QUEENSLAND WASTE & RESOURCE RECOVERY INFRASTRUCTURE REPORT

Department of Environment & Science

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IMPROVING QUALITY OF LIFE.

Department Environment and Science Queensland Waste & Resource Recovery Infrastructure Report

Revised draft

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REVISIONS

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SUMMARY

The Queensland waste and resource recovery industry is in the early stages of a once-in-a-generation transformation, supported by an ambitious but realistic *Waste Management and Resource Recovery Strategy* and key policy and regulatory reforms including the introduction of the landfill levy in 2019. The Waste Strategy sets bold targets around recycling and landfill diversion which require, amongst many other things, significant investment in new waste and resource recovery infrastructure over the next 30 years.

This *Queensland Waste and Resource Recovery Infrastructure Report* has been prepared to provide a baseline understanding of existing infrastructure and future needs to support the development of the new infrastructure required to achieve the Strategy objectives and to help Queensland transition to a circular economy where waste materials are treated as resources, given value and retained in our productive economy for as long as possible.

The Government has recognised the significant potential economic benefits of developing our resource recovery industries and investing in new infrastructure including skilled job creation, regional investment and reducing the extraction and importation of raw materials. The transformation is expected to bring unprecedented investment in new waste and resource recovery infrastructure across the state, as the landfill levy makes resource recovery more viable and attractive, and infrastructure funding support is expected to have an accelerating effect on investment. The Resource Recovery Indsutry Development Program has been created by the Government to accelerate waste diversion projects.

The Government and key stakeholders, including industry and local governments, have identified the need for a state-wide infrastructure plan to provide a framework for infrastructure development and to help industry to identify where and which types of infrastructure are needed across the state and how to support its development. This report represents the first step in delivering on that need by presenting the data that is available on existing infrastructure and waste flows.

This Report is relatively high level and is intended to identify opportunities and types of infrastructure that will be needed over the next three decades. It is agnostic on specific technologies but it does acknowledge current trends in the market and discusses solutions that are considered viable in the Queensland context. This Report in itself is not likely to support investment decisions but it should provide prospective investors, operators and local governments with relevant context and data around future opportunities for development of new waste and resource recovery infrastructure across Queensland.

The Strategy targets around recycling and landfill diversion are ambitious. New infrastructure is required but infrastructure alone will not achieve the Strategy targets and industry will not invest in new infrastructure unless other key components fall into place. Therefore, this Report works in parallel with other initiatives and priorities under the Strategy such as rethinking waste collection systems and developing sustainable end markets for recovered resources.

This Report notes the long term need for significant investment in energy-from-waste infrastructure to achieve the landfill diversion targets, but acknowledges that the Energy from Waste Policy is still under development, which will provide guidance around the conditions in which EfW is appropriate and the process for seeking approval. This Report does not specifically address infrastructure requirements in indigenous communities, noting that a separate *Indigenous Waste Management Strategy* is under development which will explore future opportunities in those communities in far greater detail.

This Report is targeted towards a broad audience. It will hopefully help local governments to work together with their neighbouring councils in regional or sub-regional groups to develop more efficient recovery and disposal solutions. It may help existing operators in Queensland to identify expansion and upgrade or diversification, opportunities. It should give investors and new players an insight into the current context and future direction of the waste and resource recovery industry in Queensland.

It is also hoped that others will read and use the Report, including commercial and industrial waste generators and operators in other industry sectors which may be complementary to resource recovery opportunities including agriculture, food processing, manufacturing, construction, power generation and other energy intensive industries such as minerals and metal processing.

The Report strongly promotes the potential for integration of conventional waste and resource recovery services and infrastructure with other industry sectors, and the potential for synergies with existing non-waste infrastructure. The formation of partnerships will be critical to realising these potential opportunities – partnerships between local governments, the private waste industry, utility operators, farmers and other industry sectors.

The future waste and resource recovery infrastructure needs vary greatly across the state, between regions and between different regional settings. The opportunities and needs in South East Queensland are very different to regional cities and their rural surrounds, which in turn are very different to the more remote areas. These differences are acknowledged in the Report and have informed the opportunities that are presented.

However, some common themes have emerged from the consultation that was undertaken to support the development of this Report and from the analysis of potential opportunities:

- To transition toward a circular economy and reduce reliance on export markets for recyclable commodities, we need to invest in MRF upgrades and new reprocessing capability. There is scope for some of this infrastructure to be developed within regional areas, to provide local solutions and reduce the costly transport of recyclables back to SEQ for reprocessing;
- We need to develop regionalised solutions where it makes sense and is beneficial to do so, but also acknowledge that some infrastructure is best delivered at the local level. We also need to develop efficient transfer facilities and networks to facilitate efficient movement of waste to regional processing hubs;
- Delivery of innovative and efficient infrastructure requires partnerships – collaboration between local governments, the waste industry, broader industry, waste generators and potential end users of recovered resources;
- We need to leverage existing complementary infrastructure and be clever about where we locate new resource recovery facilities, looking for opportunities to support and co-locate with other complementary sectors (wastewater treatment utilities, cement kilns, sugar mills or energy intensive industry). The development of well planned waste and resource recovery precincts is one way to achieve those synergies whilst reducing potential impacts on local communities and the environment.

This Report presents the relevant waste flow and infrastructure data that has been collated and analysed, including that received direct from industry in response to a data survey. Future waste flows have been projected and compared against available capacity information for existing infrastructure to identify when future capacity gaps are likely to occur.

The data that has been used from DES and direct from industry, has a number of limitations which are acknowledged within the document and it is expected that this data will improve over time, informing future revisions of this Report.

The opportunities that have been noted in this Report within each region are based on an analysis of underlying data, and on assessment of industry trends and consultation feedback. Some are quite ambitious but they are realistic and consistent with the opportunities that industry and local governments are currently exploring for the future.

Table 1 overleaf provides a summary of opportunities linked to specific material types, based on the estimated volumes of waste which are currently landfilled[1]. The potential barriers and constraints associated with those opportunities are also noted.

The subsequent Figure 1 presents a statewide summary of the future infrastructure needs in each region, within each major infrastructure type (landfills, MRFs, organics processing and C&D recycling). Future needs are depicted using traffic light indicators whereby green indicates there is likely to be adequate capacity at the regional level during that time; yellow suggests there could be capacity constraints either for the region as a whole or at a local level; while red indicates that existing capacity is unlikely to be sufficient.

Further details on the specific opportunities identified for each region are provided in the regional profiles in section 6.

[1] Landfill material breakdowns are estimated from available compositional audits, which are reasonably good for MSW but very limited for the C&I and C&D streams.

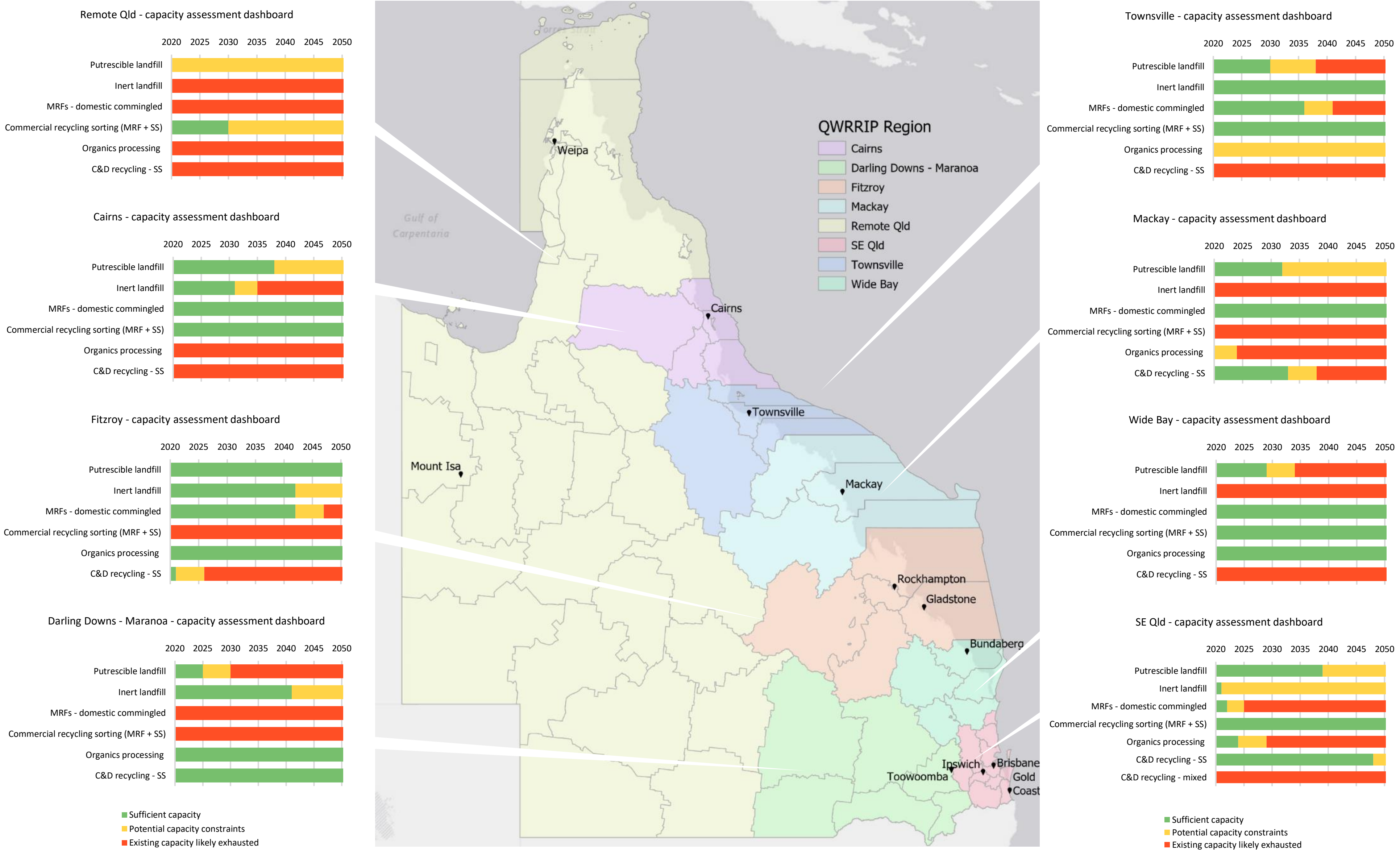
Table 1: Summary of key material streams and opportunities

Material	Total to landfill	Total managed	Recovery rate	Opportunities	Potential barriers and constraints
Food Organics	502,763	542,908	7%	▪ Significant opportunity to capture and recover food organics from commercial and household sources ▪ Potential for technologies such as AD to be applied, producing renewable energy ▪ Potential for co-processing with organics from other sectors	▪ Requires new collection systems to be implemented by councils and commercial collectors ▪ The capture of household organics is reliant on resident behaviour and participation – need to be realistic about how much food organics will be captured ▪ Likely to require new markets to be developed for recovered organics (compost)
Garden organics	469,044	1,126,708	58%	▪ Despite significant recovery volumes, there is further opportunity to capture and recover garden organics, particularly from households ▪ There is potential to invest in higher order processing to produce high value compost products and/or energy, in regions where simple mulching is common	▪ Requires new or expanded kerbside collection systems, and/or investment in drop-off facilities ▪ Mulching is a cheaper solution than composting in most cases, despite its limitations ▪ Likely to require new markets to be developed for recovered organics (compost)
Paper & Cardboard	491,468	910,530	46%	▪ Existing kerbside, self-haul and commercial collection systems still only capture less than half of this stream ▪ Potential to capture more through expanded / improved collection systems ▪ Need to invest in additional processing capacity to refine quality and produce high value materials, as markets for low grade mixed paper are not reliable	▪ Kerbside systems rely on user behaviour – need appropriate and consistent education ▪ Contamination significantly devalues the material – need source separation and pre-sorting ▪ With only one recovered paper mill in the state with limited capacity, export to interstate or overseas markets will remain an important outlet, requiring high quality products
Plastics	532,582	593,801	10%	▪ Only a small fraction of plastics are captured for recycling, mostly rigid plastic containers ▪ Significant opportunity to expand and improve household, commercial and agricultural collection systems, including soft plastics such as films and polystyrene ▪ Opportunities to invest in regional reprocessing facilities to wash and refine plastics, and reuse in local manufactured products	▪ Inefficient transport for collection / transfer of film and soft plastics ▪ Contamination and mixed polymers, significantly devalues material ▪ Lack of local manufacturing capacity may limit local offtakes for refined products
Plastics (rigid)	136,782	-	-		

Plastics (soft & other)	395,800	-	-	▪ Opportunities for difficult-to-recycle plastics to be recovered for energy including conversion to fuels and chemicals through thermal processing ▪ Opportunities for recycling into asphalt mixes for new road construction and resurfacing	
Glass	102,035	237,409	57%	▪ Potential for better capture of glass containers in regional areas through CRS, and non-CRS containers across the state ▪ With limited glass remanufacturing capacity, there are opportunities to invest in further glass crushing facilities to put glass sand into roads, concrete and other civil applications, as well as high value products such as blasting sands and filter media	▪ Need ongoing market development of end uses for glass sand ▪ Need endorsed engineering specifications for use of glass in roads and concrete within some agencies / local governments (although others have established standards) ▪ Competition with cheap virgin sand products
Ferrous metals	343,609	1,156,565	70%	▪ Good recovery rate reflecting high value of material, but still potential to capture more from household and commercial streams ▪ Reprocessing capacity exists in SEQ to produce manufacturing-ready feedstock, but opportunities for more efficient regional collection hubs and systems across the state	▪ Need accessible drop-off facilities for scrap metal ▪ Need appropriately targeted commercial collection systems ▪ Need education of users to maximise capture rates of existing collection systems
Non-ferrous metals	35,411	126,469	72%		
Timber	922,541	1,115,952	17%	▪ Opportunities to recover clean timber across the state including regional areas, for production of mulch, animal bedding, particle board products and other products ▪ Opportunity for energy recovery in dedicated small and medium scale waste wood energy facilities or through processing of mixed C&I and C&D waste into refuse derived fuels	▪ Challenges in separating clean timber from treated / painted / glued timber ▪ Contamination concerns around treated pallets which are difficult to identify ▪ Contamination concerns re metals (nails, screws, etc)
Textiles	201,641	Insufficient data	Insufficient data	▪ Significant opportunity for improved recycling and reuse	▪ Need better data on existing reuse and recovery pathways ▪ Likely that high value textiles are already captured ▪ Potential need to separate natural and synthetic textiles

Masonry, aggregate, soils	1,702,332	4,014,467	58%	▪ Further opportunities for recycling through expansion of existing networks ▪ Opportunity for investment in small scale recycling solutions in regional areas, including shared mobile processing ▪ Opportunity for investment in mixed C&D recycling capacity (e.g. skip bin waste) to recover a range of materials including soils and masonry ▪ Opportunity for investment in asphalt and concrete batching facilities designed to utilise secondary aggregates	▪ Needs market development to expand construction outlets ▪ Need endorsed engineering specifications for use of secondary aggregates in roads and concrete ▪ Secondary aggregates need to compete with cheap virgin materials ▪ Requires adequate separation at source

Figure 1: Summary of future capacity needs by region and major infrastructure types



1 OVERVIEW

The Queensland waste and resource recovery industry is in the early stages of a once-in-a-generation transformation, supported by a new Waste Management and Resource Recovery Strategy and key policy and regulatory reforms including the introduction of the landfill levy in 2019. The Waste Strategy sets bold and ambitious targets around recycling and landfill diversion which require, amongst many other things, significant investment in new waste and resource recovery infrastructure over the next 30 years.

In its new Strategy, the Government has recognised the significant potential economic benefits of developing our resource recovery industries, including job creation, regional investment and moving towards a circular economy where resources are retained within the productive economy for longer. The transformation is expected to bring unprecedented investment in new waste and resource recovery infrastructure across the state, as the landfill levy makes resource recovery more viable and attractive, and infrastructure funding support is expected to have an accelerating effect on investment. The Resource Recovery Indsutry Development Program has been created by the Government to accelerate waste diversion projects. The transformation also complements the Advance Queensland innovation and economic diversification agenda.

The Government and key stakeholders, including industry and local governments, have identified the need for a state-wide plan to provide a framework for infrastructure development and to help industry to identify where and which types of infrastructure are needed across the state and how to support its development. This Queensland Waste and Resource Recovery Infrastructure Report (the Report) has been developed as the first step towards delivering on that requirement.

This Report is relatively high level and is intended to identify opportunities and the types of infrastructure that will be needed over the next three decades. It will be supported by Regional Waste Infrastructure Plans which will provide a further level of detail and granularity around specific solutions for each region.

1.1.1 Waste Management & Resource Recovery Strategy

In June 2019 the Queensland Government released the Waste Management and Resource Recovery Strategy (the Strategy) for Queensland. This new strategy sets the strategic objectives for the waste, recycling and resource recovery sectors including long-term targets to achieve significantly improved recycling and resource recovery rates by 2050. The strategy is underpinned by the principles of the waste and resource management hierarchy and the circular economy. These will be delivered through actions focused around three key strategic priorities:

- Reducing the impact of waste on the environment and communities
- Transitioning towards a circular economy for waste
- Building economic opportunity

The Strategy identifies actions specific to state-wide infrastructure planning, with the outcome of delivering a clear and transparent waste and resource recovery planning framework. The specific action relating to this report is:

- Develop a coherent state-wide waste infrastructure planning framework and regional infrastructure plans

The strategy sets targets for waste avoidance, resource recovery and recycling, seeking to reduce the amount of waste households produce by 25%, whilst recycling at least 75% of waste and recovering 90% by 2050. In this context, energy recovery counts towards landfill diversion (recovery) but not recycling. The relevant targets are summarised below.

Table 2: Summary of relevant Waste Strategy targets

Target	Stream	Baseline (2018)	2025	2030	2040	2050
Waste reduction (total generation per capita)	MSW	0.54 tonnes per capita	10% reduction	15% reduction	20% reduction	25% reduction
Recycling	MSW	31.1%	50%	60%	65%	70%
	C&I	46.5%	55%	60%	65%	>65%
	C&D	50.9%	75%	80%	>80%	>80%
	Overall	44.9%	60%	65%	70%	75%
Landfil diversion	MSW	32.4%	55%	70%	90%	95%
	C&I	47.3%	65%	80%	90%	95%
	C&D	50.9%	75%	85%	85%	85%
	Overall	45.4%	65%	80%	85%	90%

This Report includes an assessment of the future infrastructure that will be needed to achieve these targets. Of course, having the right processing infrastructure is only part of the equation. The Strategy is supported by specific policy and regulatory measures including the introduction of the landfill levy (since July 2019). Such individual measures in isolation are unlikely to facilitate the delivery of the objectives of the Strategy. Delivering the new infrastructure to fill the gaps identified in this Report needs to be accompanied and supported by a number of other complementary workstreams and actions around aspects such as collection systems and market development for priority streams. On this basis the Strategy identifies a number of actions and action plans to be developed to achieve the targets and deliver significant change in the sector.

This Report sits within this framework, and is a key first step in delivering a statewide infrastructure plan under the Strategy (Figure 2 below). The key initiatives and projects complementary to this Report are discussed further below.

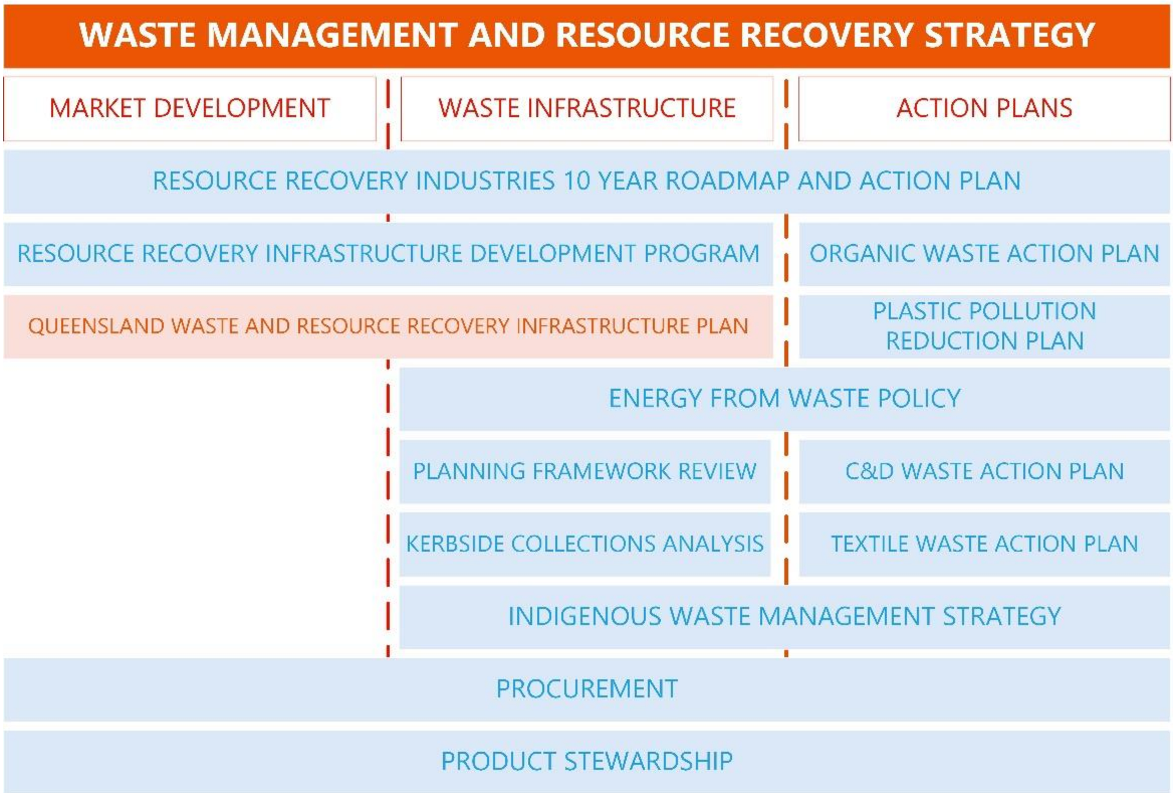


Figure 2: Waste Strategy Implementation Framework

1.1.1.1 The Resource Recovery Industries 10 year Roadmap and Action Plan

The ongoing development of markets for recycled and repurposed material through investment in modern efficient facilities and processes will reduce the amount of waste going to landfill and will assist Queensland to become a zero-waste society. Working closely with industry and other stakeholders, the Queensland Government has developed a series of roadmaps focused on emerging priority sectors with global growth potential.

The Resource Recovery Industries 10-Year Roadmap and Action Plan (the Roadmap) is a key action under the Strategy. The Roadmap provides industry and other stakeholders with an overview of the government's plan to expand and enhance this established industry sector, and support new technologies for it to grow. It will guide the sustainable growth and development of Queensland's resource recovery industries by facilitating and encouraging waste and recycling infrastructure investment.

These actions will provide business and industry with the confidence to invest in Queensland, creating new jobs, providing upskilling opportunities for the workforce, and building capacity and new markets in regional areas of the state. Actions proposed in the Roadmap will align with the Waste Strategy to ensure economies of scale and a whole-of-government approach to growing the waste and resource recovery sector, attracting industry investment, supporting jobs growth and regional development opportunities, and diverting waste from landfill.

1.1.1.2 Energy-from-waste policy development

The Queensland Government acknowledges that energy-from-waste (EfW) has a role to play in better waste management for Queensland during the transition to a circular economy. After all practical and economically viable opportunities to reduce, reuse and recycle wastes have been exhausted, EfW can be used to extract useful energy (fuels, electricity, heat) from the residual waste before final disposal. This is consistent with the waste and resource management hierarchy.

Thermal EfW technologies cannot contribute to Queensland's recycling targets. However, they can recover value from residual waste that is not practical or economically viable to separate and recycle.

This would help Queensland meet its landfill diversion target. The composition of residual waste will change over time as recycling improves and Queensland transitions to a more circular economy. EfW infrastructure must be flexible enough to accommodate this change.

The adoption of EfW in Queensland would complement the delivery of a number of Queensland Government commitments around climate change, renewable energy and industry development.

In July 2019, the Queensland Government released a discussion paper on the development of an EfW policy for Queensland. It is anticipated that the policy will be finalised by the end of the 2019 calendar year.

1.1.1.3 Kerbside collections options study

Many of the resource recovery opportunities identified in this Report will require a change in existing collection systems, particularly for household waste.

Kerbside waste collection services provided by local governments in Queensland include mixed domestic waste (red bin lid), recyclate (yellow bin lid), and green waste (green bin lid). In 2017-18, approximately 1.893 million households were provided with red bin services, 1.722 million households with yellow bin lid services, and 0.22 million households with green bin lid services.

Many councils do not have the time or resources necessary to carry out a detailed analysis of collection options during the tendering cycle, and often seek the lowest cost point, not factoring in the value that could be realised by improved source segregation and landfill avoidance. With the economics of landfilling and recycling shifting due to introduction of the Waste Disposal Levy, Container Refund Scheme and the Chinese National Sword policy restricting imports of lower grade recyclables, significant benefits could be derived from optimising kerbside collection programs across Queensland.

The aim of the Kerbside Waste Collections Analysis project is to provide economically-robust whole-of-life estimates for implementing different waste and recycling collection systems across Queensland, with a focus on organic waste (including food organic waste, and garden organic waste), and recyclate (including dry recycling: paper, cardboard, glass, and plastics).

The project is expected to provide local governments with the tools to help make informed decisions on the appropriate collection options that might warrant further investigations.

1.1.1.4 Indigenous waste management strategy

The provision of essential services in rural and remote communities remains a significant challenge to both public and private infrastructure providers. These providers are required to plan, deliver, manage, operate and maintain these services at significant cost and effort.

The Strategy recognises the geographic and other challenges in delivering an integrated waste management and resource recovery services and includes actions for state and local government, business, and industry to collaborate to develop coherent plans for waste incorporating requirements for remote, regional and metropolitan areas.

