LG TRRIP
Local Government Transport & Roads
Research & Innovation Program

LG TRRIP practitioners' guidelines

WA Local Government practitioners' guideline for the use of CRMB in sprayed seal applications

Welcome

About LG TRRIP

LG TRRIP

The Local Government Transport and Roads Research and Innovation Program is a joint initiative between WALGA and Main Roads Western Australia.

LG TRRIP seeks to provide collaborative research that positively contributes to the design, construction and maintenance of safe, sustainable transport infrastructure for local government in Western Australia.

Meet the team

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Principal Professional
Safer Smarter Infrastructure – NTRO

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Policy Manager Transport and Roads
WALGA

Our purpose

The objective of the program is to achieve better implementation of innovative practice by improving the specialist capability of local government through a collaborative program of projects which deliver advanced technology, cost effective and practical solutions.

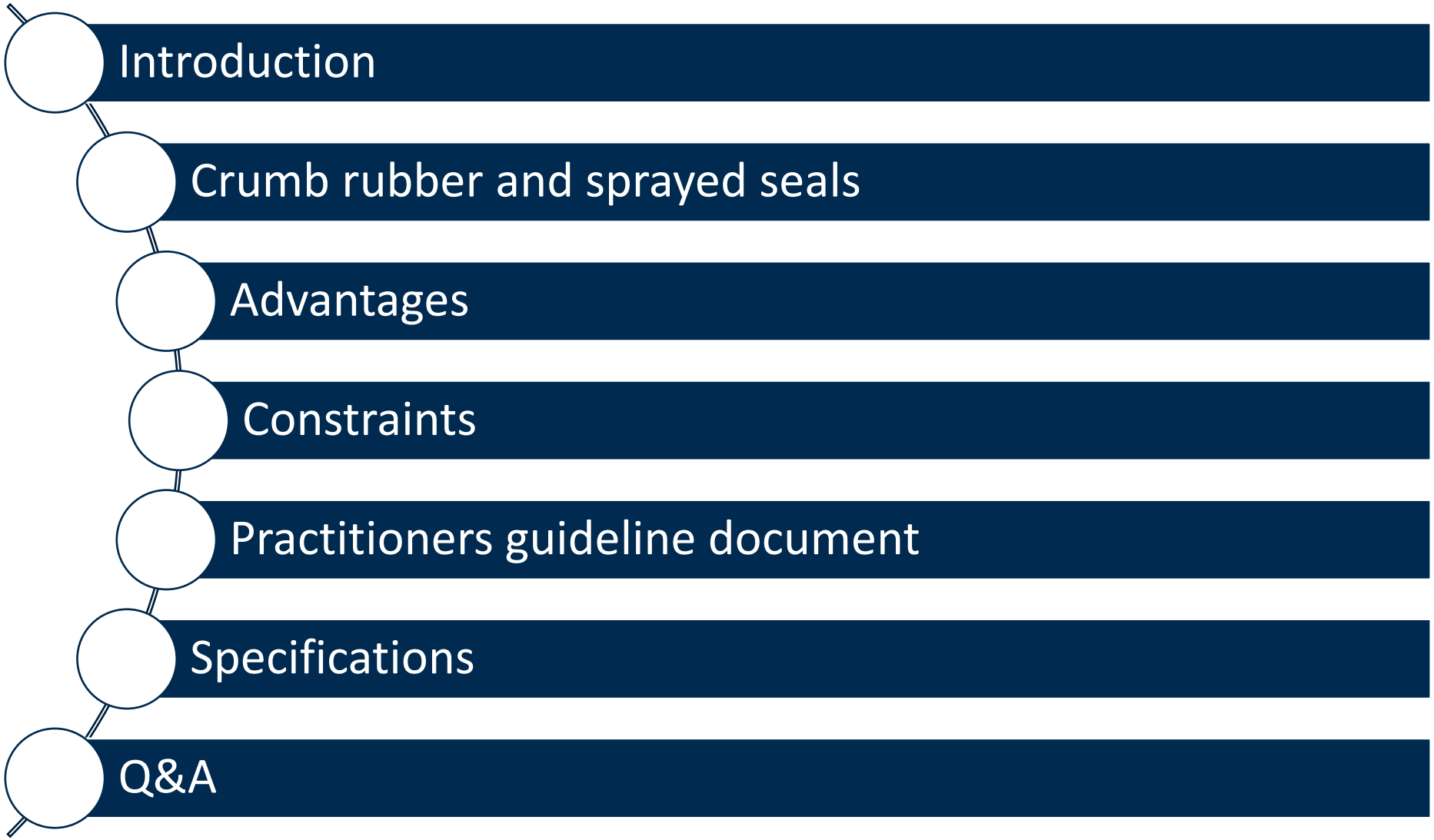
Overview of our projects

- **NTRO was engaged by WALGA and MRWA to develop a series of practitioners' guidelines**
- **Projects in progress**
  - Crumb rubber in sprayed seals
  - CRMB in asphalt
  - Road data collection technologies
- **Completed projects**
  - Crushed recycled concrete
  - RAP in asphalt
  - Catalogue of standard pavement profiles
  - Rural low-cost LG safety treatments
  - Guide for seal upgrade
  - Sustainable construction

WALGA: Western Australian Local Government Association

MRWA: Main Roads Western Australia

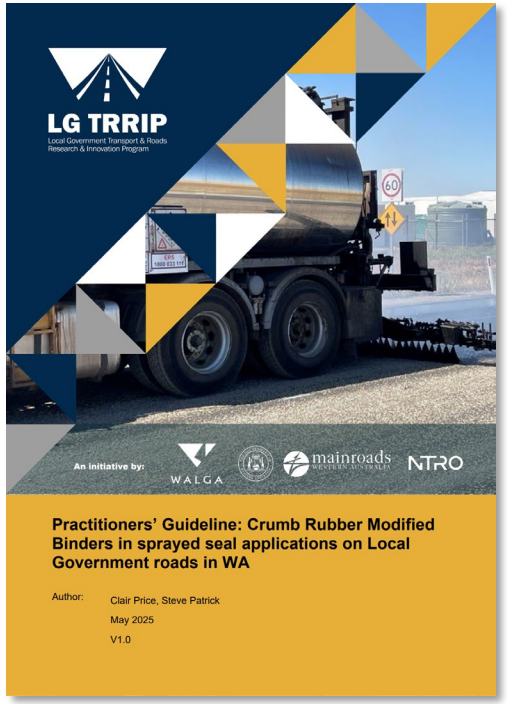
Agenda


Introduction
Crumb rubber and sprayed seals
Advantages
Constraints
Practitioners guideline document
Specifications
Q&A

Introduction

Project objectives

- **The project objectives**
