National Recovered Material Specifications for Sorting and Processing Facilities

A Submission to the Department of Agriculture, Water and the Environment

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National Recovered Material Specifications for Sorting and Processing Facilities

A report to the Department of Agriculture, Water and the Environment by the National Waste and Recycling Industry Council (NWRIC) with the assistance of MRA Consulting.

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Glossary

Terminology	Definition
ACOR	Australian Council of Recycling
ANZPAC	ANZPAC Plastics Pact
APCO	Australian Packaging Covenant Organisation
APR	Association of Plastic Recyclers
ARL	Australian Recycling Label
BSI	British Standards Institution
C&D	Construction & Demolition
C&I	Commercial & Industrial
CDS	Container Deposit Scheme
CO_2	Carbon dioxide
COAG	Council of Australian Governments
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSP	Ceramics, stone and porcelain
DAWE	Department of Agriculture, Water and the Environment
EPA	Environment Protection Authority
ESPA	Expanded Polystyrene Australia
EOW	End of waste
EPS	Expanded polystyrene
FO	Food Organics
FOGO	Food Organics and Garden Organics
GO	Garden Organics
HDPE	High density polyethylene
ISO	International Organization for Standardization
ISRI	Institute of Scrap Recycling Industries
LDPE	Low density polyethylene
LLDPE	Linear low density polyethylene
MRA	MRA Consulting Group

Terminology	Definition
MRF	Material recovery facility
MSW	Municipal Solid Waste
Mt	Million tonnes
NWRIC	National Waste and Recycling Industry Council
OCC	Old corrugated containers
OMG	Old Magazine
ONP	Old newsprint
PET	Polyethylene terephthalate
PFAS	Per- and poly-fluoroalkyl substances
PP	Polypropylene
PS	Polystyrene
PVC	Polyvinyl chlorine
rHDPE	Recycled HDPE
rPET	Recycled PET
RRE	Resource Recovery Exemptions
RRO	Resource Recovery Orders
UBC	Used beverage container
VOGO	Vegetative Organics and Garden Organics
WSAA	Water Services Association of Australia

Executive Summary

The National Waste and Recycling Industry Council (NWRIC), with assistance of MRA Consulting, was engaged by the Department of Agriculture, Water and the Environment ('the Department') to consider and recommend national performance standards (e.g., recovered resource specifications) for primary sorting facilities and secondary processing facilities handling glass, plastics, metals, paper and cardboard, and organics collected through the Municipal Solid Waste (MSW) stream.

The purpose of the recommended specifications is to assist Australian recyclers enhance the volume and value of tradeable products in domestic and overseas markets, meet market demands for recovered materials locally and overseas, improve the quality of recovered materials as tradable commodities, and stimulate domestic re-use of recovered materials by improving market information and greater confidence in the quality of recovered materials.

The project contributes to the implementation of the 2019 National Waste Policy Action Plan. Specifically, *Action 3.19 - Develop performance standards for material recovery facilities and assess opportunities for other standards (such as for markets, products and waste professionals*) and has been done in association with the DAWE funded, Australian Council of Recyclers project on recommending a national accreditation program for Australian recyclers (i.e. sorters and processors), where independent certification of recovered materials against industry, national or international specifications may be included in the accreditation process to further increase market confidence in the quality of recovered materials from sorting and processing facilities.

Findings

A literature review including government and industry reports and articles identified 65 national and international recovered resource specifications for materials collected through the MSW stream: 14 glass, 25 plastic, 8 metal, 10 paper and cardboard and 8 organics.

Of these specifications, 38 are national specifications, standards or regulations developed by the Australian Council of Recyclers (ACOR), the Australian Packaging Covenant Organisation (APCO) / ANZPAC Plastics Pact (APCO/ANZPAC), Australian Standards or state governments and 27 are international standards developed by Institute of Scrap Recycling Industries (ISRI) or other international bodies.

The specifications ranged from regulatory specifications, Australian standards, technical specifications, industry specifications, trading specifications, to listed waste export specifications.

The review also found that more and more countries (e.g. China, Malaysia) are setting higher quality import specifications which is impacting what Australian sorters and processors can export to these countries. This this includes the Basel Convention which includes specifications for the international movement of waste plastics.

To identify where there may be possible gaps or changes required, the flow of each material type and current specifications were mapped from collection, sorting and processing to final outputs and end users.

To assess the uptake, relevance, market and contract impacts as well as potential benefits of each recovered resource specification on increasing the value and volume of resource recovery, an extensive stakeholder engagement process was undertaken, including project briefing webinars and 38 one-on-one interviews with sorters, processors and end users across each material type.

The material flow mapping and stakeholder feedback found that many sorting and processing facilities and end users prefer to use the ISRI specifications to describe their recovered resource outputs and inputs in commodity transactions. In many cases these specifications are used as a benchmark or reference point in negotiating a supply agreement, which may include a price range based on quality of actual material supplied.

Many end users also have their own site-specific recovered resource specifications, due to the type of equipment and processes used at that site. Most of these specifications are commercial-in-confidence, however, some end users interviewed did advise their minimum requirements for some contaminates and items not accepted.

It is apparent from stakeholder feedback that there is a constant tension between sorters, processors and end users regarding what the sorter and processor can produce and what the processor and end user want or require.

Very few sorting or processing facilities have independently certified their material outputs against ISRI, ACOR, APCO/ANZPAC or other specifications. Rather buyers will personally inspect the supplier's material outputs or require photographic evidence or specific chemical tests. In the case of exporting, some countries have inspectors who will verify the quality of the material prior to allowing its export.

Some organic processors are independently certified against the Australian Standard AS:4454-2012 Composts, soil conditioners and mulches. While this is not a legal requirement, certain end users will specify this standard in their tenders, such as urban landscapers and architects.

As recovered organics are applied to land, states and territories have regulations or guidelines such as the NSW Resource Recovery Orders and Exemptions which stipulate processing standards and physical and chemical characteristics that must be met before the recovered organics can be used.

While most stakeholders agreed that the specifications should emphasise limits on prohibited materials rather than other aspects, some stakeholders believed that the specifications should not be minimum standards but rather be best practice specifications that the industry should strive to achieve.

Recommendations

Based on the material flow mapping, stakeholder feedback and the assessment of impacts and benefits, a total of 49 existing sorting and processing specifications have been recommended for each material type and stage of the recovery process.

Where existing minimum specifications are already available, best practice specifications have also been recommended to increase the volume and/or the value of the resources being recovered. Similarly, amendments to 11 of the recommended specifications have been proposed to improve the quality of the resources being recovered.

Seven new specifications have also been recommended to be developed where there are gaps. These include unprocessed glass fines, glass sand specification for filtration and insulation applications, liquid paperboard bale, shredded mixed flexible plastic, advanced recycled feedstock, advanced recycling output (oil) and pulp.

A series of upstream and downstream actions have also been recommended to help more sorting and processing facilities meet the specifications and improve the quality and/or quantity of the resources recovered.

These include;

- Packaging design should aim to avoid composite packaging, pressure-sensitised labels, coloured PET and limit tin content, to reduce contamination of the stream.
- Packaging labelling for all aerosol cans should clearly advise the consumer how to safely dispose of the can to prevent explosions and fires and this messaging should be reinforced in relevant state and local government community education campaigns.
- Phasing out the use of PVC and PS in packaging and ensuring the Australian Recycling Label indicates the appropriate recycling categorisation for packaging made from PVC or PS.
- National, state, territory and local governments should consider national bin input standards to reduce increase inconsistencies between LGAs, including:

    - consider only permitting washed, non-composite steel cans and aluminium used beverage cans in yellow bins.
- State, territory and local governments should consider running community education campaigns on key bin contaminant issues.
- State and territory governments should consider expanding the type of glass and plastic containers collected through container deposit schemes.
- Federal government should clarify as soon as possible listed export specifications for paper/cardboard to support timely investment to prepare for export ban.
- The recycling industry in association with packaging companies, brands and state and federal governments should consider jointly investing in upgrading sorting and processing facility equipment to remove contamination from all material types.
- State and territory governments should where possible consider aligning end of waste and resource recovery orders for organics.
- Local governments should consider aligning food and organic contracts with state and territory regulations for organic processing facilities.
- Federal, state, territory and local governments should where possible consider preventing products and packaging containing unacceptable levels of PFAS and persistent herbicides being accepted in green bins.
- AORA and agricultural sector should consider developing an organic product certification scheme driven by end user consultation to create higher value products for agriculture and incentivise product innovation.
- Federal, state and territory governments should consider assisting sorters and processors gain independent certification of processed outputs against the recommended specifications to give domestic and international end users greater confidence in the quality of material being supplied. If deemed appropriate, certification could also help streamline the export permit process.
- NWRIC should develop in consultation with ACOR, APCO, AORA, Chemistry Australia an online portal that provides sorters, processors and end users a free, single point of access to all relevant recovered material specifications.

1 Introduction

The NWRIC, with the assistance of MRA Consulting, was engaged by the Department to consider and recommend national performance standards (e.g. recovered resource specifications) for primary sorting facilities and secondary processing facilities handling glass, plastics, metals, paper and cardboard, and organics collected through the MSW stream.

This project aims to:

- assist Australian recyclers enhance tradeable products in domestic and overseas markets
- meet market demands for recovered materials locally and overseas
- improve the quality of recovered materials as tradable commodities, and
- stimulate domestic re-use of recovered materials by improving market information and greater confidence in the quality of recovered materials.

The project contributes to the implementation of the 2019 National Waste Policy Action Plan. Specifically, *Action 3.19 - Develop performance standards for material recovery facilities and assess opportunities for other standards (such as for markets, products and waste professiona*ls).

1.1 Background

In late 2018 Australia's Environment Ministers and the President of the Australian Local Government Association agreed to the National Waste Policy which set a new unified direction for waste and recycling in Australia. The policy provides a framework for collective, national action on waste management, recycling and resource recovery to 2030. It reflects a new way of thinking about waste as a resource, and it applies circular economy principles to waste management to support better and repeated use of our resources.

Subsequently, all Australian governments agreed to the National Waste Policy Action Plan[1] in 2019 with the following seven targets:

- ban the export of waste plastic, paper, glass and tyres, commencing in the second half of 2020
- reduce total waste generated in Australia by 10% per person by 2030
- 80% average recovery rate from all waste streams by 2030
- significantly increase the use of recycled content by governments and industry
- phase out problematic and unnecessary plastics by 2025
- halve the amount of organic waste sent to landfill by 2030
- make comprehensive, economy-wide and timely data publicly available to support better consumer, investment and policy decisions.

In March 2020, the Australian, state and territory governments, and the Australian Local Government Association, as members of the former Council of Australian Governments (COAG), agreed that the export of waste glass, plastic, tyres and paper be regulated by the Australian government.

[1] https://www.environment.gov.au/protection/waste-resource-recovery/publications/national-waste-policy-action-plan

The regulation of waste glass, plastic, tyres and paper commences as follows[2]:

- **1 January 2021** — Export of waste glass limited to glass that has been processed into, for example, furnace-ready or non-furnace-ready glass cullet or fines.
- **1 July 2021** — Export of waste plastic limited to:
    - plastic sorted into single resin or polymer type
    - processed with other materials into processed engineered fuel.
- **1 December 2021** — Export of waste tyres limited to:
    - tyres for re-treading to an appropriate re-treading facility
    - tyres that have been processed into shred, crumbs, buffings or granules
    - tyres that have been processed into shreds for use as tyre-derived fuel
    - tyres that will be re-used overseas.
- **1 July 2022** — Export of waste plastic limited to:
    - plastic sorted into single resin or polymer type and further processed, for example flaked or pelletised
    - plastic processed with other materials into processed engineered fuel.
- **1 July 2024** — Export of paper and cardboard limited to that which is processed or sorted to specific requirements

The Australian Government will regulate the export of certain waste from Australia under the *Recycling and Waste Reduction Act 2020,* which aims to:

- to reduce the impact on human health and the environment for products, waste from products and waste material
- to realise the community and economic benefits of taking responsibility for products, waste from products and waste material
- to develop a circular economy that maximises the continued use of products and waste material over their life cycle and accounts for their environmental impacts
- to contribute to Australia meeting Its International obligations concerning the impact on human health and the environment of waste from products and waste material.

To be able to export certain regulated waste glass, plastic, and paper and cardboard, exporters are required to meet requirements under the *Recycling and Waste Reduction Act 2020* and relevant rules for each material type. This includes processing regulated waste to a quality consistent with recognised recovered resource specifications (listed specifications) prior to export.

1.2 Scope

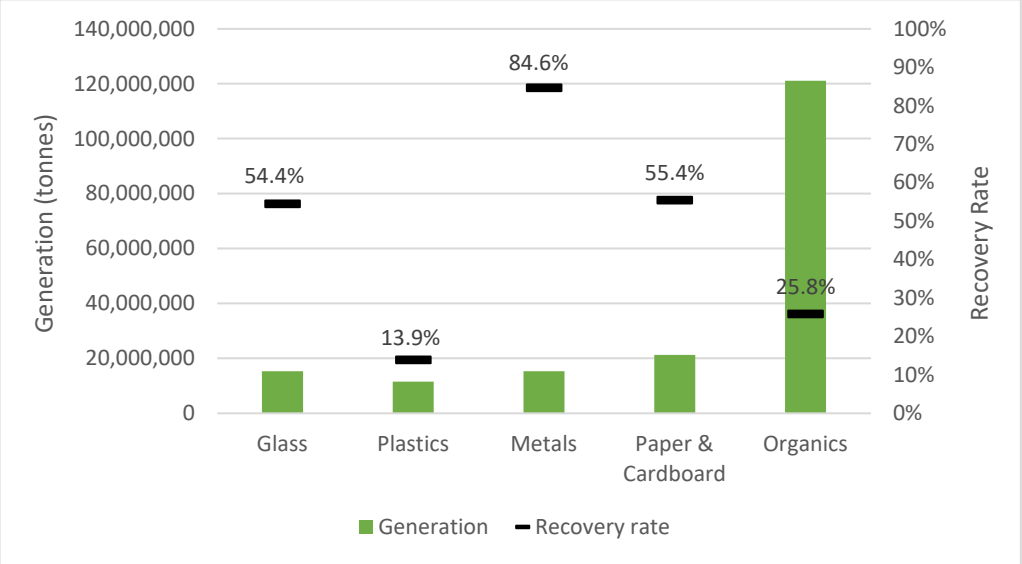
This project was limited to the MSW stream, and more specifically the glass, plastics, metals, paper and cardboard and organics recovered through either kerbside bin collections, Container Deposit Schemes (CDS) and public soft plastics collection systems (e.g. Redcycle). The bulky waste stream was not considered within the scope of this project.

According to the National Waste Report 2020, a total of 12.6 million tonnes of waste were generated through the MSW stream in 2018. Only 41% of this waste was recycled with a further 9% recovered as energy. The recovery rate for each of the five materials addressed

[2] https://www.environment.gov.au/protection/waste/exports/transition

by this project - glass, plastic, metals, paper and cardboard, and organics varied significantly from a high of 84.6% for metals to a low of 13.9% for plastics as shown in Figure 1[3].

Figure 1 MSW generation and recovery rates 2018-19



The recovered resource specifications focussed on the outputs generated by sorters (e.g. material recovery facilities (MRFs) and processors (e.g. glass beneficiation, mechanical and chemical plastic processors, organic processors) and the inputs sought by end users (e.g. manufacturers of packaging and products, infrastructure construction).

1.3 Approach

The NWRIC and MRA undertook a literature review including government and industry reports and articles pertaining to recovered resource specifications locally and internationally.

The literature review was built on an audit of existing local and overseas recovered resource specifications completed previously by NWRIC in 2020 to establish an up to date set of national recovered resource specifications across all waste streams and material types.

Material flow pathway diagrams for plastics, paper, glass, metals and organics were developed from the point of collection, through the sorting and processing steps to the final outputs and subsequent end uses. The point at which each existing recovered resource specification applied was also mapped on to the material flow pathway diagrams.

Stakeholder consultation was an essential component of this project to consider and recommend a set of national performance standards / specifications that are practical to implement, commercially sound, deliver added value back to the resource recovery chain, increase resource recovery, are easy to update in response to changing technology and market conditions, and will be acceptable to both the operators and manufacturers.

The NWRIC and MRA conducted two industry project briefing webinars with input from Department and relevant stakeholders. The webinars were followed by the release of an online survey and one-on-one interviews with industry representatives across the supply chain.

[3] National Waste Report 2020 | Department of Agriculture, Water and the Environment

The online survey received 16 responses and one-on-one interviews were held with 38 industry stakeholders across the supply chain and material types to provide more detailed feedback on the material flow pathways and recovered resource specifications. The stakeholders approached for interviews were selected with the aim to engage with organisations involved at each point along the resource recovery supply chain from sorters, processors to end users and across each material type.

A list of stakeholders consulted is provided at Appendix A. Detailed interview notes were provided separately and in confidence to DAWE. A summary of the broad range of feedback received from stakeholders is provided in the form of paraphrased comments in each material section of this report.

Following stakeholder feedback on existing specifications and the material flow pathways, the identified recovered resource specifications were then assessed with regard to:

- How each standard / specification will support resource recovery in Australia, and contribute to the circular economy;
    - Including consideration of whether processing enables remanufacture into an equivalent product or if it results in upcycling/downcycling
- The benefits, barriers and risks of each recommended standard / specification;
- Impacts on upstream processes (e.g., kerbside waste collections) and downstream processes (e.g., sorting, secondary processing and re-manufacturing);
    - Including consideration of changes to collection processes, accepted materials, limits of contamination
- Impacts on the price of recycled materials and products, relative to current costs and to virgin materials, and compliance costs;
- Impacts on consumer demand for end products;
- Impacts on the ability of businesses to compete in the market or on their incentives to compete;
    - Consideration of whether compliance with the specifications will enhance a business' competitiveness, and
- Impacts on renegotiations of local council waste and recycling contracts
    - Consideration of whether contract terms in MRF processing agreements with councils would be impacted e.g., accepted materials, recovery rates

From this assessment and stakeholder feedback, a set of recovered resource specifications for primary sorting facilities and secondary processing facilities have been recommended including indicative timeframes, responsibilities and practical steps upstream and downstream to achieve each specification.

1.4 Integration with the Australian Recycling Accreditation Program (ARAP)

ACOR has been undertaking a DAWE funded project to recommend a national accreditation program for Australian recyclers, the Australian Recycling Accreditation Program (ARAP). ARAP incorporates both the operational aspects of a recycling and resource recovery facility as well as the outputs. The certification process includes an auditing and reporting function to identify and verify the relevant standards or specifications that apply to the recovered material outputs of the recycler (i.e. sorter and processor).

The recovered material specifications recommended in this report have been considered in consultation with ACOR to provide sorters and processors with a list of minimum standard and best practice specifications they may use to have their outputs certified against.

2 Literature Review

2.1 Reports

A review was conducted of government and industry reports and articles pertaining to recovered resource specifications locally and internationally.

A report published by Equilibrium[4] highlighted the need to communicate the importance of a clean feedstock for the uptake of recycled material in end products, as further processing can add costs onto the recycled material, making its use uneconomical. The cleanliness or contamination of feedstock is closely related to upstream factors such as:

- Packaging design (reducing the use of composite and problematic materials)
- What materials are accepted in kerbside recycling bins, and
- Household recycling behaviours and the level of bin contamination observed through incorrect recycling practices.

To supplement these upstream factors, downstream actions can be implemented to improve the quality of recycled material including:

- Equipment upgrades and improvements to sorting and processing technology, and
- Adherence to performance standards and recognised recovered resource specifications.

Additionally, a report by MRA[5] in this area highlighted the lack of standards for emerging recyclate materials. The same report also identified the benefits of national harmonisation of specifications, as each state having different material specifications hinders both investment and progress towards a circular economy. These issues emphasise the importance of this project in developing national recovered materials specifications.

2.2 Standards and Specifications

Recovered resource specifications can be categorised into the following groups:

- Regulatory specifications
- Australian standards
- Technical specifications
- Industry specifications
- Trading specifications, and
- Listed waste export specifications.

Regulatory specifications are specifications referred to in Australian national, state and territory environmental and waste management legislation. They specify minimum processing, contamination thresholds, what is allowable, what is prohibited, physical and chemical requirements that must be met. Regulatory specifications relevant to this report include several NSW Environment Protection Authority (EPA) Resource Recovery Orders

[4] Review of standards and specifications for recycled content, 2019 https://www.awe.gov.au/environment/protection/waste/publications/review-standards-specifications-recycled-content

[5] https://mraconsulting.com.au/wp-content/uploads/2021/06/MRA-report-for-ACOR-Recycled-content-in-roads.pdf

(RRO) and Exemptions (RRE)[6]. The primary purpose of regulatory specifications is to protect the environment rather than optimise resource recovery. Most regulatory specifications apply to recovered materials that will be applied to land and do not cover recovered materials re-used in other settings (e.g., packaging).

Standards and technical specifications are published documents that are designed to provide guidance to help ensure safety, performance and reliability through the specifications of goods, services and systems.

There are Australian and international standards, Australian and state-based technical specifications, as well as standards developed by certain regulators, and industry standards developed by professional industry associations for the purpose of maintaining a standard in performance for particular activities within the industries.

Conforming to specific standards and technical specifications is not mandatory unless there is an associated law which requires this, e.g. AS:NZS 5377:2013 an Australian Standard for the collection, transport and processing of end of life electoral and electronic equipment is stipulated in the legislated rule for the National Television and Computer Recycling Scheme.

Industry specifications are guidelines that have been developed for Australian buyers and sellers in trading and negotiation. They are not compulsory but an important benchmark or reference point to assist transactions within industry. Industry specifications discussed in this report include ACOR[7] and APCO[8] specifications.

Trading specifications are like industry specifications but are published by international bodies and cover a wider range of material types. They aim to facilitate communications, establish quality requirements in all steps of the recovery process and assist members in the buying and selling. Trading specifications examined in this report include Institute of Scrap Recycling Industries (ISRI)[9], International Organization for Standardization (ISO)[10] and Association of Plastic Recyclers (APR)[11].

Listed waste export specifications meet the objects of the *Recycling and Waste Reduction Act 2020* and the Recycling and Waste Reduction (Export – Waste Plastic) Rules 2021. Waste processed to listed specifications is likely to be ready for recycling or re-use in a way that reduces harmful impacts to human and environmental health.

When exporters use a listed specification, they must demonstrate their processing capability of the waste material to the listed specification. If they use a non-listed specification, they need to provide evidence that the non-listed specification meets the requirements of the objects of the *Recycling and Waste Reduction Act 2020*, and evidence of their processing capability of the waste material to the unlisted specification.

Table 1 provides examples of specifications according to specification type.

[6] https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/wasteregulation/150107-order-exemptions-factsheet.pdf
[7] http://www.acor.org.au/uploads/2/1/5/4/21549240/specsandguides_introduction.pdf
[8] https://documents.packagingcovenant.org.au/public-documents/Recovered%20Polymer%20Specifications%20-%20ANZPAC%20June%202021
[9] https://www.recyclingtoday.com/article/isri-updates-scrap-specifications/
[10] https://www.iso.org/standard/45089.html
[11] https://plasticsrecycling.org/about

Table 1 Specification examples and descriptions

Specification Type	Example	Additional notes	Geographic focus
Regulatory	NSW EPA's RROs and RREs	• current system commenced in November 2014 • 39 public current orders and exemptions covering a wide range of waste materials each with individual specifications	Australia NSW
Australian standard	Australian Standard for Composts, soil conditioners and mulches (AS4454 – 2012)	• prepared by committee • approved on behalf of the Council of Standards Australia • specifies minimum processing standards • stipulates reporting requirements on a range of analytical tests	Australia
Technical specification	Specifications MRTS36 Recycled Glass Aggregate	• Administered by QLD Department of Transport and Main Roads • sets out the requirements for recycled glass aggregate used in asphalt, unbound granular road pavements, general earthworks • forms part of the Transport and Main Roads Specifications Manual	Australia Queensland
Industry	APCO Recovered Polymer Specifications	• set of 12 voluntary specifications • developed as an initiative of the 2020 APCO Materials Circularity Working Group • developed the specifications in consultation with experts along the packaging supply chain • will be periodically reviewed	Australia
Trading	Institute of Scrap Recycling Industries (ISRI) scrap specifications	• updated most recently in May 2020 • posted in PDF format at least once per year on the ISRI web site • constructed to represent the quality or composition of the materials bought and sold in the industry	International
Trading	International Organisation for Standardisation (ISO) 15270:2008	• ISO is an international standard-setting body • establishes the quality requirements that should be considered in all steps of the recovery process • First published in 2008 • reviewed and confirmed in 2018	International
Trading	Association of Plastic Recyclers (APR)	• developed 22 model bale specifications • developed to facilitate communications between bale producers (e.g. MRFs) and purchasers	International
Listed specification	Standards approved by the Australian Government *(meets the Objects of the RaWR Act for export)*	• Waste glass and waste plastics	Australia

The NWRIC and MRA conducted a literature review of existing local and overseas recovered resource specifications for the relevant materials streams.

The specifications identified as the most relevant and/or applicable for the recovery of resources from the MSW stream are listed in the following sections.

The number of specifications by material type, national and international, are summarised in Table 2. Note: some specifications for metals were considered both sorting and processing specifications, e.g. densifying/briquetting/shredding of metals may be performed by sorting or processing facilities.

Table 2 Number of specifications by material type, national vs international

Material Type	National Specifications		International Specifications		Total
	Sorting	Processing	Sorting	Processing	
Glass	1	10	1	2	14
Plastics	8	6	11	0	25
Paper and Cardboard	4	0	6	0	10
Metal	2	0	5*	1	8
Organics	N/A	7**	N/A	1	8
TOTAL	**15**	**22**	**23**	**5**	**65**

*Includes some specifications relevant to both sorting and processing facilities.
**This does not include state end use guidelines.

Some commonalities across the glass, plastics, metals, paper and cardboard (i.e. fibre) and organics specifications were observed and are outlined below.

Elements characterised

Although the specifications cover different material types at varying stages of processing, as expected all identify **contaminant material** (materials that can be tolerated or removed during the recycling / composting process) and **prohibitive material** (materials that are difficult to or cannot be removed during the recycling /composting process) that is not allowed and presence in loads can lead to rejection.

The elements commonly characterised across the specifications include:

- Description of source material (e.g., post-consumer municipal kerbside)
- Contaminant materials
- Limit of acceptable levels of contaminant materials
- Prohibitive materials
- Sizing of product

- Packaging and transport guidelines

Trading basis

The specifications commonly provide commentary describing that the specifications are guidelines or benchmarks meant to assist in facilitating transactions but do not replace individual buyer and seller agreements. Similarly, many specifications allow for negotiation between parties regarding product characteristics.

3 Glass

3.1 Material flow pathway

Glass in the household stream is made up of containers and bottles such as food, beverage, and cosmetic product packaging. In 2018-19, approximately 1.3 million tonnes of glass packaging were consumed in Australia with 900,000 tonnes estimated to be consumed in the household, see Table 3[12]. A total of 408,000 tonnes of glass packaging was collected through the MSW collection service (either a comingled recycling (yellow) bin service or a dedicated glass (purple) bin service (currently only in Victoria) and 132,000 tonnes were collected through CDS. A further 34,000 tonnes were collected via other collection services, such as commercial and industrial (C&I), bringing the national recovery rate in 2018-19 to 45%.

Table 3 Consumption and recovery of glass packaging (tonnes)

Material type	Total consumption	Consumption in the household	MSW collection	CDS collection	Total collected*	Recovery rate**
Glass	1,283,000	900,000	408,000	132,000	574,000	45%

*Including material collected via other collection services from C&I, Construction & Demolition (C&D) and other.

