Alberta
INFRASTRUCTURE AND
TRANSPORTATION

GUIDELINES FOR ASSESSING PAVEMENT PRESERVATION TREATMENTS AND STRATEGIES

EDITION 2 **JULY, 2006**

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FOREWORD

Alberta Infrastructure & Transportation's Pavement Preservation direction was originally established during a workshop held on January 29, 2002. A number of tasks were identified during the workshop. The output was Edition 1 of the "Guidelines for Assessing Pavement Preservation Strategies, June 2002".

Edition 1 has been used extensively by Alberta Infrastructure and Transportation and engineering consultants to prepare pavement preservation strategies for Alberta's provincial highway system since the Guidelines were issued in June of 2002. The 2002 Guidelines were established to provide a framework for the assessment, analysis and rehabilitation design for pavements that were near the end of their expected performance lives.

The major focus of this Edition 2 (2006) is to expand the June 2002 Guidelines to include strategies and treatments for pavements of all ages. The new Guidelines will be used by the Alberta Infrastructure and Transportation staff and engineering consultants to select pavement preservation strategies throughout life of the pavement.

Highlights of the process presented within these guidelines include:

- Roughness and structural strength of the pavement along with the observed surface condition continue to be the major factors for selecting appropriate pavement preservation treatments.

- Roughness in terms of IRI will be the initial point to determine whether a pavement should be assessed as a preventative maintenance candidate or a major pavement preservation candidate.

- If IRI is less than the established trigger values, then the pavement shall be considered for preventative maintenance. The treatment selection will primarily be based on observed distresses.

- If IRI is greater than the established trigger values, the pavement shall be considered for major pavement preservation. The treatment selection will be based on structural assessment, IRI value and observed distresses.

The background work and development for this document was undertaken by EBA Engineering Consultants Limited.

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1.0 INTRODUCTION

1.1 Background

In January 2002, Alberta Infrastructure & Transportation began to explore alternative pavement preservation strategies that could be applied to extend or maintain pavement life and thereby postpone more costly rehabilitation overlays. Through consultation with the Department's experts and review of current and past practices, the "Guidelines for Assessing Pavement Preservation Strategies, June, 2002" was developed. These guidelines supplemented the department's "Pavement Design Manual, June 1997" and have been used by department and consultants ever since.

The 2002 Guidelines were developed to assess and select preservation treatments for pavements that had been programmed for rehabilitation. More recently, the desired direction within Alberta Infrastructure and Transportation is to move to a Pavement Preservation approach which is to apply a timely series of low cost preventative maintenance treatments to early and mid-life pavements to maintain or extend their life and serviceability, in conjunction with higher cost rehabilitation treatments to older pavements. In other words, choose the right treatment for the right road at the right time.

This initiative has led to the development of new "Guidelines for Assessing Pavement Preservation Treatments and Strategies, July 2006". The purpose of these new 2006 Guidelines is to provide the Department Operations personnel and Pavement Design Consultants with a practical methodology and design approach to assist with the selection of the most appropriate preventative and rehabilitation treatments for pavements of all ages over their entire service life. It is not the intent to use low and medium cost preventative maintenance treatments on first stage pavement surfaces to delay the placement of final stage pavement. Final stage paving should be done expeditiously (within 2 to 3 years of the first stage paving) before the development of any visible distress.

The development of these 2006 Guidelines was based on:

- A review of past and current Alberta Infrastructure and Transportation design and maintenance practices.
- Input from Operations and Technical Specialists through an Expert Workshop, discussions throughout the project and review of draft documents.
- A review of current practices of other transportation agencies and organizations.

1.2 Scope

This document provides:

- A Tool Box of Preservation Treatments.
- Basic Guidelines for selecting Treatments.
- Seven Treatment Matrices to select low cost Preventative Maintenance Treatments based on the International Roughness Index (IRI) and the severity and extent of pavement distresses of the pavement segment; this would typically apply to young to mid-life pavements.
- A methodology for assessing high cost Rehabilitation Treatments and strategies based on the IRI, structural strengthening requirements, severity and extent of pavement distresses and Life Cycle Cost Analysis (LCCA) of the pavement segment; this would normally apply to mid-life and older pavements.

1.3 Definitions

For the purposes of these 2006 Guidelines, the following definitions apply:

- **Pavement Preservation** includes all activities that are undertaken to maintain and enhance the serviceability of paved roads. Pavement preservation treatments include treatments ranging from low cost treatments such as crack filling to high cost treatments such as conventional overlays and all potential treatments in between.

- A **treatment** is the single application of a preventative maintenance, surface restoration or rehabilitation activity to a pavement.

- A **strategy** is a series of treatments scheduled over the analysis period.

- **10 yr or 20 yr Structural Overlay** - the thickness of overlay required to carry traffic in terms of total number of Equivalent Single Axle Load (ESAL) applications expected during the 10 year or 20 year design period respectively.

- **Service Life of a Treatment** - the estimated time in years following the application of the treatment to when the treatment fails to meet the intended function.

2.0 TOOL BOX OF PAVEMENT PRESERVATION TREATMENTS

A list of Pavement Preservation Treatments considered appropriate for Alberta Infrastructure and Transportation's highway network is presented in Table 1. Included in this Tool Box are treatments that have been used in the past or currently, as well as newer technologies that may have limited experience within Alberta Infrastructure and Transportation. These preservation treatments are presented in Table 1 and have been grouped as:

- **Preventative Maintenance Treatments (A1 to A16)** – These are low cost maintenance treatments applied to preserve, retard future deterioration, and maintain or improve the functional condition without significantly increasing structural strength. These treatments could be applied to a pavement over its entire service life. Some of the treatments related to the repair of transverse cracks would be applied later in the life of pavement or as pre-overlay repairs.

- **Surface Treatments (B1 to B6)** – These include surface seals and treatments applied to address surface deficiencies such as general raveling, segregation, or fatigue cracking distresses. These treatments could be applied to mid-life pavements to retard future surface or structural deterioration.

- **Rehabilitation Treatments (C1-C11)** – These are high cost rehabilitation treatments such as structural overlays or Mill & Inlay treatments applied to increase structural capacity and restore serviceability and ride. These treatments could be applied to mid-life and late life pavements. These treatments are selected, if they are cost-effective.

- **Reconstruction Treatment (D1)** – This high cost treatment (either reconstruction of a portion or of the total base and pavement structure) would be used as a rehabilitation strategy under exceptional circumstances where the existing pavement has completely failed. In this case, the original roadbed may be the cause of reduced serviceability and excessive maintenance cost and other rehabilitation treatments may provide only very short term solution.

For each treatment in Table 1, the application, typical unit cost, expected service life, and some of the issues that are addressed by the treatment are presented. While these values are considered reasonable, they are guidelines only. Engineering judgment and regional experience must be applied to estimate the service life and cost for each application.

3.0 DESIGN APPROACH FOR SELECTING PAVEMENT PRESERVATION TREATMENTS

The Department uses IRI as a performance indicator of the physical condition of its paved highway network. The IRI value is also used as a trigger level to identify pavement sections in need of repair or rehabilitation work. These trigger levels are based on Department's past practices and are categorized by traffic levels in terms of AADT. This is shown in the Table below.

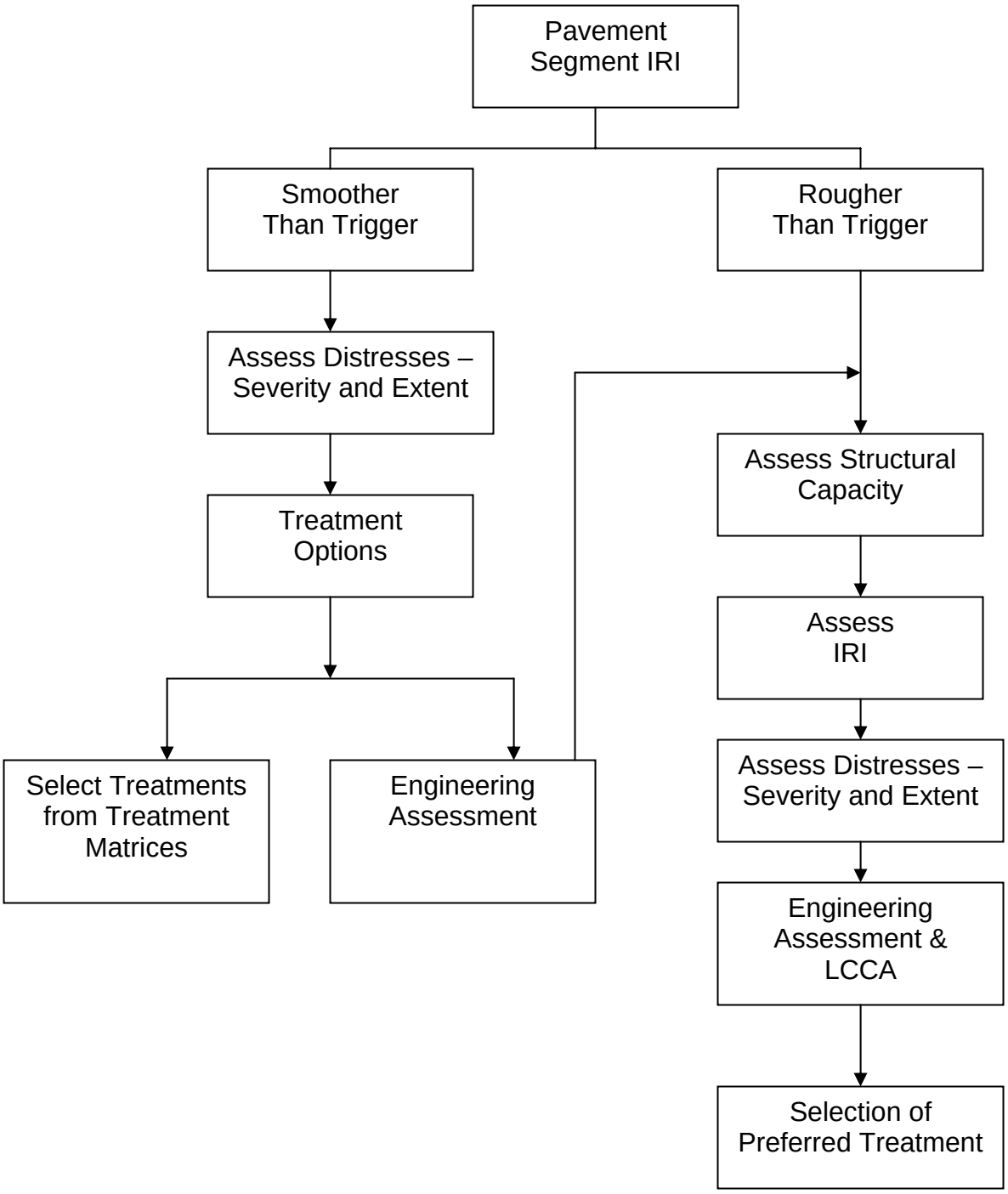
AADT	IRI TRIGGER (mm/m)
< 400	3.0
400 – 1500	2.6
1501 – 6000	2.3
6001 – 8000	2.1
> 8000	1.9

The 2006 Guidelines uses the above IRI values as the first level in the hierarchy of assessing and selecting Preservation Treatments. The IRI trigger values for a segment are based on the average IRI value for that segment. For divided highway, the IRI trigger values apply to all lanes based on the total AADT. On roadways in urban areas, where speed limits are reduced, higher IRI trigger values based on engineering judgment may be acceptable.

For pavement segments that are smoother than the established IRI trigger values (which are generally early to mid-life pavements), the second level in the hierarchy that drives the selection process is the observed or measured pavement surface distress. The severity and extent of pavement distress drives the identification of potential low cost preventative maintenance treatments. The approach for designing the strategy for these types of pavement segments is described in Section 4.0

For pavement segments that are rougher than the established IRI trigger values (which may be mid to late life pavements), the second level in the hierarchy is an analysis of the structural capacity of the pavement. Potential preservation treatments are identified to address the structural deficiency and other pavement conditions of the segment. These treatments can include the entire spectrum of low cost preventative maintenance treatments to high cost rehabilitation treatments. Alternative preservation treatments and strategies are assessed and selected based on a LCCA. The approach for designing the strategy for these types of pavement segments is described in Section 5.0

This selection process is presented in the following flow chart. More detailed descriptions of the methodologies are presented in Sections 4.0 and 5.0.



