Getting better performance from bituminous materials
—from waste to sustainability

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Executive Director  QLD/NT
Convener National Sustainability Committee

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Getting better performance from bituminous materials - from waste to sustainability

• Better PERFORMANCE?
• What is SUSTAINABILITY?
• What is WASTE?
Better PERFORMANCE?

A. costs less for same performance
B. lasts longer for the same price
C. best whole-of-life outcome (costs more but worth it)

General performance aspects to consider
1. Safety – skid resistance, smooth ride, low noise, safe traffic flow
2. User – safety, open access, travel time, ease of use
3. Cost effectiveness – budget vs demand vs changes, reduced risk
Sustainability

Many thousands of definitions . . . . . .

• . . meets the needs of the present without compromising the ability of future generations to meet their own needs.

• . . is the process of maintaining change in a balanced environment, in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations.
Waste

A. unwanted or unusable materials
B. any substance which is discarded after primary use
C. worthless, defective and of no use

Municipal waste

- Biodegradable – food & kitchen, green waste, paper?
- Recyclable – paper, cardboard, glass, tin, aluminium, metals, plastic, tyres, fabrics
- Inert – construction and demolition waste, dirt, rocks, debris, bricks, concrete
- Also Electrical | Hazardous | Toxic | Biomedical | Composite
Circular Economy

Sustainability requires circular thinking
- GHG actuals
- Users included

WASTE

again by another

Landfill Levy

$75?
Linear economy

Circular economy

Buy for durability
EME2, Perpetual Pavements, Crumb Rubber

Fog seals / Reseals?

Reseal / Rejuvenator
Foam Stabilized Bases
Crack & Seat
RAP, Glass

Crumb Rubber

Pre-Use
Use
Post-Use
Waste

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Rubbish

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End of Life Tyres
**Questions**

**ELT’s**

To the nearest five years, when was the first recorded use of ground tyre rubber in road surfacing?

<table>
<thead>
<tr>
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<tr>
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<td>✔️</td>
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</tr>
</tbody>
</table>

About how many equivalent EPU end-of-life tyres are generated each year?

<table>
<thead>
<tr>
<th>Australia</th>
<th>A) 24 million</th>
<th>B) 38 million</th>
<th>C) 44 million</th>
<th>D) 55 million</th>
<th>E) 67 million</th>
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</table>

Consider two EPU EOL tyres were placed on each seat in MCG. . . . Approximately many times could Australia’s annual EPU EOL tyres fill the seats?

<table>
<thead>
<tr>
<th>Australia - MCG</th>
<th>A) 75x</th>
<th>B) 175x</th>
<th>C) 275x</th>
<th>D) 375x</th>
<th>E) 475x</th>
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</tbody>
</table>

If those EPU tyres were laid edge to edge, using the highest packing possible. Roughly how many kilometers of 10m wide road would they cover?

<table>
<thead>
<tr>
<th>Australia</th>
<th>A) 2400 km</th>
<th>B) 2800 km</th>
<th>C) 3200 km</th>
<th>D) 3600 km</th>
<th>E) 4000 km</th>
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</tr>
</tbody>
</table>

If 10 million EPU tyres were ground to produce crumb rubber for bitumen modification. Roughly how many kilometers of 14 mm medium duty spray seals could be sprayed?

<table>
<thead>
<tr>
<th>Australia</th>
<th>A) 16 000 km</th>
<th>B) 18 500 km</th>
<th>C) 20 000 km</th>
<th>D) 23 500 km</th>
<th>E) 27 500 km</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Correct</strong></td>
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</tbody>
</table>
Crumb Rubber

Sprayed Seals – based on Australia & South Africa

A: Low percentages of crumb rubber 5%
   - Promotes adhesion, reduces need for aftercare and risk of stripping
B: Percentages 10% to 18% - factory blended / low temperature?
   - Australian experience - good alternate performance to PMB’s (SBS, PBD)
C: High percentages of crumb rubber 20% - field blended
   - For heavily cracked and high traffic loaded pavements, WOLC effective, more attention required

Asphalt – based on Arizona & California

Crumb Rubber Modified Open Graded Asphalt
   - Porous Asphalt with the long lasting properties of the crumb rubber
Crumb Rubber Modified Gap Graded Asphalt
   - Can be placed at half the thickness over cracked rigid pavements
Crumb Rubber

