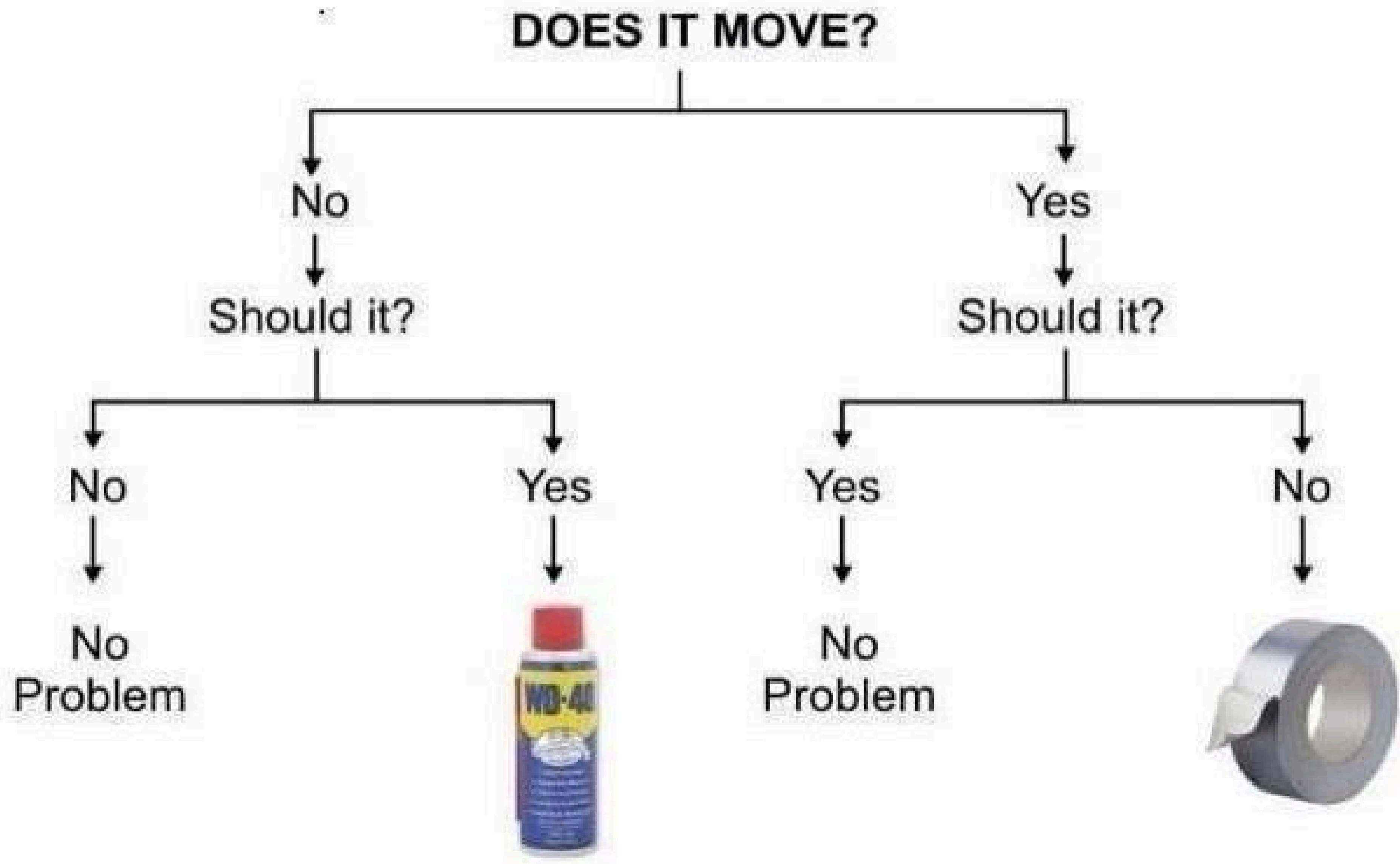

# Alaska Department of Transportation & Public Facilities

Use of Advanced Technology for Quality Assurance in Alaska

Rich Giessel

Idaho Asphalt Conference: October 25, 2018

# Engineering Flowchart



# Outline

1. Failure Modes Drive Testing Philosophy Shift
2. Implementation History of ICTs in Alaska
3. Surprising things we have discovered with Dielectric Profiling System (DPS) GPR
4. Main Features of Continuous-Full-Coverage Specifications for Compaction Acceptance
5. Compaction Defect Mapping and Remediation

# 1. Failure Modes of Asphalt Paving

## Major Failure Modes:

1. Studded Tires (a political problem)
2. Poor Compaction (a construction problem)
3. Poor Tack Bond Between Layers (a Specification and pay item problem)

## Minor Failure Modes:

- Stripping (a surface chemistry problem)
- Rutting & Shoving (a mix design problem)

# Avoidable Major Failure Modes

Avoidable Major Failure Modes:

2. Poor Compaction
3. Poor Tack Bond Between Layers

Our focus will be on Enhancing Compaction

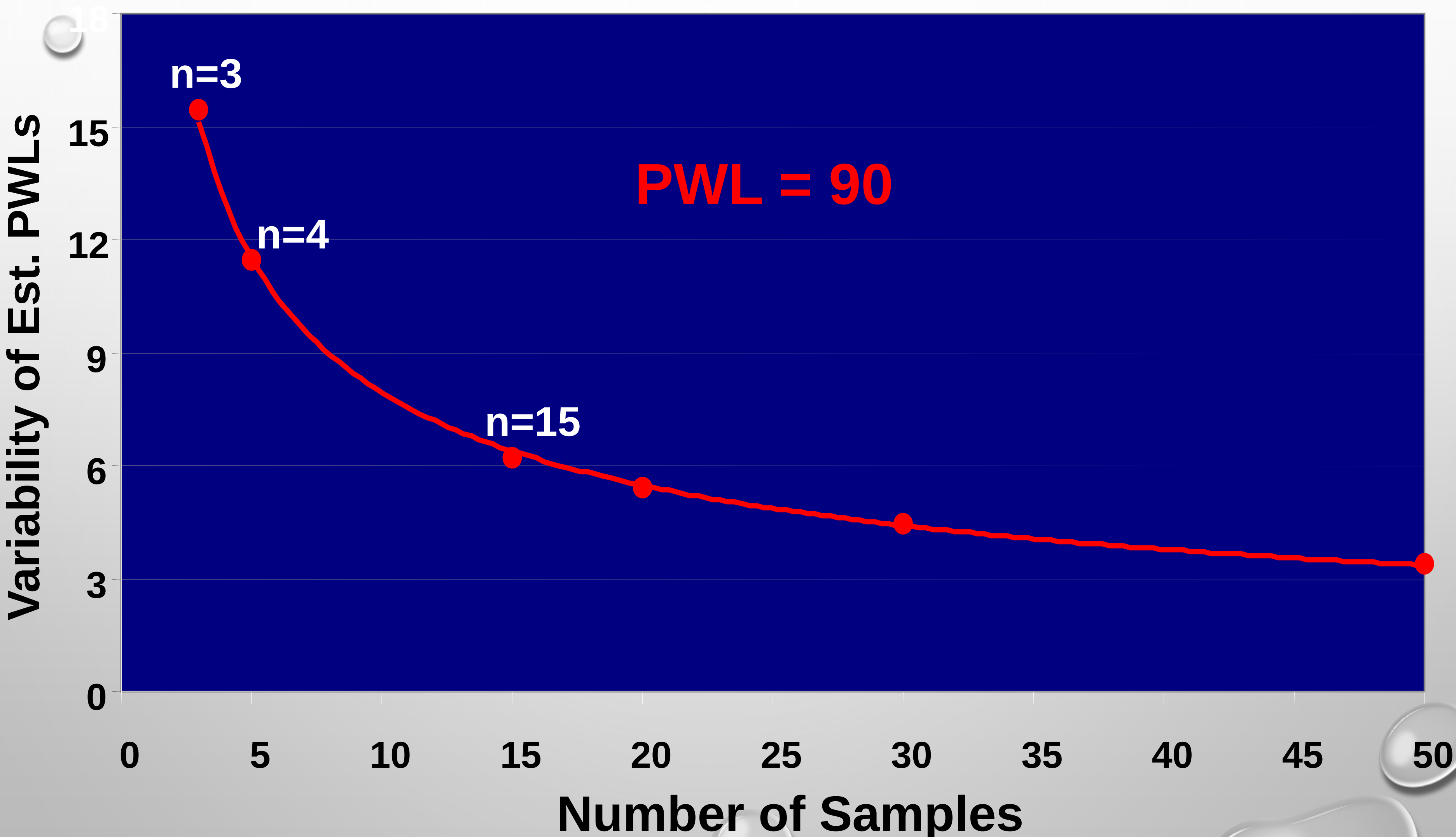
# Required Shift in Philosophy-1

- We Must Abandon Random Testing

“The primary problem is not so much to determine the average conditions, as it is to make reasonably certain that possibly the most unfavorable conditions are known over a given area that may give rise to soft spots.”

Donald M. Burmister (1948)

# OPTIMAL SAMPLE SIZE



# Required Shift in Philosophy-2

- Adopt current state-of-practice technology to achieve 100% testing & inspection coverage
  - Intelligent Compaction (IC) Rollers provide 100% pass coverage, temperature, ICMVs
  - Paver Mounted Thermal Profilers (PMTP) provide 100% thermal mapping of mat
  - Asphalt Surface Dielectric Profiling Systems (DPS) using Ground Penetrating Radar (GPR) provide 100% Mapping of compaction

# Expected Outcomes

- No potholes or raveling joints
- Longer-life pavements
- Much less maintenance
- Lower life-cycle cost

# 2. Implementation History of ICTs in Alaska

# Intelligent Compaction Rollers

- Intelligent Compaction Rollers required at Sitka Airport for Night Paving. (Bruce Brunette 2013)
- Echelon Paving also employed to reduce longitudinal joints from 11 to 5.

