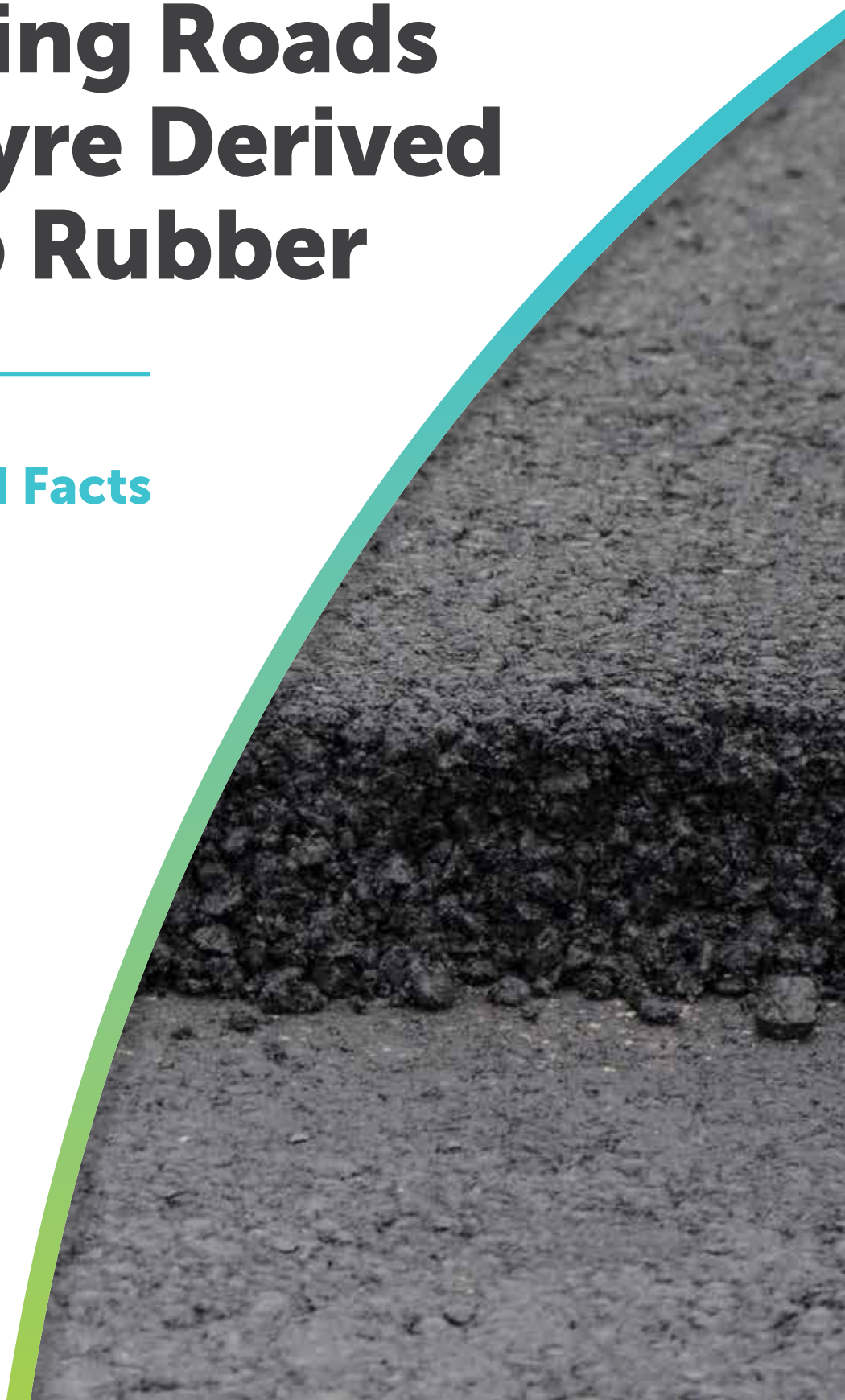
TSA Driving sustainable outcomes for end-of-life tyres

TyreStewardship AUSTRALIA

The Benefits of Surfacing Roads with Tyre Derived Crumb Rubber

Findings and Facts



Australian Government Accredited Product Stewardship Scheme

The Benefits of Surfacing Roads with Tyre Derived Crumb Rubber

Findings and Facts

Second Report

September 2024

Publication

This Report was first published in 2022. This fact sheet provides an update in the series and a snapshot of the initiatives and the activities of Tyre Stewardship Australia (TSA) in relation to use of tyre derived crumb rubber in road surfacing applications. It also provides attributes, statistics, linkages, and references to the various projects funded by TSA on the use of crumb rubber modified bitumen and asphalt in road surfacing applications.

Environment

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Acknowledgement

Tyre Stewardship Australia acknowledges the Traditional Custodians of the land and waterways on which we live, work, and depend. We acknowledge the unique spiritual and cultural connection, and continuing aspiration that the Traditional Owners have for Country, and we pay respect to Elders, past, present, and emerging.

TyreStewardship AUSTRALIA

Contents

Acronyms

Acronym	Description
ARRB	Australian Road Research Board
BZ	Benzothiazole
CRMA	Crumb Rubber Modified Asphalt
CRMB	Crumb Rubber Modified Bitumen
CRM-RAP	Crumb Rubber Modified Recycled Asphalt Pavement
DGA	Dense Graded Asphalt
DOT	Department of Transport Victoria
DTMR	Department of Transport and Main Roads, QLD
EPU	Equivalent Passenger Unit
GGA	Gap Graded Asphalt
GHG	Greenhouse Gas
LCA	Life Cycle Assessment
MRWA	Main Roads Western Australia
NACOE	National Asset Centre of Excellence
OGA	Open Graded Asphalt
PMB	Polymer Modified Bitumen
PAHs	Polycyclic Aromatic Hydrocarbons
RAP	Recycled Asphalt Pavement
SSROC	Southern Sydney Regional Organisation of Councils
TSA	Tyre Stewardship Australia
TSPs	Total Suspended Particulates
VOCs	Volatile Organic Compounds
WARRIP	West Australian Road Research Innovation Program

Glossary

Crumb rubber
A refined rubber product, typically less than 1 mm in diameter, made from recycled tyres.

