Bituminous Surfacing Guide Part 1.1

Selection of Resurfacing Treatments for Metropolitan Region
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1 INTRODUCTION

This document provides guidance to users in deciding appropriate treatments for asset maintenance purposes applicable to the Metropolitan Region. In time it will be a supplement to Part 1 “Selection of Bituminous Treatments” of the yet to be written document titled “Bituminous Surfacings Guide”. It uses a chart based approach to decide a resurfacing treatment and importantly whether the condition of an asset requires further investigation with the assistance of the Materials Engineering Branch (MEB). It also includes notes on the maintenance of a waterproof seal to protect the pavement asset, methods of minimising the rate and size of reflection cracking, skid resistance and uses worked examples to demonstrate the selection process. This document only provides guidance on the selection of treatments for resurfacing and not for asset improvement.

2 REFERENCED DOCUMENTS

- Main Roads document 6706/04/154 Guidelines for Surfacing Type Selection.
- Main Roads document 71/06/1359 Initial Skid Resistance of Stone Mastic Asphalt.

3 CONTENTS

The document uses the following charts for selecting a treatment based on the existing type of surfacing and the new type of surfacing. This version only includes Charts 1 and 2 whilst Charts 3 to 6 are yet to be developed.

<table>
<thead>
<tr>
<th>Chart</th>
<th>Existing Surface</th>
<th>New Surface</th>
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<tbody>
<tr>
<td>Chart 1</td>
<td>Dense graded asphalt</td>
<td>Dense graded asphalt</td>
</tr>
<tr>
<td>Chart 2</td>
<td>Open graded asphalt</td>
<td>Open graded asphalt</td>
</tr>
<tr>
<td>Chart 3</td>
<td>Seal</td>
<td>Seal</td>
</tr>
<tr>
<td>Chart 4</td>
<td>Seal</td>
<td>Asphalt</td>
</tr>
<tr>
<td>Chart 5</td>
<td>Dense graded asphalt</td>
<td>Seal</td>
</tr>
<tr>
<td>Chart 6</td>
<td>Seal</td>
<td>Microsurfacing</td>
</tr>
</tbody>
</table>

The selection charts will refer to a range of types of treatments. Shown in the next chart is the generic treatment with details such as depth of cold planing, thickness and type of new asphalt to be decided based on criteria used to arrive at a treatment selection.
<table>
<thead>
<tr>
<th>Treatment Type</th>
<th>Treatment</th>
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<tbody>
<tr>
<td>Type 1</td>
<td>GRS + overlay</td>
</tr>
<tr>
<td>Type 2</td>
<td>SAMI seal + overlay</td>
</tr>
<tr>
<td>Type 3</td>
<td>C170 Seal + overlay</td>
</tr>
<tr>
<td>Type 4</td>
<td>Plane + replace</td>
</tr>
<tr>
<td>Type 5</td>
<td>Plane + SAMI seal + replace</td>
</tr>
<tr>
<td>Type 6</td>
<td>Plane + GRS + replace</td>
</tr>
<tr>
<td>Type 7</td>
<td>Plane + C170 seal + replace</td>
</tr>
<tr>
<td>Type 8</td>
<td>Plane + asphalt + seal + asphalt</td>
</tr>
</tbody>
</table>

Type 1 and 2 treatments do not involve cold planing and use crack treatment and overlay. Type 3 and 7 are appropriate where there is no pumping of fines and the cracking extent is low with cracks <1mm in width.

Type 7 is used where there is a real risk that cold planing will expose the basecourse in areas because it is not practical to effectively apply a SAMI seal on to a basecourse. Type 5 and 6 treatments involve partial or complete removal of the wearing course and replacement, at the same or a different road profile.

A Type 8 treatment should only be used where it is not possible or practical to replace the existing asphalt to the same profile without damaging the waterproofing seal. This treatment creates a support layer for a new seal but it does require the placement of at least 60mm or 80mm in thickness of asphalt which could lead to premature fatigue failure of the asphalt wearing course. A Type 8 treatment should only be used in small areas and where there are large areas requiring a Type 8 treatment consideration should be given to amending the proposed works to the full width of a carriageway to facilitate a change in the finished level of the wearing course.

4 SUPPORTING NOTES

These notes only apply to the use of Charts 1 and 2 to replace dense graded asphalt (DGA) or open graded asphalt (OGA) with the same surfacing.

4.1 Waterproofing of Pavements

Granular pavement materials in-situ generally achieve optimal strength when they are well compacted and are kept within a low moisture environment. As the moisture content within a pavement increases the strength of the granular pavement materials reduces and may get to a point where the pavement does not have sufficient strength to support traffic without distress in the pavement.

Waterproofing seals on granular pavement materials are thin layers of a bituminous binder with cover aggregate. Because the layer of binder is thin the surface on to which a waterproofing seal is applied must be as smooth and uniform as possible to ensure the binder is spread in a thin film of consistent thickness. Any form of surface texture will result in pools of binder in low spots and potentially no binder on the high areas. Inconsistency in the binder film has the potential to allow surface water to penetrate through the waterproofing seal and into the pavement layers thus weakening the pavement.