# Paver Mounted Thermal Profiler (2015)

# Pave IR Benefits

- Real-time thermal mapping, color display on paver provides immediate feedback to DOT and paving crew

# Example Pave-IR Display

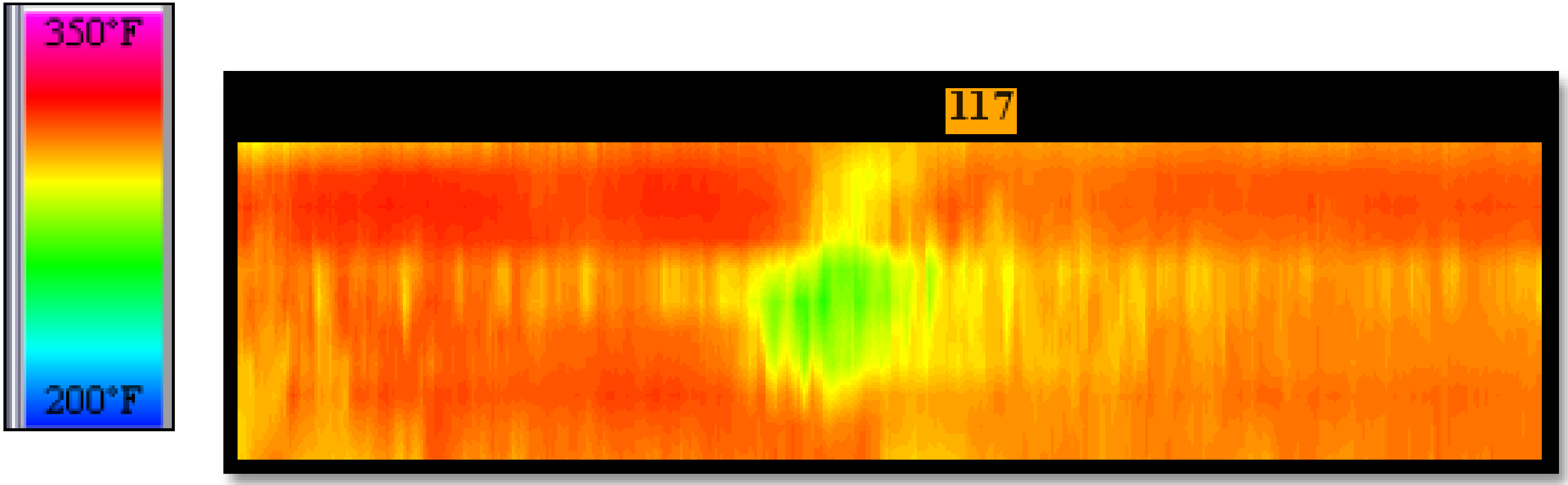



**Figure 3.2. Thermal profile from US-29 (continued).**

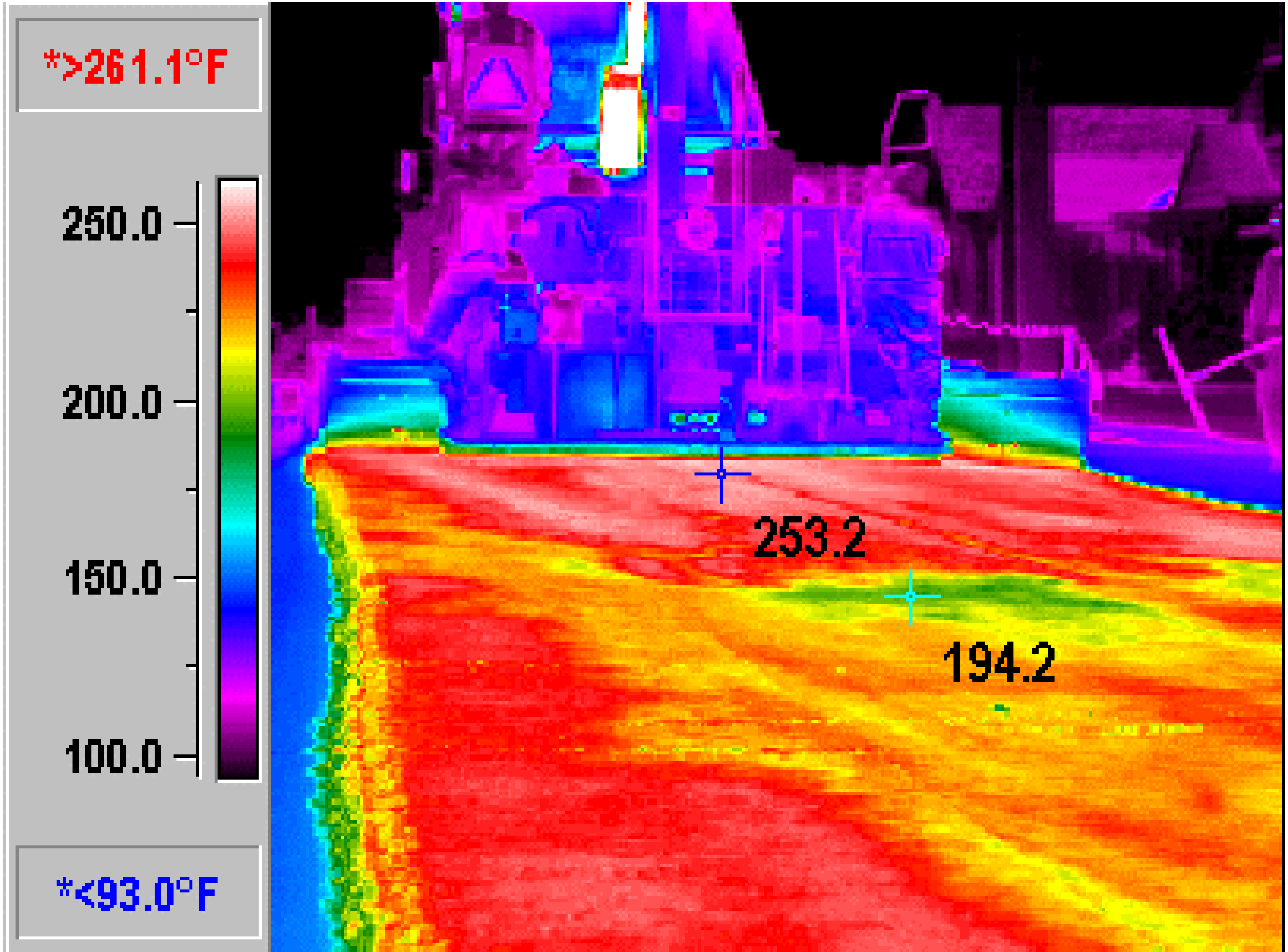
# Birth of a Pothole

**Research Report – July 1, 2001**
**Research Project Agreement T9903, Task A3**
**Cyclic Segregation**

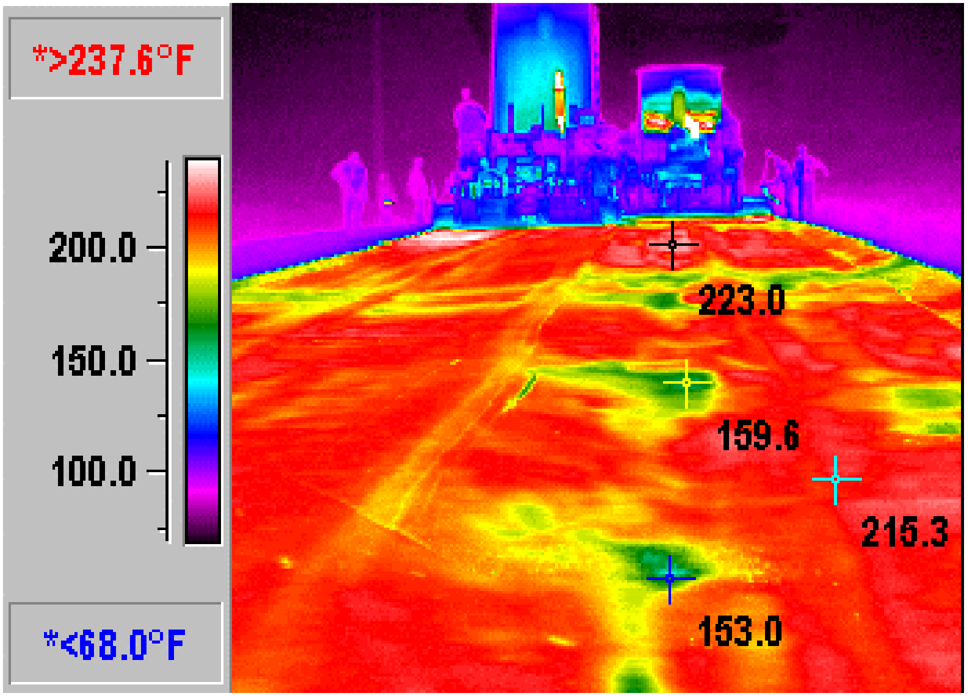
**CONSTRUCTION-RELATED ASPHALT CONCRETE PAVEMENT TEMPERATURE DIFFERENTIALS AND THE CORRESPONDING DENSITY DIFFERENTIALS – Report No:** WA-RD 476.1

**Washington State Transportation Center (TRAC)**
University of Washington, Box 354802
University District Building
1107 NE 45th Street, Suite 535
Seattle, Washington 98105-4631

# Tarped vs Not Tarped



# Cold Spots - Infrared vs B&W Photo




# Glenn Hwy Incentive (2016)

- Pay a $75 Bonus for each 150’ segment with No Thermal Segregation (0-$25^{0}$ F variation)
- 2140 each 150’ segments = $160,500 potential bonus on 15 miles of 4 lane highway

# No Incentive

- No bonus for 150’ segments with Moderate Thermal Segregation (25-$50^{0}$ F)

# Penalty or Disincentive

- $75 Penalty (not used on Glenn Hwy) for each 150’ segment with Severe Thermal Segregation (>$50^0$ F)
- Only used the Carrot☺

# PMTP Use Rewards Good QC

- PMTP is an objective tool for rewarding best practices such as:

1. Tarping all loads
2. Steady delivery of material to project with a minimum number of paver stops
3. Tying loads together when dumping
4. Use of Material transfer vehicle to homogenize temperature and smooth material flow to paver

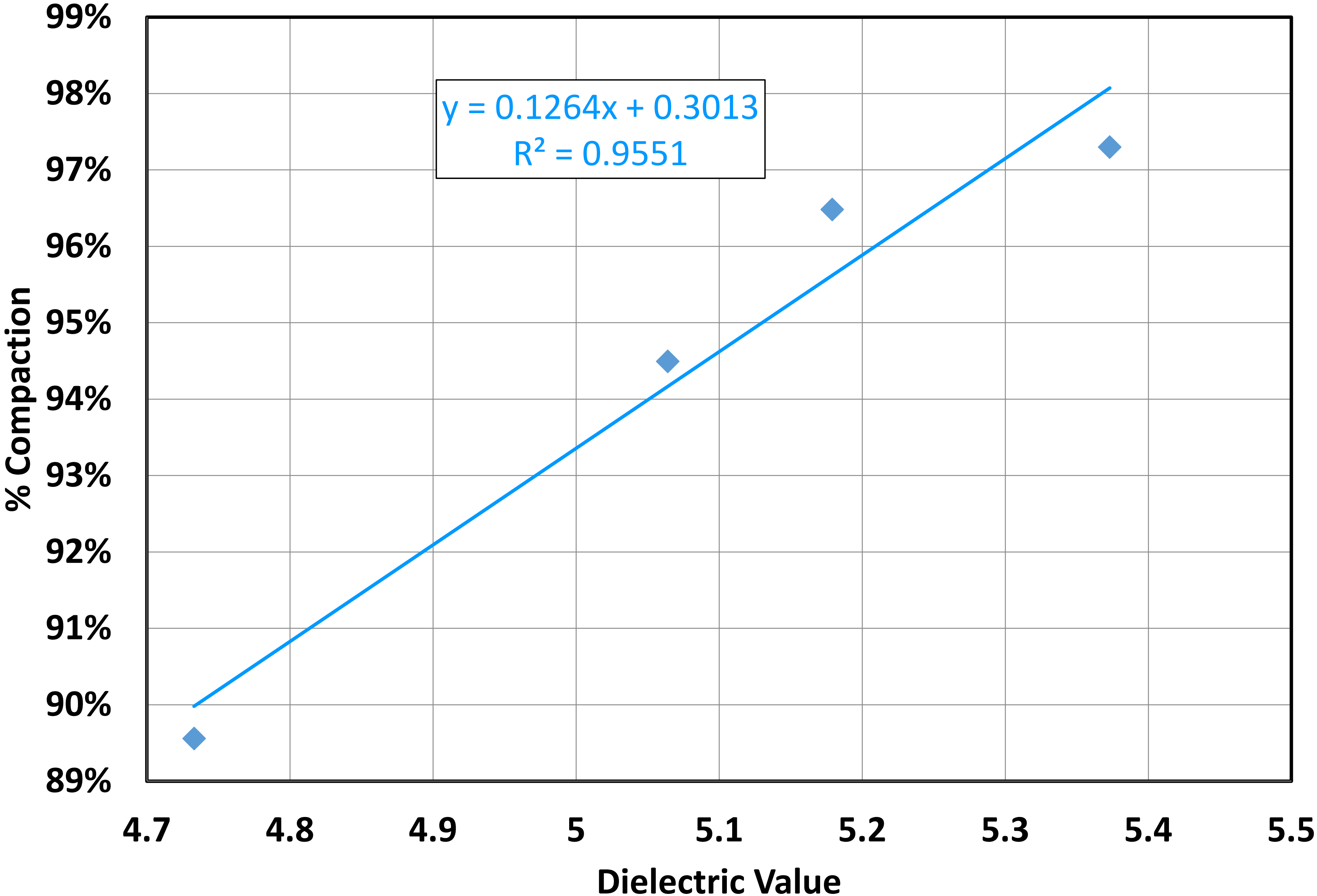
# Newest Methodology (2016)

- Dielectric Profiling System (DPS) using Ground Penetrating Radar (GPR) gives:
  1. Dielectric Mapping
  2. Readout as % Voids, % Compaction, or Density in asphalt mat in real-time once calibration data from drilled cores has been entered.