Process for Selecting Preservation Treatments

4.0 PAVEMENT SEGMENTS SMOOTHER THAN THE IRI TRIGGER VALUES

Pavement segments smoother than the IRI trigger values would typically represent early to mid-life pavements. The methodology for treatment selection for these pavement segment types is distress driven.

Figure 1 presents the guidelines for selecting the preservation treatments. The methodology is based on the type of observed or measured surface distresses which have been classified as Environmental/Construction-related or Traffic/Load-related. Within these two categories, individual distress types have been identified that represent typical conditions on the Alberta highway network.

For each individual distress type, treatment matrices have been developed and are presented in Figures 6 to 12. Based on the severity and extent of the distress, these treatment matrices can be used to select one or more potential treatments.

Where more than one preservation treatment is considered viable, selection of the preferred treatment is based on:

- regional experience
- contractor capabilities
- economic considerations
- existence of multiple distresses
- pavement age, and
- traffic

While the primary focus for preservation treatments is the traveled lanes; shoulders should also be assessed for appropriate treatments. For example, where a preventative maintenance treatment is selected to treat a distress in the traveled lanes, the same treatment can be applied to the same distress on the shoulders.

Generally a rigorous cost analysis is not required for treatments in this category. The application of low cost preventative maintenance treatments will always be the most cost-effective strategy if more expensive preservation treatments can be delayed without jeopardizing the structural integrity of the pavement. For example, on a segment with localized roughness due to depressed transverse cracks, it is more cost-effective both in terms of initial costs and life cycle costs to delay an overlay by restoring ride quality by repairing the pavement at crack locations. In cases where the extent of a distress (ravel or segregation) is “Extensive”, a simple cost analysis to compare localized spot treatments vs. more extensive treatments needs to be carried out (localized spray-patching vs. seal coat treatment).

The definitions of distress Severity and Extent presented in the Treatment Matrices have been developed based on Alberta Infrastructure and Transportation's Surface Condition Rating Manual. In some cases existing definitions have been elaborated to provide descriptions that allow better definition of the distress and subsequent treatment identification.

In situations where multiple pavement distresses exist in early or mid-life pavements, judgment and regional experience will determine the appropriate treatment or combination of treatments.

Severe Traffic/Load related distresses may indicate a weak pavement. In such cases, an engineering assessment including the structural capacity of the pavement will be required. The guidelines and methodology as listed under Section 5 should be used to determine the appropriate treatment for such segments.

5.0 PAVEMENT SEGMENTS ROUGHER THAN THE IRI TRIGGER VALUES

Pavement segments rougher than the IRI trigger values would typically represent mid-life to older pavements.

As a general rule, any highway should receive lower cost preventative maintenance treatments until a more substantial expenditure can be justified based on economics. Once a roadway is identified as requiring more than low cost maintenance activities, the following guidelines should be used to select and design the preservation or structural strengthening treatments. These guidelines supplement the methodologies outlined in the Pavement Design Manual.

5.1 Methodology

1. The first step is an assessment of the structural capacity of the existing pavement. The 10 year and 20 year structural overlay thickness requirement should be established in accordance with Alberta Infrastructure and Transportation's Pavement Design Manual.

2. The project should be divided into segments having similar IRI and 20 year structural overlay needs. The generally accepted minimum length of a treatment or uniform overlay thickness is about 2 km. This can be reduced where practical and cost-effective to do so.

3. For each segment of roadway, several strategies (combinations of treatments) should be considered over a 30 year analysis period. Figure 1 provides a guideline for selecting the first treatment of each strategy to be considered. The first treatment should consider:

a. the existing IRI
b. the 20 year structural overlay requirement
c. present severity and extent of distresses

4. There are many theoretical strategies that can be identified for the subsequent treatments required for the 30 year analysis period. As discussed in Section 5.2, a simplified approach is to use the treatment that will provide the 20 year structural overlay requirement with the appropriate service life as the second and subsequent treatment(s) in all cases.

5. The estimated service lifes of the various treatments to be used in the LCCA are provided in Section 5.3.

6. A 30 year LCCA of all selected strategies should be conducted to determine a short list of potential strategies. All strategies within about 5% of the cost of the strategy with the lowest LCCA can be considered to be equivalent in LCCA. Generally the strategy within this short list that has the lowest capital cost of the first treatment would be selected as the preferred treatment for that segment. However, issues such as traffic disruptions or other considerations relative to the level of service to the traveling public may justify a higher cost option

7. After the preferred lowest cost treatment for each segment of the project has been determined, an evaluation of all segment treatments considering such factors as economies of scale and logistics etc. should be carried out. For example, if all but one short segment is designed for 10 years, then the10 year treatment should be considered for all segments.

5.2 Factors Affecting LCCA

As part of the development of Edition 1 of "Guidelines for Assessing Pavement Preservation Strategies" in 2002 an LCCA study, which followed the methodology outlined in the Pavement Design Manual, was conducted for several actual roadway rehabilitation projects and a substantial number of strategies, i.e. combinations of treatments, were considered. The purpose of this study was to assess the new approach to the design and selection of preservation treatments.

From this study and the experience gained thereafter the following points are noted:

1. Any of the low cost preventative maintenance treatments that postpone a high cost preservation treatment are very economical. If preventative maintenance is considered as a viable alternative as a first treatment to meet ride requirements, then preventative maintenance will be the most cost-effective alternative.

2. The service lives assumed for each treatment are critical and have significant effect on LCCA. The estimated service lives of the various treatments are based on past experience, engineering judgment and local conditions. The guidelines for selecting an appropriate service life for each of the treatments are provided in Section 5.3.

3. When lane-specific treatments are considered, appropriate treatments for the shoulders will need to be identified based on their condition and the costs included in the LCCA. Lane-specific treatments should only be considered where the shoulders have an acceptable ride and surface condition, or where these conditions can be treated separately.

4. Where an overlay is being considered as the first treatment, the design needs to assess the need for any pre-treatment repair of distresses prior to the placement of the overlay, and these costs included in the LCCA.

5. In cases where the preferred strategy will result in a pavement surface width that is less than the Alberta Infrastructure and Transportation 3R/4R Guidelines, alternate strategies that could defer the need to grade widen should be assessed. The cost of grade widening should be included in the LCCA.

6. On a four lane divided highway, treatments that can be used on one lane only (i.e. M&I or HIR) are very economical, even with short lives, when compared to a treatment that must be placed full width.

7. When the 20 year structural overlay is thick (≥ 90 mm), the 10 year structural overlay alternate is not usually a cost-effective alternate.

8. When the 20 year structural overlay is thin (≤ 90 mm), the 10 year structural overlay alternate can be cost-effective.

9. The life cycle cost of a particular preservation strategy, (i.e. a combination of a particular set of treatments) is affected by existing pavement width. For the same ride and structural condition, the most cost-effective strategy on a narrow roadway may be different on a wider roadway.

10. There are many theoretical strategies that can be identified by varying the second, third and fourth treatments required to achieve a 30 year life cycle. As part of the development of Edition 1 (2002) a LCCA study, which followed the methodology outlined in the Pavement Design Manual, was conducted for several actual roadway rehabilitation projects and a substantial number of strategies, i.e. combinations of treatments, were considered. The purpose of this

study was to assess the new approach to the design and selection of preservation treatments. From this cost analysis and several other analyses, the following guidelines are provided to minimize the number of strategies to be assessed:

a) If preventative maintenance is considered as a viable alternative as a first treatment to meet ride requirements, then preventative maintenance will be the most cost-effective alternative.

b) For the majority of cases, the treatment that will provide a service life of 15 or more years should be the second treatment. This simplifying approach is because a review of example projects indicated that the choice of second treatment does not generally influence the LCCA enough to change the best initial treatment selected.

c) In some instances, second treatments of M&I, thin overlay or HIR may be viable alternates depending on traffic volume and the potential to defer grade widening.

5.3 Pavement Service Life Guidelines

The service lives assumed for each treatment are critical and have significant effect on LCCA. The estimated service lives of the various treatments are based on past experience, engineering judgment and local conditions. The guidelines for selection of an appropriate service life for each of the treatments are as follows:

1. The service of 20 year structural overlay and 10 year structural overlay should be selected based on Figures 2 and 3. Service life ranges should be adjusted based on engineering judgment and need to consider:

   - Past project performance
   - Distress type, severity and extent in the existing pavement
   - Pre-overlay repairs
   - Present and expected traffic volumes.

2. The service lives for M&I and HIR are based on past experience where these treatments were applied to structurally sound pavements. Figures 4 and 5 provide guidelines for adjusting the estimated service lives of these two treatments when applied to pavements that require strengthening based on their 20 year structural overlay requirement.

3. The designer will need to make the judgment if a thin single lift overlay will be adequate to restore ride quality and select the service life of the overlay based guideline as per Table 1. It would not be generally considered for high volume

roads. The need for pre-level must be considered, as any significant need will impact the LCCA.

4. Where the 20 year structural overlay is 70 mm or greater, the thicknesses of the 20 year structural overlays used as a second or third treatment in a 30 year LCCA, should be the same as the 20 year structural overlays required now. It is recognized that the thickness of the 20 year structural overlays will likely increase over time as overall structural condition deteriorates; however, the rate of this increase for various treatments is unknown. Regardless, the minimum thickness of the 20 year structural overlay used as a second or third treatment in the 30 year life cost analysis should be 70 mm.

6.0 PROJECT EXAMPLES

Included in Appendix B are examples that illustrate the methodologies presented in this document:

Example 1 Segment IRI is smoother than the target.

Example 2 Segment IRI is rougher than the target and the 20 year structural overlay is less than 40 mm.

7.0 CLOSURE

The major focus in the development of Edition 2 (2006) has been the inclusion of a framework for the assessment of early and mid-life pavements and to provide treatment options for the range of distresses typically found in early and mid-life ACP pavements.

The use of Edition 2 (2006) will undoubtedly identify the need for changes to these Guidelines. This is the natural evolution of the policies and procedures for management of the Alberta Provincial Highway Network.

References

- "Guidelines for Assessing Pavement Preservation Strategies", Edition 1, June 2002
- "Pavement Design Manual", June 1997
- Highway Maintenance Specification, Edition 3, Section 53
- Standard Specification for Highway Construction, Current Edition
- Contract Administration Manual Highway & Bridge Maintenance, Section 5.2, Version 2, 2003
- Crack Maintenance "In House" Guidelines
- Highway Maintenance Guidelines and Level of Service Manual Section 2.0, June 2000
- Surface Condition Rating Manual

TABLES

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TABLE 1: PAVEMENT PRESERVATION TREATMENT TOOL BOX

No.	Treatment	Application	Unit Cost	Service Life of the Treatment (yrs)	Comments
A Preventative Maintenance Treatments					
A1	Crack Fill (hot or cold pour)	Slight to Moderate cracks to slow deterioration of the crack	$0.55/ln.m.	< 1	• Not effective in providing long term sealing of the pavement from the ingress of water and air • Most effective when applied every year
A2	Blow & Go Crack Fill	Moderate cracks to fill and slow deterioration of the crack	$1.50 to $2.00/lin.m	~ 3	• Rubberized hot-pour crack sealant placed in cracks with no preparation or with pre-cleaning using hot or cold compressed air • A new treatment with little long-term performance experience. Informal reports of early performance have been promising
A3	Rout and Seal Crack Treatment	Slight to Moderate cracks on newer pavements to seal the pavement from ingress of water and air	$3.15/ln.m.	4 to 5+	• AI&T experience mixed with high rate of installation failure • Effect on extending pavement life not known; research required • Several different rout profiles available
A4	Re-sealing of Rout and Seal Treatments	Failed rout and seal installations	up to $20/lin.m	3 to 5	• Remove debonded hot-pour crack sealant • Clean previously routed cracks and reseal using hot-pour crack sealant • Limited experience with this treatment
A5	Spray-Patch (cracks)	Moderate to extreme depressed cracks; can be a preservation treatment, or a pre-overlay repair Moderate to extreme cracks Moderate to extreme depressed cracks	 $5.00/ln.m. $15.00/m²	 1 to 3 2 to 4	• Degree of improvement of ride quality is a function of quality of workmanship; as a pre-overlay repair, crack condition criteria needs to be developed • Does not address general roughness
A6	Spray-Patch	Localized failures of pavement surface (segregation, ravel, alligator cracking)	$15.00/m²	3	• Alternative is spot seal coat
A7	Thermo-Patch (cracks)	Moderate to extreme depressed transverse cracks; can be a preventative maintenance treatment, or a pre-overlay repair	$5.00/ln.m.	3 to 4	• Not applicable to cracks with extensive secondary cracking • As a pre-overlay repair, criteria for crack condition needs to be developed • Does not address general roughness
A8	Micro-Surfacing (cracks)	Moderate to extreme depressed transverse cracks; can be a preventative maintenance treatment, or a pre-overlay repair	$5.00/ln.m.	3 to 4	• Recent technology as an alternate to Thermo-patch; limited experience in Alberta. • Does not address general roughness

