



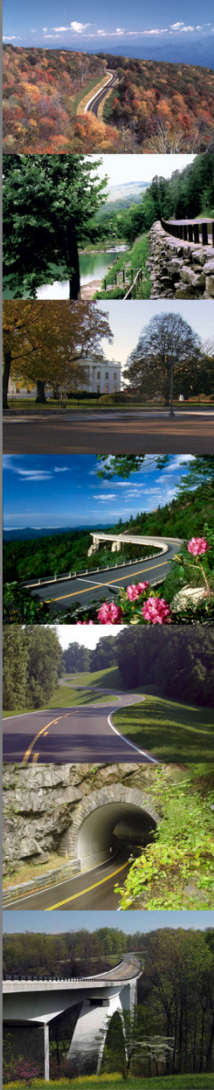
Improving and Maintaining the Alignment between Pavement Condition Rating and Maintenance and Rehabilitation Recommendations

Bill Eshbaugh, P.E.
Eastern Federal Lands Highway Division
October 26, 2007



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National Park Service

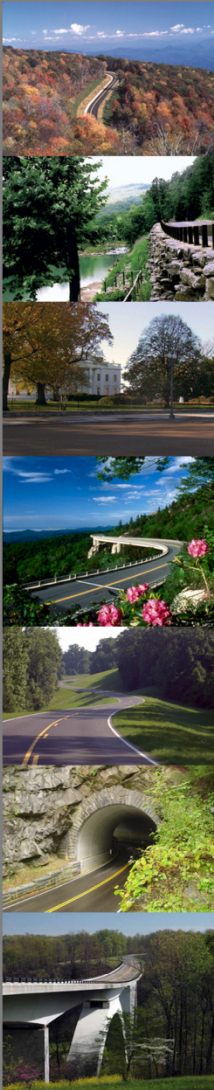
- 9,550 Miles of Paved Roads and Parkways
- All 50 States, DC, PR, VI, Guam and American Samoa
- Data Collection began in the late 1970s
- PMS Development Began in 2004
- One Cycle of Data collected every 3-5 years
- Data is collected by the FLHD Road Inventory Program (RIP)



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Automated Data Collection Methods

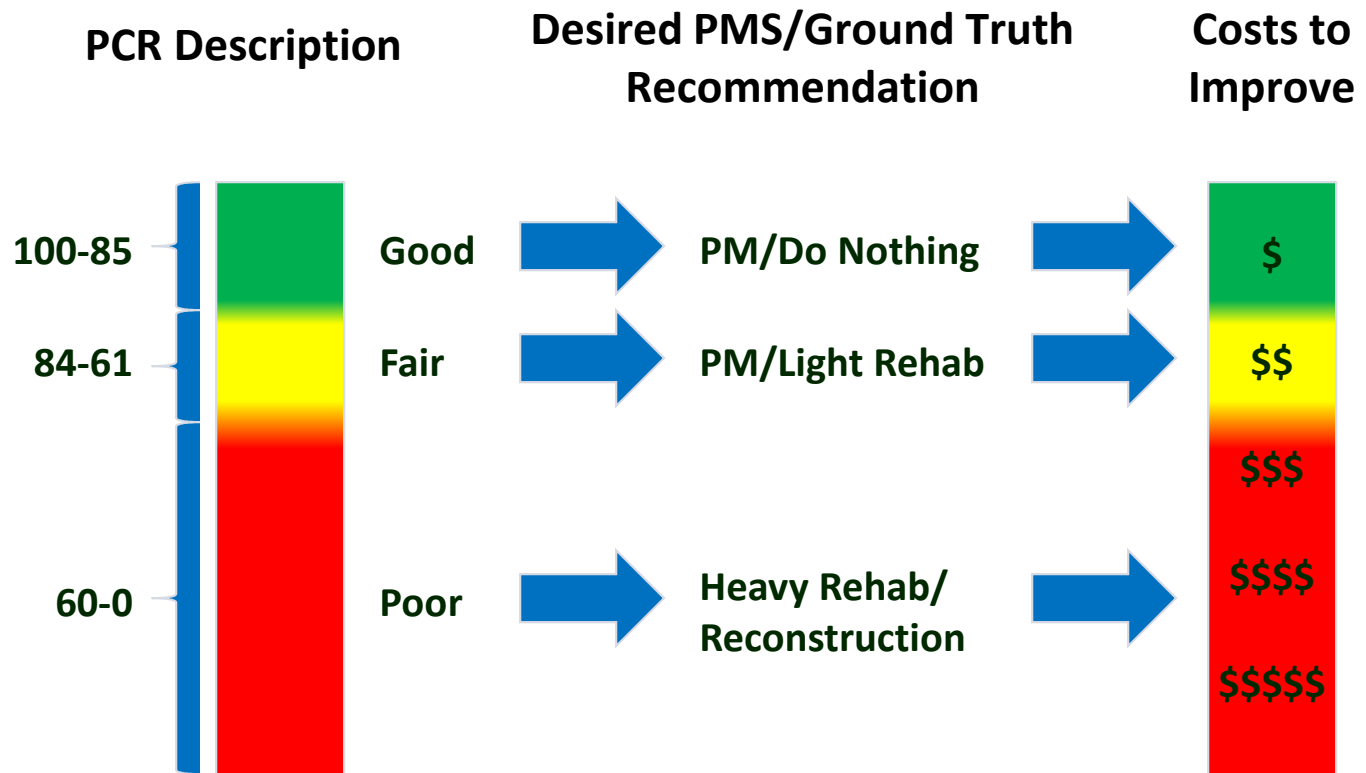


- Roughness/Rutting collected onboard
- Pavement Images recorded and used for automated crack detection and features inventory
- 100% Sampling in the Primary Lane
- Equipment updated to State of the Art in 2010





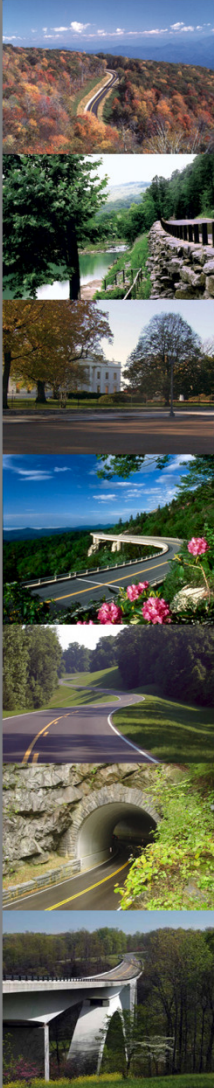
Objectives of Study



Process to Achieve Objectives Technical Development

- Identify and Document Issues
 - Review Historical RIP Data
 - Compare Data with Historical HPMA Analyses
- Review Data Collection history for FLH/NPS
 - Changes in Methodology
 - Changes in Equipment
- Expert Opinion Feedback
- Identify Improvement Strategies
- Test Improvement Strategies
- Implementation