(Note: Testing equipment became commercially available in May 2016 with FCC approval. Alaska purchased the 10th machine made in October 2016)

# Fritz Cove Dielectric (July 2018)

# Mainline Dielectric vs % Compaction



# Fritz Cove % Compaction

# DPS - PaveScan RDM (2017)

# PaveScan RDM

- PaveScan Rolling Density Meter Provides:
  - Geo-located Data
  - 400,000 pulses per second processed with equivalent time sampling to produce 60 scans/sec
  - 60 scans (dielectric readings) per second recorded to Raw Data File
  - =10 Dielectric readings per foot of travel at 6 ft/sec (~ 4 mph walking speed) per antenna

# What is Dielectric?

- Related to Speed of RADAR through a Material

$$e = C^2 / V^2 \quad \text{or} \quad (V = C / \sqrt{e})$$

Where: e = Dielectric

C = Speed of light in a vacuum

V = Speed of RADAR in material


# Relative Speeds of RADAR

RADAR is fastest in Air e = 1 (V=C)

RADAR is slowest in Water e = 81 (V=1/9C)

Asphalt Concrete e = 4-7 (V=0.5-0.35C)

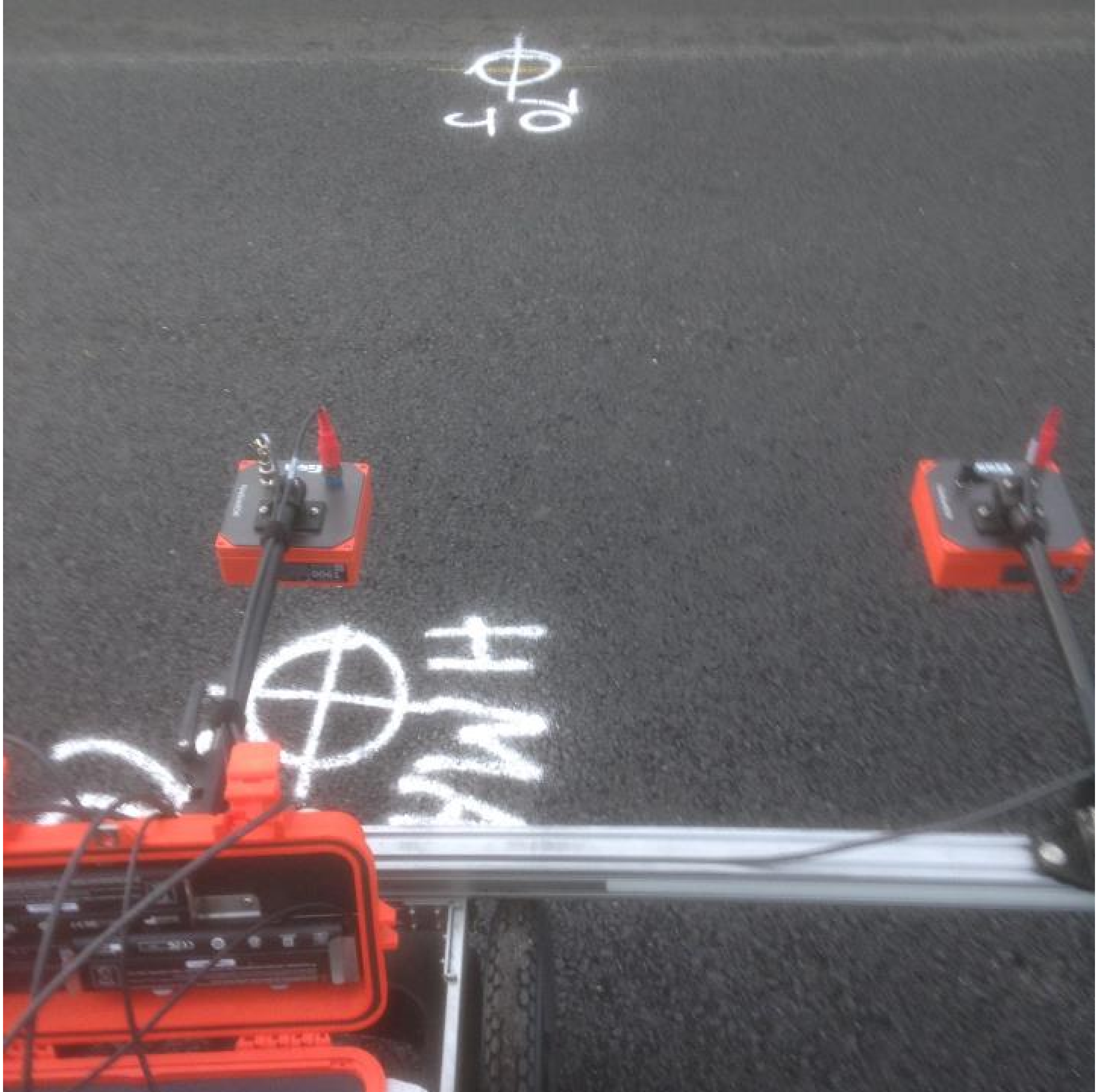
(note more air gives lower dielectric, i.e. RADAR passes through porous asphalt faster)

LOW DIELECTRIC = LOW DENSITY

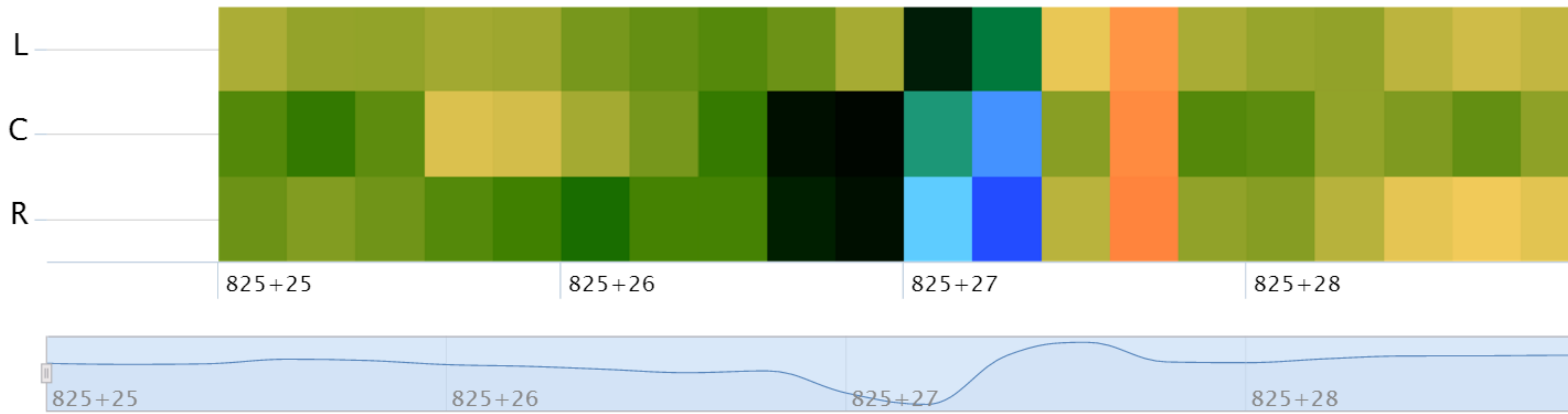

# 3. Surprising things we have discovered with DPS GPR

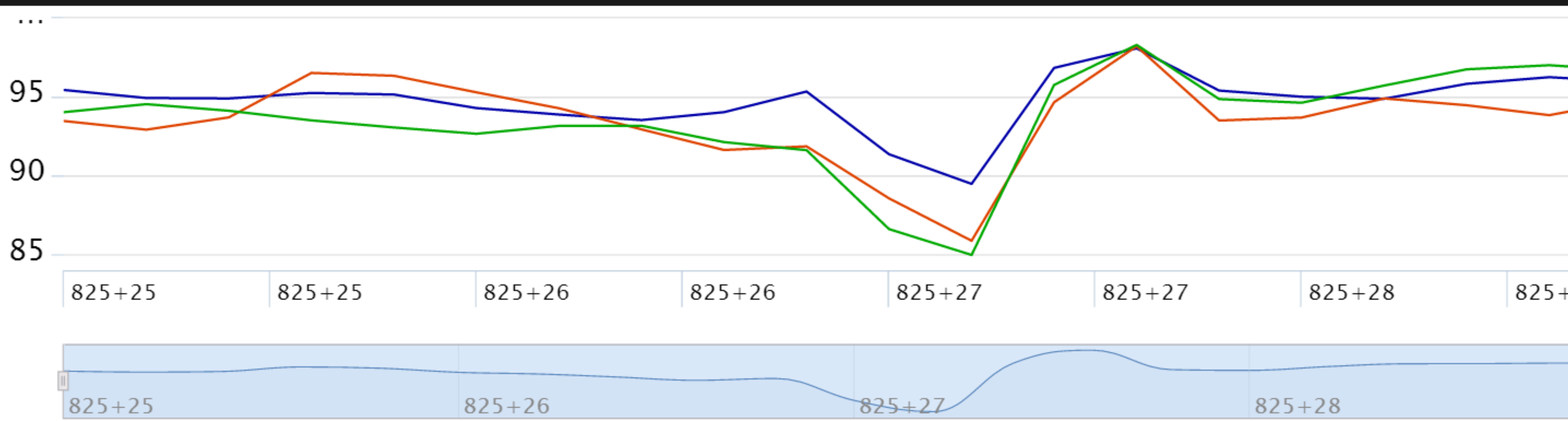

# What can we “SEE” with GPR?

- Answer: Defects we have never “SEEN” before
- For example, density variation across a longitudinal joint