**The recovery rate represents total material consumed and recovered; it is not specific to the household stream.

Once collected, the material is sorted at a primary sorting facility, such as a MRF or container sorting facility. At a MRF, glass is separated from other commingled material by way of glass breakers and screening trommels. It may be sorted into a cullet stream (pieces greater than 50mm), fines (pieces less than 50mm) or a mixed stream (sometimes referred to as “MRF glass”).

Other glass material, such as drinking glasses, window glass and light bulbs, and non-glass material, such as ceramics, stone and porcelain (CSP), may incidentally be crushed and included in the glass stream, contaminating the stream with prohibitive materials.

Cullet and MRF glass are sent to a glass beneficiation plant where it is sorted by colour, some contaminants are removed, and it is separated into cullet and fines. The cullet may or may not be washed before being sold to end users as 'furnace ready' glass where it is melted in a furnace to produce new glass bottles/containers. The glass fines, also known as 'non-furnace ready' glass, are sent to a processor to be further crushed (generally <5mm) and used in road base, asphalt, glass sand and other civil applications, as a replacement for quarried materials. Glass fines can be melted in a furnace however contamination is difficult to remove due to its small size, therefore cullet is more likely to be used in furnaces. Glass fines from a MRF are also processed this way.

Glass material coming through CDS is generally considered higher quality and therefore more valuable as it has been source separated, has fewer contaminants and has not been crushed by compaction trucks or MRF machinery. This makes CDS material more suitable for bottle manufacture. Note some CDS cullet may be approved for export without further

[12] Australian Packaging Consumption & Recycling Data 2018-19 (2021) Australian Packaging Covenant Organisation.

beneficiation if it meets the requirements of a listed specification such as the ACOR beneficiated cullet specification[13].

3.2 Specifications

Specifications for furnace ready and non-furnace ready glass material vary depending on agreements between buyers and sellers, i.e. agreements between primary sorters and secondary processors, and between secondary processors and end users.

For **furnace ready material**, there are ACOR and ISRI specifications for unbeneficiated/ unprocessed cullet coming out of sorting facilities and beneficiated/processed cullet coming out of processing facilities. As of 18 October 2021, DAWE had listed the ACOR beneficiated cullet specification (glass) as meeting the objects of the *Recycling and Waste Reduction Act 2020* and the Recycling and Waste Reduction (Export - Waste Glass) Rules 2020. Waste processed to a listed specification has been assessed to ensure that thresholds for contaminants, colour and size reduces harmful impacts to human and environmental health and is ready for recycling or re-use.

For **non-furnace ready material** either coming from sorting facilities or cullet processing facilities (to be further processed as fines) specifications are agreed between sorters/processors and end users. There aren't many published specifications for glass fines, However, details of some published specifications are outline below.

For **processed fines**, there are several state regulations and specifications set by various state engineering bodies outlining end user material requirements. This is because the use of glass fines in civil works is regulated by state governments to ensure protection of the environment. Standards vary due to different end uses (road base, filtration and insulation) and environmental conditions and other factors in different states.

In NSW, there is a mandatory Recovered Glass Sand Resource Recovery Order outlining the physical and chemical properties that suppliers (processors) of glass fines/sand must meet for use in construction projects[14]. For use in roadworks contracts led by Transport for NSW or by local councils, recovered glass sand must comply with the Transport for NSW Granulated Glass Aggregate 3154 Specification[15]. For other uses, other specifications may be used by engineers of specific projects.

In Queensland, an end of waste (EOW) code for glass fines has been drafted and is currently in a consultation period[16]. The EOW code outlines relevant requirements for the use of glass fines and the physical and chemical requirements mirror the NSW Recovered Glass Sand Resource Recovery Order.

In Victoria, there is no set specification however the *Use of Glass Fines Fact Shee*t (2019) published by EPA Victoria states that glass fines must:

- Meet the specification for its intended use (i.e. Industry specifications);
- Have less than 2% physical contaminants; and
- Be below the chemical contamination thresholds set out In the Solid Industrial waste hazard categorisation and management (EPA publication IWRG631)[17].

To use glass fines in road pavement material mixes for VicRoads roadworks projects, the material mixes must be registered in accordance with the VicRoads Registration of Crushed

[13] DAWE website: www.awe.gov.au/environment/protection/waste/exports/specifications-and-documents/glass-specifications
[14] The recovered glass sand order 2014 (2014) NSW EPA.
[15] Granulated Glass Aggregate Specification 3154 (rev 1 2020) Transport for NSW.
[16] Queensland government end of waste framework: https://environment.des.qld.gov.au/management/waste/business/end-of-waste-classification#eow-code
[17] Fact sheet: Use of glass fines (2019) EPA Victoria.

Rock Mixes Code of Practice (2017)[18]. This code of practice states that glass fines must be >4.75mm, cubical in shape and have a maximum contamination limit of 2% by mass.

In Western Australia, the use of crushed recycled glass in road construction must meet the requirements set out in Main Roads Specification 302 Earthworks[19]. The main elements of the specification include:

- Glass must be sourced from food and beverage containers (and building or window glass);
- Limits of foreign materials (maximum % retained by mass on 4.75mm sieve):
    - High density materials (brick, tiles, etc): 5.0%
    - Low density materials (plastic, plaster, etc): 2.0%
    - Wood and other vegetable matter: 1.0%; and
- A shape crushing plant to be used in the process.

No specific regulations or specifications were found regarding glass fines in the other states and territories.

The flow pathway and specifications for glass can be found in Figure 2 and Table 4, respectively. The specification key in the flow pathway corresponds to the specifications in the table.

[18] Registration of Crushed Rock Mixes Code of Practice (2017) VicRoads.
[19] Specification 302 Earthworks (2020) Main Roads Western Australia.

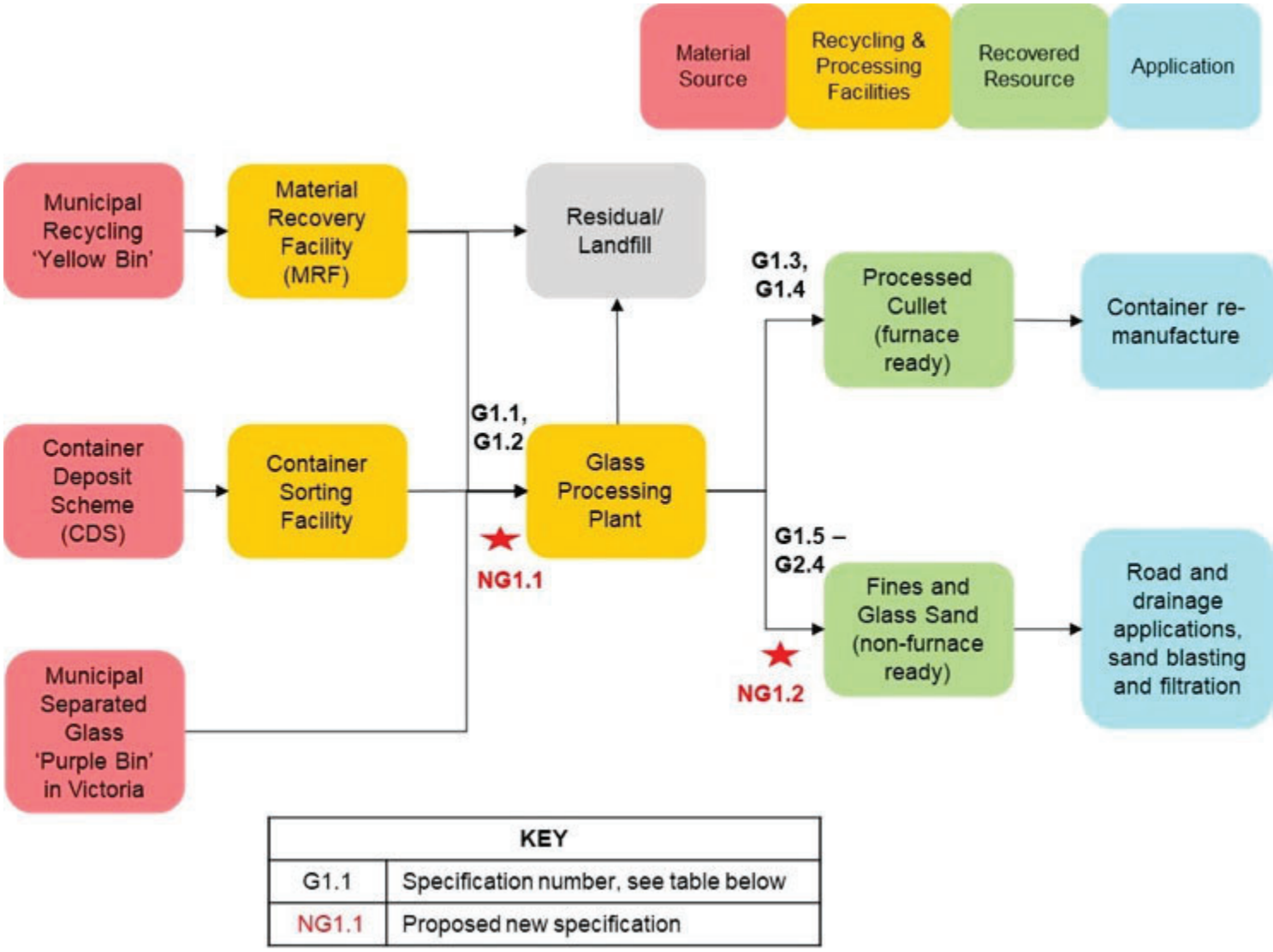


Figure 2 Glass flow pathway

Table 4 Glass specifications for sorters and processors

Flow key	Specification name	Author	Sorter/ Processor	RaWR Act listed specification (✓ / ×)[20]
G1.1	Unbeneficiated Cullet Specifications (Glass)	ACOR	Sorter	×
G1.2	Guidelines for Glass Cullet: Unprocessed container glass cullet specifications: amber, flint or green	ISRI	Sorter	×
G1.3	Beneficiated Cullet Specifications (Glass)	ACOR	Processor	✓
G1.4	Guidelines for Glass Cullet: Processed (furnace ready) Cullet Specifications: amber, flint or green	ISRI	Processor	×
G1.5	Registration of Crushed Rock Mixes	VicRoads	Processor	×
G1.6	Specifications for Recycled Crushed Glass as an Engineering Material	ARRB	Processor	×
G1.7	QA Specification 3154 Granulated Glass Aggregate	Transport for NSW	Processor	×
G1.8	Specifications MRTS36 Recycled Glass Aggregate	QLD Department of Transport and Main Roads	Processor	×
G1.9	Earthworks Specification 302	Main Roads Western Australia	Processor	×
G2.0	Specification of Basecourse Aggregate	Transit New Zealand	Processor	×
G2.1	The Recovered Glass Sand Order 2014	NSW EPA	Processor	×
G2.2	DRAFT - End of Waste Code - Glass Fines	Queensland Government	Processor	×
G2.3	WSA PS – 368 Recycled Glass Sand for Pipe Embedment	Water Services Association of Australia	Processor	×

[20] DAWE website: https://www.awe.gov.au/environment/protection/waste/exports/specifications-and-documents/glass-specifications. Listed specifications for waste glass have been assessed against the Objects of the *Recycling and Waste Reduction Act 2020* (RaWR Act). However, most exporters of waste glass apply for a licence nominating their own specification or their supplier's specification (if they don't process the waste glass themselves). Just because they don't use a 'listed specification' does not mean they won't get a licence. The department assesses all non-listed specifications for waste glass to ensure it meets the RaWR Act as part of the licence assessment process.

Flow key	Specification name	Author	Sorter/ Processor	RaWR Act listed specification (✓ / ×)[20]
G2.4	Recycled Glass Sand Specification	Metro Trains Melbourne	Processor	×
NG1.1	Unprocessed glass fines specification to be developed	NWRIC/ACOR	Sorter	×
NG1.2	Glass sand specification for filtration and insulation applications to be developed	NWRIC/ACOR	Processor	×

3.3 Stakeholder feedback

A summary of comments made by stakeholders in the glass recycling industry regarding specifications and resource recovery are included in Table 5.

Table 5 Glass stakeholder consultation summary of feedback

Output	Sorter Specifications	Processor Specifications
Cullet	• Specifications are negotiated between buyers and sellers. • Beneficiation is expensive so specifications need to be tight. • One sorter stated that the ACOR unbeneficiated cullet specification may be used by sorters however specifications are more often customer based. • Another sorter reported that the ACOR unbeneficiated cullet specification is too strict for sorters. For example, MRFs are not likely to test for chemicals as specified in the ACOR specifications. • A large processor of cullet quoted the ISRI unprocessed cullet specification as the most suitable for cullet coming out of a MRF. The material does not need to be colour sorted as specified in the ISRI specifications as processors can do this. The level of contamination is based upon the buyer and seller's agreement. • Glass pieces below 8mm are hard to sort and get contaminants out: source separated material (CDS or the dedicated glass purple bin) will solve this issue. • Glass processing equipment investments might be able to sort material down to 3mm and therefore smaller cullet pieces from MRFs may be accepted. Specifications should be updated accordingly in the future. • It is more expensive to process MRF glass compared to CDS glass as CDS material is cleaner. Funding to MRFs to put in a glass clean-up line would improve the quality of MRF cullet.	• One glass packaging manufacturer reported that the ACOR beneficiated cullet specification is old and doesn't take into account the current market. The ISRI specification for processed cullet better represents what is produced by processors. • Another glass packaging manufacturer reported that their specifications are similar to the ACOR beneficiated cullet specification but stricter for ferrous and non-ferrous metal contaminants as that is what is required to ensure the quality of the glass product. • The biggest contamination issues are metal and plastic. Metal embedded in remanufactured glass bottles causes structural and safety issues. • Packaging product design should avoid aluminium caps. Additional equipment in the beneficiation process may be required to ensure metal removal.

Output	Sorter Specifications	Processor Specifications
	• Cullet sourced from CDS streams have stricter specifications regarding contamination levels than cullet sourced from MRFs. e.g. 0% for CSP. • More cullet is recovered in states with CDS as the 10c refund provides an incentive to source separate material and there is limited crushing of CDS glass as bottles are whole/intact and avoid compaction and crushing in the collection truck and MRF sorting process. • Source separated material will always be the most valuable. To increase the recovery of glass cullet, the CDS should be operating every state and the (CDS) eligible containers list should be expanded to include condiment and wine bottles. Also increasing the deposit per bottle would increase recovery. • However, if more container types were accepted in CDS this would further reduce the quality (and price) of MRF cullet. Future glass fines specifications for MRFs should take this into account. • Contamination of paper and glass collected in the yellow bin with glass is a big issue. Purple glass bins should be expanded to other councils or drop-off sites.	
Fines/ crushed glass	• There is no official specification for glass fines coming out of a MRF. It depends on the MRF equipment. MRFs with older equipment, such as those in regional areas, might have up to 15-20% contamination while modern metro MRFs might have 2-5% contamination. • MRFs will provide the product description/specification to buyers and a price is agreed upon. Processors will generally take it all and adjust the price according to contamination levels. • Some processors can accept material from sorters with a higher level of contamination (at a reduced price) as they have the processing equipment to remove contamination.	• The cullet specifications are hard to achieve, it is easier for processors to process into glass fines. • The processor specifications are based on the end-user specs. • Road specifications are prohibitive because of the wash off and other contaminants that come off glass. The cost to process versus what you get for it is not very economical. • Fines/sand processors also take material from cullet beneficiators: it is generally <10mm glass fines and CSP and there might be <1% contamination, depending on the equipment used. The fines and CSP are then

Output	Sorter Specifications	Processor Specifications
	• MRFs will generally try to remove metal contaminants as these are valuable to recover but don't bother about plastic and paper contaminants. Batteries are the biggest contamination issue. • Glass fines material can be any size, including whole bottles, but it is generally <50mm pieces. • If a strict specification is set, it will make it harder for older MRFs to achieve and limits their offtake options. • There is a lack of regional glass processors and some MRFs are having to transport their material large distances.	crushed to meet the end-user application specs, e.g. VicRoads and Water Services Association of Australia (WSAA). • Some MRFs may employ extra processing for fines material to go straight into an end-use. These MRFs are then considered both the sorter and processor. • Although it's good to ensure all glass gets recycled or downcycled as recycled content in construction projects, there isn't much glass fines material available. As most is going into bottles, there's not much remaining for construction and this is likely to decrease as beneficiation equipment improves and becomes cheaper.

3.4 Impact assessment

To support resource recovery and the circular economy in Australia, recycling of glass into new glass bottles/containers, as opposed to glass fines, should be maximised. Increased recycling of glass into bottles will also help Australia reduce its CO_2 footprint and meet its emission targets. Melting cullet in the furnace requires less energy compared to melting virgin material and avoids the release of carbon dioxide from virgin ingredients that naturally contain carbon. On average, a 10% increase in recycled cullet in bottle-to-bottle manufacturing leads to approximately a 5% reduction in CO_2 emissions and a 3% reduction in energy usage[21]. Furthermore, every 1 tonne of glass recycled avoids quarrying, processing and transporting 1.2 tonnes of raw material.

Based on consultation with stakeholders, a specification for each material output was chosen as a general guideline for sorters and processors. The impact of each specification was assessed in regard to the actions required to achieve the specification and improve resource recovery, see Table 6.

For cullet, two sorter and two processor specifications were chosen: one to demonstrate a minimum standard and one to demonstrate a best practice standard.

Minimum standards refer to the minimum that the average processor/end user can receive due to machinery constraints and product requirements. Best practice standards are those that can increase the commercial value of the resources and are generally what the processor/end user would prefer. Best practice standards should be used where possible, e.g. where there is investment in machinery and processes.

[21] Recycling: Why glass always has a happy CO2 ending (2021) The European Container Glass Federation.

Table 6 Glass impact assessment

Sorter/ Processor	Specification	Key aspects of the specification	How it supports resource recovery	Benefits, barriers, risks to achieving the specification	Price/ market impacts	End user demand	Business benefits and (compliance) costs.	Waste and recycling contracts
Sorter	**ACOR** **G1.1 Unbeneficiated Cullet** *(best practice)*	- Defined hazardous contamination limit: less than 5kg of non-glass material per tonne of glass cullet. - Prohibited material (0% allowed) includes non-glass containers and pyroceramic material. - Size: 50% must be >60mm. The minimum amount should be <8mm. - Includes chemical composition of cullet. - Note: the specification requires material to be colour sorted. Australian processors highlighted that cullet from a MRF does not need to be colour sorted.	Provides a standard for sorters to sort glass so that best practice unbeneficiated cullet is achieved.	- The specification provides clear limits for hazardous and prohibited contamination, emphasising the importance of limiting material. - Some MRFs don't have glass beneficiators nearby. Only Melbourne, Sydney, Brisbane and Adelaide have glass beneficiation facilities. This is a barrier as some MRFs encounter high shipping costs or are required to look for alternative processors, such as glass fines processors. - Thin glass products and excessive compaction during collection is a barrier as less glass is suitable for cullet.	Limited change to current prices. Any additional costs of processing at a MRF would be passed onto the council and residents. Small number of cullet offtake options (Visy, Orora, Polytrade) means there is less competition and MRFs have limited negotiating power.	No direct impact	Limited impact on business ability or incentive to compete. Producers of cullet are generally already achieving the specification. Some MRFs may require a glass clean up line to achieve the specification.	Unlikely to impact MRF contract terms with local governments.
Sorter	**ISRI** **G1.2 Unprocessed container glass cullet** *(minimum standard)*	- Contamination levels (for outthrow materials) to be negotiated between buyer and seller (based on processing capabilities). - Prohibitive material (0% allowed) includes non-container glass, metals, CSP and others. - Size: cullet should be broken but not pulverised. - Note: the specification requires material to be colour sorted. Australian processors highlighted that cullet from a MRF does not need to be colour sorted.	Provides a minimum standard for sorters to sort glass so that the highest recovery order is achieved (bottle-to-bottle).	- The specification does not provide clear limits for outthrow materials. Allows for negotiation with processors. - Strict limits for prohibitive material emphasise the importance of limiting these materials. - Some MRFs don't have glass beneficiators nearby. This is a barrier as some MRFs encounter high transport costs or are required to look for alternative processors, such as glass fines processors. - Thin glass products and excessive compaction during collection is a barrier as less glass is suitable for cullet.	Limited change to current prices. Any additional costs of processing at a MRF would be passed onto the council and residents. Small number of cullet offtake options (Visy, Orora, Polytrade) means there is less competition and MRFs have limited negotiating power.	No direct impact.	Limited impact on business ability or incentive to compete. Producers of cullet are generally already achieving the specification. Some MRFs may require a glass clean up line to achieve the specification.	Unlikely to impact MRF contract terms with local governments.
Sorter	**NG1.1 Glass fines** *To be developed*	- To be developed In consultation with MRFs and glass fines processors.	Will provide a minimum standard for sorters to sort glass fines for further processing if cullet specifications cannot be met.	To consider: - Material quality varies widely depending on the MRF process/equipment. - A stricter specification will make it harder for the older or more regional MRFs to achieve and limits the recycling options	Limited impact however this will depend on the contamination levels chosen.	No direct impact.	Limited impact however this will depend on the contamination levels chosen.	No direct impact expected.

Sorter/ Processor	Specification	Key aspects of the specification	How it supports resource recovery	Benefits, barriers, risks to achieving the specification	Price/ market impacts	End user demand	Business benefits and (compliance) costs.	Waste and recycling contracts
				- Batteries are a major contamination issue for processors				
Processor	**ACOR** **G1.3 Beneficiated cullet** *(a 'listed specification' - meets the Objects of the RaWR Act for export)*	- Defined hazardous contamination limits (per tonne of cullet): <3kg of organic matter, <3g of ferrous materials, <15g of nonferrous materials, <15g of ceramics. Any piece of contamination should be <1cm. - Prohibited material (0% allowed) includes non-glass containers and pyroceramic material. - Size: all pieces <50mm. <10% to be <8mm. - Sorted by colour (amber/flint/ green). - Includes chemical composition of cullet. - Testing and sampling for ceramics, metals and colour required.	Provides a minimum standard for processors to beneficiate glass so that the highest order recovery is achieved (bottle-to-bottle).	- An Australian waste export listed specification allows competition in global market. - Clear maximum levels for specific contamination material emphasises the importance of limiting these materials. - Testing and sampling requirements ensure product quality. May be a barrier for some processors.	Limited to no change to current prices. Small number of beneficiated cullet offtake options.	No direct impact.	Limited impact on business ability or incentive to compete. Suppliers of beneficiated cullet will already be achieving the specifications.	No direct impact on MRF contracts with local governments
Processor	**ISRI** **G1.4 Processed (furnace ready) cullet** *(domestic)*	- Contamination levels (organic matter) to be negotiated between buyer and seller. - Prohibitive material (0% allowed) includes non-container glass, metals, ceramics and other material. - Size: Cullet should be >8mm. - Sorted by colour (amber/flint/ green).	Provides a minimum standard for processors to beneficiate glass so that the highest order recovery is achieved (bottle-to-bottle).	- The specification does not provide clear limits for organic matter contamination. Allows for negotiation with processors. - Strict limits for prohibitive material emphasise the importance of limiting these materials.	Limited to no change to current prices. Small number of beneficiated cullet offtake options.	No direct impact.	Limited impact on business ability or incentive to compete. Suppliers of beneficiated cullet will already be achieving the specifications.	No direct impact on MRF contracts with local governments
Processor	**VicRoads** **G1.5 Registration of Crushed Rock Mixes**	- Glass fines/sand should be less than 4.75mm in size and cubical in shape. - Contamination should be less than 2% of foreign material.	Provides a minimum standard for processed glass fines/sand for use in civil applications	- Provides an alternative recovery pathway for glass not suitable for furnace applications. - Lower contamination level requirement (2%) compared with NSW EPA RRO for glass sand and Qld draft End of Waste code - glass fines (both 0.5%). - Does not list absolute max. concentrations for different chemicals.	Limited to no change to current prices. Large market available for glass sand substitute in civil applications.	No direct impact	Limited impact on business ability or incentive to compete Producers of glass sand will need to manufacture to a similar standard to meet market requirements	No direct impact on MRF contracts with local governments Reciprocal arrangement for local councils to purchase glass sand would provide secure market and price incentives

Sorter/ Processor	Specification	Key aspects of the specification	How it supports resource recovery	Benefits, barriers, risks to achieving the specification	Price/ market impacts	End user demand	Business benefits and (compliance) costs.	Waste and recycling contracts
Processor	**NG1.2 Glass sand for filtration and insulation applications** *To be developed*	To be developed in consultation with end users.	Will provide a standard for processors to process glass sand for use in filtration and insulation applications.	To consider: - Likely to be similar to other current glass sand specifications.	Limited impact.	No direct impact.	Limited impact.	No direct impact expected.

3.5 Glass summary and next steps

A summary of the key findings for the sorter and processor specifications are provided in Table 7 and Table 8, respectively, including the recommendations required and timeframes.

