Grading and Base Unit Update

New Technologies

2012 Spring MEO Meeting

Rebecca Embacher

April 19, 2012

Intelligent Compaction

NEW TECHNOLOGY

Benefits Observed by Contractors

- Real-time feedback to operators
  - Coverage
    - Prevent Gaps between passes
  - Compaction Curves
    - ↓ Number of Passes
  - Identify Weak Areas
  - Moisture Control
  - View Temp (HMA applications)
- GPS System Transferrable

S-xx.3 Required Project Specific Training

(Certification of Quality Control Personnel)

- **Department**
  - Project Engineer
  - Inspectors(s)
- **Contractor**
  - Field Grading Superintendent
  - QC Field Representative
  - IC Roller Operator(s)

Required Project Specific Training

Table S-xx.2 Required Project Specific Training	
Presented By	**Topic**
IC Representative (Note 1)	• General Background Information. • Details on system relevant to both the Contractor and the Department. At a minimum: ▪ Data transfer ○ Manual ○ Web-Based Storage (cloud technology) ▪ Data Backup ▪ Recommended Operating Settings ▪ Data storage capacity of on-board documentation system ▪ Base station and repeater use, or use of VRS / CORS GPS system
Grading and Base Engineer	• Special Provisions • Goals • Forms

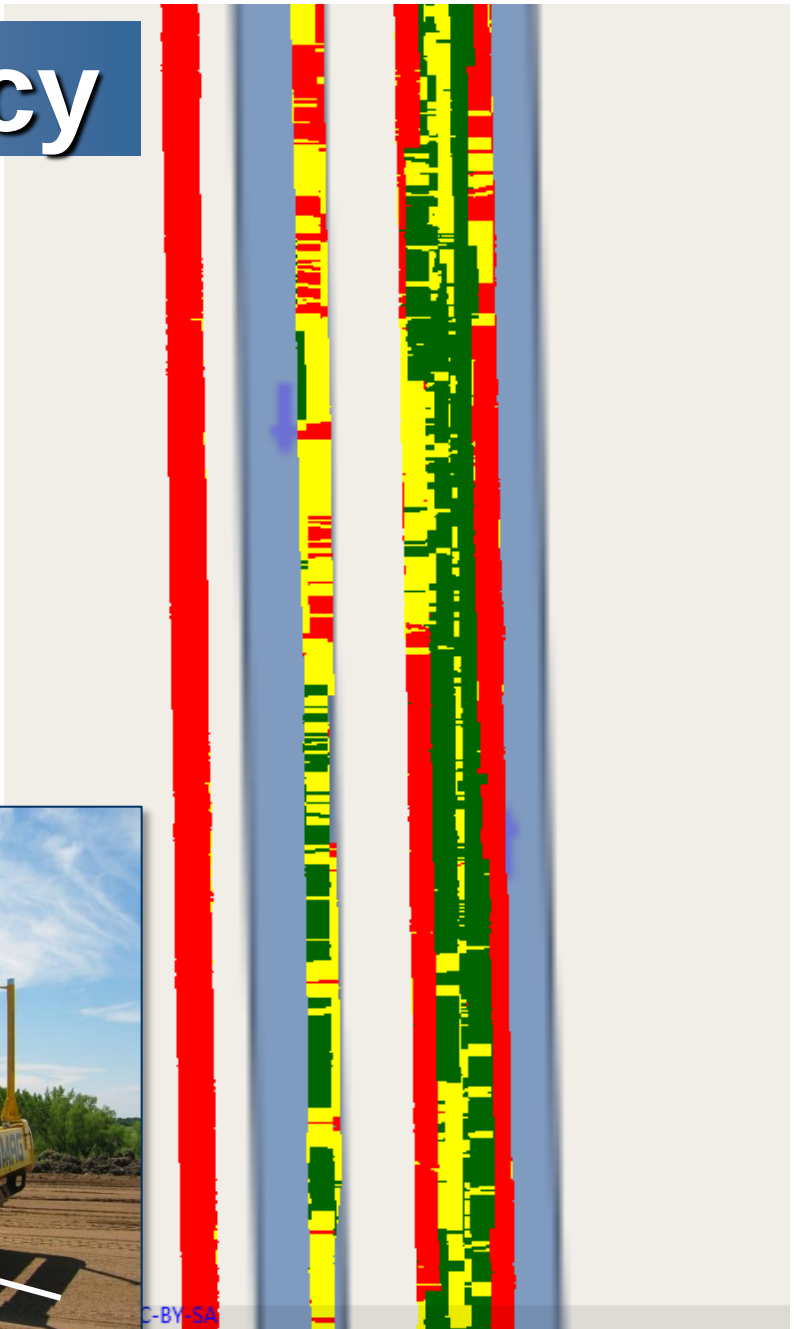
S-xx.3 Certification of the Instrumented Compactor

TABLE S-xx.3				
INSTRUMENTED ROLLER CERTIFICATION				
Case No.	Demonstration	No. of Measurement Passes	Measurement Area	
			Width	Length
VERIFICATION OF ADEQUATE SENSOR RANGE				
1	Soft Material: MVs	1	≥ 14 ft (4 m)	≥ 300 ft (100 m)
2	Stiff Material: MVs			
VERIFICATION OF DATA CONTAINED WITHIN MEASUREMENT PASS FILES				
3	Requirements of S-xx.2	2	Layer	≥ 300 ft (100 m)

MV = Measurement Values

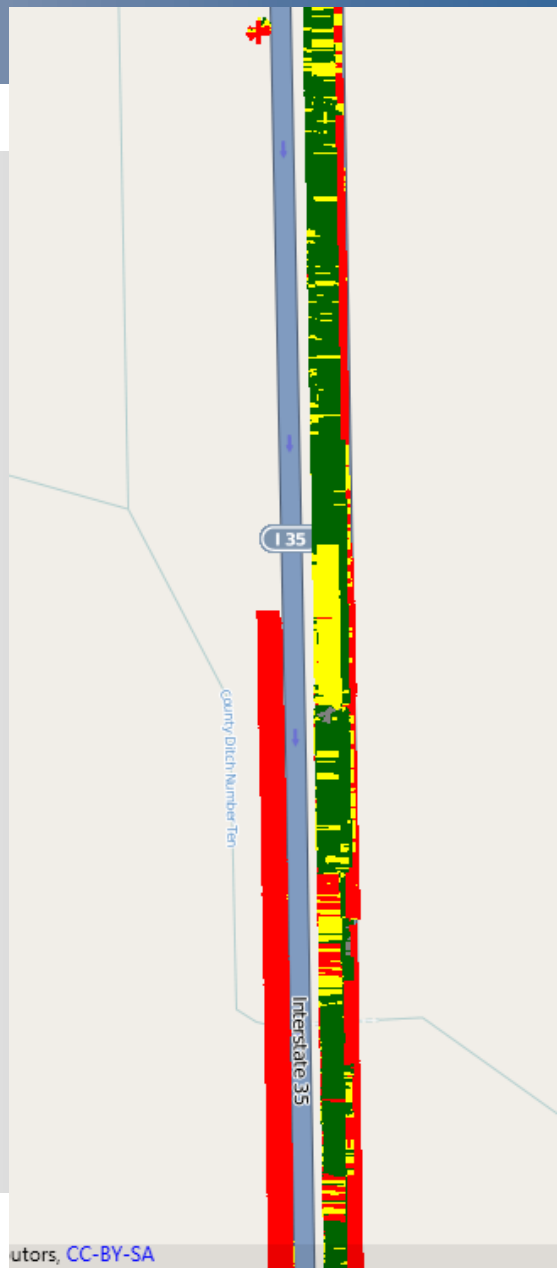
S-xx.3 GPS Accuracy

- **Verification of the IC GPS Accuracy**
  - During Roller Certification
  - Daily Use
- **Compare – Engineer's independent device**



