F I N A L   R E P O R T

Technology and Market Development for Tyre Derived Products

Prepared for

Department of Environment and Conservation

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in conjunction with

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List of Acronyms

ABS	Australian Bureau of Statistics
ARF	Alternative Fuels and Raw Materials
BCA	Benefit Cost Analysis
CATRA	Canadian Association of Tire Recycling Agencies
CIF	Cement Industry Federation
EPR	Extended Producer Responsibility
EPU	Equivalent Passenger Unit
HNRV	Highest Net Resource Value
OTR	Off The Road
PMB	Polymer Modified Binder
R&D	Research and Development
SBR	Styrene-Butadiene co-polymer
TC	Transformation Category
TDF	Tyre Derived Fuel
TDP	Tyre Derived Product
URS	URS Australia Pty Ltd

List of Definitions

Ambient grinding	Mechanical grinding process, at room temperature.
Buffings	Rubber removed from tyre cases to prepare them for retreading..
Casing	A whole used tyre .
Collector	See 'Transporter'.
Cryogenic processing	Freezing process where used tyres are frozen and then shattered.
Disposal	Permanent disposal of end-of-life tyres, eg solid waste landfill or a tyre monofil
End use market	Markets that use Tyre Derived Products as inputs (See 'End market producer').
End market producer	Means a producer of products that use Tyre Derived Products as inputs.
End-of-life Tyre	Used tyre that cannot or is not reused for its originally intended purpose and is not retreaded. Such tyres may have use as a raw material for other processes or be disposed.
EPU	An equivalent passenger unit, the weight of tyre equal to an average new passenger tyre, 9.5kg. Alternatively for used tyre see UEPU below
UEPU	A used tyre based on an equivalent passenger unit, the weight of used tyre equal to an average used passenger tyre, 8kg. Equivalent to a passenger tyre casing (See 'Casing').
Processor	A business that processes used, rejected or unwanted tyres - not a retreader or a recycler.
Producer	Refers to the originators of new tyres, essentially the manufacturers and importers of new tyres (loose and fitted tyres) that begin the flow of tyres into a market.
Recycler	See 'Transformer'.
Retreader	Business that processes used, rejected or unwanted tyres for sale as a motor vehicle tyre.
Shredding	The cutting and tearing of waste tyre mechanically using a series of rotating knives.
Transformer	Business that processes used, rejected or unwanted tyres into a saleable product that is not a motor vehicle tyre.
Transporter	Business that transports used, rejected or unwanted motor vehicle tyres within Australia.
TDF	Tyre Derived Fuel - use of tyres as a fuel in purpose built furnaces, eg cement kilns, power stations, smelters or paper mills.
TDP	Tyre Derived Product – a saleable product derived from used, rejected or unwanted tyres, which can then be used as a raw material for other manufacturing process.
Tyre category	One of six common categories of tyres, eg Off The Road (OTR) tyres, truck and bus tyres, light and medium commercial tyres, specialty tyres, passenger tyres and motor cycle tyres.
Tyre monofil	A sanitary landfill, or portion of a landfill, that receives only end-of-life tyres. The landfill has an appropriate liner, cover, leachate collection system and monitoring system.
Used tyre	Used, rejected or unwanted motor vehicle tyre, that can be reused for its originally intended purpose, retreaded, transformed, recycled, or that may be destined for final disposal..
Waste tyre	A used, rejected or unwanted motor vehicle tyre that can not be reused, retreaded, recycled or transformed. It is destined for final disposal.

An National Used Tyre Product Stewardship Scheme has been proposed for Australia. A key desire of the WA Government is to prepare the WA market to gain maximum advantage from the proposed National Scheme by providing resource and market information to potential industry players in WA. This report was contracted to help address that objective.

The number of end-of-life tyres disposed in WA in 2005 was estimated at 2.0 million tyres, with 71% of tyres coming from Perth statistical division, and 11% from the south west. Tyre numbers do not however provide a direct indication of the potential resources in end-of-life tyres. When numbers are converted into equivalent passenger units (EPU) a very different picture of the distribution of resources is provided. On an EPU basis 4.5 million EPU were disposed in 2005, of those 44% were in the Perth region and 25% in the Pilbara - 65% of OTR tyres are in the Pilbara. The weight of rubber in those disposed tyres was some 25,000 tonnes. Of that 8,650 tonnes was in OTR tyres, and 10,900 tonnes was in the Perth region.

Transforming a used tyre into a Tyre Derived Product (TDP) is largely the reduction of an end-of-life tyre into gradually smaller and smaller particles, that tend to also become more and more purified. A summary of products is provided in the following *Product Market Summary* table. In WA, Reclaim Industries has been for some time the only major business reprocessing/ transforming end-of-life tyres. They have recently been joined by Tyre Recyclers WA. About 2,150 tonnes of used truck and bus tyres was reprocessed by Reclaim in 05/06, sourced mainly from the Perth region. This was 87% of the truck and bus tyres from the Perth region, but only 13% of the EPU disposed in the Perth region, and 6.0% of the of end-of-life EPU disposed of annually in WA.

The end-of-life tyre industry WA is characterised, like the industry in other states, by the situation where end-of-life tyres are ‘pushed’ through the waste tyre system from tyre changers/ retailers, to collectors/ transporters, to landfill operators. Tyre collectors are paid by tyre changers to dispose of end-of-life tyres and they will tend to do so at the least cost destination. Perth region estimates of cost for collection, transport, and landfill total $1.30 per EPU. If tyres are baled an additional cost of 20 cents per EPU is suggested. Collectors will pay transformers to take end-of-life tyres up to the cost of the disposal cost to a landfill operator, assuming legal disposal practices. Transformers will take tyres to the point where the payment in lieu of disposal, plus the returns from transformation processes, exceeds their net costs.

The used tyre collection sector has a large influence on the recycling of tyres, as it is connects the transformers with their end-of-life tyre resources. Tyre collectors have potential to control the supply of tyres to transformers. Landfill disposal costs also have a strong influence over the viability of transformation businesses as it is a major factor in determining what collectors are prepared to pay transformers to take their tyres.

In comparison to activities that are occurring around Australia, the volume and diversity of reprocessing in Western Australia is comparatively small. In Western Australia there are only a few major tyre collection and disposal operations, and two transformation businesses. Current and potential estimates of Australian markets highlight the opportunities that are available, and the disparity between Australia wide levels of reprocessing and the current level of activity in Western Australia. Continuity of supply and price paid to transformers are key factors to transformers business risk. The indicative financial analysis undertaken for this report suggests that for high value uses at least, many of the suggested options are viable especially for tyres sourced from the Perth region and proximate areas.

The analysis of market failure in the end-of-life tyre market has shown areas where market failure might exist. Quantification of the extent of market failures associated with end-of-life tyres provides an indication of the level of market intervention that may be justified - provided that intervention addresses the identified market failure in an efficient manner. Estimates suggest that the level of market failure in Western Australia might be costing as much as $65 million over ten years, inclusive of a $30 million cost associated with illegal landfill.

A number of barriers to industry development were raised in industry discussion for this report and previous research, suggested priority areas that might be addressed by supportive government policy are:

- unsupportive public procurement policies;
- inertia in using new products/ non-standard technology/ lack of product acceptance; and
- misconception that recovered rubber is of poorer quality than substitutes.

State and local government procurement policies might be directed to show the lead and foster the use of tyre derived products. Targeted procurement policies might be a good mechanism for high volume products and where products are demonstrated to be cost and technically effective. This mechanisms will be useful to overcome inertia in using new products/ non-standard technology.

Tyre derived products are not the same, they require different processing and will be sold into very different markets. These different products and markets require tailored strategies to facilitate their development. The primary strategy for improving demand and supply of tyre-derived products should be to recognise these differences and develop targeted strategies for each particular product. Set priorities on the basis of either value or volume, or specific product, they will each have specific needs to foster their expansion in WA.

Mandatory baling of tyres disposed to landfill has been suggested (by industry) as a mechanism that might allow landfilled tyres to be more effectively accessed in the future, and as a means to raise the cost of disposal such that reprocessing activities are correspondingly more financially attractive. A mechanism that can provide a more direct for of incentive would be much more efficient and impose a lighter burden of the WA consumer, or taxpayer.

Not all of the National Scheme's activities will be based on providing financial incentives, many will need to address market failures, and barriers to industry development and expansion. These issues maybe addressed prior to the implementation of the Scheme without major costs.

The National Scheme is likely to provide most support to tyre derived products that provide the highest net economic value – those products with the greatest likelihood of being financially viable without ongoing assistance. WA may best achieve increased levels of reprocessing by fostering activities that align with that principle and similarly target activities that will produce the highest net economic value.

Product Market Summary

Product / end use	Description of product and process	Sale price of product	Cost to produce from virgin materials	Cost to produce from recycled materials	Comment on viability / practicality of implementation
Retaining Walls, Foundations, Paving/Roads and Erosion Control	Made using whole tyres (TC1) with/ without side wall removed	$45 – 65 per tonne	Similar to tyre derived product	Use in engineering systems is suggested to be price competitive.	Proponents of civil engineering systems that utilise used tyres claim that they are cost-effective and provide savings of between 20% and 25% over comparative systems. Unsupportive public procurement policies are considered to be a major barrier to their use
Stemming – used with explosives to force the explosive energy into the surrounding rock	TC4 granulate		$5 - 10 per tonne (price of gravel substitute)	Exceeds substitute cost	This end use market would be dependent on a fee structure operating whereby the mine would receive a fee to take whole tyres in order to cover transformation costs into TC3 or TC4 for stemming
Energy Uses – Tyre Derived Fuel	Use of tyres as a fuel substitute for fossil fuels within furnaces for cement kilns, power stations, smelters or paper mills. Can use whole tyres (TC1), shredded tyres (TC2) or tyre chip (TC3).	Estimated price of between $35 – 74 per tonne would be the highest that kilns would pay for used tyres	$74 – 88 per tonne (price of energy equivalent)	Negative if payed to avoid landfill costs	Use is dependant on community acceptance. Could consume a large proportion of end-of-life tyres. A number of barriers to the development of this industry have been identified: additional operating and capital costs; and operational difficulties can occur with tyre feeder systems.
Energy Uses – Blasting Material	An alternative blasting mixture has been developed and patented that is based on replacing the diesel in the blasting mix with granulate (TC4)	More than $500 – 600 per tonne	$1,025 per tonne – dependent on price of substitute (diesel)	$500 – 600 per tonne	Potentially this product could utilise large volumes of rubber product, but there are still key issues to be overcome to ensure product performance and acceptance.

Product / end use	Description of product and process	Sale price of product	Cost to produce from virgin materials	Cost to produce from recycled materials	Comment on viability / practicality of implementation
Road Surfacing - Spray Seal	As a polymer modified binder where a specialist product is used to bind cracked roads, as a waterproof seal on bridge decks, and on roads where additional strength is required; and in bitumen.	$400 - 600 per tonne	For use as binder and in bitumen is competitive with substitutes	Price of rubber modified bitumen - $700/ tonne	Crumb rubber asphalts are uncommon in Australia. But use in bitumen or as a polymer modified binder has accepted applications but operators dislike using this product as it exhibits a terrible odour, requires higher operating temperatures, wears the spraying equipment at a faster rate, and is more difficult to clean machinery after its use.
Flooring and Mats	Rubber crumb (TC4) provides low cost filler that can add elasticity and performance to products, such as: soft fall rubber surfacing for use in playgrounds, work areas, safety matting; marine decking; horse float and utility linings.	Product dependent	rubber mats typically are comparable in cost to rubber products that have no recycled content	$350 - 600 per tonne	Is an area that has strong adoption rates with widespread applications
Moulded Products	The TC4 products that typically are included in this end use market are: speed humps and cushions; crash barriers.	Product dependent	Similar to recycled cost	$350 - 600 per tonne	The principal substitute product in this end market is new rubber, which tends to be of higher quality, although also higher cost. There is a perception that the rubberised products are of poorer quality than new rubber.
Adhesives	Recovered rubber (TC5) can be used to produce industrial adhesives	Product dependent	Some alternatives are more expensive than TDP inputs, or have some health and safety implications that TDPs do not.	$550 - 900 per tonne for TC5	The adhesive manufacturers require crumb that is completely free of metal (due to the product liability issue of corrosion stains showing through in grouts) – so it is usually sourced from buffings.

1.1 Background to Project

At the national level a National Used Tyre Product Stewardship Scheme has been proposed by Australian Tyre Manufacturers Association and Australian Tyre Importers Group, the original tyre manufacturers (of both local and imported tyres), and supported by the Federal Government through the Department of Environment and Heritage. The purpose of the Scheme is to establish product stewardship through an extended producer responsibility framework. The Scheme aims to systematically address the current situation in Australia where the majority of end-of-life tyres are disposed to landfill, discarded illegally, or used for applications that may not represent their highest potential value. This is despite end-of-life tyres already being a significant resource for a number of products and markets. The scheme should create a “market-pull” demand for used tyres thus making inappropriate disposal of used tyres financially unattractive.

At the WA State level the Waste Management Board approved a *Used Tyre Strategy* for Western Australia in November 2005. The implementation of this Strategy is linked to, and will be influenced by, the National Tyres Product Stewardship Scheme. The WA strategy is designed to identify achievable actions that will set the groundwork for the introduction of the National Tyres Product Stewardship Scheme. The main focus is on establishing a sustainable local tyre recycling industry in WA with an emphasis on resource recovery and market development. The role of the WA Government is to coordinate the implementation of state regulatory, economic and market initiatives outlined in this Strategy to support national initiatives and promote market development of tyre-derived products.

1.2 This Project

A key desire of the WA Government is to prepare the WA market to gain maximum advantage from the National Scheme by providing resource and market information to potential industry players in WA. WA wants to be quick off the mark to attract investment into the WA market to gain the highest possible level of value and resource recovery. As part of Western Australia’s Used Tyre Strategy, a number of actions were identified as being required in order to address technology and market development issues for tyre-derived products. URS was commissioned by the Department of Environment and Conservation to:

- Detail and analyse existing situation including market characteristics, tyre recycling industry conditions and influences affecting the market for tyre-derived products;
- Detail and assess potential market size, trends and opportunities; and
- Undertake data consolidation.

1.2.1 Requirements of the Brief

The required elements outlined by the brief against the three primary outputs are as follows:

Detail and analyse existing situation including:

- Tyre Recycling Industry Segmentation including products and service segmentation, major market segments, industry concentration, geographic spread;
- Tyre Recycling Industry Conditions including barriers to entry, industry assistance, taxation, regulation and deregulation, cost structure, capital and labour intensity, technology and systems, industry volatility;
- Market Characteristics including current market size, linkages, downstream industries, upstream industries, demand determinants, domestic and international markets, basis of competition, life cycle;
- Identification of energy and other cost savings through the use of used tyre derived materials as against virgin materials;
- Performance including historical performance analysis, current performance analysis with data series, key sensitivities, key success factors; and
- Identify and detail all relevant stakeholders that are contacted regarding this consultancy including Australian, state, regional and local governments, mining, industry participants, tyre retailing, recycling and transport companies, etc.

Detail and assess market size, trends and opportunities, linking with the proposed national scheme for used tyres, including:

- Identification and synopsis of potential market sectors in WA, interstate and overseas;
- Market Trends including competition from imports and virgin materials, recycling of tyres;
- Market Size inc. total market by value, by product type, by volume, by end-user sector, leading markets for WA;
- Current and new technology identification including technology gaps and potential commercialisation opportunities.
- Future Trends including market niche, Asian and global markets, competitive virgin material costs;
- Regional variation and opportunities in the marketplace;
- Distribution including tyre stocks and transport economics;
- How robust is the market?; and
- Make specific recommendations to address any pertinent aspects that would detract from or hinder market development or opportunities.

Consolidate data which describes

- Tyre Recycling/Reuse Industry composition/synopsis - Key trade associations, List of activities, Enterprises, their Turnover, Assets, Industry gross product; Employment; Wages
- Imports and exports (interstate and overseas); Domestic demand.

1.3 A guide to the Report

Section 1 Introduction, introduces the Project and its objectives, and provides the context of the report.

Section 2 Market Failure - The Need for Intervention reviews what market failure is and estimates the type and size of that failure in Western Australia.

Section 3 Current and Projected Stocks and Flows - Resource Supply describes the number of tyres and the size of the resource that is reprocessed currently, and the number of tyres that are disposed to landfill, and those that are illegally disposed or stored. Flows are described for six tyre categories across nine statistical regions.

Section 4 Transformation of End-of-Life Tyres briefly describes the transformation processes and the "Transformation Categories" that are derived.

Section 5 Current and Potential Uses - Demand Analysis summarises the current and potential uses in Australia and attempts to estimate potential demands in Western Australia.

Section 6 Western Australian Tyre Derived Product Market presents an overview of market participants, market potential and imports and exports of TDP in WA.

Section 7 Indicative Returns from Alternative TDP in WA presents an analysis of indicative financial returns for each of the transformation categories for tyre product sourced from nine defined regions in WA.

Section 8 WA Market Opportunities summaries suggested opportunities for industry development.

Market Failure - The Need for Intervention

2.1 The Concept of 'Market Failure'

The term 'market failure' is used to describe situations where market forces are not able to deliver socially optimal outcomes. The concept provides a means for understanding what measures may be required to overcome the problem/s that has been identified, and whether intervention may be required. The economics literature identifies several factors that can impede the operation of markets to produce socially optimal outcomes. Under these circumstances it may be justified for government intervention to improve market performance. Definitions, examples, and cost estimations of tyre reuse were developed in detail for Australia as a whole in URS (2006). The definitions and analysis developed in that report are summarised and revised for the Western Australian situation in this report. Definitions of market failure are provided below.

- ***Externalities*** are values (costs or benefits) that arise from economic activity that are not reflected in the price of a goods or service being produced by that economic activity – its ***where private costs and benefits are not aligned with social costs and benefits.*** An external cost arises when social costs are greater than private costs. Environmental pollution is a example of an external cost that may not be taken fully into account in private decision making. Market–based instruments such as levies and subsidies are now also being used to try to internalise social costs into private decision-making.

- ***Public Goods and Collective Goods - where it is not feasible to exclude anyone from consuming goods and services***. This form of market failure can arise where consumption or use by one individual does not diminish the amount available to others (non-rivalry in consumption) or because the transaction costs of exclusion are prohibitive. Social institutions such as law and order, and information are classic examples of public goods that are non-rivalrous in consumption – subsequently they may be undersupplied without intervention. Collective goods are a sub-set of public goods, where the goods and services are provided for the mutual benefit of a group, such as an industry. For example, industry associations often collect and distribute statistics and develop training programs for the benefit of their members.

  Where waste products have not traditionally been traded and have been considered 'non-market' goods, industry institutions will not generally be well developed. Thus, industries dealing in waste products, such as end-of-life tyres, often do not have the institutional infrastructure to provide collective goods. It takes time and experience for industries to mature enough to develop the collective goods that enable them to work efficiently.

  When goods and services cannot be efficiently priced and are available to everyone in a society, taxation is typically used to pay for them. For collective goods and services, levies or membership dues support their provision. A critical issue is that unless a mechanism like this is available to ensure that everyone who benefits also pays, individuals may have an incentive not to pay - the "free-rider problem". Overcoming the free-rider problem is another rationale for government intervention in markets to enable them to perform better.

- ***Information failures.*** Information is the lifeblood of markets. Market participants need to understand the products on offer, the needs of consumers, the conditions of trade, supplies, demand, prices and costs, and to be able to identify potential participants in the market. All of these require information. Markets cannot operate optimally where consumers or producers do not have adequate information to make informed decisions or to undertake transactions. However, information is also costly. Achieving the optimum information level involves a trade-off between the benefits and costs of information. Information is likely to be limited in newly developing areas with new products, markets and operators. Governments often intervene in markets to overcome information failures. Regulation is often used in areas of high risk and where information is too technical to be widely understood, such as health and safety. Information issues can also be tackled directly through provision of information and transparent processes.

- ***Monopoly and non-competitive behaviour*** can lead to over-charging and restriction of supply of goods and services relative to the social optimum. However, when economies of scale and scope are available, the most efficient outcome may be a monopoly or oligopoly (a small number of firms). "Natural monopolies" occur when economies of scale and scope are such that the only efficient market structure is a monopoly. Utilities like electricity, water or household garbage collection and waste management have traditionally been considered to be natural monopolies. Almost by definition, such situations are likely to arise in the developmental stages of a market as firms develop new and innovative products and processes. Governments typically intervene in markets where competition may be restricted through competition policy, specific regulation or public ownership. In recent years, this field of government intervention has been subject to significant reform with improved understanding of the nature of such markets and of the strengths and weaknesses of types of government intervention itself.

