# Intelligent Compaction

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# Overview

- What is Intelligent Compaction (IC)
  - Systems available
- APAC's experience
- MODOT  IC study
  - APAC's 63 Boone County project

# What is IC?

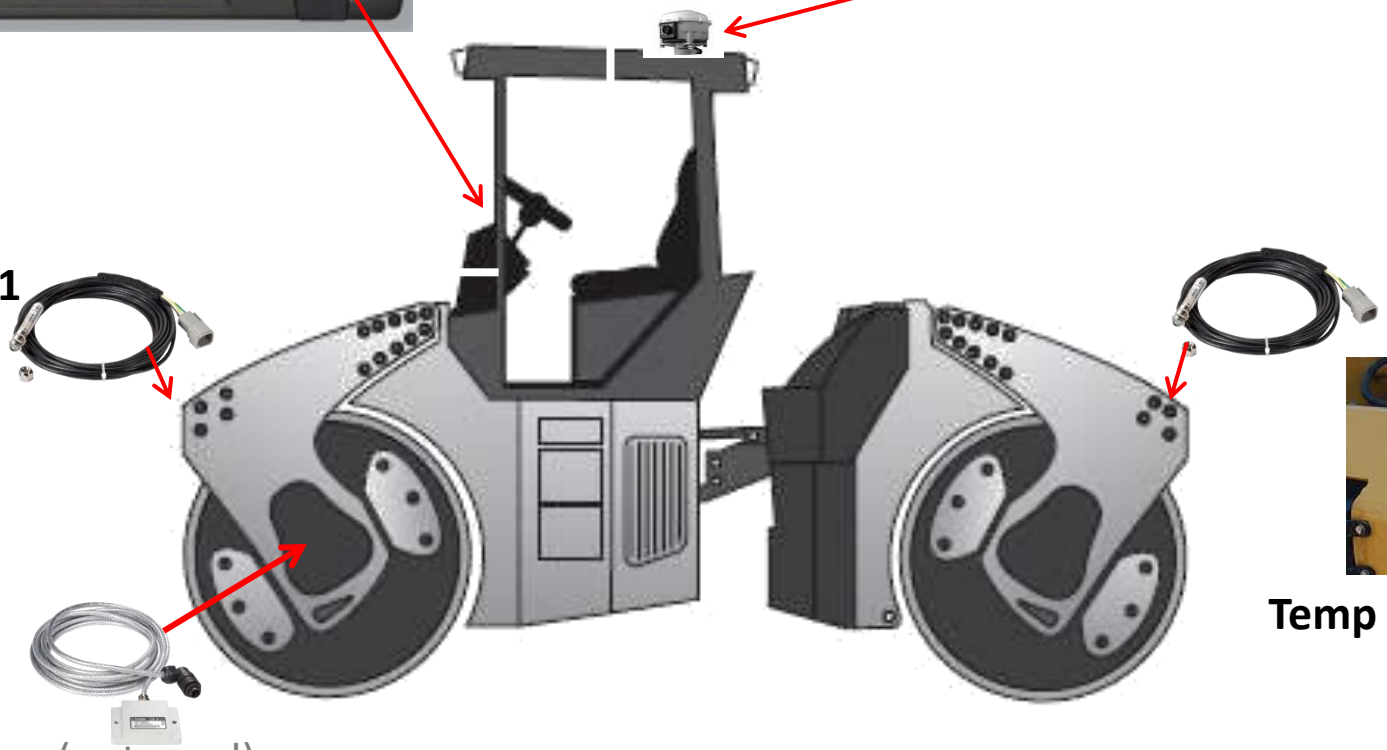
- Compaction of road materials using vibratory rollers equipped with
  - onboard computer reporting system
  - Global Positioning System (GPS) based mapping
- Facilitates real-time monitoring and adjustments to the compaction process
  - integrates measurement, documentation, and control systems
- Maintains a continuous record of color-coded plots of
  - precise location of the roller
  - number of roller passes
  - material stiffness measurements
- Compaction is one of the most important processes in roadway construction.
  - necessary to attain high quality and uniformity of pavement materials
  - Uniform densities are key
  - IC helps optimizing the compaction process

# Asphalt IC equipped rollers

# Trimble CCS Flex

Operator control box


GPS

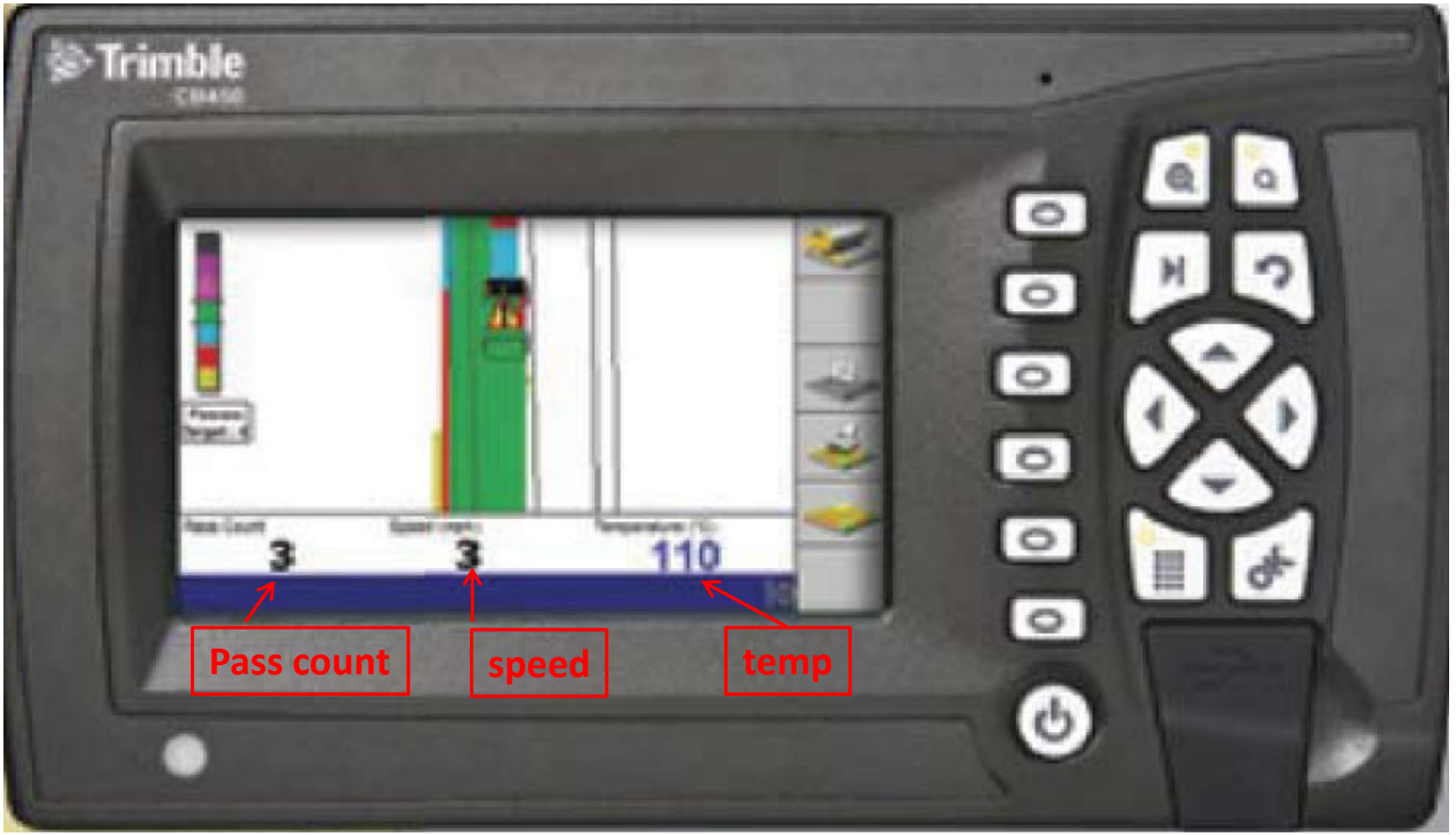


Temp sensor 1

Temp sensor 2

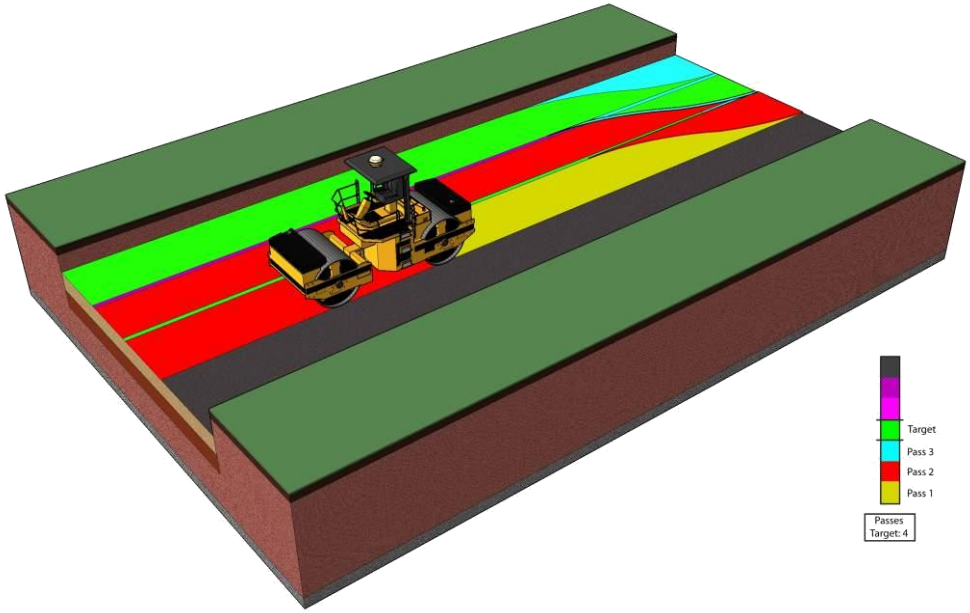
Accelerometer (not used)