  - develop guidelines with the view to facilitate the adoption of recycled content in WA local government roads where practicable
  - provide a simple reference to appropriate specifications for use
- **This project has developed**
  - a technical basis report
  - a practitioners' guideline for CRMB in sprayed seals
- **This session**
  - share the project outcomes and key learnings
  - introduce the guidelines



CRMB: Crumb rubber modified binders

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Technical Report

Use of crumb rubber modified binders in spray seals

Deliverables

- **Technical basis report**
  - Literature review
  - Stakeholder engagement
    - Survey
    - Workshop
    - Interviews
- **Practitioners' guidelines**
- **Dissemination**

Stakeholder engagement

- **Stakeholder engagement undertaken via survey, workshop and individual interviews**
- **Aimed to understand:**
  - current usage, including types of projects, specifications used, technology used,
  - barriers and challenges to use,
  - existing knowledge and capacity,
  - focus points for guidance.

Stakeholder engagement

- **Findings:**
  - Around 60% of respondents had experience with CRMB sprayed seals
    - Mostly using ‘plant’ blends, not field produced
    - Majority relying on contractors for design
  - Modest familiarity with relevant specifications
  - Barriers reported included:
    - Perceived lack of expertise
    - Issues with supply chain and logistics
    - Insufficient guidance for implementation

Crumb rubber and sprayed seals

Overview

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What is a sprayed seal?

- A sprayed seal is a road surfacing treatment consisting of a layer(s) of sprayed bitumen and crushed aggregate.
- Commonly used in Australia for low-cost construction and maintenance.
- Essential for cost-effective road construction due to vast distances between population centers.
- Effective for roads with significant traffic volumes.
- Crucial for maintaining connectivity in remote areas.

