

Public Procurement of Road Building Materials – Research into Recycled Content

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Contents

Contents.....	iii
List of Tables	iv
1 Introduction	1
1.1 Context	1
2 Research.....	2
2.1 State Project Details	3
2.2 Material Recycling Rates & Availability	4
2.3 Plastics, Tyre Crumb and Glass Recycled Content Potential	6
3 State Guidelines for Recycled Product Use	7
4 Results - Discussion.....	9
4.1 Summary Figures	9
4.2 General	9
5 Bibliography	10

List of Tables

<i>Table 1 Estimated KMs of State road projects currently under construction (10 projects only).....</i>	<i>2</i>
<i>Table 2 State by State Road Infrastructure Projects, Australia – Basic Details</i>	<i>3</i>
<i>Table 3 Tonnes Waste Recycled & Disposed of per material, per State</i>	<i>4</i>
<i>Table 4 Recycled materials availability, Nationwide</i>	<i>5</i>
<i>Table 5 Potential Tonnes of Recycled Content</i>	<i>6</i>
<i>Table 6 Recycled Materials that could be used in two road infrastructure projects per State</i>	<i>9</i>

1 Introduction

ACOR and its members wish to develop a paper to discuss the possibilities of using recycled materials in the creation of roads in major infrastructure projects. In particular, in addition to the use of crushed recycled aggregate, the study investigates the potential for the use of recycled glass, plastics and tyre crumb in road construction.

This report outlines the research results for the six Australian States of:

- New South Wales - NSW
- Queensland - QLD
- Victoria - VIC
- South Australia - SA
- Western Australia - WA
- Tasmania - TAS

The research broadly identifies:

- Two major road infrastructure projects in construction in each State;
- Current recycling material uses within each project; and
- Scope for further recycle use in road construction / upgrades.

1.1 Context

There are numerous road and other large infrastructure projects currently under construction throughout Australia. There are many more in the planning and design stages¹. Due to the timescale and scope of this project, the study focussed on two road building projects per State and excludes major projects of National importance such as the Snowy Hydro 2.0 expansion (primarily due to time constraints and lack of publically available information). Should all State, Federal and Local Government road infrastructure projects consider the uptake and use of the nominated recycled materials (glass, plastic and tyres), there would be an enormous demand for them, resulting in little or no disposal of the generated materials.

The use of recycled materials in road base is not a new concept. However, the standardised use of certain material types within road base is yet to be achieved. Each State has a specification for the use of recycled content within pavements and roads, however the materials considered tend to be limited to 'masonry' type materials from the construction and demolition sector, such as asphalt, bricks, concrete and rubble.

There is far more scope for the use of recycled materials, such as glass, mixed plastics and tyre crumb within road building. For example, it is accepted by VicRoads that a 'Close the Loop' (<https://www.closesthe-loop.com.au/>) derived asphalt mix containing soft plastics and toner additive meets their performance criteria, however, it does not meet their specification as there are no specifications for recycled polymer use in asphalt.

The addition of recovered soft plastics used as recycled polymers enhance the performance characteristics of asphalt, delivering a 65% increase in fatigue life over standard asphalt, and a huge improvement in deformation resistance, from a measurement of 9-11mm for standard asphalt down to just 2mm for asphalt containing the soft plastics additive.

¹ Infrastructure Priority List, Infrastructure Australia, September 2019

2 Research

In order to first understand the total volume of State-led road projects, an overview of all projects currently under construction per State was researched in detail. Each State was found to have at least 25 road projects under construction. These projects varied in size from 2km interchange upgrades to hundreds of km programmes, being constructed in stages over 10 year timescales. To demonstrate the extent of these developments as total km, 10 projects per State were selected to identify the results in Table 1.

The table illustrates for 10 projects per State, at least 4,300km of State-led road projects are currently under construction across Australia, including new roads, bypasses and sealing of existing roads. When projected as pro-rated km for 25 projects per State, the total exceeds 10,000km.

Table 1 Estimated KMs of State road projects currently under construction (10 projects only)

State	10 projects per State KMs (length) currently under construction	10 projects per State KMs (length*assumed 4 lanes) currently under construction	25 projects per State KMs (length*assumed 4 lanes) pro rata
NSW	360	1440	3,600
QLD	130	520	1,300
VIC	260	1040	2,600
SA	110	440	1,100
WA	170	680	1,700
TAS	60	240	600
Total	1,090	4,360	10,900

The remainder of this study focusses on the brief, which required the selection of two of the largest road infrastructure projects per State – these are identified in *Table 2*.