Data Management

- **Require Daily Submittal**
  - Instrumented Compaction Measurement Pass Data
- **Require: Modem or Radio with Wi-Fi**
  - Data Transfer – Web-based Storage
    - (Cloud Technology)
- **Adequate Cellular Data Coverage**
  - VRS / CORS GPS Network
    - Virtual Reference Station / Continuously Operating Reference Station



Data Management/Viewing/Analysis

SP1380-63 (TH35) - 2011

15 Miles

3 Compactors

11,207 Export Files

17,271,460 Rows (Raw Data)

7,750,844 Rows (Valid Data)

Massive Amounts

Intelligent Construction Data Management Tool

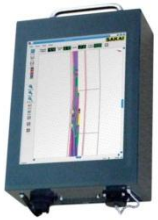
- **Geospatial Analysis Software**
- **Users:**
  - Inspectors
  - QC Field Representative and Field Superintendent
  - Engineers
  - Specification Refinement

U.S.Department of Transportation
Federal Highway Administration

Minnesota Department of Transportation

THE TRANSTEC GROUP

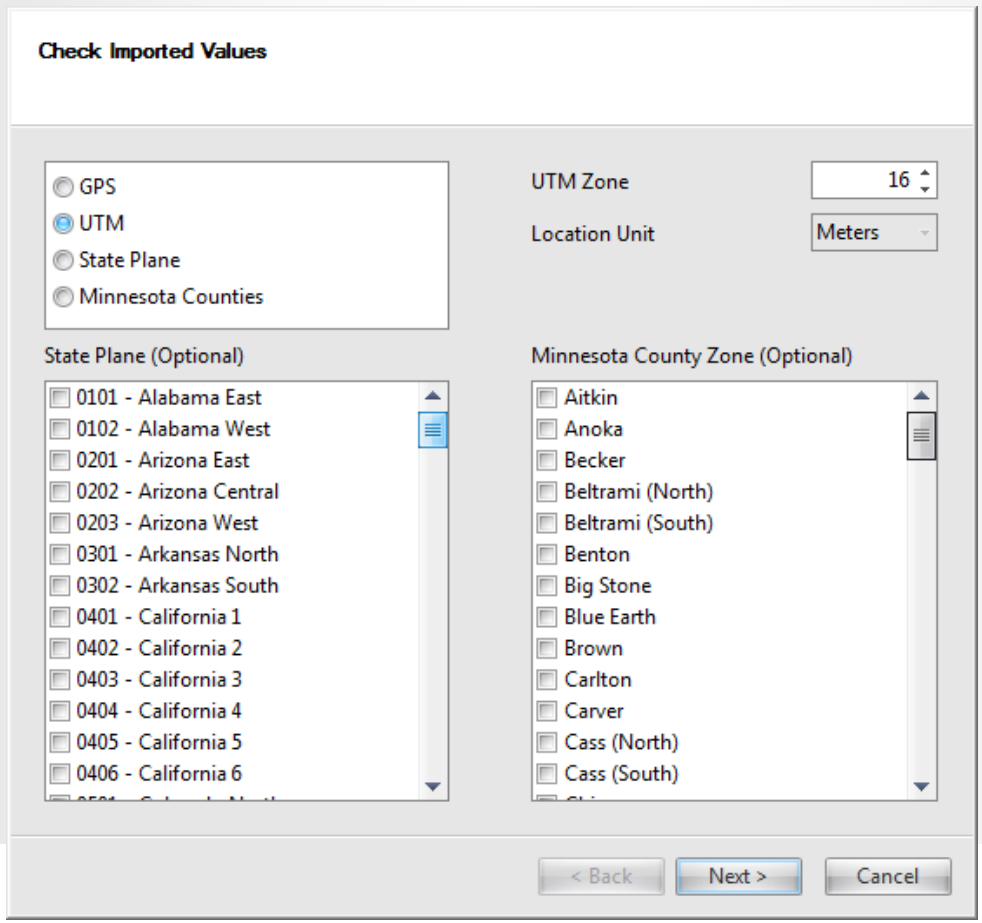
Veda Evolution

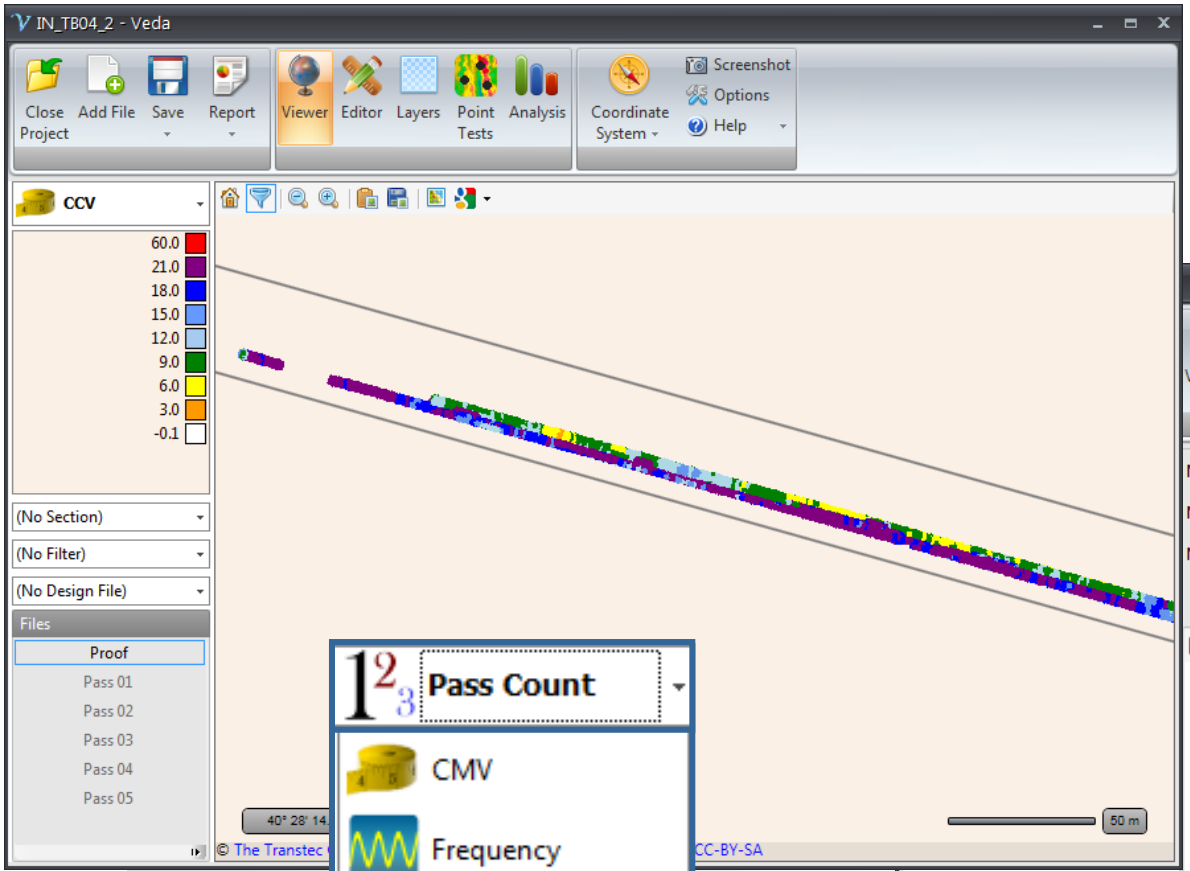

Features	Ammann/ Case	Bomag	Caterpillar	Dynapac	Sakai	Trimble
Do not require export procedures	✓					
Filename extension(s) of exported data	log and xml	csv	csv (dBase option)	*.txc and *.txt	*.pln and *.plns	csv (dBase option)
Contains Geographic GPS (Long./Lat./Elev.)	✓			✓ (*.txt)		
Contains UTM or state plane grid data (Northing/Easting/Height)		✓	✓	✓	✓	✓
Contains UTM zone or state plane references	✓ (in .xml)					
Contains all-passes data	✓	✓	✓	✓	✓	✓
Contains proof data	NA	NA	NA	✓	✓	NA
Contains pass count information				✓	✓	
Default data mesh size (h x v)	1.25m X 0.5m	0.3m X 0.3m	1.0m X 0.15m		0.3m X 0.3m	1.0m X 0.15m

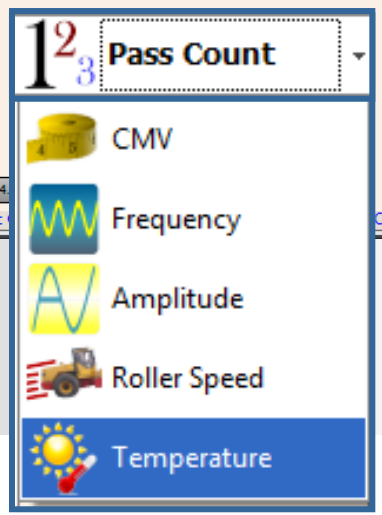
‘One Stop Shop’

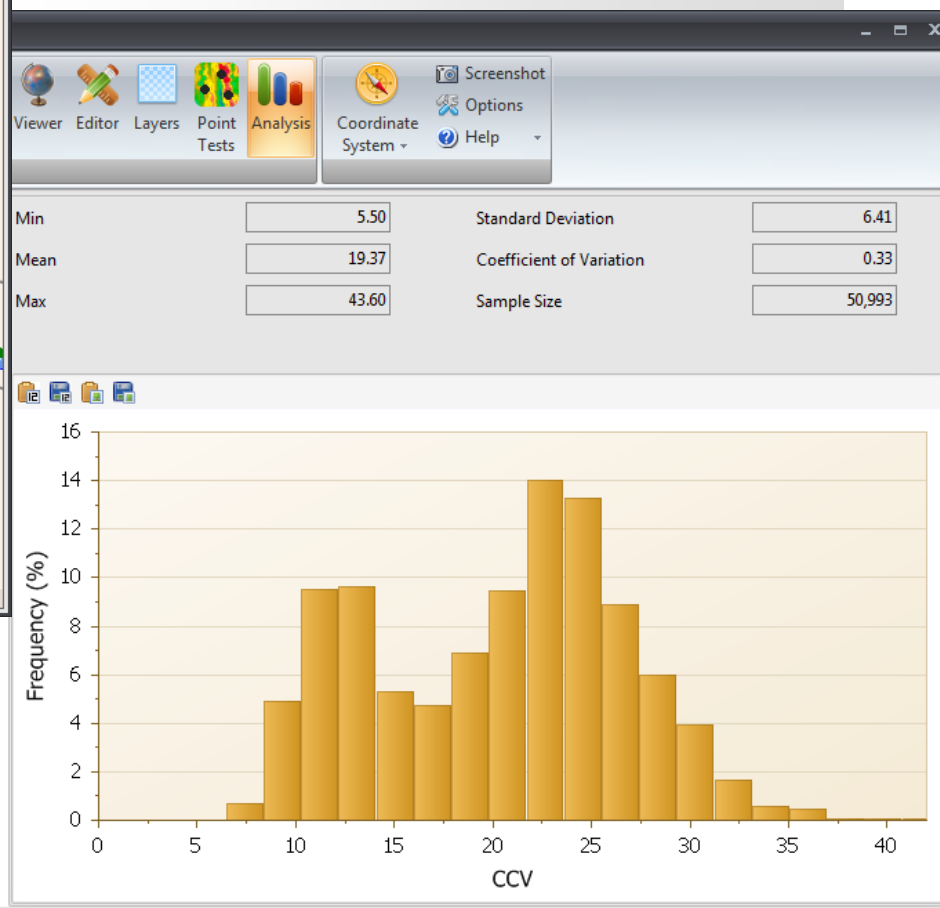
- **Export geospatial data from various IC machines and vendor-specific software into Veda.**



