Alaska Department of Transportation & Public Facilities

Alaska's Success Partnering With the PMA Industry

Newton Bingham PE

February 2018

Keep Alaska Moving through service and infrastructure

The Problem

OUTLINE

-Problem- “Stop Pavement Rutting”

-Rutting Causes

-Rutting Solutions

- PG+ changes

-Low Temperature Asphalt

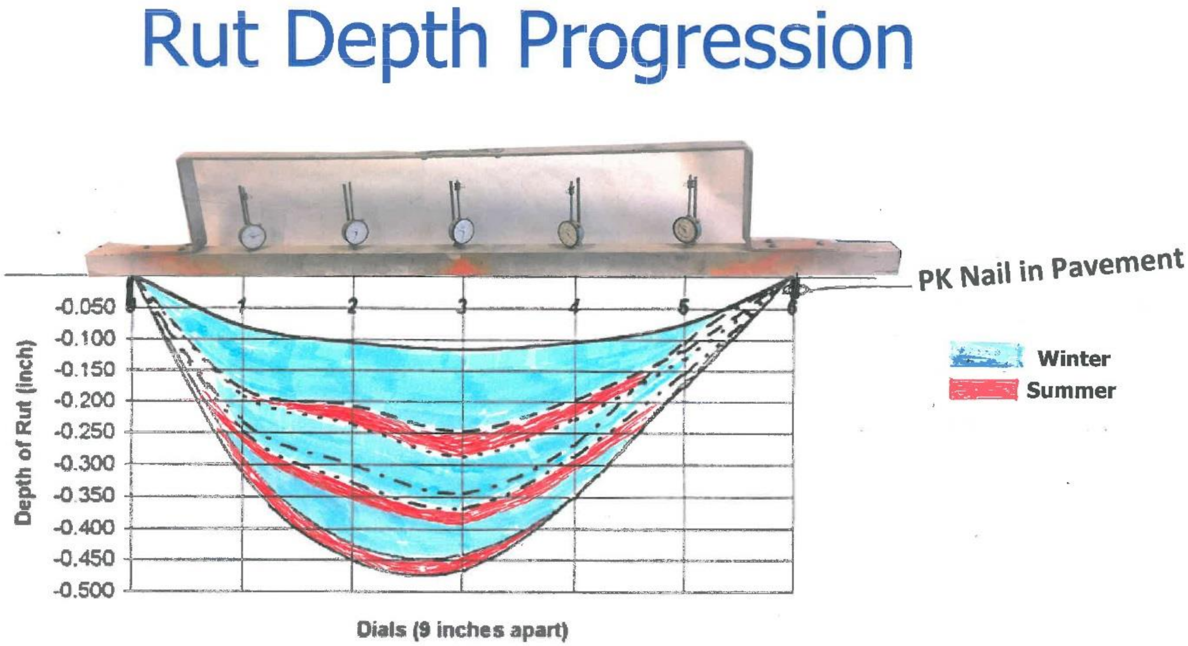
-WMA Experience

-Density: IC, Pave IR, GPR

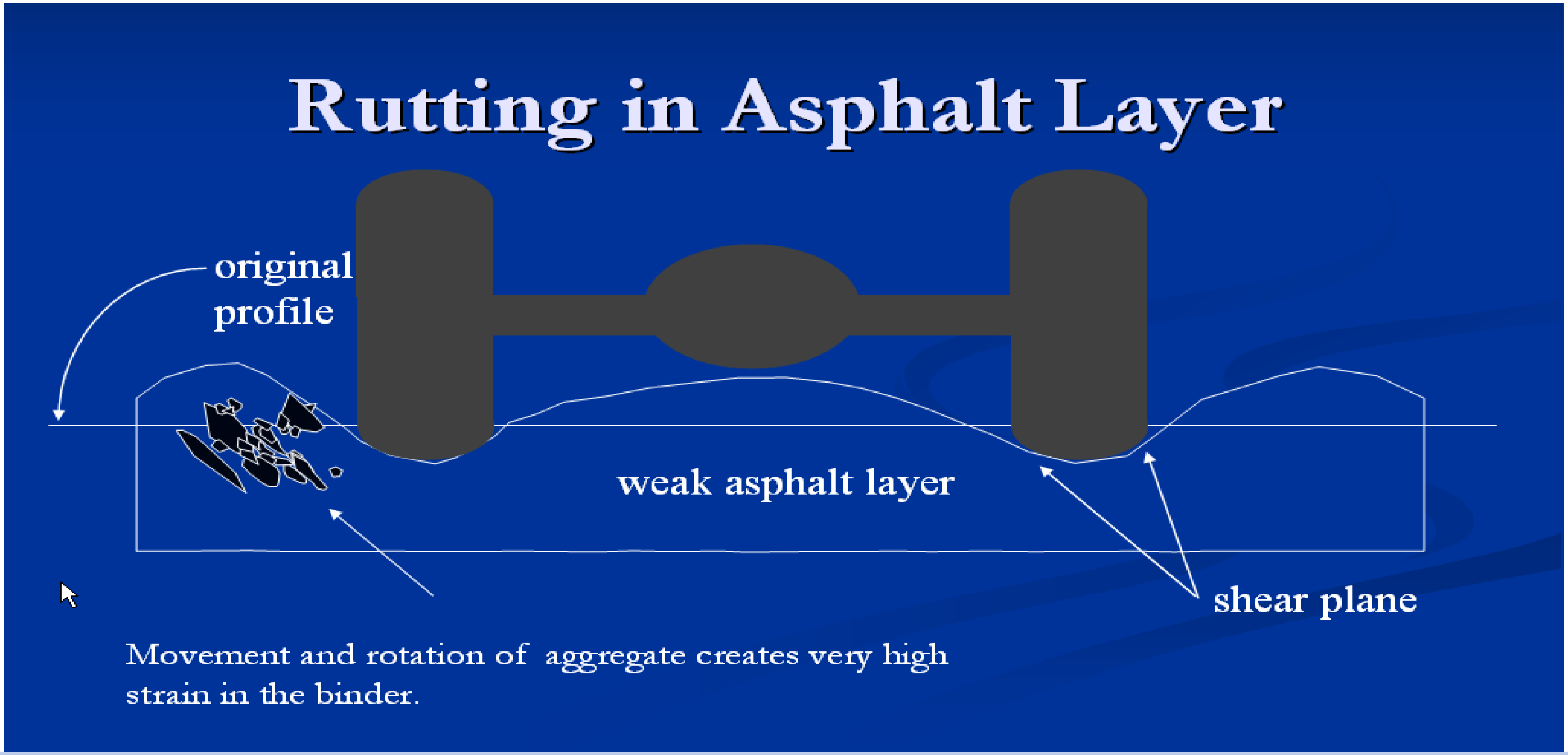
-2R Design

The Culprit (Studded Tires?)

Rut Measurements



Plastic Deformation



Cause of Rutting

1. Plastic Deformation during hot days in summer months (June & July)
2. Studded Tire Wear during winter months (mid September to April, approx. 7 months). Approximately 30%-60% passenger cars use studded tires.

Technical Solutions to Plastic Deformation

- Use polymer modified asphalt cement (PG+) in the hot mix asphalt (HMA)
- Use Superpave Design criteria to design HMA
- Use highly fractured, cubicle shaped aggregate
- Proof Test HMA Designs with Loaded Wheel Rut Tester for Plastic Deformation before approving for use

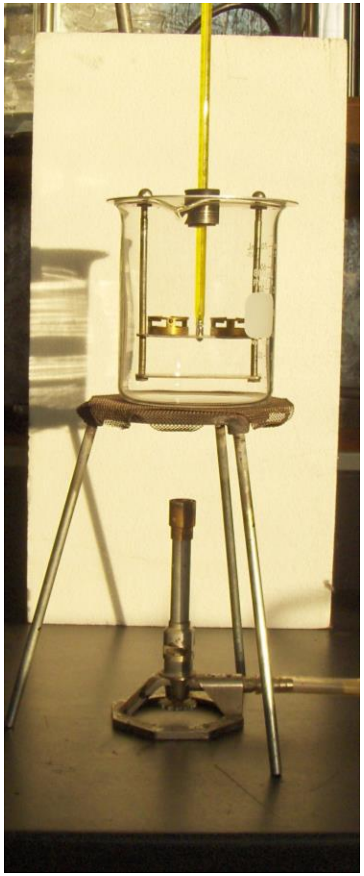
Plastic Deformation

First Polymer Modified Asphalt Spec

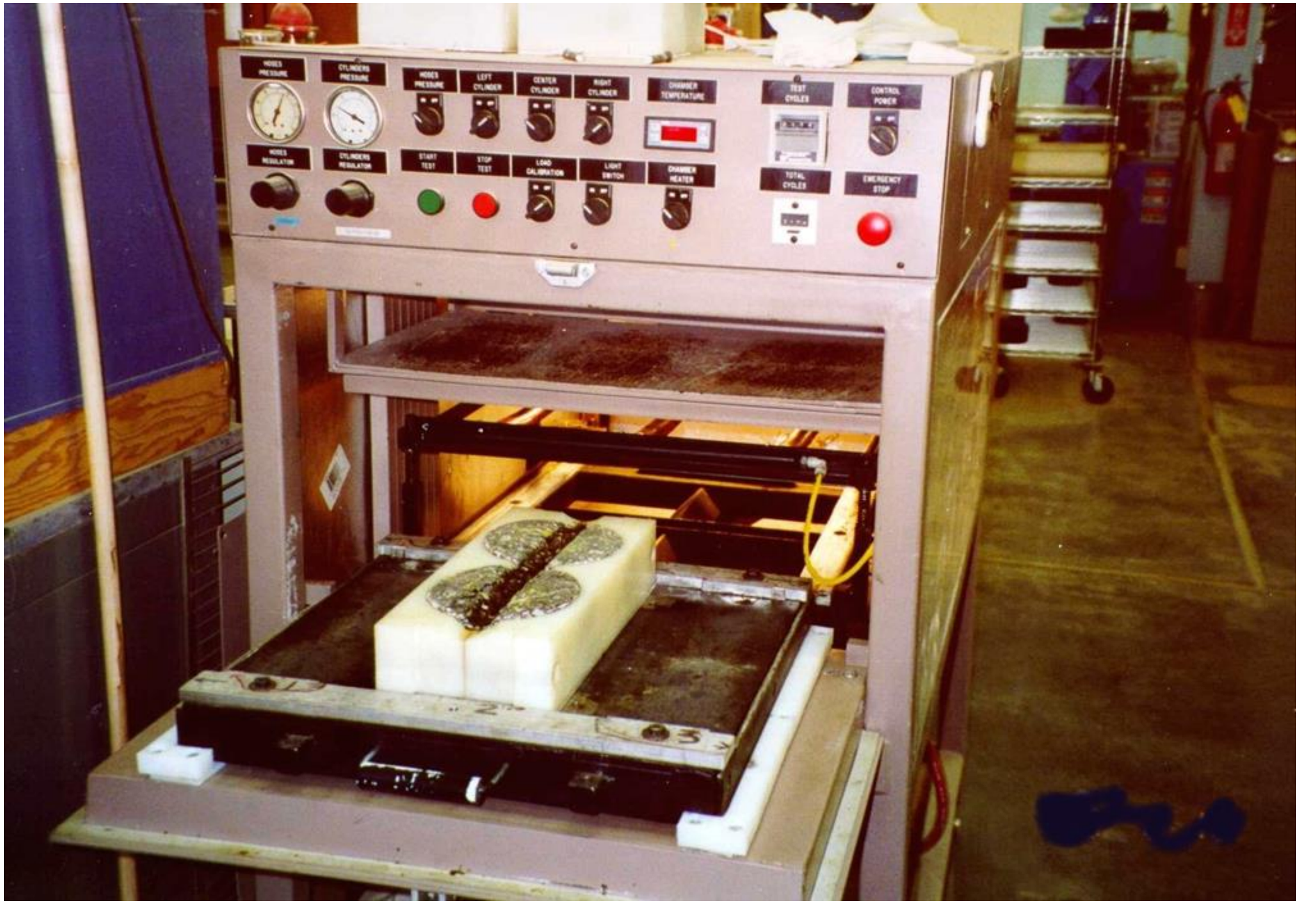
- AC 5 from Refinery + 4% SBS added by PMA Supplier
- 2 PMA Suppliers – need to define product…
- (Spec Changes AC > PG >PG+)

Existing PG+ Spec

- Softening Point 125°F
- Toughness 110 In-lbs
- Tenacity 75 in-lbs



Asphalt Pavement Analyzer



Test HMA for Plastic Deformation

Binder or Aggregate Solution?

Design Aggregate Gradation Change AC to AC-5 (No SBS) RUT: 10.3mm	Design: Aggregate Gradation PG58-28 (2.5% SBS) RUT: 0.8mm	Different Aggregate Gradation PG58-28 (2.5% SBS) RUT: 7.2mm