Table 7 Glass sorter recommended specifications, actions and timeframes

Material Output	Recommended specification	Updates required or comments	Currently achieved?	Actions to achieve the specification and/or improve resource recovery	Timeframe & who is responsible
Cullet	**ACOR** **G1.1 Unbeneficiated Cullet** *(best practice)*	None.	Achieved by some MRFs currently producing cullet. Not achieved by MRFs producing only glass fines.	Consider separate glass collection bin or drop-off sites to reduce glass crushing and produce a cleaner stream of material (and reduce contamination of other commingled material streams).	State / local government / national kerbside standard – 1 to 2 years
				Consider expansion of CDS eligible containers list to include more glass material such as wine bottles and food containers.	State government – 1 to 2 years
				Packaging design to reduce the use of metal closures on glass products to reduce contamination of the stream.	APCO, Federal government - 2 to 3 years
				Consider investment in glass clean-up lines at MRFs to remove contaminants from the cullet stream.	Packaging & Recycling Industry & Government - 2 to 3 years
				Consider investment in improved optical sorting equipment at beneficiation facilities to sort smaller glass pieces.	Packaging & Recycling Industry & Government – 2 to 3 years
				Consider investing in glass reprocessing facilities in regional areas OR glass crushing and processing equipment appended to regional MRFs to increase local recovery.	Packaging & Recycling Industry & Government – 3 to 5 years

Material Output	Recommended specification	Updates required or comments	Currently achieved?	Actions to achieve the specification and/or improve resource recovery	Timeframe & who is responsible
Cullet	**ISRI** **G1.2 Unprocessed container glass cullet** *(minimum standard)*	Less emphasis on colour separation required. Strict metal limits required. These specifications are guidelines for buying and selling container glass cullet and always subject to the buyer and seller's agreement (p. 25)	Generally achieved by MRFs currently producing cullet. Not achieved by MRFs producing only glass fines.	Consider separate glass collection bin or drop-off sites to reduce glass crushing and produce a cleaner stream of material (and reduce contamination of other commingled material streams).	State / local government / national kerbside standard – 1 to 2 years
				Consider expansion of CDS eligible containers list to include more glass material such as wine bottles and food containers.	State government – 1 to 2 years
				Packaging design to reduce the use of metal closures on glass products to reduce contamination of the stream.	APCO, Federal government - 2 to 3 years
				Consider investment in glass clean-up lines at MRFs to remove contaminants from the cullet stream.	Packaging & Recycling Industry & Government - 2 to 3 years
				Consider investment in improved optical sorting equipment at beneficiation facilities to sort smaller glass pieces.	Packaging & Recycling Industry & Government – 2 to 3 years
				Consider investing in glass reprocessing facilities in regional areas OR glass crushing and processing equipment appended to regional MRFs to increase local recovery.	Packaging & Recycling Industry & Government – 3 to 5 years
Fines	**NG1.1 Glass fines** *To be developed*	Requires further consultation with MRFs and glass fines processors.	Specifications are currently based on buyer/seller agreements with varying levels of contamination. There is no suitable publicly available specification.	Specification to be developed.	NWRIC/ACOR – 1 year

Table 8 Glass processor recommended specifications, actions and timeframes

Material output	Recommended specification	Updates required or comments	Currently achieved?	Actions to achieve the specification and/or improve resource recovery	Timeframe & who is responsible
Cullet	**ISRI** **G1.4 Processed (furnace ready) cullet (domestic)**	None.	Currently achieved or agreements are made between buyers and sellers.	Requires unbeneficiated cullet specifications for input material to be met.	See sorter specification actions above.
Cullet	**ACOR** **G1.3 Beneficiated cullet** *(a 'listed specification' - meets the Objects of the RaWR Act for export)*)	None.	Currently achieved or agreements are made between buyers and sellers.	Requires unbeneficiated cullet specifications for input material to be met.	See sorter specification actions above.
Fines	**VicRoads** **G1.5 Registration of Crushed Rock Mixes**	A stricter contamination level should be considered In NSW and Qld (0.5% instead of 2%).	Yes, most engineering projects use similar specifications.	Consider funding to support production and trialling of recycled glass fines in construction projects[22][23].	Federal/State/ local government – 1 to 2 years
				Consider national and state regulations or guidelines for increasing recycled content in construction works [24][25].	Federal/State/ local government – 1 to 2 years
				Glass crushing and processing equipment could be appended to MRFs, such as MRFs in regional areas.	Packaging & Recycling Industry & Government – 2 to 3 years

[22] For example, the Downer Group trial of glass asphalt.
[23] Sustainability Victoria: https://www.sustainability.vic.gov.au/news/news-articles/from-trial-to-reality-recycled-glass-and-plastic-in-asphalt-roads

[24] For example, Victoria's Recycled First policy requires bidders on infrastructure projects to demonstrate how they will optimise use of recycled materials. Ecologiq in Victoria also work with the state government and industry to overcome barriers and increase use of waste materials.
[25] Major Road Projects Victoria: https://roadprojects.vic.gov.au/about/recycled-first

Material output	Recommended specification	Updates required or comments	Currently achieved?	Actions to achieve the specification and/or improve resource recovery	Timeframe & who is responsible
	NG1.2 Glass sand for filtration and insulation applications *To be developed*	Requires further consultation with end users.	Agreements are currently made between buyers and sellers.	Specification to be developed.	NWRIC/ACOR – 1 year

4 Plastics

4.1 Material flow pathway

Rigid plastic in the household stream is made up of containers and bottles such as food, beverage, cosmetic and laundry product packaging made from different polymer types. The polymer types, resin identification codes and packaging product examples are provided in Table 9.

Table 9 Plastic polymers

Polymer	Resin identification code	Packaging product examples[26]
Polyethylene terephthalate (PET)	1	Soft drink bottles, food jars
High density polyethylene (HDPE)	2	Milk and juice bottles, laundry detergent bottles
Polyvinyl chlorine (PVC)	3	Blister packs, clamshells
Low density polyethylene (LDPE)	4	Squeezable bottles, container lids
Polypropylene (PP)	5	Yogurt and margarine containers, takeout containers
Polystyrene (PS) and expanded polystyrene (EPS)	6	PS: Meat trays, takeout cutlery and plates, EPS: takeout clamshells, food containers
Other	7	Large reusable water bottles, some citrus bottles, certified compostable packaging

In 2018-19, a total of 1 million tonnes of plastic packaging were consumed in Australia with approximately 833,000 tonnes consumed in the household, see Table 10[27]. 119,000 tonnes of plastic packaging were collected through the MSW stream (the commingled yellow bin service) and 19,000 tonnes were collected through CDS. A further 42,000 tonnes were collected via other collection services, such as C&I, bringing the national recovery rate in 2018-19 to 18%.

Note: these values differ from those reported in the Australian Plastics Recycling Survey as they only include plastic packaging and no other types of plastic[28].

[26] The Recycled Plastics Market: Global Analysis and Trends (2017) Locock, KES (CSIRO, Australia).
[27] Australian Packaging Consumption & Recycling Data 2018-19 (2021) Australian Packaging Covenant Organisation.
[28] 2018-19 Australian Plastics Recycling Survey (2020) Envisage Works & Sustainable Resource Use.

Table 10 Consumption and recovery of plastic packaging (tonnes)

Material type	Total consumption	Consumption in the household	MSW collection	CDS collection	Total collected*	Recovery rate**
PET	154,000	139,000	35,000	1,000	55,000	36%
HDPE	316,000	279,000	58,000	0	73,000	23%
PVC	15,000	12,000	1,000	0	1,000	7%
LDPE	233,000	167,000	1,000	0	22,000	9%
PP	155,000	128,000	19,000	0	21,000	14%
PS	11,000	10,000	2,000	0	3,000	27%
EPS	16,000	5,000	0	0	4,000	25%
Bioplastic	6,000	3,000	0	0	0	0%
Other	16,000	11,000	0	0	0	0%
Unidentified	78,000	78,000	3,000	0	3,000	4%
Overall	**1,000,000**	**833,000**	**119,000**	**19,000**	**182,000**	**18%**

*Including material collected via other collection services from C&I, C&D and other.
**The recovery rate represents total material consumed and recovered; it is not specific to the household stream.

Once collected, household plastic material is taken to a sorting facility, such as a MRF. At the sorting facility, plastics may be sorted into individual polymer streams or into mixed polymer streams.

Polymers may be sorted into a mixed polymer stream consisting of polymers 1-7 or 3-7. There may also be other mixed polymer bales mixes such as 4:4:2 bales which consist of 40% PET, 40% HDPE and 20% other polymers. Mixed polymer streams may require further sorting at a secondary sorting facility or by the processor, or they may be used in a mixed form to make composite polymer products locally in Australian as mixed bales can no longer be exported as of 1 July 2021.

As a result of the regulation of plastic waste exports and market demand, many MRFs are focused on sorting PET, HDPE and PP due to the high volume and downstream value of these polymers. There is a growing trend for MRFs to upgrade their facilities to achieve this. The individual polymer streams may be further separated by colour as clear/white and coloured.

The rigid plastic streams are baled at the MRF and sent to a plastic reprocessing plant to be mechanically recycled. The plastic is flaked, washed and further sorted to provide a clean stream of plastic flake. The plastic flake is then used by end users to manufacture new plastic products.

Liquid paperboard packaging is a composite form of packaging consisting of paperboard and plastic (and in some cases aluminium). Despite these products being perceived as recyclable, the composite nature of liquid paperboard products means that they are generally considered by MRFs as an outthrow (i.e. can be accepted in small quantities) in mixed paper bales or are sent to landfill. Funding has been granted for a recycling facility to process liquid paperboard into a building product, providing a potential recycling pathway for this material.

Flexible or soft plastic waste generated in the household consists of packaging such as bread bags, confectionary wrappers, postage satchels and bubble wrap. A large proportion of flexible plastic waste is composed of polyolefins, i.e. plastics that include polyethylene (PE) such as HDPE, LDPE, linear LDPE (LLDPE) and PP. However, some flexible plastic may be made up of other materials such as PET, PVC, aluminium and paper.

Flexible plastics are generally not accepted in yellow kerbside recycling bins, but rather householders are encouraged to separate these plastics and drop them off at their nearest REDcycle collection point. However, iQ Renew, Curby Cycle and Nestle[29] are trialling an alternative collection method for flexible plastics using Curby tagged bags deposited into yellow bins. Material collected through these two channels is sent to a plastics reprocessing plant where it is shredded (30-50mm) and contaminants are removed.

The shredded material is then bulk baled and sent to secondary processors/end-users, such as Plastic Forests and Replas, where it may be flaked and extruded into a pellet before being used to manufacture plastic products, such as benches, bollards and decking. Typically, end-users can only incorporate a small proportion of recycled flexible plastics into end products (e.g. 15%) as processing does not currently involve washing or sorting by polymer type or colour.

In March 2021, the Australian Government announced the National Plastics Plan 2021[30], including 2025 National Packaging Targets for industry (established in 2018):

- 100% of packaging is reusable, recyclable or compostable
- 70% of plastic packaging goes on to be recycled or composted
- 50% average recycled content within packaging (20% for plastic packaging)
- Problematic and unnecessary single-use plastic packaging phased out.

At an April 2021 Environment Ministers Meeting, the Environment Ministers identified eight plastic product types for industry to phase out lightweight plastic bags, plastic products misleadingly termed as ‘degradable’, plastic straws, plastic utensils and stirrers, EPS consumer food containers (e.g. cups and clamshells) and EPS consumer goods packaging (loose fill and moulded), and microbeads in personal health care products. The Ministers also agreed to harmonisation of Container Deposit Schemes jurisdictions.

4.1.1 Bioplastics

Bioplastics are plastics that are biobased (derived from biological sources), certified compostable (having the inherent property of biodegradability) or both[31]. Bioplastics can be classified into three categories:

1) Biobased but not certified compostable;
2) Certified compostable but not biobased; and
3) Biobased and certified compostable.

Biobased bioplastics which are not certified compostable are made, partly or wholly, from renewable raw materials such as sugarcane or corn. These products, such as bio-based PET and bio-based PE, can be rigid or flexible and have identical technical properties to fossil-based polymers and share the same resin identification code as their fossil-based plastic counterparts. These bioplastics are suitable for conventional mechanical recycling and relate to the specifications identified in Section 4.2. They are unsuitable for composting.

[29] iQ Renew website: https://www.iqrenew.com/news/nestle-and-iq-renew-soft-plastic-recycling-trial-to-commence-on-nsw-central-coast/
[30] https://www.awe.gov.au/sites/default/files/documents/national-plastics-plan-2021.pdf
[31] 2018-19 Australian Plastics Recycling Survey (2020) Envisage Works & Sustainable Resource Use.

Certified compostable plastics can be broken down by microorganisms. Non-biobased, certified compostable plastics are made from fossil-based polymers such as polybutylene adipate terephthalate (PBAT[32]) and polyvinyl alcohol (PVOH, PVA). Biobased, certified compostable plastics are made from renewable sources such as starch-based, cellulose-based, polyactides (PLA), polyhydroxyalkonates (PHA) and polyhydroxybutyrate (PHB)[33]. Certified compostable plastics are classified as the resin identification code #7 'Other' plastic.

Biodegradable plastics do not have identical technical properties to conventional plastics and are unsuitable for mechanical recycling. For standards regarding certified biodegradable plastics, see Section 7 Organics.

4.2 Specifications

Specifications for plastic material coming out of sorting facilities and processing facilities vary depending on agreements between buyers and sellers. There are no compulsory specifications or regulations that facilities must meet, rather specifications are determined by the customer of the output and its end-use. Despite this, there are several plastic specifications that are widely known in the industry.

For plastic bales, there are ISRI, ACOR, APCO/ANZPAC, and Association of Plastic Recyclers (APR) specifications for single polymer and mixed polymer bales. For processed flake and densified polystyrene, there are Expanded Polystyrene Australia (EPSA) and APCO/ANZPAC specifications for single polymer outputs.

A bale specification for liquid paperboard material sorted at a primary sorting facility currently does not exist and is required to be developed.

ISRI and APR specifications for LDPE film are suitable for export (until 30 June 2022), however the Australian Government deemed that they were not representative of mixed flexible plastics generated in the household.

As flexible plastics collected through the REDcycle or Curby tagged bag programs do not undergo primary sorting at a MRF, a sorting specification is not required. However, a new specification for processed mixed flexible plastics is required. Further information regarding the new specification is discussed in Section 4.4.

As at 18 October 2021, DAWE had listed several plastic specifications that meet the objects of the *Recycling and Waste Reduction Act 2020* and the *Recycling and Waste Reduction (Export - Waste) Rules 2021*. Plastic waste processed to one of the listed specifications is likely to be almost free from contamination and other types of waste and is ready for recycling or re-use in a way that reduces harmful impacts to human and environmental health.

The flow pathway and specifications for plastic can be found in Figure 3 and Table 11, respectively. The specification key in the flow pathway corresponds to the specifications in the table. The specifications listed for export are identified in the table. This flow pathway and specifications demonstrate the current flow of plastics and does not include emerging technologies and potential pathways such as advanced recycling. Advanced recycling is explored in Section 4.2.1.

[32] Note: PBAT can also be produced from renewable resources.
[33] Bioplastics Guide website: http://www.bioplastics.guide/ref/bioplastics/what-are-bioplastics/

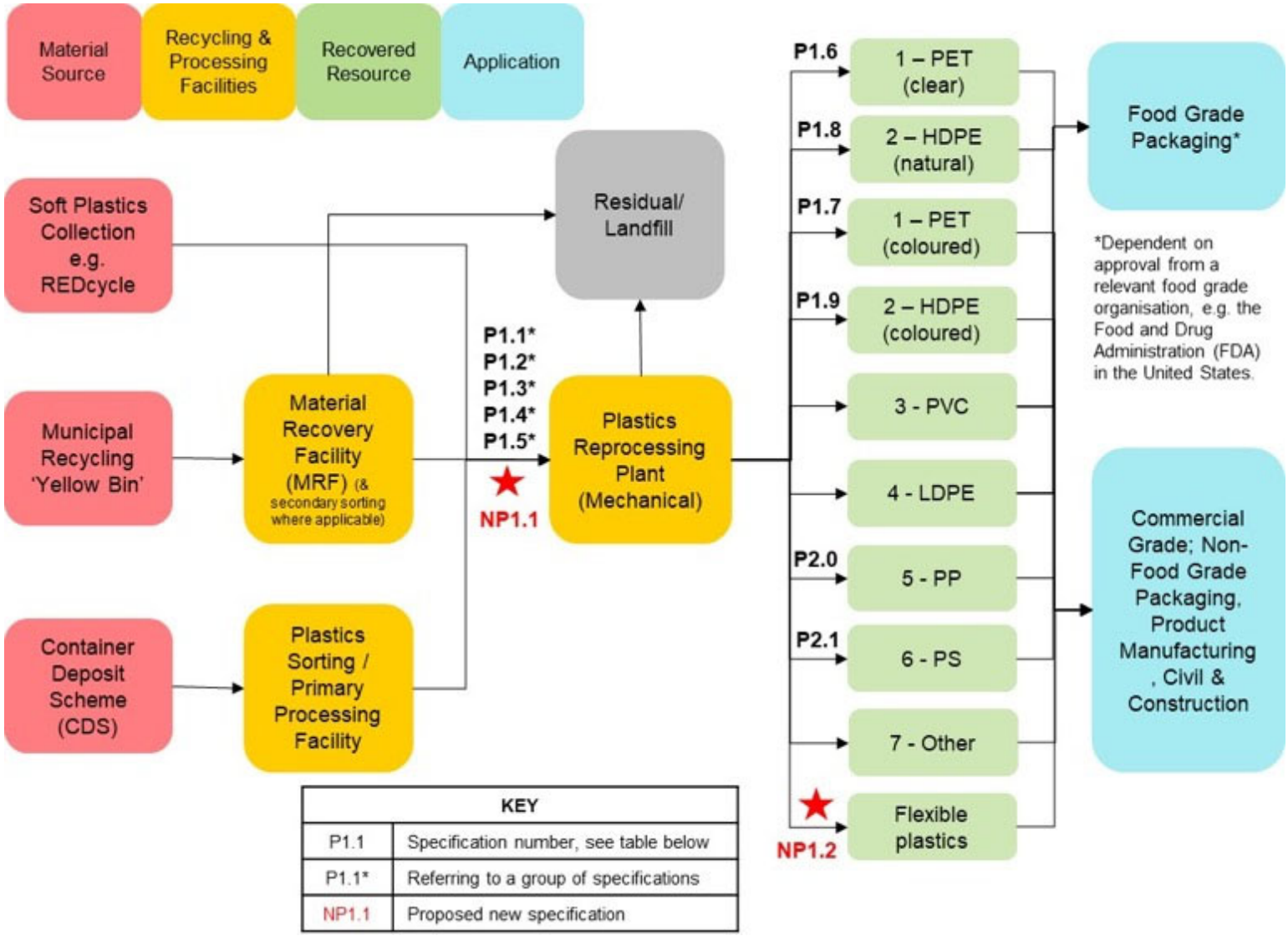


Figure 3 Plastic flow pathway

Table 11 Plastic specifications for sorters and processors

Flow key	Detailed flow key and specification name	Author	Sorter/ Processor	RaWR Act listed specification (✓ / ×)[34]
P1.1	P1.1.1 Baled clear PET bottles P1.1.2 Baled rigid HDPE natural food grade P1.1.3 Baled coloured and thermoformed PET P1.1.4 Baled rigid HDPE - all colours P1.1.5 Baled coloured PP	APCO/ ANZPAC	Sorter	✓*
P1.2	P1.2.1 PET bottles (Grade A) P1.2.2 PET thermoforms P1.2.3 HDPE natural bottles (Grade A) P1.2.4 HDPE color bottles (Grade A) P1.2.5 HDPE Injection Bulky rigids	ISRI	Sorter	✓*
P1.3	P1.3.1 Polypropylene Small Rigid Plastics P1.3.2 1-7 Bottles and Small Rigid Plastic P1.3.3 3-7 Bottles and Small Rigid Plastic P1.3.4 Tubs and Lids (PP, HDPE, LDPE containers)	ISRI	Sorter	×
P1.4	P1.4.1 PET Container Specifications P1.4.2 HDPE Bottle Recyclate Feedstock P1.4.3 Post-Consumer PVC Bottles Bale Specs for Recyclate Feedstock	ACOR	Sorter	×
P1.5	P1.5.1 PP Small Rigid Plastics P1.5.2 3-7 Bottles and all other Rigid Plastics	Association of Plastic Recyclers	Sorter	×
P1.6	PET hot washed flake	APCO/ ANZPAC	Processor	✓
P1.7	Coloured PET cold washed flake	APCO/ ANZPAC	Processor	✓
P1.8	Natural HDPE flake for food grade applications	APCO/ ANZPAC	Processor	✓
P1.9	Coloured HDPE flake	APCO/ ANZPAC	Processor	✓
P2.0	Cold washed coloured recycled PP flake	APCO/ ANZPAC	Processor	✓
P2.1	Export Densified Foamed Polystyrene	EPSA	Processor	✓
NP1.1	Liquid Paperboard bale specification	APCO/ ANZPAC	Sorter	×

[34] DAWE website: https://www.awe.gov.au/environment/protection/waste/exports/specifications-and-documents/plastic-specifications

Flow key	Detailed flow key and specification name	Author	Sorter/ Processor	RaWR Act listed specification (✓ / ×)[34]
NP1.2	Shredded flexible plastic specifications to be developed	APCO/ ANZPAC	Sorter	×
NP1.3	Advanced recycled feedstock	Chemistry Australia	Sorter	×
NP1.4	Advanced Recycling output (oil)	Chemistry Australia	Processor	×

*Valid until 30th June 2022

4.2.1 Advanced recycling of plastics

Due to limited markets for some polymer types, growing demand for food grade plastics and the export of mixed plastics being banned, 'advanced recycling' opportunities have become apparent as an alternative to mechanical recycling. A report recently published by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in consultation with industry stakeholders explores three major advanced recycling processes and the factors influencing the adoption of advanced recycling technology in Australia[35]. A major barrier identified was the different state and territory positions across Australia regarding the advanced recycling industry.

Advanced recycling, also referred to as feedstock or chemical recycling, is the conversion of plastic waste into monomers or raw materials which can be used to produce new polymers for plastics manufacturing. A range of different technologies exist to modify the chemical structure of waste plastics including gasification, pyrolysis, hydrocracking and depolymerisation. Fuel produced from this process is considered waste-to-energy while oil produced from this process to be used in plastic production is considered advanced recycling[36].

There are two types of plastics: thermoplastics and thermoset plastics. Thermoplastics, such as PET, PE and PP, are suitable for mechanical recycling while thermoset plastics, such as epoxy and silicone, cannot be melted and reformed and are therefore unsuitable for mechanical recycling. There are also other plastics unsuitable for mechanical recycling including mixed polymer, multi-layer, flexible and contaminated plastics products as well as plastics with high levels of additives. Advanced recycling is complementary to mechanical recycling, providing an alternative pathway for these hard-to-recycle plastics and an opportunity for packaging material to be recycled back into packaging material as well as reducing waste to landfill.

A future possible flow pathway incorporating advanced recycling is provided in Figure 4. Specifications NP1.2 (a sorter or feedstock specification for advanced recycling) and NP1.2 (a processor specification for the oil produced by the advanced recycling process) do not currently exist and will need to be developed in the future. Further information regarding the new specifications is discussed further in Section 4.4.

[35] Advanced recycling technologies to address Australia's plastic waste (2021) CSIRO.
[36] Advanced recycling technologies to address Australia's plastic waste (2021) CSIRO.

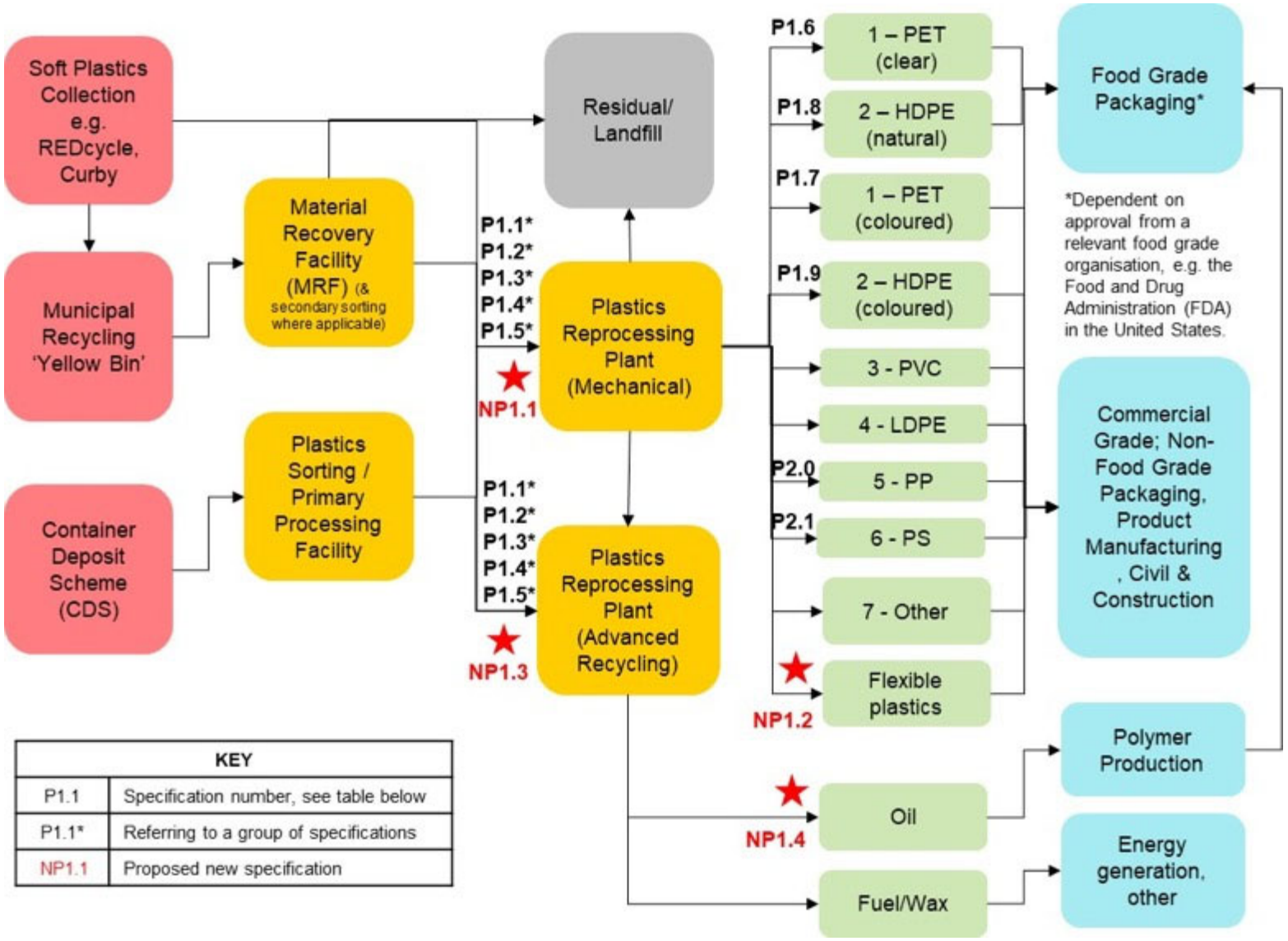


Figure 4 The potential plastic flow pathway incorporating advanced recycling

4.3 Stakeholder feedback

A summary of comments made by stakeholders in the plastic recycling industry regarding specifications and resource recovery is included in Table 12.

Table 12 Plastic stakeholder consultation summary of feedback

Output	Sorter Specifications	Processor Specifications
All polymers /general	• Bale specifications are based on agreements between buyers and sellers. These are more often based on the ISRI specifications than the ACOR or APCO/ANZPAC specifications. • The APCO/ANZPAC specifications are not commonly used by exporters, most exporters nominated the ISRI specifications in their licence applications as these are commonly used in bale trading overseas. This is because the ISRI specifications are American and the United States generate a lot of tonnes to trade. The layout and definitions in the ISRI specifications make more sense commercially. • The APCO/ANZPAC specification contamination thresholds are too strict. Millions of dollars of equipment are needed by MRFs to achieve them, such as optical sorters. Regional MRFs don't have the tonnes to justify the equipment. • Neighbouring councils should work together, consolidate funds, and build a larger facility that provides scalability. This could be led by the state government. • Without a demand for the end product, there's no incentive to improve what's coming out of a MRF (through equipment upgrades, etc). The cost of upgrades does not get covered by the sale price to processors, the cost gets passed on to the consumer.	• Specifications will always be agreed between the customer and supplier. • The ACOR and APCO/ANZPAC specifications are suitable for flake and resin. • Flake specifications are dependent on equipment. European equipment generally produces higher quality than Asian equipment. • Mechanical recycling is best in terms of the waste hierarchy as it all goes back into packaging. Advanced recycling has other outputs that don't go back into packaging. However, it is the next best option for plastic not suitable for mechanical recycling. • The specifications should be about future proofing and providing confidence regarding emerging technologies to encourage investment. They should not be the lowest standard. • Technically all polymers can go towards food grade packaging, but it requires proper decontamination processing. Specifications should reflect this potential. • Separating by colour allows penetration of more markets and improves resource recovery and increased recycled content. Specifications should reflect this for each polymer. All other components will remain the same, only colour will change. • Customers are demanding more recycled content however, recycled polymers cost more than virgin polymers. Processing

Output	Sorter Specifications	Processor Specifications
	• MRFs sort for the polymers they can sell, the rest don't get recycled. Therefore, there needs to be end markets to drive sorting at the MRF end, such as mandated recycled content. Restricting the export of mixed plastics has reduced end market options. One MRF sorts for clear PET bottles, milk bottles, coloured HDPE and PP as this is what they can sell. Other polymers go to landfill. Another MRF sorts for PET, HDPE and a mixed plastic stream. The mixed plastics are sent to South Australia for further sorting by polymer type before exporting. • Approximately 10,000 tonnes of plastic throughput (yielded feedstock, i.e. waste removed) are required at a MRF annually to justify the equipment upgrades required to sort down to the single polymer. The equipment upgrades cost approximately $2 million. This throughput is never going to be achieved at regional MRFs. There are three possible solutions: 1) Co-investment from packaging companies into sorting technology, 2) funding to invest in a plastic recycling facility (PRF) located at the MRF, or 3) further sorting equipment upgrades at the processor where high throughput is achieved. • Some MRFs don't sort to a specific specification, they run audits on their outputs and report their findings to customers. Customers then adjust their price based on the audit findings. • The specifications shouldn't be mandatory as this would limit the end markets. Some processors can take bales with different mixtures of polymers and this shouldn't be limited. Specifications should be between buyers and sellers, based on what the processor is willing to take. • The specifications should focus on the prohibitive material, not on outthrows and other aspects. These other aspects can be negotiated between parties. • Packaging design needs to produce mono-packaging not composite packaging to reduce contamination and the	costs need to be reduced to meet demand. Or we could introduce a tax or levy on any packaging that doesn't meet the minimum recycled content targets. This is being introduced in the US. • Recycled content targets should be made mandatory (for imports and domestic products) so that it creates a market demand pull and processors invest in equipment to produce food grade flake. The targets should increase over time.