No.	Treatment	Application	Unit Cost	Service Life of the Treatment (yrs)	Comments
A9	Diamond Grinding (cracks)	Ridged transverse cracks	$30.00/ln.m.	4	• Treatment primarily used for Portland Cement Concrete Pavement • Has not yet been used on Asphalt Concrete Pavements in Alberta • Will need some trials to assess effectiveness and economics of this treatment
A10	Shallow Mill and Spray-Patch (cracks)	Heaved transverse cracks	$30.00/ln.m.	4 to 6	• Degree of improvement of ride quality is a function of quality of workmanship
A11	Shallow Mill & Fill (cracks)	Extreme tented, depressed or failed transverse cracks; can be a preventative maintenance treatment, or a pre-overlay repair	$25-30/ln.m	4 to 6	• Depth of treatment < 100 mm and is a function of crack condition • Rectangular section used • Doesn't stop underlying crack from reflecting through the treatment or overlay
A12	Deep Mill and Fill (cracks)	Extreme tented, depressed or failed transverse cracks; can be a preventative maintenance treatment, or a pre-overlay repair	$35-40/ln.m.	4 to 6+	• Depth of treatment is a function of (1) crack condition, (2) thickness of existing pavement; (3) thickness of overlay if used as a pre-overlay repair • Trapezoidal (Spec 3.35) or rectangular cross-section used • Doesn't stop underlying crack from reflecting through the treatment or overlay
A13	Squeegee Patch	Localized raveled or segregated areas	$1.00/m²	1 to 3+	• Can use SS1 or proprietary products • Sand blotter can be used in conjunction with liquid asphalt to provide sand seal or slurry effect • Squeegeeing required to force the asphalt into the surface voids
A14	Mix Patch (cold mix or hot mix)	Localized failures of pavement surface	$65.00/each	variable	• Pre-mixed proprietary products are available for pothole or extreme crack applications
A15	Skin patching	Rutting, depressions and ravelling	~$100.00/t or ~$3.00/m²	5 (1 to 8 yr range)	• Hot or cold asphalt mix placed as thin lifts using a paver or grader
A16	Deep Patch (cold mix or hot mix)	Rutting, depressions, localized failures	$130.00/t or $19.00/m²	7 (2 to 12 yr range)	• Typically includes removal of the pavement structure, subgrade repairs and replacing the pavement
B Surface Treatments					
B1	Fog Coat (flush coat)	General ravelling, oxidized surface	$0.50/m² to $1.25/m²	2 to 3	• Used more commonly as a shoulder treatment • Can be applied as a strip or spot seal to localized distresses
B2	Spot Seal Coat	General or localized ravelling	$5.00/m²	5 to 7+	• Can be applied as a strip or spot seal to localized distresses

No.	Treatment	Application	Unit Cost	Service Life of the Treatment (yrs)	Comments
B3	Chip Seal Coat; Graded Aggregate Seal Coat	Structurally sound, fairly smooth pavements with surface deficiencies, e.g. ravelling, segregation; mid-life pavements exhibiting hairline to slight wheelpath fatigue cracks	$3.00/m²	5 to 7+	• Service life governed by the condition of underlying pavement structure • These treatments do not add any structural strength • These treatments can seal hairline to slight fatigue cracks and defer overlays
B4	Slurry Seal Coat	Structurally sound, fairly smooth oxidized pavements or pavements with surface deficiencies, e.g. ravelling, segregation;	$2.00/m² to $3.00/m²	3 to 5	• Slurry seal is a mixture of sand and asphalt emulsion • Used in the past on community airports • No experience with highway applications • Not effective at treating cracked ACP surfaces
B5	Micro-Surfacing	Structurally sound, fairly smooth pavements with surface deficiencies, e.g. ravelling, segregation; can also be used as a rut fill treatment	$3.50/m² to $4.50/m²	5 to 7	• Micro-Surfacing is a mixture of manufactured fine aggregate and a polymer modified asphalt emulsion • May be appropriate for semi-urban applications
B6	Reprofiling by Cold Milling	Emergency treatment of rutted or bleeding pavements to improve safety	$2.50/m² to $5.00/m²	1 to 2	• Coarse textured surface may affect motorcycles and snow ploughing effectiveness
C Rehabilitation Treatments					
C1	Hot In-Place Recycling (HIR)	Rough but structurally adequate pavements; staged rehabilitation to improve ride quality until overlay thickness reaches a practical or economic thickness Structurally adequate pavements Structurally inadequate pavements	$6.00/m²	see Figure 5	• Pavements with severe deficiencies, e.g. rutting, may not be suitable candidates • Seal coats, patching and crack sealer may affect recycled mix quality • Treatment generally applied to travel lanes only
C2	Cold Mill and Inlay	Rough and/or rutted but structurally adequate pavements; staged rehabilitation to improve ride quality until overlay thickness reaches a practical or economic thickness Structurally adequate pavements Structurally inadequate pavements	$6.00/m²	see Figure 4	• Cold milled RAP can be recycled • Typically 50 mm cold mill depth but can be increased to provide modest strengthening • Treatment generally applied to travel lanes only but can be done full width on narrow roads • Unit cost based on an assumption of $55.00/tonne for ACP

No.	Treatment	Application	Unit Cost	Service Life of the Treatment (yrs)	Comments
C3	Thin Overlay (40 mm or less in thickness)	Rough pavements with or without surface deficiencies but structurally adequate; can be applied to structurally inadequate pavements to defer grade widening or reconstruction. Structurally adequate pavements Structurally inadequate pavements	$4.00/m² to $5.00/m²	 10 5 to 7	• Can treat travel lanes only or full width • May not be able to meet QA smoothness specifications • Pre-level quantities can significantly affect LCCA • Thickness (i.e. 30 or 40 mm) needs to be selected based on the designer's assessment of the roadway condition • Can be used to defer grade widening
C4	Reprofiling by Cold Milling and Overlay	Rough pavements with or without surface deficiencies and modest strengthening needs	$6.00/m²	15 to 20	• Treatment is an option where roughness is not due to general pavement distortion • Cold milling is generally set for a depth of 20 to 30 mm at centreline with a constant 2% cross-slope • Cold milling is followed by single lift or two-lift overlay • This treatment is usually used for full width of the road
C5	Cold Mill and Inlay or HIR of Travel Lanes plus Overlay	Pavements with severe deficiencies and strengthening needs	$10.00/m² to $11.00/m²	15 to 20	• Overlay based on structural design • Has been used in the past to treat severe rutting in the outer lane of divided highways prior to overlay
C6	Deep Cold Mill and Inlay with ACP, RCC or PCC with or without Overlay	Pavements with severe rutting and very high traffic	$50 to $100/m²	20	• Used for high traffic signalized intersections in urban or semi-urban areas
C7	Whitetopping/Ultra-Thin Whitetopping	Pavements with severe rutting	$50 to $100/m²	20	• Used for high traffic signalized intersections in urban or semi-urban areas
C8	Two-lift Overlay	Pavements with distorted longitudinal profile and cross-section but structurally adequate	?	8 to 20	• Two-lift overlay required to re-establish longitudinal profile and cross-section • To correct rough and/or rutted pavements • Generally on structurally adequate pavement (60 to 80 mm thick)
C9	Structural Overlay	Structurally deficient pavements 10 year design 20 year design	$7.00/m² to $11.00/m²	10 to 20	• Structural deficiency can result from (1) initial under-design due to unanticipated increased traffic loadings; (2) pavements at the end of their structural life • Overlay thickness based on FWD analysis
				6 to 10	• Service life of the 10 yr structural overlay should be determined using Figure 3
				6 to 20	• Service life of the 20 yr structural overlay should be determined using Figure 2

No.	Treatment	Application	Unit Cost	Service Life of the Treatment (yrs)	Comments
C10	Cold In-Place Recycling (CIR) and overlay	Pavement with severe cracking	Project Specific	15 to 20	• CIR is partial depth recycling of the asphalt pavement layer, stabilized in-place without heat; the process is carried out with a train of multi-functional recycling equipment • No performance experience in Alberta
C11	Full Depth Reclamation (FDR) and Stabilization and new ACP	Failed Pavements	Project Specific	15 to 20	• FDR is where the total asphalt pavement structure and a portion of the underlying granular base is uniformly pulverized and blended in-place; the reclaimed material can be stabilized mechanically with water or with foamed or emulsified asphalt • Limited performance experience in Alberta
D Reconstruction Treatments					
D1	Reconstruction	Failed Pavements	Project Specific	20	• Generally triggered by geometric deficiencies

NOTES:
1. Pavement distress extents and severities are defined in Figures 6, 7, 8, 10, 10, 11 and 12.
2. Unit costs are based on 2005 information.
3. Pavement lift is not necessarily extended by the same amount of time as the service life of a particular treatment.

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FIGURES

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FIGURE 1: GUIDELINES FOR SELECTING PRESERVATION TREATMENTS

IRI - RIDE LEVEL

SEGMENT SMOOTHER THAN TRIGGER VALUE

SEGMENT ROUGHER THAN TRIGGER VALUE

20 YR STRUCTURAL OVERLAY REQUIREMENT - OL (20 YR)

IRI Trigger Value

AADT	IRI Trigger (mm/m)
< 400	3.0
400 - 1500	2.6
1501 - 6000	2.3
6001 - 8000	2.1
> 8000	1.9

OL (20 YR) > 40 mm

OL (20 YR) ≤ 40 mm

- Preventative Maintenance
- Thin OL
- HIR
- Mill & Inlay
- Two Lift OL

40 mm < OL (20 YR) ≤ 70 mm

- Preventative Maintenance
- Thin OL
- HIR
- Mill & Inlay
- OL (10 yr)
- OL (20 yr)

70 mm < OL (20 YR) < 90 mm

- HIR
- Mill & Inlay
- OL (10 yr)
- OL (20 yr)

OL (20 YR) ≥ 90 mm

- OL (20 yr)

NOTES:

The 20 year structural overlay requirement is the thickness of overlay required following AI & T's Pavement Design Manual based on the 20 year Design ESALs

The service life of all overlay, mill and inlay and HIR treatments should be determined using Figures 2, 3, 4 and 5.