All wearing course asphalt on the Metropolitan network is permeable, ie. water is able to move through the asphalt layer, therefore an effective waterproofing seal is required below the wearing course. Comments on the types of wearing course are:
- Open graded asphalt (OGA) is highly permeable and quickly drains water away from the road surface. The typical treatment below OGA is a layer of 10mm sized DGA and a seal below the DGA.
- Stone Mastic Asphalt (SMA) is relatively permeable and requires very good waterproofing underneath.
- DGA is permeable and water is able to migrate through the asphalt. It is commonly accepted that DGA is relatively impermeable with an in-situ air void content of less than 6.5%, however in Perth the DGA is compacted with an in-situ air void content of 8-12%. Therefore it is critical to have an effective waterproofing seal below DGA.

Most resurfacing works involve removal of the existing asphalt because of its poor condition and because the road surface needs to be maintained at its existing profile. Therefore at times removal of the existing asphalt will compromise the waterproofing seal below the existing asphalt where the asphalt is relatively thin. This is typical on newer roads such as Reid Highway (Mirrabooka Ave to Erindale Rd) where there is only one layer of asphalt over a seal in comparison to older roads such as Canning and Albany Highways where there can be multiple layers of asphalt over a seal. Where the seal is damaged by cold planing and the base course exposed the surface of the base may be left in a chiselled shape (more likely for BSL and gravel) from the cold planing whereas the surface of rock base will be loosened and uneven.

It is important at this point to recognise how to reinstate the waterproofing seal. In most instances it is not practical to rework a base course to achieve its original surface condition. Where significant lengths are exposed or the damage is uneven with deep gouges it may be necessary to use a Type 8 treatment to mill out the top of the base and lay a first layer of DGA for a new seal over which the final wearing course layer of DGA is placed.

Where there are only isolated pockets of exposed base with the remainder of the seal intact then it is more practical to cover the exposed base with a new seal. In this situation only Class 170 bitumen should be sprayed directly on to an exposed base course. An emulsion binder is not practical in this situation as it will take too long to achieve sufficient strength to not be damaged by asphalting works. Rubber or polymer modified binders are too viscous and are not suitable for application to an exposed basecourse.

Where there is concern that profiling may result in exposure of the base course a program of coring should be undertaken to establish the thickness of the existing asphalt layer(s) and whether there is a seal under the asphalt. It is difficult to change to a Type 8 treatment without advance preparation/programming, ie. this decision has to be made before the works commence. As stated in Section 3 a Type 8 treatment should only be used in small areas and where there are large areas requiring a Type 8 treatment consideration should be given to amending the proposed works to the full width of a carriageway to facilitate a change in the finished level of the wearing course.

Charts 1-1 and 1-2 in the selection process for DGA replacing DGA drive the selection of treatment type based on the average thickness of the existing asphalt. For example on Chart 1-2 where the profile cannot change at an intersection there are three options for the treatment:

- **≤45mm Type 8 or 7** – in this scenario removal of 40mm of the existing asphalt is most likely to expose much of the base as thickness varies about an average value. The treatments are to use two layers of asphalt and a new seal where the thickness is likely to be less than 40mm and between 40 and 45mm thickness a C170 bitumen seal may be an option. The extent and severity of cracking will influence the need for a SAMI seal and hence a Type 8 treatment.
- **45-55mm Type 7 or 5** - in this scenario removal of 45-50mm of the existing asphalt is likely to expose some of the base and a C170 seal is an option whereas a Type 5 treatment using a SAMI seal with PMB is not suitable for application on to an exposed base.
- >55mm Type 5 - in this scenario removal of up to 55mm of the existing asphalt is unlikely to expose any of the base and a Type 5 treatment using a SAMI seal with PMB is low risk.

4.2 Management of Cracking

When placing new asphalt any cracking in the substrate will reflect through the new asphalt, regardless of the type of cracking, therefore a SAMI seal or GRS is required to alleviate the rate and size of reflection cracking in the new asphalt. SAMI seals will not stop reflection cracking in the long term but will alleviate the rate and size of reflection cracking. SAMI seals are effective for cracking with a width less than 1mm. On the other hand a GRS in the long term will stop most cracking from reflecting through new asphalt unless there are other factors affecting the asphalt such as an extremely weak pavement causing fatigue failure in the asphalt on top of the GRS. Where the base course is Hydrated Cement Treated Crushed Rock Base a GRS shall be applied except at sites with high vehicle stresses such as traffic controlled intersections, small radius curves like ramps or steep grades such as Greenmount Hill and Bedordale Hill. For these sites discuss options for management of cracking with MEB. For other types of granular base course materials where there is significant ravelling or cracking early in the life of the OGA, say after 6-7 years, use a GRS to manage cracking otherwise if the OGA is older a SAMI seal may suffice.