Sprayed Seals – *based on Australia & South Africa*

Low percentages of crumb rubber 5% - *construction advantages*

- Promotes adhesion, reduces need for aftercare and risk of stripping
Crumb Rubber

Sprayed Seals – based on Australia & South Africa

5% crumb - provides better adhesion than C170
reduces spray drift

10% crumb - similar properties to S0.3B S35E

Percentages 10% to 18% - factory blended / low temperature?
- Australian experience provides good alternate performance to PMB’s (SBS, PBD)

VIC Roads Specifies Higher Rubber Mix in Surface Seal

Increased from 5% to 10% in 2016
Crumb Rubber
Sprayed seals

<table>
<thead>
<tr>
<th>14mm Seal</th>
<th>C170</th>
<th>S0.3B</th>
<th>CRB18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seal life (years)</td>
<td>7</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>Spray rate (l/m²)</td>
<td>1.4</td>
<td>1.5</td>
<td>1.8</td>
</tr>
<tr>
<td>Cost (Index/m²)</td>
<td>4.0</td>
<td>6.0</td>
<td>5.0</td>
</tr>
<tr>
<td>LCC (index/m²/yr)</td>
<td>0.57</td>
<td>0.67</td>
<td>0.38</td>
</tr>
</tbody>
</table>
Crumb Rubber

Sprayed Seals – based on Australia & South Africa

- Blend 20t per batch
- Load into 2 sprayers
- 2 hours turnaround time per sprayer
- 60 tonnes per shift

High percentages of crumb rubber 20% - field blended

- For heavily cracked and high traffic loaded pavements, WOLC effective, more care required
Crumb Rubber

Asphalt – based on Arizona & California

CRM OGA and GGA specification

- >18% rubber by mass of binder
- MRWA,TMR,AAPA,TSA
- Use of **warm mix** mandatory
- Mixing temperature ≤ 165 °C

Crumb Rubber Modified Open Graded Asphalt

- *Porous Asphalt with the long lasting properties of the crumb rubber*

Crumb Rubber Modified Gap Graded Asphalt

- *Can be placed at half the thickness over cracked rigid pavements*

www.aapa.asn.au/aapa-national-model-specifications/
Crumb Rubber Modified Asphalt laid as Warm Mix by Fulton Hogan
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Rubbish

Municipal waste

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• Also Electrical | Hazardous | Toxic | Biomedical | Composite
Recycled Asphalt Pavement

More sustainable asphalt pavements!

• Across Australia 15% RAP on average
• will save annually
• 1 400 000 t aggregate \((\text{over } $60m)\)
  (1% of annual aggregate production in Australia)
• 4 000 t pa bitumen \(\text{(over } $4 \text{ million)}\)
  (Equivalent to 175 road tanker loads)
AAPA RAP Management Plan

Validation
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Foam Bitumen
Stabilised Base

Converting used weak pavements into strong flood resistant, waterproofed and high quality bases

- Pioneered in Queensland
- Linked to international best practice
- Usage spreading across Australia
Bitumen Stabilised Material (BSM)

Durban, South Africa
Sustainability
Green Circle Road
Bitumen Stabilised Material (BSM)

Cape Town
South Africa
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Recycling waste - Glass

Shear magnitude of glass waste, has scope in asphalt to replace sand fraction (~10%)
Glass

Asphalt & Granular Materials – sand / fines substitute

Crushed Glass Fines

Glass fines are manufactured from container glass cullet, by removing contamination and crushing and grading to a 5 mm cubical product. Glass fines can be added to some crushed granular products and to some non-wearing course asphalt mixes in proportions as detailed in the relevant product registered mix design.