2.2 Market Failure in End-of-Life Tyre Industry

Market failure can arise from several sources, as outlined above. A summary of how these concepts apply to the Australian end-of-life tyre markets; and whether and to what extent the various forms of market failure distort resource allocation in these markets is provided in Table 2-1. Generally it is anticipated that the market failure that exists to varying extents in markets across Australia will apply similarly in the Western Australian context. Differences do exist where the rates of illegal storage/ dumping are suggested to be higher in Western Australia than the national average, and this has an effect on the level of impact as measured by the resulting environmental externality.

Table 2-1: Summary of Market Failures Applying to End-of-Life Tyres

Market Failure	Example	Effect
Externalities	Environmental Externalities	• Fire risk • Water pollution • Soil pollution • Pollution of ground and surface water • Air pollution • Visual impact • Breeding site for disease vectors
	Health Externalities	• Fire risk • Release of toxins into environment • Breeding site for disease vectors
Public and Collective Goods	Industry participants unable to capture R&D benefits	• Suboptimal investment in R&D
	Transaction costs too high to organise collective action Free rider problem	• Inability of Industry to provide Collective Goods
Information Failures - Insufficient, inadequate, or costly information	Producers	• Insufficient information on demand for tyre derived products (TDP)
	Consumers	• Inadequate information on tyre attributes, recycling, reuse and disposal costs and benefits
	End Users	• Inadequate information for TDP markets and supply of inputs
	Lack of arrangements for monitoring of EoL tyres and reprocessing/ disposal	• Lack of Used Tyre statistics and other market information • Inability to monitor illegal dumping
Monopoly or non-competitive behaviour	Use of market power Barriers to entry	• Price discrimination for collection and reprocessed materials
	Barriers to entry	• Unreliable supply/collection arrangements for small players and new entrants. Dominance of strategic market positions by larger players.
	Precarious supply chains	• Supply reliability of used tyres for transformers and end market users • Insecure collection arrangements

Source URS (2006)

2.2.1 Externalities

Externalities can arise in any sector of the end-of-life (EoL) tyre markets, including stockpiling and disposal by both legal and illegal methods. Disposal externalities such as fire, environmental and health risk are often cited, but they can also result from transport and reprocessing.

Emissions from Decomposition

Tyres are largely inert in landfill and in the landscape. They do not break down readily as they have been engineered to maintain their integrity in use. This is especially so in landfills where their formulation renders them largely chemically inert. Nevertheless, there is some evidence that landfilling and stockpiling of used tyres can contribute to leaching of inorganic and organic chemicals (UK Environment

Agency Report 1998, Section 4.5). Data are currently limited on the toxicity of tyre leachate to terrestrial organisms. No estimates of the extent of chemical leaching and gas emissions from the decomposition of tyres are available for Western Australia. Although it is not possible to quantify the externalities involved this does not appear to be a significant source of environmental external cost.

Pest breeding

Bulk surface locations of waste tyres in stockpiles and landfills can act as breeding sites for mosquitoes and other vermin to create health risks for humans and animals in the vicinity of stockpiles. Diseases associated with mosquitoes in Australia include dengue fever and Ross River virus. (SA EPA 2003, p.1). Whether tyres account for more than a marginal increase in mosquito breeding and in the risks of mosquito-borne disease in Australia is not clear. While breeding of mosquitoes and other pests constitutes an external cost, it was not possible to quantify it for Western Australia.

Legal landfill management

Intact tyres can collect land fill gas and create potential fire hazards, and can also "float" to the surface, where they can damage cover layers. While this imposes costs on landfill operators, it is not an external cost. The cost of preventing and dealing with these issues should be incorporated in landfill charges and operating procedures; alternatively it may be internalised to disposers by requiring pre-treatment such as shredding. There are however, a number of old landfill sites where such provisions have not been made. The costs were not borne by those disposing of the tyres in this way, so the costs of ongoing management can be considered a legacy external cost as the resource misallocation has already occurred.

Illegal Dumping

Illegal disposal generally refers to the dumping or stockpiling of tyres at unlicensed sites or at sites that have failed to obtain the required approvals or licenses for disposal or processing. Estimates in URS (2005) suggest about 3.2 million equivalent passenger units (EPU) were illegally disposed in Australia (9 per cent of EPU), or some 14 percent of all end-of-life tyres entering the waste stream per annum. That report suggested that passenger tyres make up about two-thirds of the total number of EPUs illegally dumped, and light truck tyres some 30 per cent. Heavy truck tyres represent only two percent of dumped EPUs. This relatively low share reflects the higher profitability of reprocessing truck tyres.

Data presented in this report (see Section 3 for discussion on methodology, and Table 3-14 for detailed results) for Western Australia suggests higher rates than the national averages. Some 1.1 million EPU are estimated to be illegally disposed or stored annually in Western Australia (23.8% of EPU disposed), or 32.4 per cent of tyres disposed. The national estimates developed for URS (2005) are probably an underestimate given the reworked results for Western Australia.

Tyres are typically disposed illegally in remote locations, which mean that these tyres can be expensive to remove. In addition, if tyres are covered with soil or are underground, then extraction costs are also high (URS 2005). Illegal disposal can also have adverse effects in the landscape. Dumping in gullies can block creeks and rivers and change water flows (NSW DEC 2004 and Atech Report 2001, Part 1, p.18). They are also an eyesore and have a detrimental impact on aesthetic values, which is an external cost.

Tyres are sometimes placed in gullies by landholders attempting to deal with soil erosion. If the tyres used in this manner work as a control measure, this should not be considered illegal dumping but reuse, akin to other civil engineering uses such as artificial reefs. If the erosion control is successful, eventually vegetation will be re-established but the tyres will remain, with all of their costs. If tyres are not generally effective in controlling erosion, then the practice imposes net costs from the start.

The costs to local authorities and landowners of cleaning up illegal tyre dumps can be quite substantial. Illegal dumping imposes external costs because those responsible for dumping are not usually identified and the current landowner or society at large is liable for both the usual costs of disposal as well as the incremental clean up costs. Costs of cleanup vary depending on the location of the dump, the difficultly in removal and the legal landfilling costs.

A number of published papers and reports list expected environmental impacts but these have not been well quantified for the Australian context. A base line measure of impact may be provided by using estimates of cleanup costs to remove illegally dumped tyres. The annual cost is estimated to be some $2.8 million (or some $30 million over 10 years), based on collection costs being three times that for legally disposed tyres and transport costs over an average of 50 km to a legal landfill. This estimate excludes the cost of cleanup of historical stockpiles, for which estimates are poor however, if they reflect current estimates of illegal disposal must exceed 10m EPU. This would add another $30 million to the estimate of future illegal disposal costs. These costs do not include any of the non-market (external) costs cited above, such as pest breeding, blocking of waterways or fire.

Fire Risk

Tyres are flammable and when in a concentrated mass they pose a significant fire and pollution risk. Stockpiling, landfilling and bulk storage of used tyres all have the potential to lead to fires, above and below ground, and such fires are particularly difficult to control. There have been a number of fires involving tyres at landfills in Australia and around the world. Tyre fires have serious environmental and health impacts because:

- They can be difficult to control and extinguish;
- Uncontrolled pyrolysis of tyres produces a complex mixture of chemical residues and particles, some of which are toxic to humans, fauna and flora and some of which may inhibit the biota on which landfill processes depend; and
- The vapours and fallout pollute the atmosphere.

A tyre fire at Bindoon WA in 1990 is estimated to have cost the WA Environmental Protection Authority $600,000 to clean-up a contaminated watercourse. Recreational activities and businesses in neighbouring properties were also adversely affected by air pollution. A similar tyre fire in 1992 in Salisbury QLD is reported to have cost the fire brigade $750,000 and a fire at a retail tyre outlet in Sydney in 2002 caused the hospitalisation of people from surrounding areas due to respiratory concerns. The runoff of water used in fighting tyre fires also has the potential to pollute waters (NSW Department of Environment and Conservation 2004) as water on tyre fires often increases the production of pyrolytic oil and provides a mode of transportation to carry the oils off-site and speed up contamination of soils and water (CIWMB 1996).

Tyre fires have the potential to impact on human and animal health as a result of the air quality and pollution created from the toxic smoke created. Many chemicals carried in the smoke, some of which are mutagens and carcinogens, have been identified in the emissions from both the controlled and uncontrolled burning of rubber tires (CIWMB 1996). These can cause acute health effects including eye, nose and throat irritation and exacerbate asthma and respiratory conditions and the potential to exacerbate pre-existing heart conditions, confirming that the most significant public health risks appear to be people with asthma, heart and lung diseases (CIWMB 2002) – all of which are significant external costs.

2.2.2 Public and Collective Goods

Public and collective goods cannot be provided at the socially optimal level without intervention in the market.. Research is an area that is often under-provided because of the inability of the researcher to appropriate the benefits of the research. This appears to apply to the waste tyre industry as well.

Collective goods are typically provided by industries for their members. They include such services as the development of standards, collection of statistics, generic marketing and information, and the building of market institutions. New industries, with immature markets, lack both the industry institutions and the services that they can provide. The transaction costs of developing such arrangements can be significant in the short term. Lack of industry standards is one factor that appears to be retarding end-of-life tyre industry development and expansion.

Socially Suboptimal Investment in R&D

If it is difficult to protect the intellectual property involved in innovative applications for waste tyres, firms in the tyres industry will not be encouraged to embark on R&D investment unless the potential rewards are correspondingly high. Consequently, insufficient funding of beneficial applied research maybe hindering product development and the development of a viable end-of-life tyre industry.

The majority of the research undertaken in the use of rubber modified asphalt has been undertaken not by the industry but by state government road authorities (URS Report 2005, p.73). Public provision of research services is a common remedy to perceived inadequacy of private R&D. While Australia can benefit from other countries' R&D for uses of end-of-life tyres, local research, or demonstration trials, may be required for applications that are sensitive to Australian conditions/ attitudes.

While it seems likely there is some market failure in the provision of research services, it is difficult to estimate its extent. Furthermore, identifying the probable existence of the market failure does not indicate what, if anything, should be done about it. Many areas of research would claim to be under-provided and compete for limited public research funds. Determining what, if any, public resources are devoted to research into EoL tyre technology or market applications requires assessment of likely benefits and costs relative to alternative areas of research. R&D where the industry as a whole would benefit might be amenable to collective industry action when the industry is mature enough to support provision of collective services.

Collective Goods

Australia's used tyre industries have not yet developed the industry institutions and arrangements that can provide the collective goods that many other industries enjoy. There appears to be little cooperation between transformers and end market producers to connect with each other and work together as a consolidated industry. Small operators in particular, are not connected to each other as the transactions costs of dealing with each other are too high.

One major area where transformers do not currently cooperate is in the generic marketing and advertising of tyre-derived products to potential users and the broader population. Collection of industry statistics, development of quality standards, generic marketing and industry research have all been identified as issues that might be improved by the collective action of those involved in the end-of-life tyre industries. Quality standards are another example of under-developed collective services for the end-of-life tyre industries. The quality of supply of tyre-derived products across the industry suffers as a result of the lack or poor enforcement of collective industry quality standards. The value of the market failure involved in the industries' inability to provide collective goods is linked to the information failures outlined below.

2.2.3 Information Failure

Poorly informed markets do not operate efficiently. Currently, statistics relating to the used tyre markets are poor. Entry to the industry will be limited if potential players are not aware of the opportunities available, or they will face a high level of uncertainty. Poor information to consumers of new tyres and potential users of tyre-derived products could also be impeding the development of these markets.

Poor Statistics

Studies, such as the ATEC (2001) report 'A National Approach to Waste Tyres', concluded that statistics on manufacturing and imports of new tyres as well as used tyre disposal, reuse and recycling, are poor. The number of new tyres entering the market can be estimated from production and import statistics, and verified via the number of vehicle registrations. However, it is more difficult to estimate the size and composition of the used tyre waste stream. For the waste tyre industry, the lack of monitoring of used tyres means that collectors, transporters, transformers, end market producers and waste management authorities and regulators do not have good information about the supply of used tyres as inputs, or to enable monitoring of compliance with environmental and waste management regulations.

URS consultations with councils and other government departments for the 2005 report revealed significant gaps in data, and reliance on estimation rather than quality statistics. For example, the number of stockpiled and illegally disposed tyres across Australia is an estimate only, which is not backed by high quality national data[1], although a tracking system has been recently introduced in WA.

Consumer Information

Better information for consumers of new tyres about disposal and recycling could influence their decisions about purchase. However, lack of information on end-of-life issues does not constitute a market failure if such information would not change purchase or disposal behaviour. Merely establishing that information is poor does not identify market failure – the essential element of market failure is that the poor information distorts resource allocation decisions.

Would better information about disposal practices change consumers' decisions about which dealer they used? Across the tyre industry, there are currently no consistent arrangements for informing consumers about disposal arrangements and costs. Many consumers are not made aware that the cost they pay for a replacement tyre encompasses the cost of collection, and then transportation of their used tyres on to a number of different destinations including: (1) landfilling; (2) illegal disposal; (3) stockpiling; or (4) transformation into a range of tyre-derived products and end market products. Consumers of new tyres are not necessarily made aware of the $2-2.50 per EPU fee charged by tyre dealers at point of sale when tyres are replaced.

The $2.50 fee per passenger tyre is greater than the suggested levy necessary to fund the proposed Product Stewardship Scheme, aimed at realising a greater proportion of the resource value embedded in tyres (URS 2005). The $2.50 is far greater than actual disposal costs of $1 to $1.50 and is a measure of the extent of the combined effects of undeveloped markets and poor information. Poor information to consumers about disposal costs reduces competitive pressure and effective consumer choice about tyre disposal.

Users of Tyre-Derived Products

Poor information about the characteristics, quality and availability of tyre-derived products will impede end user acceptance. Potential users of products that contain recycled tyres may not receive adequate or sufficient information that either: (1) informs them that these products exist; or that (2) the products are of a quality suitable for use. Potential users or end market producers may believe that transformed products offer poor value.

Examples of poor information impeding the use of tyre-derived products have been reported in the road surfacing industry, where polymers and substitutes for rubber crumb are still favoured in states such as Queensland, Western Australia and South Australia (URS 2005). Two road contractors using rubber crumb in seals, indicated that rubber crumb is cheaper than polymer substitutes. However, the Queensland Department of Main Roads believed that polymers are cheaper, principally because they have seen no

[1] Discussions with various Environmental Protection Agencies (URS 2005)

evidence to the contrary (URS 2005). There appears to be a lack of information in the market about the advantages that tyre transformed products can provide, partly due to a lack of quality standards and research and development. Road authorities are unlikely to commit to a new product if it is untested and may not be as durable as a product made from virgin materials.

It seems likely that lack of quality standards and poor information to potential users about the benefits of tyre-derived products may be impeding the development of the market and could be considered a market failure. It is allied to the immaturity of the markets themselves.

2.2.4 Monopoly or Non-competitive Behaviour

Collection, transport and disposal are highly competitive, with a large number of small operators spread around the country, although there may be limited competition in these sectors at the local level. Barriers to entry to any of these sectors of the end-of-life tyre industry are relatively low.

Among recyclers and transformers there are a few large firms, but this part of the industry is quite diverse across Australia, with a number of small companies also producing a variety of products. This is not the case in Western Australia where the number of operators has varied between one to five at most – however the share of the market potential is low and not excluding new participants.

The organisation of the industry is influenced by the need to secure reliable supplies of end-of-life tyre inputs for processing. The need to secure reliable supplies has led to pressure for vertical integration and alliances with collectors. This puts competitive pressure on those that are not vertically integrated or have not secured supplies, and encourages them to make similar arrangements.

Such industry arrangements and the economies of scale and scope available to larger firms can lead to significant differences in costs and prices throughout the industry. Given the immature nature of the industry and the differences in scale and costs between large and small operators, differences in costs and prices can be expected and would not, in themselves be evidence of anti-competitive conduct or market failure. It does not appear that lack of competition constitutes a source of market failure in relation to end-of-life tyre markets.

2.3 Quantifying Market Failure in End-of-life Tyre Markets in WA

Volumes of waste to landfill or illegal disposal are either symptomatic of market failure or simply the result of a lack of profitable opportunity to use that waste. Discussions above suggest that market failure does exist to some extent. Gross margin analysis results (URS 2005), and similar analyses undertaken for this report, suggest that there are profitable uses of end-of-life tyres in excess to current levels of reprocessing. The URS (2005) study showed that profitable options for increased levels of reprocessing exist, especially in urban areas with low transport costs and high used tyre supply volumes.

Market failure or time lags in investment in industry expansion are a cause of reduced rates of used tyre reprocessing, in urban areas at least. Lower levels of resource recovery from rural and regional areas may also be affected by the same market failures, but are predominately a result of higher collection costs –

options are less viable financially. So there exists a combination of market failure and some constraints to viable options for reprocessing, especially in rural and regional areas with higher operating costs.

Table 2-2 quantifies the extent of market failures associated with end-of-life tyres, using estimates for Australia based on the URS (2006) report and estimates for WA calculated for this report. They provide an indication of the level of market intervention that may be justified provided that intervention addresses the noted market failure in an efficient manner. A major estimate of cost associated with market failure is suggested for illegal disposal. The estimate of this cost is based on the cost of retrieving and appropriately disposing of these tyres – it is a *de facto* estimate. It is not a direct estimate of costs of illegal disposal (eg. impacts on aesthetic values) and may over estimate the social cost of illegal disposal.

Table 2-2: Estimates of Market Failures in Australia and Western Australia

Market Failure	**Estimate for Australia (URS 2006)***	**Estimate for Western Australia***
External costs		
• Environmental	Marginal but positive	Marginal but positive
• Health	Marginal but positive	Marginal but positive
• Fire risk	> $1 to $5m over 10 yrs	> $1 to $2m over 10 yrs
• Illegal Disposal	> $35 to $70m over 10 yrs	$30m over 10 yrs**
Public & collective goods, Information failure	$280m over 10 yrs*	$35m over 10 yrs *
Monopoly/ restricted competition	Not Applicable	Not Applicable
TOTAL	**> $315 to $350m over 10 yrs**	**$65m over 10 yrs**

Source: URS (2006), URS Analysis

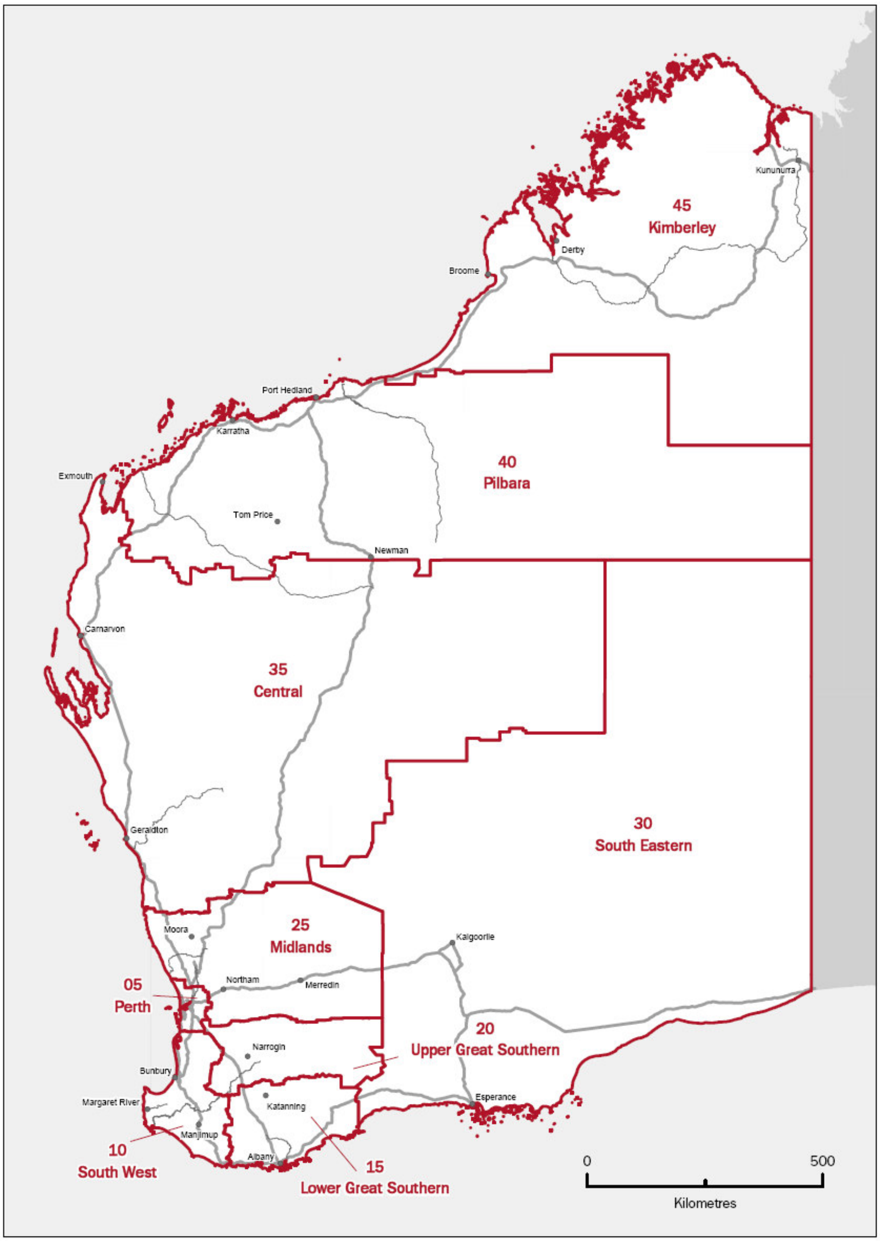
* Estimates are expressed as Present Value totals

** Western Australian estimates for illegal disposal costs are based on disposal numbers (calculated by deducting rates of reprocessing and legal disposal from the total number of end-of-life tyres). The rates of legal disposal exclude OTR tyres (which may cause an underestimate), and reprocessing estimates exclude any tyres that may be exported (may cause an over-estimate).

