Intelligent Compaction

(History, Projects, and Analysis

57th MAAPT Asphalt Conference

December 8, 2010

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Mn/DOT

Intelligent Compaction

Mn/DOT Priorities

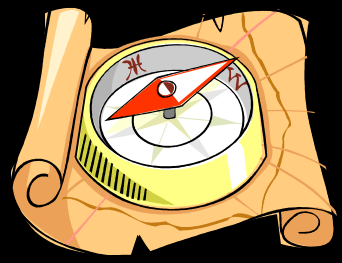
- **Uniform Compaction** - All rollers in a train having a display showing # of passes (GPS)

- **Uniform Temperature** - Surface Temperature behind Screed (Pave-IR)

1989 – “Effect of Compaction on Asphalt Concrete Performance”

Each 1% increase in air voids (over the base air void of 7 percent) tends to produce about a 10 percent loss in pavement life (or about 1 year less life)

How Did We Get Here?

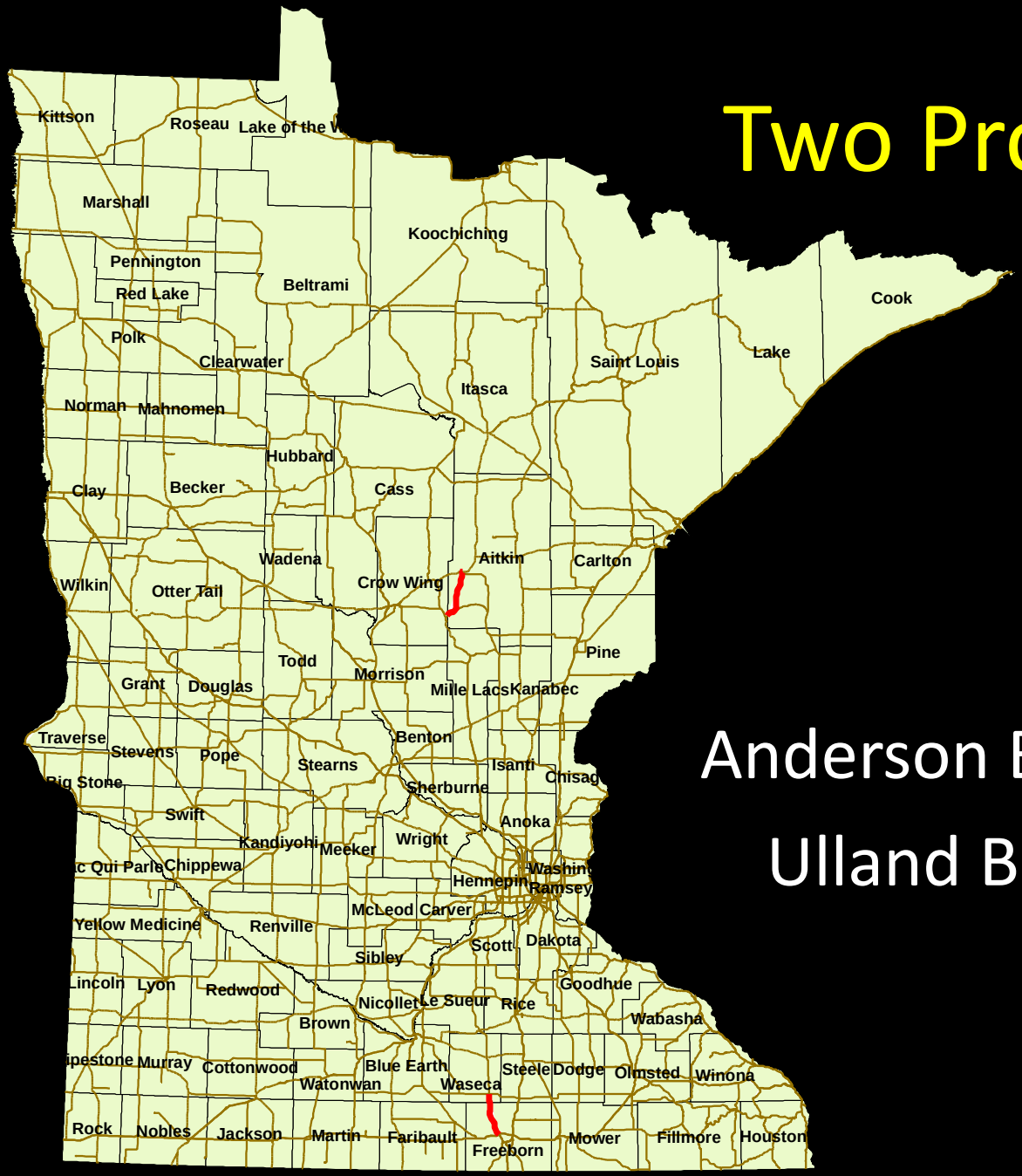


- *Washington DOT did a study in 1998 to 2001 on Temperature and Density Differentials*
  - Increasing temp. differential correspond to increasing air voids which affect pavement performance
- *Mn/DOT Study in 2001*
  - Profiles with > 25°F difference had a 50/50 split on passing and failing densities
  - Profiles with < 25°F difference had 93% passing the density requirement

Texas Implementation

- *TXDOT has a Lay-Down Operations Spec.*
  - Take a thermal profile in every sublot
    (IR Thermometer, Thermal Camera, or Pave-IR)
  - If the sublot has moderate segregation (25-50°F), contractor directed to take corrective actions
  - If sublot has severe segregation (> 50°F), Engineer may suspend operations, no bonus $ available (if not using Pave-IR)
  - Basically TXDOT is trying to minimize thermal segregation.