A C170 bitumen has very limited capability in managing reflection cracking and should not be used where management of cracking is an issue. C170 seals should not be placed under asphalt in high stress sites such as intersections with heavy vehicles as the C170 bitumen is far less viscous than a PMB or rubber binder and more prone to bleed up into the asphalt and result in deformation (rutting) of the asphalt.

Where a cracked layer of asphalt is removed by cold planing there is no guarantee that all of the affected asphalt has been removed or that the condition (cracking) of any underlying layers of asphalt or the base course layer is okay. Therefore it is recommended that even if all of the cracked asphalt is to be removed it is worthwhile to apply a SAMI seal below the new asphalt. Where only part of a cracked layer is removed application of a SAMI seal or GRS is mandatory.

Where new asphalt is to be placed over existing asphalt without cold planing sometimes sections of cracked asphalt is removed by cold planing and replaced with new asphalt as a patch as preparatory work. In this scenario it is highly likely that the existing asphalt may crack under the new asphalt and hence a SAMI seal or GRS is mandatory.

4.3 Traffic Considerations

As discussed in Section 3.5 traffic has a significant impact on the performance of asphalt and hence consideration needs to be given when deciding the type of asphalt for a location. For example intersection mix is used from the beginning of the turn pocket or 100m back from the stop line at the approach to signal controlled intersections (whichever is the greater), and a nominal 20-30m on the departure side, to cope with extra stresses from vehicles braking and accelerating. The biggest stresses are from vehicles coming to a stop and starting especially trucks, quite often manifesting as rutting. For intersections consider traffic queuing in particular in peak periods to see the length of the queue and importantly the type of vehicles in the queue. If large volumes of light vehicles or a mix of heavy vehicles is queuing beyond the intersection mix consider extending the length of the intersection mix or using a PMB in the asphalt beyond the extent of the intersection mix.

Where traffic controlled intersections are close together consider using intersection mix for the entire length between the traffic lights. Examples of this scenario include Great Eastern Hwy at Rivervale with the lights for each on and off ramp of Orrong Rd and Wanneroo Rd near Dog Swamp shopping centre.
4.4 Surface Texture, Skid Resistance and Noise

4.4.1 Asphalt Surfacings

DGA and SMA have low surface textures in comparison to OGA. DGA has a surface texture of about 0.5-0.6mm for new 10mm DGA and 0.7-0.9mm for new 14mm DGA that increases with time as traffic wears the sand fractions from the surface of the asphalt thus exposing more of the shape of the larger sized stones in the asphalt. Older 10mm DGA may have a surface texture of 0.9-1mm whilst 14mm DGA may have a texture of up to 1.4mm. SMA has an initial texture of 1.4mm for 10mm SMA and 0.8-0.9mm for 7mm SMA however the texture decreases in the first few years and then increases after that up to 1.5mm. OGA has an initial texture of 3.5-3.8mm which decreases with time to 1.5-2mm.

The greater the surface texture the more able an average vehicle tyre is of displacing water from below the tyre. On OGA surfaces the water is pushed downwards and displaced sideways. For DGA the water is displaced mainly behind the tyre as a function of the tyre treads. On new DGA it is possible to see the tread pattern of a tyre as it displaces water and as the asphalt ages and develops texture this is less obvious.

Guidance on the impact of surface texture and skid resistance on the selection of a road surfacing is available in Main Roads document 6706/04/154 Guidelines for Surfacing Type Selection. SMA has lower skid resistance in the first months after placement and in some sites may require the addition of a surface grit to improve skid resistance during its early life. Guidance on the early life skid resistance of SMA is available in Main Roads document 71/06/1359 Initial Skid Resistance of Stone Mastic Asphalt.

Laterite DGA is used on bus lanes, medians and non trafficked shoulders as a nominal 10mm sized asphalt. Laterite DGA must never be used for general traffic lanes as it may not provide the same level of skid resistance as that provided by granite aggregates. Similarly a 5/7mm laterite DGA is used on shared paths and must never be used for any on road applications including medians or shoulders. Guidance on Laterite asphalt is available in Engineering Road Note 12 Laterite (Red Coloured) Asphalt.

4.4.2 Seals

Sprayed seals provide good skid resistance if surface texture is maintained. Where a seal has a flush surface typically in the wheelpaths skid resistance is reduced and the excess bitumen should be removed.

4.4.3 Microsurfacing

Microsurfacing has an initial surface texture of 1.4-1.5mm that drops over the first few years and then rises again as the microsurfacing ages and loses sand fractions from the surface. At times microsurfacing can develop a flush surface or spots of flushing. Significant areas of flushing should be removed as they may reduce skid resistance.

4.4.4 Noise

Vehicles generate noise either from sound pressure coming from tyres moving along a surface or from other sources such as the engine, exhaust and transmission of the vehicle. This section will deal with tyre/road noise of various surfacings. Basically the faster a vehicle drives the greater the tyre/road noise and at slow speeds (60 km/hr and less) most of the noise comes from the vehicle itself as opposed to the road/tyre noise. The merits of noise properties for each type of surfacing are listed below from the most noise to a lesser amount of noise at the bottom.