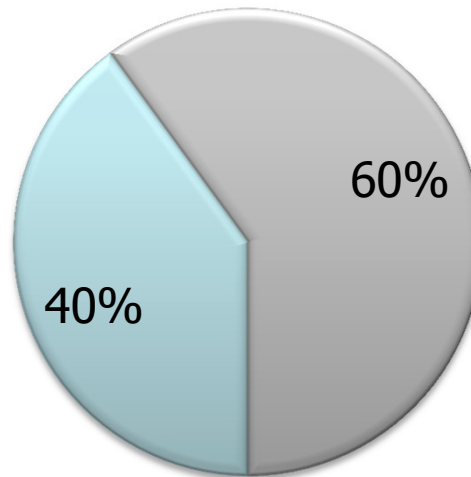


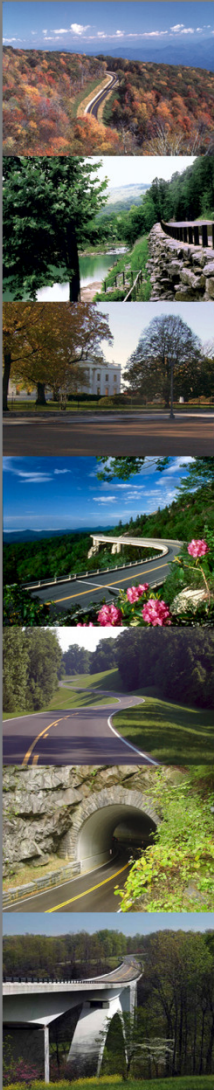


Pavement Condition Rating

Pavement Condition Rating (PCR)

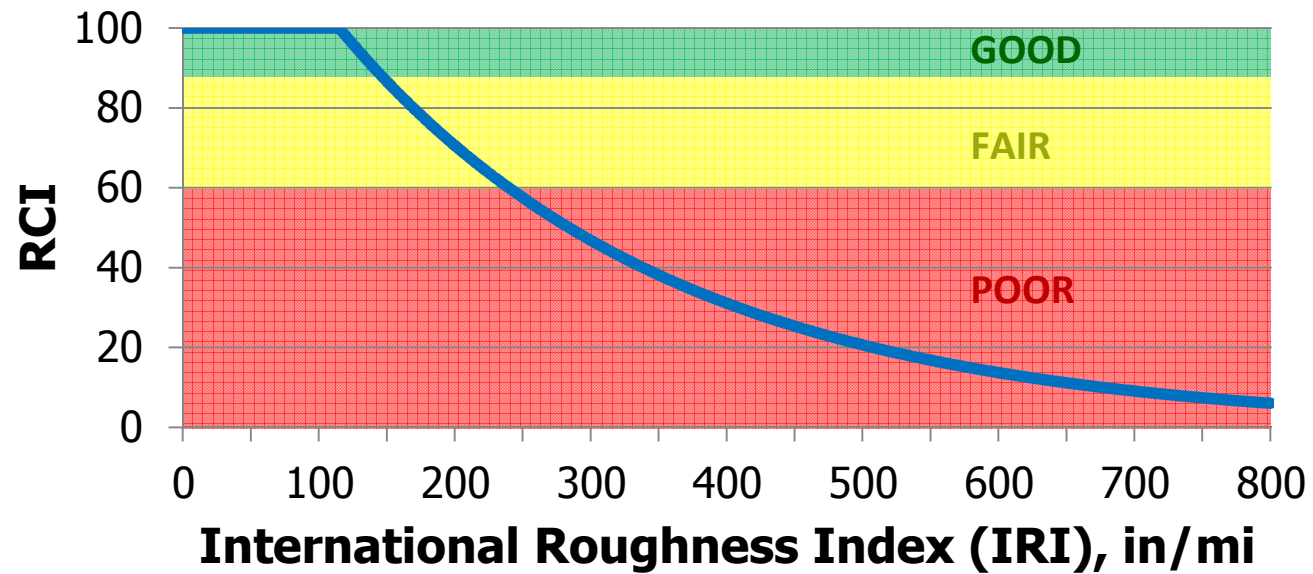
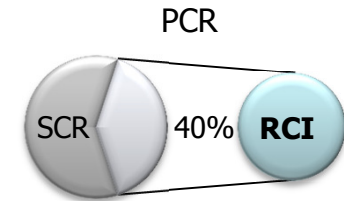
- Roughness Condition Index (RCI)
- Surface Condition Rating (SCR)





Roughness Condition Index

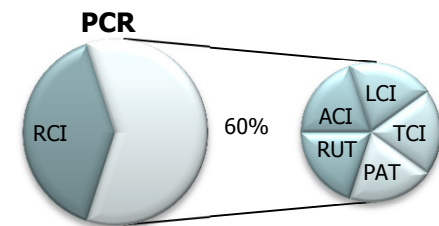
$$RCI = 32 \times 5 e^{-.0041 \times IRI}$$





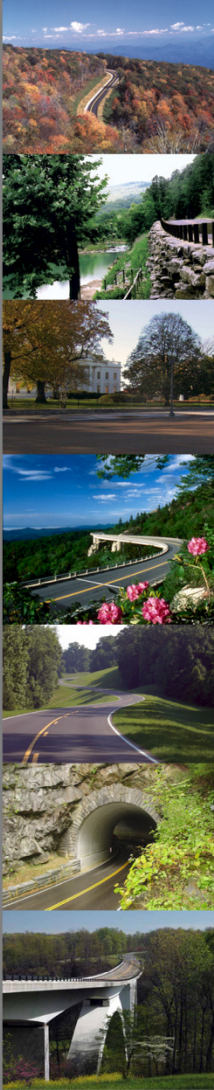
Surface Condition Rating

A Rating to indicate the total level of distress on the surface and is a combination of severity and extents of five surface distresses



Distress	Severity Based on	Extents Based on
Alligator Cracking	Development of Crack Pattern	Area Measurement
Longitudinal Cracking	Crack Width	Total Crack Length divided by segment length
Transverse Cracking	Crack Width	Total Crack Length divided by segment width
Patching	Any	Area Measurement
Rutting	Depth Measurement	Number of Ruts Measured





Surface Condition Rating

The Maximum Allowable Extents (MAE) is the failure limit established for each distress severity level

