Used Industrial Plastics in Western Australia - Waste Management Practices and Potential Recycling Strategies

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Used Industrial Plastics in Western Australia - Waste Management Practices and Potential Recycling Strategies

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This report was prepared by Cardno BSD Pty Ltd for the Waste Management Board of Western Australia. The report was reviewed by staff at the Department of Environment and Conservation and subsequently updated. However, the views expressed in the report are those of the independent inquiry and do not necessarily reflect the views of the Waste Management Board or the Department of Environment.

Cardno BSD Pty Ltd

EXECUTIVE SUMMARY

BACKGROUND

Cardno BSD was appointed by the Department of Environment and Conservation (Western Australia) to carry out general background research into issues relating to the current generation and fate of used industrial plastics in Western Australia.

In order to define the baseline information relating to the production, waste management practices and markets for industrial plastics, Cardno BSD undertook a comprehensive review of readily available literature and completed extensive stakeholder consultation with organisations operating in Western Australia. Policies, tools and programmes (measures) implemented in other jurisdictions were investigated. The policy review was completed to ensure that, where practical, a best practice approach could be adopted in Western Australia. The information gathered relating to industrial plastic manufacturing, disposal, recycling and reuse in Western Australia, together with local market data has been analysed and the key issues and barriers have been identified, together with recommendations to address them.

Used industrial plastics are defined as all plastic waste produced by the commercial and industrial operations. The WAste 2020 task force defines these operations to include but are not limited to processing and manufacturing industries, the service sector, the public trade sector, trade, transport and distribution. For this report industrial plastics also include those used in the mining, minerals, energy production, agricultural and marine industries.

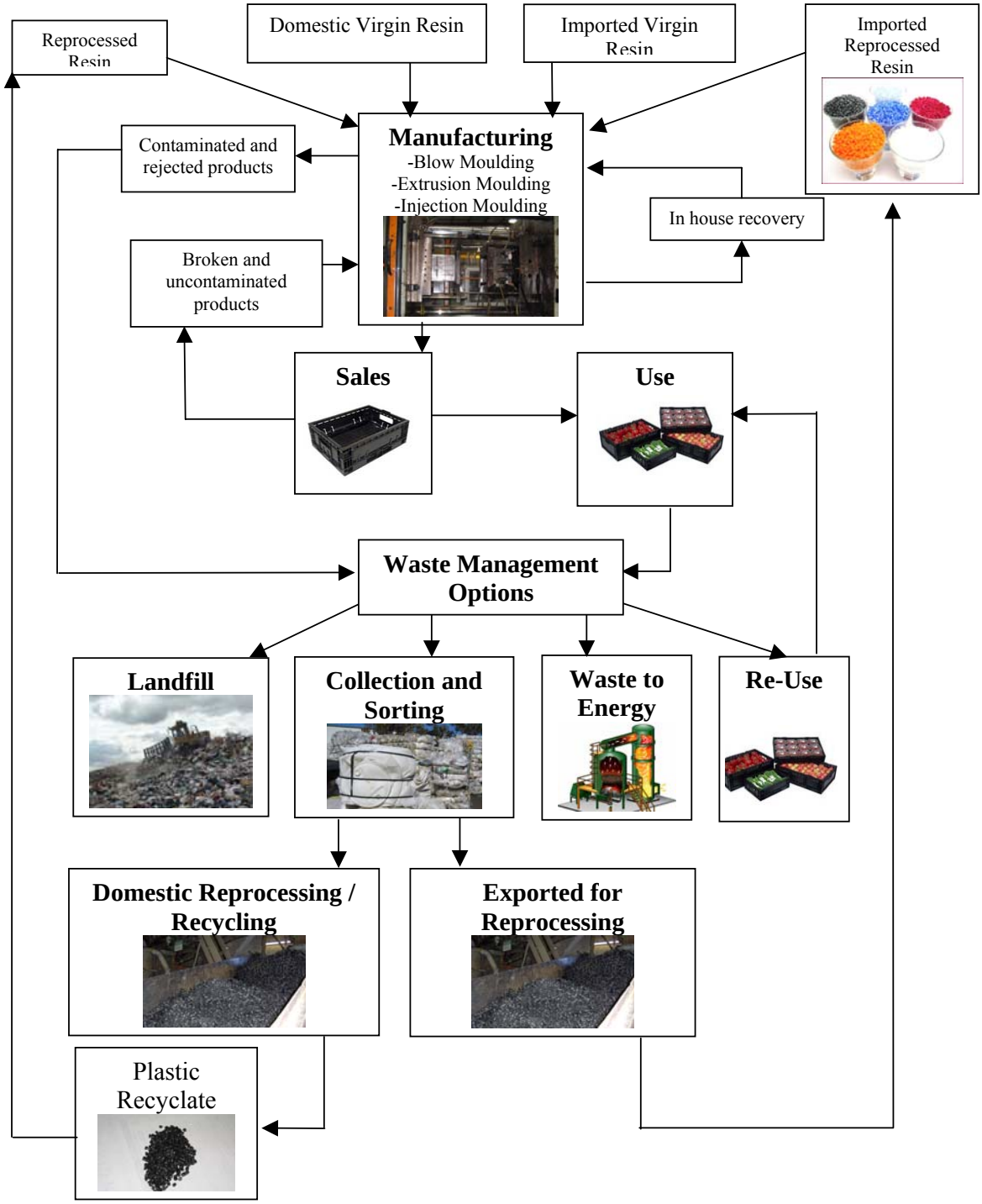
Industrial plastics can be divided into two types: thermoplastics and thermoset plastics. Thermoplastics consist of the seven types of recyclable plastics and are capable of being repeatedly softened by heat and hardened by cooling. Thermoset plastics are set by a structural framework and cannot be reformed into new products.

Industrial plastic products are manufactured using different processes, depending on their function and purpose. The six main types of plastic manufacturing include tube extrusion, extrusion blow moulding, co-extrusion blow moulding, injection moulding, injection blow moulding and injection stretch blow moulding.

INDUSTRIAL PLASTICS INDUSTRY - WASTE MANAGEMENT PRACTICES

Resin used to make industrial plastic products is supplied to manufacturers via domestic or overseas resin suppliers. Some companies also use reprocessed resin from domestic or overseas recyclers. **Figure E1** outlines the general Waste Management Practices of the Industrial Plastics Industry and Recycling / Re-use Flows.

Figure E1 Waste Management Practices of the Industrial Plastics Industry and Recycling / Re-use Flows



Industrial Plastics Industry

Industrial Plastic Manufacturers

The majority of plastic manufacturers involve in-house recovery of scrap. Clean and contaminant free off cuts are immediately reground and fed back into the manufacturing process. This process improves the efficiency of resin used. In addition, rejected plastic products, together with any plastic packaging are sort and collected by a local plastic recycler. Contaminated plastic material is generally disposed of to landfill.

Industrial Plastic Re-use

There are a number of industrial plastic re-use programmes operating in Western Australia. A user of industrial plastic drums pays a deposit for the product for it to be reconditioned and then re-used. Reconditioning companies also offer a collection service for the re-useable product and resell the product for re-use.

Industrial Plastic Recyclers

Industrial plastic recyclers obtain the majority of their plastic directly from plastic manufacturers. Recyclers receive plastic waste in a sorted or mixed form from manufacturers or provide collection services. Contaminated plastics washed and processed into shredded scrap and then resin. The Reprocessed plastic can be sold domestically and internationally as scrap or resin. Any plastic material that is contaminated or can not be reprocessed by the recycler is sent to landfill.

Automotive Industry

Polypropylene battery cases and bumper bars are commonly dismantled and recycled. Remaining plastics and other materials such as rubber, fabric and glass are usually shredded and sent to landfill as 'flock'.

Construction and Demolition Industry

PVC and HDPE piping is buried below ground and is unlikely to be removed for disposal. External plastic building products are potentially recoverable but are generally sent to landfill. Packaging plays an important role in protecting and identifying building products. Polyethylene wrap makes up the majority of plastic packaging waste on building sites and is also sent to landfill.

Agricultural and Horticultural Industry

Polyethylene plastic silage wrap can be disposed of at the local shire's landfill. Alternatively, some farmers bury or burn the plastic waste. Disposal of polyethylene plastic mulch in the horticultural industry is also currently sent to landfill. A number of farmers and horticulture companies are also involved in chemical drum re-use programmes such as drumMUSTER.

Mining Industry

Any pipes that can be re-used are collected, transported and welded for other uses around the mine-site. Alternatively, piping is disposed at the mine-site's landfill. Generally pipes are not returned to the metropolitan areas to be recycled due to the high costs of transport.

Marine Industry

Plastic recyclers collect some plastic wrap while plastic tubs are generally cleaned with a chemical and re-used. Once the tubs, bins and plastic wrap are highly contaminated or beyond repair, they are disposed to landfill.

Public Services Industry

The Public Services Industry includes the water, gas and communications services provided by companies such as the Water Corporation, Alinta Gas and Telstra. Water pipes are generally sent to landfill, however, if they are under 12 months of age they are sent to a recycle company for reprocessing into new material. Recycling services are available at 80% of Telstra's commercial sites in Australia, with the remainder being unviable due to them being un-manned or being in too remote a location. 41% of Telstra's general waste is recycled. Cable reels (90,000 per annum) are mostly recycled into new products.

INDUSTRIAL PLASTICS QUANTITIES

Detailed data and information about used industrial plastic generation and recycling in Western Australia was unavailable and consequently can not be included in this report. This was due to either commercial sensitivity or simply lack of information. The Plastics and Chemicals Industries Association (PACIA) have undertaken a number of *National Plastics Recycling Surveys* that reports on the state of plastics recycling in Australia. The level of detail reported does not include a breakdown for Western Australia into sectors (e.g. Industrial Plastics).

The information presented in this report is based upon 2004 recycling results released by PACIA in 2005, together with other referenced sources. Therefore it should be noted that the estimated values are unlikely to be accurate.

There were 1,510,850 tonnes of plastics (from all domestic and industrial sectors) consumed in Australia during 2004 (PACIA, 2005). The quantity of used plastic generated in Australia is unknown. A total of 190,979 tonnes of plastics were recycled during 2004, of which approximately 110,000 tonnes were industrial plastics (PACIA, 2005).

In Western Australia, during 2004 149,267 tonnes of plastic (from all domestic and industry sectors) were consumed (PACIA, 2005). It is estimated that at least 42,250 tonnes of used industrial plastics were generated, although this estimate excluded plastics from the mining, minerals, agricultural, marine and energy production industries. Of the used industrial plastics generated, approximately 3,242 tonnes were recycled during 2004 based upon the PACIA survey report, however feedback gathered from Western Australian based industrial plastic recyclers during the production of this report, suggest that in 2005 the quantity of industrial plastics recycled was at least 15,000 tonnes.

CURRENT MARKETS

Reprocessed Resin

Industrial and commercial plastic waste can be recovered, sorted and reprocessed into recycled resin. Recycled resin can be used in the manufacturing process of a number of plastic products. **Table E2**

outlines the recycled resin type and the potential products that are manufactured within Western Australia and nationally.

Table E2 Recycled content products manufactured in WA and Australia

Plastic Type	Products made of reprocessed resin	Western Australian market	Australian market
Type 1 – PET	Geo-fabric		✓
Type 2 - HDPE	Boxes		✓
	Coat Hangers	✓	
	Crates and pallets	✓	✓
	Drainage pipe	✓	✓
	Drums		✓
	Mobile Garbage Bins		✓
	Sewerage pipe		✓
Type 3 - PVC	Hoses		✓
	Mudflaps		✓
	Piping		✓
	Sunscreen		✓
	Vinyl Flooring		✓
	Pipe and hose fittings		✓
Type 4 - LDPE	Agricultural and Building Film		✓
	Garbage bags		✓
	Film for Packaging		✓
	Shopping bags		✓
Type 5 - PP	Crates and Pallets	✓	
	Flower pots	✓	
	Strapping		✓
Type 6 - PS	Pegs, Clothes Hangers		✓
	Photo frames		✓
	Boxes and building materials (EPS)		✓
	EPS wall panels		✓
Type 7 - other	Carpet underlay (polyurethane)	✓	✓

Mixed Plastic Waste

A number of companies in Australia have developed products using mixed plastic waste. Mixed industrial plastics including polystyrene, polyethylene, polypropylene and PVC can be used without sorting and/or a significant amount of cleaning. The mixed plastics waste is granulated, turned into agglomerate, heated and pumped into moulds. The prospective range of products that can be manufactured from the agglomerate include outdoor furniture, bollards, septic tanks, posts, decking and other plastic lumber products.

BARRIERS TO INCREASING THE AMOUNTS OF PLASTIC RECYCLED AND RE-USED

The barriers to increasing the amount of used industrial plastic products recycled and re-used were identified as listed below.

Manufacturer's Barriers

Characteristics of Plastics

If thermoplastics are not mixed, they can be repeatedly softened and hardened while thermosets can not be heated and reformed into new products

Characteristics Recycled Resin

Industrial plastic products often contain a number of different polymers (polymer compounding), dyes and other additives, which affects the resultant properties of the reprocessed resin. It is difficult for manufacturers to predict how recycled resin will interact with the manufacturing process.

Design of Product

More attention needs to be placed on influencing the design of products, which in turn, has a major impact on the ease of recovery of wastes generated.

Cost of Virgin Resin vs. Recycled Resin

The cost of resins significantly impact on the cost of the manufacturing process. Virgin resin and recycled resin are comparative in price. Due to the known properties of virgin resin and the low risk of using the material, manufacturers would continue to choose virgin resin over the recycled plastic resin. Furthermore, there are many up-front capital costs to process recycled resin including additional extruders and cooling technology, additional floor space and higher tooling and adaptive costs.

Production Time

Processes that include the use of reprocessed resin significantly impact on production time. Any variation in production time can impact on the cost of the product, competitiveness and hence the profitability of the manufacturer.

Quantity Guarantee

Industrial plastics products are manufactured in high quantities. Manufacturers therefore require a constant supply of resin for their operations. The plastic recycling industry cannot always guarantee a constant supply of recycled resin.

Industrial Plastic Standards

Some standards restrict the use of reprocessed resin in certain products.

Product Specifications

Retailers demand certain characteristics such as quality, strength shape and colour that may inhibit the use of reprocessed resin.

Re-use Collections
A number of items are lost in the re-use cycle. There is often confusion among users on the ownership of the product and where they can be returned.

In-house Knowledge
Many people who work in the commercial and industrial sector are not aware that their plastic waste can be collected for recycling.

Willingness to Change
Many plastic manufacturers are unwilling to use recycled resin in their operations. There is a fear that recycled polymers are not safe due to their unknown properties.

Recycler's Barriers

Polymer Compounding
Polymer compounding is undertaken to derive the required performance or colour for the end users finished product. The practice of polymer compounding means that industrial plastic recyclers find it difficult to supply reprocessed resin that is similar to virgin resin.

Industrial Product Properties
Some industrial products are complex and hard to deconstruct. In addition, a major proportion of the industrial plastic market comprises long-term applications with life expectancies.

Product Contamination
Industrial plastics can be hard to recycle as some are too contaminated. The cleaning phase during recycling is costly and this may outweigh the financial benefits of recycling the material.

Technological Change – Biodegradable plastics
There is industry concern that the use of biodegradable plastics will adversely affect plastic recycling by threatening the physical integrity of products made from reprocessed plastics.

Competition with Landfill
The cost to dispose of industrial plastic waste to landfills in Western Australia is currently inexpensive and encourages the disposal, rather than the recycling of the used plastics.

Cost of Virgin Resin vs. Recycled Resin
Recycled resin prices are comparable to virgin resin prices due to the cost of collecting, sorting and reprocessing plastic waste. Manufacturers tend to choose virgin resin due to the known properties of the material and conjunction with the low risk of using the resin. The lack of demand for recycled resin means that recycling companies are finding it difficult to continue to make a profit.

Cost of Collection and Reprocessing

The price industrial plastic recyclers can afford to pay in order to collect their plastic waste, given other costs and the price reprocessed resins receive, can significantly impact the profitability of the companies operations.

Cost of Sorting

The recovery and reprocessing of plastics is hampered by the difficultly of distinguishing different plastic types. For single polymer reprocessing it is necessary to sort the plastics to maintain the quality of reprocessed resins.

Financial Incentives

The Western Australia Government does not offer financial incentives for industrial plastic recyclers.

Lack of Domestic Markets

There is a lack of local markets for recycled resin in Western Australia. A large number of international markets exist which means that most of the states recycled plastic material is being exported. The cost to export resin or scrap overseas is another additional cost for the plastic recycler.

Low Supply

Plastic Recyclers can not guarantee a constant supply of reprocessed resin to manufacturers. This is due to a number of reasons including the long-life of industrial plastic product and the lack of coordinated collections

Lack of Waste Data

There is limited data available regarding the industrial plastic waste produced, the carrier of the wastes and the final disposal or recycling operation used.

RECOMMENDATIONS

The barriers and issues have been examined and using the information gathered about programmes and measures from other geographic areas together with consideration of factors specific to Western Australia, the following options have been developed. These future options would require expanding (once the measures that will have a greater impact have been suitably implemented), and would achieve further improvement throughout the entire used industrial plastic product supply chain.

Tracking of Used Industrial Plastics:

This measure would ensure that the volumes of used industrial plastics were known and the waste management options utilised were recorded. This information is essential before any recycling strategies are implemented, as the current situation of the industry summarised in this report needs to be backed up with empirical data. In addition, the effectiveness of any programmes can not be measured with out baseline data and on going monitoring. Collecting this data would also assist in tracking industrial plastic products (such as crates which are can be stolen) and the information can be used for the payment of any recycling rebate.

Free Advisory Service for Manufacturers:

This measure would include government funded advice for Western Australian businesses that would provide free, independent, confidential advice and support on practical ways to increase profits, minimise waste and reduce environmental impacts. to recycle and recover resources from the Commercial and Industrial (C&I) waste stream and hence minimise the disposal of waste. The advisory service provides waste recycling information for commercial businesses. In addition, it increases competitiveness, resource efficiency, improves environmental performance and business profitability.

Waste Exchange Database:

A waste exchange database provides an Internet based central point for producers of waste materials to list their waste product. Other manufacturers and recyclers that could use the by-products as raw materials are able to search the list of waste by-products for the materials that they require. This would be a free service, and would aim to encourage the reuse, recycling and energy recovery of wastes by allowing communication between generators of waste and potential recyclers. The website would allow for both parties to advertise any wastes available or wanted. This increase is not limited to industrial plastics, but could be used for many types of waste.

Payment for waste recycling:

The payment for each tonne of waste recycled via a 'Recycling Credit' is already used in Western Australia through the Resource Recovery Rebate Scheme (RRRS). This has been historically limited to local government, however the RRRS is currently under review. If the RRRS were available to commercial organisations, it is likely to have an impact on the rate of used industrial plastic recycling, by making recycling a more cost effective option.

Infrastructure Grant Scheme:

Grants could be awarded to increase the recovery of industrial plastics. This approach has been used in South Australia to meet one of their key targets of a 30% increase in the recovery and use of commercial and industrial materials by 2010. The grants in South Australia have been initiated to invest in infrastructure to achieve this target. The grants have stimulated investment by industry for infrastructure.

Industry Sector Programmes:

Different industry sectors have some specific issues that could be addressed to facilitate additional plastic reuse and recycling within that sector. This would require a focused and detailed analysis of an industry sector together with stakeholder consultation to assist in the management of used plastics.

Material Recycling Facility (MRF) for Commercial and Industrial Waste:

A C&I Materials Recovery Facility would enable companies to access a sorting facility for the wastes that they produce. This would operate in a similar way to existing MRF that sort domestic dry recyclables, but focus on the C&I waste streams.

Market Development via Government Procurement:

To develop the market for recycled plastic content products, procurement and tendering practices within Government Departments and Agencies together with Local and Regional Government are an area to focus on. There is potential to rapidly create a large demand for recycled materials using this approach. For example, some lower quality recycled plastics could substitute other products made traditionally from timber. 'Plastic lumber' can be used for public seating, playgrounds and other products that are currently constructed from timber.

Landfill Levy Escalator

The cost to dispose of industrial plastics is currently very cheap and does not reflect the true value of the resources that are lost. The low cost of landfill also encourages the disposal of wastes rather than the recycling of the waste. The introduction of a landfill levy escalator would reflect the true cost of waste disposal and also provide a clear signal to the industry and stakeholders that the recycling of industrial plastics will become more cost effective than their disposal.

SUMMARY

The information relating to the volume of recycled industrial plastics in Western Australia is either commercial sensitive or not collected, therefore is hard to estimate the current volume of material recycled and the potential volume that could be recycled, if the recommendations made in this report were implemented. However, during the stakeholder consultation and site visits that have been completed, it is apparent that there is a small but viable and thriving industrial plastics recycling industry in Western Australia.

If the recommendations made above were implemented, specifically those focused on increasing the awareness of industrial plastic recycling options for industry sectors and businesses and the development of the recycling industries infrastructure. This would increase the quantity of used industrial plastics that could be recycled in Western Australia, and the quality of the material that is exported. However, until accurate information is collected regarding the tonnages produced within the State, this cannot be quantified.

