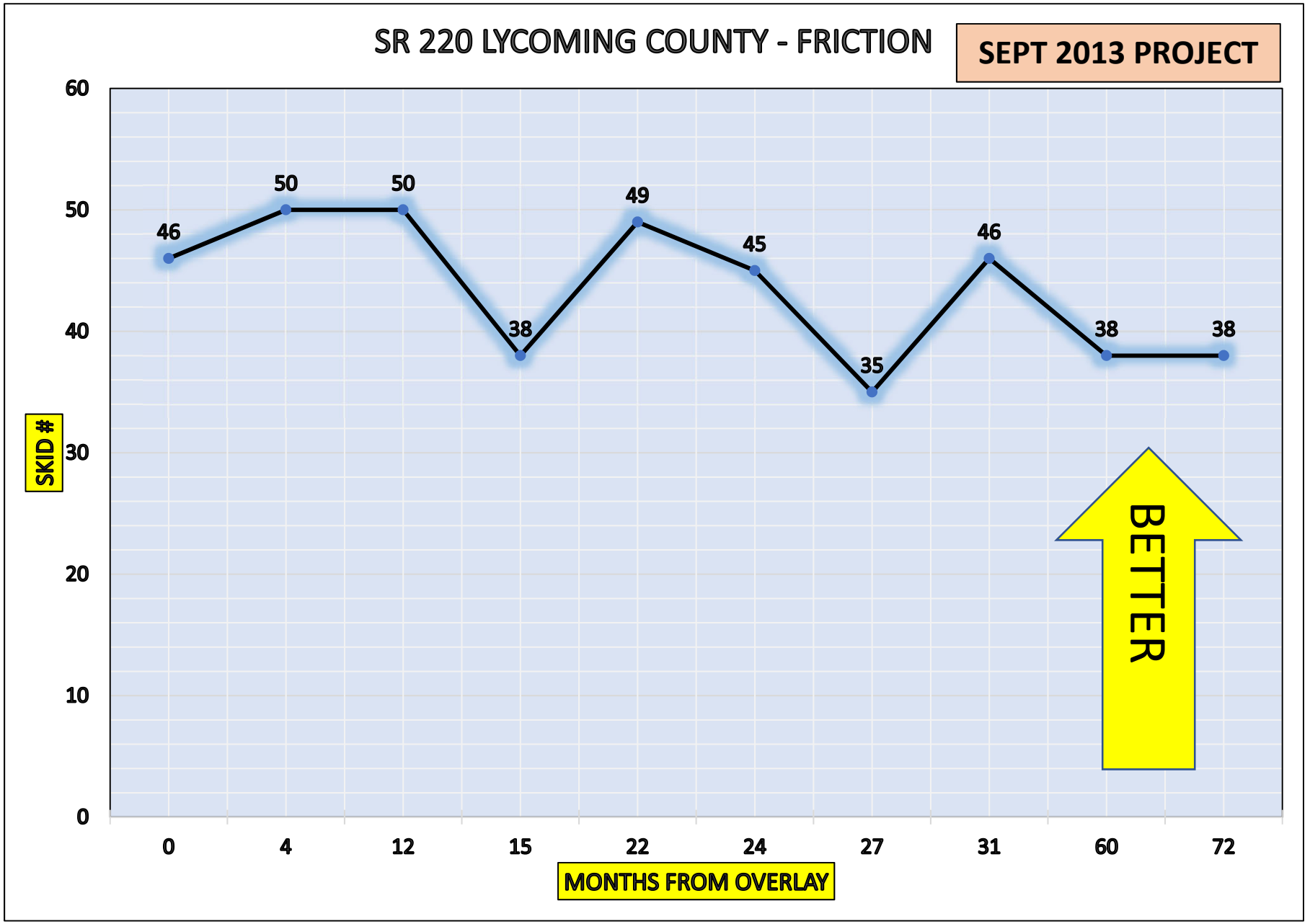
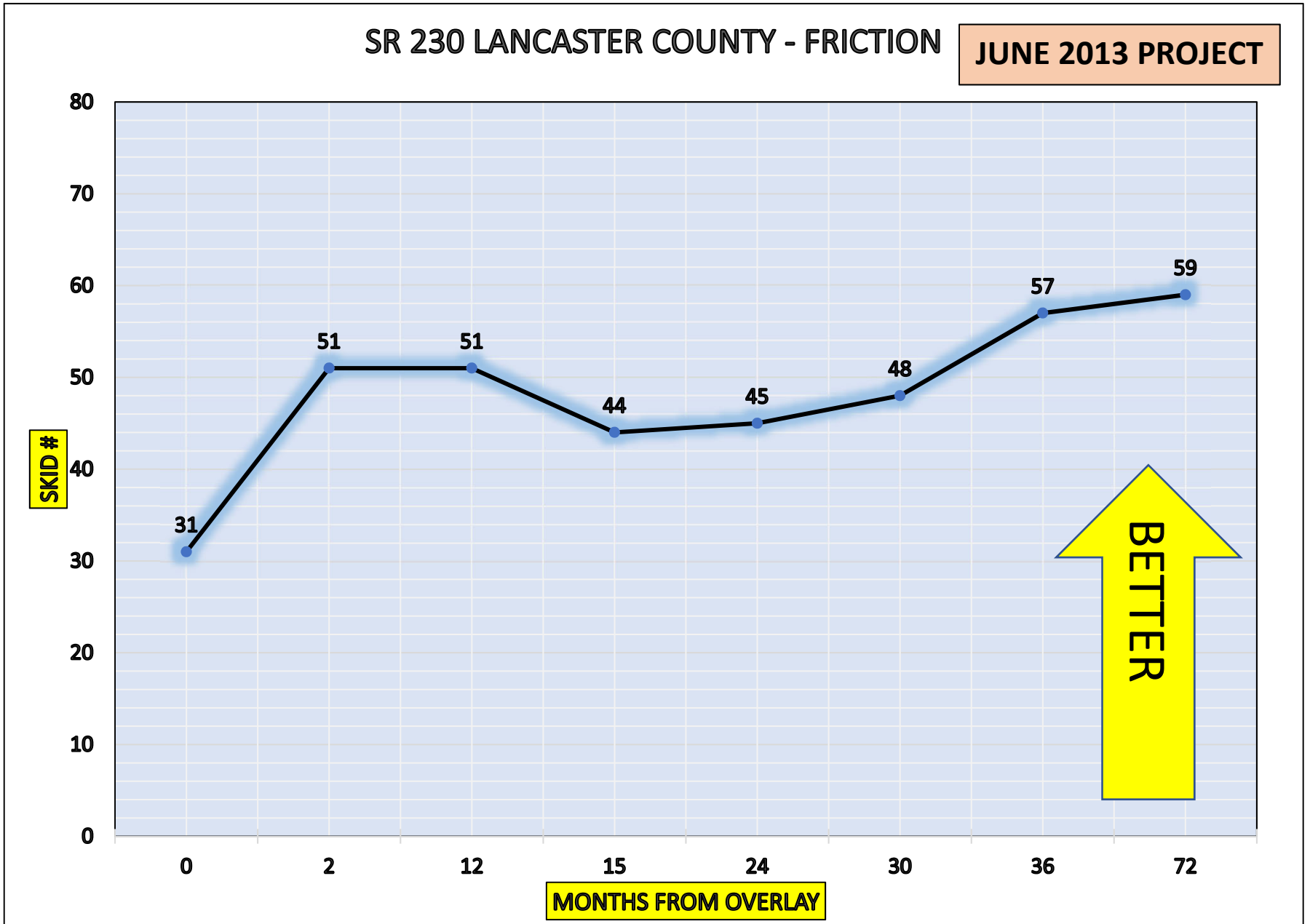