The Queensland Indigenous Waste Project (QIWP) seeks to improve waste management and resource recovery performance in Indigenous communities acknowledging the many challenges and opportunities that currently exist. The QIWP is expected to deliver a comprehensive situational analysis of waste management and resource recovery in Indigenous Queensland, which will inform the development of a Queensland Indigenous Waste Strategy.

This strategy will provide a clear pathway for Indigenous communities to achieve improved waste management and resource recovery outcomes. Regional waste infrastructure plans will also be developed to underpin the Indigenous strategy and to help deliver appropriate infrastructure that will contribute to achieving the objectives and targets of the State waste strategy.

As a result of the QWIP being developed in parallel to this Report, this document does not specifically examine issues and infrastructure needs in indigenous communities other than at a higher level, regional context.

1.1.1.5 Plastic pollution reduction plan

Plastic pollution is of significant concern across many local and global communities. The Queensland Government is committed to reducing the environmental impacts from plastic pollution in Queensland and is developing a Plastic Pollution Reduction Plan to reduce the amount of plastic in and entering the environment. The first two key actions, both commencing in 2018, were the ban on lightweight single use plastic shopping bags and the container refund scheme.

The Report references and complements existing national, state and local programs and prioritise new work to help support strategic investment decision-making and assist Queensland in attracting local recycling and remanufacturing opportunities.

1.1.1.6 Stream specific action plans

As part of the Strategy implementation, a number of stream and material specific action plans are being developed including for organics, built environment waste and textiles. These action plans will examine in further detail the collection systems, infrastructure and market development aspects required to support greater resource recovery of these streams.

1.1.2 Other relevant government strategies

This Report complements and acknowledges a number of other relevant government plans and strategies, including those noted below.

Biofutures Roadmap

The *Advance Queensland Biofutures 10-year Roadmap and Action Plan* sets out the government's vision for growing the emerging biotechnology and bioproducts industry in Queensland. As part of the Biofutures Roadmap, the Queensland Government is supporting a range of innovative new technologies and projects which are extracting valuable products including energy, fuels and bioproducts from waste materials.

Queensland Plan

The *Queensland Plan* is a 30 year vision to support vibrant and prosperous communities through planning for the right infrastructure in the right places, to support population growth. It addresses a whole range of sectors including education, communities, regions, economic development, health, environment and infrastructure. The Queensland Plan makes high level references to waste management.

Queensland State Infrastructure Plan

The *State Infrastructure Plan* (SIP) outlines the government's strategic direction for planning and prioritising the investment and delivery of infrastructure that supports growth, enables economic development and creates jobs. It was released in 2016, prior to the initiation of significant reforms in the waste and resource recovery industry, so the SIP itself makes little mention of waste and resource recovery infrastructure but a 2019 program update identifies resource recovery as a significant opportunity and notes the work of the government under the Resource Recovery Industry Development Program.

Queensland's zero net emissions future

The Queensland *Climate Transition Strategy* sets a vision of a zero net emissions future for Queensland that supports jobs, industries, communities and the environment. This vision represents Queensland's contribution to the global effort to reduce carbon pollution and arrest damaging climate change. The waste management sector in Queensland accounted for less than two percent of the state's greenhouse gas emissions in 2016.

The *Climate Transition Strategy* includes targets to:

- achieve zero net emissions by 2050

- reduce emissions by at least 30 per cent below 2005 levels by 2030 (interim target).

Queensland’s renewable energy targets

The path to achieving a zero net emissions future includes a commitment to generate 50 percent of Queensland’s energy from renewable sources by 2030. Under the Commonwealth *Renewable Energy (Electricity) Act 2000*, energy derived from organic wastes may be regarded as renewable energy. Any renewable component of electricity generated from waste would be consistent with the Queensland Government's commitment to reach 50 percent renewable electricity generation by 2030. This includes energy derived from wood waste, agricultural waste, food and food processing waste, biomass-based components of municipal waste, landfill gas, sewage gas, and biomass-based components of sewage. This type of energy is also referred to as 'bioenergy'.

There are established methods for assessing the renewable component of energy generated from mixed waste streams which are still considered a partially renewable, low carbon source of energy despite some fossil content (i.e. plastics).

1.1.3 Regulatory framework

1.1.3.1 Waste Reduction and Recycling Act 2011

The objective of the *Waste Reduction and Recycling Act 2011* is to prioritise best environmental outcomes in waste management practices. The subordinate legislation is the *Waste Reduction and Recycling Regulation 2011,* which identifies the management requirements for waste types, obligations for operators and reporting requirements. The act provides for the delivery of the state’s waste management strategy. The following additional mechanisms exist within legislation that are of relevance to infrastructure planning and market development:

- The Landfill Disposal Levy
- The management of priority products and priority waste
- Product stewardship schemes
- The ban on plastic shopping bags
- The container deposit scheme
- Littering & illegal dumping
- Local government strategic waste planning
- Reporting about waste management
- The End-of-Waste (EoW) framework

1.1.3.2 Environmental Protection Act 1994

The *Environmental Protection Act 1994* (*EP Act*) outlines the framework to protect Queensland’s environment and the program to achieve ecologically sustainable development. The *EP Act* also establishes licensing arrangements called Environmental Authorities (EAs). These EAs enable a proponent to conduct an Environmentally Relevant Activity (ERA). This is the framework under which waste infrastructure operates.

The *EP Act* introduced an integrated approach to regulating the environmental performance of industries when it commenced in 1995. The *EP Act* also established a list of ERAs and required operators undertaking these activities to be registered and hold a licence that included conditions which the registered operator had to comply with.

Since the introduction of the *EP Act,* the licensing system has had many iterations and numerous attempts to ‘simplify’ the integration of the environmental licensing process and the development assessment process.

In November 2018, the Queensland Government amended the subordinate legislation, the Environmental Protection Regulation to refine the regulated waste framework, and to modernise the waste related ERA framework.

1.1.4 National Waste Policy

The refreshed National Waste Policy provides a national framework for waste and resource recovery in Australia. It outlines roles and responsibilities for collective action by businesses, governments, communities and individuals and guides continuing collaboration between all Australian governments. It includes a number of principles and strategies around waste avoidance, resource recovery and circular economy. It does not change the responsibilities that state governments have in setting waste policy and legislation.

The Federal Government also announced an ambition to move towards banning the export of four potentially recyclable materials ("waste" plastic, paper, glass and tyres), effectively pushing the Australian industry to develop its own reprocessing and remanufacturing capacity. At the time of writing, there were no details on the timing, definition and nature of any export bans, but it will clearly require substantial investment in new infrastructure across a number of streams.

1.1.4.1 Food Waste Strategy

The National Food Waste Strategy was released by the Australian Government in November 2017 as part of efforts to contribute toward global action to reduce food waste and align with the United Nations' Sustainable Development Goal (SDG) Target 12.3, which aims to ensure sustainable consumption and production patterns in food. The Food Waste Strategy sets a target to halve food waste along the supply and consumption chain by 2030. The Strategy adopts a circular economy approach that focuses on avoiding food waste or returning food waste back into the food supply chain, before focusing on recovery of food waste into other products (e.g. compost and energy).

Under the Food Waste Strategy, food waste is defined as solid or liquid food that is intended for human consumption, with generation occuring across the entire supply and consumption chain from farm gate to consumer and end disposal. The definition includes both edible and inedible parts of food.

To support the strategy and over-arching target to halve food waste, the National Food Waste Baseline data report[2] was released in mid-2019. It acknowledges that data on food waste is generally poor and inconsistent, particularly early in the supply chain (primary production and initial processing) where food waste is not necessarily measured or reported. Nevertheless, it estimates that Australia generated 7.3 million tonnes of food waste in 2016/17 across the entire supply and consumption chain, of which 4.1 million tonnes was recycled or recovered and 3.2 million tonnes was disposed (to landfill or sewer).

In Queensland, the data baseline report estimated that around 1.8 million tonnes of food waste was generated across the entire supply chain[3]. Around 40% of that total is from primary production, defined as food that is grown but does not leave the farm, such as crops and produce that is fully grown but not harvested, or not sent to market for various reasons. Food wasted by people at home is the other major stream, while food processing and manufacturing produces a moderate proportion. Food retail, hospitality and institutional sectors (e.g. schools, universities, hospitals, aged care facilities) made relatively minor contributions overall.

1.1.4.2 National Packaging Targets

In response to the proliferation of countries introducing import restrictions for recycled commodities following China's 2018 National Sword initiative, the Federal Government has set a number of ambitious targets to improve the sustainability of packaging in Australia. Among the targets is that all packaging will be reusable, recyclable or compostable by 2025. Other targets include a goal that 70%

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[2] https://www.environment.gov.au/system/files/pages/25e36a8c-3a9c-487c-a9cb-66ec15ba61d0/files/national-food-waste-baseline-executive-summary.pdf

[3] Excluding bagasse – the inedible residue from the processing of sugarcane, which in itself accounts for around 10 million tonnes per annum

of plastic packaging is actually recycled or composted by 2025, which is more than double the current estimated national recovery rate for plastic of 32%, the lowest of all packaging types[4].
There are also targets for packaging to contain 30% recycled content and for problematic or unnecessary single-use plastics to be phased out, also by 2025.

The implementation of measures towards this target will likely increase the proportion of recyclable waste materials generated by households and businesses, which if captured in recycling systems will require additional capacity to process.

1.2 Where are we now?

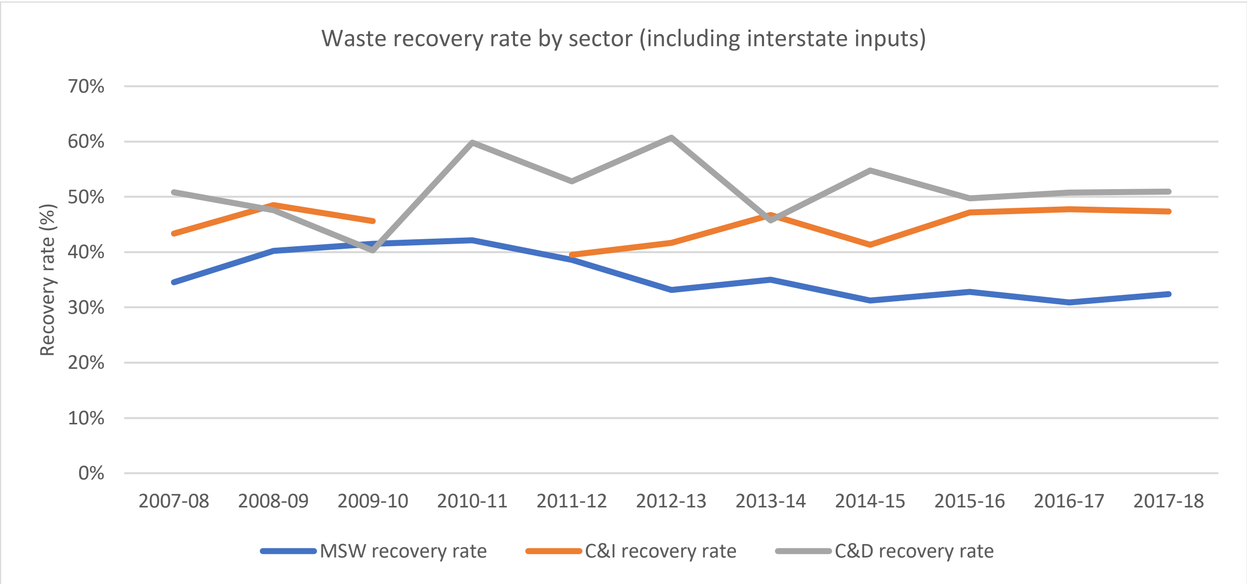
Queensland is a diverse state in terms of the industries that drive the economy and the areas that people live, which results in significant diversity in the types of waste generated and the different ways that it is managed.

In 2017-18, a total of 10.9 million tonnes of headline wastes was managed by Queensland's waste industry, which are the core waste streams that are the focus of this Report – i.e. municipal waste, commercial and industrial (C&I) waste and construction and demolition (C&D) waste. While total waste generation has continued to grow (up 11% from 2016-17), the proportion of waste that is recovered and diverted from landfill has remained relatively low, especially compared to other mainland states.

Figure 3 below shows the recovery rates for each key waste sector at the state level (including interstate imports). It shows:

- The MSW recovery rate has declined from a peak of 42% in 2010-11 down to 32% in 2017-18, meaning that two-thirds of the waste generated by households and councils is sent to landfill;
- C&I recovery has fluctuated within the 40-50% range and is currently sitting around 47% (in 2017-18);
- C&D recovery has also fluctuated, peaking at around 60% in 2010-11 and again in 2012-13 before dropping back to 51% by 2017-18. This is particularly poor in comparison to other states – both NSW and Victoria recover around 80% of C&D waste, while South Australia recovers 90%.

There a many reasons for the stagnant and lack lustre resource recovery performance, including a historic lack of strong policy drivers and a clear strategy to support resource recovery. As noted above, this is now changing at a rapid pace with the new Waste Strategy supported by strong policy measures such as the landfill levy.



[4] APCO Packaging Material Flow Analysis 2018, 2019, Australian Packaging Covenant Organisation

Figure 3: Statewide historic recovery rates by sector over the last decade

1.2.1 Challenges and Opportunities

The shift in waste policy and the introduction of the landfill levy is helping to address a number of historic barriers to investment in resource recovery infrastructure (low cost landfill, unclear policy settings). However, there remains a number of challenges and barriers which impact the industry across the state. The key barriers are discussed in the table below along with corresponding potential opportunities.

Table 3: Summary of key barriers and opportunities to resource recovery investment

Barrier / constraint	Opportunity and potential infrastructure response
Lack of local markets A critical challenge is under-developed local markets for recycled materials. The long-term decline in Australian manufacturing and the preference over recent years to export recyclables to markets in Asia has undermined domestic demand. This is a vulnerability for the waste industry, but also for general industry given the potential for resource constraints in a growing global economy.	The increasing number of effective import bans across Asia has brought into focus the urgent need to re-establish domestic reprocessing and remanufacting infrastructure. This Report, together with increasing attention in the national agenda through the Council of Australian Governmetns (COAG), will need to target recyclable packaging and particular problem streams, such as glass, tyres and textiles.
Unstable global commodity markets – the actions by China and other developing nations over the last two years, to restrict or ban the import of recyclable materials from Western nations, has resulted in a highly volatile and uncertain global market for these commodities.	The markets for clean, quality materials have generally remained strong so there is a need to develop appropriate sorting and reprocessing infrastructure which produces cleaner, single stream outputs. There is also an opportunity to develop our own remanufacturing capacity to minimise the need to export materials and our reliance on volatile global markets. Indeed, the Federal Government has challenged all of the states to stop the export of recyclable materials and keep those materials in our domestic economy.
Transport costs – recyclable materials are inherently expensive to transport long distances unless they can be significantly compacted and moved in bulk loads. The cost of transporting recyclables is a significant barrier to implementing new recycling solutions in regional areas, particularly the further north and west you go from end markets in SEQ. It has been difficult to councils and industry to justify recycling when the material can be landfilled closer to its source at a fraction of the cost of recycling. Even for residual waste, the cost of transporting to a regional processing or disposal facility can be a barrier to development of larger scale, more efficient regional infrastructure.	While there is an extensive network of transfer stations servicing communities across the state, only a small proportion have the capacity to support regional processing or disposal hubs by allowing waste to be ‘bulked up’ into large capacity, compacted loads for cost effective transport over longer distances. There is an opportunity and a need to rethink the functionality and design of transfer facilities to provide this capability in key locations. Careful planning and investment in appropriate consolidation and transfer infrastructure can help to reduce transport costs. The establishment of planned hub-and-spoke networks, where materials are consolidated at regional hubs, is one potential approach. Pre-sorting and compacting materials where possible, also dramatically improves the cost efficiency of transport. In some cases, the use of alternate modes such as rail, may help to improve the viability of transport. Ultimately though it is acknowledged that some materials will always be problematic to transport (e.g. garden organics) and the focus should be on finding local recovery solutions.
Lack of scale in regional areas – Outside of SEQ and the larger regional centres, the lack of	There may be opportunities for councils in regional areas to collaborate on a regional or sub-regional level with

scale in terms of waste volumes and the dispersed nature of communities, is often a significant constraint on formulating a viable business case for new resource recovery infrastructure.	neighbouring councils to aggregate larger volumes of waste and support more efficient solutions. Establishing efficient hub-and-spoke models to aggregate waste at local and regional hubs, supported by appropriate transfer infrastructure, can also play a role. This Report acknowledges that this will always be a challenge for some of the more rural and remote areas in Queensland where regional collaboration may not be viable. In those areas, the focus should be on discrete higher value resource recovery solutions and improving the standards of disposal infrastructure (landfills).

1.3 Where are we heading?

The new Strategy sets an ambitious direction for the waste and resource recovery industry in Queensland but it is achievable if all of the different components align.

1.3.1 Circular economy

The shift towards a more circular economy is a core pillar of the Waste Strategy. While the concept has gained significant interest globally in recent times, it is really a broadening of the long-established waste hierarchy, which already features in the W&RR Act as well as being an underlying foundation of the Waste Strategy.

Establishing a truly circular economy requires a rethink of all aspects of the economy, from extraction of resources and design and manufacturing of products, through to the way those products are used by consumers and then managed when they have reached the end of their useful life. Much like the government's Biofutures 10-year Roadmap, there are considerable linkages to economic and industry policy, in addition to the vital role of the waste and resource recovery industry.

While the waste and resource recovery sector has limited influence on the way that products are designed and manufactured, it has a vitial role providing the capability to reuse or recycle materials and keep them 'circulating' in the productive economy, or to recover energy from waste materials where recycling is not viable and disposal to landfill is the likely alternative. Its expertise is needed to ensure that high quality recycled feedstock materials are available to manufacturers and that there are adequate facilities and services available to recover products at the end of their life.

In the context of waste and resource recovery infrastructure, the transition to a circular economy means:

- Ensuring the recycling systems and processing infrastructure is in place to manage the range of waste materials that are generated
- Ensuring that adequate collection services and transfer infrastructure is in place to efficiently gather materials for recycling, while protecting the quality of those materials
- Developing local recycling and reprocessing infrastructure so that materials can be retained within local and regional productive economies for as long as possible
- Providing infrastructure which adds value to recovered resources and allows them to return to the highest practicable use
- Facilities which produce materials that compete with virgin feedstocks on quality and comply with relevant industry specifications and standards
- Integration of recycling and reprocessing infrastructure with manufacturing facilities to ensure long-term security of materials supply
- Where disposal cannot be avoided, ensure that landfills are designed and operated to minimise environmental and community impacts

1.3.2 Focus on organics

Organics are a significant component of the household and business waste currently going to landfill, and organics also cause the greatest impact when disposed to landfill, including generation of methane (a potent greenhouse gas) and contaminated leachates. Improving the capture and recovery of organics is a key priority under the Strategy but is also a strong focus for many councils and commercial generators.

Queensland already has a strong organics recovery sector which in 2018, recovered more than 1.4 million tonnes. But waste compositional data suggests that household waste which is currently going to landfill is typically 45-50% food and garden organics in urban areas and slightly lower but still significant in rural and remote areas (around 25-30%).

There are also significant sources of industrial, agricultural and forestry organics which are currently under-utilised which present a significant opportunity to recover high value products and energy, potentially through co-processing with household and commercial organics that could be collected through source separated collection systems.

1.3.3 Shift to energy recovery

There is also strong support from all levels of government and industry for a shift towards recovering energy and energy products from wastes that are not technically or economically viable to recycle. Energy recovery offers an opportunity to recover value from wastes that would otherwise be landfilled or under-utilised, so it is a critical component in the transition to a circular economy.

The Energy-from-waste Policy will provide guidance around the conditions and context in which energy recovery is considered an appropriate solution, but the waste hierarchy, as featured in the W&RR Act, is clear that energy recovery is preferable and more sustainable than landfilling.

1.3.4 Regionalised solutions and collaboration

Regional processing and disposal solutions, sourcing waste from across multiple local government areas, offer the potential to invest in new infrastructure of a scale and sophistication that would not be possible at the single local government level.

Regional solutions need to provide benefits to all parties, to ensure it is not just about the larger councils subsidising smaller councils. Councils will need to weigh up the relative costs and benefits of sending material to a regional facility, with the associated transfer and transport costs to aggregate materials. This Report acknowledges that regional solutions will not be appropriate or beneficial in every case or every region and need to be considered on a case by case basis.

For some streams and solutions though, regionalised processing supported by efficient transfer networks, will help deliver the outcomes sought by the Strategy.

1.4 The role of this Report

1.4.1 Strategic Objectives

The strategic priorities of this Report are closely aligned with those of the Waste Strategy, which are summarised below, with outcomes that are particularly pertinent to this Report highlighted in bold:

Table 4: Strategic priorities (from Qld Waste Strategy)

Strategic priority	Key outcomes

Strategic priority 1 - Reducing the impact of waste on the environment	• **Reduction in the amount of waste that goes to landfill**, is littered or illegally dumped. • Reduction in waste-related greenhouse gas emissions. • **Reduction in the long-distance transport of waste**. • Protection of Queenslander's lifestyles and the enjoyment of our natural environment. • Savings for households from avoiding unnecessary waste. • **Reduction in the impact from waste facilities on neighbouring communities and amenity value**.
Strategic priority 2 - Transitioning to a circular economy for waste	• **Sound management of waste as a valuable resource**. • Improved data and information sharing on material flows across Queensland. • Clear standards and guidelines for reuse and recycling. • Clear position and policy on the role of energy and fuels from waste in Queensland.
Strategic priority 3 - Building economic opportunity	• **Growth in the economic value of the waste management and resource recovery sector**. • **Increased number of jobs in reuse, recycling and recovery.** • **Clear and transparent waste and resource recovery infrastructure planning framework.** • Stimulated markets for new and innovative products containing recycled content and demand for recycled material.

The purpose of the Queensland Waste and Resource Recovery Infrastructure Report is to:

- Provide a forward looking document that identifies how Queensland can achieve an integrated waste and resource recovery infrastructure system that effectively manages the expected future mix and volumes of waste, minimises the impacts on the environment and public health, supports a viable waste industry, and ensures valuable materials are diverted to their highest use and material value is maintained in the productive economy for as long as possible
- Improve waste and resource recovery across Queensland by identifying the waste infrastructure needs and infrastructure investment opportunities for the State to meet the targets and objectives of the draft Waste Strategy
- Support industry development and economic growth, particularly in regional areas and providing the infrastructure needed to transition toward a more circular economy in Queensland
- Ensure that future waste infrastructure is delivered in a planned and coordinated manner that is compatible with other demands on land use and community expectations
- Ensure where possible, that infrastructure is in place so that only residual (non-recoverable) waste goes to landfill consistent with the Waste Strategy
- Set the strategic direction and fostering innovation in delivering waste and resource recovery outcomes through an improved network of waste and resource recovery infrastructure
- Identify opportunities to build regional capacity and improve the efficient management of waste and resource recovery across Queensland
- Identify actions and data collection processes that are focussed on obtaining the data required to make informed investment decisions and inform departmental policy decisions
- Provide a foundation for the development of regional waste infrastructure plans
- Support significant investment programs into waste and resource recovery infrastructure and programs such as the current Resource Recovery Industry Development Program.

1.4.2 Stakeholder interests

It is expected that this Report will be read and used by a range of stakeholders for various different purposes. The table below provides a summary of the potential stakeholders who may have an interest in this Report and their potential use of it.

Table 5: Summary of stakeholder interests in this Report

Stakeholder group	Interest or use of the Report
State government agencies ▪ Department Environment & Science (DES) ▪ Department of State Development, Manufacturing, Infrastructure and Planning (DSDMIP)	DES has primary responsibility for waste policy, strategy, legislation and regulation, including implementation of the Waste Strategy and delivery of key actions within it. The analysis of existing waste infrastructure and future needs and opportunities, will inform numerous other ongoing programs and allow the government to target future interventions to improve the performance of waste infrastructure across Queensland. DSDMIP is specifically tasked with supporting the development of the resource recovery industry in Queensland by delivering programs under the over-arching Resource Recovery Industry Roadmap. DSDMIP is also responsible for managing the land use planning framework and is currently supporting a number of actions in relation to planning reform under the Roadmap.
Local Governments	Local Governments are key providers of waste services as well as being owners and operators of waste and resource recovery infrastructure. In regional areas, local governments are the primary providers of waste infrastructure, to both domestic and commercial customers. It is hoped that this Report will inform future planning of waste infrastructure needs at a local and regional level, including helping to identify opportunities for local governments to work together with neighbouring councils to deliver efficient regionalised facilities where appropriate.
Private waste operators	The private sector also plays a significant and growing role in delivering waste and resource recovery infrastructure, particularly in SEQ. It is hoped that this Report will provide useful data and help to identify opportunities for future investment in new or expanded infrastructure across the state, contributing to the economic development goals of the government.
Waste generators	In addition to householders, waste generators vary from small businesses to heavy industry, farmers, institutions, manufacturers and service industries. For the vast majority, waste collection is seen as a basic but essential service, with little visibility on where that waste goes next. However, for generators of large volumes of waste or wastes that require specialised treatment, this Report should provide information on current and future options to manage those streams.
Investors	This Report is intended to provide data and to help identify future opportunities, to attract and support investment in new infrastructure. Whilst this Report alone will not support an investment decision, investors may use it as a first step to understand the scale and nature of potential investment opportunities.
Community	For general members of the community and community groups with an interest in how waste is managed, this Report provides useful information on the waste infrastructure that exists in different regions, future trends and some of the challenges that are faced by industry. Communities are highly sensitive to the development of new waste infrastructure as a result of potential amenity impacts and overall neighbourhood perception. This Report should help to inform discussion and enhance transparency in the planning for future infrastructure needs that may impact on the community.

1.4.3 Regional classifications

Given the vast differences in demographics and waste management practices across Queensland, it is appropriate to break up the discussion on waste infrastructure into regions that broadly reflect the way waste is managed at a regional scale. As such, the state has been divided into eight regions for the purpose of this report, which align with the regions adopted for waste data reporting purposes by DES in the Recycling and Waste annual reporting series. The regional boundaries are shown in *Figure 4* below.

Some of the regions align quite well with existing regional groupings of councils, such as the Regional Organisations of Councils (ROCs), and there is reasonably good alignment with the boundaries used in many of the existing statutory Regional Plans.