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DEFINITIONS

ABS	Acrylonitrile Butadiene Styrene
Co-extrusion Blow Moulding	Manufacturing process used to produce multiple layers of different plastic to make the product
Construction and Industrial Waste Plastic	Waste plastic material from the construction, refurbishment and building demolition industries
EPS	Expanded Polystyrene
ESCR	Environmental Stress Cracking (ESCR) is defined as the premature initiation of cracking due to the simultaneous action of stress, particularly biaxial stress and contact with specific liquids
Extrusion Blow Moulding	Manufacturing process used to produce hollow shaped plastics in large quantities
HDPE	High Density Polyethylene
Injection Blow Moulding	Manufacturing process used to produce specially shaped, hollow objects by injecting and blow into a mould
Injection Moulding	Manufacturing process used to produce specially shaped objects by injecting molten plastic into a mould
Injection Stretch Blow Moulding	Manufacturing process used to produce specially shaped, hollow objects by injecting, blow and stretched into a mould
LDPE	Low Density Polyethylene
LLDPE	Linear Low Density Polyethylene
MFI	MFI or Melt Flow Index is a measure of the ease of flow of the melt of a thermoplastic polymer. It is defined as the weight of polymer in grams flowing in 10 minutes through the capillary of a specific diameter. The melt flow rate is an indirect measure of molecular weight. High melt flow rate corresponds to a low molecular weight. Melt Flow Rate is also a measure of the ability of the material's melt to flow under pressure
Other	Polymers other than those included in the first six plastic polymer types
Packaging	Plastic material used for the containment, protection, marketing or handling of product. Includes primary, secondary and tertiary packaging in industrial packaging applications
PET	Polyethylene Terephthalate
Post Consumer Industrial Waste Plastic	Used material from non-household sources
PP	Polypropylene
Pre-Consumer Industrial Scrap	Scrap of-cuts and off-specification items in the manufacturing industry that are used by the consumer which

	are collected for reprocessing at a different site. Does not include material that is recycled directly back into manufacturing processes at the same site.
PS	Polystyrene
PVC	Polyvinyl Chloride
Recycling	The process of collection, reprocessing and reuse/re-manufacturing of waste materials
Resin	Raw polymer material
Thermoplastics	Plastics which are capable of being repeatedly softened by heat and hardened by cooling
Thermoset Plastics	A plastic, which has undergone a chemical reaction by action of heat, catalysts, ultraviolet light leading to a relatively infusible state. Once the structural framework is set, the plastics cannot be reformed
Tube Extrusion	Manufacturing process used to produce tube shape plastics
Used Industrial Plastics	There is no recognised definition for industrial plastics in Western Australia, therefore for the purpose of this report industrial plastics has included all plastic waste produced by commercial and industrial sources that is not collected during Council kerbside collections. Therefore used industrial plastics includes: • Pre-consumer industrial scrap plastic • Commercial and Industrial waste plastic (excluding waste collected by Councils via 240L & 140L MGB's) • Construction and Demolition waste plastic • Post consumer industrial waste plastic
Virgin	All-new polymer material containing no recycled material

1. INTRODUCTION

1.1 STUDY OBJECTIVE

Cardno BSD was appointed by the Department of Environment and Conservation (Western Australia) to carry out general background research into issues relating to the current generation and fate of used industrial plastics in Western Australia. The information gathered in this report will be used to support policy and programme development within the Waste Management Branch and of the Waste Management Board.

1.2 STUDY METHODOLOGY

1.2.1 Data Gathering and Consultation

In order to define the baseline information relating to the production, waste management practices and markets for industrial plastics, Cardno BSD undertook a comprehensive review of readily available literature and completed extensive stakeholder consultation with organisations operating in Western Australia.

The Plastics and Chemical Industry Association (PACIA) office in Perth was contacted to determine the key manufacturers based in Western Australia and any recycling programmes that they are involved in. The key manufacturers identified were contacted by telephone and visited (when possible) to gain a better understanding of processes and issues.

Key industry bodies and operators in the Western Australian industrial plastic recycling industry were also identified. They were contacted in order to collect further information about the plastics recycling industry and identify any issues or barriers relating to recycling and markets.

By using a combination of literature review and extensive consultation the Cardno BSD project team has identified:

- Key industrial plastic manufacturers in Western Australia and aimed to estimate the quantities (volumes/tonnes) of the plastics they generated each year by source and plastic type and the common uses of these materials in a commercial and industrial setting
- Key industrial plastic recyclers in Western Australia and the types of industrial plastic they process
- A summary of the current waste management practices used for plastics in Western Australia
- A summary of the current markets for products containing recycled industrial plastics together with information such as market size, specifications and related market issues
- A summary of issues, barriers and challenges facing the industrial plastic recycling and reuse industry in Western Australia

1.2.2 Policy Review and Assessment

Policies, tools and programmes (measures) implemented in other jurisdictions have been investigated. The policy review was completed to ensure that, where practical, a best practice approach could be adopted in Western Australia. The areas contacted for the policy review included:

- New South Wales
- Victoria
- South Australia
- USA (Federal, California and New England region)
- Canada (Federal, Greater Vancouver District Council and Nova Scotia)
- Europe (EU, United Kingdom)

Cardno BSD reviewed each jurisdiction to investigate the measures that have implemented or are planning, that relate to industrial plastic recycling and reuse.

1.2.3 Analysis and Interpretation

The information gathered relating to industrial plastic manufacturing, disposal, recycling and reuse in Western Australia, together with local market data has been analysed and the key issues have been identified and summarised.

The information gathered from the other jurisdictional areas has been assessed. The most appropriate measures for Western Australia have been considered for the reports recommendations. As well as a description of each measure recommended, the report has highlighted associated issues for each recommendation such as:

- Effectiveness
- Efficiency (cost to implement)
- Acceptability
- Enforceability
- Compatibility with policy principals in Western Australia

The potential to increase the amount of used industrial plastic recycled or re-used if the recommended measures were implemented have been summarised. This includes both the potential for increasing collection of used plastics and an assessment of the potential for increasing the beneficial use of the collected material.

2. INDUSTRIAL PLASTIC TYPES AND MANUFACTURING PROCESSES

Used Industrial plastics are defined as all plastic waste produced by commercial and industrial operations. The WAste 2020 task force defines these operations to include but are not limited to processing and manufacturing industries, the service sector, the public trade sector, trade, transport and distribution. Industrial plastics can also be used in the mining, minerals, energy production, agricultural and marine industries.

This section of the report provides an introduction to the most common polymer types, including their properties and some examples of their common uses, together with some manufacturing processes. This has been included to provide some background information about the plastics manufacturing industry.

2.1 THERMOPLASTICS

Thermoplastics are capable of being repeatedly softened by heat and hardened by cooling. Typical thermoplastics are defined in the types below:

2.1.1 Type 1 – Polyethylene Terephthalate (PET)

The good gas and moisture properties of PET, together with the fact that it is tough and clear, make it ideal for fizzy drink and beer bottles. Other common uses include fibre for clothing and carpets, and strapping. PET is now replacing HDPE in many applications.

- Clear
- Hard
- Tough
- Solvent resistant
- Good gas and moisture barrier properties
- High heat resistance
- Microwave transparency

2.1.2 Type 2 – High Density Polyethylene (HDPE)

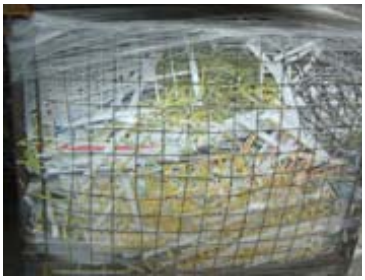
The excellent chemical resistance of HDPE makes it ideal for packaging industrial chemicals, such as detergents, bleach and acids. Other common uses include film, buckets, rigid pipes, crates, plastic lumber, garden furniture, flowerpots, and signs. As HDPE is permeable to gas it is not suitable for applications requiring an oxygen or CO_2 barrier.

- Excellent moisture barrier properties
- Excellent chemical resistance
- Hard to semi-flexible
- Strong
- Soft waxy surface
- Permeable to gas
- HDPE film crinkles to the touch
- Pigmented HDPE bottles generally have better stress crack and chemical resistance than bottles made from unpigmented HDPE

2.1.3 Type 3 – Polyvinyl Chloride (PVC)

PVC has been successfully used for pipes and fittings due to its chemical resistance, imperviousness to attack by bacteria or micro-organisms, corrosion resistance and strength. It is frequently used in food contact applications, especially frozen foods due to its low oxygen permeability and strong cold temperature properties. Other common uses include carpet backing, windows, credit cards, wire and cable sheathing, floor coverings, blood bags and medical tubing.

- Excellent transparency
- Hard, rigid (flexible when plasticised)
- Good chemical resistance
- Long term stability
- Good weathering ability
- Stable electrical properties
- Low gas permeability



2.1.4 Type 4 – Low Density Polyethylene (LDPE)

Due to its flexibility and other properties LDPE is used predominantly to manufacture films such as garment and produce bags, agricultural films, refuse sacks, and packaging films, foams and bubble wrap. Other uses include flexible lids, flexible bottles, wire and cable applications, some bottle tops, and irrigation pipes. Type 4 plastic also includes Linear Low Density Polyethylene (LLDPE), which is the primary type of resin used in packaging including film for bags and sheets. LLDPE has a lower tensile strength and exhibits higher impact and puncture resistance than LDPE.

- Tough
- Flexible
- Waxy surface
- Soft - scratches easily
- Good transparency
- Low melting point
- Stable electrical properties
- Good moisture barrier properties

2.1.5 Type 5 – Polypropylene (PP)

PP is found in everything from flexible and rigid packaging to fibres for fabrics and carpets and large moulded parts for automotive and consumer products, such as automobile battery casings. Most bottle tops are made from PP. Other common uses include refrigerated containers, medicine bottles, crates, plant pots, and heavy gauge woven bags or tarps.

- Excellent chemical resistance
- High melting point
- Hard, but flexible
- Waxy surface
- Translucent
- Strong

2.1.6 Type 6 – Polystyrene (PS)

PS is a versatile plastic that can be rigid or foamed. Common uses of rigid PS include fast food trays, disposable cutlery, video cases, vending cups, laboratory ware and seed trays. Type 6 plastic also includes Expanded Polystyrene (EPS). EPS, often called polystyrene foam, is a lightweight, rigid and an excellent shock absorber, which means it can be used for a variety of packaging needs.

- Clear to opaque
- Glassy surface
- Rigid
- Hard
- Brittle
- High clarity
- Affected by fats and solvents

2.1.7 Type 7 – other plastics

There are many polymers other than the six most common that have a very wide range of uses, often in the engineering sector. Examples include nylon (PA), acrylonitrile butadiene styrene (ABS), and polycarbonate (PC). Items that are layered, or have a mix of polymers also fall into this category.

2.2 THERMOSETS

Thermoset plastics include aminos (melamine and urea), most polyesters, alkyds, epoxies and phenolics. A thermoset is a plastic, which has undergone a chemical reaction by action of heat, catalysts, ultra-violet light leading to a relatively infusible state. Once the structural framework is set, these plastics cannot be reformed into new products. However, thermosets are able to be ground into a fine powder that can be mixed into new resin in the moulding process.

2.3 INDUSTRIAL PLASTICS MANUFACTURING PROCESS

This section outlines the processes used to manufacture industrial plastic products. Although not defined in the scope, this section provides some background information relating to the barriers to increasing the amount of industrial plastics recycled (**Section 7**).

Industrial plastics are manufactured using different processes, depending on their function and purpose. The two main types of plastic manufacturing include the following:

- Extrusion moulding
- Injection moulding

2.3.1 Extrusion Moulding

There are three variations of the extrusion moulding manufacturing process and include the following:

- Tube extrusion
- Extrusion blow moulding
- Co-extrusion blow moulding

Tube extrusion moulding is used in the product of pipe. It involves a process whereby molten polymers are extruded through an opening using pressure from a rotating screw. The molten tube is cooled with waste and cut to desired lengths. **Figure 2.1** below outlines the tube extrusion manufacturing process.

Figure 2.1 The Tube Extrusion Manufacturing Process

Source: VISY Industrial Packaging, 2006

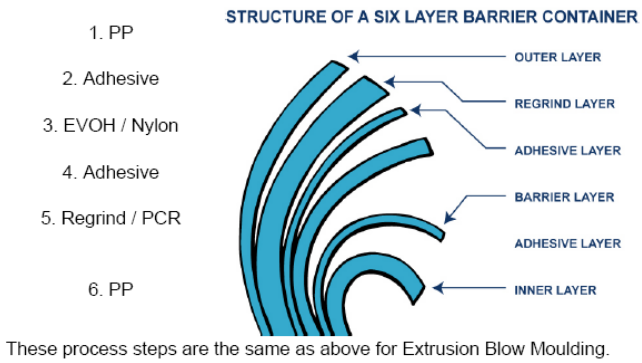
Extrusion Blow Moulding is used in the production of hollow plastic products in large quantities. It involves a process whereby molten plastics are extruded through a purpose shaped head into a plastic tube. A program controls the thickness of the plastic tube passing through the head. While it is still molten, a mould closes around the plastic to produce the required shape. Water is used to cool and harden the product. Excess plastic or "flashes" are removed and recycled directly into the process. **Figure 2.2** below outlines the extrusion blow moulding manufacturing process.

Figure 2.2 The Extrusion Blow Moulding Manufacturing Process

Source: VISY Industrial Packaging, 2006

The **co-extrusion blow moulding** involves the manufacturing of a plastic product with multiple layers of different. The process involves heating each layer in a separate extruder and are formed together at a single extrusion head. This process can use recycled material within outer layers of virgin plastic. Outer layers are generally made from virgin plastic because of food content or for visual appeal reasons. Co-extrusion can contain from two to six layers. **Figure 2.3** shows a cross section of a six layer co-extruded container involving four different plastics.

Figure 2.3 Structure of a six-layer barrier container



Source: VISY Industrial Packaging, 2006

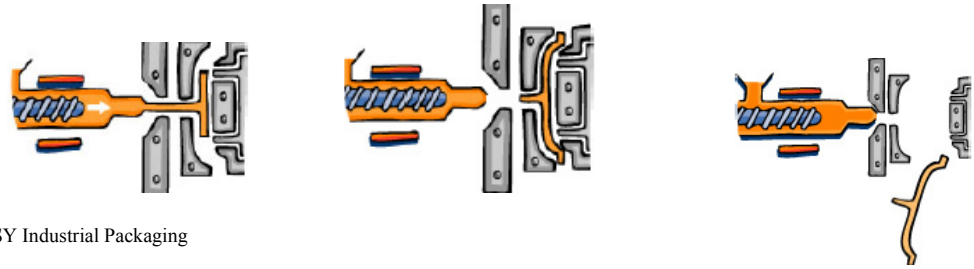
2.3.2 Injection Moulding

There are three variations of the injection moulding manufacturing process and include the following:

- Injection Moulding
- Injection Blow Moulding
- Injection Stretch Blow Moulding

Injection moulding is the primary industrial plastics manufacturing process as it can be used to make specially shaped products. Under high pressure, molten plastic is pumped into a preformed mould. The mould then cools which hardens the plastic product. **Figure 2.4** below outlines the injection moulding manufacturing process.

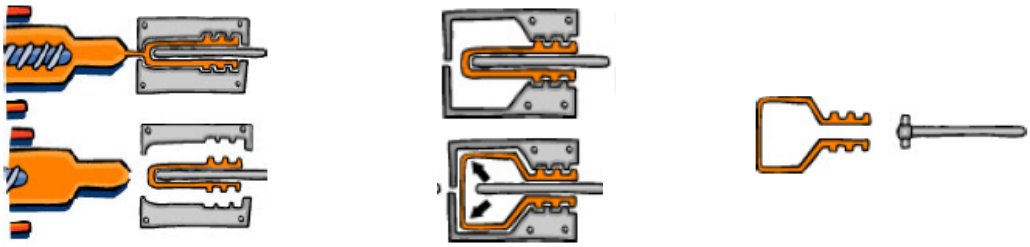
Figure 2.4 Injection Moulding Manufacturing Process



Source: VISY Industrial Packaging

Injection Blow Moulding is used to produce hollow products. Molten plastic is injected around a pin, which is then blown into a hollow shape and cooled to harden the plastic. In addition, products can be stretched and 'blown' which is referred to as **Injection Stretch Blow Moulding**. **Figure 2.5** below outlines the injection blow moulding manufacturing process.

Figure 2.5: Injection Blow Moulding Manufacturing Process



Source: VISY Industrial Packaging

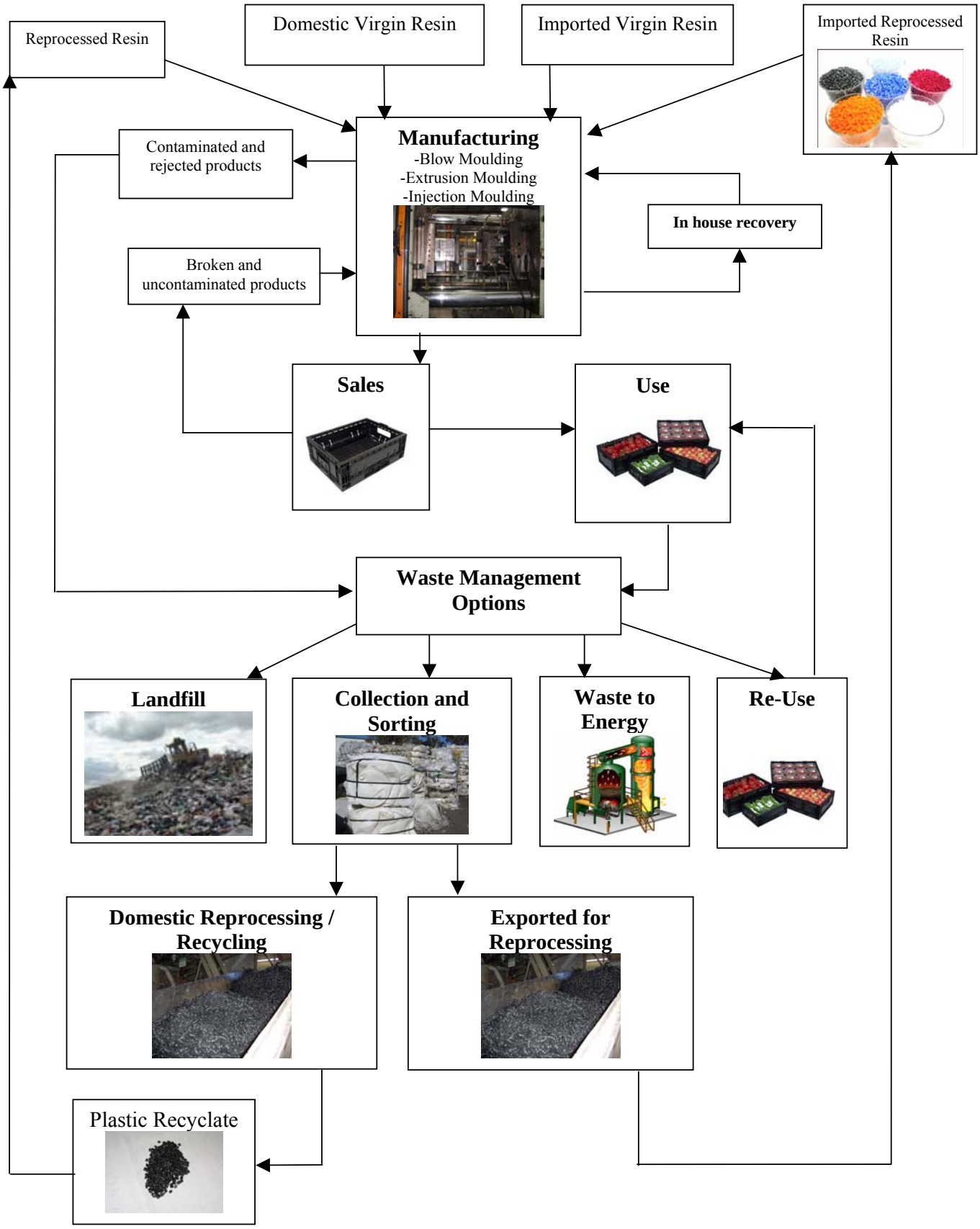
3. INDUSTRIAL PLASTIC INDUSTRY IN WESTERN AUSTRALIA

Waste management practices vary among commercial and industrial sectors in Western Australia. This section outlines the waste management practices of the following industry sectors:

- Industrial Plastics Industry
- Automotive Industry
- Building and Construction Industry
- Agricultural & Horticultural Industries
- Mining Industry
- Marine Industry
- Public Services Industry

Figure 3.1 on the following page summarises the Commercial and Industrial Plastics Industry in Western Australia from the acquisition of resin through to the disposal options available. The flow chart also outlines the recycling and re-use flows within the industry. This section also provides some case studies of Western Australian based plastic reuse / recycling companies and programmes.

Figure 3.1 Waste Management Practices of the Industrial Plastics Industry and Recycling / Re-use Flows



3.1 INDUSTRIAL PLASTICS INDUSTRY

Resin is supplied to manufacturers of industrial plastics from domestic or overseas resin suppliers. Companies who manufacture products with recycled plastic content acquire reprocessed resin.

Industrial plastic manufacturers incorporate a range of internal waste management practices. The majority of industrial plastic manufacturers involve in-house recovery of scrap. Off cut plastic material from the manufacturing process are called 'flashes', which are immediately reground and fed back into the process. These off cuts are clean and contaminant-free and improve the efficiency of resin used by the company.

Plastic products can be rejected for a number of reasons including colour and machine malfunctions. Clean and rejected products, together with any plastic packaging film, are usually sorted into polymer types for local plastic recyclers to collect. Contaminated plastic material is generally disposed of into a skip bin and sent directly to landfill.

A number of industrial plastic manufacturers also accept their products from their distributors if they are uncontaminated. For example – Viscount plastics accept any clean, broken crates, which can then be used in the manufacturing process. VISY Industrial Packaging also reconditions any agricultural drums that can then be re-sold.