Two Projects in 2010



Anderson Brothers – TH 169

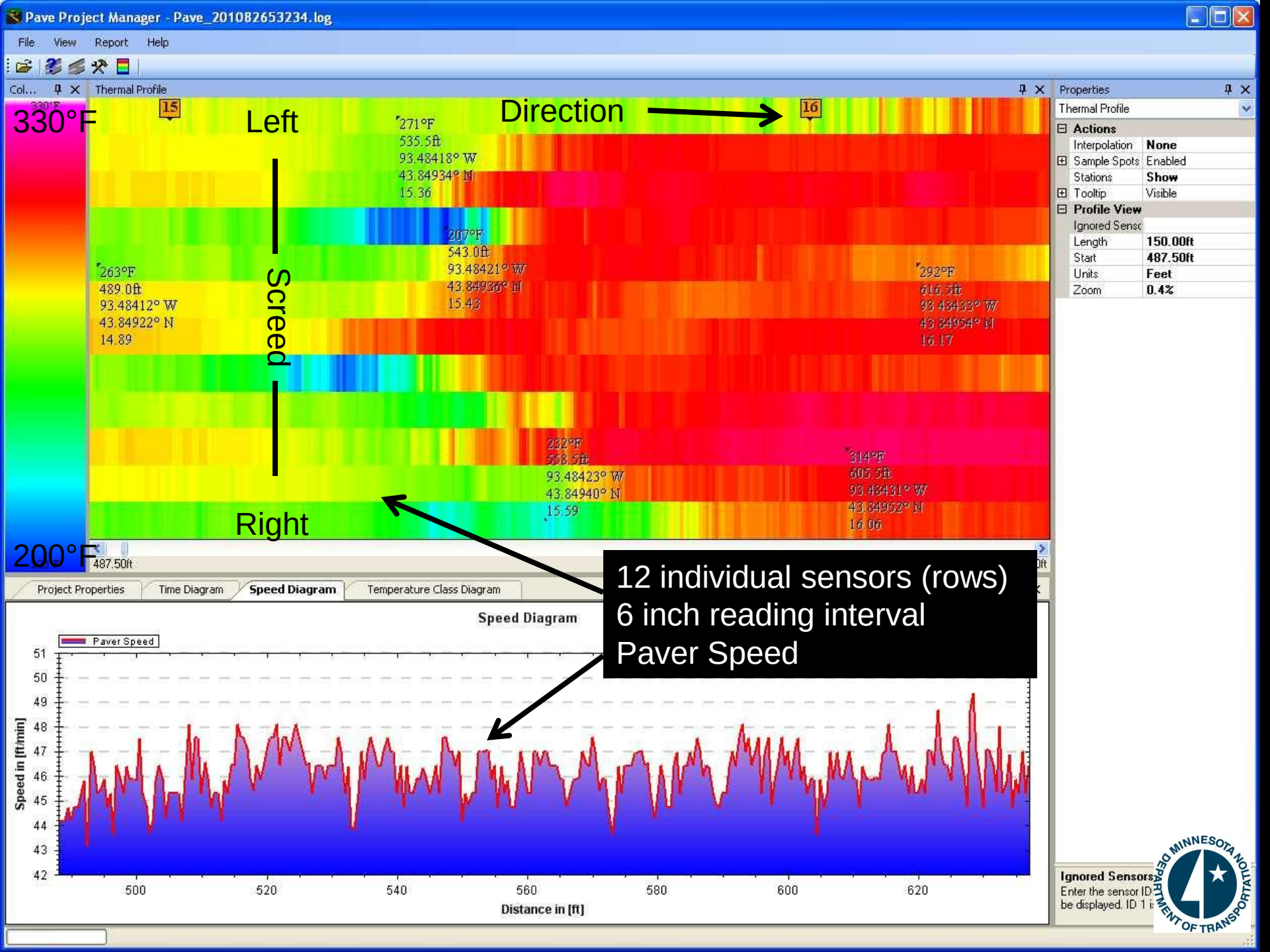
Ulland Brothers – TH 13

MOBA Pave-IR

12 sensors spaced 1 foot apart,
reading interval = every 6 inches

What will this technology do for you?

- Identify in real time if you have temperature segregation related issues due to:
  - End of truck
  - Streaks – paver/plant adjustments
  - Random – small clumps
  - Production temperature


