1.0 Background

The Highway Maintenance Program plays a critical role in performing early-life pavement preservation, late-life pavement preservation, and serviceability improvement treatments by appropriate use of crack filling, patching, chip sealing, rut-filling, and short overlays. These activities fit well with the workforce capacity and capabilities of the County Highway Departments contracted to perform the department's maintenance activities and the mission of the department's Highway Maintenance Program. As the primary provider of routine maintenance activities on the state system, county personnel familiar with the condition of our system can be a valuable resource throughout the pavement assessment process.

Investments in pavement health made by the Highway Maintenance Program and the Improvement Program must harmonize with respect to each other. This is accomplished by ensuring any pavement preservation strategy applied through the Highway Maintenance Program fits within the overall department pavement system health and asset management strategies.

2.0 Roles and Responsibilities, Central Office

The Division of Transportation Investment Management, Bureau of State Highway Programs (BSHP) is responsible for collecting pavement distress data, establishing system health goals, developing a modelling tool that helps prioritize the pavement needs within available funding to achieve optimized system health goals, and maintaining performance measures for correlating Improvement Program treatments with the optimized system health goals.

The Division of Transportation System Development, Bureau of Technical Services (BTS) – Pavement Unit maintains the Pavement Distress and Maintenance Manual which provides technical assistance in identifying different types of pavement distress and possible pavement maintenance activities to mitigate distresses. BTS will collaborate with BHM to develop performance standards and evaluate techniques for pavement maintenance strategies. BTS also provides technical assistance in development and review of project specific pavement designs, pilot project recommendations, new product guidance and evaluation.

The Division of Transportation System Development, Bureau of Highway Maintenance (BHM) -- Provides support and oversight of contracts to perform pavement maintenance strategy assistance under State Highway Maintenance funding. BHM will collaborate with BTS to develop performance standards and evaluate of techniques for pavement maintenance strategies. BHM may also provide pilot project recommendations, new product guidance, and evaluation.

2.1 Roles and Responsibilities, Regional Office

The Regional offices develop program recommendations for pavement maintenance projects within the Highway Maintenance and Improvement Programs, develop contracts for executing approved projects, and oversee contracted forces in the performance of their work in accordance with departmental policies governing pavement system health, performance measures, the Pavement Distress and Maintenance Manual, any specifications that may apply (as in a Performance Based Maintenance (PbM) project) and standard practices in the industry.

The Regions provide the critical professional engineer vetting of corporate asset system data through field reviews and comparative analysis with asset management recommendations, recommend changes to asset system data, metrics, or algorithms, and assist in policy development for all aspects of asset management.

2.2 Roles and Responsibilities, Service Provider

Any partner contracted by the department to perform a department maintenance service or provide a maintenance product.

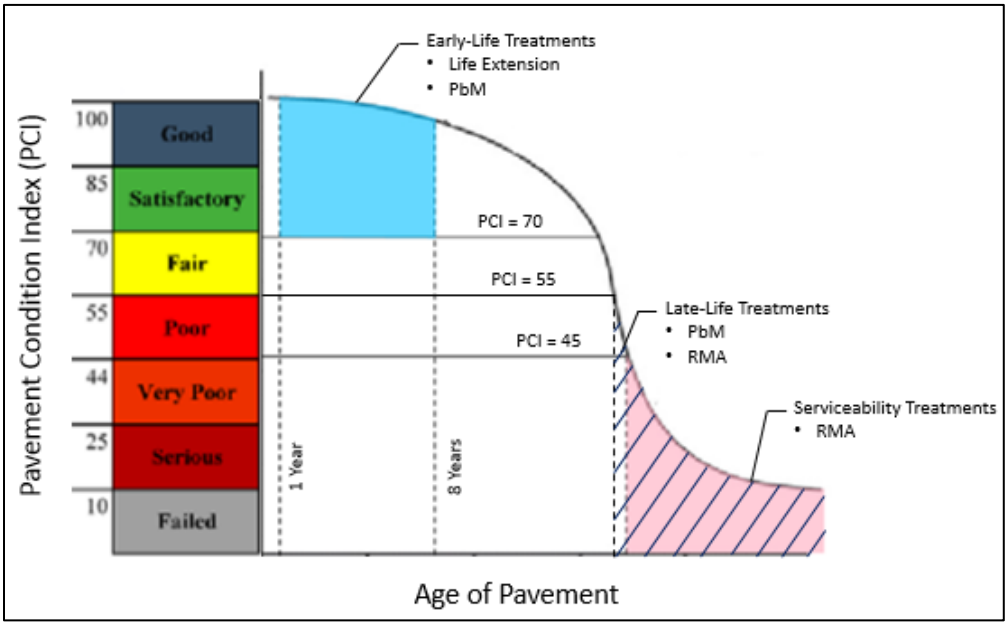
3.0 Pavement Maintenance by WisDOT Highway Maintenance Program