Plastics manufacturing requires a clean environment as any contaminant can block the machines that produce the product. Some plastic manufacturers prefer not to recycle their own plastic waste, as the process is un-clean and can introduce dust in addition to other contaminants into the factory.

WESTERN AUSTRALIAN CASE STUDY
VISCOUNT PLASTICS

Viscount Plastics has a large portfolio of industrial products, which are used in many industrial and market segments across Australia. Viscount Plastics in Canning Vale (Perth, Western Australia) specialise in manufacturing a number of consumer products including food and beverage containers. In regards to industrial plastics – Viscount Plastics manufacture the majority of Western Australia's crates for milk, bread, poultry and meat.

Viscount plastics have undertaken a number of waste management practices to maximise the efficiency of resin use and to minimise the amount of waste going to landfill.

In-House Reprocessing: After the manufacturing process, flash is collected, re-ground and recycled back into the process.

Re-use: Crates are generally re-used products. The company supplies crates to supermarkets who pay a deposit on each crate. This ensures that the crates are returned for re-use. Broken crates are also returned which are then used to produce more crates or are collected by a plastic recycler.

Recycling: A local recycler collects any products or plastic material that can not be sold by Viscount. The manufacturer generally rejects plastic products because they are the wrong colour / shape or contain some contamination. This material is sorted into bins depending on the polymer type and collected to be recycled. In addition, a plastic recycler also collects any plastic film or other clean packaging plastic material.

Landfill: Any plastic material that can not be reprocessed, re-used or recycled is sent to landfill. This is a usually highly contaminated plastic product.

(Viscount, 2006)

WESTERN AUSTRALIAN CASE STUDY
VISY INDUSTRIAL PACKAGING

VISY Industrial Packaging products and services include plastic and steel packaging, extrusion and thermoformed packaging, closure systems and sustainability services that are located across Australia. VISY Industrial Packaging in Fremantle, Western Australia specialise in the manufacturing of motor oil containers and chemical drums for agriculture and industry. The industrial plastic products are manufactured using extrusion and injection blow moulding process. VISY plastic drums are made from polyethylene and range in size from 25 to 110 litres.

In-House Reprocessing: VISY Industrial Packaging indicate that 40% of the product is removed as 'flash', collected and reprocessed in the manufacturing process.

Re-use: VISY industrial Packaging works in conjunction with a number of drum re-use companies including Drum Service Limited (DSL) and Clean Drum Company.

Recycling: A plastic recycler buys any contaminated plastic including products that are not suitable for sale and recycles the plastic into reprocessed resin.

(VISY Industrial, 2006)

WESTERN AUSTRALIAN CASE STUDY
VINIDEX PTY LTD

Vinidex is Australia's leading manufacturer of thermoplastic pipe systems for the transportation of fluid, data and energy. The manufacturing and distribution centre in O'Connor (Perth, Western Australia) specialise in the manufacturing of long life (mainly in excess of 100 year life) plastic pipes.

In house re-processing: the vast majority of plastic wastes, specifically off cuts, are re-used in the manufacturing process.

Plastic Waste Recycling: On the rare instance where contamination occurs (burned or foreign object inclusions), Vinidex sends the material to plastic recyclers who turn it into lower grade plastics for other uses. This is estimated to be less than 0.1% of material used.

Recycle plastic use: used PVC pipes are collect, sorted, cleaned, granulated, micronised and then processed through Vinidex's manufacturing facilities. The reprocessed resin is manufactured into pipes for non-pressure applications (e.g. storm waste drainage). The pipes are made up of a foam-core pipe comprising of a solid inner and outer wall made from virgin material and a thicker layer of recycled PVC in between.

The pipes using recycled PVC are lightweight, have high stiffness and have a material and energy saving of 30% (Vinidex, 2006b). The Australian Standard 1260, which previously specified the thickness of the pipe, have been re-written to specify the stiffness (or ability to resist collapse under stress) of the pipe. The re-written standard allows flexibility with the wall thickness while still fulfilling the performance requirements. The result is that a thicker pipe with recycled content complies with the required specification.

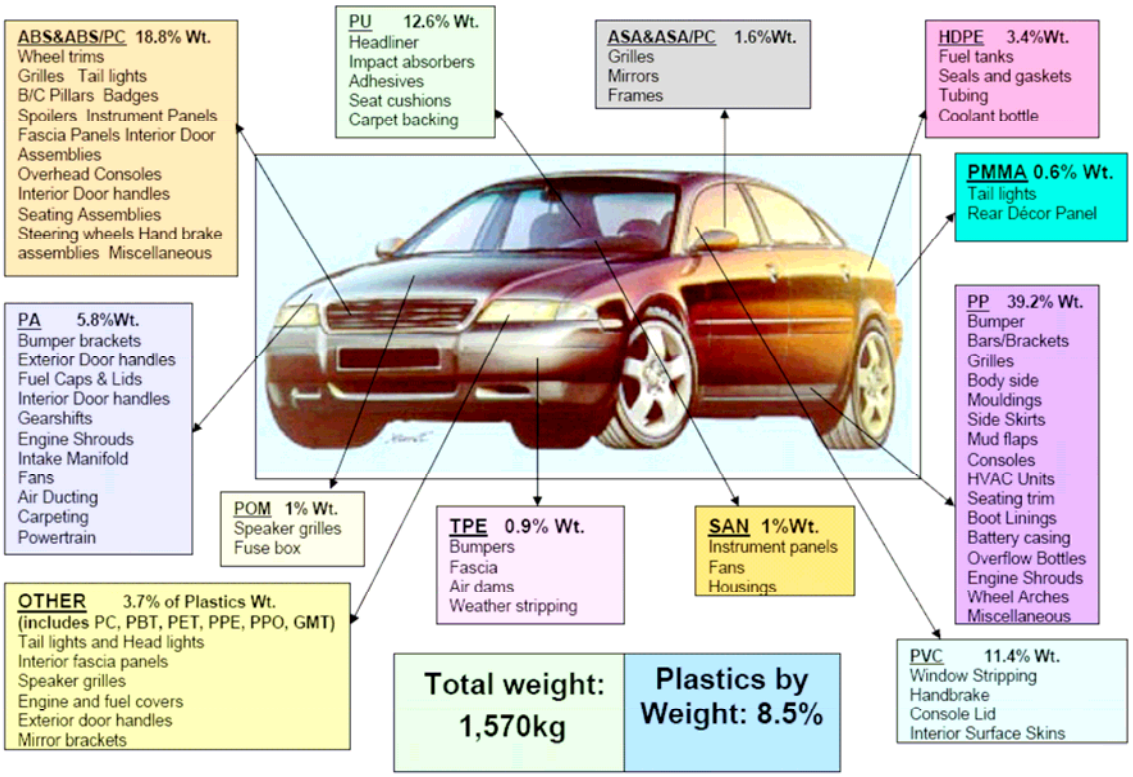
(Vinidex, 2005a)

3.2 AUTOMOTIVE INDUSTRY

By volume, cars today contain a larger proportion of plastics than any other materials. The specific properties of plastics, which include strength yet light weight, versatility and flexibility, have led to plastics being used to a much greater extent in vehicle manufacture. Due to their lightweight, plastics account for an average of only 8.5% (133kg) of the total weight of a vehicle (PACIA, 2006a). By comparison, 20 years ago, there was an average of 70kg of plastics used per car. Different types of polymers are used in over 1000 parts of various shapes and sizes, ranging from dashboards and fuel

tanks to radiator grilles. The substitution of metals with plastics in vehicles can also lead to significant fuel savings. **Figure 3.2** shows the breakdown of plastic polymer types used for plastic automotive parts.

Figure 3.2 A Breakdown of Plastic Types and Uses in the Automotive Industry

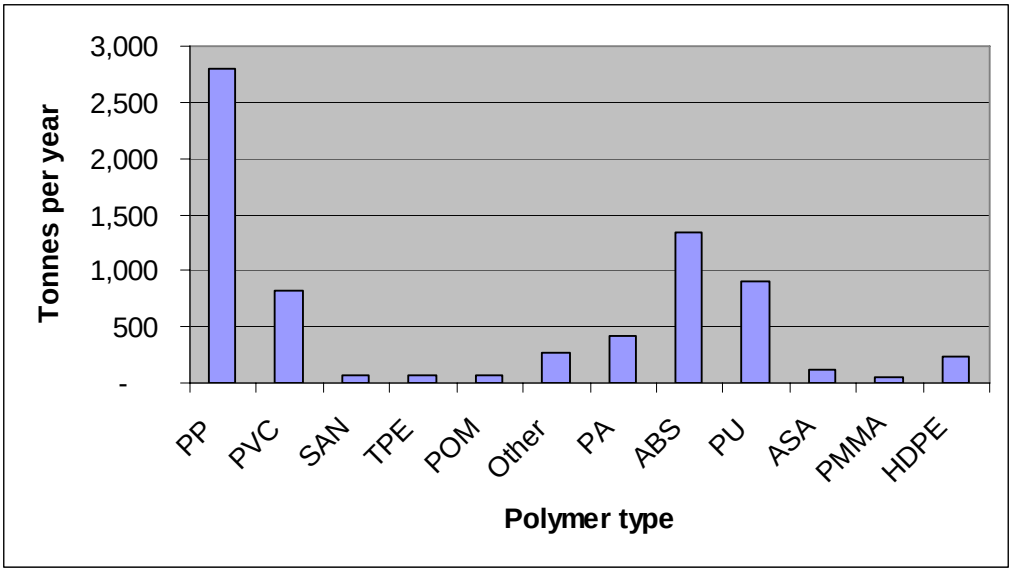


Source: PACIA, 2006a

The attrition rate (de-registration) for cars in Western Australia during 2004-05 was 53440 units (ABS, 2005). Based upon an 8.5% content of plastics, this equates to 7,132 tonnes of used plastics produced by the automotive industry in 2004-05.

The motorcar, despite the complexity of its components and materials, is one of the most effectively recycled products in Australia today, with the steel being recycled. Whoever, it is estimated that in 2004 only 7.5% of the plastics were recycled (PACIA, 2006a). PP battery cases are commonly dismantled and recycled together with some PP bumpers; the remaining plastics and other materials such as rubber, fabric and glass are usually shredded and sent to landfill as 'flock'. **Figure 3.3** shows the breakdown of plastic polymer tonnages produced in Western Australia (2004-05).

Figure 3.3 Tonnes of Plastics by Polymer Type Produced by the Automotive Industry in Western Australia, 2004-05.



* The above graph assumes an 8.5% content of plastic in one car and uses the breakdown of plastic types as outlined in Figure 3.2 (PACIA, 2006a). The total tonnes were calculated by multiplying these figures by the attrition rate (de-registration) for cars in Western Australia during 2004-05 (ABS, 2005).

3.3 BUILDING AND CONSTRUCTION INDUSTRY

The building and construction sector is an important growing market for plastics. Plastics form a wide variety of applications in the Building and Construction sector. PVC is the most common plastic used in the building and construction sector and makes up the majority of the plastics used (Waste Watch & Recoup, 2003). Other plastics include Polurethane, Expanded polystyrene, HDPE and LDPE. Common uses include pipes and ducts, insulation, floor and wall coverings, profiles, lining and fitted furniture. In addition, a large quantity of plastic flim is used to packaging building product materials for construction.

Construction Building Products

The vast majority of plastic building products are intended for a long lifetime. A large amount of PVC and HDPE piping is buried below ground and is unlikely to be removed for disposal. The cost of collecting this plastic waste outweighs the benefits of recycling or recovering the plastic (Waste Watch & Recoup, 2003).

External plastic building products, including rainwater pipes and cladding, are potentially recoverable. During demolition, these plastic products are disposed in a bulk bin with other mixed building product waste and are then disposed of to landfill.

Building Product Packaging

Packaging plays an important role in protecting and identifying building products. The majority of building products are wrapped in, or held together by packaging. Polyethylene wrap makes up the

majority of plastic packaging waste on building sites. Again, this waste is disposed of in a mixed waste bin and sent directly to landfill

3.4 AGRICULTURAL AND HORTICULTURAL INDUSTRIES

3.4.1 Plastic Silage Wrap

A significant amount of used industrial plastic arises from the use of plastic silage wrap. Silage is fermented, high-moisture forage fed to cattle or sheep. It is fermented and stored in a plastic silage wrap, which is made of Linear Low Density Polyethylene (LLDPE).

Source: (Smart, 1997)

Western Australian farmers have little choice when considering the options to dispose of used plastic silage wrap. Many farmers dispose of used plastic wrap at the local shire rubbish disposal site (Smart, 1997). The plastic wrap is usually compacted and transport by the farmer to the shire's landfill. Alternatively, some farmers bury the plastic waste on the farm.

Some plastic silage is burned on farms, in water heaters or open fires at relatively low temperatures and produces incomplete combustion. The Victorian EPA regards burning plastic on farms as an environmental nuisance (Smart, 1997). Agricultural plastic has a high relative energy value and would be suitable as a fuel for high temperature combustion if large quantities were available close to an incinerator.

There is very little recycling of polyethylene from agricultural uses in the state. The wrap is often contains too much moisture and organic contaminants. When considering the labour costs for collecting, handling and reprocessing, it is cheaper to use new plastic silage wrap than to recycle used wrap.

3.4.2 Chemical Drums

Farmers can participate in chemical drum re-use programmes such as drumMUSTER. Farm chemical users pay a 4 cent per litre levy on chemicals sold in non-returnable chemical containers. This levy funds the drumMUSTER programme and subsidises the participating councils for the costs incurred by running the collection. **Appendix 2** outlines the Western Australian councils participating in the drumMUSTER programme.

3.4.3 Plastic Mulch

Plastic mulch is a plastic product used, in a similar fashion to mulch, to suppress weeds and conserve water in crop production and landscaping. Crops grow through slits or holes in thin plastic sheeting. Plastic mulch is often used in conjunction with drip irrigation. This method is predominant in large-scale vegetable growing.

Disposal of plastic mulch is cited as an waste management problem as it is currently send to landfill. There is limited recycling and re-use opportunities as the plastic is highly contaminated with organic matter and soil. In addition, the material can be easily torn and ripped as UV light breakdowns the sheet.

Researchers are currently investigating the potential of using biodegradable plastic mulch for short-term crops including tomatoes and capsicums (Salt, 2002). Field trials using biodegradable mulch film on these crops have shown it performs as well as polyethylene film and can be simply ploughed into the ground after harvest (Salt, 2002).

3.5 MINING INDUSTRY

3.5.1 Plastic Pipes

The use of plastic pipes in mining for water, waste, chemical and slurry transport is extensive. Plastic pipes are lightweight, flexible and easy to transport and install. Pipes that a buried underground are generally left *in-situ* when they are being replaced or when operations cease. Any pipes that can be re-used are easily collected, transported and welded for other uses around the mine-site. Alternatively, piping is disposed of at the mine-site's landfill.

Generally pipes are not returned to the metropolitan areas to be recycled due to the high costs of transport. However, some plastic recyclers are accessing plastic pipe from mines around the state for their recycling operations, at a cost to the recycler.

3.6 MARINE INDUSTRY

3.6.1 Plastic Wrap

Packaging plays an important role in protecting marine industry product during transport. A plastic recycler collects most plastic wrap and highly contaminated wrap is sent to landfill.

3.6.2 Plastic Tubs and EPS

Plastic tubs and bin are used to cart fish and other marine produce. Some of the bins and tubs are lined with polystyrene to keep the produce cool during transport. These tubs are generally cleaned with a chemical and re-used. Old and worn tubs/bins are disposed of to landfill.

3.7 PUBLIC SERVICE INDUSTRY

3.7.1 Water/Gas

Plastic pipes are used extensively around Western Australia for public services. PVC or polyethylene pipes can be used for water supply, gas distribution, sewerage and drainage, electrical and communications services. When the Water Corporation replaces broken/damaged piping they are replaced with new pipes and not left *in-situ* underground. These pipes are generally sent to landfill, however, if they are under 12 months of age they are sent to a recycle company for reprocessing into new material.

3.7.2 Communications

Telstra have a National Waste Management System to collect, transport, dispose and recycle of general waste inclusive of industrial waste. Recycling services are available at 80% of Telstra's commercial sites in Australia, with the remainder being unviable due to them being un-manned or being in too remote a location. 41% of Telstra's general waste is recycled. Cable reels (90,000) per annum are mostly recycled into new products.

Major barriers indicated include disassembly of equipment, markets, bureaucracy, education to staff, redundancy of old equipment and their uses and contractual matters with waste disposal companies including clauses for collection and segregation.

3.8 INDUSTRIAL PLASTICS RE-USE PROGRAMMES

A number of companies have established businesses or programmes for the re-use of industrial plastic products. These companies mainly focus on containers and drums used for agricultural or industrial purposes. The following companies specialise in of container re-use:

- drumMUSTER
- CCR Plascon
- Clean Drum
- Coogee Drums
- Drum Services (WA)
- Kenwick Drum Launderers
- McPhee's Drum
- Western Resource Recovery

There are a number of re-use programmes operating in Western Australia. Users of agricultural or industrial drums can pay a deposit for the product and receive a refund once it is re-used. The company receiving the deposit reconditions the drum, ready for use. Alternatively the users of the agricultural, horticultural or industrial drums can pay for the reconditioning service and then reuse the container. Reconditioning companies also offer a collection service for re-useable products and resell the product.

WESTERN AUSTRALIA CASE STUDY
DSL PACKAGING

Drum Services Limited (DSL) is a leader in the reusable industrial packaging for a range of product including industrial chemicals, lubricants, food and beverages, agricultural chemicals and dangerous goods. The company was originally set up to buy, collect and sell reconditioned drums. The company incorporates a range of diverse products from 20 to 1500 litre containers and associated services. It also provides responsible solutions and disposal services for a range of industrial containers.

Manufacturing: The DSL plant in South Fremantle, Western Australia specialises in the manufacture of steel and plastic drums. The company has incorporates key features designed for the re-use programme:
Schütz EcoDrums are designed to be crack resistant, chemical resistant and for easy removal of residual contents.
Small Volume Refillable (SVR) containers are also manufacturer by DSL and are particularly suited to the agricultural chemical industry. The drums are colour coded and refilled with the same product within a closed loop system.

Re-use Services
DSL reseller's kit: DSL offers a full collection and tracking service for customers throughout Australia, as well as providing reporting mechanisms such as stock movements, status reports and a comprehensive Resellers Kit, which provides full details of DSL's Small Volume Refillable services.

Collection: DSL can organise the collection and transport of any DSL reconditioned drum to anywhere in Australia.

Tracking: DSL's tracking system accurately monitors individual fleet movements. Reliable, integrated tracking system that monitor refillable container movements maximises stock usage and minimises loss while also identifying operational inefficiencies. (website http://www.dslpackaging.com/drums/services.phtml)

Storage: DSL facilities offer the storage of both clean and dirty DSL industrial containers.

(DSL Packaging, 2006)

WESTERN AUSTRALIAN CASE STUDY
DRUMMUSTER

drumMUSTER is a national programme for the collection and recycling of empty, clean, non returnable crop production and on-farm animal health chemical containers. Since 1999 farm chemical users have paid a 4 cents per litre levy on crop production and on-farm animal health products sold in non-returnable containers. This levy funds the drumMUSTER programme and is available to reimburse participating councils for all agreed costs in running the collection programme.

drumMUSTER provides information for users to ensure that difficult to clean eligible farm chemical containers will be accepted for recycling at the local collection centre. drumMUSTER also enables manufacturers to ensure that their products are collected and disposed of in a responsible manner that is environmentally, socially and economically sound. Resellers also play an important role in the drumMUSTER programme by in reselling clean drums for re-use.

(drumMUSTER, 2006)

3.9 PLASTIC RECYCLING COMPANIES

Industrial plastic recyclers obtain the majority of their plastic directly from plastic manufacturers. Recyclers receive plastic waste in a sorted or mixed form from manufacturers or provide collection services.

Plastic recyclers sort the plastic material into polymer types. Contaminated, sorted material is washed before or after processing to ensure a clean resin. Plastic is can also be exported for further reprocessing.

Some recycling companies manufacture their own products or produce recycled resin in pellet form, which are used by plastic manufacturers to produce products with a recycled content. Any plastic material that is highly contaminated and cannot be reprocessed by the recycler is sent directly to landfill.

WESTERN AUSTRALIAN CASE STUDY
CLAW ENVIRONMENTAL

CLAW Environmental are able to recycle a wide range of plastic waste material. Common examples of plastics material received by CLAW include:

- Bags / bulka bags
- Bins / bottles / buckets / containers / drums
- Bumpers and other automotive parts
- Film / foam / wrap and other packaging material
- Pallets and Piping
- Offcuts / purgings
- Safety goggles / helmets

Self-Delivery: Companies whom produce plastic waste can self deliver their waste (at no charge) to the Welshpool facility. CLAW specifies that self-delivered plastics must be separated and free from contamination.

Metropolitan Collections: Companies who produce a considerable amount of plastics bags, wrap and film waste are provided with clear LDPE bags and are collected by CLAW's rear compaction truck. Businesses can also lease bins and frames if necessary. In addition, rigid plastics are able to be collected for recycling and cages or containers are available for lease.

Regional Collections: In special cases, CLAW Environmental may collect large loads of rigid or baled/compacted plastics. In most cases pickups coincide with drumMUSTER collections.

drumMUSTER Processing: CLAW Environmental is an approved drumMUSTER processor. Chemical drums from the programme are shredded on site with CLAW's mobile shredder prior to transport.