SR 22 DAUPHIN COUNTY - FRICTION
JULY 2012 PROJECT
70
60
50
40
30
20
10
0
SKID #
26
53
45
42
51
45
61
51
61
59
BETTER
0
3
12
16
24
30
36
40
45
84
MONTHS FROM OVERLAY


SR 220 LYCOMING COUNTY - FRICTION
SEPT 2013 PROJECT
60
50
40
30
20
10
0
SKID #
46
50
50
38
49
45
35
46
38
38
BETTER
0
4
12
15
22
24
27
31
60
72
MONTHS FROM OVERLAY



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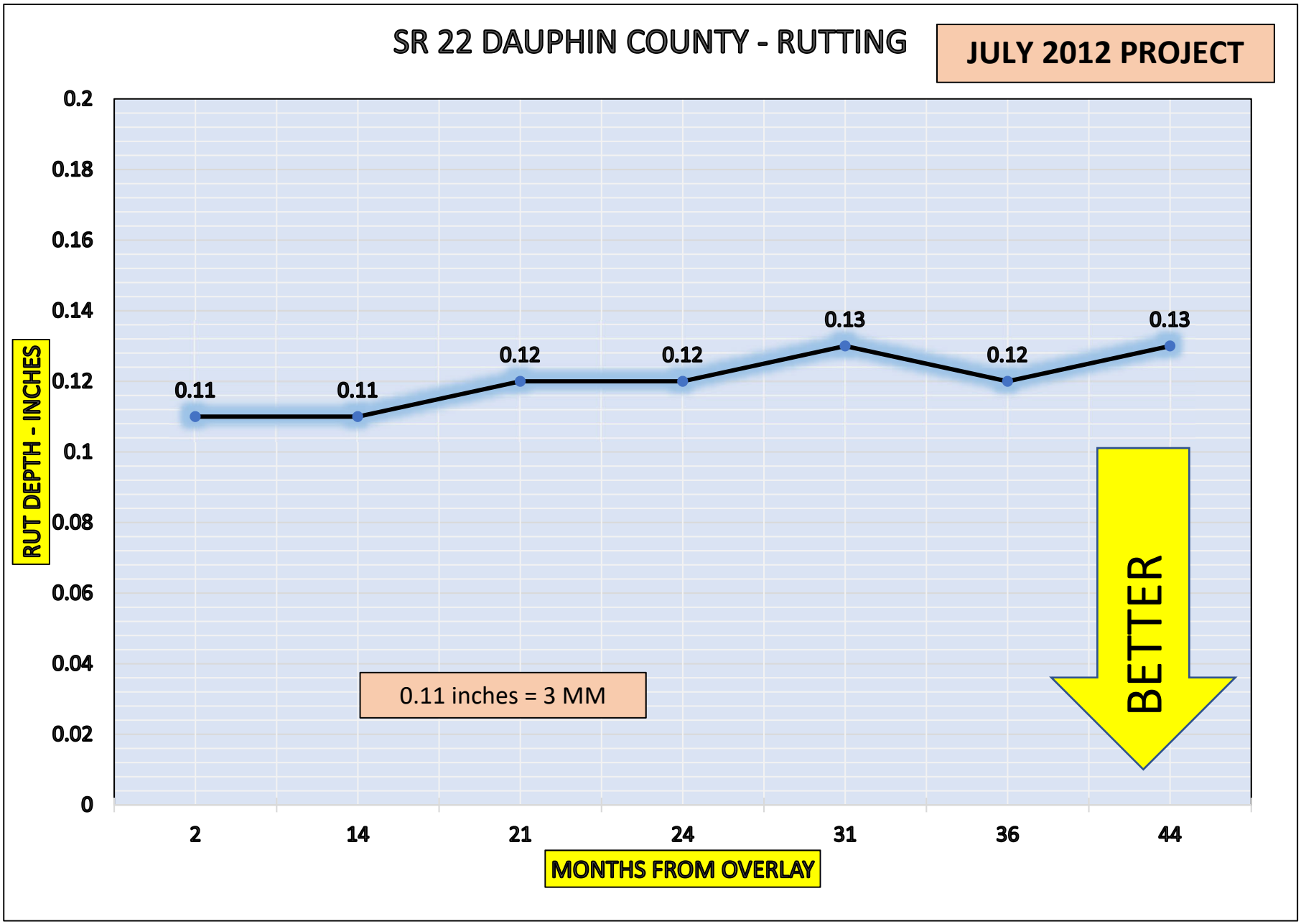
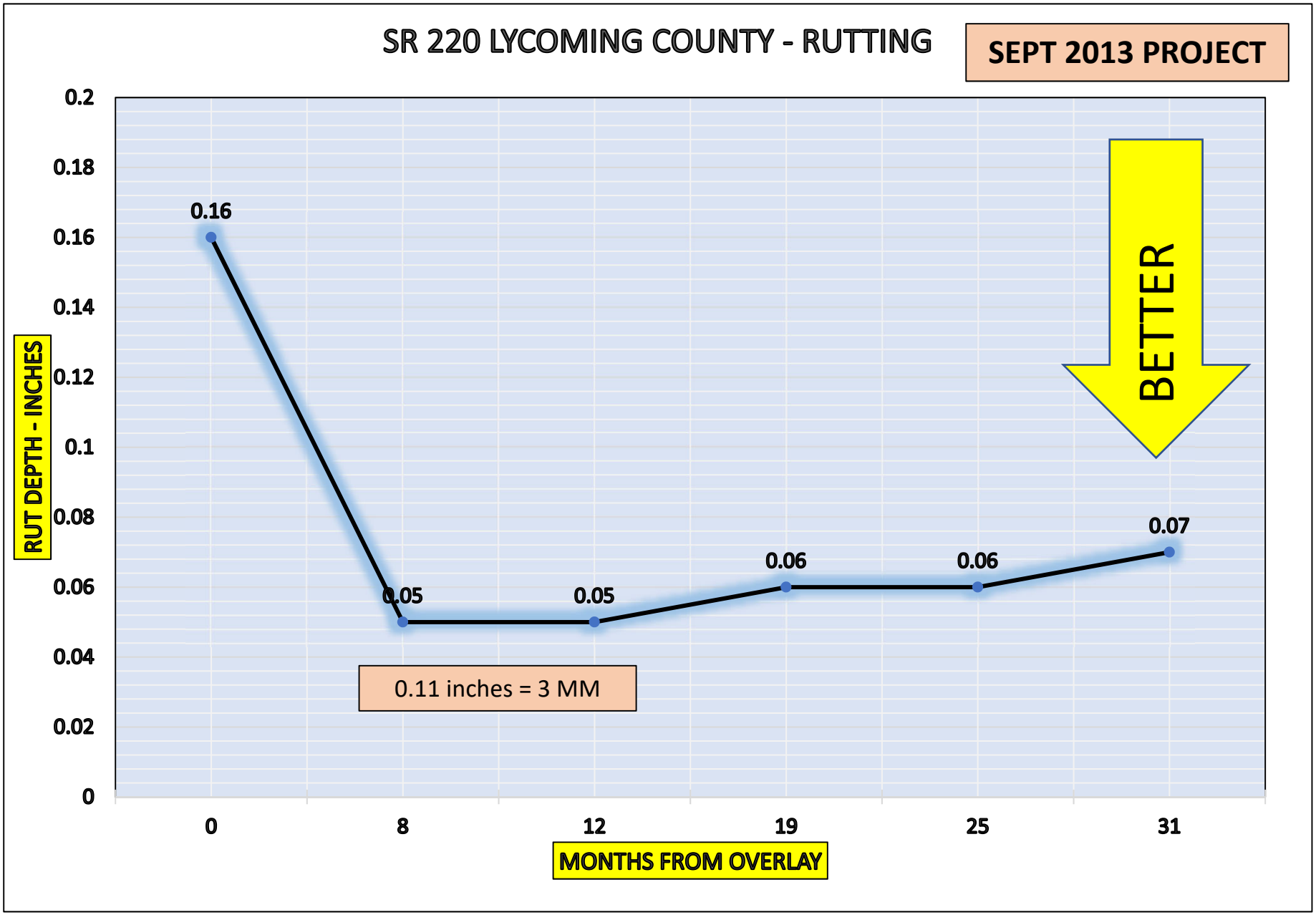
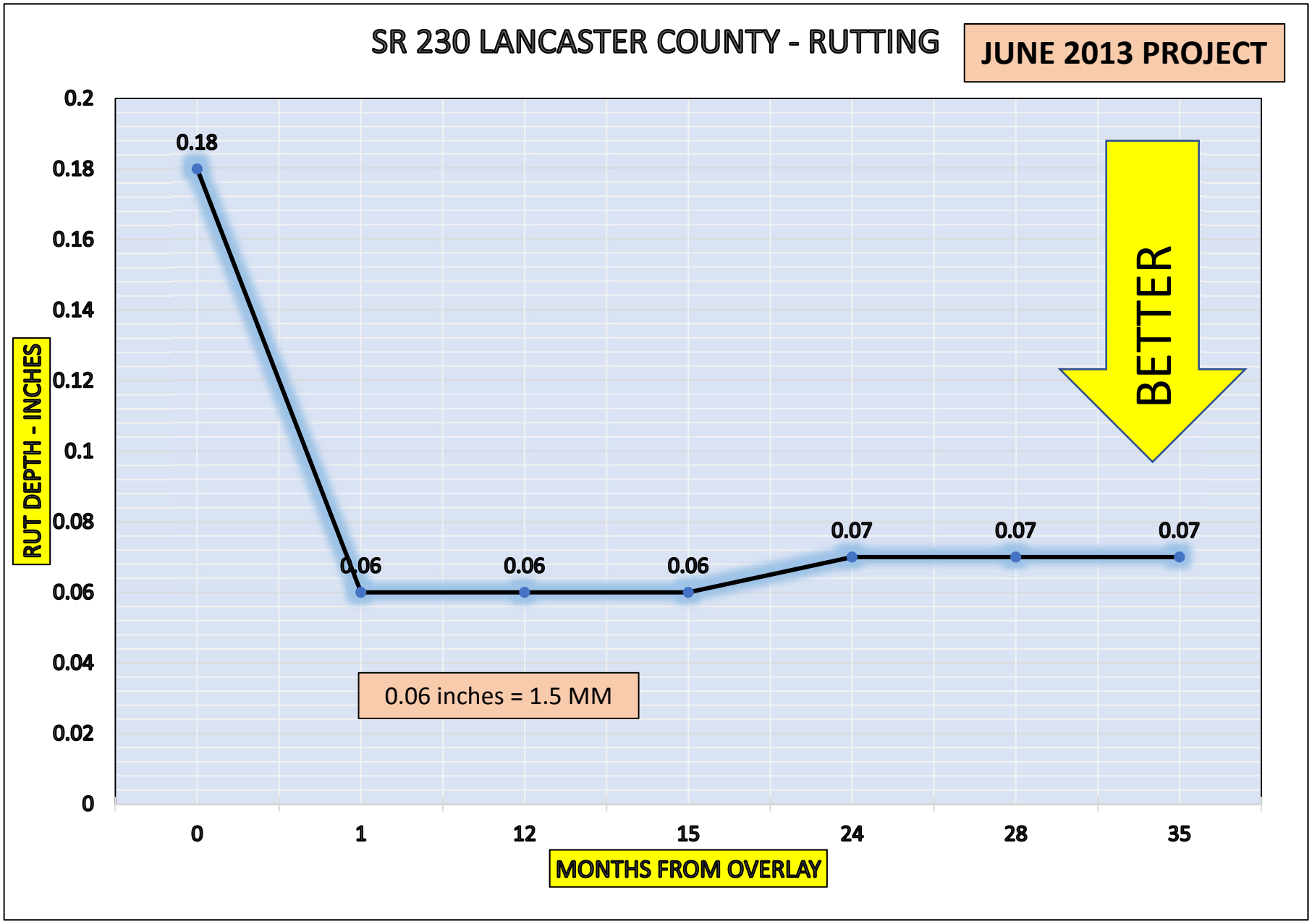
Rutting