Pave Project Manager - Pave_201082653234.log
File
View
Report
Help
Thermal Profile
330°F
200°F
Left
Right
Direction
Screed
15
16
271°F
535.5ft
93.48418° W
43.84934° N
15.36
207°F
543.0ft
93.48421° W
43.84936° N
15.43
263°F
489.0ft
93.48412° W
43.84922° N
14.89
292°F
616.5ft
93.48433° W
43.84954° N
16.17
232°F
558.5ft
93.48423° W
43.84940° N
15.59
314°F
605.5ft
93.48431° W
43.84952° N
16.06
487.50ft
Properties
Thermal Profile
Actions
Interpolation None
Sample Spots Enabled
Stations Show
Tooltip Visible
Profile View
Ignored Sensc
Length 150.00ft
Start 487.50ft
Units Feet
Zoom 0.4%
Project Properties
Time Diagram
Speed Diagram
Temperature Class Diagram
Speed Diagram
Paver Speed
Speed in [ft/min]
51
50
49
48
47
46
45
44
43
42
500
520
540
560
580
600
620
Distance in [ft]
12 individual sensors (rows)
6 inch reading interval
Paver Speed
Ignored Sensors
Enter the sensor ID
be displayed. ID 1 i
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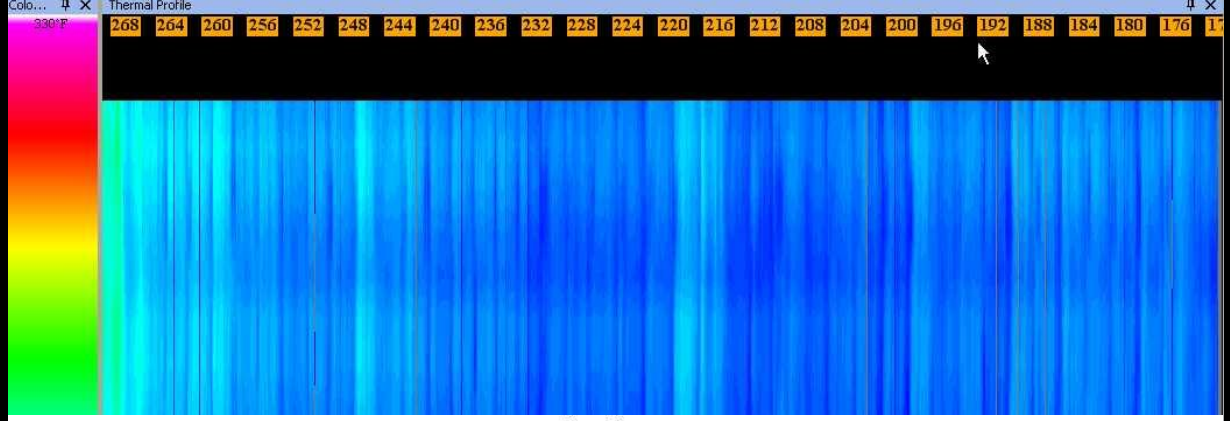
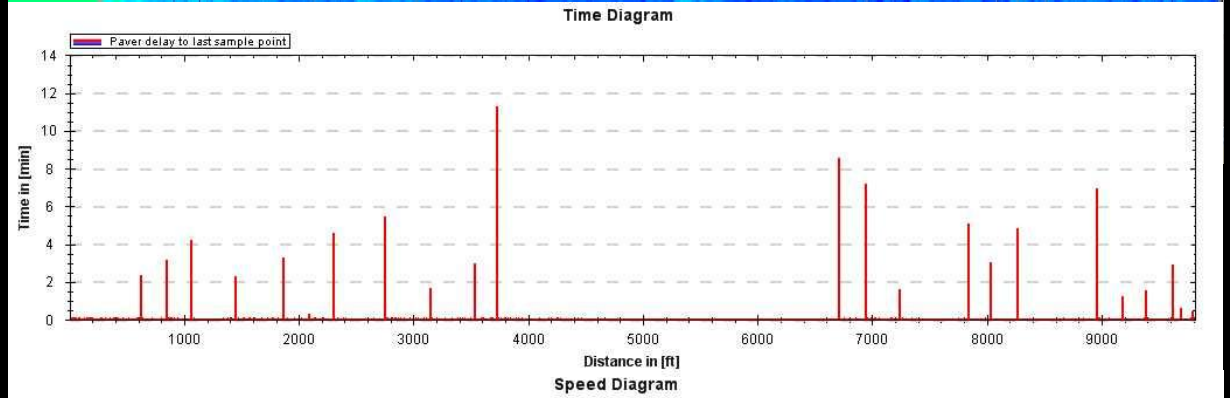
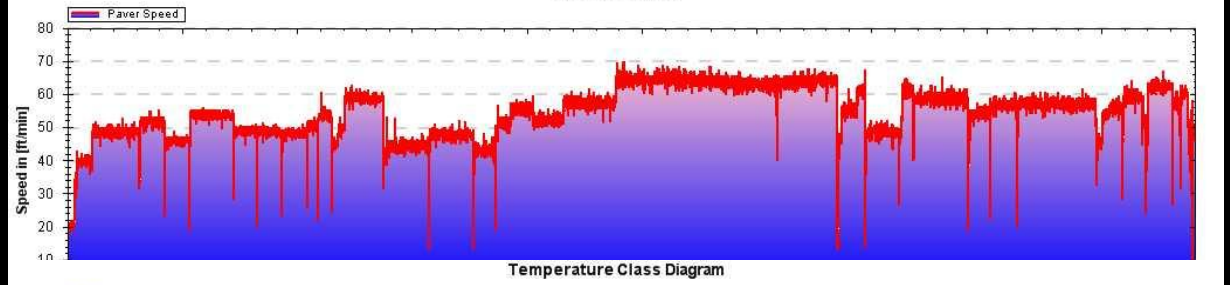
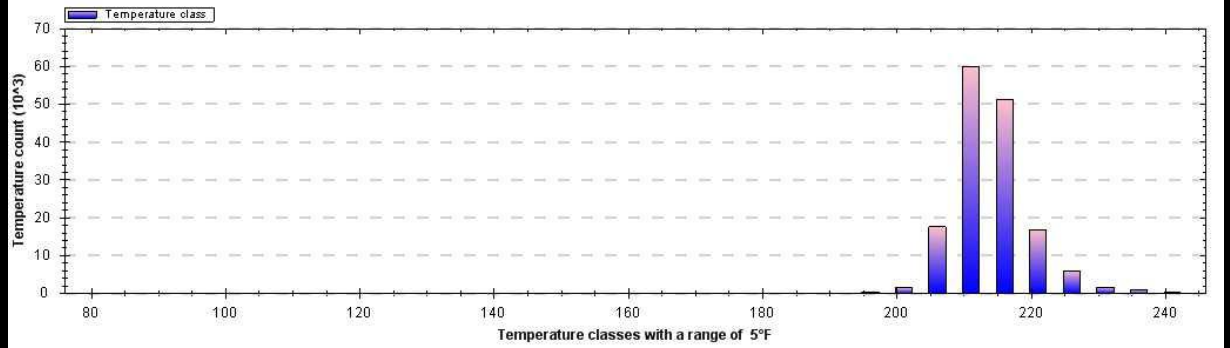