Change in Aggregate or Asphalt Binder Can Cause Plastic Deformation

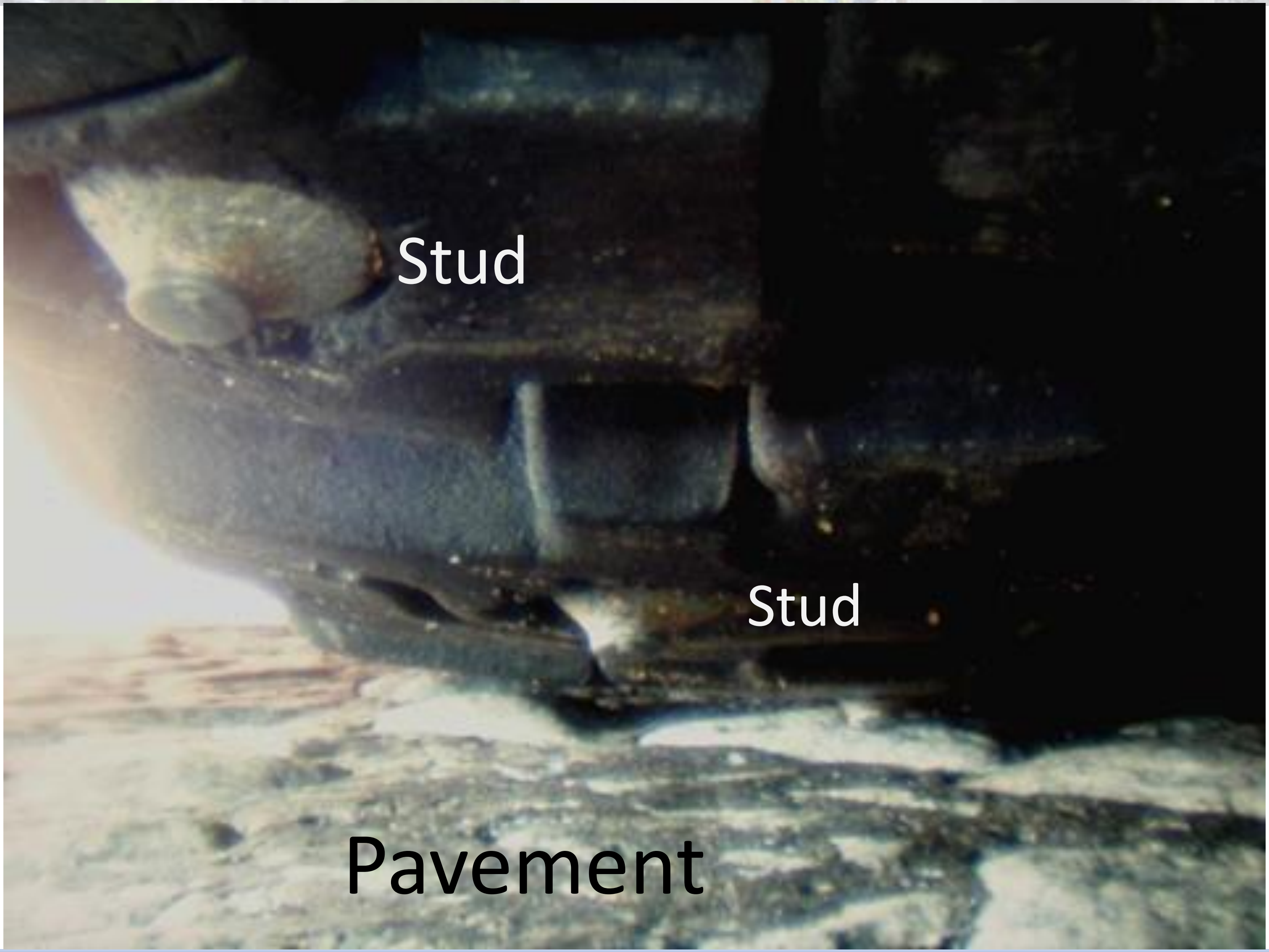
Grade Bumping Adds Polymer

SMA PG 52-28
Rut Index = 10.7

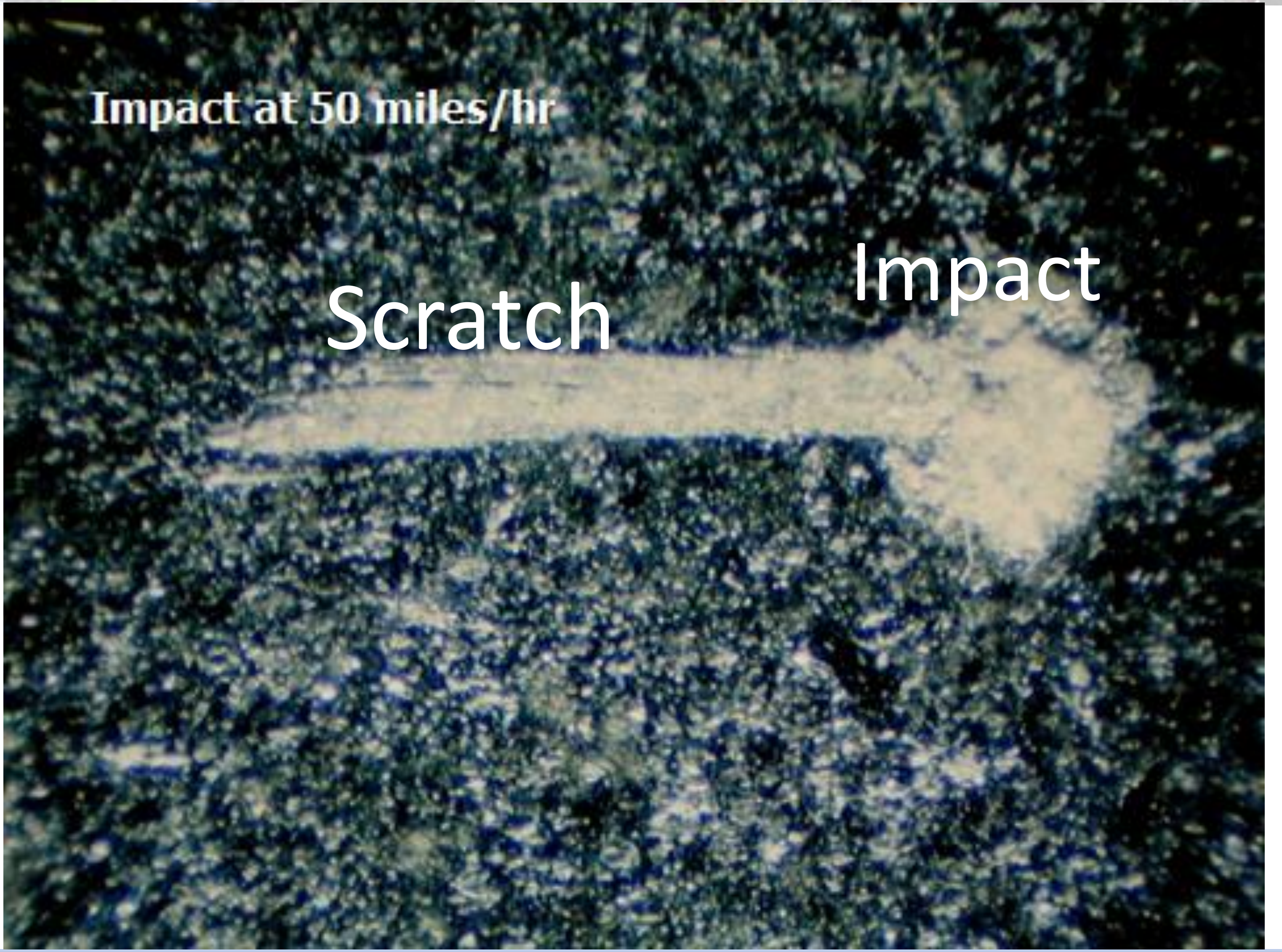
SMA PG+ 58-28
Rut Index = 4.7

SP PG+ 64-28
Rut Index = 1

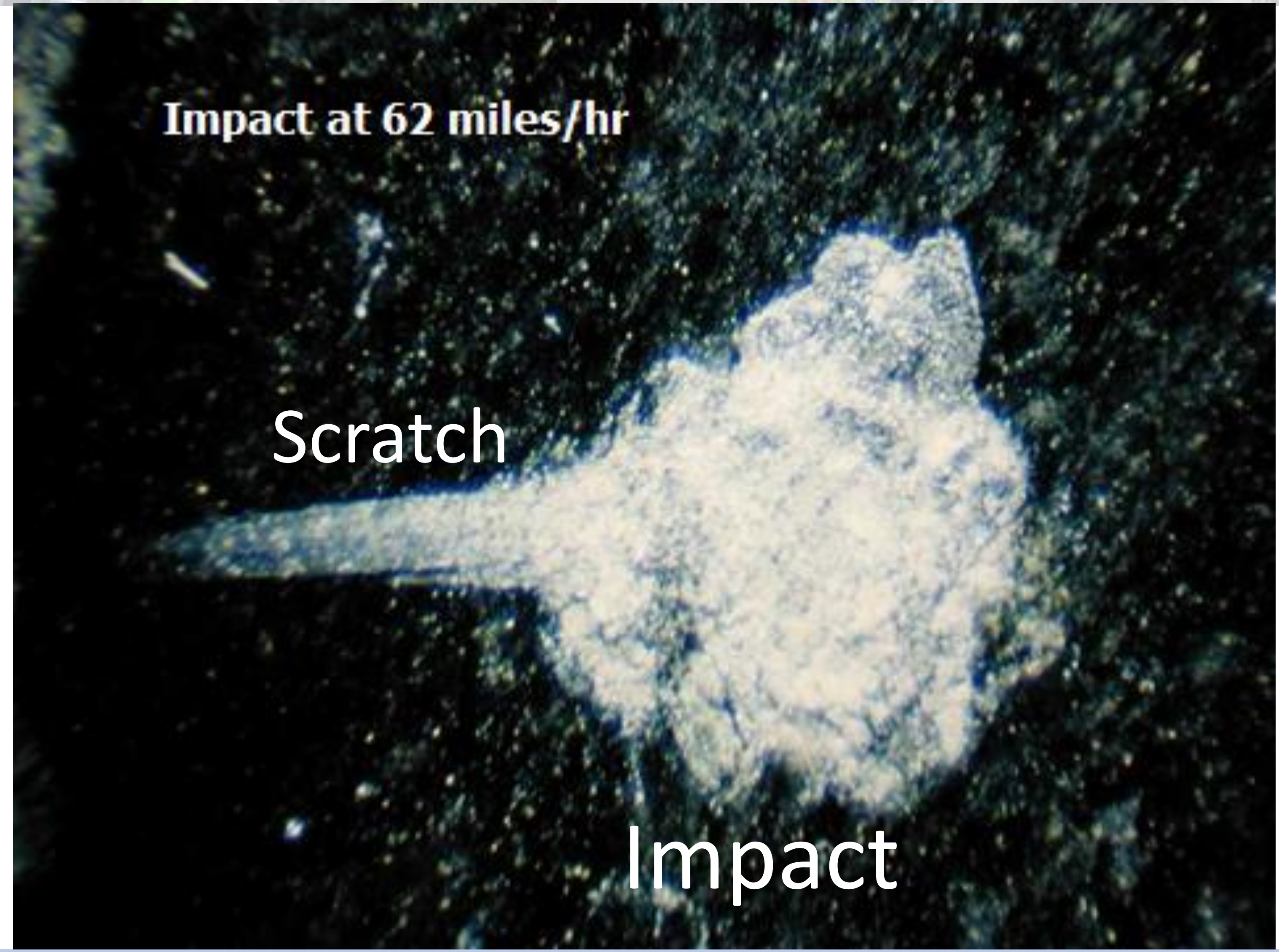
Studded Tire



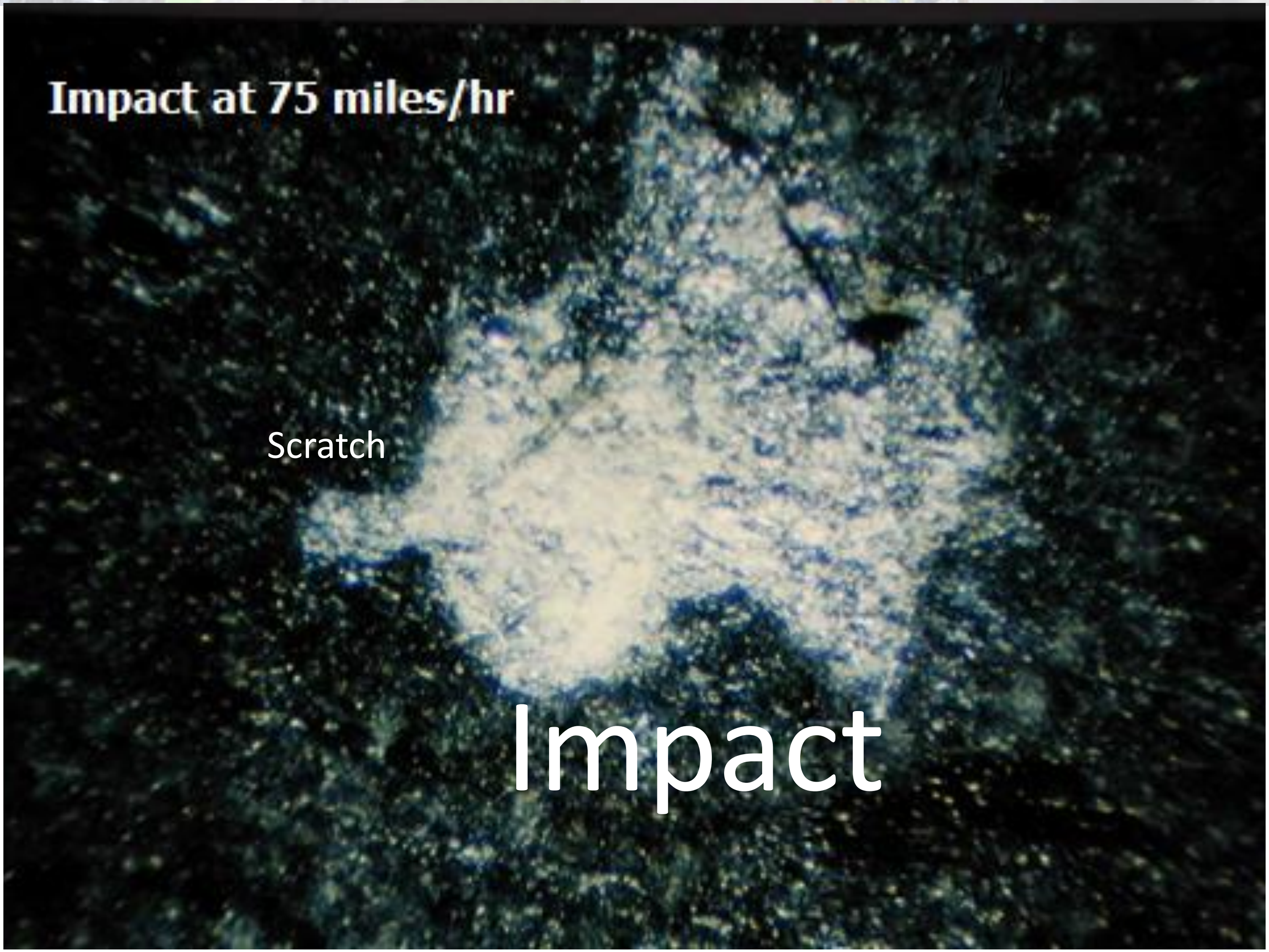
Pavement Marking



Pavement Marking



Pavement Marking



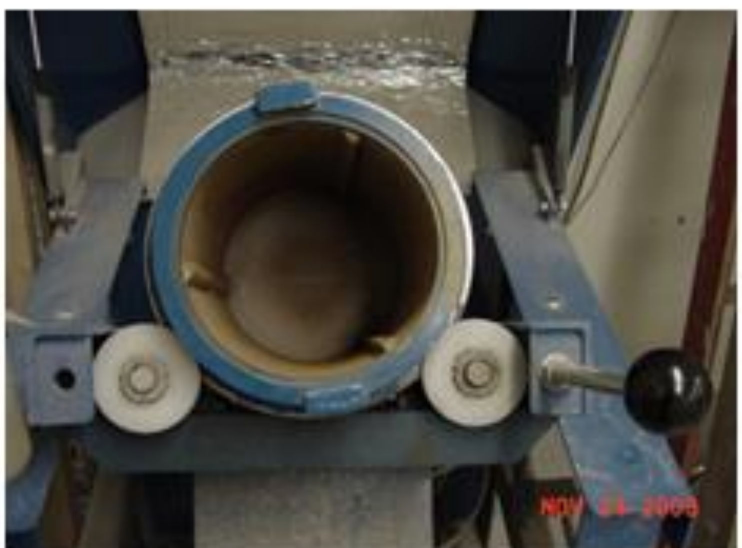
Studded Tire Wear Solutions

- Alaska Adopted Scandinavian Technology
- Nordic Abrasion for Aggregate Wear Resistance (wet ball mill)
- Prall or SRK To Simulate Studded Tire Wear of HMA

Nordic Abrasion Aggregate Test

Nordic Ball Mill Test

- Ribbed test chamber
- Wet abrasion test
- 5400 revolutions @ 90 rpm
- 7000 g shot charge, 2000 g sample
- By comparison: Micro Duvall = 1.97 x Nordic Ball Mill



Studded Tire Wear

SRK Wear Testing of Pavement

3 studded tires wearing the sides of the sample

SRK is not as commonly used in Europe as the Prall Test

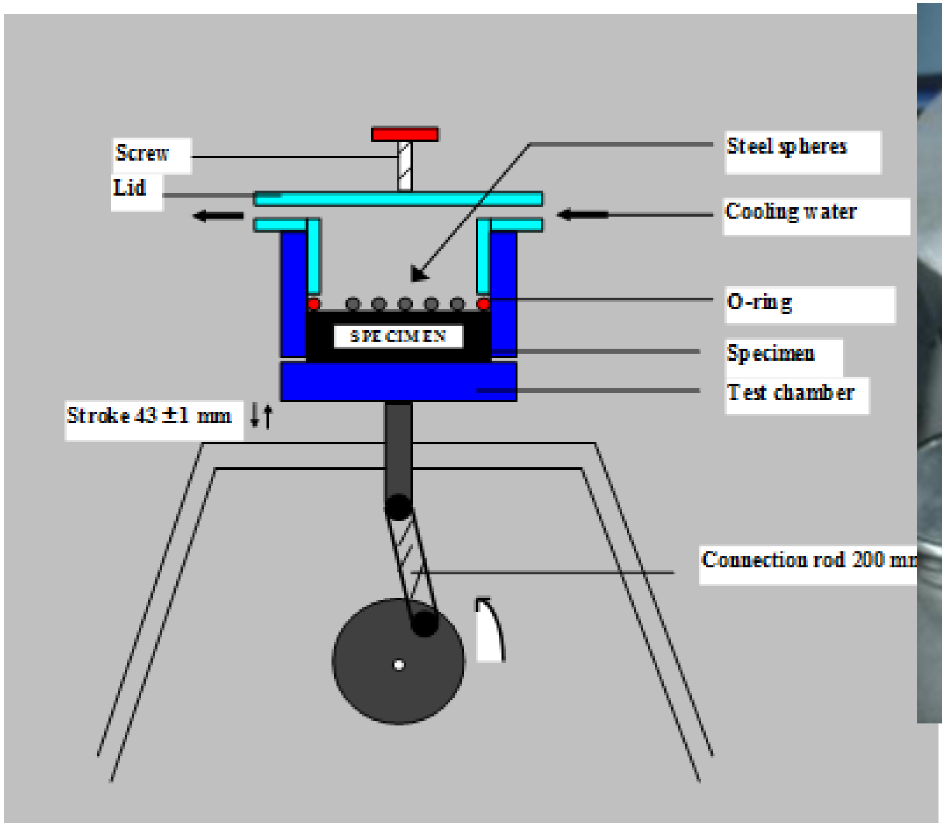
Studded Tire Wear

Prall Test

- Core samples conditioned 20hrs @ 5°C
- Impact of 40 steel bearings for 15 minutes @ 950 rpm
- Cooling water (5°C) flows over sample during test
- Results are reported in volume loss (cm³)

Prall Testing Hot Mix To Simulate Studded Tire Wear

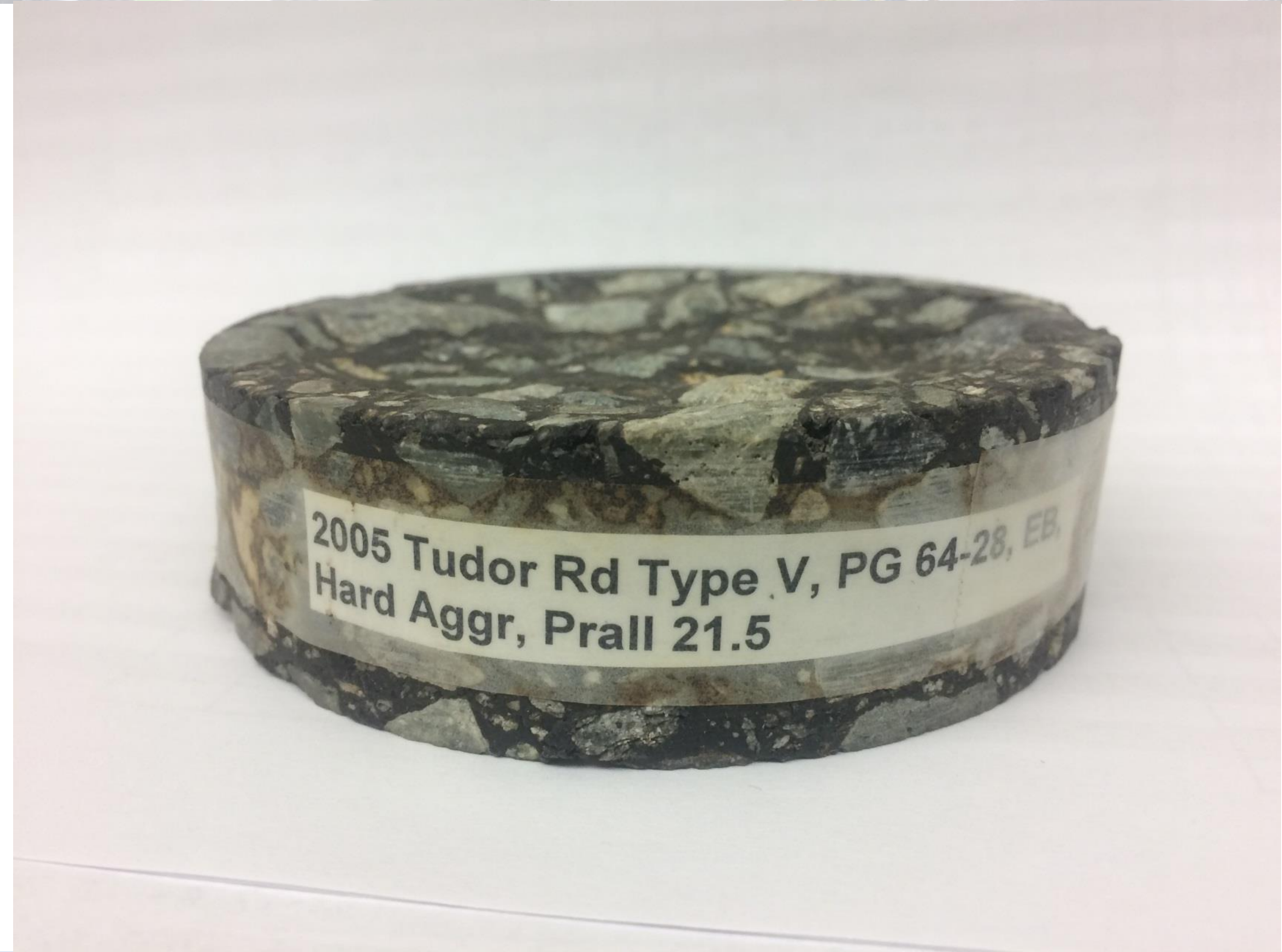
Prall Test


Screw
Lid
Steel spheres
Cooling water
O-ring
SPECIMEN
Specimen
Test chamber
Stroke 43 ±1 mm
Connection rod 200 mm