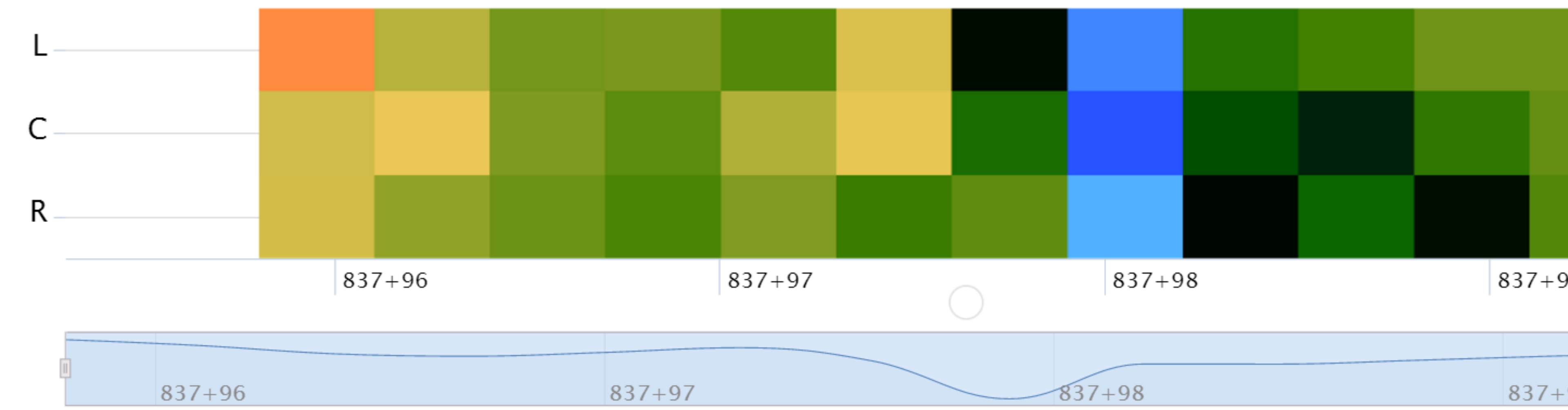


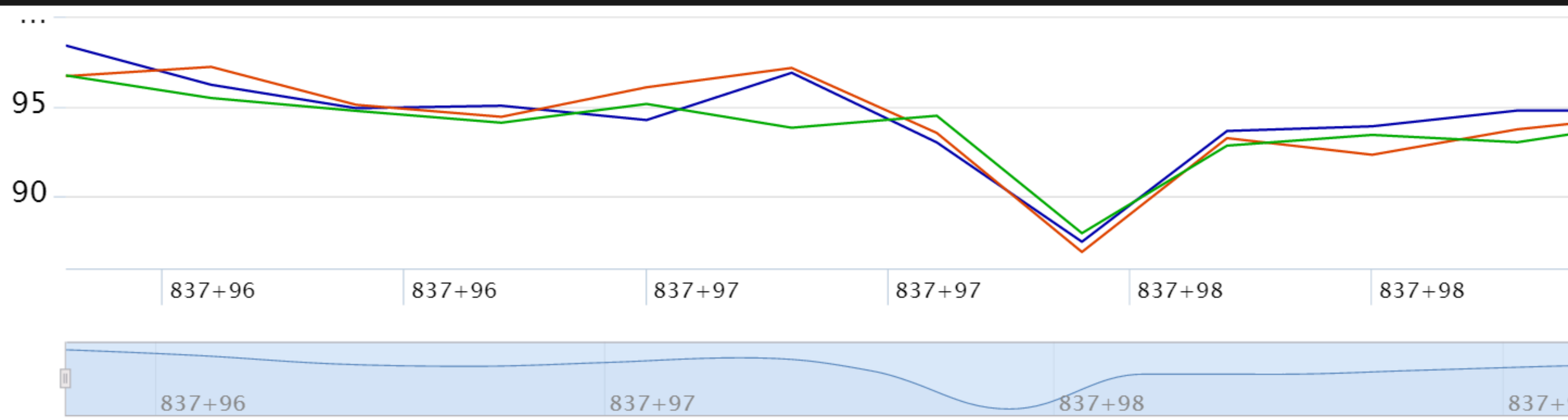
# Core 70J (91.7%) – Resolution 0.25 ft



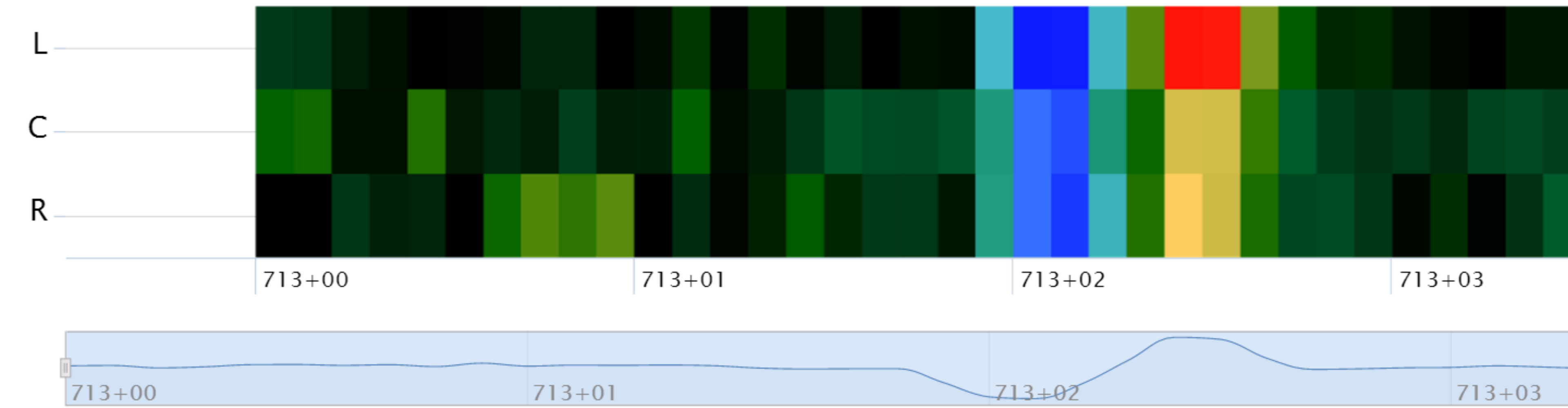



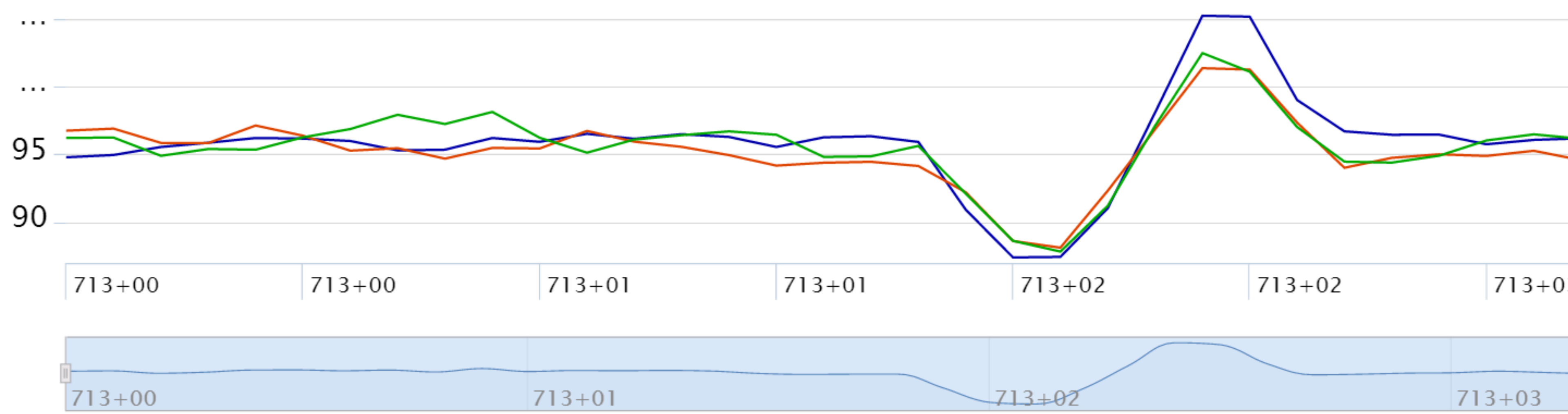
# Core 69J (92.9%) – Resolution 0.25 ft



# Core 87J (94.9%) – Resolution 0.10 ft



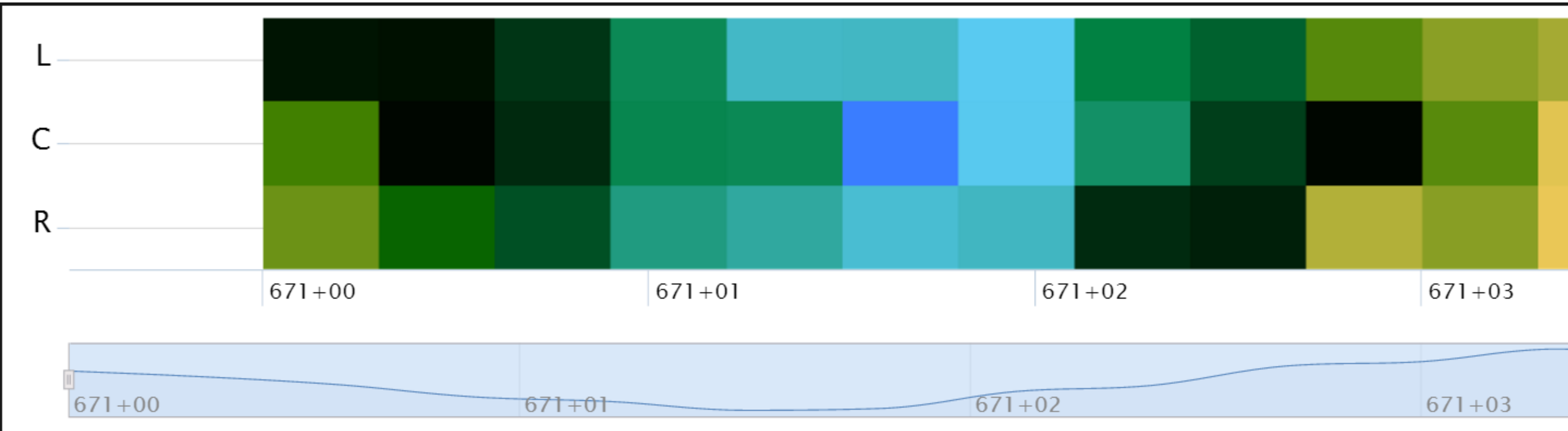
# Core 87J – Distance Statistics

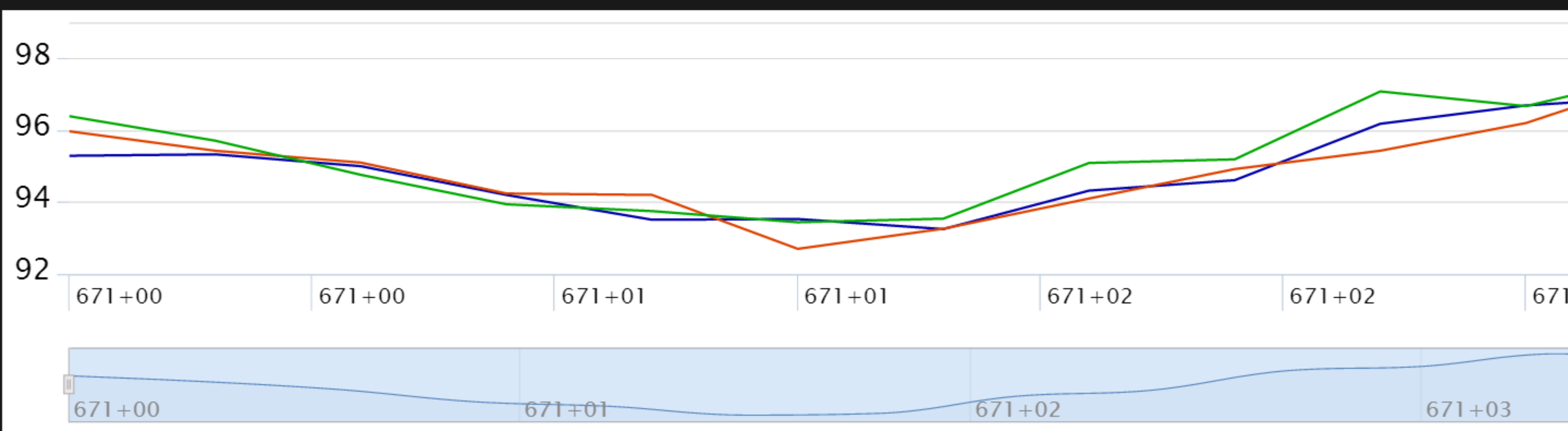
| Sensor Position | Total Dist | Median | Average | Min | Max | Standard Dev |
|---|---|---|---|---|---|---|
| Center | 4.2 | 95.2647 | 95.2054 | 88.1275 | 101.343 | 2.28774 |
| Left | 4.2 | 96.161 | 95.9437 | 87.4141 | 105.199 | 3.10059 |
| Right | 4.2 | 96.0255 | 95.6037 | 87.8418 | 102.452 | 2.49736 |