Current and Projected Stocks and Flows - Resource Supply

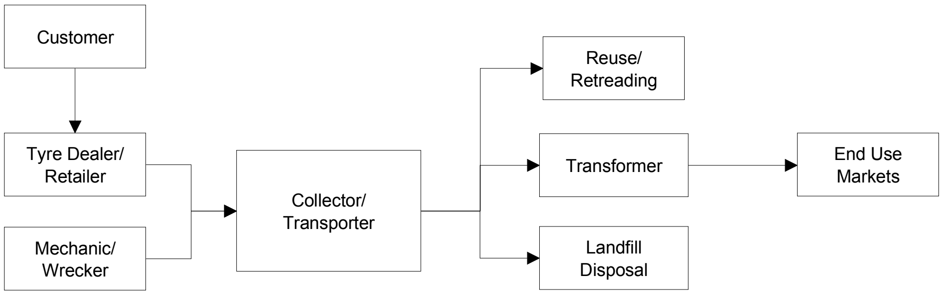
This section provides a compilation of supply side data, with numbers and the location of tyres estimated for six tyre classifications across nine WA Statistical Divisions (as per Figure 3-1). Aggregation per statistical division provides an opportunity to assess numbers of end-of life tyres against distance from Perth, or other major regional centres. Base flows estimates of each tyre category can be converted into equivalent passenger units (EPU) to allow tracking in terms of the mass of the constituent tyre components as they may be transformed into alternative products. Estimates of current numbers can be projected over time to account for changes in utilisation rates and disposal behaviour, and changes to rates of disposal with economic shifts and population growth.

Figure 3-1: Western Australian Statistical Division Boundaries



Source: Australian Bureau of Statistics (http://www.abs.gov.au)

Understanding physical flows of tyres, and constituent components, allows a tracking of volumes and the values of potential resources they may be put to, or the volumes disposed to landfill. Analysis undertaken for this project has used a spreadsheet to link the physical flows to financial analyses.



3.1 Tyre Categories

In this report, six tyre categories are used to sub-divide total numbers according to groupings generally based on tyre size and construction. They include: Off The Road (OTR) tyres, truck and bus tyres, light and medium commercial tyres, specialty tyres, passenger tyres and motor cycle tyres. A summary of these categories and their Equivalent Passenger Unit (EPU) or Used EPU (UEPU) and weight conversion factors are presented below in Table 3-1.

Table 3-1: Tyre Categories - New and Used Weights

Tyre Category	New & Used EPU	New tyres Weight (kg)	Used tyres Weight (kg)
Motor cycle tyre	0.5	4.75	4.00
Passenger tyre	1.0	9.50	8.00
Specialty tyre	5.0	47.50	40.00
Light & medium commercials	2.0	19.00	16.00
Truck & bus tyres	5.0	47.50	40.00
OTR tyre[2]	100.0	950.00	800.00

Source: URS (2005)

In general a passenger tyre weighs approximately 9.5kg when new. By the time a tyre has reached its end-of-life it has generally lost between 10% to 20% of its total weight or 30 to 40% of its tread weight (UK Environment Agency 1998, p.15 & 43 and Hird, Griffiths and Smith 2002, p.54). In this report it is assumed that the weight of an average end-of-life EPU is 8.0 kg and has lost an average of 1.5 kg of tread weight during use. Often previous work has not made this distinction between the weight of a new EPU and a used EPU. This is an important omission as there is less material in used tyres than from new tyres and in particular the rubber content is reduced disproportionately.

[2] OTR Tyres vary in size from 24 inch rims to over 57 inches, weighing anywhere from 100 kg to 4 tonnes, with an average weight that is around 100 times the size of a passenger tyre that has been used throughout this report

3.2 Tyre Composition

There are four main groups of materials used for the manufacture of tyres: natural or synthetic rubber; carbon black; steel wire and textile; and various chemical additives. The composition of each tyre category impacts on the end-use and the process that is most applicable for reuse, hence the composition is a key input into any financial analysis. The composition of each used tyre category is shown in Table 3-2 below. The proportions of each material vary depending on the type of tyre, and whether it is new or end-of-life – as a tyre wears the rubber and associated components reduce whereas metal and fabric content usually remains constant.

Table 3-2: Composition and Energy Content of End-of-life Tyres[3]

EoL Tyres	Rubber	Carbon Black	Steel	Textile	Zinc Oxide	Sulphur	Additives	Energy (GJ/tyre)
Motor cycle tyres	42%	21%	18%	12%	2%	1%	5%	0.1
Passenger tyres	42%	19%	21%	7%	1%	1%	8%	0.2
Specialty tyres	42%	21%	30%	0%	2%	1%	5%	1.1
Light/ med. commercial	42%	20%	25%	6%	1%	1%	6%	0.5
Truck & bus tyres	40%	20%	32%	0%	2%	1%	6%	1.1
OTR tyres	42%	21%	30%	0%	2%	1%	5%	21.6

Source: Hird et al 2002, p.4; Atech Group 2001, Pt.1, p.28; ETRA and URS Analysis

Table 3-2 is aggregated in Table 3-3 to show the three basic material types: rubber, steel and textiles that are most relevant for transformation. Carbon black, zinc oxide, sulphur and additives are combined into the rubber during the manufacturing process and are difficult to separate out except through advanced technologies that are essentially still under development.

Table 3-3: Combined Composition of End-of-life Tyres[4]

New Tyres	Rubber (% & kg)		Steel (% & kg)		Textile (% & kg)	
Motor cycle tyres	70%	2.8	18%	0.7	12%	0.5
Passenger tyres	72%	5.7	21%	1.7	6%	0.6
Specialty tyres	70%	28.1	30%	11.9	0%	0.0
Light & medium commercials	69%	11.1	25%	4.0	5%	1.0
Truck & bus tyres	68%	27.2	32%	12.8	0%	0.0
OTR tyres	70%	562.5	30%	234.5	0%	0.0

Source: URS Analysis

3 As a percentage of the reduced tyre weight (8kg Used EPU equivalent)
4 As note above

3.3 Current Tyre Flows

3.3.1 Methodology Used

Current volumes of end of life tyres have been estimated for six tyre categories across nine Statistical Divisions in Western Australia: Perth, South West, Lower Great Southern, Upper Great Southern, Midlands, South Eastern, Central, Pilbara, and Kimberley (as shown by Figure 3-1). The basis of this estimate is the 2005 vehicle census (ABS, 2005). This survey provides an estimate of the number of vehicles (see Table 3-5) according to type which has been matched to the six tyre types described in Section 3.1 above. By applying estimates of the number of tyres per vehicle the number of tyres in use was then calculated for each tyre type in each statistical division (see Table 3-5).

Current Tyre Numbers

Estimates of the number of end-of-life tyres disposed annually were calculated for Australia in URS (2005) using two approaches, use of ABS vehicle census data, and import and Australian manufacturing data. This enabled, a "turnover rate" (see Table 3-6) to be calculated for each tyre category in Australia, and the number of end-of-life tyres that are disposed of annually to be calculated. The national turnover rate for each tyre category has been applied to the Western Australian estimates of total tyres in use to estimate the number of end-of –life tyres disposed annually (Table 3-6). The tyre number estimates have then been translated into EPU estimates for each tyre category (Table 3-7), and then into the weight of rubber, metal and fabric contained within those tyres. Note the lower net turnover rate for truck and bus tyre reflects the higher rate of retreading in that category.

The approach used is based on the numbers of vehicles registered within each statistical division, and assumes a direct relationship between the location of the vehicle and the location of end-of-life tyre disposal. This approach is likely to underestimate the disposal rate within the Perth statistical division as a greater proportion of vehicles might be purchased and disposed of in the metropolitan area as opposed to where they might actually be registered. Also a greater proportion of tyre replacements and disposals off used vehicles might be expected to occur in the Perth division.

Allocation of OTR to Statistical Divisions

The distribution of each tyre category could be allocated to a statistical division on the basis of vehicles registered except for OTR tyres. They are not represented in the vehicle census data. URS was presented with industry data as part of the URS (2005) study, which provided base data on total OTR sales into WA on the basis of tyre size. These data do not provide an indication of the geographic location of the tyres in use. For this study data from WA Department of Industry and Development (2005) - Western Australian Mineral and Petroleum Statistics Digest 2005 were analysed to aggregate tonnage of surface mining and similar operations per statistical division. OTR tyres were then allocated to statistical divisions on the basis of the tonnes mined from each region.

Future Tyre Number Projections

Future numbers for end-of-life tyre disposal have been based on population growth rates in each statistical region in Western Australia. Western Australian Statistical Indicators (ABS 2002) provide historical data of population change from 1991 to 2001 (rates are shown in Table 3-11). The average rates of change shown over that period has been applied annually to each tyre category in all regions except the Pilbara. Although historical data indicate negative rates of growth for the Pilbara region, currently a period of rapid expansion is occurring. An average growth rate of five per cent has been applied to the Pilbara region of the ten year projection period. This may underestimate the current rapid expansion, but should reflect the mean rate over ten years.

3.3.2 End-of-Life Tyre Disposal in WA

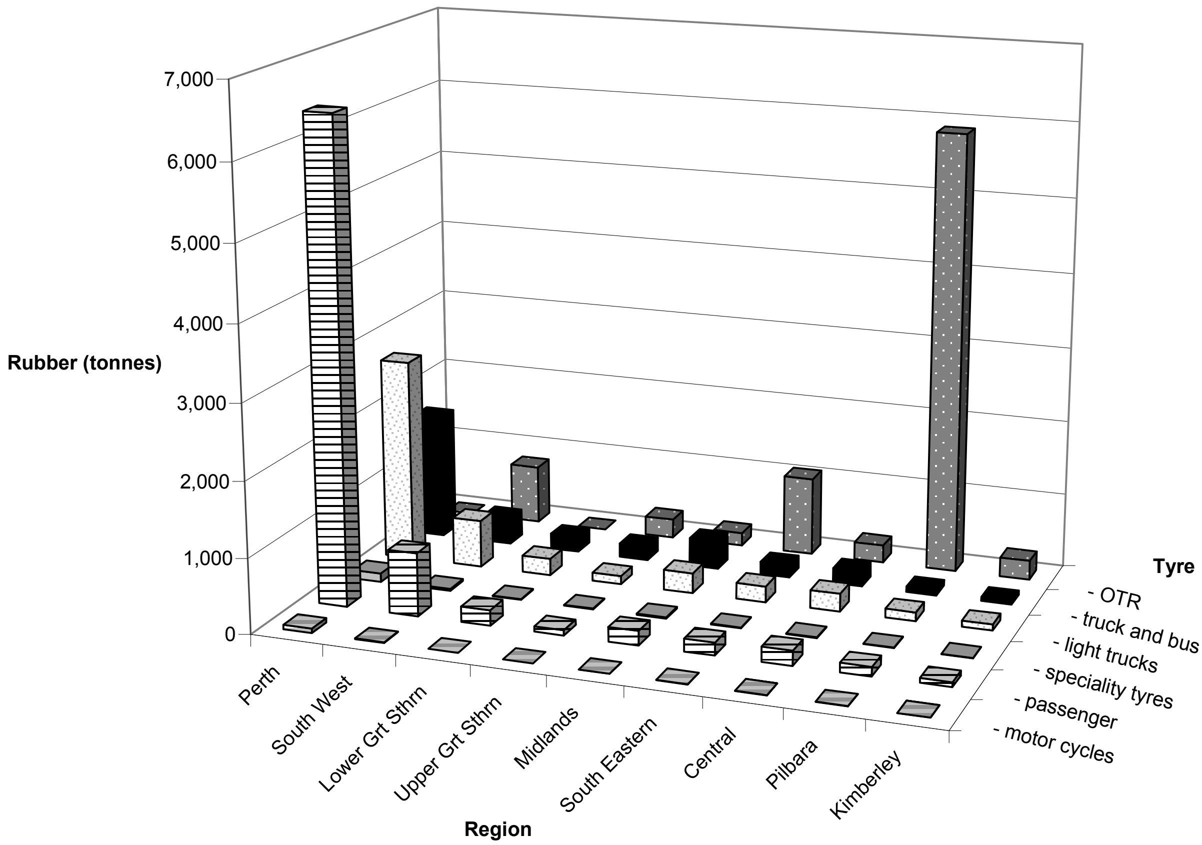
The number of end of life tyres disposed in WA in 2005 is estimated at 2.0 million tyres (Table 3-6). Of that total some 71% of tyres come from the Perth statistical division, and 11% from the south west. Tyre numbers do not however provide a direct indication of the potential resources in end-of-life tyres. When numbers are converted into equivalent passenger units (EPU) a very different picture of the distribution of resources is provided. On an EPU basis some 4.5 million EPU were disposed of in WA in 2005, of those 44% were in the Perth region and 25% in the Pilbara (see Table 3-7). The different distribution is as a result some 65% of OTR tyres being in the Pilbara.

3.3.3 Rubber, Metal and Fabric Content of Disposed Tyres

The total weight of rubber in disposed tyres in 2005 was some 25,000 tonnes for Western Australia as a whole. Of that total 8,650 tonnes was in OTR tyres, and 10,900 tonnes was in the Perth region (see Table 3-8). The total metal content of end-of-life tyres in Western Australia in 2005 was some 9,500 tonnes (see Table 3-9), and the weight of fabric about 1, 250 tonnes (Table 3-10).

The distribution of disposed rubber, by tyre category and statistical division is shown dramatically in Figure 3-3. Clearly the greatest volumes are available from passenger, small truck, and truck and bus tyres in the Perth region, and from OTR tyres in the Pilbara. OTR tyres in the south east region (Goldfields/ Esperance) are also a significant resource.

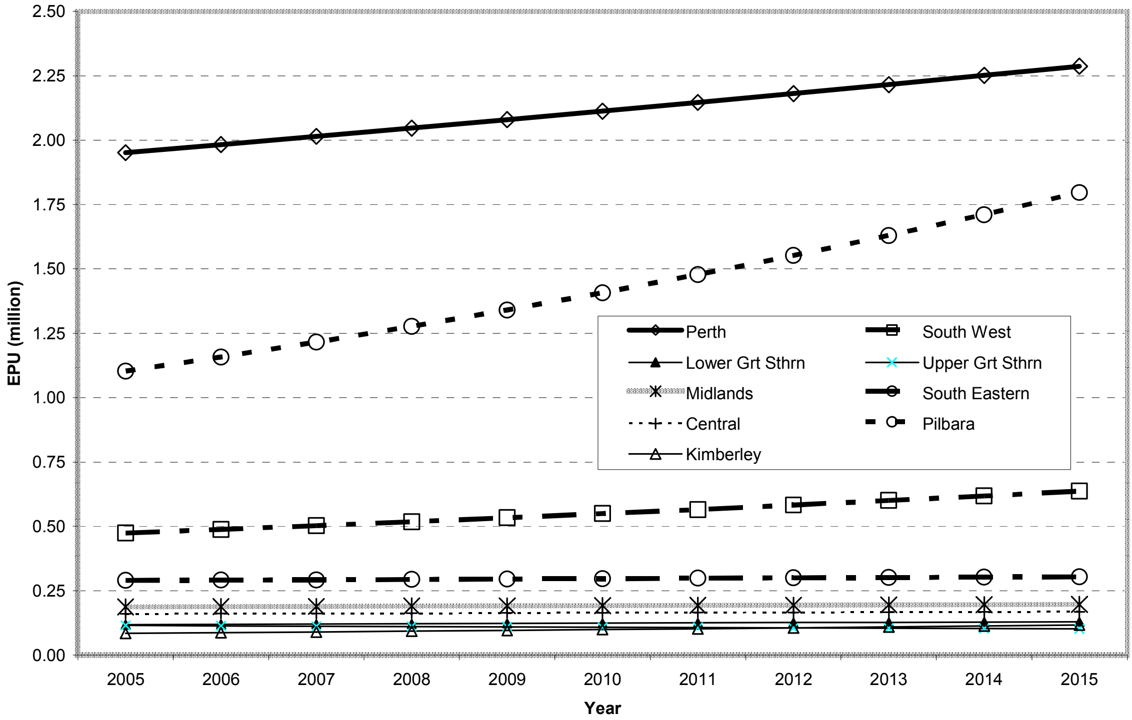
Figure 3-2: Rubber Content of Disposed Tyres by Tyre Type and Region (tonnes)



3.3.4 Projection of Equivalent Passenger Units Disposed in WA

A projection of total EPU disposed for WA, and per statistical division is provided in Table 3-11 and graphically as Figure 3-3. Total disposals are suggested to total some 5.75 million EPU by 2015 with the bulk of those coming from Perth (2.29 million) and the Pilbara (1.80 million).

Figure 3-3: Projection of EPU Disposed – per Statistical Division



3.4 Disposal and Re-Use Estimates

Data to explain rates of disposal and re-use are much less reliable and available than are data that may be used to estimate numbers of end-of-life tyres that are generated annually. Data is inconsistent in its spatial coverage and in the units of weight, and tyre categories, used to describe flows. There are also inconsistencies in the conversions of weights to passenger unit equivalents (Some reports use the weight of a new passenger tyre equivalent (9.5kg) in their conversion, and neglect to account for extent of wear that may occur – assumed by this report to be 1.5kg per EPU).

Western Australia now has a Controlled Waste Tracking System (CWTS) but this is not yet working as reliably as it might. Most recent estimates have been compiled by Matthews (2006) and form the basis of this compilation and effort to align available data against the regional and tyre classifications used in this report.

3.4.1 Re-Use/ Reprocessing Estimates for WA

Reclaim Industries has been for some time the only major business reprocessing end-of-life tyres in WA. They have recently been joined by Tyre Recyclers WA as a transformer of used tyres. Matthews (2006) assessed the numbers of tyres received by Reclaim (CWTS data) and derived a net figure for processing after deducting the volumes of unwanted tyres – some 53,750 truck tyres for the 05/06 year. Matthews

(2006) estimates the weight of tyres (2,552,697kg) based on a conversion of 47.5 kg per truck and bus tyre. However assuming wear of 1.5kg per EPU the conversion should be at a rate of 40kg per EPU and therefore some 2,149,640kg or about 2,150 tonnes of used truck and bus tyres was reprocessed, presumably sourced primarily from the Perth region.

Given the recent start-up by Tyre Recyclers, annual data on numbers transformed are not yet available and estimates of planned numbers cannot be substantiated by hard data. However, proposed use of passenger tyres suggest a tonnage at least to match that of Reclaim. Estimates of proposed production by Tyre Recyclers have not been included in reprocessing estimates developed for this report but if the planned rate of operation is sustained then rates of transformation is WA should at least double .

Using the 05/06 data, reuse/ reprocessing in WA comprised some 2,150 tonnes of end-of-life tyres or 268,705 EPU. This equates to nearly 87% of the truck and bus tyres from the Perth region but only 13% of EPU disposed in the Perth Region and 6.0% of the of end-of-life EPU disposed of annually in Western Australia. These estimates make no allowance for the sundry uses end-of-life tyres may be used for, such as in erosion control and playgrounds, although those uses may account for another one or two per cent at most.

These estimates exclude any exports of tyres that may be retreaded or used in developing countries. Any estimate of possible numbers is not known to the author, but may be expected to be at most five percent of tyres from the Perth region only. Similarly the estimate for volumes reprocessed or reused exclude tyres that may be used “informally” on rural properties for erosion control and other sundry uses across the community. This may amount to one per cent or less. Given these unknown volumes it is suggested that across the state less than 10% of end of life EPU are reprocessed or reused.