SR 22 DAUPHIN COUNTY - RUTTING
JULY 2012 PROJECT
RUT DEPTH - INCHES
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0.11
0.11
0.12
0.12
0.13
0.12
0.13
2
14
21
24
31
36
44
MONTHS FROM OVERLAY
0.11 inches = 3 MM
BETTER


SR 220 LYCOMING COUNTY - RUTTING
SEPT 2013 PROJECT
RUT DEPTH - INCHES
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0.16
0.05
0.05
0.06
0.06
0.07
BETTER
0.11 inches = 3 MM
0
8
12
19
25
31
MONTHS FROM OVERLAY


SR 230 LANCASTER COUNTY - RUTTING
JUNE 2013 PROJECT
RUT DEPTH - INCHES
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0.18
0.06
0.06
0.06
0.07
0.07
0.07
BETTER
0.06 inches = 1.5 MM
0
1
12
15
24
28
35
MONTHS FROM OVERLAY

Ride Quality & Smoothness

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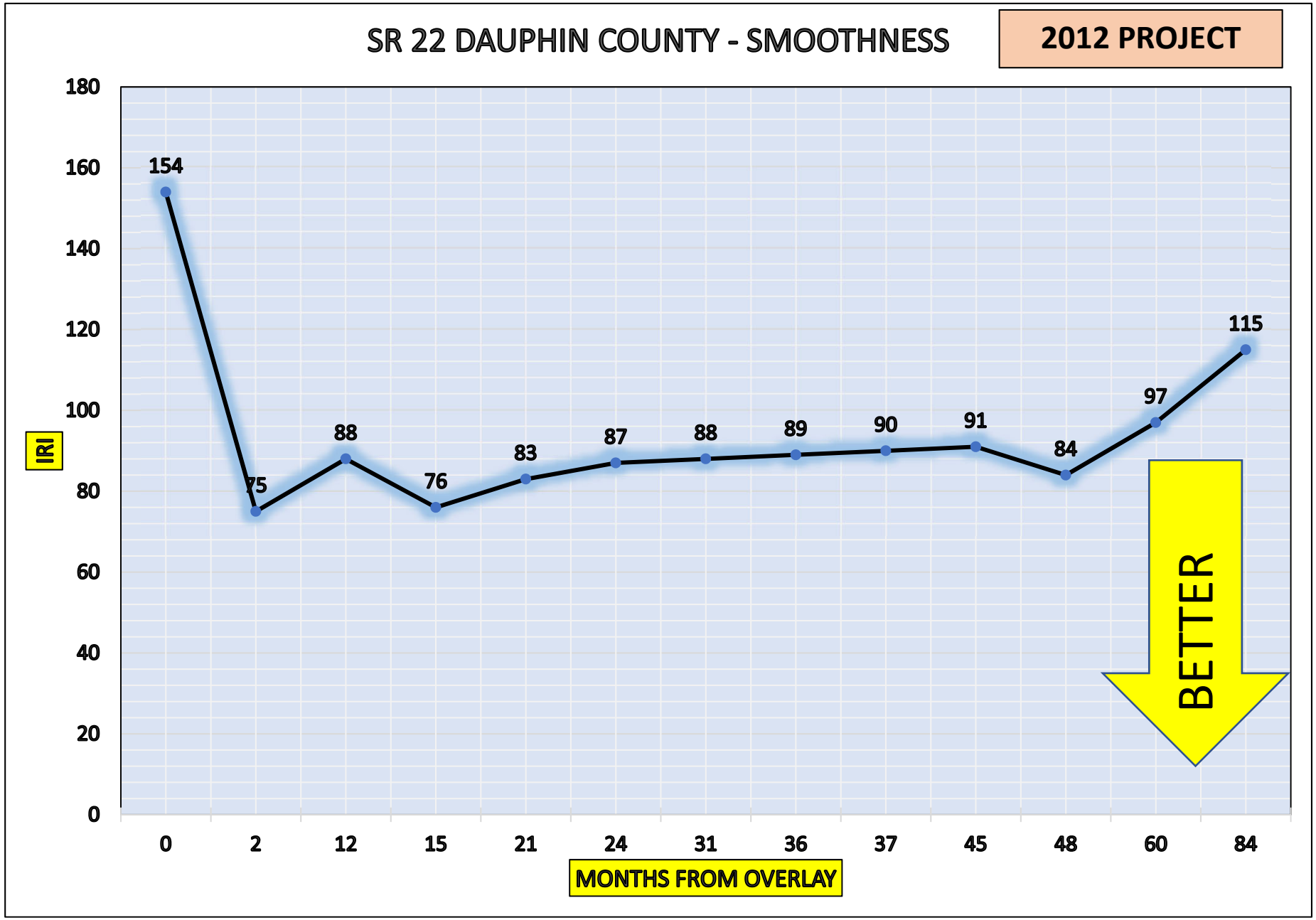
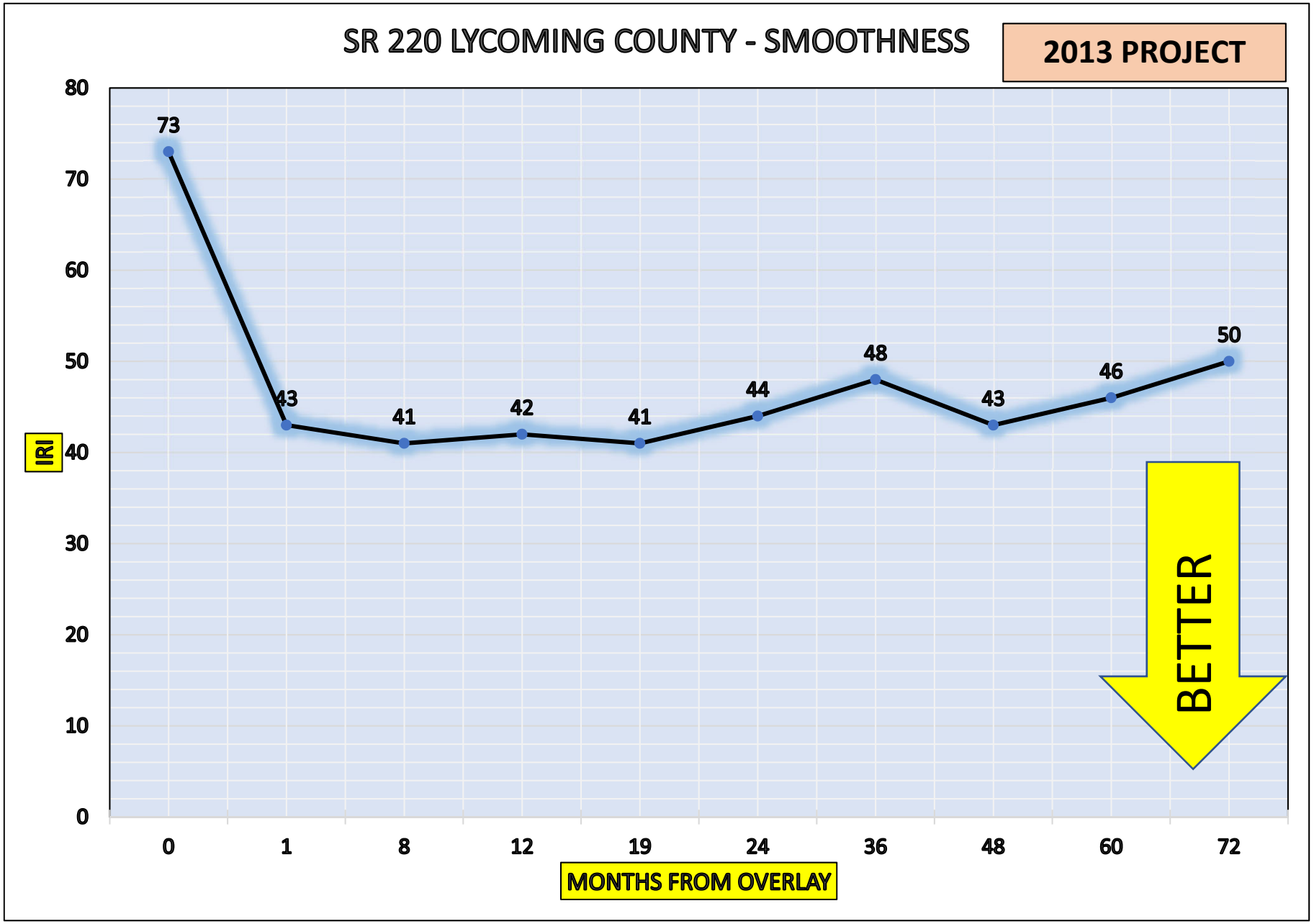
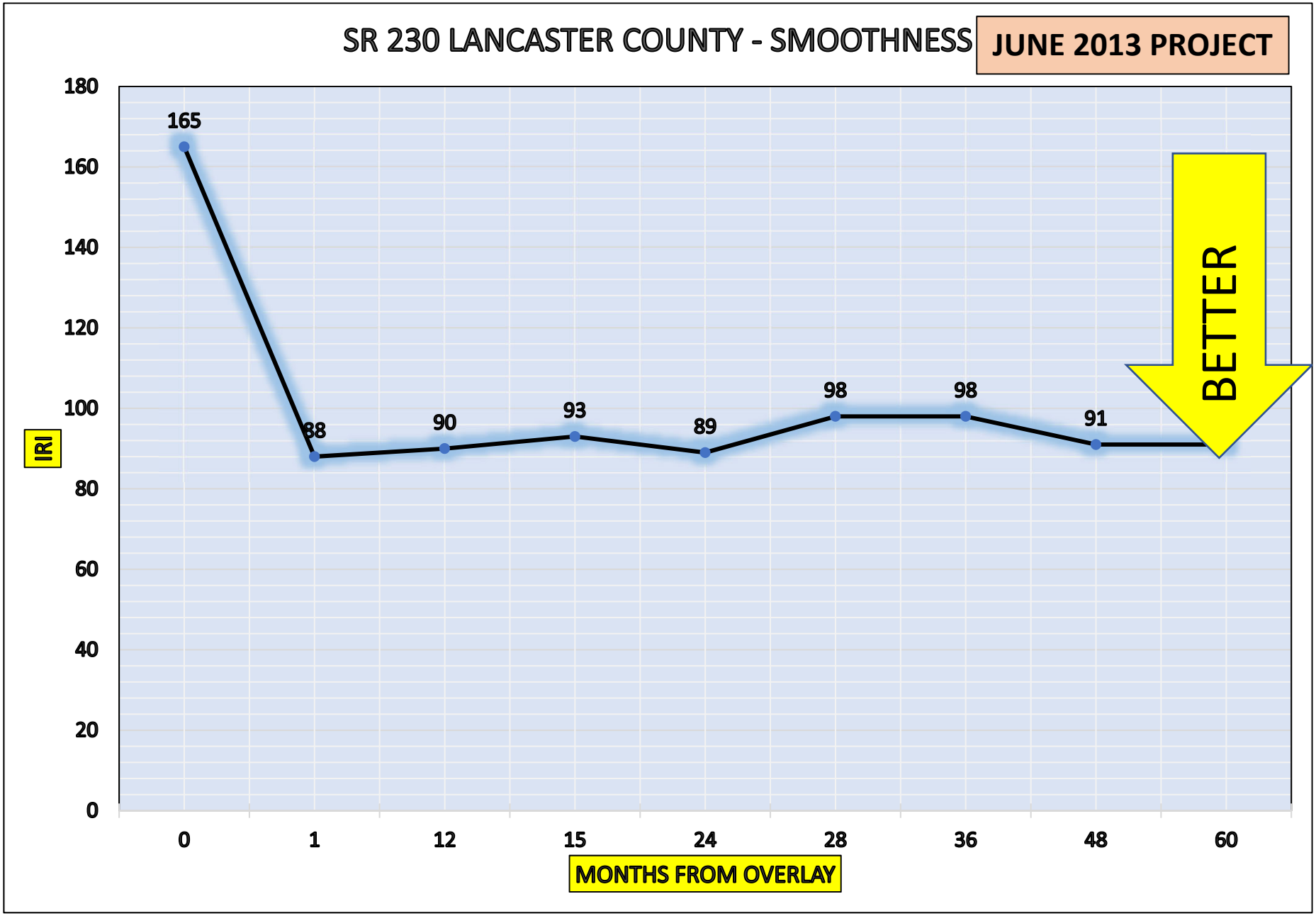