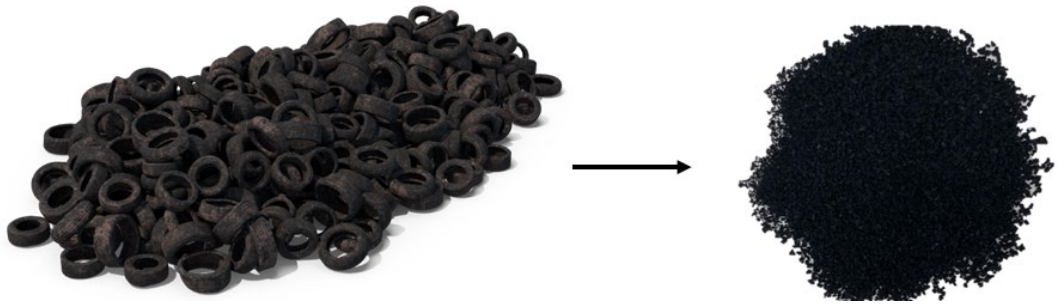
Overview

What is CRMB sprayed seal?

- A sprayed seal surfacing with bituminous binder modified with crumb rubber, and covered with crushed aggregate.
- Incorporating or crumb rubber improves the binder's properties.
- Enhances the binder's ability to adhere to the aggregate, especially in high-stress areas.
- Modified binder can be used to create thicker and more flexible membranes.
  - Provides better protection against water infiltration.
- Minimises the reflection of cracks on the road surface.

The materials

- **Crumb rubber**
  - derived from end-of-life (EoL) rubber products
  - EoL tyre recovery rate nationally is approximately 58%
  - removal of textile fires and steel,
    shredded and crumbed at ambient temperature
  - sourced sustainably from accredited suppliers



Plant or field blended?

PLANT BLENDING

FIELD BLENDING

Binders

- **Plant-manufactured: blended remotely, prior to being used in road construction**
- **Field-produced: blending bitumen and crumb rubber immediately prior to their use in road construction**

- **Recognised CRMB grades:**
  - Plant produced – S9R, S15R.
  - Field produced – S9RF, S15RF, S18RF.

Plant or field?

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Case-by-base assessment will determine the best option

- **Plant manufactured**
  - Requires transport to site
    - Management to avoid segregation
  - Numerous suppliers in WA
- **Field produced**
  - Limited/no storage required
  - Allows production flexibility
  - Requires space for specialised equipment
  - Requires labour and time onsite
  - Volume of production required to justify set-up of plant

Advantages

Advantages

- **Practitioners' guideline encourages use of CRMB for all sprayed seal applications, depending on logistical and economic factors.**
  - CRMB offers environmental, performance, and economic benefits for sprayed seals.
  - Crumb rubber is recycled, supporting circular economy outcomes.
  - Improves performance characteristics of bitumen.
  - Can be used in both low stress and high stress sprayed seals.

Environmental

- **Conversion of EoL tyres into crumb rubber diverts waste from landfill.**
  - Reduces health risks such as vermin, mosquito-borne diseases, and toxic fires.
  - Prevents environmental degradation and loss of visual amenity.
- **Use of crumb rubber in sprayed seals reduces demand for virgin materials and environmental impact.**
- **Addition of crumb rubber to bitumen has a neutral effect on embodied emissions, unlike other polymers which increase emissions.**

Performance

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CRMB Advantage
• Increasing elasticity providing resistance to shear stresses (turning movements) • Higher softening point than conventional bitumen, providing reduced susceptibility to flushing in hot climates • Increasing cohesion and aggregate retention properties • Improving crack resistance in pavements.
• Assists aggregate retention on roads with high traffic volumes. Improves road durability.
• Mitigates environmental cracking. • Reduces traffic-induced cracking propagation at a rapid rate but with low severity.

Economic

- **Crumb rubber binders are typically more expensive than unmodified bitumen.**
- **Initial higher costs are offset by long-term maintenance savings and better road performance.**
- **Studies have shown:**
  - crumb rubber binders 30% more expensive, increasing construction costs by 10%.
  - Crumb rubber may extend seal life by up to 50%, offsetting initial costs.

Constraints

Constraints

“Tramlining” - Achieving uniform binder distribution

- **A commonly reported fault with spraying CRMBs has been longitudinal streaking of the sprayed binder, often referred to as ‘tramlining’, where the sprayed bituminous binder resembles sheets of corrugated iron.**

- **Solutions**
  - Control Binder Viscosity: Viscosity decreases with temperature increase; cutter oil can temporarily reduce viscosity.
  - Spraying Width: Limit bitumen sprayers to single lanes (approx. 4 m) instead of full width (approx. 8 m).
  - Sprayer Nozzles: Larger output nozzles preferred for CRMBs to enhance performance and reduce blockage risk.
    - MRWA Specifications: CRMBs must be sprayed with large capacity A27 or B36 nozzles