# Core 87J – Time Statistics

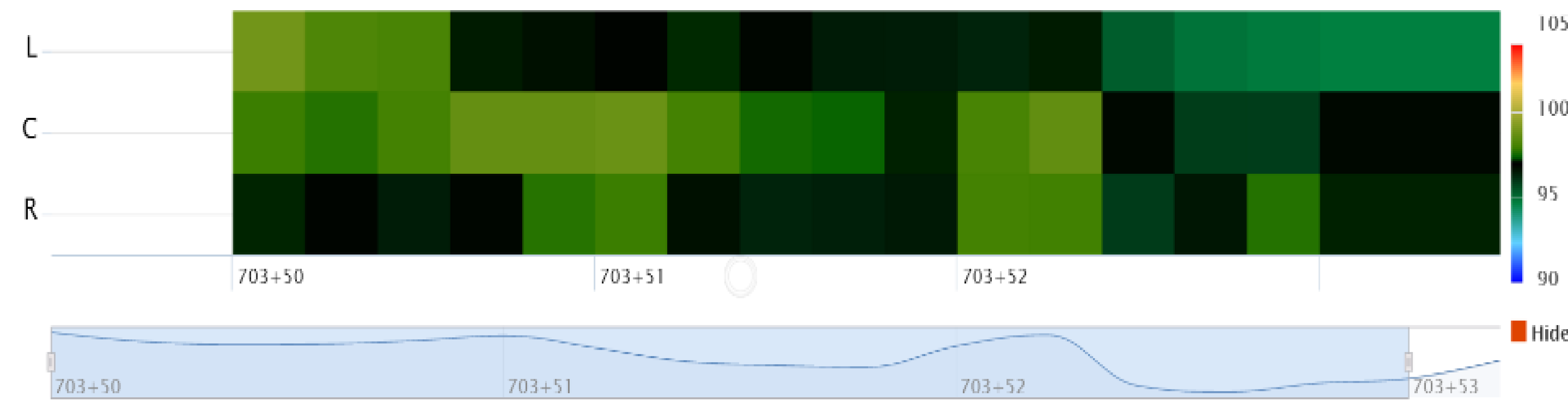
| Sensor Position | Total Dist | Median | Average | Min | Max | Standard Dev |
|---|---|---|---|---|---|---|
| Center | 1269 | 87.8607 | 87.8692 | 86.8951 | 88.8963 | 0.306642 |
| Left | 1269 | 86.557 | 86.5422 | 84.4503 | 87.6718 | 0.34858 |
| Right | 1269 | 88.985 | 88.9778 | 87.8945 | 90.2777 | 0.352063 |