ENVIRONMENTAL/CONSTRUCTION DISTRESSES

TRAFFIC/LOAD DISTRESSES

POTHOLES, DIPS, HEAVES & LOCAL DISTORTION

Generally treated as local repairs using deep patch or mix patch procedures

TRANSVERSE CRACKS (FIGURE 6)

LONGITUDINAL CENTRE OF PAVER CRACKS (FIGURE 7)

SEGREGATION (FIGURE 8)

RAVEL (FIGURE 9)

RUTTING (FIGURE 10)

LONGITUDINAL WHEEL PATH FATIGUE CRACKS (FIGURE 11)

WHEEL PATH FLUSHING/BLEEDING (FIGURE 12)

Figure 2 - Pavement Service Life Guidelines
(ACP Overlay Thickness Meets or Exceeds 20 yr Structural Requirement and IRI Exceeds the Trigger Value)

		Expected Pavement Service Life (yrs)						
ACP Overlay Thickness		**40 mm**	**50 mm**	**60 mm**	**70 mm**	**80 mm**	**90 mm**	**≥ 100 mm**
AADT	**Trigger IRI (mm/m)**		**2-lift**	**2-lift**	**2-lift**	**2-lift**	**2-lift**	**2-lift**
< 400	3.0	10 to 14	12 to 16	14 to 18	16 to 20	20	20	20
400 to 1,500	2.6	10 to 14	12 to 16	14 to 18	16 to 20	20	20	20
1,501 to 6,000	2.3	8 to 12	10 to 14	12 to 16	14 to 18	18 to 20	18 to 20	18 to 20
6,001 to 8,000	2.1	6 to 9	10 to 12	10 to 14	12 to 16	16 to 18	16 to 18	16 to 18
> 8,000	1.9	6 to 8	8 to 10	10 to 12	12 to 16	14 to 16	14 to 16	16

Interpretative Comments

1. The guideline is to be used to determine the service life of ACP overlays that meet or exceed the 20 yr Structural requirement for the purpose of Life Cycle Cost Analyses.

2. These are guidelines and the designer should use engineering judgement to decide whether or not these values are appropriate for their particular circumstance.

3. The service life guideline assumes that the required pre-overlay repair of cracks, local potholes or failures and local pavement distortion have been repaired prior to placement of the overlay.

4. The overlay thickness being considered must meet or exceed the 20 year design ESAL requirements.

5. The guidelines assume that the recommended ACP overlay will restore the average MIRI to a level of 0.8 to 1.0 mm/m at the time of construction.

Figure 3 - Pavement Service Life Guidelines (ACP Overlay Thickness Meets or Exceeds 10 yr Structural Requirement and IRI Exceeds the Trigger Value)

ACP Overlay Thickness		Expected Pavement Service Life (yrs)	
AADT	Trigger IRI (mm/m)	40 mm	50 mm
< 400	3.0	8 to 10	10
400 to 1,500	2.6	8 to 10	10
1,501 to 6,000	2.3	7 to 9	9 to 10
6,001 to 8,000	2.1	6 to 8	8 to 9
> 8,000	1.9	6 to 8	7 to 8

Interpretative Comments

1. The guideline is to be used to determine the service life of 10 yr structural overlays of 40 and 50 mm thickness for the purpose of Life Cycle Cost Analyses.

2. These are guidelines and the designer should use engineering judgement to decide whether or not these values are appropriate for their particular circumstance.

3. The service life guideline assumed that the required pre-overlay repair of cracks, local potholes or failures and local pavement distortion have been repaired prior to placement of the overlay.

4. The guidelines assume that the recommended ACP overlay will restore the average MIRI to a level of 0.8 to 1.0 mm/m at the time of construction.

FIGURE 4: ESTIMATED SERVICE LIVES OF M&I

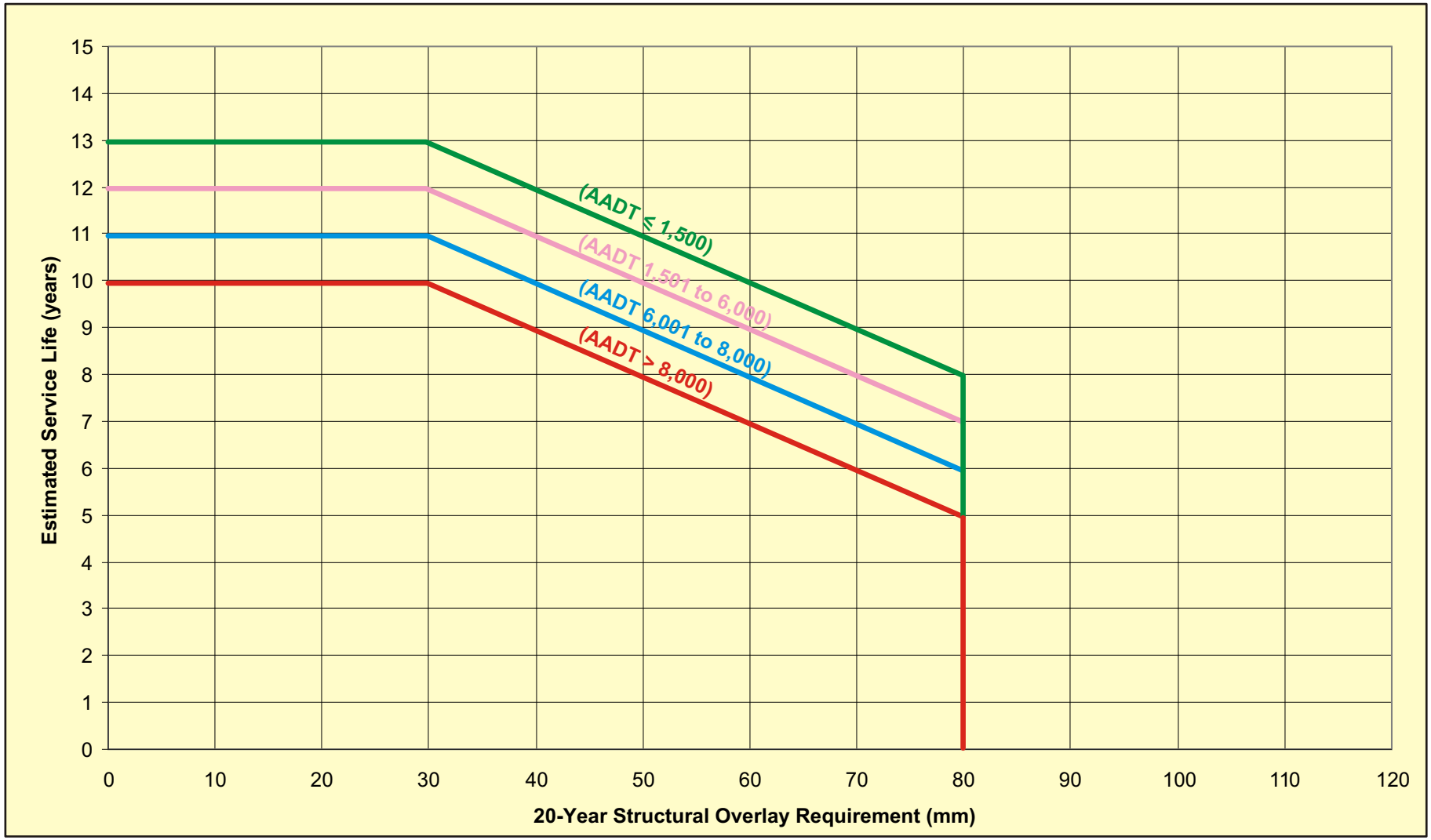


FIGURE 5: ESTIMATED SERVICE LIVES OF HIR

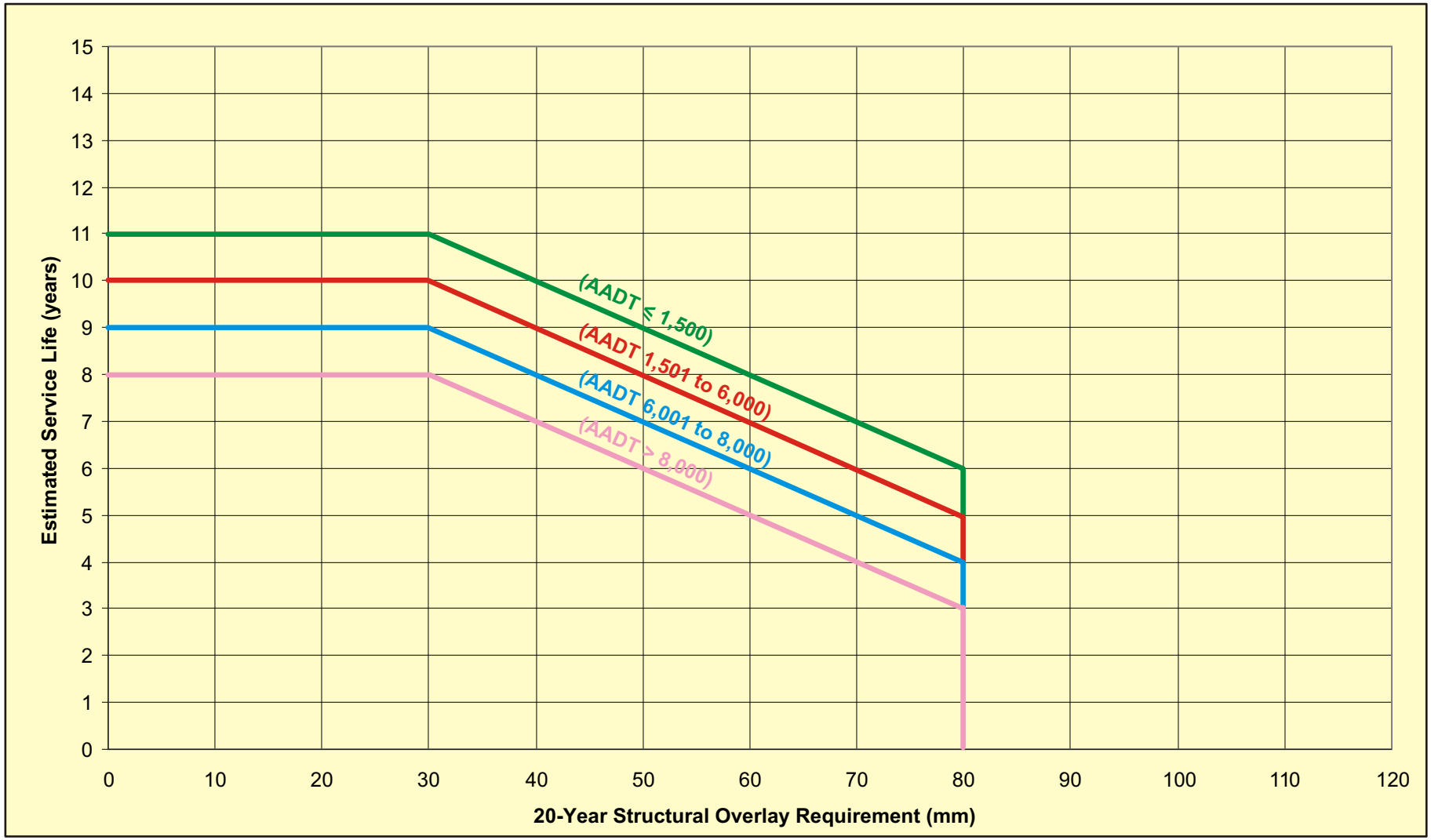
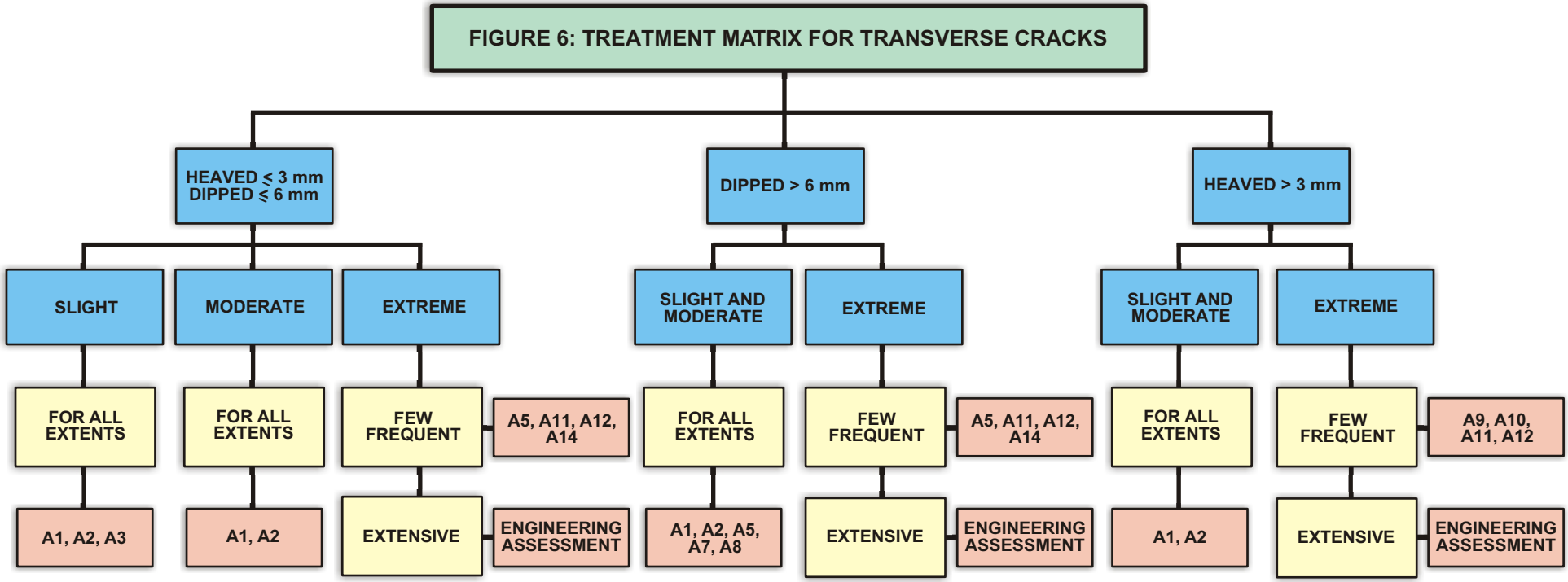


FIGURE 6: TREATMENT MATRIX FOR TRANSVERSE CRACKS



SEVERITY DEFINITION

(Reference Pages 31, 32, 48 & 49 of AIT SCRM V4.2)

Repaired: Repaired with A1, A2 or A3 where no opening is evident; bonds are intact.