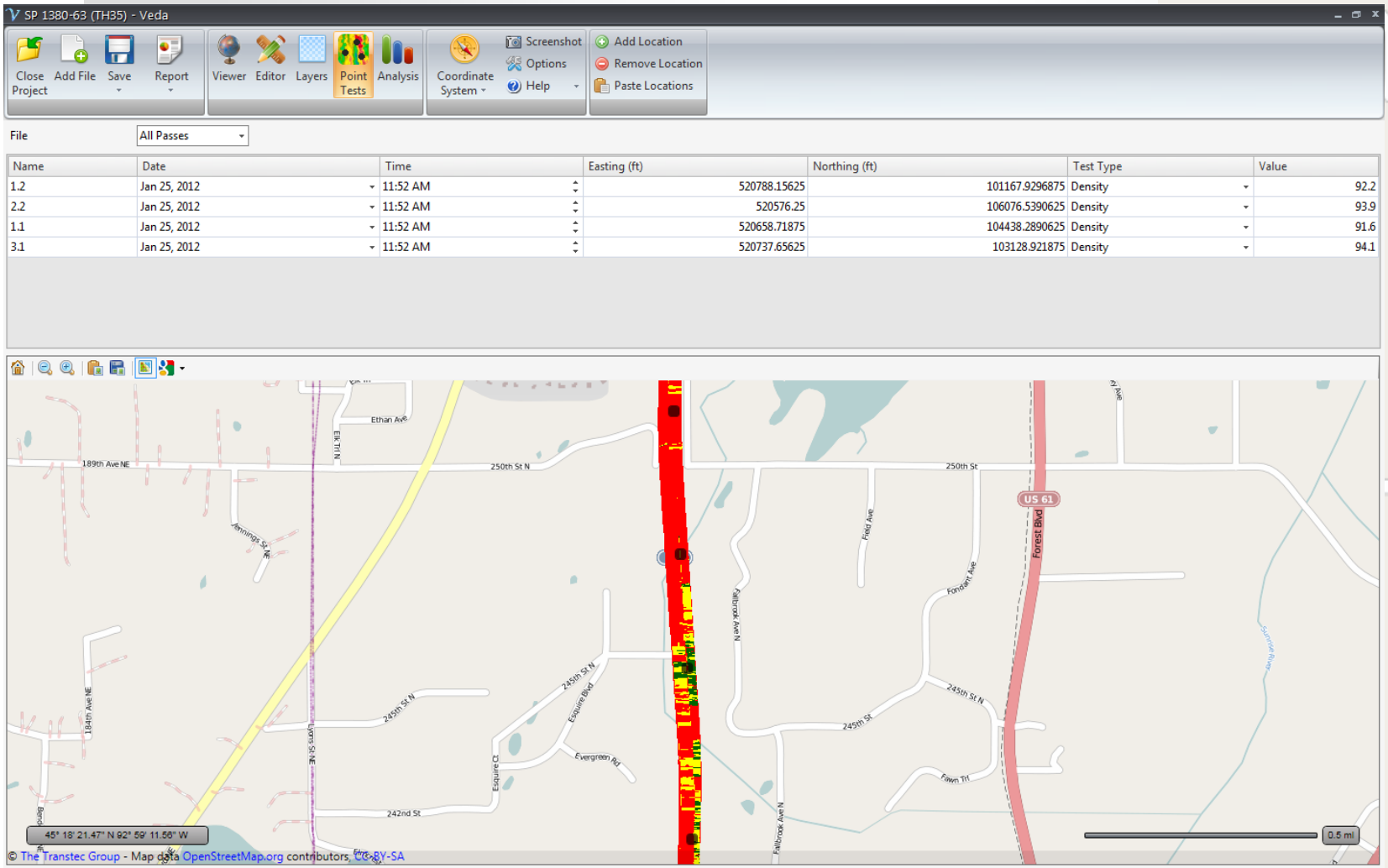
View, Edit, Analyze





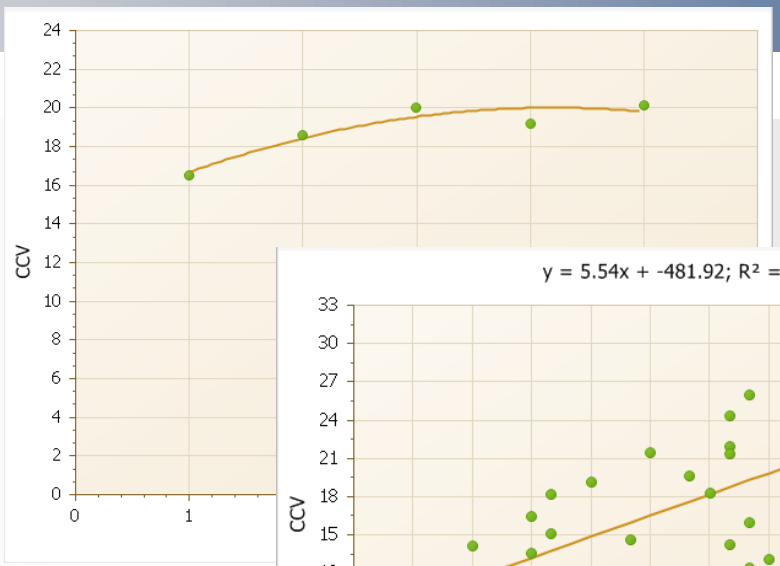


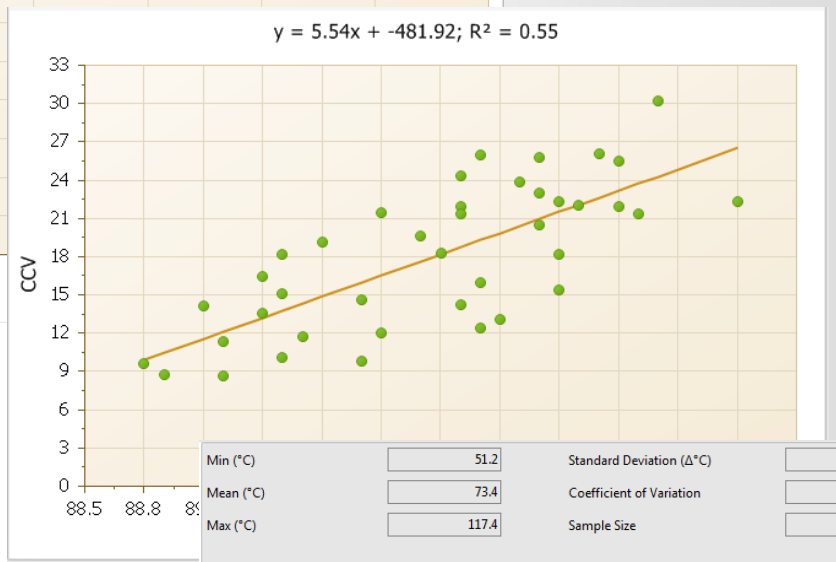
Editor and Point Tests

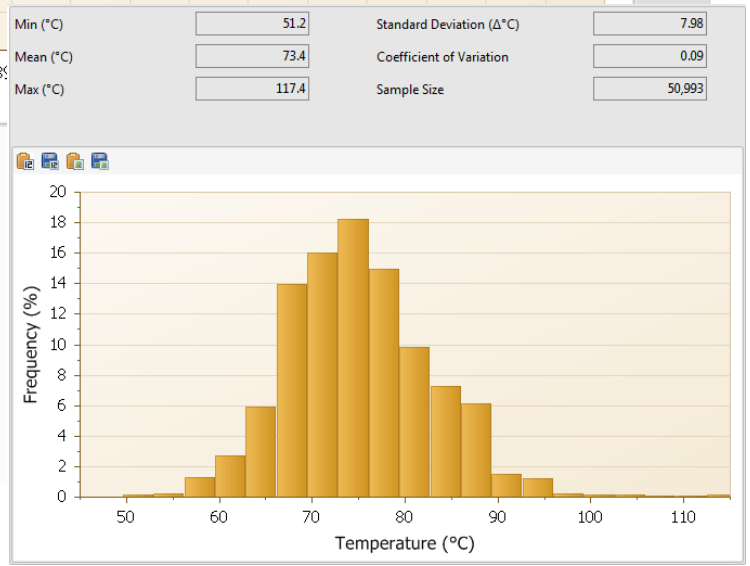


Analysis

- Statistics
- Histograms
- Correlations
- Semivariogram
- Compaction Curves
- Specification Targets