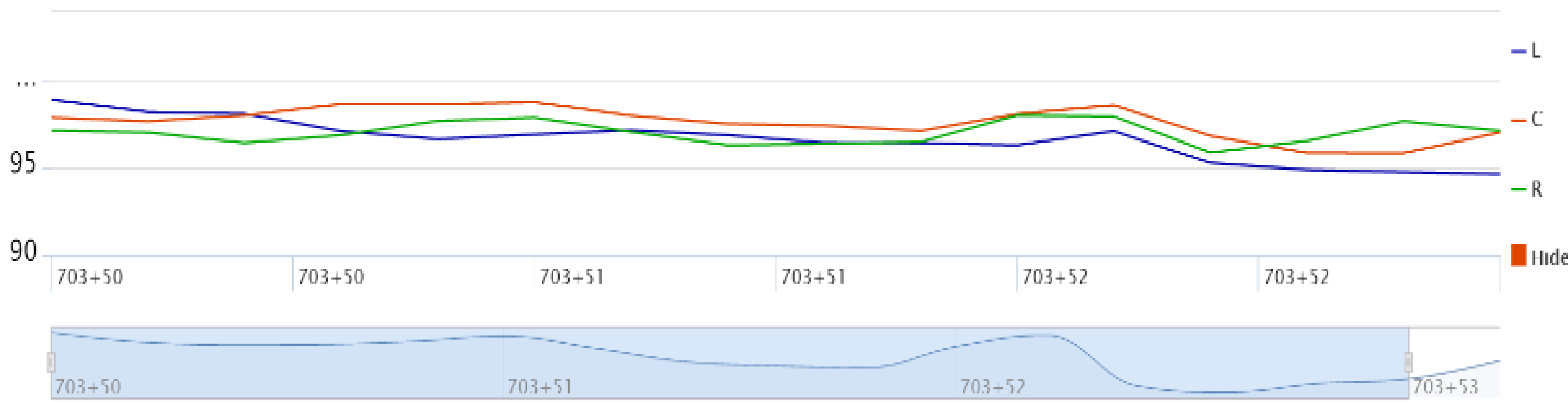
# Core 85J (92.4%) – Resolution 0.25 ft



# Calibration Core 19J (96.2%) 0.25 ft



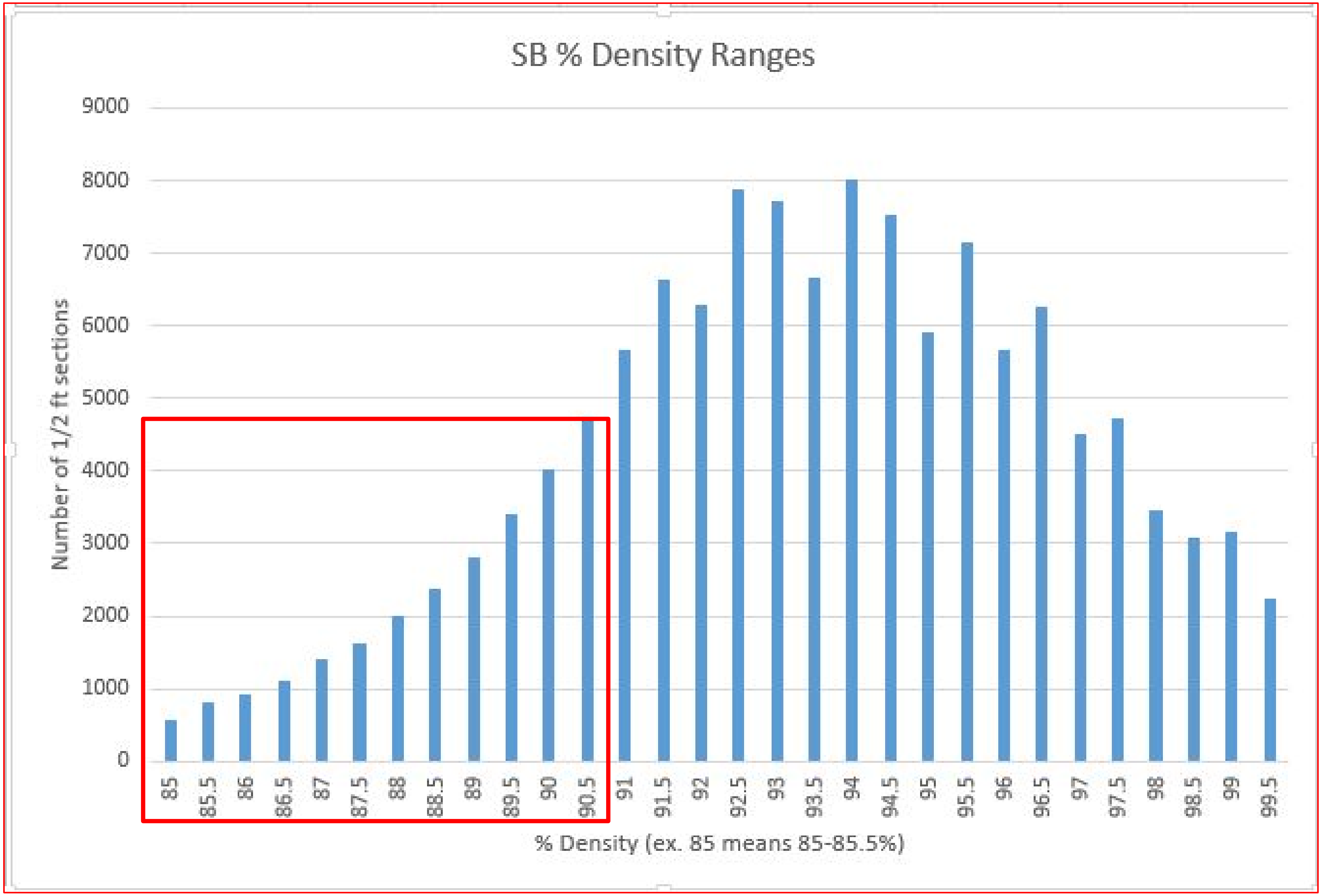



# Longitudinal Joint at Core 19J

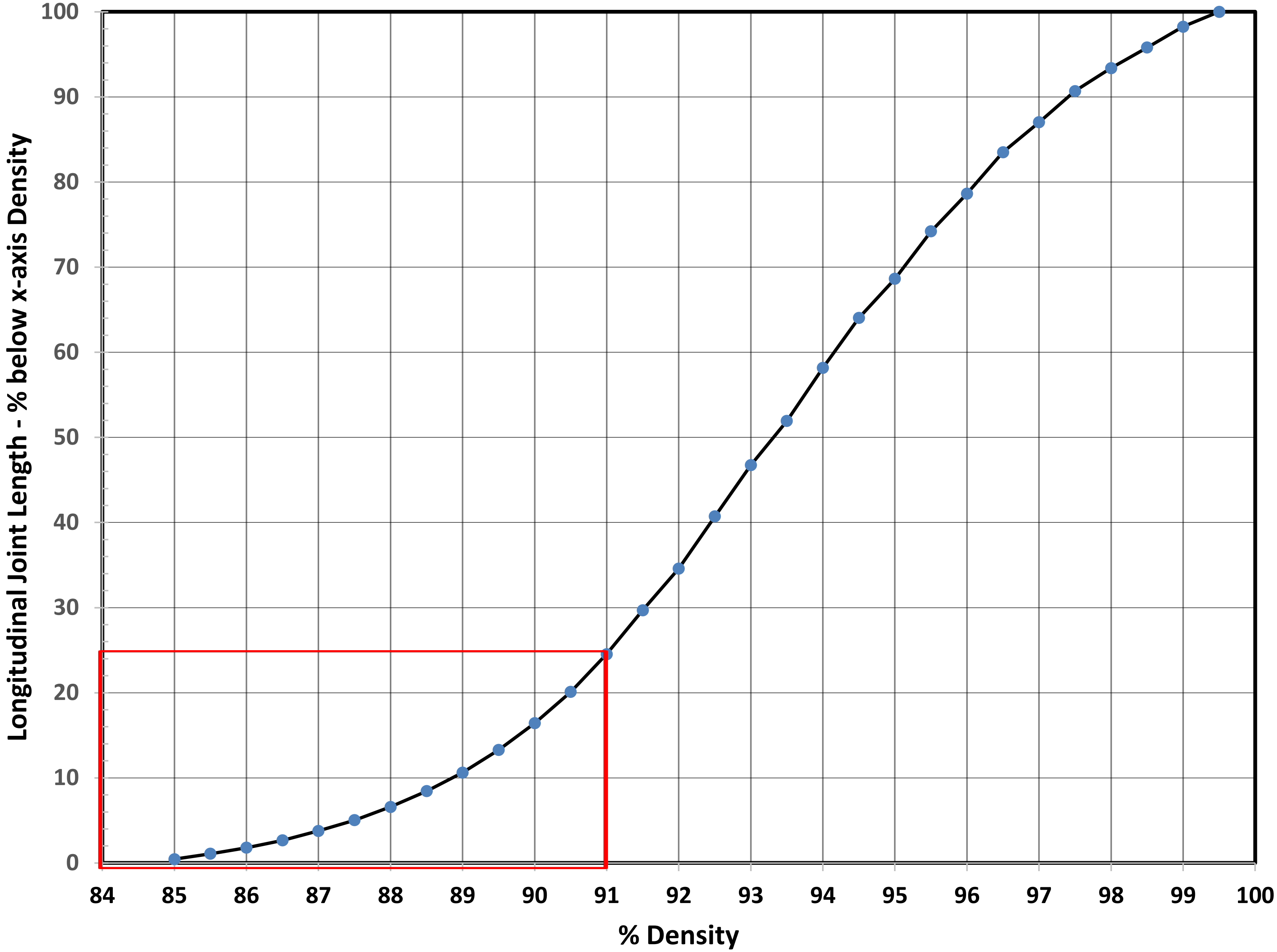
# 165 Core Densities: 90.9 to 97.8%

| Compaction Summary - 2017 Data | | |
|---|---|---|
| | % Compaction | |
| | Bulk/MSG | Bulk/MSG |
| | **Panel** | **Joint** |
| SB-L1 Average Panel Density (20 Cores) | 94.8 | |
| NB-L1 Average Panel Density (17 Cores) | 95.4 | |
| SB-L2 Average Panel and Joint Densities (33 Cores) | 94.9 | 94.1 |
| SB-L3 Average Panel and Joint Densities (3 Cores) | 95.5 | 93.4 |
| NB-L2 Average Panel and Joint Densities (28 Cores) | 94.7 | 95.0 |
| Project Averages | **94.9** | **94.5** |
| Max | 97.6 | 97.8 |
| Min | 92.3 | 90.9 |
| Note: | | |
| 50 of 101 (50%) of Panel Cores 95.0% or Higher | | |
| 26 of 64 (41%) of Joint Cores 95.0% or Higher | | |

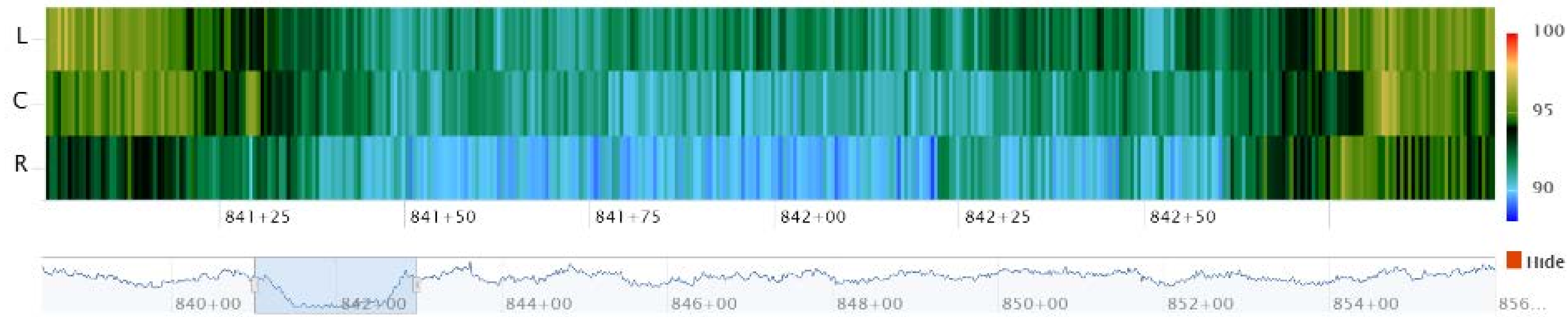
# SB(Joint CL) Density Histogram

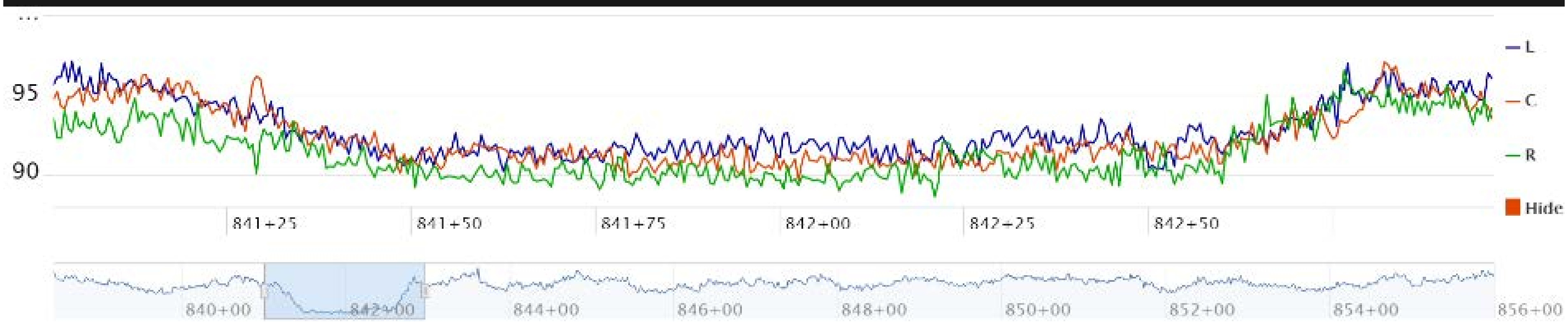


# SB Joint Cumulative Densities - 24.5% below 91%

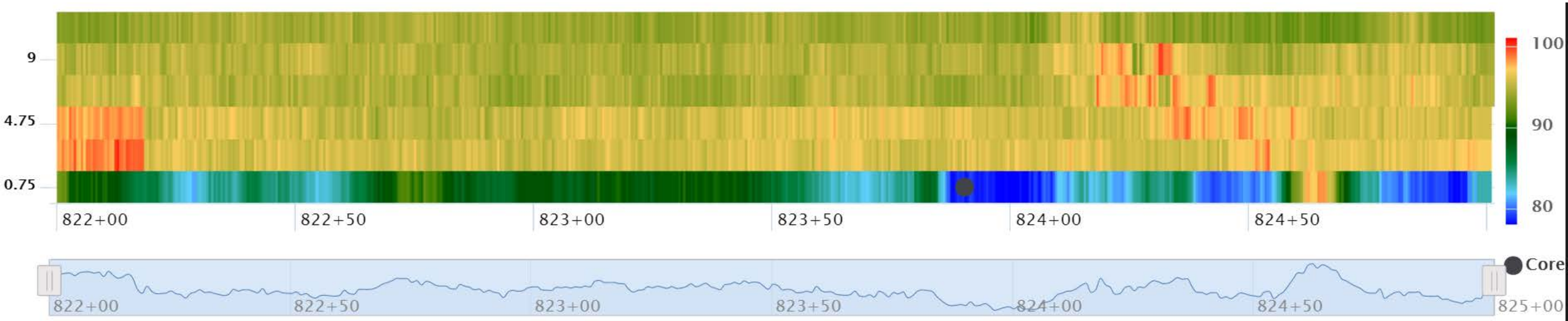


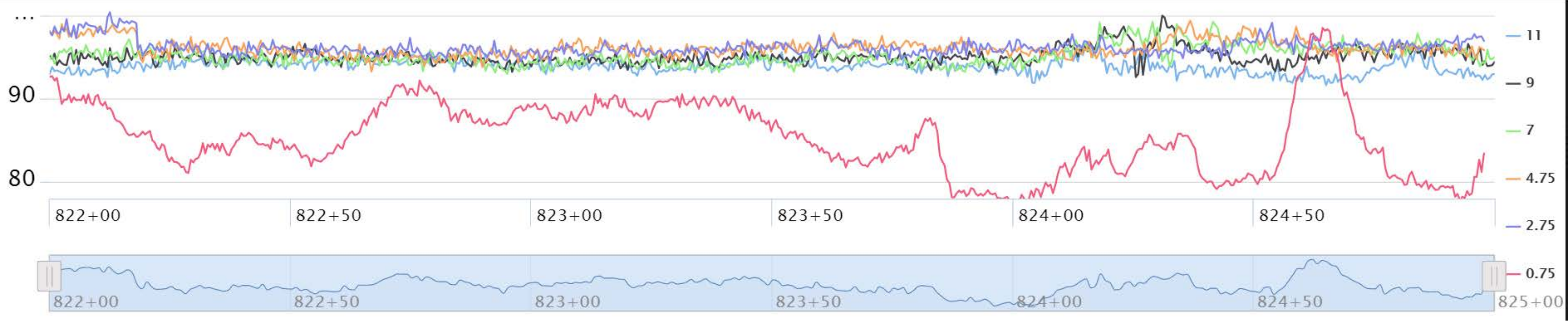
# Low Density is Typical at Bridges S. Birchwood Bridge, SB Lane 2, 18-24’ LT