Output	Sorter Specifications	Processor Specifications
	cost and effort of recycling. For example, HDPE bottles should use HDPE caps and PP bottles should use PP caps. PET bottles should use LDPE caps and sleeves.	
PET	• The contamination thresholds in the ACOR and APCO specifications are too strict and not achievable for MRFs. • Clear PET is used for food grade recycled material, coloured PET is used for commercial grade packaging or products. • Some MRFs might sort PET into clear and green, depending on the demand for these colours. • It is easier to sort the coloured PET out at the bottle stage rather than at the flake stage. • MRFs would struggle to get to the APCO/ANZPAC PET bale specifications as contamination is high but they are achievable for CDS streams which are source separated. • PET flat sheets and trays currently go to landfill or contaminate fibre stream as they get sorted as fibre. Additional equipment would be required to recover this material, such as a fibre clean-up line. • One MRF operator positively sorts coloured PET trays and they are sent overseas for recycling. Once the export ban for unprocessed polymers comes into place, coloured PET should be phased out. • PET bottles with pressure-sensitised labels are worthless and contaminate clear PET bales. Other contaminants for clear PET bales include rings and caps.	• Caution should be taken when labelling specifications as food grade. These specifications don't make the output food grade, they are just a guide. Processing needs to decontaminate the flake so that it complies with the relevant official food grade standard. E.g. US FDA, EC Directive or Chinese food contact standards. Labelling a spec food grade may confuse processors. • Producers of recycled PET (rPET) and recycled HDPE (rHDPE) resin from food grade PET and HDPE flake source recycled flake from Southeast Asia as it is not currently available in Australia due to lack of local processing capacity. One domestic company manufactures rPET and all their material will go into a joint venture with large beverage companies. There needs to be investment in hot wash flake capacity in Australia to supply the independent market.

Output	Sorter Specifications	Processor Specifications
HDPE	• The contamination thresholds in the ACOR and APCO specifications are too strict and not achievable for MRFs. 98% pure milk bottles in a bale would be hard for a MRF to achieve, the ISRI specification of 95% is more achievable. • HDPE is often sorted into natural and coloured as these bale outputs are in demand. • Coloured HDPE often goes into a mixed plastics bale along with coloured PP.	• From a 95% pure HDPE bale, one major processor can get it to a 99.5% pure HDPE flake. • Let the MRF get it to 95%, then invest in the next processing stage. • An Australian manufacturer of virgin HDPE, LDPE and LLDPE are looking into the feasibility of increasing the recycled content of their products.
PVC	• Most MRFs send PVC packaging to landfill as it contaminates other polymer streams and there aren't enough tonnes to justify the costs of recycling it. • Some MRFs believe PVC should be banned from the yellow bin. • One Victorian PVC processor can take PVC bottles and packaging from MRFs or secondary sorting facilities. It Is currently manually sorted at one MRF. • APCO is phasing out PVC packaging as the volumes are so small. But because of volumes of imported products, it will take a long time to phase out (e.g. security packaging on batteries and razor blades are PVC). • Including PVC specifications for sorters will increase the awareness of PVC recycling options. • Low levels of PVC can go through the pyrolysis process (advanced recycling). However, there is risk of releasing hydrochloric acid so if advanced recyclers do a pre-sort for PVC, this could be diverted to a PVC recycler, increasing PVC recovery.	• In Europe, PVC recycling is being driven by an accreditation scheme for recyclers. Recyclers have collected large amounts of data on the quantities of PVC. • A challenge in Australia is there is a small PVC industry. We consume 400,000 tonnes per annum (tpa) compared to 6 million tonnes in Europe. We also don't have a big PVC resin producer to provide extra funding. • One processor recycles PVC and manufactures rigid PVC pipes which have strict performance requirements that they need to meet, the Australian/NZ Standard AS/NZS1254/2010 or AS/NZS1260. • Other end uses have customer-related specifications.

Output	Sorter Specifications	Processor Specifications
LDPE	• Rigid LDPE material generally goes into mixed polymer bales or to landfill due to the low volume and limited end markets. • For flexible LDPE, see flexible plastics section below.	
PP	• One primary sorter and a secondary sorter, sort PP bales to 95% purity. Other MRFs don't get it to this quality as there are often not enough volumes of PP to invest in sorting it. • Some councils are banning PP in the yellow bin as it is not economical to recycle. This increases confusion amongst residents. • The federal government should standardise outputs for MRFs to reduce confusion about what goes into the yellow bin. • One stakeholder is aware of companies that can buy bales of mixed PE and PP and extrude them together to make recycled products. • Tonnes of PP packaging products consumed are similar to tonnes of HDPE and PET packaging products. However, PP products have broader applications, e.g. more types of food containers, which are more difficult and expensive to recover in a MRF. HDPE and PET have specific product applications, i.e. milk bottles and beverage bottles, respectively. The large quantities of specific product types make them easier to target and recover.	• One PP manufacturer undertakes mechanical recycling of PP bales into flake internationally and is assessing the feasibility of doing this in NSW. Currently, they receive recycled flake (not bales) to manufacture rPP. • PP flake is separated by colour: clear and white flake is more valuable than coloured, or 'jazz', as coloured flake produces products that are grey in colour which have less demand. • One PP processor shreds, washes, removes contaminants, flakes and pelletises PP to be made into plant pots.
PS	• Expanded polystyrene is a necessary household item and recycling through the EPSA system works. However,	• EPS can be downcycled domestically: granulated and used onshore in structural materials as a virgin material substitute.

Output	Sorter Specifications	Processor Specifications
	EPSA isn't recognised as a viable option, instead it is getting banned. • The biggest barrier for recycling EPS is that there is no kerbside collection so consumers either send it to landfill or they have to take it themselves to dedicated drop-off sites. More drop-off sites in convenient locations should be set up. Another barrier is the cost to transporting the light material. A solution is to have strategically placed densification machines in each council area. • More should be done to recover this stream. The volumes are there and there is market maturity. • Recyclers don't want food contamination, tape, or labels. • One MRF sends all PS material to landfill.	• Otherwise, EPS is densified, exported and extruded into new products such as picture frames. The densified foamed polystyrene spec is used for export.
Other	• Funding has been granted for a recycling facility to process liquid paperboard and soft plastics. • Liquid paperboard and soft plastics are currently going to landfill or contaminating other streams, such as the fibre stream. A new 'save board' facility is being built which will be able to process both liquid paperboard and soft plastics. • MRFs will be able to separate liquid paperboard products and send them for recycling. First it will take those that are CDS-eligible packaging products and then the list will expand. • Older style MRFs struggle to separate liquid paperboard products. Optical sorters at modern MRFs have the potential to separate liquid paperboard products. • The companies behind the liquid paperboard recycling facility currently don't have a bale specification for liquid paperboard products but these will need to be developed.	• The recycling facility for liquid paperboard and soft plastics will manufacture it into 'save board', an upcycled building material, ready for use.

Output	Sorter Specifications	Processor Specifications
	It is estimated that the feedstock will be 50% input of strong fibre and 50% input of flexible plastics. The recycling process can tolerate the aluminium liner in liquid paperboard products. • Bioplastics need to go through the organics pathway and not contaminate the yellow bin stream.	
Flexible plastic	• Soft plastics often don't have a resin number on it so hard to know what the composition of a bale is. Therefore, the specification should just be a mixed soft plastic spec, not LDPE specifically. • One MRF believes flexible plastics should never go in the yellow bin or through a MRF, even a special tagged Curby bag of flexible plastic. This is because it sends a confusing message to stakeholders that soft plastics can go in the yellow bin which will lead to more bagged recyclables and contamination in the comingled stream, reducing recovery. • The flexible plastics Curby program should be rolled out everywhere or not at all, to ensure consistent messaging and reduce confusion. • Soft plastic collection programs (front-of-store and yellow bin collection) are complementary to each other, and material inputs are the same. • REDcycle and Curby don't accept all flexible plastics: anything with an Australian Recycling Label (ARL). • Soft plastics collected in the yellow bin ("Curby trial") is currently taken to a MRF on the Central Coast. It is pre-sorted early at the MRF and undergoes further mechanical sorting and processing: it is shredded (30-50mm), optically sorted (sorts up to 8mm) and contaminants are removed. The material is bulk baled and sent to an end-user/secondary processor.	• Films are not easily mechanically recycled as they are complex. Their function is food preservation. • Shredded soft plastics have many offtake options where it may be flaked and extruded into pellet. • A mixed flexible plastic flake spec is not relevant as they are traded as pellets. • Some end users can only include 15% of the mixed bulk baled soft plastics. If it was cleaned and further sorted, they could include up to 40% and increase recovery of soft plastics. • To take flexible plastics and make it into food grade quality material, it needs to be chemically recycled.

Output	Sorter Specifications	Processor Specifications
	• By not flaking the soft plastics, it opens it up to more markets as some processors prefer the shredded material over flake. • There is momentum for flexible plastics going into advanced recycling. However, even with advanced recycling in the future, soft plastic material will always go through a mechanical sorting/processing step first to recover those polymers that are more valuable and can be mechanically recycled, e.g. clear LDPE, and the remainder can be sent to advanced recycling. • Packaging design changes for flexible plastics would improve resource recovery: laminates should be monomer material.	
Advanced recycling	• Many MRFs are looking at sending mixed plastics to chemical recycling. • Producing plastics via advanced recycling needs to be considered differently to producing fuel via chemical recycling. Governments need to differentiate the two as advanced recycling is more circular while chemical recycling to produce fuel is downcycling. To ensure a circular process, the advanced recycling output should go back into plastics. • A feedstock specification for advanced recycling depends on the technology regarding contamination (with PVC, PET, etc). It will also require flexibility with contamination thresholds as the technology advances. • Some advanced recycling technologies will target residual waste as well as MRF material, e.g. nappies and plastics other than packaging, to divert more waste from landfill. These facilities would require different specifications to advanced recycling facilities targeting packaging. These	• Plastics manufacturers (refineries) are increasingly looking to either do advanced recycling themselves or team up with advanced recycling entities to receive their oil. One major polyethylene manufacturer is looking into advanced recycling technology types such as pyrolysis. • After the initial pyrolysis process, some secondary processing of the output is required before it goes into a cracker: purification from the additives and other contaminants and an upgrading step to reduce the broad range of boiling points of the different plastics. In the cracker, contaminants get broken up and neutralised. • The oil end product is indistinguishable from virgin oil and can go into a cracker to produce monomers for plastic. It is the cracker/petrochemical facility who will have specifications for the feedstock they require (not in the scope of this project). • It can be used to make food grade packaging, regardless of the original polymer type.

Output	Sorter Specifications	Processor Specifications
	specifications would only need to limit heavy metals and hazardous waste. • State landfill levies should be increased in future to incentivise sorters to divert 'unrecoverable' plastics from landfill to increase supply for advanced recycling.	• Brands and retailers are demanding recycled content in their film packaging. The only viable way to do that is through advanced recycling. • To ensure the oil is turned into polymer, the traceability aspect needs to be considered.

4.4 Impact assessment

Under the current plastic recycling pathway, Australia is recovering approximately 13% of plastics. To meet the national target of 80% average resource recovery rate for all material streams by 2030, approximately 1.6 million more tonnes of plastic, or 67%, must be recovered.

Based on consultation with stakeholders, specifications for different plastic polymer types were chosen as a guideline for sorters and processors. The impact of each specification was assessed in regard to the actions required to achieve the specification and improve resource recovery, see Table 6.

The ISRI specifications were chosen as minimum standard sorter specifications as it was reported that these are currently achieved by Australian sorters involved in bale trading. While the APCO/ANZPAC specifications for baled plastics were reported by stakeholders to be too strict and not achievable for sorters, they have been recommended as best practice specifications.

The APCO/ANZPAC specifications for flake (for all polymer types with specifications) were deemed suitable processor specifications by stakeholders. It was suggested that separate specifications for clear/natural, coloured, cold washed and hot washed be created for each polymer. Having separate specifications for all forms would demonstrate the potential for polymers other than PET and HDPE to be recovered for more applications, including food grade applications, in the future. Processor specifications for PVC material were not considered necessary due to the small market in Australia and the existing relationships between processors and end users.

The regulation of unprocessed, mixed polymer plastic exports from July 2021, and baled plastics from July 2022, means that Australia is likely to look at alternative processing options, such as secondary sorting and advanced recycling. Many sorters, processors and end user stakeholders mentioned advanced recycling as a solution to target plastics not suitable for mechanical recycling such as flexible, thermoset and contaminated plastics. There are several advanced recycling technologies currently at different scales in Australia.

Table 13 Plastic impact assessment

Sorter / Processor	Specifications	Key aspects of the specification	How it supports resource recovery	Benefits, barriers, risks	Price/market impacts	End user demand	Business benefits and (compliance) costs.	Waste and recycling contracts
Sorter	**APCO/ ANZPAC** **P1.1.1 Baled clear PET bottles** **P1.1.2 Baled rigid HDPE natural food grade** **P1.1.3 Baled coloured and thermoformed PET** **P1.1.4 Baled rigid HDPE - all colours** **P1.1.5 Baled coloured PP** *(best practice)* *(a 'listed specification' - meets the Objects of the RaWR Act for export)*	Clear PET: - Product: clear PET bottles <5L - PET fraction: 98% Natural HDPE: - Product: food grade natural HDPE bottles <5L - HDPE fraction: 98% Coloured PET: - Product: coloured, rigid bottles & thermoform <5L - PET fraction: 98% Coloured HDPE: - Product: HDPE bottles <5L - HDPE fraction: 98% Coloured PP: - Product: Rigid injection moulded or thermoform packaging (clear & coloured) - PP fraction: 98% All: - Contamination: <2%	Provides a best practice standard for sorters to sort plastic down to single polymer and by colour.	- Separating by colour maximises end market opportunities. - Strict contamination limits encourage recycling into food grade applications. However, they are currently not achievable for most MRFs. - Reduces burden on processor. - No specification for clear PP. - Valid for export until 30 June 2022.	Higher value product (compared to ISRI standards)	High demand for uptake by end users.	- Allows MRFs to enter and compete in 'food grade' bale market. - Some MRFs may require equipment investment or additional staff to separate individual polymers and colours.	Unlikely to impact MRF contract terms with local governments.
Sorter	**ISRI** **P1.2.1 PET bottles (Grade A)** **P1.2.3 HDPE natural bottles (Grade A)** **P1.2.4 HDPE color bottles (Grade A)** *(minimum standards)* *(a 'listed specification' - meets the Objects of the RaWR Act for export)*	PET bottles: - Product: bottles only - PET fraction: >94% - Contamination (outthrow material) allowances to be negotiated between buyer and seller. - Prohibited material (0% allowed) includes PVC, PS, plastic film, hazardous waste, etc. HDPE natural/colour bottles: - Product: bottles only - HDPE fraction: >95% - Contamination (outthrow material) allowance: <2% - Prohibited material: 0%	Provides a minimum standard that is achievable for sorters and suitable for food grade applications and used in bale trading.	- Commonly used by MRFs. - 5-6% contamination limit is more achievable for sorters compared to the APCO/ANZPAC 2% limit. - The processor is responsible to reduce contamination. - Valid for export until 30 June 2022.	- Higher downstream processing costs to decontaminate bales and meet end market requirements may result in reduced price for MRF output compared to stricter specs.	No direct impact.	- Allows MRFs to enter and compete in 'food grade' bale market. - Some MRFs may require equipment investment or additional staff to separate individual polymers and colours.	Unlikely to impact MRF contract terms with local governments.
Sorter	**ISRI** **P1.2.2 PET thermo-forms** **P1.2.5 HDPE Injection Bulky rigids** **ISRI** **P1.3.1 PP Small Rigid Plastics** *(minimum standards)* *(a 'listed specification' - meets the Objects of the RaWR Act for export) - NOTE: PP Small Rigid Plastics specification is not a 'listed specification'.*	PET thermoforms: - Product: PET thermoform plastic - Contamination (outthrow material) allowance: <2% - Prohibited material: 0% HDPE Injection bulky rigids: - Product: buckets, pails, oversized rigid plastics - PP: <10% - PET/PVC/ LDPE/PS/other: <4% - Metal/liquid/ fibre: <2% - Prohibited material: 0% PP small rigid plastics: - Product: PP containers - Total contamination: <8% - Metal/fibre: <2%	Provides a minimum standard that is achievable for sorters and supports recovery of streams that may go to food grade applications in the future.	- 4-5% contamination limit is more achievable for sorters compared to the APCO/ANZPAC specs 2% limit. APCO/ANZPAC specs should be used by MRFs who can achieve them. - PET and HDPE specs valid for export until 30 June 2022. - The PP specifications don't reflect that clear PP is sometimes separated. - Some councils/MRFs do not accept PET thermoforms, only bottles, in the yellow bin.	- Higher downstream processing costs to decontaminate bales and meet end market requirements may result in reduced price for MRF output compared to stricter specs. - Need more processing facilities and end markets.	No direct impact.	- Allows MRFs to sort valuable streams and compete in bale market. - Some MRFs may require equipment investment or additional staff to separate individual polymers and colours.	Unlikely to impact MRF contract terms with local governments.
Sorter	**ACOR** **P1.4.3 Post-Consumer PVC Bottles Bale Specifications for Recyclate Feedstock** *(best practice)*	- Product: clear PVC bottles only. - Less than 2 pieces of prohibited materials such as aluminium cans/caps, glass fragments, steel cans, dirt, grit,	Provides a best practice standard for sorters to achieve and targets a stream currently directed to landfill.	- Increases awareness that there are domestic processing options for PVC bales.	- Low PVC volumes may mean it is not cost-effective for MRFs to sort to this spec.	No direct impact.	- Avoids landfill expenses and provides a revenue stream for MRFs that may not have existed previously.	Unlikely to impact MRF contract terms with local governments.

Sorter / Processor	Specifications	Key aspects of the specification	How it supports resource recovery	Benefits, barriers, risks	Price/market impacts	End user demand	Business benefits and (compliance) costs.	Waste and recycling contracts
		stones & no hypodermic syringes allowed. - Less than 5 visible PET, coloured PVC, PET and HDPE bottles. - Price penalty for down-gradable quality based on case-by-case basis.		- PVC processors have capacity to receive PVC bales from sorter. - Although PVC packaging may be phased out, there will still be imported PVC packaging. - Separation of PVC containers will reduce problematic contamination of other polymer streams. - Suitable for processors and advanced recyclers looking to pre-sort PVC from feedstock. - Only 1 MRF is currently known to manually sort for PVC.				
Sorter	**ISRI** **P1.3.3 3-7 Bottles and Small Rigid Plastic** **P1.3.4 Tubs and Lids (PP, HDPE, LDPE containers)** *(minimum standards)*	3-7 Bottles and Small Rigid Plastic: - Product: bottle and non-bottle containers. - Total contamination: <5% - Metal/fibre: <2% - Liquid/residues: <1% Tubs and lids: - Product: tubs and lids - Total contamination: <10% - Prohibited material: 0%	Provides a minimum standard for sorters to achieve for mixed plastics.	- Reflects what is currently done at some MRFs for mixed plastics. - Suitable for smaller/regional MRFs. - Not suitable for export. - Diverts plastics that may be destined for landfill.	For smaller/ regional MRFs, separating into individual polymers may not be cost-effective. Mixed bales are achievable.	No direct impact.	More cost-effective for smaller/ regional MRFs.	Unlikely to impact MRF contract terms with local governments.
Sorter	**NP1.1** **Liquid paperboard bale** *To be developed*	To be considered for inclusion: - Product types and sizes to be specified - Contamination limit: unknown	Provides a minimum standard for sorters to achieve for liquid paperboard and recovers a waste stream commonly sent to landfill.	- Current common perception that liquid paperboard is recyclable, i.e. minimal behaviour change required. - Achieves recovery of difficult-to-recycle composite material.	- Creates value for difficult-to-recycle material. - Low volumes may mean it is not cost-effective for MRFs to sort to this specification.	- Produces an end product suitable for building material.	- Avoids landfill expenses and provides a revenue stream for MRFs that may not have existed previously.	Unlikely to impact MRF contract terms with local governments.
Processor	**NP1.2** **Shredded flexible plastics** *To be developed*	To be considered for inclusion: - Flexible plastic with an Australian Recycling Label (ARL) - Size: 30-50mm - Contamination limit: unknown	Provides a minimum standard for sorters to achieve for flexible plastics and recovers a waste stream commonly sent to landfill.	- Reflects what is currently done at flexible plastic processing facilities.	- Creates value for difficult-to-recycle material.	- Adequately cleaned material would increase uptake by end users.	Unknown	The Curby system may require inclusion in MRF contract terms.
Sorter	**NP1.3** **Advanced recycled feedstock** *(to be developed in future in consultation with advanced recyclers and oil refiners.)*	The following proposed contamination rates to be considered for inclusion: - PVC: 2-3% - PET: 3-5% - PS: <15% (as it decreases the capability to process the maximum output) - Organics: <8%	Provides a minimum standard for sorters to achieve for difficult-to-recycle plastics and increase plastic recovery.	- Achieves increased recovery of difficult-to-recycle plastics into food grade applications. - A major barrier is the differences in state and territory positions across Australia regarding the advanced recycling industry. - Specifications will need to reflect the specific technologies of different advanced recyclers.	- Creates value for difficult-to-recycle material.	- High end user demand for food grade recycled plastics.	- Avoids landfill expenses and provides a revenue stream for MRFs that may not have existed previously.	Acceptance of new plastic products in the yellow bin will require inclusion in MRF contract terms. Increased volume will require more frequent collections.

Sorter / Processor	Specifications	Key aspects of the specification	How it supports resource recovery	Benefits, barriers, risks	Price/market impacts	End user demand	Business benefits and (compliance) costs.	Waste and recycling contracts
Processor	**APCO/ ANZPAC** **P1.6 PET hot washed flake** **P1.7 Coloured PET cold washed flake** **P1.8 Natural HDPE flake for food grade applications** **P1.9 Coloured HDPE flake** **P2.0 Cold washed coloured recycled PP flake** *(best practice)* *(a 'listed specification' - meets the Objects of the RaWR Act for export)*	PET hot washed/ Coloured PET cold washed: - Flake size: 98% 3-12mm - Total contamination: <80 parts per million (ppm) - PVC: <50ppm - Polyolefins: <25ppm - Metal: <20ppm Natural HDPE/Coloured HDPE: - Flake size: 98% 8-12mm - Total contamination: <80 parts per million (ppm) - PVC: <50ppm - PET/PS: <25ppm - Metal: <20ppm Cold washed coloured PP: - Flake size: 98% 8-12mm - Total contamination: <80 parts per million (ppm) - PVC: <50ppm - Other plastics: <25ppm - Metal: <20ppm	Provides a high standard for processors to achieve for flake that can be traded domestically or internationally.	- Some may be used as a guide to get food grade material. However, decontamination and processing need to comply with the relevant food grade standards. - Processor responsible for removing contaminants/ impurities from MRF material. - Valid for export. - PP flake spec does not cover clear/white PP which can be sorted and may be worth more than coloured PP.	- Higher downstream processing costs to decontaminate bales and meet end market requirements may make processing more expensive and virgin material more desirable.	- Mandating recycled content would drive demand.	- Allows trading in the domestics and international market. - Some processors may require equipment investment or to achieve specs.	Unlikely to impact contract terms.
Processor	**EPSA** **P2.1 Export Densified Foamed Polystyrene (for EPS)** *(best practice)* *(a 'listed specification' - meets the Objects of the RaWR Act for export)*	- Foam polystyrene blocks must include at least 98% polystyrene foam. - White grade: white PS Neutral grade: mixed colour PS - Prohibited material (0% allowed) include hazardous waste, residual chemicals, non-plastics, etc.	Provides a standard for processors to achieve for expanded polystyrene that can be traded internationally.	- The spec achieves transport efficiency. - There are adequate volumes of EPS and there is market maturity. - Valid for export. - No kerbside collection is the biggest barrier. - Doesn't cover EPS granulate used onshore in structural materials.	No direct impact.	No direct impact.	Limited impact on business ability or incentive to compete.	Unlikely to impact contract terms.
Processor	**NP1.4** **Advanced Recycling output (oil)** *(to be developed in future in consultation with advanced recyclers and oil refiners.)*	To be determined.	To ensure the pyrolysis output (oil) follows a circular process and goes back into plastics.	- Allows difficult-to-recycle plastics to be recycled into food grade applications. - Reduce the use of virgin oil. - A major barrier is the differences in state and territory positions across Australia regarding the advanced recycling industry.	- Creates value for difficult-to-recycle material.	- High end user demand for food grade recycled plastics.	- Avoids landfill expenses and provides a revenue stream for MRFs that may not have existed previously.	Acceptance of new plastic products in the yellow bin will require inclusion in MRF contract terms. Increased volume will require more frequent collections.

Plastic summary and next steps

A summary of the key findings for the sorter and processor specifications are provided in Table 14 and Table 15, respectively, including the actions required and timeframes.