Within each region, there is still a diversity of demographics amongst the LGAs in each region. Other than SEQ and Remote Queensland, each region typically comprises at least one regional city or larger regional centre surrounded by more rural local government areas. Some regions such as Fitzroy and Wide-Bay Burnett have more than one larger city or regional centre.

Whilst the presentation of data and discussion of waste infrastructure within this Report follows these regional boundaries, it is also acknowledged that there is collaboration and movement of waste or sharing of waste infrastructure either at a sub-regional level (e.g. amongst a sub-set of SEQ councils) or between councils that are in adjoining regions. The defined regions should not be interpreted as, in any way, constraining current or future efforts at collaboration between neighbouring councils that may be in adjoining regions.

For the Remote Queensland region, it is acknowledged that breaking this region down into smaller regional groupings will be of limited value. The reality is that most of the remote local government areas cover vast land areas and it is unlikely that it would be feasible to collaborate with neighbouring councils in terms of sharing waste infrastructure in any significant way. There are some potential exceptions of course, including some of the smaller local governments in Cape York, and any opportunities for remote councils to share resources for mutual benefit will be strongly supported under this Report.

Table 6 below summarises the populations and approximate land areas of each region for context. South East Queensland houses around 70% of the population in just 1.4% of the land area. By contrast, the Remote Queensland region houses 1.4% of the population spread across a majority of the state land area (63%) but has just 1.7% of the population. The other six regions are all relatively similar in population size and each contains one or two regional cities.

Table 6: Summary of region populations and land areas

Region	Population (2018 estimated)[5]	Population % of total	Land Area % of total
SE Qld	3,479,852	69.5%	1.4%
Cairns	258,377	5.2%	4.5%
Darling Downs - Maranoa	265,578	5.3%	10.2%
Fitzroy	225,625	4.5%	7.9%
Mackay	172,523	3.4%	5.5%
Townsville	236,441	4.7%	4.9%
Wide Bay	296,849	5.9%	3.0%
Remote Qld	71,731	1.4%	62.8%
Total	**5,006,976**	**100%**	**100%**

[5] QGSO estimated resident population excluding Weipa Town Authority, http://www.qgso.qld.gov.au/products/tables/erp-lga-qld/index.php

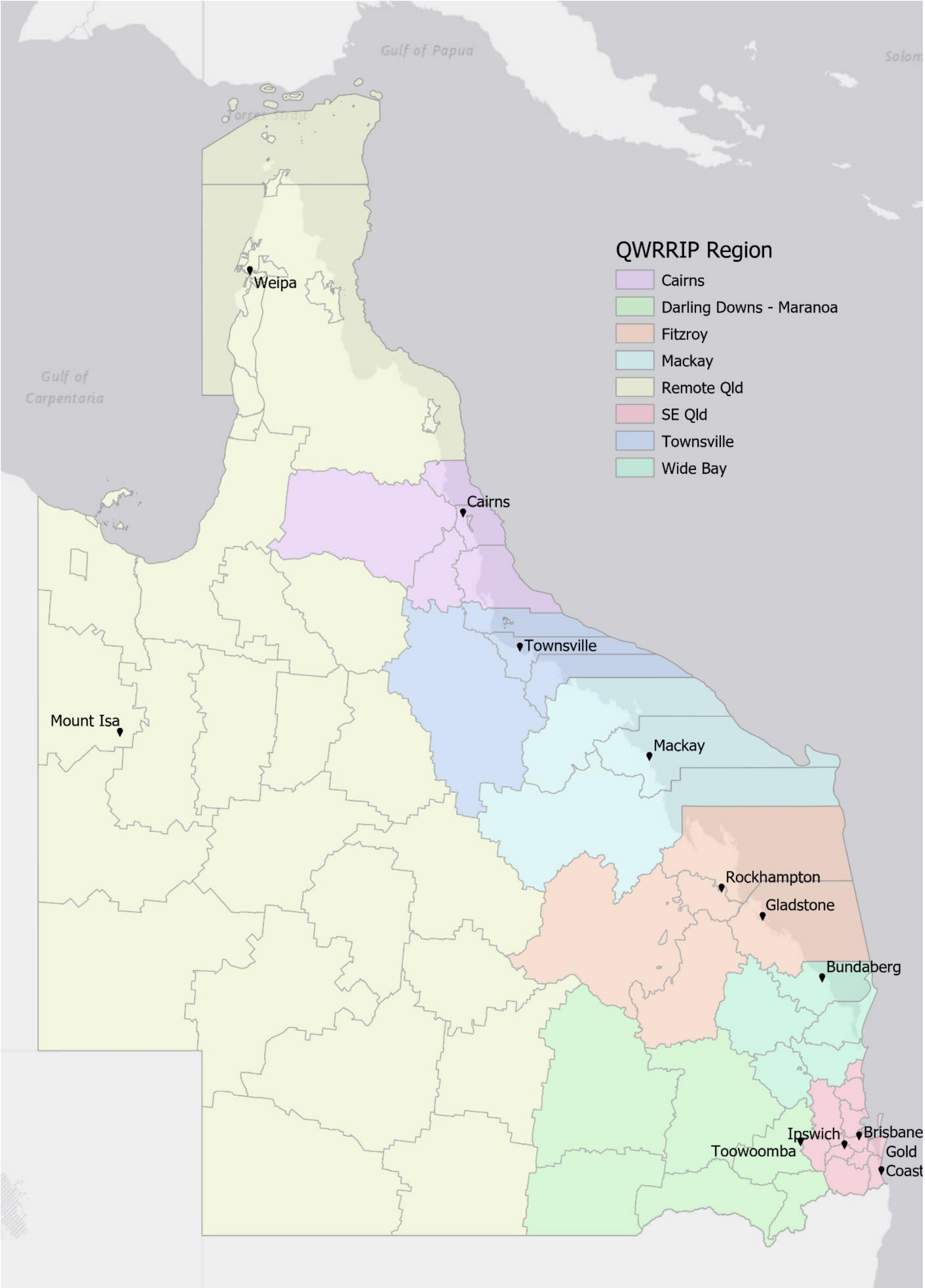


Figure 4: Regional boundaries adopted for this report

In addition to breaking up the state geographically, Arcadis has also categorised each local government area into one of the following categories, which is intended to group councils which are likely to have similar characteristics in terms of the types of waste generated and waste systems and infrastructure needs:

- **SEQ Urban** - includes the urbanised areas within South East Queensland as well as the urban fringe areas immediately bordering them. These areas generally have good access to resource recovery infrastructure and markets, and larger concentrations of population that can support larger scale infrastructure.
- **Regional cities** - include larger regional centres outside of SEQ such as Cairns, Townsville, Mt Isa, Mackay, Gladstone, Rockhampton, Bundaberg, Fraser Coast and Toowoomba. These local government areas typically have relatively large populations ranging from 60,000 to 200,000 (except Mt Isa, which is less than 20,000) and typically act as the main centre for commerce and services within their respective regions. These areas can support moderate scale waste infrastructure and potentially act as hubs for surrounding areas within their region.
- **Rural / regional areas** - include those local government areas which are mostly rural and characterised by small dispersed towns and farms, but usually adjoining or within reasonable driving distance of a regional city (i.e. typically within 200-300km). Example LGAs include Western and Southern Downs, South and North Burnett, Central Highlands, Charters Towers, Tablelands and Somerset. These councils may have an opportunity to share waste infrastructure and services with neighbouring councils and make use of infrastructure in the nearby larger regional city.
- **Remote areas** - are those local government areas in the far north and west of the state which are characterised by very small, dispersed townships and farming communities often spread across a large land area, which are a long distance (over say 300km) from the nearest regional centre. The councils in these areas are usually so dispersed that it is not viable to share waste infrastructure with neighbouring councils and it is generally cost prohibitive to send materials to the nearest regional city for recovery.

These classifications have been applied at the LGA level. There may be some apparent inconsistencies with the regional allocations above, for example Balonne Shire falls within the Darling Downs-Maranoa region, but has been classified as remote in terms of region type; while the rural councils such as Scenic Rim and Somerset which are part of the SEQ region, have been classified as rural / regional here. *Table 7* below summarises the populations relevant to each region category.

It shows that 20% of Queenslander's live in regional cities outside of SEQ, and a further 11% live in rural or regional councils.

Table 7: Summary of region populations and land areas

Region	Population (2018 estimated)[6]	Population % of total
Remote	76,065	2%
Regional City	988,604	20%
Rural / regional	571,936	11%
SEQ Urban	3,370,371	67%

[6] QGSO estimated resident population excluding Weipa Town Authority, http://www.qgso.qld.gov.au/products/tables/erp-lga-qld/index.php

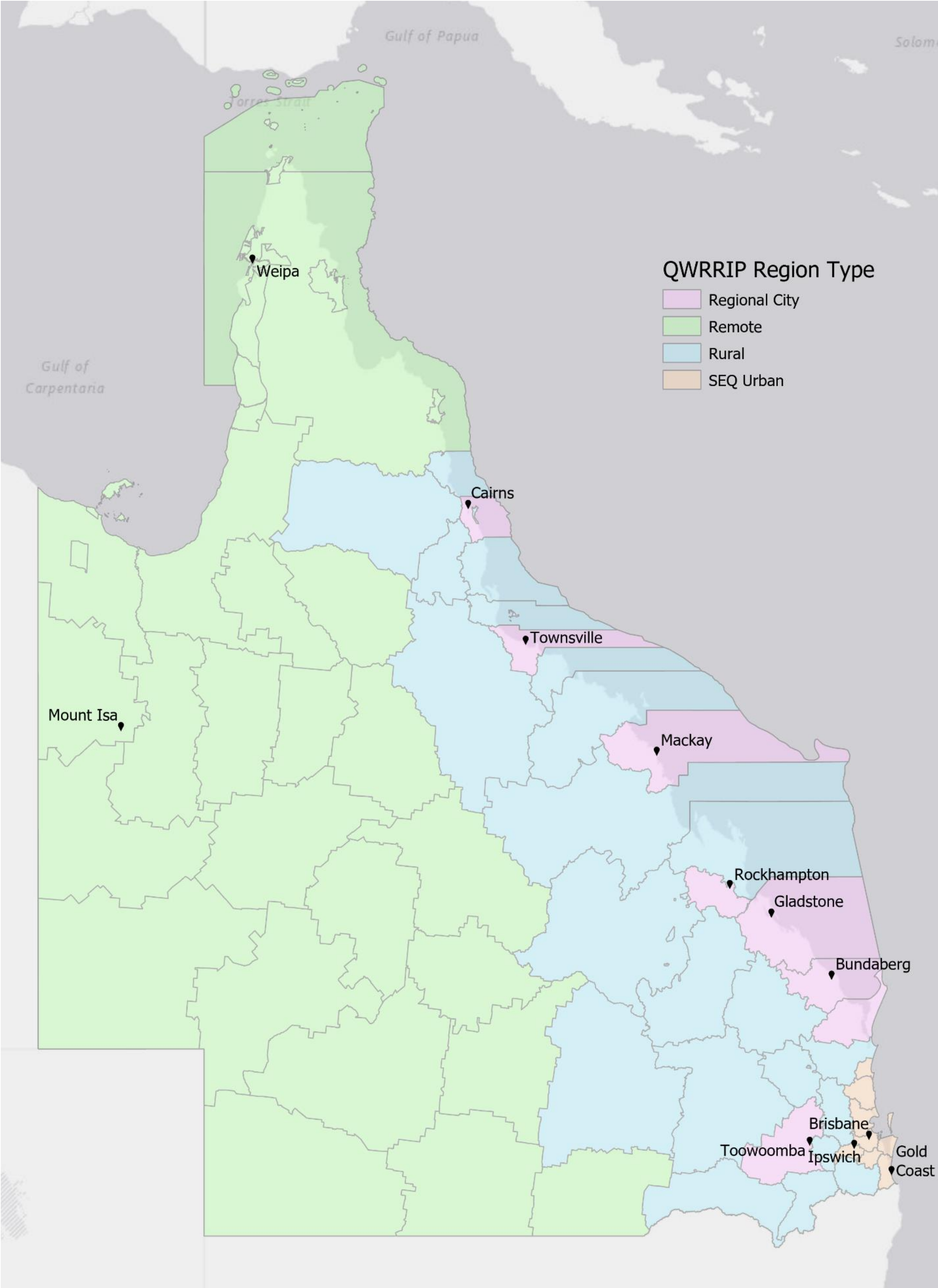


Figure 5: Region types allocated in this Report

1.4.4 Future revisions

This is the first version of the Queensland Waste and Resource Recovery Infrastructure Report and it has been developed based on the data and information that was available at the time, which is acknowledged as imperfect and limited in some respects.

It is intended that this Report will be revised and improved over time as better data becomes available, as feedback is received from industry and as each region starts to develop its own more specific regional plans.

This Report has a long-term horizon but it is important that it remains relevant and current, acknowledging that circumstances and practices change driven by government policy, industry trends and technologies.

As such, this Report will be revised within the next two years and at regular intervals thereafter. Feedback for consideration in future iterations is encouraged.

1.4.5 Regional Implementation Plans

It is expected that this Report will support the future development of Regional Infrastructure Plans which will build on the information contained in this Report and provide a further level of detail and granularity, focusing on more specific needs and opportunities in each region.

2 CURRENT WASTE FLOWS

This section provides an overview of historic trends in waste generation and current baseline waste flows (based on 2017-18 data), broken down by headline source stream (MSW, C&I or C&D) and material type where appropriate.

Future waste flows have been projected, based on achieving the Strategy targets and these projections form the basis for the subsequent infrastructure needs analysis for each region in section 6.

2.1 Data sources and constraints

In developing the baseline waste flows, Arcadis has utilised the data that DES collected through its 2017-18 annual survey of local governments and licensed waste facility operators. The data is generally very comprehensive and of reasonable quality, but it does have some limitations when applying it for the purpose of assessing infrastructure requirements at a regional or local level. In particular, there is limited granularity with respect to waste flows managed by private operators at the facility level, particularly when they have more than one facility or work across multiple regions, as they only report aggregated figures per organisation.

Nevertheless, the DES data provides a very good basis to develop waste flow estimates at a state and regional level.

In order to fill data gaps and to obtain more detailed information about existing infrastructure, Arcadis sent a data survey to all local governments and the majority of private sector operators that could be identified and contacted. Arcadis received a good level of response in the surveys, reflecting the high level of interest and support amongst councils and private operators for this project, including:

- Surveys were received back from 54 of the 77 local governments (70% response rate)
- Around 107 surveys were received from private operators out of around 280 surveys sent out (38% response rate). The response was higher amongst some sectors than others (e.g. MRFs, private landfills and organics processors had a high response rate, while C&D, scrap metal and commercial recyclers were lower).

Waste composition data is also critical to the waste flow analysis in terms of being able to estimate the material breakdown of waste going to landfill. Arcadis collated a number of different waste audit datasets which were kindly shared by councils and which provided reasonably good coverage of municipal streams. However, there remains a significant gap in compositional data for the C&I and C&D waste streams.

2.2 Historic waste generation and recovery

A review of statewide waste generation volumes for each source sector (MSW, C&I, C&D) on a per capita basis (Figure 6) reveals some interesting trends with high relevance to infrastructure planning.

MSW generation per capita declined steadily from a peak of 711 kg per person in 2008-09, dropping by 26% by 2014-15, and it seems to have plateaued since then. The reason(s) for the reduction is not clear in the data – it may be partly explained by the slower state economy compared to previous years, with Gross State Product shrinking by 3% in 2009-10 on a per capita basis and only grew by a total 10% over the next five years to 2014-15. A slow economy typically translates to subdued consumption which means less waste.

Another factor may be data quality and accuracy, which has improved over time. In particular, it is likely that data quality improved from 2011-12 when the previous landfill levy was briefly in place, which was accompanied by significant investment in better measurement of waste (i.e. weighbridges at landfills) and better data collection systems to support the levy. Prior to that, a number of regional landfills were estimating tonnages based on conversion from volume, which typically tends to over-estimate the tonnage.

While it is not clear how much of the historic reduction was a real reduction (versus data effects), a decline in per capita generation has also been recorded at the national level[7], which suggests that it is possible to reduce household waste generation, as the Strategy aims to do (25% reduction by 2050). It is, however, the most challenging target as the government has only a limited degree of control over drivers of waste generation at the household level.

C&I waste generation on a per capita basis has fluctuated slightly but remained reasonably steady over the past decade, despite variable economic conditions. No data point was available for 2010-11 financial year.

C&D waste generation per capita has been more variable. It declined to a low point in 2011-12 and has steadily increased since, more than doubling over the following six years. Over the decade to 2017-18, generation has grown by 51%. It is noted that these figures *exclude* waste imported from interstate, which is particularly significant in latter years.

As with household waste trends, it is not possible to isolate the reasons for this trend with the data available but there are a number of potential reasons:

- Rising generation may be reflective of significant infrastructure projects over this period and a strong residential construction sector.
- There may have been interstate C&D waste which was not reported as such – previous surveys only asked landfill operators about interstate waste imports but the latest 2017-18 survey attempted to address this by asking all recycling facilities to report interstate inputs.
- The completeness of the data set may have improved over time.

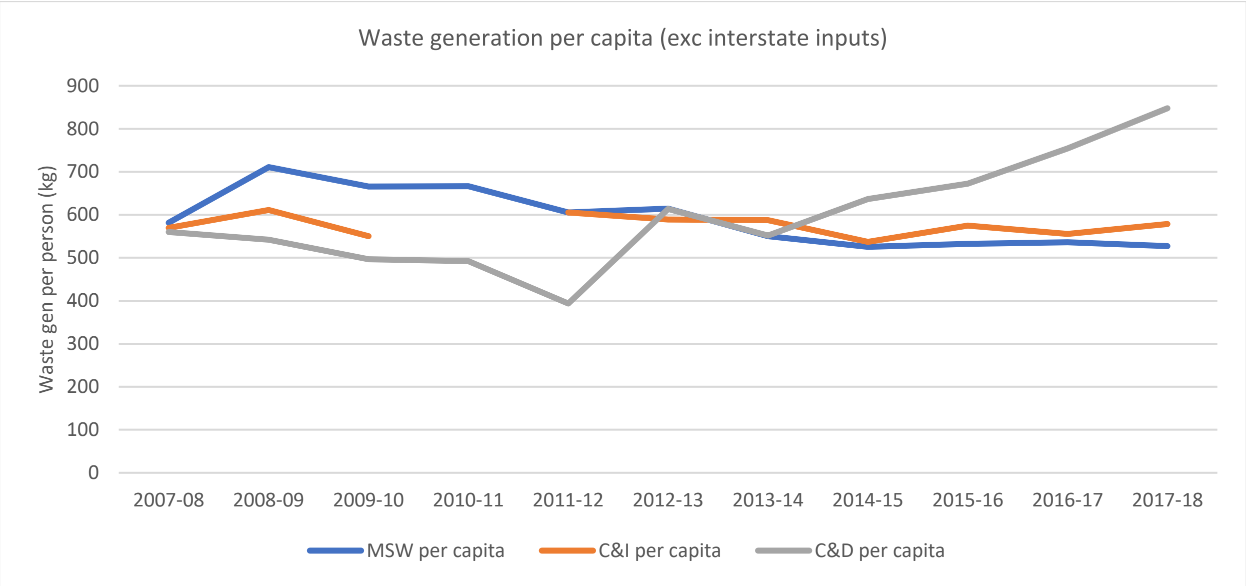


Figure 6: Statewide historic waste generation per capita over last decade

[7] National Waste Report, 2018

2.3 Baseline flows

Table 8 below provides a summary of the current baseline waste volumes managed across the state, based on 2017-18 data. Each stream is discussed in more detail in the subsequent sections.

Table 8: Summary of 2017-18 baseline statewide waste flows

Stream	2017-18 tonnes
Disposal	
MSW - kerbside to landfill	1,239,416
MSW - non-kerbside to landfill	590,430
C&I - disposal to landfill	1,521,716
C&D - disposal to landfill	2,591,752
QLD sourced C&D - to landfill	1,557,735
Interstate C&D - to landfill	1,034,017
Recovery	
MSW - commingled recycling	309,893
MSW - other recycling	136,824
MSW - green waste recovery	516,756
MSW - AWT recovery	30,367
C&I - recycling	904,510
C&I - organics & timber recovery	387,223
C&D - recovery of masonry materials	2,458,264
C&D - other recycling	377,598

In the table above, the following category definitions have been applied:

- *MSW non-kerbside to landfill* is primarily household residual waste that is self-hauled by residents to transfer stations and landfills, but may also include other council generated waste streams such as waste from public place bins or street sweeping.
- *MSW commingled recycling* is primarily household recycled packaging of the type accepted in the kerbside yellow lid bin or via council transfer stations (i.e. household paper, cardboard, glass, plastic and metal containers).
- *MSW other recycling* is other household material that is recycled, mostly through council transfer stations, such as scrap metal, reusable items, household chemicals and oils.
- *C&I recycling* is all non-organics recycling in the commercial and industrial sector and includes both recyclable packaging and non-packaging recyclables (e.g scrap metal, tyres, production offcuts).
- *C&I organics and timber recovery*, includes a wide range of commercial organics recovered by organics processors such as commercial garden waste, food, food processing residues, liquids and sludges, as well as saw dust, timber packaging and offcuts.
- *C&D recovery of masonry materials* is concrete, brick and tiles, asphalt and a small amount of plasterboard recovered from the construction and demolition stream.

- *C&D other recycling* includes C&D timber plus non-packaging recyclables (e.g. scrap metal, window glass, plastic pipe offcuts).

2.3.1 Resources lost to landfill

It is possible to estimate the loss of potential resources and priority materials to landfill by characterising the composition of waste going to landfill, acknowledging the data limitations and error margin in relying on compositional audits of mixed waste streams to estimate a breakdown of landfill waste.

Data on the breakdown of residual waste that is disposed to landfill is limited as compositional audits are labour intensive and costly. Most councils that have kerbside recycling systems tend to undertake regular audits of the commingled stream in order to track performance and/or inform contract management (e.g. to quantify contamination rates). Many of the larger councils in SEQ and regional cities also undertake compositional audits on their residual waste streams, either on a regular basis or as needed. These are typically focused on kerbside MSW but in some cases also analysing transfer station waste (self-hauled). As such, there is reasonably good data on the residual MSW stream.

Compositional data on commercial waste is far more limited – a small number of councils have undertaken audits on the commercial streams they receive into their landfills or transfer stations, which may not necessarily be representative of the broader stream. If private landfill operators undertake audits of the commercial waste they receive, that data tends not to be made publicly available.

In developing this Report, Arcadis gathered and analysed a large number of waste compositional audits either supplied by DES or received directly from councils through the data survey process. Unfortunately no audit data could be sourced from private operators. A total of 23 audits were analysed, which provided good data on residual MSW streams at the kerbside and transfer station, across a range of different regions and collection systems. A smaller number of audits (4) covered commercial waste streams received at council facilities, from different region types (urban and regional). Only one audit received covered C&D waste, which was from a regional council transfer station and unlikely to be representative of C&D waste across the state.

For the residual MSW, the audits were categorised and averaged according to the region type and collection system in place. The results are summarised in Figure 7 below and show:

- For **rural and remote councils operating a single bin** kerbside collection (four audits reviewed), which is the majority of rural and remote Queensland councils (45 out of 77 councils), the proportion that was food and garden organics was the lowest of any group, but still 28% of the general waste stream. This may indicate that households are managing more of their organic waste within their properties (through composting or feeding food scraps to animals). Potentially recoverable packaging materials[8] made 39% of the stream, with the largest streams being paper / cardboard (17%) and glass (12%). The audits all pre-date the introduction of the CRS so the plastic, glass and aluminium streams may have now reduced.
- For **rural councils operating a two-bin system** (recycling and general waste), of which there are 15 councils, the audit data (two audits reviewed) indicates a higher proportion of food and garden organics (45%). Paper and cardboard is still relatively high at 15%, suggesting room for improvement in the usage of recycling bins, but other recyclables were relatively low. The proportion of soft and film plastics was quite high at 15%.
- For the **regional cities with a two bin system** (recycling and general waste), which represents seven regional centresnot including Toowoomba (which offers an opt-in green bin), the audit data (two sets) indicates food and garden organics were similar to the rural councils at 46%. There were small to modest proportions of potentially recyclable materials.
- For **urban councils with two bins plus an opt-in third green waste bin**, which is the majority of large SEQ councils plus Toowoomba, the audit data (nine sets) indicates an average 30% food and 22% garden waste. The garden organics proportion is slightly less than those councils with 2 bins only (25%), but for most of those councils the third bin has only been taken up by between 11%

[8] All types of paper and cardboard, rigid plastics, glass, ferrous and non-ferrous metals

and 22% of serviced households (except Toowoomba which has a much higher uptake rate). There were small to modest proportions of potentially recyclable materials.

- For the two councils that provide **two bins plus a mandatory third green waste bin** (Noosa and Burdekin, for urban households only), the audit data (two sets) indicates the garden organics proportion is the lowest of any group at 10%, while food is high at 39%, in part due to the concentrating effect of removing most of the green waste.
- There were also four sets of audit data relating to self-hauled waste at council transfer stations which is predominantly household waste but may contain a small proportion of commercial loads. Timber in various forms, including clean timber, furniture and treated or painted timber, makes up the largest material component at 33%. Textiles was also quite high at 11%, while organics was comparatively low (relative to kerbside waste), comprising 9% garden organics and 2% food. There were moderate levels of paper / cardboard (8%) and soft plastics (9%).