The research used the length of road being developed as a key indicator for project selection, but in the absence of extensive km development, other factors were considered, such as project expenditure and / or availability of information. Table 2 below identifies high level details for each selected project, and *Table 3* to *Table 5* detail the potential tonnages of recycled content available and that could be used in each of the nominated projects.

2.1 State Project Details

The selected two projects per State are identified and relevant details are provided in the tables below.

Table 2 State by State Road Infrastructure Projects, Australia – Basic Details

State	Project Name	Project Length: Km	Project Value: \$	Funders	Contractor
NSW	Pacific Highway Upgrade: Woolgoolga to Ballina	155km	\$5bn	Australian & NSW Governments	Laing O’Rourke
NSW	WestConnex	33km	\$16.8bn	Australian & NSW Governments	CPB Contractors
QLD	Bruce Highway Upgrade: Section D Woondum to Curra	26km	\$1bn	Australian & Queensland Governments	Not yet awarded
QLD	Pacific Motorway M1: Mudgeeraba to Varsity Lakes	5.7km	\$200m	Australian & Queensland Governments	Seymour Whyte Constructions
VIC	CityLink Tulla Widening	50km	\$1.3bn	Transurban & Australian & Victorian Governments	CPB Contractors
VIC	M80 Ring Road Upgrade	13km	\$368m	Australian & Victorian Governments	Not yet appointed
SA	Main South Road Duplication	10km	\$305m	SA Government	Not yet appointed
SA	Northern Connector Project	15.5	\$885m	Australian & SA Governments	Lendlease
WA	Kwinana Freeway: Northbound widening	8km	\$49m	Australian & WA Governments	SmartWays Alliance: BMD Constructions, Ventia and Arup
WA	Great Northern Highway: Stage 2 Muchea to Wubin	76km	\$347.8m	Australian & WA Governments	Various (e.g. Muchea North – WBHO Infrastructure \$28m)
TAS	Hobart Airport Interchange	1.6km	\$30m	Australian & Tasmanian Governments	Tender closed in August 2019 – not yet appointed
TAS	Midland Highway: Perth Link Roads	4.5km	\$500m	Australian & Tasmanian Governments	VEC-Shaw

2.2 Material Recycling Rates & Availability

Table 3 provides the material tonnages for glass, low-grade mixed plastics and masonry currently recycled or disposed of per State (tyre data per State was not available and as such has been incorporated into total tonnages in Table 4).

Table 3 Tonnes Waste Recycled & Disposed of per material, per State

State	Glass		Mixed Plastics		Masonry Materials	
	Disposed	Recycled	Disposed	Recycled	Disposed	Recycled
NSW	147,538	195,574	609,562	28,738	1,534,958	3,947,036
QLD	92,405	122,491	382,178	18,022	961,367	2,472,085
VIC	118,136	156,600	492,647	23,253	1,229,069	3,160,463
SA	32,486	43,062	132,233	6,267	337,974	869,077
WA	48,587	64,405	197,935	9,365	505,485	1,299,819
TAS	9819.48	13,017	40079	1,921	102,160	262,697
Total	448,972	595,149	1,854,634	87,566	4,671,013	12,011,177

It is important to note that the mixed plastics figures consider plastics as identified in the Australian Plastics Recycling Survey 2017-18, but excludes polyethylene terephthalate (PET), high density polyethylene (HDPE) and low / linear low density polyethylene (PE-LD/LLD). Glass and masonry figures are as per those identified in the National Waste Report 2018, based on a per capita calculation, in order to project tonnes per State.

Table 4 identifies the availability of masonry, glass, tyres and low-grade plastics across all waste streams and the total tonnes of material not currently recycled (and therefore assumed to be available for use).

Table 4 Recycled materials availability, Nationwide

Material Type	Total Waste Generation (tonnes)	Resource Recovery Rate* (%)	Resource Recovery (tonnes)	Materials Disposed / Available (tonnes)
Masonry	17,100,000	72%	12,312,000	4,788,000
Glass	1,100,000	57%	627,000	473,000
Tyres	466,000	69%	323,000	143,000
Plastics	1,996,000	4.5%	89,900	1,906,100
Total Tonnes Available	20,662,000		13,351,900	7,310,100

Although it is stated that recycling rates of glass and masonry materials are 57% and 72% respectively, it is also reported that these materials are prone to significant stockpiling, due to commodity prices and in certain States, lack of markets.²

The plastics refer to mixed low-grade (i.e. excluding PET, HDPE and PE-LD/LLD) residual plastics across all waste streams³, and glass and glass fines across all waste streams, Australia wide (and as such, the total figures exceed those of *Table 3*, which are provided for the six nominated States). These materials are sometimes difficult to recover and not easily or cost effectively recycled.