Table 14 Plastic sorter recommended specifications, actions and timeframes

Material output	Recommended specification	Updates required or comments	Currently achieved?	Actions to achieve the specification and/or improve resource recovery	Timeframe & who is responsible
PET	**APCO/ANZPAC** **P1.1.1 Baled clear PET bottles** *(best practice)* **P1.1.3 Baled coloured and thermoformed PET** *(best practice)* **ISRI** **P1.2.1 PET bottles (Grade A)** *(minimum standard)* **P1.2.2 PET thermoforms** *(minimum standard)*	None.	APCO/ANZPAC specifications are not currently achieved by many MRFs. ISRI specifications are generally achieved or agreements are made between buyers and sellers for MRFs separating by polymer type and colour. Separation of PET bottles is more commonly performed than separation of PET thermoforms.	Consider expansion of CDS to all states and to more plastic products to increase quality feedstock.	Vic & Tas government by 2023
				Consider nationally consistent bin input standards and messaging regarding PET thermoforms and composite material to reduce inconsistencies between LGAs regarding which plastics are recyclable.	State / local government / national kerbside standard – 2 to 3 years
				Consider equipment investment or additional staff at sorting facilities to separate individual polymers and colours and product types (e.g. PET bottles and thermoforms). Options: 1) Packaging companies to co-fund sorting equipment such as optical sorters (or government funding). 2) Government to fund installation of plastics recycling facility (PRF) at MRFs. 3) See below action.	Packaging & Recycling Industry + government grants – 2 to 3 years
				Consider optical sorting equipment investments in the processor stage may be needed to decontaminate the 95% bales.	Packaging & Recycling Industry + government grants – 2 to 3 years
				Packaging design should aim to reduce the generation of composite packaging, pressure-sensitised labels, coloured PET. Encourage production of mono-material packaging to reduce the cost and effort of recycling. Caps and rings easily removable.	Packaging Industry – 2 to 3 years
HPDE	**APCO/ANZPAC** **P1.1.2 Baled rigid HDPE natural food grade** *(best practice)* **P1.1.4 Baled rigid HDPE - all colours** *(best practice)* **ISRI** **P1.2.3 HDPE natural bottles (Grade A)** *(minimum standard)* **P1.2.4 HDPE color bottles (Grade A)** *(minimum standard)* **P1.2.5 HDPE Injection Bulky rigids** *(minimum standard)*	None.	APCO/ANZPAC specifications are not currently achieved by many MRFs. ISRI specifications are generally achieved or agreements are made between buyers and sellers for MRFs separating by polymer type and colour.	Consider expansion of CDS to all states and to more plastic products to increase quality feedstock.	Vic & Tas government by 2023
				Consider equipment investment or additional staff to separate individual polymers and colours and product types. Options: 1) Packaging companies to co-fund sorting equipment such as optical sorters (or government funding). 2) Government to fund installation of plastics recycling facility (PRF) at MRFs. 3) See below action.	Packaging & Recycling Industry + government grants – 2 to 3 years
				Consider optical sorting equipment investments in the processor stage may be needed to decontaminate the 95% bales.	Packaging & Recycling Industry + government grants – 2 to 3 years
				Packaging design should aim to reduce the generation of composite packaging. Encourage production of mono-material packaging to reduce the cost and effort of recycling. Caps and rings easily removable.	Packaging Industry – 2 to 3 years
PVC	**ACOR** **P1.4.3 Post-Consumer PVC Bottles Bale Specifications for Recyclate Feedstock** *(best practice)*	Consideration of developing separate bale specifications for clear and coloured bottles/containers, subject to ongoing use of PVC for packaging.	Not currently achieved by the majority of MRFs.	Consider expansion of CDS to all states and to more plastic products to increase quality feedstock.	Vic & Tas government by 2023

Material output	Recommended specification	Updates required or comments	Currently achieved?	Actions to achieve the specification and/or improve resource recovery	Timeframe & who is responsible
	See Mixed plastics and advanced recycling feedstock specifications below.				
				Ensure the Australian Recycling Label indicates the appropriate recycling categorisation for packaging made from PVC or PS	APCO, Packaging Industry – 2 years
				Consider equipment investment or additional staff to separate PVC. Options: 1) Packaging companies to co-fund sorting equipment such as optical sorters (or government funding). 2) Government to fund installation of plastics recycling facility (PRF) at MRFs.	Packaging & Recycling Industry + government grants – 2 to 3 years
LDPE	*See Mixed plastics and advanced recycling feedstock specifications below*	N/A	N/A	N/A	N/A
PP	**APCO/ ANZPAC** **P1.1.5 Baled coloured PP** *(best practice)* **ISRI** **P1.3.1 Polypropylene Small Rigid Plastics** *(minimum standard)* *See Mixed plastics and advanced recycling feedstock specifications below*	Consideration of developing separate bale specifications for clear and coloured bottles/containers.	APCO/ANZPAC specifications are not currently achieved by many MRFs. ISRI specifications are generally achieved or agreements are made between buyers and sellers for MRFs separating by polymer type and colour.	Consider expansion of CDS to all states and to more plastic products to increase feedstock.	Vic & Tas government by 2023
PS	*See Mixed plastics and advanced recycling feedstock specifications below*	PS is getting phased out.	N/A	Ensure the Australian Recycling Label indicates the appropriate recycling categorisation for packaging made from PS.	APCO, Packaging Industry – 2 years
Mixed	**ISRI** **P1.3.3 3-7 Bottles and Small Rigid Plastic** *(minimum standard)* **P1.3.4 Tubs and Lids (PP, HDPE, LDPE containers)** *(minimum standard)* *See advanced recycling feedstock specification below.*	None.	Currently achieved or agreements are made between buyers and sellers.	Consider nationally consistent bin input standards and messaging to reduce inconsistencies between LGAs regarding which plastics are recyclable.	State / local government / national kerbside standard – 2 to 3 years
				Ensure the Australian Recycling Label indicates the appropriate recycling categorisation for packaging made from PVC.	APCO, Packaging Industry – 2 years
				Consider expansion of CDS to all states and to more plastic products to increase feedstock.	Vic & Tas government by 2023
				Packaging design should aim to reduce the generation of composite packaging. Encourage production of mono-material packaging to reduce the cost and effort of recycling. Caps and rings easily removable.	Packaging Industry – 2 to 3 years
Other (liquid paperboard)	**NP1.1** **Liquid paperboard bale** *To be developed*	To be developed in consultation with relevant stakeholders.	No	Development of specification.	APCO/ANZPAC – 1 to 2 years
				Bin input standards should reflect this specification in future.	State / local government / national kerbside standard – 2 to 3 years

Material output	Recommended specification	Updates required or comments	Currently achieved?	Actions to achieve the specification and/or improve resource recovery	Timeframe & who is responsible
				Consider investment into sorting equipment upgrades or additional staff to separate material at the MRF.	Packaging & Recycling Industry + government grants – 2 to 3 years
Flexible plastics	**NP1.2** **Shredded flexible plastics (for mechanical recycling)** *To be developed*	To be developed in consultation with iQ Renew, REDcycle and other relevant stakeholders.	One facility currently produces an output like the aspects described in the impact assessment table.	Development of specification.	APCO/ANZPAC – 1 to 2 years
				Bin input standards should reflect this specification in future.	State / local government / national kerbside standard – 2 to 3 years
				Consider effective education regarding the soft plastics system in the yellow bin.	State / local government / national kerbside standard –2 to 3 years
				Consider additional washing and sorting equipment, e.g. optical sorting, investments at processing facilities to sort by polymer type and colour and clean the material so that a higher proportion can be included in end products.	Packaging & Recycling Industry + government grants – 2 to 3 years
Advanced recycled feedstock	**NP1.3** **Advanced recycled feedstock** *Specification required to be developed in future*	To be developed and owned by Chemistry Australia as technology is established and process tolerances are better understood. This will likely include input from CSIRO, Licella, Qenos, LyondellBasell, iQ Energy, Brightmark and other relevant stakeholders.	N/A	Development of specification.	Chemistry Australia - 1 to 2 years
				Consider a national approach to the advanced recycling industry.	National & State Governments – 2 to 3 years
				Bin input standards may need to be updated to reflect any changes in plastic types accepted.	National & State Governments – 3 years
				Consider investment for additional sorting equipment and resources at sorting facilities. This will vary depending on if the sorting facility is automated or manual.	Packaging & Recycling Industry + government grants – 3 to 4 years
				Consider incentives to promote the use of recycled content for plastics production, instead of virgin material, to increase recovery.	National & State Governments – 5+ years

Table 15 Plastic processor recommended specifications, actions and timeframes

Material output	Recommended specification	Updates required or comments	Currently achieved?	Actions to achieve the specification and/or improve resource recovery	Timeframe & who is responsible
PET	**APCO/ANZPAC** **P1.6 PET hot washed flake** *(best practice)* **P1.7 Coloured PET cold washed flake** *(best practice)*	None.	Currently achieved or agreements are made between buyers and sellers.	Consider expansion of CDS to all states and to more plastic products to increase quality feedstock.	Vic & Tas government by 2023
				Consider optical sorting equipment investments in the processor stage to decontaminate the bales.	Packaging & Recycling Industry + government grants – 2 to 3 years
HDPE	**APCO/ ANZPAC** **P1.8 Natural HDPE flake for food grade applications** *(best practice)* **P1.9 Coloured HDPE flake** *(best practice)*	None.	Currently achieved or agreements are made between buyers and sellers.	Consider expansion of CDS to all states and to more plastic products to increase quality feedstock.	Vic & Tas government by 2023
				Consider optical sorting equipment in the processor stage to decontaminate the bales.	Packaging & Recycling Industry + government grants – 2 to 3 years
PVC	Customer based	PVC is getting phased out.	Currently achieved or agreements are made between buyers and sellers.	Ensure the Australian Recycling Label indicates the appropriate recycling categorisation for packaging made from PVC.	APCO, Packaging Industry – 2 years
LDPE	*See Advanced recycling output specification below.*	N/A	N/A	N/A	N/A
PP	**APCO/ ANZPAC** **P2.0 Cold washed coloured recycled PP flake**		Currently achieved or agreements are made between buyers and sellers.	Consider expansion of CDS to all states and to more plastic products to increase quality feedstock.	Vic & Tas government by 2023

Material output	Recommended specification	Updates required or comments	Currently achieved?	Actions to achieve the specification and/or improve resource recovery	Timeframe & who is responsible
	(best practice) *See Advanced recycling output specification below.*	Consideration of developing separate flake specifications for clear and coloured PP		Consider optical sorting equipment investments in the processor stage to decontaminate the bales.	Packaging & Recycling Industry + government grants – 2 to 3 years
PS	**EPSA** **P2.1 Export Densified Foamed Polystyrene (for EPS)** *(best practice)* *See Advanced recycling output specification below.*	EPS is not currently collected in the yellow bin and is getting phased out.	Currently achieved at some facilities that accept EPS drop off.	Consider more collection sites to increase recovery.	Packaging industry – 1 to 2 years
				Consider increased education about drop-off collection sites.	Packaging industry – 1 to 2 years
				Consider more densifying equipment at collection sites to increase transport efficiency.	Packaging & Recycling Industry + government grants – 1 to 2 years
Mixed plastic	*See Advanced recycling output specification below.*	N/A	N/A	N/A	N/A
Advanced Recycling output (oil)	**NP1.4** **Advanced Recycling output (oil)** *Specification required to be developed in future*	To be developed and owned by Chemistry Australia as technology is established and process tolerances are better understood. This will likely include input from CSIRO, Licella, Qenos, LyondellBasell, iQ Energy, Brightmark and other relevant stakeholders.	No.	Development of specification.	Chemistry Australia - 1 to 2 years
				Consider incentives to promote the use of recycled content for plastics production, instead of virgin material, to increase recovery.	National & State Governments – 5+ years

5 Metal

5.1 Material flow pathway

Ferrous material (steel) in the household stream is typically in the form of used steel cans containing products such as canned vegetables, dog food and other food products. Non-ferrous (aluminium) material in the household stream is mainly in the form of used beverage containers (UBCs), such as soft drink cans, and other aluminium cans, such as aerosol cans.

In 2018-19, approximately 246,000 tonnes of metal packaging were consumed in Australia with 191,000 tonnes estimated to be consumed in the household, see Table 16[37]. A total of 102,000 tonnes of metal packaging was collected through the MSW collection service (commingled recycling (yellow) bin service) and 18,000 tonnes were collected through CDS. A further 17,000 tonnes were collected via other collection services, such as commercial and industrial (C&I), bringing the national recovery rate in 2018-19 to 56%.

Table 16 Consumption and recovery of metal packaging (tonnes)

Material type	Total consumption	Consumption in the household	MSW collection	CDS collection	Total collected*	Recovery rate**
Metal	246,000	191,000	102,000	18,000	137,000	56%

*Including material collected via other collection services from C&I, C&D and other.
**The recovery rate represents total material consumed and recovered; it is not specific to the household stream.

Once collected, metal materials are sorted at a MRF or container sorting facility into two streams: ferrous (steel) and non-ferrous (aluminium). Generally, ferrous material is separated from the comingled stream via magnet separation and non-ferrous material is separated using eddy current separation.

Used steel cans are compacted and baled at the MRF and sent to a metal's processor for shredding. It is then sent to a steel mill (end user) where scrap steel is melted in a furnace and various additional processes are undertaken to produce intermediary and final products. Non-ferrous material is compacted (or densified) into a briquette or baled at the MRF or at a metals processor and sent to an aluminium smelter mill. UBCs are generally not shredded as the thin aluminium turns into a dust-like material.

5.2 Specifications

Specifications for metal material coming out of sorting facilities and processing facilities vary depending on agreements between buyers and sellers. There are no compulsory specifications or regulations that facilities must meet, rather specifications are determined by the customer of the output and its end-use. Despite this, there are metal specifications that are widely known in the industry and commonly used in the trade of recovered metals.

The flow pathway and specifications for metal can be found in Figure 5 and Table 17, respectively. The flow key assigned to the specifications in the table corresponds to the flow pathway. Some processes, such as densification or briquetting of UBCs, may be performed by sorters or processors and are therefore listed as both sorter and processor specifications.

[37] Australian Packaging Consumption & Recycling Data 2018-19 (2021) Australian Packaging Covenant Organisation.

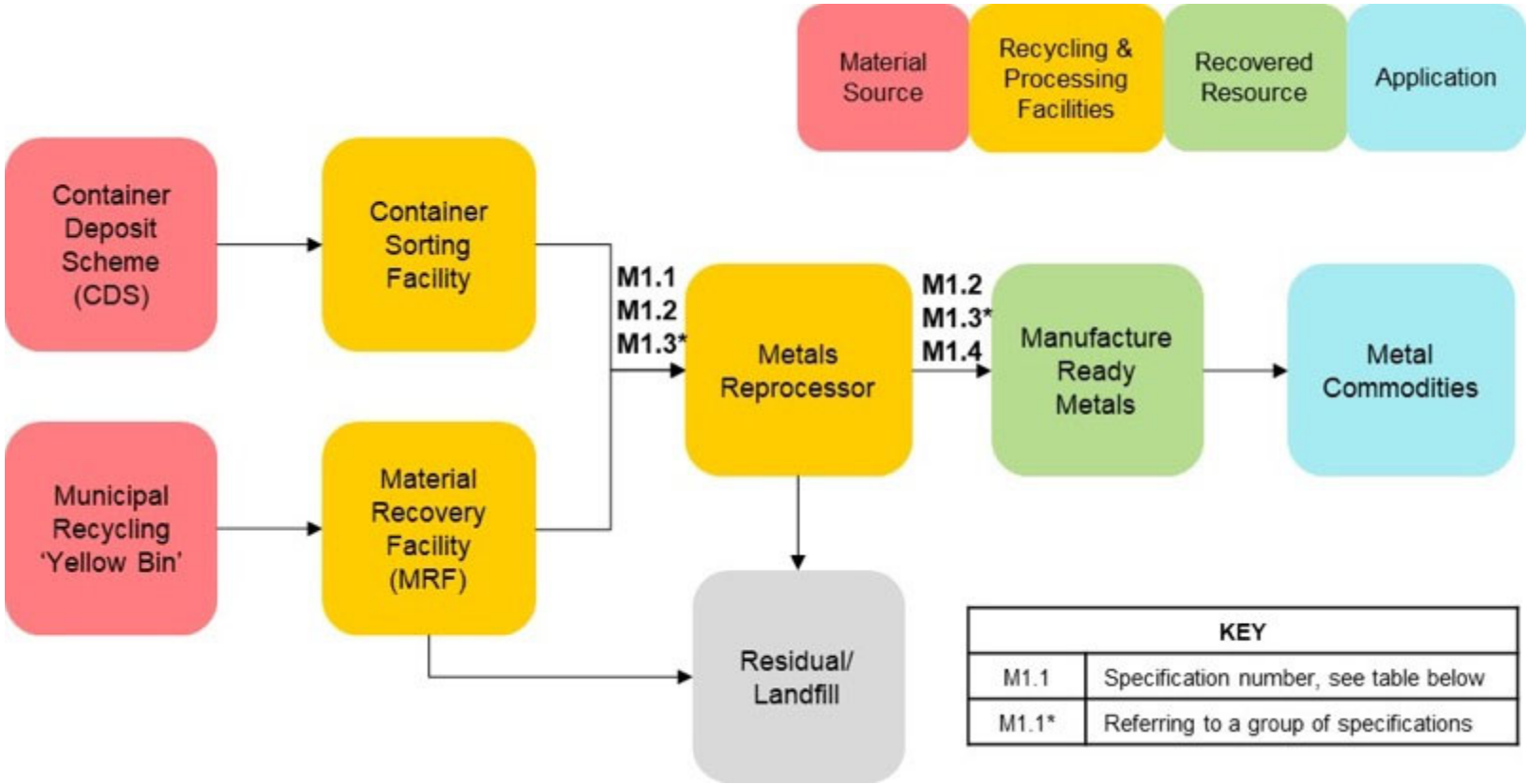


Figure 5 Metal flow pathway

Table 17 Metal specifications for sorters and processors

Flow key	Specification name	Author	Sorter/ Processor
M1.1	Steel Can Specifications	ACOR	Sorter
M1.2	Used Beverage Containers Specifications (Aluminium)	ACOR	Sorter, Processor
M1.3	M1.3.1 Post-consumer aluminium can scrap M1.3.2 Densified aluminium used beverage can (UBC) scrap M1.3.3 Baled aluminium UBC scrap M1.3.4 Briquetted aluminium UBC scrap M1.3.5 Steel can bundles	ISRI	Sorter, Processor
M1.4	Shredded (ferrous) scrap	ISRI	Processor

5.3 Stakeholder feedback

A summary of comments made by stakeholders in the metal recycling industry regarding specifications and resource recovery is included in Table 18.

Table 18 Metal stakeholder consultation summary of feedback

Output	Sorter Specifications	Processor Specifications
Steel	• The ISRI specifications are more relevant than the ACOR specifications as they are used in global trade and are well known. • Sorters may export directly to overseas processors rather than supply to domestic processors before exporting. • Sealed units and gas cannisters pose safety issues as they can explode and injure workers or cause fires.	• Used steel cans are baled or shredded for export or local steel mills depending on the acceptance criteria of the end use steel mill. • Steel scrap is being exported for recycling. There is interest in using this scrap domestically, however, it is not clean enough for domestic recyclers and Australian steel mills have specific feedstock metallurgical requirements (steel cans from MRFs are tin-plated and contain other contaminants). • Exporting steel scrap can be cheaper than domestic recycling as domestic disposal of shredder floc is expensive due to landfill levies. Local processors are not able to compete with international recyclers where processing costs are lower. • NSW steel manufacturers import scrap steel from overseas, such as the US, as there is high demand for use in steel-making processes and insufficient quantities produced by domestic processors. • The majority of ferrous scrap comes from industrial sources, such as transport vehicles. This source provides a relatively high quantity of clean material. • One end user reportedly purchases shredded steel processed to ISRI specifications and their own company specifications: shredded scrap should be in pieces <200mm and must be free from dirt, non-ferrous metal, rubber, foreign material and any tin or lead coatings. The bulk density for the load should be 965kg per cubic metre.

Output	Sorter Specifications	Processor Specifications
		• Metal recycling requires less energy than extracting and smelting virgin material.
Aluminium	• The ISRI specifications are more relevant than the ACOR specifications as they are used in global trade and are well known. • Sorters may export directly to overseas processors rather than supply to domestic processors before exporting. • MRFs don't want aluminium products other than UBCs: UBCs are composed of a known ratio of two alloys, 3104 (for the can) and 5182 (for the lid/closure). Introducing other aluminium products alters the known ratio. • CDS is presenting a consistent flow of material in respect to alloys.	• Mills will generally reject UBC stocks with aluminium aerosol cans due to other material contamination (plastic, steel, etc) and the risk of explosion. • Metal recycling requires less energy than extracting and smelting virgin material. • The majority of UBCs are going offshore as there are limited domestic aluminium smelters recycling them. Even if smelted domestically, the plate would still need to be exported to a plate rolling facility to be rolled into sheet. A domestic plate rolling mill has been explored by an organisation and was found to be not financially feasible at this time (estimated to cost hundreds of millions of dollars). • In Australia, UBCs rarely go back into UBCs as there are no plate rolling facilities. They are more likely to go into window frames or the general extrusion market. • UBC sheet has a high value as there is a global shortage.

5.4 Impact assessment

The recycling pathway of metals has remained relatively constant over time. Steel cans are often exported as the level of putrescible contamination and tin content is not acceptable for domestic processors and end users. The majority of steel packaging is tin-plated, where the steel has been coated with a thin layer of tin to prevent corrosion. High tin content can deteriorate certain characteristics of steel. Aluminium UBCs are mostly exported due to a limited processing market in Australia.

Based on consultation with stakeholders, a specification for each material output was chosen as a general guideline for sorters and processors. The ISRI specifications were reported to best reflect the current material outputs of sorters and processors. The impact of each specification was assessed in regard to the actions required to achieve the specification and improve resource recovery, see Table 19.

To increase domestic recovery, future specifications regarding metal should emphasise limiting putrescible waste and tin content in steel cans.

Upstream, ideally the types of products permitted in the yellow bin should be limited to washed, non-composite steel cans and aluminium UBCs. Aerosol cans with flammable contents are of concern due to the risk of explosion when handled in a compaction truck and sorting facility especially if they are not completely empty. Controls should be put in place that require producers and brands to clearly label aerosol cans, especially those containing flammable substances, with safe disposal instructions. State and local governments should reinforced these disposal messaged through community education campaigns. Packaging design should avoid composite products and limit tin content.

Currently, there is a shortage of suitable steel scrap in NSW and scrap steel is sourced from other countries such as the United States to meet the demand of steel makers. Counterintuitively, a large quantity of steel scrap is exported from Australia due to a lower standard accepted overseas. A relatively large proportion of a load, sometimes 25%, is made up of shredder floc (non-ferrous material) which is destined for landfill. The presence of a landfill levy in NSW, and Australia in general, means that exporting the scrap and the shredder floc is less expensive and local processors cannot compete.

There are a limited number of aluminium processors in Australia and their feedstocks are largely sourced from the C&D and C&I sectors. Aluminium processors may require processing equipment upgrades to process lower quality aluminium scrap material from the MSW stream. Once melted into aluminium plate, the material will need to be exported to a plate rolling facility to be rolled into aluminium sheet, suitable for beverage cans. A domestic plate rolling facility has been considered by one stakeholder, however, was deemed not feasible due to the high capital costs. Potentially, unrolled aluminium plate may be used in other aluminium products, such as building products, subject to the quality of the recovered material.

Table 19 Metal impact assessment

Sorter/ Processor	Specifications	Key aspects of the specification	How it supports resource recovery	Benefits, barriers, risks	Price/market impacts	End user demand	Business benefits and (compliance) costs.	Waste and recycling contracts
Sorter/ Processor	**ISRI** **M1.3.1 Post-consumer aluminium can scrap** **M1.3.2 Densified aluminium UBC scrap** **M1.3.3 Baled aluminium UBC scrap** **M1.3.4 Briquetted aluminium UBC scrap**	- Variations to the specification should be agreed upon prior to shipment between the seller and buyer. - Any free lead is basis for rejection - Biscuit / bale / briquette size ranges - Density ranges - Must be free of steel, lead, bottle caps, plastic cans and other plastics, glass, wood, dirt, grease, trash, and other foreign substances.	- Provides a minimum standard for sorters/processors for aluminium UBC. - Best reflect the current material outputs of sorters and processors	- Only UBCs accepted. - ISRI specifications are used in global trade.	Limited change to current prices.	No direct impact.	Limited impact on business ability or incentive to compete. Sorters and processors of aluminium will already be achieving the specifications.	Unlikely to impact MRF contract terms with local governments. Any additional costs of processing at a MRF would be passed onto council and other clients.
Sorter	**ISRI** **M1.3.5 Steel can bundles**	- Minimum density threshold - Cans may be baled without removal of paper labels, but free of other non-metallics. - Can include tin coated containers.	- Provides a minimum standard for sorters - Best reflect the current material outputs of sorters	- Does not specifically mention food/ putrescible waste as a contaminant to be limited. - Steel cans are often exported as the level of putrescible contamination and tin content is not acceptable for domestic processors and end users. - Future specifications should emphasise limiting putrescible waste and tin content. - ISRI specifications are used in global trade.	Limited change to current prices.	- There is a shortage of suitable steel scrap in NSW and it is sourced from overseas. Supporting domestic re-processing would allow domestic recyclers to compete and meet end user demand.	Limited impact on business ability or incentive to compete. Sorters of steel will already be achieving the specifications.	Unlikely to impact MRF contract terms with local governments. Any additional costs of processing at a MRF would be passed onto council and other clients.
Processor	**ISRI** **M1.4 Shredded (ferrous) scrap**	Homogeneous iron and steel scrap - Magnetically separated - Originating from automobiles, unprepared No. 1 and No. 2 steel, miscellaneous baling and sheet scrap. - Average density	- Provides a minimum standard for processors. - Best reflect the current material outputs of processors	- Do not specifically mention food/ putrescible waste as a contaminant to be limited. - Steel cans are often exported as the level of putrescible contamination and tin content is not acceptable for domestic processors and end users. - Future specifications should emphasise limiting putrescible waste and tin content.	Limited change to current prices.	- There is a shortage of suitable steel scrap in NSW and it is sourced from overseas. Supporting domestic re-processing would allow domestic recyclers to compete and meet end user demand.	Limited impact on business ability or incentive to compete. Processors of steel will already be achieving the specifications.	Unlikely to impact MRF contract terms with local governments. Any additional costs of processing at a MRF would be passed onto council and other clients.

Sorter/ Processor	Specifications	Key aspects of the specification	How it supports resource recovery	Benefits, barriers, risks	Price/market impacts	End user demand	Business benefits and (compliance) costs.	Waste and recycling contracts
				- ISRI specifications are used in global trade.				

5.5 Metal summary and next steps

A summary of the key findings for the sorter and processor specifications are provided in Table 20 and Table 21, respectively, including the actions required and timeframe.

Table 20 Metal sorter recommended specifications, actions and timeframes

Material Output	Recommended specification	Updates required or comments	Currently achieved?	Actions to achieve the specification and/or improve resource recovery	Timeframe & who is responsible
Aluminium	**ISRI** **M1.3.1 Post-consumer aluminium can scrap** *(minimum standard)* **M1.3.2 Densified aluminium UBC scrap** (*best practice)* **M1.3.3 Baled aluminium UBC scrap** *(best practice)* **M1.3.4 Briquetted aluminium UBC scrap** *(best practice)*	None required	Currently achieved or agreements are made between buyers and sellers.	Nationally consistent bin input standards and messaging to increase consistencies between LGAs.	National & State Governments – 2 to 3 years
				Producers and brands to clearly label aerosol cans, especially those containing flammable substances with safe disposal instructions to mitigate potential risks of explosion in compaction trucks and sorting facilities.	APCO, Packaging Industry -1-2 years
				Household education regarding washing cans and safe disposal of aerosol cans, especially those containing flammable substances is required.	State / local government – 1 to 2 years
				Aluminium processors may require processing equipment upgrades to process lower quality aluminium scrap material.	Packaging & Recycling Industry & Government - 2 to 3 years
Steel	**ISRI** **M1.3.5 Steel can bundles** *(minimum standard)*	Limits on putrescible waste and tin content	Currently achieved or agreements are made between buyers and sellers.	Nationally consistent bin input standards and messaging to increase consistencies between LGAs. Consider limiting steel products to washed, non-composite steel cans.	National & State Governments – 2 to 3 years
				Household education regarding washing cans is required.	State / local government – 1 to 2 years
				Packaging design should avoid composite products and limit tin content.	Packaging Industry - 2 to 3 years

Table 21 Metal processor recommended specifications, actions and timeframes

Material Output	Recommended specification	Updates required or comments	Currently achieved?	Actions to achieve the specification and/or improve resource recovery	Timeframe & who is responsible
Aluminium	**ISRI** **M1.3.1 Post-consumer aluminium can scrap** *(minimum standard)* **M1.3.2 Densified aluminium UBC scrap** (*best practice)* **M1.3.3 Baled aluminium UBC scrap** *(best practice)* **M1.3.4 Briquetted aluminium UBC scrap** *(best practice)*	None required	Currently achieved or agreements are made between buyers and sellers.	Requires aluminium sorter specifications for input material to be met.	N/A
Steel	**ISRI** **M1.4 Shredded (ferrous) scrap** *(minimum standard)*	None required	Currently achieved or agreements are made between buyers and sellers.	Consider employing extra processing equipment to remove putrescible waste.	National & State Governments – 2 to 3 years

6 Fibre

6.1 Material flow pathway

Fibre in the household stream is made up of packaging and containers such as newsprint, corrugated cardboard boxes, stationery items, envelopes, milk cartons. In 2018-19, approximately 3.3 million tonnes of fibre packaging were consumed in Australia with 789,000 tonnes estimated to be consumed in the household, see Table 22[38]. A total of 793,000 tonnes of fibre packaging was collected through the MSW collection service (either a commingled recycling (yellow) bin service or a dedicated paper (blue) bin service and 1,000 tonnes were collected through CDS. 1.2 million tonnes were collected via other collection services, such as C&I, bringing the recovery rate for fibre to 63%

Table 22 Consumption and recovery of fibre packaging (tonnes)

Material type	Total consumption	Consumption in the household	MSW collection	CDS collection	Total collected*	Recovery rate**
Fibre	3,262,000	789,000	793,000	1,000	2,045,000	63%

*Including material collected via other collection services from C&I, C&D and other.