# Trimble **CB450**
## operator view



# Pass Count Mapping

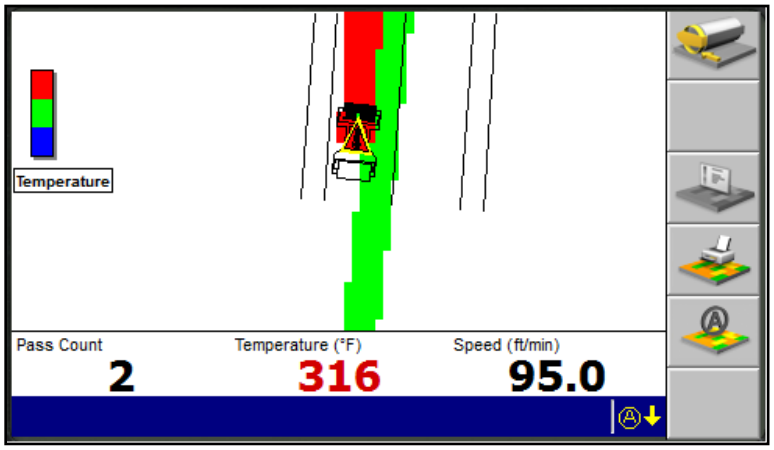
- Takes guesswork out of asphalt compaction
  - More consistent compaction effort to target pass count
  - Increased productivity by using the most efficient rolling pattern

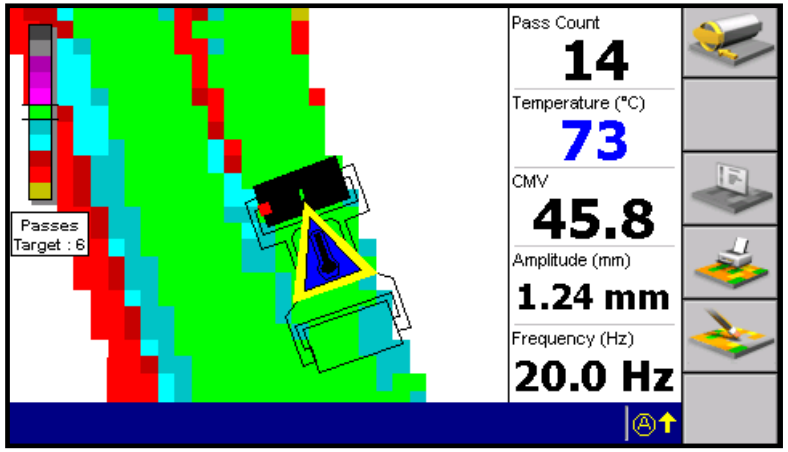


# Temperature Mapping

## Infrared Sensor

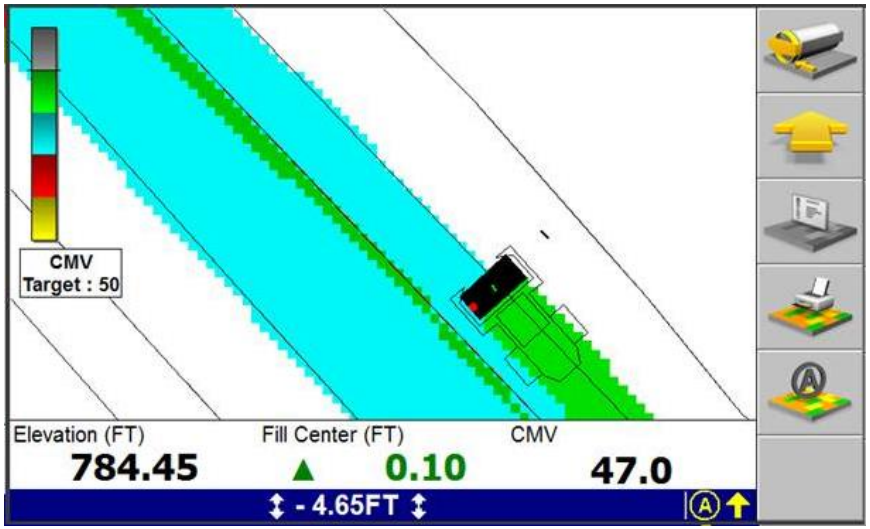
- Provides temperature maps
- User-defined high/low temp warnings
- Operator can watch pass counts and temperature **warnings** on the same screen

# Compaction Meter Value (CMV)

- Trimble CM310 Accelerometer that measures stiffness of the mat
  - Important to note that it is *not* a measure of density




# IC DATA analysis

- **VisionLink**
  - VisionLink by Trimble is the web application that displays data collected from a Product Link unit installed on a machine.
- **Veda**
  - Veda is a map-based tool for viewing and analyzing geospatial data, currently funded by MNDot

# APAC's experience

- 2013 Roller Demo
  - No investment to learn the system: hardware or software
    - No crew interest

- 2014
  - Backlog: ~$250,000 potential density bonus
  - New interest!
  - MODOT ICDM workshop
  - More control of compaction
  - High recycle mixes…compaction challenges
    - Keep up with mix changes
  - Eliminate "density checker?"
  - Trimble CCS Flex

# 2014 MODOT IC Study

- Proof of Concept
  - Hwy 63 Boone County
    - Mapping
      - 2 shifts covered, 2 uncovered
    - Trimble IC system
    - Veda
    - MOBA Pave IR


# 63 Boone County


- +80,000 tons SP125C mill/fill
- Night paving
- 3 double drum rollers, 1 pneumatic roller
  - 1 Volvo DD120 w/ Trimble IC System
  - 2 Cat CB64s w/ Trimble IC System

# Roller Operator “cheat sheet”


❶ Power button
❷ Softkey label area
❸ Softkeys
❹ Next key
❺ Zoom-in key
❻ Beeper
❼ Zoom-out key
❽ Escape key
❾ Arrow keys
❿ OK key
⓫ USB flash drive port
⓬ Menu key