Constraints

Transport over long distances - Segregation

- Crumb rubber binders may be susceptible to segregation of the bitumen and crumb rubber components (where the crumb rubber particles settle at the bottom of a tanker or bitumen sprayer) if stored at high temperatures for long periods, such as during transport over long distances

Solutions

- Equip storage tanks or trucks with augers, paddles, or piping to circulate and agitate the blended binder to prevent segregation.
- For long transport distances, field blended CRMB may be more suitable than fixed plant manufacturing

Constraints

Transport over long distances - Degradation

- Crumb rubber binders can degrade when stored for extended periods at high temperatures, predominantly due to dissolution of the rubber particles in the bitumen, and devulcanisation

►Solutions

- Limit storage time between binder manufacture and use to address degradation.
- Store/transport binder at the lowest practicable temperature.
- Suppliers of plant-produced CRMBs should advise on agitation conditions during transport to avoid segregation.
- For long transport distances, field blended CRMB may be more suitable than fixed plant manufacturing.

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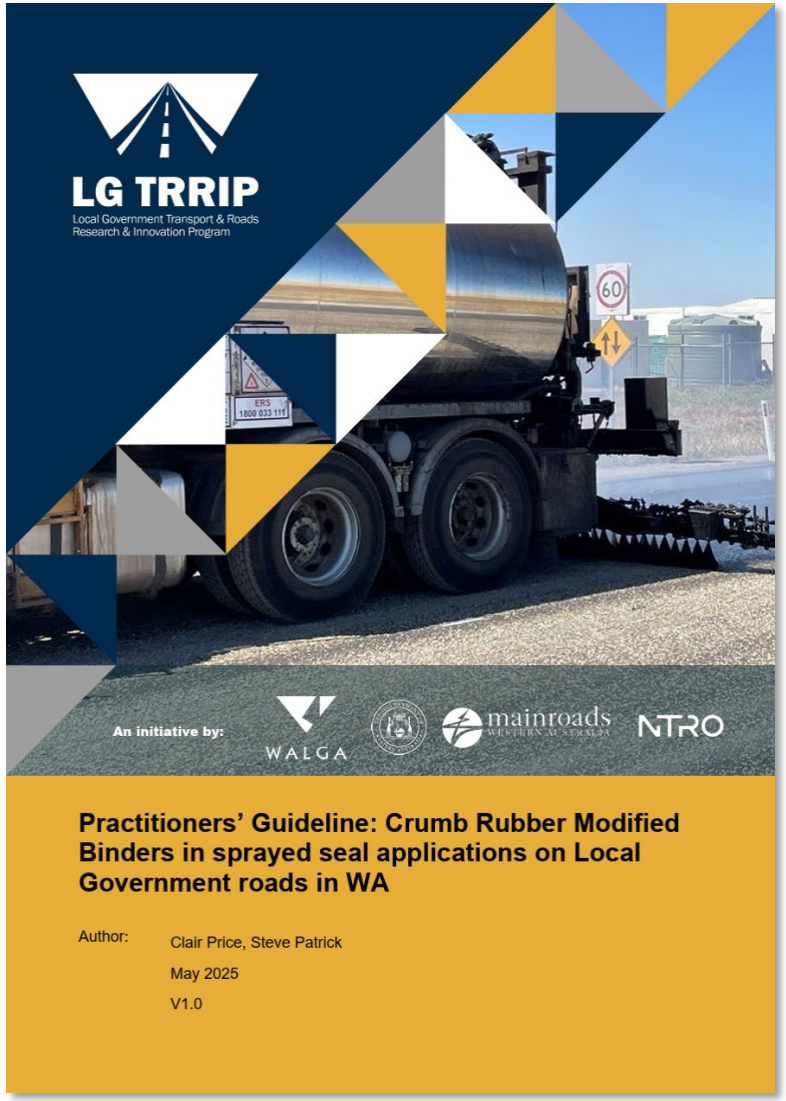
Practitioners' guideline