WisDOT Highway Maintenance can positively effect statewide system pavement health in three key areas:

- **Early-Life Treatment:** Treatments such as crack fills and chip seals can be cost beneficial, life extending pavement treatments when applied early in the life of appropriate pavement types.
- **Late-Life Treatment:** Treatments such as chip seals with crack fills or patching with chip seals can also provide cost beneficial, late-life extensions on reasonably performing pavement where age-related distresses are occurring, but which are not leading to any serviceability issues.
- **Serviceability Treatments:** Serviceability issues are when distresses can negatively affect normal driving conditions and begin to create risk of potential safety concerns. Examples would be short segments or spot locations of rutting, potholes or severe tenting. Serviceability issues have higher probability to occur on pavement segments with a Pavement Condition Index (PCI) below 45 with a segment International Roughness Index (IRI) above 170 inch/mile or on pavement segments that have significant levels of medium or high severity rutting (greater than four percent).

Figure 1 shows how the relationship of pavement condition and age can be depicted graphically to help identify where appropriate Early-Life, Late-Life or Serviceability treatments would typically occur.

Figure 1: Influence of Pavement Condition on Pavement Treatment Type



3.1 Early-Life Treatments

Early-life treatments should typically be completed through the PbM program. Early-life pavement management actions are performed to help ensure that the maximum life cycle expectancy of the underlying pavement can be achieved. These actions can address two types of early life distresses:

1. Normal, age related distresses that are statistically predicted and expected on the pavement, and which if treated early in the life of the pavement, can be prevented from leading to accelerated or wider array of pavement distresses and a shorter than desired pavement life cycle. Examples would be thermal cracking on pavement types which had an original life cycle expectancy of greater than 10 years. Typical solution is crack fill or crack seal.

2. Unanticipated pavement distress from environmental, material issues, or construction methods used on the pavement. An example would be surface raveling on an asphaltic pavement that is indication of either insufficient asphalt in the pavement that was placed, or issues with aggregate segregation when placed. Typical solution is chip seal.

Expected candidate locations for early-life treatments can be identified from the existing 6-Year Improvement program. Theme-compliant pavement projects scheduled in Improvement Program Years 1 through 3 with treatment types that have design life cycle expectancy of greater than 10 years would be the assumed candidate pool starting two to six years in the future.

3.2 Late-Life Treatments

Late-life pavement management actions can also be beneficial on normal performing pavements to help achieve maximum life cycle of the underlying pavement. Normal performance means the pavement is exhibiting the type and volume of distress expected for that type and age of pavement. Late-life actions would include crack filling, crack sealing, patch and overlay, or chip seals.

Candidates for late-life action can come from a wider spectrum of pavement sections than early-life treatments and with a wider variation in predicted, statistical deterioration curves. Professional judgement becomes a larger player in making appropriate decisions for when, where, and what late-life treatments should occur. In depth knowledge of project segment pavement history, pavement performance, the Pavement Management Decision Support System (PMDSS), and available late-life treatment strategies are critical to that professional decision-making ability.

Late-life treatments may extend reasonable service life for many years on a low volume highway with a low percentage of trucks. Other times, it may only be enough to provide the minimum time necessary to get a more substantive project through the 6-Year Improvement program.

Late-life treatments should typically be completed through the Routine Maintenance Agreement (RMA) program.

3.3 Serviceability Treatments

Serviceability concerns are when distresses begin to negatively affect normal driving conditions and may create risk of potential safety concerns. Examples would be short segments or spot locations of rutting, potholes, or severe tenting, Risk of serviceability issues occurring increases significantly when pavement reach conditions of:

- PCI < 45
- IRI ≥ 170 inches/mile
- Rutting > 4 percent medium or high severity rutting

The expected first option for serviceability treatments is the Highway Maintenance program with patching, rut paving, short segments of overlay, or aggressive base patching/chip seals. If serviceability locations are very limited in number and size, they could be resolved through RMA activities, whereas more extensive areas may require Discretionary Maintenance Agreement (DMA) or PbM projects.