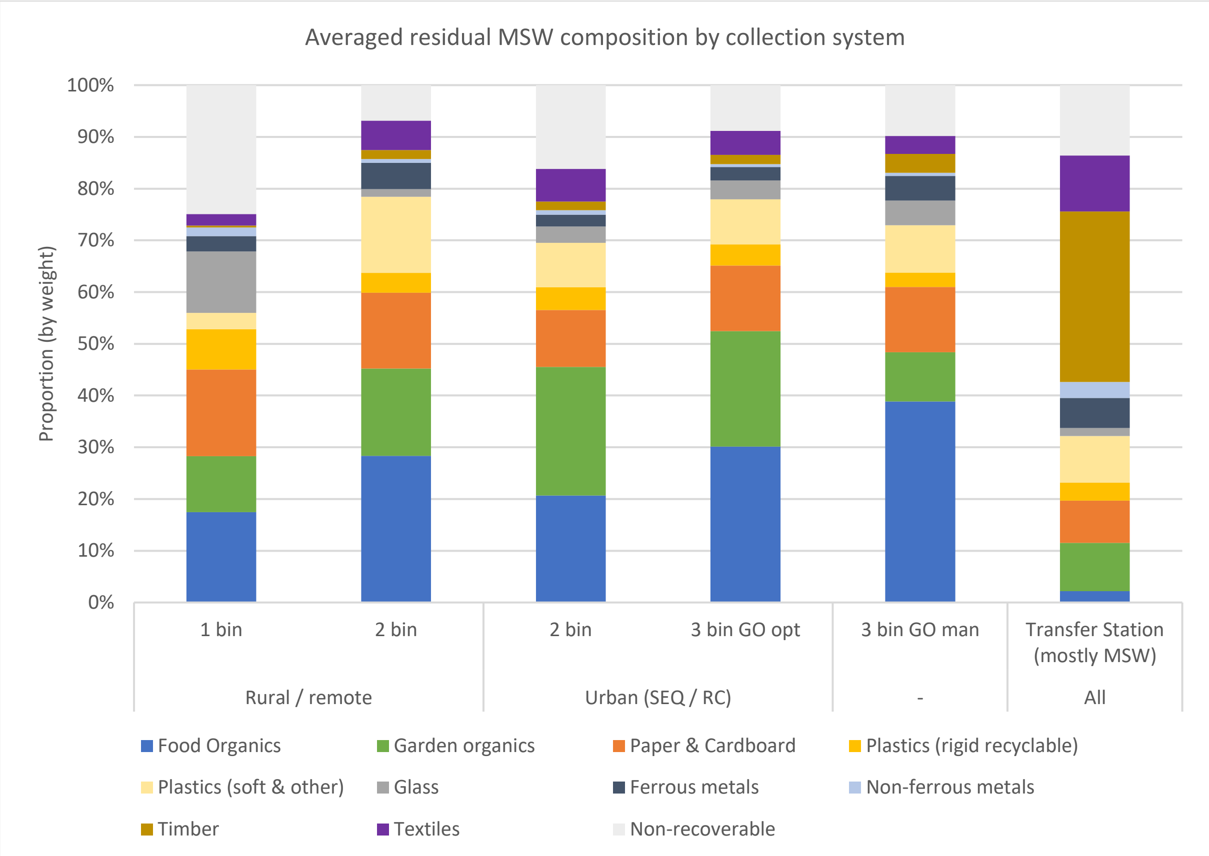


Figure 7: Summary of municipal residual waste compositions, categorised by collection system and averaged

As noted above, there were four C&I residual waste audit data sets from council owned landfills or transfer stations – two sets were from a large urban council and two were from regional centres. The averaged data is summarised in Figure 8 below and compared against average C&I composition from NSW, for which the state government undertook a broad ranging and comprehensive set of audits of C&I residual waste in 2014[9]. No such dataset exists for Queensland and the Queensland commercial waste will be slightly different to NSW waste given the different mix of industry, but it provides some confidence that the Queensland data is relatively representative (noting timber and metals are notably high than in the NSW data). The limited Queensland data that is available shows that:

- Timber is a significant proportion, which likely reflects the limited outlets available to recover timber. Unlike household transfer station waste (above), a significant proportion of C&I timber is clean packaging (e.g. pallets and reels) or offcuts, which could potentially be recovered.

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[9] https://www.epa.nsw.gov.au/~/media/EPA/Corporate%20Site/resources/warrlocal/150209-disposal-audit.ashx

- Scrap metal (ferrous) made up 13%, presenting an obvious opportunity to recover this valuable stream.
- Paper and cardboard comprised 15%, which is a further opportunity to improve recovery.
- Soft and film plastics were significant at 15%, of which some could be recoverable if collection and processing systems were in place.
- Food organics were relatively low compared to the MSW stream (9%) but clearly this will vary between different business types, and may represent a significant quantity for some business sectors.

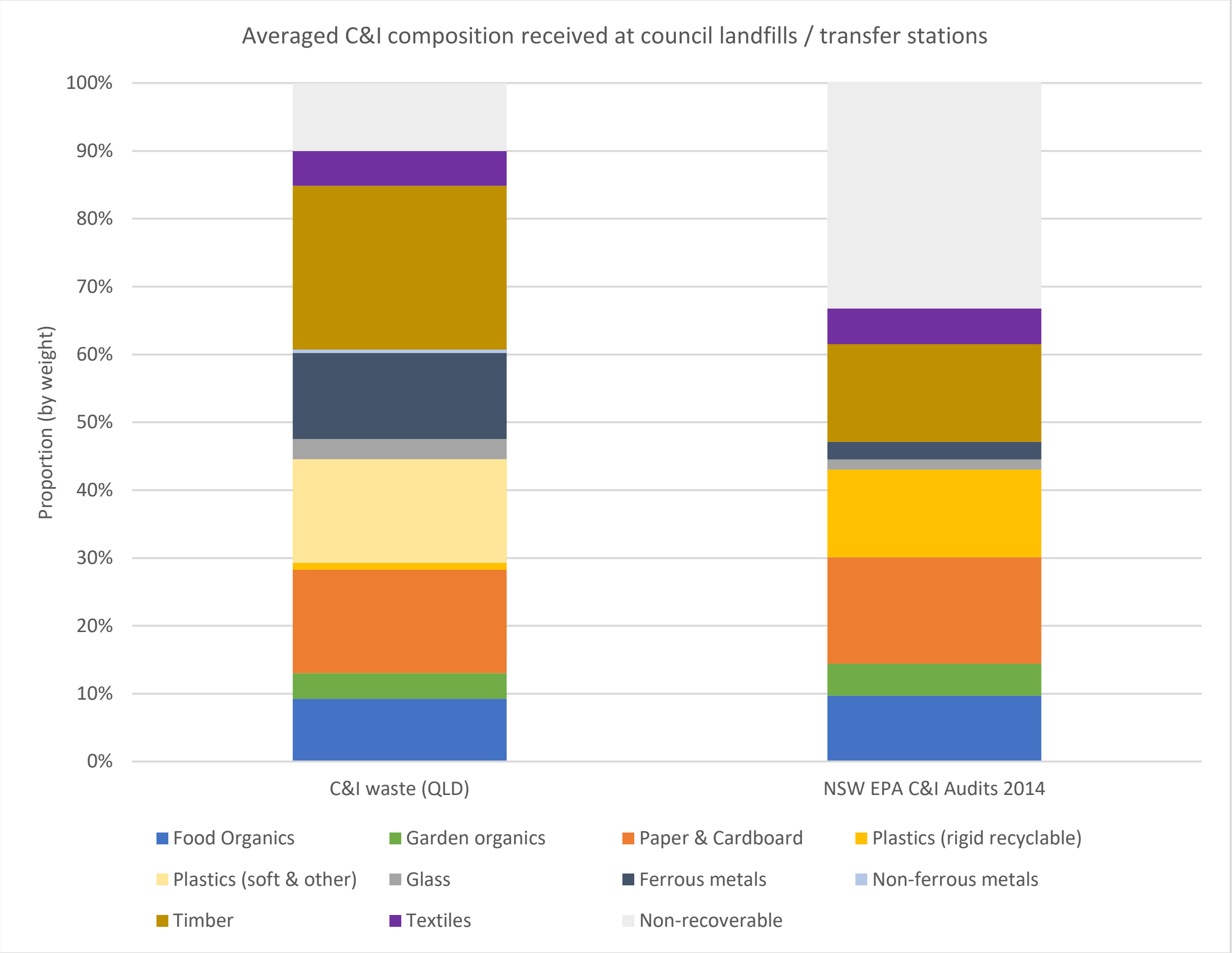

Figure 8: Summary of average C&I residual waste composition data (4 sets from council facilities) compared against NSW C&I waste data (NSW data combines all plastics and metals into aggregated streams)

Only one set of Queensland C&D waste audit data was available, which was from an audit undertaken at a regional council transfer station. Given the majority of C&D waste is generated in SEQ and managed by the private sector, the data is unlikely to be representative of the broader C&D stream. A review of Queensland and national data revealed there is limited data more broadly on C&D waste composition.

The composition of the residual stream will be heavily influenced by the level of recycling, which will predominantly sort soil and masonry materials (concrete, brick, tiles, etc). One of the most comprehensive datasets available is from the NSW Government, which undertook a series of audits of C&D residual waste disposed to Sydney landfills from 2000 to 2005[10]. While quite old now, the data may be generally relevant to Queensland given that the recovery rate for C&D waste in Sydney at the time was similar to the current recovery rate in Queensland (around 50%).

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[10] https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/warrlocal/070320-constr-demol-waste1.pdf

The NSW data is summarised below (with contaminated soils and asbestos removed) and compared to the single audit dataset from the Queensland council transfer station. The two datasets have a number of similarities, although the Sydney data shows a lower proportion of timber and higher proportion of concrete / masonry. The Sydney data is more consistent with anecdotal information on C&D composition, and given no better more recent data is available, it will be used as a proxy to estimate the composition of Queensland residual C&D waste.

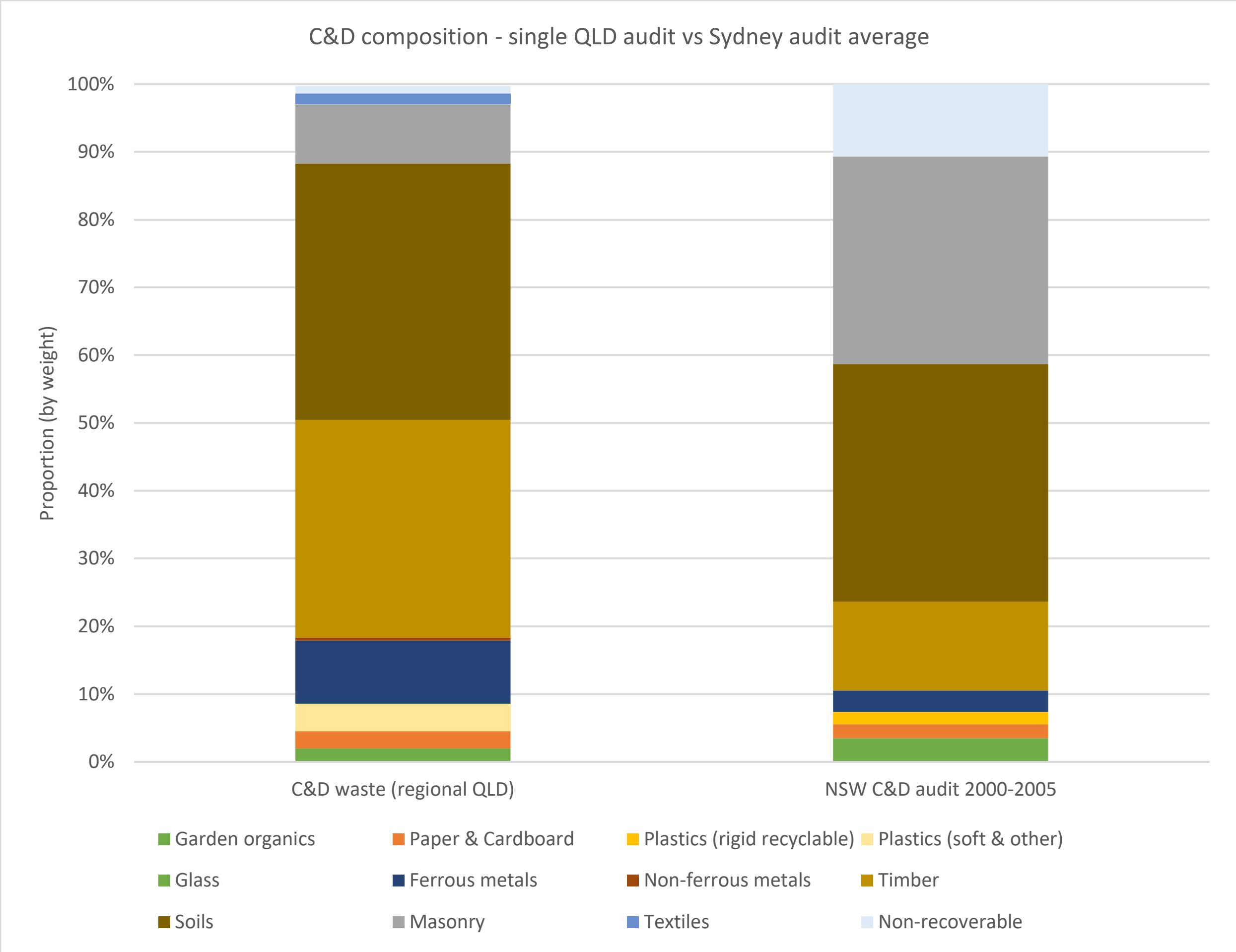

Figure 9: Summary of average C&D residual waste composition data (1 set from a council facility) compared against NSW C&D waste data.

2.3.2 Overall material breakdown

The table below (Table 9) provides an estimated breakdown of the total state waste flows by headline material types and source sector. For landfilled materials, this is based on the compositional data presented above so is indicative only and subject to a margin or error.

Table 9: Summary of current estimated waste generation by material and source stream

Material	Total managed (tonnes)	Source sector			Total recovery rate
		MSW	C&I	C&D	
Food Organics	527,724	70%	30%	0%	7%
Garden organics	1,146,177	73%	19%	8%	60%
Paper & Cardboard	851,816	40%	54%	6%	46%

Plastics	593,801	44%	47%	9%	10%
Glass	268,873	60%	37%	3%	62%
Ferrous metals	1,156,565	13%	52%	35%	70%
Non-ferrous metals	126,469	29%	56%	14%	72%
Timber & sawdust	1,115,952	19%	48%	33%	17%
Textiles	Insufficient data				-
Masonry, aggregate, soils	4,160,596	0%	0%	100%	59%
Other	355,921	16%	49%	35%	-

2.3.3 MSW flows and volumes

Municipal solid waste (MSW) typically comprises waste generated within the household and by certain activities of local governments:

- Kerbside waste collected from households including residual waste, recycling and green waste;
- Bulky items and hard waste collected during scheduled collections;
- Domestic household waste that is self-hauled to transfer stations, resource recovery centres and drop-off points, including residual waste, recycling, bulky / hard waste and green waste;
- Waste from street bins and public places (both residual and recycling);
- Litter and illegal dumping waste cleaned up by councils; and
- Disaster waste collected from or delivered by residents during a clean-up following a natural disaster event.

Challenges can arise in accurate waste classification when domestic waste becomes mixed with commercial waste, which is the case for many councils that also provide collection services to commercial customers.

Table 10 provides a statewide overview of the key material flows that make up the MSW stream. The recovery of MSW materials is based on data reported by councils and private operators to DES. The total volume of MSW landfilled is based on data reported by each council while the material breakdown of waste to landfill has been estimated for each council based on the composition data presented above, correlated to the kerbside collection system that is in place.

In 2017-18, 32% of the MSW stream was recycled. The table shows there are particular opportunities to improve recovery of this stream:

- Household food organics that enters the waste management system is largely unrecovered. A proportion of household food waste is recovered within the home (e.g. through home composting or as animal feed) but this is not currently measurable and excluded from the tonnages below. Three councils in the Cairns region that currently send kerbside MSW to an alternate waste treatment facility are diverting most of their domestic food waste through that facility. One council (Ipswich) is allowing residents with a kerbside garden organics bin to put non-protein food organics (fruit and vegetable waste) into the green bin, but this is an opt-in service with a relatively low uptake.
- Garden organics is a further opportunity, even though an estimated 62% is currently recovered, given it is relatively easy to separate, capture and process.
- Recyclable packaging materials, particularly plastics, paper / cardboard and metals, all present opportunities for improved recovery. Not all of the unrecovered materials are directly able to be recycled through current kerbside recycling systems so a combination of capture methods is needed, including via transfer stations.

- Waste timber, which likely includes a mix of furniture, building materials and packaging timber, is a significant opportunity. Only some of that is clean timber that can be proessed in most recycling approaches, but the rest is potentially suitable for energy recovery.
- Textiles are a significant opportunity in terms of the volume that is currently landfilled, noting that no data is available on the current recovery of textiles.

Table 10: Summary of MSW flows by priority materials (tonnes, 2017-18)

Material	Landfilled	Recovered	Total managed	Recovery rate
Food Organics	362,235	15,184	377,418	4%
Garden organics	320,908	497,287	818,195	61%
Paper & Cardboard	206,759	161,017	367,776	44%
Plastics	236,767	27,053	263,820	10%
Glass	56,798	73,415	130,213	56%
Ferrous metals	69,346	86,090	155,436	55%
Non-ferrous metals	26,821	10,446	37,267	28%
Timber	215,682	0	215,682	0%
Textiles	123,364	No data	123,364	NA
Masonry, aggregate, soils	0	0	0	-
Other	195,538	0	195,538	NA
Total	1,814,217	870,492	2,684,709	32%

2.3.4 C&I waste flows and volumes

Commercial and industrial (C&I) waste includes any waste which is generated by a business or institution (i.e. not domestic waste), including waste from schools, restaurants, offices, retail and wholesale businesses and manufacturing industries. The main exception is waste that is generated during construction and demolition works, which is a separate stream considered below.

C&I waste can include:

- Residual waste and recycling collected from businesses;
- Green waste from professional gardening and landscaping businesses;
- Organic wastes such as food processing residues, food waste from food service businesses, grease-trap waste and abattoir waste;
- Forestry and agricultural residues, including manures from intensive farming operations; and
- Other industrial wastes such as drilling muds, ash, sludges, oils and other regulated wastes.

In the case of some streams, such as forestry and agricultural residues, the majority of the material Is managed in the forest or 'on-farm' and never enters the conventional waste management system (i.e. collected and managed by a licensed facility), so the volumes that are captured in DES waste data are a fraction of the total generation.

Table 11 provides an overview of the key material flows that make up the C&I waste stream across Queensland. Recovery is based on volumes reported to DES as received by facility operators, while the landfill breakdown is a combination of landfill tonnages from landfill operators and the commercial waste composition data adopted above.

In 2017-18, 47% of the C&I waste that was reported to DES was recycled. The table shows there are particular opportunities to improve recovery of this stream by targeting:

- Commercial food organics and, to a lesser extent, garden organics;
- Recyclable packaging materials, particularly plastics but also paper / cardboard and, to a lesser extent, glass;
- Ferrous metals, while achieving a relatively high recover rate of 68%, should be higher and there is a significant tonnage going to landfill; and
- Waste timber, which likely includes a mix of offcuts and packaging timber that will be mostly clean and able to be recycled and/or used for energy recovery.

Table 11: Summary of C&I waste flows by priority materials (tonnes, 2017-18)

Material	L Landfilled	Recovered	Total m managed	Recovery rate
Food Organics	140,529	24,961	165,490	15%
Garden organics	57,282	160,377	217,658	74%
Paper & Cardboard	232,109	258,045	490,154	53%
Plastics	247,996	31,351	279,347	11%
Glass	45,238	55,040	100,278	55%
Ferrous metals	192,972	404,385	597,357	68%
Non-ferrous metals	7,633	63,744	71,377	89%
Timber	367,350	164,897	532,246	31%
Textiles	78,277	No data	78,277	NA
Masonry, aggregate, soils	0	0	0	-
Other	171,273	221,801	393,075	NA
Total	**1,540,659**	**1,384,600**	**2,925,259**	**47%**

2.3.5 C&D waste volumes and flows

Construction and demolition (C&D) waste is mostly non-putrescible (inert) material produced by demolition and building activities, including road and rail construction. It typically includes:

- Soils (although clean fill is reported separately);
- Timber and wood waste;
- Particle board, plasterboard, fibre-cement and plywood sheets;
- Concrete, bricks, tiles and other masonry products;
- Asphalt;
- Non-packaging glass and plastic; and

- Packaging from construction activities, including plastics and cardboard.

Some streams are relatively easy to separate at source, such as brick and concrete arising from a demolition project that is readily recycled into recovered aggregate products. Such materials account for the majority of existing C&D waste recycling in Queensland. A significant volume of C&D waste is collected from construction sites in skip bins of various types and typically delivered to waste facilities as a mixture of materials, making it more difficult but still possible to recycle.

C&D waste may also include asbestos, clean earthen materials (clean fill), acid sulphate soils and contaminated soils; however these are reported separately to DES and not considered 'headline wastes'.

Table 12 provides an overview of the material flows that make up the C&D waste stream across Queensland. It includes a significant volume of C&D waste that was imported from interstate (over 1 million tonnes), which is expected to have declined significantly following commencement of the landfill levy in July 2019. As noted in 2.3.1, there is a high level of uncertainty around the composition of C&D waste in Queensland so the landfill breakdown presented below should be considered indicative only. A further difficulty is separating out the interstate waste for the recycling analysis because the proportion that was recycled is unknown.

In 2017-18, it is estimated that 51% of the C&D waste stream was recycled across the state.

The table below shows there are further opportunities to improve recovery, including:

- Masonry / aggregate materials, even though it is already the largest recovery stream by a significant margin;
- Waste timber, some of which will be clean timber offcuts and packaging, but a significant proportion will be treated, glued or painted timber which may be more suited to energy recovery; and

Other packaging materials associated with construction works, including cardboard and plastic (both film and polystyrene).

Table 12: Summary of C&D waste flows by priority materials (tonnes, 2017-18)

Material	Landfill	Recovered	Total managed	Recovery rate
Food Organics	0	0	0	-
Garden organics	90,855	0	90,855	0%
Paper & Cardboard	52,600	0	52,600	0%
Plastics	47,818	2,815	50,634	6%
Glass	0	6,919	6,919	100%
Ferrous metals	81,291	322,481	403,772	80%
Non-ferrous metals	956	16,869	17,825	95%
Timber	339,510	28,514	368,024	8%
Textiles	0	No data	0	NA
Masonry, aggregate, soils	1,702,332	2,312,135	4,014,467	58%
Other	276,925	0	276,925	NA
Total	**2,592,287**	**2,689,733**	**5,282,020**	**51%**

2.4 Priority material volumes and flows

This section provides further discussion around the current flows of key materials which are considered a high priority for future resource recovery focus.

2.4.1 Paper and Cardboard

In 2017-18, around 510,000 tonnes of paper and cardboard was recovered across the state, mostly through kerbside recycling services (where paper and cardboard is around half of the commingled stream), commercial recycling of clean streams and through source separated material dropped off at transfer stations.

Around 40% of paper and cardboard was reprocessed in Brisbane and remanufactured back into cardboard products. The remainder was either sent to interstate papermills or exported, but still predominantly passed through SEQ-based recyclers or consolidators. It is likely that Queensland will continue to be reliant upon these external markets for recycled paper and cardboard for some time, as the capital investment required to develop new papermill capacity or significantly expand the single existing papermill is significant.

Clean, separated paper and cardboard materials are still a valuable commodity and can usually find a market, either domestically or overseas. However, a significant proportion of material is recovered as a mixed paper and cardboard stream with higher contamination levels, which is much more difficult to market and worth a lot less than it was prior to China's National Sword program impacted global demand from January 2018.

An estimated 490,000 tonnes of paper and cardboard was still landfilled, based on assumed composition, presumably lower quality material but still representing a significant recovery opportunity.

The generation of paper and cardboard could potentially grow in the future. While newspaper and magazine publications are declining, the rise in online shopping and home delivery of goods and food is generating additional packaging materials, of which cardboard is a significant component. National efforts to make more packaging recyclable and a growing community awareness around single use plastics further support the notion that paper and cardboard packaging is likely to increase.

Opportunities to improve the long-term recovery of paper and cardboard include:

- Upgrades to existing MRFs and investment in new MRFs capable of producing separate fibre streams;
- Investment in new paper and cardboard refinement or beneficiation processes, that take a mixed fibre output from MRFs and separate it into higher value, cleaner materials;
- Assessment of options to expand or develop new recovered papermill capacity in Queensland to reduce reliance on export markets;
- Consideration of single stream cardboard collection systems, particularly in regional areas where commingled recycling is challenging. Clean streams which are prepared at source through basic sorting and baling, can be cost effectively transported to market with analysis showing this could be a viable option for many regional parts of Queensland; and
- Potential for paper and cardboard in commercial waste to be recovered as refuse derived fuel (along with other calorific materials).

2.4.2 Plastics

Around 26,400 tonnes of packaging plastics was recovered in Queensland in 2017-18, together with another 21,500 tonnes of non-packaging plastics, mostly from the C&D stream (e.g. plastic pipe offcuts). More than half of this material (56%) was exported, but there a number of small reprocessors in SEQ that take selected recovered plastics and add value to it or produce new products.

The current recovery rate of plastics is very poor at an estimated 10% overall. Significant volumes of plastics are landfilled in both household and commercial waste streams, the majority of which is soft and film plastics that are considered difficult to recycle via conventional pathways. Future priorities will be around capturing a greater proportion of the plastics stream for recovery, improving product quality and developing additional capacity within Queensland to reprocess and remanufacture plastics, reducing reliance on export markets.

There is a general shift in society away from unnecessary and single use plastics as a result of growing community awareness around the impact of plastics on the environment. However, plastic packaging has an important role to play in the economy,for example, allowing fresh food to transported and distributed from farms to consumers without spoiling. As packaging generally becomes more recyclable in line with national targets – which are also driving demand for recycled content – it should become easier to capture more plastics through kerbside and commercial collection systems, supported by better education of waste generators. The national targets include

There is also a growing interest in the use of compostable plastics as a substitute for single use plastics. Compostable plastics have a number of benefits but need to be adopted with some caution as they will only be composted if they can be collected separately from other packaging (in the organics stream) and subjected to high temperatures in a commercial composting environment. This may only be achieved in large scale composting facilities and whilst Queensland has a number composters that may be capable of procesing this material, not all of them are willing or currently set up to receive compostable plastic products. Hence, any significant shift towards compostable plastics needs to be supported by development of appropriate collection systems and processing infrastructure.