SR 22 DAUPHIN COUNTY - SMOOTHNESS
2012 PROJECT
IRI
180
160
140
120
100
80
60
40
20
0
154
75
88
76
83
87
88
89
90
91
84
97
115
BETTER
0
2
12
15
21
24
31
36
37
45
48
60
84
MONTHS FROM OVERLAY


SR 220 LYCOMING COUNTY - SMOOTHNESS
2013 PROJECT
80
70
60
50
40
30
20
10
0
IRI
73
43
41
42
41
44
48
43
46
50
BETTER
0
1
8
12
19
24
36
48
60
72
MONTHS FROM OVERLAY


SR 230 LANCASTER COUNTY - SMOOTHNESS
JUNE 2013 PROJECT
180
160
140
120
100
80
60
40
20
0
IRI
165
88
90
93
89
98
98
91
BETTER
0
1
12
15
24
28
36
48
60
MONTHS FROM OVERLAY

New PUB 408 Section 412
Plant Mix 6.33mm Thin Asphalt Overlay

Revised PUB 408 Section 460
Bituminous Tack Coat

Publication 242 PAVEMENT POLICY MANUAL
May 2015 Edition

6.3mm Mix Project Selection

- This is a **Preservative Treatment – 3/4" to 1½" Depth**
- It is a highly competitive alternate to a POLYMER-MODIFIED EMULSIFIED ASPHALT PAVING SYSTEM (MICRO SURFACING) or ULTRA-THIN BONDED WEARING COURSE
- Advantages of 6.33 WMA Thin Lift Asphalt Mix:
  - SY cost similar to Micro & UTBWC
  - Maintains both long term surface smoothness & friction
  - Quiet pavement
  - Adds structure to the pavement
  - Conventional paving methods & equipment
  - 10+ years of service/minimal maintenance/reduced life cycle costs

Table 1. SHRP 2 data on preservation treatment life and cost (Peshkin et al., 2011)

Treatment	Life, Years		Cost Per Square Yard		Square Yard Cost Per Year	
	Min	Max	Min	Max	Min	Max
Microsurfacing (single course)	3	6	$1.50	$3.00	$0.25	$1.00
Chip Seal (single course)	3	7	$1.50	$4.00	$0.21	$1.33
Thin HMA Overlay	5	12	$3.00	$6.00	$0.25	$1.20
Ultra-Thin HMA Overlay	4	8	$2.00	$3.00	$0.25	$0.75

6.3mm Mix Spec. Possible Changes

- 6.3mm asphalt mix currently only allows PG 76-22 asphalt
- Research project constructed in 2018 is evaluating PG 64-22 mixtures
- Centre Co., SR 1001

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6.3mm Mix Spec. Possible Changes

- Additional 6.3mmsection added to further evaluated PG 64-22 only option
- Clearfield Co., SR 453
- Construction by the end of July 2019