Use of crumb rubber modified binders in spray seals

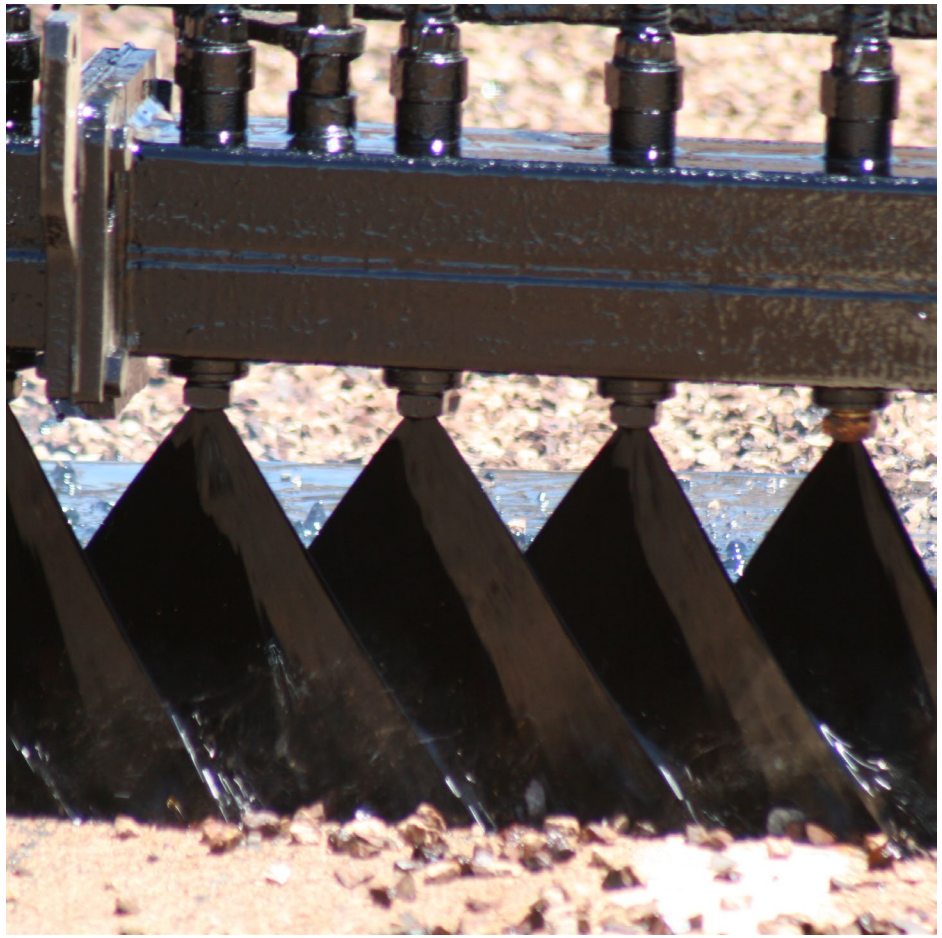
Practitioners guideline

- **Purpose:**
  - Practical information on selecting and constructing crumb rubber bitumen (CRMB) sprayed seals.
  - Targeted for Western Australian Local Government roads.
  - To be used with local and national standards (Austroads, AfPA, IPWEA).
  - Aims to help Local Governments make informed decisions on CRMB use.
  - Provides guidance on supervising operational crews for CRMB sealing works.



Purpose and background

- **Descriptions of sprayed seals**
  - Field/plant blending
  - Layers/structure
- **Advantages**
  - Elasticity
  - Improved temperature susceptibility
  - Aggregate retention
  - Crack mitigation



Scoping a CRMB project

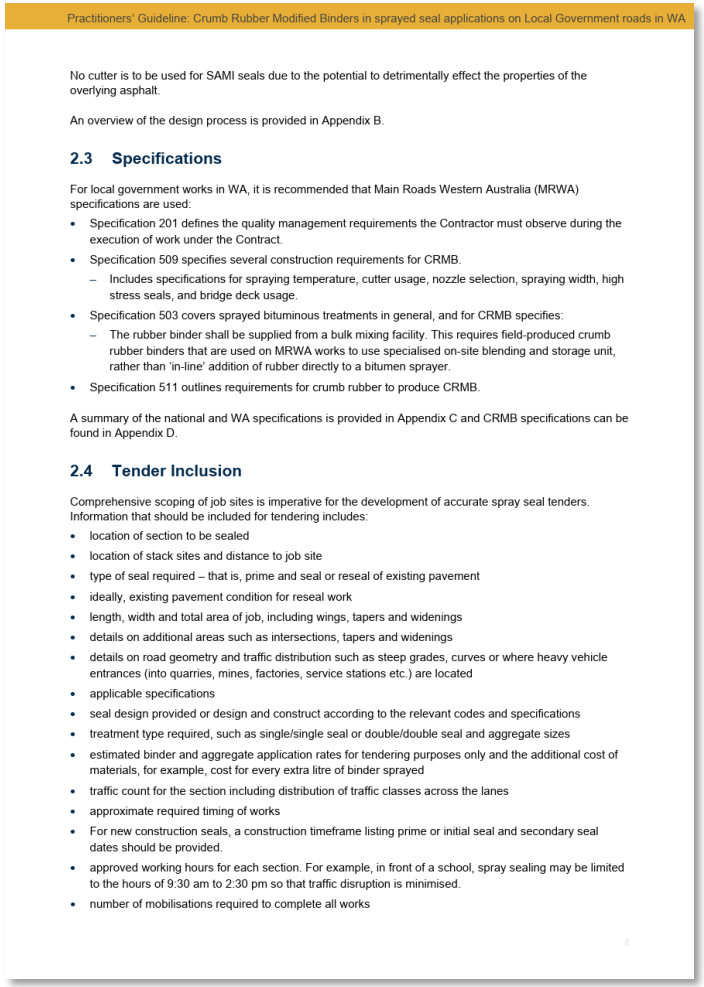
- **Details on where to use and how to select projects suitable for CRMB**
- **Guidance on parameters to consider**
  - Existing condition of road surface (for reseals)
  - Condition of surface (for new construction
  - Practicality of treatment type
  - Cost and Scope size
  - Traffic Logistics
  - Social & Environmental factors