Opportunities to improve the recovery of plastics include:

- Maximising the recovery of rigid plastic containers through existing commingled systems and the Container Refund Scheme (CRS) by expanding collection points and services, supported by improved community education;
- Expand source separated collections of commercial plastics, including film packaging;
- Establish separate collection networks for expanded polystyrene, particularly from commercial and construction sources, to feed existing and future businesses in Queensland that are able to reprocess clean polystyrene into new products;
- Support council transfer stations and resource recovery centres to provide individual collection points for a range of plastics (rigid, film, polystyrene and non-packaging plastics);
- Investment in new MRF equipment and refinement lines to separate mixed plastics into clean polymer streams;
- Investment in plastic washing and flaking / pelletising processes to maximise the value of recovered plastics;
- Support for and investment in remanufacturing facilities that use recycled content materials;
- Support for research and development of innovative new ways to recycle lower quality plastics, such as chemical recycling and thermal processes; and
- Recovery of the high energy content contained within plastics, either through thermal treatment of plastics in mixed waste, diversion of plastics to a refuse derived fuel stream or conversion of plastics to fuels and chemicals through one of a number of emerging technologies.

Case Study – FNQ Plastics

FNQ Plastics is a local family owned business in Cairns which has an established business doing custom fabrications in plastic making items such as tanks, crates, tubs, pallets, signs, decorative screens, bench tops and pipe components. A few years ago the owners recognised a need and an opportunity to shift from virgin resins to using more recovered products as feedstock. They have been developing plans to install a plastics reprocessing facility in Cairns which would require a significant capital investment. In order to secure the necessary funding, it was clear that they needed to demonstrate to investors that they could make a high quality product which had a diverse market.

Under the banner of new entity ReGen Plastics, and with the help of matched funding from the state government, the company installed a new extrusion moulding line which is capable using recycled resins to produce long section moulded HDPE profiles. The first product developed by the company is a unique custom designed plank product which could be used in place of treated timber sleepers and joists in a variety of building and landscaping applications. Unlike treated timber, it will not be subject to rot and degradation and presents no risk of leaching toxic chemicals.

At the moment, the feedstock for the new product line is recovered HDPE purchased from a reprocessor in Brisbane in pellet form. The longer term plan is to establish a local reprocessing facility in Cairns which will be capable of taking HDPE from a variety of sources (e.g. the Cairns MRF, local manufacturers, commercial collections and agricultural plastics including chemical drums). The plant would include shredding, washing, drying and pelletising stages, producing a clean high purity resin as an input to the manufacturing line. The proposed plant is modest in scale with a capacity of just over 5,000 tonnes per annum,but is expected to support up to 30 new jobs.

The project is a perfect example of circular economy in action and working in regional areas. By focusing on the end market and seeking to make high quality products that have diverse market potential, the company will be supporting local recycling programs including kerbside recycling, by reducing the need to transport valuable resources to markets in Brisbane or overseas.

2.4.3 Glass

Around 88,500 tonnes of packaging glass was recovered in Queensland in 2017-18, along with 14,700 tonnes of non-packaging glass (e.g windows, windscreens, etc). Almost all of the collected glass was reprocessed in Queensland, with a tiny fraction (less than 1%) sent interstate for reprocessing. Queensland is fortunate to still have a glass bottle factory in Brisbane that provides an outlet for the majority of clean glass cullet, using it to produce new glass containers. A glass beneficiation plant in SEQ also provides refinement of contaminated glass fines from MRFs to recover additional glass product for use in other applications, such as recycled glass sand in civil engineering projects. However, there are pressures on the bottle-to-bottle market. Recovered glass competes with low cost virgin sand as a feedstock into glass manufacturing. Further, Australian glass manufacturers are under commercial pressure due to competition from imported bottles, which are produced in countries with cheaper labour, energy and raw materials. Hence, the prices paid for recovered glass are typically low compared to other recyclable materials. It is difficult for MRFs and other processors in regional areas to make glass recycling commercially viable given the lower commodity value, which is often outweighed by the cost of transporting glass to SEQ.

The introduction of the Container Refund Scheme (CRS) has provided a particularly clean source of recovered glass compared to that collected through kerbside commingled systems. This presents a further challenge for MRF operators, which are finding it more difficult to market their lower quality glass cullet.

As a result, a number of regional MRFs and some facilities in SEQ have invested in glass crushing technology to produce secondary sand and aggregate products from waste glass, which can be used locally and avoid the need to transport the material. Operators are finding that the glass needs to be cleaned of organic residues and crushed to a consistent particle size in order to be accepted as an input in construction uses such as asphalt or concrete mixes. Whilst some are still refining their conversion process and product quality, others are finding outlets for the product. For example, a Townsville manufacturer of pre-cast concrete blocks is regularly substituting virgin sand with glass sand, while some material is going into higher value uses such as sand blasting and filtration media.

With appropriate processing technology and broader acceptance by the construction and engineering community (through appropriate standards and guidance), there is potential for significant volumes of recovered glass that cannot be viably remanufactured into bottles to be used in roads and other construction uses. The road construction industry is now embracing the use of secondary materials in roads and acknowledging that they can enhance the performance and durability of roads. Government agencies are also working to ensure that standards and specifications do not present a barrier to the use of materials such as glass sand and aggregate.

Opportunities to improve the recovery of glass include:

- Maximise the recovery of clean glass through the Container Refund Scheme through adequate collection infrastructure and community education, particularly in regional areas where other recycling options are not available;
- Invest in MRF upgrades to provide additional sorting and cleaning of glass cullet from commingled streams, so that it is attractive as a manufacturing input;
- Where transporting glass cullet to SEQ for remanufacturing is not commercially sustainable, regional MRFs should continue to invest in crushing and washing technologies that produce a high quality product that meets all relevant engineering standards; and
- Develop new markets for recovered glass sand including expansion of high volume outlets such as asphalt, concrete and pipe bedding applications, but also niche low volume, higher value outlets such as filtration media and industrial applications. To support these markets, technical specifications should be updated where necessary to allow for recycled materials and specify the maximum proportion, and be consistently applied by state and local government agencies.

2.4.4 Organics

Organic waste arises from a range of domestic, council, commercial, industrial and agricultural sources, which collectively represents one of the largest waste streams in the state. It can have significant environmental impacts when landfilled or managed inappropriately.

When organics decompose in an anaerobic landfill environment (no oxygen) they produce methane, which is a potent greenhouse gas. They also contribute to the production of contaminated leachates, which have the potential to seep into the environment and impact groundwater, soil and surface water bodies. On the other hand, organic wastes contain valuable nutrients and carbon that can be recovered and returned to soils. Hence, there is a strong incentive to divert organics from landfill, beyond simply reducing the tonnage of material that is landfilled.

In terms of the wastes managed by councils, the primary organic waste streams of concern are food organics, green waste and biosolids. However, significant volumes of organic waste are produced by business, institutions, industry, agriculture, forestry and other sectors. The Waste Strategy identifies organics as a priority waste stream, particularly domestic food and garden organics, and commercial food waste from hospitality and food processing industries. Organics from households and businesses are more likely to be disposed to landfill than organics from other sectors such as agriculture and forestry.[11]

The processing and recovery of organics in Queensland typically involves blending of various waste materials (both organic and inorganic) and processing via a composting process. Some materials such as green waste and forestry waste may be simply shredded and sold as mulch (unpasteurised). A number of liquid and high moisture organic wastes such as biosolids and manures are managed by direct spreading to farm land. The materials accepted by organics processors may include:

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[11] National Food Waste Baseline, 2018

- Biosolids;
- Grease-trap waste;
- Green waste;
- Food organics;
- Putrescible MSW (mixed waste);
- Clean timber and wood waste including sawdust;
- Abattoir waste, food processing waste, agricultural residues, forestry residuals, manure, cotton gin trash, other farm organics; and
- Other regulated and inorganics wastes, ash, contaminated soil, drilling muds.

2.4.4.1 Garden organics

A significant volume of garden organics, or green waste, is recovered across Queensland. In 2017-18, around 661,000 tonnes of garden organics were recovered, most of which was collected by local governments (597,500 tonnes or 90%) as source separated material through kerbside collections and council landfills and transfer station networks. Eight councils currently provide kerbside collection services for garden organics, which in 2017-18 collected more than 60,000 tonnes from 220,000 households. A significant volume of commercial garden organics, generated by gardening and landscape businesses and facilities management services, is also delivered to composters and council transfer stations.

Clean garden organics are relatively easy to process and recover. In Queensland at present, the main processing options are mulching or composting. A number of councils mulch garden organics, which generally produces an unpasteurised product that is lower in value than other mulch products such as forestry bark and woodchips. Given the broad range of input materials (in terms of plant species) and the limited control over those inputs, plus the potential for contamination (both physical and chemical), unpasteurised green waste mulch is a low grade product that presents potential biosecurity risks (spread of weeds, plant disease and invasive insects). While some councils are able to put it to good use, many find it difficult to secure outlets and often give it away for free, use it as erosion control or daily cover on landfill sites, or stockpile it. These outlets are generally unsustainable in the long term and fail to capitalise on the potential nutrient value within the green waste.

A significant volume of garden organics is composted, which is a higher order recycling avenue for the material, producing a product that captures the valuable nutrient and carbon content in a form that can be applied to land as a soil improver. Compost has the potential to improve arid soils, build soil carbon, improve moisture retention, reduce the use of chemical fertilisers and reduce sediment and nutrient runoff. All of these properties mean there is significant market potential for compost across Queensland, but particularly in areas of intense horticulture including tree crops and broad-acre farming in catchments with a need to reduce nutrient and sediment runoff. The potential role of compost in supporting efforts to improve farming practices and reduce nutrient runoff in Great Barrier Reef catchment areas has so far been largely. .

There is a strong composting industry in Queensland, led by various private sector operators across the state using open windrow methods. In 2017-18 it processed almost 300,000 tonnes of garden organics, along with a range of other solid, liquid and sludge materials. Garden organics plays an important role in the composting process as a bulking agent, allowing a range of other higher moisture and high nitrogen organic wastes to be composted by supporting the right nutrient and moisture balance and maintaining good pile structure and air flow to support effective composting.

The majority of produced compost goes into the the lower value urban landscaping market, mostly as bulk compost and soil mix materials, with a small proportion going into higher value bagged garden products for household use. As such, composting can be a commercially challenging business, with operators highly reliant on gate fees from more noxious organics streams such as liquid wastes and sludges. That said, a number of niche composters are producing for agricultural markets and there are some cases where farmers are recognising the true commercial value of compost as a soil additive, reflected in higher offtake prices.

There is also one facility using garden organics as a fuel for energy production, along with clean waste timber. The Rocky Point Green Energy facility in the northern Gold Coast area is now an ageing facility with variable inputs, but it has played a significant role in managing SEQ garden organics over recent years, without the end-market constraints that challenge some composting and mulching facilities.

Despite established collection networks and successful composting facilities, and an overall estimated recovery rate of around 60%, it is still estimated that over 470,000 tonnes of garden organics is being disposed to landfill, mostly within general household and commercial waste streams. In addition, the significant proportion of garden organics that is currently diverted from landfill through mulching represents an opportunity to recover a higher value resource by investing in new composting infrastructure.

Opportunities to improve the recovery of garden organics include:

- Councils to enhance the collection of source separated garden organics from households after assessing which options are most appropriate in the context of their communities. For some councils, that will mean the expansion or implementation of kerbside organics collection services, whilst for others it may be more appropriate to maximise self-haul / drop-off options and/or promote options such as home or community composting or on-call collections.
- Improving existing facilities to receive and store self-hauled garden organics from householders and small businesses, such as ensuring council transfer stations have dedicated garden waste pads.
- Consider the development of garden waste-only transfer facilities in areas where there is a high generation of garden organics, existing transfer stations are space-constrained or there is a need for additional collection facilities.
- Councils should view garden organics as a resource and consider how best to recover the highest value from it, by developing or supporting investment in appropriate processing infrastructure. This may involve a shift from simple mulching to composting, or from open windrow composting to more advanced processing such as enclosed composting or anaerobic digestion (likely dry AD).
- Councils who outsource garden waste processing should consider how their procurement approach can be improved to encourage private sector investment in new, higher order processing infrastructure. For example, longer contract terms, aggregation of regional volumes and taking back some of the end product for use on council projects can all support the business case for infrastructure investment.
- Councils are also encouraged to consider a more integrated approach to managing the full range of organic wastes over which they have some control, such as co-processing of garden organics and household food with biosolids and other streams.

2.4.4.2 Food organics

In 2017-18, an estimated 66,000 tonnes of food organics was recovered via composting facilities, almost entirely from commercial sources. Landfill composition data suggests that some 500,000 tonnes of food organics was landfilled across the state, of which over 70% is in household general waste.

Food waste is highly putrescible, such that in an anaerobic landfill environment it decomposes to produce methane as well as concentrated leachate. However, it is high in nutrients including nitrogen, which if recovered as a compost or soil conditioner product can be returned to soil to produce more food, providing a neat example of true circular economy principles. Given the increased odour risk associated with handling and processing food organics compared to garden organics, it may be necessary to use enclosed or covered composting methods near urbanised areas. Food organics can also be processed through anaerobic digestion to produce energy in the form of biogas.

As noted in section 1.1.4.1, the baseline estimate developed under the National Food Waste Strategy estimated that Queensland generated around 1.8 million tonnes of food waste (in 2016-17) across the entire food supply chain. This includes significant contributions from sectors which are not generally captured in conventional waste management datasets such as primary production, which contributed an estimated 40% of the total food waste, mostly in unharvested crops or unsaleable food disposed of on-farm. Food processing and manufacturing facilities also generate a significant volume of food organics, a small proportion of which is processed by composters but in the main reused as animal feed or, to a lesser extent, recovered through on-site processing facilities. In considering future systems and infrastructure to recover commercial and domestic food organics, there may be opportunities to also process some of the food waste that is currently managed outside of conventional waste systems.

A growing volume of food waste from the manufacturing, wholesale and retail sectors is being reused for human consumption via food rescue organisations that provide it to disadvantaged people, which is a high order reuse opportunity that should be maximised. In 2016-17, the food waste baseline estimated some 14,000 tonnes of food was recovered in this way across Queensland.

Given the linkage of food waste to agriculture and food manufacturing, with potential to return nutrients to soils and produce energy, there is potential to develop integrated solutions and organics-focused waste precincts or ‘bio-hubs’ based around food organics processing and linking in with other sectors, as discussed further in Section 7.4.

There is a significant opportunity to increase the recovery of food organics in Queensland and to produce high value products including soil improvers and energy. Potential opportunities include:

- Councils to assess how they can capture and collect source separated household food organics and which system is most appropriate in the context of their communities. For some councils that will mean implementation of kerbside collection services for food organics, which may either be combined with garden organics or target food only. Collection systems are likely to vary across different types of communities and for different housing arrangements – for example, it may be more appropriate to collect food organics only from high density areas such as apartment buildings which have no garden waste. Tools being developed by DES such as the kerbside collection analysis tool will help to inform these assessments.
- For rural and remote areas, where an additional kerbside service may not be a viable option, councils may consider facilitating home or community scale composting initiatives to divert food organics to compost. Community gardens paired with neighbourhood composting schemes provide a localised circular economy solution to food organics.
- Expand collection services for source separated commercial food organics, particularly from sectors such as hospitality, shopping centres and institutions (e.g. universtities, hospitals, aged care facilities).
- Invest in new processing infrastructure which is able to safely recover food organics without adverse impacts on the environment or local communities. For regional and rural facilities that are isolated from communities, open windrow composting may be an appropriate processing solution, but enclosed processing is likely to be required to manage food organics closer to communities and urban areas.
- Invest in anaerobic digestion of food and other organics to recover both energy and soil improver products.
- Consider and invest in integrated solutions that combine the recovery of food organics with co-processing of garden organics, food processing residues and other putrescible organics, to produce energy and soil improver products. This will require councils and other stakeholders to work in partnership and to think more broadly than the waste streams for which they have direct responsibility. Co-locating organics recovery with other industry, such as food processing and agriculture / horticulture in a precinct or bio-hub, could provide significant synergies.

2.4.4.3 Timber

Waste timber is another largely untapped and under-utilised resource. In 2017-18, organics processors in Queensland recovered 137,200 tonnes of sawdust, wood and timber waste as reported to DES. While this stream is not broken down, it is understood that the majority of that stream sawdust. A small quantity of clean timber is used in composting and mulch production, but this is constrained by concerns around separating clean timber from treated timber, which is not suitable for composting. The major recovery streams are 57,000 tonnes of timber was recovered by councils, private landfills and C&D recyclers, most likely as mulch products, and 41,000 tonnes used for energy recovery, for which Rocky Point Green Energy is only existing facility.

Landfill composition data suggests there is a significant volume of waste timber currently being disposed to landfilln each year, in the order of 790,000 tonnes. There is uncertainty around this number given nearly half of that is within the C&I stream and a quarter is within the C&D landfill stream, both of which have limited compositional data. Nevertheless, there is likely to be a significant volume of timber which is currently landfilled that could potentially be recovered if there was appropriate infrastructure to process it.

There are a number of potential recycling opportunities for clean, untreated, unpainted timber such as use in animal bedding (e.g. poultry litter), particle board manufacture or mulch products. Otherwise, waste timber is a good renewable fuel that can be used in dedicated waste wood thermal energy recovery processes, or as part of a refuse derived fuel stream recovered from mixed C&I or C&D waste.

Potential opportunities to improve the capture and recovery of waste timber include:

- Expansion of collection facilities for waste timber including source separated collections of C&I and C&D timber;
- Providing facilities within council transfer stations to collect separated clean timber for recovery;
- Investment in new timber recycling and reprocessing facilities matched to end market demand in each region;
- Investment in dedicated waste timber energy recovery facilities, which can be small to medium scale and co-located with industrial energy users to supply heat and/or power;
- Investigation into the use of processed waste timber as a supplementary fuel in existing coal fired boilers and power stations across the power generation and manufacturing sectors;
- Recovery of waste timber to a refuse derived fuel stream for combustion in an industrial process such as a cement kiln, or in a dedicated RDF energy-from-waste facility.

2.4.4.4 Agricultural residues

Queensland's agricultural sector produces significant volumes of residues including sugarcane trash and bagasse, straw from crops, husks and hulls, and manures from intensive livestock raising (piggeries, feedlots, poultry farms). Such wastes are generally managed on-farm, either by leaving them in the field or otherwise spreading them back on land (e.g. manures). In the case of bagasse, which is a by-product of sugar cane processing and arises at the sugar mill, most mills are already using the majority of bagasse as a fuel for production of heat and power within the mill.

In any case, the majority of agricultural residues are managed outside of conventional waste management systems and infrastructure networks. While agricultural wastes are not a core focus of this Report, there is value in understanding the approximate volumes that are generated in different regions and the potential for integrated infrastructure solutions that co-process these residues with more conventional waste materials.

DES does not generally collect data on agricultural residues, except for that small proportion which is processed by licensed waste facilities, mostly composting facilities. In 2017-18, Queensland licensed organics processors recovered some 188,000 wet tonnes of manure and 48,000 tonnes of agricultural residues such as sugar cane waste and straw. A further 5,700 tonnes of cotton gin trash was processed, all of it in the Fitzroy region.

However, the volume received by organics processsors is a fraction of the total generation. The Australian Biomass for Bioenergy Assessment (ABBA) project[12] is a national study aiming to collect and publish detailed data on biomass resources, including agricultural residues, which may be suitable for use for bioenergy. Data on the generation of biomass is presented on a mapping platform[13] along with other useful information for developers of bioenergy projects, such as energy infrastructure. The methods used to derive each dataset are presented on the ABBA Queensland website[14]. The data is based on estimated generation of each stream rather than a known actual volume that is available for

[12] https://www.data.qld.gov.au/dataset/australian-biomass-for-bioenergy-assessment
[13] https://www.nationalmap.gov.au/renewables
[14] https://www.publications.qld.gov.au/dataset/abba-tech-methods

potential use, unless otherwise stated. Nevertheless, it is useful to provide some context around the scale of different materials in each region.

Figure 10 shows the estimated production of livestock residues in each region, including manures from intensive livestock farming and residues from meat processing (abattoir waste). The volumes are significant in some cases, suggesting there is strong potential to co-process these residues with other organic wastes, including for energy recovery, to improve the scale and viability of projects. Of particular note:

- The Darling Downs-Maranoa region is home to many intensive livestock farming operations of various types, producing an estimated 760,000 wet tonnes of manures. It also produces around 500,000 dry tonnes of crop residues from wheat, sorghum and cotton.
- SEQ is home to a significant number of poultry farms producing some 600,000 wet tonnes of poultry litter, as well as a number of significant abattoirs producing an estimated 190,000 tonnes of residues.
- The Cairns, Townsville and Mackay regions are home to significant sugarcane industries producing millions of tonnes (dry) of sugarcane trash and bagasse. Sugarcane trash is generally left in the field as a mulch blanket (except in the Burdekin region near Townsville, where it is still burned) as a technique to provide soil quality benefits and reduce sediment runoff, so any harvesting of cane trash will need to weigh up the loss of that function. Bagasse is generated in the sugar mills and generally already well utilised for energy production.

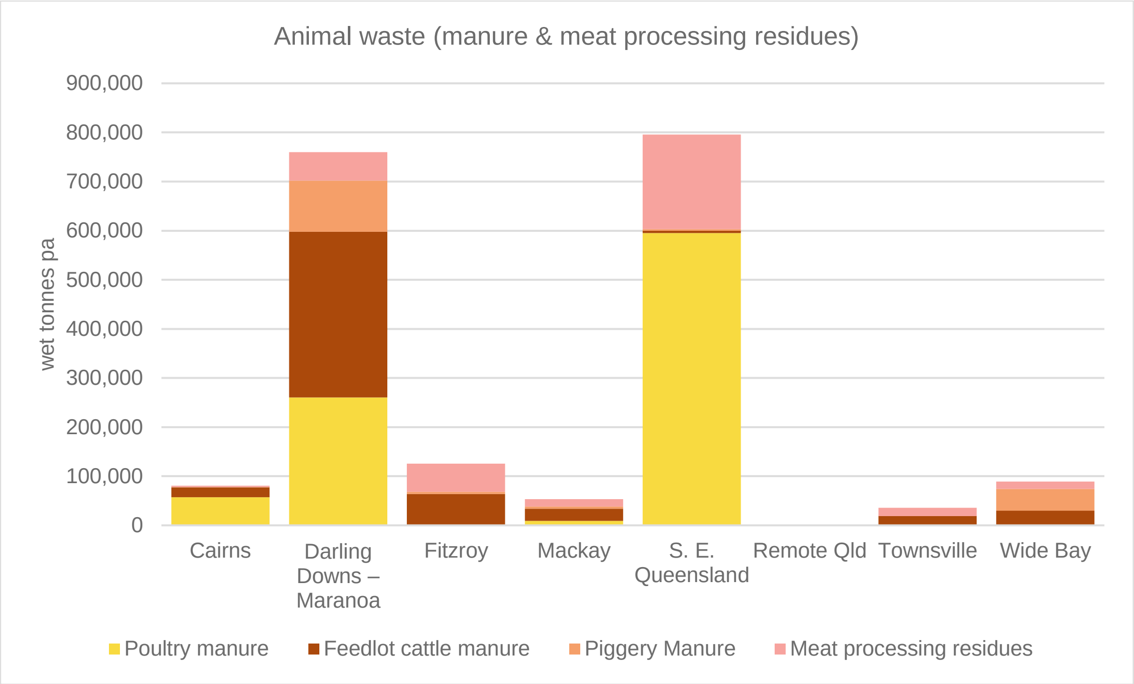

Figure 10: Summary of estimated livestock residues generated in each region in wet tonnes (converted from dry tonne data via assumed moisture contents), averaged over varying timeframes, source ABBA[15].

[15] https://data.qld.gov.au/dataset/australian-biomass-for-bioenergy-assessment

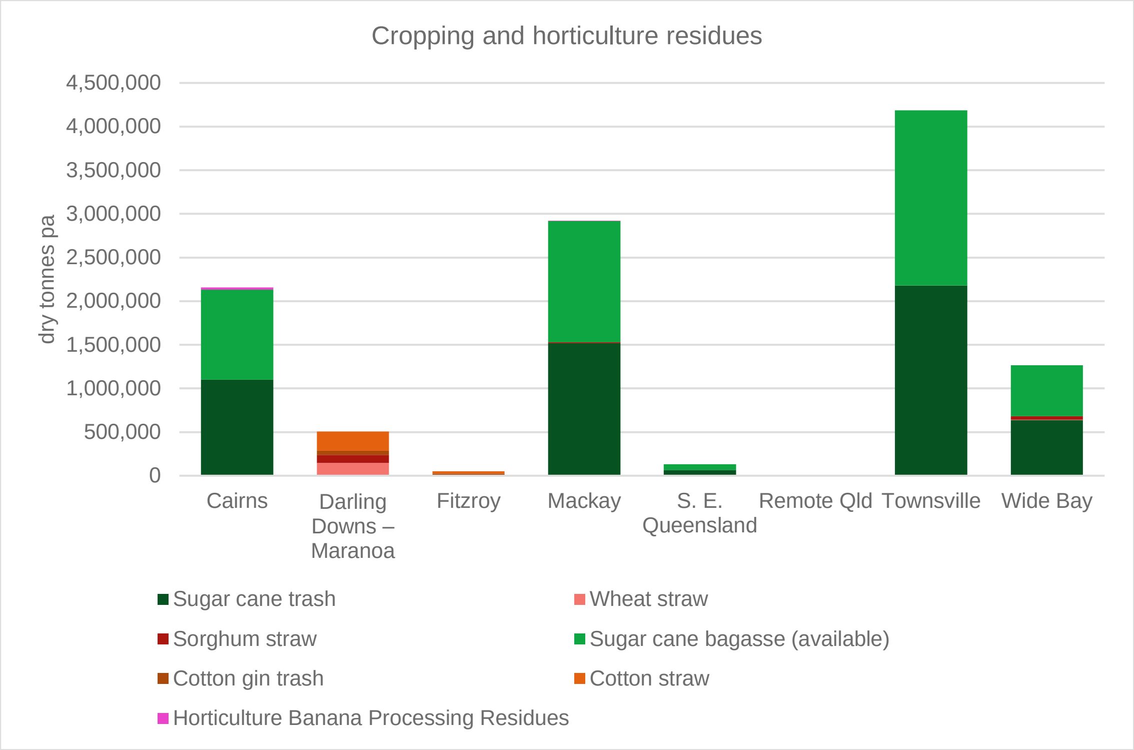

Figure 11: Summary of estimated cropping and horticulture residues generated in each region in dry tonnes, source ABBA[16].