Crumb rubber modified asphalt
A type of asphalt pavement mix that incorporates crumb rubber to enhance durability, flexibility, and resistance to cracking, while promoting sustainability.

Crumb rubber modified bitumen
A type of bituminous binder enhanced with crumb rubber to improve its elasticity, temperature resistance, and durability, making it more effective for road construction and maintenance.

Dense graded asphalt
An asphalt mix with a well-distributed range of aggregate sizes, designed to provide a compact, smooth, and durable surface with minimal voids, offering strength and resistance to deformation.

Disposal
The dumping, landfilling, direct incineration, unsustainable burning, and stockpiling as an end point of used tyres.

Dry process
Involves adding crumb rubber directly to the aggregate before mixing it with bitumen, where the rubber acts as part of the aggregate structure rather than modifying the binder.

End-of-life tyre
A tyre that is deemed no longer capable of performing the function for which it was originally made.

Equivalent passenger unit/EPU
One EPU contains as much rubber and other materials as a 'typical' passenger tyre. The assumed weight of one new EPU is taken to be 9.5 kg and one end-of-life EPU is taken to be 8 kg.

Gap graded asphalt
An asphalt mix with missing or limited intermediate-sized aggregate particles, designed to create an open structure that enhances flexibility, resistance to deformation, and reduced cracking.

Life cycle assessment
A methodology for quantifying the environmental impacts of a product or service over the course of its entire life.

Open graded asphalt
An asphalt mix with a high proportion of voids between the aggregates, designed to improve drainage, reduce noise, and minimize water spray on road surfaces.

Recycled asphalt pavement
A reclaimed asphalt material from old roads that is processed and reused in new asphalt mixtures, reducing waste and conserving resources in road construction

Recycled/recovered tyres
Used tyres that are collected and either reused, recycled or repurposed either in Australia, or overseas.

Sprayed seal
A road surface treatment where a layer of bitumen is sprayed onto the pavement and covered with aggregate to provide a protective, durable, and skid-resistant surface.

Tyre Stewardship Australia
The entity created to administer The Tyre Product Stewardship Scheme.

Wet process
Involves blending recycled crumb rubber with hot bitumen before mixing it with aggregates, allowing the rubber to react and modify the binder for improved elasticity, durability, and performance in pavements.

Introduction

1

Crumb rubber, derived from end-of-life tyres, has been used in road surfacing applications since 1975, with its first use in Victoria. Progressively, crumb rubber was then used in NSW and Western Australia. Recently the uptake has spread nation-wide, including an increase in the diversity of road surfacing applications that can utilise crumb rubber.

Since its inception in 2014, Tyre Stewardship Australia (TSA) has played an important part in better understanding the sustainability and performance value contributed by the use of crumb rubber. Various projects supported by TSA in creating demand by overcoming barriers, demonstrating benefits, and enabling supply, have been instrumental in this regard.

Create demand

- Research & Development into use and benefit
- Specification alteration and creation

Demonstrate benefit

State authorities:

- Department of Transport VIC
- Transport and Main Roads QLD
- Main Roads WA

Local Government:

- Logan City Council
- City of Mitcham
- Southern Sydney Regional Organisation of Councils

Enable supply

- Infrastructure procurement
- Supply chain sustainability

Through investment, we've made impact

1.1

Over the last ten years, TSA has committed over $10 million towards projects that drive sustainable outcomes for Australia's used tyres. Over $7 million alone was committed to road related projects, and research and development.

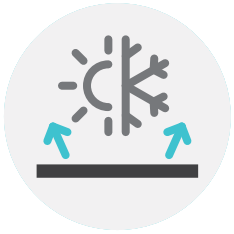
Crumb rubber can provide significant benefits, by extending the life of our roads and increasing performance. It can also help reduce carbon emissions and environmental impacts, making it a powerful way for Australia to derive value from its end-of-life tyres in the circular economy.

Benefits of using crumb rubber modified bitumen compared to neat bitumen

2

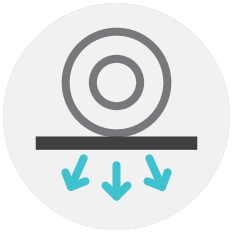
Crumb rubber modified bitumen's (CRMB) superior performance across a wider temperature range ensures that the binder remains flexible in cold conditions and stable in hot conditions, leading to better performance in various climates. These improvements not only enhance the quality of the road but also reduce the frequency and cost of maintenance, offering long-term economic benefits. The circular economy benefits of using crumb rubber from end-of-life tyres further add to the appeal, promoting sustainability while delivering high-performance road surfaces.

Key benefits of using crumb rubber in road and pavement applications:



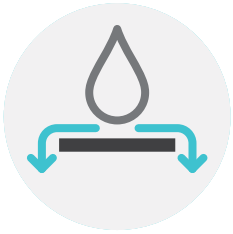
Increases service life, reduces the frequency and cost of maintenance

Crumb rubber helps to improve fatigue resistance, making roads better able to withstand the stresses and strains of heavy traffic and changing temperatures.