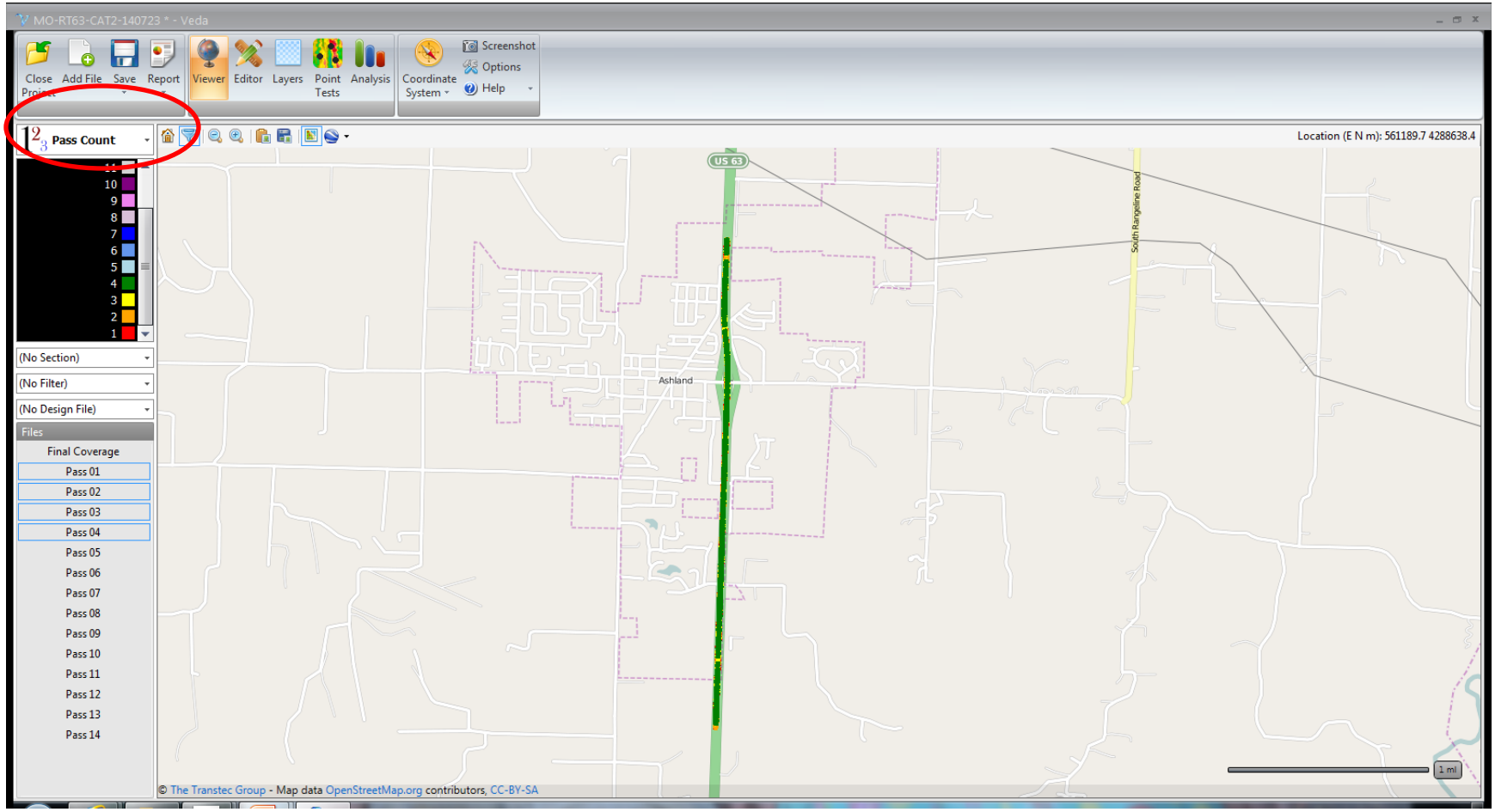
1. **Set up Design:**
   - Press Menu
   - Highlight “Select Design”. Press OK
   - Using the softkey, select “new map”

     CAT 1: Select “use last”, press OK
   - Key in design name (yymmdd C1, C2, or V) using arrow keys
     - ← backspace, ↕select characters, →next/space
   - Press OK then OK again to get back to main menu
   - Press Escape Key
2. **Adjust Brightness**
   - Hold Menu Key
   - Press Zoom-in/Zoom-out to adjust brighter or dimmer
3. **Mapping**
   - Press 2nd soft key from the bottom
   - Icon to the left will be color when mapping is on, gray when off

     Turn mapping off when not in a roller pattern
4. **Adjust Pass Count (only if instructed)**
   - Press Menu
   - Highlight “mapping/recording”, press OK
   - Use arrow keys to change pass count
   - Press OK then press Escape to get to main view