The tyres are derived across all sectors, and total 58 million EPUs (2018/2019) Australia wide⁴. The breakdown of used tyres includes 190,000 tonnes (23.7million EPUs) from passenger vehicles and motorbikes; 158,000 tonnes (19.7million EPUs) from trucks and buses; and 118,000 tonnes (14.7 million EPUs) off the road vehicles. The 69% of EPUs recovered are reused (10.6 million EPU), processed into tyre derived products (23.8 million EPU) or used whole in thermal processing (5.9 million EPU).

² National Waste Report, Australian Government Department of the Environment and Energy 2018

³ Australian Plastics Recycling Survey, Australian Government Department of the Environment and Energy 2017-18

⁴ 2018-19 Australian tyre consumption and recovery Factsheet, Tyre Stewardship Australia

2.3 Plastics, Tyre Crumb and Glass Recycled Content Potential

The estimates in *Table 5* identify the potential tonnes of recycled materials that could be diverted from landfill and used in road building, per two projects identified per State. Assumptions have been used in terms of plastics at 1.5% and tyre crumb at 2.5% allowable limits of the total mass, in the absence of a specification for detailing these. The allowable limits for recycled glass content vary dependent on road/pavement type, so 10% has been used as a median figure (Queensland specifies 5% glass cullet content, whilst NSW allow 15% as a total of fine aggregate).

Table 5 Potential Tonnes of Recycled Content

State	Asphalt layer at 350mm				Sub-base layer at 650mm			
	Total from projects listed (tonnes)	Potential recycled content (tonnes) 1.5% plastic	Potential recycled content (tonnes) 2.5% tyre crumb	Potential recycled content (tonnes) 10% glass	Total from projects listed (tonnes)	Potential recycled content (tonnes) 5% glass	Potential recycled content (tonnes) 10% glass	Potential recycled content (tonnes) 15% glass
NSW	3,290,000	49,350	82,250	329,000	6,110,000	305,500	611,000	916,500
QLD	554,750	8,321	13,869	55,475	1,030,250	51,513	103,025	154,538
VIC	1,102,500	16,538	27,563	110,250	2,047,500	102,375	204,750	307,125
SA	446,250	6,693	11,156	44,625	828,750	41,438	82,875	124,313
WA	1,470,000	22,050	36,750	147,000	2,730,000	136,500	273,000	409,500
TAS	106,750	1,601	2,669	10,675	198,250	9,913	19,825	29,738
Total	6,970,250	104,554	174,256	697,025	12,944,750	647,238	1,294,475	1,941,713

*Calculations conducted based on thickness⁵ (asphalt 350mm; sub-base 650mm) x lane width⁶ (3.5m) x 6 lanes x KMs (total of two projects per State)

⁵ Roads and Maritime Supplement to Austroads Guide to Pavement Technology Part 2: Pavement Structural Design Document No: RMS 11.050 Version 3.0 | August 2018

⁶ AustRoads Guide to Road Design Part 3 Geometric Design Sydney 2016

3 State Guidelines for Recycled Product Use

Generally, across each State, (uncontaminated) excavated materials are stipulated to be reused within developments, in preference to importing fill materials. Targets of 80% to 100% reuse are often required within Environmental Impact Statements, Construction Environmental Management Plans and other relevant sustainability documents.

When considering recycled content use within road infrastructure developments, the focus is primarily on the use of crushed concrete as concrete additive and / or crushed stone (pavement, asphalt, gravel etc) for sub-base and pavement use. Specifications and / or guidance documents again encourage the use of these materials in projects, but there is often inconsistency from project to project and State to State in terms of the targets set and the amounts of recycled materials suggested / permitted to be used.

For example, in NSW, the Pacific Highway upgrade from Woolgoolga to Ballina estimates the required use of 750,000m³ of concrete, and 240,000 tonnes of asphalt. The targets state 100% on site reuse of demolition derived asphalt / gravel, 50% reuse / recycling of bricks on-site, and 70% reused, recycled, and reprocessed excess construction materials. The total quantity of recycled materials to be used within the overall project was not specified.

