Pavement Management Systems Implementation for Local Agencies using Automated Data Collection

Lax Premkumar, P.E.

September 29, 2023

2023 Fall Conference at Ashore Resort & Beach Club, Ocean City, Maryland

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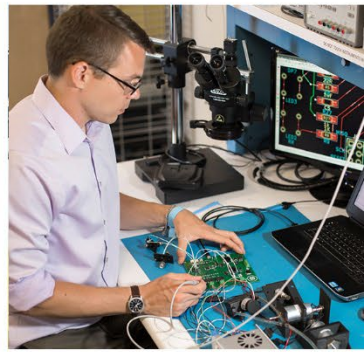
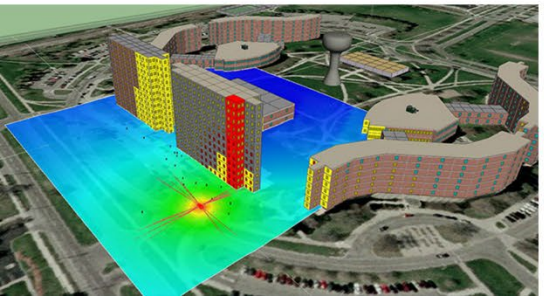
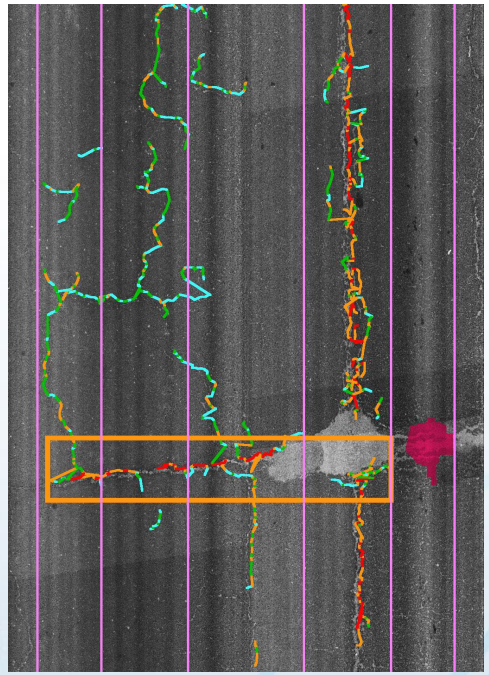




Presentation Outline

- Introduction- Pavement Management Concepts
- Implementation Process
  - Info from Agencies
  - Data Collection & Condition Rating
    - ✓Automated Data Collection and Processing
    - ✓Case Study
  - Data Analysis
  - Software Options
  - QC/QA



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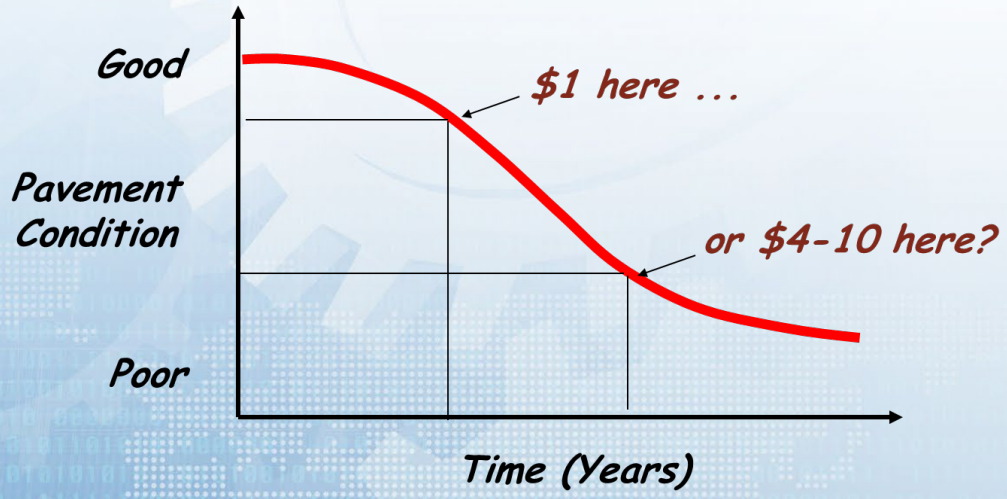
Fundamental Concept of Pavement Management

- Quantifies condition objectively
- Predicts condition (next few years)
- Helps identify optimal type & timing of treatment



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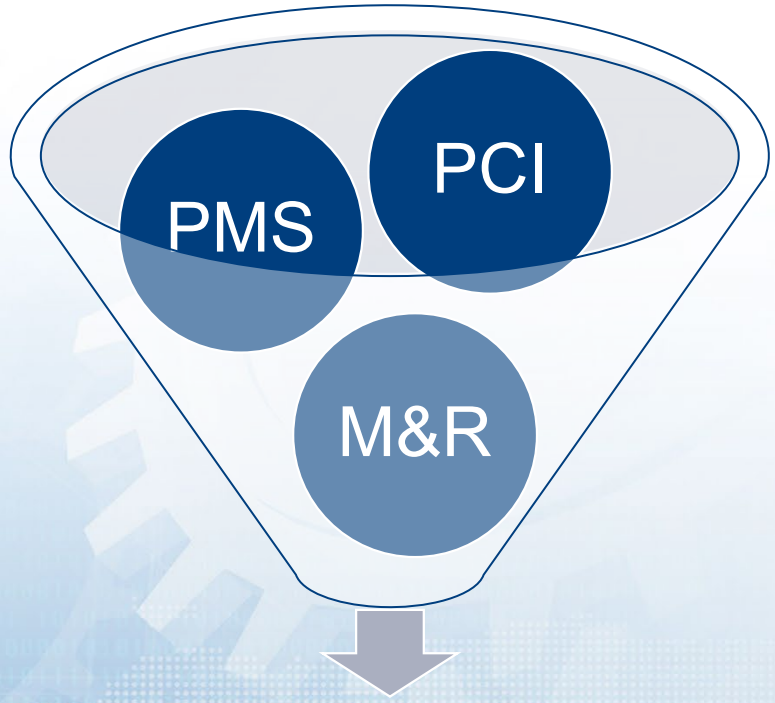
…With the Ultimate Goal of …



The Best Bang for the Buck!

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Components of a PMS

Data Collection

Condition Survey

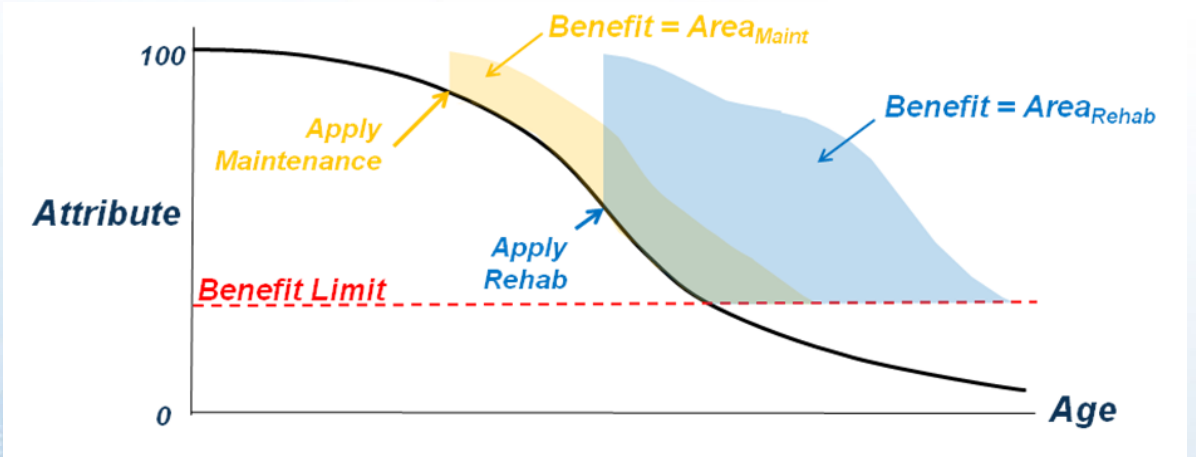
Performance Model

Treatment Selection

Budget

M&R Optimization

CIP



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Information Required from Agencies

PMS Setup	Budget	Treatment
• Network Segmentation • Pavement Type • Performance Model • Treatment Matrix • Pavement Age • Traffic • Construction History	• 5 or 10-Year Budget • Budget bucket assignment	• Treatment Activity Type • Unit Cost • Consequence of Activity (PCI change, year to next activity etc.)

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Data Collection Methods

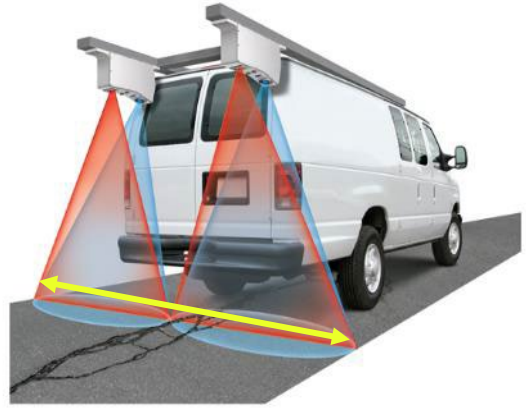
Manual Method

- Foot-on-ground or windshield surveys in the field
- Typically, sample unit based

Semi-Automated

- Combination of automated and manual methods
- Survey performed manually using images collected using automated methods

Fully-Automated



- Using automated data collection and analysis
- Minimal manual intervention

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Data Collection Methods

- **LCMS 3D Pavement Imaging** - 1mm cracks are clearly visible; full lane-width coverage
- **Right of Way Imaging** - High resolution, geotagged images
- **IRI, Faulting and Rutting** - High-speed laser profiler is certified at TTI
- **Pavement Geometry** - Cross slope and grade
- **Sub-meter accuracy GPS Coordinates**