NOV 24 2003

Ball Charge in Prall Tester

Prall Tested HMA



Prall & Nordic Test Results

Nordic Countries Classification Using Prall Results

Class	Prall-loss, cm^3	Wear resistance
1	< 20	Very good
2	20 – 29	Good
3	30 – 39	Satisfactory
4	40 –50	Less satisfactory
5	> 50	Poor

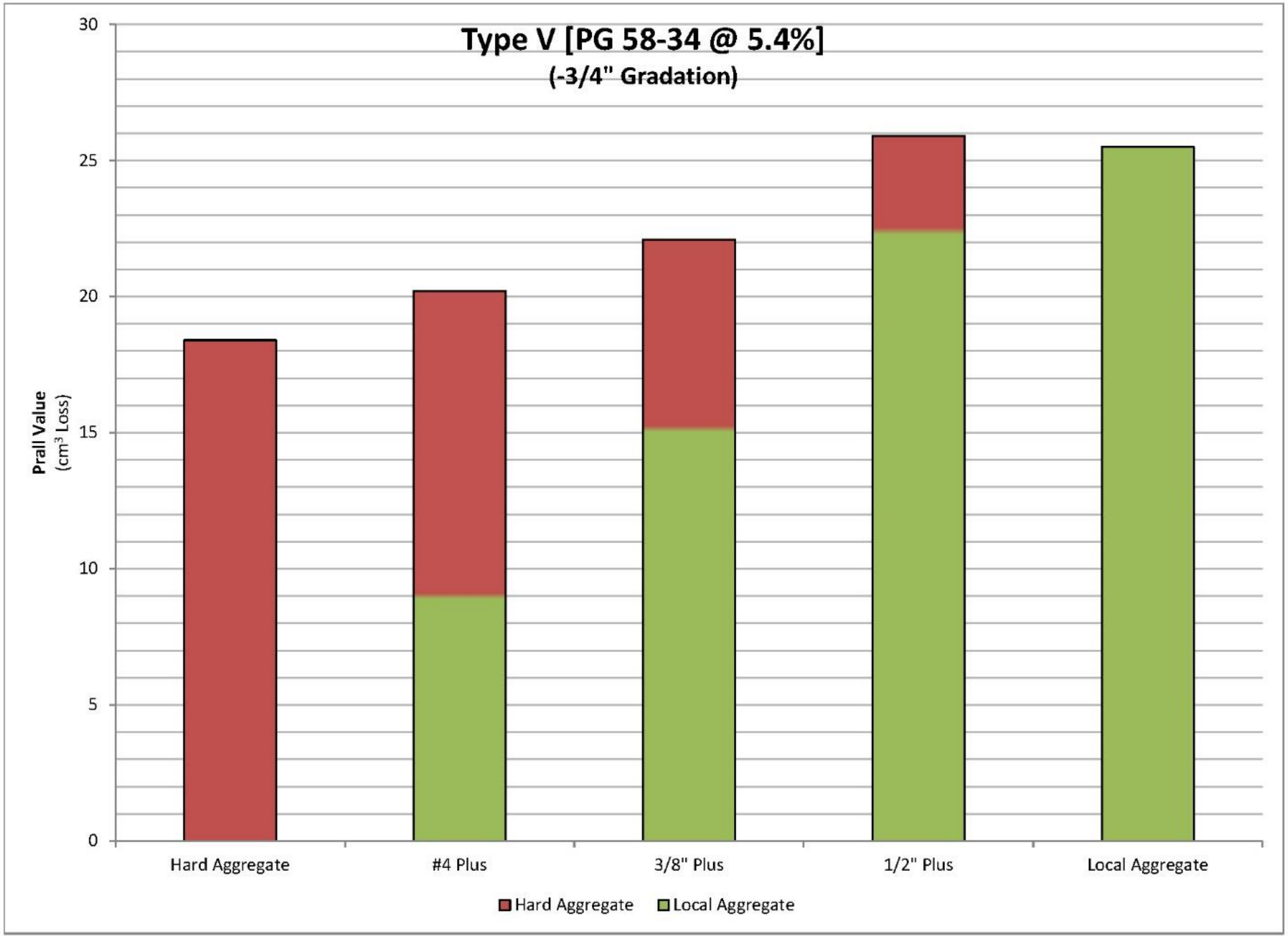
Nordic Abrasion & Prall Test Data

- PlusRide: Nordic = 12, Prall = 13
- Type II: Nordic = 12, Prall = 40-50
- SMA Nordic = 12, Prall = 25-40
- Hard Aggr. Nordic = 6-8, Prall = 20
- Type R Nordic = 12 Prall = 8

% Hard Aggregate vs Prall

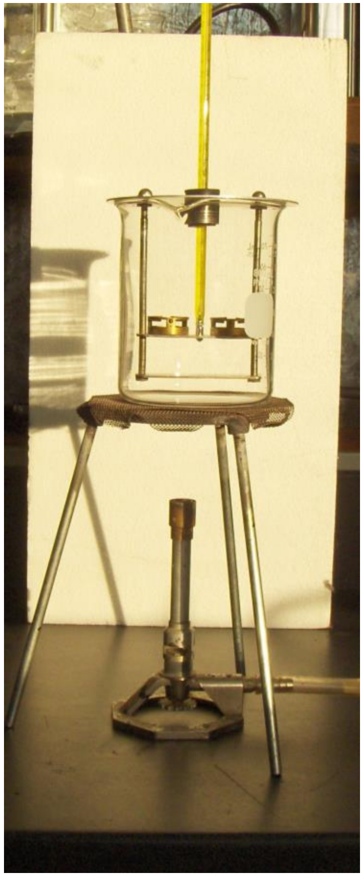
Hard Aggregate has Nordic value < 8

Prall Value



Existing PG+ Spec

- Softening Point 125°F
- Toughness 110 In-lbs
- Tenacity 75 in-lbs

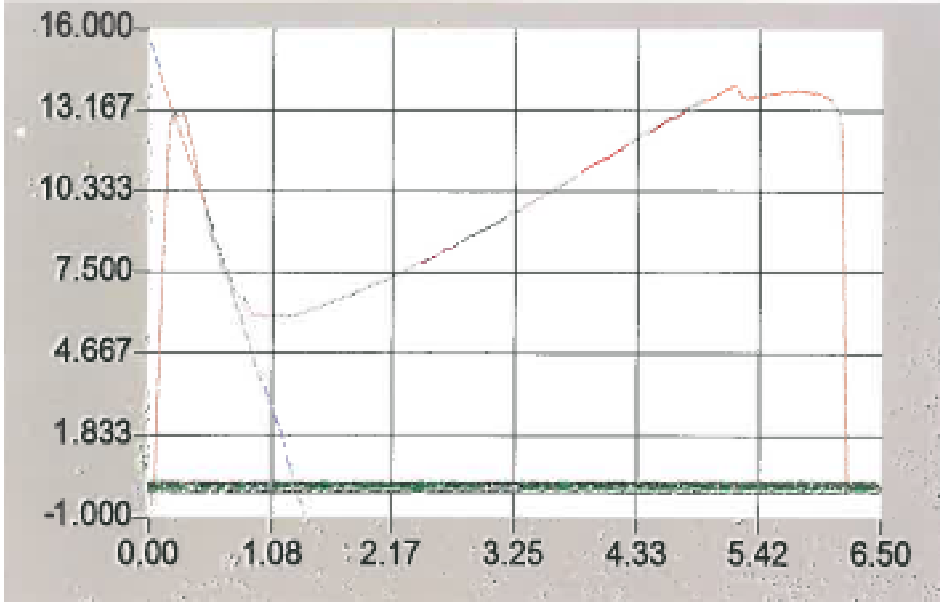


Toughness & Tenacity Problem

Test Toughness 61.5117 in-Lb

Test Tenacity 52.9687 in-Lb

Load (Lb) v. Pos (In)



T&T Issues

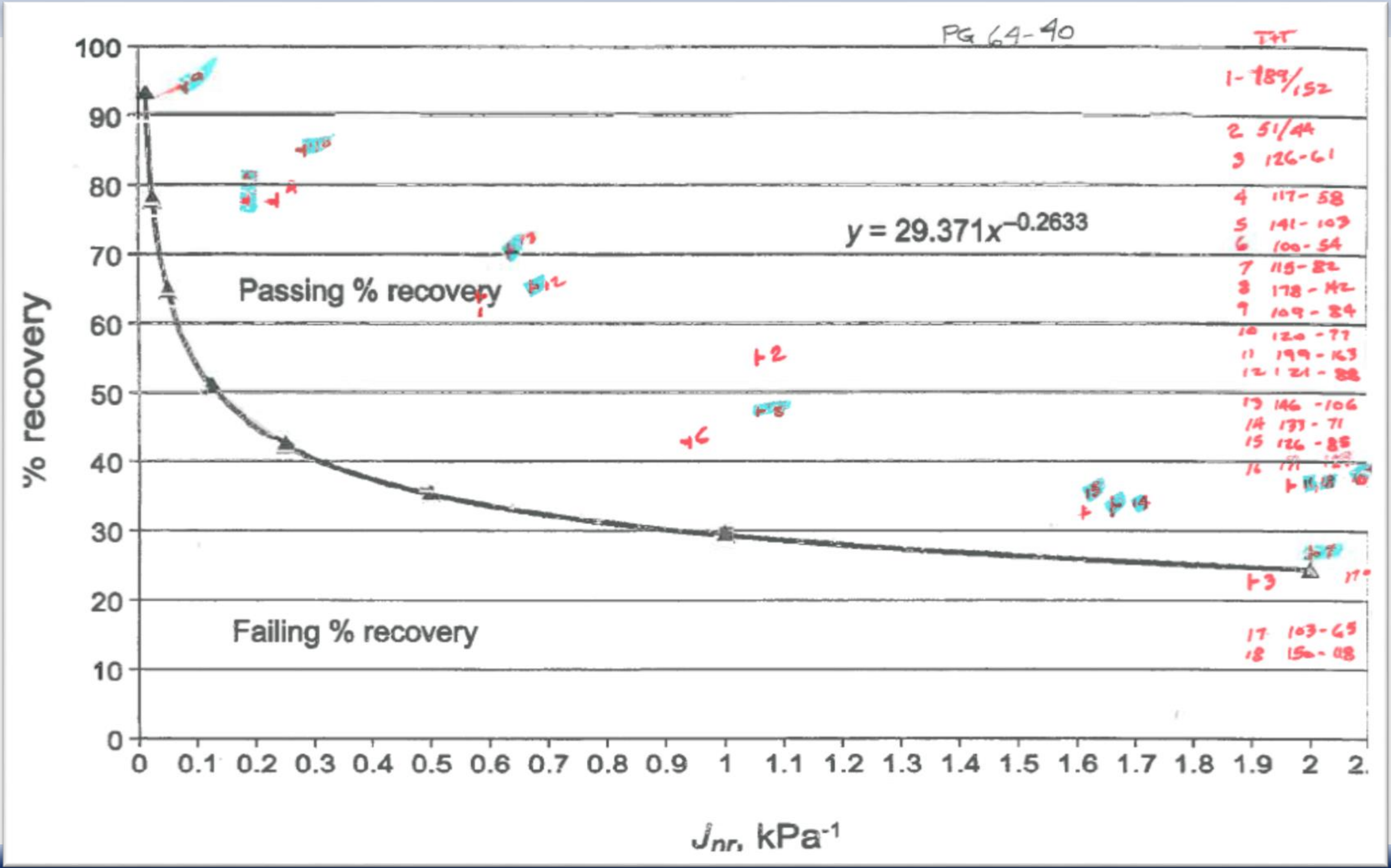
- Test was not completed, as sample detached from Spindle
- Area under curve not complete
- Test results failed
- Test run at temperature different than MSCR
- Default to MSCR testing of Binder

AASHTO T53	Softening Point, °F	149.0	125°F min.
ASTM D5801	Toughness	52.5	110 in.lbs. min.
ASTM D5801	Tenacity	46.4	75 in.lbs. min.
AASHTO T316	Viscosity, 135°C Pas	0.668	3 max.
AASHTO T48	Flash Point COC, °C		
AASHTO T315 *	Dynamic Shear (DSR) (G* / sinδ), kPa	1.58	1.00 min.
	Phase Angle	64.0°	
AASHTO T49	Penentration @ 4°C	58	
	RTFO Aged Binder		
AASHTO T240	Mass Change %	-0.214%	1.00 max.
AASHTO T315 *	Dynamic Shear (DSR) (G* / sinδ), kPa	3.01	2.20 min.
	Phase Angle	65.4°	
AASHTO TP70	MSCR, @ 100 Pa Recovery 98.6% Jnr	0.00	
AASHTO TP70	MSCR, @ 3200 Pa Recovery 90.1% Jnr	0.19	< 0.5 Jnr OK
	Jnr % Difference	6788.9	
	PAV Aged Binder		
AASHTO T315 *	Dynamic Shear (DSR) (G* • sinδ), kPa	2930	5000 max.
	Phase Angle	49.3°	
AASHTO T313	Creep Stiffness		
	Normal Conditioning		
	S, MPa	265	300 max.
	m-value	0.309	.300 min.

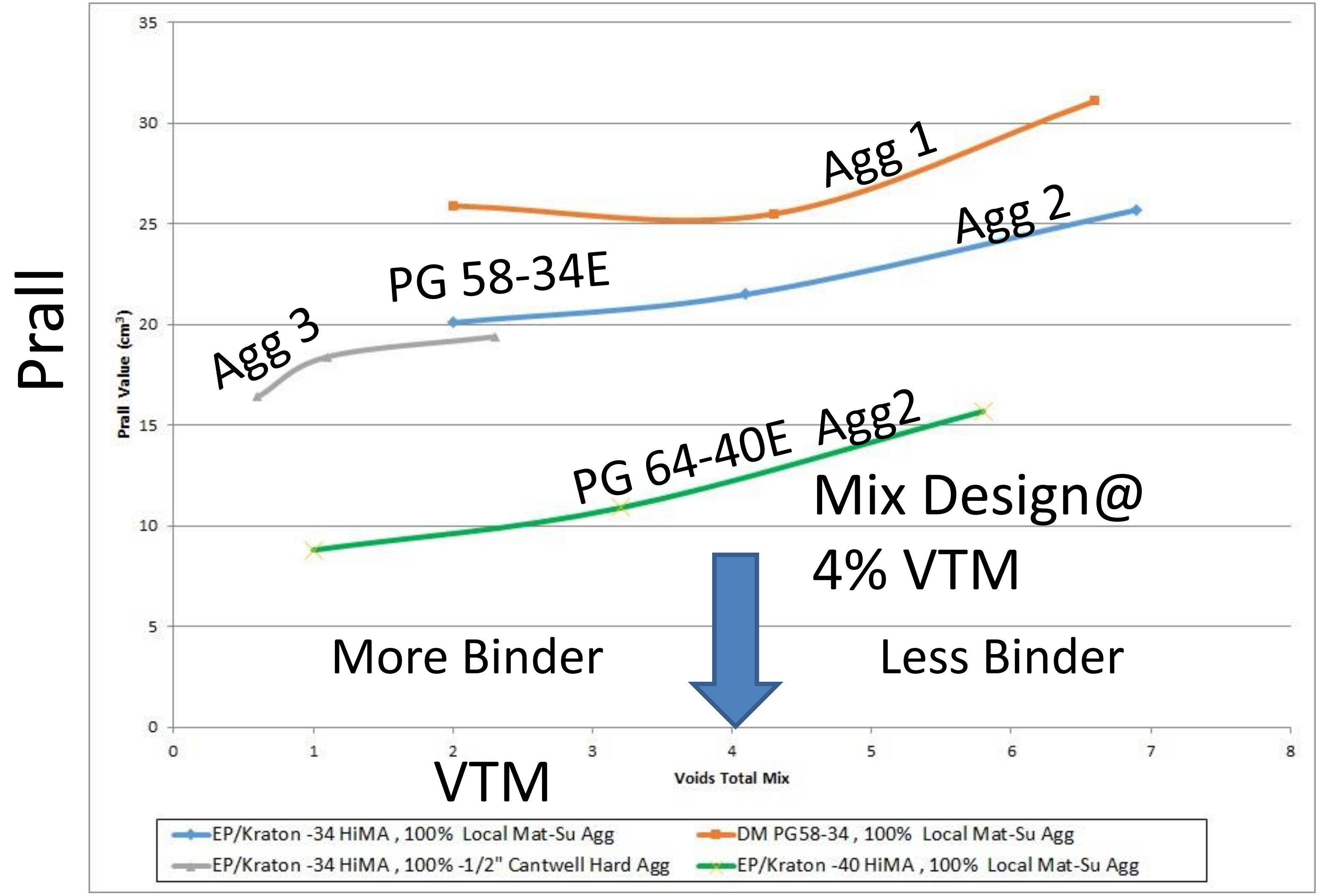
PERM. DEFORMATION

SAME AS MIX DESIGN

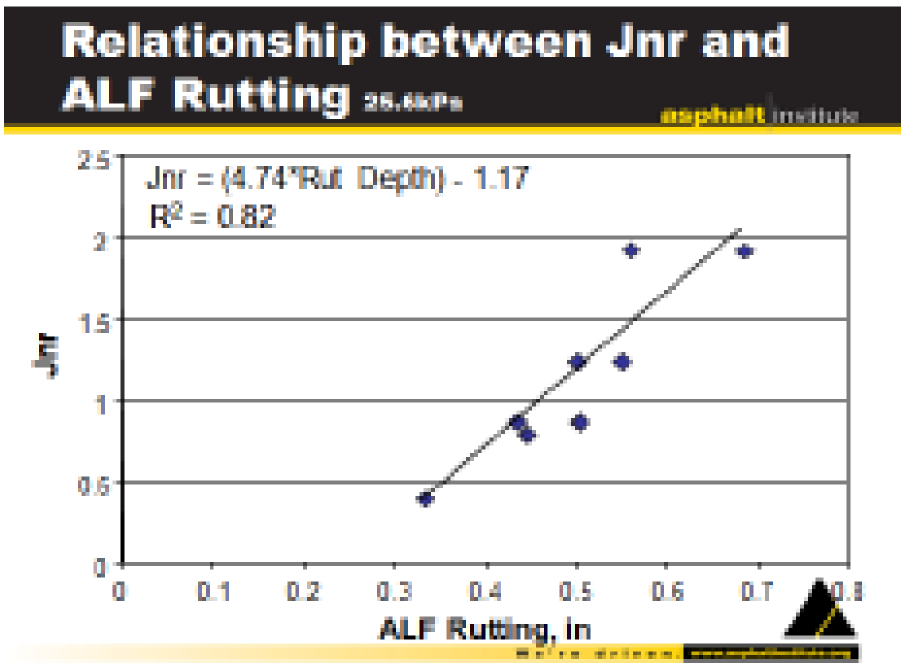
T&T vs MSCR


PG 64-40
T+T
1- 189/152
2 51/44
3 126-61
4 117-58
5 141-103
6 100-54
7 115-82
8 178-142
9 109-84
10 120-77
11 199-163
12 121-88
13 146-106
14 137-71
15 126-85
17 103-65
18 156-108
$y = 29.371x^{-0.2633}$
Passing % recovery
Failing % recovery
% recovery
J_{nr}, kPa^{-1}
100
90
80
70
60
50
40
30
20
10
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2