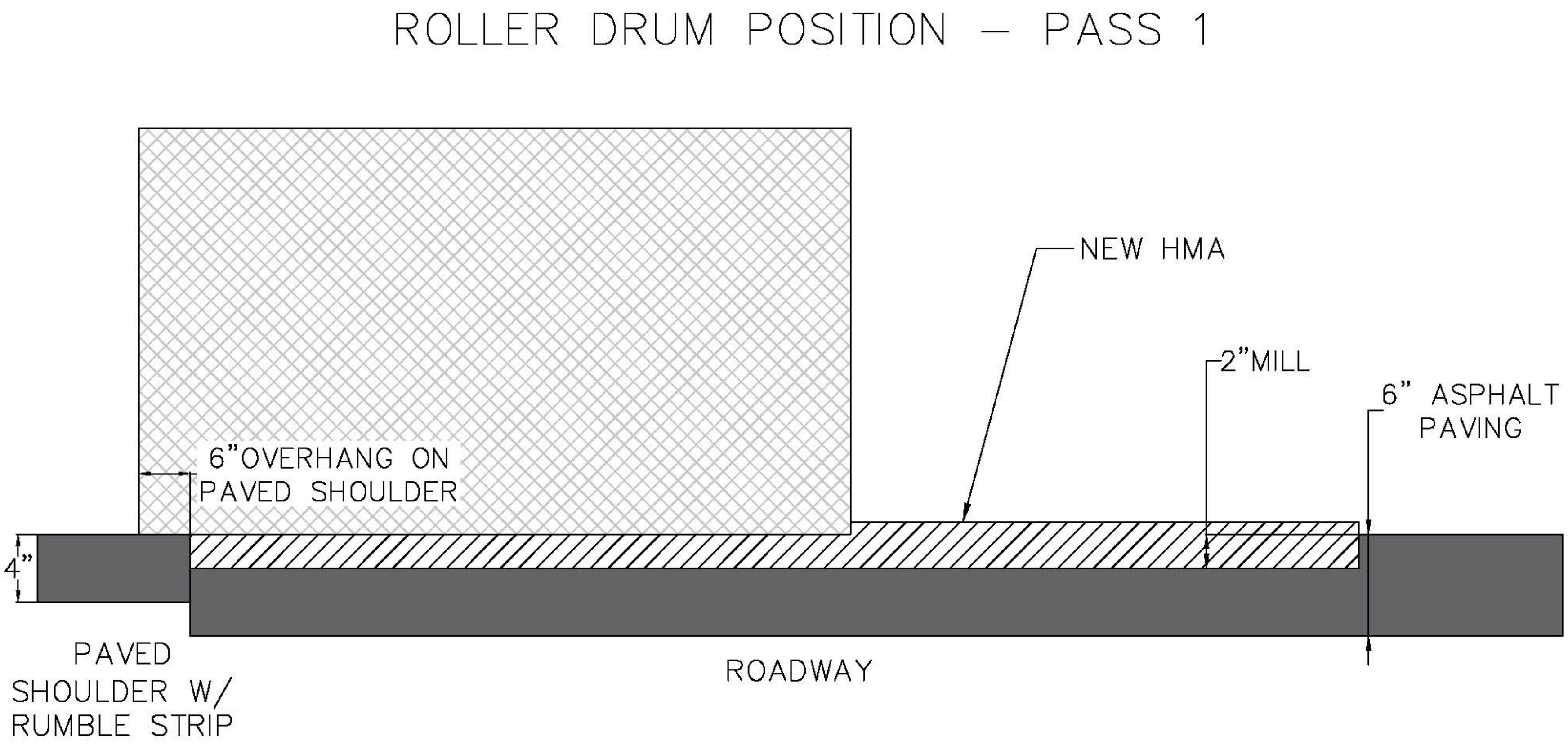



# Low Density Adjacent Rumble Strip

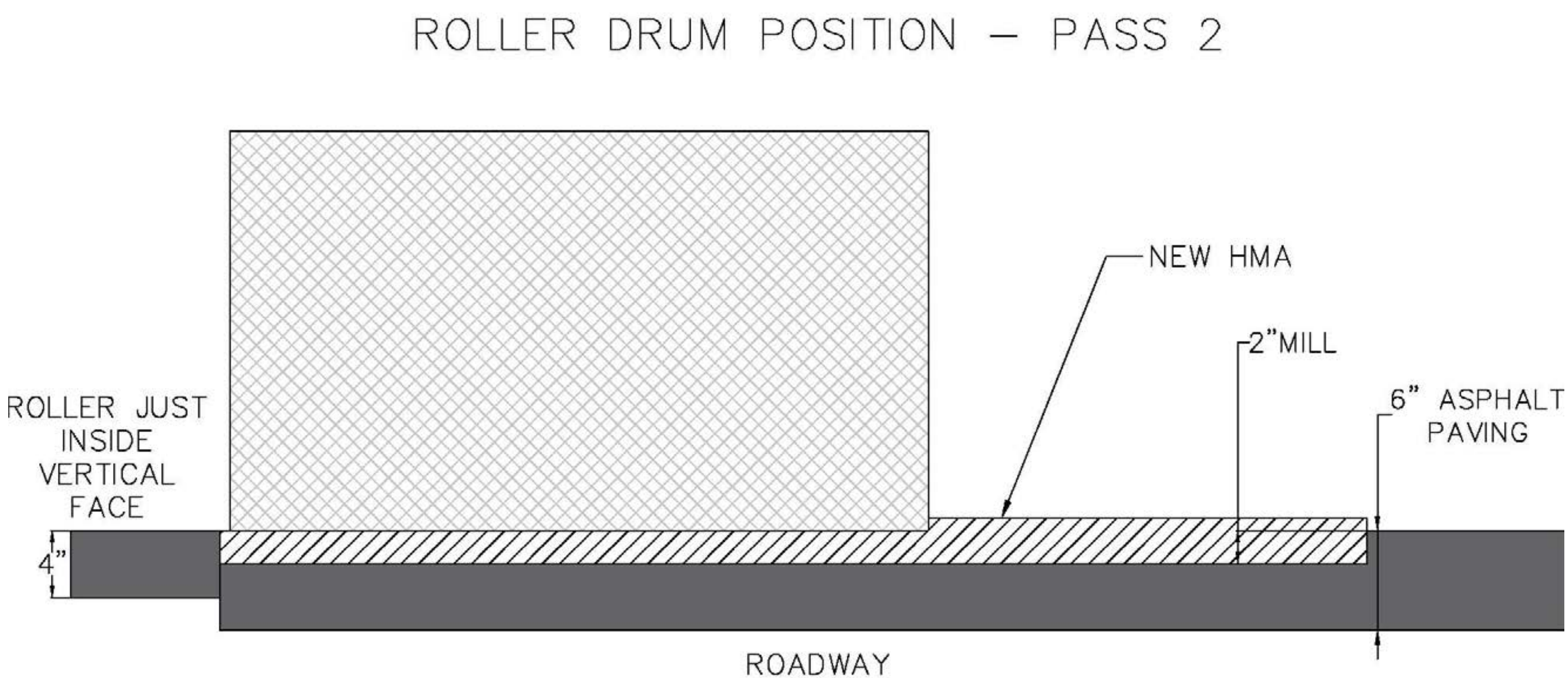


# We don’t want a “Pretty” edge joint



# We Want a “Compacted” edge joint




# 4. Main Features of CFC Specs for Compaction Acceptance

# What Changes?

The main specification change for implementation of GPR technology is substituting Percent Conforming (PC) for Percent Within Limits (PWL) in the Density Pay Factor.

For a lot (5000 tons) of asphalt, placed in a 2” thick lift, PC will be based on approximately 400,000 density readings (one per square foot, assuming an asphalt density of 150 pcf). PWL for that same lot of asphalt would be based on 10 density readings (one per sublot).

# What % Conforming thresholds should trigger repair, R&R?

Mat Density Pay Factor = 0.55 + PC/200, allowing up to 5% bonus at PC = 100%.  (Lower limit of PC = 50%, PF = .80)

- Remove and Replace is triggered if PF is below 0.80

What PC should trigger repair with Sand Seal?

- Perhaps from PC = 50% to 70%, PF = 0.80 to 0.90?

Or

- Perhaps from PC = 50% to 80%, PF = 0.80 to 0.95?

# Cost of Potholes

American drivers pay [an estimated $3 billion a year] to repair damage caused by potholes, according to AAA. Over a five-year period, 16 million drivers reported their vehicles were damaged by potholes, from tire punctures and bent wheels to suspension damage.

# Instead of Percent Conforming should we use defect size and low compaction threshold for repair criteria?

# What size low-compaction area should trigger mat repair?

Current programming allows PaveScan Operator to Select defect size and compaction threshold for identification and mapping of both linear and area defects.

What size area should trigger repair?

(Currently using 8 $ft^2$)

What % compaction should trigger repair?

(Currently using <92%)

# What length of low-compaction Longitudinal Joint should trigger repair?

What length should trigger joint repair?

(Currently using 5 ft)

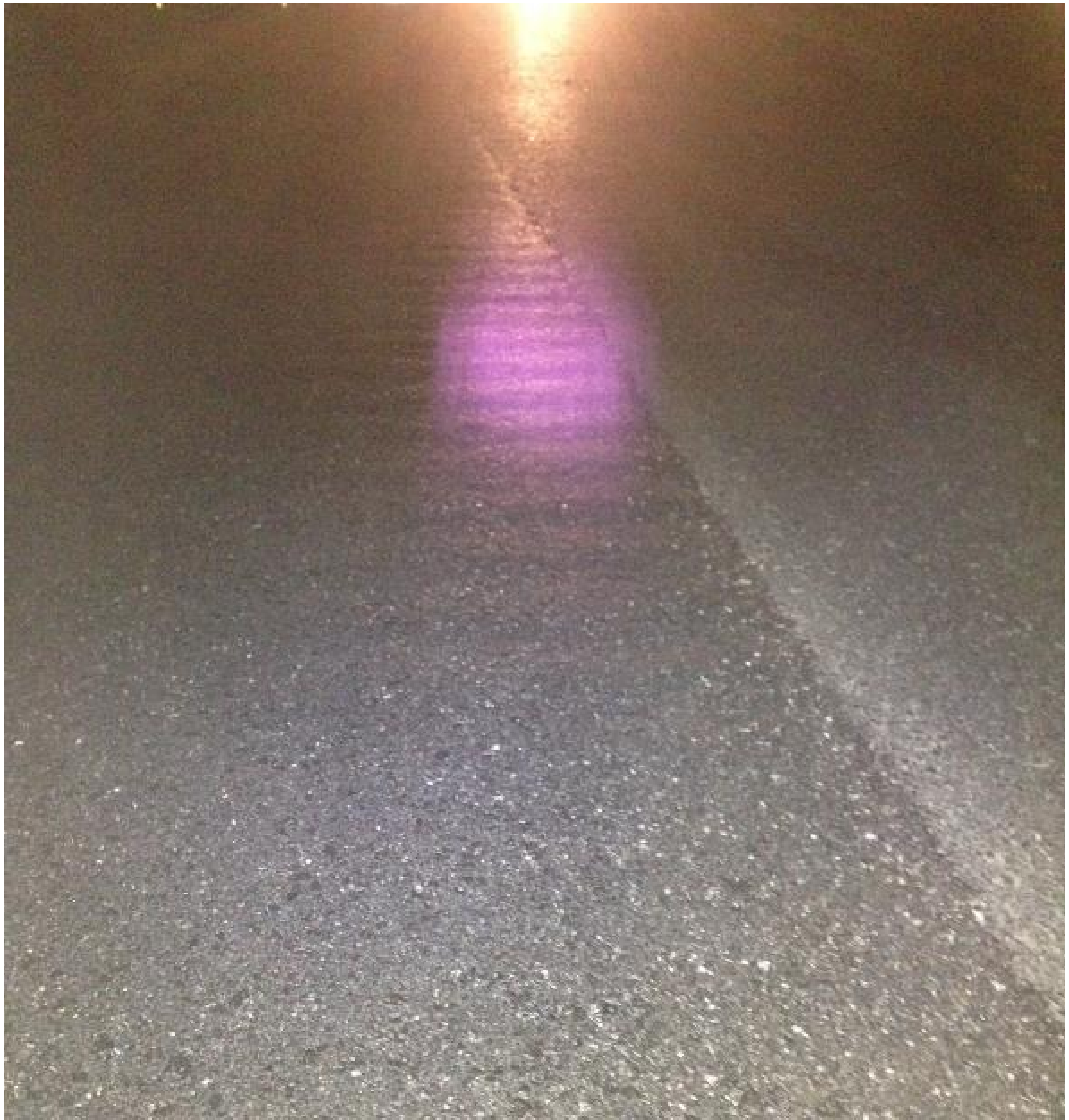
What % Compaction should trigger repair?