- 14mm or 14/7mm seal – there is no discernible difference from the roadside between a single/single seal or double/double seal. For a driver the double/double seal seems to be less noisy within the vehicle.
- 10mm seal – marginally quieter from the roadside and quieter within the vehicle.
- Microsurfacing – more quiet than a seal but noisier than DGA. It does provide a more comfortable ride for the driver.
- DGA and 10mm SMA – most noisy asphalt surface but quieter than microsurfacing or seals. These surfacings generate high levels of water spray particularly at high vehicle speeds. Therefore 10mm SMA is not recommended for high volume high speed roads such as freeways, parts of Roe Highway or Reid Highway.
- 7mm SMA – more quiet than DGA and 10mm SMA but noisier than OGA. It also generates high levels of water spray particularly at high vehicle speeds which means it is not recommended for high volume high speed roads such as freeways, parts of Roe or Reid Highways.
- OGA – quietest road surfacing placed by Main Roads. Used on freeways and high volume highways plus roads where demand for skid resistance is high such as Greenmount Hill. OGA generates low levels of water spray from vehicles at high speeds.

4.5 Modified Binders

4.5.1 Asphalt Grades

A polymer modified binder (PMB) is typically Class 170 bitumen that has been modified by incorporating a polymer to enhance the properties of the bitumen. PMBs require manufacture at a facility that will ensure the polymer is completely integrated into the bitumen and is stable for transport and storage. PMBs require extra care in handling, storage and require enhanced work practices in manufacturing and placing asphalt with a PMB. These constraints, along with the extra cost of PMB, means it should only be used on a needs basis.

PMB can provide an improvement in the following properties of asphalt:

- Better resistance to deformation (rutting)
- Improved resistance to fatigue failure
- Improved aggregate retention in OGA and SMA
- Resistance to high stresses such as turning trucks
- Increase the stiffness of intermediate course in a full depth asphalt pavement.

There are two groupings of PMB, those with an elastomeric polymer and those made with a plastomeric polymer. For asphalt resurfacing works only elastomeric type PMB shall be used which will be A15E for dense graded asphalt (DGA). For open graded (OGA) or stone mastic asphalt (SMA) an A20E binder shall be used at all times. A plastomeric binder is A35P which should never be used for resurfacing works and is only used in full depth asphalt pavements where specified by MEB.

Guidance on the use of PMB is shown in Section 4.5.2. As a general rule A15E should not be used for all applications of DGA. Reasons for this can include:

- PMB makes the asphalt less workable so it needs to be used in warm to hot conditions. When used during cooler weather it may be difficult to achieve optimal compaction. If A15E needs to be used in cooler weather a Warm Mix Additive (eg. Sasobit) shall be added to the binder in accordance with Specification 504.
- PMB properties will degrade if left unused in a storage tank between smaller sized projects using the PMB. Degradation in properties of the PMB could have a negative influence on the performance of the asphalt. Where projects require PMB it would be wise to make the paving works within the project consecutive so the use of PMB is continuous. If this is not practical then consider using PMB for the paving works not requiring PMB to ensure continuous use of PMB.
4.5.2 Asphalt Applications

(a) Rutting

Rutting usually occurs in DGA but can occur in SMA and typically happens due to low in situ air voids in the asphalt causing instability. When DGA is laid it has average in situ air void content of 7 to 11% and over the years, reduces by about 3% with traffic compaction. However in very heavy traffic environments, with say trucks stopping at traffic lights, this reduction in void content may be greater. Rutting is more prevalent in newer asphalt with lower air voids whilst older asphalt with lower air voids is stiffer than new asphalt due to ageing of the bitumen and hence more resistant to rutting. A typical mode of rutting can be binder from a SAMI seal or Class 170 seal bleeding into new asphalt and causing instability.

The use of A15E improves the resistance of DGA to rutting however when the in situ air voids become very low (about 3% or less) even PMB modified asphalt may become unstable. Rutting typically occurs at the approach to and exit from traffic controlled intersections or roundabouts especially where there are numerous heavy truck movements. Examples of the use of PMB include:

Where to Use

- Roe/GEH Bypass intersection
- Leach Hwy signalised intersections
- GNH/West Swan Rd
- Thomas Rd/Melville Mandurah Hwy

Where Not Necessary

- Canning Hwy/North Lake Rd intersection
- Karrinyup Morley Hwy/Camboon Rd intersection
- Stirling Hwy/Eric St intersection
- South St/Karel Ave intersection

(b) Resistance to Fatigue Failure

The classic mode of failure here is when the pavement does not have adequate strength or stiffness to support the asphalt wearing course and under cumulative traffic loading excessive strain builds up in the asphalt and it cracks. Another mode can be where fatigue failure occurs within the base course layer of the pavement and as it cracks it may also crack the seal and the asphalt with moisture then entering the pavement which gets weaker and the asphalt may suffer from fatigue failure. In some cases an A15E binder is used to extend the life of the wearing course where the pavement may have insufficient strength to support an asphalt wearing course manufactured with normal bitumen.