Because recurring end-of-life treatments for serviceability issues can be costly, there needs to be an ongoing plan for managing them. This plan needs to be cooperatively developed by the Region Maintenance Engineer, the Region Programming Engineer, and the Region Pavement Engineer to ensure the full spectrum of treatment, service provider, and funding options are fully explored; and most importantly, that Highway Maintenance efforts remain cost effective.

The Improvement programming theme may “backlog” segments with serviceability issues depending on funding assumptions and roadway classification. However, the theme performance measure expectations have allowances that provide reasonable flexibility to address issues such as extreme serviceability while still meeting overall thematic performance goals. Any determinations to move serviceability treatments options to the Improvement Program must be supported by documented economic, thematic, and performance measure analysis. Close coordination with the Region Program Engineer needs to occur to ensure this is done appropriately.

Serviceability treatments may extend reasonable service life for many years on low volume, low truck percentage highway. Other times, it may only be enough to provide the minimum time necessary to get a more substantive project through the 6-Year Improvement program. Serviceability treatments should be limited to those specific locations where serviceability issues are identified.

Pavement sections at or nearing the higher risk for serviceability issues, or which have already begun to exhibit serviceability issues, need to be monitored on an ongoing basis by Regional Maintenance, Pavement, and Program Engineering personnel to identify optimal treatment solutions and timing. Professional expertise and judgement become a larger player in making appropriate decisions for when, where, and what late-life treatments should occur. In depth knowledge of project segment pavement history, pavement performance, PMDSS, and available late-life treatment strategies are critical to that decision-making ability.

Serviceability treatments should typically be completed through the RMA program.

4.0 Pavement Maintenance Actions, Distresses Prompting Action

4.1 Crack Filling

Projects in the 6-Year Improvement Program scheduled as PSRS 40, COLD10,20,30, and RSRF10,20,30 (see Table 1 for definitions) are candidates for early-life crack fill within the first five years of construction. RCND10,20, PVRPLA and RECST are also likely candidates for an early-life crack fill. Characteristics for early-life crack fill projects include:

- Age = 1 to 5 years
- Longitudinal and Transverse (L&T) Cracking = Low Severity at 2-12 percent

L&T crack density is reported in the PMDSS portion of the department's asset management system or it can be requested through the Region Programming Engineer. The percentage of cracking reported by PMDSS is a function of the measured length of L&T cracking identified in a segment. For calculation purposes, the width of the crack is assumed to be 1-foot. For example, a segment is 1.67 miles long and has low severity L&T crack density of 6.7 percent. The length of crack sealing required for a segment can be calculated in the following manner.

Sequence Number Length (SNL):	1.64 miles
Pavement Width (W):	24 feet (2, 12-foot lanes)
Density of L&T Cracking (D)	6.7%
Length of L&T Crack to be Sealed:	SNL*W*D or 1.64 mi*5280 ft/mi*24 ft*.067=13,942 feet

If current PMDSS data is used to determine when an early crack fill project should occur, the Region Maintenance Engineer should field review the pavement condition and confirm the PMDSS distress data before scheduling the project. Documentation of the field review observations and resulting conclusions needs to occur as it will be a required part of the approval process for any proposed PbM pavement maintenance funding for this work.

Because there can be time lags of up to 12-18 months between data collection by DTIM Pavement Data Unit and updated PMDSS calculations for a pavement, early-life candidate segments must be regularly field reviewed by Regional staff for L&T crack density. These field reviews may be the critical determinant that allows a crack fill need to be identified, validated, and action taken within the optimal window for early-life crack fills. Several field reviews at different times of the year is highly recommended for these candidate project segments

4.3 Patching

Candidates for patching of asphalt pavements are identified in PMDSS by looking for segments with one to two percent low severity alligator cracking, with some possible trace amounts of moderate to severe alligator cracking. The areas of alligator cracking should be prepared by removing material until sound pavement structures remains, cleaned and the structure replaced with high quality asphalt hot mix. This is a very cost effective means to extend pavement life if done properly.