**The recovery rate represents total material consumed and recovered; it is not specific to the household stream.

Fibre in the household stream is predominantly collected in the commingled recycling (yellow) bin and dropped off at sites by households as source-separated material. A small number of councils provide separate paper bins and a small number provide comingled recycling bins excluding glass. There are a number of grades that fibre can be sorted into and the ones most relevant to MRFs sorting household material include:

- Soft mixed: consists of various qualities of paper including newspapers.
- Old corrugated containers (OCC): consists of corrugated cardboard boxes
- Hard mixed: consists of a mix of paper ('soft') and OCC
- Old newsprint (ONP): predominantly consists of old newspapers. May also contain small amounts of paper and magazines. Similar to the soft mixed grade, some MRFs may produce either soft mixed or ONP outputs.

The fibre grades are then baled and sent to a pulping facility where it is mixed with water and screened to remove non-fibre components such as plastic and glue. The pulp product is then dried and rolled into new fibre products. Domestically, paper manufacturing facilities, also known as 'paper mills', consist of an integrated pulping and paper production facility. However, these two processes can be separate and a new pulping facility has been proposed in Western Australia.

6.2 Specifications

Specifications for fibre material coming out of sorting facilities vary depending on agreements between buyers and sellers. There are no compulsory specifications or regulations that facilities must meet, rather specifications are determined by the customer of the output and its end-use. However, there are a number of fibre specifications that are widely known and

[38] Australian Packaging Consumption & Recycling Data 2018-19 (2021) Australian Packaging Covenant Organisation.

used in the industry. The export market predominantly works to ISRI guidelines which are provided for multiple grades. ACOR has also developed Australian Recovered Paper Specifications for:

- Soft mixed
- Old corrugated containers (OCC)
- Hard mixed
- Kerbside Newspapers or old newsprint (ONP)

Local mills have their own contracts with specification requirements for quality. They may refer to ISRI but they also have unique grades.

Currently in Australia the major fibre pulping facilities are connected to a paper milling facility, circumventing any requirement for external specifications for fibre pulp material. However, a new $86.6 million pulp mill is proposed in Western Australia and therefore a pulp specification may need to be developed. The flow pathway and specifications for fibre can be found in Figure 6 and Table 23, respectively. The flow key assigned to the specifications in the table corresponds to the flow pathway.

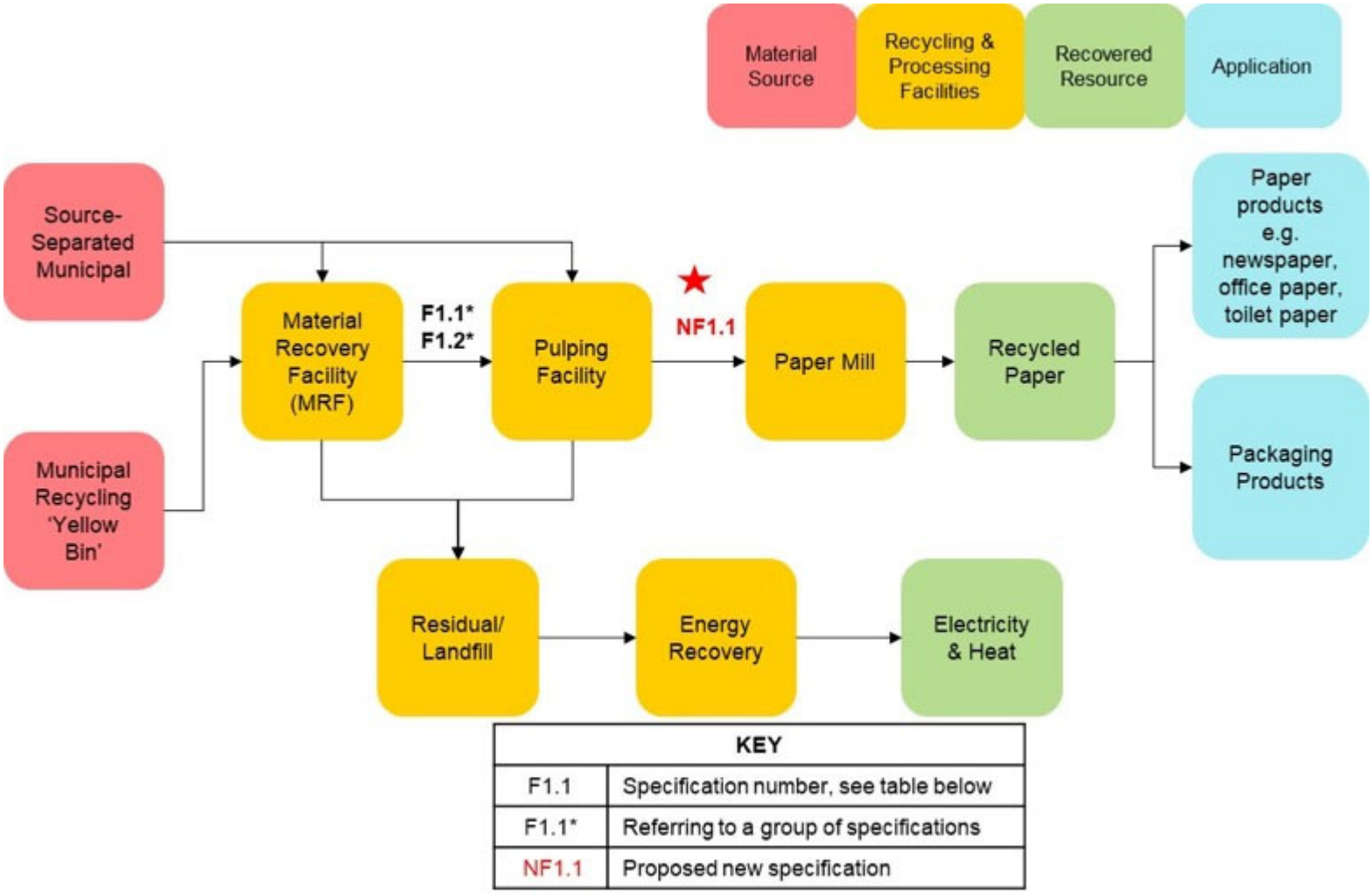


Figure 6 Fibre flow pathway

Table 23 Fibre specifications for sorters and processors

Flow key	Specification name	Author	Sorter/ Processor
F1.1	Australian Recovered Paper Specifications: F1.1.1 Soft mixed F1.1.2 Old corrugated containers (OCC) F1.1.3 Hard mixed F1.1.4 Kerbside Newspapers or old newsprint (ONP)	ACOR	Sorter
F1.2	Guidelines for Paper Stock: F1.2.1 Sorted office paper (Grade 37) F1.2.2 Unsorted office paper (Grade 36) F1.2.3 Old corrugated containers (OCC) (Grade 11, Grade 12) F1.2.4 Mixed Paper (Grade 54) F1.2.5 Sorted Residential Papers & News (Grade 56) F1.2.6 Magazines (OMG) (Grade 10)	ISRI	Sorter
NF1.1	Pulp specifications to be developed.	NWRIC/ ACOR	Processor

6.3 Stakeholder feedback

A summary of comments made by stakeholders in the fibre recycling industry regarding specifications and resource recovery is included in Table 24. As issues regarding the sorting and processing of different fibre outputs are closely related, the stakeholder feedback for paper, mixed and OCC outputs is presented together.

Table 24 Fibre stakeholder consultation summary of feedback

Output	Sorter Specifications	Processor Specifications
Paper, mixed and cardboard	• Most fibre coming out of a MRF is predominantly short fibre (from soft mixed paper). Very little long fibre (OCC) is going through the household stream compared to C&I sources however it is increasing due to online shopping. OCC from the C&I stream is generally cleaner than the household stream as it is sourced separated with few contaminants. • OCC is the most valuable fibre stream so it is often separated at the MRF. Some MRFs also separate ONP and magazines while others include these in the (soft) mixed fibre stream. Soft mixed fibre is what is left after removing OCC, ONP and magazines. Soft mixed fibre carries all the contamination like soft plastics. • Plastic and glass are the main contaminants in the fibre stream. Glass is problematic as it grinds down the paper mill equipment. Plastic/paper composite products such as waxed board and high wet strength board, soft plastics and organics are a problem as they contaminate the material and require removal. • To clean the soft mixed stream, optical sorting equipment or more staff is required. Without manual sorting, plastics don't get sorted out of the paper stream.	• Australia's main fibre processor's business model is integrated: they use all the feedstock and process it to their specifications for their own packaging. • More domestic pulp mills will be required for material not suitable for export. • Investment is needed into domestic pulping facilities and for this to occur, processors need clarity from the government regarding the baled paper and cardboard specifications that can be exported once the export ban comes into place (July 2024). • A pulping mill planned for WA will have an international offtake market, predominantly Singapore, due to the large distance and cost of transport to the east coast of Australia. • If Australia wants to maintain exports then quality and reputation is important. Australia has smaller volumes so can't attract volume-based discounts, so quality is key. • Australia has a reputable law system and should have strong specifications and regulations to back that up.

Output	Sorter Specifications	Processor Specifications
	• Better-quality inputs in the bin are also required: separate paper bin collection is best practice. It can then go straight to a paper sorting facility. • MRFs can introduce optical sorting equipment or additional staff in the fibre line to meet the paper mill specifications but paper mills don't pay a higher price for cleaner mixed fibre because they know the MRF can't trade it internationally. Local paper mills are pushing prices back onto the MRF. These costs inevitably will flow to the gate fee. • One MRF received funding to upgrade their MRF to reduce contamination in the fibre stream to meet local and international market. This is mixed messaging as the government wants to support local pulping but encouraging export quality. • New paper sorting facilities would have to produce to export quality because there is a limited market in Australia. • The best grade of cardboard is 98/2 (98% OCC, 2% outthrows) = ISRI Specification 12. Overseas paper mills require 95/5: 95% OCC, 5% paper. MRFs might be able to get 90/10: 90% OCC, 10% paper. • Sorters currently achieve between 2 and 15% contamination in a mixed paper bale. MRFs might claim to achieve 2-3% contamination but it is probably closer to 5-6%. • 90:10 Is the minimum standard for a mixed paper bale and is used to describe the product. If there is higher levels of contamination, the price will lower but it will still be called a 90:10 bale.	• Paper mills are now all about speed of production (running very tight margins). Lower quality material is dumped because cost associated with running through a mill is too high. • Recycled pulp is a relatively new commodity that is gaining momentum in trade. Demand for recycled pulp is forecast to grow as the demand for mixed fibre Is healthy (from China). • Pulp is not considered waste (compared to baled fibre), the hazardous nature has been removed. • Pulp specifications are more scientific than bale specifications, e.g. moisture and ash content, as it is already assumed that there are low levels of contamination. • China is currently drafting a pulp specification for recovered paper pulp, to be reviewed by paper mills. It will be different to virgin pulp specs. • Draft China recycled pulp spec: contamination limit for pulp board: 0%, contamination limit for fluff pulp/dry pulp: 3%. • Domestic contamination limit for pulp board: 4%, contamination limit for fluff pulp/dry pulp: 0%. • Dry pulp is more sensitive than wet pulp as plastic contamination ends up in the end product. The quality of the feedstock needs to be more stringent. • Recycled fibre adds properties that make it superior to virgin e.g. a third less ink is required printing onto recycled newsprint compared to virgin. However, every

Output	Sorter Specifications	Processor Specifications
	• Drum pulpers are able to accept a larger range of contamination (e.g. 15%) and are therefore expected to recover more fibre. Drum pulpers could be installed in current facilities to recycle mixed paper. • One stakeholder claimed that CDS and the export bans are contentious because the scheme operators are obliged to accept liquid paperboard but export won't be allowed and they will need to be landfilled (or are considered an outthrow in mixed paper bales). • Grant funding has been announced to process liquid paperboard and soft plastics into building materials, 'save board', to be used as an alternative to plywood. The plan is for MRFs to separate liquid paperboard products: first those that are CDS-eligible and then more. There is no bale specification for liquid paperboard that has been developed yet however processing can tolerate aluminium liners in aseptic cartons. The accepted criteria will likely depend on the ease of access to feedstock. • Paper specifications are well defined in the market between buyers and sellers. The ISRI specifications are often quoted for paper. • Specifications should focus on prohibited items, not outthrows, as this is what causes issues for paper mills, e.g. batteries. Outthrows are negotiable between buyers and sellers: they impact the price as there is less material that the buyer wants. • Contamination levels and prohibitive materials from the ACOR specifications are used in some specifications. ISRI specifications don't emphasise what items are not allowed.	time paper is recycled, the fibre is shortened so there are limits and some virgin input is required. • End users making moulded paper products want short fibres. • Small local manufacturers use recycled newsprint for home insulation, kitty litter, etc. They need more newsprint at a very high quality. There needs to be a chain of custody: if a processor sells to a trader, some of the responsibility should stay with the processor. There are many ways to track material.

Output	Sorter Specifications	Processor Specifications
	• ISRI specifications are a good guideline but local mills have their own contracts with specification requirements for quality. They may refer to ISRI but they also have unique grades. Mills purchase material based on customer relationships and what has been sent in the past. • The export market predominantly works to ISRI specifications. American and European specifications are used because this is where the majority of tonnes come from. Having Australian standards will restrict the market as they won't be recognised in international trading. • Overseas standards are also governed by customs (what the country will allow in). Each country has a different capability to process. E.g. South Korean mills have EfW plants to send plastic contaminants while Indonesia and India dump plastics. International contamination limits for fibre bales: 0.5% (Indonesia), 1% (India), 3% (Korea). • By law, every shipment arriving to Malaysia and Indonesia is inspected and can be rejected: the paper mill has to pay for the inspection. Indonesia recently rejected a shipment of OCC due to one PET bottle in one of the bales opened at inspection. • Malaysia is currently deciding on their allowance of contamination, they will probably land on 3-5%. • Some customers purchase very specific mixtures which aren't captured by any current specifications. E.g. 70% newspaper and 30% magazine mixture for paper moulded products. Hard mixed bales are currently	

Output	Sorter Specifications	Processor Specifications
	exported to Thailand consisting of 60% soft mixed and 40% OCC. • There is only one mill in Australia that accepts mixed paper. Mixed paper bales are internationally competitive and export from Australia should not be banned. The fibre export ban will create a monopoly on mixed paper and cardboard in Australia and reduce its value. • Without certainty over what will be allowed for export, it is hard to know whether to invest to remove contamination in the soft mixed stream.	

6.4 Impact assessment

Based on consultation with stakeholders, specifications for multiple fibre stream outputs were chosen as a general guideline for sorters. The impact of each specification was assessed in regard to the actions required to achieve the specification and improve resource recovery, see Table 25.

Currently, specifications for fibre are determined by agreements between customers and suppliers of recovered paper bales and pulp. The ISRI specifications include known paper grades and these are often quoted in contracts as a guide. Further criteria may also be set between the parties. The ISRI specifications would therefore be a suitable minimum standard for sorters to follow. However, the following updates are recommended:

- Clearly specifying the problematic non-fibre items (“prohibitive materials”) that cause major problems at the baling and pulping stages such as batteries, plastic and glass material. This will ensure problematic items are clearly communicated to all sorters;
- Communicating that some customers may accept mixtures of different paper types/grades (“outhrows”). It was reported that limiting the mixture of different paper types would restrict the market unnecessarily.

The ACOR specifications have also been included as they are also used and the terms "soft mixed" and "hard mixed" were commonly referred to by stakeholders.

To meet these standards, the following downstream actions may be required (at some facilities):

- A paper clean-up line consisting of manual sorting or optical sorting equipment to remove contaminants such as plastics and batteries;
- Installation of drum pulpers at pulping facilities to better handle contamination.

In future, the specifications will need to be updated with the export specifications nominated based on the rules of the paper export ban coming into place from 1 July 2024.

It was reported by stakeholders that the fibre export ban will also limit the offtake options for baled paper as there is currently only one fibre processor in Australia. Therefore, sorters will likely strive to meet export specifications so they can compete in the global market. Additional sorting processes will be required (as mentioned above).

Specifications for pulp material will need to be developed in consultation with processors. A draft recycled pulp import specification was being developed by China in late 2021 and could serve as a guide. It was reported by one stakeholder that it is expected that this specification will limit contamination to 0.3% for fluff pulp/dry pulp and 0.0% for pulp board. It was also reported that feedstock for pulp board is mixed fibre (e.g. OCC, mixed paper, old magazine (OMG), ONP) with less than 4.0% contamination and feedstock for fluff pulp/dry pulp is single fibre streams with 0.0% contamination (e.g. single streams of OCC, ONP or OMG).

Table 25 Fibre impact assessment

Sorter/ Processor	Specifications	Key aspects of the specification	How it supports resource recovery	Benefits, barriers, risks	Price/market impacts	End user demand	Business benefits and (compliance) costs.	Waste and recycling contracts
Sorter	**ACOR** **F1.1.1 Soft Mixed** **F1.1.3 Hard Mixed** **F1.1.4 Old Newsprint (ONP)** *(minimum standard)*	- Limits for prohibitive material levels - Limits for outthrows material levels - Defines common sources and common end uses - Refers to equivalent ISRI grade	Provides a minimum standard for sorters to sort fibre.	- Similar to ISRI specifications however includes soft and hard mixed which is often used by sorters and ONP which is not outlined by ISRI. - Higher outthrow limits than ISRI for some streams. Therefore, ACOR specifications are a minimum standard and ISRI specifications are recommended. - May need to update once paper export ban comes into place.	Limited change to current prices. Any additional costs of sorting and removing contamination at a MRF would be passed onto council and other clients.	No direct impact.	Limited impact on business ability or incentive to compete.	Unlikely to impact MRF contract terms with local governments. Any additional costs of processing at a MRF would be passed onto council and other clients
Sorter	**ISRI** **F1.2.4 Mixed Paper** **F1.2.5 Sorted Residential Papers & News** **F1.2.6 Magazines**	- Limits for prohibitive material levels - Limits for outthrows plus	Provides a minimum standard for sorters to sort fibre.	- ISRI specifications are often quoted for trading. - ISRI specifications do not have a newspaper stream	Limited change to current prices. Any additional costs of sorting and removing contamination at a	No direct impact	Limited impact on business ability or incentive to compete	Unlikely to impact MRF contract terms with local governments. Any additional costs of

Sorter/ Processor	Specifications	Key aspects of the specification	How it supports resource recovery	Benefits, barriers, risks	Price/market impacts	End user demand	Business benefits and (compliance) costs.	Waste and recycling contracts
	(best practice)	prohibitive material levels - Prohibited materials <2% - Outthrows <3%		which may be sorted at some MRFs. Included in ACOR specifications below. - May need to update once paper export ban comes into place.	MRF would be passed onto council and other clients			processing at a MRF would be passed onto council and other clients
Sorter	**ISRI** **F1.2.3 Old corrugated containers (OCC) (Grade 11, Grade 12)**	- Limits for prohibitive material levels - Limits for outthrows plus prohibitive material levels	Provides a minimum standard for sorters to sort fibre.	- ISRI specifications are often quoted for trading. - May need to update once paper export ban comes into place.	Limited change to current prices. Any additional costs of sorting and removing contamination at a MRF would be passed onto council and other clients.	No direct impact	Limited impact on business ability or incentive to compete	Unlikely to impact MRF contract terms with local governments. Any additional costs of processing at a MRF would be passed onto council and other clients
Processor	**NF1.1** **Pulp specifications** *To be developed*	To be considered for inclusion: - Contamination levels and other aspects to be based on import specifications of	Provides a minimum standard for processors to achieve.	- Allows processors to compete in the international trading market.	- Creates value for internationally traded material.	Demand for pulp is increasing, especially overseas.	Unknown	Unlikely to impact MRF contract terms with local governments.

Sorter/ Processor	Specifications	Key aspects of the specification	How it supports resource recovery	Benefits, barriers, risks	Price/market impacts	End user demand	Business benefits and (compliance) costs.	Waste and recycling contracts
		importing countries, e.g. Chinese recycled pulp import specification (currently being drafted), as well as in consultation with domestic end users.						

6.5 Fibre summary and next steps

A summary of the key findings for the sorter and processor specifications are provided in Table 26 and Table 27, respectively, including the actions required and timeframe.

Table 26 Fibre sorter recommended specifications, actions and timeframes

Material Output	Recommended specification	Updates required or comments	Currently achieved?	Actions to achieve the specification and/or improve resource recovery	Timeframe & who is responsible
Paper/ mixed	**ACOR** **F1.1.1 Soft Mixed** **F1.1.3 Hard Mixed** **F1.1.4 Old Newsprint (ONP)** *(minimum standard)*	Update to emphasise specific problematic items that should be limited. Contamination limits may need to be updated once paper export ban comes into place and greater clarity on range of fibre mixtures accepted is suggested.	Currently achieved or agreements are made between buyers and sellers.	Consider how separate glass or paper collection bin or drop-off sites would reduce contamination in the paper stream.	State / local government / national kerbside standard – 1 to 2 years
				Some facilities may require: • A paper clean up line consisting of manual sorting or optical sorting equipment to remove contaminants such as plastics and batteries;	Packaging & Recycling Industry + government grants – 1 to 2 years

Material Output	Recommended specification	Updates required or comments	Currently achieved?	Actions to achieve the specification and/or improve resource recovery	Timeframe & who is responsible
				• Installation of drum pulpers at pulping facilities to better handle contamination. Clarity from the government is required regarding listed export specifications for paper/cardboard to support investment.	
Paper/ mixed	**ISRI** **F1.2.4 Mixed Paper** **F1.2.5 Sorted Residential Papers & News** **F1.2.6 Magazines** *(best practice)*	Lacks emphasis on specific problematic items that should be limited. With the introduction of the export ban, the ACOR specification should be used, instead of ISRI, as it can be updated.	Currently achieved or agreements are made between buyers and sellers.	Separate glass or paper collection bin or drop-off sites (reduces glass contamination)	State / local government / national kerbside standard – 1 to 2 years
				Some facilities may require: • A paper clean up line consisting of manual sorting or optical sorting equipment to remove contaminants such as plastics and batteries; • Installation of drum pulpers at pulping facilities to better handle contamination. Clarity from the government is required regarding listed export specifications for paper/cardboard to support investment.	Packaging & Recycling Industry + government grants – 1 to 2 years
OCC	**ISRI** **F1.2.3 Old corrugated containers (OCC) (Grade 11, Grade 12)** *(minimum standard)*	Improved with stronger emphasis on specific problematic items that should be limited.	Currently achieved or agreements are made between buyers and sellers.	Some facilities may require: • A paper clean up line consisting of manual sorting or optical sorting equipment to remove contaminants such as plastics and batteries; • Installation of drum pulpers at pulping facilities to better handle contamination.	Packaging & Recycling Industry + government grants – 1 to 2 years

Material Output	Recommended specification	Updates required or comments	Currently achieved?	Actions to achieve the specification and/or improve resource recovery	Timeframe & who is responsible
				Clarity from the government is required regarding listed export specifications for paper/cardboard to support investment.	

Table 27 Fibre processor recommended specifications, actions and timeframes

Material Output	Recommended specification	Updates required or comments	Currently achieved?	Actions to achieve the specification and/or improve resource recovery	Timeframe & who is responsible
Pulp	**NF1.1** **Pulp specifications** *To be developed*	N/A	N/A	Specification to be developed.	NWRIC/ACOR – 2 years
				Processing facilities may require equipment upgrades. Clarity from the government is required regarding listed export specifications for paper/cardboard to support investment.	Packaging & Recycling Industry + government grants – 2 to 3 years

7 Organics

7.1 Material flow pathway

In 2018-19, nationally a total of 6.6 million tonnes (Mt) of organic waste was generated by households, including 3.1 Mt of food waste[39]. The recycling rate for organic waste within the household stream is reported as 2.4 Mt, and organics recycling in the C&I and C&D streams (excluding hazardous waste such as grease trap sludge), is 2.1Mt and 0.3 Mt respectively. Overall, approximately 49% of organics waste is recovered. Approximately 3.7 Mt (84%) was reported as disposed of to landfill.

Table 28 (Core) Organic waste and recovery (tonnes)

Material type	Total generation	Generation in the household	MSW collection	Total collected*	Recovery rate**
Organic waste	14,300,000	6,600,000	2,400,000	6,990,000	49%

*Including material collected via other collection services from C&I, C&D and other.

**The recovery rate represents total material generated and recovered; it is not specific to the household stream.

The 2019 National Waste Policy Action Plan provides a target to halve the amount of organic waste sent to landfill for disposal by 2030 (this would require diverting an additional 3.4 MT). Some States have (and all are expected to) come on board with the Federal Government's target. For example, NSW has recently mandated MSW and C&I collection of food waste by 2030.

Organics in the household stream may be collected in one of four streams:

1. Garden Organics (GO);
2. Food Organics (FO); or
3. Food Organics and Garden Organics (FOGO)
4. Vegetative Organics and Garden Organics (VOGO) (very occasionally as a transition to a FOGO service).

GO and FOGO are collected in the green-lidded bin while FO can be collected in a separate, maroon-lidded bin. The material is taken to an organics facility where it is typically processed depending on the stream:

1. GO undergoes open windrow composting;
2. FO undergoes anaerobic digestion; and
3. FOGO/VOGO undergoes enclosed composting and windrow maturation.

There are occasional variations to these pathways, where GO is processed in enclosed composting facilities and FO can also be processed along with FOGO in enclosed composting facilities.

There are a wide variety of outputs from organics processing facilities, including mulch, pasteurised compost and mature compost, which are applied to land to improve soil quality and yield healthier growth. The input collection stream does not necessarily determine the

[39] National Waste Report 2020 (2020) Blue Environment.

output and end use. For example, GO may be processed into a mulch, pasteurised or mature compost.

The quality and type of outputs also vary depending on the source of material, the composting process, the local environmental conditions and the requirements of the specific end use. The material may be used for landscaping, urban amenity, agriculture, horticulture, environmental rehabilitation and mine site rehabilitation. Within each use category, there is a wide range of more specific end users, such as, grazing, or cropping of wheat, cotton, bananas, grapes, nuts, sugar cane etc, that have requirements particular to the crop and environmental conditions.