It is impossible to provide guidance using traffic scenarios because the primary driver is the strength of the pavement and in particular the base course. Asphalt in a car park can suffer from fatigue failure if the base is very wet yet there is typically only light traffic in a car park. In general the greater the traffic loading and the slower heavy vehicles are moving the greater the risk of fatigue failure in asphalt when placed on a granular pavement. On a full depth asphalt pavement fatigue failure should not occur in the wearing course.

Where there is evidence of fatigue failure in the existing asphalt, typically occurring as crocodile cracking in the wheelpath areas, this would be an indicator that A15E could be useful in new DGA. In this scenario Chart 1 in the selection process would guide you to seek advice from MEB. For OGA Chart 2 guides you to applying a GRS.
(c) High Stress Sites

An increasing mode of failure is diagonal or crescent cracking within turning areas of intersections. This is caused by shearing from multiple truck axle groups. The A15E binder will provide resistance to the development of cracks due to shear forces within turning areas. Examples of the use of PMB include:

Where to Use

- All intersections where there are numerous heavy truck movements such as Roe/GEH Bypass and Leach Hwy/Stock Rd
- Tonkin Hwy Northbound Abernethy Rd off ramp (loop ramp)
- Roundabouts with heavy trucks such as the Eelup rotary at Bunbury
- Loop ramps at interchanges, eg. GEH/Roe Hwy

Where Not Necessary

Intersections with only light vehicles or service trucks without multiple axle groups such as the South St/Karel Ave intersection.

5 SELECTION PROCESS

The region’s resurfacing strategy “Resurfacing Strategy – Metropolitan Region” should be consulted when considering the resurfacing type appropriate to the subject site.

5.1 Chart 1 – Replacing Dense Graded Asphalt with the Same

Proceed to Chart 1 in Appendix A where the decision making process commences. The primary drivers for decision making on Chart 1 are cracking of the asphalt and whether it has lost shape through rutting and shoving. The outcomes of Chart 1 are referral to Charts 1-1 and 1-2 or to MEB to investigate. Although there appears to be many referrals to MEB these are the extreme scenarios where further guidance or investigation is required whilst most cases should fall into Charts 1-1 and 1-2.

Guidance on types of cracks in road surfaces and rutting and shoving is available in the Austroads document Guide to Pavement Technology Part 5 Pavement Evaluation and Treatment Design.

Chart 1-1 provides guidance where the existing asphalt is suffering from deformation that may include rutting and/or shoving of asphalt. Chart 1-2 provides guidance where DGA is cracked, with the drivers for decision making being whether the existing profile or height of the asphalt can change, whether the asphalt is in a midblock or intersection traffic environment and then the thickness of the existing asphalt. If the existing asphalt has both rutting and cracking use Chart 1-2 but keep in mind that the full depth of the rutted asphalt needs to be removed.

5.2 Chart 2 – Replacing Open Graded Asphalt with the Same

Proceed to Chart 2 in Appendix A where the decision making process commences. The primary drivers for decision making on Chart 2 are ravelling and cracking of the asphalt. The outcomes of Chart 2 are applying a SAMI seal or GRS, enrichment or to do nothing.

Guidance on ravelling and the types of cracks in road surfaces is available in the Austroads document Guide to Pavement Technology Part 5 Pavement Evaluation and Treatment Design.
6 WORKED EXAMPLES

6.1 Example 1 – Canning Highway Mid Block

<table>
<thead>
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<tbody>
<tr>
<td>Road</td>
<td>Canning Hwy</td>
</tr>
<tr>
<td>Site Specifics</td>
<td>Mid block with traffic close to speed limit</td>
</tr>
<tr>
<td>Width of work</td>
<td>Carriageway (2 lanes)</td>
</tr>
<tr>
<td>Existing Surface</td>
<td>10mm Dense Graded Asphalt</td>
</tr>
<tr>
<td>Asphalt thickness</td>
<td>Mainly 1 layer of 30mm thickness</td>
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<tr>
<td>Age of wearing course asphalt</td>
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<tr>
<td>Traffic volume and type</td>
<td>40,000 AADT mainly comprised of light vehicles</td>
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<tr>
<td>Speed limit</td>
<td>60 km/hr</td>
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<tr>
<td>Profile of road</td>
<td>The existing profile can increase in height</td>
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<td>Adjacent land use</td>
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<table>
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<tr>
<th>Condition of Road</th>
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<tbody>
<tr>
<td>Cracking type, location and</td>
<td>Block cracking (CB) across the lane width of both lanes, no</td>
</tr>
<tr>
<td>extent</td>
<td>pumping of fines, not pronounced in the wheelpaths. Infrequent</td>
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<td></td>
<td>crocodile cracking (CR) in some wheelpaths.</td>
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<tr>
<td>Rutting</td>
<td>None</td>
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<tr>
<td>Shape</td>
<td>Good</td>
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<tr>
<td>Ravelling</td>
<td>None</td>
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Discussion of Conditions