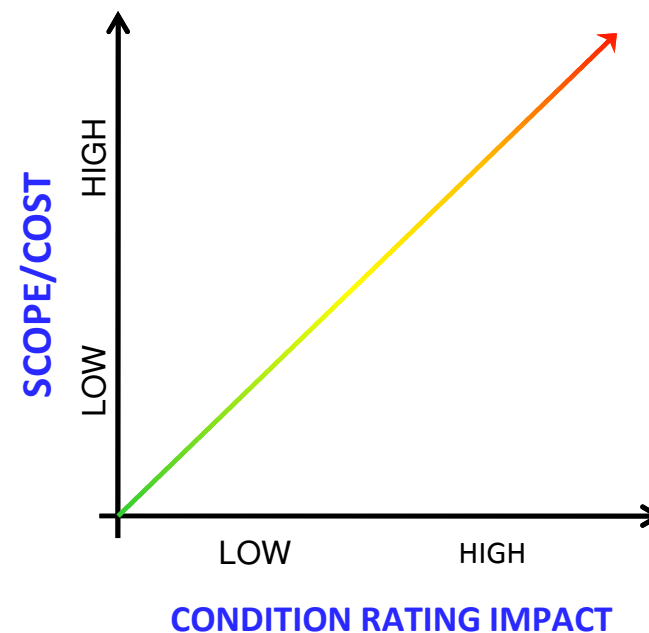
- Each severity level's MAE determines the overall weight in the SCR formula.
- Once a distress reaches the MAE, this should mean rehabilitation is the only recourse

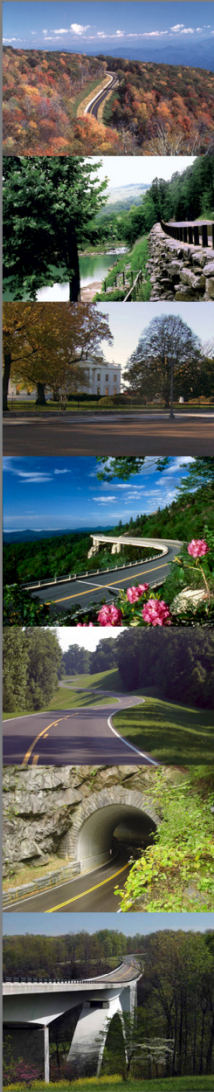




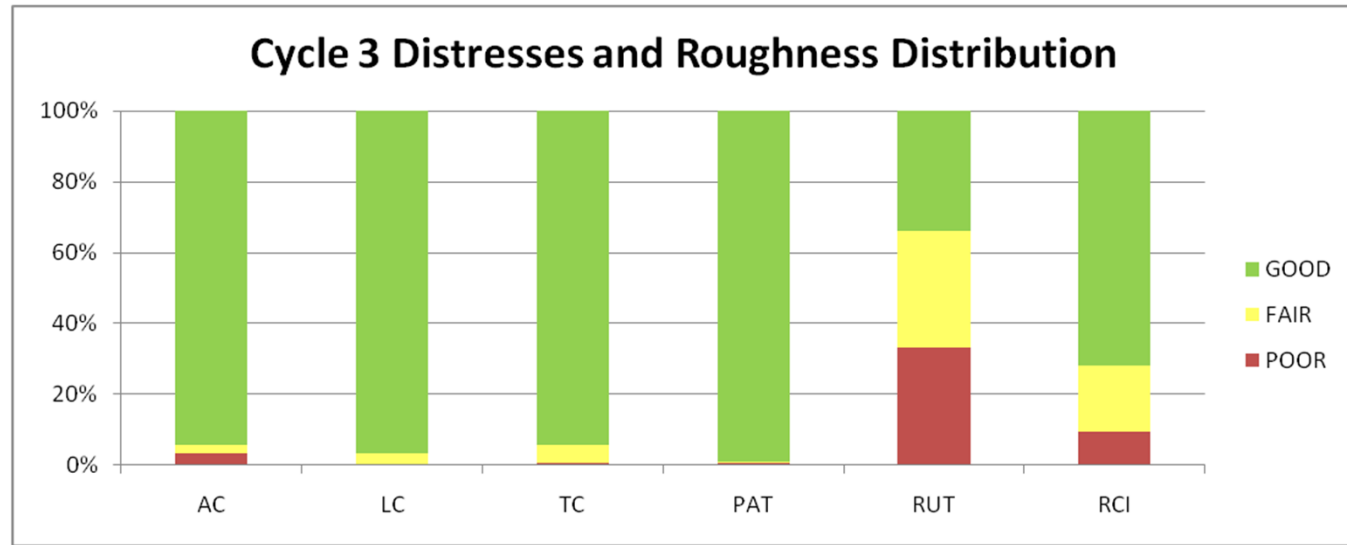
Improving the PCR

To be able to effectively differentiate needs between one section of highway and another, those factors which most directly influence selection, scope and costs must be appropriately represented in the overall condition rating.



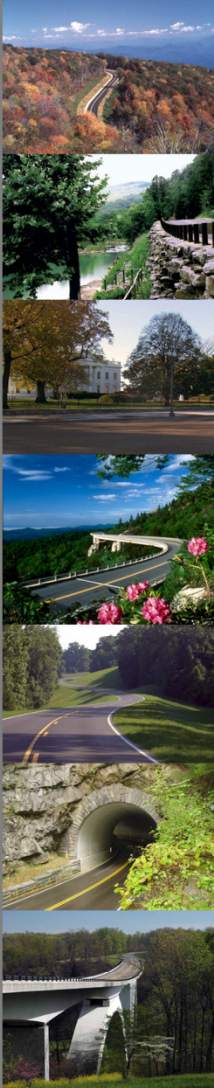


What's Driving the PCR?



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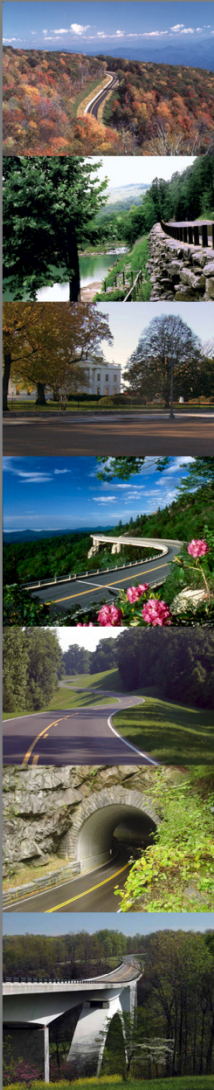


What's Driving Scope and Costs?

