Smart Pavements Australia Research Collaboration

SPARC HUB

Supplementary Submission

Inquiry into the implications of severe weather events on the national regional, rural, and remote road network

House of Representatives Standing Committee on Regional Development, Infrastructure and Transport

16 June 2023

SPARC HUB Smart Pavements Australia Research Collaboration
ARC Smart Pavements Hub
Department of Civil Engineering,
Monash University
www.sparchub.org.au

1. Response to Questions on Notice

1.1. Question on Notice#1

Member	Question
Mr PASIN (Deputy Chair)	Going back to sprayed seals, there are 800,000 kilometres of road in our country. Do we know how much of that network that is bituminised is subject to a sprayed seal as opposed to a thick seal? Does anyone have that data? I would appreciate, on notice, getting that detail rather than my back-of-the-envelope calculation.

We have estimated the proportion of sealed and unsealed roads concerning the total length of the Australian road network, utilising data from the BITRE Yearbook (2022), specifically for 2015. Table 1 provides a detailed breakdown of these road lengths for each state and territory. According to Austroads (2017), approximately 90% of the sealed road network comprises sprayed seal roads, amounting to 343,067 km in 2015.

Table 1 Road length by type of road, by state and territory for the Year 2015 (BITRE, 2022)

State or territory	Sealed (km)	Unsealed (km)	Total (km)
New South Wales	102,397	104,790	207,187
Victoria	82,604	63,132	145,736
Queensland	85,138	139,113	224,251
South Australia	31,532	65,386	96,918
Western Australia	55,797	101,572	157,369
Tasmania	11,526	8,426	19,952
Northern Territory	8,843	10,439	19,282
Australian Capital Territory	3,348	100	3,448
Total (km)	**381,185**	**492,958**	**874,143**
The percentage of **sealed road network** in relation to the total length of the Australian road network	44		
The percentage of **unsealed road network** in relation to the total length of the Australian road network	56		
The percentage of **sprayed seal road network** in relation to the *total length of the sealed road network in Australia*	~ 90 (Austroads, 2017)		
The percentage of **sprayed seal road network** in relation to the total length of the Australian road network	~ 39		

1.2. Question on Notice#2

Member	Question
Mr PASIN (Deputy Chair)	Could you tell me what it costs—ballpark figure—to apply a single sprayed seal per kilometre; a double sprayed seal per kilometre; and then what it costs per kilometre to apply a seal on a highway to a thicker prescription? If you can't do it here, getting that on notice would be important.

Following the public hearing on June 1, 2023, we contacted several local suppliers to obtain estimates for the cost of seal materials, delivery expenses, and equipment hire charges for seal construction. However, due to the need

SPARC HUB Smart Pavements Australia Research Collaboration
ARC Smart Pavements Hub
Department of Civil Engineering,
Monash University
www.sparchub.org.au

for specific project details such as construction location, site drawings, material quantities, and construction duration, we were unable to obtain accurate quotes.

Based on available data from reports, guidelines, online sources, and the cost of constructing our two-layer asphalt testbed in Victoria in 2021, we have estimated the costs for material and construction of various types of road surfacing material layers, as presented in Table 2.

Table 2 Estimated cost for materials and construction of different types of road surfacing material layers

Seal type	Rate (AUD per lane-km)*	The calculation details are provided in the Appendix
single/single	13,200	Table A1
double/double	22,400	Table A1
75 mm asphalt	178,000	Table A7
175 mm asphalt	403,000	Table A7

*one lane-km is equivalent to 3,600 m^2 area on average; a kilometre-long segment of road that is a single lane in width. To calculate for a road of 4 lanes (two ways), the above numbers need to be multiplied by 4 and so on.

It should be noted that the estimate provided above does not include additional costs such as design expenses, haulage costs, construction equipment mobilisation costs, pavement surface condition assessments conducted before opening the road to traffic, project management expenses, and site supervision costs. These factors should be considered when calculating the overall cost of a seal construction project.

2. Supplementary Details Regarding Certain Aspects Discussed in the Public Hearing on 1 June 2023

2.1. Automated crack sealing machine

Following the public hearing on June 1, 2023, we conducted an extensive search to gather information on the current research activities regarding automated crack-sealing machines as the committee expressed significant interest in adopting this technology for Australia. We found that the US company SealMaster introduced the CrackPro Robotic Maintenance Vehicle (RMV) in 2022 (https://www.youtube.com/watch?v=6aicARWczVw). This vehicle is equipped with an automated blower system that cleans cracks for sealing, as well as an advanced AI vision system that measures and scans cracks, controls the flow of crack sealant material, communicates with a robotic arm, and guides the wand and shoe of the heated hose for dispensing the sealant. The actual cycle time will vary depending on the size and density of the cracks. The vehicle operator receives a red/green light signal and live crack processing data on the operator interface for informational purposes only. The operator is responsible for proper operation, braking, and controlling the truck's speed (https://rmv.llc).