Designing CRMB sprayed seals

- **Typically designed by contractor or specialist consultant.**
- **Procedures follow national guidance - Austroads**
- **Design based on binder application and aggregate spread rates for standard bitumen.**
  - Adjustment of binder factor needed for crumb rubber binders.
- **Binder selection influences necessary application rate.**
  - Polymer modified binders, including crumb rubber, are thicker, more flexible, and applied at higher rates for better performance.

Tendering guidance

- **Comprehensive scoping of job sites is imperative for the development of accurate spray seal tenders.**
- **Guidance included for:**
  - Information to include in tenders
  - Evaluating responses
  - Navigating specifications



No cutter is to be used for SAMI seals due to the potential to detrimentally effect the properties of the overlying asphalt.

An overview of the design process is provided in Appendix B.

2.3 Specifications

For local government works in WA, it is recommended that Main Roads Western Australia (MRWA) specifications are used:

- Specification 201 defines the quality management requirements the Contractor must observe during the execution of work under the Contract.
- Specification 509 specifies several construction requirements for CRMB.
  - Includes specifications for spraying temperature, cutter usage, nozzle selection, spraying width, high stress seals, and bridge deck usage.
- Specification 503 covers sprayed bituminous treatments in general, and for CRMB specifies:
  - The rubber binder shall be supplied from a bulk mixing facility. This requires field-produced crumb rubber binders that are used on MRWA works to use specialised on-site blending and storage unit, rather than 'in-line' addition of rubber directly to a bitumen sprayer.
- Specification 511 outlines requirements for crumb rubber to produce CRMB.

A summary of the national and WA specifications is provided in Appendix C and CRMB specifications can be found in Appendix D.

2.4 Tender Inclusion

Comprehensive scoping of job sites is imperative for the development of accurate spray seal tenders. Information that should be included for tendering includes:

- location of section to be sealed
- location of stack sites and distance to job site
- type of seal required – that is, prime and seal or reseal of existing pavement
- ideally, existing pavement condition for reseal work
- length, width and total area of job, including wings, tapers and widenings
- details on additional areas such as intersections, tapers and widenings
- details on road geometry and traffic distribution such as steep grades, curves or where heavy vehicle entrances (into quarries, mines, factories, service stations etc.) are located
- applicable specifications
- seal design provided or design and construct according to the relevant codes and specifications
- treatment type required, such as single/single seal or double/double seal and aggregate sizes
- estimated binder and aggregate application rates for tendering purposes only and the additional cost of materials, for example, cost for every extra litre of binder sprayed
- traffic count for the section including distribution of traffic classes across the lanes
- approximate required timing of works
- For new construction seals, a construction timeframe listing prime or initial seal and secondary seal dates should be provided.
- approved working hours for each section. For example, in front of a school, spray sealing may be limited to the hours of 9:30 am to 2:30 pm so that traffic disruption is minimised.
- number of mobilisations required to complete all works

Constraints

- **Collation of information regarding:**
  - Achieving uniform binder distribution.
  - Transport over long distances
    - Risk of segregation.
  - Transport over long distances – risk of degradation.
  - Safety considerations
  - Climatic conditions