% AC in HMA (VTM) vs Prall



Jnr - Rutting



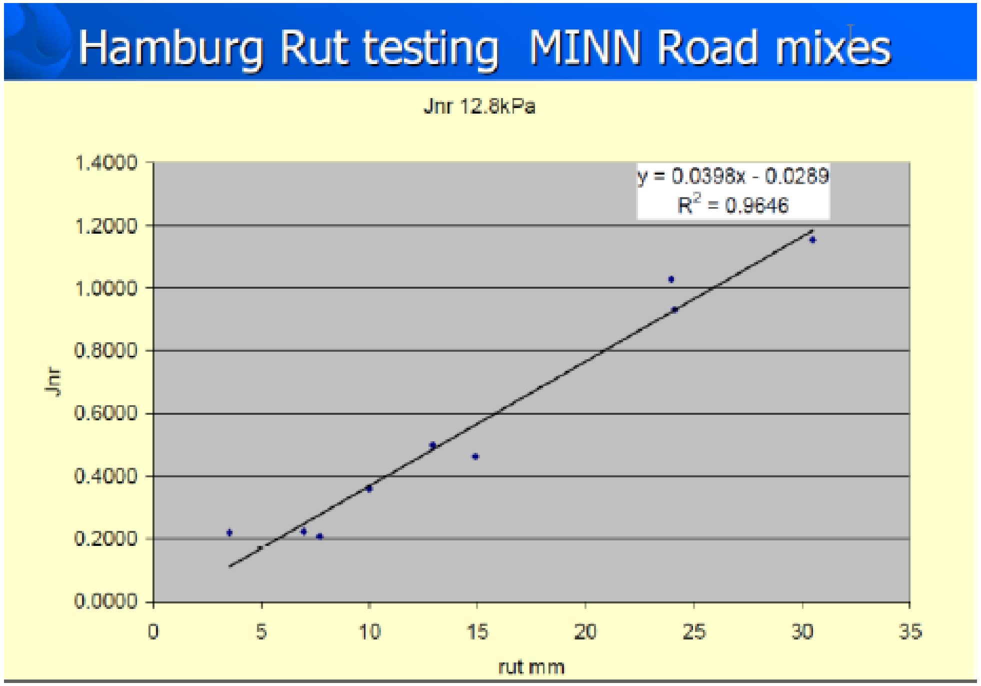
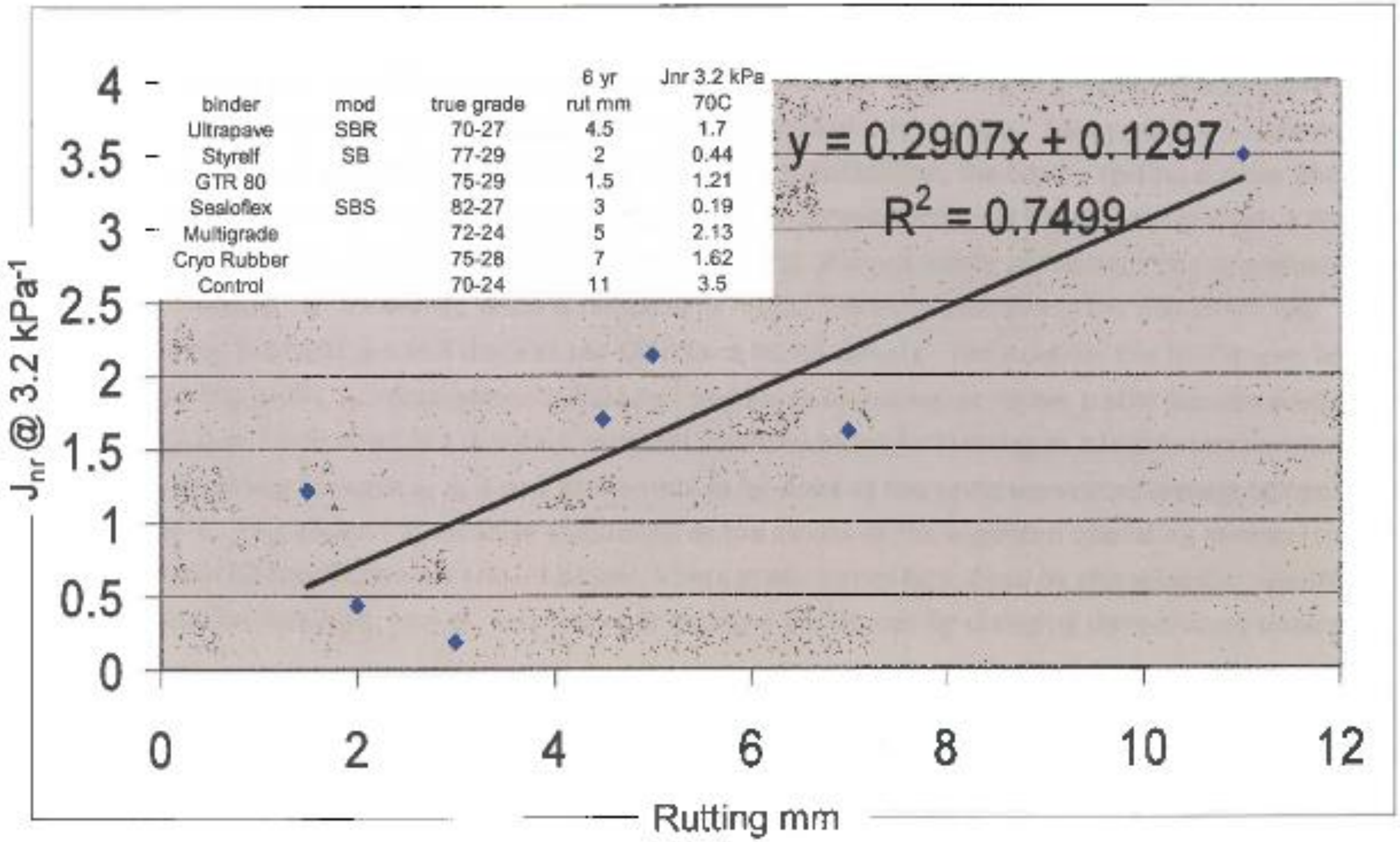


Figure 5- Hamburg Rut Testing on MnROAD Mixes

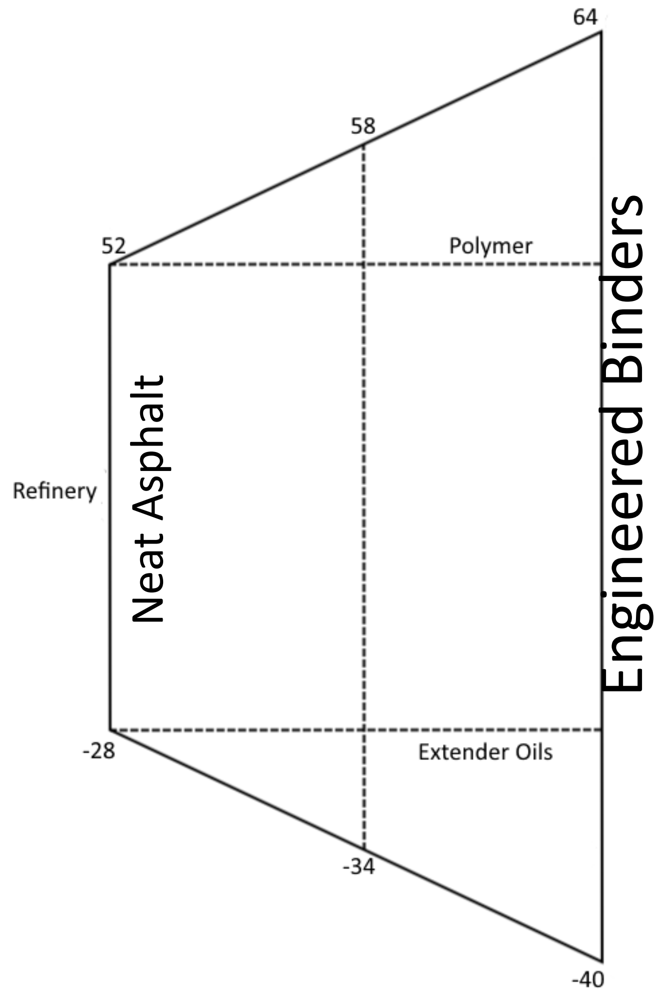
Jnr - Rutting



binder	mod	true grade	6 yr rut mm	Jnr 3.2 kPa 70C
Ultrapave	SBR	70-27	4.5	1.7
Styrelf	SB	77-29	2	0.44
GTR 80		75-29	1.5	1.21
Sealoflex	SBS	82-27	3	0.19
Multigrade		72-24	5	2.13
Cryo Rubber		75-28	7	1.62
Control		70-24	11	3.5

Figure 3: Rutting on I-55 Mississippi vs J_{nr}.

Alaska’s PG+

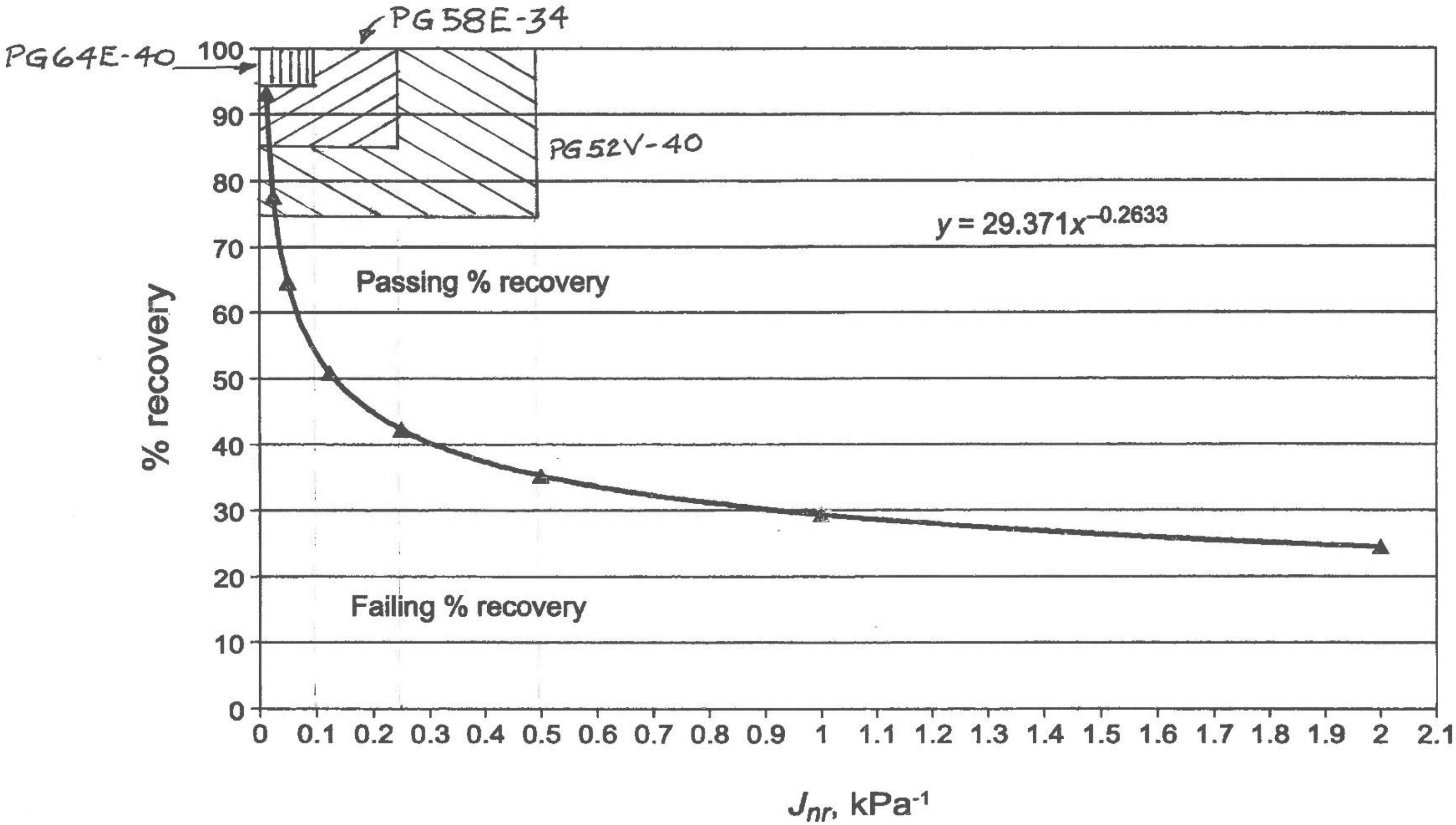


Antistrip
Extender Oils
SBS (Lineal, Radial, ?)
PPA
Sulfur
WMA

MSCR DATA (averages)

- PG 52-40, $Rec_{3.2}$ = 85 %, $J_{nr3.2}$ = 0.33
- PG 58-34, $Rec_{3.2}$ = 89 %, $J_{nr3.2}$ = 0.22
- PG 64-40, $Rec_{3.2}$ = 96 %, $J_{nr3.2}$ = 0.07

MSCR Values on M332 Graph



CR PG+ Spec

Performance Grade	Grade	Viscosity T316	MSCR, T350			PAV, T315 Dynamic Shear	Direct Tension
			$J_{NR3.2}$ kPa^{-1}	J_{NR} Diff	% $Rec_{3.2}$	G*Sinδ, kPa	
PG 52-40	V	3 PaS max.	0.50 max.	Delete	75 min.	6000 max.	Delete
PG 58-34	E	3 PaS max	0.25 max.	Delete	85 min.	6000 max.	Delete
PG64-40	E	1.0 PaS max.	0.10 max.	Delete	95 min.	5000 max @ 4°C	Delete

Future Performance Test

- Hamburg Rut Testing
- Ts-Tm
- Longer PAV Evaluation
- DSR
  - Softening Point
  - Tackiness Test
- Maximize use of PG Binder Tools

Resolve Binder Penalty Disputes

ASTM D 3244

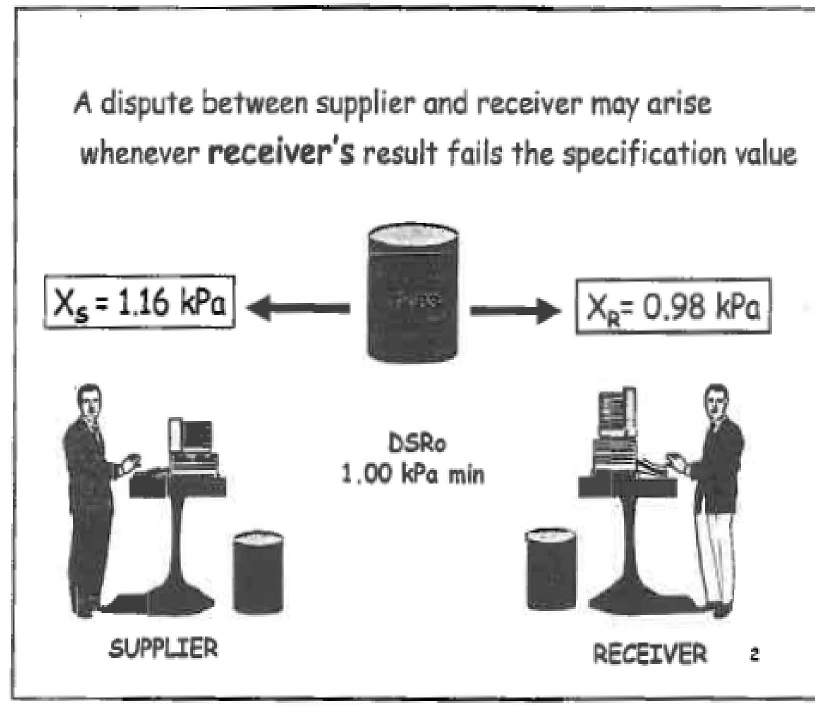
PROCEDURE FOR RESOLVING DIFFERENCES IN TEST RESULTS