Reduces road noise and increases passenger comfort

Crumb rubber absorbs sound, providing a more comfortable in-car driving experience, while making roads quieter for residents and businesses.



Has a high resistance to moisture and water infiltration

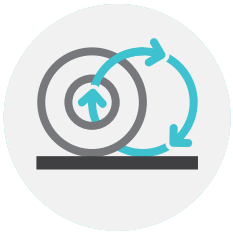
Crumb rubber can improve resistance to moisture, reducing the risk of damage caused by water infiltration.

Reduces surface deformation from heavy traffic

Crumb rubber can improve resistance to rutting and cracking, which are common issues that lead to road deterioration.

Is cost effective and priced below that of neat bitumen

Cost effective binder relative to other polymer modified bitumen (PMB), crumb rubber pricing is well below that of bitumen.



Supports a circular economy for end-of-life tyres

The extended service life and reduced environmental impacts underscore the importance of crumb rubber as a valuable resource in Australia's circular tyre economy.

Summary of benefits in sprayed sealing applications 2.1

CRMB is highly effective in sprayed seal applications. The addition of crumb rubber enhances the material's ability to withstand oxidative aging, preserving its properties over time and leading to more durable seals. This increased durability translates to lower maintenance needs and extended service life of the sprayed seal surfaces. Additionally, the elasticity imparted by the crumb rubber helps in absorbing stresses from traffic loads, which minimizes the occurrence of cracks and other forms of distress.

- **Higher softening point**
  High flow resistance and higher impact resistance – takes heavy vehicular traffic.
- **Improved adhesion**
  Through anti-stripping properties – less wind-screen damage and improves safety.
- **Increased viscosity**
  Reduces flushing onto the surface of the sprayed seal and improves skid resistance.
- **Improved durability**
  Through the ability to use higher binder film thickness, results in increased service life.
- **Improved elasticity and tensile strength**
  Provides resistance against reflective cracks at lower temperature.

Summary of benefits in asphalt applications 2.2

Incorporating crumb rubber into asphalt mixes offers a range of performance benefits. CRMB significantly enhances the durability and longevity of asphalt pavements. The rubber particles improve the resistance to rutting and cracking, which are common issues that lead to road deterioration. The increased elasticity and resilience of CRMB help in absorbing traffic-induced stresses, reducing deformation and extending the pavement's service life.

- **Improved resistance to rutting**
  Crumb rubber can help improve the resistance of asphalt to permanent deformation caused by heavy traffic at increased axle loads and high road temperatures.
- **Improved flexibility**
  The rubber particles in the mix can help to improve the fatigue resistance of the asphalt, making it better able to withstand the stresses and strains of heavy traffic and changing temperatures.
- **Enhanced skid resistance**
  The use of crumb rubber in dense graded asphalt (DGA) mixes can increase the skid resistance of the road surface, reducing the likelihood of accidents caused by slippery road conditions.
- **Improved durability**
  Crumb rubber can help to improve the durability by slowing down the ageing process of open graded asphalt (OGA), gap graded asphalt (GGA) and DGA mixes.
- **Better adhesion**
  The crumb rubber particles improve the adhesion of the asphalt to the road surface, reducing the risk of delamination and improving the overall performance.

Demonstrated benefits of using crumb rubber modified bitumen

3

The following is an example of research and development activities undertaken to demonstrate the benefits of CRMB in both sprayed sealing and asphalt applications.

Performance benefits of CRMB in sprayed sealing

3.1

In sealing, CRMB with high rubber content can be applied at a higher spray rate than bitumen without flushing (binder-bleeding on the road surface under traffic) occurring. The higher spray rate, in combination with the improved elastic, viscous and ductile properties of the binder, leads to benefits of CRMB seals compared to seals with neat bitumen. These benefits include:

- **Service life is significantly increased**
  The higher spray rate and increased binder film thickness lead to later onset of oxidation cracking and stone loss. The carbon black component of the tyres working as an antioxidant is also believed to contribute to the superior longevity of CRMB seals (Hoffmann & Potgieter 2007).
- **Durability of skid resistance is improved**
  The higher viscosity of the CRMB leads to reduced stone embedment, and as a result, the seal maintains its texture depth (Hoffmann & Potgieter 2007).
- **Resistance against reflective cracking**
  There is superior resistance against reflective cracking (California Department of Transportation, 2003). CRMB use originated from a desire to create a durable seal over cracks in asphalt roads. Its ability to arrest cracking is still one of the main reasons why CRMB technology is used in sprayed seals. CRMB seals are used as a maintenance action over cracked road surface. They are also used in specialised applications to insulate new pavement layers placed over existing pavements from cracks reflecting up from underlying layers. This application is known as a strain alleviating membrane interlayer. (Austroads 2013).
- **Improvement in waterproofing**
  Improvement in waterproofing of the road surface (Hoffmann & Potgieter 2007). One of the main functions of a sprayed seal is to keep water out of the pavement. The high spray rate of a CRMB seal leads to a durable waterproof surface, which protects the underlying material.

Performance benefits of CRMB in asphalt

3.2

In asphalt, the use of CRMB allows higher binder application rates in certain asphalt types without excessive drain down or bleeding due to the high viscosity of the binder (Lo Presti, 2013). The higher binder film thickness comes with considerable durability benefits. High binder film thicknesses retard oxidative aging, which is especially important in OGA mixes.

In OGA mixes oxidation eventually leads to ravelling of the material, which is the main mode of failure for such asphalt. In GGA mixes, the high binder film thickness, in combination with the improved elastic properties of CRMB, results in much improved resistance to reflective and fatigue cracking (California Department of Transportation 2003). This was also verified in laboratory tests on Australian mixes (Austroads Pavements Research Group 1999).