4.4 Chip Seals

Early-life chip seal treatments are the preferred treatment for pavements exhibiting characteristics of poor mix design (i.e. a "dry" mix) or aggregate segregation from poor construction methods. If any low severity weathering/raveling is present or if the pavement is prematurely grey, a chip seal would be appropriate. Characteristics of candidates for early chip seals include:

- Age
  - 5 to 8 years
- Pavement Condition Index
  - 70 to 85
- Weathering and Raveling
  - Low Severity – any amount
  - Medium Severity – no more than 35 percent
  - High Severity – no high severity
- Bleeding
  - Medium Severity – any amount
  - High Severity – no more than 12 percent
- Alligator cracking
  - No distress of any severity

For pavements not exhibiting these characteristics, crack filling and patching treatments are likely more cost effective preventive maintenance treatments.

PMDSS data may not be able to detect or differentiate the early stages of these type of surface distresses. Multiple annual field reviews by Region staff is critical in the early years of these pavements for identifying and properly diagnosing these distresses, and getting appropriate early-life treatment actions scheduled.

Late-life chip seals can be similarly beneficial on older pavements where the mix design and construction were 'marginal' rather than 'poor' at time of construction, and it took a longer a time for these same distress characteristics to begin to manifest themselves. Late-life chip seals are typically supplemented by strategic base patching to assure structural life extension. PMDSS data and field reviews will be essential to detect these pavement candidates.

5.0 Highway Maintenance Program

Each region shall be responsible for developing and maintaining a 3-Year Pavement Maintenance Program (3PMP). The 3PMP would consist primarily of early-life treatments for asphalt pavement projects completed through the region's 6-Year Improvement Program. These treatments include:

- Crack fill projects,
- Asphalt patching and
- Chip seal projects

The early-life treatment projects should generally be asphalt paving projects completed in the State Trunk Highway Improvement Program within the last five years. These projects will be identified using criteria discussed in Section 4.0. Candidate projects can be either from the 3R or Backbone systems.

Regional Maintenance Engineers must consider available county expertise, county resource availability, project timing, and roadway traffic characteristics (i.e. high-volume Interstate vs lower volume rural 3R) for determining which candidate locations are viable for county service providers. 3PMP candidates should only be those deemed viable for county services and which are then prioritized for determining which become part of the final 3PMP.

The Memorandum of Understanding agreed to by WisDOT, Wisconsin County Highway Association and Wisconsin Transportation Builders Association on September 1, 2015, and the subsequently issued Maintenance Paving Guidance relating to the MOU may limit or define the appropriate service provider depending on the scope of the maintenance work.

Quarterly meetings with the maintenance staff and programming staff should be held to:

- Discuss status of the Region's 6-Year Improvement Program and any changes that may affect current 3PMP prioritization.
- Identify segments that are requiring significant or extra-ordinary maintenance, or where cost of the maintenance effort has been determined to no longer be the most cost-effective actions for that pavement.
- Review of the condition of project segments scheduled in Program Year 1 and 2 of Improvement Program and what amount of pavement maintenance should occur until their let date. Outcomes could be determination to cease maintenance actions and redeploy those assets elsewhere, or identifying a

serviceability action to get the segment to its let date.

5.1 Contracting for Pavement Maintenance Actions

Figure 2 shows correlation of project characteristics that can influence which type of contract (bid item or actual cost) is most appropriate for a project. Low risk projects would suggest agreement based on bid items (PbM-style), while high risk would suggest an actual cost (DMA-style) contract.

Figure 2: Project Characteristics and Recommended Contract Type

High cost, low uncertainty
 	
Project Characteristics:
• Rural two-lane
• Rural multi-lane
•
  ○ Low ADT
• Urban roadway
  ○ Low ADT
• Project length > 1 mile
• Low to medium crack density
 	
Preferred contract type: Bid Item
	High cost, high uncertainty
	
	Project Characteristics:
	• Urban freeways or frontage roads
	• Urban multi-lane roadway
	  ○ High ADT
	• Rural multi-lane
	  ○ High ADT
	• Project length > 1 mile
	• Low, medium or high crack density
	
	Preferred contract type: Actual Cost
		Project Cost

Low cost, low uncertainty
 	
Project Characteristics:
• Rural two-lane
• Rural multi-lane
  ○ Low ADT
• Urban roadway
  ○ Low ADT
• Project length ≤ 1 mile
• Low to medium crack density
 	
Preferred contract type: Bid Item
	Low cost, high uncertainty
	
	Project Characteristics:
	• Low ADT roadways in rural or urban locations
	  ○ High crack density
	• High ADT roadways in rural or urban locations
	  ○ Project length ≤ 1 mile
	
	Preferred contract type: Actual Cost	

Risk (uncertainty of cost)		

5.2 Highway Maintenance Program, Annual Approval

Candidate pavement maintenance projects under the PbM program are developed by the Regions and submitted to BHM according to annual program submittal deadlines established by BHM. Candidate pavement maintenance projects must include the following information for approval consideration.