3.4.2 Disposal– Landfill/ Legal Disposal & Illegal Disposal/ Storage

Matthews (2006) notes that “it is still not possible to obtain definitive figures for tyre disposal to landfill, particularly for country areas”. Data are suggested to have gaps in terms of aggregate numbers or tonnes of tyres and the proportion according to tyre type. Despite the difficulties Matthews (2006) provides estimates of the aggregate volume of tyres to metropolitan and rural landfills, these data are replicated as Table 3-4. These aggregates, in conjunction with reuse/ reprocessing estimates have been used to model volumes to landfill and other legal disposal, and then in turn volumes that comprise illegal disposal or storage.

Table 3-4: Summary of Tyre Volumes to Landfill

Landfill	Tyres Received (kg)
Metropolitan	12,652,000
Rural	1,269,422
Total	13,921,422

Source: Matthews (2006)

Volumes to Landfill/ Legal Disposal

The number of tyres that are disposed to landfill, by tyre categories and between regional areas, have been estimated by working rates backwards from estimated totals in metropolitan and regional areas (see Table 3-13) . Known rates of use for truck tyres suggest only 13% are landfilled in the Perth statistical division. With that being the case then 90% of other tyres, across all categories, are landfilled in the Perth area.

Data do not allow differentiation in rates of landfilling to be assessed for regional areas. Assuming OTR tyres are disposed under agreed methods, and they are not included in the total estimated by Matthews (2006), then only some nine per cent of tyres are landfilled in regional areas. However, the available data are likely to be in error by underestimating volumes, so the actual number would be expected to be greater than the calculated estimate.

Given the above caveats the available estimate is that some 25,000 tonnes or 3.1 million EPU are disposed to landfill annually in Western Australia. This is about 70% of the end-of-life tyres as a proportion of total EPU disposed annually.

Volumes to Illegal Disposal or Storage

Volumes that are illegally disposed have been estimated by deducting estimates of numbers reprocessed/ reused, and numbers to landfill from the estimated numbers of tyres disposed annually (see Table 3-14). Given the assumptions imbedded in estimates of tyres reprocessed and disposed to landfill, it is suggested that up to 24%, on an EPU basis, is illegally dumped or stored across Western Australia. Estimates suggest this is much lower in the Perth area (8.4%) but correspondingly higher in some regional areas.

It was noted that estimates of rates of reuse or reprocessing exclude any exports for retreading or use in developing countries, and that a number of tyres that may be used "informally" on rural properties for erosion control and other sundry uses across the community. Given these unknown volumes it is suggested that across the state less than 10% of end of life tyres are reprocessed or reused, this is some four per cent above the known rate of use. If that was the case then rates of illegal disposal across Western Australia would be some 20% of end-of life tyres on an EPU basis.

3.5 Historic Stocks – Legal and Illegal Storage

The above estimates suggest that currently some 4.5 million EPU of end-of-life are disposed annually. Of that only 270,000 are reprocessed. The rest are legally or illegally stored or dumped. This suggests that historic stock must be very significant in comparison to annual throughputs. Historic stocks might well exceed 100 times the current rate of reprocessing.

Table 3-5: Vehicle Numbers and Tyres in Use - Across WA Statistical Divisions (EPUs)

Vehicles		**Perth**	**South West**	**Lower Grt Southern**	**Upper Grt Southern**	**Midlands**	**South Eastern**	**Central**	**Pilbara**	**Kimberley**	**Total**
- OTR											
- truck and bus		30,939	6,587	3,837	3,514	7,013	3,111	3,757	1,398	1,002	62,110
- light trucks		149,585	35,051	12,533	6,167	14,911	11,799	13,245	6,380	4,732	257,531
- speciality tyres											0
- passenger		891,537	117,125	29,018	10,006	26,556	23,939	27,431	16,976	8,694	1,156,923
- motor cycles		36,901	6,502	1,731	215	1,283	1,673	1,648	1,702	1,192	43,126
		1,108,962	165,265	47,119	19,902	49,763	40,522	46,081	26,456	15,620	1,519,690
Tyres in Use	**/ Vehicle**										
- OTR		0	3,516	0	1,151	795	4,733	1,071	26,395	1,171	38,832
- truck and bus	12	358,506	76,328	44,463	40,715	81,262	36,045	43,529	16,202	11,616	719,694
- light trucks	6	898,364	210,504	75,269	37,036	89,554	70,863	79,546	38,315	28,417	1,546,655
- speciality tyres		12,613	2,761	1,259	918	1,947	1,093	1,276	539	393	22,799
- passenger	5	4,457,685	585,625	145,090	50,030	132,780	119,695	137,155	84,880	43,470	5,784,615
- motor cycles	2	73,801	13,004	3,462	431	2,565	3,346	3,297	3,404	2,384	86,252
		5,800,969	891,738	269,543	130,281	308,903	235,775	265,874	169,735	87,451	8,198,847
Allocation to Regions											
- OTR		0.0%	9.1%	0.0%	3.0%	2.0%	12.2%	2.8%	68.0%	3.0%	100.0%
- truck and bus		50.6%	10.8%	6.3%	5.7%	11.5%	5.1%	6.1%	2.3%	1.6%	100.0%
- light trucks		58.8%	13.8%	4.9%	2.4%	5.9%	4.6%	5.2%	2.5%	1.9%	100.0%
- speciality tyres		54.7%	12.3%	5.6%	4.1%	8.7%	4.9%	5.7%	2.4%	1.7%	100.0%
- passenger		77.4%	10.2%	2.5%	0.9%	2.3%	2.1%	2.4%	1.5%	0.8%	100.0%
- motor cycles		70.1%	12.5%	3.2%	0.1%	2.0%	3.2%	3.0%	3.5%	2.5%	100.0%

Source: ABS 2005, URS Analysis

Table 3-6: End of Life Tyre Disposal – Number of Tyres per WA Statistical Division

Tyres Disposed	Turnover	Perth	South West	Lower Grt Southern	Upper Grt Southern	Midlands	South Eastern	Central	Pilbara	Kimberley	Total
- OTR	33%	0	1,160	0	380	262	1,562	353	8,710	386	12,814
- truck and bus	17%	60,946	12,976	7,559	6,922	13,815	6,128	7,400	2,754	1,975	122,348
- light trucks	27%	242,558	56,836	20,323	10,000	24,180	19,133	21,478	10,345	7,673	417,597
- speciality tyres	33%	4,162	911	415	303	643	361	421	178	130	7,524
- passenger	25%	1,114,421	146,406	36,273	12,508	33,195	29,924	34,289	21,220	10,868	1,446,154
- motor cycles	35%	25,830	4,551	1,212	151	898	1,171	1,154	1,191	834	30,188
		1,447,918	222,841	65,781	30,262	72,992	58,278	65,094	44,399	21,865	2,036,625
		71%	11%	3%	1%	4%	3%	3%	2%	1%	

Source: URS Analysis

Table 3-7: End of Life Tyre Disposal – Number of EPUs per WA Statistical Division

EPU Disposed	EPU	Perth	South West	Lower Grt Southern	Upper Grt Southern	Midlands	South Eastern	Central	Pilbara	Kimberley	Total
- OTR	120.0	0	139,244	0	45,579	31,479	187,419	42,403	1,045,234	46,375	1,537,734
- truck and bus	5.0	304,730	64,879	37,794	34,608	69,073	30,638	37,000	13,772	9,873	611,740
- light trucks	2.0	485,116	113,672	40,645	20,000	48,359	38,266	42,955	20,690	15,345	835,194
- speciality tyres	5.0	20,812	4,555	2,077	1,515	3,213	1,804	2,105	889	649	37,619
- passenger	1.0	1,114,421	146,406	36,273	12,508	33,195	29,924	34,289	21,220	10,868	1,446,154
- motor cycles	0.5	12,915	2,276	606	75	449	586	577	596	417	15,094
		1,937,995	471,032	117,394	114,284	185,768	288,636	159,329	1,102,401	83,527	4,483,535
		44%	11%	3%	3%	4%	6%	4%	25%	2%	

Source: URS Analysis

Table 3-8: Rubber Content of Disposed Tyres – Tonnes per WA Statistical Division

Rubber Content	Perth	South West	Lower Grt Southern	Upper Grt Southern	Midlands	South Eastern	Central	Pilbara	Kimberley	Total
- OTR	0	783	0	256	177	1,054	239	5,879	261	8,650
- truck and bus	1,656	353	205	188	375	167	201	75	54	3,325
- light trucks	2,683	629	225	111	267	212	238	114	85	4,619
- speciality tyres	117	26	12	9	18	10	12	5	4	212
- passenger	6,374	837	207	72	190	171	196	121	62	8,272
- motor cycles	73	13	3	0	3	3	3	3	2	85
	10,903	2,640	653	636	1,030	1,617	888	6,198	468	25,162

Source: URS Analysis

Table 3-9: Metal Content of Disposed Tyres – Tonnes per WA Statistical Division

Metal Content	Perth	South West	Lower Grt Southern	Upper Grt Southern	Midlands	South Eastern	Central	Pilbara	Kimberley	Total
- OTR	0	331	0	108	75	445	101	2,482	110	3,652
- truck and bus	782	166	97	89	177	79	95	35	25	1,569
- light trucks	968	227	81	40	96	76	86	41	31	1,666
- speciality tyres	49	11	5	4	8	4	5	2	2	89
- passenger	1,906	250	62	21	57	51	59	36	19	2,473
- motor cycles	18	3	1	0	1	1	1	1	1	22
	3,723	988	246	262	413	656	346	2,598	187	9,471

Source: URS Analysis

Table 3-10: Fabric Content of Disposed Tyres – Tonnes per WA Statistical Division

Fabric Content	Perth	South West	Lower Grt Southern	Upper Grt Southern	Midlands	South Eastern	Central	Pilbara	Kimberley	Total
- OTR	0	0	0	0	0	0	0	0	0	0
- truck and bus	0	0	0	0	0	0	0	0	0	0
- light trucks	230	54	19	9	23	18	20	10	7	397
- speciality tyres	0	0	0	0	0	0	0	0	0	0
- passenger	635	83	21	7	19	17	20	12	6	824
- motor cycles	12	2	1	0	0	1	1	1	0	14
	878	140	41	17	42	36	40	22	14	1,235

Source: URS Analysis

Table 3-11: Projection of EPU Disposed – EPU per WA Statistical Division (2005 – 2014)

EPU Disposed	Perth	South West	Lower Grt Southern	Upper Grt Southern	Midlands	South Eastern	Central	Pilbara	Kimberley	Total
Projected Annual Growth	1.6%	3.0%	0.9%	-1.2%	0.5%	0.5%	0.5%	5.0%	3.4%	
Base Year - 2005	1,951,585	473,832	118,565	115,089	187,499	289,647	160,506	1,102,922	83,891	4,483,535
2006	1,982,810	488,047	119,632	113,708	188,436	291,095	161,308	1,158,068	86,744	4,589,848
2007	2,014,535	502,688	120,709	112,343	189,378	292,551	162,115	1,215,971	89,693	4,699,983
2008	2,046,768	517,769	121,795	110,995	190,325	294,013	162,925	1,276,770	92,742	4,814,103
2009	2,079,516	533,302	122,891	109,663	191,277	295,483	163,740	1,340,608	95,896	4,932,376
2010	2,112,788	549,301	123,997	108,347	192,233	296,961	164,559	1,407,638	99,156	5,054,981
2011	2,146,593	565,780	125,113	107,047	193,194	298,446	165,381	1,478,020	102,527	5,182,103
2012	2,180,938	582,753	126,239	105,763	194,160	299,938	166,208	1,551,921	106,013	5,313,935
2013	2,215,833	600,236	127,375	104,493	195,131	301,438	167,039	1,629,518	109,618	5,450,682
2014	2,251,287	618,243	128,522	103,240	196,107	302,945	167,875	1,710,993	113,345	5,592,555
2015	2,287,307	636,790	129,678	102,001	197,087	304,460	168,714	1,796,543	117,199	5,739,779

Source ABS (2002), URS Analysis

Table 3-12: Tyres Reprocessed in Western Australia

	Perth	South West	Lower Grt Sthrn	Upper Grt Sthrn	Midlands	South Eastern	Central	Pilbara	Kimberley	Total
Tyres Reprocessed										
- OTR										0
- truck and bus	53,741									53,741
- light trucks										0
- speciality tyres										0
- passenger										0
- motor cycles										0
	53,741	0	0	0	0	0	0	0	0	53,741
EPU Reprocessed										
- OTR	0	0	0	0	0	0	0	0	0	0
- truck and bus	268,705	0	0	0	0	0	0	0	0	268,705
- light trucks	0	0	0	0	0	0	0	0	0	0
- speciality tyres	0	0	0	0	0	0	0	0	0	0
- passenger	0	0	0	0	0	0	0	0	0	0
- motor cycles	0	0	0	0	0	0	0	0	0	0
% EPU Reprocessed	268,705	0	0	0	0	0	0	0	0	268,705
% EPU Reprocessed										
- OTR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
- truck and bus	86.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	43.9%
- light trucks	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
- speciality tyres	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
- passenger	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
- motor cycles	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
% EPU Reprocessed	13.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	6.0%

Source Matthews (2006), URS Analysis

Table 3-13:Tyres Landfilled/ Legally Disposed in Western Australia

	Perth	South West	Lower Grt Sthrn	Upper Grt Sthrn	Midlands	South Eastern	Central	Pilbara	Kimberley	Total
Kg Landfilled/ Legally Disposed										
- OTR	0	1,113,951	0	364,634	251,835	1,499,356	339,225	8,361,869	371,002	12,301,872
- truck and bus	326,139	47,440	27,635	25,305	50,506	22,403	27,054	10,070	7,219	543,772
- light trucks	3,535,787	82,850	29,624	14,577	35,247	27,890	31,308	15,080	11,184	3,783,548
- speciality tyres	148,142	3,325	1,517	1,106	2,347	1,317	1,537	649	474	160,414
- passenger	8,063,148	105,929	26,244	9,050	24,018	21,651	24,809	15,353	7,863	8,298,064
- motor cycles	76,133	1,359	346	9	217	343	326	383	271	79,387
Total Kg	12,149,349	1,354,855	85,367	414,681	364,169	1,572,960	424,259	8,403,404	398,013	25,167,056
EPU Landfilled/ Legally Disposed										
- OTR	0	139,244	0	45,579	31,479	187,419	42,403	1,045,234	46,375	1,537,734
- truck and bus	40,767	5,930	3,454	3,163	6,313	2,800	3,382	1,259	902	67,972
- light trucks	441,973	10,356	3,703	1,822	4,406	3,486	3,913	1,885	1,398	472,943
- speciality tyres	18,518	416	190	138	293	165	192	81	59	20,052
- passenger	1,007,893	13,241	3,281	1,131	3,002	2,706	3,101	1,919	983	1,037,258
- motor cycles	9,517	170	43	1	27	43	41	48	34	9,923
Total EPU	1,518,669	169,357	10,671	51,835	45,521	196,620	53,032	1,050,426	49,752	3,145,882
% EPU Landfilled/ Legally Disposed										
- OTR	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
- truck and bus	13.2%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	11.1%
- light trucks	90.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	56.6%
- speciality tyres	90.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	53.3%
- passenger	90.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	71.7%
- motor cycles	90.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	65.7%
% EPU Landfilled	77.8%	35.7%	9.0%	45.0%	24.3%	67.9%	33.0%	95.2%	59.3%	70.2%

Source Matthews (2006), URS Analysis

Table 3-14:Tyres Illegally Disposed or Stored in Western Australia

	Perth	South West	Lower Grt Sthrn	Upper Grt Sthrn	Midlands	South Eastern	Central	Pilbara	Kimberley	Total
EPU Illegally Stored or Dumped										
- OTR	0	0	0	0	0	0	0	0	0	0
- truck and bus	0	59,959	34,927	31,983	63,834	28,314	34,194	12,727	9,125	275,063
- light trucks	49,108	104,714	37,442	18,423	44,548	35,250	39,570	19,060	14,136	362,250
- speciality tyres	2,058	4,202	1,917	1,398	2,966	1,664	1,943	821	599	17,567
- passenger	111,988	133,882	33,170	11,438	30,355	27,364	31,356	19,405	9,938	408,896
- motor cycles	1,057	1,718	438	11	274	434	412	484	343	5,171
% EPU Reprocessed	164,211	304,475	107,894	63,254	141,978	93,027	107,473	52,496	34,140	1,068,947
% Illegally Stored or Dumped										
- OTR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
- truck and bus	0.0%	91.0%	91.0%	91.0%	91.0%	91.0%	91.0%	91.0%	91.0%	45.0%
- light trucks	10.0%	91.0%	91.0%	91.0%	91.0%	91.0%	91.0%	91.0%	91.0%	43.4%
- speciality tyres	10.0%	91.0%	91.0%	91.0%	91.0%	91.0%	91.0%	91.0%	91.0%	46.7%
- passenger	10.0%	91.0%	91.0%	91.0%	91.0%	91.0%	91.0%	91.0%	91.0%	28.3%
- motor cycles	10.0%	91.0%	91.0%	91.0%	91.0%	91.0%	91.0%	91.0%	91.0%	34.3%
% EPU Illegally Stored/ Dumped	8.4%	64.3%	91.0%	55.0%	75.7%	32.1%	67.0%	4.8%	40.7%	23.8%

Source, URS Analysis

4.1 Tyre Transformation

Transforming a used tyre into a Tyre Derived Product (TDP) is largely the reduction of an end-of-life tyre into gradually smaller and smaller particles, that tend to also become more and more purified. Seven Transformation Categories (TCs) have been used in recent reports (URS 2005), based on industry definitions by the Tyres Roundtable and by industry stakeholders (see Table 4-1). These accepted categories are used in this report. Differentiation of the TCs enables comparitive analysis of each TDP based on the size of the final product's particles, the cost of production, and the value received for its sale in the market.

Table 4-1: Transformation Categories for TDPs

TC	Type	Size (mm)	Transformation Cost[5] ($/tonne)	Est. Value ($/tonne)
TC1	Whole Tyres		$0	$45 - 65
TC2	Cut Tyres	(300 mm+)	$35 - 50	$55 - 70
TC3	Tyre Chip	(30 mm – 299 mm)	$75 - 140	$120 - 135
TC4	Granulate & Buffing	(1 mm – 29 mm)	$160 - 250	$340 - 630
TC5	Crumb (Powder)	(0 micron[6] – 0.9 mm)	$250 - 350	$500 – 1,000
Steel	Steel	N/A	Included in above costs	$50 - 70
Textile	Textile	N/A	Included in above costs	$150 - 200

Source: Industry Discussions and URS Analysis 2005

The number of used EPU recycled into the various TDP categories in 2005, as well as the tonnes of TDPs that was produced from these end-of-life tyres in 2005 are detailed below:

Table 4-2: Tonnes of TDP Produced

TDP	Type	TDPs Produced (Tonnes in Aust 2005)	TDPs Produced (Tonnes in WA 2005)
TC1	Whole Tyres	21,280	
TC2	Cut Tyres	210	
TC3	Tyre Chip	110	
TC4	Granulate & Buffing	9,760	1,500 (15% of Aust.)
TC5	Crumb (Powder)	17,775	
Steel	Steel	9,121	
Textile	Textile	1,496	
		59,752	1,500 (2.5% of Aust.)

Source: Industry Discussions and URS Analysis 2005, 2006

5 Transformation costs include labour, power, maintenance, overheads, capital depreciation, property rental cost; but do not include collection, transportation or storage costs.