Accelerated pavement testing conducted by the University of California has shown that GGA crumb rubber modified asphalt (CRMA) placed at half the thickness of conventional asphalt over concrete outperforms the conventional asphalt in terms of resistance to reflective cracking (Jones, Harvey & Monismith 2007). This has led the California Department of Transportation to implement the rule that for overlays over concrete, conventional dense-graded asphalt may be substituted with CRMB GGA at one-half the intended dense-graded mix thickness (California Department of Transportation 2003). Note that this half- thickness rule is relevant to resistance to crack reflection only, it does not pertain to the asphalt design thickness required to protect underlying layers.

Long-term pavement performance monitoring in Arizona has shown that CRMB GGA outperformed conventional asphalt in terms of cracking, maintenance costs, ride quality and resistance, and rutting (Way, Kaloush & Biligiri 2011). Other studies have found CRMA to have rut resistance like conventional asphalt, although there are indications that CRMB GGA may be more susceptible to rutting than conventional asphalt (Jones, Harvey & Monismith 2007).

In Australia, the use of crumb rubber in asphalt is becoming increasingly prevalent, particularly in Western Australia and Queensland. This trend is largely driven by initiatives under the National Asset Centre of Excellence (NACOE) and the Western Australian Road Research Innovation Program (WARRIP), both of which emphasize the environmental and performance benefits of CRMA. These programs have facilitated its broader adoption in road construction through rigorous research, testing, and the development of technical specifications.

Studies under NACOE and WARRIP have demonstrated that CRMA exhibits superior durability and resistance to cracking compared to conventional asphalt. For example, in Queensland, CRMB GGA has been found to offer enhanced crack resistance, potentially leading to longer-lasting road surfaces and reduced maintenance costs. This improved performance underscores the value of crumb rubber as a key component in modern asphalt mixtures.

To support the widespread use of CRMA, both NACOE and WARRIP have been instrumental in developing technical specifications. In Queensland, Department of Transport and Main Roads (DTMR) introduced specifications that guides the use of crumb rubber in various asphalt mixes. Similarly, in Western Australia, Main Roads Western Australia (MRWA) has developed draft specifications for CRMB, paving the way for its standard application across the state. These specifications are crucial for ensuring the consistent and effective use of crumb rubber in asphalt construction.

Refer to section 7.1 for links to the various specifications

Several demonstration projects have validated the practical application and performance of CRMA. These projects involved the manufacture, construction, and laboratory testing of crumb rubber mixes, with results indicating that they perform as well as, if not better than, traditional PMB. The success of these trials has set the stage for the broader implementation of CRMA in Australia, particularly in regions where the benefits of enhanced durability and sustainability are most needed.

Looking ahead, the ongoing and future work under Austroads, various state road authorities and industry initiatives aims to further refine the specifications for CRMA and expand its use across other regions of Australia. The outcome of these initiatives will represent a significant step forward in sustainable road construction, demonstrating that CRMA is not only a viable but also a highly beneficial alternative to traditional road construction materials.

Sustainability benefits

4

An advantage of using crumb rubber in road applications is the potential to reduce greenhouse gas (GHG) emissions across the life cycle of the road.

Traditional asphalt production and paving are energy-intensive processes that contribute to significant GHG emissions. CRMA integrates end-of-life tyres, which provides a sustainable management pathway compared to other disposal alternatives. The inclusion of crumb rubber in asphalt can decrease the demand for new asphalt materials, reducing the need for energy-intensive production and lowering overall GHG emissions.

GHG emissions arise throughout the roads products applications value-chain from:

- Production of raw materials
- Energy use during manufacturing
- Energy use during application
- Fuel consumption in transport

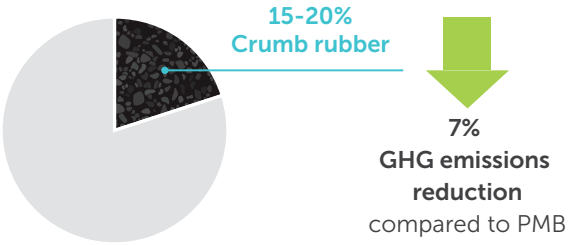
Life cycle assessments (LCA) are a common industry method to measure the environmental impacts across these different stages of manufacturing. TSA have conducted LCA research that assesses the impacts associated with several generic asphalt and sprayed seal mix designs, including measuring transport, processing and manufacturing stages.

Reduction in GHG emissions by using crumb rubber

4.1

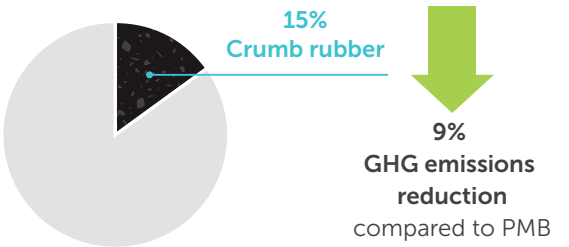
Asphalt binder

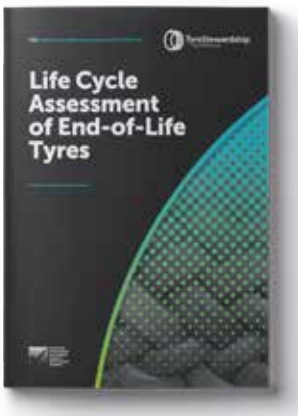
Crumb rubber used as 15-20% of an asphalt binder in the wet process has the potential to improve GHG emissions (kg CO_2 eq) by 7% compared to an average PMB.



