SHRP2 SOLUTIONS
STRATEGIC HIGHWAY RESEARCH PROGRAM

Rapid Technologies to Enhance Quality Control on Asphalt Pavements
Infrared (IR) Scanner Showcase

Hosted by:
Missouri DOT
June 1, 2016

U.S. Department of Transportation
Federal Highway Administration

American Association of State Highway and Transportation Officials
AASHTO

Welcome & Introductions

1. Missouri DOT
2. AASHTO
3. FHWA

Our Focus for Today

Showcase Objective …

1. Describe the Infrared Scanner Technology (Equipment and Software)
2. Understand how to install and use the IR Equipment & Software
3. Discuss the results from the Missouri DOT Project
4. Understand the Contractor's and Agency's Opinions and/or Perspective as a QC or QA Tool
5. Know the Implementation Strategies of Lead Agencies

IR Showcase Agenda

Time	Topic
8:00	**Welcome and Introductions** • Missouri DOT • AASHTO • FHWA
8:15	**Overview of Infrared Technology:** • Equipment • Software
8:45	**Overview of MODOT Demonstration Project:** • Project Summary: plant, delivery, paving, compaction operations • Data Summary: density, IR-data
9:30	**Points of View and Perspective:** • Contractor QC Requirements and Perspective • MODOT QA Requirements and Perspective
9:45	**Break**
10:00	[Re-group for short presentation and overview on following items; then board buses and travel to paving site and plant.] **Field Visit/Demonstration:** Field Trip Overview and Logistics; divide into groups (paver/roadway and plant) • Logistics overview • Safety requirements; paver/roadway and plant • Traffic control
10:15	**Field Visit/Demonstration:** Four groups: 2 groups initially go to plant and 2 groups to roadway. • Paver: Equipment and Data Collection – on site. • Plant: Monitoring Data and Decision Making – at plant.

Time	Topic
12:15	**Lunch on own**
1:30	**Summary of Results from IR Field Demonstration Projects** • Mat Uniformity • Incentives/disincentives • Lessons learned • Specifications
2:00	**Implementation of IR Technology**; An Overview and Introduction to Lead Agency Practice
2:10	**Agency Implementation Efforts and Successes** (Panel; 20 min. each)
	Panel Question/Answer and Discussion from field visit and SHRP 2 Products; Topics of discussion (Panel consists of Turgeon, Carrasco, Giessel, Wells, and Stone): • Specifications: Control and/or Acceptance Tool • Incentives/disincentives • Best Practices/Trouble Shooting Guide • Etc.
3:45	**Showcase Wrap Up** • Showcase Assessment Questionnaire • Photo Release Form
4:00	**GPR Scanner Presentation/Demonstration (optional)**
4:30	**Adjourn Showcase**

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Infrared Technology Showcase

Overview of Infrared Technology

June 1, 2016

U.S. Department of Transportation
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AASHTO

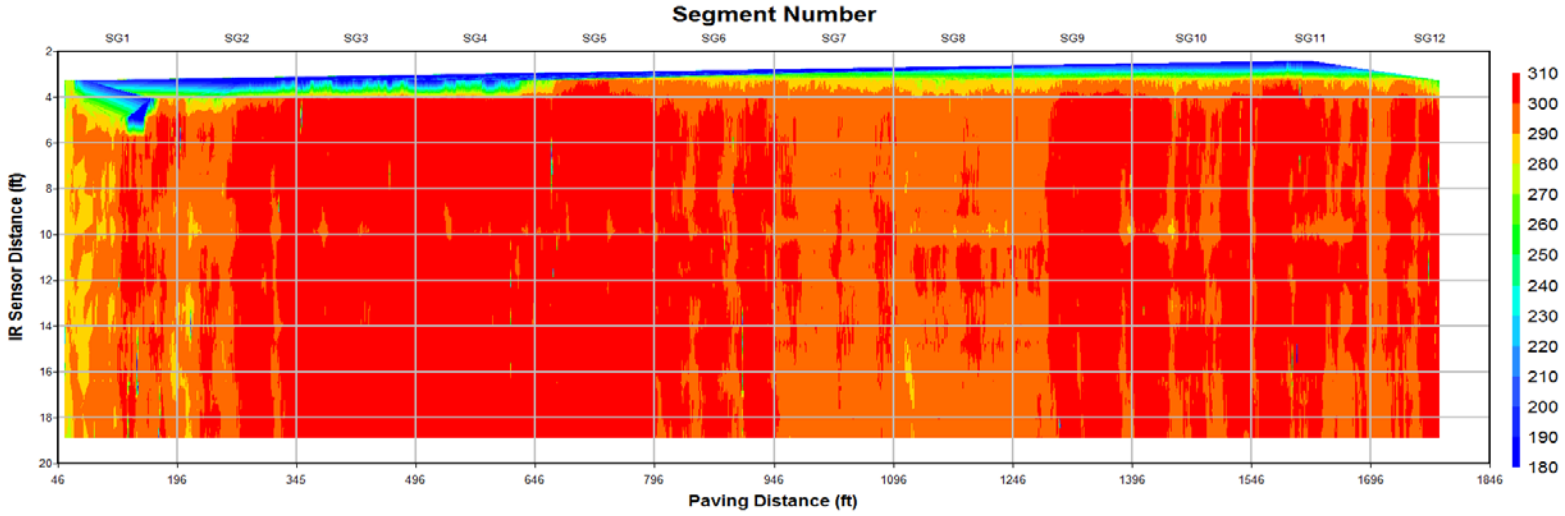
Overview of IR Technology

1. Brief History of IR Use
2. IR Equipment and Installation
3. IR Software and Data Analyses

Brief History of IR Use

Infrared Thermography Defined:

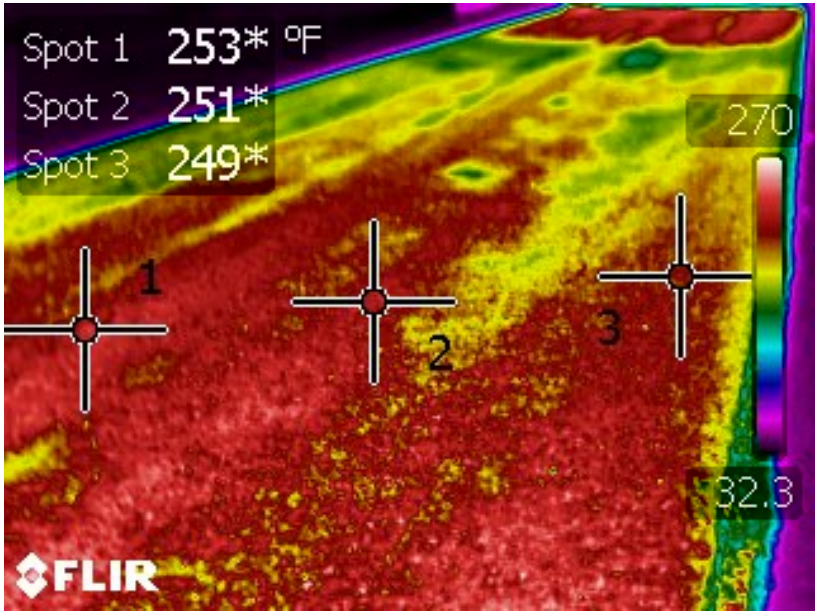
- The mapping of temperature contours (equal temperature) over the surface of a material.
- Contours are used to evaluate materials by measurement of their surface temperature and its variation.

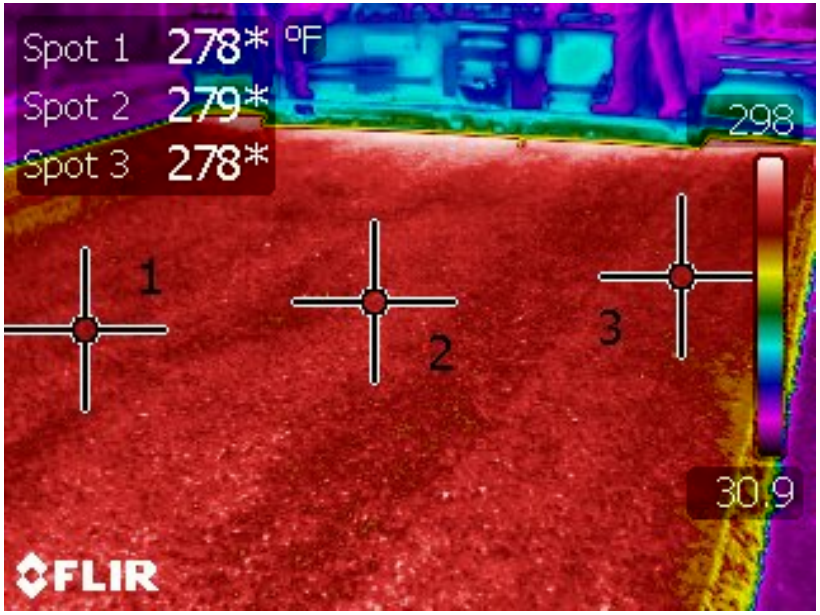


Brief History of IR Use

Temperature Segregation (Differential) Defined:

- More than 25 ºF difference in mat temperature behind screed.





Brief History of IR Use

History; Mat Temperature Measurements

- Temperature guns
  - Point readings
- Temperature cameras
  - Time specific to identify areas with cold spots or thermal streaks

Brief History of IR Use

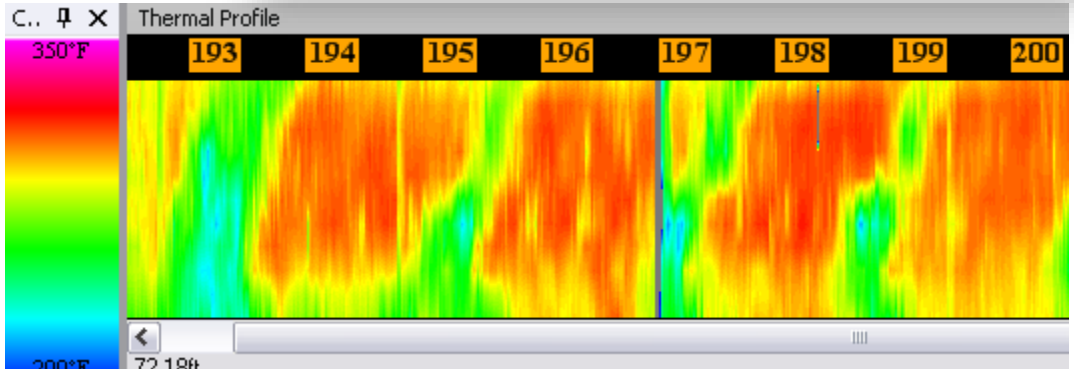
History; Mat Temperature Measurements

- IR sensors, IR-Bar; first device for continuous readings
- Pave-IR Scanner; second generation device for continuous readings

Brief History of IR Use

Application & use of IR-Bar and Scanner

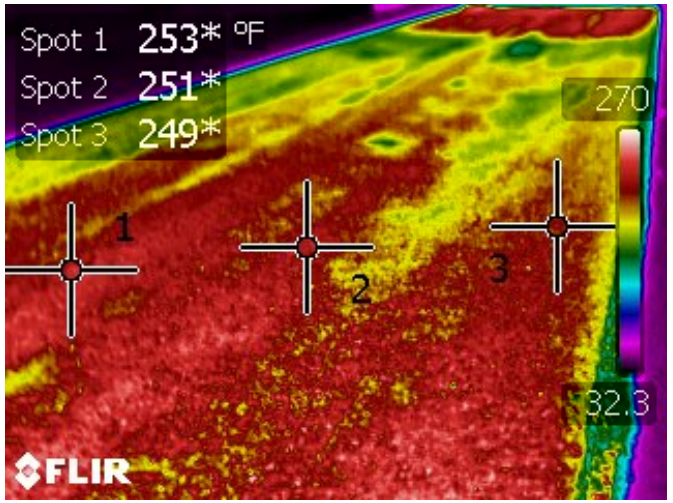
- Continuous readings to evaluate mat uniformity through temperature uniformity.
- Non-uniform temperatures usually mean, non-uniform densities.

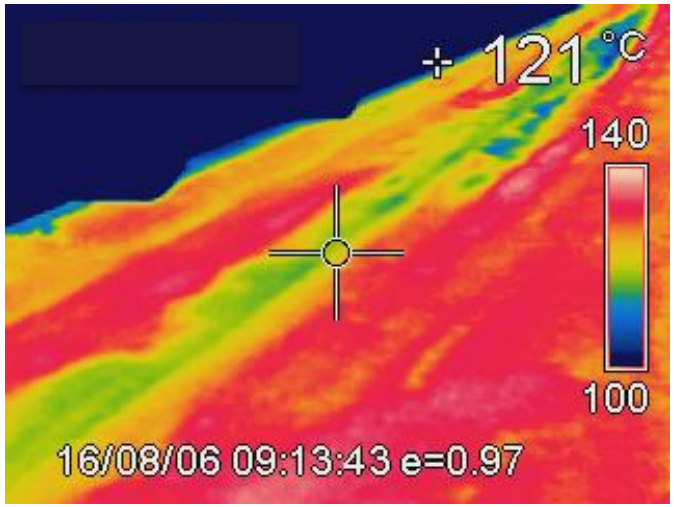


Brief History of IR Use

Types of Temperature Differentials:

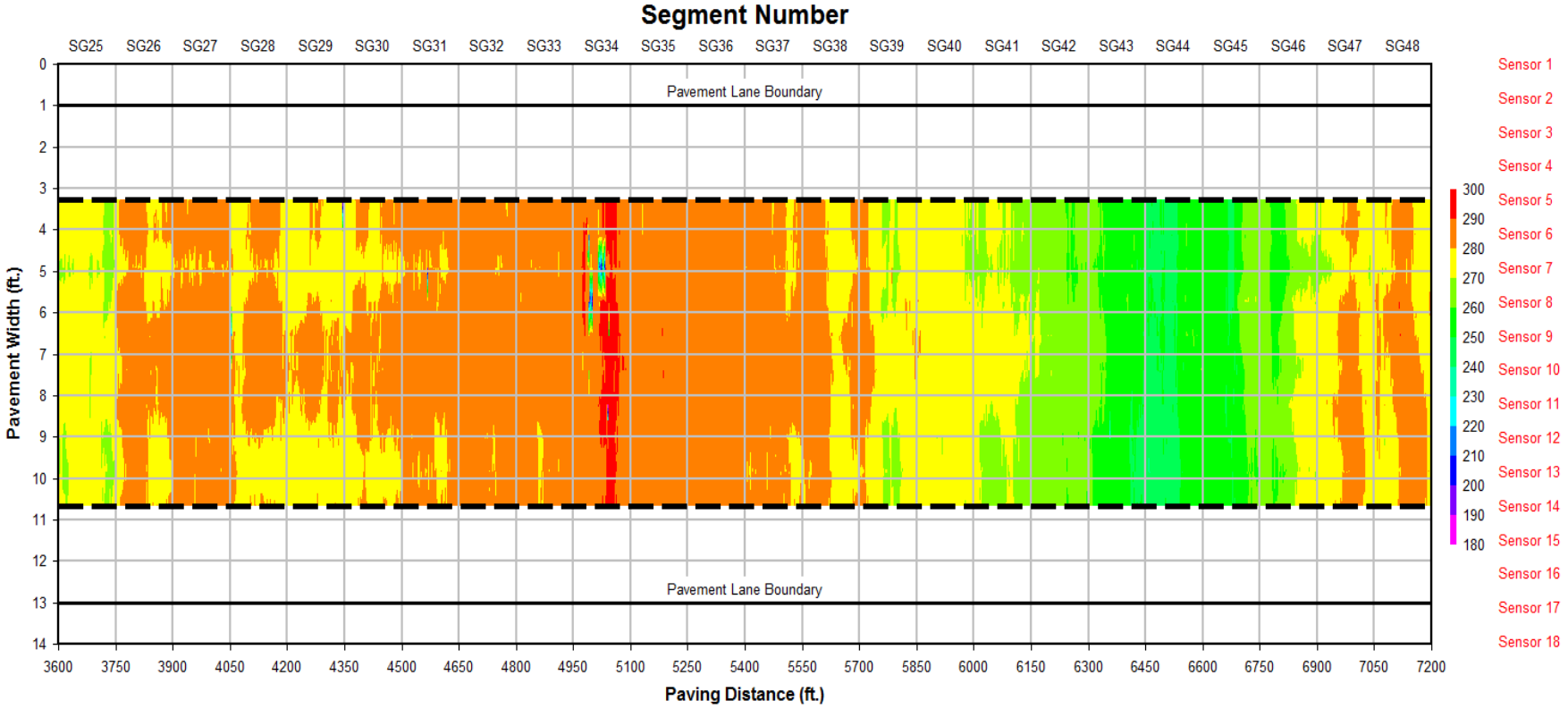
1. Cold spots
   - Truck to truck temperature differences
   - Improper loading and unloading of trucks
2. Thermal streaks
   - Longitudinal segregation
   - Inadequate or non-uniform amount of material across the mat





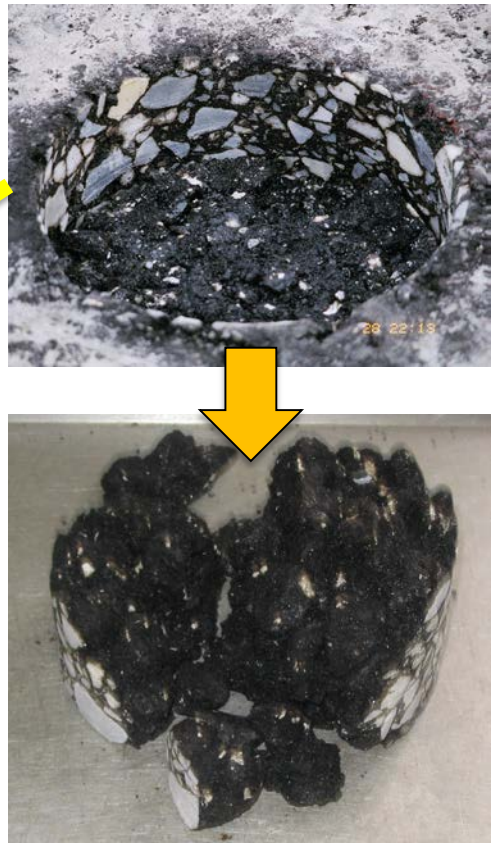
Brief History of IR Use

- Aggregate segregation in mat = temperature differentials
- Non-uniform temperatures = non-uniform densities



Brief History of IR Use

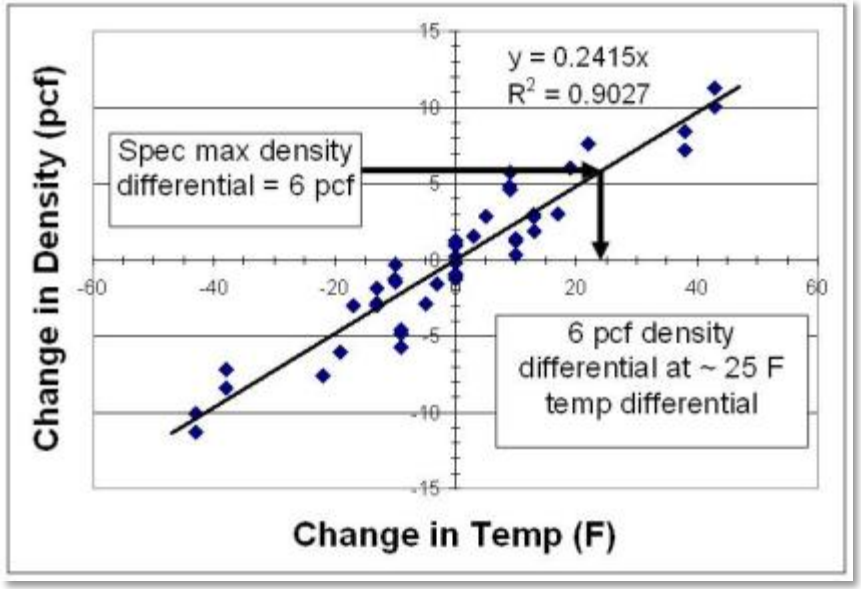
Segregation – A difficult issue to resolve, when it is difficult to identify or confirm.