Expanded Polystyrene Recycling: CLAW Environmental have become Western Australia's official expanded polystyrene collection centre. Through PACIA, CLAW has obtained a polystyrene compactor. This traditionally difficult material can now be recycled. The machine shreds, heats and compacts polystyrene into long brick like lengths, enabling the volume of the material to be significantly reduced. Polystyrene can be accepted from grower markets and polystyrene manufacturers in a clean and dry form. Processing fees remain the cheapest in Australia and significantly cheaper than landfill.
(CLAW Environmental, 2006)

WESTERN AUSTRALIAN CASE STUDY
POT RECYCLERS

Pot Recyclers and SITA Environmental Solutions are working together to reduce the amount of plastics disposed to landfill. Bob Williamson, director of Pot Recyclers identified that almost 8,000 tonnes of plastic plant pots from the nursery and gardening industry are being disposed of to landfill in Western Australia each year.

The company provides bins to a number of nurseries and transfer stations located around Perth to collect the polypropylene pots (Type 5 plastic). The company works in conjunction with SITA Environmental to collect the pots from different locations.

Pots are sorted, shredded and granulated into a raw plastic product, ready to be manufactured into pots with 100% recycled polypropylene content.

In addition, Pot Recyclers are now targeting industrial packaging products made from polypropylene including milk and bread crates. These are reprocessed using the same process.

For their efforts, Pot Recyclers have received a number of national and international environment awards including the Plastics and Chemical Industry National Environment Award and the Outstanding Business Award. Pot Recyclers were also finalists in the United Nations Association World Environment Day Awards and the Prime Minister's Award for Environmentalist of the Year. (Pot Recyclers, 2006)

WESTERN AUSTRALIAN CASE STUDY
JO JO PLASTICS

Jo Jo plastics are accepting any post household, commercial and industrial plastic waste including products such as mobile garbage bins and polyethylene pipe from mine sites in regional areas to be processed at their Wangara facility. All waste plastics are mixed together and fed through a processor, granulated and processed to produce a plastic lumber product.

Currently research is being undertaken by the company to investigate the potential markets in Western Australia for the plastic lumber products manufactured from this process such as bollards and pallets.

4. INDUSTRIAL PLASTIC QUANTITIES

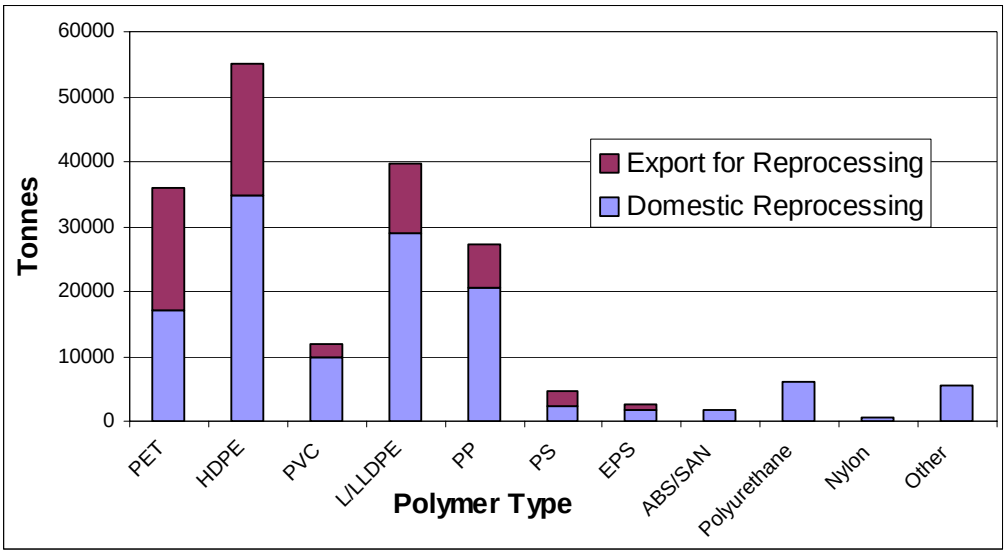
The Plastics and Chemicals Industries Association (PACIA) have undertaken a number of *National Plastics Recycling Surveys* that reports on the state of plastics recycling in Australia. The latest report was produced in 2005 and contains information about recycled plastic quantities from 2004. The information is this report is presented as aggregated results to protect any commercially sensitive information from being released. The level of detail reported does not include a breakdown for Western Australia into sectors (e.g. Industrial Plastics).

A new report is being produced, and PACIA was contacted by Cardno BSD to determine if the results relating to Western Australia could be released together with more detailed information about the breakdown of plastic production and recycling. However, the information could not be released due to commercial confidentiality. Therefore the information presented in this section of the report is based upon 2004 results reported in the PACIA report, together with other referenced sources.

4.1 A NATIONAL PERSPECTIVE

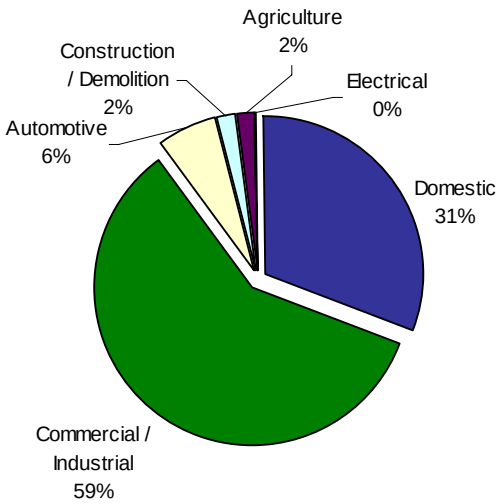
A total of 1,510,850 tonnes of plastics were consumed in Australia during 2004 (PACIA, 2005), and 190,979 tonnes of plastics were recycled. The total amount of all plastics recycled in Australia by polymer type is shown in **Figure 4.1**. This includes the quantities reprocessed domestically or exported for reprocessing overseas. The average rate of plastic recycling in Australia in 2004 was 12.6%, which is the highest rate recorded from the five surveys that have been completed since 1997.

Figure 4.1 Total Australian Plastic Recycling by Polymer Type in 2004 (PACIA, 2005)



The PACIA survey report does provide limited data about the breakdown of plastic recycling material produced by each sector, as shown in **Figure 4.2**, however this is an average figure for Australia.

Figure 4.2 Source of Recycled Plastics by Sector in 2004 (PACIA, 2005)



The PACIA report also broke down the source of recycled plastics into the three sectors of:

- Commercial and Industrial (56.4% of Recycled Plastics)
- Building, Construction and Demolition (1.2% of Recycled Plastics)
- Municipal (42.4% of Recycled Plastics)

The municipal sector consists of almost entirely domestic packaging, and the total quantity recovered from this sector was 80,975 tonnes in 2004. The Commercial and Industrial sector generates the majority of the plastic recovered for reprocessing during 20043, a total of 107,712 tonnes, of which over half is pre consumer scrap. Western Australia has a small plastic manufacturing base, so it is unlikely that the proportion of recycled plastics produced from pre consumer scrap is the same proportion as the national average.

4.2 WESTERN AUSTRALIA DATA FROM PACIA SURVEY REPORT

4.2.1 Total Western Australian Industrial Plastic Consumption and Waste Generation

Overall plastic consumption in Western Australia during 2003 was 149,267 tonnes, as based upon a per capita estimation using national plastic consumption data (PACIA, 2005).

There is little available data relating to the generation of used industrial plastics in Western Australia, however in 2001 it was estimated that about 40,000 tonnes per annum of Commercial and Industrial waste consists of plastic and is currently landfilled (Waste 2020 taskforce, 2001). This estimate includes waste from commercial and industrial operations including the processing and manufacturing industries, the service sector, the public sector, trade transport and distribution. It DOES NOT include waste from mining, minerals and energy production, agriculture and marine activities, therefore it is likely to be an under estimate for the total volume of waste industrial plastics disposed in Western Australia.

The total consumption of plastics in Australia increased by 5.6% between 2001 and 2004 (PACIA, 2005). If this rate of increase were assumed to be even throughout Australia and all sectors, the volume of industrial and commercial waste plastic disposed of to landfill during 2004 in Western Australia would be estimated at approximately 42,250 tonnes. However, again this does not include waste plastics from mining, minerals, energy production, agriculture and marine activities.

During the stakeholder consultation process, associations representing plastic manufacturing, agriculture, mining and minerals were contacted and these association could not provide any further information about plastic consumption in Western Australia due to either the commercial sensitivity of the data, or simply a lack of available data.

The only conclusions that can be drawn from the available data is that in 2004 an estimated 42,250 tonnes of industrial and commercial waste plastics were landfilled, and this figure would be larger if mining, minerals and energy production, agriculture and marine activities were included. Finally, this is the disposal quantity rather than the consumption quantity, which would be larger again, as the life span of many plastic products is greater than one year (e.g. Electrical, automotive, drums, pipe, cable insulation, etc).

4.2.2 Breakdown of Used Industrial Plastics Generated

The original scope of work for this report requested amounts of used plastic generated in Western Australia by source and plastic type to be estimated. However, due to either issues of commercial sensitivity or lack of information there is insufficient empirical data from which to develop any accurate and comprehensive estimates for either used industrial plastic generation by industry source or plastic type for Western Australia.

4.2.2.1 Estimates Based upon PACIA Survey Report

The following estimate of plastic type is based upon the national breakdown of sector sources for all plastics recycled in Australia (**Figure 4.2**). This estimate is of limited accuracy as the data is not specific to Western Australia; the results are shown in **Figure 4.3.** However, there is no allocation for the resources sector, which makes up a significant proportion of the Western Australian economy and is likely to be a significant generator of used industrial plastics.

Figure 4.3 Calculations to Estimate Sector Source of Used Industrial Plastics Generated in Western Australia during 2004

Sector	**Total Recycled Material -** Australia wide for all plastics excluding domestic packaging **(PACIA, 2005)**	**Proportion of Recycled Material** - Australia wide for all plastics excluding domestic packaging **(PACIA, 2005)**	**Calculated Proportions for WA Used Industrial Plastic Generation**
Commercial / Industrial	113442	85.7%	36214
Automotive	11650	8.8%	3719
Construction / Demolition	3438	2.6%	1097
Agriculture	3056	2.3%	975
Electrical	764	0.6%	244
Total	132348	100.0%	42250

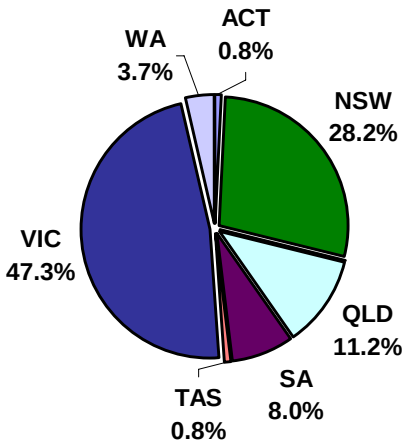
Note: These estimates assume the tonnage of plastics generated is proportionally linked to the tonnages of plastics recycled.

There is sufficient information about used plastic generation from the automotive industry to test the estimate calculated in **Figure 4.3**. Based upon the attrition (de-registering) of 53,440 vehicles during 2004-05 in Western Australia (ABS, 2005) and an 8.5% average plastic content of vehicles. The total used plastic generated by the automotive industry in Western Australia during 2004-05 is estimated to be approximately 7,100 tonnes, which is nearly twice the tonnage estimated in **Figure 4.3**. This highlights the issue relating to the availability of empirical data for used industrial plastics in Western Australia.

4.2.3 Plastic Recovery in Western Australia

Based upon data from the PACIA survey report the overall recovery of plastics from Western Australia during 2004 was 7,125 tonnes, which is 3.7% of the total plastics recycled in Australia as shown in **Figure 4.4**. Based upon these figures the overall Western Australian plastic recycling rate was 4.8% during 2004 for all plastic sources.

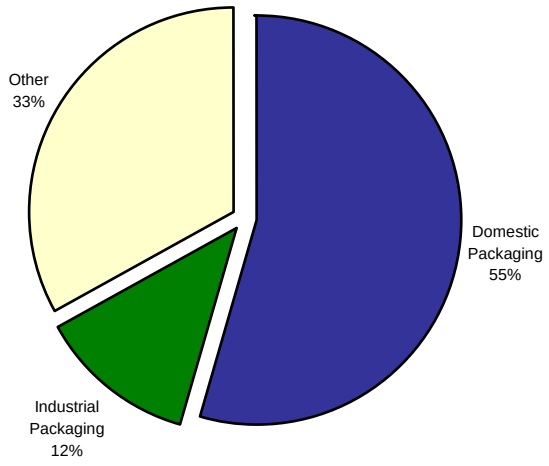
Figure 4.4 Source of Australian Recycled Plastics by State in 2003 (PACIA, 2004)



In Western Australia, the source of the 7,125 tonnes of recycled plastics can be broken down to these three sectors:

- Domestic Packaging 3883 tonnes (55%)
- Industrial Packaging 887 tonnes (12%)
- Other 2355 tonnes (33%)

Figure 4.5 Source of Western Australian Recycled Plastics by Sector in 2004 (PACIA, 2005)



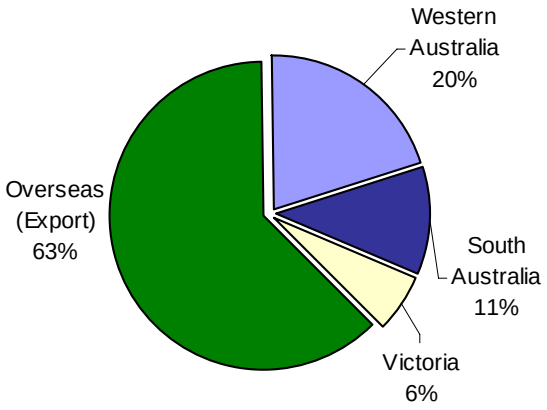
Therefore even if the total of the 'Other' plastics was assumed to be from industrial sources, the total used industrial plastics recycled in Western Australia during 2004 was 3,242 tonnes based upon the PACIA survey report.

During the stakeholder consultation completed for the production of this report a number of plastics recyclers were contacted. During these discussions and visits a number of the organisations provided data relating to the tonnages of industrial plastics that they recycle, however due to the commercial sensitivity of the data, only aggregated information can be provided. The quantity of plastics recycled during 2005 in Western Australia was at least 15,000 tonnes; this does not include the tonnages recycled by all the plastics recyclers contacted, as some companies would not provide this commercially sensitive data. In addition, this tonnage may include some non-industrial plastics, but the majority is from industrial sources. Therefore considering these constraints, it is likely that this estimate is considerably lower that the actual industrial plastic recycling tonnages for Western Australia.

4.2.4 Reprocessing of Recycled Plastics

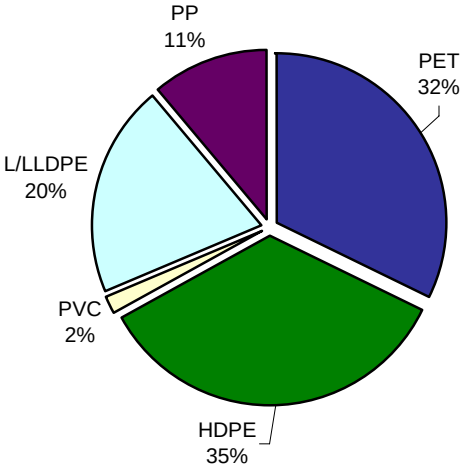
The majority of the plastics collected for recycling in Western Australia are sent out of State and overseas for reprocessing, **Figure 4.6** shows the proportions of the total plastics collected (inc domestic plastics) and their reprocessing destinations. 20% of the recycled plastics are reprocessed in Western Australia, this is due to the relatively small plastic manufacturing industry in the State. The majority (62%) of the recycled plastics from Western Australia are exported overseas for reprocessing.

Figure 4.6 Reprocessing Destination for ALL Recycled Plastics Collected in Western Australia during 2004 (PACIA, 2005)



The plastics that are exported from Western Australia for reprocessing include a range of plastic polymer types as shown in **Figure 4.7**. PET and HDPE account for 67% of the recycled plastics exported for reprocessing.

Figure 4.7 Plastic Polymer Type Exported from Western Australia for Reprocessing during 2004, includes plastics from all sectors **(PACIA, 2005)**



4.2.5 Summary

There were 1,510,850 tonnes of plastics (from all domestic and industrial sectors) consumed in Australia during 2004 (PACIA, 2005). The quantity of used plastic generated in Australia is unknown. A total of 190,979 tonnes of plastics were recycled during 2004, of which approximately 110,000 tonnes were industrial plastics (PACIA, 20054).

In Western Australia, during 2004 149,267 tonnes of plastic (from all domestic and industry sectors) were consumed (PACIA, 2005), and it is estimated that at least 42,250 tonnes of used industrial plastics were generated, although this estimate excluded plastics from the mining, minerals, agricultural, marine and energy production industries. Of the used industrial plastics generated, approximately 3,242 tonnes were recycled during 2004 based upon the PACIA survey report, however feedback gathered from Western Australian based industrial plastic recyclers during the production of this report, suggest that in 2005 the quantity of industrial plastics recycled was at least 15,000 tonnes.

Detailed data and information about used industrial plastic generation and recycling in Western Australia has been found to be unavailable to be included in this report, due to either commercial sensitivity or simply lack of information. Therefore it should be noted that the estimated values are unlikely to be accurate.

5. MARKETS FOR PRODUCTS WITH RECYCLED INDUSTRIAL PLASTIC CONTENT

5.1 REPROCESSED RESIN

Industrial and commercial plastic waste can be recovered, sorted and reprocessed into recycled resin. Recycled resin can be used in the manufacturing process of a number of plastic products. **Table 5.1** below outlines the recycled resin type and the potential products for each polymer type. Internet searches were undertaken to identify whether these products are manufactured in Western Australia or inter-state. The table is not intended to provide a complete list of products manufactured in Australia from reprocessed plastics.

Table 5.1: Current Markets for Recycled Resin in

Plastic Type	Products made of reprocessed resin	Western Australian market	Australian market
Type 1 – PET	Geo-fabric		✓
Type 2 - HDPE	Boxes		✓
	Coat Hangers	✓	
	Crates and pallets	✓	✓
	Drainage pipe	✓	✓
	Drums		✓
	Mobile Garbage Bins		✓
	Sewerage pipe		✓
Type 3 - PVC	Hoses		✓
	Mudflaps		✓
	Piping		✓
	Sunscreen		✓
	Vinyl Flooring		✓
	Pipe and hose fittings		✓
Type 4 - LDPE	Agricultural and Building Film		✓
	Garbage bags		✓
	Film for Packaging		✓
	Shopping bags		✓
Type 5 - PP	Crates and Pallets	✓	
	Flower pots	✓	
	Strapping		✓
Type 6 - PS	Pegs, Clothes Hangers		✓
	Photo frames		✓
	Boxes and building materials (EPS)		✓
	EPS wall panels		✓
Type 7 - other	Carpet underlay (polyurethane)	✓	✓
	Industrial padding (polyurethane)		✓

5.2 MIXED PLASTIC WASTE

A number of companies including Advance Plastic Recyclers (APR) in South Australia and Jo Jo Plastics in Western Australia have developed products using mixed processed plastic waste. Mixed industrial plastics including polystyrene, polyethylene, polypropylene and PVC can be mixed without sorting and without a significant amount of cleaning. The mixed plastics waste is granulated, turned into agglomerate, heated and then pumped into moulds.

The agglomerate is suitable for the manufacturing of bulky products such as:

- Outdoor furniture – tables, park benches
- Bollards
- Electric fence posts
- Fence posts
- Forever decking
- Oyster bed poles
- Parking lot stops
- Plastic lumber
- Retaining walls
- Warf Beams
- Dunnage
- Septic tanks
- Sound barriers and baffling
- Pallets
- Parking dividers
- Manhole covers and surrounds
- Railway sleepers
- Highway guard posts
- Pipe supports
- Electrical power poles

(Advanced Plastic Recycling, 2006)

This material is commonly known as plastic lumber and the resultant products are not only made from recycled materials but also outperform traditional materials such a metals and wood. These advantages include:

- Pliable and easily moulded or extruded into required shapes
- Not susceptible to white ants, insects, salt, water, barnacles
- No adverse or significant leaching of chemicals
- Durable with no cracking or splitting and minimal UV damage
- Negligible reduction in strength after prolonged outdoor exposure
- Flexible – so more resistant to breakage in the field
- Can be cut, drilled, nailed, screwed, bolted, stapled and nailed hold well
- Consistent in size
- Smooth in finish and convenient to handle – no protective gloves needed
- Lightweight – easy to transport and handle
- No insulators needed for electrical fencing

(Advanced Plastic Recycling, 2006)

5.3 VOLUNTARY ENVIRONMENTAL LABELLING STANDARD

The Australian Eco-label Programme is an initiative by the Australian Environmental Labelling Association (AELA) encouraging the use of post industrial and post consumer material into new products. The voluntary standard specifies requirements for a range of plastics product sectors. These requirements include a minimum quantity of recycled content, restrictions on certain treatments of the product and plastic type information to be shown clearly.

The AELA created the standard through research into life cycle assessments, reviewing international eco-label standards, liaising with the Plastic and Chemical Industry Association (PACIA) and plastic stakeholders and then market testing the product. The standard takes into account product stewardship, ensuring the recycled product is of a high quality. A certified product will perform well for its intended application, however the producer must ensure the product meets the performance requirements for the relevant Australian or International standard.