Glass fines are able to met the requirements for some granular filter materials in VicRoads Standard Section 702 Subsurface Drainage.
### Glass in Asphalt
- Asphalt about 3.6 M tonnes pa
- 360,000 tonnes pa glass maximum*
- 7,370 tonnes non-packaging glass
- 119,321 tonnes packaging glass

### Recycled Asphalt
- Asphalt about 3.6 M tonnes pa
- About 10% on average in all asphalt

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**Table 1.1: Commercial and industrial waste materials recovered during 2017–18**

<table>
<thead>
<tr>
<th>Material</th>
<th>Amount recovered (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper and packaging</td>
<td>315,536</td>
</tr>
<tr>
<td>Non-packaging glass</td>
<td>7,370</td>
</tr>
<tr>
<td>Non-packaging plastic</td>
<td>19,359</td>
</tr>
<tr>
<td>Ferrous scrap metal</td>
<td>385,240</td>
</tr>
<tr>
<td>Non-ferrous scrap metal</td>
<td>58,989</td>
</tr>
<tr>
<td>Timber</td>
<td>164,296</td>
</tr>
<tr>
<td>Green waste</td>
<td>192,308</td>
</tr>
<tr>
<td>Cotton gin trash</td>
<td>5,680</td>
</tr>
<tr>
<td>Food waste</td>
<td>66,045</td>
</tr>
<tr>
<td>Drilling mud</td>
<td>99,793</td>
</tr>
<tr>
<td>Tyres</td>
<td>66,020</td>
</tr>
<tr>
<td>Other mixed waste</td>
<td>3,965</td>
</tr>
</tbody>
</table>

* Glass recycled glass more expensive than sand component

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**Table 1.2: Construction and demolition waste materials recovered during 2017–18**

<table>
<thead>
<tr>
<th>Material</th>
<th>Amount recovered (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete</td>
<td>1,851,243</td>
</tr>
<tr>
<td>Asphalt</td>
<td>360,146</td>
</tr>
<tr>
<td>Bricks and tiles</td>
<td>84,066</td>
</tr>
<tr>
<td>Plasterboard</td>
<td>55,124</td>
</tr>
<tr>
<td>Timber</td>
<td>30,036</td>
</tr>
<tr>
<td>Non-packaging glass</td>
<td>7,370</td>
</tr>
<tr>
<td>Non-packaging plastic</td>
<td>2,151</td>
</tr>
<tr>
<td>Ferrous scrap metal</td>
<td>283,726</td>
</tr>
<tr>
<td>Non-ferrous scrap metal</td>
<td>15,645</td>
</tr>
<tr>
<td>Other construction and demolition material</td>
<td>226</td>
</tr>
</tbody>
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Recycling waste - plastic

Significant drive to reduce landfill and use value in waste

- Plastic bags
- Plastic milk bottles
- Plastic toner cartridges & toner wax
- Blended plastic pellets - UK
Executive general manager of road services at Downer Dante Cremasco, right, shows roads minister Chris Steel and member for Yerrabi Suzanne Orr the kind of glass used in the asphalt trial.
PHOTO: The new stretch of road in Craigieburn is made of plastic bags and glass bottles. (Supplied: Close the Loop)
Port Phillip mayor Dick Gross and Fulton Hogan's Peter Curl with plastic used to resurface Mozart Street.
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PETE</td>
<td>Clear tough plastic such as soft drink, juice and water bottles.</td>
</tr>
<tr>
<td>HDPE</td>
<td>Common white or coloured plastic such as milk containers and shampoo bottles.</td>
</tr>
<tr>
<td>V</td>
<td>Hard rigid clear plastic such as cordial bottles.</td>
</tr>
<tr>
<td>LDPE</td>
<td>Soft flexible plastic e.g. squeezable bottles such as sauce bottles.</td>
</tr>
<tr>
<td>PP</td>
<td>Hard but flexible plastic such as microwave ware, takeaway containers, some yoghurt/ice cream/jam containers, hinged lunch boxes.</td>
</tr>
<tr>
<td>PS</td>
<td>Rigid, brittle plastic such as small tubs and margarine/butter containers.</td>
</tr>
<tr>
<td>OTHER</td>
<td>All other plastics, including acrylic and nylon. Examples include some sports drink bottles, sunglasses, large water cooler bottles.</td>
</tr>
</tbody>
</table>

How, which plastic, $, ????
Asphalt with Plastic

*Individual company proprietary products initially*

- Managing the plastic selection from waste stream
- Performance assessments through standard testing
- Durability proving and potential system certification
- Performance based specifications likely
- Opportunities for branding and proprietary products
ADVANCING A ZERO-WASTE FUTURE!

Recycled content in roads and infrastructure
STUDY TOUR TO MELBOURNE

An opportunity to learn from experts about technologies creating sustainable uses for recycled content.