Brief History of IR Use

Background

- 1996 through 2000s – field work concluded temperature differences could be accurately detected and quantified:
  - Low temperatures result in low density zones in mat
  - A few States adopt temperature uniformity specification



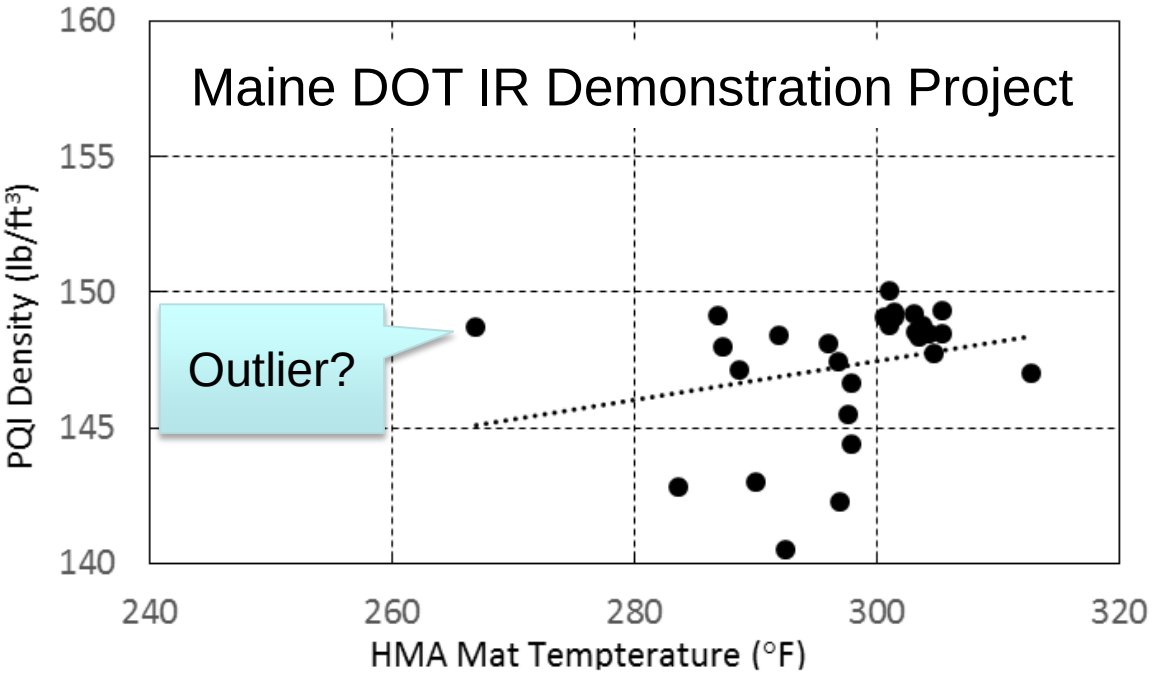
Temperature profile criteria based on desired density uniformity.

Brief History of IR Use

- Effect of cold spots, low mat temperatures on percent compaction; densities are:
  - Lower
  - More variable

TTI Study:
Δ25 ºF ~ Δ6 pcf

Maine DOT:
Δ20 ºF ~ Δ4 pcf



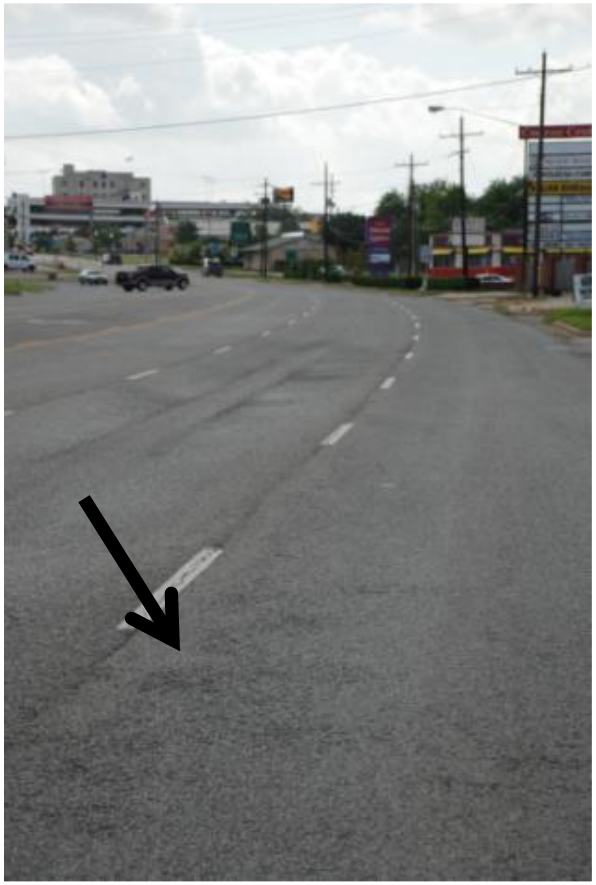
Brief History of IR Use

Impact of temperature differences or areas with low temperatures.

Brief History of IR Use

Cold spots; areas with increased potential for:

- Fatigue cracks
- Raveling
- Pot holes



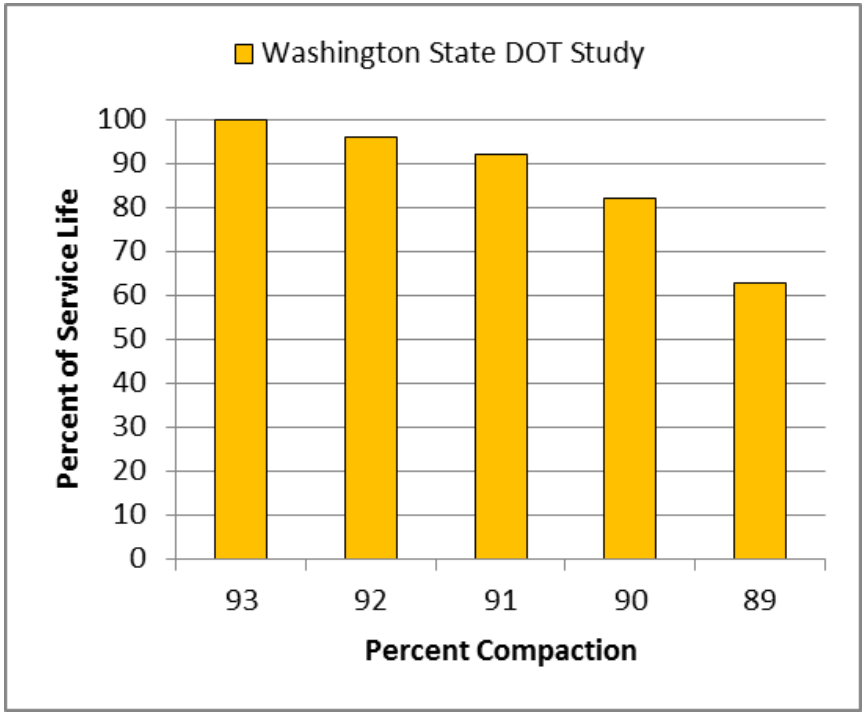
Brief History of IR Use

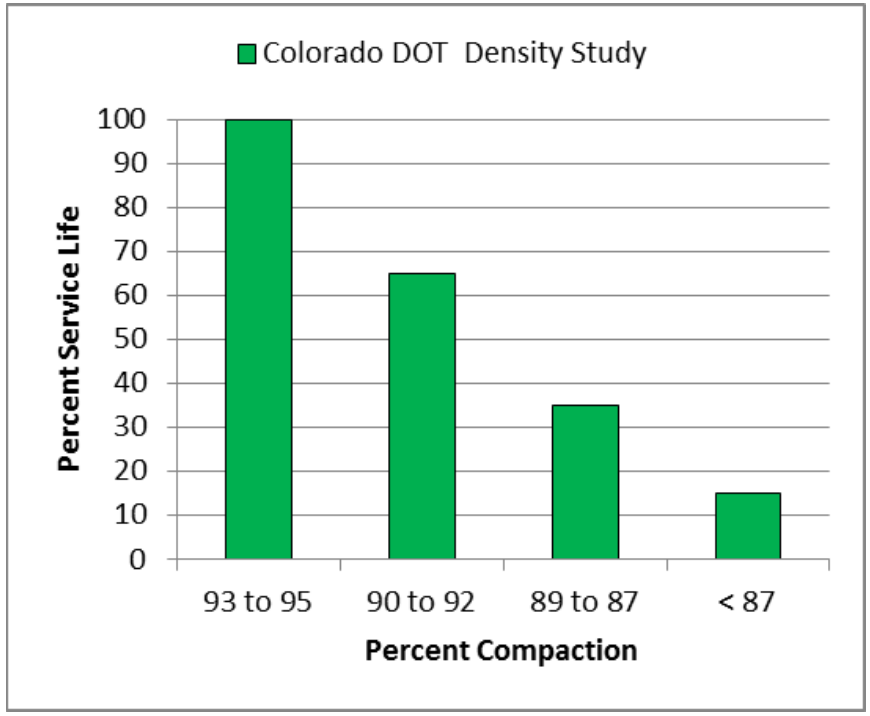
Thermal streaks; longitudinal areas with increased potential for:

- Longitudinal cracking

Brief History of IR Use

- Effect of reduced compaction because of lower mat temperatures or inadequate rolling.





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Overview of Infrared Technology

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Overview of IR Technology

1. Brief History of IR
2. IR Equipment and Installation
3. IR Software and Data Analyses

IR Equipment

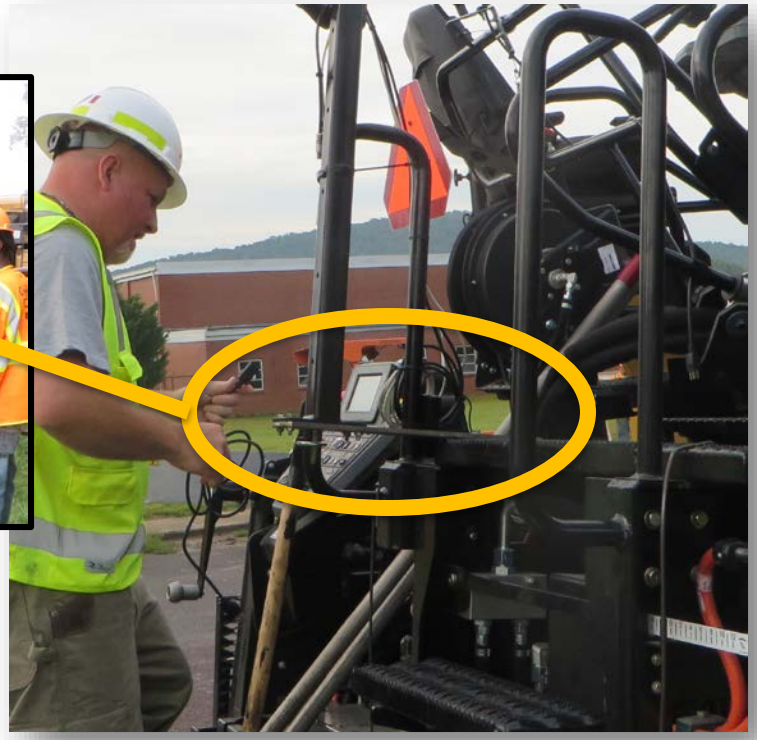
Equipment

- Mast Base
- Mast Extension
- Mast Arm
- IR Scanner
- DMI
- GPS Unit
- Wiring
- Connection bolts & materials

IR Equipment

IR mast base and extension attached to paver.

Mounted Directly to Screed



Mounted to a Steel Plate Attached to Work Platform

IR Equipment

- IR Scanner attached to paver; scans mat behind screed in one direction.
- GPS attached to the mast arm.

IR Equipment

IR scan screen used to see/monitor mat temperatures in real time; attached to the mast post or extension.

IR Equipment

DMI placed on wheel hub to measure distance during paving operation.

IR Equipment

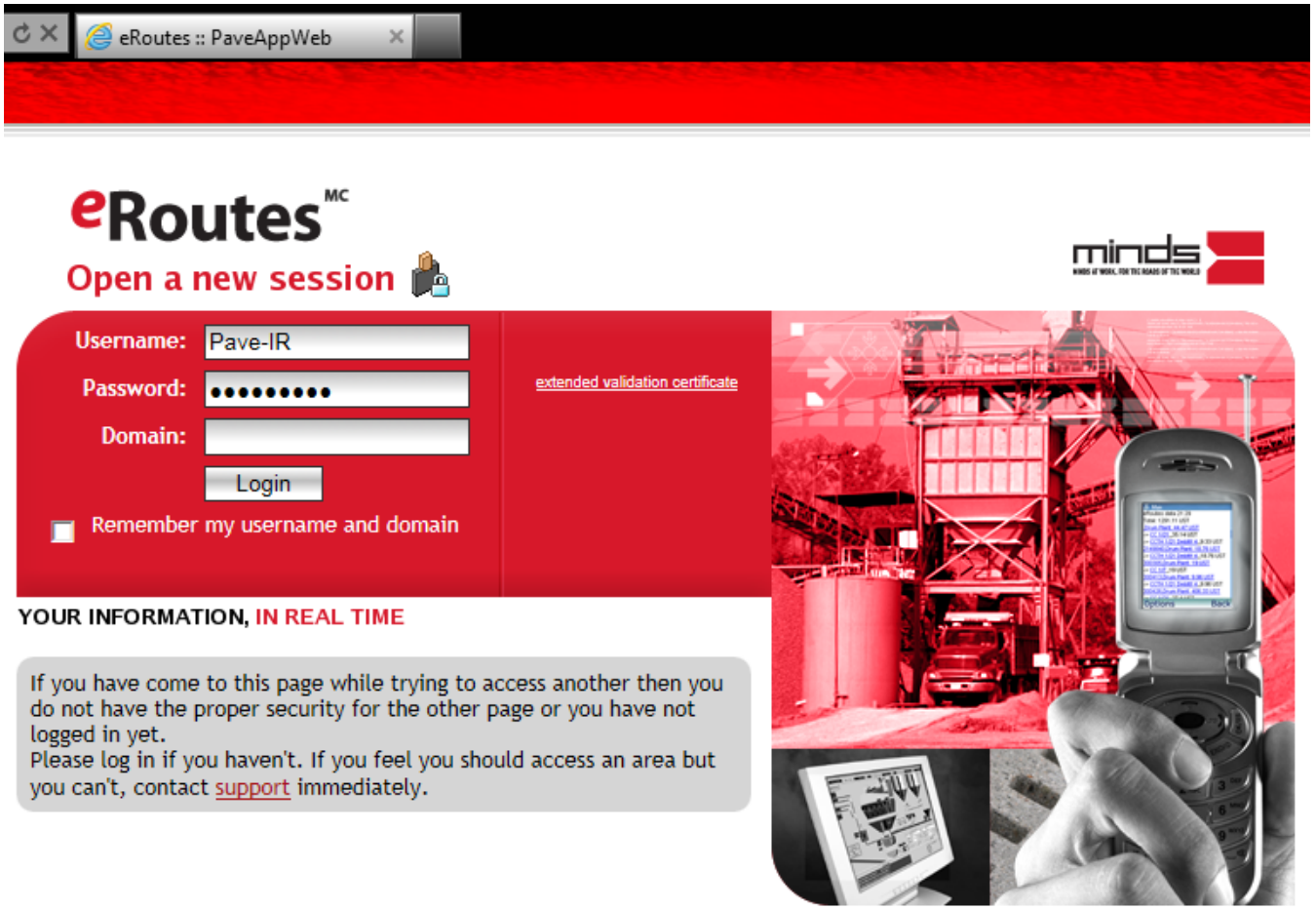
Two models of data transfer and extraction