The standard is applicable to the following categories:

Category	Description	Minimum Recycled Content (%)
2.9	Flexible packaging and sheeting, includes plastics bags and sheets, geo-textiles, tree protectors	30
2.1	Construction and road materials, includes all materials used in the construction of structures whether stationary or transportable, such as fencing, formwork, shingles or pavers	50
2.2	Traffic management products including signage, bollards, guide posts, car stops and speed humps	50
2.3	Produce containers: includes containers for agricultural produce such as eggs, fruit and vegetables	50
2.4	Non-food containers: includes all containers for non-food products such as detergent bottles, drums, recycling crates, mobile waste bins and pallets	50
2.5	Office supplies: includes all implements and containers for office use such as dispenser holders, transparency sheets and ring binders	50
2.6	Recreational equipment and outdoor furniture; includes all implements and support structures for the recreational market such as playground equipment, mats patio tables and chairs	50
2.7	General household products: includes buckets, clothes pegs, coat hangers and cutlery trays	75
2.8	Horticultural supplies: includes all products, containers, implements and support structures used in horticultural activities such as flower pots, trays, garden edging, wheel barrows and compost bins	75
2.10	Irrigation and agricultural equipment such as stormwater pipes, pipes and associated equipment used for transporting low pressure fluids including irrigation pipes and drainage pits/covers	90
2.11	Raw recycled plastic resin	100

6. REVIEW OF NATIONAL AND INTERNATIONAL POLICIES AND PROGRAMMES

6.1 AUSTRALIA (FEDERAL)

6.1.1 The Department of the Environment and Heritage

The main federal measure focused on the recycling of used plastics is the National Packaging Covenant and its associated programmes. In July 1999, ANZECC Ministers agreed to the *National Packaging Covenant.* The Covenant is based on the principles of shared responsibility, product stewardship and lifecycle management. Its main intentions are: to ensure costs are shared equitably; to close the recycling loop and develop economically viable and sustainable recycling collection systems. The Covenant encompasses the entire packaging chain including governments, producers, wholesalers, distributors, retailers, fillers and brand owners, who make the key decisions on design and characteristics of the packaging used for their products. An important component of the Covenant is the industry offer of $17.45 million, matched by funds from participating States and Territories, to develop sustainable market-based kerbside recycling collection systems.

Plastics and Chemicals Industries Association (PACIA) and the National Packaging Covenant

The Plastics and Chemicals Industries Association (PACIA) is the national representative of the plastics, chemicals, adhesives and sealants industries in Australia. PACIA members include companies from the entire supply chain from importers and distributors through raw material suppliers and chemical manufacturers to plastic fabricators and compounders (PACIA 2006b). Through promotion and representation of the industry, PACIA seeks to ensure that the economic value of plastics and chemicals industries is not overlooked.

PACIA is a strong supporter of the National Packaging Covenant and works in conjunction with partners in Industry, Federal, State and Local Governments to achieve the joint objectives. The areas where PACIA is in the National Packaging Covenant:

- Representing industry on and providing governance and administrative support to the peak National Packaging Covenant Council. This includes the review and re-structure of the Covenant itself.
- Representing industry on and providing governance and administrative support to the National Packaging Covenant Industry Association. This includes the collection and disbursement of funds to run the Covenants programmes, projects and secretariat
- Representing industry on the Committee responsible for the Environmental Cost of Practice for Packaging. This includes the recent review and re-writing of the Code and it's ongoing management
- Participation in the Review and Evaluation Working Group providing quality control support for signatory action plans
- Representing industry on State Project Groups in both Victoria and Tasmania
- Project management support to the National Projects Group for the Rigid Plastics Recovery and Recycling project

- Annual compiling and reporting the performance of plastics recycling in Australia with the PACIA Annual Plastics Recycling Survey. This is now the authoritative work for industry, governments, communities and academia in this important area.
- Development of a Code of Practice for Bio-degradable Plastics
- Development of a Resource Map for available materials and products
- Guidance to members on Action Plan development
- Litter Management through active participation on both the Victorian Litter Action Alliance as well as the New South Wales Litter and Illegal Dumping Taskforce
- Plastic bag management through participation on the National Working Party
- Improving expanded polystyrene recovery and recycling outcomes through REPSA (Recycled Polystyrene Australia)
- Improving vinyl recovery and recycling outcomes through the Vinyl Council of Australia

(PACIA, 2006b)

Environment Australia Biodegradable Plastics – Developments and Environmental Impacts - 2002

Environment Australia undertook a national review of biodegradable plastics with the primary aim of identifying and characterising emerging environmental issues associated with biodegradable plastics. It is designed to assist industry and the Commonwealth to develop initiatives to address these issues effectively.

Environmental Impact of End-of-Life Vehicles: An Information Paper - Department of Environment and Heritage - 2002

The purpose of this information paper is to help inform discussion by presenting facts and pertinent observations about the environmental impacts of end-of-life vehicles (ELVs). The paper provides information to help generate discussion about the nature and extent of any environmental impacts resulting from end of life vehicles (ELVs).

The potential of Market Based Instruments to better manage Australia's waste streams -. McLennan Magasanik Associates Pty Ltd and the BDA Group - 2003

The objective of this study is to assess the potential of market instruments to better achieve the goals of waste policy. The paper includes market mechanisms that provide direct or indirect monetary incentives to reduce waste or increase the level of recycling. It was shown under certain circumstances markets mechanisms may deliver outcomes faster and at lower cost than more prescriptive measures.

End-of-life Environmental Issues with PVC in Australia, ExcelPlas Polymer Technology (EPT) - 2003

ExcelPlas Polymer Technology was commissioned by Environment Australia to identify and characterise:

- Environmental issues and impacts associated with PVC products at end of life;
- The main impediments to addressing each of the above;
- Possible approaches and key characteristics of solutions to address each issue or impact.

The report identified the range, quantities and life expectancies of the major PVC products and applications. It identifies current producers and suppliers of PVC and characterises the end of life

environmental issues and impacts relating to PVC, including leaving the product in situ, mechanical recycling, landfilling, incineration and waste to energy conversion.

6.2 VICTORIA

6.2.1 EPA Victoria

Waste eXchange Database
The Waste eXchange Database is a free service offered through wastepro, a joint venture between the Victorian Environmental Protection Authority (EPA) and the Victorian Waste Management Authority (VMWA). The service aims to encourage the reuse, recycling and energy recovery of waste by allowing for communication between generators of waste and potential recyclers. The website allows both parties to advertise any wastes available or wanted (EPA Victoria & Victorian Waste Mangement Association, 2006)

Plastic Waste Resource Map
Victorian EPA and PACIA, have produced the Plastic Waste Resource Map of the plastic waste types, amounts and locations to enable more accurate business planning for recycling and recovery in Victoria.

6.2.2 Sustainability Victoria

PACIA and Sustainability Victoria – Industrial / Automotive Plastics Management Project
PACIA (Victoria) and Sustainability Victoria undertook research, which identified that industry is more prone to get information and be influenced from industry associations than from government. The Victorian government have therefore funded project managers at several industry associations, one being, PACIA.

Sustainability Victoria has liaised with a number of automotive manufacturers in the state to help them identify their environmental concerns. Both Ford and Toyota identified plastic waste as an issue. Plastic are increasingly used in automotive manufacturing. It was found that 90% of automotive environmental impacts occur during the use phase (due to emission). Plastics are lighter weight and improve fuel efficiency. Metals are energy intensive and costly to process when compared to plastics.

The key objectives of the projects are to:

- Collect pertinent data and make it available
- Increase Resource Efficiency
- Increase End-of-Life recycling and diversion of material from landfill
- Engage key stakeholders and raise awareness
- Develop project template models to be applied to other priority areas of plastics waste
- Provide a focus and resource for product stewardship in automotive/industrial plastics management

The project mapped out and quantified the plastics used in an average Australian car. It was found that polypropylene was the main polymer used in Australian car manufacturing, making up 39.2% of the total plastics weight.

The amount of plastics currently recycled from the automotive sector has been quantified during the last National Plastics Recycling Survey (PACIA, 2004). It was shown that pre-consumer automotive plastic recycling is low (4% of the total collected from the commercial / industrial sector). It was found that post-consumer recycling was much higher (22% of the total being collected from the commercial/industrial sector) due to battery case and number bar recycling.

A case study was also investigated involving Life Cycle Analysis of bumper bars. It was shown that close to 900 tonnes of plastic bumper bar material was recycled per year. The economics for bumper recycling is viable as the car component is made of a single polymer, polypropylene, which is often replaced by smash repairers. Heather Thurman, project manager mentioned that the repairers need to remove the damaged bumpers in the repair process, so labour cost is not an issue.

PACIA and Sustainability Victoria are currently investigating potential markets of used automotive plastics to make a timber replacement product to use for pallets. The idea came from an automotive component manufacturer who would like to replace their existing timber pallets with recycled plastic. There are also recycling companies interesting in using automotive plastics waste streams to develop new and improved recycled polymers. Heather Thurman comments that the hope is to 'close the loop' on the recycling so that these recycled plastics can be used in high value applications (like automotives) instead of low grade uses (such as plant pots etc.)

Silage Film Recycling Project

LLDPE plastic used for silage wrap is currently collected from three regions in Victoria. The unprocessed, contaminated film is collected and exported to Hong Kong to be reprocessed. However a number of problems have arisen as the material has been rejected by the Hong Kong markets due to high water and contamination issues. If the silage is rejected, the cost to transport the silage back to Victoria is incurred.

Sustainability Victoria is also undergoing trials to reprocess the film in Victoria to produce new plastic silage film. In addition, research into using plastic silage material to produce biodiesel is in process.

Resource Efficiency Measurement Grants

Sustainability Victoria offers Resource Efficiency Measurement Grants to companies. The grants ensure that these companies are aware of the true costs of their production process, as there are often inefficiencies that are overlooked or accepted. This included aspects such a energy and material use and waste management. Currently Sustainability Victoria is assessing the resource efficiency of automotive industry, which includes industrial plastics.

EcoBuy

ECO-Buy is a joint initiative of Sustainability Victoria - the delivery agency for the Government's Framework for Environmental Sustainability; the Victorian Greenhouse Strategy - the Department of

Sustainability and Environment's plan to reduce Victoria's greenhouse emissions and of the Municipal Association of Victoria - the peak body for Victorian local government.

The initiative encourages the purchasing of green products based on the simple premise that every product purchased impacts the environment. The website (www.ecobuy.com.au) gives consumers a choice to buy green over conventional materials which in turn causes less damage to the environment and human health. The site covers a wide variety of materials from building and construction to industrial plastics such as drums, moulded packaging, plastic containers and plastic film. ECO-Buy works with local government and business to progress along the green product continuum to purchase 'greener' products by targeting the following sectors in a products lifecycle:

- Source of raw materials
- Production & manufacturing
- Packaging
- Distribution
- Potential for reuse and recycling
- Operation
- Maintenance
- Disposal of the product

6.2.3 VISY Industrial Packaging

Oil Container Recycling Programme

VISY Industrial Packaging in conjunction with the Australian Institute of Petroleum and it's member (Caltex, BP Castrol, Mobil, Shell, Valvoline) have developed a recovery and recycling system for discarded plastic oil containers. Oily plastic containers are commonly not recycled using current method and are rejected by kerbside recycling programmes. At landfill, 10% of the oil is retained in the bottles and can contaminate soil, groundwater, rivers and streams in addition to drinking water.

A programme in Victoria has established 50 collection facilities at local waste transfer station. Consumers can take their used oil in the oil container. Oil recyclers take the used oil for reprocessing and reuse as fuel. VISY collects the plastic to produce post consumer recyclate for the use in agricultural and industrial grade products, such a drainage pipes and builders film.

Bialcrow Liquid Storage Solution (acquired by VISY Industrial Packaging)

Bialcrow offers its customers steel and plastic drum reconditioning and recycling. Bialcrow has pioneered the reuse of Intermediate Bulk Containers (IBCs) by adopting the latest technology. Recondition IBCs are now at a lower cost and are an environmentally sound solution for industrial packaging in Victoria. Bialcrow buys and collects a range of IBCs.

6.2.4 Armstrong World Industries

Armstrong World Industries – Green Building Challenge

Armstrong is a manufacturer of flooring product including vinyl, linoleum, carpet and wood. The company is introducing recycling practice in their manufacturing processes including the use of post-consumer PVC bottle which are sorted, cleaned and reground for the reuse into commercial flooring. The company also recycled HDPE shopping bags for use in products such as garden stakes and flooring.

In regards to post industrial plastic waste, Armstrong World Industries manufactures scrap industrial plastic material at various points of the manufacturing process. The company sorts the material by type and colour. Plastic material is then granulated, recycled and used in Cryovac food packaging that saves 100 tonnes of plastic waste landfilled each year in Victoria. Armstrong also collect plastic scrap from building sites, which is returned for recycling into new commercial flooring. Armstrong World companies are also trialling a system to return flooring at the end of life (Armstrong World Industries, 2006).

6.3 SOUTH AUSTRALIA

6.3.1 ZeroWaste South Australia

Review of Recycling Activity in South Australia

Zero Waste SA reviewed the current recycling activity in South Australia and identified future expansion priorities. Stage 1 identified the total tonnes of material collected and recycled each year in South Australia (on a materials by materials basis). Stage 2 involved an analysis of products and their materials. The report identified a number of barriers and the potential to increase the re-use and recycling of a number of industrial plastic products including flexible plastic freight packaging, freight packaging pallets, cars, carpet and piping.

Reuse and Recycling Infrastructure Grants

A number of grants have been awarded to increase the recovery and use of commercial and industrial waste materials. One of the key targets of the SA State strategy is for the 30% increase in the recovery and use of commercial and industrial materials by 2010. The grants have been initiated to invest in infrastructure to achieve this target. The grants have stimulated investment by industry for infrastructure.

Plastics Granulating Services

Plastics Granulating Services (PGS) were awarded a $250,000 grant for a consumer and industrial plastic capacity upgrade. PGS is the largest processor of post-consumer plastics in South Australia. The grant was used to acquire and install an extruder, washing plant and compaction press to process more difficult industrial plastic waste streams including heavily soiled plastic films and plastics containing high moisture levels.

The Zero Waste SA grant enabled Plastics Granulating Services to provide recycled resin from low quality disposed plastic waste products such as packaging waste, used agricultural pipe, silage wrap and potentially, polypropylene woven sacks. The resin will be used to produce irrigation pipe,

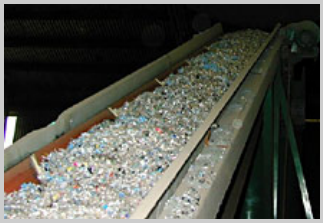
packaging film and mouldable products and diverts 6000 tonnes of industrial plastic waste from landfill (Zero Waste SA, 2006).

Advanced Plastics Recycling

Zero Waste SA awarded a grant of $250,000 in 2005 to enable Advance Plastics Recycling to invest in new equipment which doubled the companies capacity to process mixed waste into recycled plastics products such as bollards and posts. The 1000kg/hour extrusion machine ensures that the company no longer rejects significant amounts of waste plastic material, which would previously be landfilled.

The Advanced Plastics Recycling (APR) Technology Process

The APR process takes all post household, commercial and industrial plastic waste. All waste plastics are mixed together and fed through a processor. The process operates without sorting, washing or cleaning. Impurities such as metals, sand and grit are removed, however some contamination can occur with materials such as aluminium and paper.


The mixed plastics are granulated and processed into an agglomerate. When heated, the mixed plastics are pumped or pressure filled into a mould and water is then used to cool the product. The range of products that can be manufactured using this process is diverse and can include:
Warf beams, retaining walls, plastic lumber, parking lot stops, bollards, fence posts, oyster bed poles, electric fence posts, outdoor furniture, decking, electric power poles, pipe supports, high guard posts, railway sleepers, septic tanks, pallets, man hole covers and surrounds, sound barriers and baffling.



The resultant product has a number of advantages over wood and metal products.
(Advanced Plastic Recycling, 2006)

Research and Market Development Grants

Zero Waste South Australia have also investment money in research and development of new products specifically adding materials to recycled plastics to increase the strength of products. The investment involves marketing plans for the products.

6.4 NEW SOUTH WALES

6.4.1 Department of Environment and Conservation

Waste Avoidance and Resource Recovery in NSW – A progress report 2004

Commercial and Industrial Waste Audit 2003

The Department of Environment and Conservation (NSW) undertook a disposal –based audit of 14,000 tonnes of commercial and industrial waste disposed at 16 landfill facilities and transfer stations in the Sydney Metropolitan Area. The audit showed that plastic was a major category by volume. Quantities were made up of a wide range of polymers in a plethora of forms and products (Department of Environment and Conservation, 2004). The major component was plastic film in the form of shrink wrap and other sheet film.

Commitments from sectors and organisations

In new South Wales, PACIA has announced a commitment to the elimination of plastic waste from landfill using supply chain stewardship to achieve this. In addition, the drumMUSTER program found that the recovery rate of chemical drums was 24%.

NSW Extended Producer Responsibility Priority Statement for 2005-06

The NSW Extended Producer Responsibility Priority Statement for 2005-06 identifies End of Life Vehicles residuals or 'shredder floc' as a major waste stream that is disposed of to landfill. More than 100,000 tonnes of shredder floc are generated in NSW each year, with a considerable amount being plastic waste (Department of Environment and Conservation, 2005). The DEC has been asked to provide advice on regulatory and other options to reduce the amount of shredder floc that is disposed of in NSW.

The Extended Producer Responsibility Priority Statement also identifies PVC as one of seventeen targeted wastes of concern. The Vinyl Council of Australia (VCM) is committed to reducing the toxicity of stabilisers and plasticisers by phasing out the use of cadmium stabiliser and limiting the use of lead stabilisers.

6.4.2 Plastic Industry Pipe Association of Australia Ltd (PIPA)

Plastic Pipe Recycling Trial

PIPA negotiated with Sydney Recycling Centres operated by Collex to extract waste plastic pipes from construction and demolition waste delivered to the Banksmeadow Centre. Three 20m^2 bins of plastic waste pipes were collected (Pesudovs, 2005).

Four Sydney recycling centres processed approximately 8,000 tonnes of construction and demolition waste per week. Approximately 15% is sent to landfill after the metals, concrete and timber products are recycled (Pesudovs, 2005). The objective of the trial was to recover plastic pipes from the waste that would be eventually sent to landfill. It was found that the majority of pipe was not contaminated with other materials such a metal brackets. It was also found that the PVC pipe would require little

cleaning which allows them to be granulated, micronised and reprocessed into new pipe or sold as reprocessed resin (Pesudovs, 2005).

6.5 UNITED STATES OF AMERICA

There appears to be little US Federal legislation relating to industrial plastic waste. However, there are different regulations within each of the states that promote plastic waste recycling. The areas of New England and California have been examined closely to determine the policies that have been implemented or are being considered to increase the recycling of plastic waste.

6.5.1 Massachusetts

The Commonwealth of Massachusetts Department of Environmental Protection have implemented a waste disposal ban (310 CMR 19.017: Waste Disposal Ban Regulation) to prevent the disposal of certain waste materials to landfill including single polymer plastics. The 2006 Solid Waste Master Plan summarises the waste streams that will be targeted, and although this includes organic waste, paper and cardboard, plastics are not highlighted in the Master Plan and no initiatives are aimed at the plastics wastes stream (Commonwealth of Massachusetts, 2006).

However, the use of recycled plastics is promoted with the Environmentally Preferable Products Procurement Program (EPPPP), specifically the use of plastic lumber which is most commonly manufactured from recycled high density polyethylene (HDPE), but linear low density polyethylene (LLDPE) and low density polyethylene (LDPE) are also used. These plastic feed stocks are derived from such raw materials as post-consumer milk jugs, soda bottles, grocery bags, plastic wrap, bubble rap, detergent bottles, and water bottles, and other used plastic commodities. The Commonwealth of Massachusetts is using plastic lumber instead of timber for the production of children playgrounds and street furniture. The use of the recycled plastic content products that is required under the EPPPP provides a market for the recycled plastics.

6.5.2 California

California does not appear to have any regulation or policy specifically focused on industrial plastics; instead plastics are grouped as a single waste stream whether they are post consumer or post industry plastics.

In California plastics production continues to far outpace plastics recycling, and it is displacing other more recyclable materials. As a result, plastics in municipal solid waste continue to grow rapidly, and plastics represent the fastest growing portion of the municipal solid waste stream. Plastics represent approximately 8.9 percent (by weight) and an estimated 17.8 percent (by volume) of the material disposed in California landfills. This ranks plastics as the second-largest category of waste volume (behind paper) going into municipal landfills (CIWMB, 2003).