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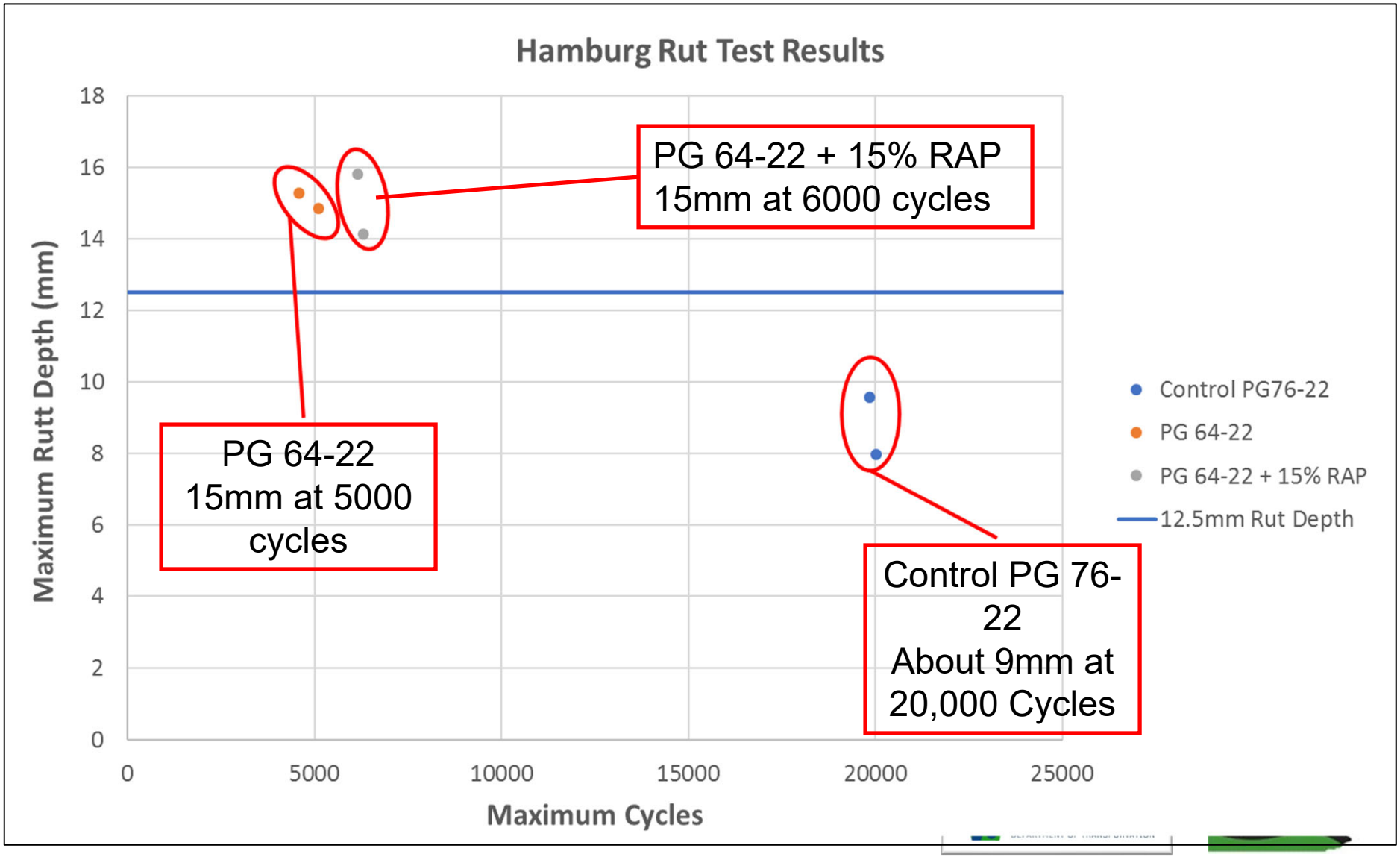
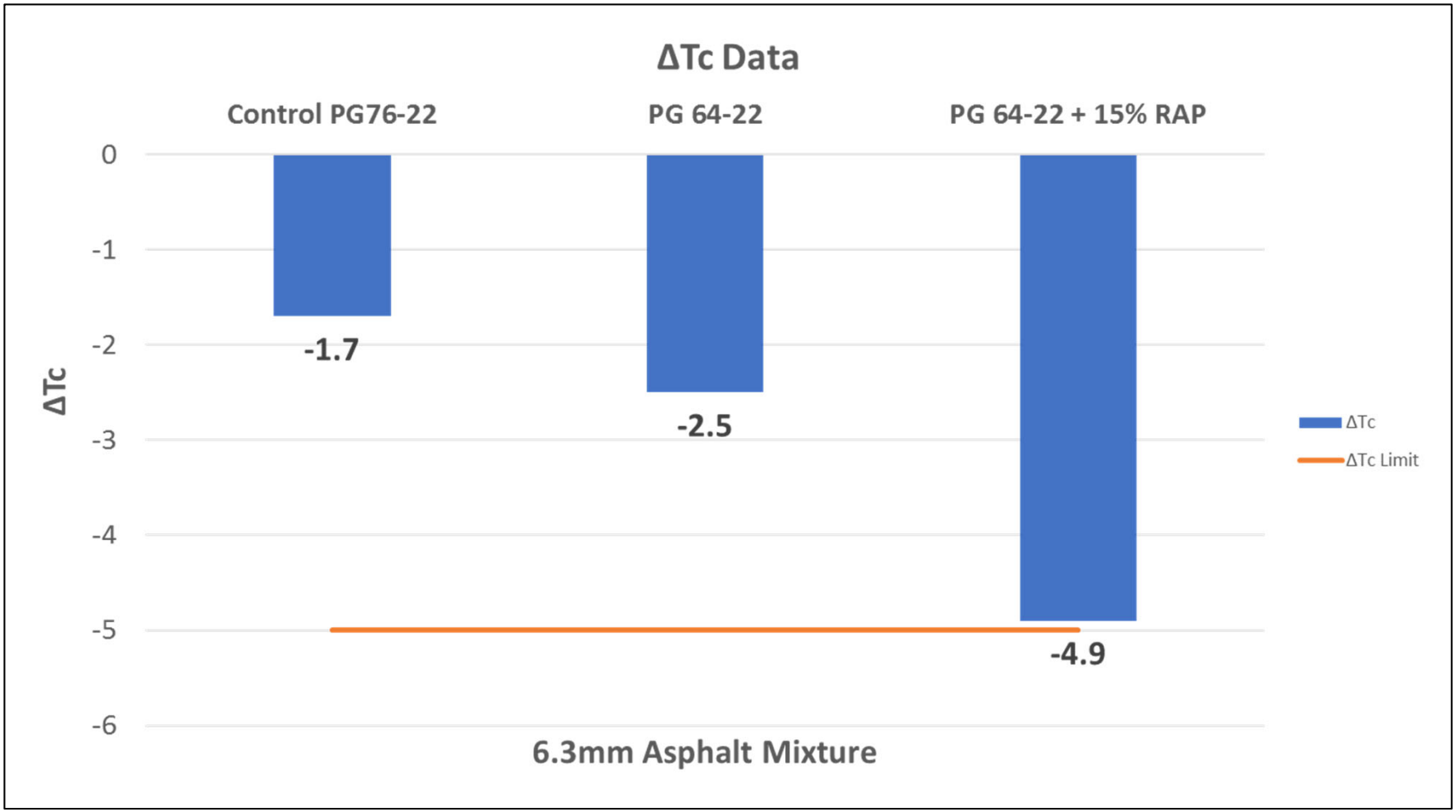
Hamburg Test Results