Overview of IR Technology

1. Brief History
2. Equipment and Installation
3. Software and Data Analyses

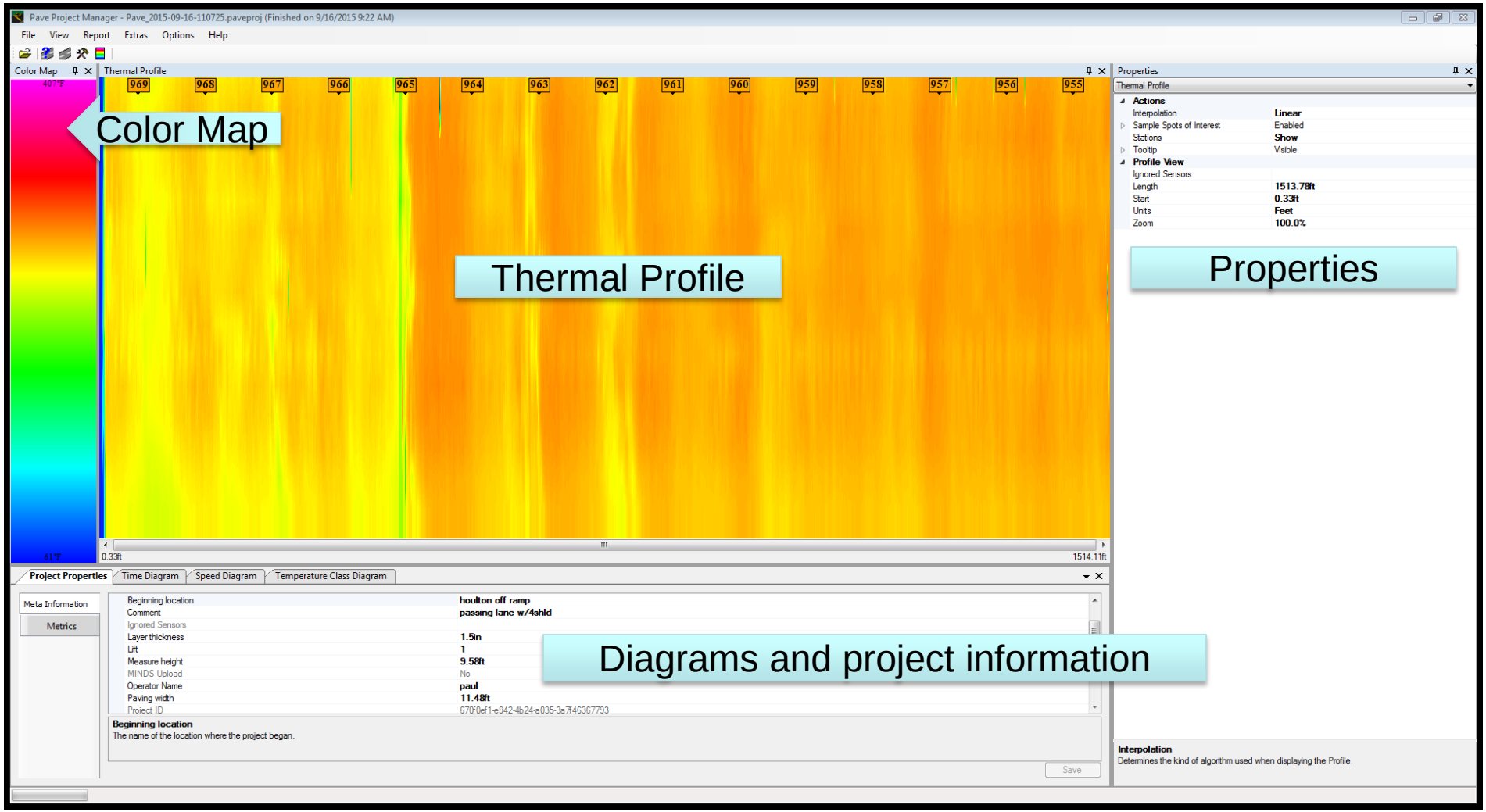
IR Software and Data Analyses

- Online Web App: https://eroutes.info/paveappweb/
- Login is user specific



IR Software and Data Analyses

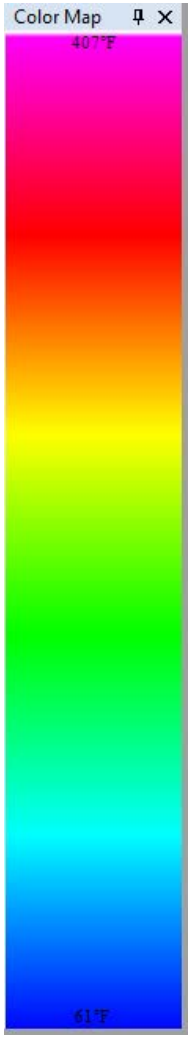
Explore Data: MOBA Pave Project Manager Main Screen