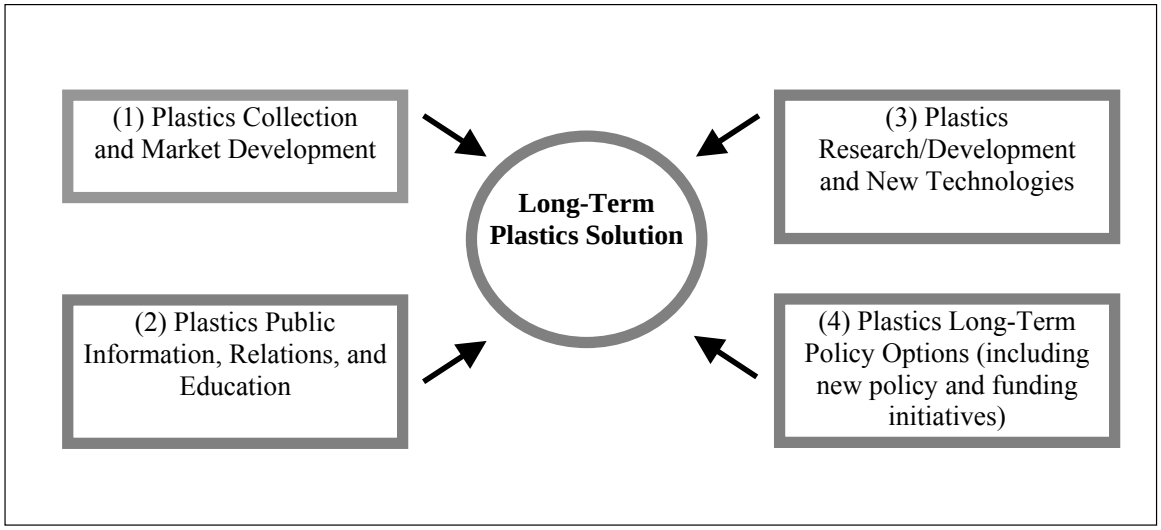
The plastics recycling rate has stagnated at a low level, and plastic recycling quantities and rates remain lower than other materials such as steel, aluminium, glass, and paper. Plastics “bottle-to-bottle”

recycling historically has been miniscule compared to other secondary material closed-loop recycling. Closed-loop recycling means that the specific material recycled is used to manufacture the same product again. Plastics historically have been uneconomical to recycle in California without subsidies (average collection and processing costs exceed scrap values by more than 250%). Plastics are generally not as economic to recycle as other material types, and plastic recycling costs could rise further due to the proliferation of different plastic containers. Higher plastic recycling rates come at a high cost, and higher than that for other material types.

California has four major existing environmental laws that relate to plastics. Three of the laws, the California Integrated Waste Management Act (IWMA), the Rigid Plastic Packaging Container (RPPC) Act, and the "Plastics Trash Bag Law" are under the jurisdiction of the CIWMB. The fourth law, the California Beverage Container Recycling and Litter Reduction Act of 1986 ("Bottle Bill,") is under jurisdiction of the Department of Conservation. In the Plastics White Paper, *Optimizing Plastics Use, Recycling, and Disposal in California* (CIWMB, 2003) it was concluded that these four laws, both individually and combined, are flawed with regard to effectively managing California's plastics. Hence, the State's plastics issues are not being adequately addressed.

The Plastics White Paper outlines the future policy in California to improve plastic recycling and includes a long-term approach to promoting plastics resource conservation, increasing plastics recycling, and increasing the use of recycled plastics has four key components. Three legs of the solution are policies for: (1) plastics collection and market development, (2) plastics public information, public relations, and public education, and (3) plastics research/-development and new technologies. These three policy legs are supported by a fourth new long-term plastics product stewardship policy framework. This framework includes funding initiatives to finance programmes in the first three areas.

Figure 6.1: The Four Key Components of California's Long-Term Plastics Solution



A number of recommendations were made to improve the recycling of plastics in California and a summary of those that are applicable to industrial plastics include:

1. *Provide additional funding and research support for collection and processing technology development*. Emphasise efforts that will improve the quality of incoming materials and increase throughput (for example, automation of processing lines). This policy could support research, pilot projects, and equipment purchases. An important aspect is that the policy should not jeopardise or put existing recyclers at a competitive disadvantage. One option is to provide a payment to recyclers and processors, based on tons of plastics recycled, with the funds to be used for specified purposes. The recipient would be responsible for reporting recycling quantities and how the funds were used. This funding policy could be directed at plastic beverage containers, as well as other plastics collection such as film and polystyrene. These funds would be provided in addition to funding research at universities and other institutions.
2. *Develop and disseminate "best practices" in collection and processing systems to further support the economical collection of clean plastic streams.*
3. *Provide loans and grants for the purchase of collection and processing equipment such as automated lines, washing systems, etc.* This policy would have to be implemented carefully to avoid putting companies that have already invested in such equipment at a competitive disadvantage.
4. *Develop plastic material quality standards for recycled plastics (with an industry working group).* Refine and promote quality standards for recycled plastics and design the material for recycling. These standards should allow recyclers to grade their materials and reduce the number of loads that are turned down by manufacturers because they do not meet standards.
5. *Develop and publicise a list of recycled-content and environmentally friendly plastic products for State and local government procurement*. In addition, publicise the list more broadly; for example, to large companies and consumers.
6. *Provide support for and undertake forums and workshops on plastics initiatives, including promising and significant plastics technologies.* These could include plastics conversion technologies, biodegradable plastics and composting, auto shredder plastics recycling, commingled/mixed plastics processors for recycled value-added products, and many others to be determined.
7. *Support plastics conversion by addressing the barriers that limit further commercialisation of plastics conversion technologies*. This includes technical and financial assistance with (1) financing for commercial-scale plastic conversion facilities, (2) large-scale plastic collection practices, (3) permitting plastics conversion and other new facilities, and (4) further statutory and/or regulatory relief, as appropriate, or required.
8. *Provide government stimulation to address the current price differential between petroleum-based plastics and biodegradable plastics.* This differential is likely to hinder the growth of biodegradable packaging and other applications in the short-term. The CIWMB and the Department of Conservation need to consider ways to help narrow this price differential now, including the use of research and development tax credits or other jump-start subsidies.

6.6 CANADA

The information provided below has been sourced from the Environment Canada, the Greater Vancouver Regional District and the Government of Nova Scotia websites.

The Canadian Federal Government does not regulate industrial plastic waste, all regulation and policy is developed at a regional level. Two examples of regional policy from the Great Vancouver Regional District and Nova Scotia are summarised below and focus on the use of landfill bans and product stewardship in facilitating plastic recycling.

6.6.1 Great Vancouver Regional District

The Greater Vancouver Regional District is a partnership of 21 municipalities and one electoral area that make up the metropolitan area of Greater Vancouver. The Greater Vancouver Regional District have a number of targets and strategies to minimise waste disposal and encourage waste recycling, including waste bans, recycling collection schemes and product stewardship programmes. However, none of these initiatives are focused on industrial plastics. Indeed industrial plastics are not a waste stream that is being targeted by the Greater Vancouver Regional District for recycling, therefore there are no initiatives that can be included in this policy review.

6.6.2 Government of Nova Scotia

Nova Scotia is a province of just over 900 000 people. In 1989, it generated 622 000 tonnes of municipal solid waste, much of it incinerated in open dumps. There was virtually no recycling or recovery of resources from municipal solid waste. While Nova Scotia has no policy focused on industrial plastics, their general strategy has four main goals:

- 50% diversion of municipal solid waste by the year 2000
- Increased environmental standards
- Regional cooperation
- Increased economic opportunities

Waste ban legislation and product stewardship programmes are impacting on the current and future recycling of general plastics in Nova Scotia. Currently, PET, HDPE and LDPE is recovered and recycled, due to bans on the disposal of these plastics. Since the bans were introduced, Nova Scotia has seen its volume of recovered plastic waste increase dramatically. A plant to recycle the PET plastic recovered in New Brunswick and Nova Scotia has been built. This plant will be able to sell recycled feedstock directly back to the plastic industries already in the province (NSEL, 2004).

6.7 UNITED KINGDOM

The information provided below has been sourced from European Union, Wastewatch, RECOUP, WRAP and other United Kingdom based websites, together with a telephone conversation with Andrew Simmons (CEO) from RECOUP and emails with Paul Davidson from WRAP.

Generally packaging is the largest category of waste plastics in Europe, and of this, about 65% is domestic packaging and 35% is from commercial and industrial sources. The majority of packaging plastics is film (50%), production line scrap and rejects (15%), crates & pallets (10%), and the reminder is made up of container drums, expanded polystyrene, etc (Simmons, 2006).

6.7.1 Legislation

6.7.1.1 Packaging Directive

Legislation that is particularly relevant to plastics includes the 1994 European Union Directive on Packaging and Packaging Waste 94/62/EC (the Packaging Directive), which aimed to establish producer responsibility for packaging waste. The directive was implemented in the United Kingdom through the Producer Responsibility Obligations (Packaging Waste) Regulations 1997 and the Packaging (Essential Requirements) Regulations 1998. The former sets targets for the recovery and recycling of packaging wastes, including plastics packaging waste. These targets are currently being revised by the European Union. The United Kingdom government has recently published the national packaging recycling and recovery targets for 2006 and beyond. These require 23% of plastics waste to be recovered by 2006, rising to 25.5% by 2010. The targets apply to commercial and industrial plastic packaging, as well as post consumer plastics.

The Packaging and Packaging Waste Directive aims to harmonise measures concerning the management of packaging and packaging waste and in particular, obligates the United Kingdom to meet targets for the recovery and recycling of packaging waste. The Directive covers all packaging placed on the Community market. Targets are set as a percentage of packaging flowing into the waste stream.

The Directive:

- Sets targets for recovery and recycling
- Requires the encouragement of the use of recycled packaging materials in the manufacturing of packaging and other products
- Requires packaging to comply with 'essential requirements' which include the minimisation of packaging volume and weight, and the design of packaging to permit its reuse or recovery
- Requires the implementation of measures to prevent packaging waste in addition to preventative measures under the 'essential requirements', which may include measures to encourage the re-use of packaging

The United Kingdom Government originally introduced targets in 1997, to be met by 2001. More recent targets have been agreed by the European Union, to be met by the 31st December 2008. The overall recovery target is set at 60%, with a recycling target of between 55% and 80%. Material specific targets for each packaging material have also been set: 60% for glass, 60% for paper, 50% for metals, 22.5% for plastics and 15% for wood.

The United Kingdom has a number of regulations that target industry sectors rather than the specific industrial plastic waste stream.

6.7.1.2 Automotive Sector

By volume, cars today contain a larger proportion of plastics than any other materials. The specific properties of plastics, which include strength yet light weight, versatility and flexibility, have led to plastics being used to a much greater extent in vehicle manufacture. Due to their light weight, plastics account for an average of only 9.3% (105kg) of the total weight of a vehicle (APME 1999).

The End-of-life Vehicles (ELV) Directive (2000/53/EC) came into force in October 2000. The Directive aims to reduce the amount of waste from ELV and sets the following targets for recycling and recovery:

Year	Recovery	Recycling
	% of vehicle weight	
2006	85%	80%
2015	95%	85%

It should be noted that these targets do not specify which materials are to be recovered and recycled, but may include metal, plastics, rubber and glass. In addition, the directive:

- Requires EU member states to ensure that ELV can only be scrapped ('treated') by authorised dismantlers or shredders, who must meet tightened environmental treatment standards
- Requires economic operators (this term includes producers, dismantlers and shredders among others) to establish adequate systems for the collection of ELV
- States that last-owners must be able to return their vehicles into these systems free of charge from January 2007
- Requires producers (vehicle manufacturers or importers) to pay 'all or a significant part' of the costs of takeback and treatment from January 2007 at the latest
- Sets rising re-use, recycling and recovery targets for economic operators
- Restricts the use of heavy metals in new vehicles from July 2003

6.7.1.3 Electrical and Electronics Sector

In the broadest sense, electrical and electronic equipment refers to any product that relies on batteries and/or electricity for operation, as well as equipment that transports electricity to the product, such as wire and cable. There is a wide range of products defined as electrical and electronics equipment, such as mobile phones, household appliances, electric tools and IT equipment.

Plastics are used in electrical and electronic appliances because they are durable, lightweight, cost-effective, corrosion-resistant and have excellent insulation properties (APC 2000). In 1980, on average, plastics made up 15% by weight of all electrical and electronic equipment. By 2000, this had risen to over 20% (APME 2001).

Waste Electrical and Electronic Equipment Directive is planned to come in to force in the United Kingdom around November 2006. The purpose of this directive is to reduce the amount of waste electrical and electronic equipment requiring disposal. It aims to increase re-use, recycling and other forms of recovery of such wastes and to minimise their environmental impact. The broad objectives of the directive are:

- Separate collection of waste electrical and electronic equipment
- Treatment according to specified standards
- Targets for recovery and recycling (table 10) to be met within forty-six months of the directive coming into force
- Producer pays from collection onwards

- Retailers to offer free take-back
- Consumers to return waste electrical and electronic equipment free of charge

6.7.1.4 Building and Construction Sector

The building and construction sector is the second largest plastics user after the packaging sector and is an important growing market for plastics (APME 1998a). Compared to other materials used in the building and construction industry, the percentage of plastics used in this sector is relatively small (less than 1% by weight).
However, they form part of a wide variety of applications. Approximately, 0.8 million tonnes of plastics are used per year in the United Kingdom much of which does not enter the waste stream for many decades.

There is currently no legislation directly relating to the recycling of plastics from the building and construction sector. However, the Producer Responsibility Obligation (Packaging Waste) Regulations 1997, discussed above, will apply to packaging waste arising from this sector.

6.7.1.5 Agricultural Sector

The use of plastics has grown in the agricultural sector and covers a range of applications. Plastics are used in products such as packaging, permanent/semi-permanent buildings, crop covers, irrigation systems and tools and equipment.

The government has recently extended existing waste management controls to include waste from agriculture in the implementation of the EC Framework Directive on Waste. This has introduced a waste management licensing system, a legal duty of care and a registration system for businesses transporting waste. Waste disposal on farms will no longer be possible without a waste management licence or exemption.

6.7.1.6 Future European Legislation

The current European legislation targeting plastics is applied through EC Directives that target different commercial sectors (e.g. Automotive), however, future Directives are may focus on material or waste streams, rather than industry sectors.

6.7.2 Financial Factors

6.7.2.1 Packaging Waste Recovery Notes (PRN)

The Packaging Waste Recovery Note (PRN) or Packaging Waste Export Recovery Note (PERN) is a tradeable certificate used to record and identify packaging waste materials received for recovery or recycling. PRNs/PERNs are controlled by the regulatory bodies, The Environment Agency, SEPA and the Environment and Heritage Service.

Businesses who are obligated to recover and recycle packaging under the Packaging Regulations must

obtain PRNs/PERNs as proof that they have achieved their targets and therefore achieved compliance with the regulations. These can either be obtained through joining a Compliance Scheme or by dealing direct with accredited packaging reprocessors.

When an accredited reprocessor recycles a tonne of packaging waste, it can issue a PRN. The PRN is then available to be bought on the open market as evidence that a tonne of that particular material has been recycled. Companies calculate their obligation under the Packaging Waste Regulations, and purchase the equivalent number of PRNs to demonstrate that they have met their obligation.

PRNs/PERNs are purchased against the amount of packaging sent for recovery or recycling. They are traded and so have a market value. PRNs are issued relating specifically to the material that has been recycled. As with many other commodity markets, the value of PRNs and PERNs does fluctuate. The balance between supply of and demand for PRNs/PERNs can have a dramatic effect on their value, i.e. when there are many plastic PRNs/PERNs available, the price will be low and similarly, when PRNs/PERNs are in short supply, the price will rise, in the last 12 months the value of plastic PRN's has been between £20 – £80 ($50 - $200) per tonne (Letsrecycle, 2006).

The money that a reprocessor receives for a PRN is then reinvested into the reprocessor's business, contributing to the growth of recycling infrastructure in the UK. This current system guarantees a continuous stream of investment flowing into packaging recovery and recycling.

6.7.2.2 Landfill Tax

The United Kingdom has used taxation policy with The Landfill Tax Regulations, 1996 to increase the cost of waste disposal and therefore improve the economics of recycling. To increase the cost of plastic waste disposal there is a landfill tax of £21.00 per tonne (approximately $50.00 per tonne). The United Kingdom government has stated that the landfill tax will increase by at least £3.00 per year up to £35.00 ($85.00) per tonne (DEFRA, 2005).

6.7.3 Programmes

The United Kingdom has a number of organisations and programmes to facilitate minimising plastic waste production and increase recycling. The most significant organisations include the Waste and Resource Action Programme, Envirowise and Recoup.

6.7.3.1 Waste and Resource Action Programme (WRAP)

In order to encourage market and manufacturing development for recycled materials, the United Kingdom Government has established the Waste and Resources Action Programme (WRAP) whose task is to promote sustainable waste management by creating stable and efficient markets for recycled materials and products, including plastics. A number of objectives have been identified for plastics in the WRAP 2006-2008 Business Plan, as summarised below.

Manufacturing development will focus on identifying a small number of significant projects where a major shift in material use from virgin to recycled can be achieved. Early objectives already identified are:

- To include up to 30% of recycled HDPE in the manufacture of one quarter of the United Kingdom's plastic milk bottle production. This will involve capital support for new equipment and work with local authorities to increase collection of plastic bottles
- To include up to 50% of recycled PET in selected plastic food containers and up to 30% in plastic bottles, building on our successful trials with Coca- Cola Enterprises Ltd., and Marks & Spencer

To deliver these projects, WRAP will combine grants with technical advice and support to provide assurance on the performance characteristics of recycled materials in comparison with virgin materials. WRAP will also highlight potential to reduce carbon emissions through recycling and reduced energy use, making the business case through energy cost savings as well as environmental benefit. In some areas, such as large-scale use of recycled HDPE in milk bottles, this work involves world leading technology and provides great opportunities for major shifts from virgin to recycled material use (WRAP, 2006).

6.7.3.2 Envirowise

Envirowise delivers a government-funded programme of free, confidential advice to United Kingdom businesses. This assistance enables companies to increase profitability and reduce environmental impact.

Independent, practical and proven guidance is available through a free helpline, on-site visits delivered by a nationwide team of expert advisors, information resource from case studies to best practice guides, over 200 events a year, from intimate seminars to major exhibitions and a website(www.envirowise.co.uk). Envirowise solutions are driven by the specific needs of individual firms, to genuinely improve their business practices, profitability and competitiveness. Since 1994, Envirowise has helped United Kingdom industry save more than £1.3 billion. The Envirowise programme is available to any United Kingdom business, completely free of charge.

Envirowise allows companies to receive free confidental visits that provide expert advise to minimise the waste produced be improving the efficecy of the manufacturing process, and providing information about collection and recycling services for the wastes that are still produced, including industrial plastics.

ENVIROWISE ~ CASE STUDY

This Action Profile outlines the benefits to a company of having a structured framework for reducing waste and improving environmental performance. McKechnie Plastic Components responded to supply chain pressure by appointing an environmental co-ordinator in 1998 to develop an accredited environmental management system (EMS). The success of this approach surprised the company which was able to make considerable cost savings through simple environmental improvements and reducing waste. The EMS is now an integral part of the business and the company uses it to help set goals for on-going cost reductions. From the targets set in 2001, cost savings are estimated at £93,400 per year.

Source: Envirowise (2006)

6.8.1.1 Recoup

Recoup is the United Kingdom's leading authority on plastics waste management, providing expertise and guidance to a wide range of clients across the plastics supply, use and disposal chain. Recoup is built on a network of members and associated organisations across all sectors involved in plastics manufacture, use, disposal and recycling. Recoup works with many other leading international plastics recycling organisations to ensure that it stimulates the implementation of latest best practices and developments world-wide.

Historically Recoup's core funding has come from the packaging industry through voluntary membership payments. This has also been supplemented by income from public sector grants (e.g. EU LIFE scheme), the landfill tax credits scheme, consultancy and defined sponsorship deals. Recoup also has a trading subsidiary that trades plastics for recycling and the profits generated are used in non-profit programmes.

Recoup works to maximise efficient plastics recycling. It does this by activities in the following areas:

- Stimulating the development of sustainable plastics waste management, especially the development of plastics recycling schemes across the United Kingdom
- Undertaking research and analysis to identify good practices and remove barriers to the development of efficient plastics recycling systems
- Providing expert technical support, training and consultancy services for the development of efficient plastics recycling schemes for local government and waste contractors
- Promoting the use of recycled plastics in high quality end products

- Providing strategic guidance, training and consultancy services to plastics supply chain businesses on the commercial opportunities and risks resulting from a growth in recycling and associated legislation
- Representing the interests of the plastics recycling supply chain to National Government and other key stakeholders and lobbying for improved national approaches and allocation of finance

Recoup works primarily on projects in the United Kingdom and also provides consultancy services to support international programmes (Recoup, 2006).

7. BARRIERS AND ISSUES RELATING TO INDUSTRIAL PLASTIC RECYCLING

The following section outlines the barriers to increasing industrial plastic recycling in Western Australia's manufacturing and recycling industries. Discussions with key stakeholders from both industries identified the main barriers as outlined in the following sections.

7.1 INDUSTRIAL PLASTIC MANUFACTURERS

7.1.1 Technology

Characteristics of Plastics

The characteristics of plastics affect the ability of the material to be recycled. Plastics are made up of a range of difference synthetic and organic compounds. Each compound brings with it differing physical and chemical properties, which determines their ability to be reprocessed.

There are two types of plastics: thermoplastics and thermosets. Thermoplastic include the seven recyclable plastic types as outlined in section 2. If thermoplastics are not mixed, they can be repeatedly softened and hardened without seriously damaging the property of the resin (Industry Commission, 1991). Thermosets include epoxy melamine, unsaturated polyesters, urea-formaldehydes resins and phenolic. Polyurethane foams are usually considered to be thermosets, but have some characteristics similar to thermoplastics. Thermosets can not be heated and reformed into new products as their structure prevents the movement of their molecular chains beyond a certain point (Industry commission, 1991). However, thermosets can be ground into a very fine powder, which is then mixed into new resin in a moulding process.

Infinite recycling of the same plastic material is technically impossible as reprocessing and contamination generally degrade plastic polymers and adversely affect characteristics such a durability and dimensional stability (Industry Commission, 1991). Degradation of some of these properties can be minimised by incorporating virgin material, by making the product thicker or by co-extrusion.

Characteristics Recycled Resin

Reprocessed resins can vary significantly from batch to batch. Industrial plastic products can often contain a number of different polymers (polymer compounding), dyes and other additives, which affects the resultant strength, melt flow index, colour, and contaminant level of the reprocessed resin. These properties can cause processing and quality problems for manufacturers of industrial plastics. It is difficult for manufacturers to predict how recycled resin will interact with the manufacturing process. As the manufacturing process relies on the properties of plastics, any variations in the resin will impact significantly on the manufacturing process and hence the quality of the end product. Use of recycled resin can lead to problems such as environmental stress cracking (ESCR).