2.4.4.5 Forestry residues

Like agricultural residues, forestry residues are also usually managed outside of conventional waste systems, except a small proportion of sawdust, barks and woodchips which are received by organics processors. The ABBA project has also estimated forestry residues across the state, averaged over te five years from 2012 to 2016, with the data summarised in Figure 12 below.

It is broken down by plantation type (softwood, hardwood, cypress) and residue type (harvest residues versus sawmilling residues). It shows that across the state, 1.2 million tonnes of forestry residues are produced annually. The Wide Bay region, which is home to a significant timber growing and processing industry, produces around 450,000 tonnes of forestry residues annually. SEQ region and the Darling Downs-Maranoa region are both significant, both producing over 250,000 tonnes.

A significant challenge with utilising forestry harvest residues (the foliage and branches left behind in the forest at harvest) is designing a commercially viable and practical method of harvesting the residues from the forest floor. That said, just under half (43%) of the total residues are sawmill residues that will be generated at the sawmill and therefore not requiring an additional harvesting step.

16 https://data.qld.gov.au/dataset/australian-biomass-for-bioenergy-assessment

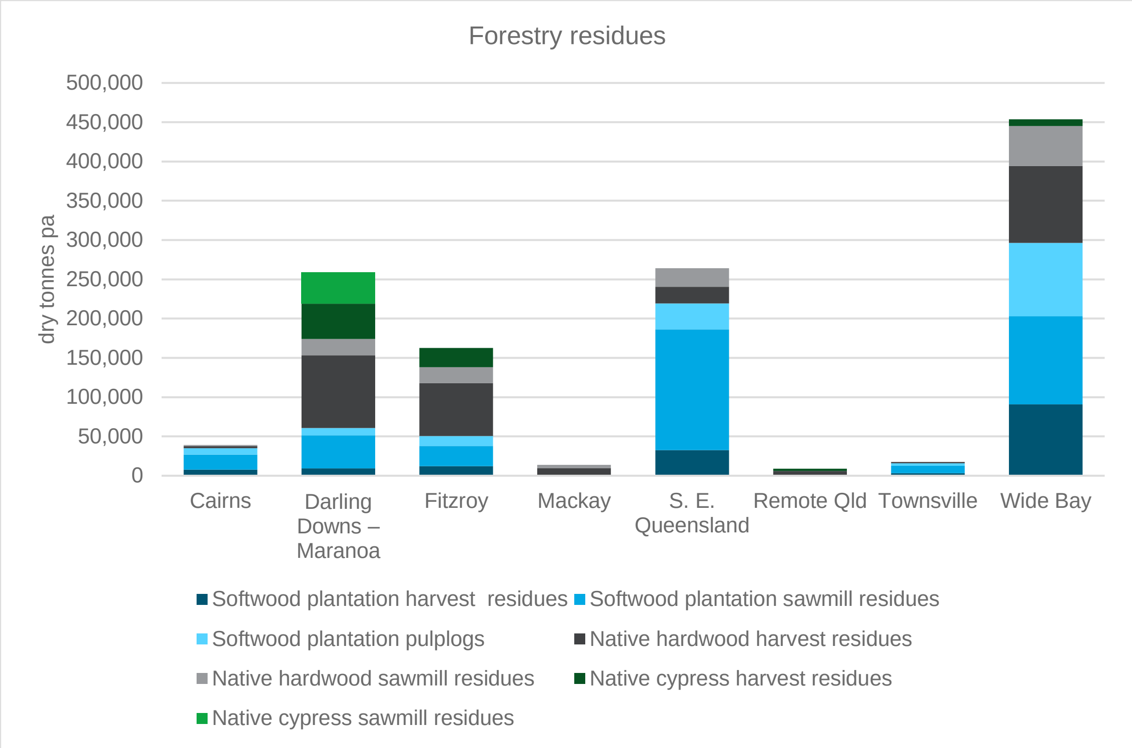

Figure 12: Summary of estimated cropping and horticulture residues generated in each region in dry tonnes, source ABBA

2.4.5 Textiles

A significant amount of recycling and reuse of textiles is undertaken across Queensland through various channels, including charity networks and second hand shops. However, there is limited data collected on the recovery of textiles. Facility operators are not asked about textiles recovery in the DES annual survey and the majority of companies involved in the recycling of textiles are unlikely to be regulated by DES.

The disposal of textiles to landfill has been estimated based on available composition data, which reveals it as a significant stream, worthy of further investigation to identify if there are viable opportunities to improve recovery.

2.5 Cross-border flows

The Queensland waste industry operates in an open market and waste and recyclable materials move into and out of the state in significant quantities.

Significant volumes of recyclable packaging materials are transported outside the state for reprocessing and remanufacturing. In 2017-18, DES data shows that some 336,000 tonnes was sent interstate and 882,000 tonnes was sent overseas for further recovery.

Metals are typically the largest group of exported materials (by tonnage), given the limited smelting capacity within Queensland and Australia.

Paper and cardboard is also a significant export stream. Whilst a recovered paper mill in Brisbane reprocesses a large volume of material and manufactures new cardboard products, it is not able to take all of the paper and cardboard recovered in Queensland. Some goes to interstate mills, but a significant proportion (around one third) is exported to international paper and cardboard commodity markets, creating a significant exposure to the recent restrictions by China and other nations on the import of low quality recyclable materials.

The export market also takes the majority of recovered plastics, although the tonnages are much lower than other streams (around 27,000 tonnes exported). Other exported materials including waste oils (mineral and vegetable) and tyres.

Significant volumes of waste are also imported to Queensland from interstate sources, for either disposal or processing. The discrepancy in landfill pricing between Queensland and other states, prior to the implementation of the Queensland landfill levy in July 2019, provided a strong financial incentive for waste to move from high levy regions such as Sydney, to landfills in SEQ.

Imports from interstate sources have grown rapidly over recent years and in 2017-18 reached some 1.25 million tonnes. The majority (over 1 million tonnes) is C&D waste, which predominantly comes from the Greater Sydney area and is disposed to private landfills in SEQ. A smaller volume of MSW was imported from councils in northern NSW that face particular challenges in terms of local landfill capacity. A significant volume of contaminated soil, acid sulphate soil and regulated waste is also imported from various sources, most of it for disposal but some for treatment in dedicated facilities.

The quantum of waste imported is expected to significantly decline in 2019-20 as a direct result of the landfill levy, which effectively removes the financial incentive for most materials. Some waste material will continue to come. For example, it is likely that transporting MSW to landfills in SEQ will still be the lowest cost option for some councils in the north-east of NSW. It remains to be seen whether the starting levy rate (at $75 per tonne) is sufficient to fully stop the trade in C&D waste from Sydney where the levy rate is over $140 per tonne and landfill capacity is scarce.

3 FUTURE WASTE FLOW PROJECTIONS

Projecting the volumes and types of waste that will be generated in the future and how they might be managed is subject to a high degree of uncertainty. For the purpose of developing this Report, a 'base case' has been modelled which assumes the Strategy targets are achieved and makes a number of assumptions around how that could occur. The subsequent infrastructure capacity gap and needs analysis is predicated on the base case. Alternative sensitivity scenarios have also been modelled to provide an understanding of the range of potential future waste flows, under less optimistic resource recovery assumptions.

The base case future projections assume that the Strategy waste avoidance and resource recovery targets are met, which is likely to be the most optimistic case – i.e. a scenario withcombines low waste generation growth with high resource recovery to meet the Strategy's very ambitious targets. However, as noted in section 1.4, one of the objectives of this Report is to assess the infrastructure that may be required to achieve those targets, in part to attract the . Achieving themsignificant investment in new resource recovery infrastructure that will be required. Major changes will also be needed in the way that products and packaging are made and in consumer and business behaviour, as well as changes to the way that waste is managed at source and collected, and the way that recovered resources are utilised in the behaviour of individuals and organisations.

Whilst the Strategy sets stretch targets, it is prudent to consider the impact of less optimistic outcomes. These have been modelled as sensitivity cases (see below).Queensland economy.

There are many different scenarios through which the Strategy's resourceStrategy recycling and recovery targets could be achieved. It is likely that the SEQ region and regional cities will do most of the heavy lifting in terms of increasing resource recovery across the state, given the benefits from aggregating significant volumes to support development of more advanced recovery solutions with greater efficiencies and improved access to end markets. The base case projections below set out just one potential pathway to achieve the targets, withthe underpinning assumptions set out in further detail in Appendix A.

The assumptions around future waste generation are as follows:

- The generation of MSW on a per capita basis is assumed to reduce by 25% over the next three decades to 2050, in line with the Strategy. Considering that per capita MSW generation in Queensland has already declined by this percentage over the past decade, this is an optimistic but plausible goal. Government influence over the amount of waste that Queenslanders generate within their homes typically focuses on education and facilitation of new waste behaviours, but the reduction will likely be driven by broader macro trends, which may include:
  - Growing awareness and interest amongst the community around the environmental and health impacts of waste and the need to minimise waste;
  - Ongoing improvements and efficiencies in packaging, including reduced incidence of single use and disposable packaging (in line with national commitments to make all packaging reusable, recyclable or compostable);
  - Reductions in household food waste through consumer education and improved lifespan of food products, as well as growth in home composting; and
  - Trend towards outsourcing the preparation of meals to third parties through the growth in home delivery services
  - Increasing activation of circular economy business models, such as repairable and reusable products[17], returnable packaging (e.g. current trials in food delivery[18] and coffee cup exchanges[19]) and packaging-free bulk grocery stores.
- The generation of C&I and C&D waste per capita is also assumed to reduce but at a more modest rate of 10% by 2050. Again, this will be driven by macro trends such as:

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[17] https://ww8.ikea.com/auresource/buyback/
[18] https://returnr.org
[19] www.cupexchange.com.au and https://greencaffeen.com.au

- Reduced disposable / single use packaging for materials and goods, including intermediate transport packaging;
- Reduction and reuse of manufacturing wastes at source;
- Ongoing efficiencies in building design and operations to minimise waste;
- Increased reuse of building materials and extension of asset lifespans, to reduce demolition waste.

For the C&D stream, the significant volume of waste that was previously imported from interstate for disposal in Queensland (over 1 million tonnes in 2017-18) is assumed to decline rapidly with the introduction of the landfill levy. Based on industry feedback, it may not cease immediately but is assumed to drop sharply in 2019-20 then decline more slowly to zero over the next two years as the levy rate ramps up. The smaller quantities of MSW and C&I waste received from interstate may continue at smaller scale, but their total impact in 2017-18 was only around 2% of the respective landfill streams, so they have not been separately modelled.

The future projections for each key stream presented below assume that existing recovery systems and pathways are maintained and that the associated volumes of recovered materials continue to grow in line with population growth at the regional and/or local government level. New resource recovery has then been estimated based on a number of factors including the estimated content of residual waste currently landfilled (see discussion above and composition data in 2.3.5), knowledge of achievable capture rates and market trends in resource recovery systems and solutions.

In developing the future waste flow projections, the exact timing of certain changes has been nominally assumed and generally staggered, with differing assumptions made for each region, but the main focus is on the medium and longer term Strategy target horizons (2030, 2040 and 2050).

3.1.1 Future MSW resource recovery

The significant growth in MSW recycling and recovery capacity and capability that is required to meet the Strategy targets is based on the estimated composition of household waste currently going to landfill as set out in 2.3.5.

3.1.1.1 Organics

It shows that the greatest opportunity to improve recycling within the MSW stream is organics. Capturing the significant volume of food and garden organics currently in household waste will require implementation and/or expansion of segregated collection systems for these materials. Each council will need to assess the most effective collection system option for their particular context and DES is preparing some guidance and tools to assist in these decisions. However, broadly the options for organics collections include:

- New or expanded kerbside collections of garden organics;
- New kerbside collection systems for food organics, which may be combined with garden organics in a FOGO bin or collected separately (particularly for high density areas);
- Expanding and improving the capture of garden organics through council transfer station networks; and
- Capturing household organics in small scale or community based composting projects.

Achieving the targets will likely require all larger urban councils (SEQ and regional cities) and some regional councils to pursue one of these options, or some other approach, to capture a significant proportion of household organics. For more rural areas where additional kerbside services may not be viable, councils are likely to focus on improving the efficiency of garden organics diversion through other means such as improving drop-off options at transfer stations. Remote councils and smaller communities may be able to improve the diversion of garden organics through transfer stations but may also explore smaller home or community scale composting solutions for food waste.

In modelling the potential future additional organics capture and recovery, the base case considers the proportions of food and garden organics currently in residual MSW and optimistic but realistic assumptions around the proportion of these materials that can potentially be captured through new collection systems. The modelling assumes higher organics capture rates in SEQ than other regions and a minor change (mostly garden organics) in Remote Queensland areas.

3.1.1.2 Household recyclables

The base case also assumes a gradual but optimistic increase in the capture of recyclable household packaging materials (paper and cardboard, plastics, metals and glass, which also make up a significant proportion of the general waste stream currently disposed to landfill. Whilst the recycling sector is currently experiencing significant market challenges, in the long term there is an expectation that the sector will recover and expand by investing in better sorting equipment to produce higher quality commodities, as well as more local reprocessing capacity to add value to materials and reduce reliance on volatile export markets.

As more packaging becomes recyclable, it is expected that a higher proportion of the household waste stream will become available to shift into the kerbside recycling bin. For areas where there are established kerbside recycling systems, it is expected that capture rates will improve over time. In areas where there is no existing kerbside recycling system (mostly rural and remote councils), it is assumes that new collection services may be introduced, but the format of those service is yet to be determined by each council and may not necessarily be based on the conventional commingled recycling model.

In modelling this under the base case, pragmatic assumptions have been made around the proportion of recyclable materials that can reasonably be captured from the residual stream. The modelling assumes slightly higher capture rates in SEQ than other regions and a minor change in Remote Queensland. The modelling has not specifically assumed an increase in the capture of other materials such as timber and textiles, although clearly there are potential opportunities within those streams that will be explored and supported.

3.1.1.3 Energy from waste

Energy from waste, particularly thermal treatment of residual waste, is likely to play a moderate role in the base case (more significant in SEQ but also some regional centres) and is considered an essential part of the mix if the longer-term recovery targets are to be achieved. The Strategy targets for recycling versus recovery (where recovery = recycling plus energy recovery) are based on an inherent assumption that across the state, energy recovery will account for no more than 25% of MSW generated by 2050.

As such, the base case assumes moderate uptake of EfW in SEQ (e.g. a number of large scale EfW plants processing a mix of MSW and C&I waste) and a phased implementation of smaller scale EfW plants in some regional cities over the next three decades. The modelling nominally assumes EfW is implemented in selected regions where there may be potential to aggregate sufficient volumes of waste and other favourable factors, such as landfill constraints and potential to co-locate with industry or co-process other materials.

In the base case, EfW has been assumed to be in Townsville and Fitzroy regions by 2030 and in Cairns and Wide Bay regions by 2040. However, there is a need for further investigation in all regions to explore the feasibility of EfW, so this should not be taken as any signal of preference or intent. It may be found that EfW is not viable in some of those regions, or is viable in others. There are existing technologies that can operate efficiently at the likely scale of waste volumes that will be available within those regions (range of 70,000 to 110,000 tonnes per annum) and new technologies are likely to be commercialised over coming decades which are viable in that and smaller scale ranges.

3.1.1.4 Container Refund Scheme (CRS)

The capture of recyclable beverage containers through the CRS is assumed to continue growing over the next decade as the program becomes more established and ingrained amongst the community. CRS recovery is assumed to contribute to both MSW and C&I recovery rates (assumed 70:30 split, respectively) and to be spread across the regions in proportion to population.

The base case projections of future MSW flows across the state are summarised in Figure 13 below. Further details on regional waste flow projections are provided within the regional profiles in Section 6.

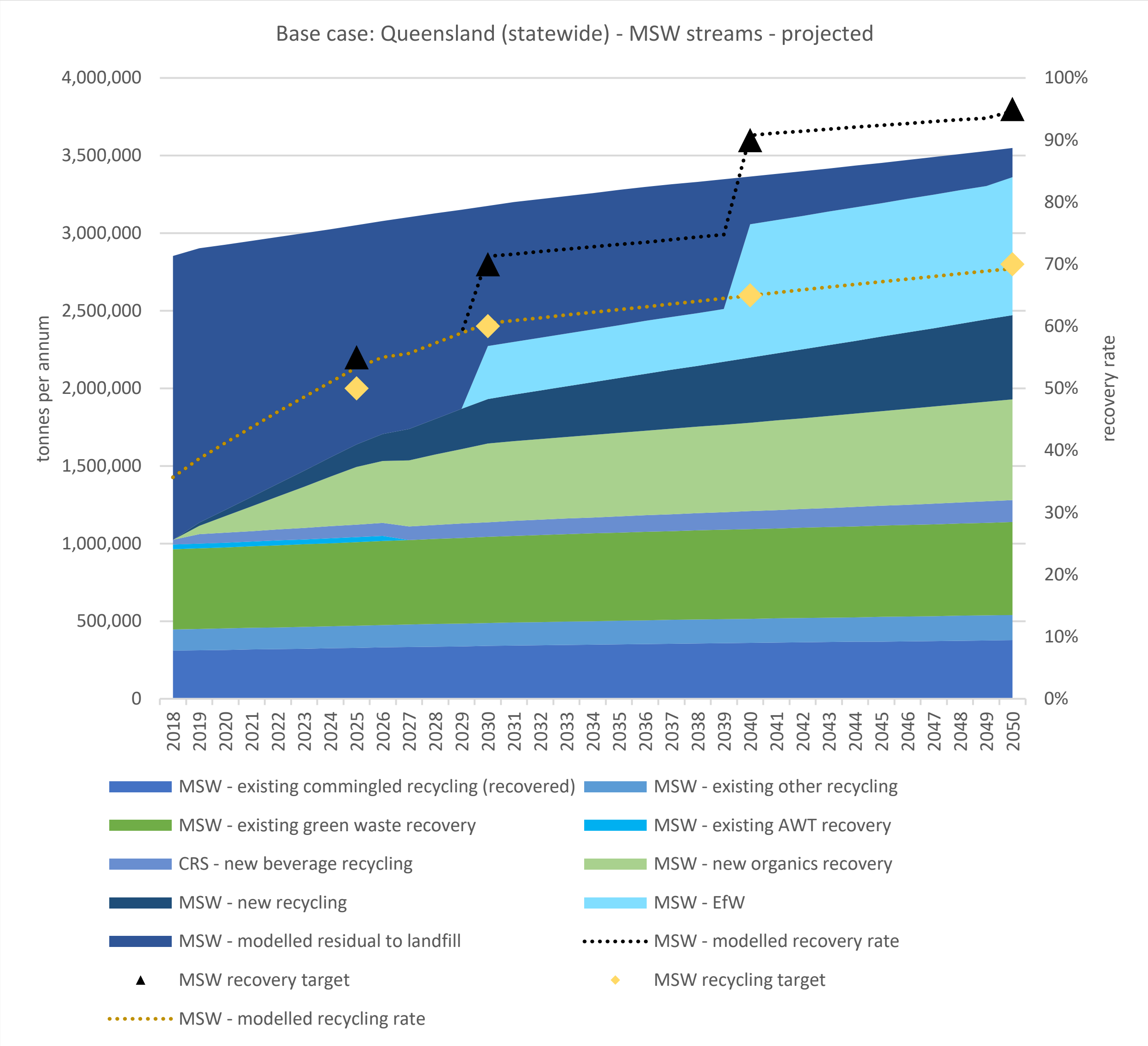


Figure 13: Base case statewide projections for MSW stream

3.1.2 Future C&I resource recovery

The future improvements in resource recovery in the C&I stream will be largely driven by the landfill levy, particularly in SEQ and regional cities where access to services and infrastructure are likely to be better.

To achieve the Strategy targets, future efforts are assumed to focus on:

- Improved capture of commercial and industrial organics for recovery, including an increase in separate collections of commercial food waste;
- Moderate improvements in the capture of recyclable commercial packaging materials (paper and cardboard, soft plastics, metals and glass) that are currently going to landfill, through expansion of source separated collection services;
- Energy from waste, which will likely be a combination of:
  - Plants that produce refuse derived fuel (RDF) or process engineered fuel (PEF)

– Thermal EfW plants that are primarily commissioned to process MSW but will have some capacity to process C&I residuals
– Specialised single stream EfW plants processing C&I waste such as waste timber.

The base case projections of C&I waste flows across the state are summarised in Figure 14 below. Further details on regional waste flow projections are provided within the regional profiles in Section 6.

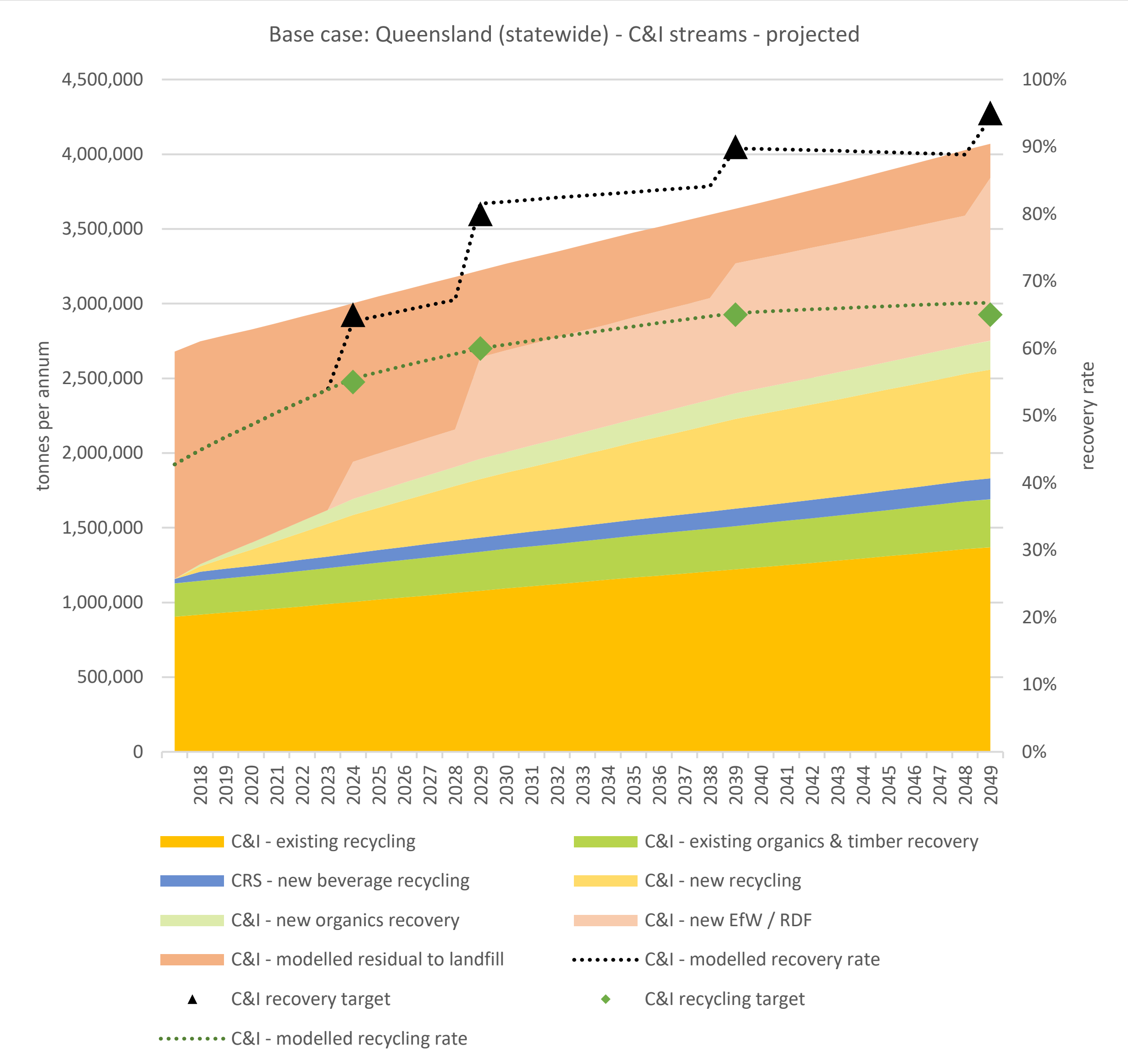


Figure 14: Base case statewide projections for C&I stream

3.1.3 Future C&D resource recovery

The recovery rate of the C&D stream is expected to respond rapidly to the introduction of the landfill levy in the short term, based on the experiences in other jurisdictions. Initial focus will likely be on source separated clean streams such as concrete, brick and soils, which can be recovered relatively easily with equipment that is readily available and can be leased.

Significant and rapid improvements in C&D recycling are expected in SEQ and new C&D processing is also expected in regional cities. In the medium term, industry is expected to shift towards more focus on processing of mixed C&D waste (such as skip bin waste), particularly in SEQ where the large volumes justify the larger capital investment in more sophisticated processing equipment. Again, this is following the trend in other markets where landfill levies are longer established, such as Sydney and Melbourne.

The base case projections of C&D waste flows across the state are summarised in Figure 15 below. Further details on regional waste flow projections are provided within the regional profiles in Section 6.