6 Note: 1mm is equal to 1,000 micron

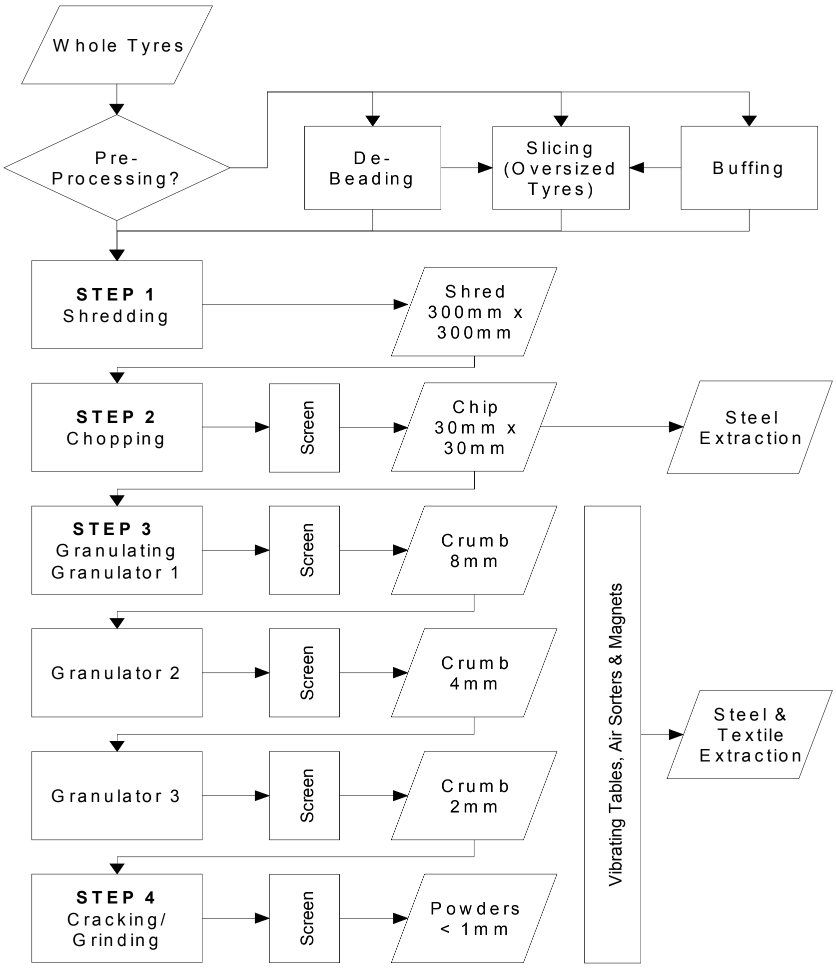
Across Australia there are a number of transformers who conduct the processing to recycle end-of-life tyres into the various TCs. Transformation is dominated by a few companies that include: SIMS Tyrecycle (VIC, NSW, QLD, SA); AEM Regenerative Rubber (NSW); Chip Tyre (QLD); and Affordable Rubber (QLD).

In Western Australia, Reclaim Industries is currently the only company that is reprocessing end-of-life tyres. They are using truck tyres only as they currently do not have equipment to deal with the fabric that is in passenger and light truck tyres. Estimates in Section 3 suggest they used some 53,750 truck tyres or about 2,150 tonnes of used truck and bus tyres - sourced primarily from the Perth region.

4.1.1 A Description of Generic Used Tyre Transformation

A generic overview of tyre transformation is provided to demonstrate the general procedure working down through the Transformation Categories. As shown in Figure 4-1, initial processing steps include chopping, de-beading and/or buffing - depending on the tyre size.

Figure 4-1: Generic Used Tyre Transformation Process



Source: URS (2005)

Following the initial processing, there are two types of tyre processing that are common to produce the smallest TDP particles (TC4 or TC5 size particles) – ambient grinding and cryogenic processing (URS 2005). While Steps 1 and 2 must occur to begin transformation into any level of TC, Steps 3 and 4 alter depending on whether the ambient or cryogenic processing is to be carried out in the final stages of transformation. Tyre transformers are tending to use ambient grinding more in recent years as it maintains elasticity and is usually more cost efficient (ARRB Transport Research 2004, p.36).

Ambient Grinding

The ambient grinding process is based on continual size reduction at ambient temperature. Step down size reduction is undertaken to balance efficient size reduction steps and the heat generated at each step. The steps involved if ambient grinding will occur in the final stages are as follows:

- **Step 1 - Shredding** – Tyres are shredded to produce a coarse shred (TC2) size of 300mm x 300mm or larger. In some cases shredding is undertaken against a screen to sieve out different particle sizes.
- **Step 2 - Chopping** – Coarse shred is chopped to produce a chip (TC3) between the sizes of 30mm x 30mm up to 299mm x 299mm. It is possible to chop to produce particles of size 15mm x 15mm (a TC4 granulate) if required for specific end uses. Up to 95% of the steel can be removed at this step.
- **Step 3 - Granulating –** The chips are granulated using two or three granulators depending on the size reduction required for the TC4 produced. Granulators use cutting teeth (or knives) rotating at medium high speed. Buffing machinery is an alternative to produce TC4, with buffing a tyre removing the need to conduct the previous two steps.
- **Step 4 - Cracking or grinding –** Rubber granules are processed through a cracker (or grinding) mill to produce TC5 or some TC4.

Cryogenic Processing

Cryogenic processing is based on the use of liquid nitrogen or super chilled air to shatter the rubber. As with ambient grinding and depending on the tyre sizes some initial processing (de-beading, chopping, etc.) may take place.

- **Step 1 - Shredding** – Same as Step 1 for ambient grinding above.
- **Step 2 - Chopping** – This step may not be required depending on the cryogenic equipment but if done produces a chip (TC3) between the sizes of 30mm x 30mm up to 299mm x 299mm.
- **Step 3 - Cryogenic process** – Tyre shred (TC2) or chip (TC3) is passed through a freezing chamber where either liquid nitrogen or super chilled air is used to freeze the tyre pieces to a temperature that allows tyre pieces to be shattered in a similar manner to glass. Liquid nitrogen consumption tends to be approximately equal to the quantity of crumb (TC5) produced.
- **Step 4 - Fracturing** – Frozen tyre pieces are size reduced using a high impact crusher in a fracturing mill to shatter the shred/chip into a TC4 or TC5 particle size. Rubber crumb from cryogenic processing has a smooth surface and steel and textile is removed during fracturing.

4.1.2 TC 1 (Whole Tyres)

TC1 products are whole tyres that are no longer suitable for repair, retreading, or reuse as a vehicle tyre. This TC is characterised by little or no processing occurring, as the tyres can be recycled in their whole form. The principal costs associated with the recycling of whole tyres relates to collection, transport and storage costs. This means that the transformation costs for a TC1 product is zero or close to zero.

End use markets pay between $45 – 65 per tonne for whole tyres (URS 2005). Cement kilns are one of the largest users of TC1 products in Australia, with over 10,000 tonnes of TC1 used in kilns in 2005 as a Tyre Derived Fuel. This occurs primarily in Victoria,. End use markets for TC1 product in Australia include:

- **Tyre Derived Fuel;**
  - Cement kiln energy;
- **Civil and marine applications;**
  - Retaining walls (with sidewalls removed);
  - Soil embankments (can require sidewalls removed);
  - Void filler;
  - Mine wall stabilisation;
  - Anti-erosion measures; and
  - Artificial reefs and flood defences.

4.1.3 TC 2 (Cut/Shredded Tyres)

The second transformation category (TC2) is shredded/cut tyres that are processed and sold into the end use market in sizes ranging from 300 mm and larger. Transformation costs for TC2 (not including collection, transport or storage costs) ranges between $35 – 50 per tonne of end-of-life tyres processed (URS 2005). For some end use markets such as retaining walls and soil embankments, the sidewalls of a tyre are removed, which gives a transformation cost of approximately $25 - $50 per tonne. This type of TC is included in the TC2 category as transformation has occurred over and above a TC1, and market prices are generally higher than for a TC1. End use markets currently pay between $55 – 70 per tonne of Cut Tyre. The end use markets that use TC2 in Australia include:

- **Tyre Derived Fuel;**
  - Cement kiln energy; and
- **Civil applications.**

4.1.4 TC 3 (Chip)

Transformation of end-of-life tyres into the TC3 category involves size reduction that generally requires an additional process stage than TC2. The cost to transform an end-of-life tyre into Tyre Chip is between $75 – 140 per tonne of product produced (URS 2005). The most common sizes of TC3 sold in the market are in 30mm, 40mm and 50mm particles (URS 2005). The applications for TC3 are similar to TC2, but are generally where further size reduction is necessary. The end market value for Tyre Chip is between $120 – 135 per tonne of the TDP, with uses including:

- **Tyre Derived Fuel;**
  - Cement kiln energy;
  - Blasting;
- **Civil applications;**
  - Stemming; and
  - Drainage.

4.1.5 TC 4 (Granulate & Buffing)

The fourth transformation category, TC4, encompasses TDPs ranging from 1mm – 29mm in size. The transformation costs for these TDPs are between $160 - 250 per tonne of TDP produced, and the end market value paid to transformers for TC4 is between $340 - 630 per tonne (URS 2005). TC4 buffing from both specialised buffing processes and from retreading, are generally cheaper to produce, as they are a by-product of the retreading industry, and receive higher prices in the end market in comparison to the less pure TC4 granulate. Hence there is a variation in the cost structure of these final products, although the particle sizes are similar.

There have been significant changes for the retread buffings market over recent years, as 15 years ago retreaders had to pay disposers and collectors to remove buffings, whereas in the current situation retread buffings have a positive value (URS 2005). This is perhaps an indicator of the overall increasingly positive value that TDPs are receiving in Australia. The end use markets that use TC4 in Australia include:

- **Energy uses;**
  - Blasting material;
- **Soft surfacing and matting;**
  - Equestrian matting;
  - Sub floors;
- **Mulches; and**
- **Moulded products.**

4.1.6 TC 5 (Crumb/Powders)

With an estimated 18,000 tonnes of rubber crumb produced in 2005 in Australia, the TC5 market is the second largest of the TC markets following the TC1 whole tyre market (see Table 4.10). This is a capital intensive activity so there are only a small number of processing plants, which tend to be located in the more populous States where large numbers of waste tyres are generated.

A transformer reducing used tyres down to the smallest TC5 category tends to create other TCs throughout processing, as rubber particles of all sizes are created as a tyre proceeds through the process. The transformation costs for producing a TC5 are between $250 – 350 per tonne of product (URS 2005). The most common size of TC5 sold in the Australian market is 30 U.S. Mesh (630 microns[7]), which is used in road surfacing, moulded products and adhesives.). The end market value for rubber crumb/powders is between $500 – 1,000 per tonne of the TDP sold (URS 2005), with end uses including:

- **Road surfacing;**
  - Asphalt;
  - Spray seal;
- **Adhesives;**
- **General rubber mixing; and**
- **Elastomers.**

4.1.7 Steel

Steel has an established recycling market in Australia and current scrap steel pricing is high due to a world-wide demand. Prices paid by metal recyclers are dependent on a number of factors such as the percentage of contamination (rubber), density (per cubic metre) and any impurities (alloys or non ferrous metal coatings). Transforming tyres to TC3, TC4 and TC5 will liberate steel as a by-product of the transformation process and as such steel is often viewed a contaminant in TDPs, particularly in rubber crumb and powder products. This contamination and its percentage is reflected in market prices in that premium prices are obtained for TDPs that are guaranteed metal free, and magnetically separated materials are not acceptable (URS 2005).

Research undertaken for the URS (2005) study revealed that some recyclers are recovering steel and obtaining prices between $50 and $70 per tonne depending on the level of rubber contamination, with the higher price reflecting 'clean' steel. Scrap steel prices in Australia range from $50 – 100 per tonne (URS 2005). Any contamination and its percentage resulting from transformation of steel from used tyres is reflected in lower market prices (Recyclers World Website 2005). When tyres are used as fuel in cement kilns the steel in tyres also has a value as it contributes to the requirement for iron in the cement manufacturing process.

4.1.8 Textile

Unlike steel, textile derived from reprocessed tyres does not have an established market in Australia. Options for reuse of tyre recovered textile exist, however most transformers stockpile or landfill this material. Potential prices paid by recyclers are dependent on a number of factors including the percentage

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[7] 1 mm is equal to 1,000 micron

of contamination (rubber or other impurities), and its density (per cubic metre). Dependent on these factors, textile is reported to sell for an equivalent of $150 to $200 per tonne internationally (URS 2005). End use markets that textile can be used for in Australia include carpet backing.

4.2 Enhancement of Tyre Derived Products

In addition to the proposed TCs 1-5, TDPs can be further value-added by steel, fibre and miscellaneous contaminant removal, devulcanisation, advanced thermal treatments, solvent deconstruction and surface activation techniques to improve their marketability and net value to defined end uses and applications. These incremental enhancements to the various size-based transformational categories can be recognised as possible Enhancement Benefits (EBs) additional to the basic size-based categories (TCs), as they tend to produce the same sized particles but are of a higher quality or are more applicable to particular end uses than the basic TCs. As EB technologies are only in initial developing stages and are comparatively experimental in Australia, there is little or no transformation cost or end-market value data available to determine increased costs or values for EBs over TCs at this stage (URS 2005).

Devulcanisation

Devulcanisation refers to the technology that works to break the carbon-sulphur bonds of rubber so that the material can be recombined with polymers in a greater percentage than vulcanised rubber. This recycled rubber can be used as, or is compounded back into virgin rubber to give lower cost rubber products with good physical properties.

Surface modification

Surface activation/modifications involves treating crumb rubber particles so they bond together better, and is a compromise between using recycled rubber strictly as a filler and wholesale devulcanisation (URS 2005). Size-reduced rubber is exposed to either fluoride or bromide gas, and the gas causes a permanent chemical change to the outer layer molecules of rubber particles and allowing it to blend with urethane.

Pyrolysis

Pyrolysis involves heating of an end-of-life tyre (usually shredded) in the absence of oxygen to decompose the tyre into a number of products: carbon black, oil, gas, steel and a small quantity of inorganic slay or ash (URS 2005). While markets exist in Australia for these products, they are generally of a low quality when separated from tyres and hence their commercial value is limited.

Current and Potential Uses - Demand Analysis

Tyre Derived Products (TDPs) are used in a number of final end markets. Where transformation is required, particle size, purity, and other requirements may be specific to each application. There are generally three broad classifications of end use markets that currently or potentially utilise TDPs in Australia: civil engineering; energy; and material recovery (rubber and other materials).

5.1 Civil Engineering Uses

Civil engineering applications utilise the inherent structural properties and resilience of tyres and generally require relatively little processing. Even so the applications can be relatively sophisticated. Generic engineering uses include:

- Retaining walls;
- Building foundations;
- Paving;
- Erosion control;
- Stemming; and
- Landfill engineering.

5.1.1 Retaining Walls, Foundations, Paving/Roads and Erosion Control

Retailing Walls

Retaining walls are made using whole tyres (TC1) with one side wall removed, that are then filled with crushed aggregate to form a 'structural' unit that can be used in various configurations and can be surfaced with a range of surface finishes such as coloured spray concrete (spraycrete or shotcrete), timber or coloured metal cladding. The walls can be either a gravity type, relying on their own weight to retain the supported material, or reinforced if the supported material is greater than a specified height. In storm water retaining wall applications tyres can be used in conjunction with geofabrics. Advantages of end-of-life tyre retaining wall systems are high strength, high drainage capacity, flexibility in design and appearance, reduced construction time, ease of installation and low maintenance.

Building Foundations

An increasingly popular practice in concrete floor design for domestic and commercial ground floor concrete slabs is the use of permanent internal sub-floor formwork to reduce the volume of concrete and steel used. A 'pod' system using tyres as fillers provides an alternative to traditionally used polystyrene blocks. This type of system has the ability to utilise site generated fill material that is otherwise likely to be disposed off-site.

Paving/Roads

End-of-life tyres can be used in permeable road and hardstand construction systems for use in areas with poor soil conditions. Truck or passenger tyres are used as containment devices enabling a structural sub base to be constructed from a single or double layer arrangement depending on ground conditions and load requirements. These roads can be left with permeable surface or sealed. Advantages include the ability of tyres to withstand high structural loads, stability, draining characteristics and ease of laying and construction.

Erosion Control

Tyres are used to retain free-draining aggregates to allow energy dissipation, improved flow characteristics, reduced velocity of water, and to provide a resilient surface that is not washed away. Advantages include construction speed, durability and reusability and cost effectiveness – suggested prices are 20% below competing technologies.

Current Status and Size of the Industry in Australia and Western Australia

It is understood that three organisations operate in this sector in Australia, these are:

- Ecoflex: civil engineering systems (retaining walls, foundations, erosion control, roads and paving);
- Biofloat: evaporation pontoons (e.g. cotton growers); and
- Industrial Recyclers: underground retention/distribution of on-farm water.

Ecoflex has stated that over 1.2 million UEPUs of used tyres have been recycled to date in over 500 projects that they have undertaken utilising tyre derived civil engineering systems. The experience of Ecoflex suggests that this markets use of TDP inputs has potential in Australia. They have not yet operated in Western Australia.

Overall market size in Australia is uncertain as there many sub-sectors within each end use market. Some sources have suggested that the retaining wall market is valued at between $220 - $270 million and the concrete slab market at between $120 - $170 million (URS 2005).

Table 5-1: Retaining Walls, Foundations, Erosion Control - Industry Overview

Industry Variable	Quantity - Australia	Quantity - WA
TDP Inputs	TC1	
Price paid for TDP inputs	$45 – 65 per tonne	
Industry size	3 major end market users	
Imports		Little or none
Exports		Little or none
Volume of TDP inputs pa – Current	174,000 EPU, 1,400 tonnes	Uncertain but limited
Volume of TDP inputs pa – Potential	5 million EPU, 40,000 tonnes	500,000 EPU or 4,000 tonnes given uptake proportional to population size

Source: Industry Sources 2005 and URS Analysis

Value of Products

Proponents of civil engineering systems that utilise used tyres claim that they are cost-effective and provide savings of between 20% and 25% over comparative systems. Additionally the systems can be re-used, providing long-term savings. The cost of TDP preparation is estimated to be in the region of $45 to $65 per tonne depending on whether the sidewall is removed or not. The value of the prepared TDP in these systems is estimated to be $200 per tonne.

Competition from Substitute Products

In each product area there are a range of competing materials, and competition from these substitutes is strong. The capacity for TDP's to compete will be product dependent. Use in engineering systems is suggested to be price competitive.

Barriers to Industry Development

Key issues suggested as barriers by stakeholders (URS 2005) for development of civil engineering markets in Australia are:

- Unsupportive public procurement policies;
- Private sector inertia in using different systems/ non-standard technologies;
- Cheap landfill pricing diverting tyres away from transformers;
- Lack of consistent and reliable tyre supplies due to current collection and disposal arrangements; and
- Lack of regulation supporting the recycling of end-of-life tyres.

5.1.2 Stemming

When blasting and charging is conducted in mines it commonly occurs whereby holes are charged with explosives and the hole is then filled with stemming to force the explosive energy into the surrounding rock, rather than back out the hole. Stemming maximises the amount of energy utilised in the fragmentation process and prevents dust explosions. The mechanism that allows stemming to work is the frictional properties and locking capacity of the material when it is confined in a blast hole.

Tyre derived stemming has been successfully trialled at a number of Hunter Valley open cut coal mines and demonstrated that the tyre material performs as well as conventional stemming materials in highwall blasting applications. Comparisons of CO_2 emissions with standard quarried stemming indicates a 50% reduction of CO_2 per tonne of product per annum for tyre derived stemming (Confidential Industry Source in URS (2005)).

Current Status and Size of the Industry in Australia

The stemming market in Australia is difficult to determine as stemming material varies in its characteristics and for some mining operations the material is quarried onsite, an overview of the stemming industry is provided in Table 5-2.

Table 5-2: Stemming Industry Overview

Industry Variable	**Quantity - Australia**	**Quantity WA**
TDP Inputs	TC4 Granulate	
Price paid for TDP inputs	$5 - 10 per tonne (price of gravel substitute)	
Industry size	1 potential producer trialling	
Imports		Little or none
Exports		Little or none
Volume of TDP inputs pa – Current	0 tonnes (trials only)	Little or none
Volume of TDP inputs pa – Potential	9.4 million EPU, 55,000 tonnes	Possibly 4-5 million EPU 25-30,000 tonnes

Source: Industry Sources 2005 and URS Analysis

Value of Product

For those mines that require imported gravel stemming, the delivered cost is approximately $10 per tonne. No cost data are available for mines that source stemming onsite. To be competitive with gravel, tyre derived stemming would need to be delivered for a price less than gravel stemming. This indicates that this end use market would be dependent on a fee structure operating whereby the mine would receive a fee to take whole tyres in order to cover transformation costs into TC3 or TC4 for stemming

Barriers to Industry Development

Key issues suggested by industry stakeholder feedback for the development of this market are:

- Availability of tyres must be within an economically viable distance to the mine operation;
- Miner operator acceptance of the product;
- Competition from higher resource value uses of TDPs reducing the end-of-life tyre resources; and
- Price of substitute (gravel) is only $10 per tonne so a fee or benefit will always need to be provided to a mine for tyre derived stemming to be substituted.

5.1.3 Landfill Engineering

Chipped tyres (TC3) can be used as material in landfill leachate draining layers. Leachate collection and removal systems are key components of modern-day engineered landfill sites and are designed to remove contaminated water from the base of a landfill cell to minimise the hydraulic head on the liner system (Warith, Evgin and Benson 2004, p. 967-979 in URS 2005). Currently leachate collection layers are constructed at the base of each landfill cell using a 300mm think layer of river gravel. River gravel is a diminishing resource, and at $35 to $40 per tonne is one of the more expensive construction cost items in landfill development. It is understood that end-of-life tyres are not used in this application in Australia, but that opportunity may exist in the future. The potential industry size has been difficult to estimate due to the fact that this market is not yet operating in Australia (URS 2005).