Many products use a mix of polymers and additives. Polyvinyl Chloride (PVC), for example, is rarely used as a virgin resin and relies on stabilisers and additives to derive the required characteristic. These additives significantly impact the recyclability of the product and ability for it to be manufactured into another product.

Design of product

A number of plastic manufacturers are not focusing on the design and manufacturing stage of the product. More attention needs to be placed in influencing the design of product, which has a major impact on the amount, environmental impacts, and ease of recovery of wastes that will be generated throughout its life. Companies need to be better aware of the true costs of their production processes. There are often inefficiencies that are overlooked or accepted which results in waste that could possibly be prevented if more time was spent on improving the design of manufacturing process.

7.1.2 Economic

Cost of virgin resin vs. recycled resin

Depending on the product and process, virgin resins account for between 28 and 54 per cent of the costs of industrial plastic manufacturing (Industry Commission, 1991). The cost of resins therefore significantly impact on the cost of the manufacturing process. Due to the known properties of virgin resin and the low risk of using the material, manufacturers would continue to choose virgin resin over the recycled plastic resin.

Cost of technology

Co-extrusion technology enables multiple materials to be combined in a unified structure. This multilayer structure can incorporate the use of recycled plastic. However, co-extrusion technology comes at a price. Up-front costs include additional extruders and cooling technology, additional floor space and higher tooling and adaptive costs. There are also ongoing costs such as including commingling scrap and increase levels of process complexity. Also because of the increased complexity of this technology, there is often need for experienced factory staff (O'Connor, 2005).

Production Time

Manufacturing costs are dependent on production time. Processes that include the use of reprocessed resin significantly impact on production time. Any variation in production time could impact on the cost of the product, competitiveness and hence the profitability of the company.

Quantity guarantee

Industrial plastics products are manufactured in high quantities. Manufacturers therefore require a constant supply of resin for their operations. The plastic recycling industry can not guarantee a constant supply of recycled resin due to a number of factors such as the lack of coordinated collection systems.

7.1.3 Quality and Regulations

Industrial Plastic Standards

Australian standards exist which can define the properties required for number industrial plastic products. SAI Global publishes a number of standards and draft Australia standards that refer to the general test methods and definition for plastic products. A search indicates that there are 340 references to standards for rubber and plastic products. Some standards restrict the use of reprocessed resin in certain products. For example, AS2070 specifies defines the use of plastic materials for food contact use. The standard specifies materials and the procedures for use during the various stages of production of plastic materials, coating and printing of plastic items for food contact and subsequent use. This includes such items as packages, domestic containers, wrapping materials, utensils or any other plastic items intended for food content applications.

Product Specifications
Retail companies who sell industrial plastic products specify the quality and properties of the product to the manufacturer. The retailer demands certain characteristics such as quality, strength, shape and colour that may restrict the use of reprocessed resin.

7.1.4 Social

Re-use Collections
When considering industrial plastics for re-use, a number of items are lost in the re-use cycle. There is often confusion among users on the ownership of the product (for example: plastic pallets) and where they can be returned. Products are often 'stolen', for example, milk crates are lost in the re-use pool and limit the availability of the product to be re-used. Viscount plastics replaces 10% of all crates used in Western Australia. The company state the almost 4 million milk crates per year are replaced, due to a high number being stolen.

In-house knowledge
Many people who work in the commercial and industrial sector do not know that recyclers can accept their plastic waste. There is considerable amount of plastic waste going to landfill that could be sent to a recycler.

Willingness to change
Many plastic manufacturers are unwilling to use recycled resin in their operations. There is a fear that recycled polymers are not safe due to their unknown properties. Unknown properties of recycled plastics can alter the manufacturing process and quality of the end product.

7.2 INDUSTRIAL PLASTIC RECYCLERS

7.2.1 Technology Barriers

Polymer Compounding

Polymer compounding is the activity of mixing a base resin with colour dyes, additives or other types of resins. Polymer compounding is undertaken to derive the required performance or colour for the end users finished product. The practice of polymer compounding means that industrial plastic recyclers find it difficult to supply reprocessed resin that is similar to virgin resin. Manufacturers require resin that is to the consumer's specification for example: specific colour and single polymer types. It is technically difficult to separate polymer types and remove additives and dyes. Polymers are generally too viscous to economically remove fillers and would be damaged by many of the processes that could cheaply remove the added dyes.

Industrial Product Properties

Some industrial products are complex and hard to deconstruct. A car dashboard, for example, may contain several plastic types, foam and bonding agents. In addition, a major proportion of the industrial plastic market comprises long-term applications with life expectancies greater than 10 years and evens 50 years or longer depending on the use of the product. This is evident in the building and construction sector where product such as PVC pipe are made to last. Products that are used long term mean that there is not a constant supply of plastic to the recycling industry.

Product Contamination

Industrial plastics can be hard to recycle as some are too contaminated. The cleaning phase during recycling is costly and this effort and cost may outweigh the financial benefits of recycling the material. Plastic silage wrap, for example, is sticky and a large amount of organic feed stays on the wrap. In addition, plastic can carry a lot of moisture, soil and other organic contaminants.

Technological Change – Biodegradable plastics

Research and development initiatives in Australia and overseas are expected to lead to greater use of biodegradable plastics (Industry Commission, 1991). The perception among many of the industrial plastic stakeholders is that it will not solve all of the problems associated with the disposal of industrial plastic waste but could achieve a reduction in quantities going to landfill.

There is industry concern that the use of biodegradable plastics will adversely affect plastic recycling by threatening the physical integrity of products made from reprocessed plastics (Industry Commission, 1991). Another concern is that the use of degradable products may encourage people to litter

7.2.2 Economic

Competition with landfill

The cost to dispose of industrial plastic waste to landfills in Western Australia is currently very cheap and encourages the disposal of used industrial plastics rather than the recycling of the material.

Many recycling companies are offering a free collection service to obtain plastic waste from manufacturing companies in order to compete with the disposal of plastic to landfill. Some recycling companies are even paying for plastic waste.

It is estimated that plastics account for 8% by weight of industrial waste disposed each year. The practice of assessing the costs of landfilling in terms of weight rather than volume understates these costs in the case of bulky articles such as industrial plastics. Plastic has around twice the volume relative to weight of aluminium cans, and four time that of glass (Industry commission report). This can results in an underestimation of the savings in landfill if plastic containers are re-used or recycled.

Cost of virgin resin vs. recycle resin

Recycled resin prices are comparable to virgin resin prices due to cost for recyclers to collect, sort and reprocess plastic waste. There is a perception among purchasers of reprocessed resin that virgin resin is of better quality than reprocessed resin. Manufacturers tend to choose virgin resin due to the known properties of the material and conjunction with the low risk of using the resin. The lack of demand for recycled resin means that recycling companies are finding it difficult to continue to make a profit.

Cost of collection and reprocessing

Information provided by industry indicated that collection costs account for between 30 and 40 per cent of the total cost of reprocessing resins (industry commission report). The cost of collection is significantly greater in rural areas given the distance between source of plastic and location of the repressor. The price industrial plastic recyclers can afford to pay in order to collect their plastic waste, given other costs and the price reprocessed resins receive, can significantly impact the profitability of the companies operations. The size and regularity of the quantity collected also depend on participation in collection schemes.

The availability factor is a key factor influencing the cost of industrial plastic collection and quantity of plastic supply. A number of industrial products, such as PVC pipes are generally left insitu and thus are not available for recovery. It is estimated that more than 71% of PVC pipe are left insitu.

Cost of sorting

The recovery and reprocessing of plastics is hampered by the difficultly of distinguishing different plastic types. For single polymer reprocessing it is necessary to sort the plastics to maintain the quality of reprocessed resins. Laser technology is currently available which can sort mixed plastic waste by polymer type, however products are usually sorted using manual labour. The efficiency and cost of mechanical separation technologies is improving, leading to their increased use in modern material recovery facilities (MRF).

Financial Incentives

The Western Australia Government does not offer many financial incentives for plastic recyclers. The Resource Recovery Rebate Scheme (RRRS) only allows local governments and regional councils to claim a rebate for material they can demonstrate has been reused, recovered or recycled. In addition, funds from the National Packaging Covenant are only available to manufacturing companies and industry associations.

Lack of domestic markets

There are a small number of products that can be manufactured with reprocessed resin in Western Australia as outlined in **Table 5.1**. Additional markets for recycled industrial plastic products are available interstate. A number of plastic recyclers are sending their reprocessed resin to markets interstate. The majority of the material is being sent to South Australia and Victoria where additional manufacturing infrastructure is available. A large number of international markets exist which means that most of the states recycled plastic material is being exported. This is another additional cost for the plastic recycler.

Low supply

Plastic Recyclers cannot guarantee a constant supply of reprocessed resin to manufacturer. This is due to a number of reasons including the long-life of industrial plastic product and the lack of coordinated collections. In addition, a number of waste generators are not aware of plastic recyclers.

7.2.3 Environmental

Life cycle analysis of waste management options

The disposal of used industrial plastics has impacts on the increased consumption of non-renewable fuels and energy, increased production of solid waste (including all the environmental impacts of landfilling waste).

There does not appear to be a life cycle analysis (LCA) assessment that specifically targets industrial plastics, however there are many LCA studies for general plastics. The recent report produced by WRAP (UK) titled *Environmental Benefits of Recycling: An international review of life cycle comparisons for key materials in the UK recycling sector* comprised 10 studies, including a total of 60 scenarios comparing the three plastic waste management options of recycling, incineration and landfilling to each other. The studies covered many different geographical regions from Norway, Sweden and Denmark in the North to New Zealand in the South and comprising both the EU and the USA.

The pre-processing of the collected material before recovery, typically cleaning/washing, is an essential part of most plastics systems, and in all cases where this was relevant, it was considered and included. The overall conclusion was that the reviewed studies represented a reasonable handling of the system boundary issues for plastics. The review concluded that the applied system boundaries and assumptions divided the studies and their scenarios into three main categories that differed so much from each other that they should be addressed as separate groups of scenarios, namely:

I. Scenarios that anticipated recovered material to substitute virgin material of the same kind in the weight/weight ratio of 1:1
II. Scenarios that anticipated recovered material to substitute virgin material of the same kind in the weight/weight ratio of 1:0.5
III. Scenarios that included substantial washing/cleaning of the plastic product before material recovery was possible, in which this washing/cleaning had the dominating environmental significance

The vast majority of scenarios belonged to group I. With this basic assumption for material recovery, all reviewed studies and scenarios concluded that recycling/material recovery was environmentally better than both incineration and landfilling on all environmental impact categories included in the studies, with recycling being around 50 % better on average. The net CO_2 saving from recycling was found to be 1.5 – 2 tonnes CO_2-eq. per tonne of plastics on average (WRAP, 2006).

In cases where the quality/grade of the recovered plastic implied a less favourable substitution ratio (worse that 1:1), the scenarios dealing with this issue demonstrated that a ratio of 1:0.5 was about the break-point at which recycling and incineration with energy recovery were environmentally equal.

In scenarios where washing/cleaning was needed (for example when plastics have organic contamination), the scenarios dealing with this demonstrated that this might lead to incineration being environmentally preferable to recycling. The reason was the need for hot water for washing and the fact that the organic contaminants have a heat value that is an advantage in the incineration scenarios, but a disadvantage in recycling, because the removal of contaminants in municipal wastewater treatment required energy (WRAP, 2006).

Greenhouse Gas Emissions

The disposal of used industrial plastics has impacts on the increased emissions of greenhouse gases such as carbon dioxide (CO_2).

The WRAP *Environmental Benefits of Recycling* report reviewed the Greenhouse Gas (GHG) emission calculated in the various assessments and found an unambiguous advantage to plastics recycling within the main population of scenarios. The net CO_2 saving from recycling instead of the incineration of plastics, in this case, ranged from 0 to 4 tons of CO_2-eq. per tonne of plastics with an average around 2 tonnes CO_2-eq. per tonne of plastic.

The net saving of CO_2-emission reported in the comparison of the various scenarios that included landfilling was found in the range of 0- 2.5 tonnes CO_2-eq. per tonne of plastic, with an average of around 1.5 tonnes CO_2-eq. per tonne of plastic.

Biodegradable plastics

The environmental effect on the decomposed plastic on soil, water and fauna is uncertain (Industry Commission, 1991). Moisture needs to be present in the landfill for bacteria to break down the plastic and even under the best conditions; biodegradable plastics may still take years to decompose. Photodegradable plastics, which break down in sunlight are also available. However, they do not readily break down in landfill due to the absence of sunlight (Industry Commission, 1991).

Standards Australia is developing a number of standards for degradable plastics in response to a request from the Environment Protection and Heritage Council in 2003. There was a need for standards due to variable conditions in Australia's environment; public concern from dubious claims made by bioplastics companies and potentially toxic residues left after the plastic was degraded. The standards are split into 2 categories, biodegradable plastics (micro-organisms) and oxo-degradable plastics (environment).

A number of standards will be created to relation to bioplastics. Two of these standards have already been released as of July 2006 and include:

- AS 14852-2005 - Plastic materials – Determination of the ultimate aerobic biodegradability in an aqueous medium – Method by analysis of evolved carbon dioxide (Released April 2005)
- AS 14855-2005 - Plastic materials – Determination of the ultimate aerobic biodegradability and disintegration under controlled composting conditions – Method by analysis of evolved carbon dioxide (Released April 2005)

The remaining standards will be released over the coming year. The standards detail the effect on the biological treatment process, effect on the quality of compost and the biodegradability and/or disintegration of products during biological treatment. Whilst bioplastics will mainly target consumer plastics with a short shelf life, bioplastics can be incorporated into short life industrial plastics such as plastic mulch for horticulture.

Heavy Metal Contamination in PVC

PVC is never used as a virgin resin. Rather it relies on stabilisers and additives to derive the required characteristics. PVC materials have come under significant scrutiny as Cadmium and Lead can be used as stabilisers in PVC pipe manufacturing. Cadmium stabilisers are toxic to both humans and the environment. Some report have outlined that a potential contamination of the environment by the use of lead or cadmium stabilisers in PVC can take place during the waste management phases. The reports also state that disposal by incineration could potentially be a source of diffuse spreading of lean and cadmium where there is incorrect disposal of residue (fly ash) (Scheirs, 2003).

Australian PVC pipe formulations do not contain plasticisers or cadmium. Lead stabilisers are not used in the manufacture of pressure water pipe in Australia and they are being phased out in other piping applications under the PVC Industry's Product Stewardship Program. Small quantities of lead based compounds are used as a thermal stabiliser in some pipe products. The lead stabilisers are held within the PVC matrix and to quote the CSIRO Report from 2001 "the concerns relating to extraction are overstated" (PIPA, 2006). There have been extensive studies both in Australia and Europe on leachate from waste water pipes and landfill situations. In both cases the conclusion is that the amount of lead released is insignificant (PIPA, 2006).

In-Situ PVC

The environmental impact of insitu disposal of PVC pipe is considered low (Scheirs, 2003). OVC products are resistant to biodegradation and additive are encapsulated with the polymer matrix. However, thermal degradation may result in the product becoming more porous and brittle. The higher

the breakdown of the polymer type, the higher the migration of additives such a heavy metals. However, it is suggested that PVC article take 1000 years to break down.

7.2.4 Lack of waste data

In addition to the manufacturers and recyclers barriers to increasing plastic recycling, there is limited data available regarding the industrial plastics in Western Australia. This included the amounts of waste produced, the carrier of the wastes and the final disposal or recycling operation used. This information is needed to track the wastes produced each year, so that:

- Waste production levels can be quantified and monitored, this will allow the effectiveness of waste minimisation and recycling programmes to be assessed
- Wastes can be tracked from production to final disposal or treatment, this audit trail can be used to combat illegal tipping
- The end use of wastes can be recorded to see what proportion is disposed of or recycled

The tracking of waste production, transportation and end use are important to monitor the industry's performance against waste reduction and recycling targets. A waste tracking system is used in the UK and known as Waste Transfer Notes (WTN), further details about this system are included in **Appendix 3**.

8. OPTIONS

A number of issues have been identified in Section 8. These issues have been examined and using examples of programmes and measures from other geographic areas together with consideration of factors specific to Western Australia, the following measures have been developed. These would require further analysis to identify the priority measures that could be easily implemented and achieve rapid improvement in terms of waste minimisation and recycling of used industrial plastics.

8.1 TRACKING OF USED INDUSTRIAL PLASTICS

Objective

- Used industrial plastic production levels can be quantified and monitored, this will allow the effectiveness of waste minimisation and recycling programmes to be assessed
- Wastes can be tracked from production to final disposal or treatment, this audit trail can be used to combat illegal tipping and used for the payment of any recycling rebate

Description

This measure would ensure that the volumes of used industrial plastics were known and the waste management options utilised were recorded. This information is essential before any recycling strategies are implemented, as the current situation of the industry summarised in this report needs to be backed up with empirical data. In addition, the effectiveness of any programmes can not be measured with out baseline data and on going monitoring.

Collecting this data would also assist in limiting the risk of illegal tipping and the information can be used for the payment of any recycling rebate. A similar system is used in the UK and known as Waste Transfer Notes (WTN), further details about this system are included in **Appendix 3**.

Effectiveness

This provides a very useful source of information that can be used for measuring disposal and recycling rates, waste generation and industry practice. It also provides a tool for auditing operators and prosecuting illegal waste tipping (fly-tipping).

Efficiency

This is likely to be a relatively expensive measure, to gather and process the information. Electronic or on-line systems could automate the process and reduce the resources required to maintain the system.

Acceptability

There may be issues of confidentiality with this potentially commercially sensitive information, however provided the information was gathered with a suitable process and the detailed results remained confidential with only aggregated results were available for public access, the confidentiality concerns could be addressed.

Enforceability

This measure would be difficult to enforce without extensive administration.

Compatibility with policy principles
This measure is compatible with the Waste Management Branch's data collection programme.

8.2 FREE ADVISORY SERVICE FOR MANUFACTURERS

Objective

- To recycle and recover resources from the Commercial and Industrial (C&I) waste stream
- Minimise the disposal of commercial and industrial waste
- Provide waste recycling information for commercial businesses
- Increase business competitiveness
- Increase resource efficiency on a business by business basis
- Improve environmental performance and 'green image' of businesses
- Improve busness profitability

Description
This measure would include government funded advice for Western Australian businesses that would provide free, independent, confidential advice and support on practical ways to increase profits, minimise waste and reduce environmental impacts. This measure could also provide the central 'hub' that a number of the further measures could attached to, such as a waste exchange and grant system., while able to provide information about collection schemes (e.g drumMUSTER) and recycling companies that could collect the waste plastics.

A model that could be replicated is the UK Envirowise Programme (www.envirowise.gov.uk). During discussions with Andrew Simmons from Recoup (UK), he suggested this this was one of the most effective programmes that has been implemented in the UK for improving the minimisation and recycling of industrial plastics.

Business recognise the profitablity benefits that can be gained from implementing waste efficency measures, while the indirect benefits are reduced waste production and increased recycling of the remaining wastes. Such a scheme could be widened to cover all type of businesses in Western Australia and have a significant impact on all industrial waste streams and resources used, such as energy and water.

Effectiveness
Provided the scheme was well advertised, the advise given was practical to implement and provided cost savings to each business this measure would be very effective.

Efficiency
This measure is likely to be relatively expensive to provide, but provided it is well managed it should provide effective resource efficiency advice for Western Australian businesses and assist in minimising resource use (e.g. materials, energy and water). Therefore providing benefits to the Western Australian economy, minimising water and energy consumption and reducing waste disposal.

Acceptability

Industry is likely to be supportive of this measure.

Enforceability
This measure would be voluntary.

Compatibility with policy principles
This measure is compatible with the Strategic Direction for Waste Management in Western Australia and with the mission statement of the Department of Environment and Conservation.

8.3 WASTE EXCHANGE DATABASE

Objective

- To provide a central point for waste producers and re-users to link up and exchange materials
- Minimise the disposal of waste by-products (including used industrial plastics)
- Increase the reuse and recycling of waste by-products

Description
A waste exchange database provides an Internet based central point for producers of waste materials to list their waste products; other manufacturers and recyclers that could use the by-products as raw materials are able to search the list of waste by-products for the materials that they require. This would be a free service, and would aim to encourage the reuse, recycling and energy recovery of wastes by allowing communication between generators of waste and potential recyclers. The website would allow for both parties to advertise any wastes available or wanted. This increase is not limited to industrial plastics, but could be used for many types of waste.

Effectiveness
The existing Waste Exchange in Victoria has provided this service to industry. However the database's effectiveness is debatable to whether it has successfully diverted significant amounts of material away from disposal.

Efficiency
The efficiency of the measure would depend upon the level of use by industry. Therefore an effective advertising campaign would be an important element of this measure. Once established the cost to maintain the service would be low.

Acceptability
The industry and other stakeholders are likely to be supportive of this measure.

Enforceability
This measure would be voluntary.

Compatibility with policy principles
This measure is compatible with the Strategic Direction for Waste Management in Western Australia and with the mission statement of the Department of Environment and Conservation.

8.4 PAYMENT FOR WASTE RECYCLING

Objective

- To improve the economics of recycling used industrial plastics

Description

The payment for each tonne of waste recycled via a 'Recycling Credit' is already used in Western Australia through the Resource Recovery Rebate Scheme (RRRS). This has been historically limited to local government, however the RRRS is currently under review. If the RRRS were available to commercial organisations it would be likely to have an impact on the rate of used industrial plastic recycling, by making recycling a more cost effective option.