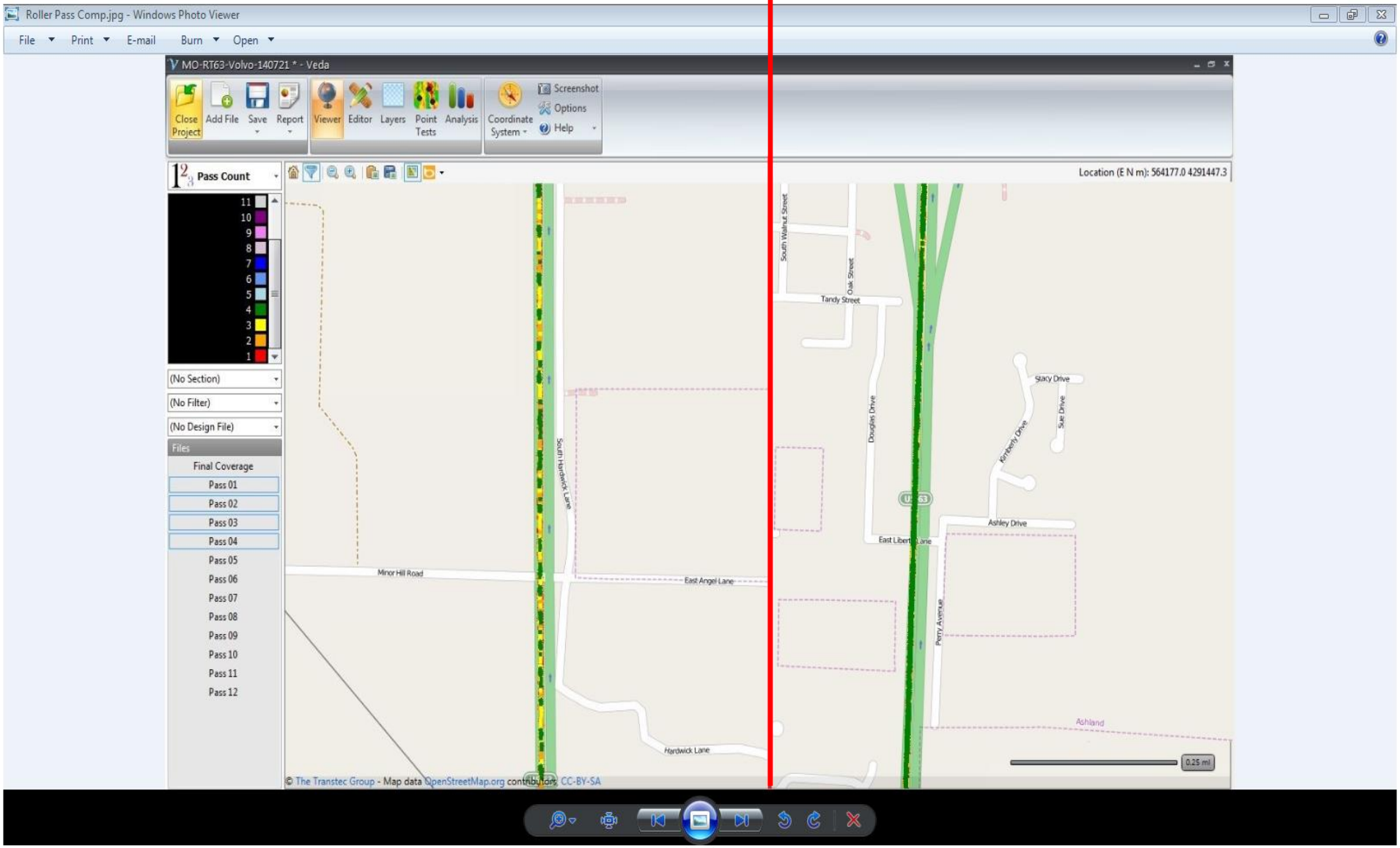
# VEDA screenshot study area

Pass count

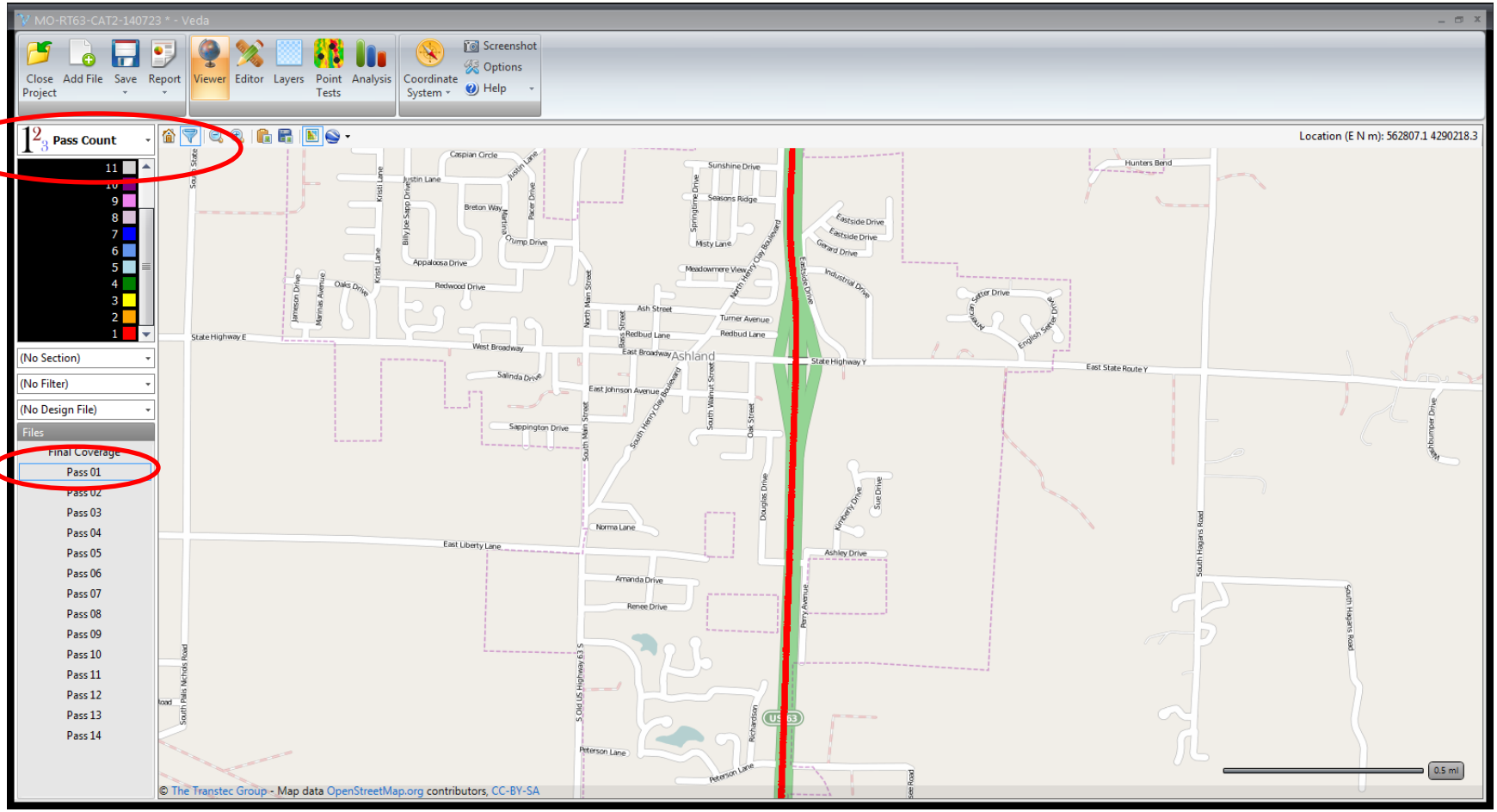


# Screen covered

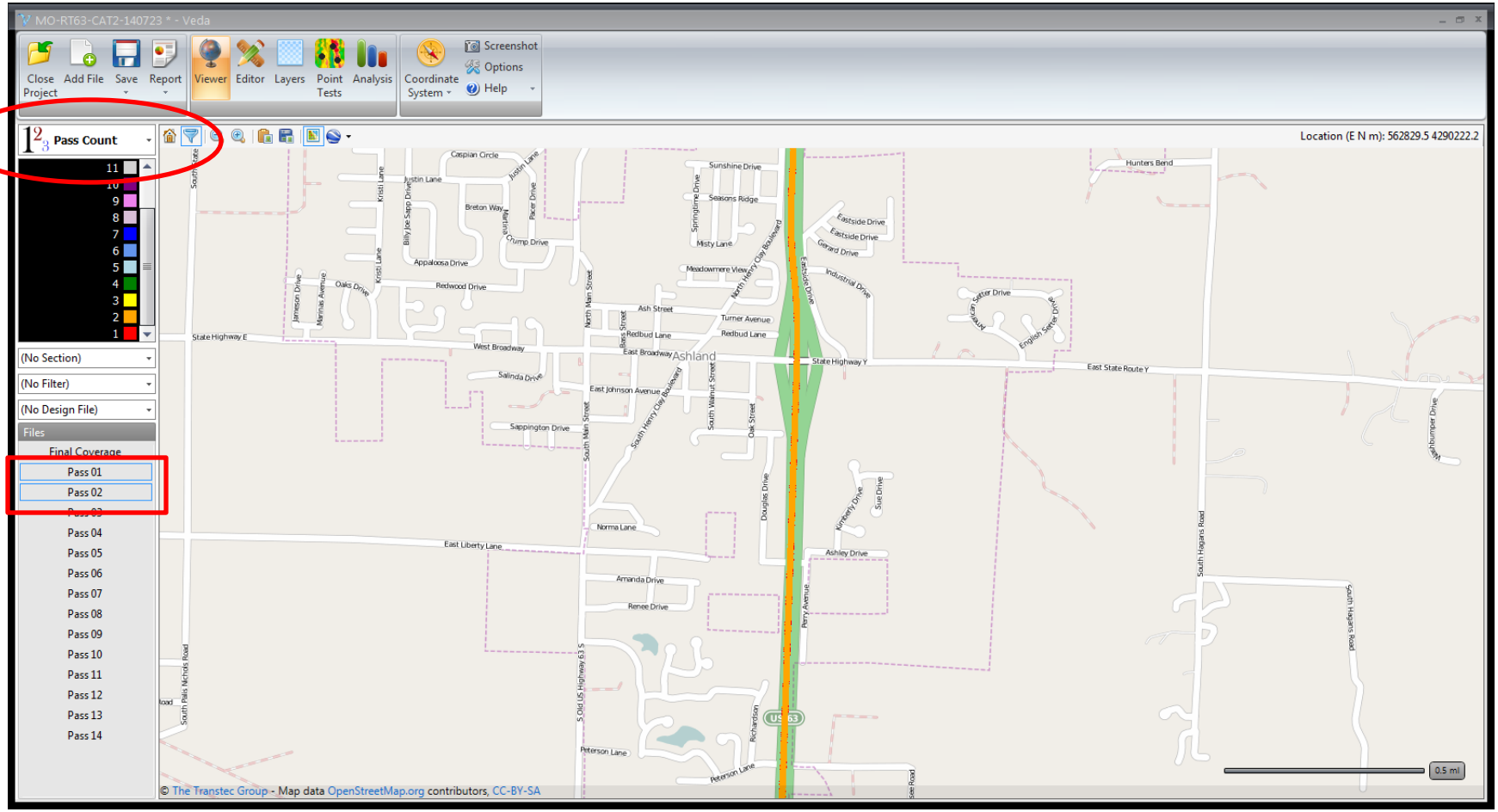
# Screen uncovered



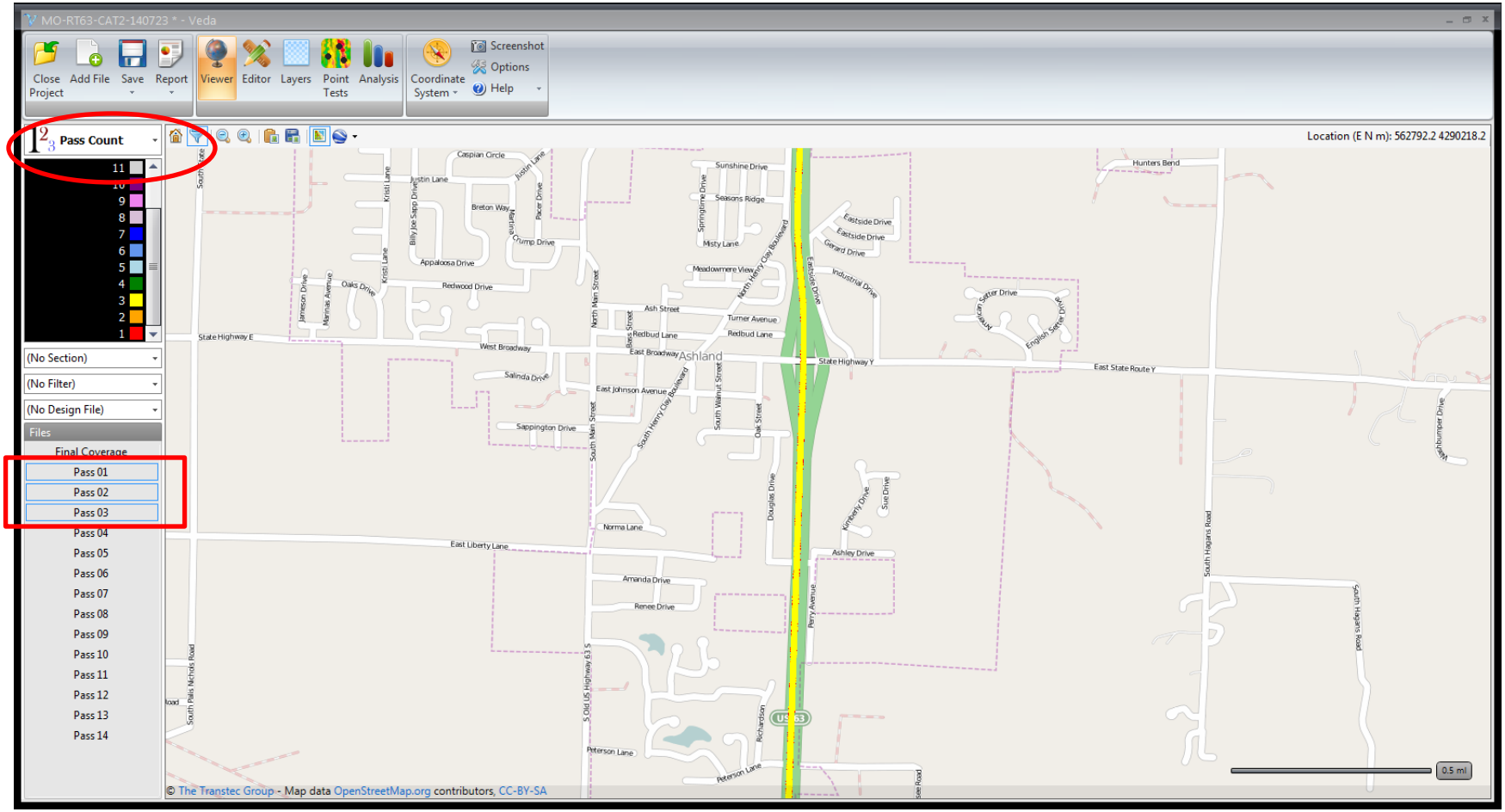
# Veda pass count 1



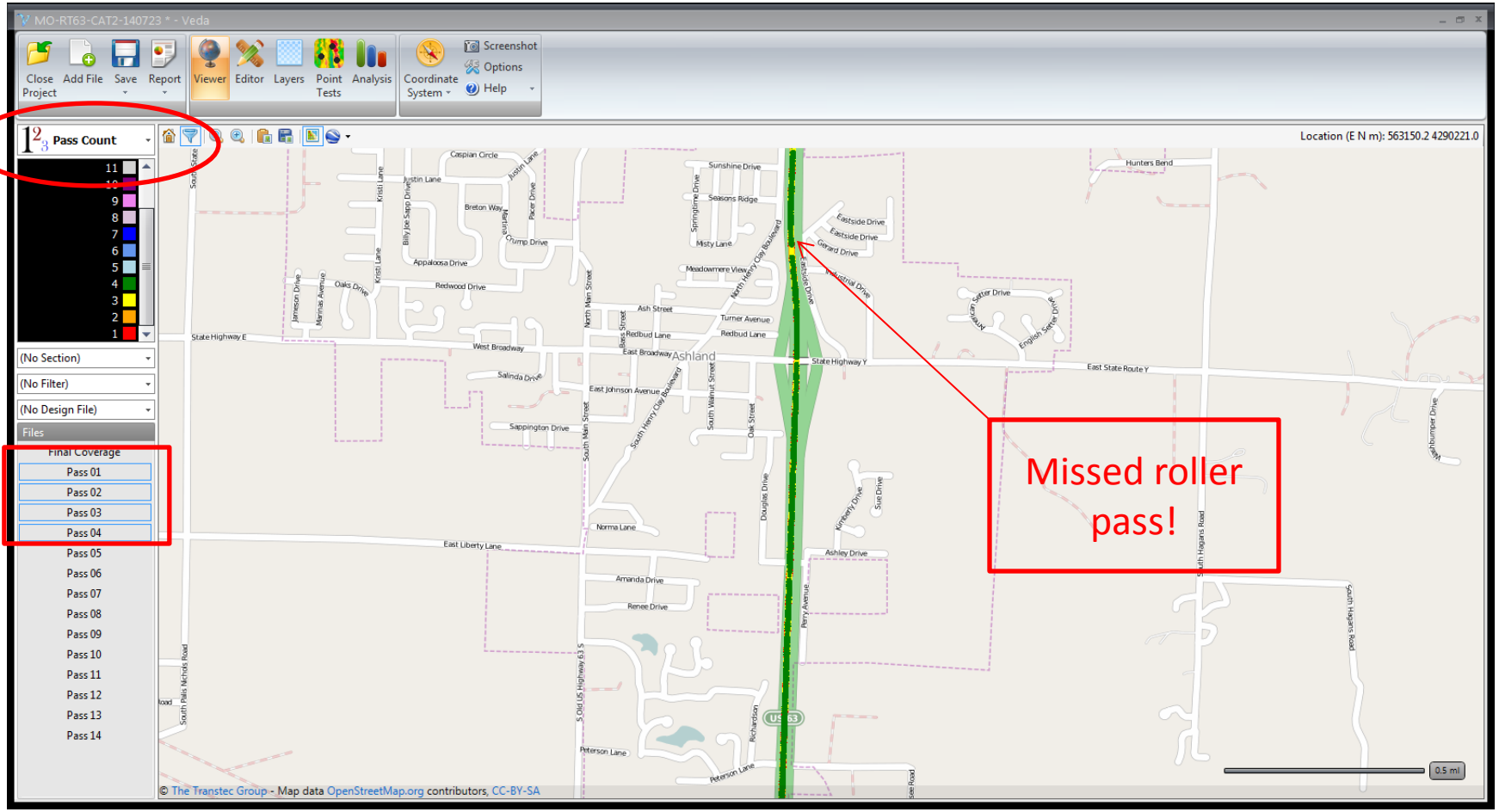