Bitumen spray seal

Crumb rubber used as 15% of a bitumen sprayed seal has the potential to improve GHG emissions (kg CO_2 eq) by 9% compared to an average PMB sprayed seal.





More information on the assumptions, mix designs, inputs and environmental impacts for each scenario can be found in the full LCA report.

Download the report:
Life Cycle Assessment of end-of-life tyres

Improvements in emissions across pavement life

4.2

Roads made with CRMA typically require less frequent maintenance and repairs, reducing the energy, materials, and emissions associated with road maintenance over time. This long-term reduction in maintenance activities contributes to a lower overall carbon footprint for transportation infrastructure.

Research conducted by RMIT University considered the environmental impacts for different designs, maintenance and the service life of roads. CRMA is known to both increase service life and reduce the frequency of pavement maintenance. Several proposed scenarios, which capture these performance improvements, were modelled using LCA methodology and the results are outlined below.

> **Overall, it was found that a proposed 40% extension of service life with CRMA results in an approximate 29% reduction in kg CO_2 eq per square metre of pavement. This figure becomes a 9%, 17%, and 23% reduction in kg CO_2 eq for 10%, 20%, and 30% extensions of the pavement service life respectively.**

Figure 1 highlights the clear opportunity to reduce GHG emissions by incorporating materials that enhance performance, like crumb rubber, into road design.

Refer to the link provided in section 7.2 for the complete report

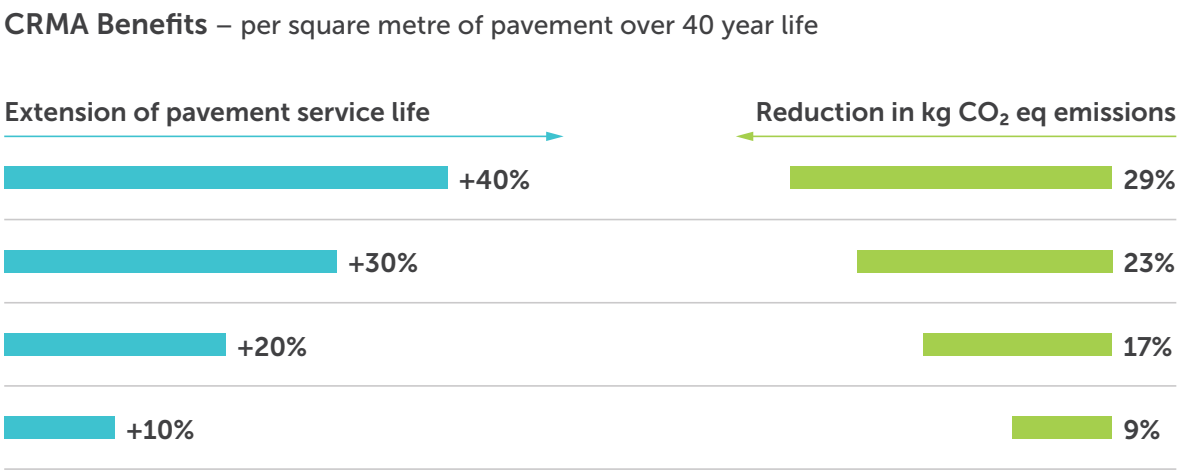


Figure 1: Percentage extension of service life of the pavement and the decrease in kg CO_2 eq over 40 year life.

Use of crumb rubber and recycled asphalt pavement 4.3

Crumb rubber has been successfully used with recycled asphalt pavement (RAP) in several projects across the U.S. and Canada, including by the Arizona, Florida, California, and Texas Departments of Transportation, as well as the Ontario Ministry of Transportation.

> **These projects, which utilised RAP in ranges from 15% to 25%, demonstrated that combining crumb rubber with RAP enhances pavement durability, resistance to cracking, and performance under varying temperatures and heavy traffic.**

This sustainable approach not only further reduces waste and conserves resources but also leads to cost savings and improved pavement longevity.

As a result of increasing use of crumb rubber in asphalt, there is therefore a need to understand how, and ultimately if, CRMA can be recycled to produce crumb rubber modified recycled asphalt pavement (CRM-RAP), and to identify any barriers which may prevent this technology from being effective. A collaborative research project between MRWA, WARRIP, and ARRB was conducted to examine these issues. The outcome of the laboratory investigation revealed repeatability issues with extraction and characterisation of CRM-RAP binder in addition to demonstrating the unrepresentative and variable nature of CRM-RAP binder viscosity results.

The Stage 2 practicality study also demonstrated issues with processing at high volumes to the inherent stickiness of the CRM-RAP product. However, even with the processing issues, a processed CRM-RAP product was still able to be obtained, but not in an efficient manner.

Click here for full report:
Investigation of the use of RAP from Crumb Rubber Modified Asphalt

Health, environment and safety factors

5.

Laboratory and field monitoring exercises have recently been conducted with state road authorities in Australia as part of the step in adopting the use of crumb rubber in asphalt. Three notable ones include, DTMR Queensland under NACOE, MRWA under WARRIP and Department of Transport (DOT) Victoria.

Monitoring results conducted in Australia were consistent with those from previous studies undertaken internationally – i.e. that CRMA mixes produce emissions that are comparable to those from PMB asphalt mixes made from synthetic polymers. The NACOE findings indicated that temperature was a dominant factor in determining the relative risk of personnel with regards to asphalt emissions. It was also found that producing asphalt at lower temperatures (which may require the use of warm mix asphalt additives) could reduce the emissions during asphalt manufacture and placement.