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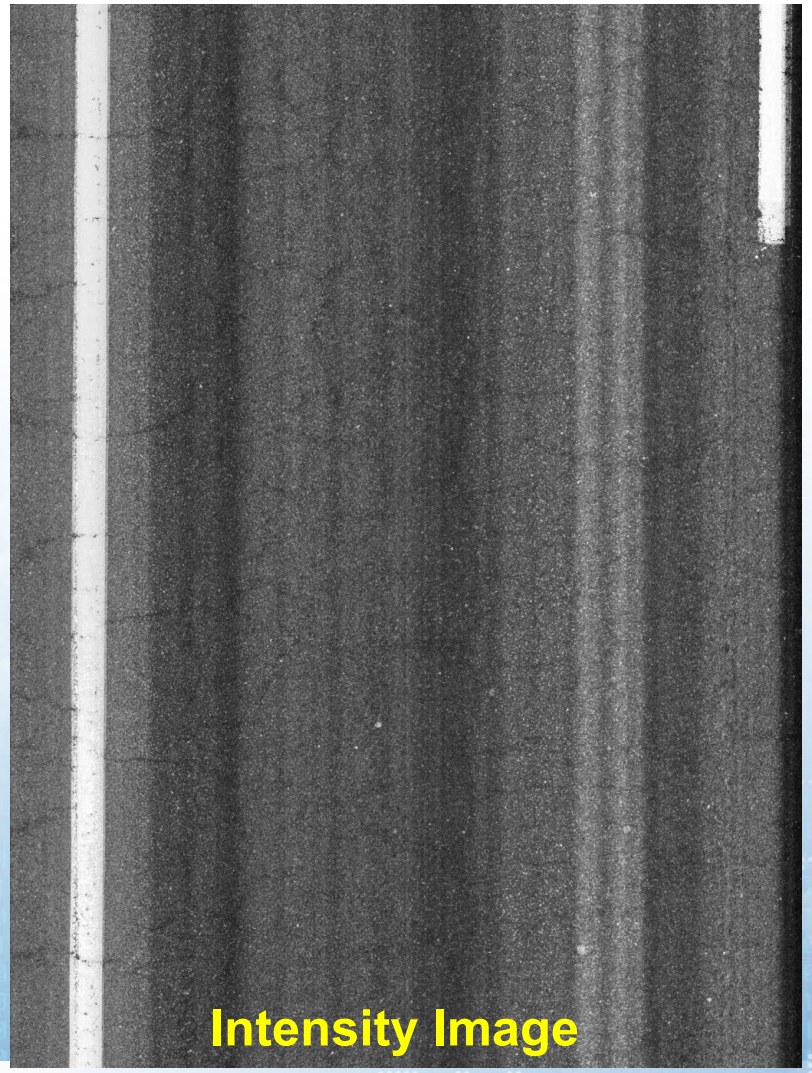
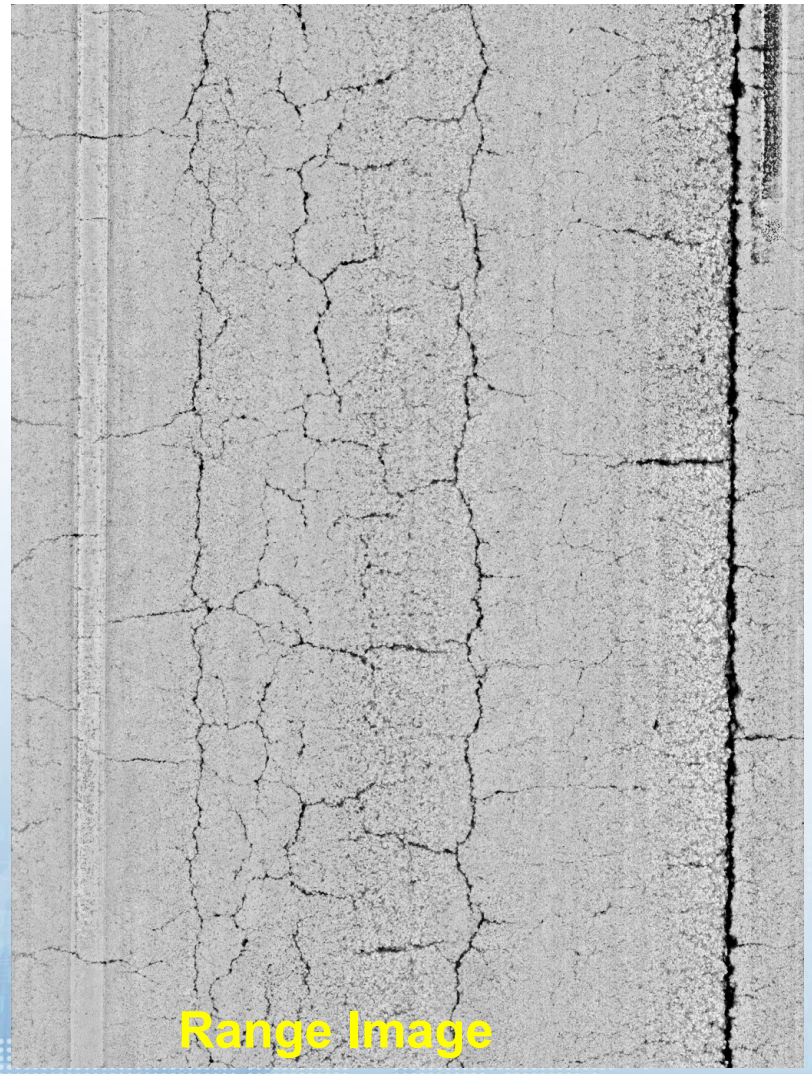
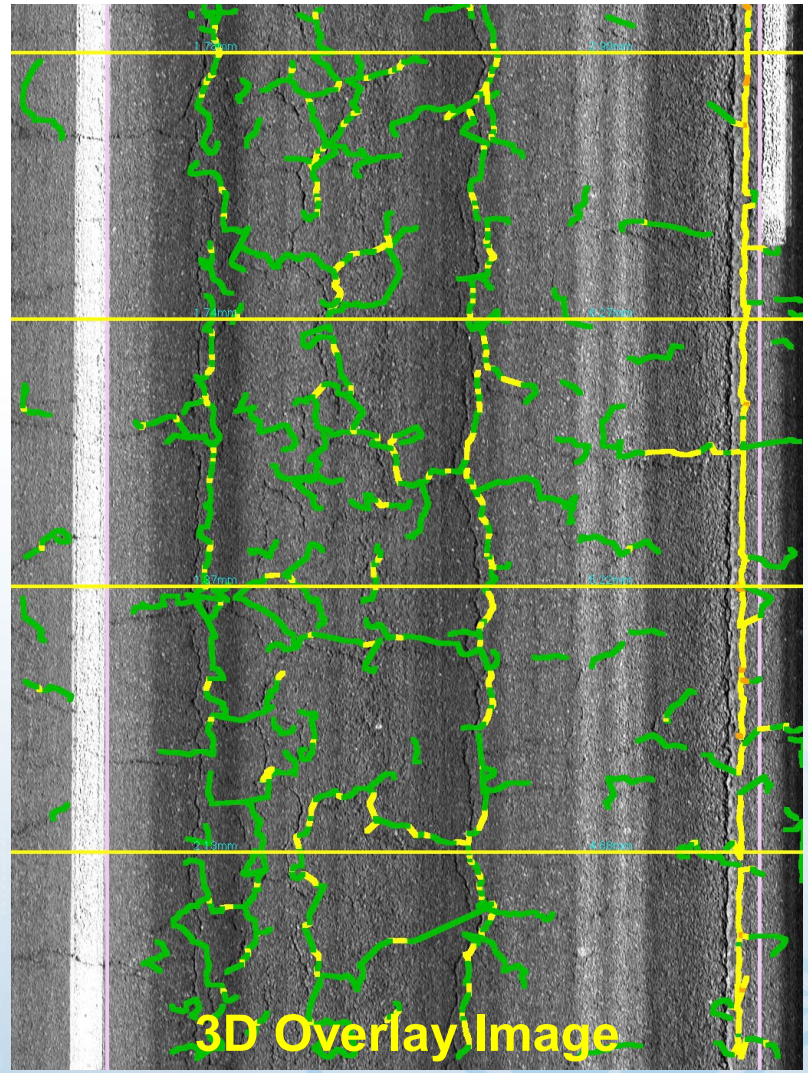
Example Pavement Images







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Example Right of Way Images

Angled Left

Center

Angled Right

Georeferenced Right of Way Images
(Rear View also Captured)

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Processing Pipeline

Automated condition surveys are a good option to increase productivity for large networks

Vendor Processing Software

Distress
Severity
Extent

Custom program to generate xml

PCI

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Distress Rating

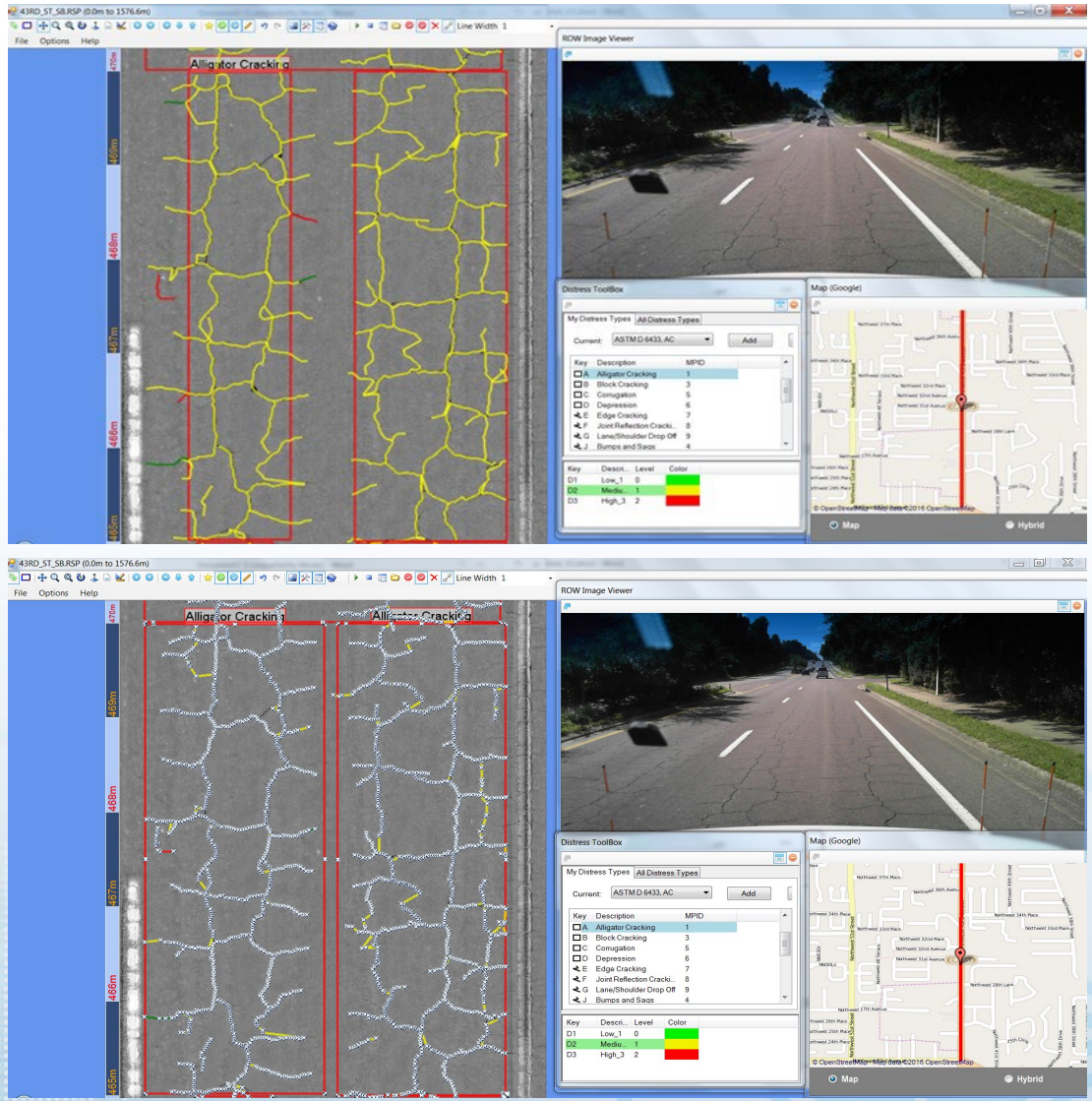
100% Distress Rating on Surveyed Area

STEP 1
AUTOMATED

- Alligator cracking
- Block cracking
- Longitudinal cracks
- Transverse cracks
- Sealed cracks
- Edge cracks
- Potholes
- Curbs or edge drop-off
- Rutting
- Raveling
- Concrete joints

STEP 2
MANUAL REVIEW

- Editing quantities and severities
- False positives
- False negatives
- Other distresses
- PCC pavement distresses



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Automated Surveys – Things to consider

Higher Level Distresses

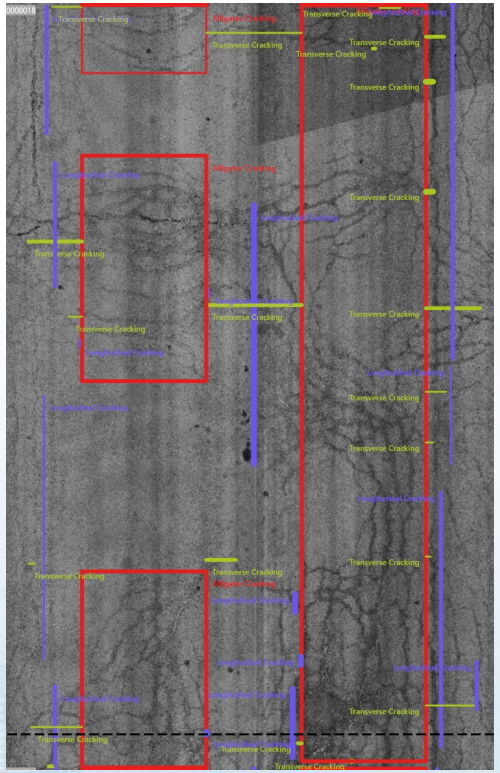
- Lower traffic
- Thinner pavement cross sections
- Longer rehabilitation cycles

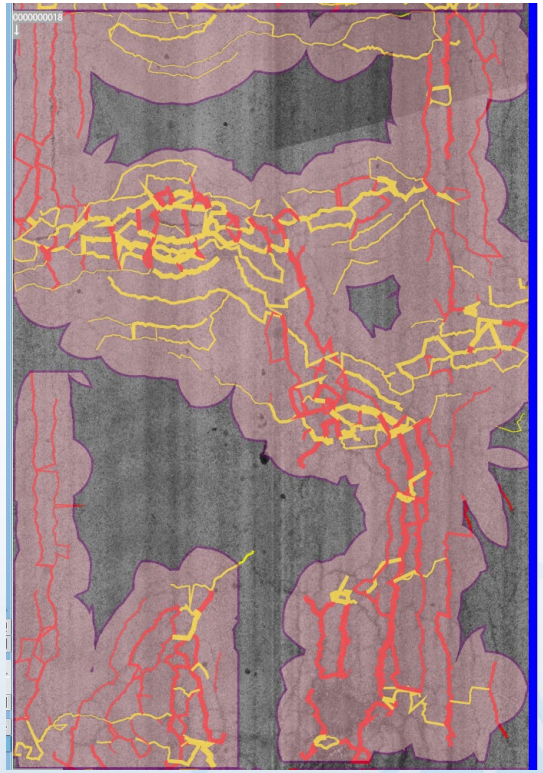
Unique Geometry

- Curb and gutter
- Unsupported edges

Factors Affecting Analysis

- Equipment accuracy during collection
- Distress classification





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Switch from Manual to Automated?