IR Software and Data Analyses

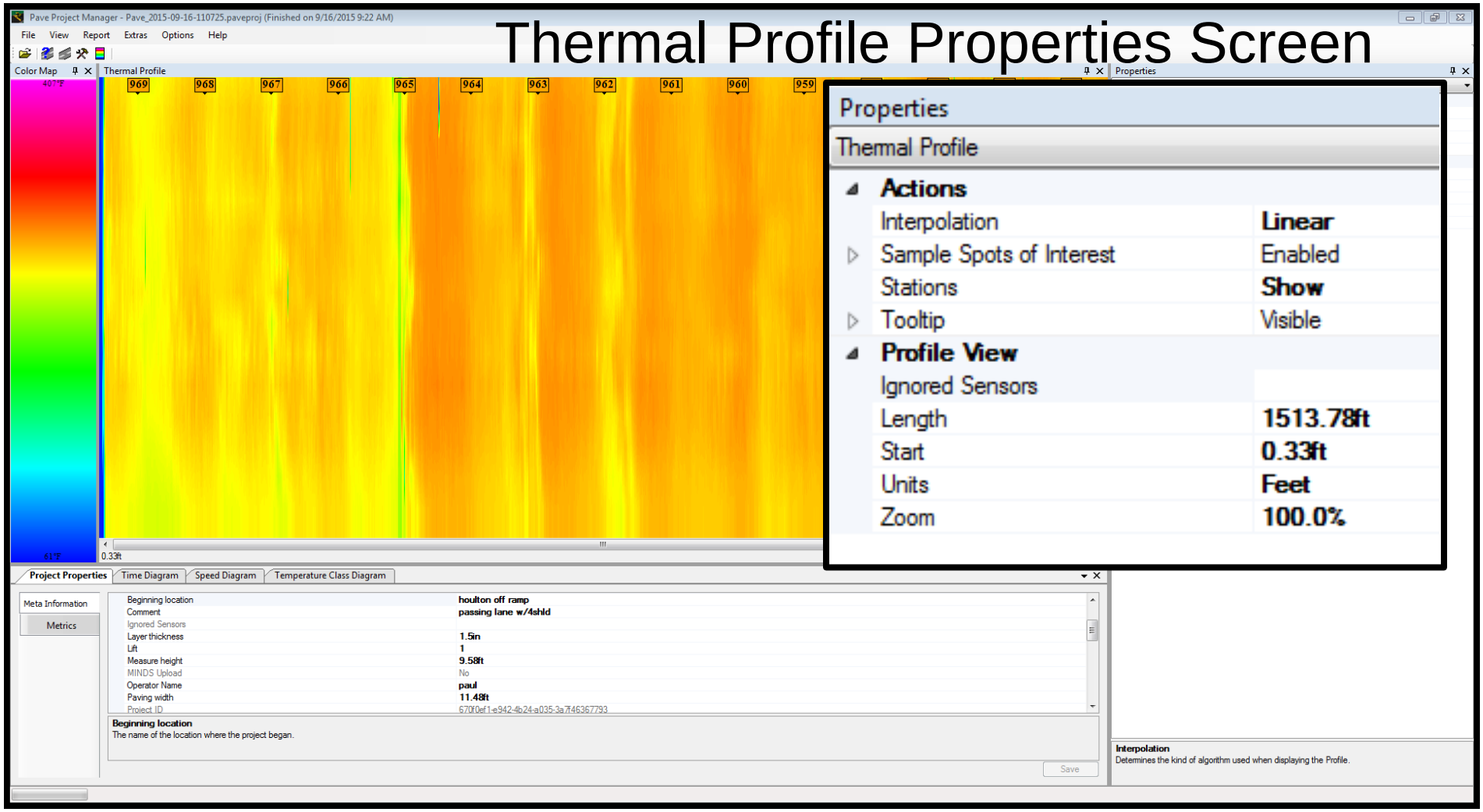
Color Map and Properties for Screen

Properties	
Color Map	
Temperature range	
Max	407°F
Min	61°F



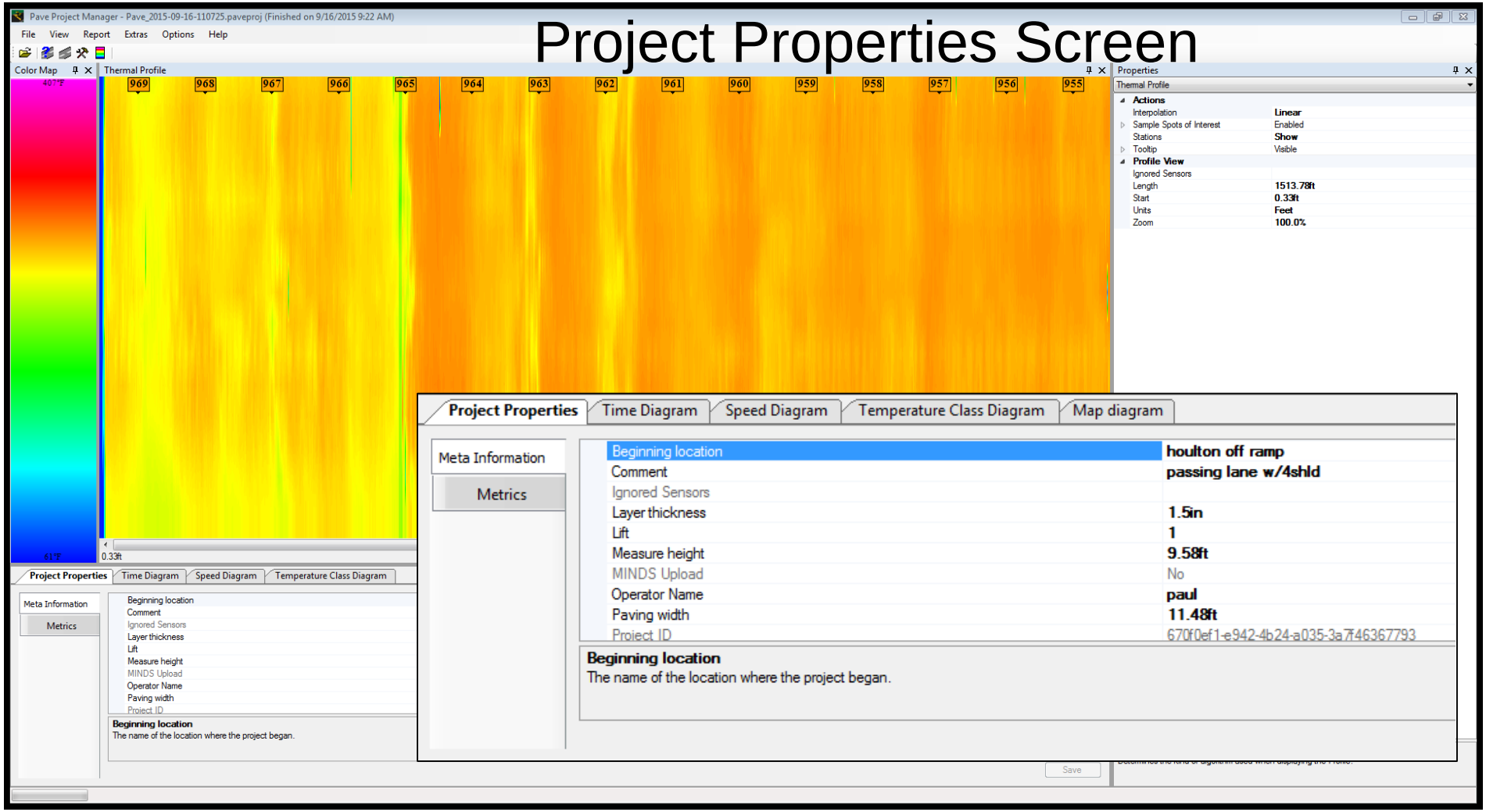
IR Software and Data Analyses

Thermal Profile Properties Screen



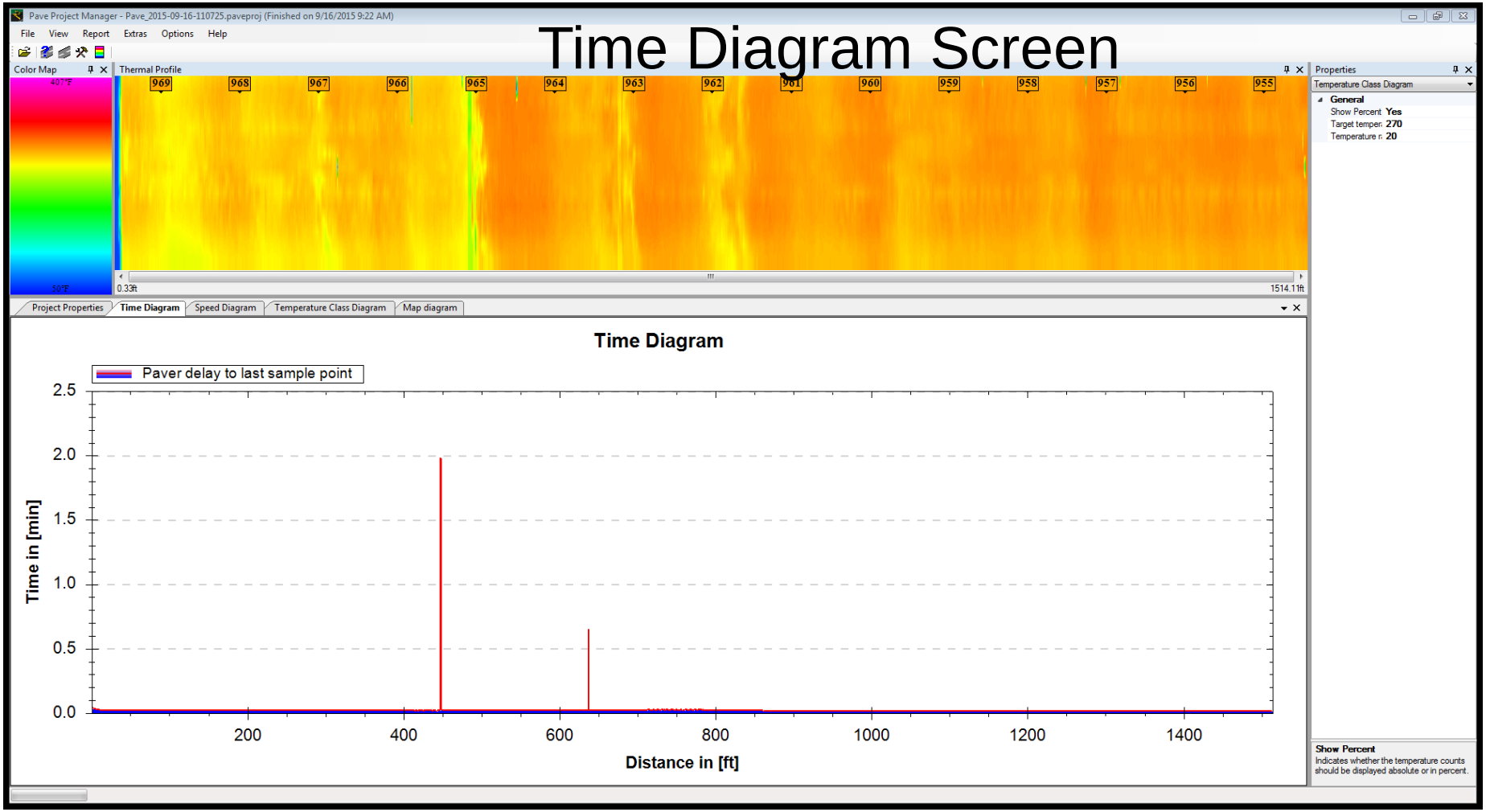
IR Software and Data Analyses

Project Properties Screen

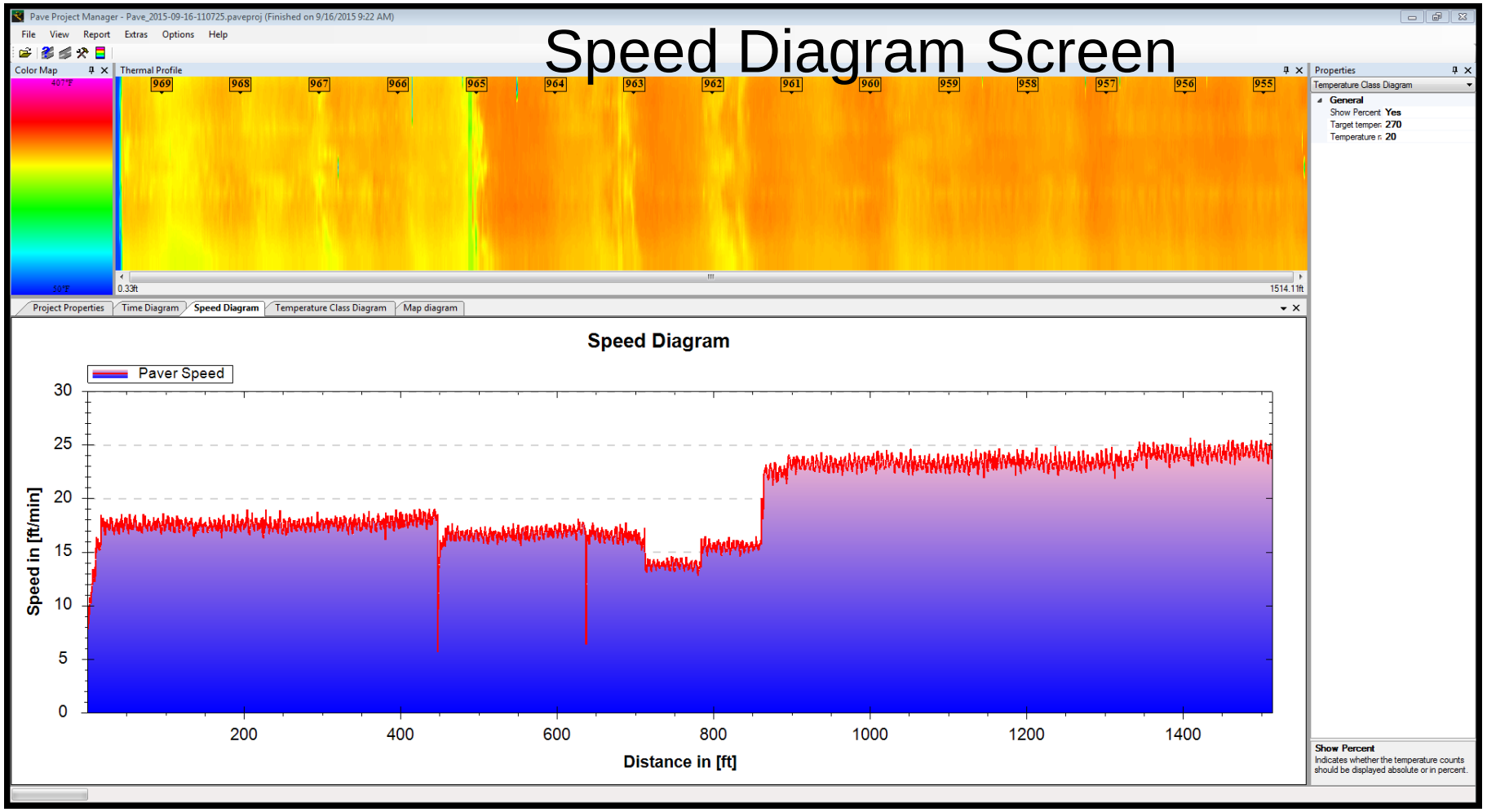


IR Software and Data Analyses

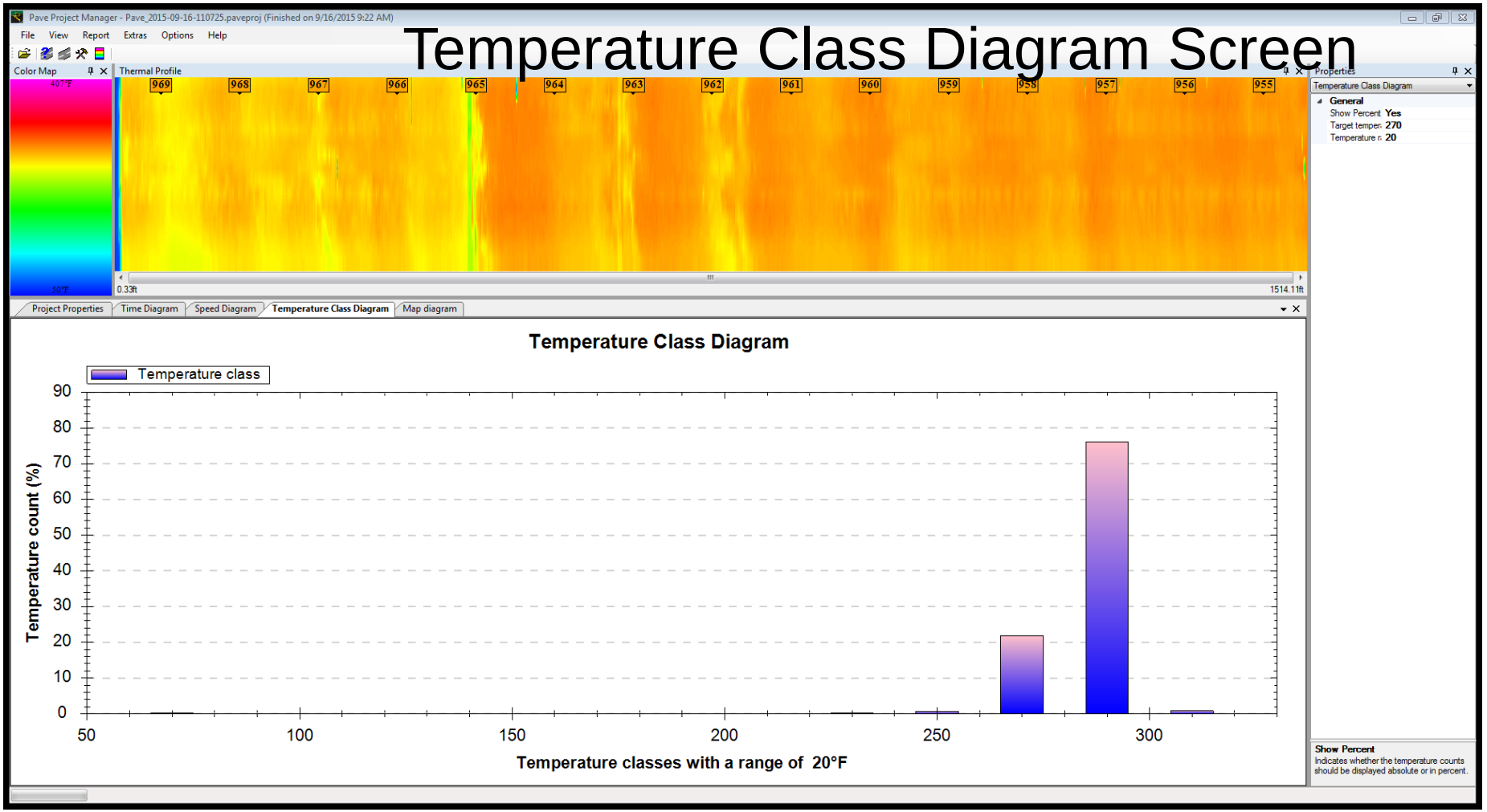
Time Diagram Screen



IR Software and Data Analyses

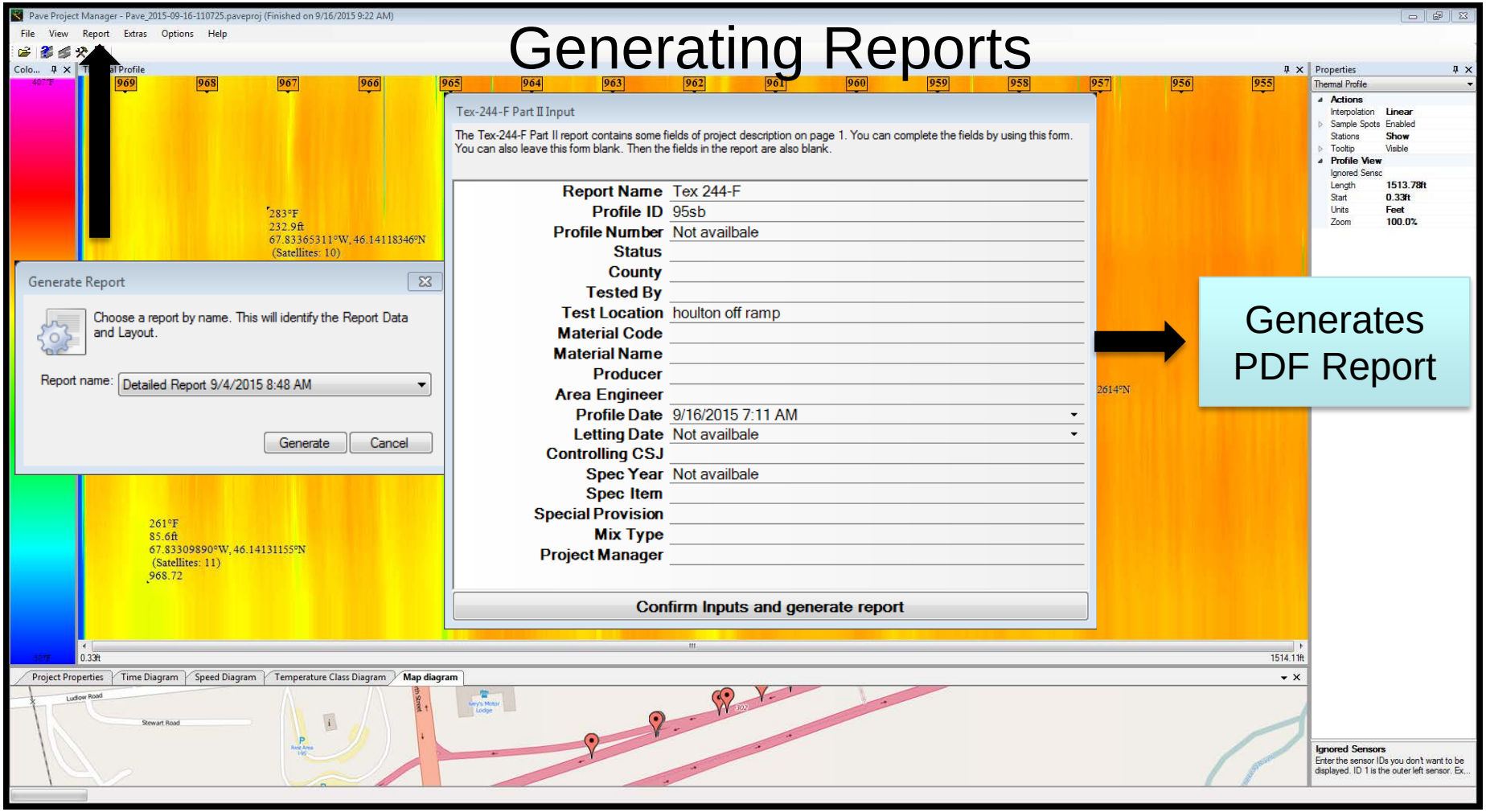


IR Software and Data Analyses



IR Software and Data Analyses

Generating Reports



IR Software and Data Analyses

Generating Reports

Tex 244-F

Thermal Profile Summary Report

Profile ID:	95sb	Profile Date:	9/24/2015 9:18:13 AM
Profile Number:		Letting Date:	
Status:		Controlling CSJ:	
County:		Spec Year:	
Tested By:		Spec Item:	
Test Location:	194	Special Provision:	
Material Code:		Mix Type:	
Material Name:			
Producer:			
Area Engineer:		Project Manager:	

Course/Lift:	3	Temperature Differential Threshold:	25.0
Segment Length (ft):	150	Sensors Ignored:	-

Thermal Profile Results Summary

Number of Profiles	Moderate 25.0°F < differential <= 50.0°F		Severe differential > 50.0°F	
	Number	Percent	Number	Percent
28	0	0	0	0

Summary of Locations Without Thermal Segregation

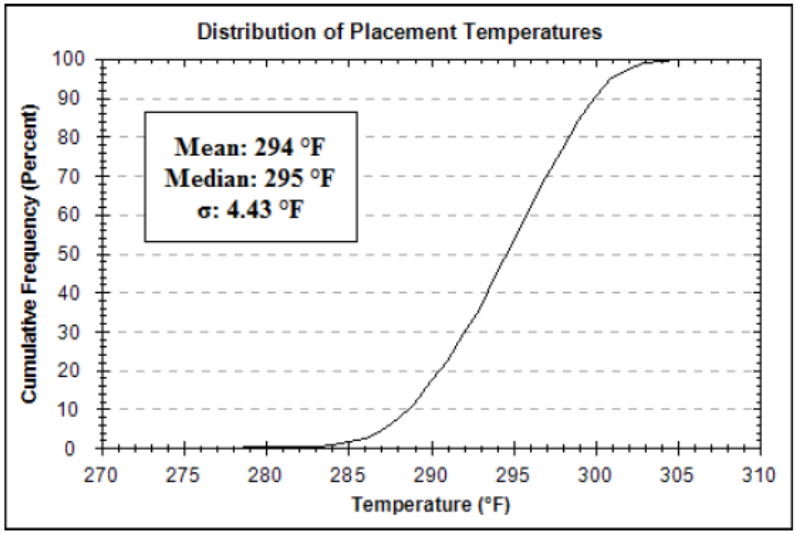
Profile Nr	Beginning Location		Ending Location		Max Temp	Min Temp	Temperature Differential
	Station	GPS in °	Station	GPS in °			
1	194.49	68.12363437 W, 46.11892049 N	193.00	68.12419593 W, 46.11879052 N	303.4	287.8	15.7
2	192.99	68.12419985 W, 46.11878960 N	191.50	68.12476079 W, 46.11866149 N	304.9	289.6	15.3
3	191.49	68.12476285 W, 46.11866104 N	190.00	68.12532427 W, 46.11853654 N	301.1	286.3	14.8
4	189.99	68.12533012 W, 46.11853523 N	188.50	68.12589203 W, 46.11840836 N	299.3	285.8	13.5
5	188.49	68.12589363 W, 46.11840800 N	187.00	68.12645526 W, 46.11828259 N	297.7	285.4	12.2
6	186.99	68.12645906 W, 46.11828176 N	185.49	68.12702186 W, 46.11815402 N	298.9	283.5	15.5
7	185.49	68.12702379 W, 46.11815360 N	183.99	68.12758506 W, 46.11802607 N	302.2	283.8	18.4
8	183.98	68.1275889 W, 46.11802512 N	182.49	68.12815126 W, 46.11789818 N	303.1	292.6	10.4
9	182.49	68.12815319 W, 46.11789773 N	181.00	68.12871395 W, 46.11777111 N	306.1	288.1	18.0
10	180.99	68.12871621 W, 46.11777052 N	179.50	68.12928274 W, 46.11764036 N	302.2	284.4	17.8
11	179.49	68.12928577 W, 46.11763966 N	178.00	68.12985205 W, 46.11751058 N	302.9	287.6	15.3
12	177.99	68.12985387 W, 46.11751020 N	176.50	68.13042113 W, 46.11738235 N	302.0	288.0	14.0
13	176.49	68.13042482 W, 46.11738148 N	175.00	68.13099093 W, 46.11725309 N	301.8	289.2	12.6
14	174.99	68.13099275 W, 46.11725265 N	173.50	68.13155886 W, 46.11712703 N	302.2	288.0	14.2
15	173.49	68.13156263 W, 46.11712618 N	171.99	68.13212684 W, 46.11699931 N	303.6	286.3	17.3
16	171.99	68.13212971 W, 46.11699866 N	170.49	68.13269254 W, 46.11687031 N	302.9	286.5	16.4
17	170.48	68.1326963 W, 46.11686947 N	169.00	68.13325913 W, 46.11674378 N	305.8	288.9	16.9
18	168.99	68.13326314 W, 46.11674285 N	167.50	68.13382973 W, 46.11661558 N	302.0	286.0	16.0
19	167.49	68.13383168 W, 46.11661512 N	166.00	68.1343973 W, 46.11648481 N	298.6	284.2	14.4
20	165.99	68.13440119 W, 46.11648392 N	164.50	68.13497078 W, 46.11635549 N	298.4	282.9	15.5
21	164.49	68.13497271 W, 46.11635503 N	163.00	68.13554162 W, 46.11622699 N	297.5	282.4	15.1
22	162.99	68.13554551 W, 46.11622616 N	161.49	68.13611883 W, 46.11609795 N	296.1	283.6	12.4
23	161.49	68.13612069 W, 46.11609752 N	160.00	68.13668796 W, 46.11596968 N	301.6	277.2	24.5
24	159.99	68.13669173 W, 46.11596883 N	158.49	68.13725615 W, 46.11584140 N	299.7	281.1	18.5
25	158.49	68.13725879 W, 46.11584082 N	157.00	68.1378221 W, 46.11571525 N	301.6	287.4	14.2
26	156.99	68.13782589 W, 46.11571440 N	155.50	68.13839327 W, 46.11558715 N	302.2	288.5	13.7
27	155.49	68.13839721 W, 46.11558631 N	154.00	68.1389655 W, 46.11545741 N	302.2	289.8	12.4

IR Software and Data Analyses

Generating Reports

Summary of Locations Without Thermal Segregation

Profile Nr	Beginning Location		Ending Location		Max Temp	Min Temp	Temperature Differential
	Station	GPS in °	Station	GPS in °			
28	153.99	68.13896866 W, 46.11545670 N	153.24	68.13925736 W, 46.11538960 N	299.1	287.2	11.9



Location of Paver Stops greater than One Minute

Location (stations)	Duration (h:min:sec)
185.89	0:2:0
172.06	0:4:22
168.59	0:4:25

IR Software and Data Analyses

Exporting Data

- Export to .txt (semicolon separated)
- Save as .paveproj

Questions?

NEXT:

- Overview of the Missouri I-29 Demonstration Project, I-29 St. Joseph, MO





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Overview of Missouri Demonstration Project: I-29 Rehabilitation; St. Joseph, MO

June 1, 2016

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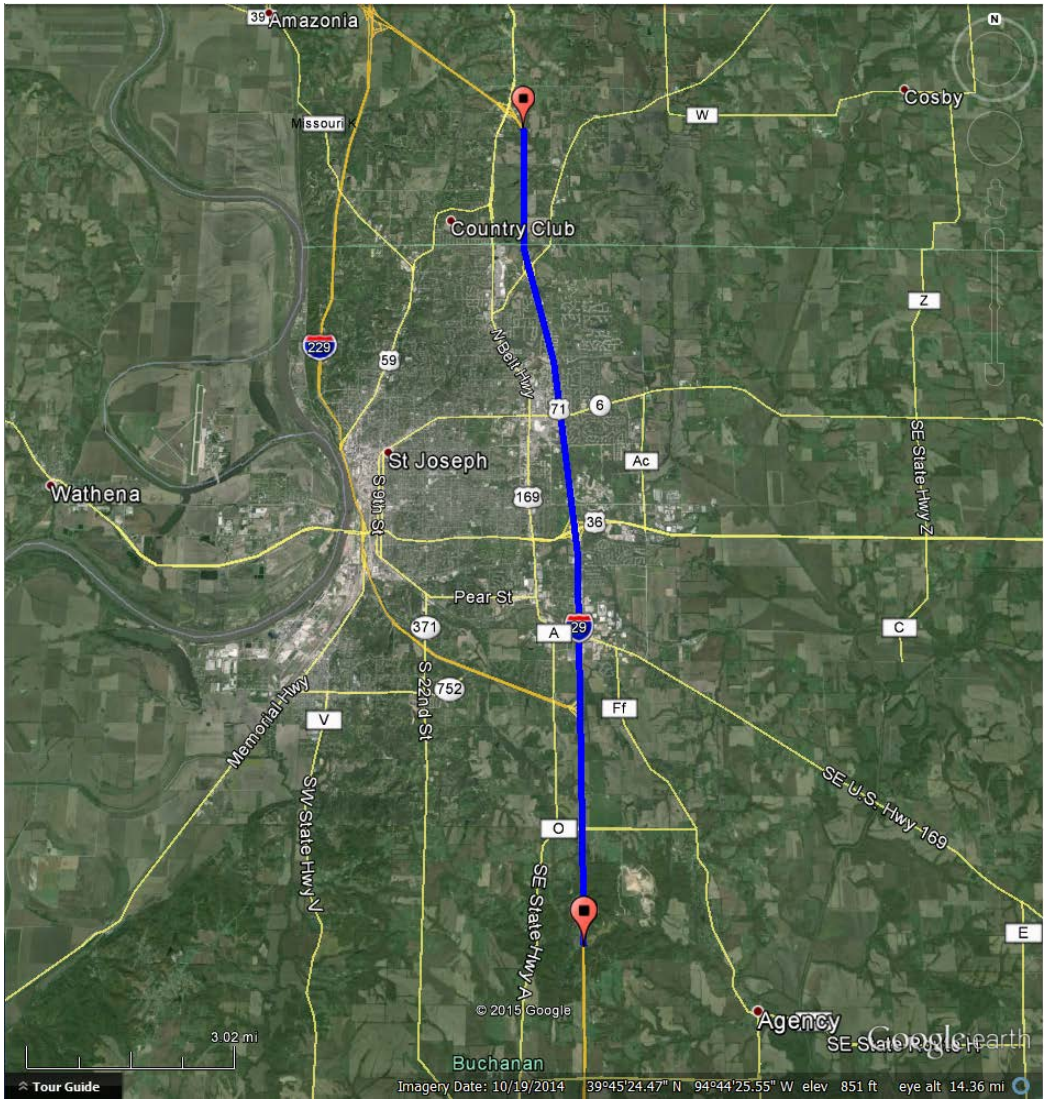
MODOT I-29 Demonstration Project

1. Project Overview
2. Data Collection
3. Data Processing
4. Data Summary

MODOT I-29 Demonstration Project

I 29; Northbound and Southbound Lanes



MODOT I-29 Demonstration Project

Mixture delivered to site with end dump and horizontal discharge discharge trucks.