> **During the WARRIP demonstration trial, samples were taken for monitoring of emissions. The results of the monitoring indicated the levels of airborne contaminants at the work site were being adequately controlled regarding the impact on workers' personal exposure. Almost negligible levels of exposure were recorded for inhalable dust and volatile emissions.**

A DOT Victoria study comparing CRMA and conventional asphalt found the fumes and airborne particles are not above SafeWork Australia standards, are not carcinogenic and the inclusion of crumb rubber does not appear to increase negative symptoms for asphalt construction workers, for the various constituents in the emissions the study indicated:

- ### Volatile Organic Compounds (VOCs)

  No significant amounts of VOCs were detected in any of the samples. All levels were well below the Time-Weighted Average SafeWork Australia Workplace Exposure Standards.

- ### Benzothiazole (BZ)

  The highest breathing zone benzothiazole levels were measured whilst laying the CRMA mixes. There are no exposure standards set for BZ in the working environment in Australia or in most other nations.

- ### Total Suspended Particulates (TSPs)

  All TSP levels were below the SafeWork Australia recommended guideline value for Dusts Not Otherwise Classified of 10 mg/m^3 and the Australian Institute of Occupational Hygienists trigger value of 5 mg/m^3.

  TSP exposure was significantly higher for the control mixes than for any of the CRMA mixes. The highest TSP exposure levels were for the paver driver for the control mixes.

- ### Bitumen Fumes

  The results indicate that the bitumen fume exposure monitoring of the three members of the asphalting crew were generally higher for the control mixes than for the CRMA mixes.

  Most of the CRMA mixes had non-detectable to barely detectable levels of bitumen fume exposure, except in one case. All bitumen fume levels were well below the SafeWork Australia time-weighted average workplace exposure standard for bitumen fume of 5 mg/m^3.

Polycyclic Aromatic Hydrocarbons (PAHs)

The major PAHs compounds detected were naphthalene, fluorene, phenanthrene, anthracene and pyrene, none of which are classified as carcinogenic PAHs.

SafeWork Australia has set a workplace exposure standard for only one PAH, naphthalene (a non-carcinogenic and the most volatile PAH), at 52 mg/m³. Naphthalene was the most prominent PAH detected and was well below the SafeWork Australia workplace exposure standard.

A potent carcinogenic PAH, benzo(a)pyrene, which is set at the workplace exposure limit of 0.2 µg/m³ by the Australian Institute of Occupational Hygienists, was not detected in any of the samples for either the control or CRMA mixes.

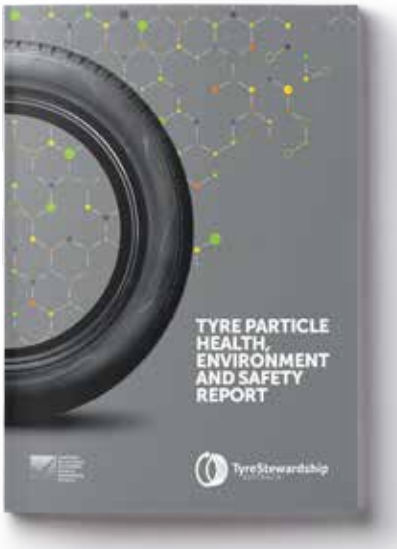
Click here for further information and full reports on the above:

NACOE Final Report P31 Crumb Rubber Modified Asphalt

Transfer of Appropriate Crumb Rubber Modified Bitumen Technology to WA

East Boundary Road Crumb Rubber Asphalt Trial Emissions Monitoring Report

TSA Tyre Particle Health, Environment and Safety Report



Statistics

6.

CRMB use in Australia

6.1

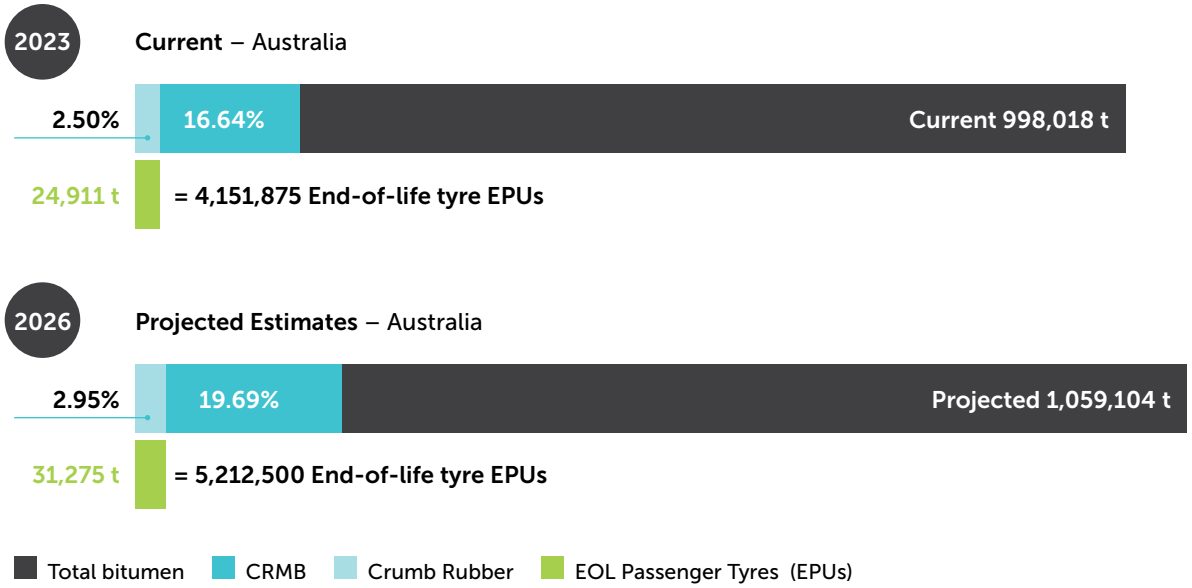
- **The overall estimated neat bitumen market in 2023 in Australia was in the order of 998,018 tonnes.**

It is estimated that in 2023, 16.64% (166,075 tonnes) of the total bitumen used in Australia was modified using crumb rubber, with the crumb rubber component being 24,911 tonnes, equivalent to 4,151,875 equivalent passenger units (EPUs).