Rocky Mountain
Asphalt User Producer Group Meeting

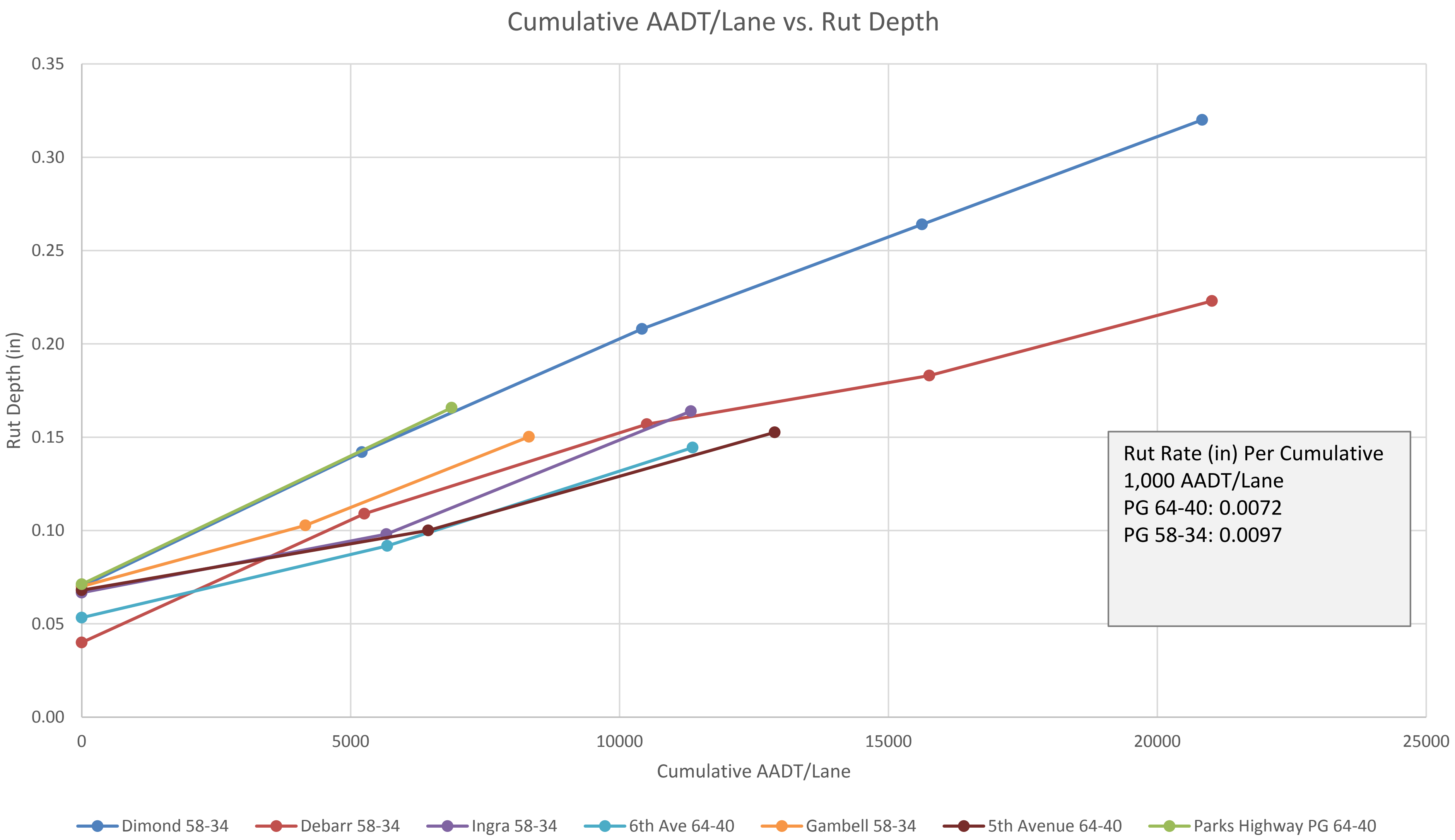
April 16, 2003
San Antonio, Tx

Ralph Shirts, Olga Puzic
ExxonMobil

R 40297-2003 1



PMS Rutting Rate



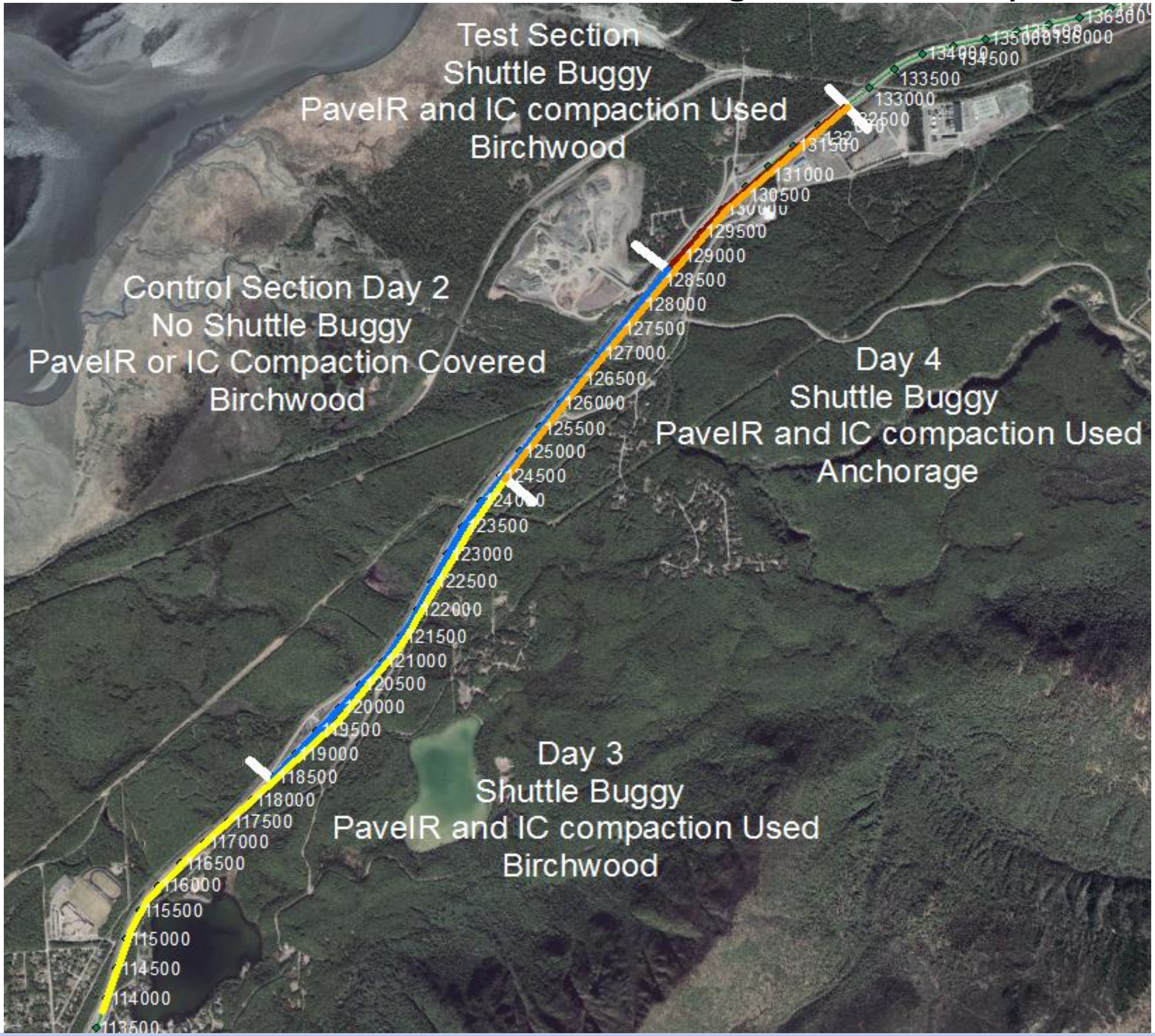
Glenn Hwy Density Enhancement

- 4-Lane High Speed- Mill & Fill Driving Lanes 2”
- WMA required in HMA with PG64-40 E &Hard Aggregate
- MTV required
- Pave IR Scan with incentive
- IC on Breakdown & Intermediate Roller
- GPR for Density

Glenn Hwy: Highland to Eklutna

2016 Construction

FHWA/DOT Goal: Consistent High HMA Density

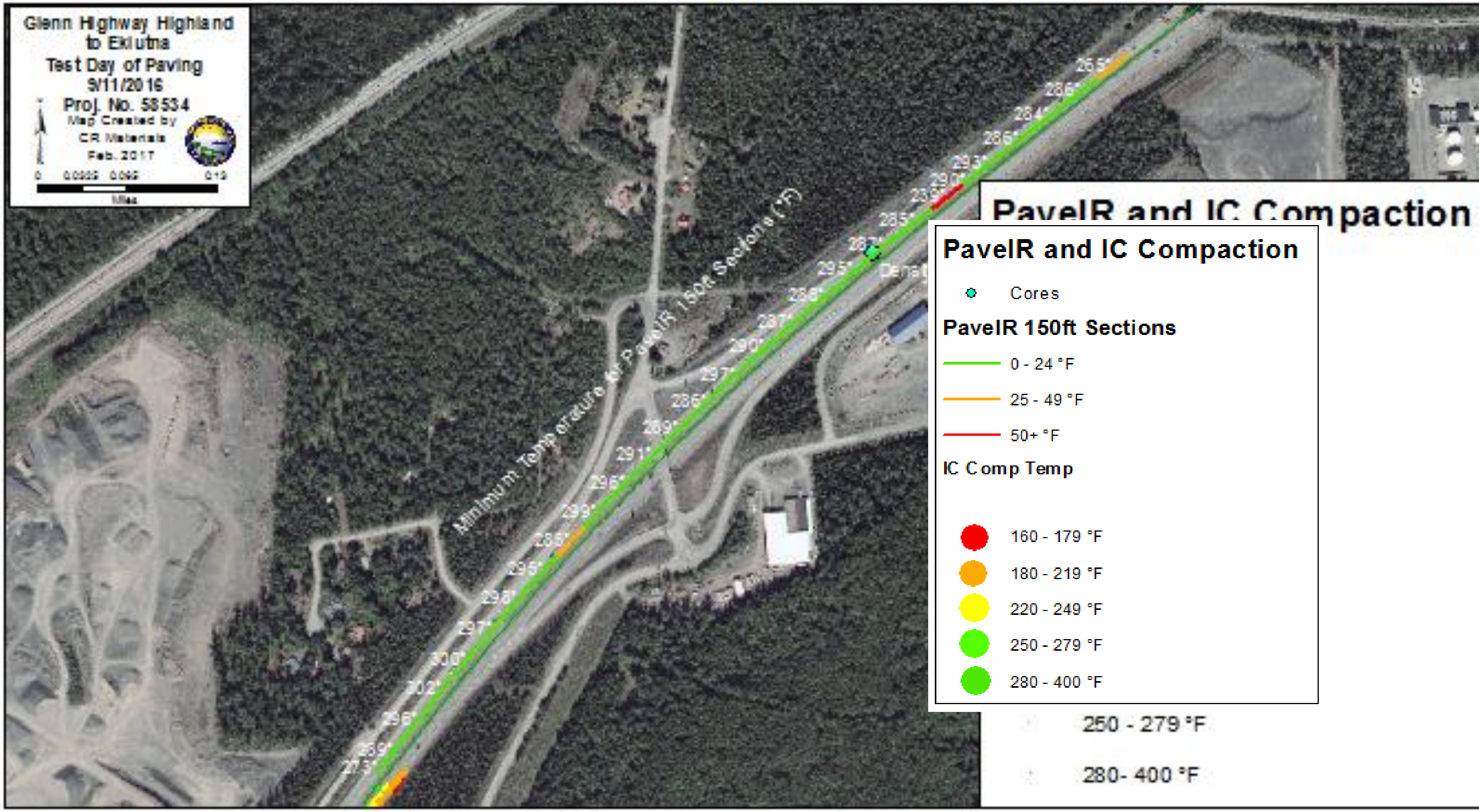


Test Strip-Day 1

Paving with Birchwood Supplied HMA
12 IR sections meet bonus for $75 ea.
25 * 75 = $1875

IR 0-25 (green) = 25/28 sections
IR 25-50 (orange) = 2/28 sections
IR 50+ (red) = 1/28 sections

Station 1327+00 - 1287+00 SB

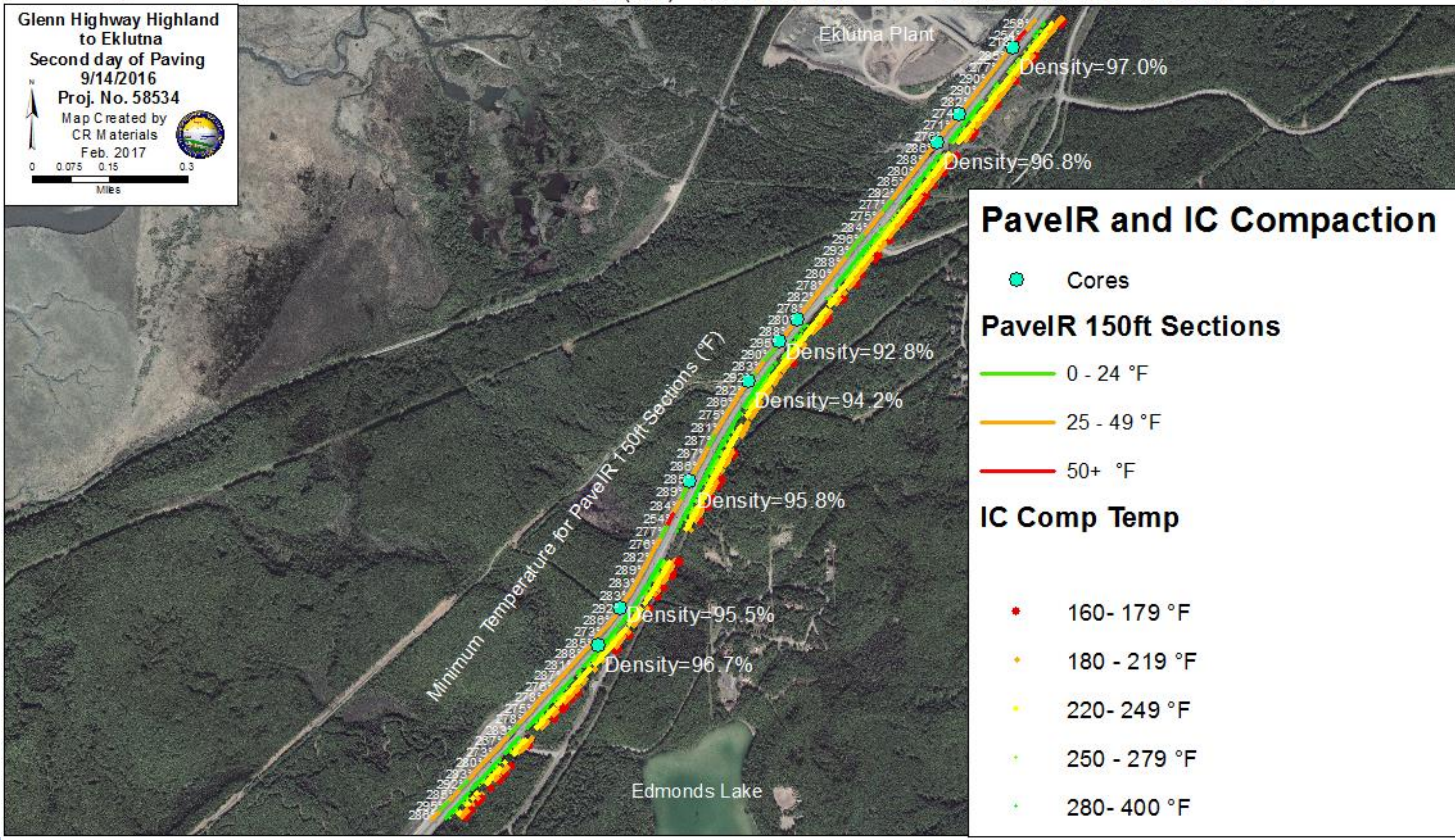


Second Day-w/o MTV, IC, IR

Paving with Birchwood Supplied HMA
12 IR sections meet bonus for $75 ea.
12 * 75 = $900

IR 0-25 (green) = 12/69 sections
IR 25-50 (orange) = 54/69 sections
IR 50+ (red) = 3/69 sections