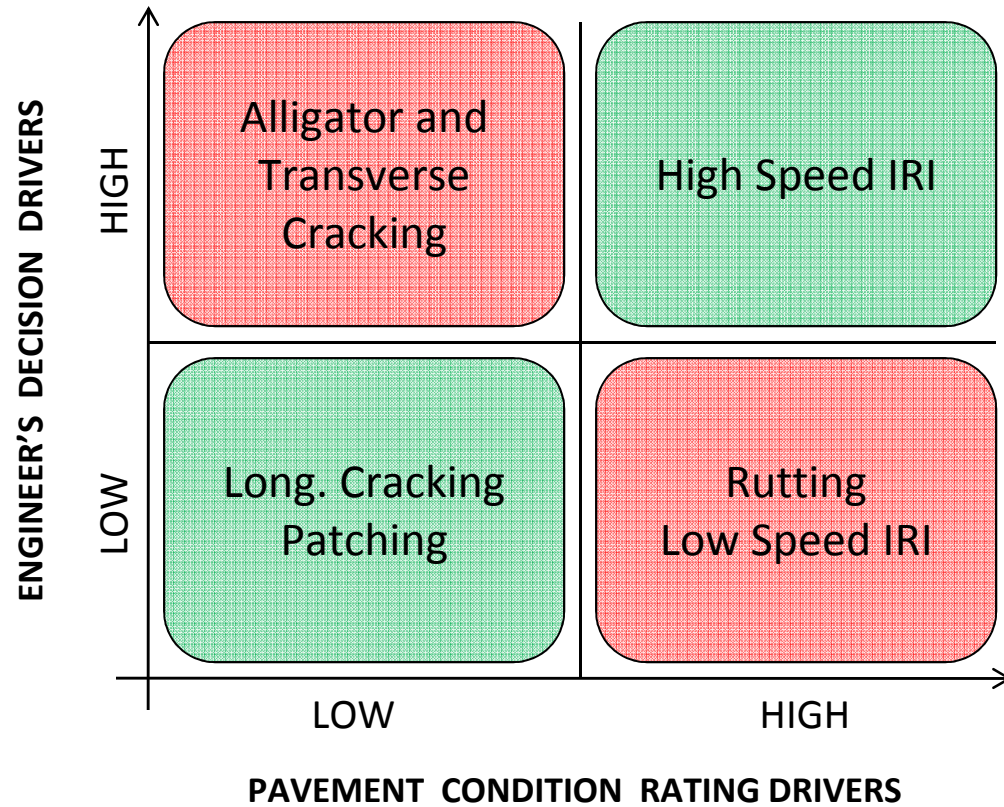
Engineer's Decision Drivers

Low Drivers	High Drivers
Rutting	Fatigue/Alligator Cracking
Longitudinal Cracking	Transverse Cracking
Roughness (Low Speed)	Roughness (High Speed)
Patching	





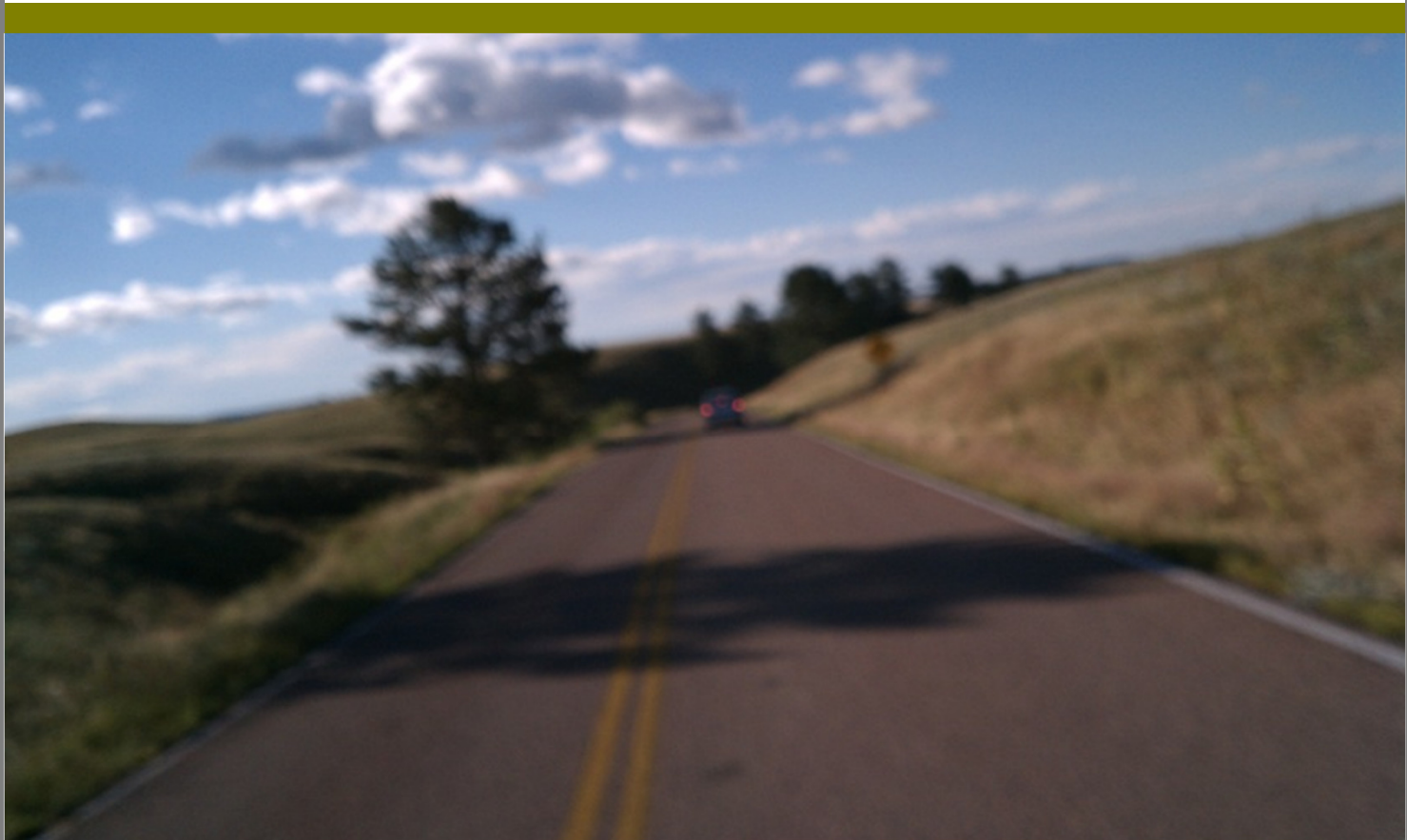
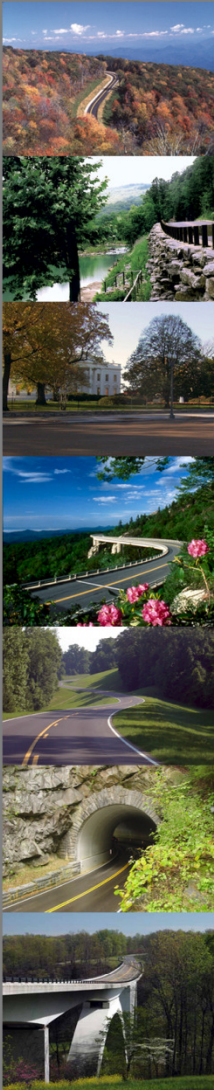
Rating/Design Compatibility