- The general improvement type (i.e. PSRS 40 or RSRF 10) pavement design or typical section of the most recent paving project on the candidate segment.
- The pavement and maintenance history prior to the last improvement treatment.
- The treatment type being proposed and its relevance to the current deficiencies.
- Analysis and recommendation of how these deficiencies meet the need criteria established in 4.1 thru 4.3.
- Identification of any Improvement Projects on the segment and evidence the proposed work does not conflict with the Improvement Program work.

Candidate pavement maintenance projects under the RMA program are projects that typically address a safety or serviceability issue. The Region will include the upcoming year of pavement maintenance projects to be completed through the RMA program in the 3PMP. BHM will not be the approval authority for these projects, but will review this list to ensure that maintenance funds are being allocated per this policy.

5.3 3-Year Pavement Maintenance Program (3PMP), Project Approval

It is department policy that any PbM contract, including those for pavement maintenance, shall be reviewed and approved by BHM for compliance with current department pavement asset management rules. This will require that a 3-Year Pavement Maintenance Program (3PMP) be established and annually updated by the Regions. Annual 3PMP updates shall be provided by the Regions to BHM for approval no later than July 15.

Prioritized 3PMP projects proposed to be performed through a PbM project must be approved and signed by either the State Highway Maintenance Engineer or the Director of the Bureau of Highway Maintenance before any work can begin.

If work begins on a PbM project before BHM has approved the agreement, BHM may not approve the project. If the project is not approved, the County shall be reimbursed for any project-related expenses through its annual RMA allocation. For work reimbursed through the RMA agreement, reimbursement more than the actual costs for labor, equipment, materials and overhead expenses is not permissible (s. 84.07 (2)(a), Wis. Stats.).

5.4 Performance Effectiveness Measures for Pavement Maintenance

At the completion of a calendar year, BHM will review the Early-Life crack fill projects completed on the state trunk system and compare these projects against the paving projects completed during the last five years of the Improvement Program. Each region will be measured by how well the completed early-life crack fill program aligns with Improvement's asphalt paving program. The goal is to have the region's completed early-life crack fill program for asphalt pavements align with Improvement's paving program at a level of "good" or above at both the statewide and regional levels (matched location 80 percent and matched scope 80 percent).

Table 1: Highway Improvement Concept Codes

Improvement Concept Code	FDM 3-5-2 Highway "Roadway" Improvement Type	Improvement Concept Definition
PSRS10 PSRS20 PSRS30 PSRS40	Preservation/Restoration	**PRESERVATION/RESTORATION –** Preservation/restoration treatments may address cracks, joints and surface imperfections, seal and protect the road surface, improve friction and/or remove and apply a minimal riding surface (code varies by treatment type)
RSRF10 RSRF20 RSRF30 COLD10 COLD20	Resurfacing	**RESURFACING** – placing a new surface on an existing roadway to provide a better all-weather surface, a better riding surface and to extend or renew the pavement life (code varies by thickness of resurface. Cold-in-place recycling when applicable
RCND10 RCND20	Reconditioning	**RECONDITIONING** – work in addition to resurfacing. Minor reconditioning (10) includes intersection work, pavement widening and/or shoulder paving. Major recondition (20) includes improvement of an isolated grade, curve, intersection or sight distance problem to improve safety.
PVRPLA PVRP_O COLD30	Pavement Replacement	**PAVEMENT REPLACEMENT** – structural improvement of the pavement structure or removal of the total thickness of all paving layers from an existing roadway and providing a new paved surface without changing the subgrade. PVRP_O includes operation improvements. Full depth cold-in-place recycling where applicable.
RECST	Reconstruction	**RECONSTRUCTION PRESERVATION** – total rebuilding of an existing highway to improve maintainability, safety, geometrics and traffic service.
RECSTE	Expansion	**RECONSTRUCTION EXPANSION** – includes the same types of work associated with reconstruction, but also involves the construction of additional through travel lanes.