Station 1287+00 - 1184+50 SB

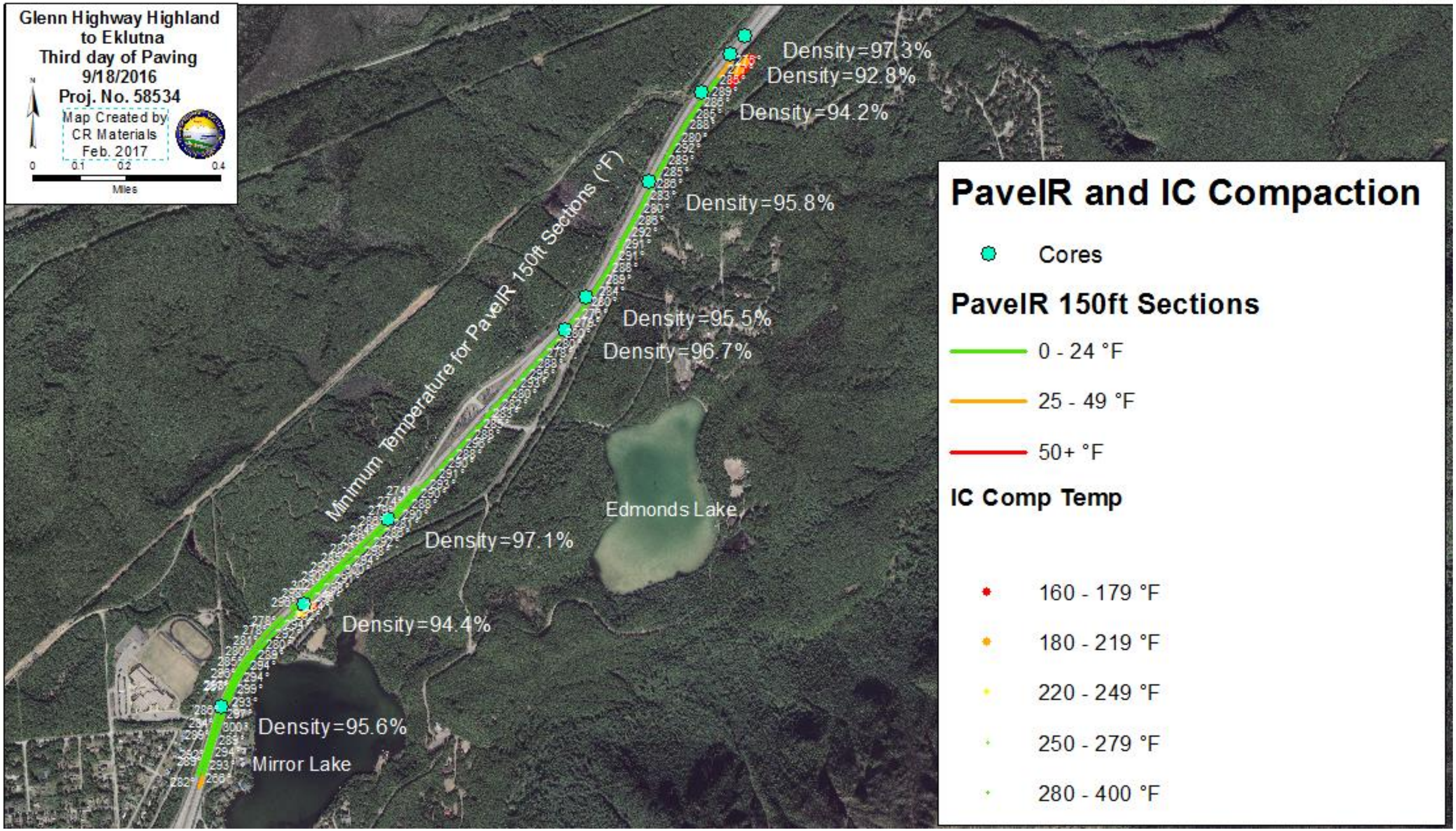


Third Day – MTV, IR, IC

Paving with Birchwood Supplied HMA
12 IR sections meet bonus for $75 ea.
92 * 75 = $6,900

IR 0-25 (green) = 92/96 sections
IR 25-50 (orange) = 4/96 sections
IR 50+ (red) = 0/96 sections

Station 1184+50 - 1143+00 SB & 1142+00 - 1245+25 NB

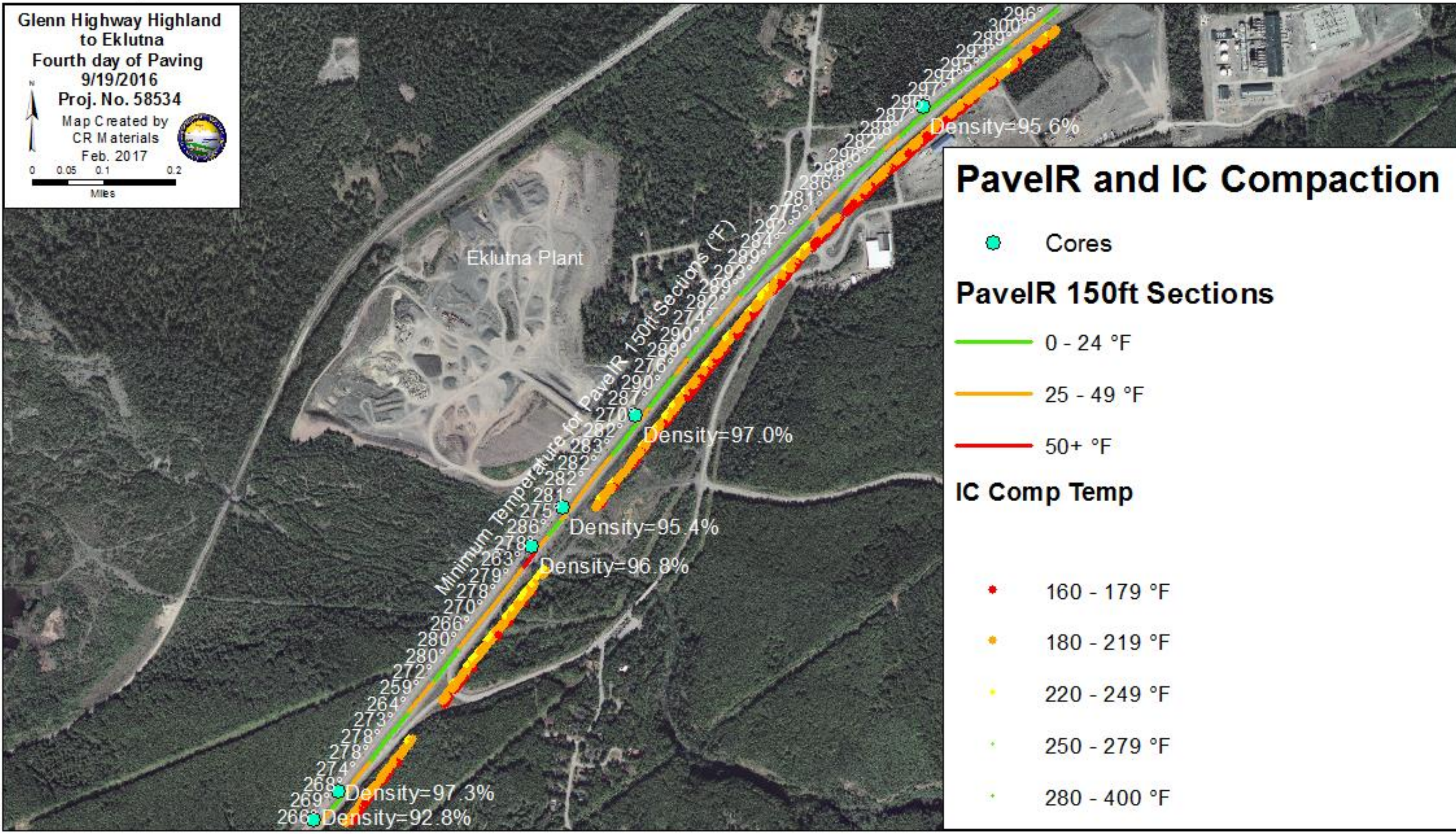


Fourth Day – MTV, IR, IC (40 mile haul)

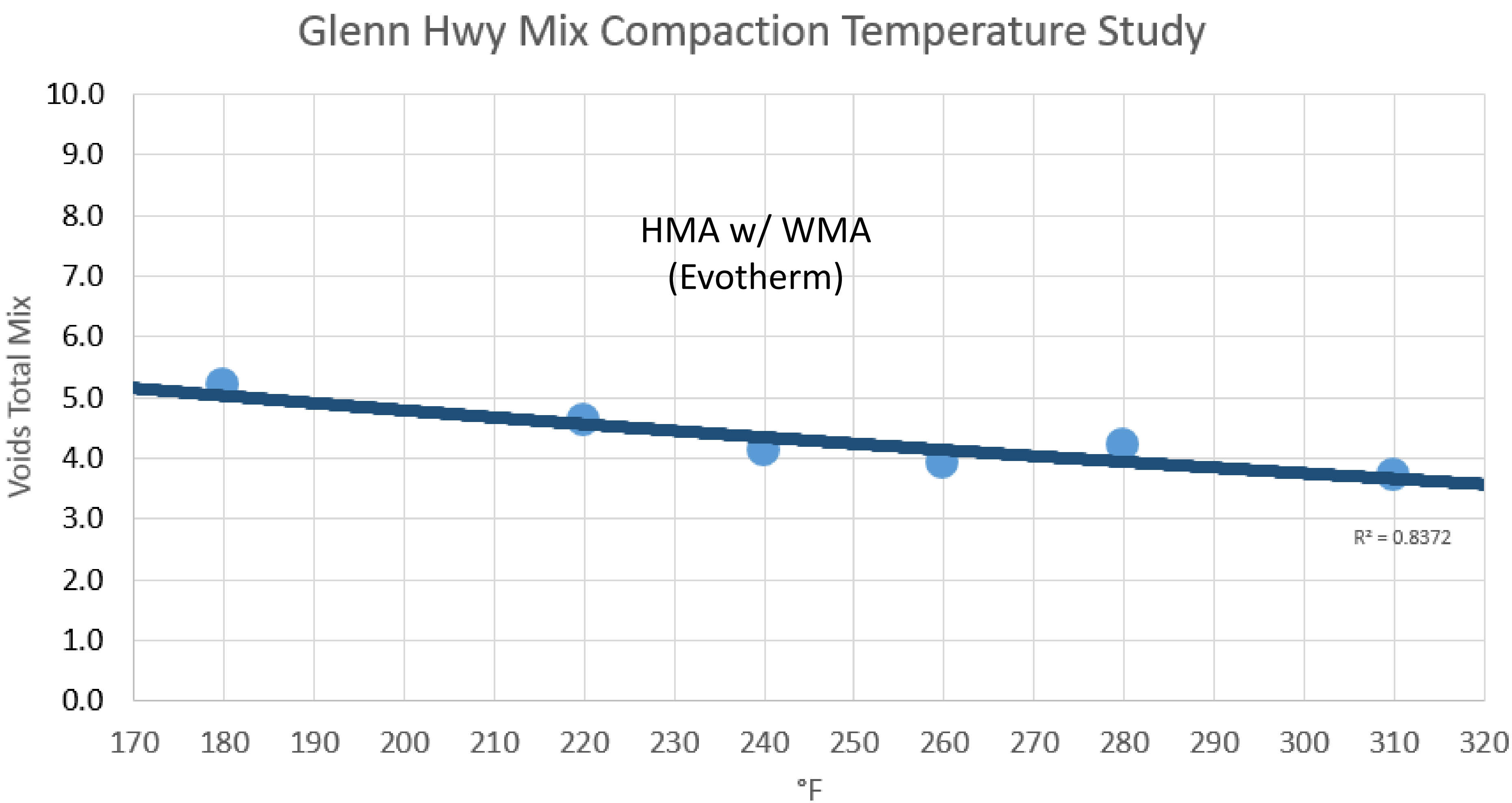
Paving with Anchorage Supplied HMA
12 IR sections meet bonus for $75 ea.
29 * 75 = $2,175

IR 0-25 (green) = 29/55 sections
IR 25-50 (orange) = 26/55 sections
IR 50+ (red) = 0/55 sections

Station 1245+25 - 1327+00 NB

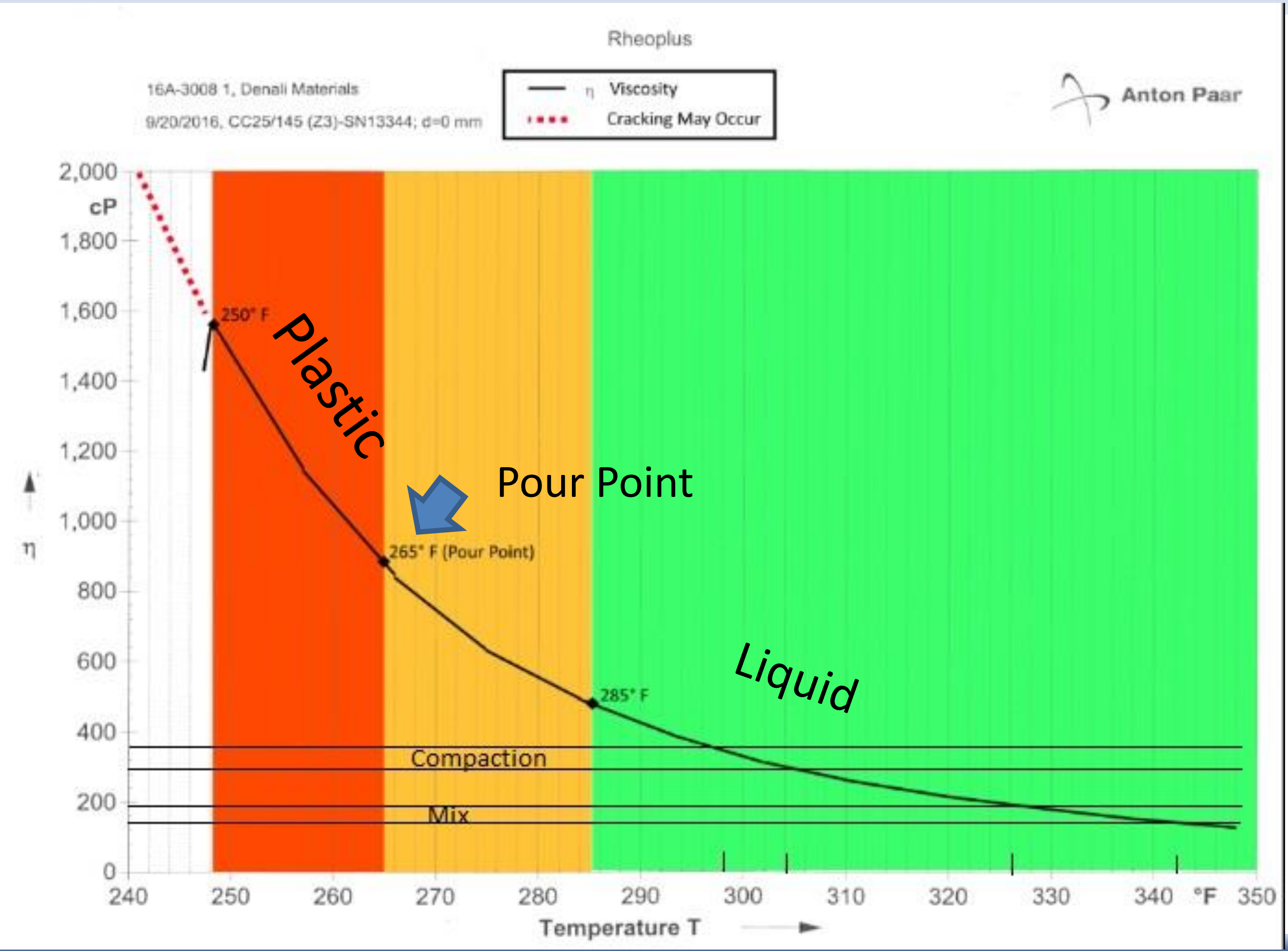


Mix Design



Glenn Hwy Mix Compaction Temperature Study
HMA w/ WMA
(Evotherm)
Voids Total Mix
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
170
180
190
200
210
220
230
240
250
260
270
280
290
300
310
320
°F
$R^2 = 0.8372$

PG 64-40E Viscosity



Windrow Pickup on MTV

Windrow – MTV - Paver

Pave IR Scan

Temperature Scan
Full Width of Lane
1’ width

Section 412 – Cont. Thermal Profiling

Section 412 – Cont. Thermal Profiling

Segment Temperature Price Incentive adjustment is measured according to Table 412-3.

TABLE 412-3
SEGMENT TEMPERATURE PRICE INCENTIVE

Segment Temperature Differential		Monetary Adjustment
Range	Category	Adjustment per 150-ft Segment
< = 25.0°F	Good	$75 incentive
> 25.1 and < = 50°F	Moderate	No pay adjustment, check with density profile, repair per 408-3.19
> 50 °F	Severe	No pay adjustment, check with density profile, repair per 408-3.19

412.5.01 BASIS OF PAYMENT. The contracted price will be paid for at the Contract lump sum price. Payment will be full compensation for preparing and installing the equipment including software, providing support, maintenance, and training, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

This work will be paid under the following pay items.