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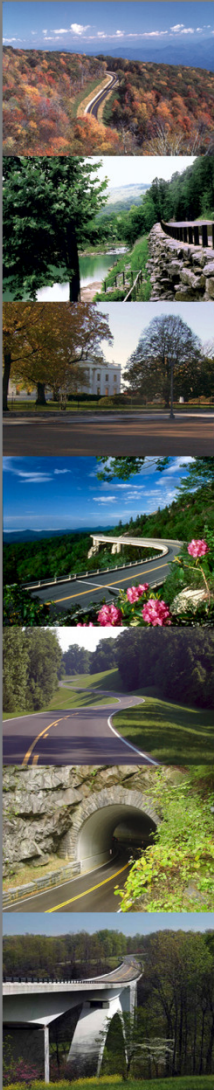
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Where can we improve?



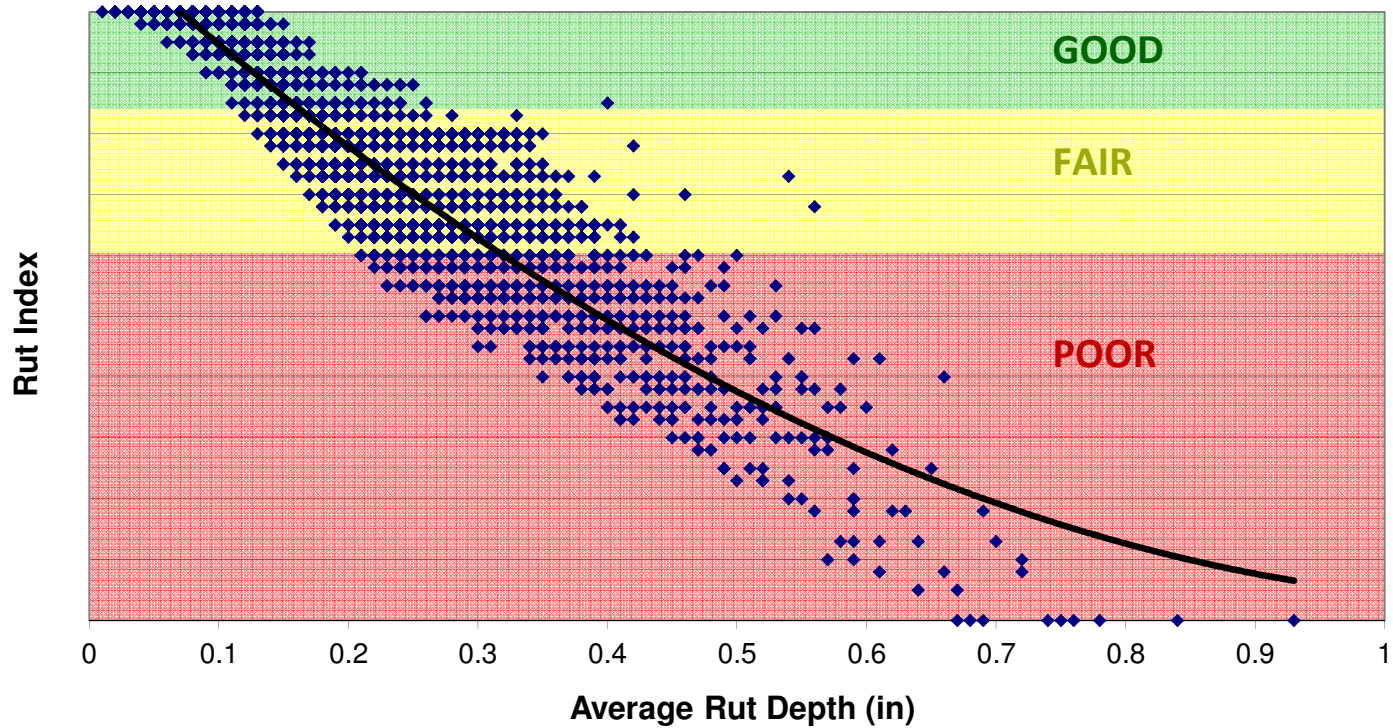
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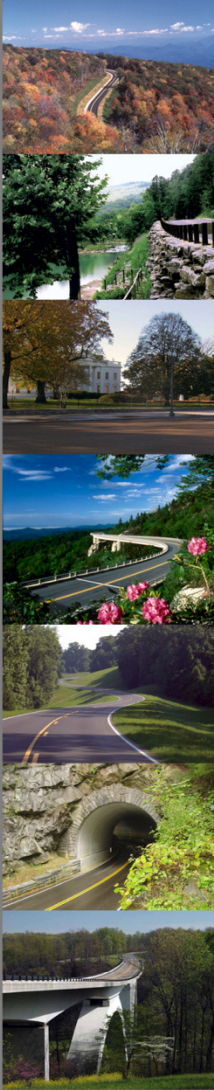
Rutting Index

Grand Teton – 2008 Rut Index Vs AVG Rut Depth



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Rutting Index

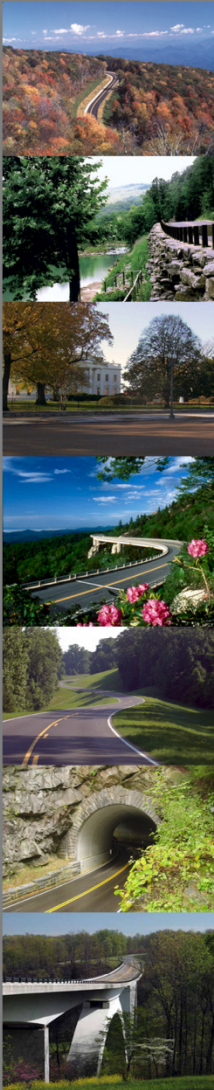
Determinations from Index/Quantity Relationship

- Failure Occurs too soon
- Shape of Curve is undesirable (too much early drop-off and too little late drop-off)