Road profile – all asphalt is permeable to some extent so it is important that there be at a minimum a waterproofing layer underneath the lowest layer of asphalt to protect the granular or asphalt pavement from the ingress of moisture. Water will cause a loss of strength in a granular pavement resulting in pavement weakening and failure. In an asphalt pavement water entering the lower layers of asphalt can cause stripping of the bitumen off the aggregate particles. Thus it is critical that the existing seal be maintained in an undisturbed condition, or if it is removed, that a new seal be reinstated. When cold planing work goes into a granular basecourse it will leave the surface of the base with a textured and uneven surface finish and the application of a seal to such a surface will not provide total waterproofing of the pavement. At times the application of a corrector layer of dense graded asphalt may be required to create an even, low textured substrate suitable for the application of a waterproof seal. Similarly it is important that moisture does not enter the pavement through existing cracks or new cracks that may form in any residual aged asphalt left in a resurfacing treatment.
Cold Planing - Cold planing needs to be done at a target depth to ensure the existing seal is not damaged. The target depth should be less than the minimum thickness where depths are known from taking core samples or 10mm less than the nominal thickness for the type of asphalt where thickness has not been verified. Where there are two layers of existing asphalt then this allows the removal of sufficient asphalt to accommodate a layer of new asphalt and any seal. This also facilitates a treatment being applied to a single lane only without the need to use a second layer of asphalt as a foundation for a waterproofing seal.

In this example the asphalt is quite thin at 30mm such that if all of the asphalt was removed a significant proportion of the basecourse will be exposed. However this road allows for a change in profile so removal of none or only some of the existing asphalt is necessary, thus overcoming the likelihood of exposing the basecourse.

Cracking – the presence of cracking may indicate amongst other things cracking due to aged asphalt, reflection of cracks from underlying asphalt or basecourse layers, fatigue of the asphalt due to inadequate support from the pavement or cracking of construction joints.

In this scenario block cracking is occurring across the width of the lane. Block cracking can be caused by cracking in aged asphalt, cracking in underlying cemented materials such as a basecourse or an early sign of fatigue cracking due to inadequate support from the pavement, although the latter is usually associated with traffic loading and may only occur in the wheelpath areas as block cracking before developing into crocodile cracking.

The lack of pumping of fines usually indicates the cracking is not coming from an underlying layer, as in this scenario, and when taken into account that this asphalt is very old it can be assumed that the block cracking is fatigue of aged asphalt. In undertaking any treatment any residue of the existing asphalt will reflect the cracks through to the new asphalt. Therefore a SAMI seal or GRS needs to be used to alleviate the rate and size of reflection cracking in the new asphalt.

Other Factors – there is no rutting and the general shape of the surface appears to be good. These do not indicate any issues with the performance of the pavement in general and provide further evidence that the problem is likely just a surfacing matter.

Types of Asphalt

A 10mm DGA has been chosen as the new wearing course because it is a mid block scenario not requiring a heavy duty mix and the speed zone is 60km/hr so a high textured asphalt such as SMA or OGA is not required. If traffic is queuing back on to the mid block mix with stop/start traffic consideration could be given to extending 14mm Intersection mix further back from an intersection or using a modified binder such as A15E within the 10mm DGA. This decision will be driven by issues on site with the extra thickness of 14mm mix and the amount of heavy duty mix required if the bulk of the work uses just 10mm DGA. Similarly if intersections are close together consider laying the 14mm Intersection mix continuously between the two or more intersections.

A 7mm SMA could be used for this site as it is suitable for paving at 30mm thick, provides a quieter surface for drivers and has better fatigue resistance than DGA. However SMA costs at least 30% more than DGA and unless there are factors that suggest the performance of DGA may be impacted it is unlikely that the extra cost of the SMA is warranted.

Options for Resurfacing

1) TYPE 5 - Cold plane off 20mm of asphalt full width, apply a SAMI seal and place 30mm of 10mm DGA
2) TYPE 2 - apply a SAMI seal and place 30mm of 10mm DGA full width.
Pros and Cons

1) Type 2 Treatment

This overcomes a need to cold plane the road which is a small cost saving but does have the advantage of speeding up the resurfacing works by only having to do two operations, sealing and asphalt, saving time on profiling and sweeping. If the cracks are greater than 1mm in width this will make it more difficult for a SAMI seal binder to reduce the impact of reflection cracking. In this situation the larger cracks should be crack patched well before the resurfacing works OR cold planing needs to be done to remove the larger cracks and place new asphalt as patches.

Another consideration for this option is whether there is sufficient kerb height to accommodate an increase in road height of approx 40mm. Similar the impact of the new profile has to be considered for drainage structures, pedestrian crossing points and bus stops where PTA disability guidelines require a minimum of 150mm kerb height has to be available.

2) Type 5 Treatment

This treatment has the advantage that it keeps the road profile closer to the existing but not at the same level. The cold planing thickness has been limited to 20mm to maintain the waterproof seal below the existing asphalt and to leave a serviceable thickness of asphalt after cold planing that is less likely to break up under construction or public traffic. This means that the new profile will be upwards of 15mm higher than the existing due to the thickness of the asphalt and seal. Consideration will need to be taken of the kerb height and impact on drainage or other structures in or on the edge of the road. The other advantage of cold planing is that cracks usually reduce in width the deeper down in a wearing course. This means that a SAMI seal will perform better in limiting reflection cracking.