False Comparisons

- Too many variables
- Index translation
- Some details might be used by one and not the other

Consistency

- Use of old data
- Progression of condition
- Existing settings and tools

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Case Study-IL County

Size: 250 centerline miles

Timing: 2015, 2018, 2021 & 2023

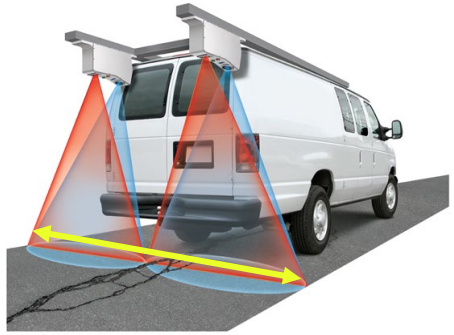
Evaluations:

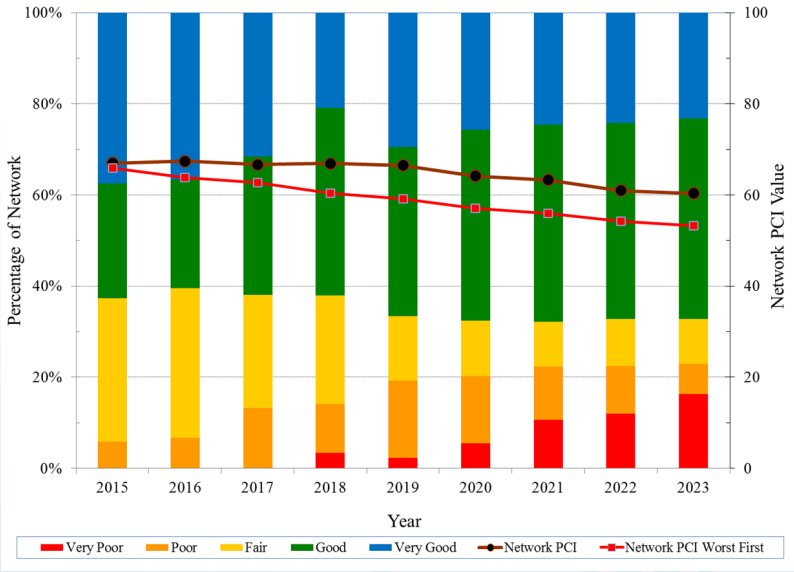
- Surface using modified PCI
- Structural using FWD

Surface Condition Equipment

- LCMS Sensors
- ICC Connect for LCMS to PCI

ARA's RoadCare Software





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Modified Pavement Condition Index

Manual surveys performed with sampling

Automated surveys performed at 100% of surveyed area

Manual Survey	Automated Survey
Longitudinal Cracking	Longitudinal Cracking
Transverse Cracking	Transverse Cracking
Fatigue Cracking	Fatigue Cracking
Potholes	
Centerline Cracking	Linear Cracking
Block Cracking	
Bleeding	
Patching	
Weathering	

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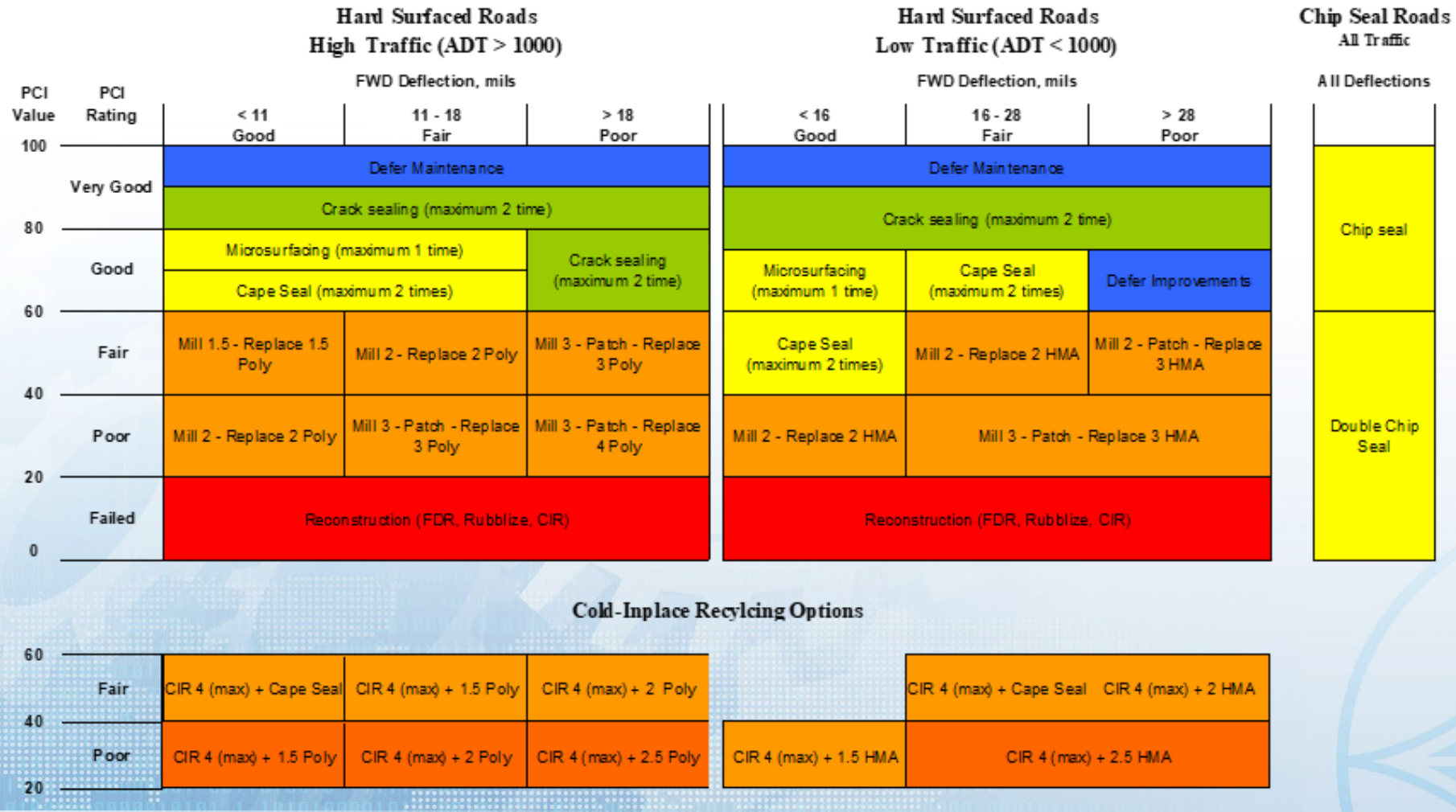
IL County Treatment Matrix



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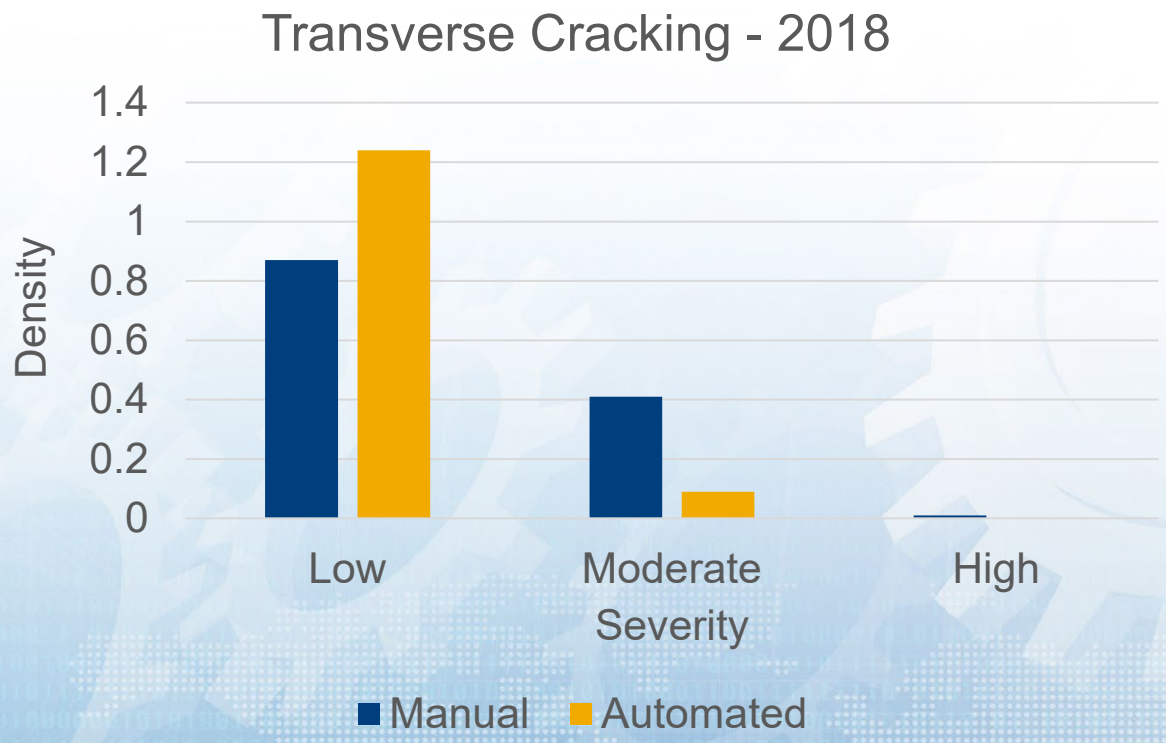
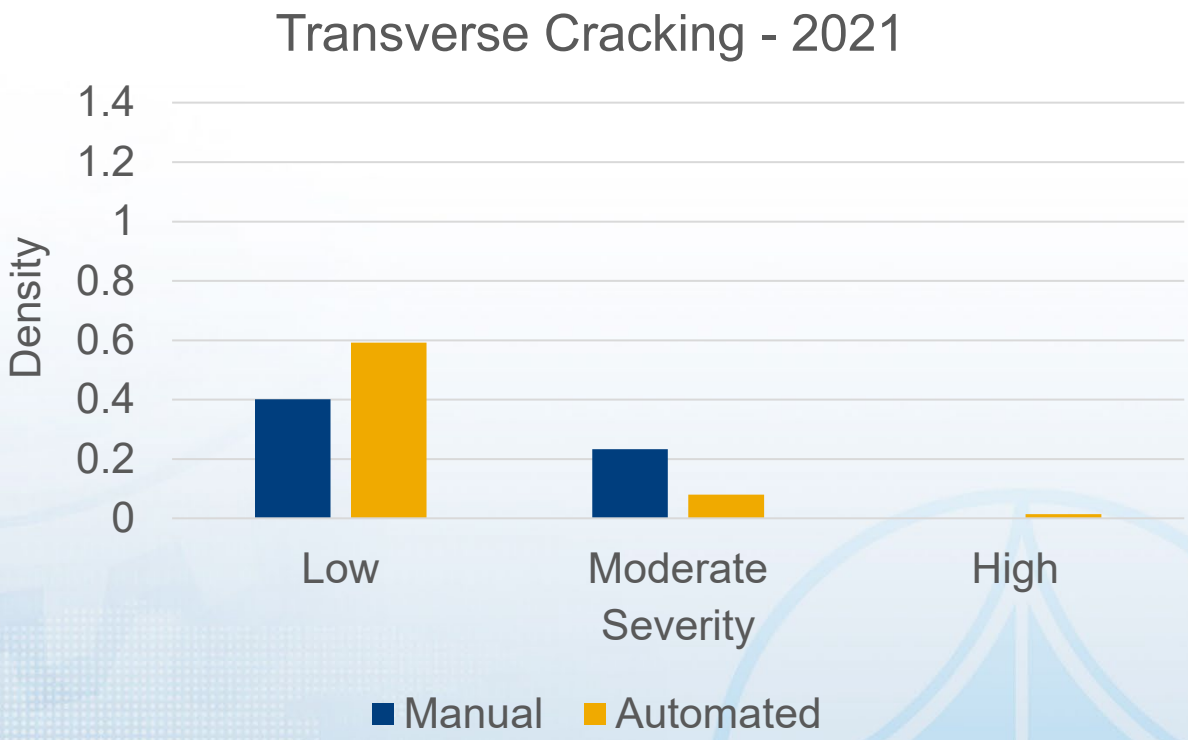
Individual Distresses





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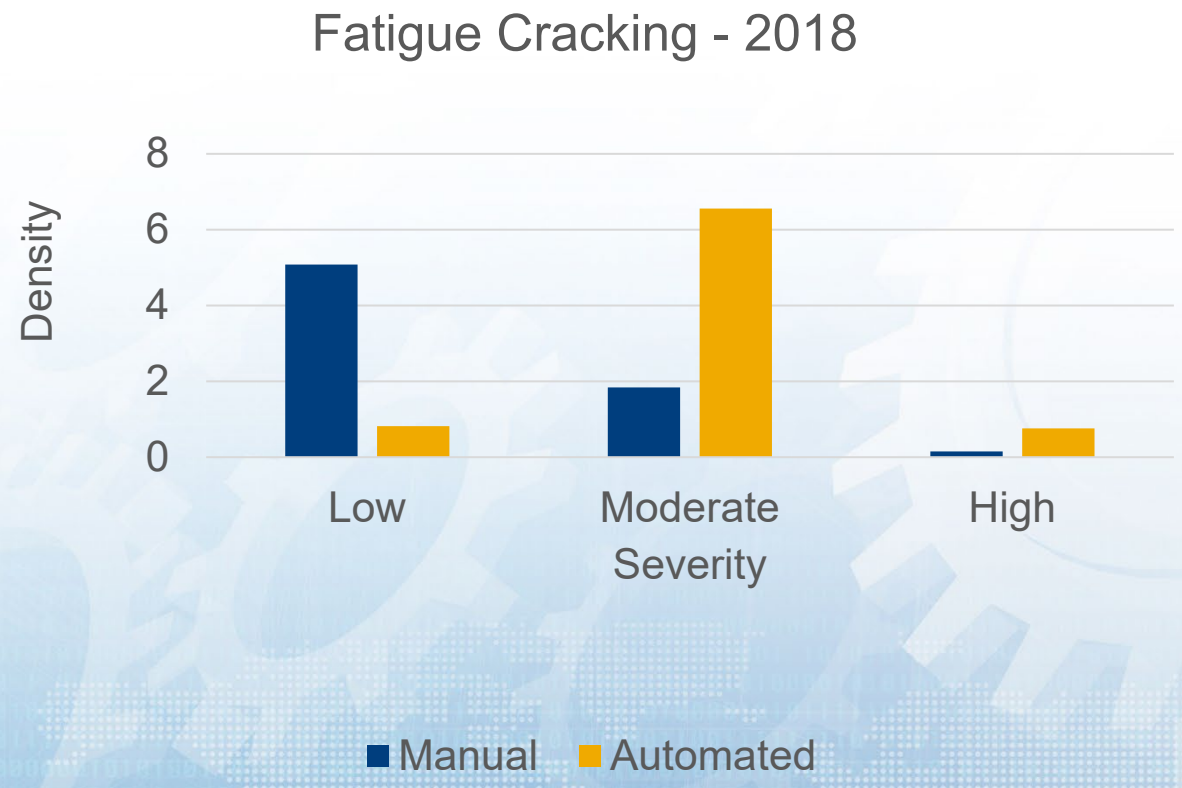
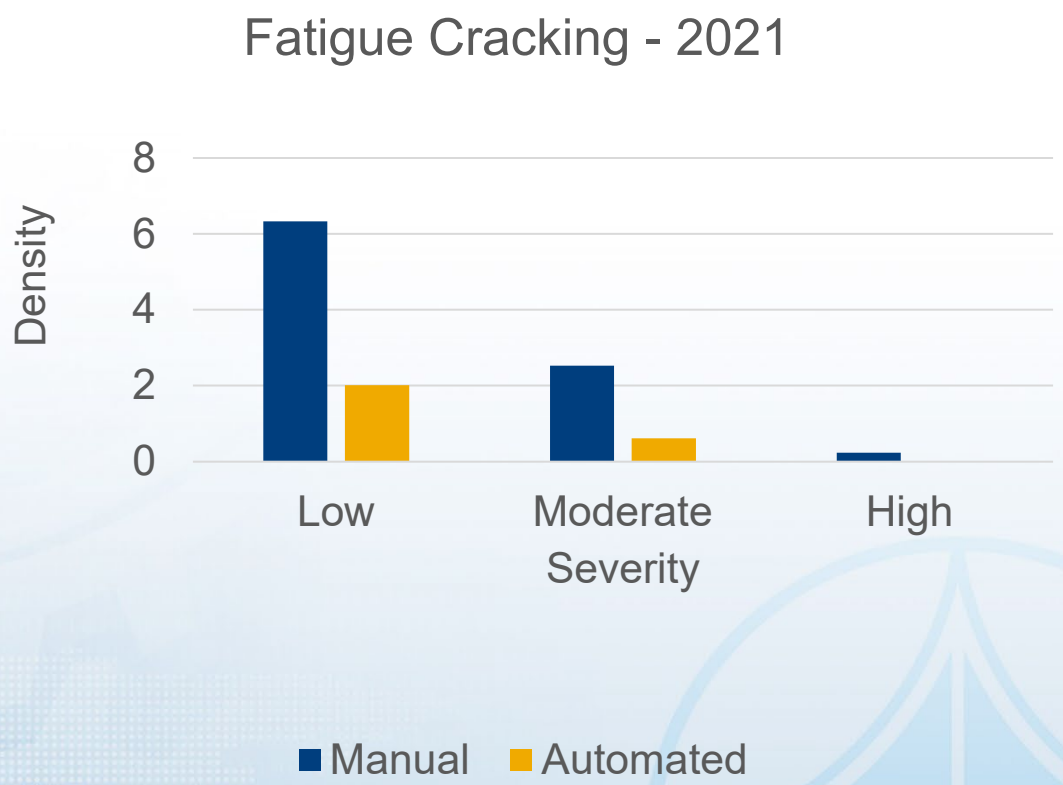
Individual Distresses