Currently, the CrackPro RMV is not available for purchase in Australia. However, we were able to establish contact with an international business consultant and obtain a quote for the RMV. The purchase price of the RMV is USD 949,000 (~ AUD 1,394,370, Ex Works). The *obtained quote and product brochure are attached below* for the committee's reference. It should be noted that further research and development and specification development may be required to implement this technology, considering the local road conditions, climate conditions, safety standards, and maintenance practices.

SPARC HUB Smart Pavements Australia Research Collaboration

ARC Smart Pavements Hub
Department of Civil Engineering,
Monash University
www.sparchub.org.au

2.2. Permeability of seals

2.2.1 Permeability measurements by SPARC for single-single sprayed seals

Twenty years old sprayed seals (single-single) collected from operating roads in Narrandera, New South Wales were subjected to constant head-saturated permeability test in the laboratory using a flexible wall permeameter (Maha Madakalapuge et al., 2023). Table 3 presents the measured saturated permeability values for these seals.

Table 3 Experimental results of saturated permeability of single-single seals obtained from flexible wall permeameter

Aggregate size (mm)	Seal sample thickness (mm)	Saturated permeability from constant head method (m/s)	Time taken by rain water to pass through 20 mm seal (hours)	Time taken by rain water to pass through 40 mm seal (hours)	Time taken by rain water to pass through 75 mm seal (hours)
10	20	1.3×10^{-6}	4.3	8.5	16.0
14	10	1.8×10^{-7}	30.9	61.7	115.7

It should be noted that the pressure exerted by vehicle tyres on the road seal surface can significantly decrease the time required for rainwater to penetrate through a seal layer.

2.2.2 In-situ permeability measurements on low and high traffic roads in Mexico

The researchers at Universidad Michoacana de San Nicolás de Hidalgo, Morelia, México developed an innovative field infiltrometer to measure the surface infiltration rates of road pavements (Dante Uriel et al., 2022). Using this equipment, the researchers conducted several in-situ tests on both low and high-traffic roads in Mexico, considering cracked and uncracked surfaces. The estimated permeability values, obtained from the measured mean infiltration rates, are presented in Table 4 below.

It should be noted that during the field testing, certain external factors were observed to affect the infiltration rates of cracked pavements, such as the presence of debris filling the cracks and the internal conditions of the pavement structure, including cracking interconnection and the state of the interface between the asphalt and base courses. These studies highlight that the permeability of seals with debris-filled cracks can be ten times higher than the uncracked pavement seal. If cracks are open, a much higher increase (several orders of magnitude) in permeability can be expected.

Table 4 In-situ permeability measurement values for low and high traffic roads in Mexico

Road type	Seal condition	Estimated permeability, k (m/s)	Time taken by rain water to pass through 20 mm seal (hours)	Time taken by rain water to pass through 40 mm seal (hours)	Time taken by rain water to pass through 75 mm seal (hours)
Parking lot	a 4cm multi layered asphalt chip seal, *uncracked surface*	1.24×10^{-6}	4.5	8.9	16.7
Low traffic road	Asphalt Chip seal surface, *uncracked*	1.10×10^{-7}	50.6	101.2	189.8
High Traffic	a 10 cm thick dense graded asphalt surface course, *cracked surface*	2.42×10^{-6}	2.3	4.6	8.6
High Traffic	a 10 cm thick dense graded asphalt surface course, *uncracked surface*	1.38×10^{-7}	40.2	80.4	150.8

It should be noted that the pressure exerted by vehicle tyres on the road seal surface can significantly decrease the time required for rainwater to penetrate through a seal layer.

2.3. The Commonwealth's role in road resilience planning

There was a discussion regarding our proposal for establishing a Commonwealth-funded national centre and how the federal, state, and local governments can collaborate by improving the coordination of their funding for the road network. In this regard, we are presenting additional details on how this centre could be established and operated to address the urgent issues in transport infrastructure.

Financial Context: Australia allocates approximately $30.25 billion (BITRE, 2019) annually to roads, with a substantial portion dedicated to maintaining its extensive 900,000 km road network, which holds the world's highest per capita maintenance expenditure. Additionally, the Australian Government has committed $120 billion over the next decade for national transport infrastructure projects. Further, unsealed roads constitute approximately 60% of the Australian road network and are mainly managed by local governments.