Slight: Single cracks ≤ 3 mm, cracks repaired with A1, A2 or A3 but sealant not bonded.

Moderate: All single cracks > 3 mm and < 10 mm, branched cracking with branching interval of 3 or more branches per lin. m., Secondary cracks are present.

Extreme: All cracks ≥ 10 mm wide, multiple cracking, spalling with considerable break-up and loss of material.

EXTENT DEFINITION

Description	Ave. Crack Spacing (m)	Equivalent T-cracks/km
Few	> 50	0 - 20
Frequent	20 - 50	20 - 50
Extensive	< 20	> 50

Preventative Maintenance Treatments		Surface Treatments		Rehabilitation Treatments	
A1	Crack Fill	B1	Fog Coat	C1	HIR
A2	B&G Crack Fill	B2	Spot Seal Coat	C2	M&I
A3	R&S Crack Seal	B3	Seal Coat	C3	Thin OL
A4	Re-seal R&S	B4	Slurry Seal	C4	Reprofiling and OL
A5	SP (Cracks)	B5	Micro-Surfacing	C5	M&I or HIR and OL
A6	SP (spot)	B6	Reprofiling	C6	Deep M&I
A7	Thermo-Patch			C7	Whitetopping
A8	Micro-Surfacing Patch			C8	Thick OL
A9	Diamond Grind (Cracks)			C9	Structural OL
A10	Shallow Mill and SP (Cracks)				
A11	Shallow M&F (Cracks)				
A12	Deep M&F (Cracks)				
A13	Squeegee Patch				
A14	Mix Patch				
A15	Deep Patch				

INTERPRETIVE NOTES

1) Transverse cracks that are dipped > 6 mm with slight and moderate severity can benefit from the use of clean sand blotter in conjunction with Treatment A1.

2) Where hot-pour route and seal crack treatments have failed, A4 should be considered as a treatment.

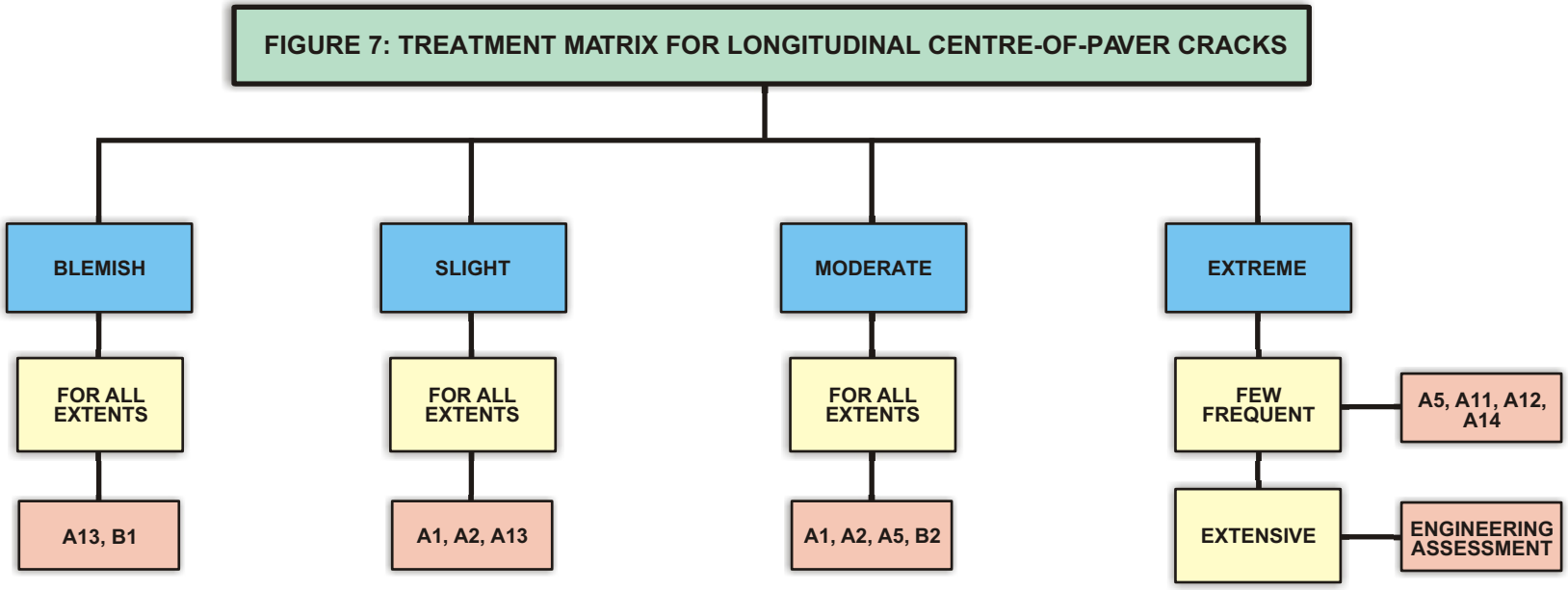
3) Other environmental/construction related longitudinal, meandering or random cracking can be assessed using Figure 6.

Repaired Transverse Crack Heaved < 3 mm

Moderate to Extreme Transverse Crack Heaved > 3 mm

Extreme Transverse Crack Dipped > 6 mm

FIGURE 7: TREATMENT MATRIX FOR LONGITUDINAL CENTRE-OF-PAVER CRACKS



SEVERITY DEFINITION

(Reference Pages 31, 32, 48 & 49 of AIT SCRM V4.2)

Blemish: Appears as a continuous or semi-continuous straight longitudinal "streak" typically located in the middle of the paver "mat".

Repaired: Repaired with A1, A2 or A3 where no opening is evident; bonds are intact.

Slight: Single cracks ≤ 3 mm, cracks repaired with A1, A2 or A3 but sealant not bonded.

Moderate: All single cracks cracks > 3 mm and < 10 mm, branched cracking with branching interval of 3 or more branches per lin. m., Secondary cracks are present.

Extreme: All cracks ≥ 10 mm wide, multiple cracking, spalling with considerable break-up and loss of material.

EXTENT DEFINITION - Percent of the Length Affected in Each Lane

Few - < 20%
Frequent - 20 to 50%
Extensive - > 50%

Preventative Maintenance Treatments		Surface Treatments		Rehabilitation Treatments	
A1	Crack Fill	B1	Fog Coat	C1	HIR
A2	B&G Crack Fill	B2	Spot Seal Coat	C2	M&I
A3	R&S Crack Seal	B3	Seal Coat	C3	Thin OL
A4	Re-seal R&S	B4	Slurry Seal	C4	Reprofiling and OL
A5	SP (Cracks)	B5	Micro-Surfacing	C5	M&I or HIR and OL
A6	SP (spot)	B6	Reprofiling	C6	Deep M&I
A7	Thermo-Patch			C7	Whitetopping
A8	Micro-Surfacing Patch			C8	Thick OL
A9	Diamond Grind (Cracks)			C9	Structural OL
A10	Shallow Mill and SP (Cracks)				
A11	Shallow M&F (Cracks)				
A12	Deep M&F (Cracks)				
A13	Squeegee Patch				
A14	Mix Patch				
A15	Deep Patch				

INTERPRETIVE NOTES

1) Longitudinal Centre-of-Paver cracks not located in wheel paths with slight severity can be considered for an A3 treatment option.

2) Longitudinal Centre-of-Paver cracks are readily distinguishable from longitudinal fatigue cracks. The former are generally very straight; the latter tend to meander within the wheel path.

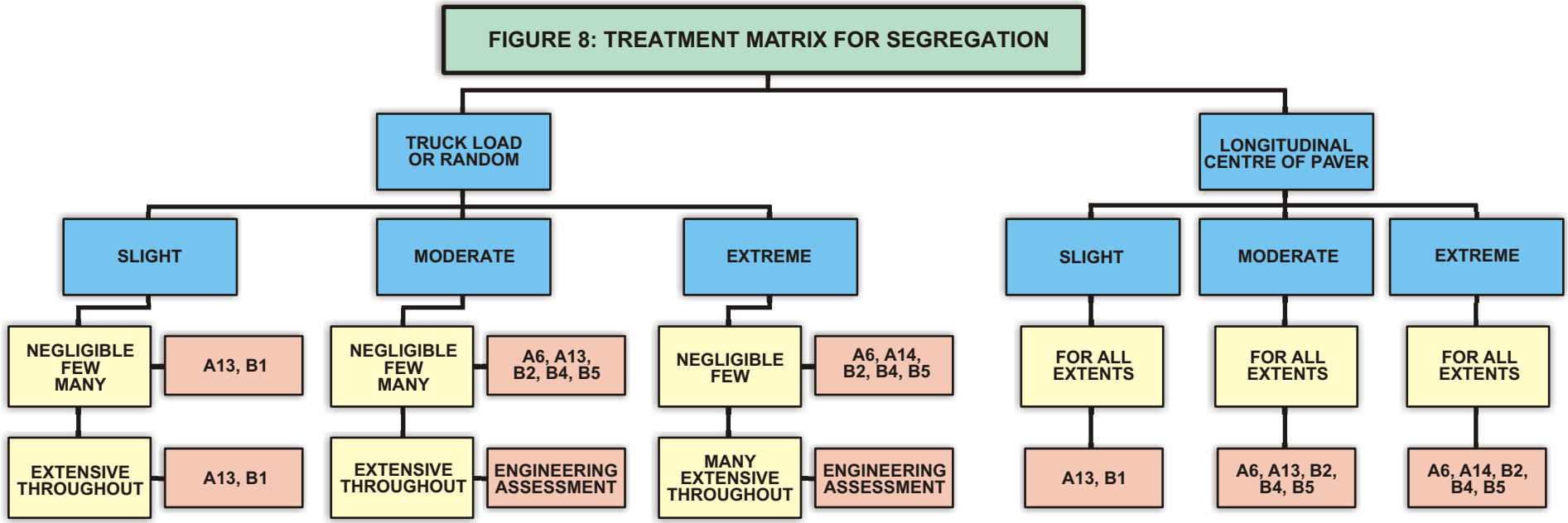
3) The Blemish Severity is generally an indication of segregation in the asphalt mix (refer to Figure 8 for more detailed information).

4) Longitudinal Centre-of-Paver cracks located in the wheel paths can deteriorate and have short transverse fatigue cracks and fatigue blocking associated with them. In this situation the assessment should use Figure 11 - Fatigue Cracking.

Moderate Severity Centre-of-Paver Crack

Centre-of-Paver Crack Located in Outer Wheel path

FIGURE 8: TREATMENT MATRIX FOR SEGREGATION



SEVERITY DEFINITION

(Reference Spec 3.50.4.7.2)

Slight: The matrix, asphalt cement and fine aggregate is in place between the coarse aggregate. However, there is more stone in comparison to the surrounding area.