7.2 Specifications

Organics differ from the other material types as the processing outputs are applied to land and can pose risks to the environment and human health. To manage the risks, each state has regulations controlling the application of recycled organics outputs. These regulations, such as the Resource Recovery Order and Exemption for Compost in New South Wales and the Standard for the production and use of Waste Derived Soil Enhancer in South Australia, have maximum threshold limits for chemical and physical contamination. As State regulations are a legal requirement, they take precedence over all other specifications and dictate some output specifications due to the limits described within them.

Organics processing guidelines in Australia primarily address the environmental management of processing sites, focussing on environmental controls across facility operation and potential causes of environmental harm, with only minimal attention given to end-product quality. The main organics processing guidelines for Australian States are:

- Environmental Guidelines: Composting and Other Organics Recycling Facilities. 2004. Department of Environment and Conservation, **New South Wales**.
- Designing, Constructing and Operating Composting Facilities. Publication 1588.1. 2017. Environment Protection Authority, **Victoria**.
- Compost Guideline. 2019. Environment Protection Authority, **South Australia**.
- Guideline: Open Windrow Composting Under Environmentally Relevant Activity 53(a). Organic Material Processing by Composting. 2019. Department of Environment and Science, **Queensland**.
- Guideline: Better Practice Composting. 2020. Draft for External Consultation. Department of Water and Environmental Protection, **Western Australia**.

The Australian Standard for composts, mulches and soil conditioners (AS4454) describes processing requirements and testing/sampling procedures for products in general and these may be used by processors and requested by end users. However, AS4454 is a voluntary market standard and is largely used to support retail product lines and not a product specification.

There are a few (of the larger) compost producers that are third-party certified to AS4454 for some or all of their product range.

Processors or others in the supply chain (such as landscaping suppliers, retail suppliers) may then blend outputs to produce end products, such as soil mixes, composts, and mulches, that meet end user specific requirements or other processing standards such as AS4419 Soils for landscaping and garden use or AS3743 Potting mixes. Product certifications have not been developed for these end products due to the diverse range of site-specific factors and end uses.

Any future product certifications for organic outputs from initial processing should include limits on contamination levels for the following:

- glass and plastic;
- persistent herbicides;
- Per- and poly-fluoroalkyl substances (PFAS); and
- Other chemical contaminants.

In the interim AS4454 is used to provide these limits (no limit exists currently for PFAS).

The Department has commenced work to update the AS4454. This is a long-term project that includes reviewing, and where necessary and possible updating the list of contaminants, maximum threshold levels for contaminants, and requirements of the composting process to ensure the safety of recycled organic products. The work will include consideration of structural changes to the standard to cover alternative recycled organic products and uses and incorporating emerging industry certification and accreditation programs, if available. The work will also look at other mechanisms to manage contamination in recycled organic products.

There are a number of guidelines produced by state government agencies for specific applications/end uses of organics, such as landscaping and horticulture applications. Some examples include:

- Compost mulches for orchard production (NSW);
- Guide to Best Practice for Organics Recovery (VIC);
- Compost Guideline (SA); and
- Application of recycled organics in mine site rehabilitation (NSW).

In addition to the guidelines already published, Green Deal Alliance WA is currently developing a guideline, or model specification, for the use of FOGO-derived soil conditioner in large infrastructure projects, such as rail and road projects.

There are two Australian Standards relating to certified compostable packaging in the household:

1) AS4736-2006 Biodegradable plastics suitable for composting and other microbial treatment
2) AS5810-2010 Biodegradable plastics suitable for home composting

The Australasian Bioplastics Association (ABA) administers a voluntary verification scheme for companies or individuals who wish to have their claims of compliance with these standards verified. Packaging that is certified compostable against either AS4736-2006 or AS5810-2010 are suitable for commercial composting facilities. Packaging that is only certified to AS4736-2006 is not suitable for home composting.

Some local government councils with a FO, FOGO or VOGO service accept AS4736-2006- and AS5810-2010-certified items in the FO/FOGO/VOGO bin, such as certified compostable bin caddy liners and packaging[40]. Some councils only accept AS4736-2006-certified bin liners and no other certified compostable packaging[41]. These differences are due to different capabilities of the processing facilities. While these standards do not relate to material output of a sorting or processing facility, they relate to facility input standards and are relevant to the development of nationally consistent FOGO bin input standards (discussed in Section 7.4).

The flow pathway and specifications for organics can be found in Figure 7 and Table 28, respectively. The flow key assigned to the specifications in the table corresponds to the flow pathway. The certified compostable standards are not included.

Note: there are no sorting specifications, only processing specifications as organics is collected as a single waste stream. However, there are various stages of processing including removal of non-organic materials. Sources other than the household stream, for

[40] City of Hobart website: https://www.hobartcity.com.au/Residents/Recycling-and-rubbish/FOGO-and-compost
[41] Wollongong City Council website: http://wollongongwaste.com.au/fogo-Collection-Services

example C&I streams, have been included in the flow pathway to demonstrate the wide variety of sources of material and highlight the challenges and risks that this poses.

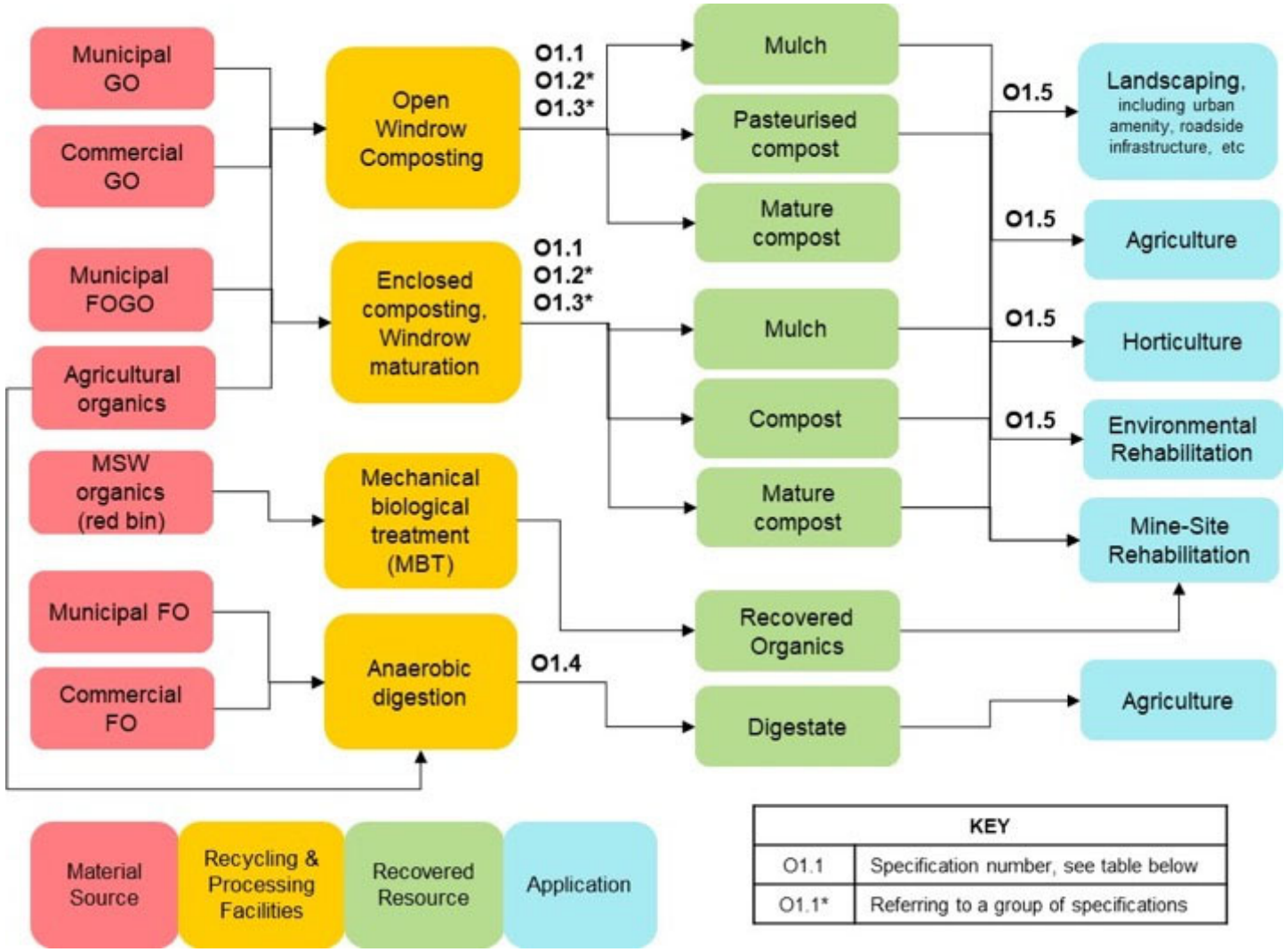


Figure 7 Organics flow pathway

Table 29 Organics specifications for processors

Flow key	Specification name	Author	Sorter/ Processor
O1.1	Standard for the production and use of waste derived soil enhancer	SA EPA	Processor
O1.2	NSW Resource Recovery Orders: O1.2.1 Pasteurised Garden Organics 2016 O1.2.2 Mulch 2016 O1.2.3 Compost 2016	NSW EPA	Processor
O1.3	Australian Standards: O1.3.1 AS4454 (2012) Composts, Soil Conditioners and Mulches O1.3.2 AS4419 Soils for landscaping and garden use O1.3.3 AS3743 Potting mixes	Standards Australia	Processor
O1.4	PAS110:2014 Specification for whole digestate	British Standards Institution (BSI)	Processor
O1.5	Various state guidelines: e.g. Compost mulches for orchard production (NSW), Guide to Best Practice for Organics Recovery (VIC), Compost Guideline (SA), Application of recycled organics in mine site rehabilitation (NSW).	State and Territory governments	Processor

7.3 Stakeholder feedback

A summary of comments made by stakeholders in the organics recycling industry regarding specifications and resource recovery is included in Table 30.

Table 30 Organic stakeholder consultation summary of feedback

Output	Processor Specifications
All	• The organics processing industry is very different to other material processing industries: it is family business dominated and there isn't a standardised model. Every company tends to do their own thing and may have different processes at different sites. One processing company has 4 sites and each site has a completely different flow of materials. • State regulatory specifications and standards, such as Resource Recovery Orders (RRO) in NSW, are prioritised by processors as these are mandatory to apply product to land while the Australian Standards, such as AS4454, are voluntary. • The Compost RRO is relevant to FO and FOGO and the Pasteurised Garden Organics RRO is relevant to GO. • The RROs would be a good minimum standard but there are too many outputs that aren't covered. • Local government waste collection contracts should reflect the relevant state and territory regulatory requirements, such as RROs. Currently, some contracts allow more material types than what is allowed in RROs. For example, there are a number of materials that are treated as 'incidental contamination' in contracts but are not accepted in the RROs. It would be easier if there was consistent regulation across the states and territories regarding application of organic waste to land. • If objectives are set at a state or national level that conflict with state or local regulations, the risk-based cost Is put on the processor. • AS4454 is used by some processors as it provides a lot of the testing/sampling procedures however it is not mandatory. 90% of organic product is not sold under the AS4454 standard. • Key aspects of AS4454 include physical contamination, pasteurisation and composting. One organics company uses AS4454 as the basic guideline but then do additional chemical tests. • AS4419 applies to soils and garden mixes. It is important for businesses using the compost from processors. E.g. processors might sell an AS4454 compost to a wholesaler or retail yard which may produce an AS4419 soil mix. • Contamination is the big risk in growing the recycling rate. Local and state governments need to fix contamination issues and ban materials like plastic. • Reasonable maximum contamination varies based on the scale of the facility: small regional facilities are capable of processing up to 2% but a larger facility with pre-sorting could accept up to 5% by weight (a significant volume of low density contaminants e.g. plastic). • The risk profile of the contract: some councils will state 10% contamination so there's a significant risk for the composter. Some councils use contamination bands with associated costing levels. This provides an incentive to decrease contamination and increase resource recovery. It also puts the onus on education. • PFAS and plastic are the highest risk contaminants in the stream because they pose human health and environmental risks and bioaccumulate. Glass contamination is a significant problem for handling and re-use of compost. • Persistent herbicides are a high risk contaminant. While PFAS has a cumulative impact, persistent herbicides have an immediate impact In parts per billion and are hard to detect. • Banning PFAS is a necessary next step. • It is an onerous and costly task to do routine testing for PFAS and therefore many facilities do not do it.

Output	Processor Specifications
	• It's important to make sure no one is exporting compost with PFAS in it. • Some processors can accept certified compostable packaging, but others don't want it as it offers no nutrients (it dissolves into salt, water and carbon dioxide) and causes confusion amongst consumers leading to higher contamination with non-certified packaging. • There is a concern in NSW that there will be too much compostable packaging. • A focus on feedstock controls is required. In Europe, they are banning compostable packaging to reduce confusion. All Australian LGAs should make a consistent decision about whether it is allowed or not. Consistent messaging is required. • It would be beneficial to do joint waste collection tenders for retail food waste and household food waste. While it is anti-competitive to do a joint tender, economic food waste collections are needed. Commercial bins would need to be emptied several times a week. • State governments need to support local initiatives and accelerate FOGO-derived material use in large infrastructure projects close to where FOGO is generated/processed. • It is difficult for processors to get ongoing investment without certainty of feedstock and offtake markets. South Australia is best practice. They don't do anything extraordinary, but they do it long-term and consistently which provides certainty for investment. Most councils elsewhere don't have long-term vision however they are the biggest suppliers of the industry, and they use the offtake so it is in their interests to support the industry. • Most councils don't have organics contracts at all, just get rid of processed material in a spot market. • Every state is different in terms of end use requirements: Queensland, NSW and Victoria use output for landscaping and urban amenity applications. Queensland and NSW also put organic outputs into mine sites. In South Australia, a lot goes into horticulture and agriculture is also growing. Western Australia is putting a lot of funding and effort into agriculture. • Compliance with the Australian Standard is requested by some end users.

7.4 Impact assessment

Feedback was received about the lack of alignment between Council waste contracts and state regulations regarding contamination. It was reported that some Councils list particular contaminants as 'incidental contamination' which processors must accept while state regulations, such as RROs, do not allow these contaminants in any form.

Materials acceptable in organics collection services, often defined by Councils, should reflect the relevant regulations regarding application to land. This is likely to be a challenge when considering opportunities to standardise bin inputs nationally, as different states have different regulations. The main issue here is the inclusion or not of compostable packaging. The use of compostable caddy liners has shown to increase household participation and the level of food organics diverted from landfill[42]. More research is required to detail this impact and justify universal use of compostable liners.

Further to the issue of developing consistent state regulations regarding organics recovery, a report reviewing regulations and standards for recycled organics published by Frontier Ag & Environment (2021) recommended an integrated and overarching policy framework upon which individual state regulations can be based on[43]. The example of a national end of waste (EoW) code for compost was given. The EoW concept involves consistently classifying feedstock so that physical and chemical contamination are effectively managed early on. This places the responsibility for feedstock quality on the suppliers of the feedstock, local councils, and allows for consistent education.

Voluntary product standards/guidelines/certifications should also continue being developed to give end users' greater confidence in the quality of these end products and in their specific uses.

To maximise recovery in this stream, it is recommended that:

- FOGO bin inputs and education be standardised across Australia;
- A consistent, evidence-based approach to use of compostable caddy liners (and acceptance of other compostable packaging) be developed;
- Council contracts should present contamination ranges (e.g. 0-2%, 2-4%, etc) and associated costing levels to encourage reduced contamination;
- Products and packaging with PFAS and persistent herbicides should not be accepted in the green bin, following PFAS bans in the United States and other countries;
- Nationally consistent limits for PFAS and persistent herbicides in organic outputs are established through a robust risk assessment; and
- State governments support the use of processed FOGO material in large-scale infrastructure and landscaping projects.

Based on consultation with stakeholders, a specification for each material output was chosen as a general guideline for processors. The impact of each specification was assessed in regard to the actions required to achieve the specification and improve resource recovery, see Table 6.

[42] A guide for local government (2018) Victoria State Government & Metropolitan Waste & Resource Recovery Group. https://www.mwrrg.vic.gov.au/assets/resource-files/MWRRG-FOGO-Guide-2021.pdf
[43] Review of Regulations and Standards for Recycled Organics in Australia (2021) Frontier Ag & Environment.

Table 31 Organics impact assessment

Sorter/Processor	Specification	Key aspects of the specification	How it supports resource recovery	Benefits, barriers, risks	Price / market impacts	End user demand	Business benefits and (compliance) costs.	Waste and recycling contracts
Processor	**State regulations** **O1.1 Standard for the production and use of waste derived soil enhancer** **O1.2.1 Pasteurised Garden Organics 2016** **O1.2.2 Mulch 2016** **O1.2.3 Compost 2016** *(minimum standards)*	Focussed on limiting risks to the environment and human health	Outlines requirements for applying recycled organic products to land	- Legal requirement - Focussed on managing risks to the environment and human health - Too many organic outputs aren't covered under regulations - Variation across states	Limited impact	No direct impact	Already a requirement to operate	Contracts should reflect state regulations.
Processor	**Australian Standards:** **O1.3.1 AS4454 Composts, Soil Conditioners and Mulches** **O1.3.2 AS4419 Soils for landscaping and garden use** **O1.3.3 AS3743 Potting mixes** *(best practice)*	Describes minimum processing standards Provides limits for chemical and physical contaminants	Describes the processing requirements and testing / sampling procedures required to meet product standards	- Voluntary market standard - Used to support retail product lines and not a product specification - Blending of outputs to produce end products results in diverse range of products - 90% of organic product is not sold under these standards - No limit for PFAS	Limited impact	May improve saleability if product is certified to the standard Some urban designers call out these specifications in tenders	Product certification may be required by some purchasers	Alignment of contracts and State regulation in terms of the materials / items declared contaminants in kerbside organics bins

7.5 Organics summary and next steps

A summary of the key findings for organics processor specifications are provided in Table 32, including the actions required and timeframe.

Table 32 Organics processor recommended specifications, actions and timeframes

Material Output	Recommended specification	Updates required or comments	Currently achieved?	Actions to achieve the specification and/or improve resource recovery	Timeframe & who is responsible
Processed organics*	**State regulations** **O1.1 Standard for the production and use of waste derived soil enhancer** **O1.2.1 Pasteurised Garden Organics 2016** **O1.2.2 Mulch 2016** **O1.2.3 Compost 2016** *(minimum standards)*	None.	Achieved as a requirement to operate.	Materials accepted in organics collection services should reflect the feedstock requirements outlined in state regulations for application to land. State and territory governments should where possible consider aligning end of waste and resource recovery orders for organics. Consider not accepting products and packaging with PFAS and persistent herbicides in the green bin.	National & State & local governments – 2 to 3 years
				Develop a nationally consistent approach to compostable packaging that can be accepted in the FOGO bin.	National & State & local governments – 2 to 3 years
				National, State and local governments to support initiatives and accelerate FOGO-derived material use in large infrastructure projects close to where FOGO is	National, State and local governments – 2 to 3 years

Material Output	Recommended specification	Updates required or comments	Currently achieved?	Actions to achieve the specification and/or improve resource recovery	Timeframe & who is responsible
				generated/processed (metro and regional)[44][45].	
				An organic product certification scheme driven by end user consultation to create higher value products for agriculture and incentivise product innovation.	AORA & Agricultural Sector - 1 to 2 years
Processed organics*	**Australian Standards:** **O1.3.1 AS4454 Composts, Soil Conditioners and Mulches** **O1.3.2 AS4419 Soils for landscaping and garden use** **O1.3.3 AS3743 Potting mixes** *(best practice)*	Include testing for PFAS.	Currently achieved however few organics processors choose to certify their products to the Standard	Develop a nationally consistent approach to compostable packaging that can be accepted in the FOGO bin.	National & State & local governments – 2 to 3 years
				Nationally consistent limits for PFAS and persistent herbicides in organic outputs are established through a robust risk assessment.	National & State & local governments – 2 to 3 years
				National, State and local governments to support initiatives and accelerate FOGO-derived material use in large infrastructure projects close to where FOGO is generated/processed (metro and regional).	National, State and local governments – 2 to 3 years

[44] For example, WA's Sustainability Waste Alliance was established to identify specific opportunities for using recycled materials, including organics, in major infrastructure projects. A 5-year deal has been made for the state government to take FOGO derived soil conditioner for use in rail and road projects.
[45] Sustainability Waste Alliance website: https://www.swainnovationhub.org/

Material Output	Recommended specification	Updates required or comments	Currently achieved?	Actions to achieve the specification and/or improve resource recovery	Timeframe & who is responsible
				An organic product certification scheme driven by end user consultation to create higher value products for agriculture and incentivise product innovation.	AORA & Agricultural Sector - 1 to 2 years

*Material output varies by process and facility.

8 Conclusions and next steps

Many of the specifications identified and assessed in this report provide a benchmark or reference point from which all actors in the resource recovery value chain negotiate their individual seller-buyer contracts. Often supply/buy contracts will be based on these specifications with additional unique terms negotiated around quality, contamination and price depending on the varying capability of each site's ability to sort, process and manufacture into a new product or material.

Economies of scale (i.e. value and volume) play a significant factor on the how much sorters, processors and/or end-users invest in equipment to sort, wash, clean, shred, flake, pelletise or process. As a result of this there is a constant tension between sorters, processors and end users as to what the sorter and processor can produce and what the processor and end user want or require.

However, what is clear from all stakeholders along the recovery chain is that the cleaner the feedstock is at the point of collection, the less comingling of materials that are difficult to separate, and the greater knowledge of the source and processes used to recover the materials, the more resources are recovered, the greater the market confidence and the greater the value of the recovered material. Certainty of quality within an agreed range and consistency of supply is what all end users are looking for.

Tolerances of quality vary with material types and end uses. While most stakeholders agreed that the specifications should emphasise limits on prohibited materials rather than other aspects, some stakeholders believed that the specifications should not be minimum standards but rather be best practice specifications that the industry should strive to achieve.

By recommending both a minimum and best practice specification for a number of material types we have tried to show what is required to increase the volume and valued of resources recovered. Juggling between volume and value is a constant commercial challenge for sorters and processors. As is quality and quantity for end users.

Overall, stakeholders have reported that specifications are a useful tool to know what quality of material they have to supply and provide the basis of many contracts. Being able to access these from a single point will help reduce confusion, increase confidence within the supply chain and assist sorters and processors to produce high quality recycled outputs.

It is uncommon for sorters or processors to have their recovered material outputs independently certified against an industry specification or standard. Rather independent certification and compliance is focussed on operation of the facility against state and territory regulations, license requirements, resource recovery orders, and Australian and international worker safety and environmental management.

To improve resource recovery, recyclers (i.e. sorters and processors) are encouraged to have their outputs independently certified as part of the ARAP process. The certification process includes an auditing and reporting function to identify and verify the relevant standards or specifications that apply to the recovered materials generated by the sorter or processor.

Table 33 below lists the recommended specifications for each material type. An example of how a specification may be assessed in the ARAP process is provided in Appendix C.

Table 34 lists the recommended actions, responsibilities and timeframes to encourage uptake of the recommended specifications and the upstream or downstream processes that will help achieve the specifications and improve the volume and the value of resources recovered and available to end users.

Glass

For glass specifications, it has been recommended that the ISRI and ACOR cullet specifications be adopted and that new sorting and processing specifications for use of glass fines and sand in roads,

filtration or insulation be developed. It has also been recommended that the colour separation requirement in the ACOR cullet specification be removed and that metal is added to the list of specific contaminates.

Upstream it is recommended that CDS be expanded to include all glass containers and that manufacturers are discouraged to use metal closures in glass containers.

Downstream it is recommended that there is greater joint industry (packaging and recycling) and government investment in sorting facility clean-up lines and optical sorting at beneficiation facilities to supply higher quality cullet to container manufacturers. To increase recovery and use of glass fines, more proactive government procurement of glass fines into civil construction is encouraged as is the investment in regionally based crushing or processing equipment.

Plastic

For rigid plastics the recently created APCO/ANZPAC specifications have been recommended as best practice, with the ACOR and ISRI specifications as the minimum standard. However, stakeholders have advised that many material recycling facilities (i.e. primary sorters) do not currently meet the APCO/ANZPAC bale specifications.

Upstream, if recovery rates are to improve and more plastics are recycled back into higher valued products, there needs to be greater consistency in what polymer types are accepted in the kerbside bin across the country. Based on markets, volumes and processing equipment it is recommended that only PET, HDPE and PP rigid plastics are accepted in the yellow bin at this stage. PVC and PS plastics in packaging should be phased out in packaging wherever possible and the Australian Recycling Label should clearly indicate the appropriate recycling categorisation for these plastics. Downstream, the optical sorting capability of material recycling and plastic recycling facilities needs to be further upgraded if these facilities are to be able to meet the APCO/ANZPAC bale specifications.

Flexible or soft plastics are currently only collected by REDcycle through its national supermarket drop off network. There are trials underway to collect flexible plastics via the yellow bin to increase the quantity and quality of flexible plastics recovered. It is strongly recommended that collection of flexible or soft plastics via the yellow bin not be implemented nationally until there are proven commercial secondary processors (i.e. mechanical and advance recycling) and markets (i.e. food and non-food grade packaging and products); the sorting procedures can be easily implemented; material recycling facilities have been upgraded and flexible bale specifications are in place. To do otherwise would cause equipment failures and contaminate paper bales.

Development of new specifications have also been recommended for the evolving liquid paperboard and advance recycling sectors.

Metal

The ISRI metal specifications for aluminium and steel are well understood and adopted by sorters, processors and end users. All aluminium and steel (tin cans) are exported for processing offshore.

The main challenges for domestic metal sorters and scrap metal processors is removing putrescible waste, sorting the various grades of aluminium and aerosol cans exploding. Upstream, these challenges should be addressed by having nationally consistent messages educating householders to wash and remove food from metal containers, and/or upgrading sorting and processing facilities downstream to remove putrescible waste.

Secondly, producers and brands should provide clearer instructions on the correct disposal of aerosol cans, especially those containing flammable substances to reduce explosions in collection trucks and sorting facilities. These disposal instructions should be reinforced by state and local government community education campaigns.

Thirdly, scrap metal processor facilities should be upgraded to sort and process lower grades of aluminium.

Paper and cardboard

Both ISRI and ACOR paper and cardboard specifications are commonly used in trading bales of various paper grades (i.e. soft or hard mixed, newspaper, magazine) and cardboard containers. The main effort to improve the volume and value of the fibre being recovered should be focussed on removing the primary contaminates (i.e. prohibited items plastic, glass and batteries).

Efforts to remove contamination should be made at all stages of the process from upstream to downstream. Upstream, this would include having separate glass or paper collection pathways (i.e. glass drop off through CDS or other or paper household bin). Noting that Victoria's decision to go down the separate household glass bin option has the added downside of increased noise when the bins are emptied into the trucks. Educating the householder not to put batteries in any of their household kerbside bins.

Downstream it is recommended to upgrade sorting facility paper clean up lines with optical sorting equipment and/or adding more manual sorting to remove contamination. Installing and upgrading drum pulpers at processing facilities is also recommended.

There is currently no specifications for wet or dry pulp paper and therefore it is recommended pulp specifications be developed as soon as possible so that the sector can be prepared for the impending ban on baled mixed paper on 1 July 2024. Likewise the ACOR specifications should be updated to reflect the agreed rules for the export of waste paper and cardboard.

Clarity from the federal government is urgently required regarding listed export specifications for paper/cardboard to support timely investment

Organics

Specifications for recovered organics are managed differently to glass, plastics, metals, paper and cardboard, due to the recovered material being applied to land rather than being used as a raw material for manufacturing. Therefore, there are a suite of state and territory government regulations and guidelines that control accepted feedstock, processing and end use to manage physical and chemical contamination. These have been recommended as the minimum standard.