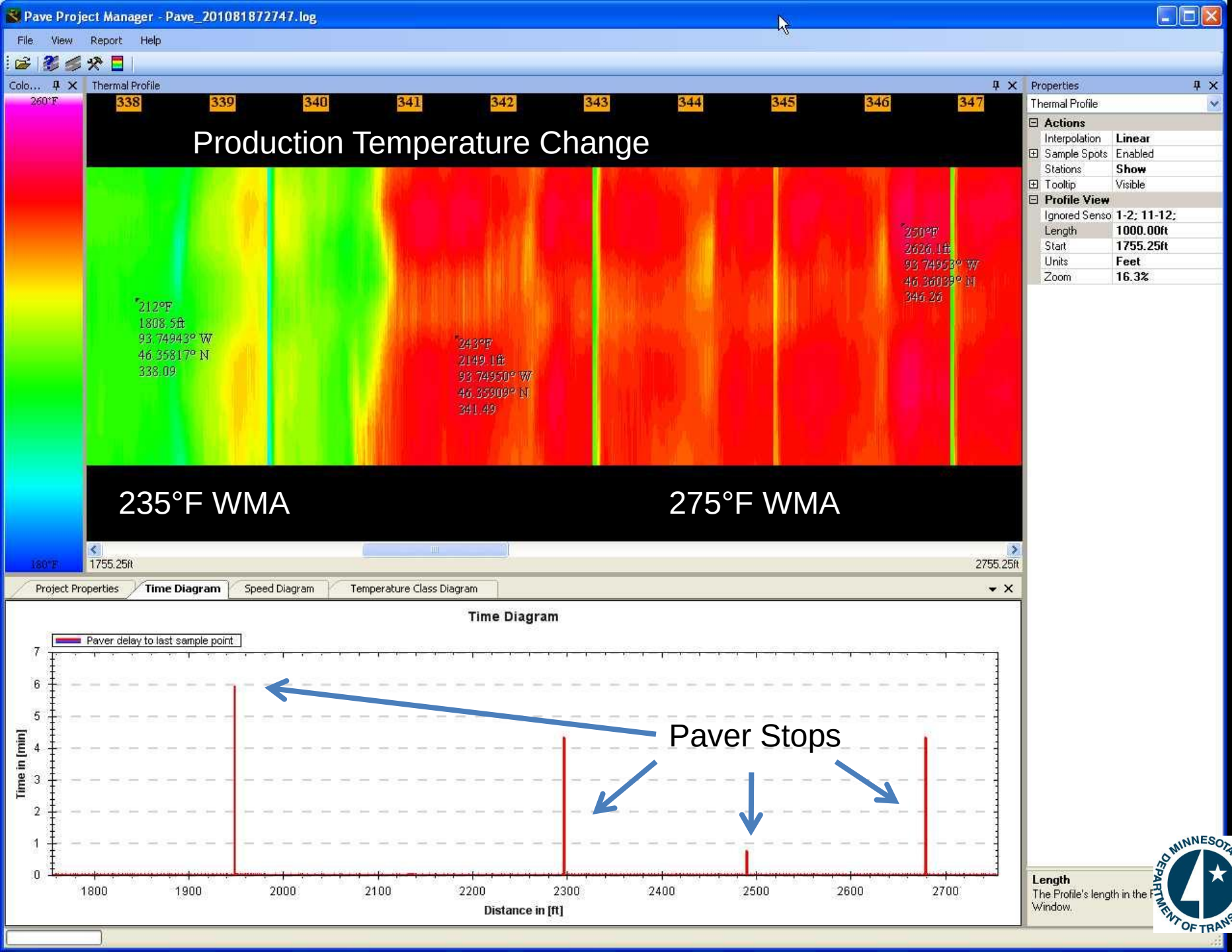


<u>Duration</u>
4 hr 30 min

<u>Paver Stops Total</u>
1 hr 25 min

<u>Avg. Paver Speed</u>
36 ft./min

<u>Surface Temp</u>


Pave Project Manager - Pave_201081872747.log
File View Report Help
Thermal Profile
338 339 340 341 342 343 344 345 346 347
Production Temperature Change
212°F
1808.5ft
93.74943° W
46.35817° N
338.09
243°F
2149.1ft
93.74950° W
46.35909° N
341.49
250°F
2626.1ft
93.74953° W
46.36039° N
346.26
235°F WMA
275°F WMA
1755.25ft
2755.25ft
Properties
Thermal Profile
Actions
Interpolation Linear
Sample Spots Enabled
Stations Show
Tooltip Visible
Profile View
Ignored Senso 1-2; 11-12;
Length 1000.00ft
Start 1755.25ft
Units Feet
Zoom 16.3%
Project Properties
Time Diagram
Speed Diagram
Temperature Class Diagram
Time Diagram
Paver delay to last sample point
Time in [min]
Distance in [ft]
1800 1900 2000 2100 2200 2300 2400 2500 2600 2700
Paver Stops
Length
The Profile's length in the F
Window.
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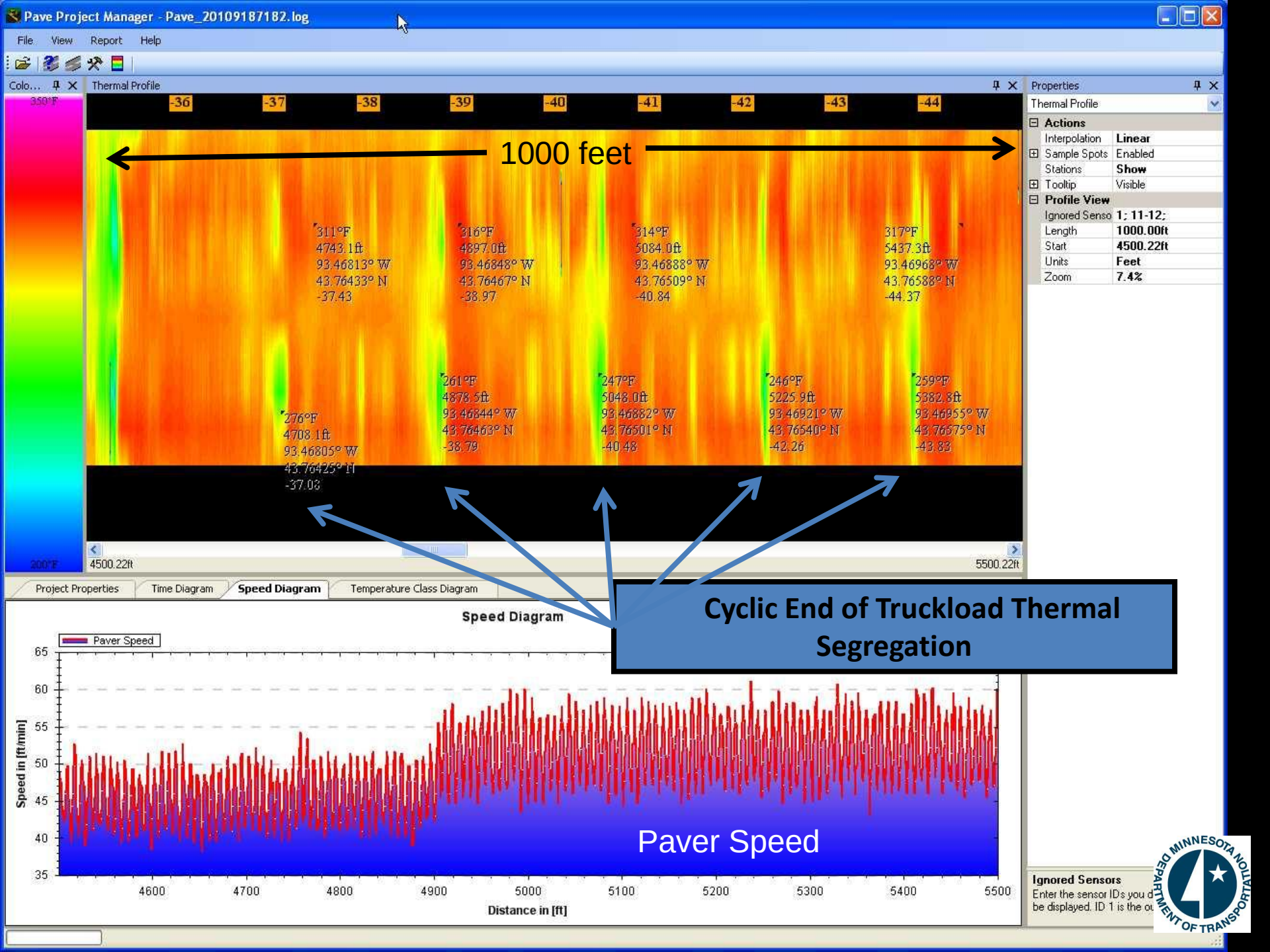
Pave Project Manager - Pave_20109187182.log
File
View
Report
Help
Thermal Profile
-36
-37
-38
-39
-40
-41
-42
-43
-44
1000 feet
311°F
4743.1ft
93.46813° W
43.76433° N
-37.43
316°F
4897.0ft
93.46848° W
43.76467° N
-38.97
314°F
5084.0ft
93.46888° W
43.76509° N
-40.84
317°F
5437.3ft
93.46968° W
43.76588° N
-44.37
276°F
4708.1ft
93.46805° W
43.76425° N
-37.03
261°F
4878.5ft
93.46844° W
43.76463° N
-38.79
247°F
5048.0ft
93.46882° W
43.76501° N
-40.48
246°F
5225.9ft
93.46921° W