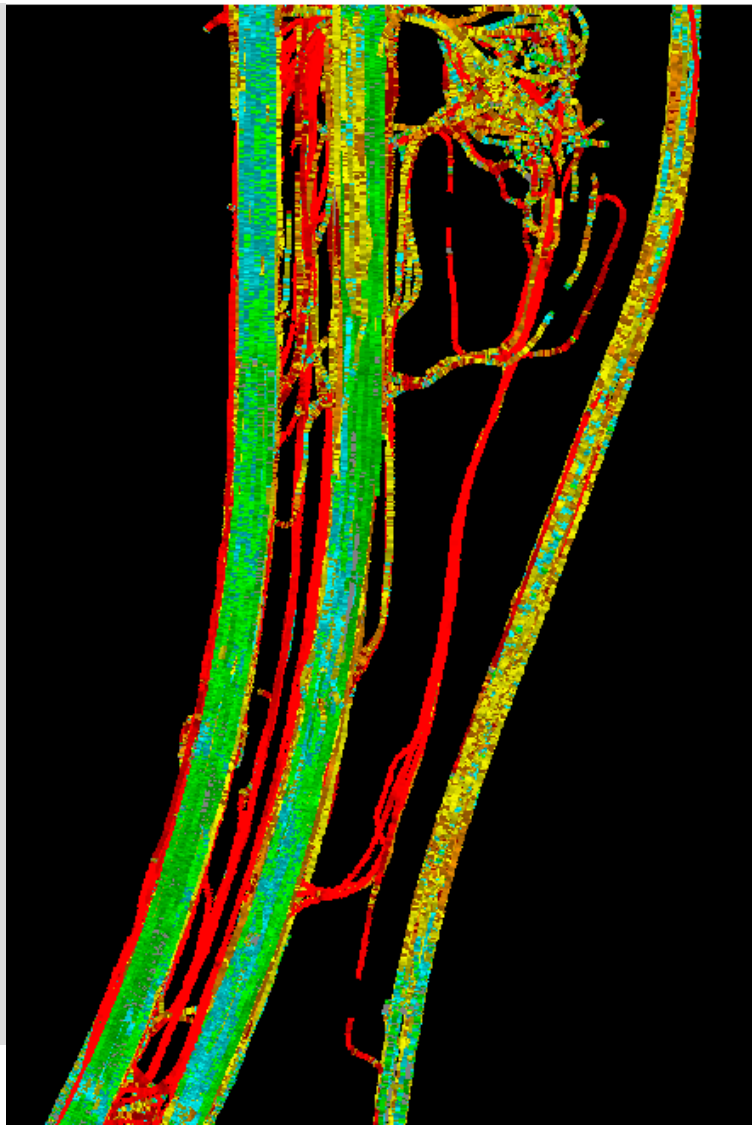




Control Strips – Stiffness Target Values

- **Previously Required:**
  - Passing:
    - 90% of the measurements ≥ 90%*IC-Target Value prior to placing next lift
  - Corrective Action:
    - Areas < 80%*IC-Target Value

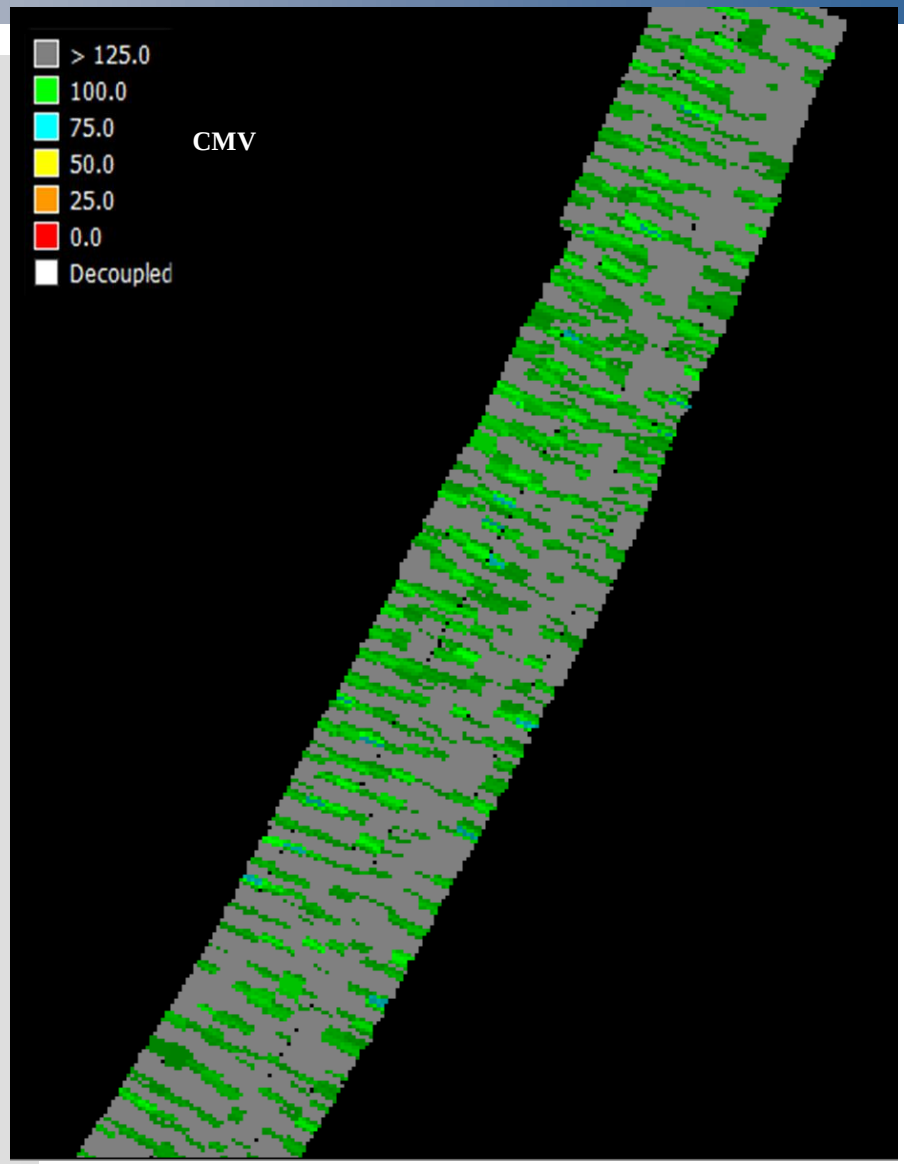
- **Currently not Requiring Control Strips**



Measurement Passes

- **Previously Required:**
  - Bottom of Fill / Cut up to grading grade.
  - Measurement Pass Layers:
    - ~ 2 ft.
- **Currently Require Measurement Passes at**

Table S-xx.4	
Required Measurement Pass Locations	
Specification	**Measurement Pass Location**
2105 / 2106(SP)	Top of Subgrade When the depth is within 6 ft (2 m) below of Grading Grade.
	Grading Grade
2211	Top of the Base
2215	Top of the Reclaimed Base
2331	



Promote Certifications & IC Use

Partial Payment Schedule

(A) Instrumented Roller Certification…….…. ……5% Payment
(B) QC Field Rep. Certification…….……. …5% Payment
(C) IC Roller Operator(s) Certification……. …5% Payment

(D) 10% Measurement Pass Completion……. …8% Payment
(E) 40% Measurement Pass Completion ……. 24% Payment
(F) 70% Measurement Pass Completion ……. 24% Payment
(G) 100% Measurement Pass Completion ……...24% Payment

No payments for (D) – (G) until items (A) – (C) is approved.
No payment for (E) – (G), until item (D) is approved.
Payment for (D) – (G) will be made after Department review of data.
The Department will review the data within 10 business days after notification.