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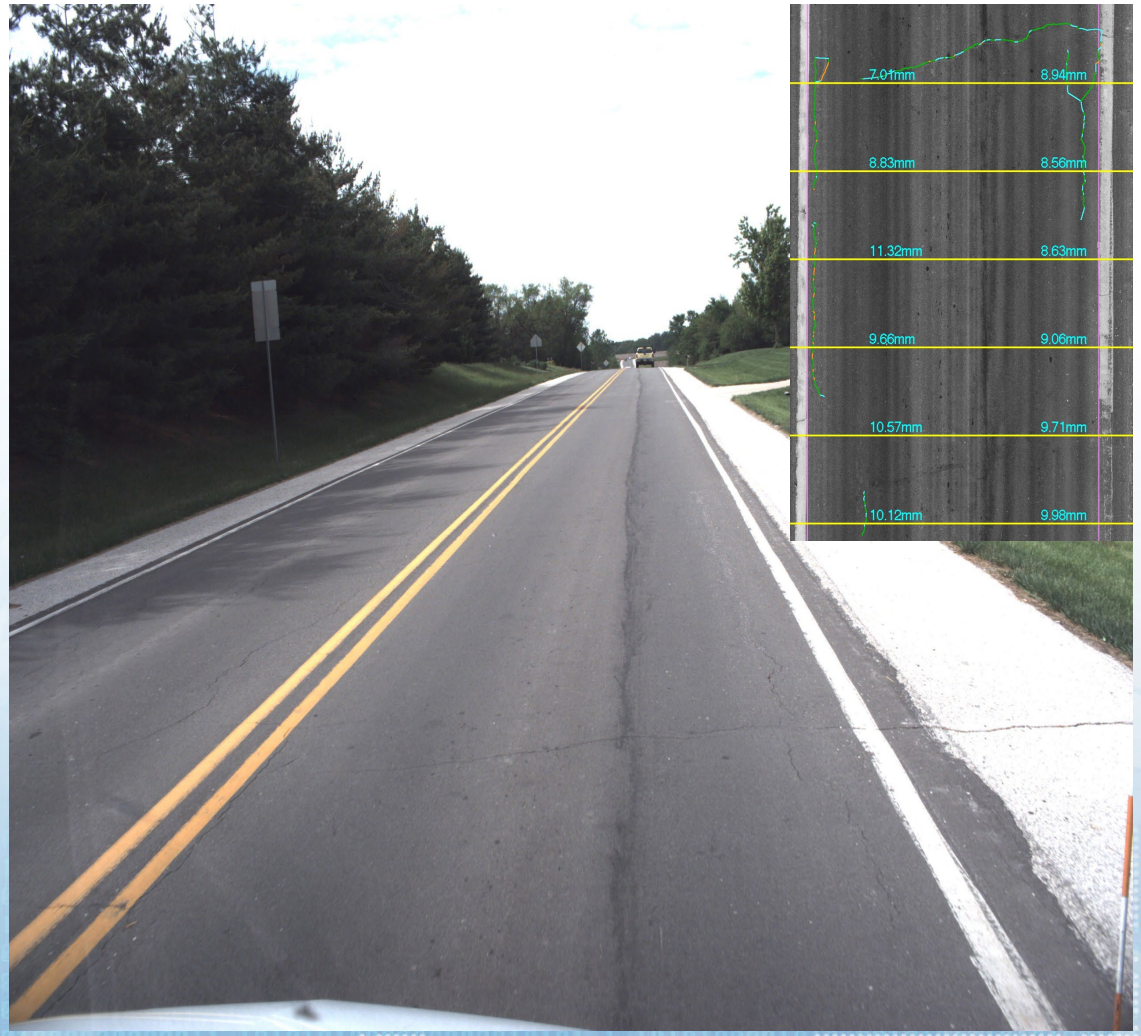
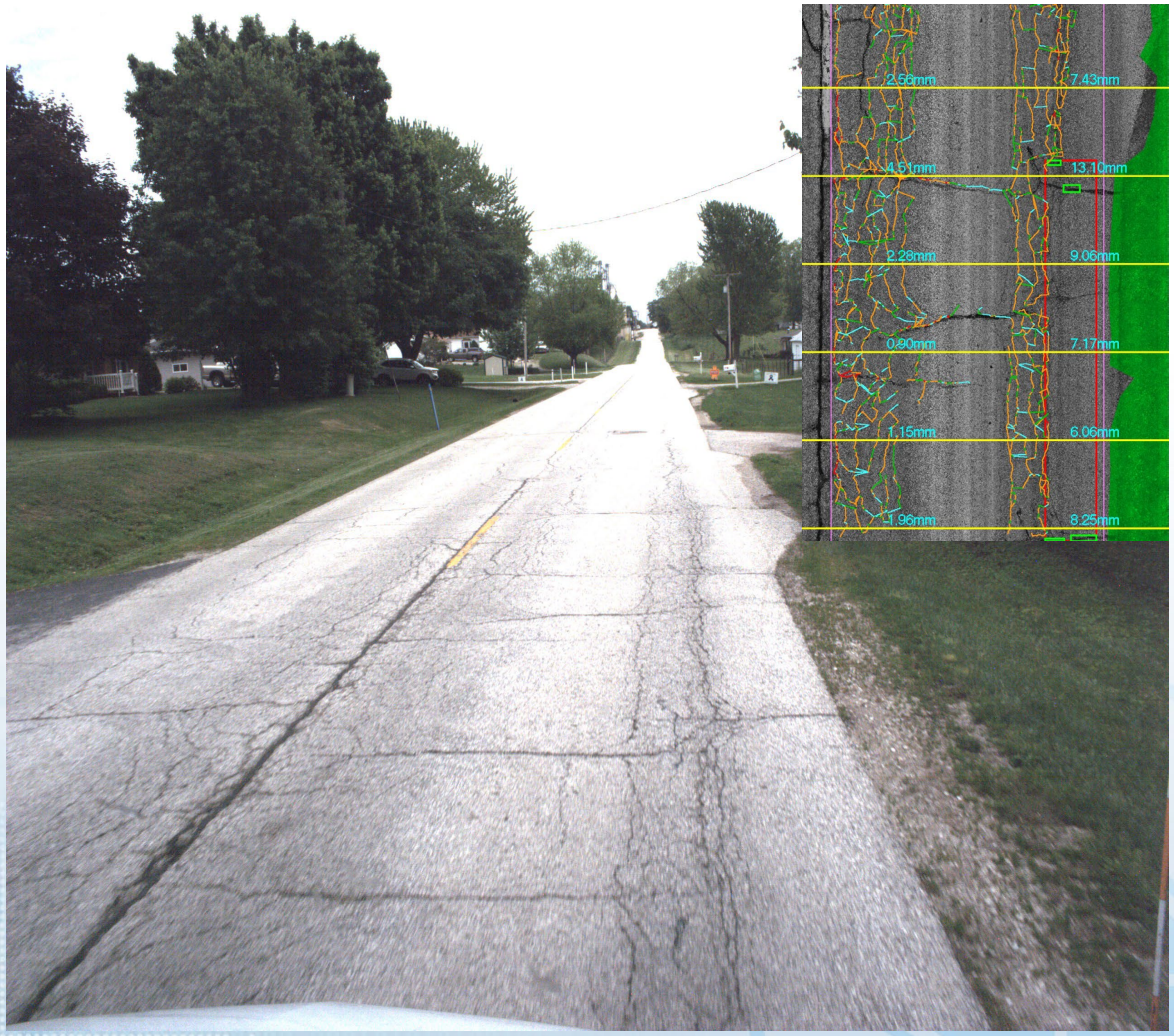
Sample Images





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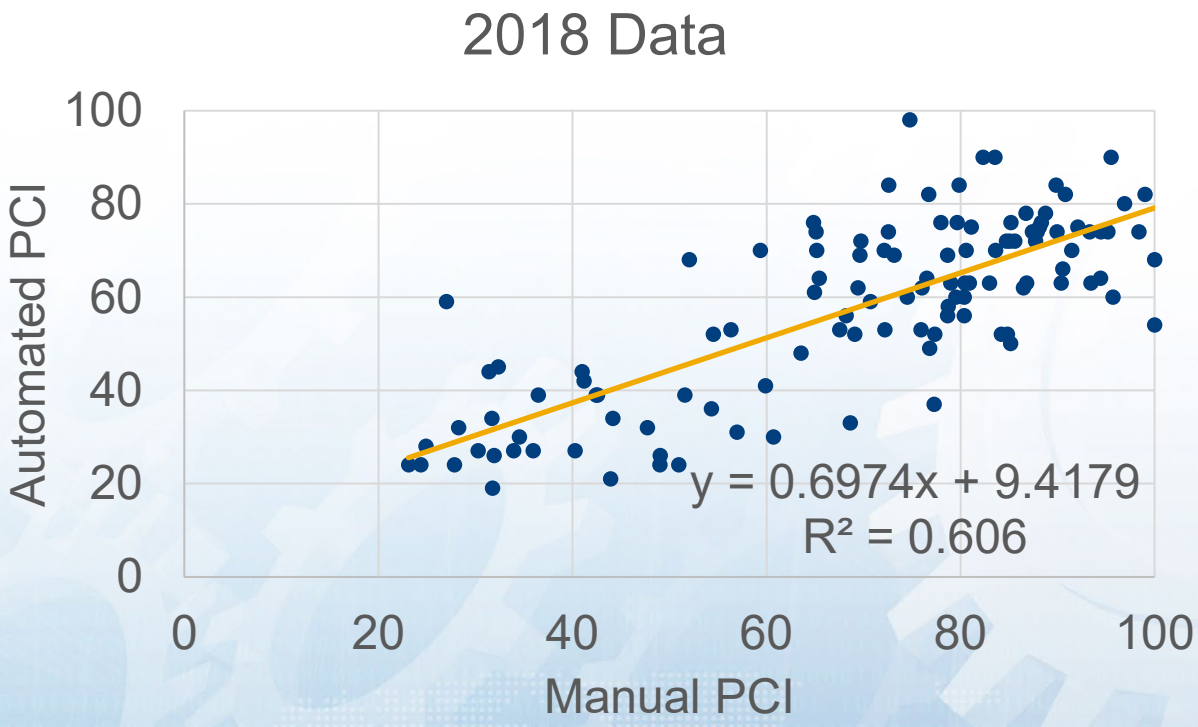
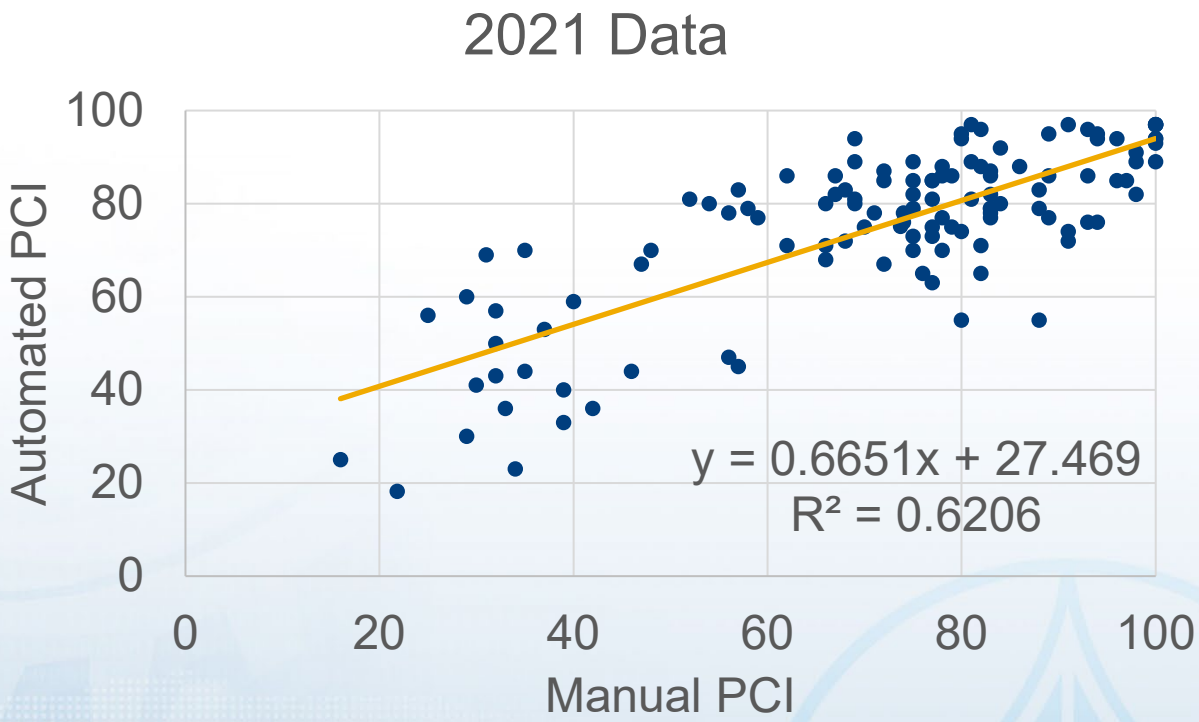
Pavement Condition Index