There is scope for the overall modified bitumen market to grow further and in specific, modification using crumb rubber. It is projected that in 2026, the neat bitumen market in Australia will be 1,059,104 tonnes of which 19.69% (208,500 tonnes) of it modified using crumb rubber with the crumb rubber component being 31,275 tonnes equivalent to 5,212,500 EPUs. Refer to figure below for projections for the years 2023 to 2026.

The volume of crumb rubber is likely to increase sharply due to the recent uptake of crumb rubber in asphalt application. This application uses the most amount of crumb rubber per lane kilometre constructed. In a positive development, most states in Australia are now moving towards the use of crumb rubber in various road surfacing applications

Australia CRMB Volumes	**2023**	2024	2025	**2026**
Total Bitumen Usage (tonnes)	**998,018**	1,017,978	1,038,337	**1,059,104**
CRMB usage (tonnes)	**166,075**	179,100	193,300	**208,500**
CRMB usage, % of overall bitumen used	**16.64%**	17.59%	18.62%	**19.69%**
Crumb rubber component equivalent @ 15% average loading in CRMB (tonnes)	**24,911**	26,865	28,995	**31,275**
Crumb rubber component, % of overall bitumen used	**2.50%**	2.64%	2.79%	**2.95%**
End-of-life tyres @ 6 kgs crumb rubber per unit (EPUs)	**4,151,875**	4,477,500	4,832,500	**5,212,500**



CRMB use across State and Territory

6.2

2023 CRMB
2026 Projected CRMB

Volume use presented to scale.

New South Wales – 2023 Total bitumen **231,566 t** – 2026 Projected bitumen **245,740 t**

17.28%

19.54%

Victoria – 2023 Total bitumen **214,855 t** – 2026 Projected bitumen **228,006 t**

24.05%

26.32%

Queensland – 2023 Total bitumen **310,346 t** – 2026 Projected bitumen **329,342 t**

13.29%

14.88%

Western Australia – 2023 Total bitumen **131,300 t** – 2026 Projected bitumen **139,337 t**

15.80%

20.81%

South Australia – 2023 Total bitumen **71,618 t** – 2026 Projected bitumen **76,002 t**

13.61%

19.74%

Tasmania – 2023 Total bitumen **17,905 t** – 2026 Projected bitumen **17,905 t**

6.43%

15.79%

Northern Territory – 2023 Total bitumen **13,265 t** – 2026 Projected bitumen **14,077 t**

1.88%

21.31%

Australian Capital Territory – 2023 Total bitumen **7,162 t** – 2026 Projected bitumen **7,600 t**

17.29%

19.54%

TSA research and market development initiatives

7.

TSA identified three areas of support needed to use crumb rubber in road surfacing applications. These are:

- Creating demand by overcoming barriers.
- Demonstrating benefits.
- Enabling supply.

Creating demand by overcoming barriers

7.1

Significant barriers have been overcome with specifications on crumb rubber modified bitumen in National (Austroads) and State Road Authorities specifications. Furthermore, TSA is actively working with academic and research institutions, state road authorities, statutory organisations and industry bodies in technology transfer, specification developments, performance assessments and training in the use of crumb rubber for road surfacing applications.

Jurisdiction and relevant guidelines, codes and specifications

- **International**

  D6114/D6114M Standard Specification for Asphalt-Rubber Binder

  This specification covers CRMB, consisting of a blend of bitumen, crumb rubber and other additives, as needed, for use as binder in pavement construction

- **Australia (Federal)**

  Austroads Technical Specification ATS 3110 Supply of Modified Binders

  This specification sets out the requirements for the supply of PMBs and CRMB for use in both sprayed sealing and asphalt applications

- **New South Wales**

  Specification D&C 3256 Crumb Rubber

  This Specification sets out the requirements for crumb rubber

  Specification D&C R118 - Crumb Rubber Asphalt

  This Specification sets out the requirements for CRMA

  Specification D&C 3252 - Polymer Modified Binder for Pavements

  This Specification sets out the requirements for the supply of PMBs (including blended CRMB) for use in asphalt and sprayed bituminous seals

- **Victoria**

  Section 408 - Sprayed Bituminous Surfacing

  This section covers the requirements for materials, design and application of sprayed bituminous surfacings including primes and sprayed seals of various types

  Section 421 - High Binder Crumb Rubber Asphalt

  This section covers special requirements for High Binder Crumb Rubber Asphalt

  Section 422 - Light Traffic Crumb Rubber Asphalt

  This section provides the requirements for Light Traffic Crumb Rubber Asphalt

Queensland

MRTS11 Sprayed Bituminous Treatments

This Technical Specification applies to the application of sprayed bituminous treatments but excludes the use of bituminous emulsions. It covers various types of treatment

MRTS18 Polymer Modified Binder (including Crumb Rubber)

This Technical Specification sets out the requirements for the supply (including transport and storage) of PMBs and CRMB for use in both sprayed sealing and asphalt applications