43.76540° N
-42.26
259°F
5382.8ft
93.46955° W
43.76575° N
-43.83
4500.22ft
5500.22ft
Properties
Thermal Profile
Actions
Interpolation
Linear
Sample Spots
Enabled
Stations
Show
Tooltip
Visible
Profile View
Ignored Senso
1; 11-12;
Length
1000.00ft
Start
4500.22ft
Units
Feet
Zoom
7.4%
Project Properties
Time Diagram
Speed Diagram
Temperature Class Diagram
Speed Diagram
Paver Speed
Speed in [ft/min]
65
60
55
50
45
40
35
4600
4700
4800
4900
5000
5100
5200
5300
5400
5500
Distance in [ft]
Paver Speed
Cyclic End of Truckload Thermal Segregation
Ignored Sensors
Enter the sensor IDs you d
be displayed. ID 1 is the ou
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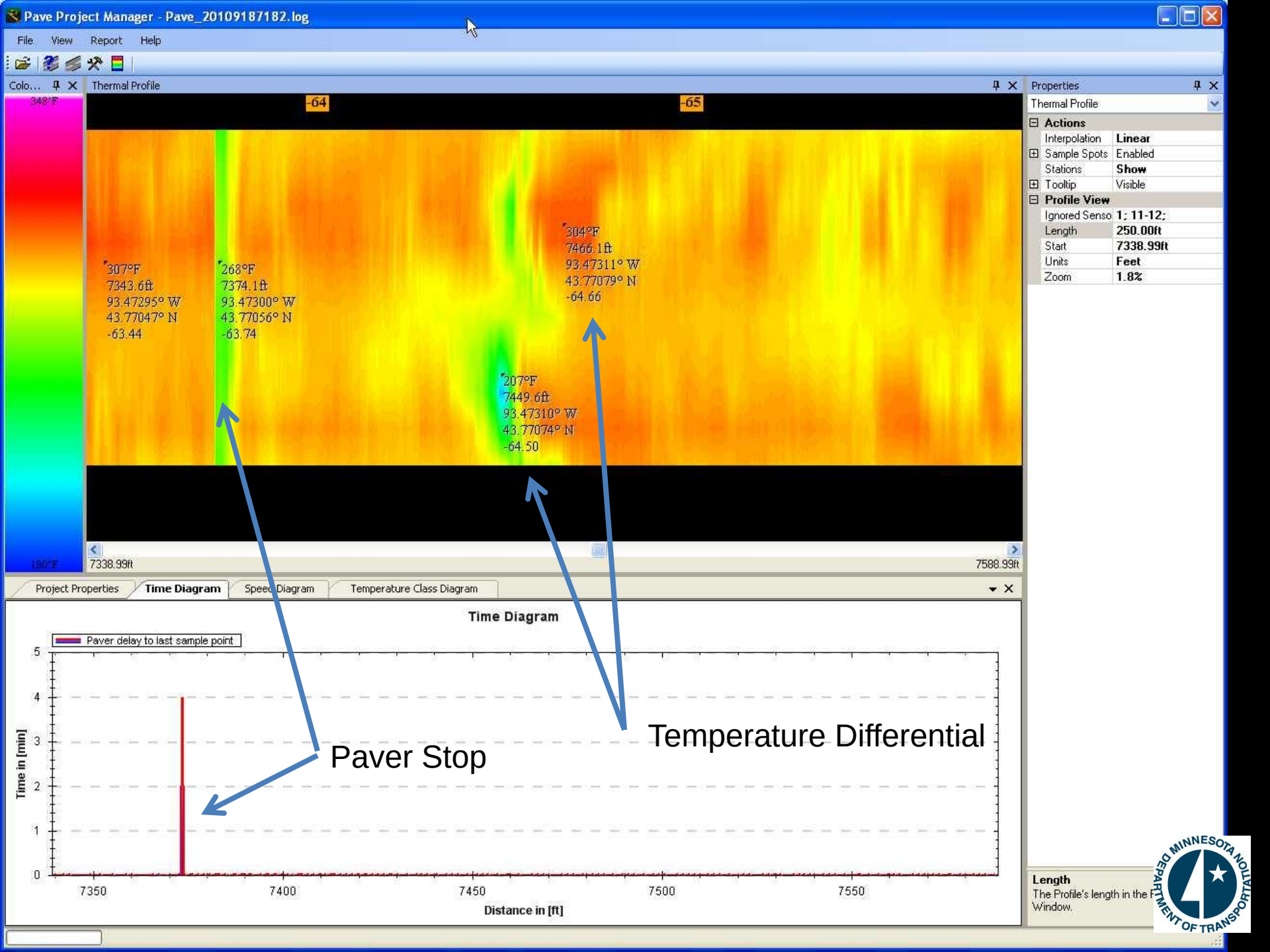
Pave Project Manager - Pave_20109187182.log
File
View
Report
Help
Thermal Profile
-64
-65
307°F
7343.6ft
93.47295° W
43.77047° N
-63.44
268°F
7374.1ft
93.47300° W
43.77056° N
-63.74
304°F
7466.1ft
93.47311° W
43.77079° N
-64.66
207°F
7449.6ft
93.47310° W
43.77074° N
-64.50
7338.99ft
7588.99ft
Properties
Thermal Profile
Actions
Interpolation Linear
Sample Spots Enabled
Stations Show
Tooltip Visible
Profile View
Ignored Senso 1; 11-12;
Length 250.00ft
Start 7338.99ft
Units Feet
Zoom 1.8%
Project Properties
Time Diagram
Temperature Class Diagram
Time Diagram
Paver delay to last sample point
Time in [min]
Distance in [ft]
7350
7400
7450
7500
7550
Paver Stop
Temperature Differential
Length
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Material Name:			
Producer:			
Area Engeneer:		Project Manager:	