Competition from Substitute Products

Currently river gravel is used however this is a diminishing resource indicating an area of opportunity for the use of TDPs in this market.

Barriers to Industry Development

Key issues suggested by industry stakeholder feedback for the development of this market are:

- Concern by regulators about the heavy metals in tyres leaching into the landfill leachate; and
- Industry acceptance and changes to construction methods.

5.2 Energy Uses

Tyres can be used to generate energy for various applications as they have a chemical composition and calorific value useful for energy recovery. Energy recovery is used in the following uses in Australia:

- Tyre derived fuel; and
- Blasting material.

5.2.1 Tyre Derived Fuel

Tyre Derived Fuel (TDF) refers to the use of tyres as a fuel substitute for fossil fuels within furnaces for cement kilns, power stations, smelters or paper mills. In Australia cement kilns are currently the only TDF facilities in operation (URS 2005). Cement kilns can use whole tyres (TC1), shredded tyres (TC2) or tyre chip (TC3), where they are fed directly into the kiln that produces cement clinker. Tyres are burnt at very high temperatures (1450 degrees Celsius), and the steel in the tyres actually contributes to the kilns chemical requirements. Any residue can be incorporated into the clinker material that is ground to gypsum to produce cement.

Current Status and Size of the Industry in Australia

A summary of the size of the tyre derived fuel industry and the value of inputs is provided in Table 5-3.

Table 5-3: Tyre Derived Fuel Industry Overview

Industry Variable	Quantity - Australia	Quantity - WA
TDP Inputs	TC1, TC2, TC3	
Price received by kilns for TDP inputs	≤ $2.50 per EPU	
Value of TDP inputs	$74 – 88 per tonne[8] (price of energy equivalent)	
Industry size	2 cement kilns	Not in WA
Imports		Little or none
Exports		Little or none
Volume of TDP inputs pa – Current	1.2 million EPU 9,740 tonnes	Little or none
Volume of TDP inputs pa – Potential	8.8 million EPU 70,000 tonnes	Dependant on community acceptance. Could consume a large proportion of end-of-life tyres (>25%) as in Victoria.

Source: Industry Sources 2005 and URS Analysis

8 Calculations for Price of Whole Used Tyre Energy Equivalent:

Given that October 2005 thermal coal price USD 54/tonne = AUD 74/tonne (CNN International Website 2005 and Universal Currency Converter Website 2005)

And given that Energy from used tyres = 27 GJ/tonne, and Energy from thermal coal = 27 GJ/tonne (Atech Group 2001, p.28)

Hence, price of used tyre energy equivalent = (27 GJ/tonne / 27 GJ/tonne)*AUD 74/tonne = AUD 74/tonne

Calculations for Price of Shredded Used Tyre Energy Equivalent:

Given that October 2005 thermal coal price USD 54/tonne = AUD 74/tonne (CNN International Website 2005 and Universal Currency Converter Website 2005)

And given that Energy from used tyres = 32 GJ/tonne, and Energy from thermal coal = 27 GJ/tonne (Atech Group

Value of Products

Comparison can be made with the use of thermal coal, a substitute energy source. This comparison reveals that the energy equivalent price of end-of-life tyres is $88 per tonne of shredded tyres burnt for fuel, or $74 per tonne of whole tyres. The Cement Industry Federation indicated that an estimated price of between $35 – 74 per tonne would be the highest that kilns would pay for used tyres (i.e. they would not be willing to pay the thermal coal price of $74 given the increased capital costs to implement a new fuel) (URS 2005).

Competition from Substitute Products

While on a per tonne basis tyres are comparable to the use of coal, there are a number of other issues that favour the use of coal as a substitute product. A chief reason for this is that cement kilns and other power generating plants are currently set up for the use of coal, and the capital investments for converting facilities to take tyres as a fuel can be considerable. An industry source estimated that the capital cost of an alternative feeder system would be around $1 - 3 million (URS 2005). Other barriers to the TDF market to generate energy are discussed below.

Barriers to Industry Development

While the energy value of tyres is not disputed, only 2 cement kilns in Australia have even partially taken up the use of waste tyres in energy recovery. A number of barriers to the development of this industry have been identified:

- Additional operating and capital costs;
- Operational difficulties can occur with tyre feeder systems;
- Unreliability of supply;
- Earthmoving tyres are too large for processing in the kilns unless they are chipped or shredded; and
- Negative public perception of environmental issues associated with burning tyres.

5.2.2 Blasting Material (Fuel)

In mining operations, the removal of overburden to expose the ores is achieved by rock blasting using ammonium nitrate based explosives, eg ammonium nitrate-fuel oil mixtures, commonly known as ANFO. An alternative blasting mixture has been developed and patented that is based on replacing the diesel in the blasting mix, of diesel and ammonium nitrate, with granulate (TC4) in a proportion that reduces the ammonium nitrate percentage to 93%. It is understood that successful trials of this mixture have been

2001, p.28)
Hence, price of used tyre energy equivalent = (32 GJ/tonne / 27 GJ/tonne)*AUD 74/tonne = AUD 88/tonne

undertaken (URS 2005).

Current Status and Size of the Industry in Australia

The blasting material market is dominated by two suppliers, Orica and Dyno Nobel. It is understood that this market has changed recently with Orica purchasing the business of Dyno Nobel. These suppliers are also manufacturers of ammonium nitrate. It was estimated that in 2002 approximately 1 million tonnes of ammonium nitrate and 64,000 tonnes of diesel was supplied to the Australian mining industry for blasting (Confidential Industry Source in URS 2005). A summary of the size of the blasting material industry and the value of inputs is provided in Table 5-4.

Table 5-4: Blasting Material - Industry Overview

Industry Variable	Quantity - Australia	Quantity - WA
TDP Inputs	TC4 Buffing	
Price paid for TDP inputs	$500 – 600 per tonne	
Price of substitute	$1,025 per tonne	
Industry size	Developing	Little or none
Imports		Little or none
Exports		Little or none
Production of TDP inputs pa – Current	0 tonnes (trials only)	Little or none
Consumption of TDP inputs pa – Potential	12.6 million EPU 74,000 tonnes	Possibly 6-8 million EPU 35-40,000 tonnes

Source: Industry Sources 2005 and URS Analysis

Value of Product

It is understood that the cost of the substitute rubber crumb supplied to the specification requirements would be in the region of $500 - 600 per tonne. The cost of diesel would need to reduce to $635 per tonne to equal the saving suggested by the rubber crumb product. The cost of TDP input can in that sense rise to $950 per tonne before it is no longer a viable substitute for blasting diesel. Current prices for diesel (September 2006) net of the off-road diesel fuel rebate are moving around $1.00 per litre or some $1000 per tonne.

Barriers to Industry Development

Industry stakeholder feedback revealed some key issues for the development of this market including:

- Current mining industry practices and reliance on contracted blasting suppliers could impede change to new products;
- Miner operator acceptance of the product would require increased awareness and knowledge of the

benefits of TDP use;

- Contracted blasting suppliers tend to be subsidiaries of ammonium nitrate manufacturers so these suppliers have the advantage of vertical integration and have more control over price charged for ammonium nitrate; and
- The availability of waste tyres within an economically viable distance to the mine operation and the resultant transport costs affects the cost of the TDP.

5.3 Rubber Recovery Uses

Some 70% of a used tyre is rubberised product (inclusive of carbon black sulphur and other additives) . Rubber recovery from end-of-life tyres is a growing market in Australian and many other countries in the world, and a number of TDPs are becoming inputs into of a variety of end market products. Potential end use markets include:

- New tyres;
- Road surfacing;
- Flooring and mats;
- Moulded products; and
- Adhesives.

5.3.1 New Tyres

Recovered rubber is not commonly transformed for use in the production of new tyres, because safety and other performance requirements of new tyres requires that they be made mostly from virgin rubber compound. There are some indications that firms in the U.S. have found that mixing 5 - 15 percent recycled rubber into the virgin rubber provides a few advantages in the production process, including better mixing properties and an increase in plant efficiency due to reduced curing times (URS 2005). Devulcanised rubber is more suitable for use in new tyres; however this technology is only in development stages in Australia. Further, new tyre production does not occur in Western Australia.

5.3.2 Road Surfacing

In Australia, there are two road surfacing applications where rubber crumb can be used as inputs:

- Spray Seal – rubber modified binder can be used in this process; and
- Asphalt – Bitumen can be modified by the incorporation of rubber top to create asphalt.

Recovered Rubber in Spray Seal

Spray seal is a pavement surface treatment that consists of a sprayed film of bituminous binder covered with aggregate. A rubber modified binder used in a Spray Seal is commonly referred to as Crumb Rubber Modified binder (CRM). The use of CRM is generally to extend the use of roads that are cracked or near the end of their life. Successful trials have been conducted on the use of recovered rubber in spray seals by VicRoads and NSW Road Traffic Authority. The use of rubber crumb in spray seals is now a standard practice in NSW and Victoria, and is included in the specifications of use for most other Australian states/territories (URS 2005). Most of the rubber crumb used in roads in Australia is used in spray sealing. Estimates suggest that some 1.6 tonnes of recovered rubber is required for each kilometre of single-laneway constructed using spray seal (ARRB Transport Research 2004, p.36).

In Western Australia there are currently two main uses for recovered rubber:

- as a polymer modified binder applied as a strain alleviating membrane interlayer (SAMI) where a specialist product is used to bind cracked roads, as a waterproof seal on bridge decks, and on roads where additional strength is required, such as on corners where turning heavy vehicles put additional stress on the surface; and
- in bitumen.

When used in bitumen it is said to be a similar cost to other binders and has good adhesive properties. However, it wears bitumen sprayers, is difficult to clean, and needs to be used in large batches of at least 5,000 litres.

Recovered Rubber in Asphalt

Crumb rubber asphalts are uncommon in Australia. The few trials carried out in Australia where crumb rubber asphalt has been placed over badly cracked concrete and flexible pavements have performed very well. In asphalt, TC5 crumb can be used as a part of the asphalt binder that is modified, or as an aggregate substitute. There are two processes used to incorporate TC5 into asphalt:

- Wet process – crumb rubber and bitumen are combined at high temperature then added to aggregate;
- Dry process – dry rubber particles are added to aggregate and bitumen at the asphalt mixing plant, with rubber usually mixed with the aggregate prior to bitumen addition.

Generally, the amount of TC5 that can be used in asphalt roads is 5% of the mix (in comparison with 20% of the mix in spray sealed applications). Partly because asphalt mix is usually about twice the density of a spray seal mix, three tonnes of recovered rubber is required for each lane-km constructed using asphalt compared to 1.6 tonnes of TC5 for each lane-km of spray seal) (ARRB Transport Research 2004, p.37).

Recovered rubber is not currently used in asphalt in WA as there are a number of difficulties associated with its use. Operators dislike using this product as it exhibits a terrible odour, it requires higher operating temperatures, wears the spraying equipment at a faster rate, and is more difficult to clean machinery after its use.

Current Status and Size of the Industry in Australia and WA

A summary of the road surfacing industry in Australia and in WA is provided by Table 5-5.

Table 5-5: Road surfacing Industry Overview

Industry Variable	Quantity - Australia	Quantity - WA
TDP Inputs	TC5 (30 U.S. Mesh)	
Price paid for TDP inputs	$400 - 600 per tonne	
Price of substitute input	See Table 5-7	
Industry size	3 states use TDPs in roads 5 main road contractors supply	
Imports		60-100 tonnes of crumb is imported for this use
Exports		Little or none
Consumption of TDP inputs pa – Current	160,125 EPU 915 tonnes	SAMI and Bitumen – 10,000 – 16,650 EPU, or 60-100 tonnes Asphalt - 2,625 EPU 15 tonnes (URS 2005)
Consumption of TDP inputs pa – Potential	15.8 million EPU 90,000 tonnes	1-2 m EPU (spray seal), 6-12,000 t 150,000 EPU (asphalt), 900 tonnes

Source: Industry Sources 2005 and URS Analysis

In a report conducted for the Western Australian Department for Environment, Matthews (2005, p.33) stated that the amount of rubber crumb that Main Roads WA uses in road surfacing has diminished to 15 tonnes per annum, which is approximately one-tenth of the amount used previously. The reasons cited in the Matthews report for this reduction in demand are:

- Crumbed rubber in bitumen has been largely replaced over the past ten years by polymers;
- Problems with consistency of supply;
- Noxious fumes during the blending with bitumen at 170-180 degrees Celsius; and
- The need to clean trucks immediately after spraying to prevent blockages.

In relation to the demand for TDPs of the road end market producers, the annual use of rubber crumb in Australia's roads is estimated below in Table 5-6.

Table 5-6: Use of TDPs in Roads 2005 (per State/Territory)

State/Territory	Tonnes pa
VIC	400
NSW	500
WA	15
SA	0
QLD	0
TAS	0
NT	0
ACT	0
Total	**915 tonnes pa**

Source: Industry Sources July/August 2005

Value of Products

The value of crumb rubber modified bitumen is approximately $700 tonne produced (URS 2005). The price paid for TC5 (U.S. 30 Mesh) for input into rubberised asphalts and spray seals is in line with the market price of between $400 – 600 per tonne of the TDP.

Competition from Substitute Products

A comparison of the costs of road surfacing substitutes is shown in Table 5-7.

Table 5-7: Comparison of Road Surfacing Substitutes to TDPs

Substitute	Price per tonne
Price of TC5 inputs	$400 - 600/tonne
Price of polymer inputs	$3,000/tonne
Price of rubber modified bitumen	$700/tonne
Price of polymer modified bitumen	$800-900/tonne
Price of straight bitumen	$400-500/tonne
Price of multigrade binder bitumen	$550/tonne

Source: URS Analysis (2005)

For use as an aggregate in road construction, rubber competes with crushed rock, which is less costly to produce and transport. Rubber modified binders (CRM) and polymer modified binders (PMBs) are generally used for similar applications (preservation treatments for lower-volume roads that are cracking or deteriorating); hence polymer products are the most direct substitutes to TC5 use in road surfacing. Some advantages of recovered rubber use in roads include:

- Performance – PMB is not stable and can degrade with long haulage times before application - CRM binder does not suffer this disadvantage (ARRB Transport Research 2004, p.38); and
- Long term savings – Use of recovered rubber produces ongoing savings from reduced maintenance and a longer replacement life cycle add dramatically to the initial savings.

Barriers to Industry Development

Industry consultations undertaken for URS (2005) and in the experience of Main Roads WA cited above, revealed a number of barriers to the use of recovered rubber in roads, including:

- Lack of specifications for the use of rubberised asphalt is limiting its use.
- Laying costs of rubberised asphalt mix is some $25 per tonne more than polymerised mix - although rubber is reported to have an extended life it has higher construction costs.
- Inconsistent supply of TDPs makes producers wary of relying on rubber inputs for road surfacing;
- Trials suggest some difficulty using rubber crumb in asphalt as it can block and clog up machinery; and
- Health and Safety – due to the high temperatures required to mix recovered rubber, rubber is reported to increase emissions - OH&S implications of any fumes released.

Despite numerous studies it is likely that significant testing and development work over several years would be required before rubber would be used for road making in all States and Territories in Australia.

Potential Industry Size

Spray seal market – Western Australia's road network is some 105,000 kilometres (ABS 2005b). The sealed network is over 50,000 km or one third of the road network - the majority of the Australian sealed network is spray seal bitumen (Atech Group 2001, Pt.1, p.70). Given that seals last an average of 12 to 15 years (US Department of Transportation 2002, p.9), this would equate to 7 percent replacement per year, or approximately 3,500 km replaced per annum. With 20 percent recovered rubber in a spray seal mix, using 3.3 tonnes of CRM per kilometre, this indicates that if rubberised spray seal was used on Western Australia's sealed network, then up to 11,550 tonnes of recovered rubber could be used per annum. This equates to nearly 2 million EPU, or about 50% of the available material.

Table 5-8: Km of Roads in Australia (June 2004)

	NSW	Vic	Qld	SA	WA	Tas	NT	ACT	Total
Bitumen or concrete	91,746	76,000	70,608	28,557	50,562	10,456	6,463	2,570	336,962
Gravel, crushed stone	90,421	53,800	52,513	40,825	55,044	13,343	6,763	128	312,837
Total	182,167	129,800	123,121	69,382	105,606	23,799	13,226	2,698	649,799

Source: ABS (2005b)

Asphalt market – in terms of all Australian road works occurring on an annual basis, an estimated 10% of all works involve asphalt, which equals a total of approximately 6.5 million tonnes of asphalt, or 110,000 lane-km of asphalt used per annum (ARRB Transport Research 2004, p.38). Around 7.5 percent of lane-km of all asphalt works in Australia require a modified bitumen (polymer or rubber modified), and that market is currently all going to PMB asphalt apart from the small quantities of recovered rubber used for trialling. The current PMB asphalt market size indicates the potential market size for rubberised asphalt, should it penetrate this sector.

As a percentage of the total 110,000 lane-km of asphalt laid per year, 7.5% of lane-km of asphalt is equivalent to around 8,250 lane-km of PMB asphalt. Based on 3 tonnes of recovered rubber being used on each kilometre of asphalt lane, a penetration rate of 25% of rubberised crumb into the current PMB asphalt market will result in the redirection of between 1.05 million used EPU per annum to produce 6,000 tonnes. Given that WA has some 15% of Australia's surfaced roads this may equate to 150,000 EPU and 900 tonnes for WA, which is comparatively small.

5.3.3 Flooring and Mats

The use of recovered rubber in flooring and mats is a growing industry in Australia. The use for TDPs in flooring and matting applications provide low cost fillers that can add elasticity and performance to products, such as:

- Soft fall rubber surfacing for use in playgrounds, work areas, industrial applications, etc.;
- Carpet underlay;
- Safety matting; Marine decking; Horse float and utility linings;
- Sport flooring, and equestrian surfaces and workout areas; and
- Rubber mulch.

Current Status and Size of the Industry in Australia and Western Australia

A summary of the flooring and matting industry is shown in Table 5-9.

Table 5-9: Flooring and Matting Industry Overview

Industry Variable	Quantity - Australia	Quantity WA
TDP Inputs	TC4, TC5	
Price paid for TDP inputs	$350 - 600 per tonne	
Industry size	35 surfacing companies	
Imports		Unknown as TDP or in rubber based products - significant
Exports		Approx 1,500 tonnes as TDP and rubber based products
Production of TDP inputs pa – Current	2.12 million EPU 10,850 tonnes	250,000 EPU 2,000 tonnes
Consumption of TDP inputs pa – Potential	3.21 million EPU 15,850 tonnes	200-300% of current WA production

Source: Industry Sources 2005 and URS Analysis

In Western Australia, Reclaim Industries has been recycling tyres since 2001. In that time Reclaim has processed approximately ten thousand tonnes of old tyres or the equivalent of 250,000 truck tyres or 1.25 million car tyres. Reclaim manufactures many different raw rubber granule products including:

- Adhesives and bitumen to provide elasticity and durability;
- Compression moulding and surfacing as well as synthetic turf infill;
- Surfaces, pre-colour, equine surfacing, and all moulded product (from retread buffings);
- Surfacing product or as synthetic turf underlay.
- "Cushion" under playground soft fall surfaces.
- A barrier in turf to prevent wear and conserve water (sourced from Reclaim website).

Table 5-10 shows the number of EPU that are required to produce surfacing/flooring products.

Table 5-10: Tyre Usage for Surfacing/Flooring Products

Treatment	EPU Used	Product
Playground surface (25 mil)	1,400	per playground (av. 500m^2)
Play area safety surface	300	per play area (av. 50m^2)
Sports field (15 mil)	6,000	per 6000m^2
Tennis courts	700	per 680m^2
Indoor tracks & surfaces	1,300	per 1000m^2 gymnasium
Tram rail beds	2,000	per kilometre
Metro rail	2,000	per kilometre

Source: Annex 5, Basel Convention Technical guidelines on the identification and management of used tyres, URL: www.basel.int, cited in SATRP 2005

Another flooring product is rubber mulch, which is being produced in Australia by buffing solid rubber tyres (mainly solid forklift truck tyres) into coarse mulch for use in landscaping and sporting/equestrian surfaces. Approximately 500 tonnes of tyres is being processed per annum, with all the mulch produced currently exported to the U.S.

Competition from Substitute Products

According to the California Integrated Waste Management Board (CIWMB Website 2005) rubber mats typically are comparable in cost to rubber products that have no recycled content, and in addition the product will often last longer or have other benefits such as non-slip properties (CIWMB 2005).

Barriers to Industry Development

Industry stakeholder feedback revealed that key issues relating to the development of the flooring and mat industry's use of recovered rubber include:

- Lack of knowledge of rubberised substitutes in the market;
- Misconception that recovered rubber is a poor quality input; and
- Lack of consistent and reliable TDP supplies at favourable prices, as there are only three or four major producers of TDPs in Australia providing for a variety of industries.