2012 Construction Season

- **Stewardship Council – Destination Innovation**
  - Awarded $405,000
  - Champion: Nick Thompson
  - Funds Expended by: June 30, 2013
  - Implementation of Intelligent Compaction

Destination Innovation

Goals:

- Optimize Compaction Efforts
- Ensure Full Coverage
- Find Weak Areas
- Increase Uniformity

- **FDR / SFDR**
  - Instrument 1 to 2 soils compactors
  - Map
    - Stiffness (also used as Base map for HMA)
    - Position of the Roller
    - Number of Passes

Destination Innovation (Cont.)

- **Bituminous Pavement**
  - PAVE-IR Bar
  - Intelligent Compaction
    - Instrument Rolling Train
      - Pneumatic
      - Steel-Double Drum (Vibratory Position)
      - Steel-Double Drum (Static Position)
    - Map
      - Stiffness
      - Position of the Roller
      - Number of Passes
      - Temperature

2012 Construction Season

Submitted Proposal – Implementation Funding

Enhancements to the Intelligent Construction Data Management (Veda)

- Include import and analyses tools for PAVE-IR (temperature) Data
- Include import and analyses tools for PROVAL (Ride/Smoothness) Data
- Additional Analyses Features

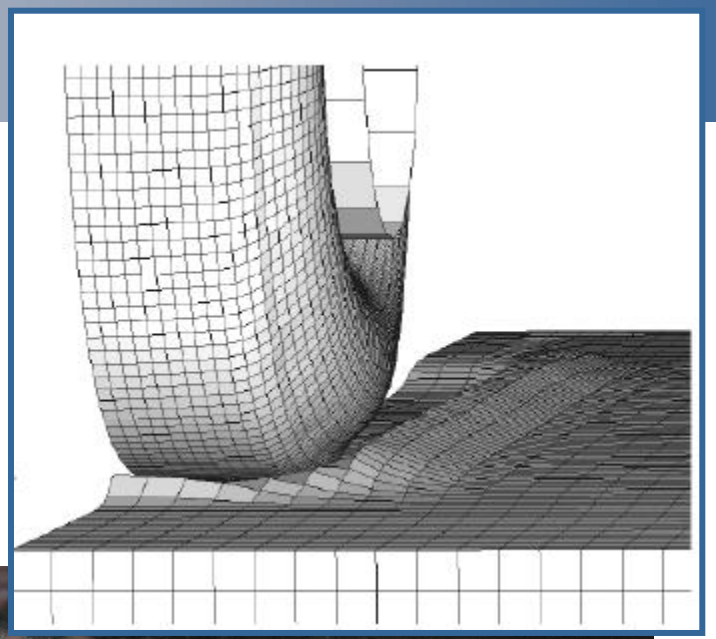
Sonic Test Rolling

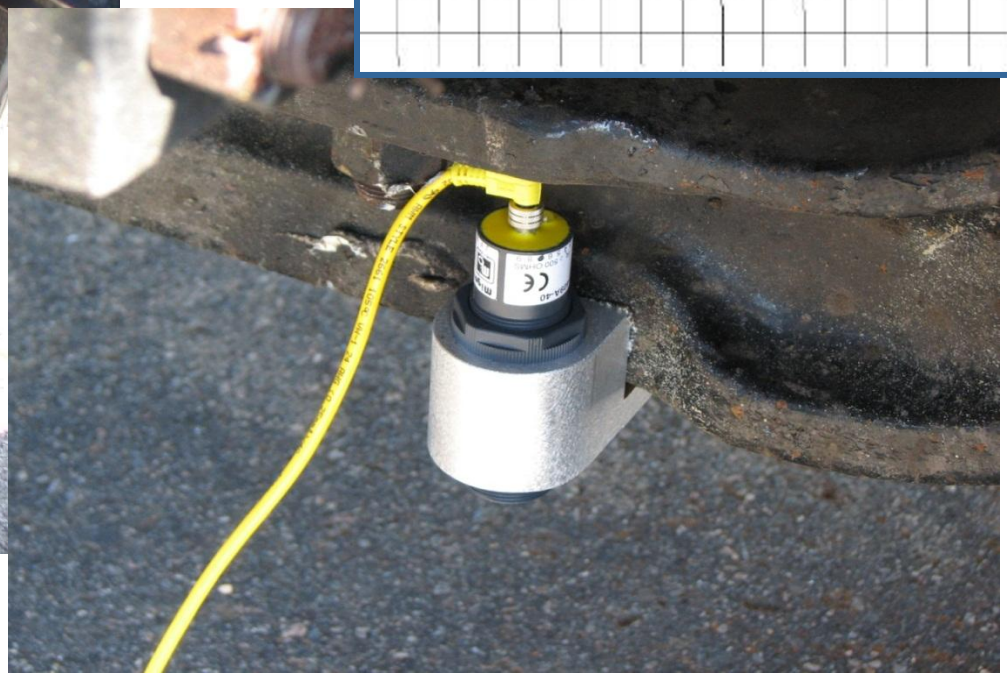
NEW TECHNOLOGY

Sonic Test Rolling System

Left and Right Sonic Sensors

Sensor Offset





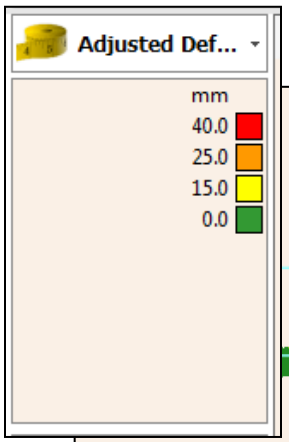
GPS Coordinates for Tires

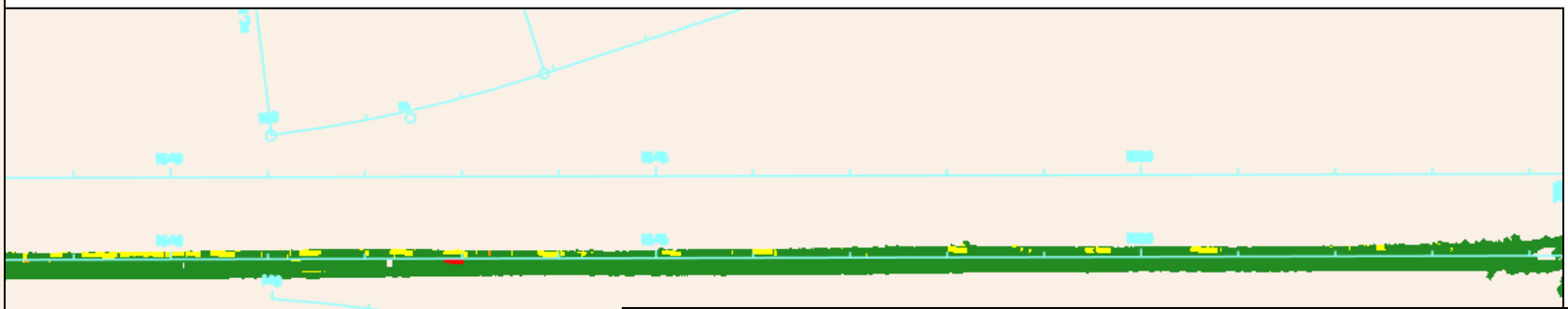
GPS Unit Mounted on Cab

View, Edit, Analyze