(Currently using <91%)

# What equipment might one see when incentives are given for superior mat & joint compaction?


16-8527
E650

# What you don’t want to see




# 5. Compaction Defect Mapping & Remediation


Portage Glacier Road
File 008 Area Defects
Legend
Area Defect
Feature 1
Linear Defects
Portage
Portage Glacier Cafe and Gallery
Google earth
Image © 2018 DigitalGlobe
© 2018 Google
Image Municipality of Anchorage
N
4000 ft

Portage Glacier Road
Linear Defects - Longitudinal Joint
Legend
Area Defect
Feature 1
Linear Defects
Portage
Portage Glacier Cafe and Gallery
Google earth
Image Municipality of Anchorage
1000 ft
N

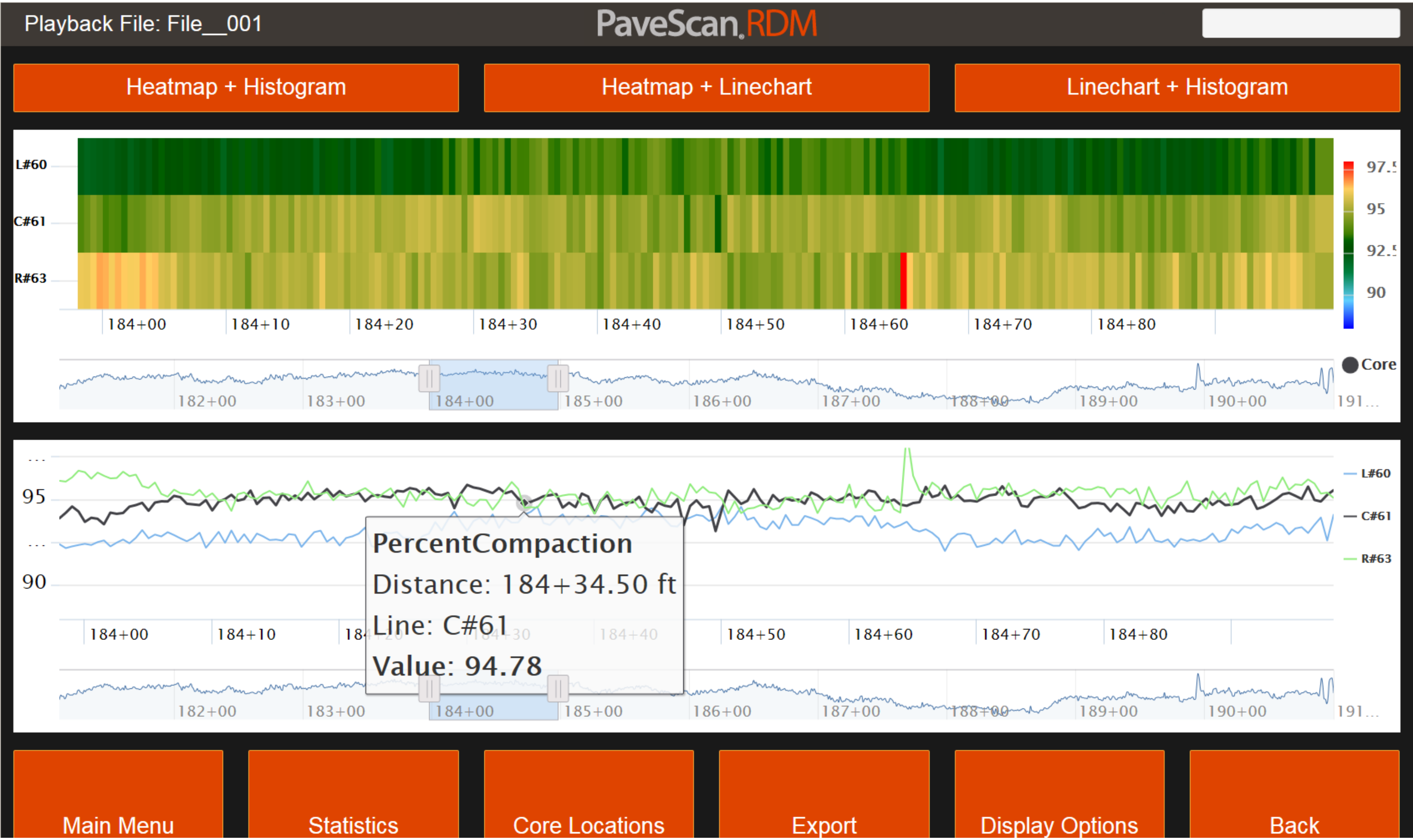
Portage Glacier Road
Linear Defects - Longitudinal Joint
Legend
Area Defect
Feature 1
Linear Defects
Portage
Portage Glacier Cafe and Gallery
Google earth
© 2018 Google
Image Municipality of Anchorage
N
100 ft


Portage Glacier Road
Sta. 191-181, 11-17' Right
Area defects
Legend
Area Defect
Portage
Portage Lake & Byron Glacier -Portage Valley AK 6-20-2010
Google earth
Image Municipality of Anchorage
200 ft
N

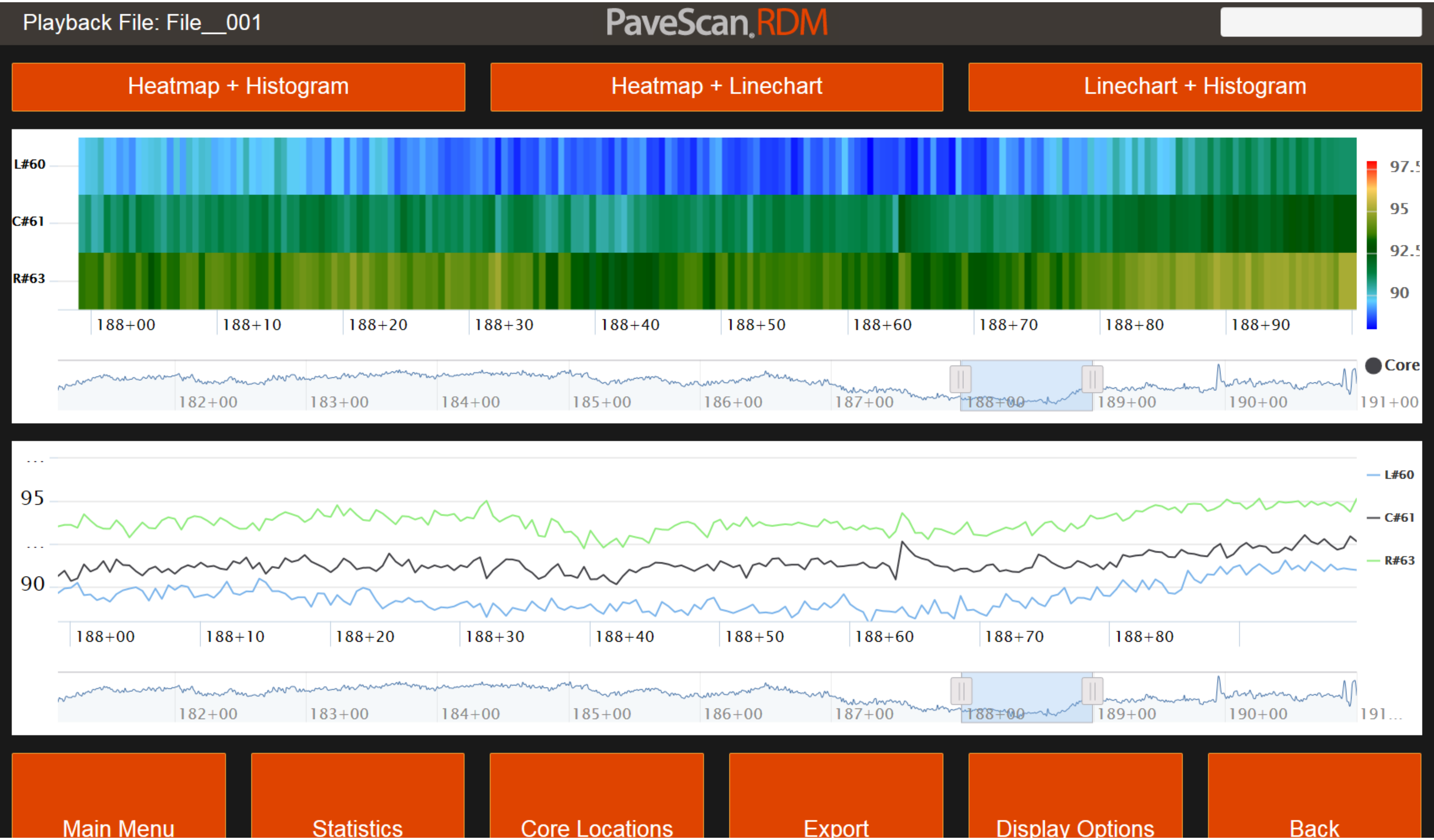
# Number and % Defective – File 001

| Station | Starting Distance | Segment (ft) | Defective % | # of 2-D Defects | Defect Straddles Segments |
|---|---|---|---|---|---|
| 181 | 0 | 89.5 | 4.07 | 1 | No |
| 182 | 0 | 100 | 10.95 | 2 | No |
| 183 | 0 | 100 | 3.65 | 0 | No |
| **184** | **0** | **100** | **0.17** | **0** | No |
| 185 | 0 | 100 | 15.92 | 3 | Yes |
| 186 | 0 | 100 | 16.09 | 2 | Yes |
| 187 | 0 | 100 | 51.08 | 3 | Yes |
| **188** | **0** | **100** | **62.02** | **1** | No |
| 189 | 0 | 100 | 32.84 | 2 | Yes |
| 190 | 0 | 100 | 31.51 | 5 | Yes |
| 191 | 0 | 0 | 33.33 | 0 | No |

# Station 184, 0.17% Defective



# Station 188, 62% Defective



# Defect Locations – File 001

| Starting Station | Start Distance (ft) | Ending Station | End Distance (ft) | Start Offset (ft) | End Offset (ft) |
|---|---|---|---|---|---|
| 181 | 11.75 | 181 | 15.75 | 17.75 | 15.75 |
| 182 | 48.25 | 182 | 52.75 | 17.75 | 15.75 |
| 182 | 65.25 | 182 | 73.75 | 17.75 | 15.75 |
| 185 | 62.75 | 185 | 73.25 | 17.75 | 15.75 |
| 185 | 73.75 | 185 | 91.75 | 17.75 | 15.75 |
| 185 | 97.75 | 186 | 2.25 | 17.75 | 15.75 |
| 186 | 80.25 | 186 | 86.75 | 17.75 | 15.75 |
| 187 | 6.25 | 187 | 14.25 | 17.75 | 13 |
| 187 | 16.75 | 187 | 21.25 | 17.75 | 13 |
| **187** | **22.75** | **189** | **93.25** | **17.75** | **13** |
| 189 | 96.75 | 190 | 7.25 | 17.75 | 15.75 |
| 190 | 8.25 | 190 | 17.75 | 17.75 | 15.75 |
| 190 | 18.25 | 190 | 42.75 | 17.75 | 13 |
| 190 | 49.25 | 190 | 89.25 | 17.75 | 13 |
| 190 | 91.25 | 190 | 95.75 | 17.75 | 15.75 |

# Portage Glacier Rd - Sta 139-144

# Glenn Hwy at Eagle River Bridge Lane 1 Compaction Coverage

# Glenn Hwy at Eagle River Bridge Lane 1 Area Defects

# Glenn Hwy at Eagle River Bridge Lane 1 Linear Defects


Rich Giessel

richard.giessel@alaska.gov

(907) 269-6244

richard.giessel
@alaska.gov
907-269-6244