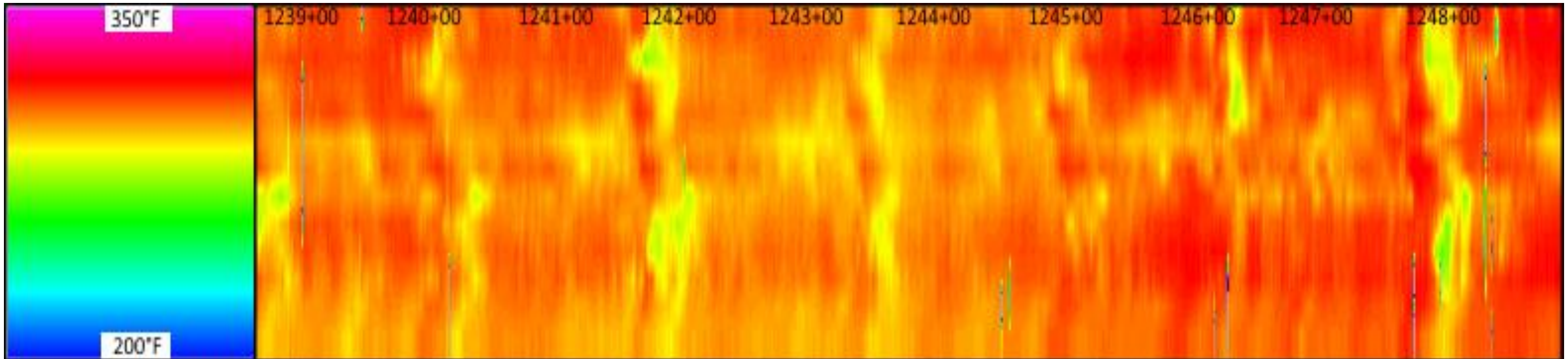
Pay Item No.	Pay Item	Pay Unit
412(1)	Continuous Thermal Profile	Lump Sum
412(2)	Segment Temperature Price Incentive	Contingent Sum

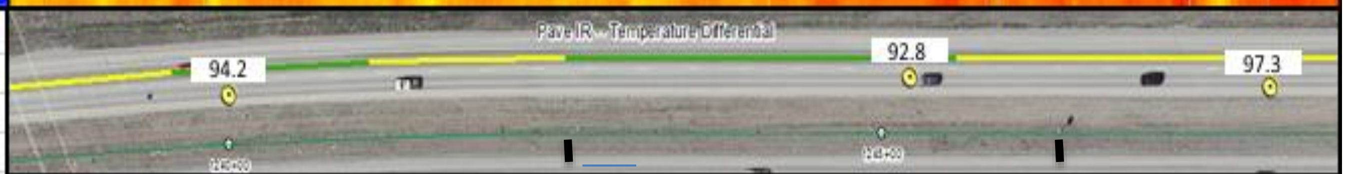
Data – Temperature Differential

Day	NB/SB	Begin Station	End Station	Total Daily Square Yards (100's)	Total Daily Tonnages	Total Daily Square Yard with ΔT > 25 °F	# of 150 ft Sections with T ≤ 285°F	% Area at ΔT ≥ 25°F	% Area at ΔT ≥ 50°	Number of 150 ft Bonus Sections	% IR Available Bonus	Number of 150 ft Sections with ΔT between 25°F & 50°F	Number of 150 ft Sections with ΔT ≥ 50°F
9/11/2016 Test Strip N. Birchwood HMA With IC, IR & MTV	SB	1327	1287	53.33	614.83	3.99	1	7.5%	3.8%	25	89.3%	7	1
9/13/2016 Normal Paving N. Birchwood HMA No MTV No IC, IR Visible	SB	1287	1184.5	136.67	1666.09	108.80	42	79.6%	2.9%	12	17.4%	54	3
9/17/2016 N. Birchwood HMA With IC, IR & MTV	SB	1184.5	1143	55.33	2269.15	1.99	4	3.6%	3.6%	92	95.8%	3	0
	NB	1142	1245.25	137.67		5.49		4.0%	0.0%				
9/19/2016 Anchorage HMA With IC, IR & MTV	NB	1245.3	1327	109.00	1298.51	50.79	21	46.6%	0.0%	29	52.7%	26	0

Intelligent Compaction Roller

IR & IC Evaluation





IR - Temp. Differential

- < 25
- 25 - 50
- > 50

IR - Min. Temperatures

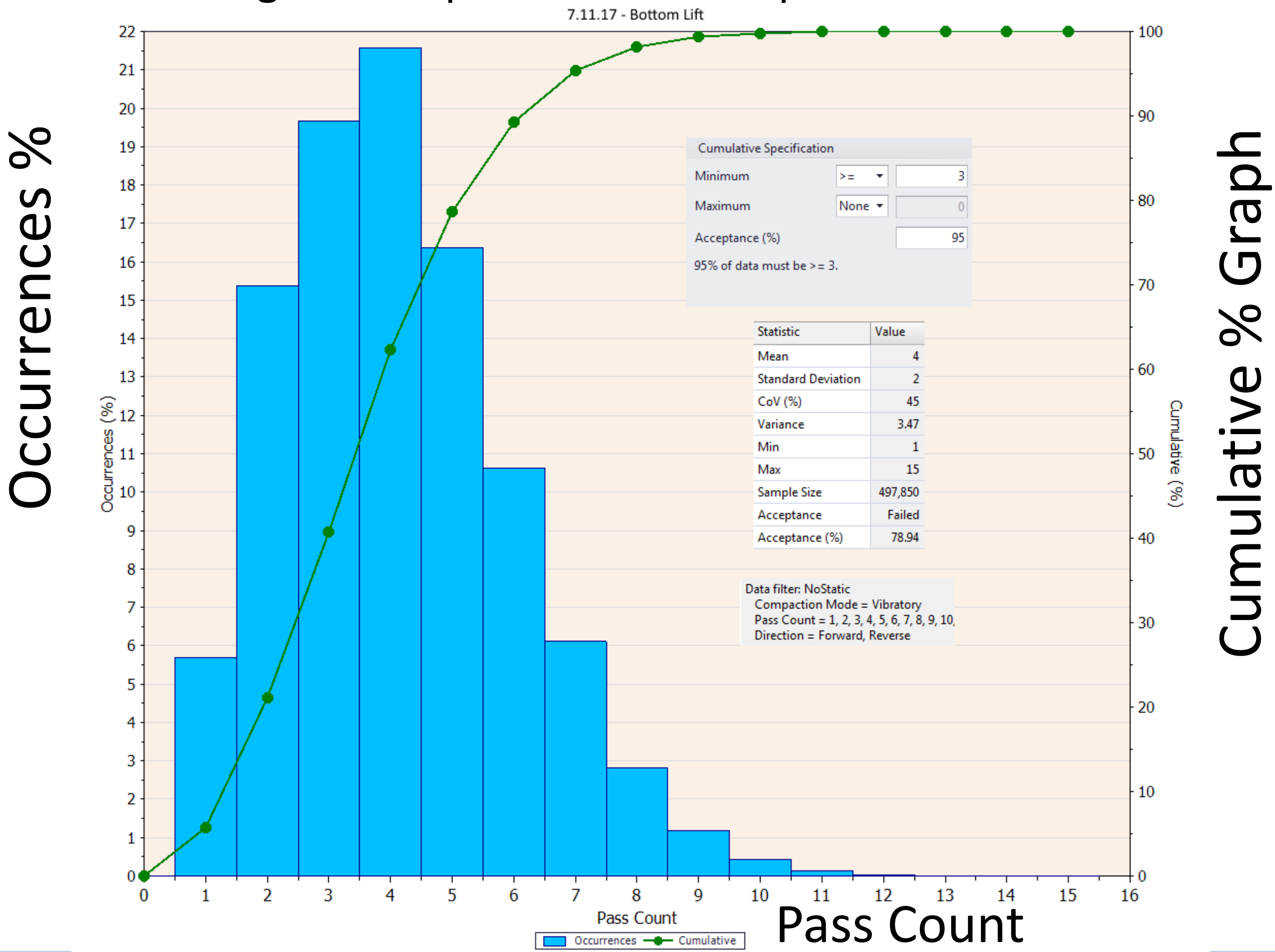
- Less Than Average

Station 1240+00

Station 1245+00

Pass	Type	Section A	Section B	Section C	Section D	Section E	Section F	Section G	Section H	Section I	Section J	Section K
1	Temp Avg.	285	269	268	252	241	252	246	260	256	241	234
	Viscosity Color	Green	Orange	Orange	Red	Cold	Red	Cold	Red	Red	Cold	Cold
	CMV Avg.	38	29	27	26	32	39	32	32	31	30	33
3	Temp Avg.	289	270	257	240	234	241	248	245	240	232	224
	Viscosity Color	Green	Orange	Red	Cold	Cold	Cold	Cold	Cold	Cold	Cold	Cold
	CMV Avg.	51	51	48	58	55	53	54	48	52	51	51
5	Temp Avg.	258	279	260	263	232	222	235	246	236	225	216
	Viscosity Color	Red	Orange	Red	Red	Cold	Cold	Cold	Cold	Cold	Cold	Cold
	CMV Avg.	69	64	52	55	60	63	61	59	60	52	51

Intelligent Compaction Veda output



Statistic	Value
Mean	4
Standard Deviation	2
CoV (%)	45
Variance	3.47
Min	1
Max	15
Sample Size	497,850
Acceptance	Failed
Acceptance (%)	78.94

Continuous Full Coverage (CFC)

- FHWA and AASHTO through SHRP2 have invested 9 years and $232 Million promoting adoption of CFC testing technologies.

- Why should Alaska DOT&PF change from random testing to CFC testing technologies?

Problems with Random Testing

- Assumes a Bell Curve or Gaussian Distribution of values, thus PWL specs are Not suitable for heterogeneous materials
- Not suitable for finding defects on paving projects as there is almost zero probability of locating pot hole size defects

Advantages of CFC Testing

Continuous Full Coverage Testing:

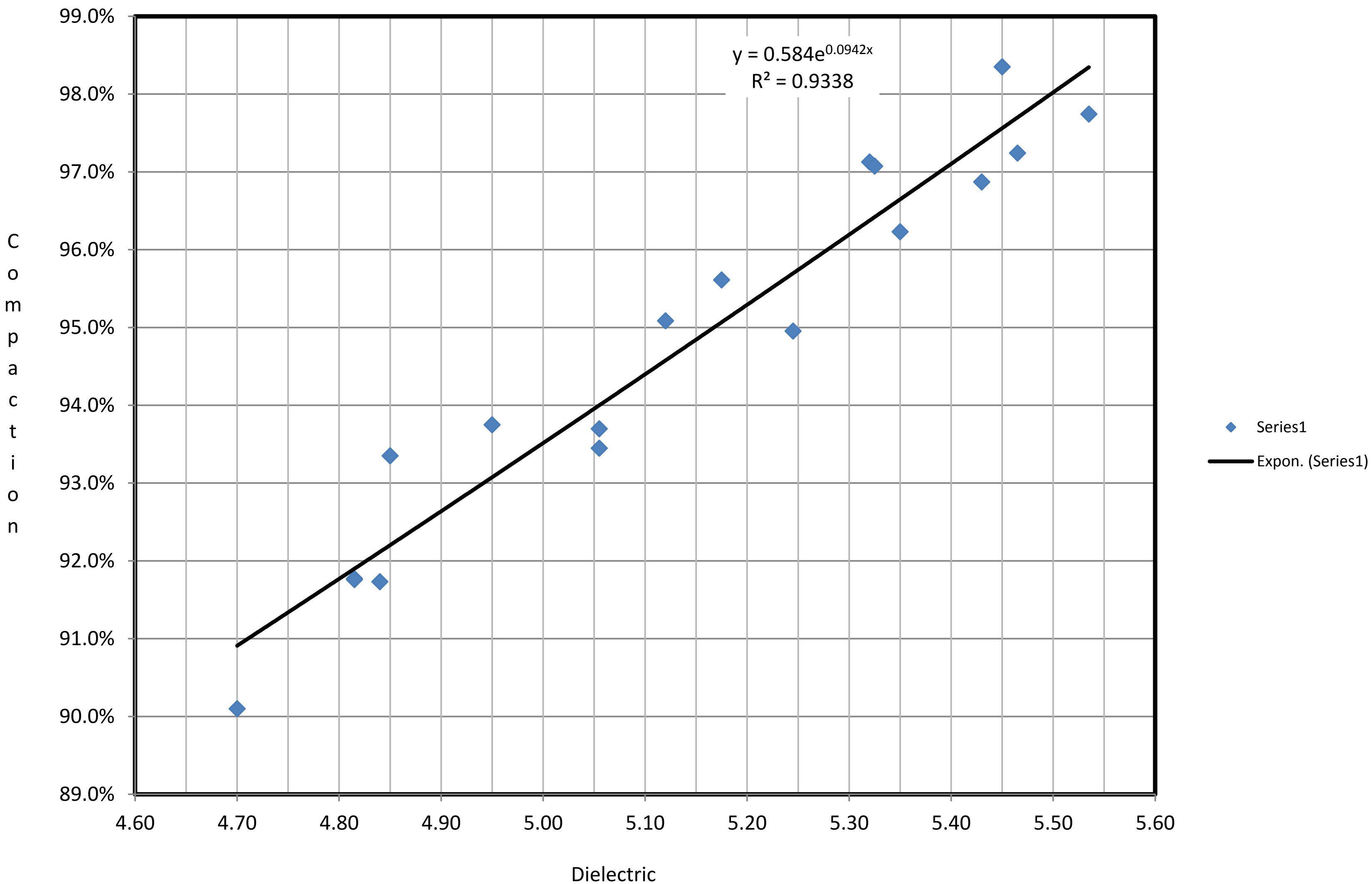
- Takes a test every square foot
- Locates every test with GPS coordinates
- Has the potential to produce a nearly defect free project with open communication of data and proper incentives/corrective actions

PaveScan RDM (2017)

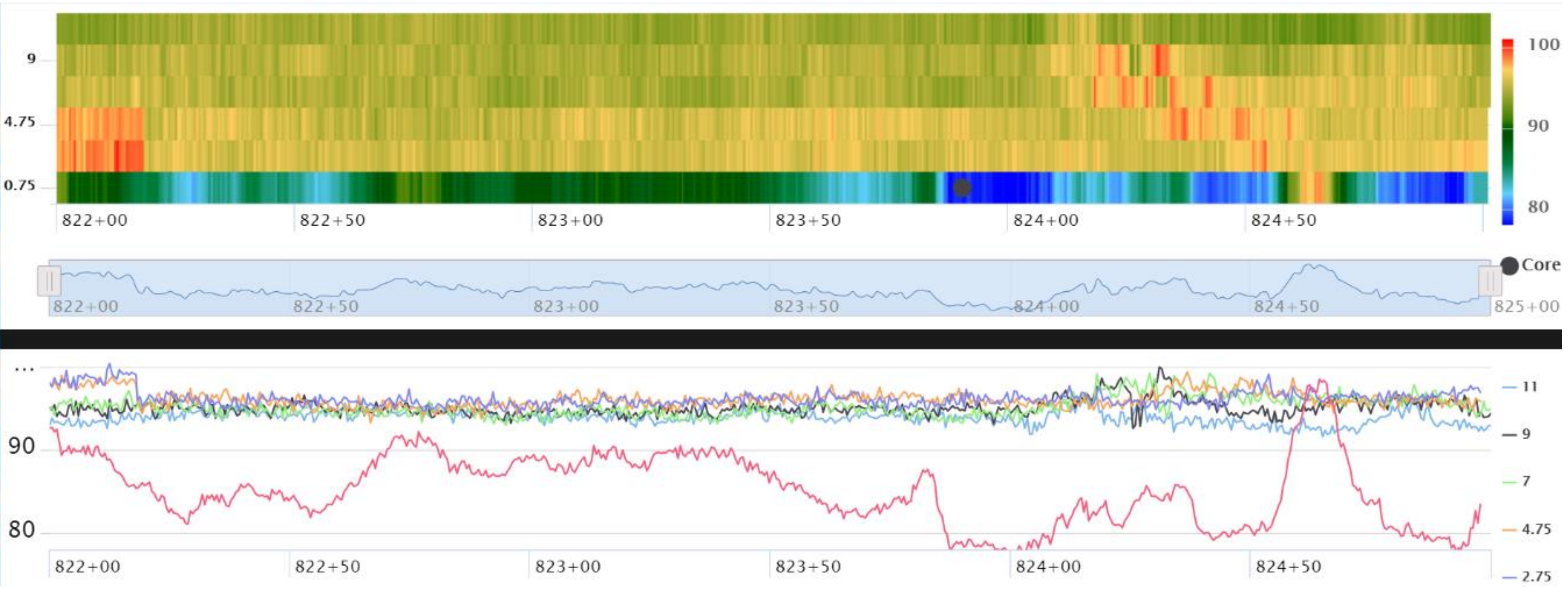
PaveScan RDM

- PaveScan Rolling Density Meter Provides:
  - Geo-located Data
  - 60 scans (dielectric readings) per second recorded to Raw Data File
  - ~10 Dielectric readings per foot of travel at 4 mph walking speed per antenna