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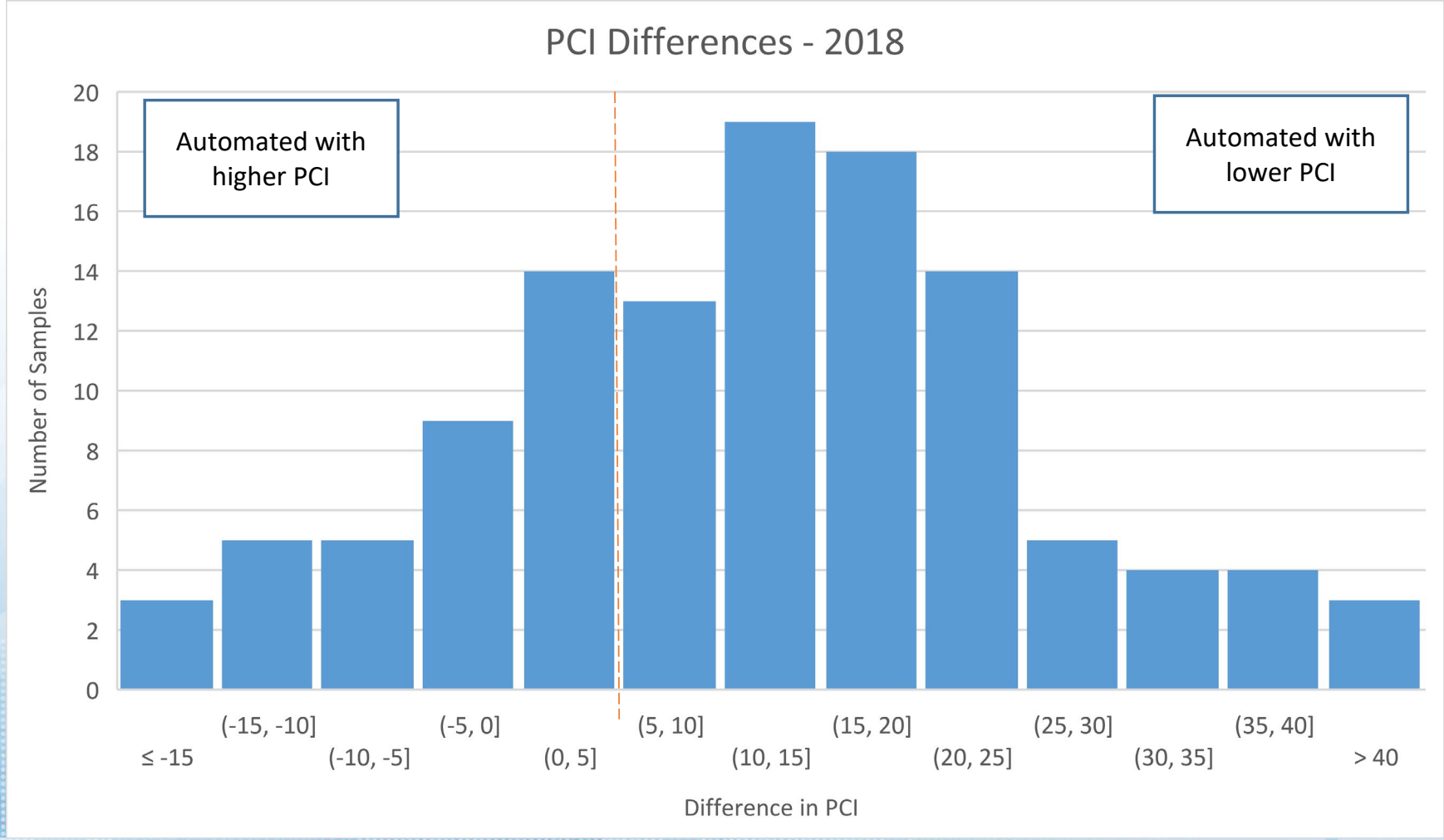
PCI Difference Histogram



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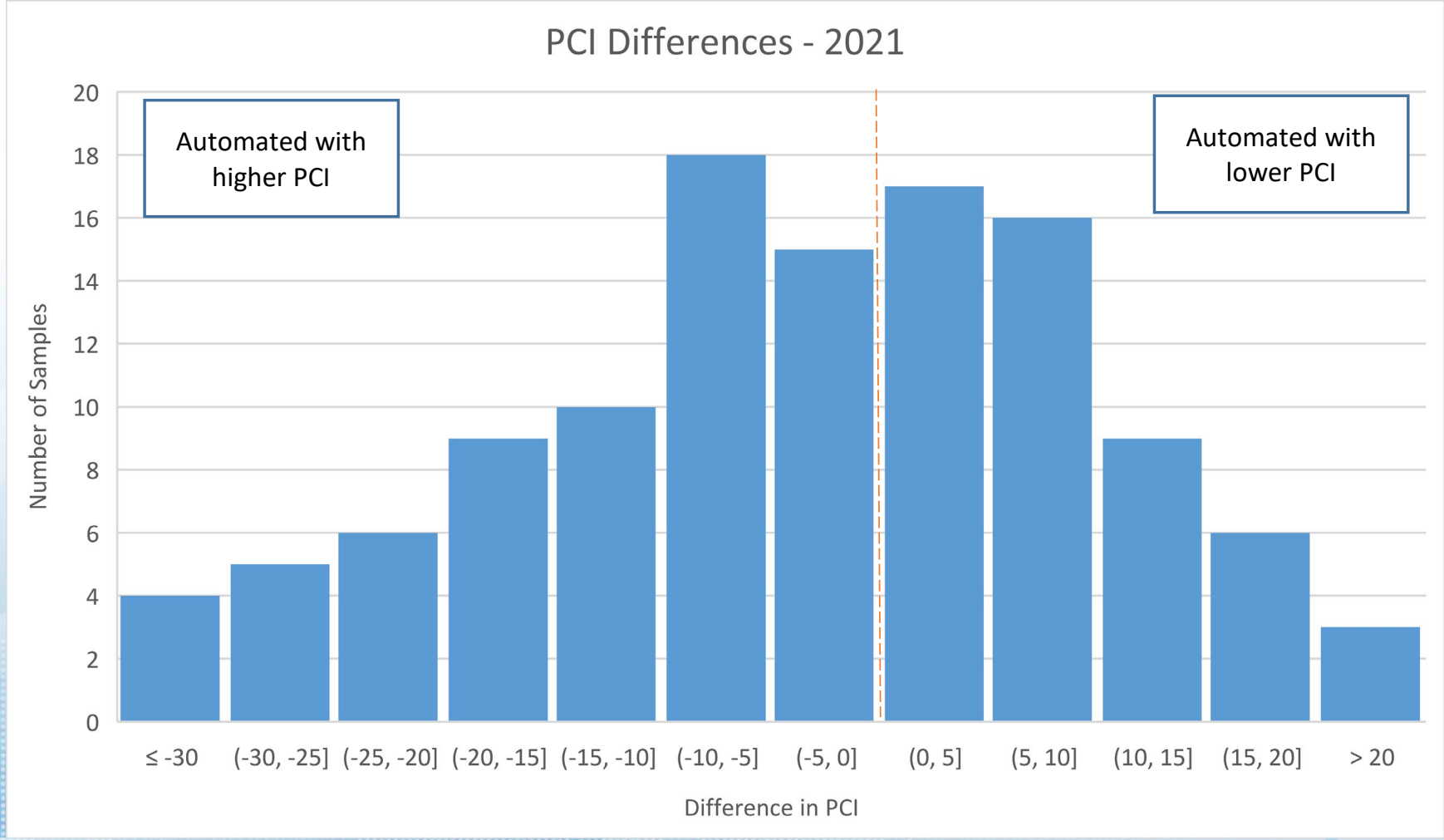

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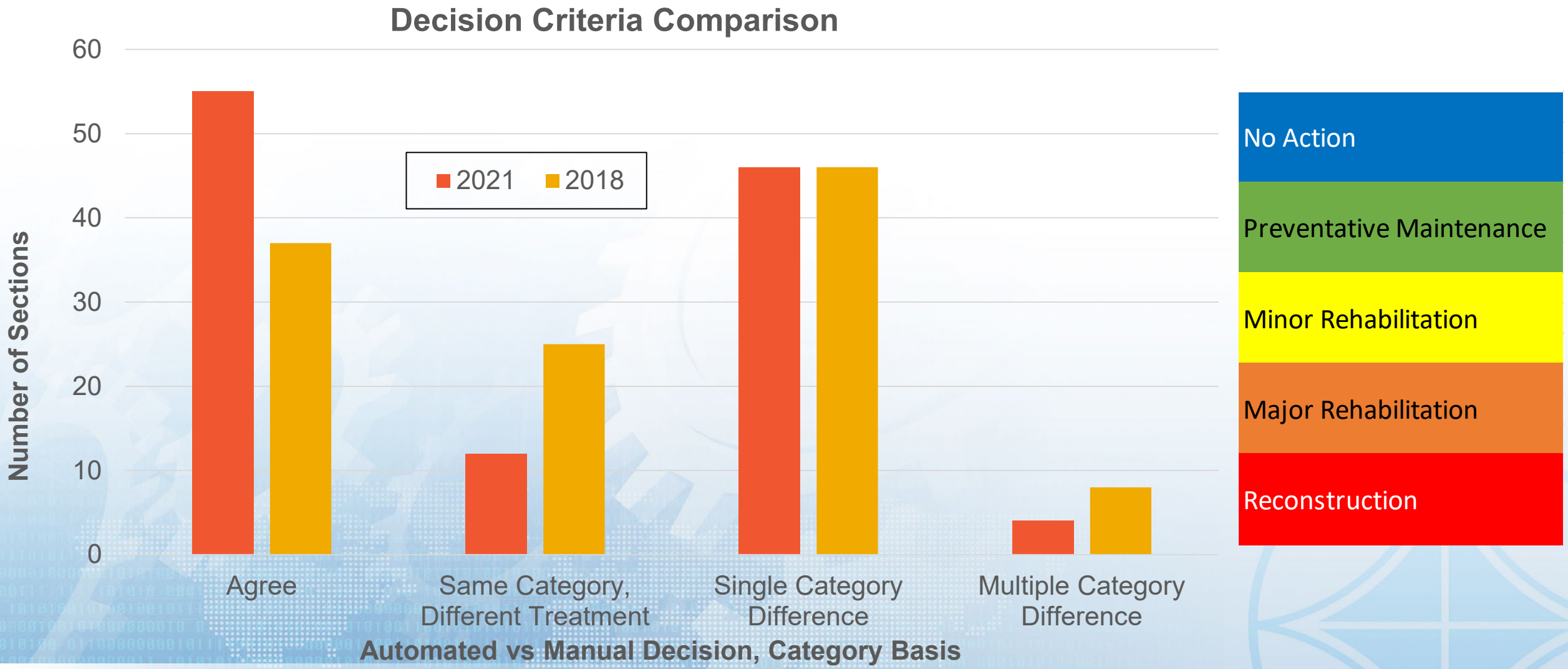
Decisions



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Back to PMS-Software

- Several types of PMS software available
- Wide range in capabilities, ease of use & cost

Cartegraph

RoadCare version 3.0
Decision Support System (DSS)