ΔTc Data


ΔTc Data
Control PG76-22
PG 64-22
PG 64-22 + 15% RAP
0
-1
-2
-3
-4
-5
-6
ΔTc
-1.7
-2.5
-4.9
ΔTc
ΔTc Limit
6.3mm Asphalt Mixture

AGGREGATE GRADATION TWEAKS

PROPOSED AT APQIC MEEETING

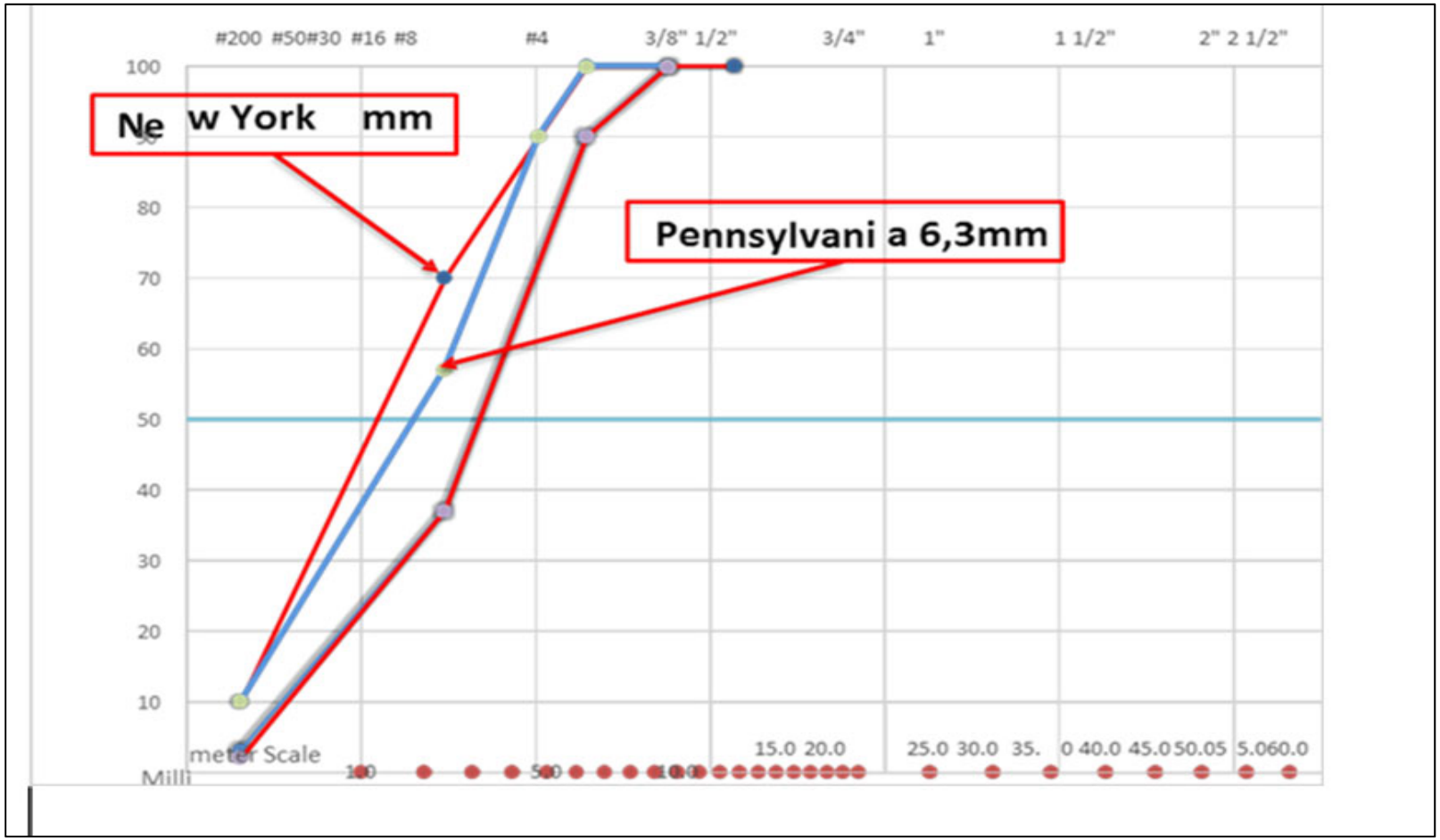
AGGREGATE GRADATION REQUIREMENTS, PERCENT PASSING	
Sieve Size	Min. – Max.
3/8"	100 Min.
1/4"	90-100
No. 4	~~0-85~~90 Max.
No. 8	37-~~55~~57
~~No. 50~~	~~8-25~~
No. 200	3-10

pennsylvania DEPARTMENT OF TRANSPORTATION

PAPA

AGGREGATE GRADATION TWEAKS

PROPOSED AT APQIC MEEETING



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PAPA

Summary/Findings

Summary/Findings

- 6.33 mm Thin Asphalt A Good Tool for Surface Treatment – A Preservative Treatment!
- Proper Base Repair is a MUST
- Improved Ride and Friction (Initial)
- Improved Ride and Friction Maintained (7Yrs.)
- Minimal Rutting Observed

Summary

- **Concerns:**
  - Rapid Mat Cooling
  - Reflection of cracks is a challenge on jointed or cracked pavement
- **Good Mix Lab Performance:**
  - Rutting and Moisture Resistance (HWTD)
  - Crack Resistance (Texas Overly Test)
  - Good Tack Goat Adhesion

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