Calibration: Cores vs RDM, $R^2 = 0.93$

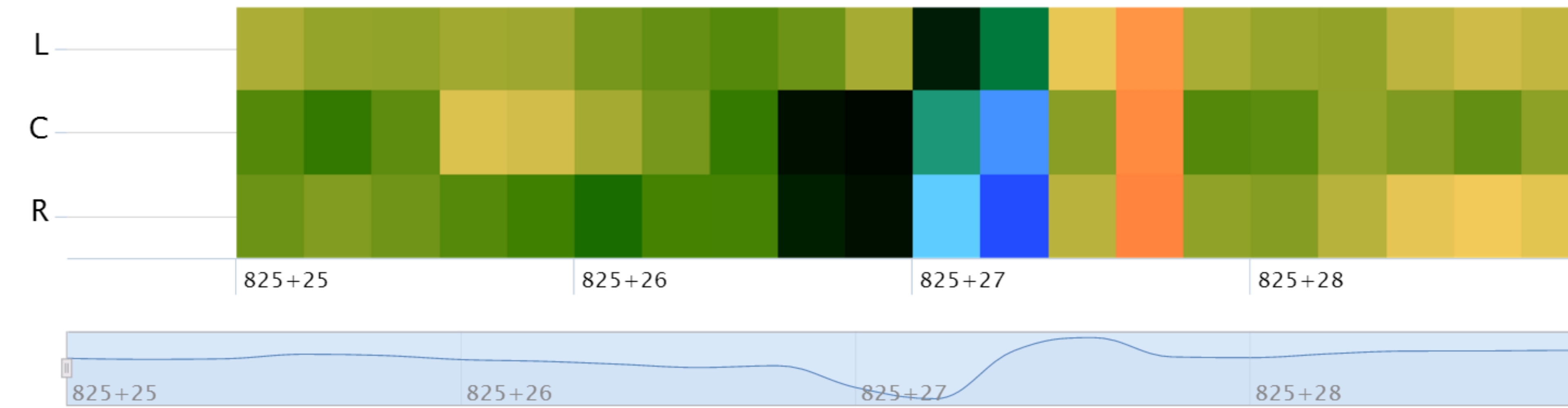


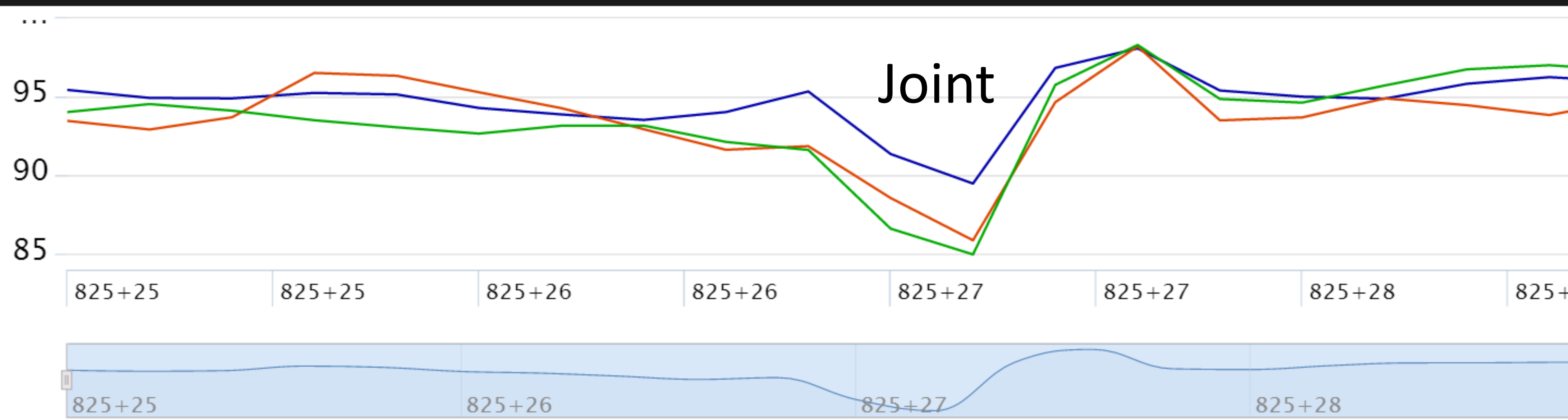
GPR of Lane



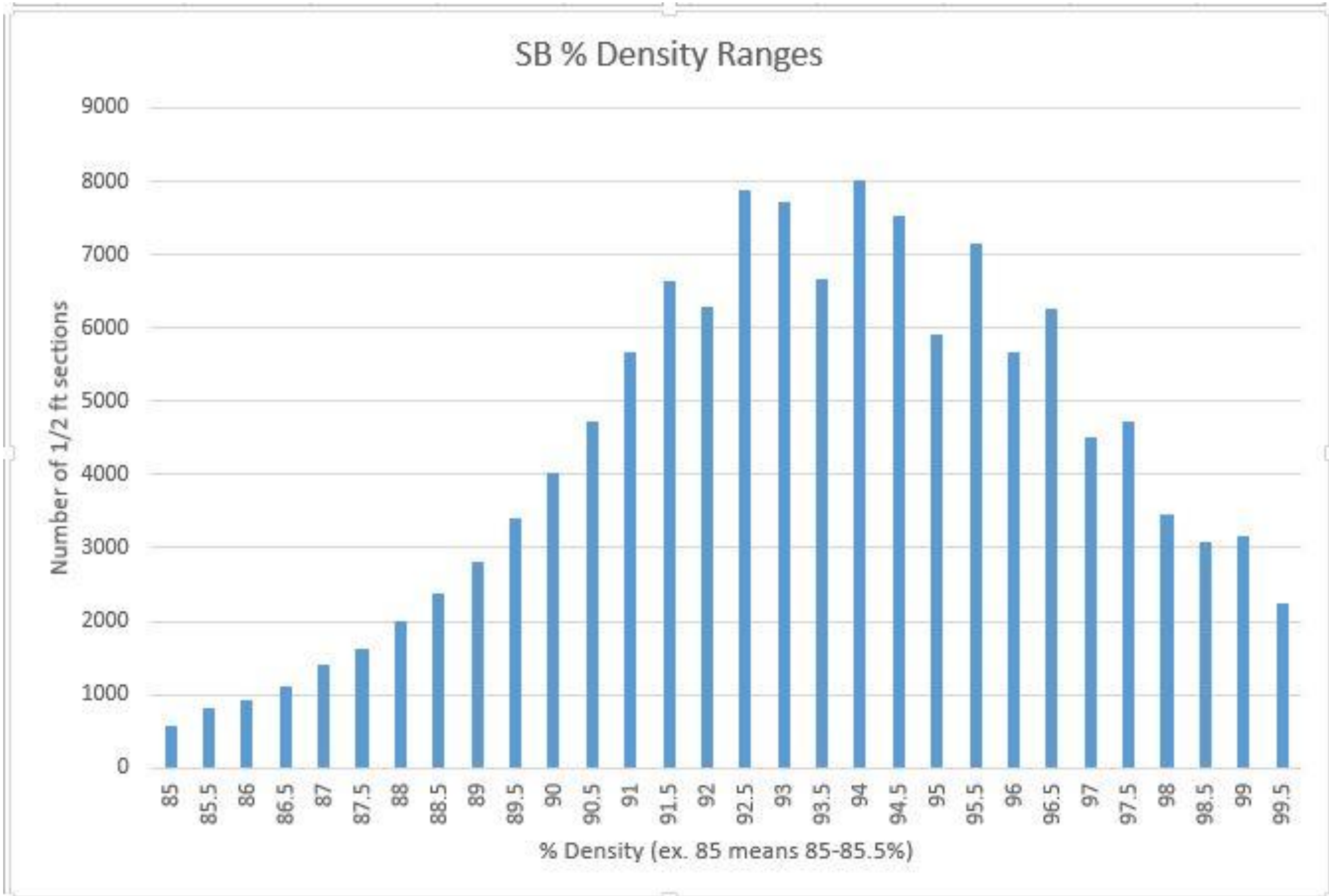
9
4.75
0.75
822+00
822+50
823+00
823+50
824+00
824+50
100
90
80
Core
825+00
90
80
11
9
7
4.75
2.75

Core 70J (91.7%) – Resolution 0.25 ft

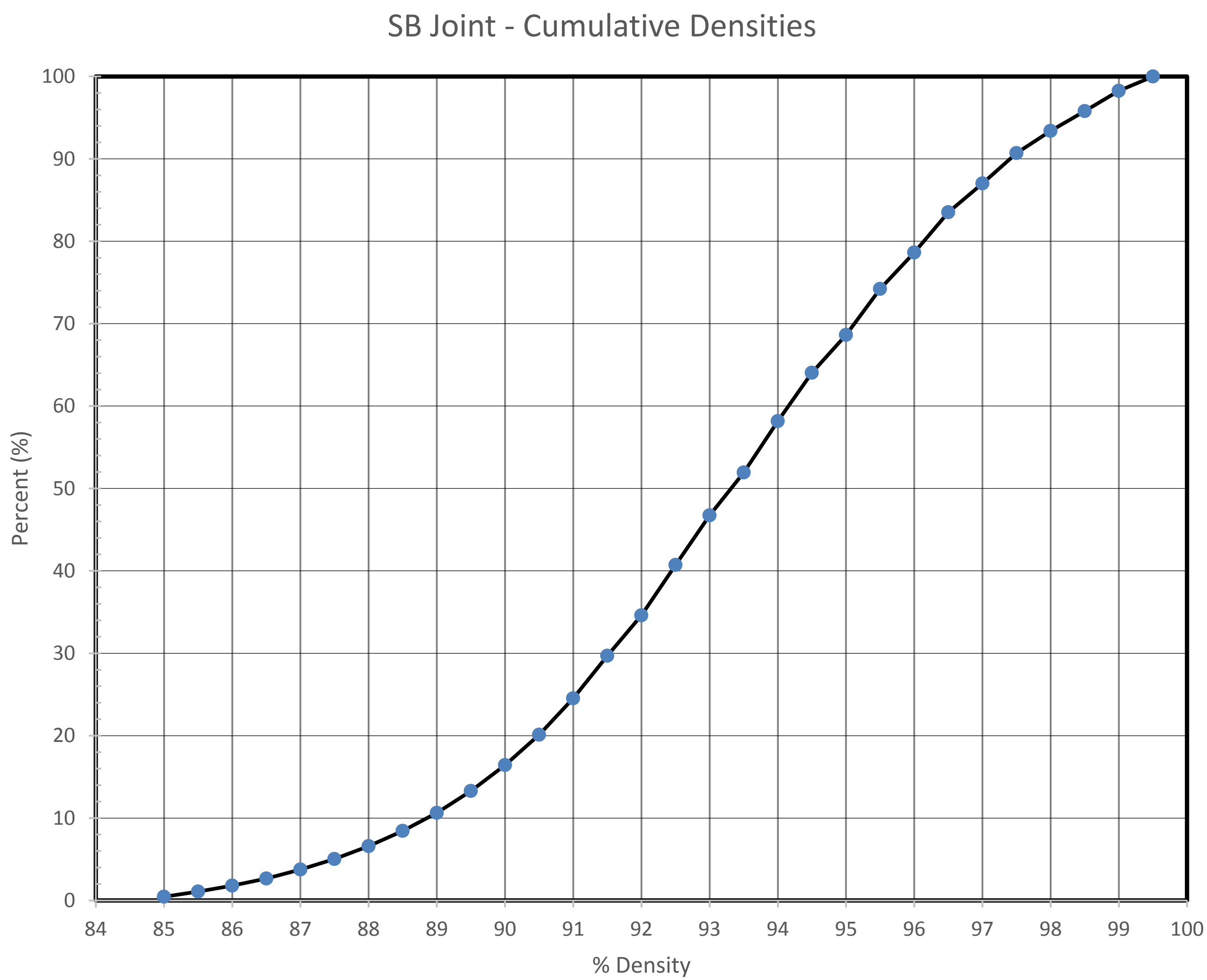




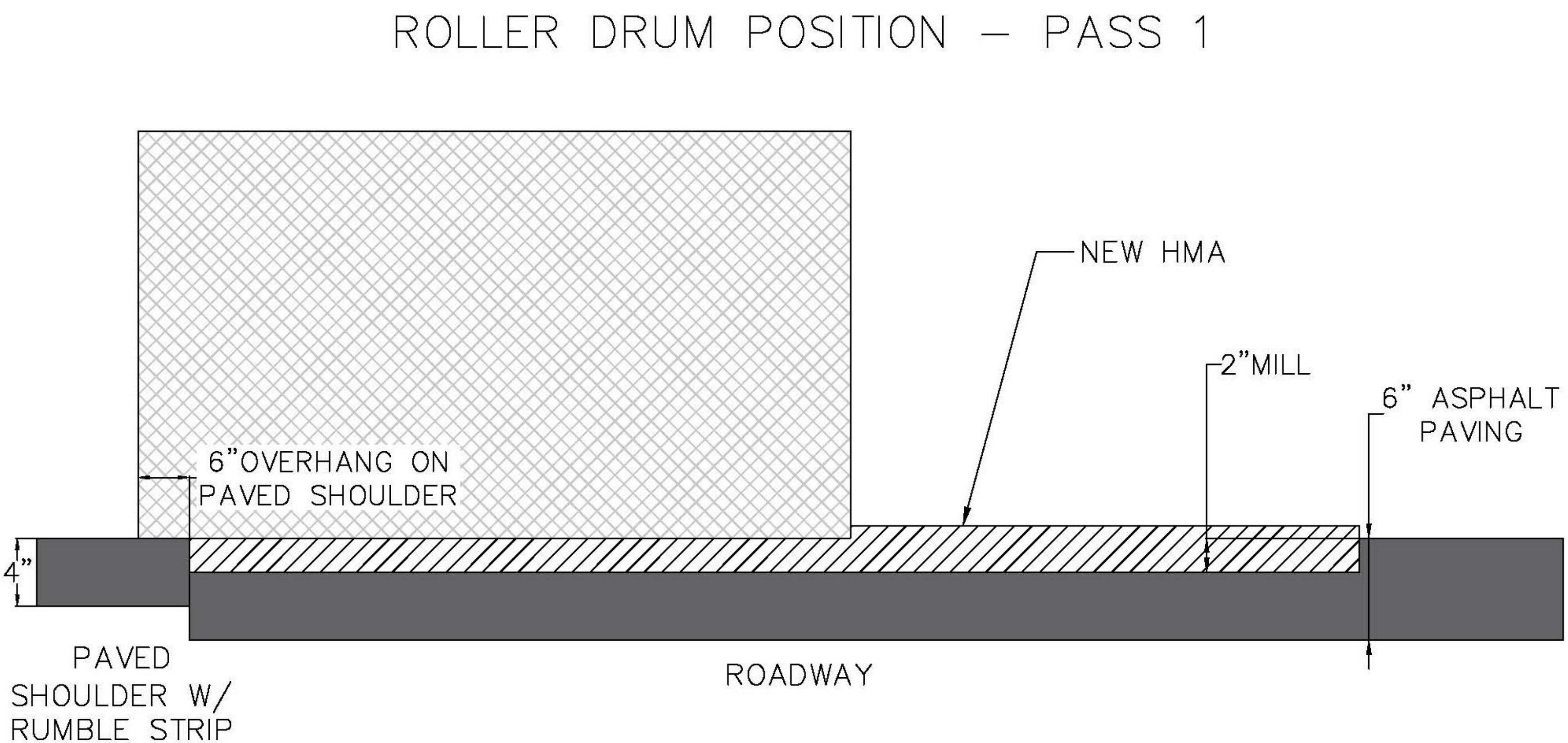
SB(Joint CL) Density Histogram



SB Joint 24.5% below 91% Density



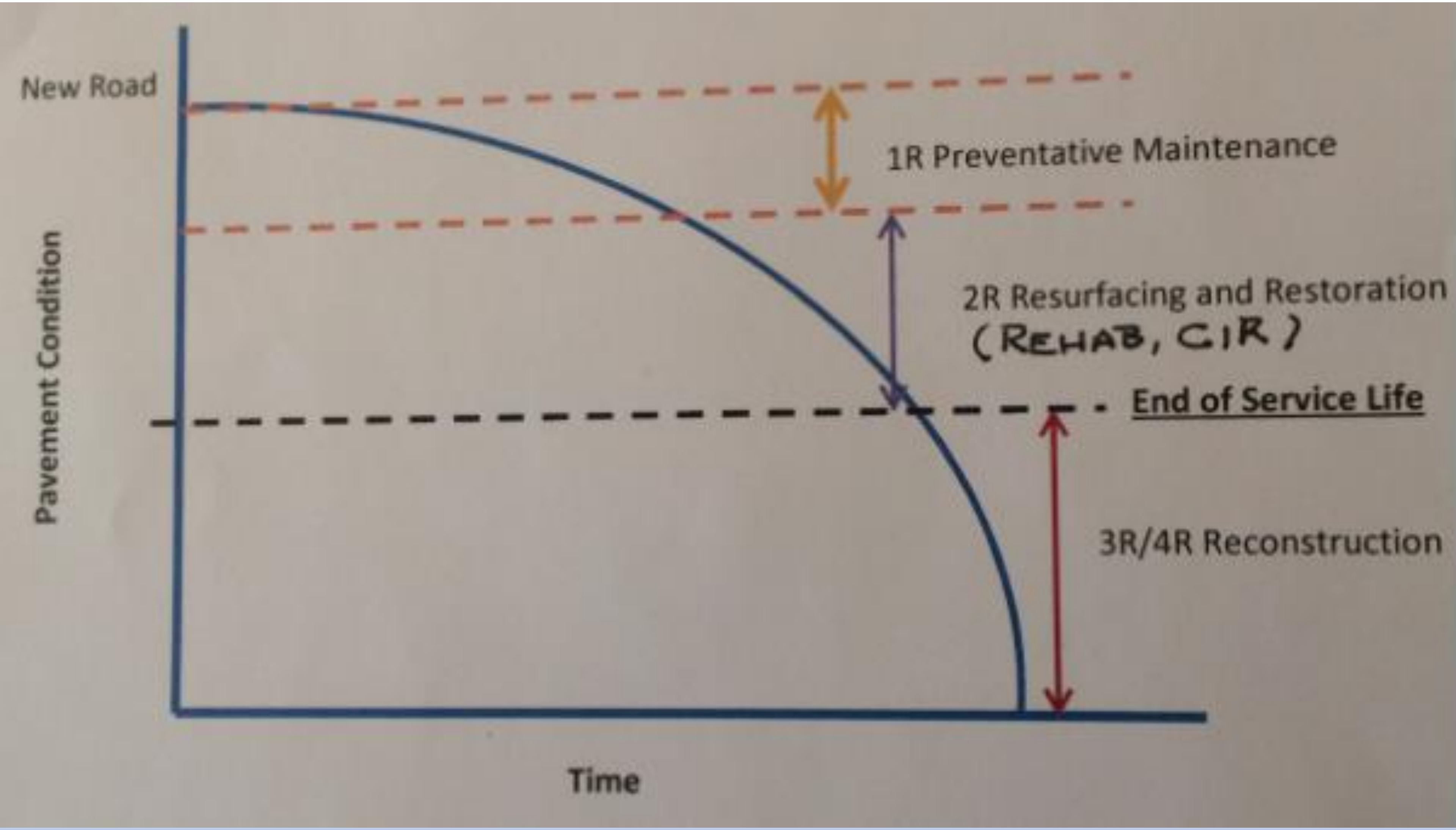
We don’t want a “Pretty” edge joint



Glenn Hwy Notes

- WMA is a valuable tool for night paving, long haul, cool temperatures
- WMA additive negated some of the temperature differential concerns of Pave IR Scan
- IC – Compaction coverages from test strip is a good tool to demonstrate replication on the mat by Veda % coverage.
- GPR – needs more accurate GPS system, but reveals all of the low density areas that may revel or pothole. Good correlation to core density. Can be calibrated on test strip and possibly used for density acceptance.
- Incentivized increasing joint density 92-94% MSG $.50-1.50 / lf

2R Proposal To FHWA



2R Justification

At this time there is no "fix the pavement" type of project. A 4R reconstructs the entire roadway and is used to expand capacity. A 3R project typically includes pathway, sidewalks, and upgrades other features. 1R projects are intended to maintain pavement in a state of good repair (they are not used on aging or failing pavement structures).

2R projects can fill the gap between these types of projects by allowing "pavement focused" projects on roads that are safe, have sufficient capacity, and do not require pathway or sidewalk construction. By utilizing cold-in-place recycling technology and other economical construction methods aging pavements can be restored to a state of good repair.

- This Option is For Rehabilitating Existing Pavement To Better Than New with Safety considerations
- Will Allow CIR Base Stabilization > Eliminate Spring Weight Restrictions
- Pulverize Existing Thermally Cracked Pavement (AC-5 Binder) into Aggregate Base and Stabilize
- Allow Use Of HMA with Engineered Binder to Resist Thermal Cracking
- Allow Use of Grade Control, Making a Pavement Smoother Than Original Lowering IRI and Cracking Metrics Reported to FHWA
- Will Provide PMS a better LCCA Option Due to Stronger, Smoother,Longer Life, Pavement

Alaska’s Success, Partnering with the PMA Industry and FHWA Implementing New Technology

Questions?

Thank You

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