HANSON
Engineering | Planning | Allied Services

deighton

AgileAssets
A TRIMBLE COMPANY

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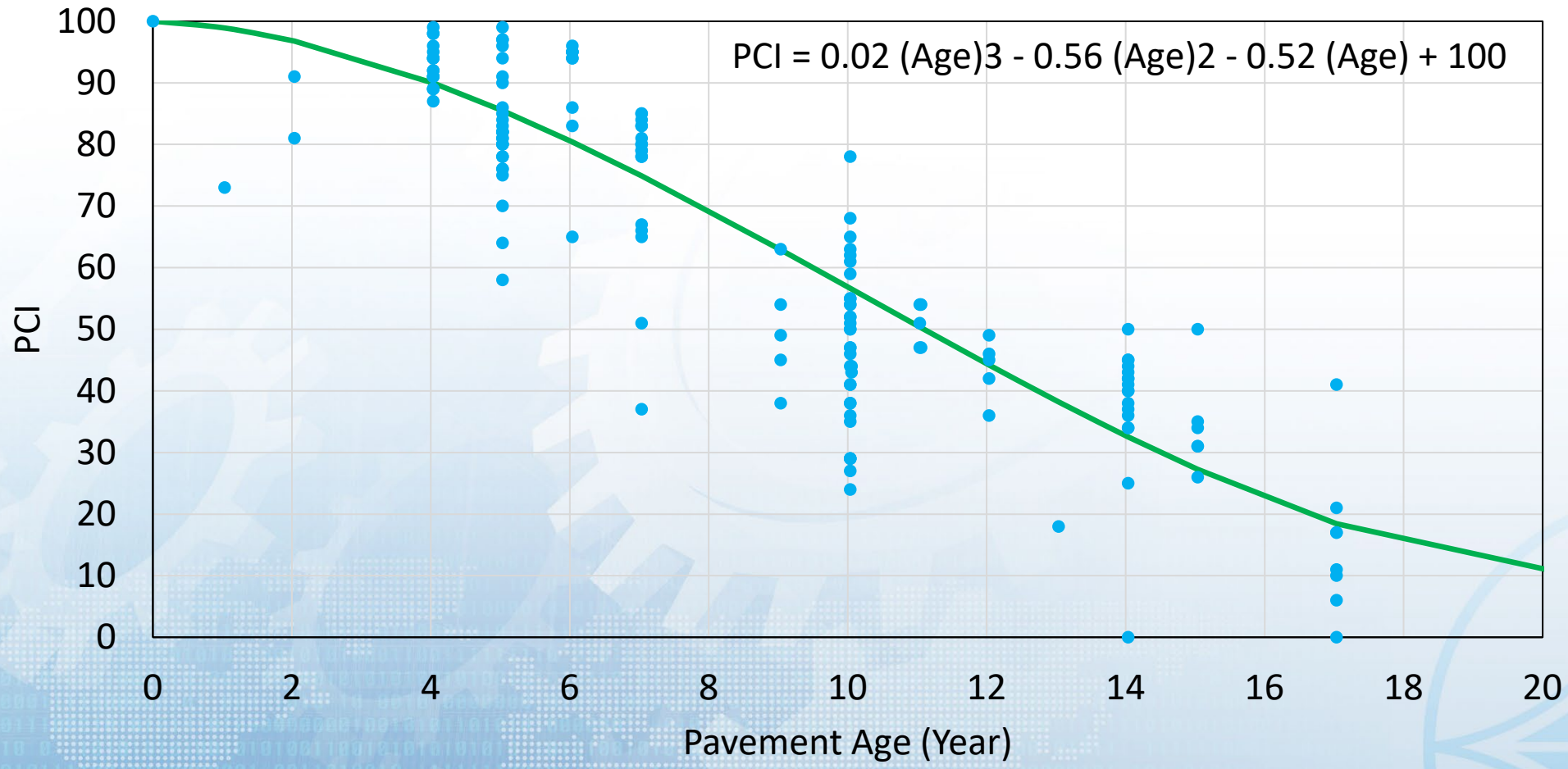
Pavement Performance Models



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Treatment Selection Criteria

Treatment Matrix for Arterial/Collector Roads

PCI	Localized Preventive	Localized Stop Gap	Major M&R
0	No Localize Preventive Treatment Recommended	Patching and Repair	Reconstruction
25			4.0" Mill & Overlay
40			3.0" Mill & Overlay
65	Crack Seal and Distress Repair	No Localized Stop Gap/ Major M&R Recommended	
100			

Treatment Matrix for Local/Residential Roads

PCI	Localized Preventive	Localized Stop Gap	Major M&R
0	No Localize Preventive Treatment Recommended	Patching and Repair	Reconstruction
25			3.0" Mill & Overlay
40			2.0" Mill & Overlay
60	Crack Seal and Distress Repair	No Localized Stop Gap/ Major M&R Recommended	
100			

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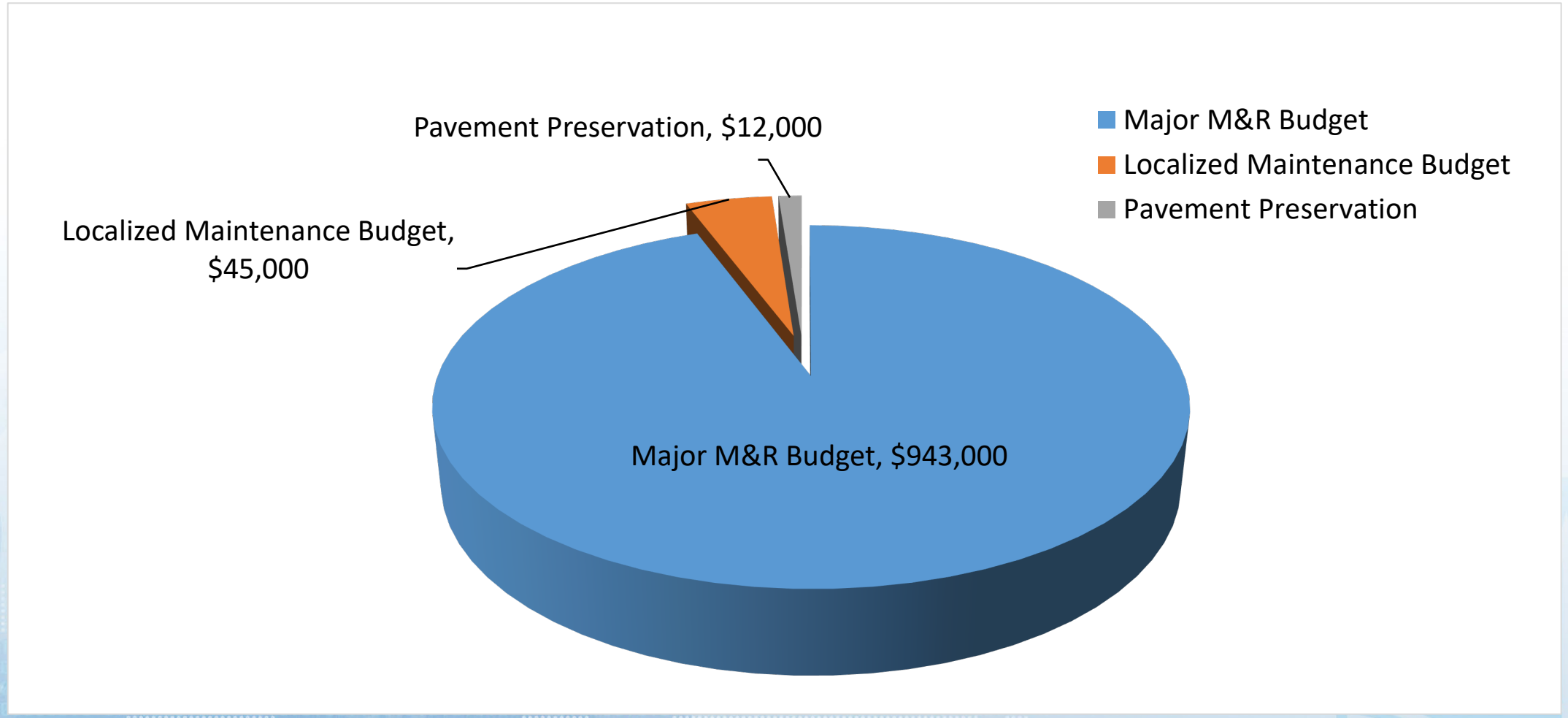
Budget Allocation-Example



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Treatments

Maintenance & Rehabilitation Treatment Description	Budget Category	$/lane mile
Crack Seal	Maintenance	$6,200
Thin Lift Treatment (TLT)	TLT	$75,000
M&R 2”	Rehabilitation	$85,000
M&R 3-3/4”	Rehabilitation	$145,000
Reconstruction	Rehabilitation	$1,200,000

Maintenance & Rehabilitation Treatment Description	Budget Category	Impact on CRS	Years before same treatment	Years before any treatment	Impact on Surface Age
Crack Seal	Maintenance	+3%	5	2	+1
Thin Lift Treatment (TLT)	Minor	= 7.0	10	1	+1
M&R 2”	Major	= 8.0	8	1	0
M&R 3-3/4”	Major	= 8.5	12	1	0
Reconstruction	Major	= 9.0	20	1	0

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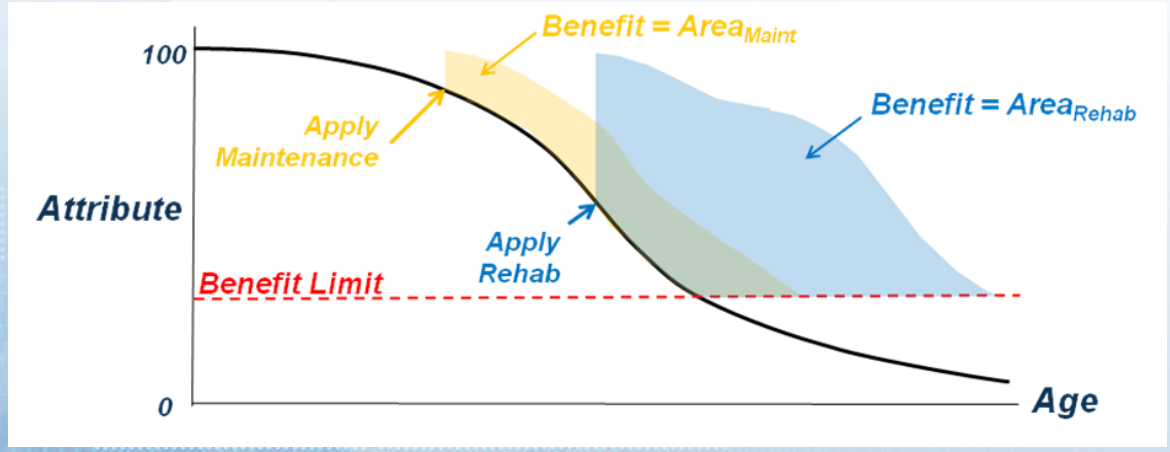
Multi-year CIP?

- Predict treatment activities for future years
- Use performance models, treatment matrix, budget, feasibilities & constraints
- Benefit-Cost Ratio or other methods



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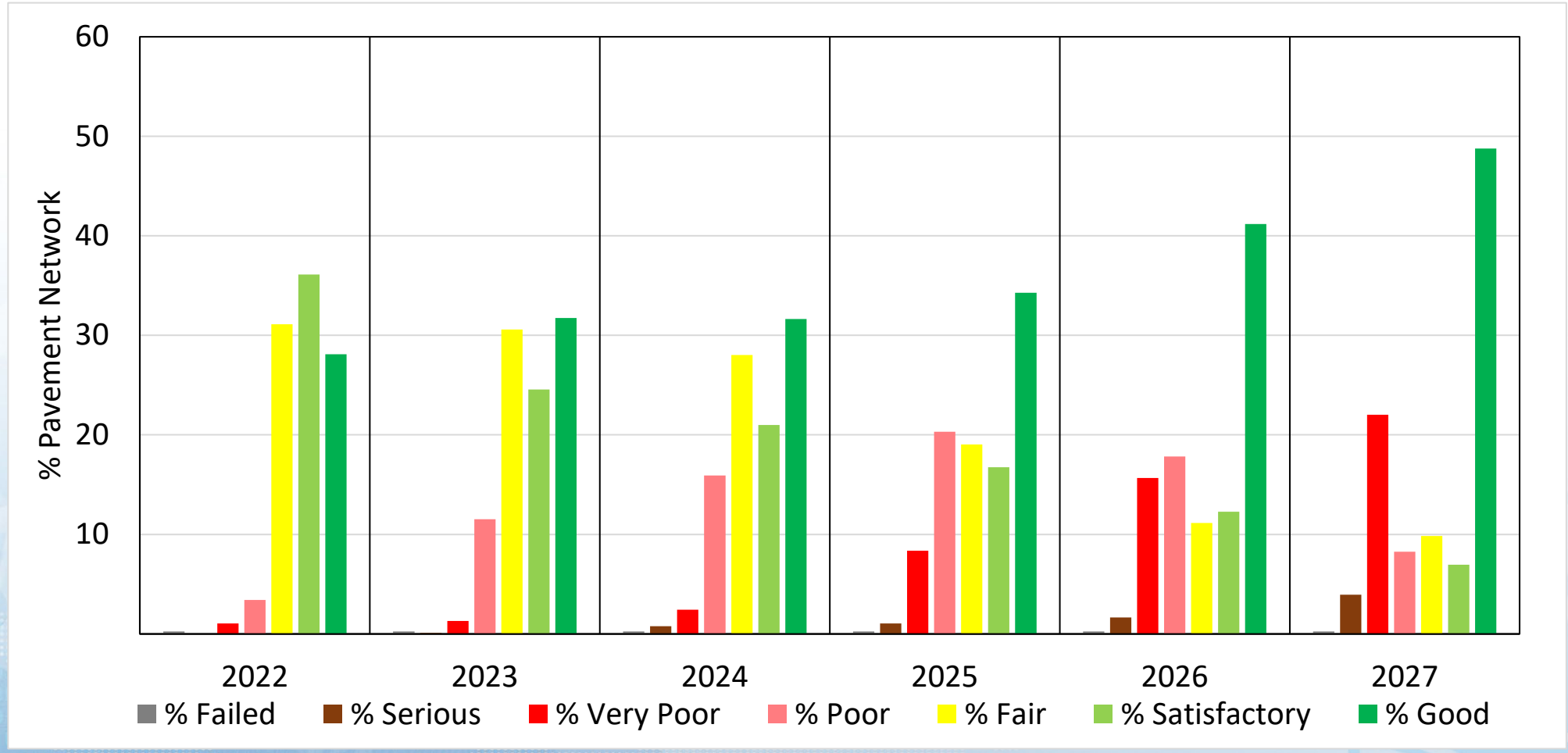
Multi-year CIP