26th–28th NOV 2019

Contact
Ph: 07 3000 2212
Em: robert_ferguson@lgaq.asn.au
W: lgaq.asn.au
Bituminous product sustainability
From waste to increased durability and lower costs

1. Bitumen – bottom of the barrel – waste in 1890’s
2. Recycling – up-cycling used asphalt
3. Lowering energy consumption – “warm mix”
4. Renewable energy – wood chips, solar power
5. Using less – EME2, perpetual pavements
6. Durability – no cracks from the bottom – “perpetual pavement”
7. Removing waste – vehicle tyres, glass, toner ink, plastics too
8. Available – Ultra Thin Friction Courses UTFC, Performance Based Specifications (PBS) Emulsions for primer / initial seals, Non-reversing chip spreaders
Sustainability Framework for Asphalt*

Asphalt product &
production process

Asphalt producer - Organisation

Road Project

Circular Economy and
Life Cycle

Company A

Company B

Typical levels
LG: ★
SRA: ★★★
Fed: ★★★★

Client sets Star level for
• plant
• company
• project

Project must meet Star status level.

CE & LC for large projects

* Under industry trials for implementation 2020 onwards
Sustainability Framework for Asphalt

Asphalt product & production process
- Asphalt KPIs
  - Asphalt product composition
  - GHG intensity (scope 1+2) of asphalt
  - Carbon footprint (scope 1+2+3) of asphalt
  - Asphalt production energy use
    - Bitumen
    - RAP usage / content
    - Bio based alternatives
    - Alternative binders / enhancing materials
- Aggregates
  - Stockpile kept dry
  - Local & recycled aggregates
  - Recycled local fillers
- Energy / GHG
  - GHG Intensity of production
  - Carbon footprint of asphalt
  - Energy use of production
  - ISO 14001 EM certification
  - Modern Slavery Act compliance
- Local Community
  - Programs and engagement
  - Minimise noise / odour
  - Regular planned meetings
- Diversity
  - % women in executive roles / management roles / employed
  - Reports on diversity & inclusion
  - Employee development & retention program & training
- Safety
  - Health and Safety certification
  - Reporting LTIFR & TRIFR
  - Reduction in LTIFR & TRIFR
  - Hazard & safety analysis & Improvements
- Environment
  - Waste recycling system for whole organization
  - Measure of environmental indicators (spills, EPA notices...)
  - Water use

Asphalt producer - Organisation
- Sustainability Commitment
  - Mission, Vision & Values
  - Sustainability report
  - Board remuneration policy
  - GHG Intensity of production
  - Carbon footprint of asphalt
  - Energy use of production
  - ISO 14001 EM certification
  - Modern Slavery Act compliance
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Road Project
- Sustainability enhancement
  - Strategy to use road equipment more efficiently
  - Low emission fuels used in road construction equipment
  - Using advanced technology to promote sustainability
  - Sustainable procurement systems used on the project
- Materials
  - Local asphalt materials and recycled aggregates
  - Construction waste reduction policies
- Workforce
  - Job hazard & safety analysis
  - Strategic workforce planning policy
  - Jobs & skills policy
  - Workforce culture and wellbeing policy
  - Sustainable site facilities policy
- Constructability
  - Model construction plan, productivity & delay
  - Reduce / Mitigate work zone traffic delay
- Planning
  - GHG Analysis of alternative design options
  - Social impact of workforce

Circular Economy and Life Cycle
- Materials CE
  - Maximise material recovery at end-of-life
  - % of secondary raw materials / resources used
  - Materials Circularity Indicator
  - Develop a Materials passport
  - List / Prevent toxic materials entering project
  - LCA and EPD
  - EPDs available for the materials used in the project
  - EPD for the whole project
  - ISCA Materials Calculator LCA
  - Cradle-to-gate project LCA
- Whole of life costs
  - Life cycle costing used to optimize decisions
  - Cost of externalities included
- Circular economy
  - The company is an active participant in initiatives aimed at reducing environmental impacts outside the sector
  - Demonstrate recyclability over multiple life cycles
  - Program for network performance
  - Define required functionality, user comfort...
Are there limits to recycling waste into improving bituminous products?

NOW THAT'S INTERESTING

Amsterdam is now using recycled toilet paper extracted from sewage as an ingredient in asphalt.
Thank you!!

AUSTRALIAN ASPHALT PAVEMENT ASSOCIATION