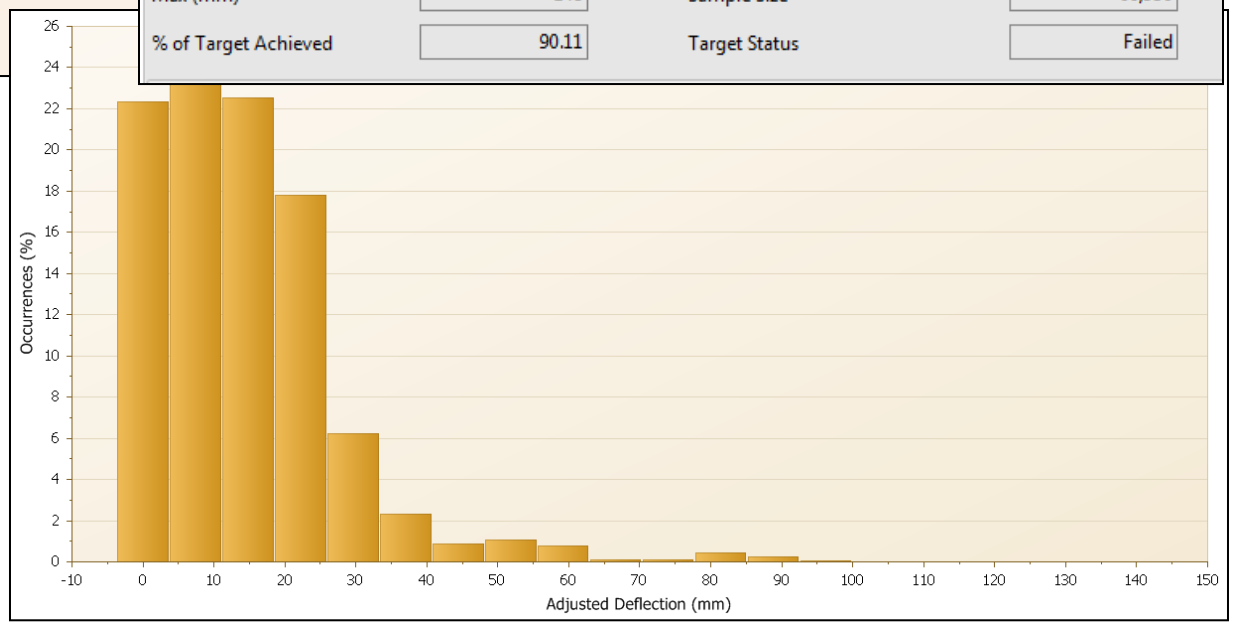
Intelligent Construction Data Management Tool

Veda

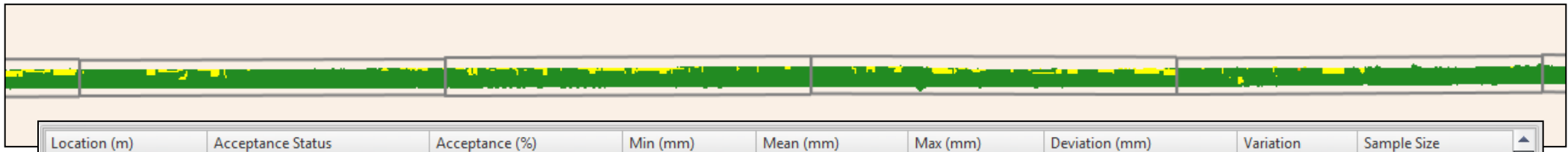




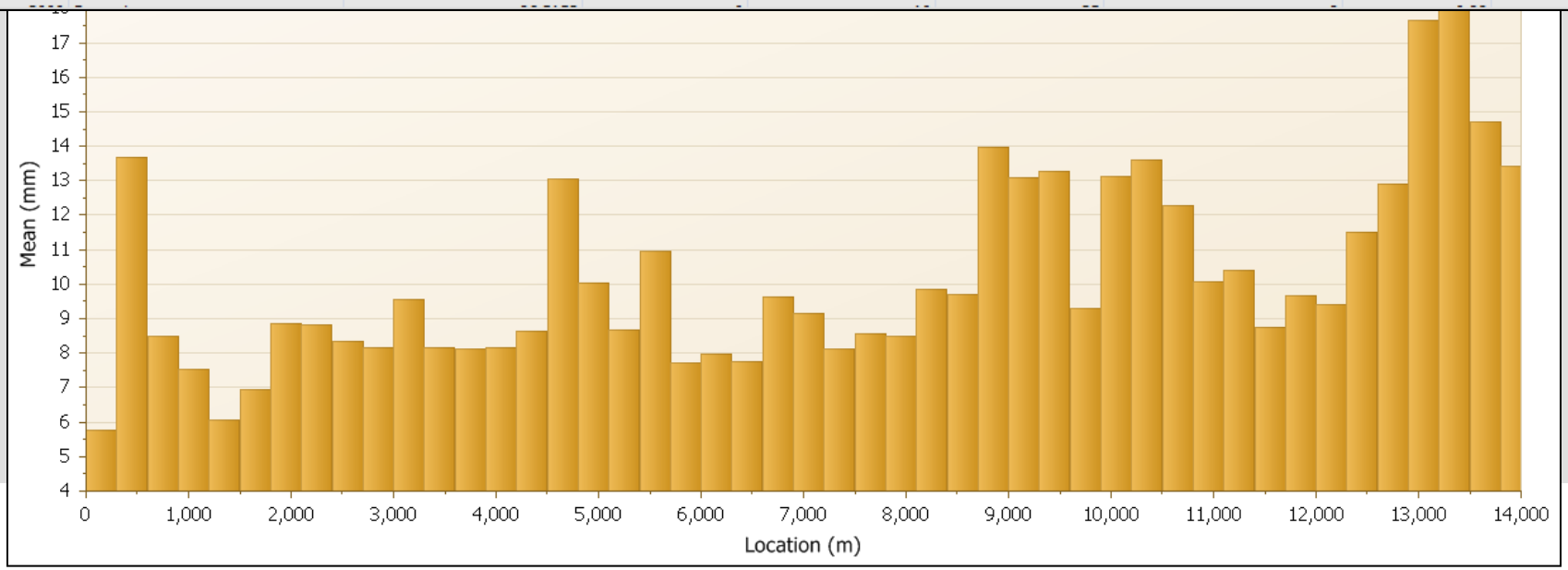
Min (mm)	0	Standard Deviation (mm)	13
Mean (mm)	11	Coefficient of Variation	1.15
Max (mm)	148	Sample Size	66,956
% of Target Achieved	90.11	Target Status	Failed



Create Lots



Location (m)	Acceptance Status	Acceptance (%)	Min (mm)	Mean (mm)	Max (mm)	Deviation (mm)	Variation	Sample Size
0	Passed	95.28129	0	6	97	9	1.49	1549
300	Passed	95.08546	0	14	36	7	0.54	936
600	Passed	98.47186	0	8	137	8	0.93	930
900	Passed	99.83001	0	8	27	6	0.76	1133
1200	Passed	99.99999	0	6	22	5	0.80	1049
1500	Passed	99.41199	0	7	108	7	0.95	970
1800	Passed	99.01165	0	9	29	7	0.79	942
2100	Passed	99.49084	0	9	38	7	0.77	920
2400	Passed	99.52805	0	8	29	6	0.73	906
2700	Passed	98.59174	0	8	32	7	0.83	932



2012 Construction Season

- **Tentative Projects:**
  - Evaluated system on Class 5 of TH14 (Owatonna)
  - TH169 (D1, Grand Rapids)
  - City of Minneapolis
  - TH19 & TH 56 (FDR / SFDR)
  - CSAH 31, Pennington County
  - TH60 (D7)

2012 Construction Season

- **Submitted Proposal – Implementation Funding**
  - Enhancements to the Sonic Test Rolling System
    - Connect to Virtual Reference Station (VRS) / Continuously Reference Station (VRS/CORS) GPS network
    - Re-evaluate sonic measurement computer analysis coding.
    - View saved data ‘live’ during collection to ensure that it is collecting.
    - …further enhancements as a result of implementation findings.