6.2 Example 2 – Leach Highway

<table>
<thead>
<tr>
<th>Road Details</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Road</td>
<td>Leach Hwy</td>
</tr>
<tr>
<td>Site Specifics</td>
<td>Mid block with traffic close to speed limit</td>
</tr>
<tr>
<td>Width of work</td>
<td>1 lane (lane carrying most truck traffic)</td>
</tr>
<tr>
<td>Existing surface</td>
<td>10mm Dense Graded Asphalt</td>
</tr>
<tr>
<td>Asphalt thickness</td>
<td>2 layers of 60mm total thickness</td>
</tr>
<tr>
<td>Age of wearing course asphalt</td>
<td>Old</td>
</tr>
<tr>
<td>Traffic volume and type</td>
<td>60,000 AADT with high proportion of large trucks</td>
</tr>
<tr>
<td>Speed limit</td>
<td>80 km/hr</td>
</tr>
<tr>
<td>Profile of road</td>
<td>The existing profile must remain the same (say within 10mm)</td>
</tr>
<tr>
<td>Adjacent land use</td>
<td>Industrial area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Condition of Road</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cracking type, location and extent</td>
<td>Crocodile cracking (CC) in wheelpaths, limited cracking outside of wheelpath areas, no pumping of fines.</td>
</tr>
<tr>
<td>Rutting</td>
<td>None</td>
</tr>
<tr>
<td>Shape</td>
<td>Good</td>
</tr>
<tr>
<td>Ravelling</td>
<td>None</td>
</tr>
</tbody>
</table>
Discussion of Conditions

Road profile – all asphalt is permeable to some extent so it is important that there be at a minimum a waterproofing layer underneath the lowest layer of asphalt to protect the granular or asphalt pavement from the ingress of moisture. Water will cause a loss of strength in a granular pavement resulting in pavement weakening and failure. In an asphalt pavement water entering the lower layers of asphalt will cause stripping of the bitumen off the aggregate particles. Thus it is critical that the existing seal be maintained in an undisturbed condition or if it is removed that a new seal be reinstated. When cold planing work goes into a granular basecourse it will leave the surface of the base with a textured and uneven surface finish. The application of a seal to such a surface will not provide total waterproofing of the pavement. In such circumstances the application of a corrector layer of dense graded asphalt will be required to create an even low textured substrate suitable for the application of a waterproof seal. Similarly it is important that moisture does not enter the pavement through existing cracks or new cracks that may form in any residual aged asphalt left in a resurfacing treatment.

Cold Planing - Cold planing needs to be done a target depth to ensure the existing seal is not damaged. The target depth should be less than the minimum asphalt thickness where depths are known from taking core samples or 10mm less than the nominal thickness for the type of asphalt where the thickness has not been verified. Where there are two layers of existing asphalt then this allows the removal of sufficient asphalt to accommodate a layer of new asphalt and any seal. This also facilitates a treatment being applied to a single lane only without the need to use a second layer of asphalt as a foundation for a waterproofing seal. In this example the asphalt is 60mm thick which facilitates replacement with up to 40mm of asphalt plus a SAMI seal or GRS leaving at least 10mm of the existing asphalt undisturbed.

Cracking – the cracking in the wheel paths may be due to amongst other things cracking due to aged asphalt, reflection of cracks from underlying asphalt and fatigue of the asphalt due to insufficient support from the pavement. The lack of pumping could suggest the seal under the lowest layer of asphalt is intact and has not cracked.

Taking into account that this asphalt is old it is likely that the cracking is due to the age of the asphalt or reflection cracking due to age related cracking of the lowest layer of asphalt. If the cracking was due to fatigue failure of the asphalt due to insufficient support from the pavement expect to see a loss of shape and some loss of waterproofing, ie. pumping of fines due to ingress of moisture.

In undertaking any treatment any residue of the existing asphalt will reflect cracks through to the new asphalt. Therefore a SAMI seal or GRS needs to be used to alleviate the rate and size of reflection cracking in the new asphalt. Because of the presence of crocodile cracking it is recommended that a GRS be used.

To ensure that the condition of the remnant of the older asphalt does not contribute to failure of the new asphalt coring needs to be undertaken to verify that the lowest layer of asphalt is in reasonable condition to support a new layer of asphalt.

Other Factors – there is no rutting and the general shape of the surface appears to be good. These do not indicate any issues with the performance of the pavement in general and provide further evidence that the problem is limited to the surfacing.
Types of Asphalt

A 10mm DGA has been chosen as the new wearing course because it is a mid-block scenario not requiring a heavy duty mix and the speed zone is 80 km/hr so a high textured asphalt such as SMA or OGA is not required. If traffic is queuing back on to the mid-block mix with stop/start traffic consideration could be given to extending 14mm Intersection mix further back from an intersection or using a modified binder such as A15E within the 10mm DGA. This decision will be driven by issues on site with the extra thickness of 14mm mix and the amount of heavy duty mix required if the bulk of the work uses just 10mm DGA. Similarly if intersections are close together consider laying the 14mm Intersection mix continuously between the two or more intersections.