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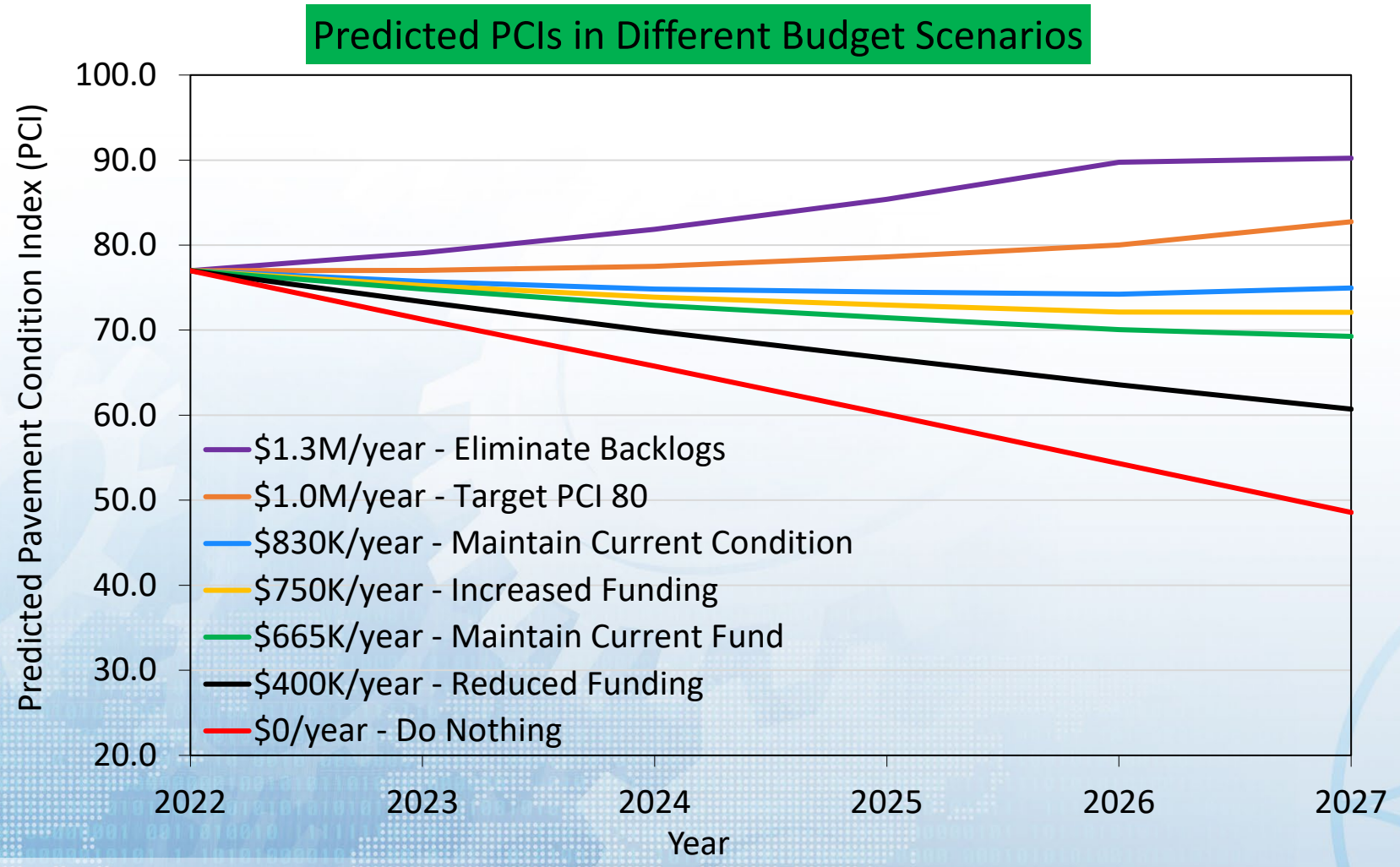
Multi-year CIP



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Multi-year CIP

Funding Scenario	Total 5-Year Funded Costs (2023-2027)	Remaining M&R Backlogs in 2027	Total 5-Year Costs	Predicted PCI 2027
$1.3M/year - Eliminate Backlogs	$6.7	$0.0	$6.7	90
$1.0M/year - Target PCI 80	$5.2	$2.2	$7.5	83
$830K/year - Maintain Current Condition	$4.2	$3.4	$7.6	75
$750K/year - Increased Funding	$3.7	$3.9	$7.6	72
$665K/year - Maintain Current Fund	$3.3	$4.4	$7.7	69
$400K/year - Reduced Funding	$2.0	$5.8	$7.8	61
$0/year - Do Nothing	$0.0	$8.1	$8.1	49

1. 'M&R Backlogs' refers to the amount required to resurface/reconstruct all pavements at or below critical PCI.
2. 'Total 5-Year Costs' refers to the sum of 5-year major M&R expenses and remaining backlogs at the end of 5-year period

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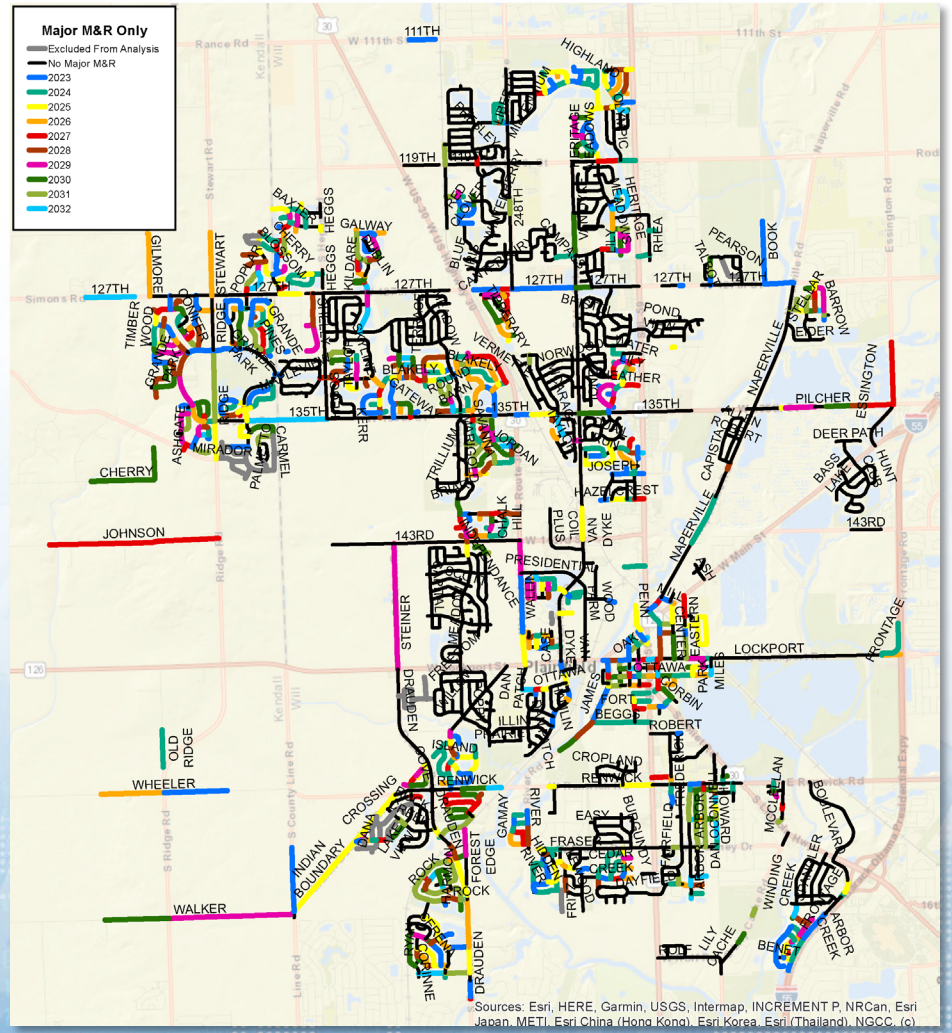
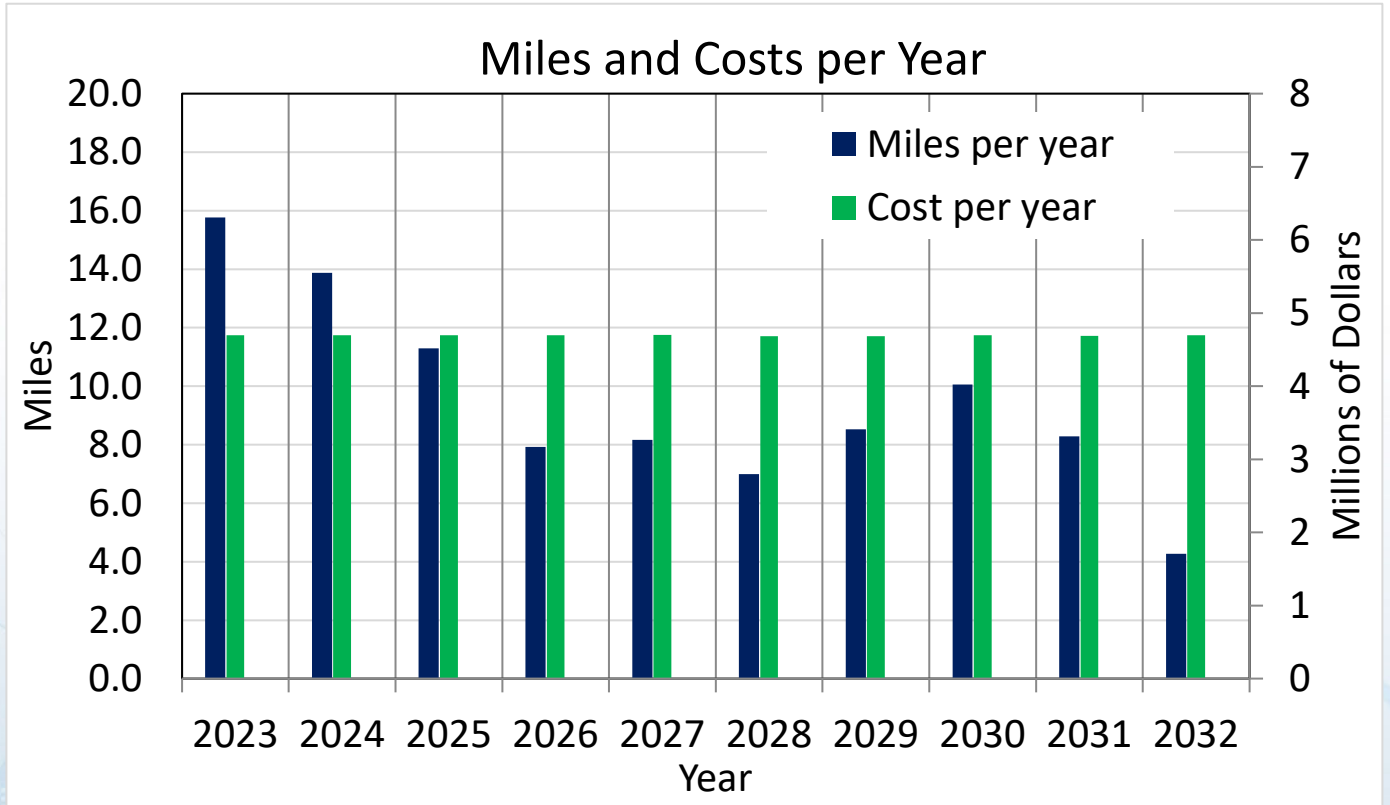
Multi-year CIP





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Sample Output (Summarization)

Year	Branch ID	Section ID	PCI Before	Area (sqft)	Cost	Functional Class	Surface Type	Length (ft)	Width (ft)	Work Type
2031	WATERFORD_	578	57.46	3,584	11068.65464	Resdential	AC	224	16	1.75" - 2.25" Mill and Overlay
2031	WEINHOLD_D	104	59.42	8,679	26803.80961	Resdential	AC	263	33	1.75" - 2.25" Mill and Overlay
2031	WHITE ASH_	949	57.46	9,842	30395.56333	Resdential	AC	518	19	1.75" - 2.25" Mill and Overlay
2032	127TH_ST	91	0	52,962	912836.2114	Collector	AC	2037	26	Full Reconstruction
2032	135TH_ST	21	0	121,356	2091653.474	Collector	AC	3371	36	Full Reconstruction
2032	ALISON_RD	351	57.83	22,240	72119.20289	Resdential	AC	1112	20	1.75" - 2.25" Mill and Overlay
2032	ARBOR_CT	1342	59.68	6,112	19819.80972	Resdential	AC	191	32	1.75" - 2.25" Mill and Overlay
2032	ARBOR_DR	1344	59.68	11,808	38290.62715	Resdential	AC	369	32	1.75" - 2.25" Mill and Overlay
2032	ARBORVIEW_	742	57.83	11,480	37226.99862	Resdential	AC	410	28	1.75" - 2.25" Mill and Overlay
2032	BIRCH_CT	1129	59.68	4,116	13347.24097	Resdential	AC	147	28	1.75" - 2.25" Mill and Overlay