Effectiveness

The UK has introduced Packaging Waste Recycling Notes (PRN's) and this has proven to be an effective way to increase the recycling of packaging materials, including plastics, from both commercial and domestic waste streams.

Efficiency

The efficiency of the measure would depend upon the level of use by industry. Therefore an effective advertising campaign would be an important element of this measure. It is understood that the RRRS currently utilises about 50% of the revenue generated by the landfill levy in Western Australia, therefore widening the scope of the scheme could produce significant increases in the cost of the scheme, however the increases in the levy may be sufficient to pay for the additional cost.

Acceptability

The industry and other stakeholders are likely to be supportive of this measure, although Local Government are likely to protect their current level of subsidy.

Enforceability

This measure would be voluntary.

Compatibility with policy principles

This measure is compatible with the Strategic Direction for Waste Management in Western Australia and with the mission statement of the Department of Environment and Conservation.

8.5 INFRASTRUCTURE GRANT SCHEME

Objective

- To increase the processing infrastructure capacity in Western Australia
- To add value to the collected industrial plastics

Description

Grants could be awarded to increase the recovery of industrial plastics. This approach has been used in South Australia to meet one of their key targets of a 30% increase in the recovery and use of commercial and industrial materials by 2010. The grants in South Australia have been initiated to

invest in infrastructure to achieve this target. The grants have stimulated investment by industry for infrastructure.

Based upon the market size, the current plastic recycling industry and the industrial plastics manufacturing base in Western Australia, the infrastructure investment is likely to be focused on the collection, cleaning and consolidation of recycled plastic prior to distribution to overseas and interstate markets. This would include equipment such as mobile shredders, washing plant and size reduction machinery, which would add value to the plastics prior to distribution.

Effectiveness
This measure would be effective at increasing the capacity of the industrial plastics recycling infrastructure in Western Australia, while adding value to the existing industrial plastics that are exported out of the State.

Efficiency
The cost of this measure to the Department of Environment and Conservation would depend on the nature of the programme and the grants could be expensive. However, the infrastructure grant scheme is likely to stimulate further investment in the industrial plastics recycling industry by industry, i.e. additional to the grant payments.

Acceptability
The industry and other stakeholders are likely to be supportive of this measure, provide the grants are awarded via an equitable and transparent process.

Enforceability
Not applicable.

Compatibility with policy principles
This measure is compatible with the Strategic Direction for Waste Management in Western Australia and with the mission statement of the Department of Environment and Conservation.

8.6 INDUSTRY SECTOR PROGRAMMES

Objective

- To target issues specfic to individual industry sectors
- To include plastic waste streams that could fall outside general measures

Description
Different industry sectors have some specific issues that could be addressed to facilitate additional plastic reuse and recycling with in that sector. This would require a focused and detailed analysis of an industry sector together with stakeholder consultation to assist a sector in the management of used plastics.

An example of this would be to develop a viable shredder residue (floc) recovery processes with the automotive industry. Development work could focus on maximising the value of plastics in shredder

residue. This would involve evaluating existing technology capable of separating specific polymers from shredder residue and trialling samples of shredder residue from commercial operators to identify suitable technology for Western Australia and the conditions for viable implementation.

Effectiveness
Provided the industry sector targeted supported the scheme, this could enable the reuse and recycling of used plastics from a specific industry sector.

Efficiency
This measure is likely to be intensive and therefore relatively expensive to provide, but it may attract industry funding, therefore reducing the cost to Government.

Acceptability
Industry may be resistant to change, but would hopefully see the benefits and be supportive of this measure.

Enforceability
This measure would be voluntary.

Compatibility with policy principles
This measure is compatible with the Strategic Direction for Waste Management in Western Australia and with the mission statement of the Department of Environment and Conservation.

8.7 MATERIAL RECYCLING FACILITY (MRF) FOR COMMERCIAL AND INDUSTRIAL WASTE

Objective

- To recycle and recover resources from the Commercial and Industrial (C&I) waste stream
- Minimise the disposal of commercial and industrial waste

Description
A C&I Materials Recovery Facility would enable companies to access a sorting facility for the wastes that they produce. This would operate in a similar way to existing MRF that sort domestic dry recyclables, but focus on the C&I waste streams.

Effectiveness
Provided suitable wastes were delivered to the MRF, resources could be sorted and recycled.

Efficiency
Currently the cost to sort a waste stream and recycle the resources is more expensive than disposal, therefore within the current economic environment the C&I MRF would require government subsidises to lower the gate-fee and attract C&I wastes.

Acceptability
Industry is likely to be supportive of this measure, however the subsidising of a C&I waste management facility may meet resistance from some stakeholders.

Enforceability
This measure would be voluntary.

Compatibility with policy principles
This measure is compatible with the Strategic Direction for Waste Management in Western Australia and with the mission statement of the Department of Environment and Conservation.

8.8 MARKET DEVELOPMENT VIA GOVERNMENT PROCUREMENT

Objective

- To create a demand for recycled materials
- For Government to lead by example

Description
To develop the market for recycled plastic content products, procurement and tendering practices within Government Departments and Agencies together with Local and Regional Government are an area to focus on. There is potential to rapidly create a large demand for recycled materials using this approach. For example, some lower quality recycled plastics are used to produce 'plastic lumber' that can be used for public seating, playgrounds and other products that are currently constructed from timber.

Effectiveness
This measure would be very effective in creating a demand for recycled materials.

Efficiency
This measure would require a programme to communicate the strategy with the appropriate government departments.

Acceptability
Once the procurement departments were aware of the alternative products and their benefits, there should be little resistance.

Enforceability
This measure may be difficult to enforce. However, provided the benefits of the plastic lumber were explained, the transition to using this material should be straightforward.

Compatibility with policy principles
This measure is consistent with the Strategic Direction for Waste Management in Western Australia. This measure is compatible with the mission statement of the Department of Environment and Conservation.

8.9 LANDFILL LEVY ESCALATOR

Objective

- To increase the cost of disposal to landfill and make recycling more price competitive
- To provide a strong signal to the industry that waste disposal will only get more expensive

Description

The cost to dispose of industrial plastics is currently very cheap and does not reflect the true value of the resources that are lost. The low cost of landfill also encourages the disposal of wastes rather than the recycling of the waste. The introduction of a landfill levy escalator would reflect the true cost of waste disposal and also provide a clear signal to the industry and stakeholders that the recycling of industrial plastics will become more cost effective than their disposal.

Effectiveness

This would be a very effective way of increasing the cost of disposal while making recycling a more cost effective option for industrial plastics.

Efficiency

This measure would require no additional funding of the existing landfill levy scheme

Acceptability

The landfill industry and waste producers are likely to be opposed to this measure. However, most are aware that landfill taxes in Europe and landfill levies in most other states within Australia are already far higher than the levy in Western Australia.

Enforceability

There would require no additional enforcing than the existing landfill levy

Compatibility with policy principles

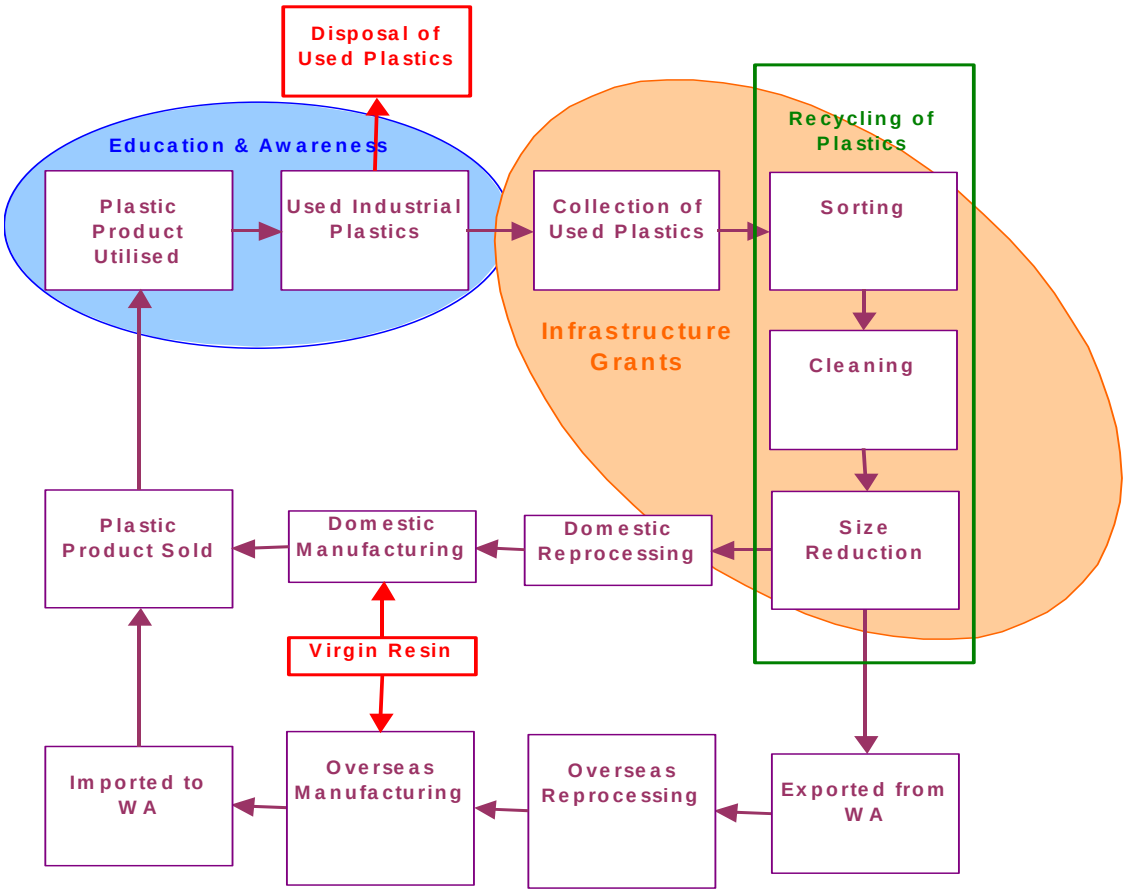
This measure is compatible with the mission statement of the Department of Environment and Conservation.

9. POTENTIAL TO INCREASE THE QUANTITY AND QUALITY OF RECYCLED INDUSTRIAL PLASTICS

The information relating to the volume of recycled industrial plastics in Western Australia is either commercial sensitive or not collected, therefore is hard to estimate the current volume of material recycled and the potential volume that could be recycled, if the recommendations made in this report were implemented. However, during the stakeholder consultation and site visits that have been completed, it is apparent that there is a small but viable and thriving industrial plastics recycling industry in Western Australia. This industry is operating with little or no government support, in a volatile international market.

The barriers that are limiting the recycling of industrial plastics are based around the supply of clean, sorted used plastics to recyclers, rather than market development for the recycled content products. The issue of supply of used material needs to be focused at business and industry sectors that produce used plastics. This can be addressed with education and advice about the plastic recycling options available for businesses and specific programmes that could be developed with industry sectors. This would improve the quantity of material available for recycling.

Figure 9.1 A flow diagram of the industrial plastics cycle, showing focus areas to increase the quantity and quantity of recycled industrial plastics



Provided significantly more used plastic was available for Western Australian plastic recyclers, there could be a requirement to rapidly increase the recycling capacity within the State. This could be addressed with infrastructure grants that would likely be matched with industry investment. As most of the recycled plastics collected are reprocessed in either the Eastern States or overseas, the infrastructure grants could also by used to improve the quality of the recycled plastic before it leaves the state. The quality and therefore value of the recycled plastic can be increased by the investment in cleaning equipment and size reduction machinery.

Given the size of the plastic manufacturing industry in Western Australia, the measures introduced should focus on the processing of recycled plastics ready for export from the State, rather than the manufacturing of recycled content plastic products in Western Australia. The one exception to this may be the manufacturing of plastic lumber, as this could utilise the lower value, mixed and contaminated plastics that are not suitable for export.

In summary, there is a great potential to increase the quantity of used industrial plastics that could be recycled in Western Australia, and the quality of the material that is exported. However, until accurate information is collected regarding the tonnages produced within the State, this cannot be quantified.

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APPENDIX 1 – CONSULTATION LIST

Industrial Plastic Manufacturers

Kingstonbridge Engineering		
Vinidex	Warren Cutts	Regional General Manager WA
Viscount Plastics	Ian Kidd	General Manager
Viscount Plastics	Mitchell Ryan	QA/HSH & E Administrator
VISY Industrial Packaging	Dermot Convery	Regional Manager WA

Industrial Plastic Recyclers

CLAW Environmental	Martin Ladyman	Managing Director
Dalwallinu Recycling	Max Evens	
Jo Jo Plastics	Liza Joubert	
Jo Jo Plastics	Jan Joubert	
PP Recyclers Pty Ltd (Pot Recyclers)	Bob Williamson	Director
Recycle Plas	Victor Kipis	

Commercial / Industrial Sectors

Department of Agriculture and Food – Perth	John Burt	
Department of Agriculture and Food – Bunbury	Bill Smart	
Department of Agriculture and Food – Manjimup	John Doust	
Department of Fisheries	Mario Zelino (port)	
Department of Fisheries	Mark Donaty (distribution)	
Hamersley Iron	Ruth Jamison	OHS &E Officer
Water Corporation	Nathan	
Western Power	Craig Morgan	
Telstra	Turlough Guerin	

Other Jurisdictions

Department of Environment and Conservation (New South Wales)	John Street	
Eco Label Programme	Peter Johnson	
PACIA	Heather Thurman	Project Manager – Industrial / Automotive Plastics
PACIA	Peter Bury	Project Manager – National Plastics Recycling Report
Recoup (United Kingdom)	Andrew Simmons	CEO
WRAP (United Kingdom)	Paul Davidson	
Sustainability Victoria	Simon Clay	
Western Australian Local Government Association	Bernard Ryan	
Department of Environment and Heritage	Paul Bainton	

APPENDIX 2 – COUNCILS OFFERING THE DRUMMUSTER PROGRAM

Kimberly Region	Wongon-Ballidu Shire Council, Wongan Hills
• Broome Shire Council, Broome	**Goldfields / Esperance Region**
• Derby-West Kimberly Shire Council, Derby	• Coolgardie Shire Council, Coolgardie
• Halls Creek Shire Council, Halls Creek	• Dundas Shire Council, Norseman
• Wyndham-East Kimberly Shire Council, Kununurra	• Kalgoorlie-Boulder City Council, Kalgoorlie
Pilbara Region	• Laverton Shire Council, Laverton
• Ashburton Shire Council, Tom Price	• Leonora Shire Council, Leonora
• East Pilbara Shire Council, Newman	• Menzies Shire Council, Menzies
• Port Headland Town Council, Port Headland	• Ngaanyatjarraku Shire Council, Warburton Ranges via Kalgoorlie
• Roebourne Shire Council, Karratha	**Great Southern**
Gascoyne Region	• Albany City Council, Albany
• Carnarvon Shire Council, Carnarvon	• Broomehill City Council, Broomehill
• Exmouth Shire Council, Exmouth	• Carnbrook City Council, Carnbrook
• Shark Bay Shire Council, Denham	• Denmark City Council, Denmark
• Upper Gascoyne Shire Council, Gascoyne Junction	• Espernace Shire Council, Esperance
Midwest Region	• Gnowangerup Shire Council, Gnowangerup
• Carnamah Shire Council, Carnamah	• Jerramungup Shire Council, Jerramungup
• Chapman Valley Shire Council, Nabawa	• Katanning Shire Council, Katanning
• Coorow Shire Council, Coorow	• Kojonup Shire Council, Kojonup
• Cue Shire Council, Cue	• Plantagenet Shire Council, Mt Barker
• Geraldton City Council, Geraldton	• Ravensthorpe Shire Council, Ravensthorpe
• Geraldton Greenough Regional Council Waste Management, Geraldton	• Tambellup Shire Council, Tambellup
• Greenough Shire Council	• Woodanilling Shire Council, Woodnilling
• Irwin Shire Council, Dongara	**South West**
• Meekathara Shire Council, Meekathara	• Augusta-Margaret River City Council, Margaret River
• Mingenew Shire Council, Mingenew	• Boddington Shire Council, Boddington
• Morawa Shire Council, Morawa	• Boyup Brook Shire Council, Boyup Brook
• Mount Magnet Shire Council, Mount Magnet	• Bridgetown-Greenbushes Shire Council, Bridgetown
• Mullewa Shire Council, Mullewa	• Bunbury City Council, Bunbury
• Murchison Shire Council, Mullewa	• Busselton Shire Council, Busselton
• Northhmpton Shire Council, Northhmpton	• Capel Shire Council, Capel
• Perenjori Shire Council, Perenjori	• Collie Shire Council, Collie
• Sandstone Shire Council, Sandstone	• Dardanup Shire Council, Dardanup
• Three Springs Shire Council, Three Springs	• Donnybrook-Balingup Shire Council, Donnybrook
• Wiluna Shire Council, Wiluna	• Harvey Shire Council, Harvey
• Yalgoo Shire Council, Yalgoo	• Manjimup Shire Council, Manjimup
Wheatbelt Region	• Murray Shire Council, Pinjarra
• Chittering Shire Council, Bindoon	• Nannup Shire Council, Nannup
• Dalwallinu Shire Council, Dalwallinu	• Waroona Shire Council, Waroona
• Gingin Shire Council, Gingin	**Peel Region**
• Moora Shire Council, Moora	• Mandurah City Council, Maundrah
• Victoria Plains Shire Council, Victoria Plains	• Sepentine-Jarrahdale Shire Coucnil, Mundijong

Perth	
• Armadale City Council, Armadale	• Melville City Council, Applecross
• Bassendean City Council, Bassendean	• Mosman Park Town Council, Mosman Park
• Bayswater City Council, Morley	• Nedlands City Council, Nedlands
• Belmont City Council, Cloverdale	• Peppermint Grove Shire Council, Peppermint Grove
• Cambridge Town Council, Floreat	• Perth City Council, Perth
• Canning City Council, Welshpool	• South Perth City Council, South Perth
• Claremont Town Council, Claremont	• Stirling City Council, Stirling
• Cottesloe Town Council, Cottesloe	• Subiaco City Council, Subiaco
• East Fremantle Town Council, Fremantle	• Victoria Park Town Council, Victoria Park
• Fremantle City Council, Fremantle	• Vincent Town Council, Leederville

APPENDIX 3 – UK WASTE TRANSFER NOTES EXPLANATION

Sourced from: www.netregs.gov.uk

What is a Waste Transfer Note (WTN)?

A Waste Transfer Note (WTN) is a document which must be completed and accompany any transfer of waste between different holders.

A WTN must be created for each load of waste that leaves your site. For repetitive transfers, there is provision to use a 'season ticket' i.e. one transfer note will cover multiple transfers over a given period of time of up to 12 months. The use of a season ticket is, however, only permissible where the parties involved in each transfer are the same and where the description of the waste transferred remains the same.

What information should it contain?

The WTN must contain enough information about the waste to enable anyone coming into contact with it to handle it safely and either dispose of it or allow it to be recovered within the law. Failure to give enough information may result in prosecution.

You should describe on the WTN both in words and by reference to the appropriate codes in the European Waste Catalogue (EWC) and the quantity and types of each different waste being transferred. The requirement was introduced in England, Wales and Scotland by the respective Landfill Regulations.

If you are operating in Northern Ireland, you currently need to describe the quantity and types of each different waste being transferred both in words and by reference to the appropriate category (chapter heading) of the EWC. This is a requirement of the Controlled Waste (Duty of Care) Regulations (Northern Ireland) 2002.

The WTN should also include details of how the waste is contained i.e. loose or packaged and, if packaged, then in what type of containers.

Never rely on waste carriers or waste management contractors to describe your waste for you on WTN's. You, as the producer, are in the best position to accurately describe your waste. Ensure that description of the waste on documentation is accurate - ideally write the description yourself. Non-specific terms such as 'general waste' or 'inert waste' are not acceptable. The purpose of the description is to allow other people who handle the waste to know what they are dealing with so that they can manage it safely and properly.

Both parties to the transfer must sign the transfer note e.g. you and the waste carrier must sign the WTN before the waste leaves your site. If you transport the waste yourself, you and the operator of the waste management site to whom you hand over your waste must sign the transfer note. If you use a waste broker, you must ensure that they are registered with your Environmental Regulator and that they also sign the WTN in their own right. This is your record of the nature and quantity of waste you transferred, how it was packaged, when you transferred it, where it should go and who you transferred it to - all requirements of the Duty of Care.

You must keep copies of all WTN's for at least two years.

Whatever the destination of your business wastes and whichever organisations are handling them, it will help you to prove that you have properly discharged your Duty of Care if you undertake periodic audits. This will help you to ensure that your wastes are being handled correctly from the moment they leave your premises to the final point of disposal or recovery.

WTN's and Hazardous/Special Waste

The transfer documentation for Hazardous/Special Waste is referred to as a 'consignment note'. If the material you are handling has hazardous properties, it may need to be dealt with as Hazardous/Special Waste. In this case, completion of a Consignment Note (requiring similar information to a WTN) will fulfil the Duty of Care requirements; a separate waste transfer note is then not required.

Be aware that waste defined by the EWC as hazardous (i.e. those where the description matches an entry with an asterisk) can only go to a waste treatment facility that is licensed to receive hazardous waste.

Ensure that wastes that arise irregularly (e.g. redundant materials, wastes arising from cleaning up spills) are declared on WTNs. Note that some of these wastes may have to be handled as Special Waste or Hazardous Waste.