Options For Resurfacing

Chart 1 shows that where there is no loss in shape and there is cracking, there is no pumping and the asphalt is more than 8 years in age that we go to Chart 1.2. On Chart 1.2 for midblock and >45mm in thickness of existing asphalt a Type 5 or 6 treatment is suggested. Discussion of the impact of cracking indicates that a GRS should be used so use a Type 6 treatment.

1) TYPE 6 - Cold plane off 40mm of asphalt, apply a Geotextile Reinforced Seal, apply an asphalt tack coat and place 30mm of 10mm DGA modified with A15E; OR
2) TYPE 6 - Cold plane off 50mm of asphalt, apply a Geotextile Reinforced Seal, apply an asphalt tack coat and place 40mm of 14mm Intersection Mix. Use an A15E binder if the mix is laid in a high stress area.

Pros And Cons

1) Option 1

Removal of only 40mm of the existing asphalt ensures the cold planing work is well away from the underlying seal which is assumed to be intact. The GRS provides optimal performance in managing reflection cracking that is most likely to occur from the lowest layer of older asphalt. The modified binder provides improved resistance to rutting and fatigue cracking from heavy vehicles especially where there may be vehicle queuing on to the 10mm DGA.

2) Option 2

The extra depth of cold planing should leave sufficient thickness of the older asphalt such that the underlying seal is untouched. However if the lowest layer of asphalt is in poor condition it could be removed during the cold planing process. Intersection mix performs better with respect to resistance to rutting than 10mm DGA so Option 2 does not include the use of A15E binder. The cost of Option 2 will be higher with a greater depth of cold planing and more asphalt depth.

7 APPENDICES

<table>
<thead>
<tr>
<th>Appendix</th>
<th>Title</th>
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<tbody>
<tr>
<td>Appendix 1</td>
<td>Selection Process Charts</td>
</tr>
</tbody>
</table>
Appendix 1: Selection Process Charts
Chart 1: Resurfacing existing DGA with new DGA

- **Loss of shape and cracking**
  - Investigate (MEB)

- **Loss of shape no cracking**
  - Rutting and Shoving
    - Rutting only
      - Investigate (MEB)
  - Chart 1.1

- **Cracking with no shape loss**
  - Pumping
    - Wheelpath only
      - Investigate (MEB)
  - Lane width
    - < 8 years old
      - Investigate (MEB)
    - > 8 years old
      - Chart 1.2
  - No pumping
    - < 8 years old
      - Investigate (MEB)
    - > 8 years old
      - Chart 1.2
Chart 1.1: Repair of asphalt deformation

Asphalt > 4 years old
- Remove shoving by cold planing
  - Midblock:
    - < 30mm: Type 8 (Note 1)
    - > 30mm: Type 7 or 5 (Note 2)
  - Intersection:
    - < 40mm: Type 8
    - > 40mm: Type 5 (Note 2)

Asphalt < 4 Years old
- Location of new asphalt
  - Total thickness of asphalt:
    - < 30mm
    - > 30mm

Note 1 – the use of a Type 8 treatment should be limited, refer to notes in Sections 3 and 4 of the guide

Note 2 – where a SAMI seal is below the asphalt being removed and the SAMI is to be removed use a Type 5 treatment. Where the asphalt can be removed without disturbing the SAMI seal a Type 4 treatment can be used
Chart 1.2: Resurfacing of cracked DGA

Profile can change

Intersection

- ≤ 40mm → Type 2 or 5
- > 40mm → Type 5

Midblock

- ≤ 30mm → Type 1, 2, 5 or 6
- > 30mm → Type 5 or 6

Profile can't change

Intersection

- 45 - 55 mm → Type 7 or 5
- > 55mm → Type 5
- ≤ 45 mm → Type 8 or 7 (Note 1 on Chart 1.1)

Midblock

- 35 - 45 mm → Type 7 or 5
- > 45 mm → Type 5 or 6
- ≤ 35 mm → Type 8 or 7 (Note 1 on Chart 1.1)
Chart 2: Resurfacing existing OGA with new OGA

- **Ravelling**
  - No cracks
    - Isolated Stone Loss from Wheelpaths
      - OGA < 6 yrs old
        - Enrichment (refer to MEB for advice)
      - OGA > 6 yrs old
        - Do Nothing
  - Significant Stone Loss
    - Type 5 or 6 (Note)
  - Transverse or Longitudinal Cracking
    - Type 5 or 6 (Note)
  - Crocodile Cracking
    - Investigate (MEB)

- **No Ravelling**
  - No cracks OR Isolated Transverse or Longitudinal Cracks - no pumping
    - Do Nothing
  - All other cracking
    - as per Ravelling and Cracking above

Note – Refer to notes in Section 4.2 of the guide