Table 3: Constraints for CRMB application and potential solutions

Constraint	Description	Potential solution
'Tramlining' - Achieving uniform binder distribution	A commonly reported fault with spraying CRMBs has been longitudinal streaking of the sprayed binder, often referred to as 'tramlining', where the sprayed bituminous binder resembles sheets of corrugated iron.	Control binder viscosity – Binder viscosity is directly affected by its temperature (viscosity reduces as temperature increases), and cutter oil can be added to temporarily reduce viscosity. Specification 509 requires that bitumen sprayers spray at a maximum width of 4.0 m, due to the capacity of the sprayers pumps). Sprayer nozzles – Larger output nozzles are sometimes preferred for CRMBs, because they are perceived to provide better performance and present less risk of blockages due to the larger sized nozzle outlet. Specification 509 requires that CRMBs must be sprayed with A27 or B36 nozzles. .
Transport over long distances – Segregation	Crumb rubber binders may be susceptible to segregation of the bitumen and crumb rubber components (where the crumb rubber particles settle at the bottom of a tanker or bitumen sprayer) if stored at high temperatures for long periods, such as during transport over long distances.	When transporting CRMBs over long distances, it is highly important that adequate measures are taken to ensure that segregation does not occur. Suppliers of plant-produced CRMBs are expected to advise on required conditions for agitating the binder during transport to avoid segregation. Crumb rubber binder segregation issues can be addressed by equipping storage tanks or trucks with augers or paddles, or piping to circulate the binder, which agitates the blended binder. Where long transport distances are required from a fixed plant, field-blended CRMB may be a more suitable manufacturing method.
Transport over long distances – Degradation	Crumb rubber binders can degrade when stored for extended periods at high temperatures, predominantly due to dissolution of the rubber particles in the bitumen, and devulcanisation.	Degradation can be addressed by limiting the storage time between binder manufacture and use, and/or storing/transporting the binder at the lowest practicable temperature. This is predominantly due to dissolution of the rubber particles in the bitumen and devulcanisation (a process that reverses the vulcanisation of rubber, which is the cross-linking of rubber molecules with sulphur or other agents to improve its strength and elasticity) of the crumb rubber. Suppliers of plant-produced CRMBs are expected to advise on required conditions for agitating the binder during transport to avoid segregation. Where long transport distances are required from a fixed plant, field-blended CRMB may be a more suitable manufacturing method. AfPA Advisory Note 7 *Guide to the heating and storage of binders for sprayed sealing* provides a general guide to heating temperatures and storage times of bituminous binders used in sprayed sealing applications.
Climatic conditions	The successful application of crumb rubber binders in sprayed seals can depend on the climatic conditions during construction.	Specification 509 requires that the surface to be sealed shall be dry and no binder shall be applied during wet or rainy conditions, or when adverse weather conditions may prevail at any time during such work. When binder is applied and rain is forecast during the 24 hour period after application of the seal the Contractor shall be responsible for any damage to or defects in the seal and action and cost to maintain or repair the seal. No binder shall be applied whilst the pavement surface temperature is less than 20 °C. Seals constructed in winter with high proportions of cutter and likely to flush with the onset of warmer weather.
Safety considerations	To minimise the risk of burns, handling of both plant- and field-blended CRMB should be in accordance with the Austroads *Bituminous Materials Safety Guide* (Austroads 2015) in conjunction with each company's work health and safety management system, complementing standard operating procedures (SOP) and safe work method statements (SWMS).	

Distilled key information

- **Product descriptions**
  - Terminology, applications, treatments
- **Crumb rubber sources**
- **Design overview**
- **Specification overviews**
  - Lists of key documents
  - Overview of requirements/specification limits
  - Cutter rates
- **Plant and field blending procedures**

Specifications

Specifications

- **It is recommended that MRWA specifications are used:**
  - Specification 201 – defines the quality management requirements the Contractor must observe during the execution of work under the Contract.
  - Specification 509 – specifies several construction requirements for CRMB
  - Specification 503 – covers sprayed bituminous treatments in general, and specifically for CRMB specifies:
    - *"The rubber binder shall be supplied from a bulk mixing facility. This requires field produced crumb rubber binders that are used on MRWA works to use specialised on-site blending and storage unit, rather than 'in-line' addition of rubber directly to a bitumen sprayer".*
  - Specification 511 – outlines requirements for crumb rubber to produce CRMB.