Proposed Commonwealth-funded National Centre: To enhance road resilience planning, there is an opportunity to establish a Commonwealth-funded centre that addresses transport pavement (roads, rails, airport runways, port pavements and min-haul pavements) needs on a national scale. SPARC model (https://sparchub.org.au) is one that the Commonwealth can consider for fostering research and skill enhancement for the future advancement of Australian transport pavements.

This centre would link the entire value chain of universities, peak bodies (such as Austroads and AfPA), state road authorities, local government association (LGA) representing local councils, contractors and research organisations (such as NTRO) to future-proof the transport pavements industry, making transport pavements cost-effective, climate-resilient, safer, with a lower environmental footprint and adaptable to future transport demands and climate changes.

State and Local Governments' Involvement: we would like to emphasise the participation of state and local governments in the proposed Commonwealth-funded centre, which would enhance collaboration and coordination for effective road resilience planning through Commonwealth involvement. State road authorities and the local government association representing 537 councils in Australia are crucial stakeholders in road resilience planning. Their involvement will ensure that road resilience planning is effectively coordinated at all levels of Government. To optimise the utilisation of funds and ensure comprehensive engagement, these entities should actively participate in the proposed centre. By involving state road authorities and the local government association – the peak body representing councils, the centre would benefit from their extensive experience, local knowledge, and understanding of the unique challenges faced at different regional levels.

Objectives and Activities of The Centre: The centre could lead efforts in industry-relevant research, skill enhancement and knowledge dissemination, innovations, technology evaluations and commercialisation, and the development of standardised guidelines and protocols for road resilience planning. Some key areas of focus could include:

- *Advanced testing and design methods*
- *Innovative and recycled materials*
- *Enhancing roads safety*
- *Effective condition assessment, maintenance and rehabilitation technologies for sealed and unsealed roads*
- *Intelligent construction technologies and technology validation field trials*
- *Climate resilience of transport infrastructure*
- *Sustainability, net-zero within the circular economy*
- *Undergraduate and Higher Degree (MSc and PhD) training, short courses, webinars and conferences*
- *Data security and sharing*
- *Advanced sensing and Digital twins of transport infrastructure for intelligent asset management*
- *Knowledge transfer and international collaboration*

SPARC HUB Smart Pavements Australia Research Collaboration
ARC Smart Pavements Hub
Department of Civil Engineering,
Monash University
www.sparchub.org.au

3. References

1. Bureau of Infrastructure and Transport Research Economics (BITRE), 2022, Yearbook 2022: Australian Infrastructure and Transport Statistics, Statistical Report, BITRE, Canberra ACT.
2. Bureau of Infrastructure, Transport and Regional Economics (BITRE), 2019, Yearbook 2019: Australian Infrastructure Statistics, Statistical Report, BITRE, Canberra ACT.
3. Austroads (2017). Guide to Pavement Technology Part 2: Pavement Structural Design, AGPT02-17, Sydney, Australia.
4. Maha Madakalapuge, C., et al. (2023). Experimental and numerical investigation of moisture variations in unbound pavements with sprayed seals during drying and wetting. Transportation Geotechnics, 2023. 39: p. 100951.
5. Dante Uriel Contreras-Ferreyra, Carlos Chávez-Negrete and Nelio Pastor- Gómez (2022). In-situ measurement of surface infiltration in flexible pavements, International Journal of Pavement Engineering, 23:11, 3958-3972, DOI: 10.1080/10298436.2021.1931196

4. Appendix

Table A1 Breakdown for spray seals

Item	Rate (AUD per lane-km)	Further details
Cleaning the surface using a sweeping truck	40	Table A2
Spraying prime	4,000	Table A3
Aggregate -Single/single	3,600	Table A4
Aggregate -double/double	7,200	Table A4
Binder - single/single	5,200	Table A5
Binder - double/double	10,400	Table A5
Compaction – single/single	360	Table A6
Compaction – double/double	720	Table A6
Total cost - single/single	**13,200**	
Total cost - double/double	**22,400**	

Table A2 Breakdown for sweeping

Description	Value
Productivity of the sweeping truck (m^2/hr)	32,400 [1]
Productivity of the sweeping truck (lane-km/hr)	9
Cost of sweeper truck including driver and fuel (AUD/hr)	360 [2]*
Cost of sweeper truck including driver and fuel (AUD/lane-km)	**40**

*Includes inflation. This rate does not consider minimum hours of hiring.