Modifications

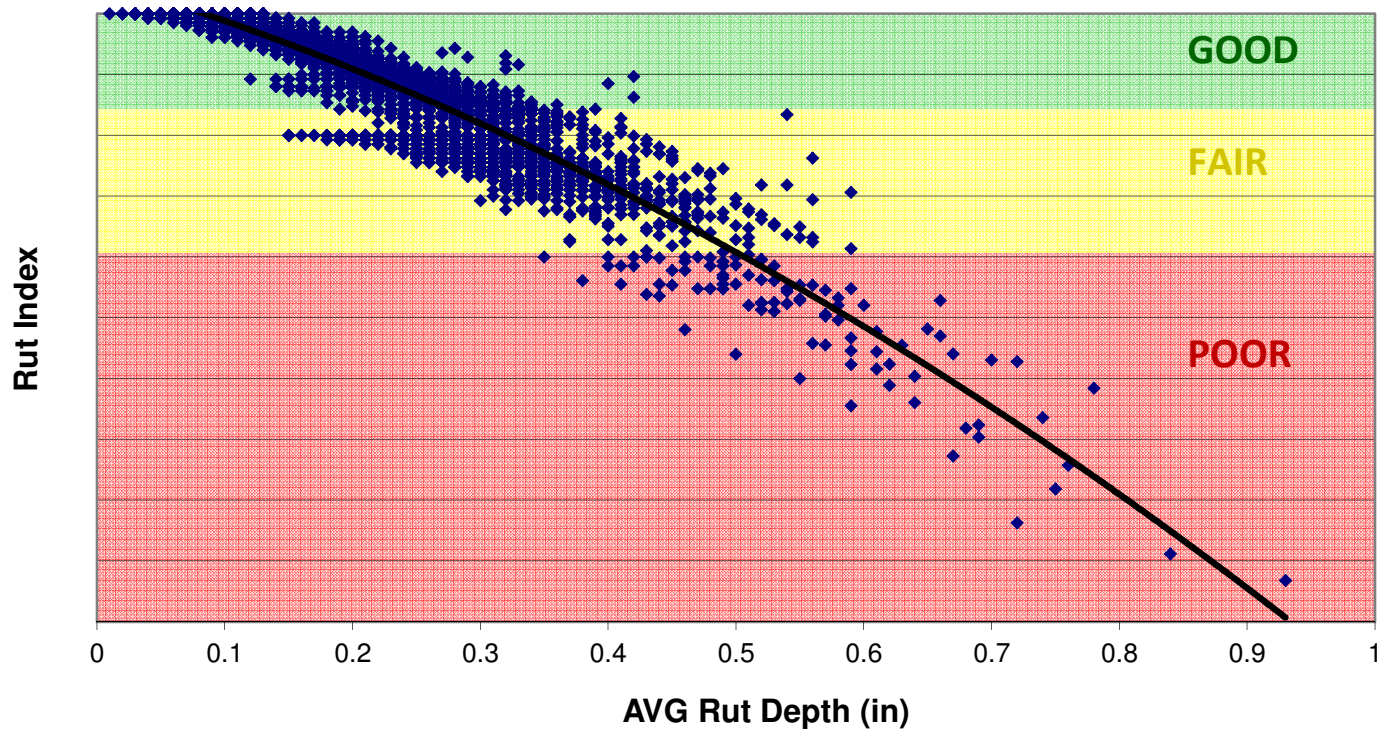
- Align severity levels with condition category
- Low severity = Good, Mod severity = Fair, High Severity = Poor





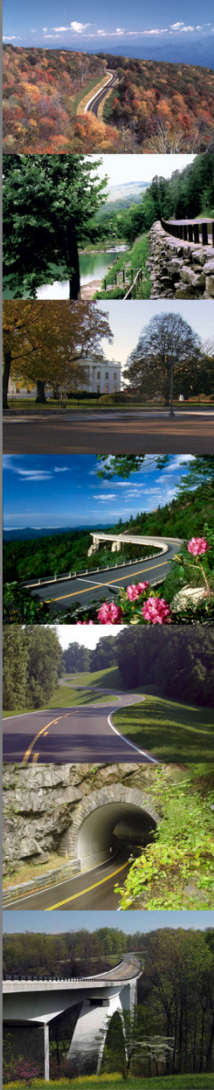
Rutting Index

GRTE – 2008 Modified Rut Index Vs AVG Rut Depth



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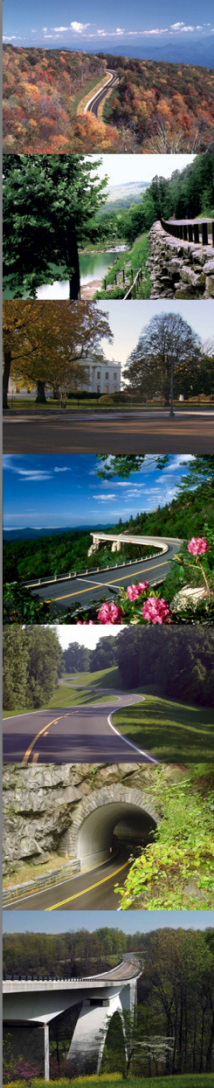


Cracking Indexes

Analysis Approach

- View Existing Cracking Data
- Verify Crack Detection Accuracy
 - Ground Truth Data Collection
- Determine when rehabilitation needs arise in terms of the MAE's
 - Obtain Expert Opinion



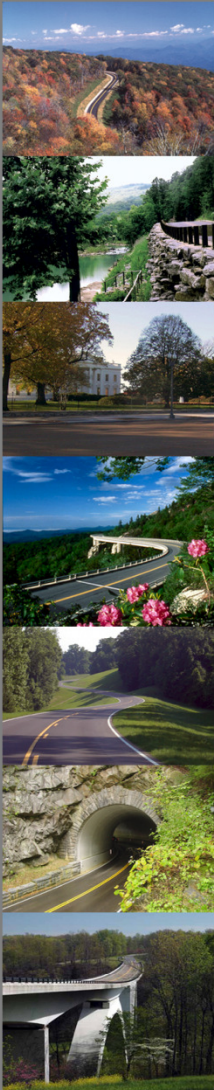


Cracking Indexes

Existing Cracking Data

- Alligator Cracking
 - Crack Detection Accurately identifies crack areas
 - PMS Dynamic Sectioning dilutes highly distressed areas
- Longitudinal Cracking
 - Most identified LC is early stage fatigue cracking
- Transverse Cracking
 - Too many severity types