The three Australian Standards AS:4454 Composts, Soil Conditioners and Mulches, AS:4419 Soils for landscaping and garden use and AS:3743 Potting mixes are recommended as best practice.

To improve the quality and quantity of organics recovered, it is recommended that FOGO and GO council contracts align with state and territory regulations, specifically the materials acceptable in FOGO and GO collection services mirror the relevant state regulations. The main issue here is the inclusion or not of compostable packaging and the use of compostable caddy liners.

It is clear that to maximise recovery in this stream nationally consistent specifications that are reflected in each state and territory's regulations are required for collection, feedstock and processor outputs.

Specifically, it is recommended that FOGO bin inputs and education be standardised across Australia. A consistent, evidence-based approach to the use of compostable caddy liners (and acceptance of other compostable packaging) should be developed.

Council contracts should include contamination ranges (e.g. 0-2%, 2-4%, etc) and associated costing levels to encourage reduced contamination. This may include limits that effectively prohibit contamination from PFAS, and persistent herbicides and other chemicals.

State, territory and local governments should consider,

- not accepting products and packaging with PFAS and persistent herbicides,
- establish nationally consistent limits for PFAS and persistent herbicides in organic outputs,
- only accepting AS 4736 caddy liners in the FOGO services,

- supporting the use of processed FOGO material in appropriate large-scale infrastructure and landscaping projects, and
- aligning end of waste and resource recovery orders for organics.

Table 33 Recommended specifications

Material Output	Recommended specifications	RaWR Act listed specification (✓ / ×)[46]	Action required
Glass			
Sorting			
Cullet	*Best practice* - ACOR - G1.1 - Unbeneficiated Cullet *Minimum standard* - ISRI - G1.2 - Unprocessed container glass cullet specifications	× ×	Yes
Fines	NG1.1 - Glass fines specifications to be developed for construction, filtration and insulation uses	×	Yes
Processing			
Cullet	*Domestic* - ISRI - G1.4 - Processed (furnace ready) cullet *Export* - ACOR - G1.3 - Beneficiated cullet	× ✓	No No
Fines	*Minimum standard* - VicRoads - G1.5 - Registration of Crushed Rock Mixes NG1.2 - new specification for glass sand for filtration and insulation applications	N/A ×	Yes Yes
Plastic			
Sorting			
PET	*Best Practice* - APCO/ANZPAC P1.1.1 Baled clear PET bottles P1.1.3 Baled coloured and thermoformed PET *Minimum standard* - ISRI P1.2.1 PET bottles (Grade A) P1.2.2 PET thermoforms	✓* × 	No .
HPDE	*Best Practice* - APCO/ANZPAC P1.1.2 Baled rigid HDPE natural food grade P1.1.4 Baled rigid HDPE - all colours *Minimum standard* - ISRI P1.2.3 HDPE natural bottles (Grade A)	✓* ×	No

[46] DAWE website: https://www.awe.gov.au/environment/protection/waste/exports/specifications-and-documents/glass-specifications. Listed specifications for waste glass have been assessed against the Objects of the *Recycling and Waste Reduction Act 2020* (RaWR Act). However, most exporters of waste glass apply for a licence nominating their own specification or their supplier's specification (if they don't process the waste glass themselves). Just because they don't use a 'listed specification' does not mean they won't get a licence. The department assesses all non-listed specifications for waste glass to ensure it meets the RaWR Act as part of the licence assessment process.

	P1.2.4 HDPE colour bottles (Grade A) P1.2.5 HDPE Injection Bulky rigids		
PVC	*Best Practice* - ACOR P1.4.3 Post-Consumer PVC Bottles Bale Specs for Recyclate Feedstock	 ×	Yes
LDPE	*See mixed plastics and advanced recycling feedstock specifications below*	N/A	No
PP	*Best Practice* - APCO/ANZPAC P1.1.5 Baled coloured PP *Minimum standard* - ISRI P1.3.1 Polypropylene Small Rigid Plastics *See also mixed plastics and advanced recycling feedstock specifications below*	✓* ×	No
PS	*See mixed plastics and advanced recycling feedstock specifications below*	×	N/A
Mixed plastics	*Minimum standard* - ISRI P1.3.3 3-7 Bottles and Small Rigid Plastic P1.3.4 Tubs and Lids (PP, HDPE, LDPE containers) *See also advanced recycling feedstock specification below*	 × ×	No
Other (liquid paperboard)	NP1.1 - New specification required	×	Yes
Flexible plastics	NP1.2 - New specification required	×	Yes
Advanced recycled feedstock	NP1.3 - New specification required	×	Yes
Processing			
PET	*Best practice* - APCO/ ANZPAC P1.6 PET hot washed flake P1.7 Coloured PET cold washed flake	 ✓	No
HDPE	*Best practice* - APCO/ ANZPAC P1.8 Natural HDPE flake for food grade applications P1.9 Coloured HDPE flake	✓	No
PVC	Customer based	×	N/A
LDPE	*See advanced recycling output specification below*	N/A	N/A
PP	*Best practice* - APCO/ ANZPAC P2.0 Cold washed coloured recycled PP flake *See advanced recycling output specification below*	✓	Yes
PS	*Best practice* - EPSA P2.1 Export Densified Foamed Polystyrene (for EPS)	✓	No
Mixed plastic	*See advanced recycling output specification below*	N/A	N/A
Advanced Recycling output (oil)	NP1.4 New specification to be developed	N/A	Yes
Metal			
Sorting			
Aluminium	*Best practice* - ISRI M1.3.2 Densified aluminium UBC scrap M1.3.3 Baled aluminium UBC scrap M1.3.4 Briquetted aluminium UBC scrap	N/A	No

	Minimum standard - ISRI M1.3.1 Post-consumer aluminium can scrap	N/A	No
Steel	*Minimum standard* - ISRI M1.3.5 Steel can bundles	N/A	Yes
Processing			
Aluminium	*Best practice* - ISRI M1.3.2 Densified aluminium UBC scrap M1.3.3 Baled aluminium UBC scrap M1.3.4 Briquetted aluminium UBC scrap *Minimum standard* - ISRI M1.3.1 Post-consumer aluminium can scrap	N/A N/A	No No
Steel	*Minimum standard* - ISRI M1.4 Shredded (ferrous) scrap	N/A	No
Paper & Cardboard			
Sorting			
Paper/mixed	*Minimum standard* - ACOR F1.1.1 Soft Mixed F1.1.3 Hard Mixed F1.1.4 Old Newsprint (ONP) *Best Practice* - ISRI F1.2.4 Mixed Paper F1.2.5 Sorted Residential Papers & News F1.2.6 Magazines	Export ban not in place until July 2024	Yes
OCC	*Minimum standard* - ISRI F1.1.2 Old corrugated containers (OCC) (Grade 11, Grade 12)	Export ban not in place until July 2024	Yes
Processing			
Pulp	NF1.1 New specification to be developed	Export ban not in place until July 2024	Yes
Organics			
Sorting			
Organics	Sorter specifications not relevant		
Processing			
Composts, Soil Conditioners and Mulches	*Minimum standard* - State regulations O1.1 Standard for the production and use of waste derived soil enhancer O1.2.1 Pasteurised Garden Organics 2016 O1.2.2 Mulch 2016 O1.2.3 Compost 2016 *Best Practice* - Australian Standards O1.3.1 AS4454 Composts, Soil Conditioners and Mulches O1.3.2 AS4419 Soils for landscaping and garden use O1.3.3 AS3743 Potting mixes	x x	No Yes

Table 34 Recommended actions, responsibilities, and timeframe to increase resource recovery

Actions to achieve the specification and/or improve resource recovery	Responsibilities	2021-22	2022-23	2023-24	2025-26
Glass					
Updates and Additions to Specifications					
ACOR - G1.1 Unbeneficiated Cullet - Remove colour separation requirement. - Metal to be listed as a specific contaminant.	ACOR				
NG1.1 - new specification for glass fines coming out of MRFs for use in construction, filtration and insulation purposes.	NWRIC/ACOR				
NG1.2 - new specification for glass sand for filtration and insulation applications	NWRIC/ACOR				
Upstream Actions					
Consider separate glass collection bin or additional drop-off sites (e.g. CDS).	National, State & Local Governments				
Consider expansion of CDS eligible containers.	State and Territory governments				
Packaging design to reduce metal closures	APCO				
Downstream Actions					
Consider investment in glass clean-up lines at MRFs.	Packaging & Recycling Industry National, State & Local Governments				
Consider investment in improved optical sorting at beneficiation facilities.	Packaging & Recycling Industry National, State & Local Governments				

Actions to achieve the specification and/or improve resource recovery	Responsibilities	2021-22	2022-23	2023-24	2025-26
Continued updating and endorsement of civil work specifications.	National, State & Local Governments				
Consider investing in glass reprocessing facilities in regional areas OR glass crushing and processing equipment appended to regional MRFs.	Packaging & Recycling Industry and Government				
Consider national and state regulations or guidelines for increasing recycled content in construction works.	National, State & Local Governments				
Consider funding to support production and trialling of recycled glass fines in construction projects	National, State & Local Government				
Plastic					
Updates and Additions to Specifications					
APCO/ANZPAC - P1.1.5 Baled coloured PP - Separate bale specifications for clear and coloured PP bottles/containers to be developed. **ACOR - P1.4.3 Post-Consumer PVC Bottles Bale** - Specifications for Recyclate Feedstock **ISRI - P1.3.1 Polypropylene Small Rigid Plastics** - Develop separate specifications for baled clear and coloured bottles/containers.	APCO/ANZPAC ACOR				
APCO/ANZPAC - P2.0 Cold washed coloured recycled PP flake. - Develop separate flake specifications for clear and coloured flake.	APCO/ ANZPAC				
NP1.1 - develop specification for liquid paperboard	APCO/ANZPAC				
NP1.2 - develop specification for shredded flexible plastics.	APCO/ANZPAC				
NP1.3 - develop specification for advanced recycling from sorters.	Chemistry Australia				

Actions to achieve the specification and/or improve resource recovery	Responsibilities	2021-22	2022-23	2023-24	2025-26
NP1.4 - develop specification for advanced recycling oil output.	Chemistry Australia				
Upstream Actions					
Consider national bin input standards to reduce increase inconsistencies between LGAs.	National, State & Local Governments				
Bin input standards should consider advanced recycling feedstock specifications when they are developed.	National, State & Local Governments				
Bin input standards should consider excluding packaging made from composite material in the yellow bin	National, State & Local Governments				
Consider expansion of CDS eligible containers.	State and Territory governments				
Expand CDS to all states and territories.	Vic & Tas government				
Packaging design should avoid composite products	APCO, Packaging industry				
Ensure the Australian Recycling Label indicates the appropriate recycling categorisation for packaging made from PVC or PS.	APCO, Packaging industry				
Consider effective education regarding soft plastics in the yellow bin.	National, State & Local Governments				
Consider incentives to promote the use of recycled content for plastics production, instead of virgin material, to increase recovery.	National & State Governments				
More collection sites with densifying equipment for EPS to be considered.	Packaging industry				
Downstream Actions					
Consider investment into MRFs to separate individual polymers and colours and product types.	Packaging & Recycling Industry National, State & Local Governments				

Actions to achieve the specification and/or improve resource recovery	Responsibilities	2021-22	2022-23	2023-24	2025-26
Consider optical sorting equipment investment at the processor stage to decontaminate bales	Packaging & Recycling Industry National, State & Local Governments				
Consider investment in additional washing and optical sorting equipment for soft plastics.	Packaging & Recycling Industry National, State & Local Governments				
Consider national approach to the advanced recycling industry	Packaging & Recycling Industry National, State & Local Governments				
Metal					
Updates and Additions to Specifications					
ISRI - M1.3.5 Steel can bundles - Limits on putrescible waste and tin content.	ISRI or NWRIC/ACOR to develop National specification				
Upstream Actions					
Consider limiting metal products permitted in the yellow bin to washed, non-composite steel cans and aluminium UBCs.	National, State & Local Governments				
Packaging design should avoid composite products and limit tin content.	APCO				
Producers and brands should provide clearer instructions on the correct disposal of aerosol cans, in particular those containing flammable substances to reduce explosions in collection trucks and sorting facilities. State and local government community education campaigns should reinforce safe disposal instructions.	APCO, Packaging Industry State & local government				
Downstream Actions					

Actions to achieve the specification and/or improve resource recovery	Responsibilities	2021-22	2022-23	2023-24	2025-26
Consider investing in additional processing equipment to remove putrescible waste from metals.	Packaging & Recycling Industry National, State & Local Governments				
Consider investing in aluminium processing equipment upgrades and infrastructure.	Packaging & Recycling Industry National, State & Local Governments				
Paper & Cardboard					
Updates and Additions to Specifications					
ISRI **F1.2.4 Mixed Paper** **F1.2.5 Sorted Residential Papers & News** **F1.2.6 Magazines** - Review specification once paper export ban comes into place.	ISRI or NWRIC/ACOR to develop National specification				
ISRI - F1.2.3 Old corrugated containers (OCC) (Grade 11, Grade 12) - Stronger emphasis required on specific problematic items that should be limited	ISRI or NWRIC/ACOR to develop National specification				
NF1.1 - new specification for pulp coming out of a pulper	NWRIC/ACOR				
Upstream Actions					
Consider how separate glass or paper collection would reduce contamination in the paper stream.	National, State & Local Governments				
Downstream Changes					
Consider investing in the installation of drum pulpers at pulping facilities to better handle contamination.	Packaging & Recycling Industry National, State & Local Governments				

Actions to achieve the specification and/or improve resource recovery	Responsibilities	2021-22	2022-23	2023-24	2025-26
Consider investing in paper clean up lines at MRFs consisting of manual or optical sorting	Packaging & Recycling Industry National, State & Local Governments				
Organics					
Updates and Additions to Specifications					
Australian Standard - O1.3.1 AS4454 Composts, Soil Conditioners and Mulches - Include testing for PFAS	Australian Standards & National government				
Upstream Actions					
Consider national FOGO bin inputs standards, including compostable packaging and caddy liners.	National, State & Local Governments				
Consider not accepting or banning products and packaging with PFAS and persistent herbicides in the green bin.	National, State & Local Governments				
Consider only accepting AS4736 liners in the FOGO service	National, State & Local Governments				
Consider bin input standards reflecting the feedstock requirements outlined in state regulations for application to land.	National, State & Local Governments				
Downstream Changes					
Establish nationally consistent contamination limits for PFAS and persistent herbicides in organic outputs through a robust risk assessment process.	National & State Governments				
Consider an organic product certification scheme driven by end user consultation.	AORA & Agricultural Sector				
Support initiatives and accelerate FOGO-derived material use in large infrastructure projects close to where FOGO is generated/processed (metro and regional).	State Governments				

8.1 Online portal

It is proposed that a publicly accessible online portal be developed early in 2022 by NWRIC that would include the material flow pathways and lists of the specification titles and authors for each of the material type outputs including links to the actual specifications.

Having the specifications in one location for sorters and processors to access will help to reduce confusion and increase confidence within the supply chain. Other parties that may wish to access the specifications include local councils developing contracts and providing recycling education to residents, and end users of recycled materials.

The online portal will highlight that the recommended specifications are a guide only and that other specifications can be agreed upon between buyers and sellers of the material to suit different processing and supply chains. The use of the recommended specifications does not serve as a price guarantee or certification of the material, it rather serves as a guide for negotiations between buyers and sellers to kick off.

A contact email will be provided on the online portal for users to provide feedback and recommendations to be considered as the specifications are reviewed.

Appendix A Stakeholder Consultation

Table 34 Stakeholder consultation matrix

Stakeholder organisation	Sorter	Processor	End User	General/ Other	Glass	Plastic	Paper	Metal	Organics	Webinar	Interview	Survey
Cleanaway	✓				✓	✓	✓	✓	✓	✓	✓	✓
JJ's Waste & Recycling	✓				✓	✓	✓	✓	✓	✓	✓	✓
Suez	✓				✓	✓	✓	✓	✓	✓	✓	✓
Cryogrind	✓	✓				✓				✓	✓	✓
Qenos		✓				✓				✓	✓	✓
Brightmark		✓				✓				✓	✓	✓
Australian Packaging Covenant Organisation (APCO)				✓	✓	✓	✓	✓	✓	✓	✓	
Australian Organics Recycling Association (AORA)				✓					✓	✓	✓	
Australian Local Government Association (ALGA)				✓						✓	✓	
Pact Group		✓				✓				✓	✓	

Stakeholder organisation	Sorter	Processor	End User	General/ Other	Glass	Plastic	Paper	Metal	Organics	Webinar	Interview	Survey
Vinyl Council Australia				✓		✓				✓	✓	
Lyondell Basell		✓				✓				✓	✓	
Australian Food and Grocery Council (AFGC)				✓	✓	✓	✓	✓	✓	✓	✓	
Martogg			✓			✓				✓	✓	
iQ Energy		✓				✓				✓	✓	
Chemistry Australia		✓				✓				✓	✓	
AusWaste				✓		✓	✓			✓	✓	
Coca-Cola Amatil			✓		✓	✓		✓		✓	✓	
ThinkNewsBrands		✓							✓	✓	✓	
Orora		✓			✓					✓	✓	
Veolia	✓				✓	✓	✓	✓		✓	✓	
Australian Institute of Packaging (AIP)			✓						✓	✓	✓	

Stakeholder organisation	Sorter	Processor	End User	General/ Other	Glass	Plastic	Paper	Metal	Organics	Webinar	Interview	Survey
YCA Recycling		✓			✓	✓	✓			✓		✓
NuGrow	✓	✓							✓	✓		✓
EPA Vic				✓	✓	✓	✓	✓	✓	✓		✓
JR Richards & Sons		✓			✓	✓	✓	✓	✓	✓		✓
NT Recycling Solutions	✓				✓	✓	✓		✓			✓
Oatley Resources				✓		✓	✓	✓			✓	✓
Waste Contractors and Recyclers Association of NSW (WCRA)				✓	✓	✓	✓	✓	✓		✓	
Peats Soils		✓							✓		✓	
Polymer Processors		✓				✓					✓	
SoilCo		✓							✓		✓	
Visy	✓	✓			✓	✓	✓	✓			✓	
BlueScope Steel			✓					✓			✓	
Australian Paper		✓					✓				✓	

Stakeholder organisation	Sorter	Processor	End User	General/ Other	Glass	Plastic	Paper	Metal	Organics	Webinar	Interview	Survey
Recovery (APR)												
SIMS Metal Management		✓						✓			✓	
Closed Loop		✓				✓					✓	
National Retail Association (NRA)				✓	✓	✓	✓	✓	✓		✓	
Ecologiq			✓		✓	✓					✓	
Polytrade	✓	✓			✓	✓	✓	✓		✓		
Nextek		✓				✓				✓		
Sell and Parker		✓						✓		✓		
Weston		✓						✓		✓		
Vanden Recycling		✓				✓				✓		
Glencore		✓						✓		✓		
Go Organics		✓							✓	✓		
Waste Management and Resource Recovery Association of Australia (WMRR)				✓						✓		

Stakeholder organisation	Sorter	Processor	End User	General/ Other	Glass	Plastic	Paper	Metal	Organics	Webinar	Interview	Survey
Queensland Department of Environmental Science				✓						✓		
Western Australian Department of Water and Environmental Regulation (DWER)				✓						✓		
Alex Fraser		✓			✓						✓	
REDcycle				✓		✓					✓	
iQ Renew	✓			✓		✓					✓	
NSW Department of Industry, Planning and the Environment (DPIE)				✓						✓		

Appendix B List of Specifications Reviewed

Table 35 List of all specifications reviewed and new specifications to be developed

Flow key	Specification name	Author	Sorter/ Processor	RaWR Act listed specification (✓ / ×)[47]
Glass				
G1.1	Unbeneficiated Cullet Specifications (Glass)	ACOR	Sorter	×
G1.2	Guidelines for Glass Cullet: Unprocessed container glass cullet specifications: amber, flint or green	ISRI	Sorter	×
G1.3	Beneficiated Cullet Specifications (Glass)	ACOR	Processor	✓
G1.4	Guidelines for Glass Cullet: Processed (furnace ready) Cullet Specifications: amber, flint or green	ISRI	Processor	×
G1.5	Registration of Crushed Rock Mixes	VicRoads	Processor	×
G1.6	Specifications for Recycled Crushed Glass as an Engineering Material	ARRB	Processor	×
G1.7	QA Specification 3154 Granulated Glass Aggregate	Transport for NSW	Processor	×
G1.8	Specifications MRTS36 Recycled Glass Aggregate	QLD Department of Transport and Main Roads	Processor	×
G1.9	Earthworks Specification 302	Main Roads Western Australia	Processor	×
G2.0	Specification of Basecourse Aggregate	Transit New Zealand	Processor	×
G2.1	The Recovered Glass Sand Order 2014	NSW EPA	Processor	×
G2.2	DRAFT - End of Waste Code - Glass Fines	Queensland Government	Processor	×
G2.3	WSA PS – 368 Recycled Glass Sand for Pipe Embedment	Water Services Association of Australia	Processor	×

[47] DAWE website: https://www.awe.gov.au/environment/protection/waste/exports/specifications-and-documents/glass-specifications. Listed specifications for waste glass have been assessed against the Objects of the *Recycling and Waste Reduction Act 2020* (RaWR Act). However, most exporters of waste glass apply for a licence nominating their own specification or their supplier's specification (if they don't process the waste glass themselves). Just because they don't use a 'listed specification' does not mean they won't get a licence. The department assesses all non-listed specifications for waste glass to ensure it meets the RaWR Act as part of the licence assessment process.

G2.4	Recycled Glass Sand Specification	Metro Trains Melbourne	Processor	×
NG1.1	Unprocessed glass fines specification to be developed	NWRIC/ACOR	Sorter	×
NG1.2	Glass sand specification for filtration and insulation applications to be developed	NWRIC/ACOR	Processor	×
Plastics				
P1.1	P1.1.1 Baled clear PET bottles P1.1.2 Baled rigid HDPE natural food grade P1.1.3 Baled coloured and thermoformed PET P1.1.4 Baled rigid HDPE - all colours P1.1.5 Baled coloured PP	APCO/ ANZPAC	Sorter	✓*
P1.2	P1.2.1 PET bottles (Grade A) P1.2.2 PET thermoforms P1.2.3 HDPE natural bottles (Grade A) P1.2.4 HDPE color bottles (Grade A) P1.2.5 HDPE Injection Bulky rigids	ISRI	Sorter	✓*
P1.3	P1.3.1 Polypropylene Small Rigid Plastics P1.3.2 1-7 Bottles and Small Rigid Plastic P1.3.3 3-7 Bottles and Small Rigid Plastic P1.3.4 Tubs and Lids (PP, HDPE, LDPE containers)	ISRI	Sorter	×
P1.4	P1.4.1 PET Container Specifications P1.4.2 HDPE Bottle Recyclate Feedstock P1.4.3 Post-Consumer PVC Bottles Bale Specs for Recyclate Feedstock	ACOR	Sorter	×
P1.5	P1.5.1 PP Small Rigid Plastics P1.5.2 3-7 Bottles and all other Rigid Plastics	Association of Plastic Recyclers	Sorter	×
P1.6	PET hot washed flake	APCO/ ANZPAC	Processor	✓
P1.7	Coloured PET cold washed flake	APCO/ ANZPAC	Processor	✓
P1.8	Natural HDPE flake for food grade applications	APCO/ ANZPAC	Processor	✓
P1.9	Coloured HDPE flake	APCO/ ANZPAC	Processor	✓
P2.0	Cold washed coloured recycled PP flake	APCO/ ANZPAC	Processor	✓
P2.1	Export Densified Foamed Polystyrene	EPSA	Processor	✓
NP1.1	Liquid Paperboard bale specification	APCO/ ANZPAC	Sorter	×
NP1.2	Shredded flexible plastic specifications to be developed	APCO/ ANZPAC	Sorter	×
NP1.3	Advanced recycled feedstock	Chemistry Australia	Sorter	×
NP1.4	Advanced Recycling output (oil)	Chemistry Australia	Processor	×

Metal				
M1.1	Steel Can Specifications	ACOR	Sorter	×
M1.2	Used Beverage Containers Specifications (Aluminium)	ACOR	Sorter, Processor	×
M1.3	M1.3.1 Post-consumer aluminium can scrap M1.3.2 Densified aluminium used beverage can (UBC) scrap M1.3.3 Baled aluminium UBC scrap M1.3.4 Briquetted aluminium UBC scrap M1.3.5 Steel can bundles	ISRI	Sorter, Processor	×
M1.4	Shredded (ferrous) scrap	ISRI	Processor	×
Paper and Cardboard				
F1.1	Australian Recovered Paper Specifications: F1.1.1 Soft mixed F1.1.2 Old corrugated containers (OCC) F1.1.3 Hard mixed F1.1.4 Kerbside Newspapers or old newsprint (ONP)	ACOR	Sorter	×
F1.2	Guidelines for Paper Stock: F1.2.1 Sorted office paper (Grade 37) F1.2.2 Unsorted office paper (Grade 36) F1.2.3 Old corrugated containers (OCC) (Grade 11, Grade 12) F1.2.4 Mixed Paper (Grade 54) F1.2.5 Sorted Residential Papers & News (Grade 56) F1.2.6 Magazines (OMG) (Grade 10)	ISRI	Sorter	×
NF1.1	Pulp specifications to be developed.	NWRIC/ACOR	Processor	×
Organics				
O1.1	Standard for the production and use of waste derived soil enhancer	SA EPA	Processor	×
O1.2	NSW Resource Recovery Orders: O1.2.1 Pasteurised Garden Organics 2016 O1.2.2 Mulch 2016 O1.2.3 Compost 2016	NSW EPA	Processor	×
O1.3	Australian Standards: O1.3.1 AS4454 (2012) Composts, Soil Conditioners and Mulches O1.3.2 AS4419 Soils for landscaping and garden use O1.3.3 AS3743 Potting mixes	Standards Australia	Processor	×

O1.4	PAS110:2014 Specification for whole digestate	British Standards Institution (BSI)	Processor	×
O1.5	Various state guidelines: e.g. Compost mulches for orchard production (NSW), Guide to Best Practice for Organics Recovery (VIC), Compost Guideline (SA), Application of recycled organics in mine site rehabilitation (NSW).	State and Territory governments	Processor	×

Appendix C ARAP assessment example specification

ACOR PET Container Specifications – audit protocol

☐ **Do you supply PET containers into markets that are based on the ACOR PET Container Specifications?**

Contractual arrangement documents to be sighted and reviewed

☐ **Can you confirm that the only allowable contaminant materials are present in the recovered PET containers?**

☐ **Can you confirm that no prohibited materials are present in the recovered PET containers?**

☐ **Can you confirm that the maximum prohibited, and allowable materials meet the maximum level of contaminants in the recovered PET container (See Page 4 of the ACOR PET Container Specifications document)?**

- Is automated detection equipment used to assess contaminant levels?
- Manual sorting (visual) should be carried out to separate non- PET materials from the PET bale prior processing. Estimates of the amount (percentage) of contamination undertaken on the pre-baled materials.
- Review contaminant reports used for recording supplier history and/or continuous improvement.
- If it is confirmed that the bale is highly contaminated review contamination reports that are provided to the supplier.

☐ **Can you confirm that the bale quality meets the bale quality guidelines (Section 4 of the ACOR PET Container Specifications document)?**

Visual inspection should be carried out to estimate that the bale quality meets the guidelines.

☐ **Can you confirm that the delivery arrangements including documentation and bale weights meet the delivery guidelines (Section 5 of the ACOR PET Container Specifications document)?**