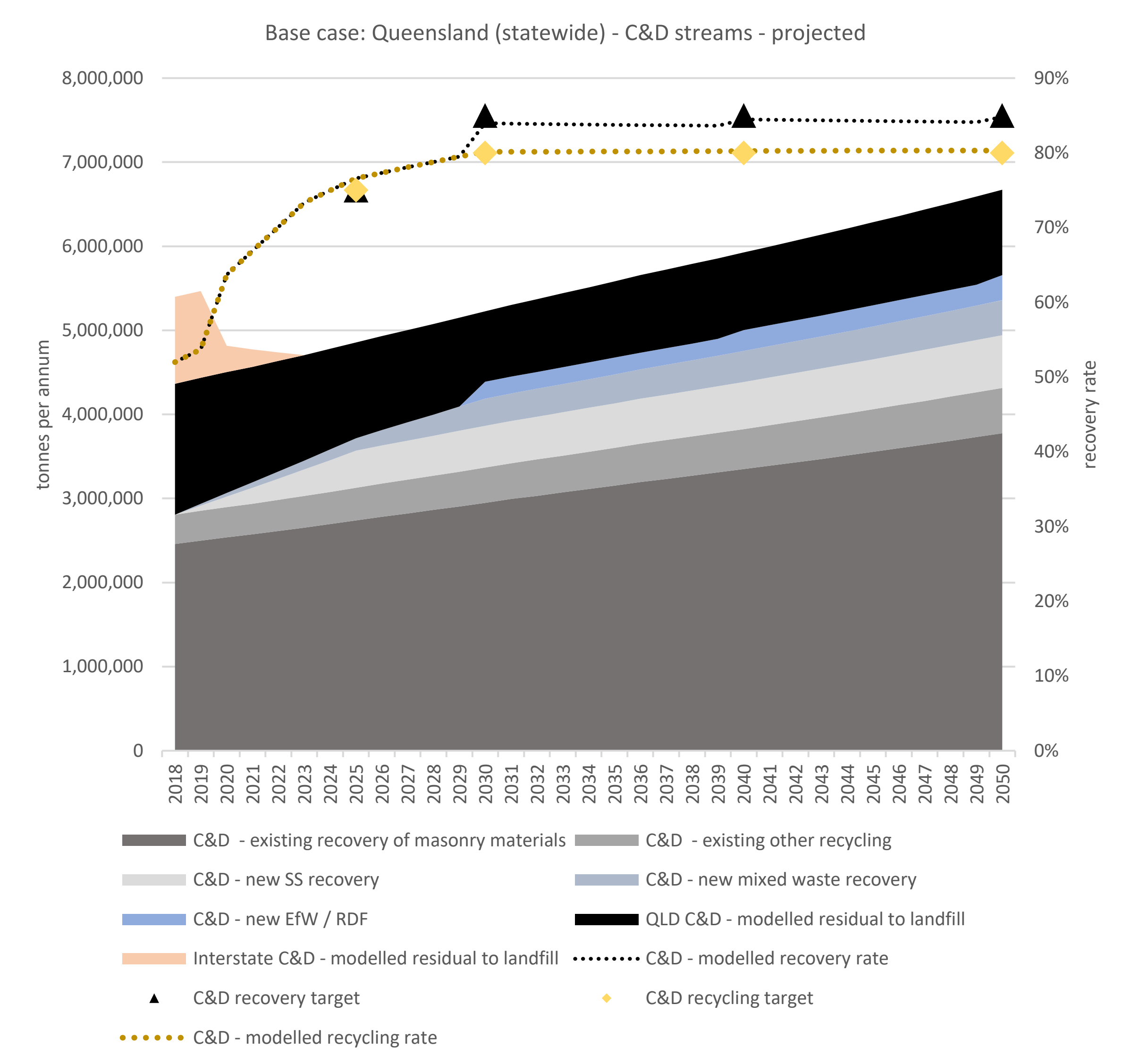


Figure 15: Base case statewide projections for C&D stream

3.1.4 Overall waste flows

The consolidated forecast for waste generation and flows in Queensland over 30 years to 2050 is presented in Figure 16 overleaf. Total annual generation is expected to increase from 10.9 million tonnes to 14.3 million tonnes.

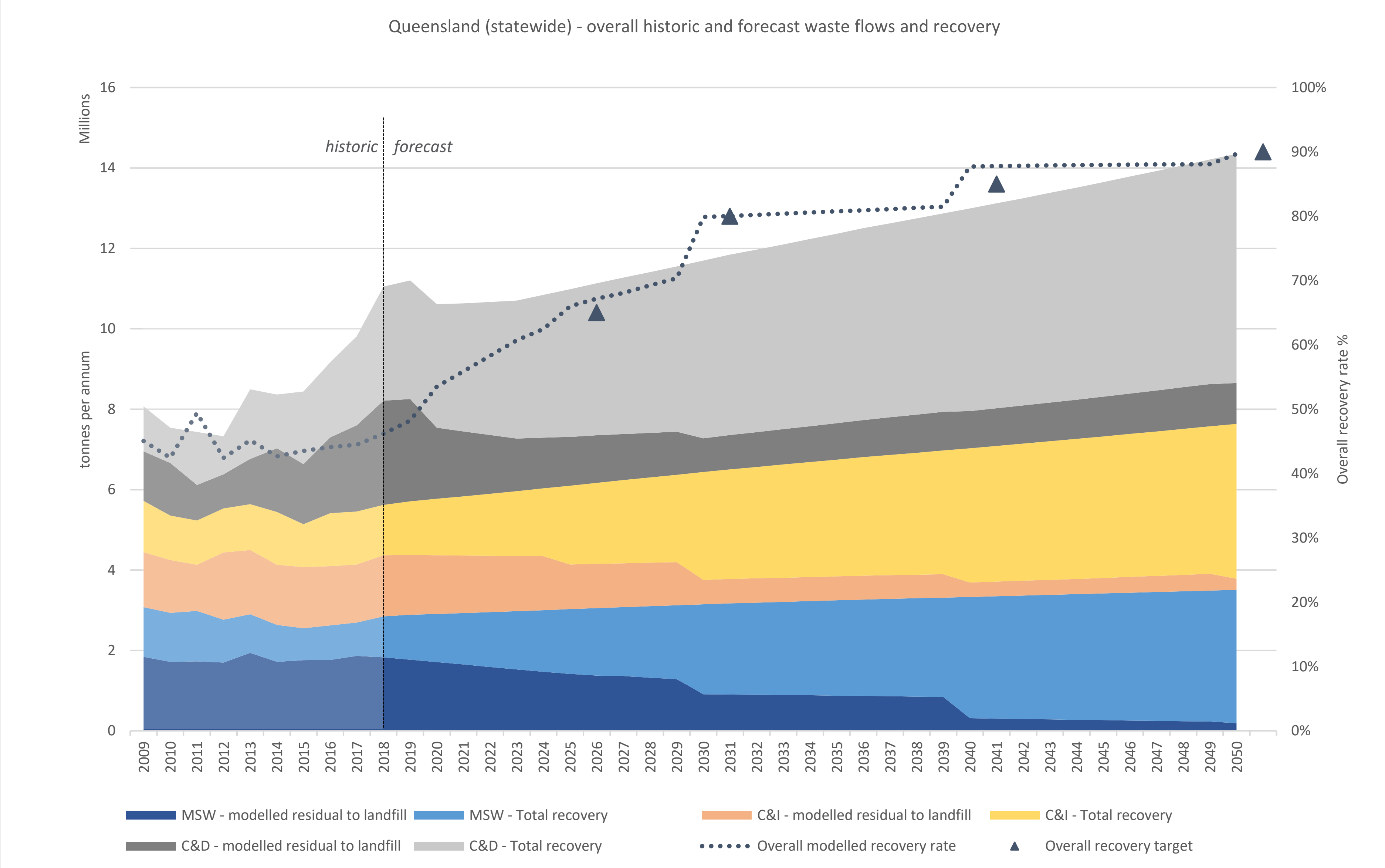


Figure 16: Base case – overall Queensland waste flow projections – all streams

3.1.5 Sensitivity modelling scenarios

Given the uncertainty around predicting future waste flows and resource recovery performance, in addition to modelling the base case as described above, a small number of alternate scenarios were tested to show the likely range of waste flows. These alternative sensitivity scenarios are described in further detail in Appendix A, but include:

- **High EfW scenario** – Uses the same waste generation rates as the base case and assumes the Strategy recovery targets are achieved, but by relying on a higher proportion of energy recovery, which means the recycling targets are not met. It assumes more modest improvement in recycling and organics recovery than the base case, with higher uptake of EfW in both SEQ and regional cities.
- **Mid-recovery scenario** – More modest improvements in recycling and organics recovery than the base case, particularly focused in SEQ and regional cities, and modest uptake of EfW in SEQ and selected regional cities. Under this scenario, the Strategy targets (both recycling and recovery) will not be achieved.
- **Low recovery scenario** – This is the lowest performing scenario from both a waste avoidance and resource recovery perspective, but still assumes some level of improvement from current recovery levels given the impact of the landfill levy and other measures. Waste generation across all three streams is assumed to remain steady, with no change in per capita generation rates. New recycling across all streams is modest and mainly focused in SEQ. The increase in C&D recovery is still relatively good, reaching 75% in the long term as a direct result of the levy and the relative ease of recycling the stream. Recycling of the MSW and C&I streams is more subdued. There is minor uptake of EfW in SEQ, mostly beyond 2030. This scenario is particularly relevant in testing the likely maximum residual waste tonnages that can be expected in each region, in terms of planning for future landfill capacity in the event that the Strategy recovery targets are not achieved.

4 EXISTING INFRASTRUCTURE

This section provides an overview of existing waste and resource recovery infrastructure in Queensland.

4.1 Classifying waste infrastructure and defining capacity

To identify and assess waste infrastructure and allow a discussion on future needs, it is first important to define the different types of waste and resource recovery infrastructure. This section describes the infrastructure definitions adopted in this report and some of the key characteristics of each type of infrastructure. Capacity is also discussed and defined for different infrastructure types, as this is a key element of the subsequent future needs assessment. The following sections identify how waste and resource recovery infrastructure has been classified in this Report.

4.1.1 Transfer infrastructure

A transfer station is a facility that receives waste from collection vehicles and waste generators for consolidation before transfer to a disposal or recovery facility. Transfer stations may handle a range of different waste types or target specific wastes and may include drop-off and consolidation facilities for recyclables and problem wastes. The majority of transfer stations in Queensland are council-owned and open to the community, often incorporating a range of recycling options and other waste services for householders and small business customers. Most council facilities are stand-alone and have replaced a former landfill at some point. Some transfer stations are co-located with landfills, where their function is to provide a safe public interface, rather than an efficient method of bulking up and transferring waste the short distance to the tip face.

There are a smaller number of private transfer stations across the state which receive commercial waste and/or C&D waste. A number of private waste collectors also operate networks of depots, which are multi-use facilities that may serve as initial consolidation and storage points for waste, as well as other functions such as housing vehicles.

Transfer stations can be further categorised according to their scale and functionality within the broader network as:

- **Bulking transfer stations** – Facilities specifically designed to consolidate waste into high volume trailers or containers for efficient long-haul transfer. Most private transfer stations fall into this category, along with a small number of council facilities. Some council facilities may have some degree of bulking capacity, but in this context the focus is on facilities capable of loading into high volume vehicles, which typically requires specific design features and plant.
- **Primary transfer stations** – Transfer stations which service a significant proportion of the population or market within the local area (e.g. local government area). Most councils have one larger primary transfer station that offers the full range of services, although larger urban councils may have multiple facilities within this category. Some are co-located with landfills, whilst others are stand-alone.
- **Secondary and satellite transfer stations** – These are smaller facilities servicing a smaller catchment population, sometimes with a reduced range of services on offer and specifically located to service urban fringe, rural areas and smaller towns or villages.
- **Rural bin stations** – These are provided by some councils as a means for servicing rural and remote communities isolated from townships and unable to be serviced with kerbside collections. They typically comprise a cluster of bins, often within a locked enclosure that local residents can access.
- **Depots** – In addition to private transfer stations, which are typically large capacity and feature bulking capability, private waste collectors may operate their own depots where, apart from storing and servicing vehicles, they may aggregate and consolidate relatively small volumes of waste – typically recyclables and/or regulated wastes, for transfer to a recovery or disposal facility.

In addition to the ability to consolidate waste for transfer to disposal or processing, council owned transfer stations tend to incorporate a number of other functions, such as:

- A resource recovery centre (RRC), which is a public drop-off facility for reusable and recyclable materials from householders and small businesses, sorted by the customer as they deposit the materials. It often also includes facilities to safely receive and store household problem and regulated wastes for safe management, including waste oils, paints, chemicals, tyres and e-waste. It may also incorporate basic processing activities such as mulching of green waste or crushing of concrete.
- A resale centre ('tip shop' or salvage shop) where reusable items including furniture, books, toys and building materials, which are in useable condition are captured at the transfer station and sold to the public in a retail shop – usually on the same site as the transfer station, but occasionally on a separate site.

4.1.2 Recovery and reprocessing infrastructure

A recovery facility is one which takes mixed recyclable material and sorts it, usually mechanically, into material streams, which are then able to be sold on as commodities for further refinement. A reprocessing facility takes those sorted materials, either as outputs from a recovery facility or that have been segregated at source, and substantially changes the nature of the material (physically or chemically), converting it into either a new product which is ready for market or a feedstock material that is manufacturing-ready.

In some cases, the delineation between a recovery and reprocessing facility is not clear. For example, a materials recovery facility (MRF) is primarily a sorting facility (recovery) but may include reprocessing of glass into sand and aggregate. A C&D waste recycling facility is primarily a recovery facility but may incorporate crushing and screening (reprocessing) of aggregates to a standard that is ready to sell direct into the market. As such, recovery and reprocessing infrastructure has been considered together in this Report.

Within this broad category, common facility types include:

- **Materials recovery facility (MRF) –** A MRF typically receives and sorts mixed streams of recyclables that have been somewhat segregated at source (e.g. commingled kerbside recycling) but may also receive source separated recyclables. Recyclables are sorted by material type through mechanical and manual processes, then consolidated (compacted and baled) and sent to reprocessing facilities. A 'clean MRF' typically refers to a facility processing a pre-sorted, lightly contaminated stream such as kerbside commingled recycling, while a 'dirty MRF' is a mechanical process for mixed, unsorted waste with a significant unrecoverable fraction. The recyclables extracted from mixed waste in a dirty MRF are of lower quality than those from a clean MRF, but a dirty MRF may also recover a refuse derived fuel (RDF) or process engineered fuel (PEF) product.
- **C&D recycling facility –** A sorting and reprocessing facility that is specifically designed to recover process C&D waste. Most existing facilities are only capable of processing source separated materials such as concrete, brick and soils, with relatively basic processing including crushing and screening to produce secondary aggregate and road-base products. Increasingly, more sophisticated facilities are being developed which are capable of receiving a mixed C&D stream (such as that collected in skip bins) and sorting it into material types through various stages of mechanical and manual sorting, to extract reusable or recyclable materials including soils, concrete, brick, tiles, metals, plastics and timber.
- **Reprocessing facilities** – Typically specialising in a particular material stream, these facilities take pre-sorted materials and change their physical and/or chemical nature, adding value to the processed material so that it can become a feedstock for a manufacturing process or otherwise re-enter the economic cycle. Reprocessing facilities typically manage single-stream materials such as paper / cardboard, plastics, glass, timber, metals, batteries, e-waste, tyres and oils.

4.1.3 Organics processing infrastructure

Organics processing facilities are a form of reprocessing but have been considered separately as they specifically target sorted organic wastes, which are a significant proportion of the waste stream and quite different in nature to dry recyclable streams. Organics processing is typically either aerobic (composting) or anaerobic (digestion). These processes change the physical and/or chemical nature of putrescible organic materials, usually through some form of controlled biological decomposition, resulting in products and/or energy which are ready to re-enter the economic cycle. They may also involve mechanical processing such as shredding and screening.

Outputs are most commonly compost, soil improver and mulch products, which are applied to land, while in the case of digestion facilities, energy may also be produced. Organics processing facilities can potentially process a range of organic wastes including food waste, green waste and timber; as well as agricultural and forestry residues. Organic liquid waste may also be co-processed with drier materials such as green waste, and selected inorganic wastes such as ash and drilling muds may also be blended in.

Organics processing facilities have been categorised as follows:

- **Mulching** – Involves mechanical processing to shred or grind woody organics such as green waste or clean timber, to produce mulch products. Significant quantities of green waste are currently mulched across Queensland, producing an unpasteurised mulch product. Pasteurised mulch may also be produced from oversize material that has been composted.
- **Composting facilities** – Aerobic decomposition of organic waste to produce compost or other soil improver products, which are then sold into landscaping and agricultural markets. Most existing composting facilities in Queensland utilise open windrow methods, but there is one enclosed, in-vessel composting facility (under construction at the time of writing) and it is likely that more enclosed facilities will be developed over time to accommodate processing of more odorous streams such as food waste.
- **Anaerobic digestion (AD)** – The anaerobic decomposition of organic waste (in the absence of oxygen) results in the production of methane-rich biogas, an energy source. AD is used in Queensland to process specific waste streams such as sewage sludge and biosolids, manures from intensive agriculture (e.g. piggeries) and some on-site industrial organic streams. In the future, AD is likely to play a greater role in processing food waste and other commercial and industrial streams (wet AD) and possibly in processing mixed food and garden organics streams (e.g. through dry AD systems).
- **Mechanical biological treatment (MBT) facilities** – Also known as alternate waste treatment (AWT), a facility that processes mixed putrescible waste (typically MSW, C&I and other organic wastes) to separate recyclables and an organic fraction from the residual waste. The recyclables are sent to reprocessors, while the organic fraction is processed biologically on-site (either through enclosed composting or anaerobic digestion) to produce a soil improver and/or recover energy. A refuse derived fuel output may also be produced. These facilities could also be classified as recovery, but given the main purpose is usually organics recovery, they have been categorised as an organics processing solution. There is one existing MBT facility in Queensland (Cairns). In the future, MBT facilities could potentially be deployed, as they are Europe, as a method of producing refuse derived fuel from putrescible waste, by bio-drying the organic fraction rather than composting.
- **Land spreading** – Involves the direct application of organic residues (usually liquids or sludges) to agricultural land with minimal processing. There is minimal physical infrastructure involved, which perhaps explains the significant volumes of biosolids and manures that are currently managed in this way in Queensland.

4.1.4 Energy recovery infrastructure

Energy recovery technologies may utilise thermal, chemical and/or biological processes to recover energy from waste materials in various forms (electricity, heat or gaseous, liquid or solid fuels). The most common technology in energy from waste facilities globally is combustion, which is well established and proven. The energy is recovered from waste as electricity via a steam boiler and turbine, while heat (in the form of steam or hot water) may also be captured. There are several examples of this technology being applied to single-stream waste materials in Queensland such as the multiple sugar mills generating power from sugarcane waste, or the Rocky Point Green Energy plant which uses garden and timber waste as fuel.

Other technologies are in varying stages of commercial development and maturity. Gasification has been used to process waste in some countries such as Japan and, more recently, the UK. Emerging technologies such as advanced gasification, pyrolysis, torrefaction, plasma gasification or hydrothermal liquefaction are starting to be used on specific materials, but not yet proven for broader waste applications at commercial scale. An example is the application of pyrolysis type technologies to waste tyres to produce liquid fuels and carbon char, with Queensland home to the first commercial plant of this nature in Australia[20]. It is likely that such new technologies will become more widely available in the market during the coming decades covered by this Report. These technologies offer the potential to recover energy from waste in other forms including as liquid fuels and chemicals, as gases (including hydrogen) or as solid fuels such as carbon char.

The other way to recover energy from waste which uses relatively simple technology and is being employed elsewhere in Australia, is to mechanically process mixed waste streams to produce a refuse derived fuel (RDF) or process engineered fuel (PEF). Such fuels can potentially be utilised in existing industrial processes, with some modification. The use of PEF in cement kilns is safe and well established in Australia (Adelaide and Sydney) and internationally, and there is potential for greater use of waste derived fuels in Queensland's only cement kiln in Gladstone. Using waste fuels in other industrial furnaces such as power plants or smelters is more challenging but there are opportunities to utilise or repurpose such existing energy infrastructure to process waste fuels.

Anaerobic digestion (AD) and other biological processes also recovery energy from waste materials, in the form of biogas for AD or ethanol for fermentation. These technologies process pre-sorted organic waste streams and largely compete with, or provide an alternative to, other organics processing methods such as composting. For this reason, such technologies are considered as organics processing solutions within this Report, which is not to understate or devalue the potential energy production role of these technologies. As such, the term energy-from-waste (EfW) when used in this Report is generally referring to the thermal processing of residual waste or other difficult-to-recycle materials (e.g. waste timber, tyres, mixed plastics) to recover energy.

4.1.5 Disposal infrastructure

Landfills in Queensland play, and will continue to play, a vital role in safely managing waste that is not practical or economically viable to reuse, recycle or recover energy from. This Report acknowledges that although the Strategy has strong objectives to reduce the use of landfill and the long-term vision is for minimal waste going to landfill, it will be a slow and gradual shift away from our current strong reliance on landfill as the main method for managing waste.

Landfills can be broadly classified according to their ability to receive putrescible waste. Landfills that hold putrescible waste (i.e. with readily decomposable organic content) have a higher potential for environmental impact (e.g. landfill gas generation or leachate seepage) and therefore tend to have higher standards of containment and regulation. Landfills that only receive non-putrescible, or inert, waste still have the potential for environmental impact but the risks are lower and the standards of containment and regulation are slightly different. The vast majority of landfills in Queensland are putrescible landfills that receive both putrescible and inert waste streams. A smaller number of inert-only landfills are only able to receive non-putrescible wastes such as C&D waste or inert commercial waste.

The other way to dispose of waste is incineration (without energy recovery), which is typically only considered for those highly hazardous materials that cannot be safely landfilled. In Queensland, there is a small number of specialised high temperature waste incineration facilities that process materials such as clinical waste and highly toxic chemical residues.

4.1.6 Mobile processing infrastructure

Mobile processing equipment plays an important role in managing a number of wastes across Queensland and could potentially play a greater role in regional areas in the future. While quite different to fixed or static processing infrastructure, it is important to acknowledge the role of mobile processing in dealing with materials that cannot be viably collected or which are best managed on-

[20] The Pearl Global facility at Stapylton, Gold Coast

site, as these systems can make a significant contribution to resource recovery which is not necessarily captured in state data. Examples include:

- Mobile processing of land clearing material (i.e. trees) for use as mulch and manufactured soils on large infrastructure projects
- On site crushing and screening of C&D masonry materials to allow direct reuse on construction projects
- Mobile baling of agricultural plastics
- Mobile tyre baling or shredding

4.2 Defining capacity

A key element of this Report is the need to identify and, where possible, quantify, the capacity of existing waste and resource recovery infrastructure in order to make an assessment of its capability to accommodate future growth and to identify future needs and gaps in infrastructure capacity. However, the capacity of waste infrastructure is not always easy to describe or quantify as it can be constrained and defined by a range of different parameters.

For most waste and resource recovery facilities, there is an upper limit to the quantity of waste (usually measured in tonnes) that can be received in a year. That limit may be determined by a design constraint or may be a regulatory limit that is specified in the Environmental Authority or Development Approval for the facility.

For most mechanical processing plant, capacity is defined in design hourly capacity terms and the annual capacity is therefore a function of the run-time, which is in-turn a function of the operational shift patterns and reliability of the plant. For many waste facilities, there are constraints on the number of vehicles that can access the site at peak times, whether that is specified in the development approval or just a function of the physical constraints of the site and its access way.

For some facilities, the capacity may vary depending on the types of waste received and their properties, such as bulk density. For landfills, the total capacity is typically assessed based on the available void or airspace within a site but that is a volumetric measurement and converting it to tonnes requires knowledge of properties such as the density of the different waste streams that are received, when compacted in the landfill.

The table below describes how capacity is typically defined or constrained for different types of waste infrastructure. For all facilities, capacity may be constrained by conditions within the EA or DA, but this not universally true. The table also shows the scale classifications that have been adopted in this Report to describe the approximate capacity of facilities. Scale is relative for each different type of facility, so varying capacity brackets have been adopted for each category.

Table 13: Summary of capacity definitions for different waste infrastructure types

Facility type	Capacity parameters / definitions	Scale classifications
Transfer stations	▪ The capacity of a transfer station, including resource recovery centres, is usually constrained by the maximum traffic flows that can be accommodated during peak times ▪ Storage space for waste may also be a constraint on some sites but this can be managed, to a point, by more frequent removal of waste off-site	Difficult to quantify capacity, but facilities have been classified as: ▪ Primary ▪ Primary with bulking capability ▪ Secondary / satellite ▪ Rural bin station ▪ Depots
Mechanical processing – e.g. MRF, C&D recycling,	▪ Mechanical equipment is typically rated for a certain hourly throughput. Annual plant throughput is then a function of the running hours and can be increased in some cases by adding shifts (if permitted)	*For C&D recycling:* ▪ Small: <20,000 tpa ▪ Medium: 20,000 to 100,000 tpa ▪ Large: >100,000 tpa

Facility type	Capacity parameters / definitions	Scale classifications
reprocessing facilities	▪ Throughput may need to be adjusted according to the waste composition to maintain sorting efficiency and product quality ▪ Capacity may also be constrained by the storage areas available for feedstock and products	*For Metals recycling:* ▪ Small: <10,000 tpa ▪ Large: >10,000 tpa
Organics processing (biological)	▪ The capacity of a composting process is usually constrained by the land area that is available for feedstock storage, composting windrows, compost maturation and product storage ▪ Capacity is a function of the residence time that is required for materials to fully decompose and stabilise, which varies for different feedstocks and processes ▪ Capacity may be defined in terms of capacity to receive both solid and liquid feedstocks. In composting for example, the solids are used to absorb the liquids, so there is a maximum ratio between the two streams	*For existing composting:* ▪ Small: <10,000 tpa ▪ Medium: 10,000 to 50,000 tpa ▪ Large: >50,000 tpa
Thermal processing – e.g. energy from waste	▪ The capacity is typically defined by the thermal capacity of the boiler or furnace – the maximum rate of input of energy within the feedstock. The energy content of the waste feedstock then determines how the thermal capacity translates into a tonnage throughput rate	*Not defined*
Landfills	▪ Landfill capacity is primarily defined in terms of remaining airspace – the volume of void which is available to fill with waste ▪ Airspace is a volumetric measure and translating it to tonnes is a function of the density of the waste when compacted in the landfill ▪ Some sites may have constraints on vehicle numbers or truck movements, which will limit the tonnage inputs	▪ Very small: <2,000 tpa ▪ Small: 2,000 to 10,000 tpa ▪ Medium: 10,000 to 25,000 tpa ▪ Large: 25,000 to 100,000 tpa ▪ Very large: >100,000 tpa

4.3 Collection systems and infrastructure

While collection systems are not strictly infrastructure and not a core focus of this Report, there is a very clear and strong link between the systems that are in place to collect waste from the waste generators and the infrastructure that is needed to process it. Without kerbside recycling services, there would be little need for MRFs and downstream reprocessing facilities. In the future, the growing separate collection of household organics is likely to spur investment in new organics processing infrastructure, including more advanced systems which are capable of safely processing larger proportions of food organics.