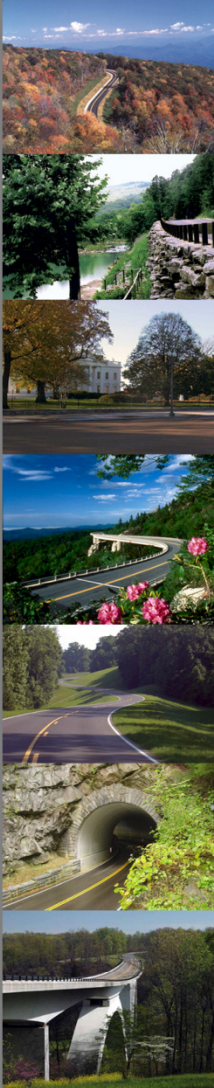




Cracking Distress Modifications

	MAE's	Low	Moderate	High	Effect
Alligator Cracking	Current	70%	30%	10%	↑
	Proposed	35%	15%	5%	
Longitudinal Cracking	Current	350%	200%	75%	↑
	Proposed	175%	75%	25%	
Transverse Cracking	Current	3.5 feet	7 feet	55 feet	↑
	Proposed	5 feet	24 feet	40 feet	

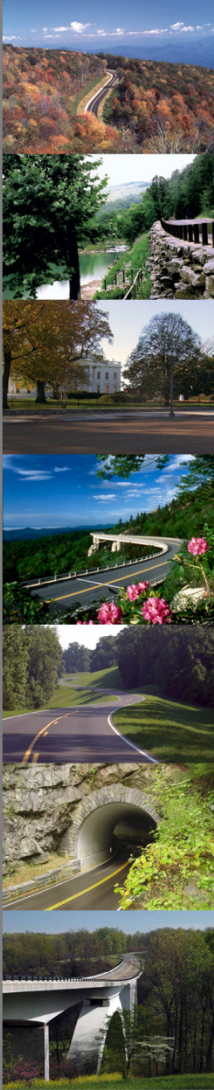




Surface Condition Rating Proposed Modification

- Combine Longitudinal and Alligator into a Rating for Structural Distress (Structural Crack Index)
- Allow the lowest (Dominant) distress to equal the SCR (Currently we combine all distresses)
- SCR for an segment or section will be the lowest out of the following:
 - Structural Crack Index
 - Transverse Crack Index
 - Patching Index
 - Rutting Index





Roughness Condition Index

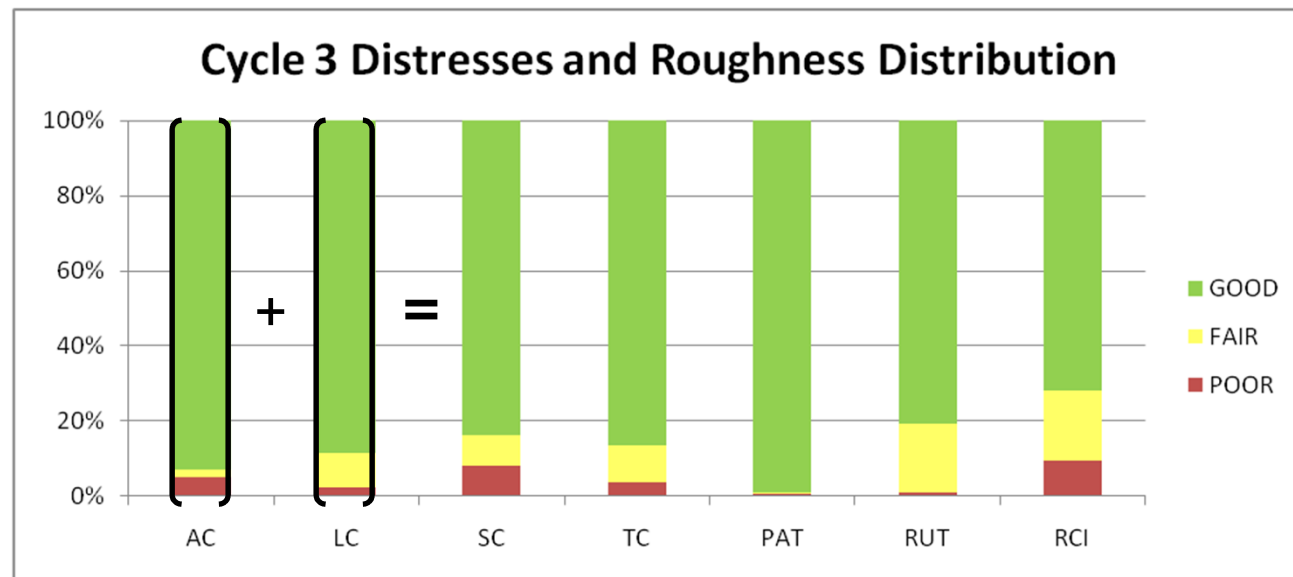
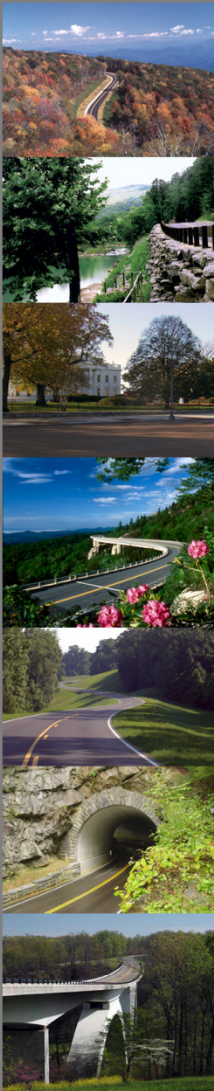
Changes in Reporting Method

New Guidelines will be implemented as to where and when to report RCI. No RCI Reported when:

- Posted Speed limit is <25 mph for a majority of the overall length
- Route Length is <0.5 mi
- Judgment call by the data collection crew where safe vehicle operation would be exceeded by achieving the required collection speed.