Moderate: Significantly more stone than the surrounding mix. Moderately segregated areas usually exhibit a lack of surrounding asphalt and fine aggregate matrix.

Extreme: Appears as an area of very stony asphalt mix, stone against stone with very little or no fine aggregate matrix.

EXTENT DEFINITION

TRUCK LOAD OR RANDOM (number/lane-km) (Reference AIT SEAL COAT RATING GUIDELINES)

Negligible - < 5
Few - 5 to 10
Many - 11 to 20
Extensive - 21 to 30
Throughout - > 30

LONGITUDINAL CENTRE OF PAVER (Percent of Length of Lane Affected)

Few - < 10%
Intermittent - 10 to 20%
Frequent - 20 to 50%
Extensive - 50 to 80%
Throughout - 80 to 100%

Preventative Maintenance Treatments		Surface Treatments		Rehabilitation Treatments	
A1	Crack Fill	B1	Fog Coat	C1	HIR
A2	B&G Crack Fill	B2	Spot Seal Coat	C2	M&I
A3	R&S Crack Seal	B3	Seal Coat	C3	Thin OL
A4	Re-seal R&S	B4	Slurry Seal	C4	Reprofiling and OL
A5	SP (Cracks)	B5	Micro-Surfacing	C5	M&I or HIR and OL
A6	SP (spot)	B6	Reprofiling	C6	Deep M&I
A7	Thermo-Patch			C7	Whitetopping
A8	Micro-Surfacing Patch			C8	Thick OL
A9	Diamond Grind (Cracks)			C9	Structural OL
A10	Shallow Mill and SP (Cracks)				
A11	Shallow M&F (Cracks)				
A12	Deep M&F (Cracks)				
A13	Squeegee Patch				
A14	Mix Patch				
A15	Deep Patch				

INTERPRETIVE NOTES

1) Moderate and extreme severity segregated areas will ravel quickly. Immediate identification and treatment of these areas will reduce the rate of deterioration significantly.

2) Treatment A13 - Squeegee Patch, is generally hand placed using a variety of materials. For slight severity, a application of an emulsified asphalt similar to a fog seal would be appropriate. Moderate and Extreme severity areas could have emulsified asphalt with fine sand mixed in or use of proprietary products for spot patching.

3) Longitudinal Centre of Paver segregation will appear as a straight longitudinal continuous or semi-continuous streak, typically located in the middle of the paved mat.

4) Segregated areas that have experienced ravel should be assessed for treatment using the RAVEL treatment decision tree (Figure 9).

5) When treating Segregated areas, treatments should extend beyond the visible edge of the segregated area.

6) Segregated areas that are left untreated are subject to ravel and premature fatigue cracking.

7) Segregated areas that have been treated as part of the pavement construction process should be monitored for additional treatment on a continuing basis.

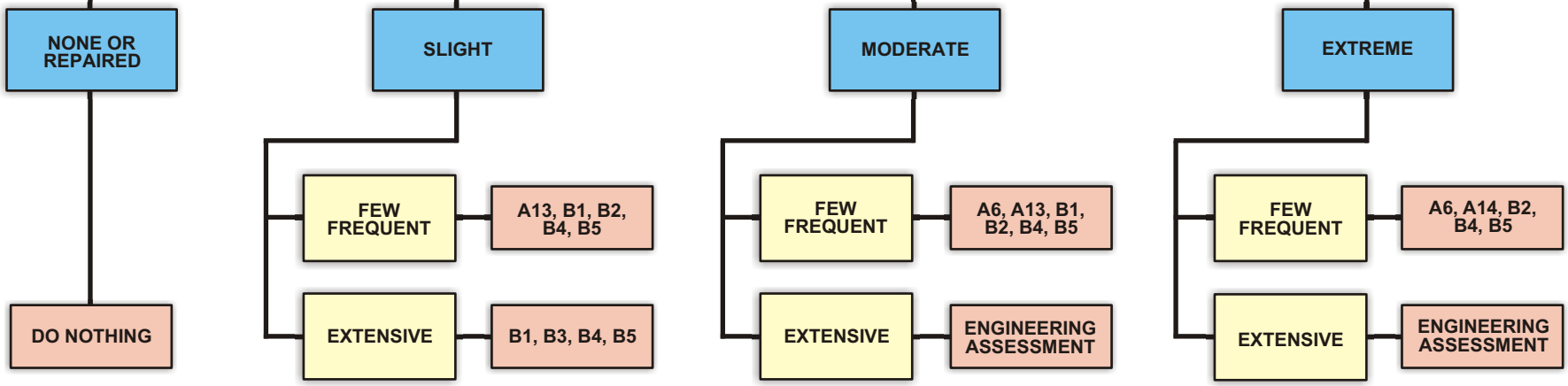
8) When an Engineering Assessment is required, the AI & T Guidelines for the Assessment, Rating and Prioritization of Pavements for Seal Coat should be used as the primary procedure.

Segregation

Segregation

Segregation

FIGURE 9: TREATMENT MATRIX FOR RAVEL



SEVERITY DEFINITION

(Reference - AIT Seal Coat Rating Guidelines; pages 50 & 51 of AIT SCRM V4.2)

None or Repaired: There is little evidence of ravelling outside areas of segregation, less than 5 pick outs per 0.1 square metre.

Slight: Asphalt binder and fines matrix is beginning to disappear to a depth less than 1/8 aggregate top size, 5 to 25 pick outs per square metre.

Moderate: Asphalt binder and fines matrix is beginning to disappear to a depth of 1/8 to 1/4 aggregate top size. The surface texture is becoming rough and pitted, 26 to 50 pick outs per square metre.

Extreme: Asphalt binder and fines matrix is beginning to disappear to a depth of more than 1/4 aggregate top size. The surface is very rough and pitted, greater than 50 pick outs per square metre.

EXTENT DEFINITION - Percent of the Area Affected

Few - < 20%
Frequent - 20 to 50%
Extensive - > 50%

Preventative Maintenance Treatments		Surface Treatments		Rehabilitation Treatments	
A1	Crack Fill	B1	Fog Coat	C1	HIR
A2	B&G Crack Fill	B2	Spot Seal Coat	C2	M&I
A3	R&S Crack Seal	B3	Seal Coat	C3	Thin OL
A4	Re-seal R&S	B4	Slurry Seal	C4	Reprofiling and OL
A5	SP (Cracks)	B5	Micro-Surfacing	C5	M&I or HIR and OL
A6	SP (spot)	B6	Reprofiling	C6	Deep M&I
A7	Thermo-Patch			C7	Whitetopping
A8	Micro-Surfacing Patch			C8	Thick OL
A9	Diamond Grind (Cracks)			C9	Structural OL
A10	Shallow Mill and SP (Cracks)				
A11	Shallow M&F (Cracks)				
A12	Deep M&F (Cracks)				
A13	Squeegee Patch				
A14	Mix Patch				
A15	Deep Patch				

INTERPRETIVE NOTES

1) Treatment A13 - Squeegee Patch, is generally hand placed using a variety of materials. For slight severity, an application of an emulsified asphalt similar to a fog seal would be appropriate. Moderate severity areas could be treated using an emulsified asphalt blotted with sand or with sand pre-mixed with the emulsified asphalt. Proprietary slurry seal type products can also be used.

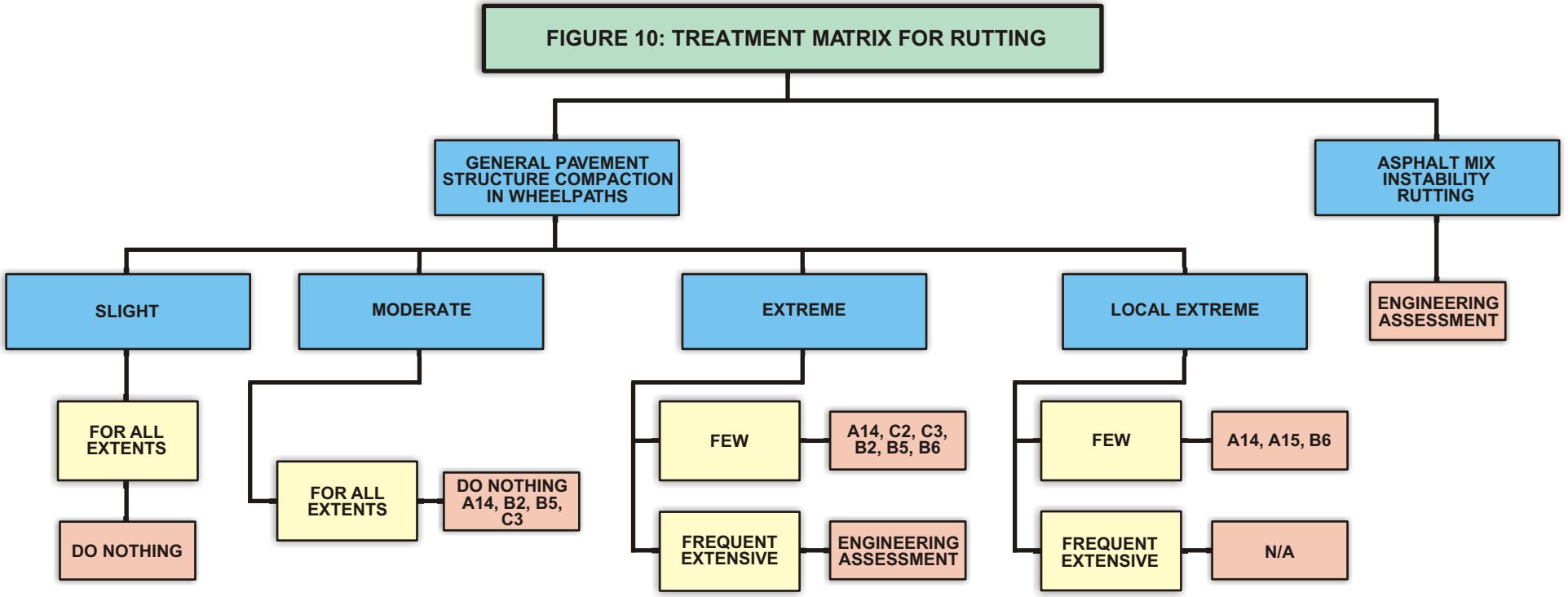
2) When an Engineering Assessment is required, the AI & T Guidelines for the Assessment, Rating and Prioritization of Pavements for Seal Coat should be used as the primary procedure.

Moderate general ravel

Severe ravel on shoulders

Severe ravel and pickouts

FIGURE 10: TREATMENT MATRIX FOR RUTTING



SEVERITY DEFINITION
(Reference Page 30 of AIT SCRM V4.2)

Slight: Rut depths of 3 to 8 mm

Moderate: Rut depths of 9 to 13 mm

Extreme: Rut depths greater than 13 mm

EXTENT DEFINITION - Percent of the Length Affected in Each Lane

Few - <20%
Frequent - 20 to 50%
Extensive - > 50%

Preventative Maintenance Treatments		Surface Treatments		Rehabilitation Treatments	
A1	Crack Fill	B1	Fog Coat	C1	HIR
A2	B&G Crack Fill	B2	Spot Seal Coat	C2	M&I
A3	R&S Crack Seal	B3	Seal Coat	C3	Thin OL
A4	Re-seal R&S	B4	Slurry Seal	C4	Reprofiling and OL
A5	SP (Cracks)	B5	Micro-Surfacing	C5	M&I or HIR and OL
A6	SP (spot)	B6	Reprofiling	C6	Deep M&I
A7	Thermo-Patch			C7	Whitetopping
A8	Micro-Surfacing Patch			C8	Thick OL
A9	Diamond Grind (Cracks)			C9	Structural OL
A10	Shallow Mill and SP (Cracks)				
A11	Shallow M&F (Cracks)				
A12	Deep M&F (Cracks)				
A13	Squeegee Patch				
A14	Mix Patch				
A15	Deep Patch				

INTERPRETIVE NOTES

1) Asphalt Mix Instability rutting is characterized by lateral displacement and shoving outward from the ruts and is commonly identified by the dual wheeltrack in each rut. This type of rutting distress is most often seen where trucks are operating at low speeds, starting or stopping.