In contradiction, the NSW WestConnex project stipulates reuse / recycling rate of 80% minimum to be achieved for spoil and C&D materials created on site. However, the percentage of recycled material used in road base and sub base during the construction stage was only 10%, and the percentage of cement replacement material, measured by mass, used in concrete during the construction stage, was just 5%. The reasons for this are unclear (e.g. was it due to availability of materials, or lack of confidence in material performance, or something else?).

South Australia's guideline only allows a maximum of 20% mass of total materials used to be of recycled content (when referencing aggregates). In Tasmania, restrictions apply as to where asphalt that contains reclaimed asphalt (RAP) can be used and to the proportion of RAP that is acceptable in a mix. Generally, 15% RAP is permitted, but additional caveats and requirements are placed on mixes of over 15% RAP. Queensland also has a specification for recycled material blends for pavements, stipulating the mix and mass of recycled materials permitted to be used.

Western Australia is encouraging the use of recycled materials within their road infrastructure projects, but with no definitive percentage requirement. The Kwinana Freeway upgrade from Russell Road to Roe Highway is currently utilising 25,000 tonnes of recycled road base as a demonstration project. This is a joint initiative between Main Roads WA and the Waste Authority's 'Roads to Reuse' project.

There are numerous specifications and guidelines existing and in development for the inclusion of tyres / tyre crumb within national and state led projects, driven primarily by Tyre Stewardship Australia (TSA). These include:

- Austroads 2006: technical specifications framework AP-T41 coupled with a guide to the selection and use of Polymer Modified Binders: AP-T42 including the use of rubberised bitumen, identified as Crumb Rubber Modified binder. The AP-T42 guide also included a "Crumb Rubber Protocol" in which Constituent Specification, Binder Design, Field Blending Binder Specification Limits and other restrictions regarding and Sampling and Testing to check requirements were indicated;

- VicRoads, RTA NSW, Main Roads WA 2019: Study of the Australian Bitumen and Asphalt Industry’s capabilities and challenges in handling tyre derived crumb rubber technologies, Bitumen Solutions;
- Australian Asphalt Pavement Association (AAPA) 2018: Open graded and gap graded asphalt with a crumb rubber component specifications;
- Sustainability Victoria, AAPA and the Australian Roads Research Board (ARRB): developed Low Traffic Road Crumb Rubber Specifications; and
- Austroads & TSA (in development): developing national crumb rubber specifications.

Specifications continue to be developed and updated, often collaboratively, between States and trade organisations.

4 Results - Discussion

4.1 Summary Figures

- It is clear, as identified in *Table 6*, that the uptake of the use of recycled materials (plastic, tyre crumb and glass) in just two major road projects per State, could consume almost 2.3 million tonnes of recyclables.

Table 6 Recycled Materials that could be used in two road infrastructure projects per State

State	Potential recycled content (tonnes)		
	1.5% plastic Asphalt Layer	2.5% tyre crumb Asphalt Layer	10% glass Asphalt & Sub-Base Layers Combined
NSW	49,350	82,250	940,000
QLD	8,321	13,869	158,500
VIC	16,538	27,563	315,000
SA	6,694	11,156	127,500
WA	22,050	36,750	420,000
TAS	1,601	2,669	30,500
Sub-Total	104,554	174,256	1,991,500
TOTAL	2,270,310		

There are significantly more recyclable materials available than are currently being used (i.e. 28% masonry, 43% glass, 31% tyres, 95% plastics), whether due to stockpiling or inability to capture these materials (*Table 4*).

- It is clear that there is a significant need for road (and other major infrastructure) building materials (recycled or virgin), with almost 20 million tonnes of asphalt and sub-base alone required for a total of 12 State projects (*Table 5*).
- It is acknowledged that there are thousands of tyres currently disposed of/stockpiled in their whole form, and these may be difficult to obtain due to their origin at remote mine site locations. Transport logistics and associated distances may prove to be the main barrier to recovering these tyres.

4.2 General

- Each State supports the use of recycled content materials within road infrastructure development.
- There are specifications for the type and mass of materials that can be used / blended with virgin materials. However, in some cases each State has different material specifications. It would be greatly beneficial to have National specifications for all recycled content materials in road building, consistent in approach and including alternative recyclables.
- State and National governments need to be bolder in their support and acceptance of much higher use of recycled content materials in road infrastructure development (by using demonstration / case study projects to support the update of existing specifications).
- Availability of recycled materials requires further investigation.
- Consistency within State projects and across different jurisdictions would assist the progression of this industry – a minimum baseline could be developed, which could be enforced by specific procurement criteria / target setting.

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