Specifications

- **Specifications implement controls to achieve quality outcomes**
  - spray bar widths are limited to 4.0 m
    - high viscosity of CRMB makes pumps in sprayers work very hard
  - CRMB are sprayed at 190 to 200 °C
  - cutter oil rates are supplied
  - higher capacity nozzles to be used on spray bars

Specifications

- **Austroads (national body of state road agencies)**
  - ATS 3110 Supply of polymer modified binders
    - Sprayed sealing binder properties (S9R, S15R, S9RF, S15RF, S18RF)
  - AGPT04K Guide to Pavement Technology: Selection and design of sprayed seals
    - Historical background
    - Operational environments
    - Selection
    - Design
    - Construction procedures

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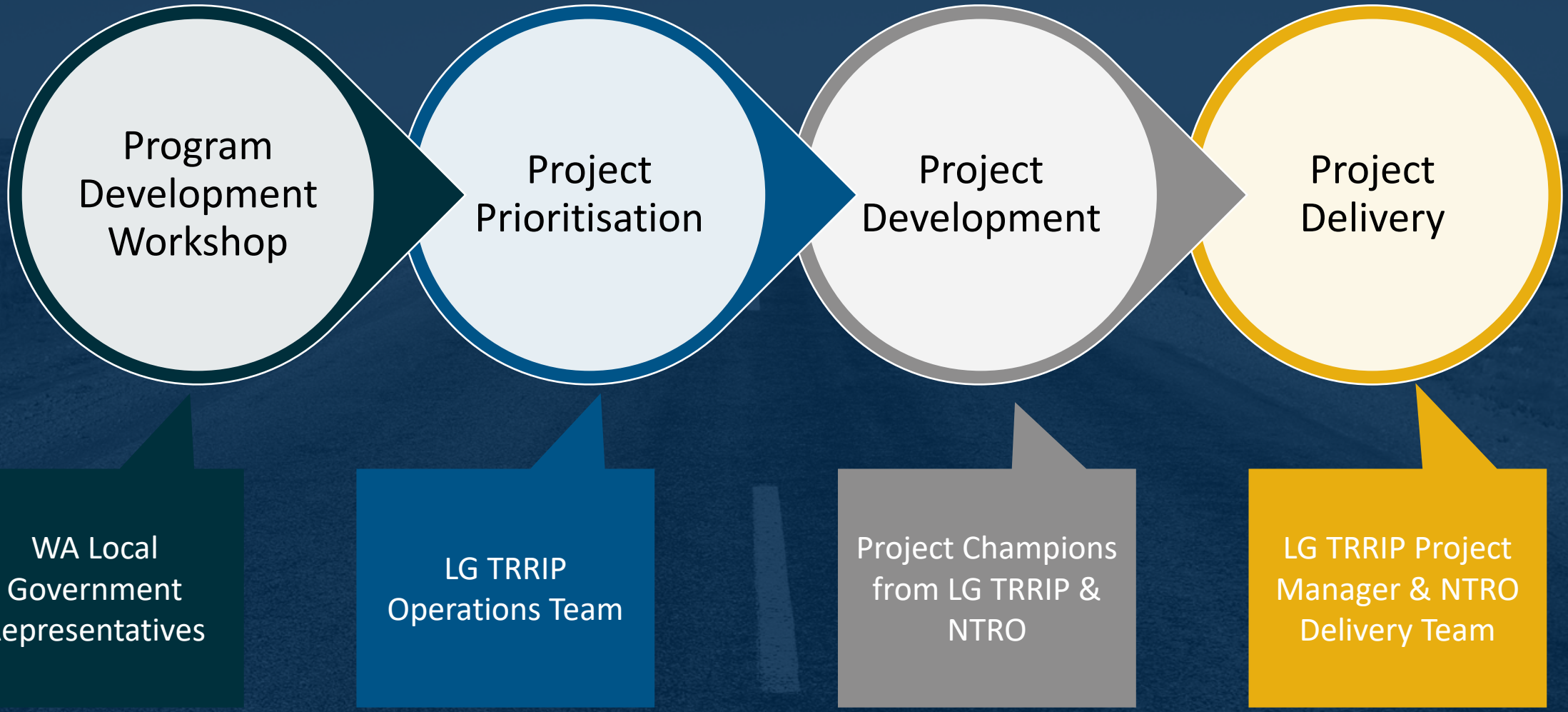
Thank you!

Questions?

Program Development



How to get involved

Find out more on our websites

- https://warrip.com.au/lg-trrip/
- https://walga.asn.au/policy-and-advocacy/our-policy-areas/infrastructure/resources/lg-trrip

Nominate projects and get involved:

- https://warrip.com.au/lg-trrip/