ARC Smart Pavements Hub
Department of Civil Engineering,
Monash University
www.sparchub.org.au

Table A3 Breakdown for spraying prime

Description	Value
Spray truck hire including driver and fuel (AUD/hr)	250 [3]
Spraying speed (km/hr)	10 [4]
Spray rate (litre/m^2)	0.9 [5]
Required volume of prime (litre/lane-km)	3,240
Price of prime (AUD/litre)	1.2 [6]
Spraying cost of prime (AUD/lane-km)	**4,000**

Table A4 Breakdown for spreading aggregates

Description	Value
Typical density of 14 mm aggregate (kg/m^3)	1,700
Price of the aggregate (AUD/kg)	0.05 [7]
Application rate of aggregates for ALD (average lease dimension) of 14 mm (m^2/m^3)	90 [8]
Required volume of the aggregates for one lane-km of single/single seal (m^3)	40
Required volume of aggregates for one lane-km of double/double seal (m^3)	80
Aggregate spreading truck hire including driver and fuel (AUD/hr)	250 [3]
Aggregate spreading speed (km/hr)	10 [4]
Aggregate cost for single/single (AUD/lane-km)	**3,600**
Aggregate cost for double/double (AUD/lane-km)	**7,200**

Table A5 Breakdown for binder

Description	Value
Typical application rate including allowances for C170 bitumen (litre/m^2)	1.2 [8]
Price of C170 bitumen (AUD/litre)	1.2 [6]
Cost of binder for single/single seal (AUD/lane-km)	**5,200**
Cost of binder for double/double seal (AUD/lane-km)	**10,400**

Table A6 Breakdown for compaction

Description	Value
Recommended roller productivity (m^2/hr)	3,000 [9]
Roller hire and operator (AUD/hr)	150 [10]
Expected number of roller passes	2
Rolling charge (AUD/lane-km)	**360**

ARC Smart Pavements Hub
Department of Civil Engineering,
Monash University
www.sparchub.org.au

Table A7 Breakdown for asphalt work

Description	Value
Typical productivity of asphalt paving (lane-km/day), assuming paver speed of 6m/min and the mix delivery of 240 tonnes per hour for 75 mm thickness and 560 tonnes per hour for 175 mm thickness	2.5 [12]
Cost of asphalt paving crew and paver (AUD/day)	14,000 [11]
Asphalt material cost (AUD/ton)	260 [11]
Asphalt delivery cost	TBD*
Typical asphalt density (ton/m^3)	2.4
Required volume of asphalt to construct one lane-km asphalt layer with 75 mm thickness (m^3)	270
Required volume of asphalt to construct one lane-km asphalt layer with 175 mm thickness (m^3)	630
Cost of compaction (pneumatic and double-drum roller hire, fuel, and operator) assuming 6 roller passes (AUD/lane-km)	2,450
Cost of direct-transmission NDG density tests at the end of compaction (AUD/Day)	1,200
Total cost - 75 mm asphalt layer (AUD/lane-km)	**178,000**
Total cost -175 mm asphalt layer (AUD/lane-km)	**403,000**

* This depends on factors such as the location of the construction site, the availability of an asphalt plant nearby, and other relevant considerations.

References used in the calculations

1. EMC Electric vehicles. *Dulevo-the-sweeper-giants*. 2018; Available from: https://www.electriccarts.com.au/dulevo-the-sweeper-giants/.
2. Pratt, J. *Road Sweeper Hire Rates: How much does road sweeper hire cost?* 2019; Available from: https://blog.iseekplant.com.au/blog/street-sweeper-hire-rates-guide.
3. Palm council. *2022-2023 FEES AND CHARGES SCHEDULE*. 2022; Available from: https://www.palmcouncil.qld.gov.au/downloads/file/190/2020-21-fees-and-charges.
4. Department of Transport and Main Roads, *Transport and Main Roads Specifications MRTS11 Sprayed Bituminous Treatments (Excluding Emulsion)*. 2022.
5. Austroads, *Selection and Design of Initial Treatments for Sprayed Seal Surfacings*. 2016.
6. Department of Transport and Main Roads. *C170 Bitumen Prices as at 15th day of each month*. 2023.
7. Fulton Hogan, *Materials for Purchase*. 2021.
8. Department of Transport and Main Roads, *Technical Note 175 Selection and Design of Sprayed Bituminous Treatments*. 2017.
9. Australian Flexible Pavement Association, *Pavement work tips - No 24 Sprayed sealing - Rolling of cover aggregate*. 2000.
10. iseekplant. *Roller Hire Rates Guide*. 2019.
11. Asphalt & Civil Construction Pty Ltd, *Quote No: KP2021/033B*. 2021.
12. Australian Flexible Pavement Association (AfPA), Asphalt Paving Speed – pavement work tips – no.31. 2001.