Course/Lift:	1	Temperature Differential Threshold:	25.0
Segment Length (ft):	150	Sensors Ignored:	1, 12

Thermal Profile Results Summary

Number of Profiles	Moderate 25.0°F < differential <= 50.0°F		Severe differential > 50.0°F	
156	Number	Percent	Number	Percent
	15	10	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	646.00	93.73985 W, 46.44106 N	647.50	93.73963 W, 46.44143 N	268.2	253.6	14.6
2	647.50	93.73963 W, 46.44143 N	649.00	93.73937 W, 46.44181 N	270.9	258.1	12.8
3	649.00	93.73937 W, 46.44181 N	650.50	93.73911 W, 46.44217 N	270.7	251.6	19.1
4	650.50	93.73911 W, 46.44217 N	652.00	93.73888 W, 46.44255 N	278.2	258.4	19.8
5	652.00	93.73888 W, 46.44255 N	653.50	93.73862 W, 46.44291 N	278.4	255.6	22.9
6	653.50	93.73862 W, 46.44291 N	655.00	93.73838 W, 46.44329 N	278.8	261.1	17.6
7	655.00	93.73838 W, 46.44329 N	656.50	93.73814 W, 46.44365 N	279.9	267.3	12.6
8	656.50	93.73814 W, 46.44365 N	658.00	93.73788 W, 46.44402 N	281.7	263.7	18.0
9	658.00	93.73788 W, 46.44402 N	659.50	93.73765 W, 46.44440 N	279.9	264.9	14.9

Location of Paver Stops greater than One Minute

Location (stations)	Duration (h:min:sec)
697.16	0:3:35
703.20	0:4:52
707.66	0:7:36
710.07	0:9:12
717.48	0:4:18
731.04	0:5:13
735.79	0:6:5
744.82	0:8:0
747.03	0:9:2
749.58	0:4:41
753.99	0:7:32
757.81	0:6:26
766.32	0:3:32