5.3.4 Moulded Products

Moulded products can use both new and recycled rubber as inputs. These products can be made from more than 90% recovered rubber, with added binder and colour pigment if required (Matthews 2005, p.30). The products that typically are included in this end use market are:

- Speed humps and cushions;
- Crash barriers;
- Guideposts;
- Bollard bases; and
- Regulatory signage (Sustainable Strategic Solutions 2005, p.30).

Current Status and Size of the Industry in Australia

A summary of the moulded products industry is provided in Table 5-11.

Table 5-11: Moulded Products Industry Overview

Industry Variable	Quantity - Australia	Quantity - WA
TDP Inputs	TC4 Buffing, TC5	
Price paid for TDP inputs	$350 - 600 per tonne	
Industry size	Unknown	
Imports		Unknown but significant
Exports		Part of volume (1,500 tonnes) indicated for flooring and mats produced in WA
Production of TDP inputs pa – Current	2.2 million EPU 10,000 tonnes	Part of volume indicated for flooring and mats produced in WA
Consumption of TDP inputs pa – Potential	4.3 million EPU 13,000 tonnes	10% of national estimate = 430,000 EPU or 1,300 tonnes

Source: Industry Sources 2005 and URS Analysis

Competition from Substitute Products

The principal substitute product in this end market is new rubber, which tends to be of higher quality, although also higher cost. Discussions with industry (URS 2005), revealed that the principal reason they do not use recovered rubber in the majority of their rubber products is the perception that the rubberised products are of poorer quality than new rubber. In particular it was believed that rubberised products have a poor surface finish, poor mechanical properties, and a higher viscosity which makes it more difficult to process (URS 2005).

Barriers to Industry Development

Barriers to industry development from industry stakeholder feedback include the following:

- Lack of knowledge of rubberised substitutes in the market;
- Misconception that recovered rubber is of poorer quality than substitutes; and
- Perception that supply of TDPs is unreliable.

5.3.5 Adhesives

Recovered rubber can be used to produce industrial adhesives, for example, rubber crumb (TC5) is used in the manufacture of tile adhesives. It provides benefits such as weight reduction, improved coverage, longer workability, flexibility and sound attenuation. A disadvantage is poor bonding into the adhesive matrix.

Current Status and Size of the Industry in Australia

A summary of the adhesive industry is provided in Table 5-12.

Table 5-12:Adhesive Industry Overview

Industry Variable	Quantity - Australia	Quantity - WA
TDP Inputs	TC5	
Price paid for TDP inputs	$550 - 900 per tonne	
Imports		100 tonnes approx
Exports		nill
Consumption of TDP inputs pa – Current	1.1 million EPU 6,000 tonnes	Not produced but approx 100 tonnes used
Production of TDP inputs pa – Potential	1.8 million EPU 10,000 tonnes	Unknown but possibly 10% of Australian estimate – 1,000 tonnes or 180,000 EPU

Source: Industry Sources 2005 and URS Analysis

Value of Products

The adhesive manufacturers require crumb that is completely free of metal (due to the product liability issue of corrosion stains showing through in grouts) – so it is usually sourced from buffings. Prices paid by this market for TC5 range from $550 up to $900 per tonne.

Competition from Substitute Products

There are a number of alternative inputs to TDPs that are currently used in the adhesives market, including foamed glass, hollow micro-spheres, perlite and vermiculites. Other natural materials can also be used. Some of these alternatives are more expensive than TDP inputs, or have some health and safety implications that TDPs do not, which should favour the use of recovered rubber adhesives.

Potential Industry Size

Industry sources indicate that considerable market potential exists for recovered rubber adhesives, particularly given growth opportunities in the multi-storey housing sector and the need to comply with changes to the Building Code of Australia e.g. relating to sound attenuation (impact sounds from floors above other habitable rooms). The combination of a tile adhesive with sound deadening/attenuation properties in a single liquid that is applied in a 5 – 15 mm elastomeric film indicates the positives and market potential. Rubber sheet systems can be used in this application however liquid systems tend to perform better when there are floor penetrations for pipes and services (URS 2005).

Barriers to Industry Development

Barriers to industry development, based on industry stakeholder feedback include:

- Concern within the industry that there could be insufficient supply of rubber crumb to meet potential market growth in adhesives;
- Lack of transformers providing material to exact adhesive specifications; and
- Lack of broader market knowledge of the benefits of rubberised adhesives.

6.1 Market Participants

The end-of-life tyre industry Western Australia is characterised, like the industry in other states, by the situation where end-of-life tyres are 'pushed' through the waste tyre system from tyre changers/ retailers, to collectors/ transporters, to landfill operators. The situation of market push presented in the used tyre industry is typical of the situation in other sectors of the waste industry where materials are not valued positively in their own right (URS 2005).

Tyre collectors are paid by tyre changers to dispose of end-of-life tyres and they will tend to do so to the least cost destination. Collectors will pay a fee to transformers to take end-of-life tyres up to the cost of the disposal cost to a landfill operator, assuming legal disposal practices. In the current market setup, the dealers play a key role, as they control arrangements with tyre collectors. Many dealers charge customers a 'disposal fee' or 'environmental fee' of around \$2.50 per EPU, which in full or part is paid to the collector to cover the costs of collection, transportation, and disposal. Transformers will take tyres to the point where the payment in lieu of disposal, plus the returns from transformation processes, exceeds their net costs.

The used tyre collection sector has a large influence on the recycling of tyres, as it is connects the transformers with their end-of-life tyre resources. Tyre collectors have potential to control the supply of tyres to transformers. Landfill disposal costs also have a strong influence over the viability of transformation businesses as it is a major factor in determining what collectors are prepared to pay transformers to take their tyres.

In Western Australia there are only a few major tyre collection and disposal operations, and two transformation businesses. Continuity of supply and price paid to transformers are key factors to transformers business risk. Reclaim Industries has been for some time the only major business reprocessing end-of-life tyres in WA. They have recently been joined by Tyre Recyclers WA as a transformer of used tyres.

6.2 Market Potential in Western Australia

Estimates of current production/ consumption and potential production in Western Australia, and the suggested barriers to market expansion are summarised in Table 6-1 from data presented in Section 5. The suggested total potential use, inclusive of stemming, and blasting material uses, is some 14.5 million EPU. This is a speculative total as neither of these major uses is being put to practice to a major extent in Australia currently. The total potential use ex of stemming, and blasting material uses is some 2.9 million EPU. This compares against current use of 270,000 EPU, and the current volume of end-of-life tyres in WA of 4.5 million EPU – a figure which may well double with the recent startup of a second transformation operation. The suggested potential use excludes any estimate for tyre derived fuel, as used in cement kilns, and potential exports.

Financial implications as well as market failures may be limiting rates of reprocessing, as well as the barriers identified in Table 6-1. Indicative financial values of alternative products sourced from each region are discussed in Section 7.

6.3 Imports and Exports

Accurate estimates of imports and exports of rubber product is difficult to obtain from statistical sources - collection of such data should be a priority of the potential Stewardship Scheme to improve industry statistics. A relatively small volume of second hand tyres are exported interstate and overseas for ongoing use on vehicles or for retreading. These exports are strictly not of end-of-life tyres and do not represent transformed or tyre derived products.

Industry sources suggest there are both exports and imports of tyre derived product out of and into WA. At present there is a shortfall of finer grade crumb (30 mesh) that is used, for example, in adhesive manufacture and this is imported from eastern states. Other imports include product from South Africa that is used in bituminous products, this is apparently not a great volume but in the order of 60-100 tonnes.

Slightly more than 2,000 tonnes of tyre derived product has been produced annually by Reclaim Industries, of that it appears that some 30 to 40 tonnes per month (360-480 tonnes annually) are used by Reclaim to make rubber products for the WA market. The remainder is exported into eastern states markets.

Tyre Recyclers WA have recently started to produce product from passenger tyres that is suitable for adhesive manufacture.

Both manufacturers suggest security of supply is the primary constraint on further investment in their plants. They suggest they can compete against imports for higher value product provided they can be sure of their supply arrangements. Currently they are paid to take tyres by collectors so collectors avoid the higher cost of disposal into legal landfills.

Table 6-1: Current and Potential Size of TDP End Use Markets in WA

End Use	TDP Input	Current Used Tyre Inputs	Potential Used Tyre Inputs[9]	Barriers to Industry Development
Civil Engineering				
Retaining Walls, Foundations, Pavings & Erosion Control	TC1	Uncertain but limited	500,000 EPU or 4,000 tonnes	• Unsupportive public procurement policies; • Inertia in using different systems/ non-standard technologies; • Cheap landfill pricing diverts tyres away from transformers; • Lack of consistent and reliable tyre supplies; and • Lack of regulation supporting the recycling of end-of-life tyres.
Stemming	TC4 Granulate	0 tonnes	Possibly 4-5 million EPU 25-30,000 tonnes	• Tyres within an economically viable distance to the mine operation; • Miner operator acceptance of the product; • Competition from higher resource value uses of TDPs; and • Price of substitute (gravel) only $10 per tonne.
Landfill Engineering	TC3, TC4 Granulate	0 tonnes	Unknown	• Concern of heavy metals in tyre leaching into the landfill leachate; and • Industry acceptance and changes to construction methods.
Energy				
Tyre Derived Fuel	TC1, TC2, TC3	0 tonnes	Dependant on community acceptance	• Additional operating and capital costs; • Operational difficulties can occur with tyre feeder systems; • Unreliability of supply; • Earthmoving tyres are too large unless they are chipped or shredded; • Negative public perception of environmental issues
Blasting Material	TC4 Buffing	0 tonnes	Possibly 6-8 million EPU 35-40,000 tonnes	• Miner operator acceptance of the product • Blasting suppliers often subsidiaries of ammonium nitrate manufacturers; • Availability of waste tyres within an economically viable distance

9 Note: Potential inputs of used tyres is based on stakeholder feedback and estimates for growth

End Use	TDP Input	Current Used Tyre Inputs	Potential Used Tyre Inputs[9]	Barriers to Industry Development
Rubber & Material Recovery				
Road Surfacing	TC5	2,625 EPU 15 tonnes	1-2 mill EPU (spray seal) 6-12,000 tonnes 150,000 EPU (asphalt) 900 tonnes	• Lack of specifications for the use of rubberised asphalt • More expensive laying costs - although rubber may have longer life. • Inconsistent supply of TDPs makes producers wary of relying on rubber; • Difficulty using rubber crumb as it can block and clog up machinery; • Variable demand – most road construction occurs in the warmer months. • Health and Safety –rubber is reported to increase emissions; and • Need for further testing before used in all States and Territories in Aust.
Flooring & Mats	TC4, TC5	250,000 EPU 1,500 tonnes	330,000 EPU 2,000 tonnes (short term)	• Lack of knowledge of rubberised substitutes in the market; • Misconception that recovered rubber is a poor quality input; and • Lack of consistent and reliable TDP supplies at favourable prices
Moulded Products	TC4 Buffing, TC5	Part of volume shown for Flooring and Mats produced in WA	10% of Aust estimate 430,000 EPU or 1,300 tonnes	• Lack of knowledge of rubberised substitutes in the market; • Misconception that recovered rubber is of poorer quality than substitutes; and • Perception that supply of TDPs is unreliable.
Adhesives	TC5	Not produced but maybe consumed	?	• Lack of transformers providing material to exact adhesive specifications; • Lack of broader market knowledge of the benefits of rubberised adhesives.
Steel		By-product	By-product	
Textile		By-product	By-product	
		Total EPU	**12.4 – 14.4 million EPU**	
		Total EPU- ex Stemming and Blasting Material	**2.4 – 3.4 million EPU**	

Source: Industry Sources, URS (2005), and URS Analysis

7.1 Indicative Returns from Alternative TDP in WA

Western Australia presents a challenging situation for reprocessing activities because of its isolation from markets internationally, and other domestic populations, and because of the distances between relatively small regional populations and the major metropolitan centre. Because of these issues, financial implications, as well as market failures, maybe limiting rates of reprocessing, as well as the more technical barriers identified in Table 6-1. Indicative financial values of alternative products sourced from each region are discussed below.

7.1.1 Gross Value per EPU

Indicative gross values per EPU have been estimated for each TDP (see Table 7-1), they account for different compositions of each tyre category and recovery from each transformation process. Higher gross values are shown for transformation category five (TC5) outputs, which are in the range of $3 to $6 depending on the grade of product. Estimate of value for TC1 used in cement kilns is 40 cents per EPU, or up to $1.60 if the side wall is removed and the tyre is used for engineering purposes.

7.1.2 Collection, Transport and Landfill Costs

Collection, transport, landfill disposal (inclusive of levy), baling and storage cost estimates are presented as Table 7-2. Perth region estimates for collection, transport, and landfill total $1.30 per EPU. If tyres are baled an additional cost of 20 cents per EPU is suggested. This total is in accordance with that suggested by industry representatives, the breakdown between elements and across regions was developed by URS. No estimate has been made for reduced landfill costs per EPU if tyres are baled – this might be expected as the volume required per EPU would be reduced with baling. Transport costs are based on $60 per tonne over 150 kilometres (Matthews, 2005), which has been extrapolated to other mean distances from each region to the Perth area.

7.1.3 Transformation Costs

Transformation cost estimates used for this analysis are presented as Table 7-3. Note these estimates are based on a scaled conversion from passenger tyre cost estimates, that may not be an accurate estimation of OTR costs where they may require specialist equipment and handling capacity.

7.1.4 Gross Margin Returns per EPU

For each of the six tyre categories, collection, transportation, storage and transformation costs, and landfilling costs have been estimated, incorporating differences between metropolitan and regionally sourced tyres. Transport and collection costs vary depending on location, however storage costs are estimated with the assumption that any major storage will be located in the metro area as this is where tyres are stored prior to transformation. Transformation costs have been estimated across the range of five TC definitions and based on stakeholder data and URS analysis. The composition of new tyres for each of the six tyre categories was defined, and was then adjusted to reflect the proportional losses during wear and the changes during each of the transformation processes.

Value was based on the prices paid by the end use markets, or as the value of a TDP used as a substitute for another input – as discussed in Section 5. Gross margins indicate the returns from each TC according to tyre category, they also include the value of any steel or textile recovered, and the collection, transformation, storage and transportation costs. URS modelling undertaken as part of the URS (2005) report developed transformation cost estimates from first principles – the cost of owning and operating an example set of machinery. The estimated transformation costs are therefore indicative and don't reflect any financial costs of any borrowings nor do they include a profit margin. There is also some uncertainty that each tyre type can be used for each output, this may apply to OTR tyres in particular.

Gross Margin Returns per EPU – ex of Collector Payments

Gross margin returns, ex of any collector payments to avoid landfill disposal costs (processing and any levy) are presented in Table 7-4 and as Figure 7-1. The tabulated data show results for the major statistical divisions and the impact of transport costs from regional areas. These results exclude collector payments to transformers to avoid landfill disposal costs. These data show the direct financial implications of a business sourcing and transforming tyres, they are buying the resource at the cost of collection and transport.

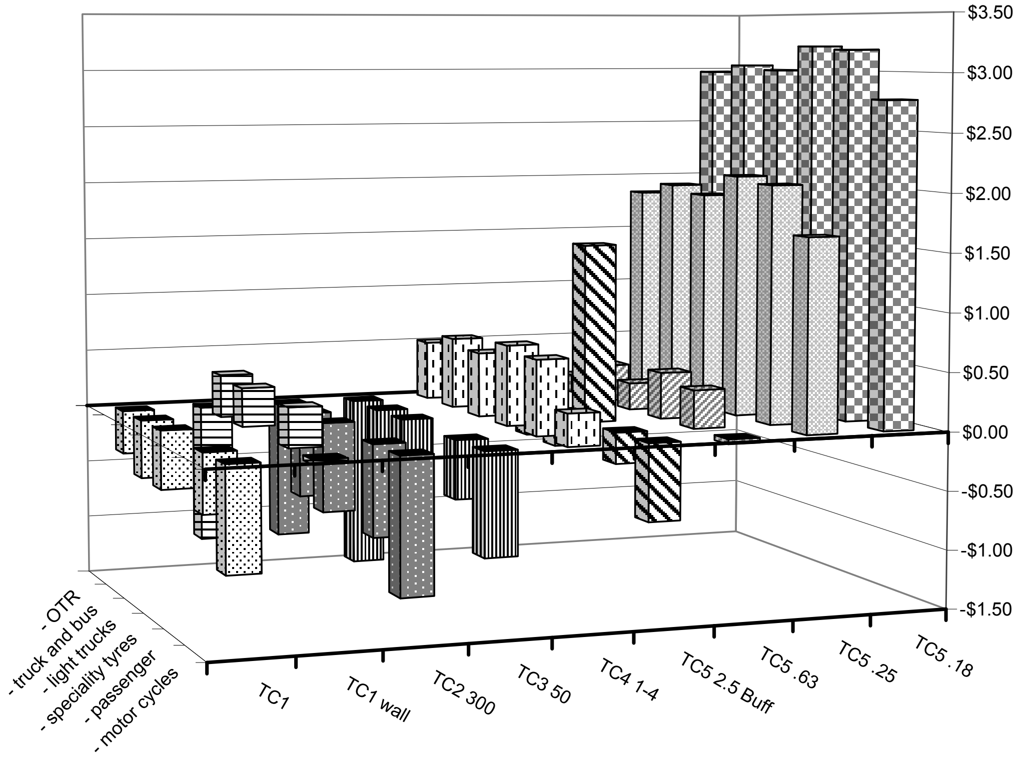
Figure 7-1 highlights the higher returns from TC4 and TC5 products, differences between tyre categories. Without these cross payments many of the transformation categories exhibit negative returns, even when tyres are sourced from the Perth metropolitan area. Only TC5 and some TC4 products show positive returns when tyres are sourced from regional areas, and then from the areas closer to Perth.

Gross Margin Returns per EPU – Inclusive of Collector Payments

Gross margin returns, inclusive of collector payments to avoid landfill costs (processing and any levy) are presented in Table 7-5 and graphically as Figure 7-2. Collector payments are assumed at $60 per tonne, inclusive of landfill disposal costs and a landfill levy cost. This equates to 48 cents per EPU. Consequently the positive difference in gross margin between the above data (ex of collector payments) is 48 cents per EPU. Positive returns are now shown for some TC1 and TC2 products and higher returns overall. These data also suggest that positive returns can be gained from tyres sourced from closer regional areas such as the Midlands, South West, and South Eastern. The imposition of mandatory baling would effectively add another 20 cents per EPU to the indicated margins. However, as discussed in the following chapter this is a very blunt mechanism to achieve a relatively small incentive.

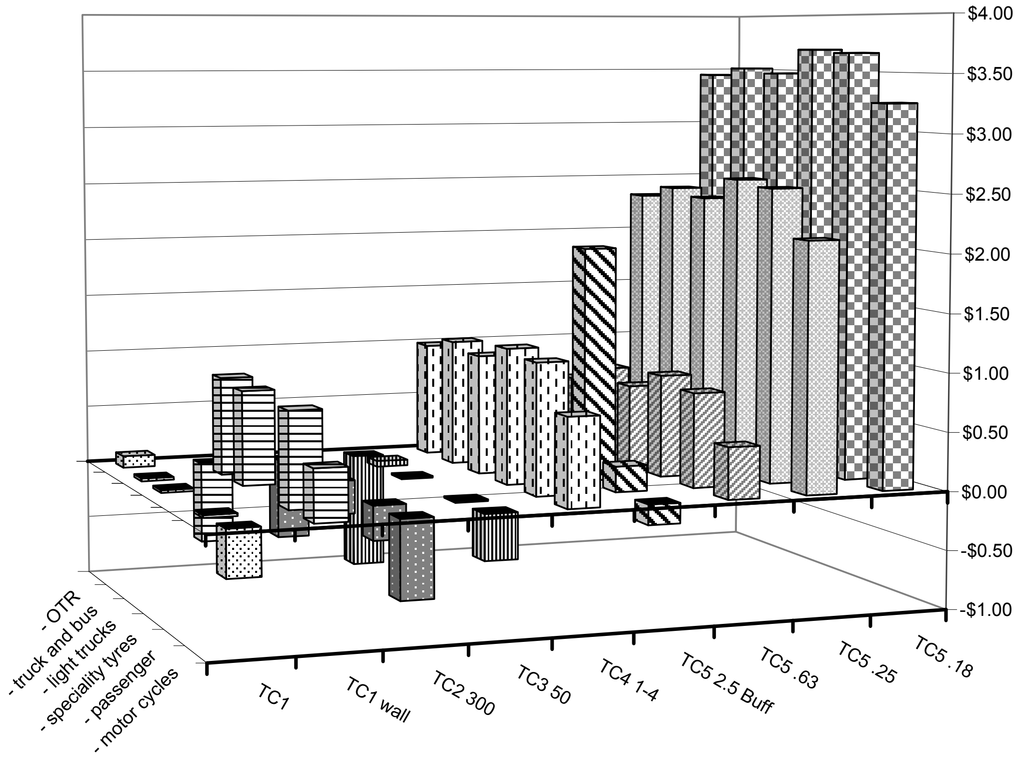
Overall these results highlight the many uses that provide potentially positive returns. It also shows the impact of increased costs associated with transport from regional areas. This will preclude some tyres from having viable reprocessing options unless they can be used near to their source. This is certainly the case for some of the engineering uses that use whole tyres, or tyres with sidewalls removed.