Light Weight Deflectometer (LWD)

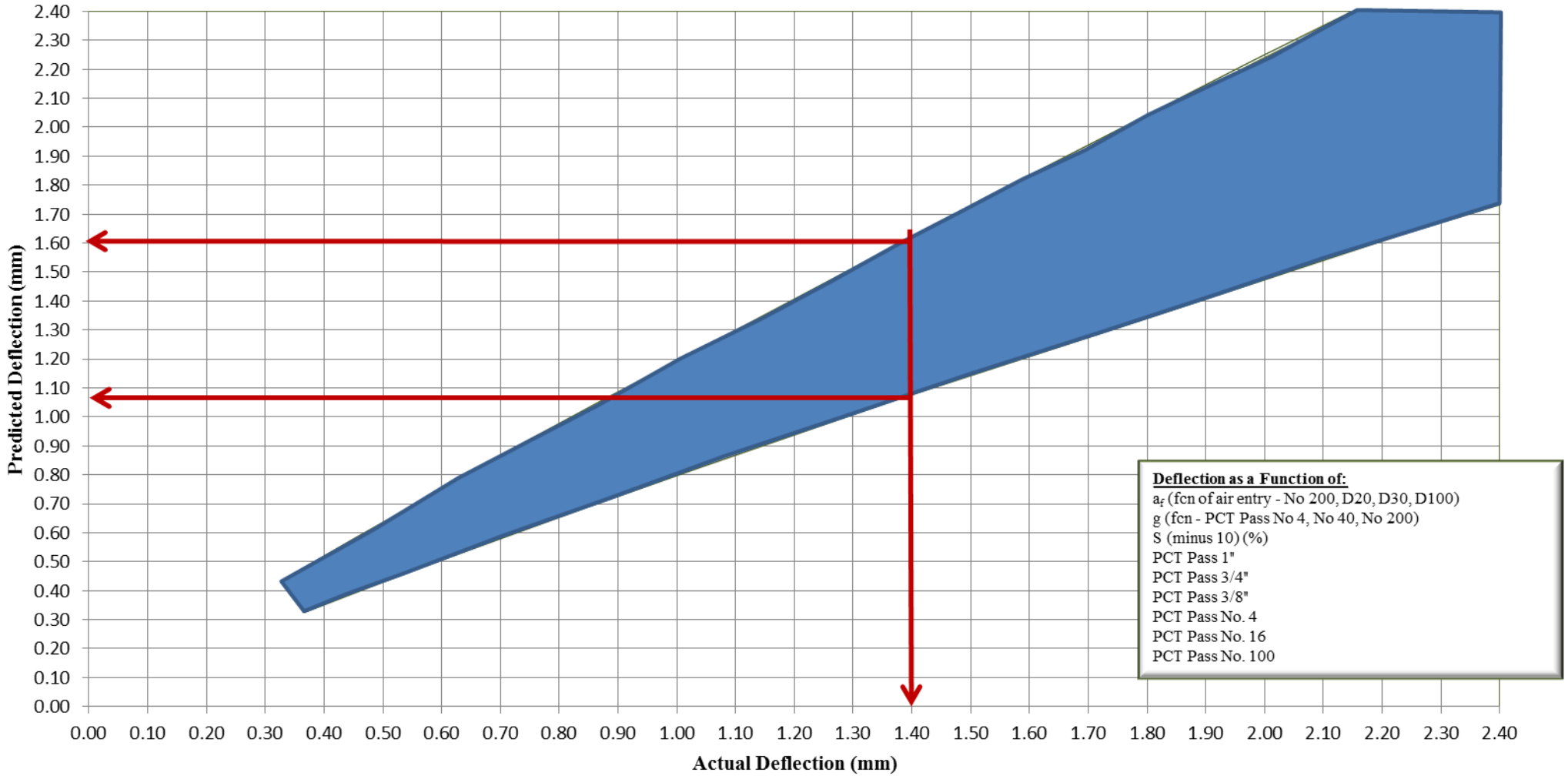
NEW TECHNOLOGY

Goal: Establish Target Value Table

		Method		
		Mod DCP		LWD Deflection
GN	MC	Max Allow. Seat (mm)	Max. Allow. DPI (mm/blow)	Max. Allowable Deflection (mm)
3.1-3.5	<5.0	40	10	
	5.0-8.0	40	12	
	>8.0	40	16	
3.6-4.0	<5.0	40	10	
	5.0-8.0	45	15	
	>8.0	55	19	
4.1-4.5	<5.0	50	13	
	5.0-8.0	60	17	
	>8.0	70	21	
4.6-5.0	<5.0	65	15	
	5.0-8.0	75	19	
	>8.0	85	23	
5.1-5.5	<5.0	85	17	
	5.0-8.0	95	21	
	>8.0	105	25	
5.6-6.0	<5.0	105	19	
	5.0-8.0	115	24	
	>8.0	125	28	

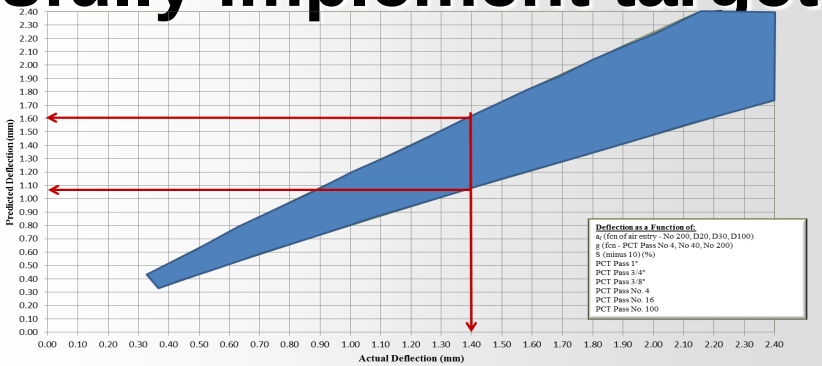
$R^2_{adj.}$ = 0.23, n = 88, 95% Prediction Band

Loamy Sand and Sand



Granular LWD – Target Value

- **Currently unable to successfully implement target value table for LWD.**
  - Mixed Success
    - Upper Prediction Band Equation
    - Control Strips



- **Investigate Further – Additional Data**
- **Currently Allow:**
  - Control Strips or Companion Testing
- **2012 - Evaluate Use on Aggregate Base**

Thank You