# Veda pass count 2



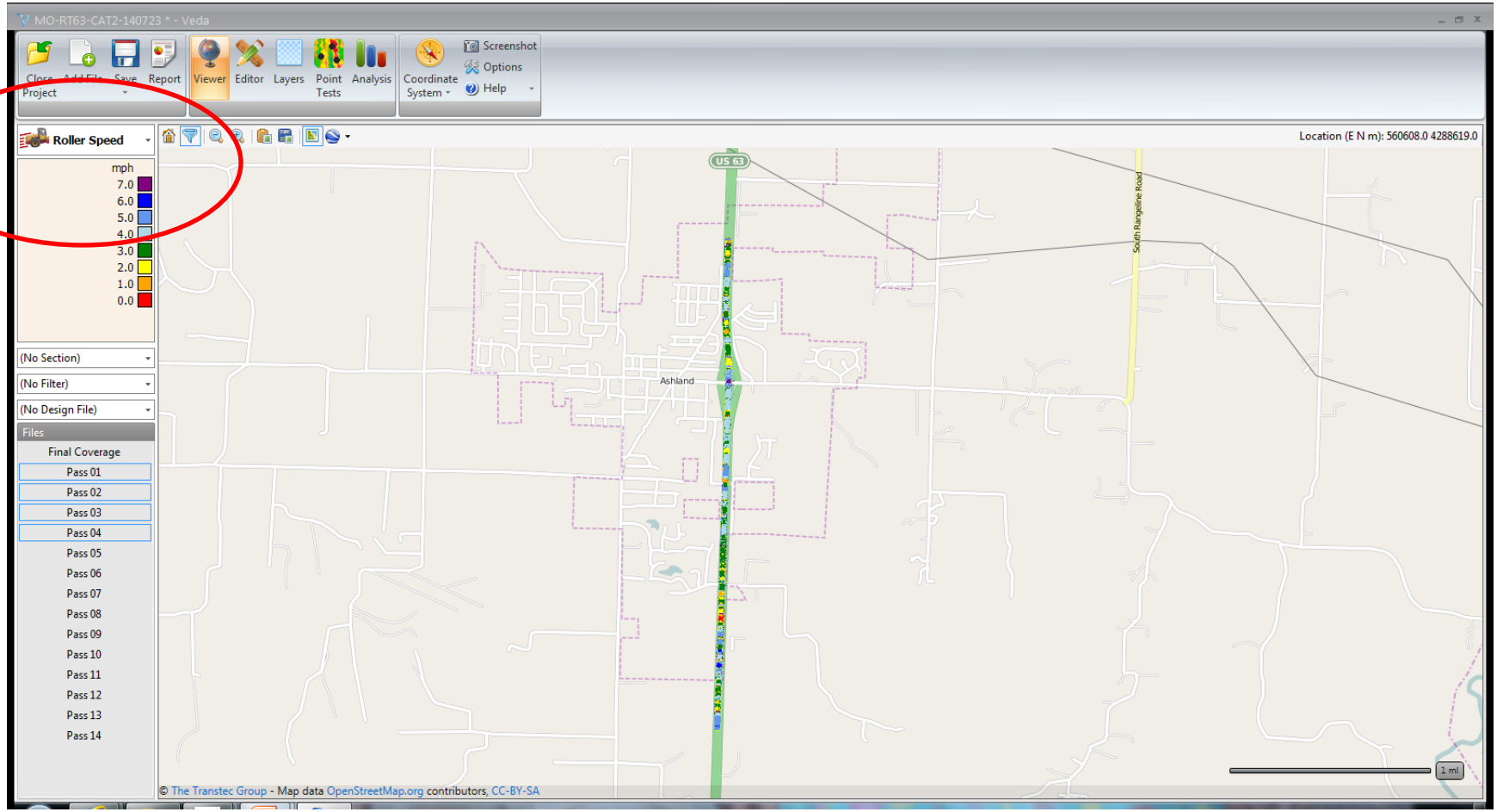
# Veda pass count 3



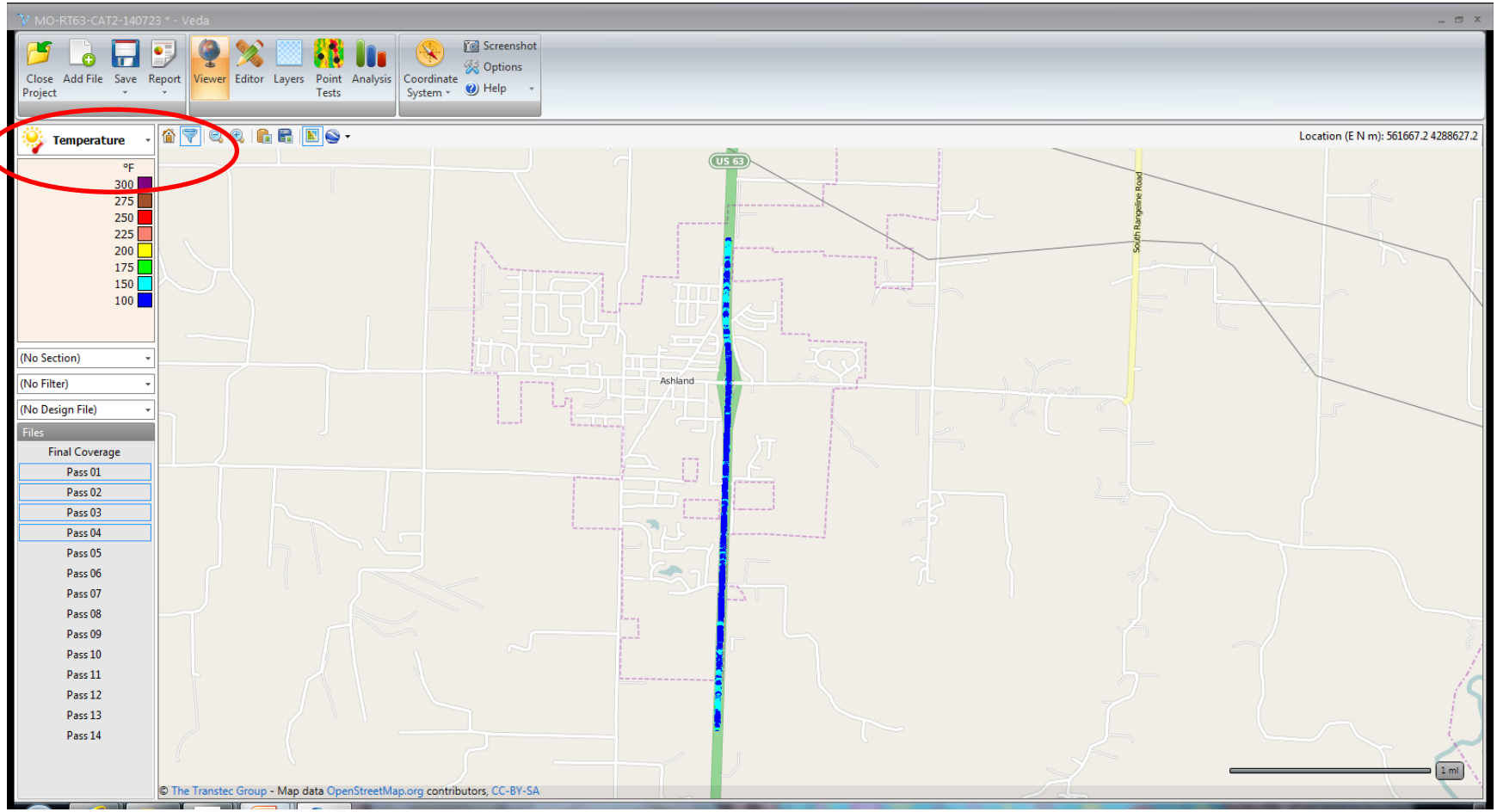
# Veda pass count 4



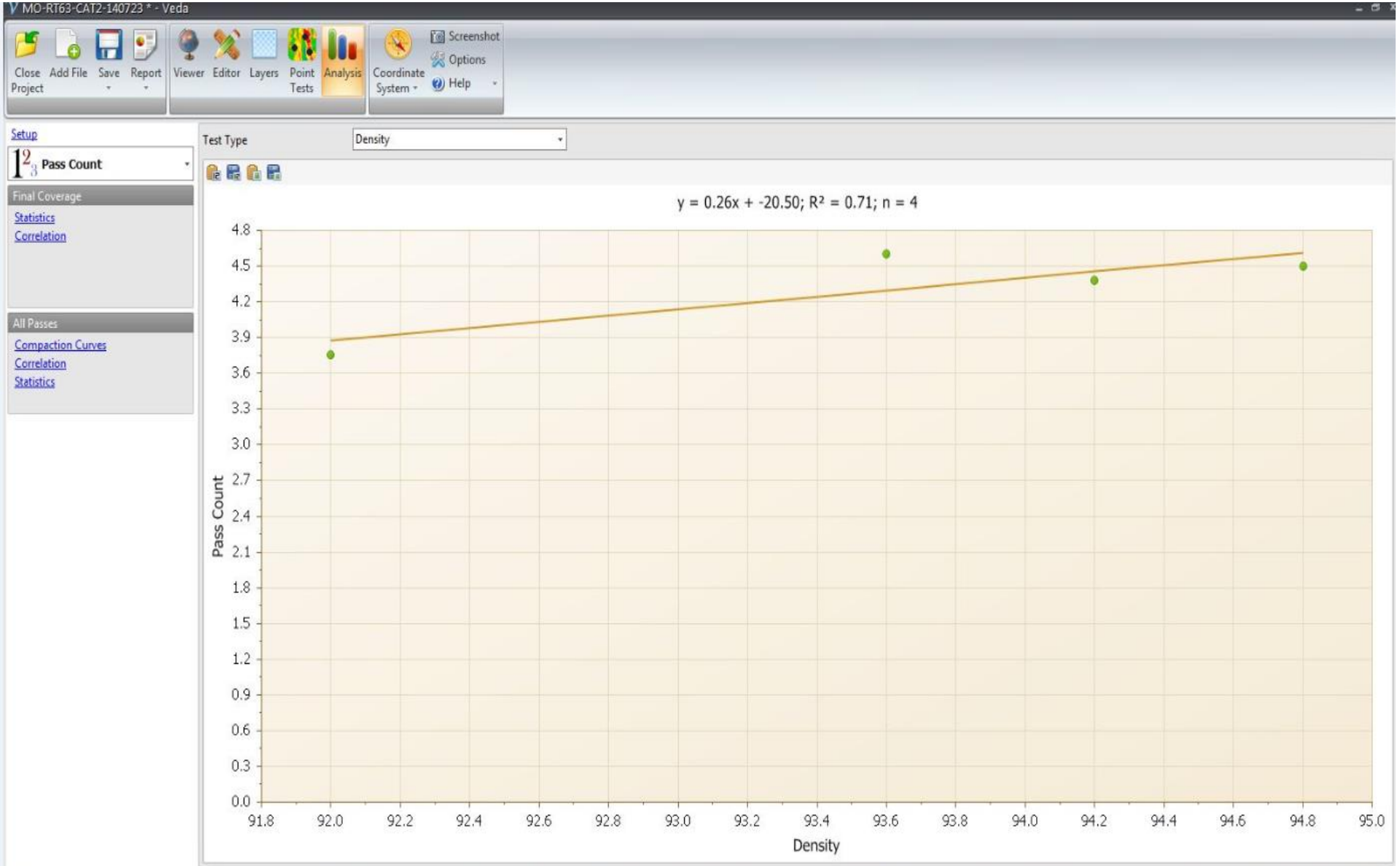
# Roller speed



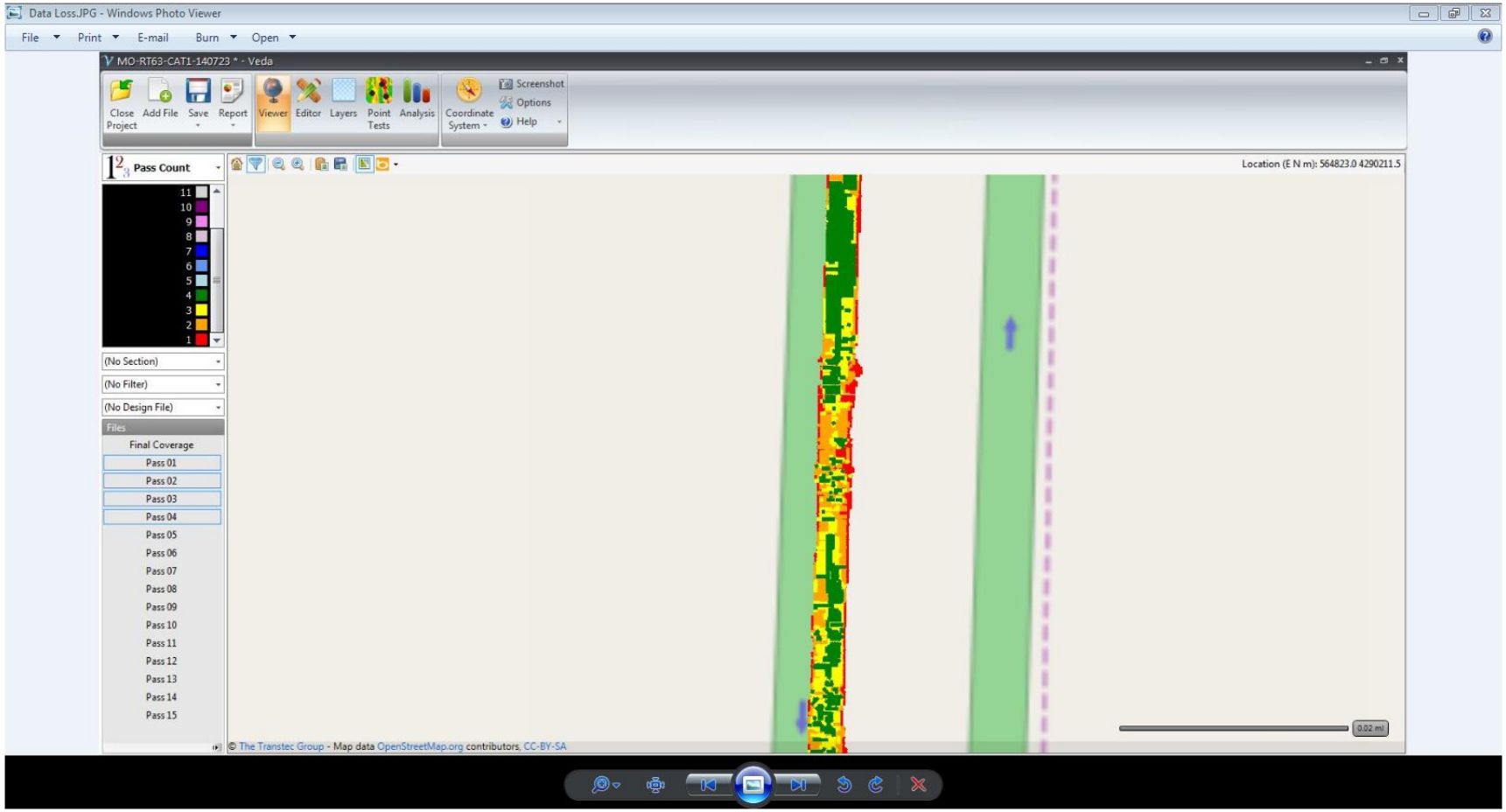
# Rolling temperature



# Density results

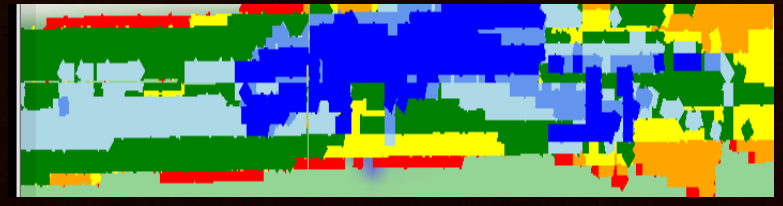