Number Sections	Cost	Wt. Avg. of PCI before Maintenance	Wt. Avg. of PCI after Maintenance
7.33 mi (Localized Preventive)	$137,659	67.9	78.5
71.97 mi (Localized Stopgap)	$103,268	25.2	25.9

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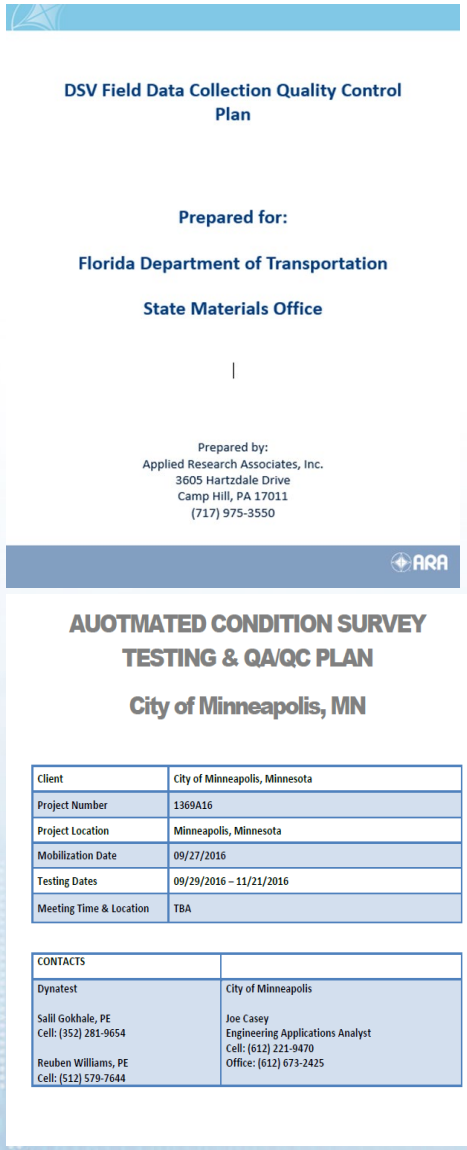
Data Quality Management Plan



DSV Field Data Collection Quality Control Plan

Prepared for:

Florida Department of Transportation

State Materials Office

Prepared by:
Applied Research Associates, Inc.
3605 Hartzdale Drive
Camp Hill, PA 17011
(717) 975-3550

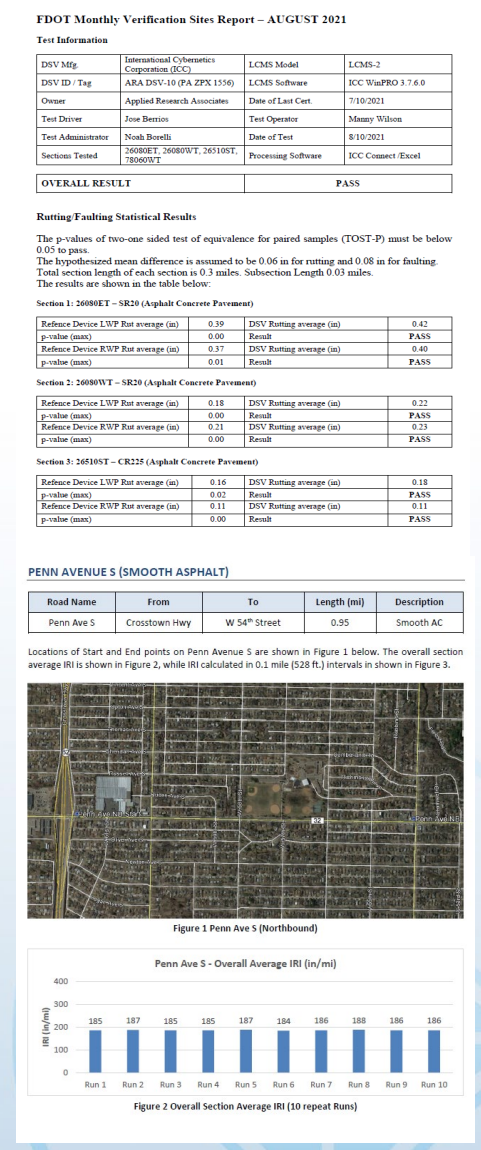
ARA

AUOTMATED CONDITION SURVEY TESTING & QA/QC PLAN

City of Minneapolis, MN

Client	City of Minneapolis, Minnesota
Project Number	1369A16
Project Location	Minneapolis, Minnesota
Mobilization Date	09/27/2016
Testing Dates	09/29/2016 – 11/21/2016
Meeting Time & Location	TBA

CONTACTS	
Dynatest Salil Gokhale, PE Cell: (352) 281-9654 Reuben Williams, PE Cell: (512) 579-7644	City of Minneapolis Joe Casey Engineering Applications Analyst Cell: (612) 221-9470 Office: (612) 673-2425



FDOT Monthly Verification Sites Report – AUGUST 2021

Test Information

DSV Mfg.	International Cybernetics Corporation (ICC)	LCMS Model	LCMS-2
DSV ID / Tag	ARA DSV-10 (PA ZPX 1556)	LCMS Software	ICC WinPRO 3.7.6.0
Owner	Applied Research Associates	Date of Last Cert.	7/10/2021
Test Driver	Jose Berrios	Test Operator	Manny Wilson
Test Administrator	Noah Borelli	Date of Test	8/10/2021
Sections Tested	26080ET, 26080WT, 26510ST, 78060WT	Processing Software	ICC Connect /Excel

OVERALL RESULT	PASS

Rutting/Faulting Statistical Results

The p-values of two-one sided test of equivalence for paired samples (TOST-P) must be below 0.05 to pass.
The hypothesized mean difference is assumed to be 0.06 in for rutting and 0.08 in for faulting.
Total section length of each section is 0.3 miles. Subsection Length 0.03 miles.
The results are shown in the table below:

Section 1: 26080ET – SR20 (Asphalt Concrete Pavement)

Refence Device LWP Rut average (in)	0.39	DSV Rutting average (in)	0.42
p-value (max)	0.00	Result	PASS
Refence Device RWP Rut average (in)	0.37	DSV Rutting average (in)	0.40
p-value (max)	0.01	Result	PASS

Section 2: 26080WT – SR20 (Asphalt Concrete Pavement)

Refence Device LWP Rut average (in)	0.18	DSV Rutting average (in)	0.22
p-value (max)	0.00	Result	PASS
Refence Device RWP Rut average (in)	0.21	DSV Rutting average (in)	0.23
p-value (max)	0.00	Result	PASS

Section 3: 26510ST – CR225 (Asphalt Concrete Pavement)

Refence Device LWP Rut average (in)	0.16	DSV Rutting average (in)	0.18
p-value (max)	0.02	Result	PASS
Refence Device RWP Rut average (in)	0.11	DSV Rutting average (in)	0.11
p-value (max)	0.00	Result	PASS

PENN AVENUE S (SMOOTH ASPHALT)

Road Name	From	To	Length (mi)	Description
Penn Ave S	Crosstown Hwy	W 54th Street	0.95	Smooth AC

Locations of Start and End points on Penn Avenue S are shown in Figure 1 below. The overall section average IRI is shown in Figure 2, while IRI calculated in 0.1 mile (528 ft.) intervals in shown in Figure 3.

Figure 1 Penn Ave S (Northbound)

Figure 2 Overall Section Average IRI (10 repeat Runs)

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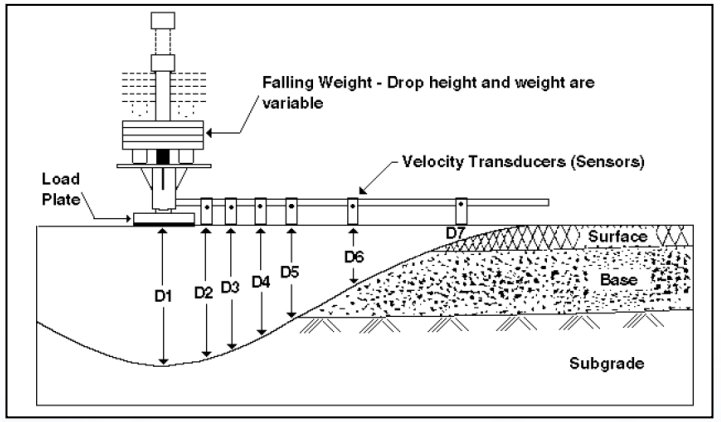
What about Structural Testing?

- Falling Weight Deflectometer (FWD)
- Nondestructive testing
- Measures deflection
- Composite Modulus of HMA, Subgrade modulus, & Structural capacity



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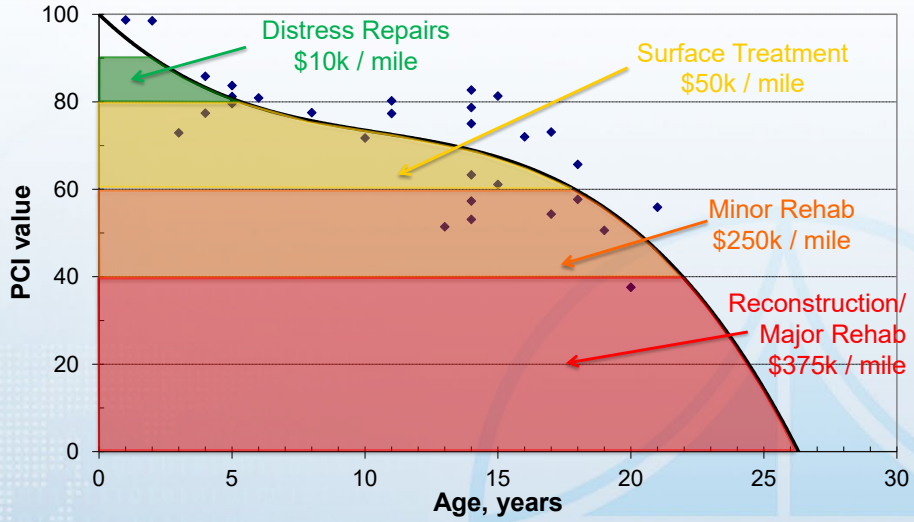
Why the Interest in Pavement Preservation?

- Pavement Infrastructure a Huge Investment
- Important to Preserve Investment
- Effective Pavement Preservation Program:
  - Right Pavement
  - Right Treatment
  - Right Time



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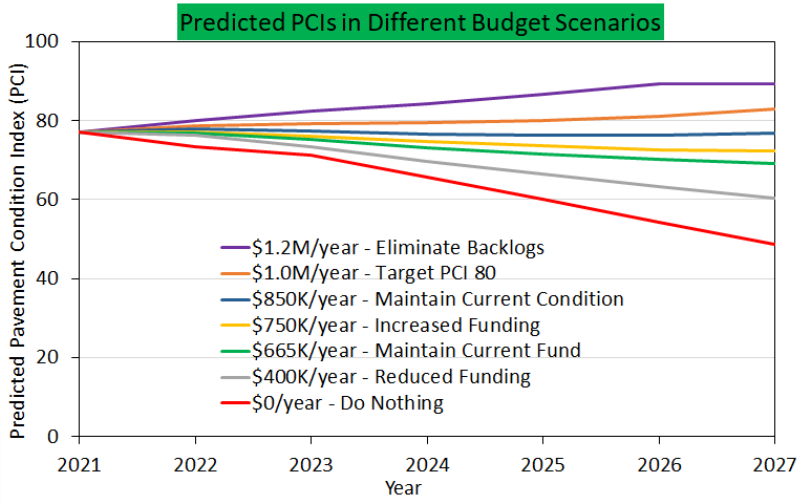
Conclusions

- Benefits of PMS-Objective tool for selecting when, how, and which roads to improve
- Quality of data
- Structural data is beneficial
- Pavement preservation



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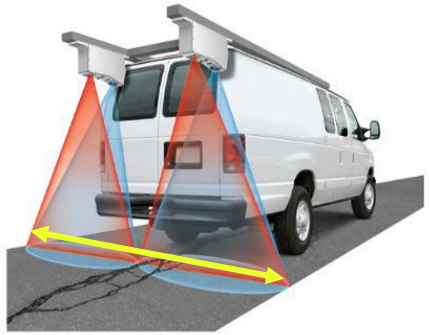
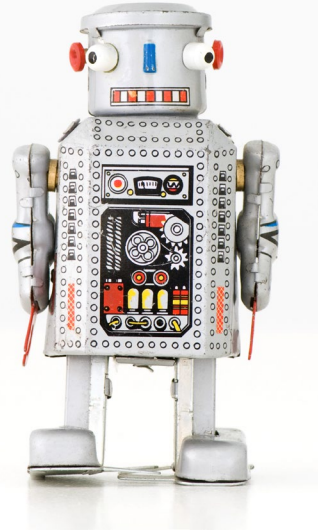
Conclusions (Automated Surveys)

Pavement Management Critical Items

- Understand the differences
  - ✓ Distress identification and classification methodology
  - ✓ Multiple vendors
  - ✓ Reprocess old data to evaluate
- Focus on Decisions
- Effect of sampling





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THANK YOU FOR THE OPPORTUNITY

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