MODOT I-29 Demonstration Project

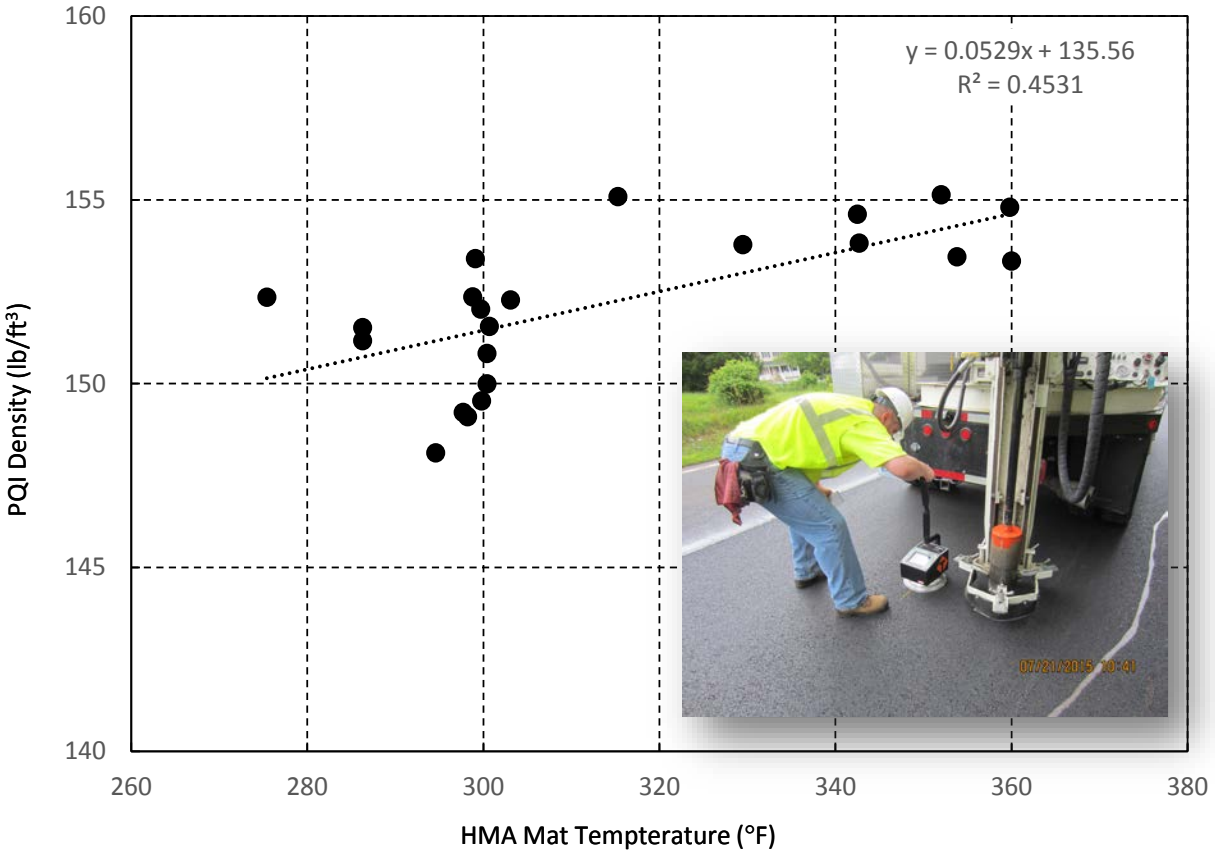
Mixture delivered to the Terex paver with a Roadtec MTV.

MODOT I-29 Demonstration Project

Compaction train included two steel wheel rollers and a rubber tired roller.

MODOT I-29 Demonstration Project

Non-nuclear density gauge used to measure mat density and superimposed on temperature profiles.



TTI Study:
Δ25 ºF ~ Δ6 pcf

Maine DOT:
Δ20 ºF ~ Δ4 pcf

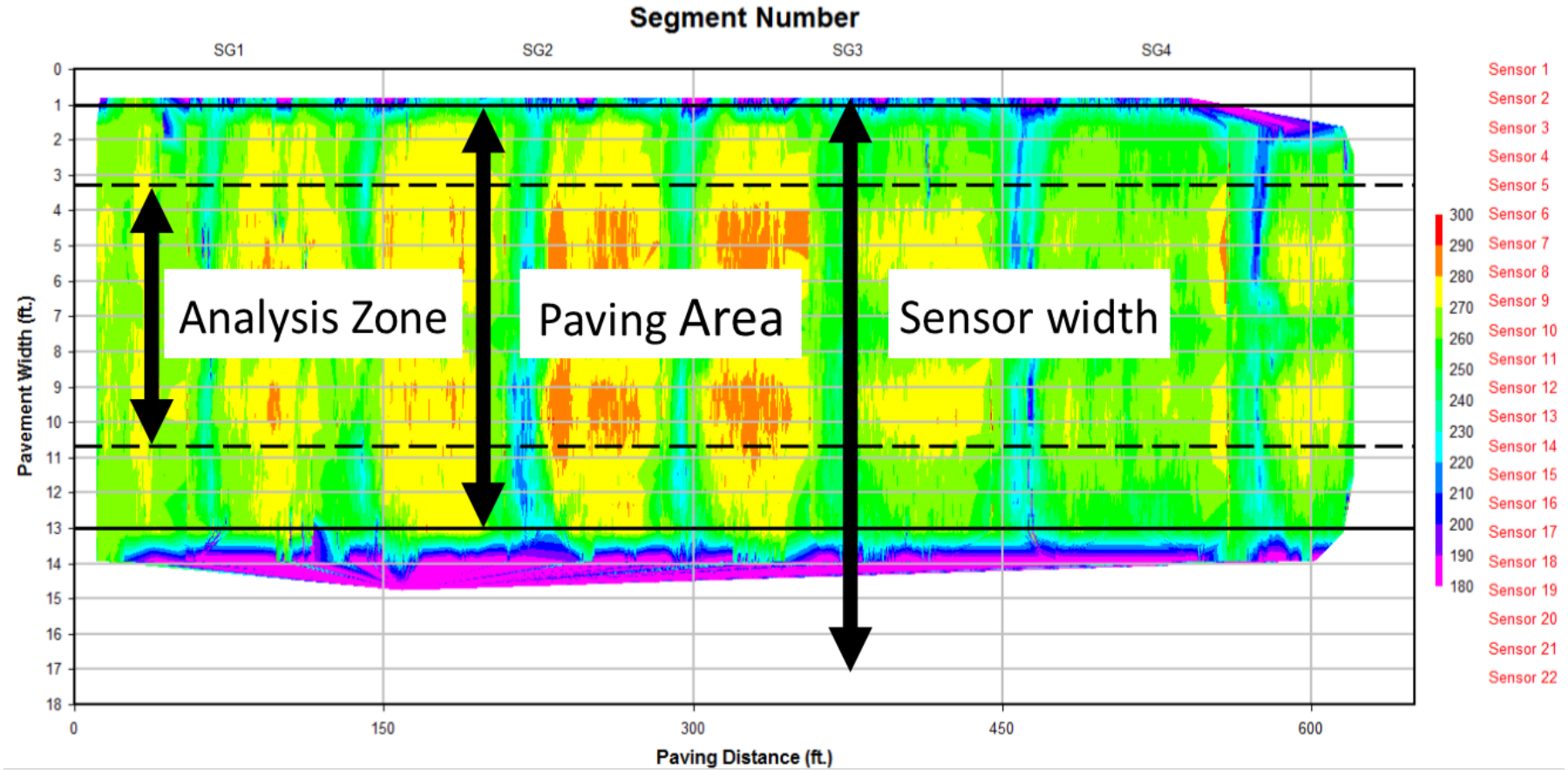
Missouri DOT:
Δ25 ºF ~ Δ5 pcf

Data Analyses & Findings

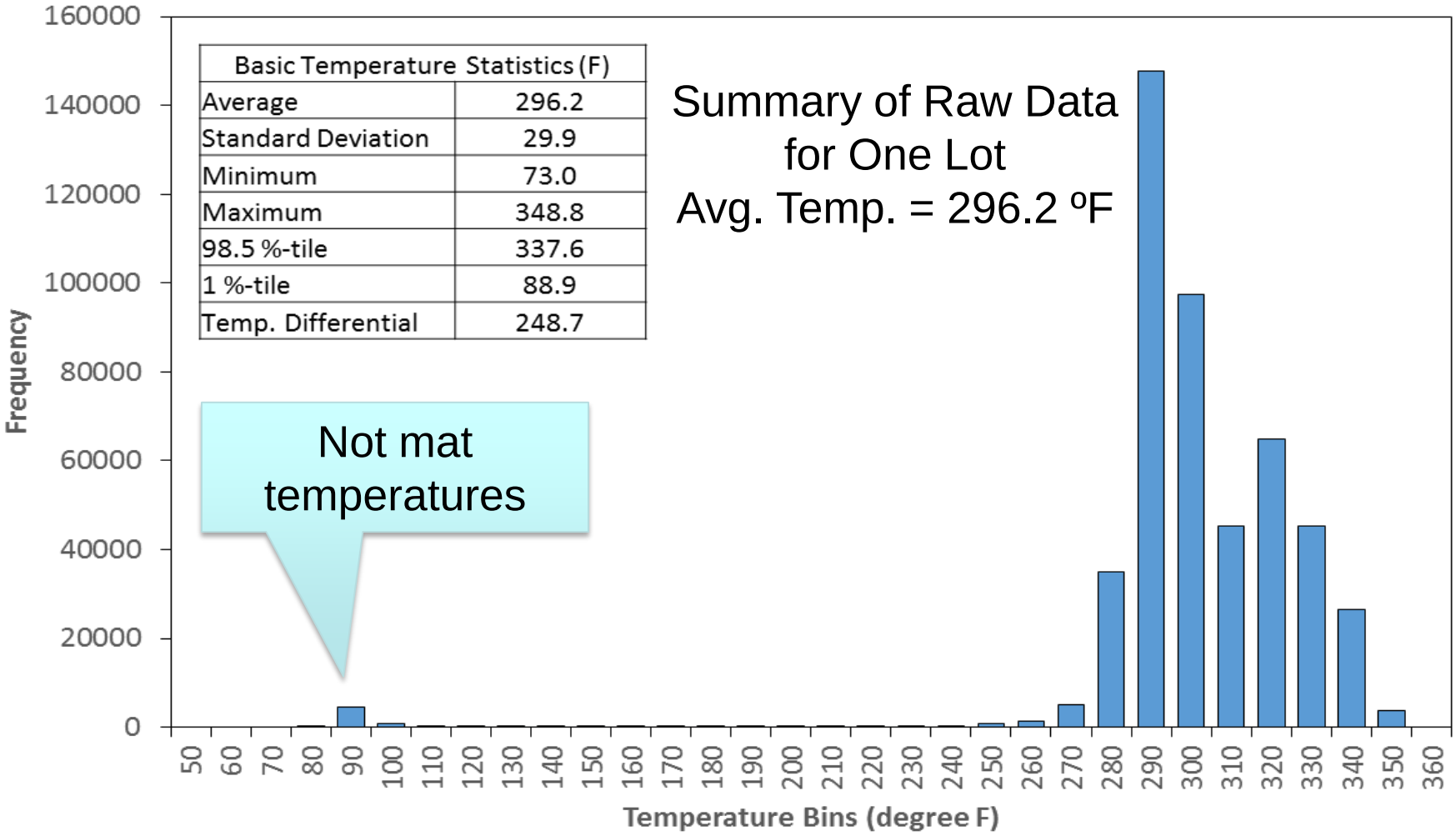
1. Project Overview
2. Data Collection
3. Data Processing
4. Data Summary

MODOT I-29 Demonstration Project

Raw Temperature Profile for first part of the first lot.



MODOT I-29 Demonstration Project

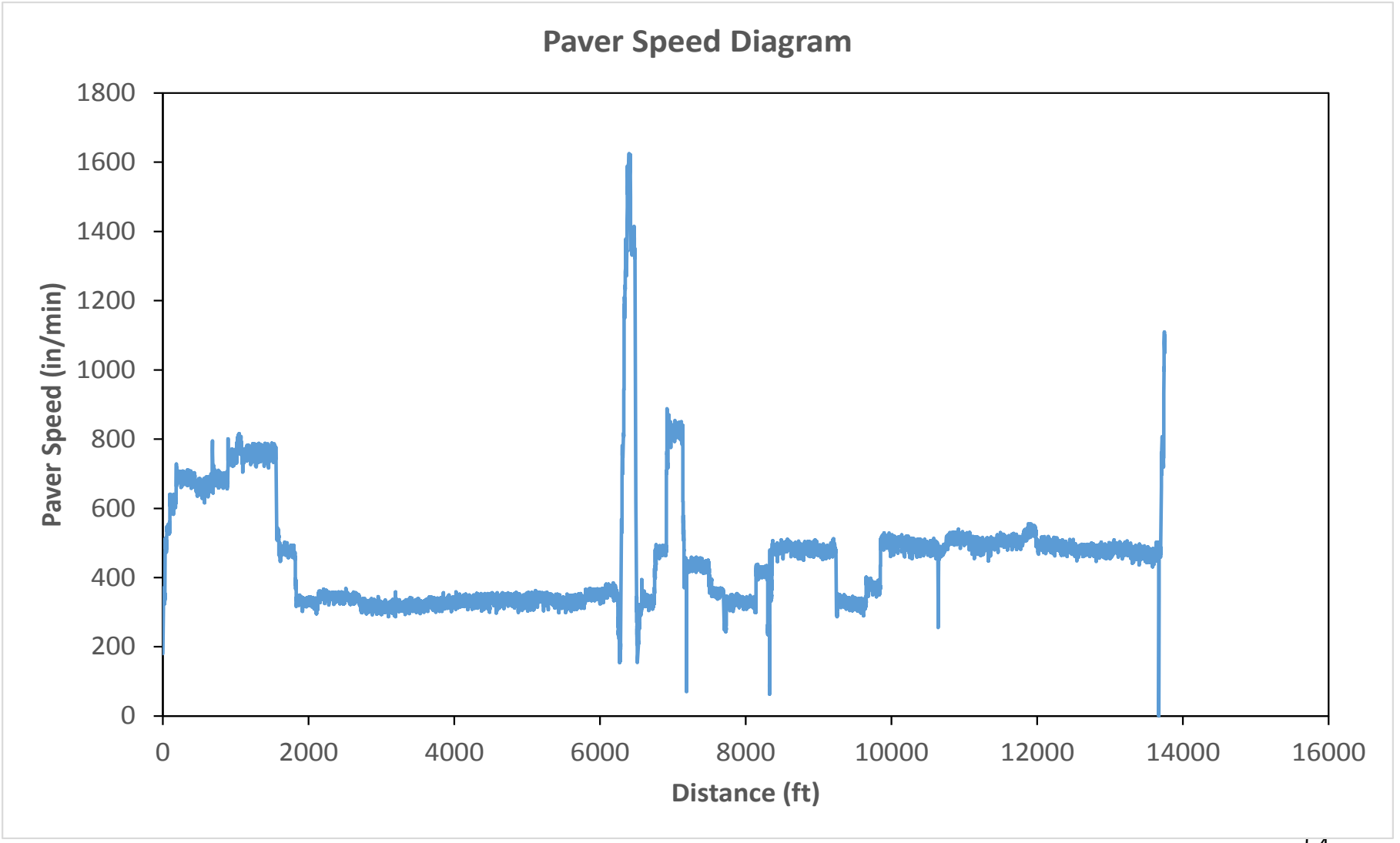


MODOT I-29 Demonstration Project

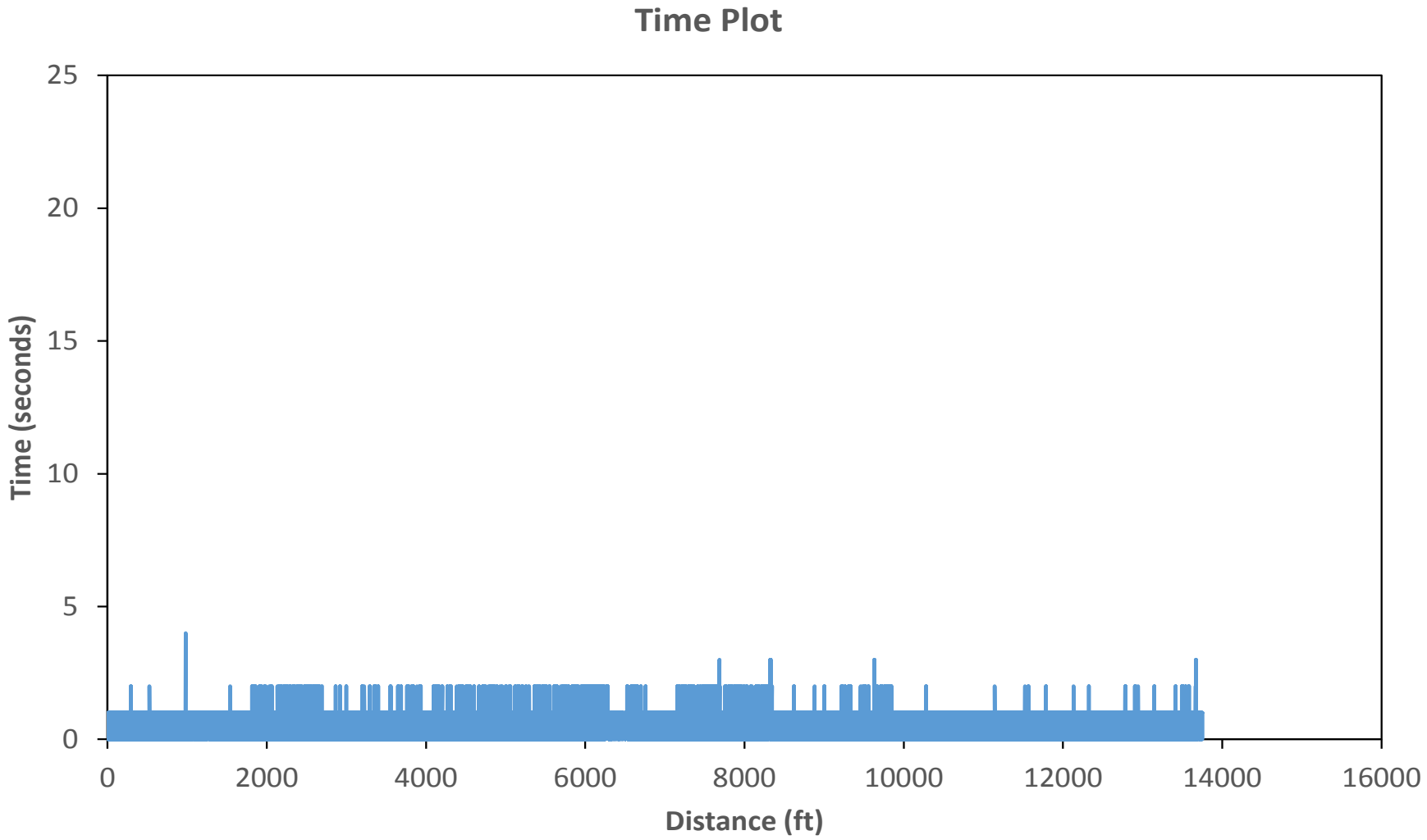
Data diagrams reviewed during production:

1. Paver speed diagram
2. Time plot
3. Average temperature plot

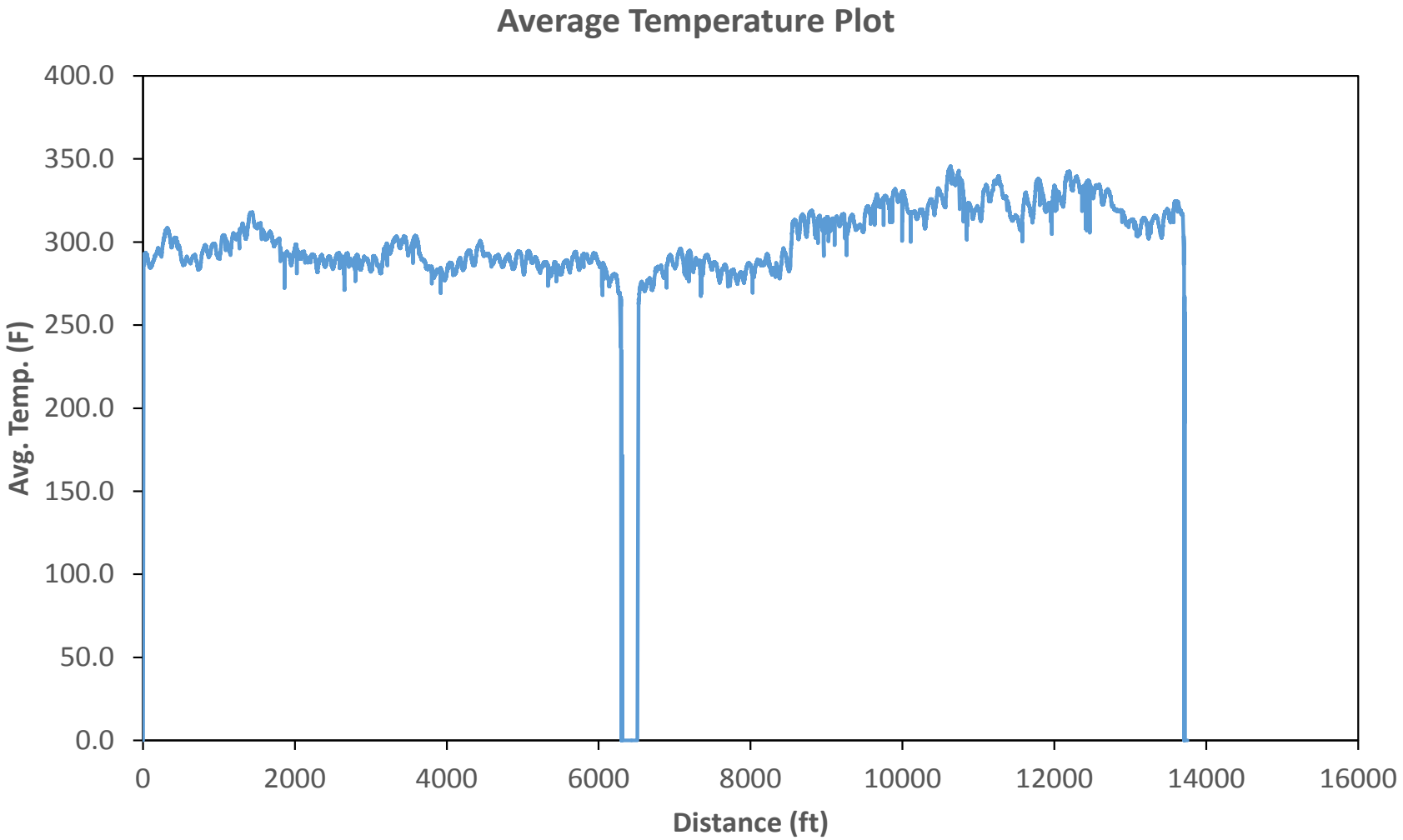
MODOT I-29 Demonstration Project



MODOT I-29 Demonstration Project



MODOT I-29 Demonstration Project



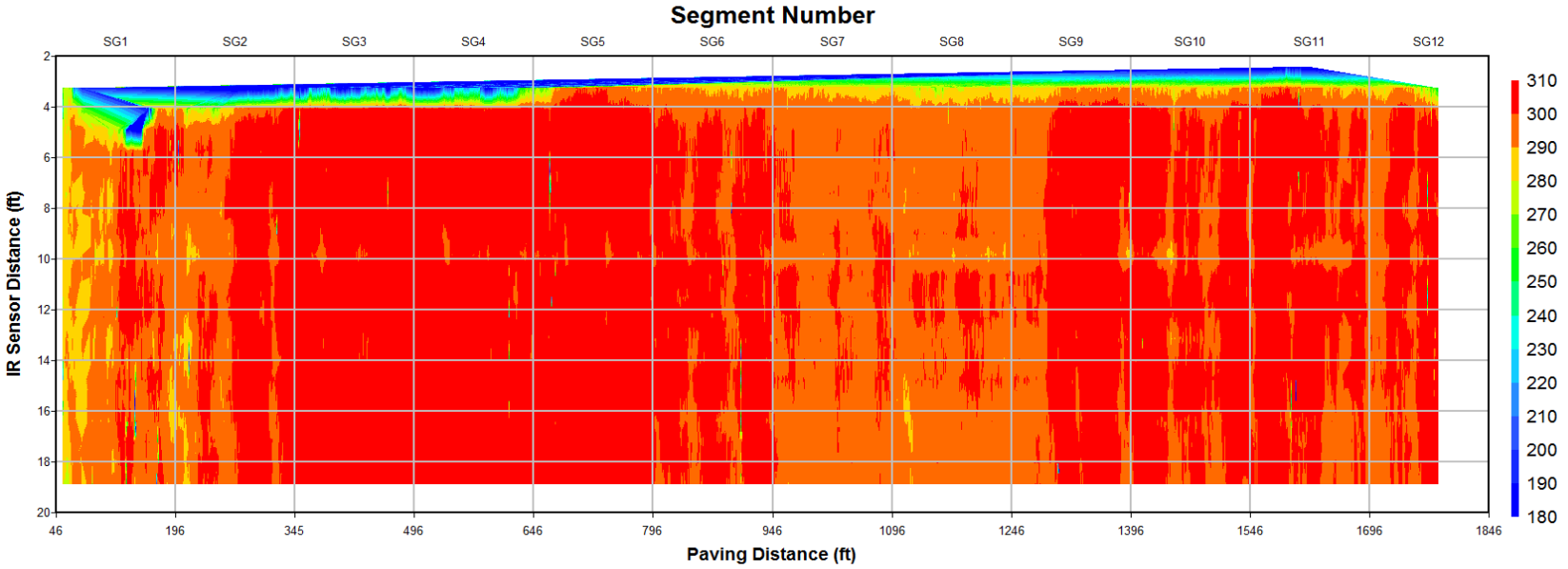
MODOT I-29 Demonstration Project

1. Project Overview
2. Data Collection
3. Data Processing
4. Data Summary

MODOT I-29 Demonstration Project

Data Processing—eliminate invalid temperature measurements:

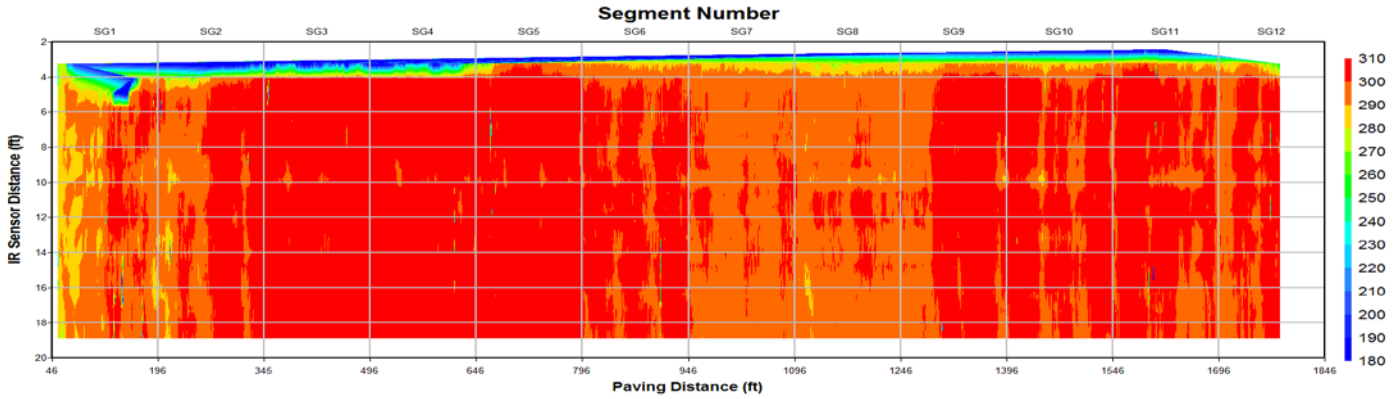
1. Eliminate measurement locations within 2 feet of the mat's edge.



MODOT I-29 Demonstration Project

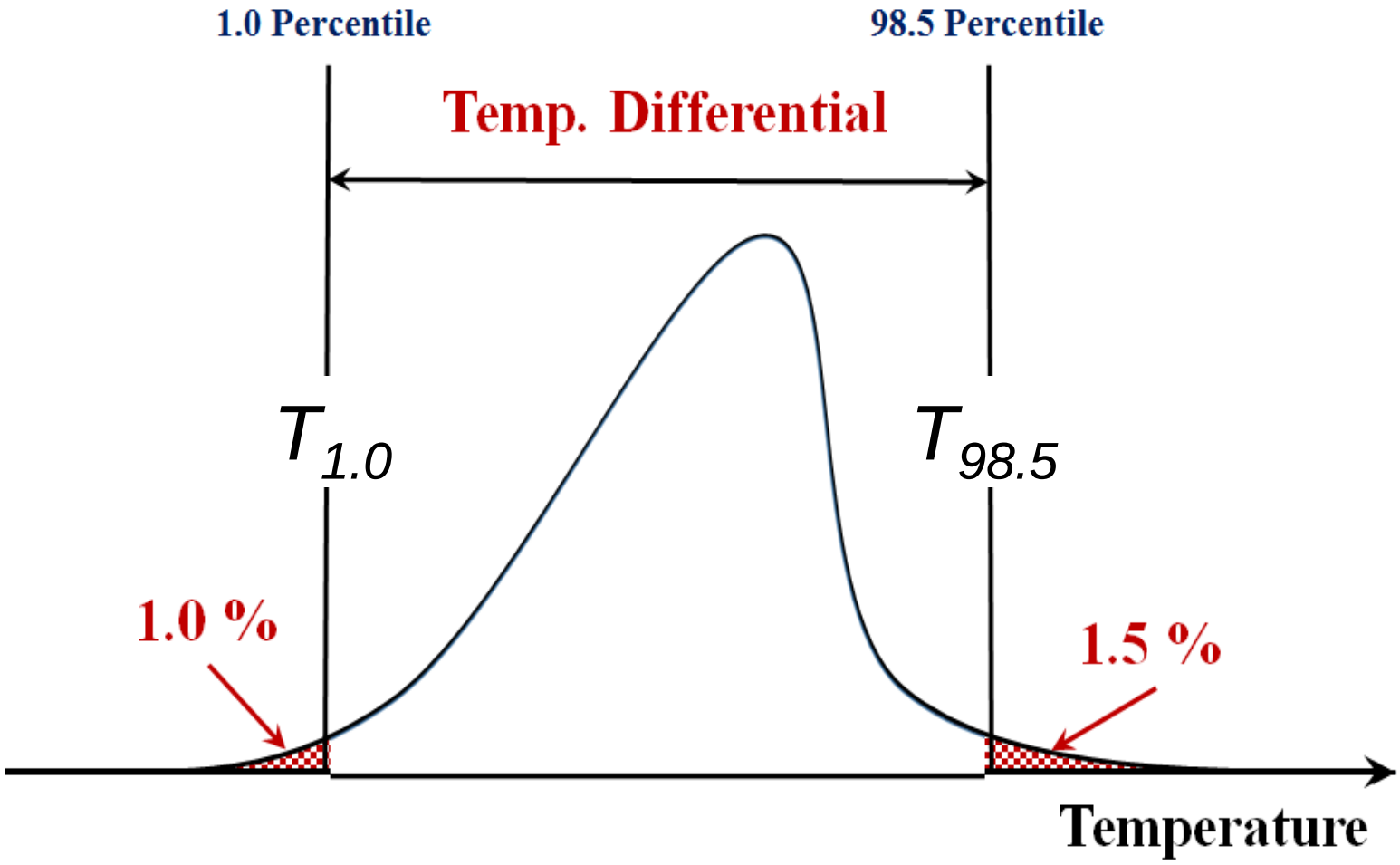
Data Processing—eliminate invalid temperature measurements:

2. Eliminate data with paver stops greater than 10 seconds, between locations:
   - 2 feet behind measurement location of stop
   - 8 feet in front of measurement location of stop
3. Eliminate temperature readings < 170 ºF and > 400 ºF.



MODOT I-29 Demonstration Project

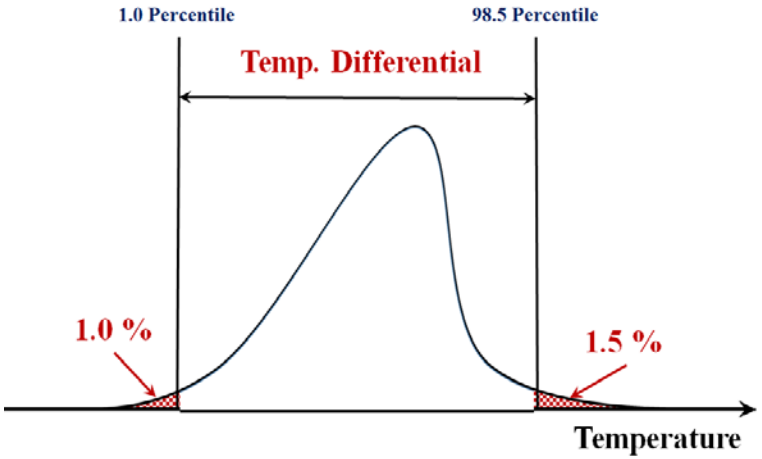
- Temperature Differential, each 150 foot segment



MODOT I-29 Demonstration Project

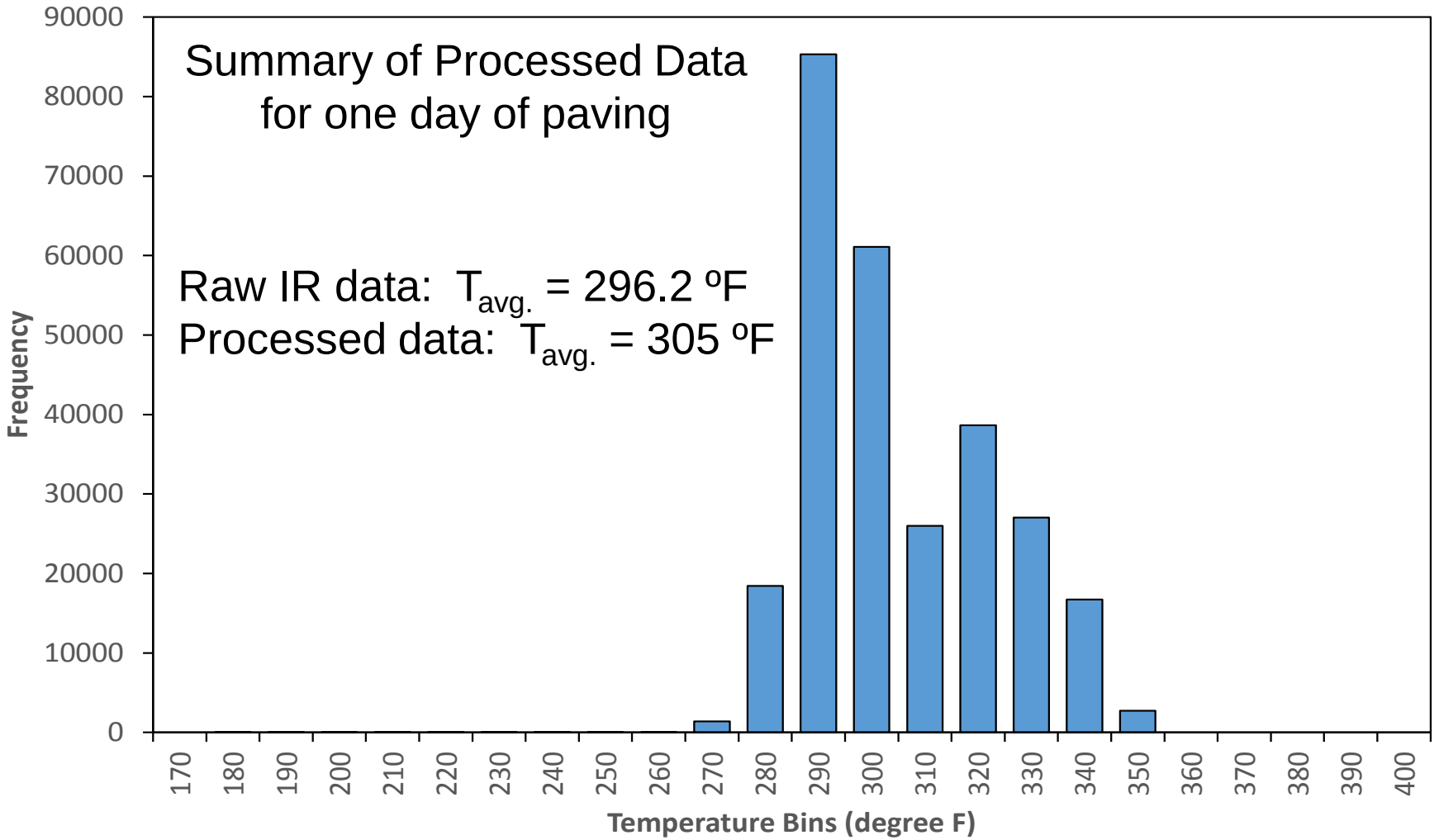
- Temperature Differential Criteria, each 150 foot segment:

$$T_{Diff} = T_{98.5} - T_{1.0}$$



- **$T_{diff} \leq 25$ ºF** — **No temperature difference**
- 25 ºF < $T_{diff} \leq 50$ ºF — Moderate temperature difference
- **$T_{diff} > 50$ ºF** — **Severe temperature difference**

MODOT I-29 Demonstration Project



MODOT I-29 Demonstration Project

1. Project Overview
2. Data Collection
3. Data Processing
4. Data Summary

MODOT I-29 Demonstration Project

Processed Data

Paver Stops	Total Number of Increments	Number of Increments within Temp. Difference Regimes			Thermal Streaking
		Minor	Moderate	Severe	
Excluded	816	648	135	33	None
Included	816	440	170	206	None

To include or exclude paver stops?
If paver stop cause severe temperature differences:
they should be included. However:

MODOT I-29 Demonstration Project

Required paver stops due to sampling should be eliminated from temperature difference profiles.