2) General pavement structural compaction rutting is identified by the smooth general swail shape of the rut in each wheelpath.

3) Local extreme severity rutting should be assessed for deep patch repair.

4) Micro-Surfacing has been used on general pavement structure rutting of up to 30 mm. When rut depth exceeds 13 mm, a micro-surfacing rut-fill of each rut should be considered.

5) Thickness of treatment A14, B6 and C3 will be dependent on the depth of ruts, but will generally be in the range of 30 mm to 60 mm.

6) Mix patch (Treatment A14) can be cold or hot asphalt mix and can be hand placed, blade laid or paver laid. This applies on shorter segments when an asphalt paver is not available.

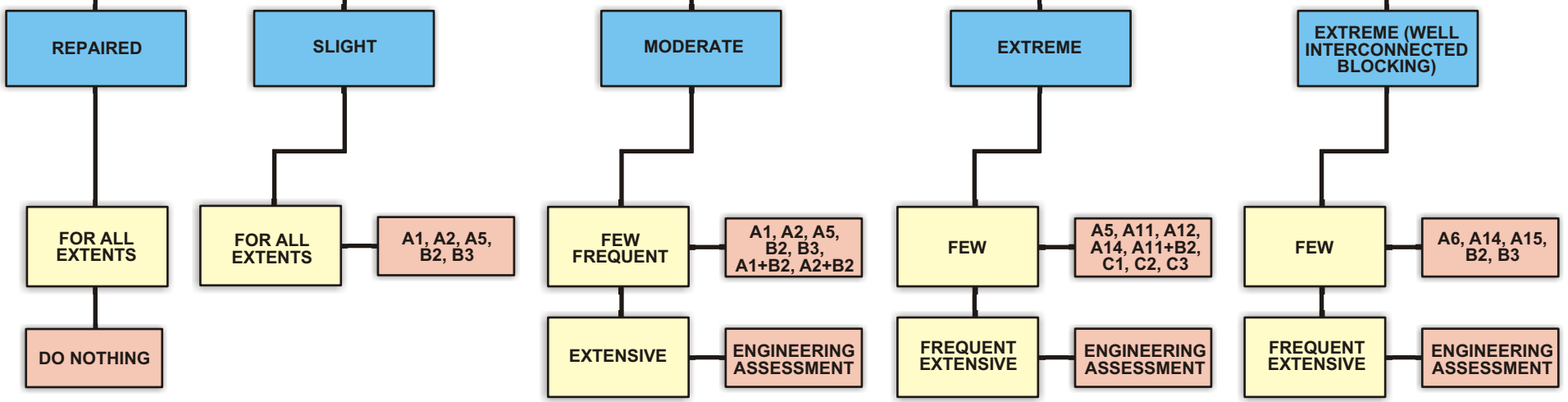
7) In general, the asphalt mix type used for treatment C3 (Thin OL) should meet the current AIT Guideline for mix type selection.

8) Treatment B6 (Reprofiling by Cold Milling) is generally considered to be an emergency treatment for rutting of extreme severity.

General Pavement Structure Compaction Rutting

Asphalt Mix Instability Rutting

FIGURE 11: TREATMENT MATRIX FOR LONGITUDINAL WHEEL PATH FATIGUE CRACKS



SEVERITY DEFINITION
(Reference Pages 31, 32, 48 & 49 of AIT SCRM V4.2)

Repaired: Repaired with A1, A2 or A3 where no opening is evident; bonds are intact.

Slight: Single cracks ⩽ 3 mm, cracks repaired with A1, A2 or A3 but sealant not bonded.

Moderate: All single cracks > 3 mm and < 10 mm, branched cracking with branching interval of 3 or more branches per lin. m., Secondary cracks are present.

Extreme: All cracks ⩾ 10 mm wide, multiple cracking, spalling with considerable break-up and loss of material.

Extreme (well interconnected blocking):
All well interconnected blocking or alligator cracking. Sometimes referred to as chicken wire cracking.

EXTENT DEFINITION - Percent of the Length of Worst Wheelpath

Few - < 20%
Frequent - 20 to 50%
Extensive - > 50%

Preventative Maintenance Treatments		Surface Treatments		Rehabilitation Treatments	
A1	Crack Fill	B1	Fog Coat	C1	HIR
A2	B&G Crack Fill	B2	Spot Seal Coat	C2	M&I
A3	R&S Crack Seal	B3	Seal Coat	C3	Thin OL
A4	Re-seal R&S	B4	Slurry Seal	C4	Reprofiling and OL
A5	SP (Cracks)	B5	Micro-Surfacing	C5	M&I or HIR and OL
A6	SP (spot)	B6	Reprofiling	C6	Deep M&I
A7	Thermo-Patch			C7	Whitetopping
A8	Micro-Surfacing Patch			C8	Thick OL
A9	Diamond Grind (Cracks)			C9	Structural OL
A10	Shallow Mill and SP (Cracks)				
A11	Shallow M&F (Cracks)				
A12	Deep M&F (Cracks)				
A13	Squeegee Patch				
A14	Mix Patch				
A15	Deep Patch				

INTERPETIVE NOTES

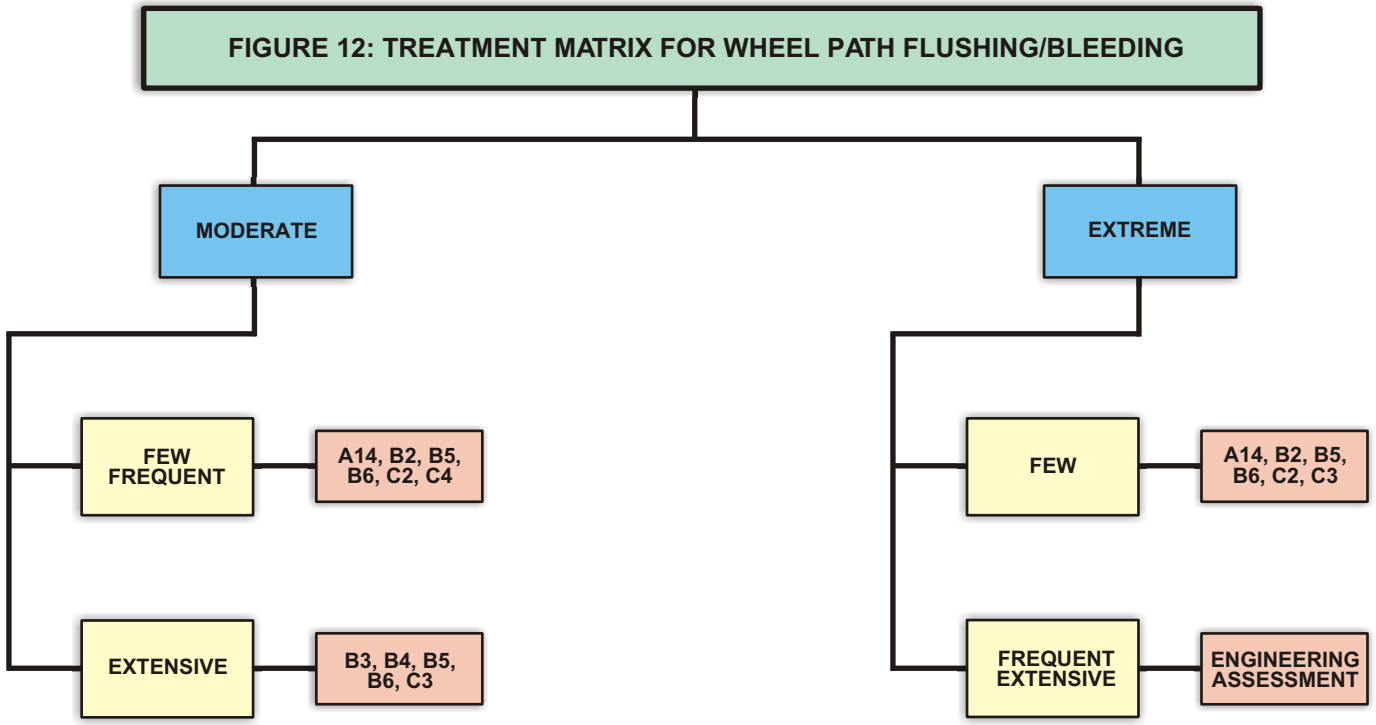
1) Treatment A3 (Rout and Seal Crack Treatment) is not recommended to treat longitudinal wheel path fatigue cracking.

2) Top down fatigue cracking can be effectively treated with spot seals or full seal coats.

Longitudinal Fatigue Cracks

Extreme Severity Longitudinal Fatigue Cracks

FIGURE 12: TREATMENT MATRIX FOR WHEEL PATH FLUSHING/BLEEDING



SEVERITY DEFINITION

Moderate: Distinctive appearance with free excess asphalt on chip seal surfaces, chips are more than 80% embedded in the asphalt.

Extreme: Free asphalt gives the pavement a slick, wet appearance. In extreme cases tire tracks can be seen in the surplus asphalt on hot days. On chip seal surfaces, aggregate chips are totally embedded in the asphalt binder.

EXTENT DEFINITION - Percent of the Length Affected by Lane

Few - < 20%
Frequent - 20 to 50%
Extensive - > 50%

Preventative Maintenance Treatments		Surface Treatments		Rehabilitation Treatments	
A1	Crack Fill	B1	Fog Coat	C1	HIR
A2	B&G Crack Fill	B2	Spot Seal Coat	C2	M&I
A3	R&S Crack Seal	B3	Seal Coat	C3	Thin OL
A4	Re-seal R&S	B4	Slurry Seal	C4	Reprofiling and OL
A5	SP (Cracks)	B5	Micro-Surfacing	C5	M&I or HIR and OL
A6	SP (spot)	B6	Reprofiling	C6	Deep M&I
A7	Thermo-Patch			C7	Whitetopping
A8	Micro-Surfacing Patch			C8	Thick OL
A9	Diamond Grind (Cracks)			C9	Structural OL
A10	Shallow Mill and SP (Cracks)				
A11	Shallow M&F (Cracks)				
A12	Deep M&F (Cracks)				
A13	Squeegee Patch				
A14	Mix Patch				
A15	Deep Patch				

INTERPRETIVE NOTES

1) Extreme severity flushing/bleeding in ACP surfaces is a very unusual occurance on AIT highways.

2) Extreme severity flushing/bleeding does occur on chip seal or graded aggregate seal coats and is generally associated with construction related issues or heavy vehicles making sharp turning movements.

3) Placement of surface treatments B2, B3, B4 and B5 should take into consideration the excess asphalt on the existing surface.

4) Wheelpath flushing and bleeding in ACP surfaces is often associated with mix instability rutting.

5) An option to Treatment C4 is Reprofiling by Cold Milling and Seal Coat.