# Data loss

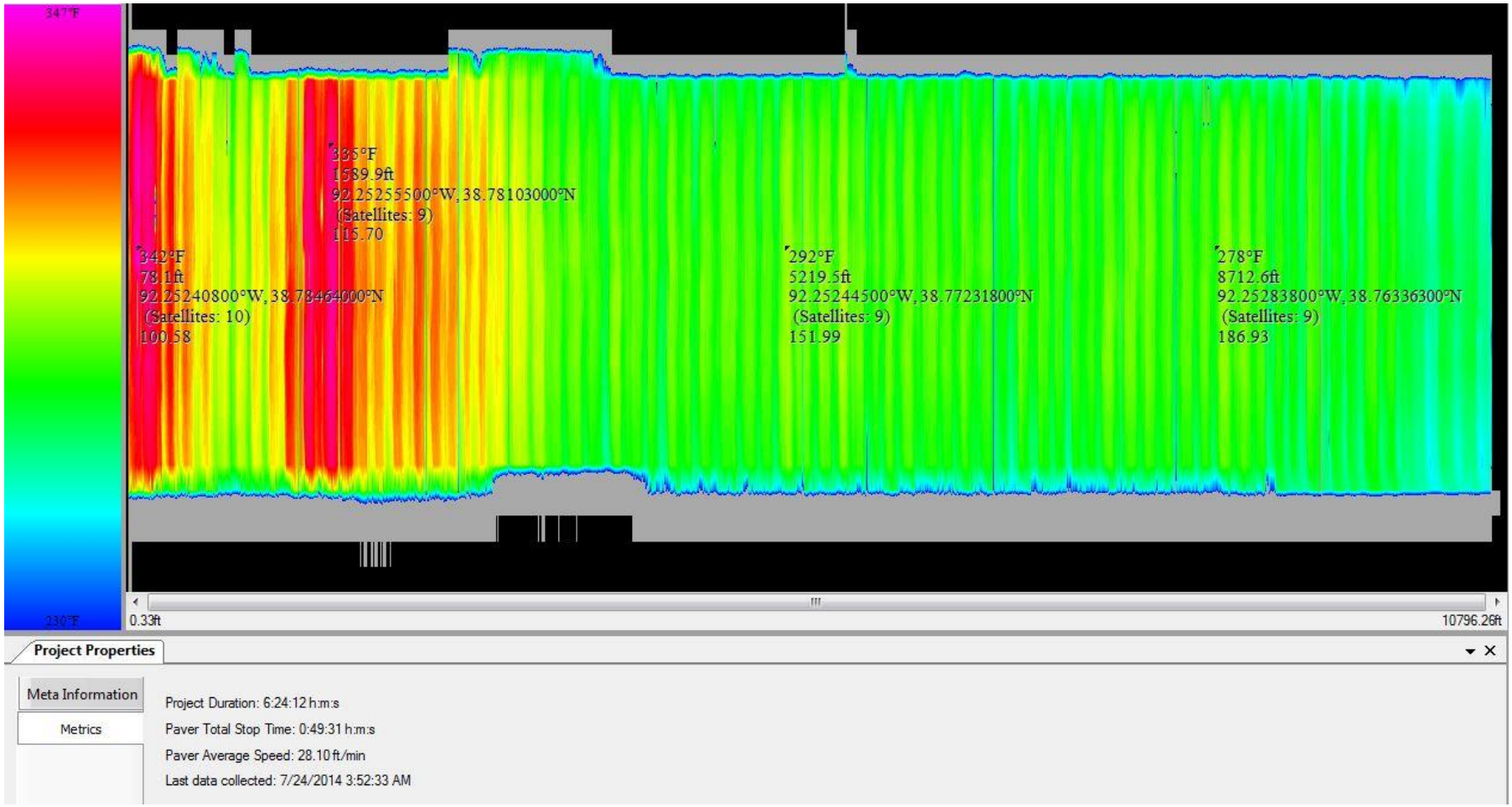

Data Loss.JPG - Windows Photo Viewer
File
Print
E-mail
Burn
Open
MO-RT63-CAT1-140723 * - Veda
Close Project
Add File
Save
Report
Viewer
Editor
Layers
Point Tests
Analysis
Coordinate System
Screenshot
Options
Help
Pass Count
11
10
9
8
7
6
5
4
3
2
1
(No Section)
(No Filter)
(No Design File)
Files
Final Coverage
Pass 01
Pass 02
Pass 03
Pass 04
Pass 05
Pass 06
Pass 07
Pass 08
Pass 09
Pass 10
Pass 11
Pass 12
Pass 13
Pass 14
Pass 15
Location (E N m): 564823.0 4290211.5
0.02 mi
© The Transtec Group - Map data OpenStreetMap.org contributors, CC-BY-SA