Western Australia

Specification 511 - Materials For Bituminous Treatments

This specification consists of the supply and use of materials for sprayed bituminous surfacings and asphalt

Specification 516 - Crumb Rubber Open Graded Asphalt

This specification consists of the supply and application of crumb rubber OGA for pavement wearing courses

Specification 517 - Crumb Rubber Gap Graded Asphalt

This specification consists of the supply and application of crumb rubber GGA for pavement wearing courses

South Australia

Specification Part R25: Supply of Bituminous Materials

This part specifies the requirements for the supply and delivery of bitumen, primers, primer binders, polymer modified binders, emulsions, multi-grades and crumb rubber

Specification: Part R26 Application of Sprayed Bituminous Surfacing

This part specifies the requirements for the application of sprayed bituminous surfacing or resurfacing (sprayed seal coat treatment)

Northern Territory

Standard Spec for Civil Maintenance V9.0 (FEB 2021), Spray Seal Surfacing

This specification relates to the Selection of Binder Type and Standard Specification for Roadworks and contains some requirements and details regarding use of crumb rubber binders

Tasmania

Section 421 - High Binder Crumb Rubber Asphalt

This section covers special requirements for High Binder Crumb Rubber Asphalt

Section - 422 Light Traffic Crumb Rubber Asphalt

This section provides the requirements for Light Traffic Crumb Rubber Asphalt

Australian Capital Territory

Municipal Infrastructure Technical Specification 04 - Flexible Pavements

This covers the Flexible pavement base and subbase, including supply, spreading, compaction and trimming of crushed rock, gravel and suitable soil pavement layers as documented

Demonstrating real-world applications

7.2

While there is already widespread use of crumb rubber in road surfacing applications, there are still applications where it has been necessary to demonstrate the benefits; the major one continues to be in the application of hot mix asphalt. TSA has provided significant support to various collaborations with the road authorities, local government and industry in placement and monitoring of road surfacing demonstration projects. Projects supported to date have provided valuable learnings.

TSA initiatives to promote benefits of CRMA

In a recent initiative, the Southern Sydney Regional Organisation of Councils (SSROC) led one of Australia's largest multi-council demonstration projects, using rubber recovered from end-of-life tyres blended into bitumen to enhance asphalt durability, performance, and environmental sustainability of road pavements.

Conducted by RMIT University, a LCA entitled *Life Cycle Assessment and Potential Environmental Benefits of Crumb Rubber Asphalt using Field Data* has studied the environmental impacts associated with incorporating recycled rubber from end-of-life tyres into bitumen for asphalt pavement construction and has found that recycled rubber extends pavement service life, reduces demand for raw materials and lowers environmental impacts.

Led by SSROC with the support of Tyre Stewardship Australia, and in partnership with the Australian Flexible Pavement Association, the Paving the Way - Recycling Tyres for Roads project involved: Bayside, Burwood, Canada Bay, Canterbury-Bankstown, City of Sydney, Georges River, Inner West, Randwick, Sutherland, Waverley and Woollahra and Northern Beaches councils.

In 2023, the twelve participating councils each resurfaced a road using a CRMA mix. Of the demonstration sites, three in Burwood Council, City of Sydney and Northern Beaches Council areas, were selected for an in-depth investigation into the potential environmental benefits of using CRMB in council asphalt roads.

Image credit: Southern Sydney Regional Organisation of Councils Inc.

The comprehensive LCA assessed the carbon footprint kg CO_2 eq and other environmental impacts of production, construction, and maintenance of crumb rubber asphalt pavements compared to conventional asphalt mix (without crumb rubber) laid at the same location and exposed to comparable traffic and weather conditions.

The study found that incorporating crumb rubber into asphalt mixes using the wet method (crumb rubber assimilated into bitumen at high temperature to produce a modified binder) can reduce environmental impacts during the production and construction phase compared to conventional asphalt.

Adding 10% crumb rubber by weight of the total binder (100 grams of crumb rubber to 900 grams of virgin bitumen to manufacture 1 kg of CRMB) resulted in lower environmental impacts compared to using 1 kg of conventional bitumen, leading to reduced emissions during the construction phase.

The assessment considers existing research that has demonstrated improvements in pavement performance due to CRMA needing fewer maintenance interventions during the service life, consequently reducing environmental impacts (up to 30%) associated with the maintenance phase of the road asset. It also demonstrated indirect environmental benefits, such as recovering steel from end-of-life tyres during crumb rubber production and diverting used tyres from landfills, which will further decrease GHG emissions associated with using CRMA.

Click here for link to full report:
1 February 2024 - Life Cycle Assessment and Potential Environmental Benefits of Crumb Rubber Asphalt using Field Data - Southern Sydney Regional Organisation of Councils (nsw.gov.au)

Enabling supply 7.3

The use of crumb rubber involves either pre-blending the crumb rubber with bitumen at a centralised plant and then transporting to the jobsite or having the mixing equipment onsite for blending 'just in time'. This is designated as a "wet process." Alternatively, in asphalt applications the crumb rubber can be directly introduced during the manufacture of the hot mix, this is designated as a "dry process." In either case of the process, the blending or the introduction of the crumb rubber requires additional and sometimes specialised equipment to ensure better dispersion, thus providing a consistent quality outcome.

TSA has supported the enhancement and the expansion of the blending capacities by supporting industry partners in the setup of improved processes and procurement of specialised equipment.

Click here to see road projects funded by TSA:
Tyre Stewardship Australia - Projects Archive

Click here to visit TSA's Source Recycled Page for a list of crumb rubber suppliers:
TSA Accredited Crumb Rubber Suppliers

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