Slight to Moderate Flushing of Seal Coat in wheel paths

Extreme Flushing of Seal Coat in wheel paths

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APPENDIX A

GLOSSARY OF ABBREVIATIONS

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Commonly Used Abbreviations:

AADT	Average Annual Daily Traffic
ACP	Asphalt Concrete Pavement
B & G	Blow and Go
ESAL	Equivalent Single Axle Load
HIR	Hot In Place Reclycing
IRI	International Roughness Index
LCCA	Life Cycle Cost Analysis
LCC	Life Cycle Cost
OL	Overlay
M & F	Mill and Fill
M & I	Mill and Inlay
R & S	Route and Seal
SP	Spray Patch

3R/4R	Resurfacing, Restoration, Rehabilitation/ Resurfacing, Restoration, Rehabilitation, Reconstruction

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APPENDIX B

PROJECT EXAMPLES

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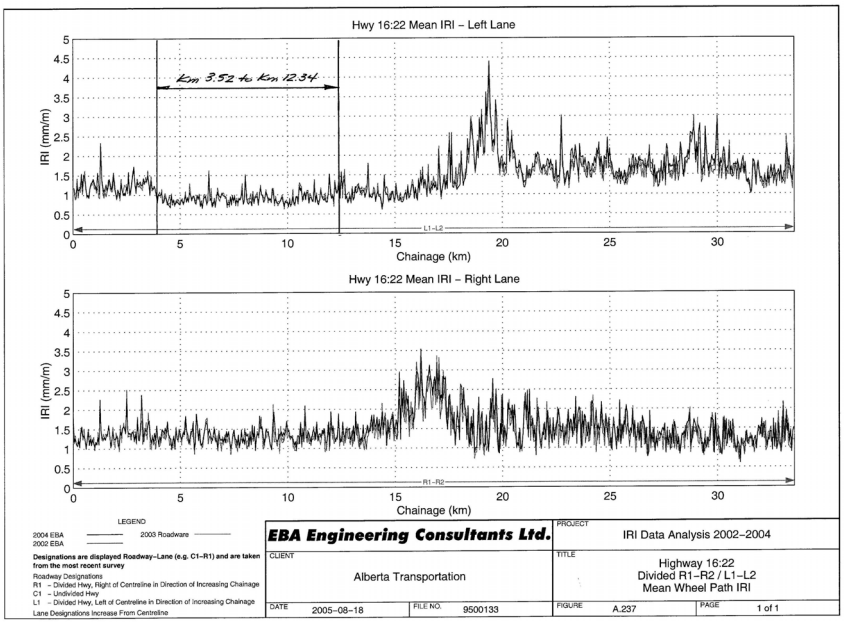
Example – Segment IRI is Smoother than the Trigger Value

1. Project Segment Description

- Hwy 16:22 WB Outer Lane (L1-L2)
- km 3.52 to km 12.34
- Existing Pavement Structure (2004 PMS Summary)
  - 2001 Seal Coat
  - 1998 80 mm ACP Overlay
  - Soil Cement Base constructed in 1970
- 2004 WAADT = 7660 (Traffic Volume, Vehicle Classification, Travel and ESAL Statistics Report)



2. IRI Ride Level Trigger – Figure 1

- For AADT = 7660, IRI Trigger = 2.1 mm/m

3. Present IRI of Segment (from AI&T IRI Plots 2004)

- Visual Examination indicates 2004 IRI generally ranged from 0.8 to 1.3 mm/m
- Therefore Segment Smoother than the Trigger Value

4. Existing Pavement Distresses

- Full Width Transverse Cracks
- Crack Severity rated as slight to moderate
- Crack Frequency rates as extensive – 50 to 200 T-cracks/km
- Cracks dipped 0 to 2 mm
- Cracks not previously treated

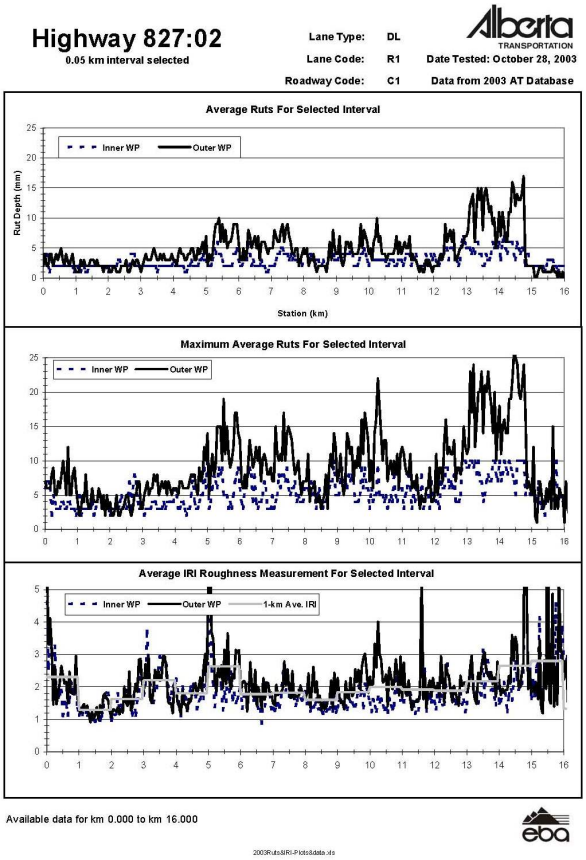
5. From Figure 6 Treatment Matrix for Transverse Cracks

- Transverse Cracks dipped ≤ 6 mm
- Slight to Moderate Severity
- Extensive Extent
- Potential Treatments are:
  - Crack fill
  - B&G Crack Fill
  - R&S Crack Fill
- Selected Treatment – B&G crack fill based on success of this treatment on other sections of Hwy 16
  - Estimate Cost – 11.8 m crack length x 100 cracks/km x $2/m = $2,360/km (2 lanes and 2 shoulders)
  - Expected Treatment Service Life – 3 years

Example – Segment IRI is Rougher than the Trigger Value

1. Project Segment Description

- Hwy 827:02 Hwy 28 to Thorhild
- km 0.000 to km 14.900
- Existing pavement structure (2004 PMS Summary)
  - 1985 Seal Coat
  - 1984 60 mm ACP
  - 1981 50 mm OB
  - 1981 175 mm SC
- 2004 WAADT = 760 (Traffic Volume, Vehicle Classification and ESALs Statistics Report)



2. IRI Ride Level Trigger – Figure 1

- For AADT = 760, IRI Trigger = 2.6 mm/m

3. Present IRI of Segment (from EBA analysis of AI&T 2003 IRI Data)

- IRI ranges from about 1.3 to 2.6 mm/m based on 1 km averages.
- The average IRI is expected to increase by about 0.1 mm/m/year and most of the segment will reach the target level by the 2007 program year.

4. Existing Overlay Requirement

- Based on the analysis of the of the most recent FWD testing carried out in July 2000 using DARWin 3.1, and estimated 20 year Design ESALs of 0.59×10^6, the 20 year structural overlay requirement is 0 mm. This is not unexpected for a soil cement base pavement structure.

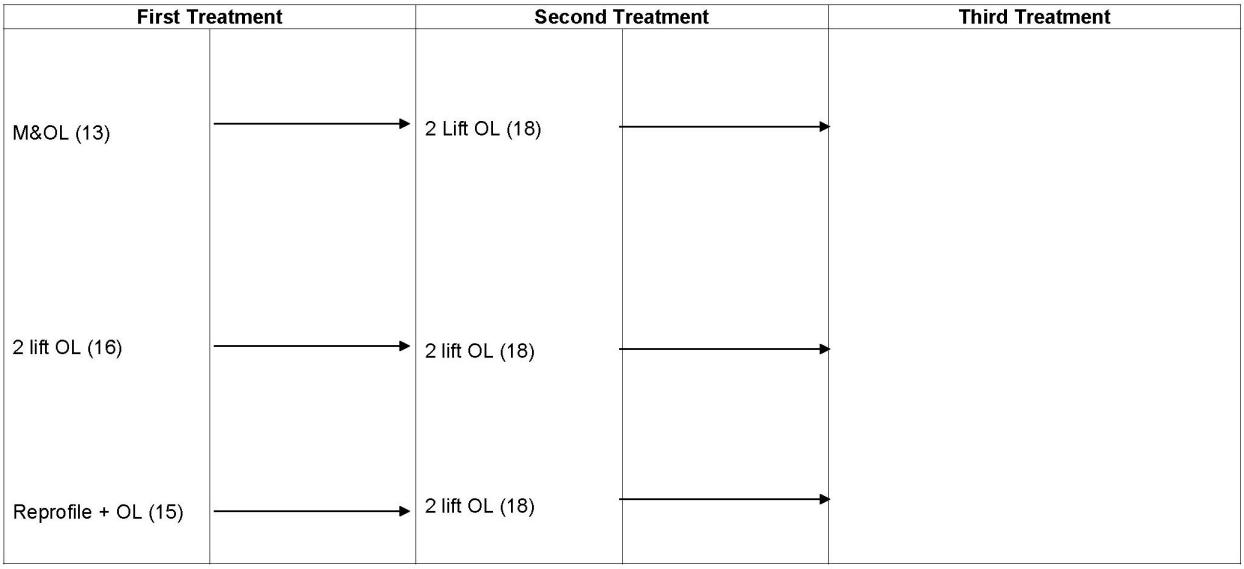
5. Selection of Potential First Treatments and Service Lives

- Preventative Maintenance – This was not considered feasible due to the age of the most recent ACP (20+ years), the high extent of distresses present and extensive investment in past maintenance treatments.
- Thin OL – This was not considered feasible due to the age of the most recent ACP, the existing roughness and high extent of distresses present.
- HIR – This was not considered feasible due to the extensive spray-patching, crack filler and seal coat.
- Mill and Inlay – This was considered a feasible treatment. However due to the condition of the shoulders, this treatment was modified to a full width cold mill (50 mm depth) and full width overlay (50 mm). Based on Figure 4, the service life of this treatment was estimated at 13 years.
- Two Lift OL – A 70 mm two lift overlay was considered feasible. Based on the past performance of this pavement, past AI&T performance experience of overlays of soil cement base pavements, and projected future traffic, and Figure 2, the service life of this treatment was estimated at 18 years.
- Reprofiling and Overlay – This is defined as shallow cold milling (average 20 mm depth) to remove surface distresses and partially re-establish the cross-section of longitudinal profile followed by a 50 mm full width overlay. Based on engineering judgement, and that this treatment provides a net overlay thickness of 30 mm, the service life of this treatment was estimated at 15 years.

6. Selection of Potential Strategies and Service Lives of Subsequent Treatments

- Figure A presents a summary of treatments and strategies identified for LCCA. Within a strategy, a sequence of treatments has been identified to achieve a minimum 30 year life cycle.
- A 70 mm two-lift OL with an estimated service life of 18 years was used as the second treatment for all strategies.

FIGURE A: SUMMARY OF STRATEGIES ASSESSED AND TREATMENT SERVICE LIVES



7. LCCA

- Figure B presents a summary of the LCCA for the selected strategies carried out in accordance with AI&T's Pavement Design Manual. The following information is presented:
  - For each treatment: the description, the estimated service life, unit costs and total costs per km (excluding mob/demob, contingencies and engineering).
  - For each strategy: the sequence of treatments, the cost of Treatment 1 and the Total Present Worth Cost discounted to Year '0'.
  - The strategies are ranked in increasing Total Present Worth Cost.

- The following Table provides a summary of the most cost-effective strategies.

Rank	Treatment 1 (Service Life, yrs)	Initial Cost ($/km)	Total Present Worth Cost of Strategy ($/km)
1	Two-lift OL (18)	75,400	104,900
2	Reprofile + OL (15)	73,200	111,200
3	Mill & OL (13)	83,200	127,200

8. Recommendation

- Two-lift overlay of 70 mm ACP.

FIGURE B: LCCA SUMMARY

COST SUMMARY

LIFE-CYCLE COSTING ANALYSIS CHART 30-YEAR ANALYSIS HWY 827:02 (KM 0.000 to KM 14.900) DISCOUNT RATE 4.0% 20 YR. OVERLAY: <40 mm AVERAGE MIRI: 1.9 mm/m

Hwy 827:02 From Hwy 28 To Hwy 18	
20 YR. Design ESALs:	0.59×10^6
10 YR. Design ESALs:	0.25×10^6

Treatment Table

Treatment	Average Section Width (m)	Section Length (m)	OL Thickness (mm)	Service Life (Years)	Unit Cost ($)	Capital Cost of Treatment ($/km)
Mill & OL (13)	8.7	1000	50	13	*$3.00/m²	$83,200
Two-Lift OL (18)	8.7	1000	70	18	$55.00/tonne	$75,400
Reprofile & OL (15)	8.7	1000	50	15	**$2.00/m²	$73,200

*Unit cost is for milling only, overlay is based on $55.00/tonne
**Unit cost is for reprofiling only, overlay is based on $55.00/tonne
Material Density: 2330kg/m³ Side Slopes: 4:1
All rates are in Year 2006 dollars.

Strategy Summary

Rank	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Capital Cost of Treatment 1 ($/km)	Total P.W. Cost of Strategy Discounted to Year '0' ($/km)
1	Two-Lift OL (18)	Two-Lift OL (18)			$75,400	$104,871
2	Reprofile & OL (15)	Two-Lift OL (18)			$73,200	$111,192
3	Mill & OL (13)	Two-Lift OL (18)			$83,200	$127,191

July 13, 2006