MODOT I-29 Demonstration Project

Processed Data

Paver Stops	Total Number of Increments	Number of Increments within Temp. Difference Regimes			Thermal Streaking
		Minor	Moderate	Severe	
Excluded	816	648	135	33	None
Included	816	440	170	206	None

Minnesota DOT's specification:

- Minor Temperature Difference: +$20 per Increment
- Moderate Temperature Difference: $0 per Increment
- Severe Temperature Difference: -$20 per Increment

Total Incentive to Contractor:
$4,860 for the project segment [Including paver stops].

MODOT I-29 Demonstration Project

In summary: infrared scanner data suggest overall uniform mat temperatures.

MODOT I-29 Demonstration Project

Contact Information:

- Bill Stone: william.stone@modot.mo.gov
- Bob Wills: bwills@herzog.com
- Mike McGee: mike.mcgee@dot.gov
- Paul Angerhofer: pangerhofer@moba.de
- Joe Reiter: jreiter@ara.com
- Harold Von Quintus: hvonquintus@ara.com

Questions?

NEXT:

- Deployment: Missouri DOT and Contractor Points of View and Perspective

SHRP2 SOLUTIONS
STRATEGIC HIGHWAY RESEARCH PROGRAM

Infrared Technology Showcase

Deployment: Missouri DOT and Contractor Points of View and Perspective

June 1, 2016

U.S. Department of Transportation
Federal Highway Administration

American Association of State Highway and Transportation Officials
AASHTO

Agency/Contractor Deployment

1. MODOT Presentation; Bill Stone:
   - Reasons for deploying IR Technology
   - Benefits – Agency points of view
   - Plans to implement IR Technology; short-term plans
   - Schedule for deployment
2. Contractor Herzog Presentation; Bob Wills:
   - Reasons for using IR Technology
   - Benefits – Contractor points of view
   - Making decisions in real time to minimize penalties
   - Use on future projects

Questions?

NEXT:

- Field Visit Project; City of St. Joseph, MO

Field Visit/Demonstration

1. Overview of Field Visit
2. Safety Comments and Requirements
3. Field Visit Stages and Groups
4. Buses
5. Lunch

SHRP2 SOLUTIONS
STRATEGIC HIGHWAY RESEARCH PROGRAM

Infrared Technology Showcase

Summary of R06C-IR Demonstration Projects

June 1, 2016

U.S. Department of Transportation
Federal Highway Administration

American Association of State Highway and Transportation Officials
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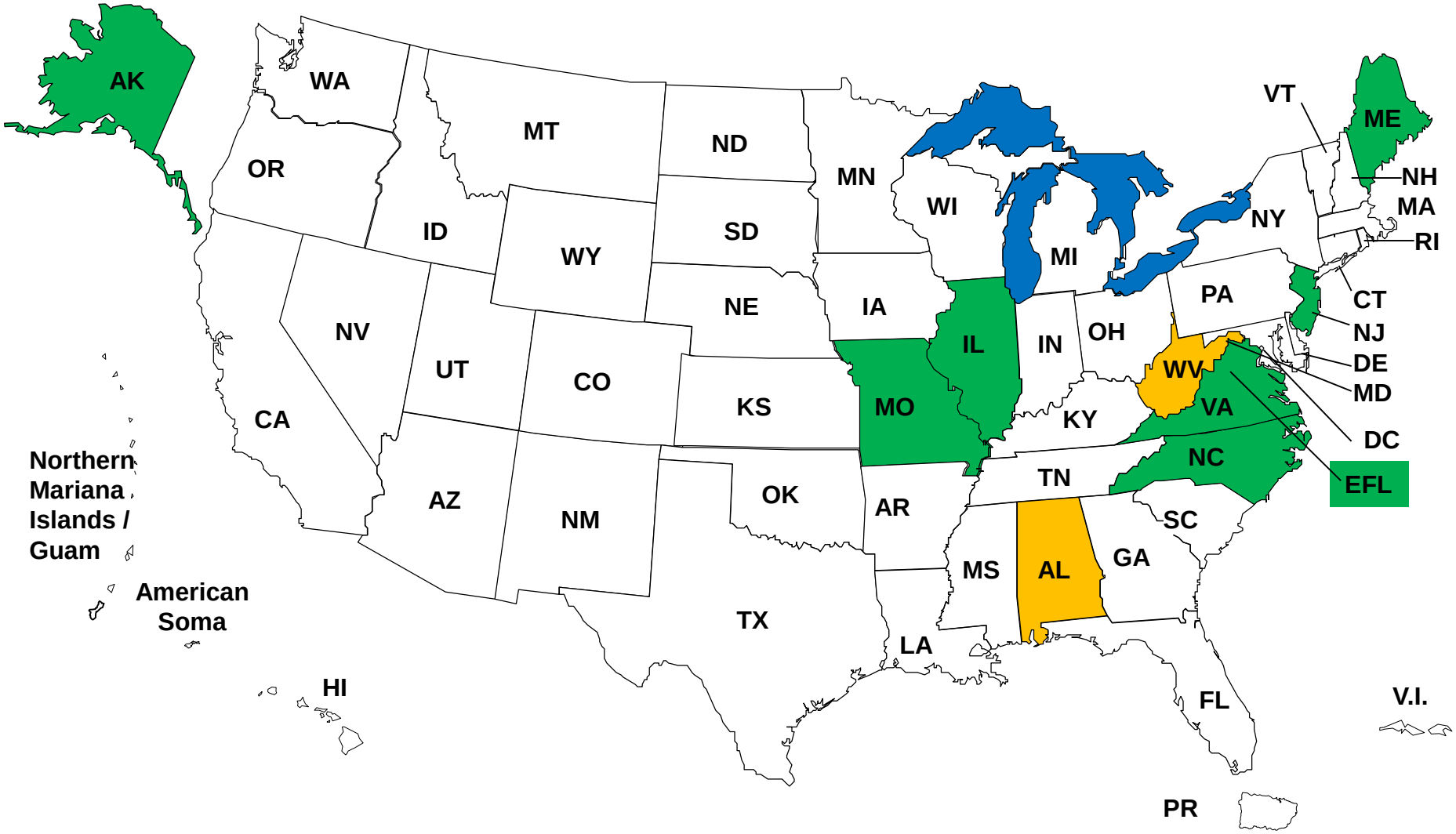
Summary of Demonstration Projects

1. R06C-IR Demonstration Projects
2. Application and Use: Examples

R06C-IR Demonstration Projects



R06C-IR Demonstration Projects

Paver Stops	Total Number of Increments	Number of Increments within Temp. Regimes			Thermal Streaking
		Minor	Moderate	Severe	
Alaska DOT Project					
Excluded	36	27	9	0	None
Included	36	22	8	6	None
Maine DOT Project					
Excluded	579	546	25	8	None
Included	579	494	56	29	None
Virginia DOT Project					
Excluded	84	72	10	2	None
Included	84	71	9	4	None

R06C-IR Demonstration Projects

Paver Stops	Total Number of Increments	Number of Increments within Temp. Regimes			Thermal Streaking
		Minor	Moderate	Severe	
Eastern Federal Lands					
Excluded	108	2	24	82	None
Included	108	2	16	90	None
New Jersey DOT Project					
Excluded	262	188	49	25	None
Included	262	163	43	56	None
Missouri DOT Project					
Excluded	816	648	135	33	None
Included	816	440	170	206	None

R06C-IR Demonstration Projects

Percentage of Segments with Severe Temperature Differentials

Project	Delivery Truck Type	MTV Included	Percent Severe Temp. Differentials	Thermal Streaking
Alaska	Bottom-Dump	Windrows	17	None
EFL	*End Dump*	*No*	*83*	*None*
Illinois	*End Dump*	*No*	*40*	*None*
Maine	End Dump	Yes	5	None
Missouri	End Dump & Flow Boys	Yes	25	None
New Jersey	End Dump	Yes	21	None
Virginia	End Dump	Yes	5	None

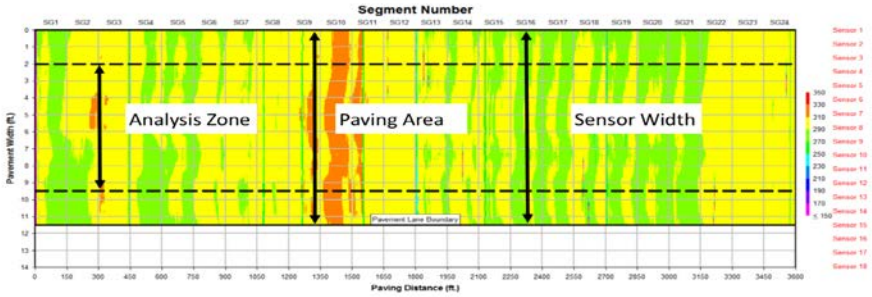
Above include paver stops.

R06C-IR Demonstration Projects

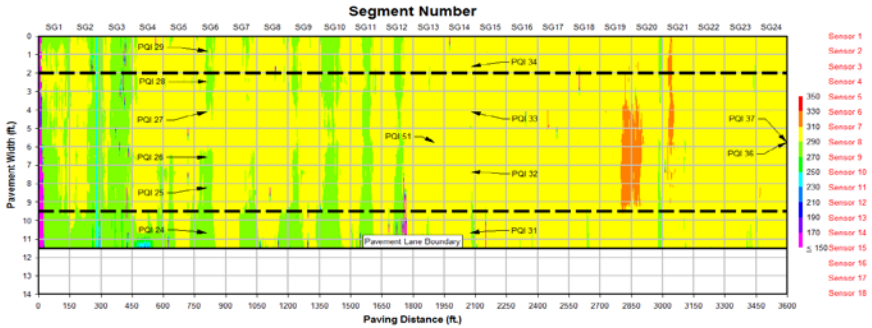
Raw Temperature Profile showing continuous improvement or more uniform mat temperatures as paving progresses.

Example from Maine demonstration project.

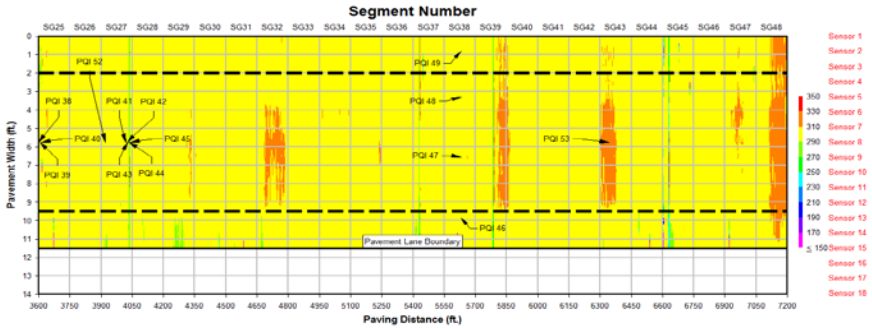
Near Start of Lot



Near Center of Lot



Near End of Lot

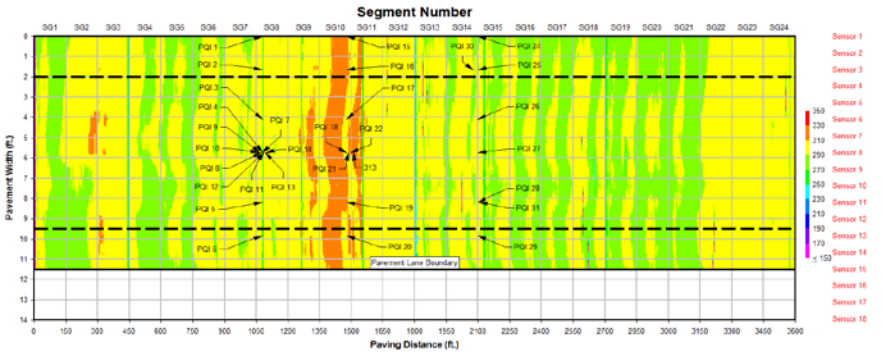


R06C-IR Demonstration Projects

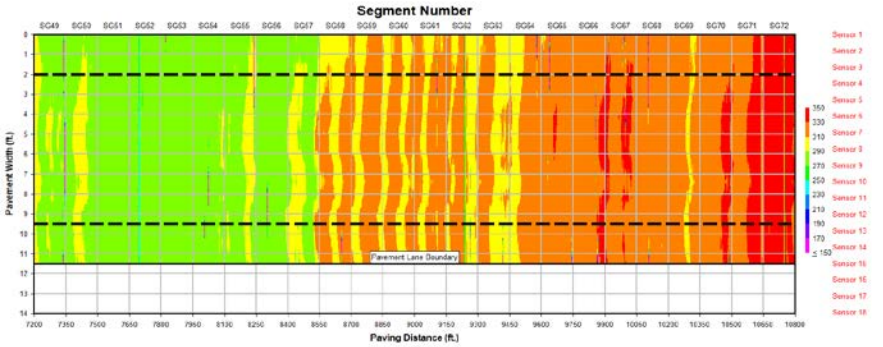
Raw Temperature Profile showing continuous improvement or more uniform mat temperatures as paving progresses.

Example from Missouri demonstration project.

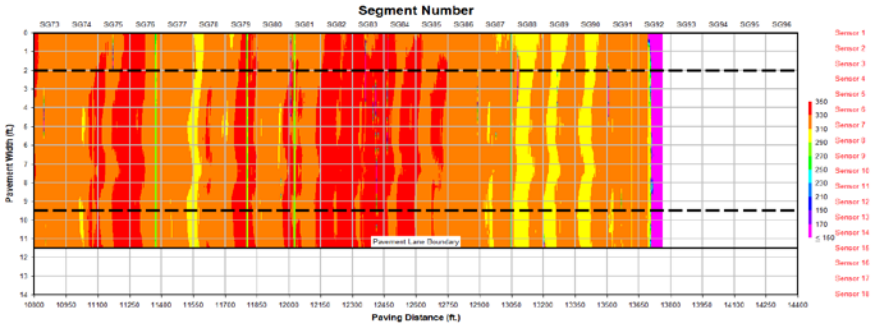
Near the beginning



Near Center of Lot



Near End of Lot



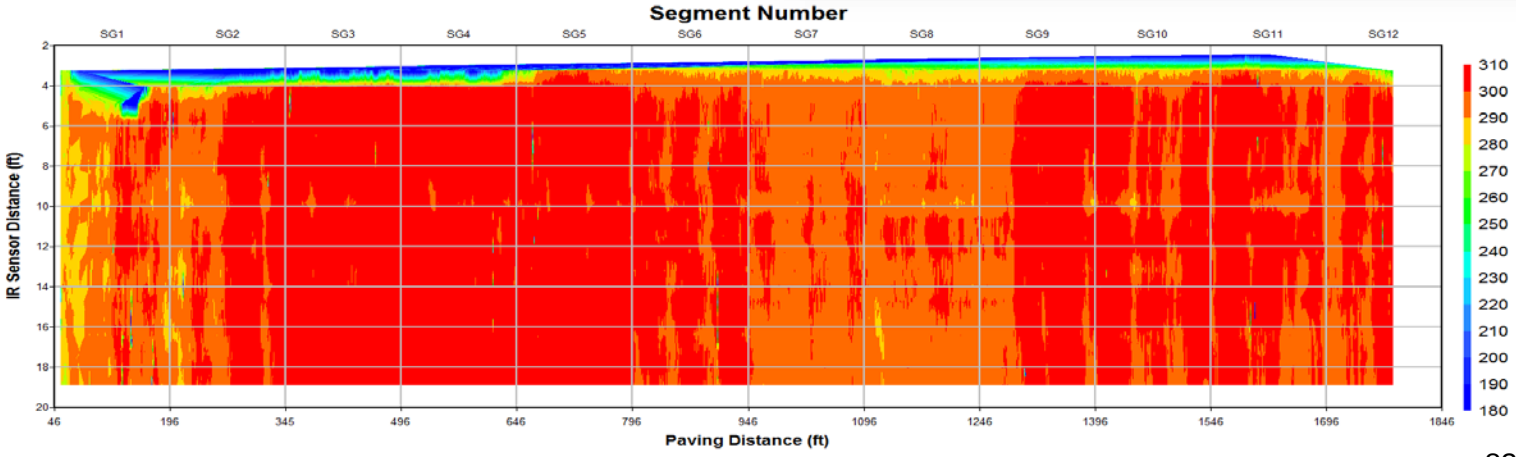
Summary of Demonstration Projects

1. Field Demonstration Projects and Products
2. Application and Use: Examples

Application and Use: Examples

Application & Use, WHY:

- Continuous readings to evaluate mat uniformity through temperature uniformity.
- Non-uniform temperatures imply non-uniform densities, which usually mean higher maintenance.



Application and Use: Examples

Role of IR in Quality Assurance Programs

1. Quality control plan; contractor
   - Improve communication between personnel
   - Reduce risk of being penalized
   - Forensic tool to trouble shoot low or non-uniform densities
2. Acceptance plan; agency
   - Reduce future distress and maintenance costs
   - Dispute resolution

Application and Use: Examples

IR Role in Quality Control Plan; 4 examples

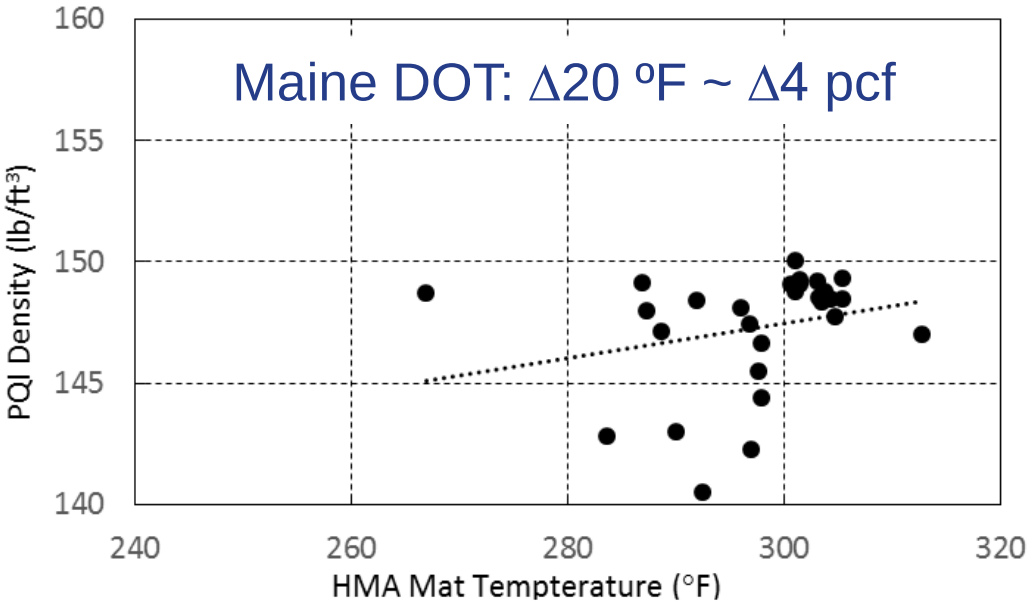
1. **Missouri demonstration project**
2. **Maine demonstration project**
3. **Virginia demonstration project**
4. **Federal Lands demonstration project**

Application and Use: Examples

1. Missouri demonstration project
   - Increased communication between plant and paver to minimize temperature differentials of mat.