Figure 7-1: Gross Margins Ex of Collector Payments – Perth sourced tyres ($/EPU)



Source: URS Analysis

Figure 7-2: Gross Margins Inc. Collector Payments to Transformers – Perth sourced tyres ($/EPU)



Source: URS Analysis

Table 7-1: Gross Value of TDP per EPU

	TC1	TC1 wall	TC2 300	TC3 50	TC4 1-4	TC5 2.5 Buff	TC5 .63	TC5 .25	TC5 .18
Value of TDP per EPU									
- OTR	$0.40				$2.81	$0.89	$2.81	$4.50	$5.63
- truck and bus	$0.40	$1.60	$0.50	$1.04	$2.73	$0.86	$2.72	$4.35	$5.44
- light trucks	$0.40	$1.60	$0.50	$1.04	$2.77	$0.87	$2.77	$4.43	$5.53
- speciality tyres	$0.40				$2.81	$2.66	$2.81	$4.50	$5.63
- passenger	$0.40	$1.60	$0.50	$1.04	$2.86	$0.90	$2.86	$4.58	$5.72
- motor cycles	$0.40	$1.60	$0.50	$1.04	$2.81	$0.89	$2.81	$4.50	$5.63
Value TDP ($/ t)	$50	$200	$63	$130	$490	$630	$500	$800	$1,000
Value of Recoverd Metal per EPU									
- OTR					$0.14		$0.14	$0.14	$0.14
- truck and bus					$0.15		$0.15	$0.15	$0.15
- light trucks					$0.11		$0.12	$0.12	$0.12
- speciality tyres					$0.14		$0.14	$0.14	$0.14
- passenger					$0.10		$0.10	$0.10	$0.10
- motor cycles					$0.08		$0.09	$0.09	$0.09
Value Metal ($/ t)					$60		$60	$60	$60
Value of Recoverd Fabric per EPU									
- OTR									
- truck and bus									
- light trucks					$0.08		$0.09	$0.09	$0.09
- speciality tyres									
- passenger					$0.10		$0.10	$0.10	$0.10
- motor cycles					$0.16		$0.17	$0.17	$0.17
Value Fabric ($/t)					$180		$180	$180	$180
Gross Value per EPU									
- OTR	$0.40				$2.95	$0.89	$2.96	$4.64	$5.77
- truck and bus	$0.40	$1.60	$0.50	$1.04	$2.87	$0.86	$2.87	$4.50	$5.59
- light trucks	$0.40	$1.60	$0.50	$1.04	$2.97	$0.87	$2.97	$4.63	$5.74
- speciality tyres	$0.40				$2.95	$2.66	$2.96	$4.64	$5.77
- passenger	$0.40	$1.60	$0.50	$1.04	$3.05	$0.90	$3.07	$4.78	$5.93
- motor cycles	$0.40	$1.60	$0.50	$1.04	$3.06	$0.89	$3.07	$4.76	$5.88

Source: Industry Sources, URS (2005), and URS Analysis

Table 7-2: Collection, Transport, Landfill and Baling Costs ($/EPU)

	Perth	South West	Lower Grt Sthrn	Upper Grt Sthrn	Midlands	South Eastern	Central	Pilbara	Kimberley
Collection	0.66	0.76	0.83	0.83	0.83	0.83	0.83	0.99	0.99
Transport	0.16	0.48	1.12	0.80	0.48	1.60	1.44	8.00	9.60
Landfill	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
Baling	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Metro Storage	0.08								
Transport cost based on $60 per tonne over 150km									
Km Travelled	20	150	350	250	150	500	450	2500	3000

Source: Industry Sources, URS Analysis, Matthews (2005)

Table 7-3: Transformation Costs ($/tyre) - based on conversion from passenger tyre cost estimates

	Adjust	TC1	TC1 wall	TC2 300	TC3 50	TC4 1-4	TC5 2.5 Buff	TC5 .63	TC5 .43	TC5 .25	TC5 .18
- OTR	1.1	0.00	42.00	42.00	72.00	172.80	30.00	210.00	210.00	210.00	210.00
- truck and bus	0.9	0.00	1.49	1.49	2.55	6.12	1.06	7.44	7.44	7.44	7.44
- light trucks	1.0	0.00	0.60	0.60	1.02	2.45	0.43	2.98	2.98	2.98	2.98
- speciality tyres	0.9					6.12	1.06	7.44	7.44	7.44	7.44
- passenger	1.0	0.00	0.35	0.35	0.60	1.44	0.25	1.75	1.75	1.75	1.75
- motor cycles	1.0	0.00	0.26	0.26	0.45	1.08	0.19	1.31	1.31	1.31	1.31

Source: URS (2005) and URS Analysis

Table 7-4: Gross Margin per EPU (No Cross Payments)

	TC1	TC1 wall	TC2 300	TC3 50	TC4 1-4	TC5 2.5 Buff	TC5 .63	TC5 .25	TC5 .18
Perth									
- OTR	-$0.38	-$1.18	-$1.18	-$1.47	$0.51	-$0.18	$0.16	$1.84	$2.97
- truck and bus	-$0.50	$0.37	-$0.73	-$0.43	$0.61	-$0.28	$0.32	$1.95	$3.04
- light trucks	-$0.50	$0.33	-$0.77	-$0.49	$0.55	-$0.29	$0.23	$1.89	$3.00
- speciality tyres					$0.69	$1.52	$0.40	$2.09	$3.21
- passenger	-$0.50	$0.33	-$0.77	-$0.49	$0.64	-$0.26	$0.33	$2.04	$3.19
- motor cycles	-$0.87	-$0.04	-$1.14	-$0.86	$0.27	-$0.65	-$0.04	$1.65	$2.77
South West									
- OTR	-$0.78	-$1.59	-$1.59	-$1.87	$0.11	-$0.58	-$0.25	$1.44	$2.57
- truck and bus	-$0.92	-$0.05	-$1.15	-$0.85	$0.19	-$0.70	-$0.10	$1.53	$2.62
- light trucks	-$0.92	-$0.09	-$1.19	-$0.91	$0.13	-$0.71	-$0.19	$1.47	$2.58
- speciality tyres					$0.27	$1.10	-$0.02	$1.67	$2.79
- passenger	-$0.92	-$0.09	-$1.19	-$0.91	$0.22	-$0.68	-$0.09	$1.62	$2.77
- motor cycles	-$1.34	-$0.51	-$1.61	-$1.33	-$0.20	-$1.12	-$0.51	$1.18	$2.30
South Eastern									
- OTR	-$1.96	-$2.76	-$2.76	-$3.05	-$1.07	-$1.76	-$1.42	$0.27	$1.39
- truck and bus	-$2.11	-$1.24	-$2.34	-$2.03	-$1.00	-$1.89	-$1.29	$0.34	$1.43
- light trucks	-$2.11	-$1.28	-$2.38	-$2.10	-$1.05	-$1.90	-$1.37	$0.29	$1.39
- speciality tyres					-$0.92	-$0.09	-$1.21	$0.48	$1.61
- passenger	-$2.11	-$1.28	-$2.38	-$2.10	-$0.97	-$1.87	-$1.28	$0.44	$1.58
- motor cycles	-$2.56	-$1.73	-$2.83	-$2.55	-$1.42	-$2.34	-$1.73	-$0.04	$1.08
Pilbara									
- OTR	-$8.49	-$9.30	-$9.30	-$9.59	-$7.61	-$8.30	-$7.96	-$6.27	-$5.15
- truck and bus	-$8.67	-$7.80	-$8.90	-$8.60	-$7.56	-$8.45	-$7.85	-$6.22	-$5.13
- light trucks	-$8.67	-$7.84	-$8.94	-$8.66	-$7.62	-$8.46	-$7.94	-$6.28	-$5.17
- speciality tyres					-$7.48	-$6.65	-$7.77	-$6.08	-$4.96
- passenger	-$8.67	-$7.84	-$8.94	-$8.66	-$7.53	-$8.43	-$7.84	-$6.13	-$4.98
- motor cycles	-$9.21	-$8.38	-$9.48	-$9.20	-$8.06	-$8.99	-$8.38	-$6.69	-$5.56
Midlands									
- OTR	-$0.84	-$1.64	-$1.64	-$1.93	$0.05	-$0.64	-$0.30	$1.39	$2.51
- truck and bus	-$0.99	-$0.12	-$1.22	-$0.91	$0.12	-$0.77	-$0.17	$1.46	$2.55
- light trucks	-$0.99	-$0.16	-$1.26	-$0.98	$0.07	-$0.78	-$0.25	$1.41	$2.51
- speciality tyres					$0.20	$1.03	-$0.09	$1.60	$2.73
- passenger	-$0.99	-$0.16	-$1.26	-$0.98	$0.15	-$0.75	-$0.16	$1.56	$2.70
- motor cycles	-$1.44	-$0.61	-$1.71	-$1.43	-$0.30	-$1.22	-$0.61	$1.08	$2.20

Source: URS Analysis

Table 7-5: Gross Margin per EPU (Inclusive of Payment to avoid Landfill Disposal Costs)

	TC1	TC1 wall	TC2 300	TC3 50	TC4 1-4	TC5 2.5 Buff	TC5 .63	TC5 .25	TC5 .18
Perth									
- OTR	$0.10	-$0.70	-$0.70	-$0.99	$0.99	$0.30	$0.64	$2.32	$3.45
- truck and bus	-$0.02	$0.85	-$0.25	$0.05	$1.09	$0.20	$0.80	$2.43	$3.52
- light trucks	-$0.02	$0.81	-$0.29	-$0.01	$1.03	$0.19	$0.71	$2.37	$3.48
- speciality tyres					$1.17	$2.00	$0.88	$2.57	$3.69
- passenger	-$0.02	$0.81	-$0.29	-$0.01	$1.12	$0.22	$0.81	$2.52	$3.67
- motor cycles	-$0.39	$0.44	-$0.66	-$0.38	$0.75	-$0.17	$0.44	$2.13	$3.25
South West									
- OTR	-$0.30	-$1.11	-$1.11	-$1.39	$0.59	-$0.10	$0.23	$1.92	$3.05
- truck and bus	-$0.44	$0.43	-$0.67	-$0.37	$0.67	-$0.22	$0.38	$2.01	$3.10
- light trucks	-$0.44	$0.39	-$0.71	-$0.43	$0.61	-$0.23	$0.29	$1.95	$3.06
- speciality tyres					$0.75	$1.58	$0.46	$2.15	$3.27
- passenger	-$0.44	$0.39	-$0.71	-$0.43	$0.70	-$0.20	$0.39	$2.10	$3.25
- motor cycles	-$0.86	-$0.03	-$1.13	-$0.85	$0.28	-$0.64	-$0.03	$1.66	$2.78
South Eastern									
- OTR	-$1.48	-$2.28	-$2.28	-$2.57	-$0.59	-$1.28	-$0.94	$0.75	$1.87
- truck and bus	-$1.63	-$0.76	-$1.86	-$1.55	-$0.52	-$1.41	-$0.81	$0.82	$1.91
- light trucks	-$1.63	-$0.80	-$1.90	-$1.62	-$0.57	-$1.42	-$0.89	$0.77	$1.87
- speciality tyres					-$0.44	$0.39	-$0.73	$0.96	$2.09
- passenger	-$1.63	-$0.79	-$1.90	-$1.62	-$0.49	-$1.39	-$0.80	$0.92	$2.06
- motor cycles	-$2.08	-$1.25	-$2.35	-$2.07	-$0.94	-$1.86	-$1.25	$0.44	$1.56
Pilbara									
- OTR	-$8.01	-$8.82	-$8.82	-$9.11	-$7.13	-$7.82	-$7.48	-$5.79	-$4.67
- truck and bus	-$8.19	-$7.32	-$8.42	-$8.12	-$7.08	-$7.97	-$7.37	-$5.74	-$4.65
- light trucks	-$8.19	-$7.36	-$8.46	-$8.18	-$7.14	-$7.98	-$7.46	-$5.80	-$4.69
- speciality tyres					-$7.00	-$6.17	-$7.29	-$5.60	-$4.48
- passenger	-$8.19	-$7.36	-$8.46	-$8.18	-$7.05	-$7.95	-$7.36	-$5.65	-$4.50
- motor cycles	-$8.73	-$7.90	-$9.00	-$8.72	-$7.58	-$8.51	-$7.90	-$6.21	-$5.08
Midlands									
- OTR	-$0.36	-$1.16	-$1.16	-$1.45	$0.53	-$0.16	$0.18	$1.87	$2.99
- truck and bus	-$0.51	$0.36	-$0.74	-$0.43	$0.60	-$0.29	$0.31	$1.94	$3.03
- light trucks	-$0.51	$0.33	-$0.78	-$0.50	$0.55	-$0.30	$0.23	$1.89	$2.99
- speciality tyres					$0.68	$1.51	$0.39	$2.08	$3.21
- passenger	-$0.51	$0.33	-$0.78	-$0.50	$0.63	-$0.27	$0.32	$2.04	$3.18
- motor cycles	-$0.96	-$0.13	-$1.23	-$0.95	$0.18	-$0.74	-$0.13	$1.56	$2.68

Source: URS Analysis

In comparison to activities that are occurring around Australia, the volume and diversity of reprocessing in Western Australia is comparatively small. Current markets and potentials for Australia, as shown in Section 5, highlight the opportunities that are available, and the disparity between Australia wide levels of reprocessing and the current level of activity in Western Australia. However, as discussed previously, there are potentially a number of additional uses of end-of-life tyres in Western Australia with sufficient likely demands to use a high proportion of the available resource.

The indicative financial analysis undertaken for this report suggests that for high value uses at least, many of the suggested options are viable especially for tyres sourced from the Perth region and proximate areas. A caveat on this result is that it can't take into account the detailed business implications required for setting up, operating, and marketing a business with products new to the Western Australian market. There are obviously barriers to the development of these industries which is reflected in the current position of tyre reprocessing in Western Australia.

8.1 Market Failure Test applied to WA Situation

The analysis of market failure in the end-of-life tyre market has shown areas where market failure might exist. Quantification of the extent of market failures associated with end-of-life tyres provides an indication of the level of market intervention that may be justified - provided that intervention addresses the identified market failure in an efficient manner. Estimates suggest that the level of market failure in Western Australia might be costing as much as $65 million over ten years, inclusive of a $30 million cost associated with illegal landfill.

It should be noted that the volume of end-of-life tyres that goes to landfill or illegal disposal is either symptomatic of market failure or simply the result of a lack of profitable opportunity to use that waste. Discussions above suggest that market failure does exist to some extent. Gross margin analysis results suggest that there are profitable uses of end-of-life tyres in excess to current levels of reprocessing - profitable options for increased levels of reprocessing exist, especially in urban areas.

There exists a combination of market failure and some constraints to viable options for reprocessing, especially in rural and regional areas with higher operating costs. The existence of market failure provides some justification for market intervention, and also an indication of where that intervention should occur. Public and collective goods and inadequate provision of information are key areas to be addressed. For example, research is an area that is often under-provided because of the inability of the researcher to appropriate the benefits of the research. This appears to apply to the waste tyre industry as well. Collective goods are typically provided by industries for their members. They include such services as the development of standards, collection of statistics and generic marketing and information, as well as the building of market institutions. New industries, with immature markets, lack both the industry institutions and the services that they can provide. The transactions costs of developing such arrangements can be significant in the short term and may require government support or at least coordination.

8.2 Addressing Suggested Barriers

A number of barriers to industry development have been raised in industry discussion both for this report and the research undertaken for the URS (2005) report. They are summarised below with suggested priority areas for policy support highlighted.

- **Unsupportive public procurement policies.**
- **Inertia in using new products/ non-standard technology – implied risk/ lack of product acceptance.**
- Lack of consistent and reliable tyre supplies - makes producers wary of relying on rubber.
- Lack of regulation and product standards supporting the recycling of end-of-life tyres.
- **Operational difficulties or costs - additional capital investment required to make net gains.**
- Negative public perception of environmental issues.
- **Misconception that recovered rubber is of poorer quality than substitutes.**

Financial constraints are also a reality in some circumstances but where that is expected to continue in the long term government subsidies or market interference to distort costs to consumers cannot be seen as a permanent remedy. Market support might only be seen as a short-term remedy to address any inertia in using new products/ non-standard technologies, or lack of business investment. The use of supportive public procurement policies might be on mechanism to overcome this inertia in the longer term.

8.3 Fostering Business Opportunities

Tyre derived products are not the same, they require different processing and will be sold into very different markets. These different products and markets require tailored strategies to facilitate their development. The primary strategy for improving demand and supply of tyre-derived products should be to recognise these differences and develop targeted strategies for each particular product. Set priorities on the basis of value and volume, for example road surfacing, stemming and blasting material have been suggested as products with high volume uses. Flooring and mats, moulded products, and adhesives might be targeted as high value uses. They will each have specific needs to foster their expansion in Western Australia.

Procurement policies

State and local government procurement policies might be directed to show the lead and foster the use of tyre derived products. Targeted procurement policies might be a good mechanism for high volume products and where products are demonstrated to be cost and technically effective. This mechanisms will be useful to overcome inertia in using new products/ non-standard technology. There are many examples when the lead in sustainability policy is provided by government. The Mandurah bypass road to might be a good project, aim to get at least one part built on the basis of a "sustainability" platform. There would present a very visible opportunity with signage to highlight the positive elements of reprocessing. The project could use engineering technologies for retaining walls, culverts, road base, and erosion control, and rubberised asphalt for the road surface.

Avoid Zero Disposal Costs

The landfill levy should equal the cost of environmental externality for all categories of tyre.

Classification of OTR Disposal and Development of Options

At present OTR tyres appear to be considered sympathetically. Disposal in mines, pits and quarries is seemingly considered an appropriate form of disposal. Whilst it is categorised so, major companies that take their sustainability reporting seriously will not have to address this issue. Options for the use of OTR tyres will be less attractive whilst they continue to incur zero disposal costs. Research is suggested to be limiting the development to commercial reality the use of reprocessed rubber in stemming and blasting. Given the volume of rubber in OTR in WA (30% of disposed tyres on an EPU basis) then this might be a key area to invest in.

Mandatory Baling or Direct Incentives

Mandatory baling of tyres disposed to landfill has been suggested (by industry) as a mechanism that might allow landfilled tyres to be more effectively accessed in the future, and as a means to raise the cost of disposal such that reprocessing activities are correspondingly more financially attractive. At present some 1.95 million EPU are disposed (mostly to landfill) from the Perth region. Given the cost of baling is suggested at 20 cents per EPU, then the cost to consumers by imposing this policy would be in the order of $390,000 annually. The benefit to transformers will only arise as tyres are reprocessed - presently only some 110,000 EPU. The immediate effect, prior to any increase in rates of reprocessing, would be to provide some $21,750 worth of incentives to businesses that reprocess tyres.

8.4 Optimising Value for WA from National Stewardship Scheme

An objective for Western Australia is to gain the most from the planned National Stewardship Scheme. Prior to the scheme being implemented there are two generic opportunities:

- Initiate actions that are likely to pre-empt similar activities within the Scheme – get those tyres of activities going now and effectively extend the Scheme; and
- Target tyre resources and tyre-derived products that the Scheme is likely to target – activities with highest net economic value, not necessarily maximum volume.

Pre-emptive Activities

An aim might be to get scheme-like activities rolling now to effectively extend the life of the Scheme in WA, it will also ensure that when the Scheme commences information and needs of the Scheme are clearly identified.

Not all of the Schemes activities will be based on providing financial incentives, many will need to address market failures, and barriers to industry development and expansion. These issues maybe addressed without major costs. For example, inadequate provision of information is a key areas to be addressed. As suggested above research that develops uses for OTR will be of major importance to WA, a coordination of efforts across major mining houses might be a way to achieve this with limited cost to government.

Target tyre resources and derived products that the Scheme is likely to target

The National Scheme will provide most support to tyre derived products that provide the highest net economic value – those products with the greatest likelihood of being financially viable without ongoing assistance. WA needs to maintain the reprocessing that it currently has, and similarly target activities that will produce the highest net economic value.

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