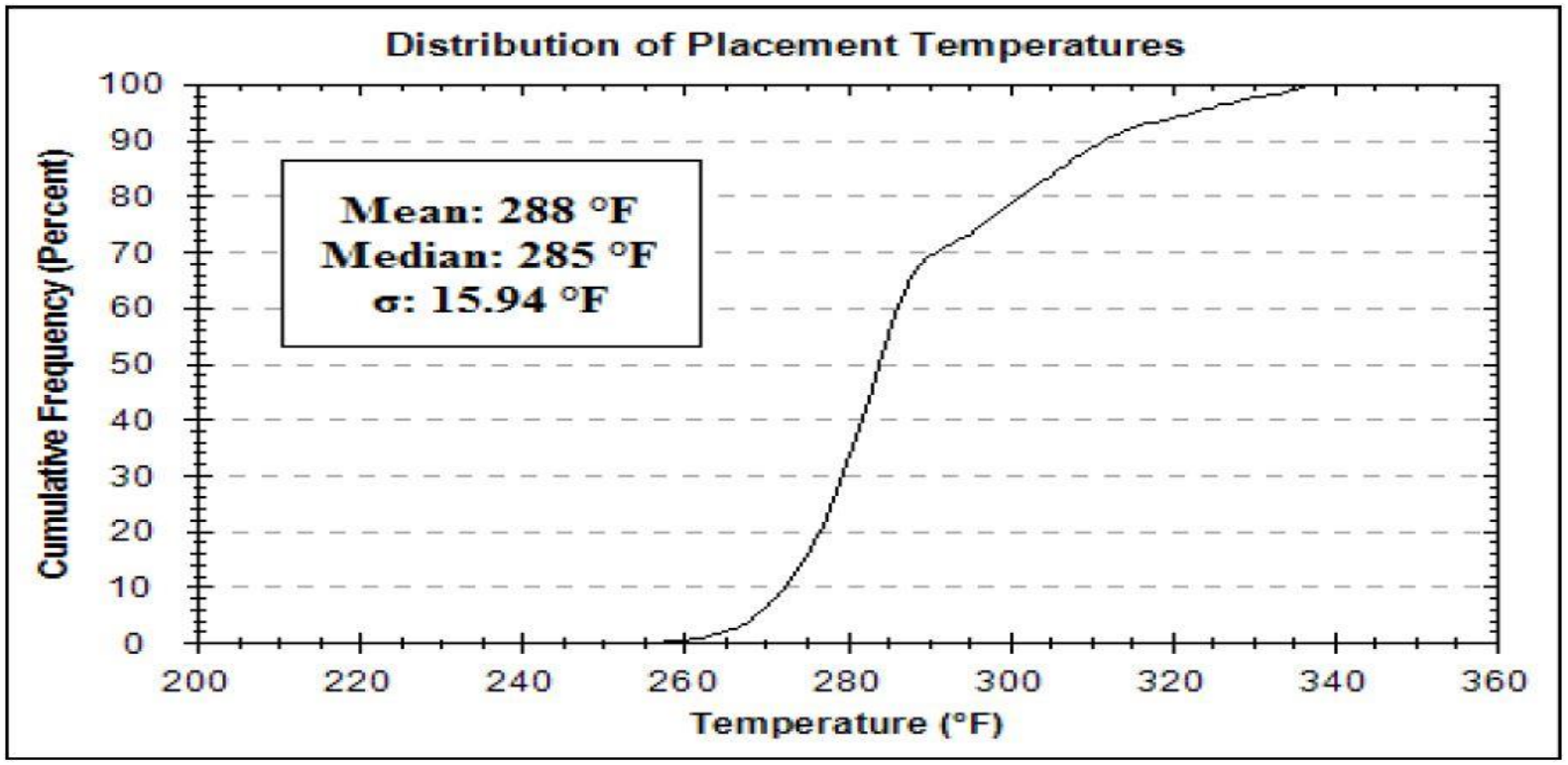
# Business Loop 70, Columbia

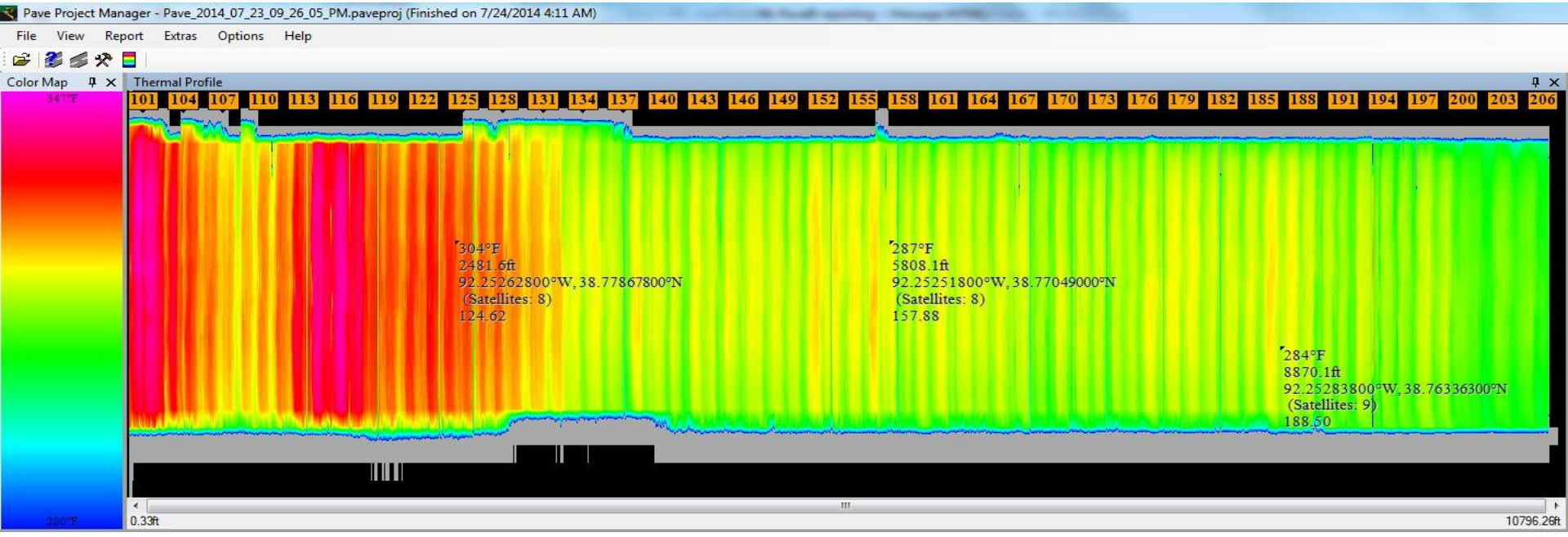
Significant Data Loss, overhead lines, lights, etc.



# MOBA Pave IR


347°F
230°F
335°F
1589.9ft
92.25255500°W, 38.78103000°N
(Satellites: 9)
115.70
342°F
78.1ft
92.25240800°W, 38.78464000°N
(Satellites: 10)
100.58
292°F
5219.5ft
92.25244500°W, 38.77231800°N
(Satellites: 9)
151.99
278°F
8712.6ft
92.25283800°W, 38.76336300°N
(Satellites: 9)
186.93
0.33ft
10796.26ft
Project Properties
Meta Information
Metrics
Project Duration: 6:24:12 h:m:s
Paver Total Stop Time: 0:49:31 h:m:s
Paver Average Speed: 28.10 ft/min
Last data collected: 7/24/2014 3:52:33 AM


Distribution of Placement Temperatures
Mean: 288 °F
Median: 285 °F
σ: 15.94 °F
Cumulative Frequency (Percent)
Temperature (°F)
0
10
20
30
40
50
60
70
80
90
100
200
220
240
260
280
300
320
340
360


Pave Project Manager - Pave_2014_07_23_09_26_05_PM.paveproj (Finished on 7/24/2014 4:11 AM)
File
View
Report
Extras
Options
Help
Color Map
Thermal Profile
304°F
2481.6ft
92.25262800°W, 38.77867800°N
(Satellites: 8)
124.62
287°F
5808.1ft
92.25251800°W, 38.77049000°N
(Satellites: 8)
157.88
284°F
8870.1ft
92.25283800°W, 38.76336300°N
(Satellites: 9)
188.50
0.33ft
10796.26ft

# Challenges with Intelligent Compaction

- Cost
  - +$10,000.00 (basic mapping only)
  - +$30,000.00 for some systems
- GPS
  - must have clear view of sky
- Roller patterns change
  - mix changes
  - weather/moisture changes
- NOT a true measurement of density

# Benefits of Intelligent Compaction

- Quality Control & Process Control
  - Consistency & Uniformity
- Increased operator awareness
  - pass count, temperature readings
- Improved density & smoothness
  - better understanding of mat/mix conditions
- Improve efficiencies
  - Cost savings
- Roller Operators LOVE IT!

NAPA Quality in Construction Award
GREEN ASPHALT PAVEMENTS
OVER 50,000 TONS

# US 63 - Boone County, MO

# www.intelligentcompaction.com

- Questions?