Application and Use: Examples

2. Maine demonstration project
   - Monitor average temperature differential on a lot by lot basis for identifying need to take action.
   - 85 percent of segments exhibited < 25 ºF.
   - If average temperature differential exceeds 15 ºF, risk for penalty increases.



Application and Use: Examples

3. Virginia demonstration project
   - Identify reason for severe temperature differentials and take action.
     - Avg. temperature differential at start of paving project; about 30 ºF.
     - Avg. temperature differential after adding two trucks; about 15 ºF.

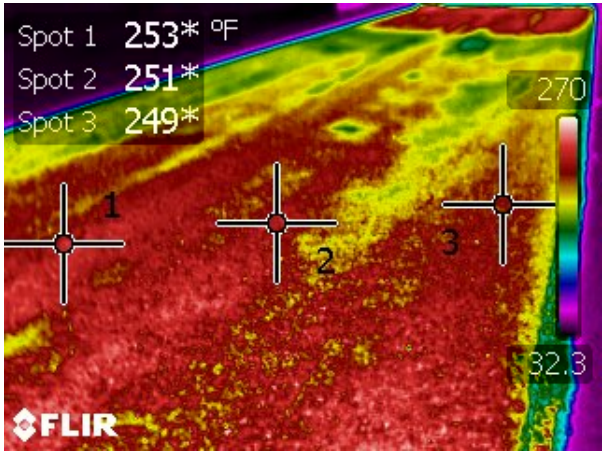
Application and Use: Examples

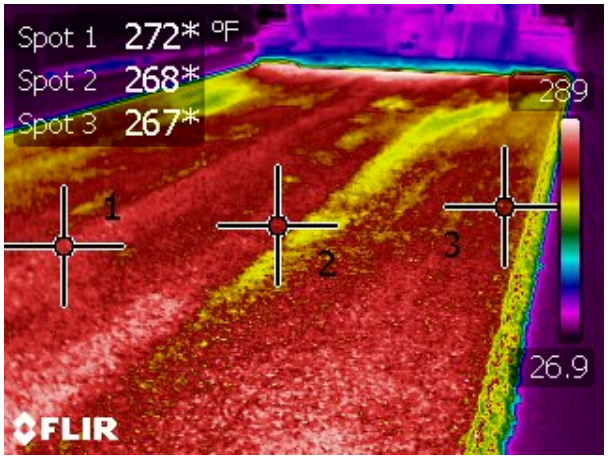
4. Federal Lands demonstration project
   - Identify reason for severe temperature differentials and take action; loading of trucks.
     - One dump of mix in truck bed – severe temp. differential
     - Two dump, no stockpile – reduced temp. differential.

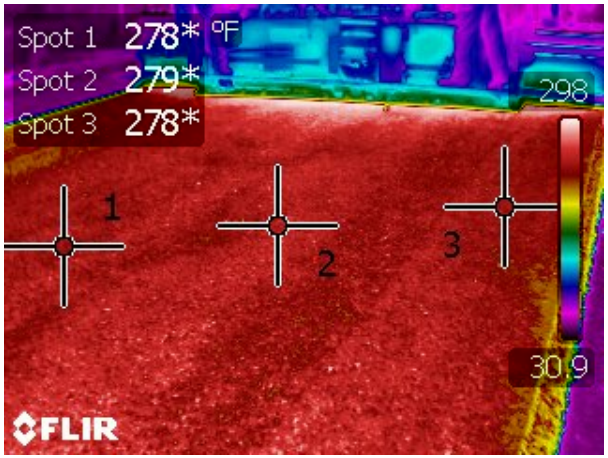
Application and Use: Examples

IR Role in Acceptance Plan; examples:

1. Identify cold spots
   - Colorado, Michigan, Minnesota, Quebec, Texas, Washington
2. Identify thermal streaks
   - Quebec



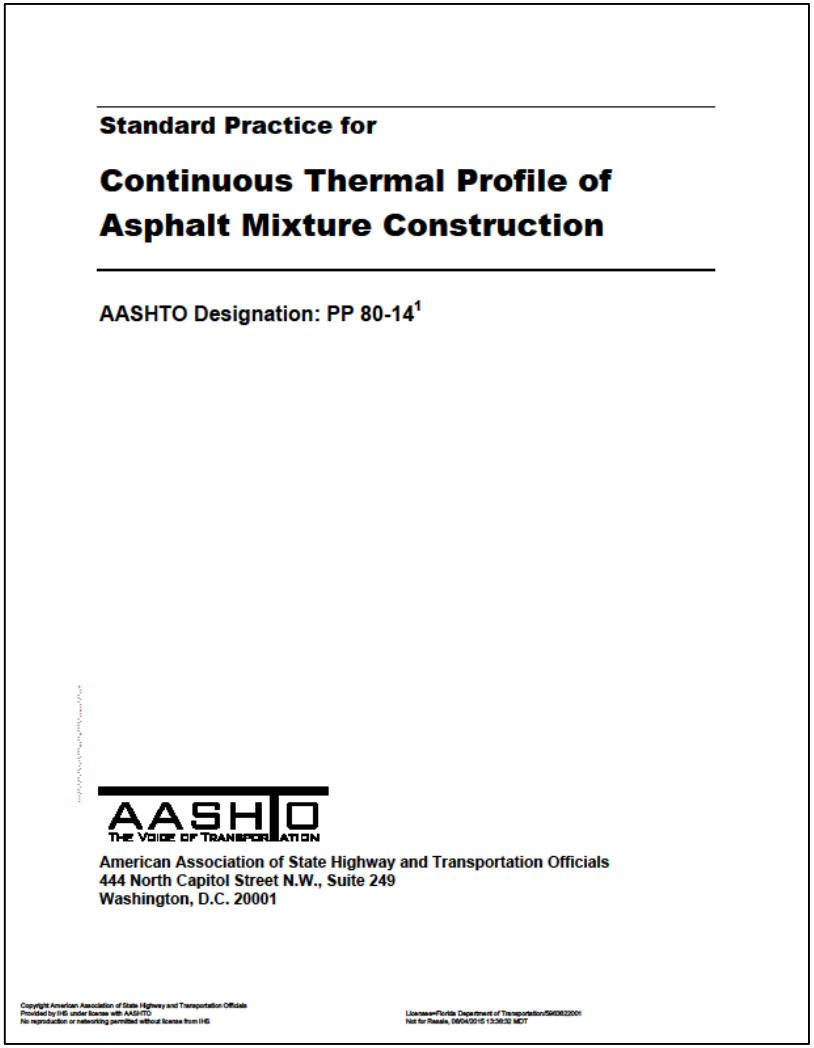




Application and Use: Examples

Specification Guide; AASHTO PP 80-14

1. Scope
2. Referenced Document
3. Terminology
4. General Thermal Profile Requirements
5. Hardware
6. Data File Format
7. Calibration
8. Profiler Accuracy
9. References
10. Appendices (Non-mandatory)
    1. Example Acceptance Criteria
    2. Terminology
    3. Criteria
    4. Monetary Adjustment



Standard Practice for

Continuous Thermal Profile of Asphalt Mixture Construction

AASHTO Designation: PP 80-14[1]

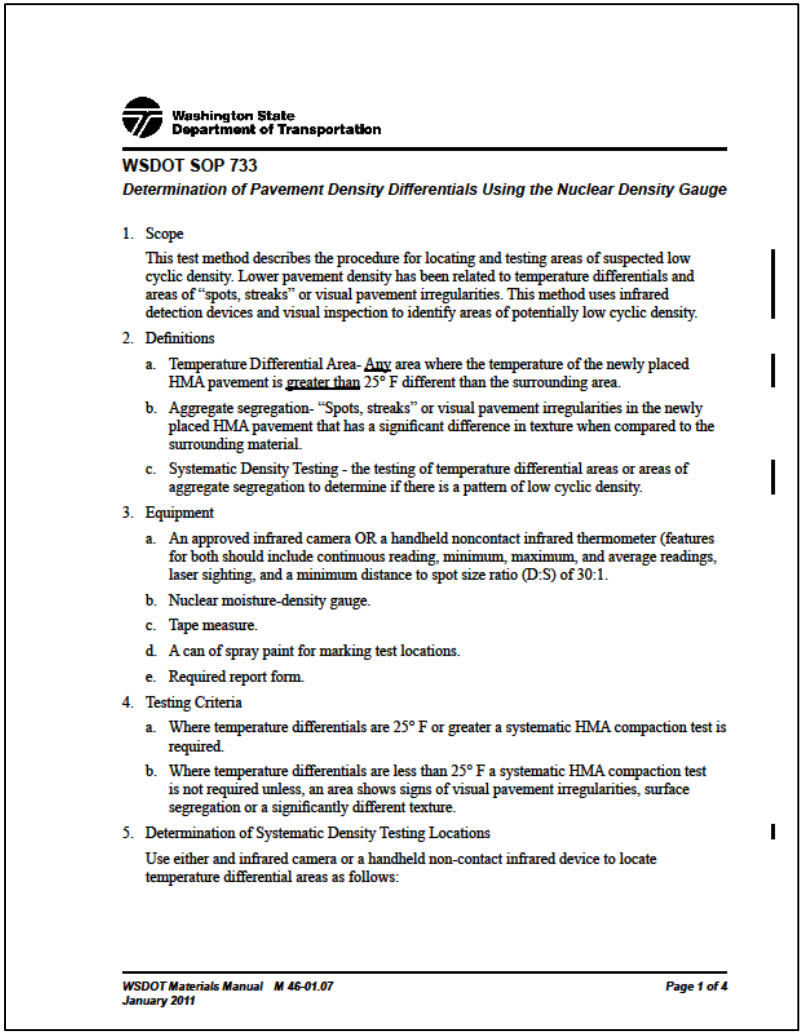
AASHTO
THE VOICE OF TRANSPORTATION

American Association of State Highway and Transportation Officials
444 North Capitol Street N.W., Suite 249
Washington, D.C. 20001

Application and Use: Examples

IR Role in Acceptance Plan

- Determine biased areas for sampling and testing
  - Washington DOT
- Determine pay factors
  - Minnesota DOT
  - Quebec
- Minnesota pay factors for each 150 foot segment:
  - $20 bonus; <25ºF
  - $20 penalty; >50ºF



Washington State Department of Transportation

WSDOT SOP 733

Determination of Pavement Density Differentials Using the Nuclear Density Gauge

1. Scope

   This test method describes the procedure for locating and testing areas of suspected low cyclic density. Lower pavement density has been related to temperature differentials and areas of "spots, streaks" or visual pavement irregularities. This method uses infrared detection devices and visual inspection to identify areas of potentially low cyclic density.

2. Definitions

   a. Temperature Differential Area- Any area where the temperature of the newly placed HMA pavement is greater than 25° F different than the surrounding area.

   b. Aggregate segregation- "Spots, streaks" or visual pavement irregularities in the newly placed HMA pavement that has a significant difference in texture when compared to the surrounding material.

   c. Systematic Density Testing - the testing of temperature differential areas or areas of aggregate segregation to determine if there is a pattern of low cyclic density.

3. Equipment

   a. An approved infrared camera OR a handheld noncontact infrared thermometer (features for both should include continuous reading, minimum, maximum, and average readings, laser sighting, and a minimum distance to spot size ratio (D:S) of 30:1.

   b. Nuclear moisture-density gauge.

   c. Tape measure.

   d. A can of spray paint for marking test locations.

   e. Required report form.

4. Testing Criteria

   a. Where temperature differentials are 25° F or greater a systematic HMA compaction test is required.

   b. Where temperature differentials are less than 25° F a systematic HMA compaction test is not required unless, an area shows signs of visual pavement irregularities, surface segregation or a significantly different texture.

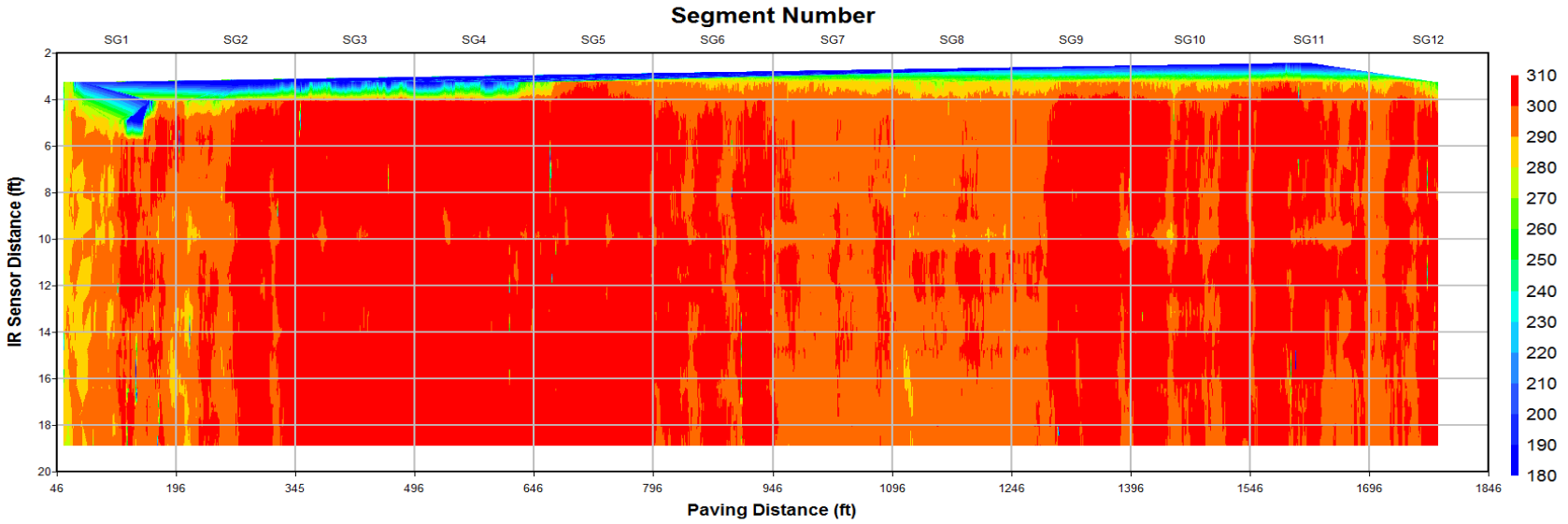
5. Determination of Systematic Density Testing Locations

   Use either and infrared camera or a handheld non-contact infrared device to locate temperature differential areas as follows:

Summary of Demonstration Projects

Conclusion from demonstration projects, to-date:

- Pave-IR scanner is one tool to confirm a uniform, high-quality mat.
- Lessons learned



Questions?

NEXT:

- Implementation of IR Technology

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Implementation of IR Technology

June 1, 2016

U.S. Department of Transportation
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Implementation of IR Technology

1. Some Common Steps for Deployment
2. Texas DOT: Gisel Carrasco
3. Minnesota DOT: Curt Turgeon
4. Alaska DOT: Richard Giessel

Steps for Deployment

Deployment Strategy, Common Steps/Tasks:

1. Define temperature differences that cause significant distress, increasing maintenance cost & reducing service life (Minnesota, Ontario, Texas, Washington).
   a) Many published reports that document the importance of temperature
2. Identify mat property changes between areas with severe temperature differentials (Ontario, Texas).
   a) Many research reports that identify how density affects the mat's properties related to performance
3. Draft IR specification (Minnesota, Ontario, Texas, Washington)
4. Obtain comments from industry for revising specification; getting input from other partners (Ontario, Minnesota, Texas)
5. Host/sponsor training sessions with equipment/software

Steps for Deployment

Deployment Strategy, Common Steps/Tasks:

6. Execute pilot projects over 1 to 2 years (Minnesota, Ontario)
7. Educate industry/agency personnel on results (Ontario)
8. Update/revise specification (Minnesota, Ontario, Texas, Washington)
9. Establish actions based on temperature profile differences (all)
    a) Increased density testing (Texas)
    b) Biased testing (Washington)
    c) Incentives/disincentives based temperature differentials (Minnesota, Ontario)
10. Confirm appropriateness of acceptance plan (Ontario)
11. Full deployment

Steps for Deployment

Some Questions for Deployment:

1. How many projects has Pave-IR Scan™ been used on?
2. How many projects were for quality assurance?
3. What percent of profiles exhibited medium & severe temperature differences?
4. How easy is it to set up the project in Pave-IR Scan™?
5. Any problems experienced with the equipment?
6. Has the Pave-IR system changed daily practice?
7. Has use of the Pave-IR system changed interaction between the owner & contractor?
8. How easy is the IR data to extract and process?
9. Do you review the Pave-IR reports at the end of the day?
10. Do you think you are getting a higher quality mat at the end of the day using the Pave-IR system?
11. How have agencies/contractors used the IR products?

Implementation of IR Technology

1. Some Common Steps for Deployment
2. Texas DOT: Gisel Carrasco
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SHRP2 SOLUTIONS
STRATEGIC HIGHWAY RESEARCH PROGRAM

Infrared Technology Showcase

Panel Discussion on IR Deployment and Use

June 1, 2016

U.S. Department of Transportation
Federal Highway Administration

American Association of State Highway and Transportation Officials
AASHTO

Panel Discussion

- Moderator: Mike McGee, FHWA
- Participants:
  - Missouri DOT: Bill Stone
  - Herzog: Bob Wills
  - Texas DOT: Gisel Carrasco
  - Minnesota DOT: Curt Turgeon
  - Alaska DOT: Richard Giessel

Some Questions

1. Is the type of project a consideration for IR use?
2. How easy is it to set up the project in Pave-IR Scan™?
3. Any problems experienced with the equipment or software?
4. Has the Pave-IR system changed daily practice?
5. Has use of the Pave-IR system changed interaction between the owner & contractor?
6. How easy is the IR data to extract and process?
7. Do you review the Pave-IR reports at the end of the day?
8. Do you think you are getting a higher quality mat at the end of the day using the Pave-IR system?
9. How have agencies/contractors used the IR products?
10. What is value of IR to the Contractor and Agency?

Workshop Wrap-Up

- Complete workshop forms
- R06C: additional information on Infrared Tech.
  - AASHTO Site: http://shrp2.transportation.org
  - FHWA Site: www.fhwa.got.gov/goshrp2
- Next on the agenda:
  - Presentation and Demonstration of Ground Penetrating Radar Equipment