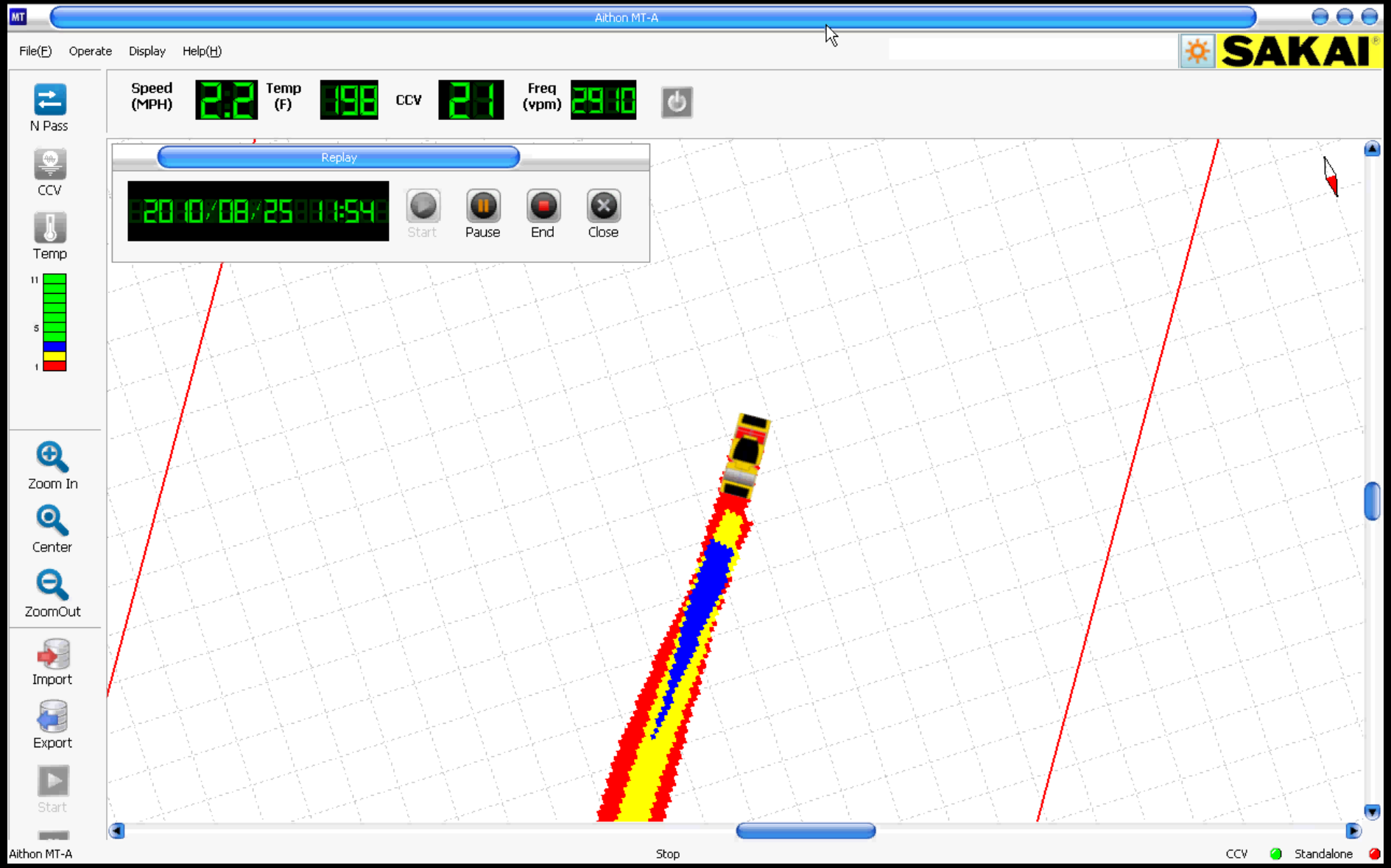
IC Roller & Display

What Data is Collected

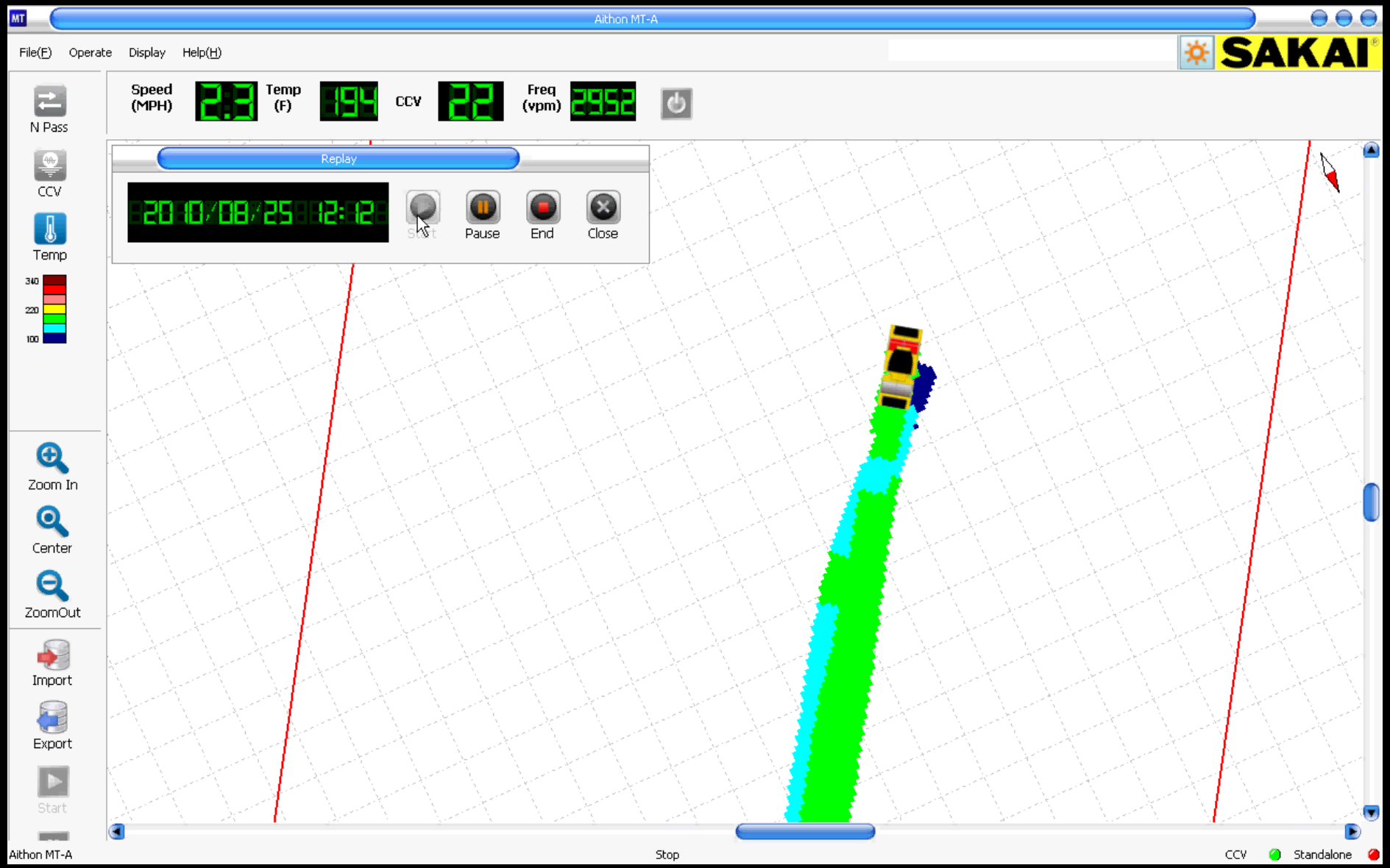
- GPS Coordinates (Location)

- Collects all data, but only displays the following data if drum is vibrating.
- Mat Temperature (in front of lead drum)
- Number of Passes
- Material Stiffness