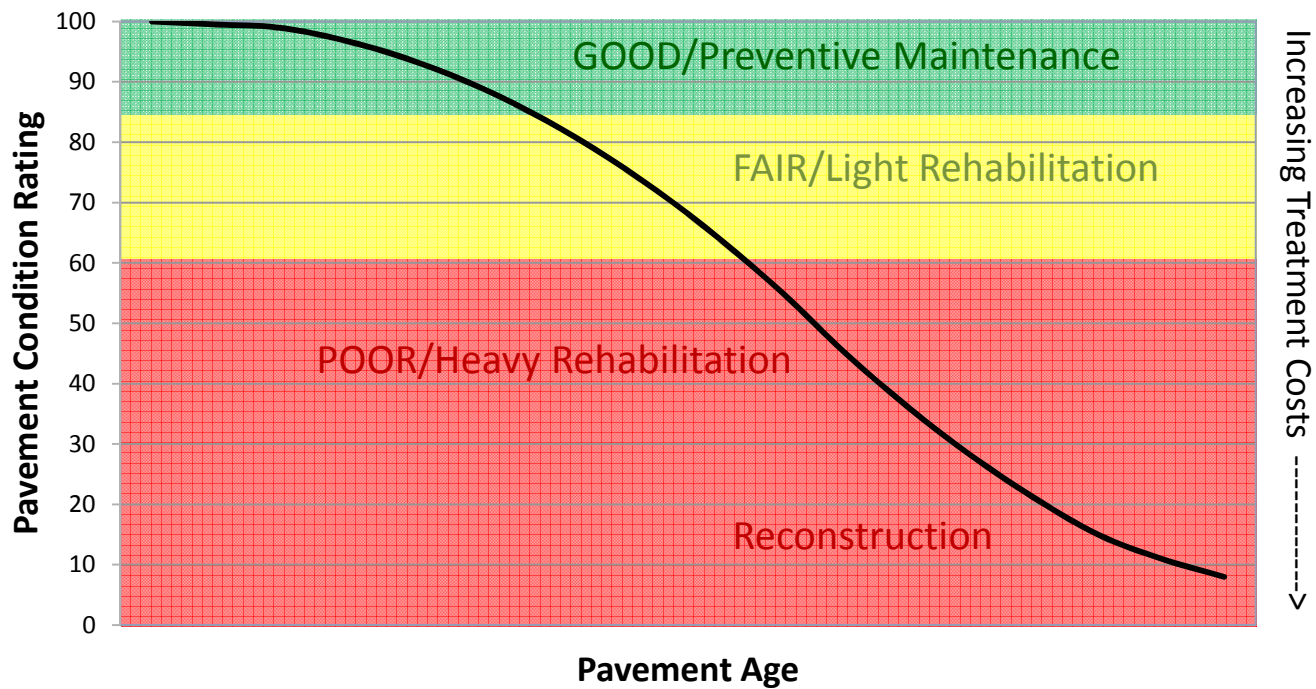
PCR Drivers after Modifications





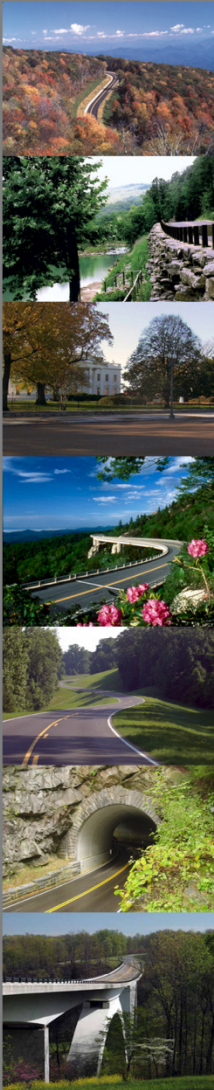
Tying Condition Description to M&R Needs

Condition Categories and Treatments

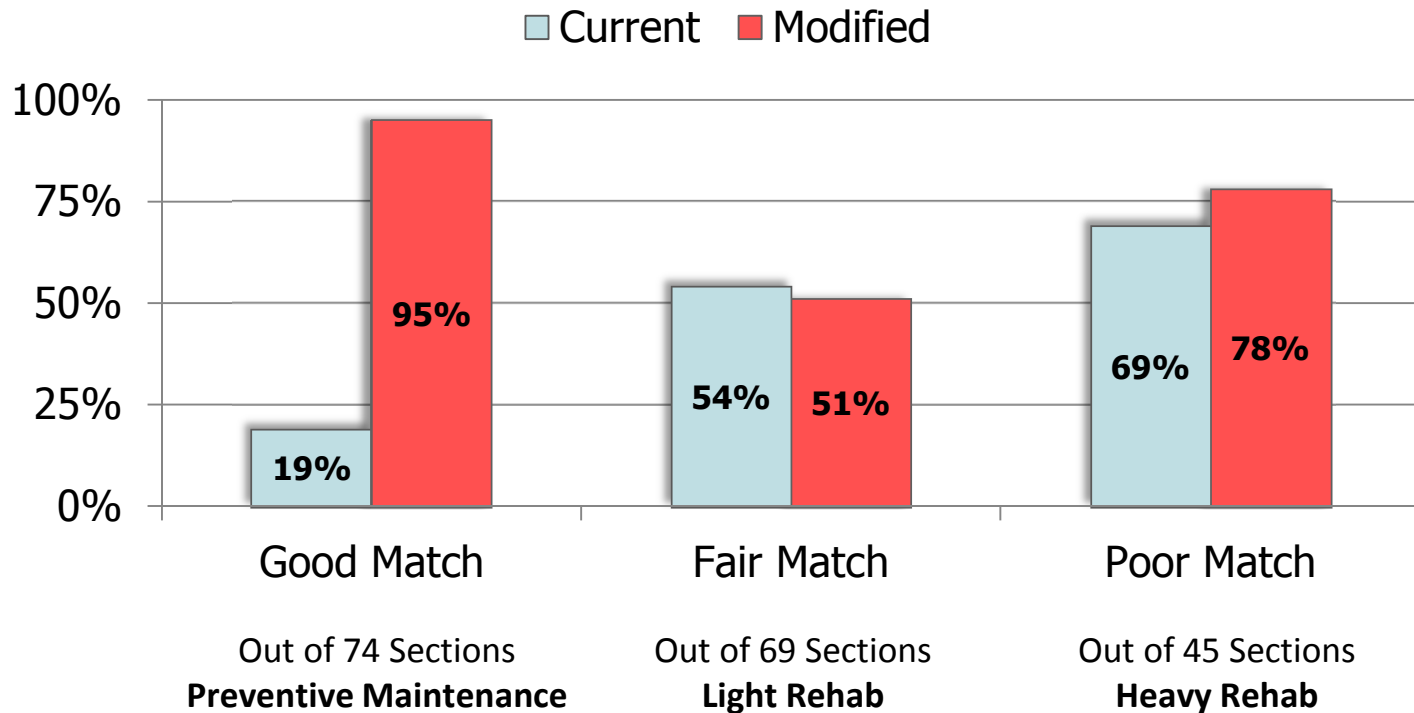


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Measureable Results from Ground Truth



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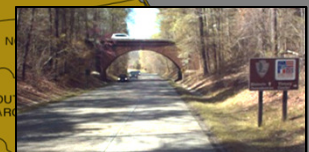
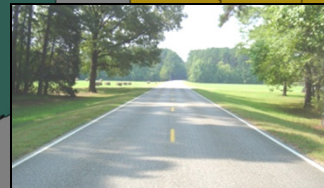
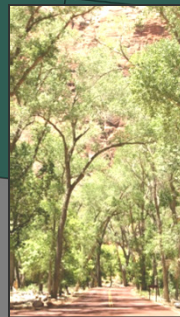
Western Federal Lands



Central Federal Lands



Eastern Federal Lands



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