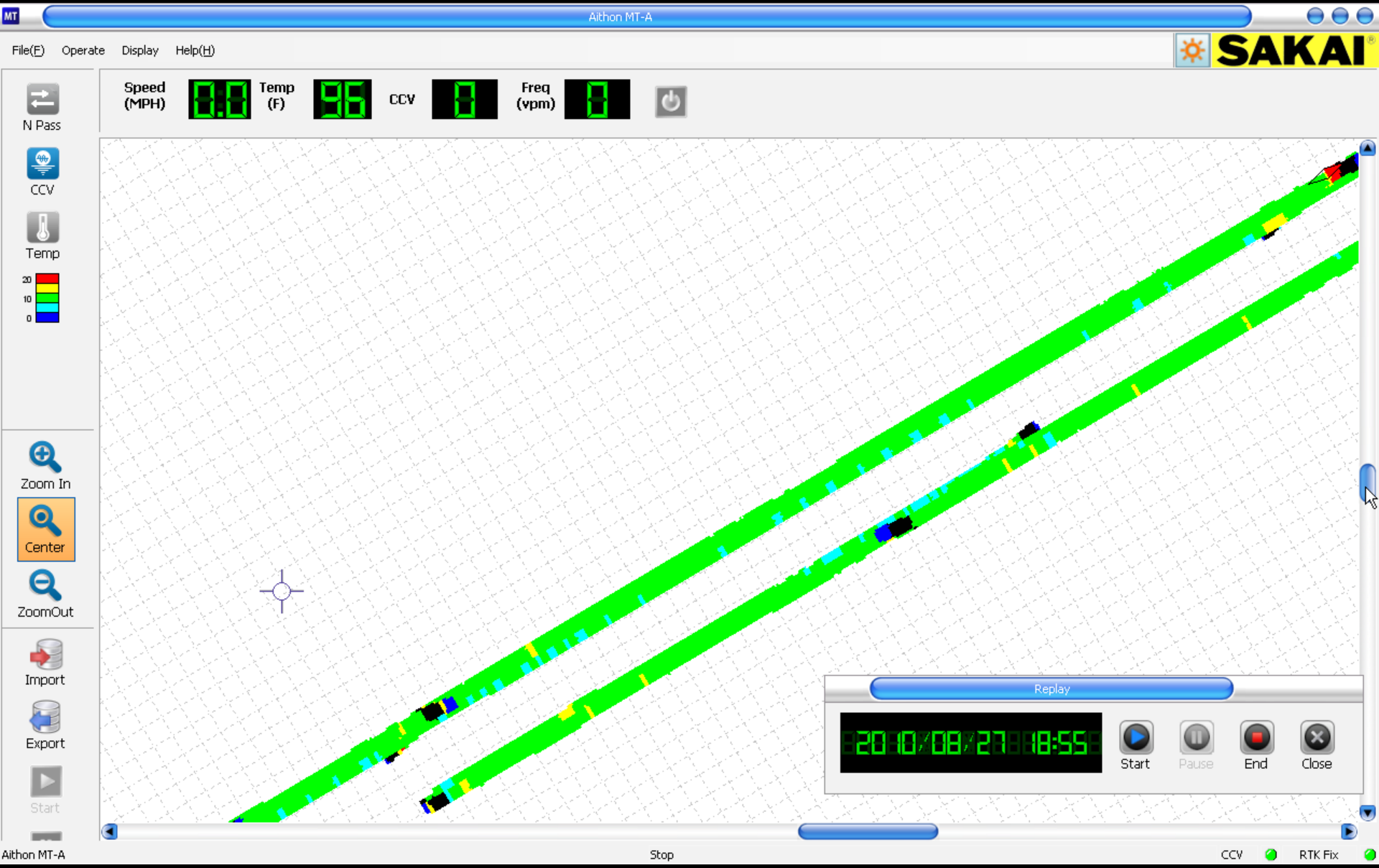
Roller – Number of Passes

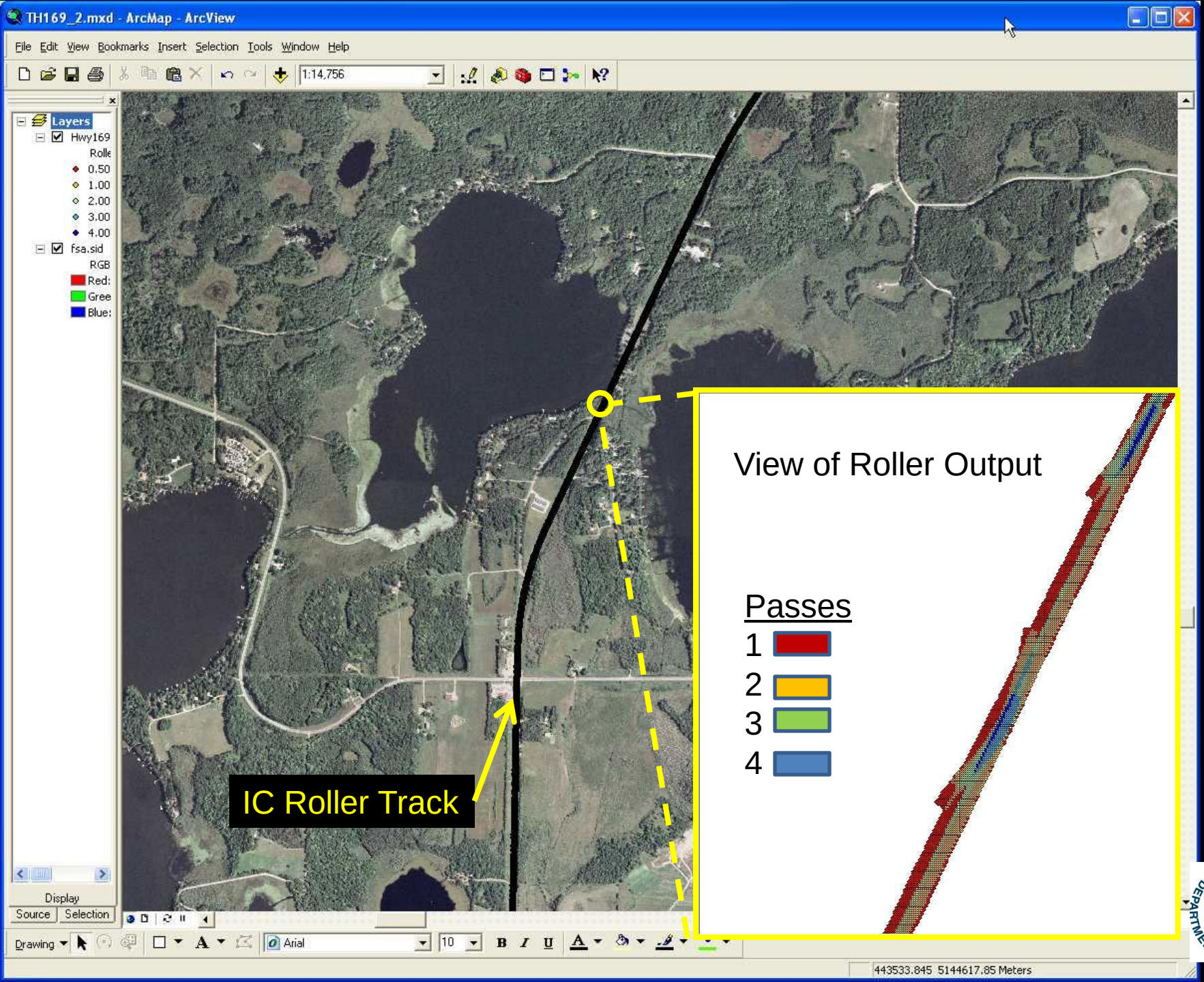


Roller – Temperature



Roller – Compaction Value




TH169_2.mxd - ArcMap - ArcView
File Edit View Bookmarks Insert Selection Tools Window Help
1:14,756
Layers
Hwy169
Rolle
0.50
1.00
2.00
3.00
4.00
fsa.sid
RGB
Red:
Gree
Blue:
Display
Source
Selection
Drawing
Arial
10
IC Roller Track
View of Roller Output
Passes
1
2
3
4
443533.845 5144617.85 Meters

What is Gained?

- Values of mapping existing support before construction or overlay
- Significant improvements of rolling patterns, thus, consistent products
- Improvement of roller operators' accountability
- Measurement influence depth varies depending on technology and site conditions

Benefits of Intelligent Compaction

- Improve density –better performance
- Improve efficiency – cost savings
- Increase information – better QC/QA
- Overall benefit – improved pavement performance
- Shortcomings of density acceptance process
  - Limited number of locations
  - After compaction is complete

Next?

- Pave-IR
  - Encourage its use as a construction aid to reduce thermal segregation
- Roller IC
  - Install a retro fit system on an entire roller train

TH 18 (169) Elk River, 1920's

Questions?