Around 40% (32 out of 77) of Queensland councils provide a regular kerbside collection service for household recyclables (yellow lid bin). However, given that includes most of the larger urban and regional councils, a total of 1.7 million households or 86% of Queensland households receive this service. Recycling poses significant challenges in most rural and remote areas as noted above. None of the 34 councils in Remote Queensland currently provide this service and a number of rural councils in other regions also do not offer this option.

Eight Queensland councils provide a total of 220,000 households (11% of all households) with a third kerbside bin to collect household garden organics (in 2017-18), and this number is growing as more households opt-in to this service. Six of those councils are in SEQ, with Toowoomba and Burdekin the only councils outside of SEQ offering the service. Only one council (Ipswich City Council) currently allows residents with a green bin to put non-protein food scraps into it with garden waste (i.e. fruit and vegetable scraps only). Only two of the councils providing green bins make it mandatory for all urban households to have one (Burdekin and Noosa), while the other six all provide the bins as an opt-in service, usually at an additional charge. The uptake rate of optional green bins within those councils varies from 11% to 45%.

Figure 17 below shows the kerbside services provided by proportion of households, in each region. Figure 18 shows the breakdown of kerbside services by region type.

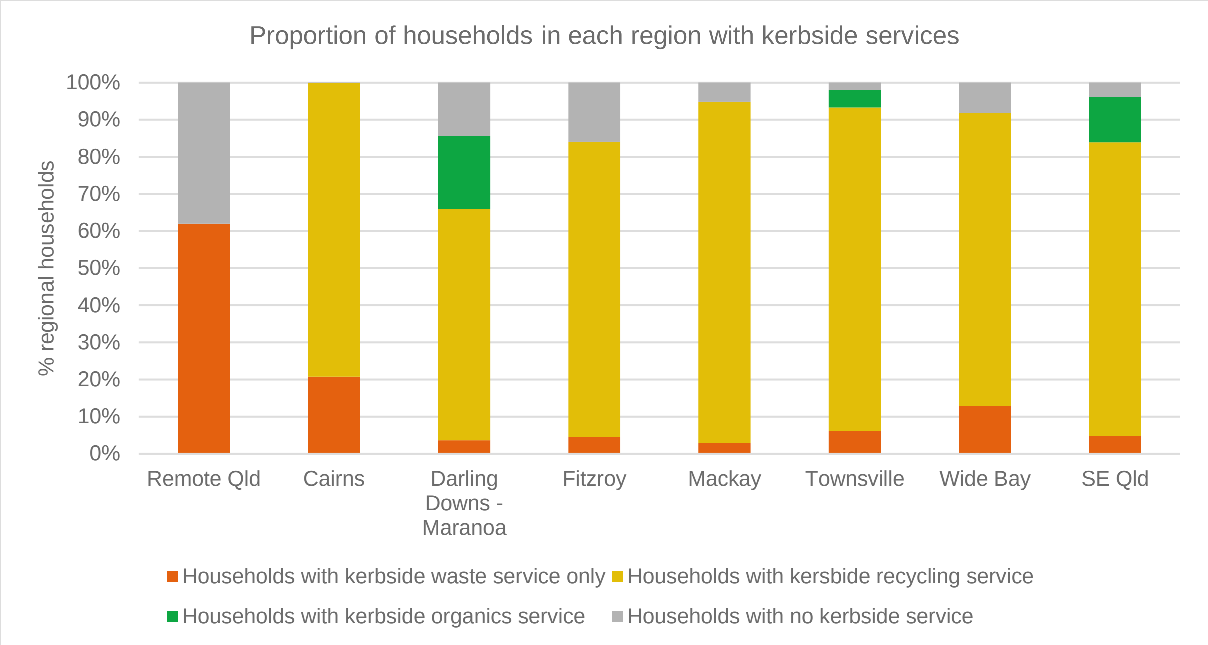


Figure 17: Proportion of households with each region, with different kerbside services

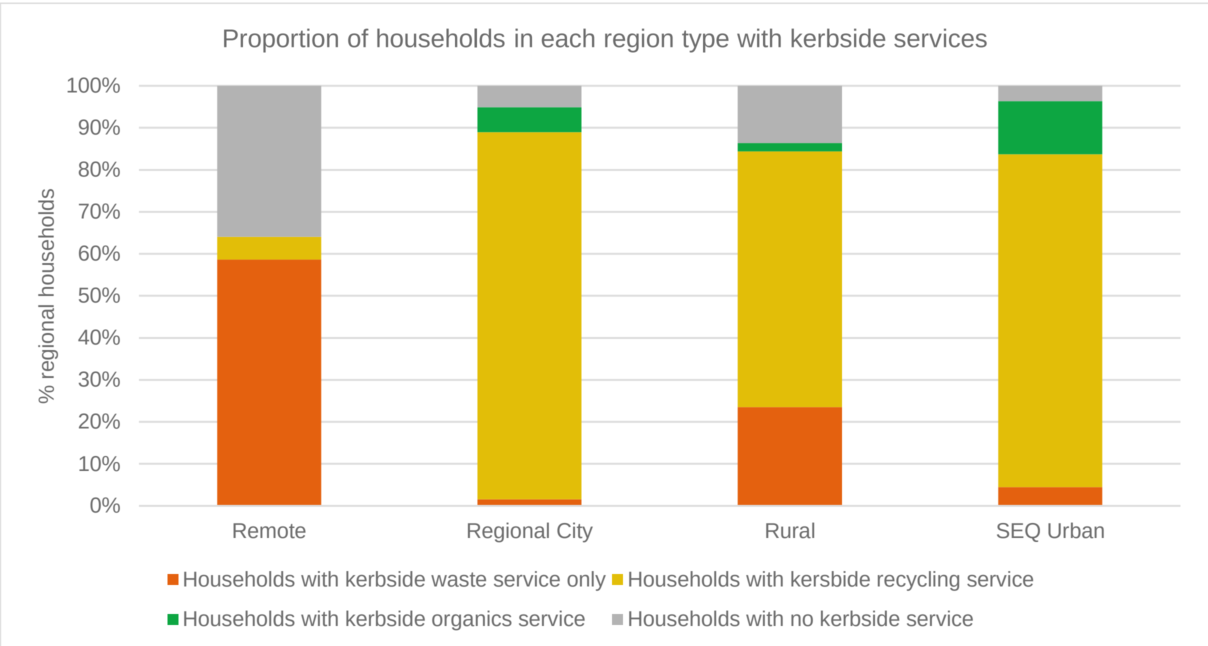


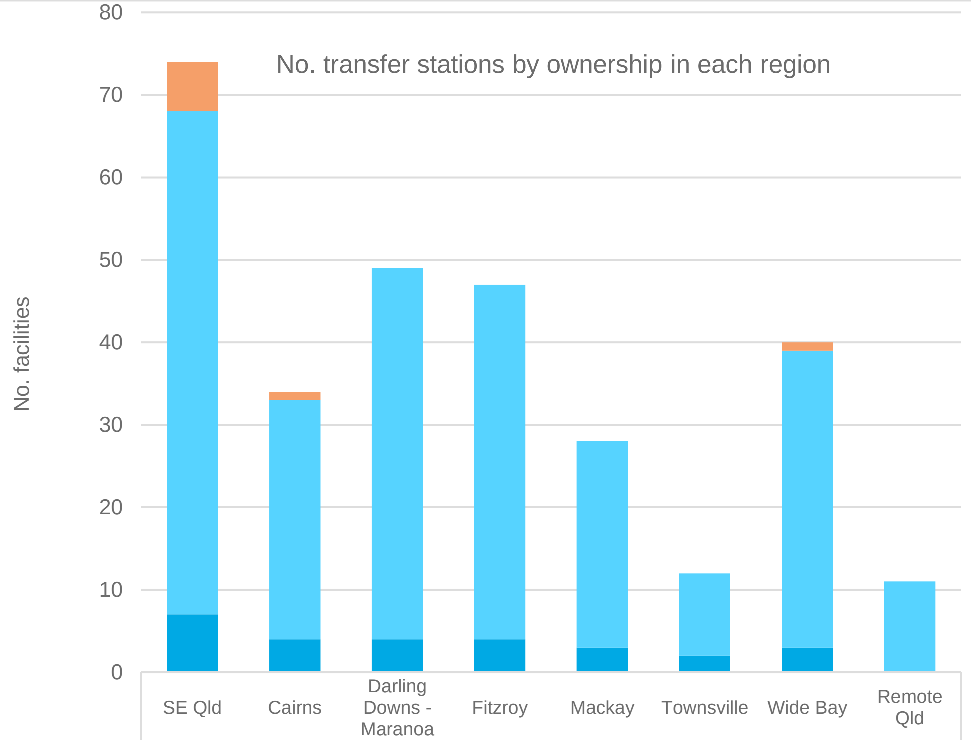
Figure 18: Proportion of households in each region type, with different kerbside services

4.4 Transfer Infrastructure

Transfer stations play a key role in waste and resource recovery networks which will evolve and expand in the future as more regionalised solutions are implemented. Transfer stations can play a number of different roles as discussed in 4.1 above. Each local government tends to have multiple transfer stations to service each main community within their boundary and there is significant variation in the scale and functionality of these council facilities. There is a smaller number of private transfer stations which are predominantly designed as bulking facilities to support efficient long-haul transfer of waste. Figure 19 below shows a summary of the number of transfer stations in each region, with council facilities broken into stand-alone facilities versus those which are co-located on landfill sites and therefore serve a slightly different purpose.

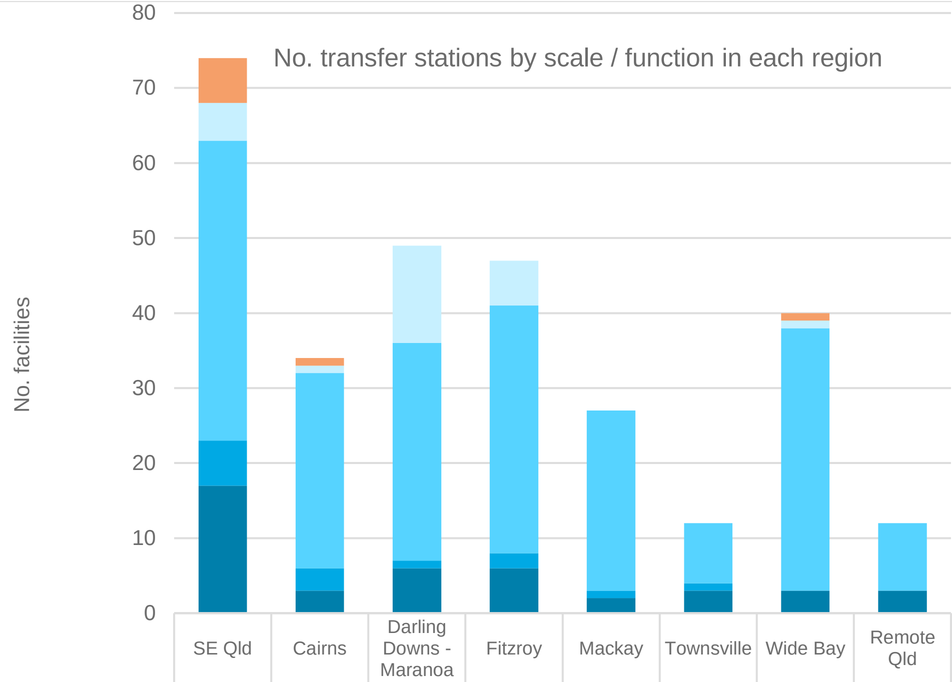
Figure 20 provides an alternative breakdown of the council transfer stations by scale. It shows the numbers of primary transfer stations (as defined in 4.1) and separately, the number which are thought to have bulking capability to support long-haul transfer of waste in high capacity vehicles. It shows that the vast majority of council transfer stations are secondary / satellite facilities, and that rural bin stations are used to differing degrees in each region.

The figures below exclude transfer stations and depots that are solely intended to manage C&D waste, as these are discussed separately below and more closely aligned with C&D recycling networks. The figures below also exclude private depots which are typically maintained by waste collection companies across the state, to provide a location where they can aggregate and consolidate relatively small volumes of waste – typically recyclables and/or regulated wastes, for transfer to a recovery or disposal facility. A total of 37 active private depots were identified throughout the state, mostly in regional areas. These facilities are usually for the exclusive use of the operator that owns them – they are not open to third party users or the general public. Nevertheless, they do play an important role in allowing those operators to service regional areas and offer recycling services.



	SE Qld	Cairns	Darling Downs - Maranoa	Fitzroy	Mackay	Townsville	Wide Bay	Remote Qld
Private Transfer station	6	1	0	0	0	0	1	0
Stand-alone Council Transfer stations	61	29	45	43	25	10	36	11
Council Transfer Station at a landfill	7	4	4	4	3	2	3	0

Figure 19: Summary of transfer station numbers by type (excluding C&D transfer stations and depots)



	SE Qld	Cairns	Darling Downs - Maranoa	Fitzroy	Mackay	Townsville	Wide Bay	Remote Qld
Private Transfer station	6	1	0	0	0	0	1	0
Rural bin station	5	1	13	6	0	0	1	0
Secondary / satellite transfer station	40	26	29	33	24	8	35	9
Primary transfer station - bulking capacity	6	3	1	2	1	1	0	0
Primary transfer station	17	3	6	6	2	3	3	3

Figure 20: Summary of transfer stations by number and scale (excluding C&D transfer stations and depots)

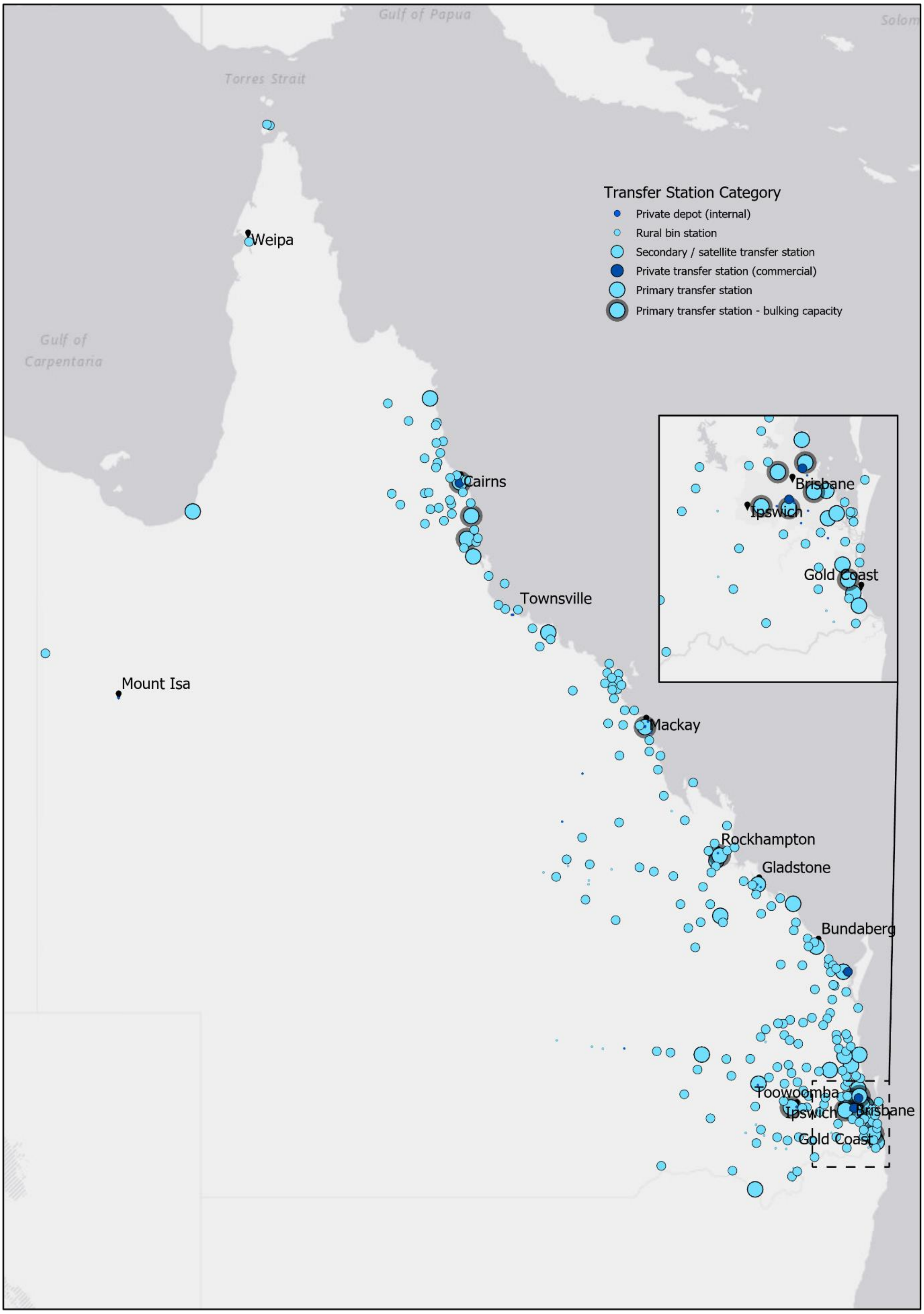


Figure 21: Statewide map of transfer facilities

4.4.1 C&D transfer facilities

Transfer stations which specifically handle C&D waste have been considered separately as (a) they are not generally capable of managing general or putrescible waste, and (b) they are more closely tied to C&D recycling networks. Hence these facilities are shown in Figure 24 in section 4.5.3 and summarised in Table 14 below.

Table 14: Summary of C&D transfer facilities

Region	C&D collector / depot	C&D Transfer station
Remote Qld	-	-
Cairns	3	-
Darling Downs - Maranoa	2	-
Fitzroy	2	-
Mackay	4	-
Townsville	3	-
Wide Bay	2	-
SE Qld	28	9
Totals	**44**	**9**

4.5 Recovery and reprocessing infrastructure

4.5.1 Material Recovery Facilities

For the purpose of this Report, MRFs are those facilities which primarily process a commingled stream of recyclable packaging, sourced predominantly from household kerbside collections with some commercial material. These facilities are differentiated from facilities that primarily receive and sort source separated recyclables sourced mostly from commercial sources and council transfer stations, which are discussed below.

A total of 16 operational MRFs have been identified across Queensland of which six are council-owned and the rest are private. Half of those MRFs are in SEQ while Wide Bay region has three small MRFs. Townsville, Cairns and Fitzroy region all have a single regional MRF servicing multiple councils within those regions. Darling Downs-Maranoa has no MRF currently and it is understood that recyclables are bulked up and transported to SEQ for processing.

The quality of data received for MRFs was moderate and assumptions have been made about the capacity of some facilities, based on historic data.

Table 15: Summary of MRFs by region

Region	MRF Numbers	Total Regional MRF capacity (tpa)
Remote Qld	-	-

Cairns	2	32,500
Darling Downs - Maranoa	-	-
Fitzroy	1	16,800
Mackay	1	20,000
Townsville	1	15,000
Wide Bay	3	35,000
SE Qld	8	459,000
Totals	16	**578,300**

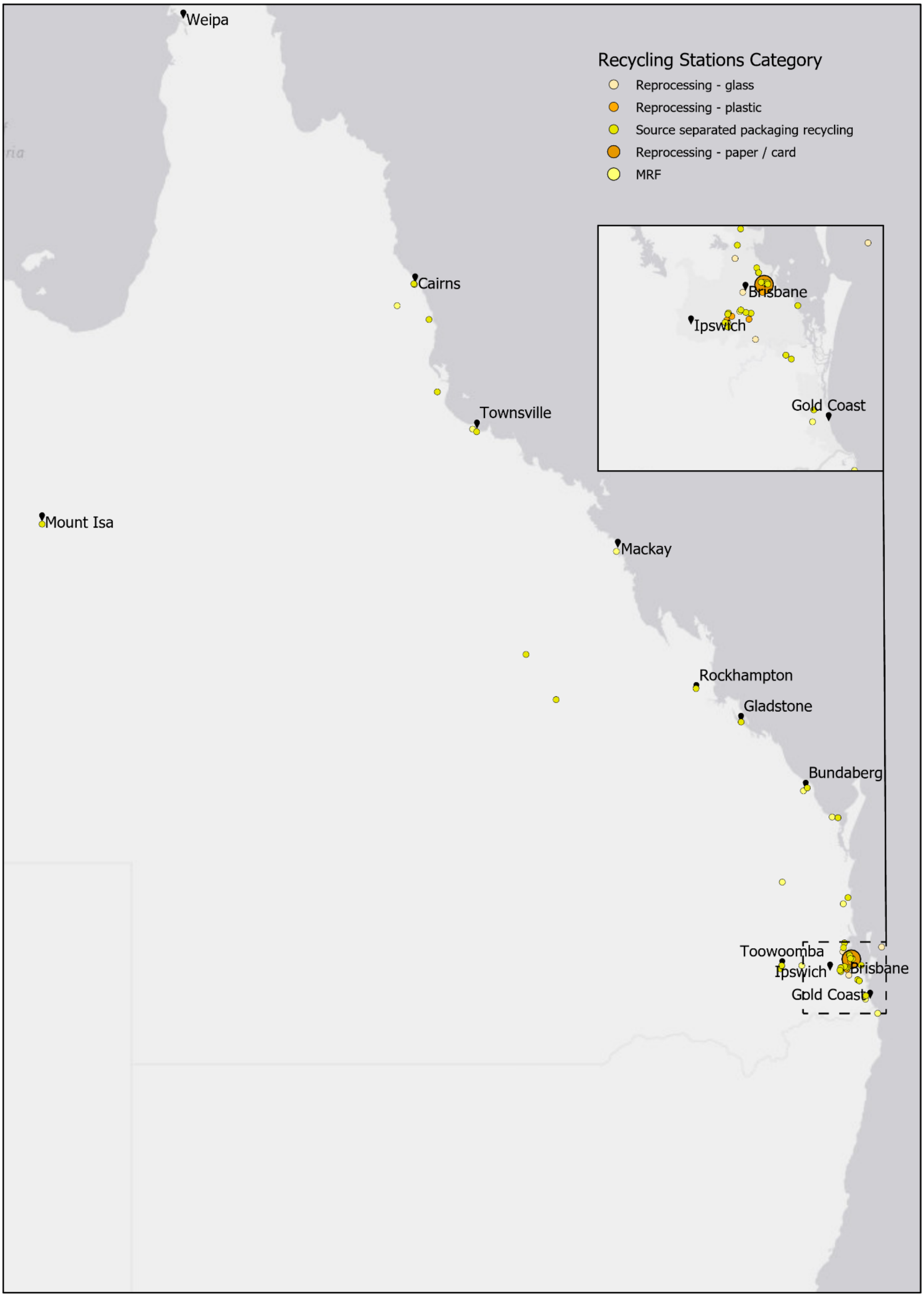


Figure 22: Statewide map of packaging recycling and reprocessing facilities

4.5.2 Source Separated Recycling Facilities

Source separated recycling facilities take in recyclable packaging materials which have already largely been separated by the waste generator and separately collected. Materials may be sourced from commercial recycling collections (mostly paper, cardboard and plastics) or from council transfer stations. These facilities may also receive recyclables which have been pre-sorted in regional MRFs. The material may undergo further sorting to separate material types (e.g. plastics by polymer) and then the materials are typically baled ready for sale to market.

Data on the capacities of these facilities was generally poor – very few responded to the data survey and number have not reported any tonnages to DES in 2017-18. The figures below are mostly estimated based on the data that was available (2017-18 throughputs). As such, the capacities below are likely to be an under-estimate of the total actual capacity in the network. In any case, these facilities will likely have a high degree of flexibility to increase or decrease capacity to meet market demand.

Table 16: Summary of source separated recycling facilities by region

Region	SS Recycling Numbers	SS Recycling capacity (tpa)
Remote Qld	1	500
Cairns	2	13,500
Darling Downs - Maranoa	3	5,000
Fitzroy	3	-
Mackay	1	-
Townsville	2	13,500
Wide Bay	2	-
SE Qld	22	544,000
Totals	**36**	**576,500**

4.5.3 Packaging materials reprocessing

There are a small number of facilities, predominantly in SEQ, which take sorted recyclables and reprocess them into new products or higher value commodities. Examples include:

- Visy's Gibson Island Recovered Paper Mill in Brisbane, which takes around 40% of the paper and cardboard recovered in Queensland via kerbside recycling and commercial collections, and produces a range of cardboard sheet products.
- The Owens-Illinois (OI) glass bottle factory in South Brisbane which takes the majority of clean glass cullet from Queensland MRFs and CRS processors and uses it together with virgin resources to produce glass bottles. The main facility is also supported by a glass beneficiation plant at Crestmead which takes contaminated glass fines from MRFs and processes it to recover usable glass cullet and other recyclables.
- A stand-alone facility in Brisbane which processes glass into sand products for use in roads and range of other applications, noting that a number of regional MRFs identified in 4.5.1 above also incorporate glass reprocessing capabilities internally.
- A facility which produces glass fibre insulation products from waste glass cullet
- Around six facilities, mostly small-scale facilities in SEQ, were identified which reprocess various plastic streams, either into new products or into high grade, manufacturing ready pellets. These

facilities accounted for around 30% of plastics recovered in Queensland in 2017-18, with the majority still exported.

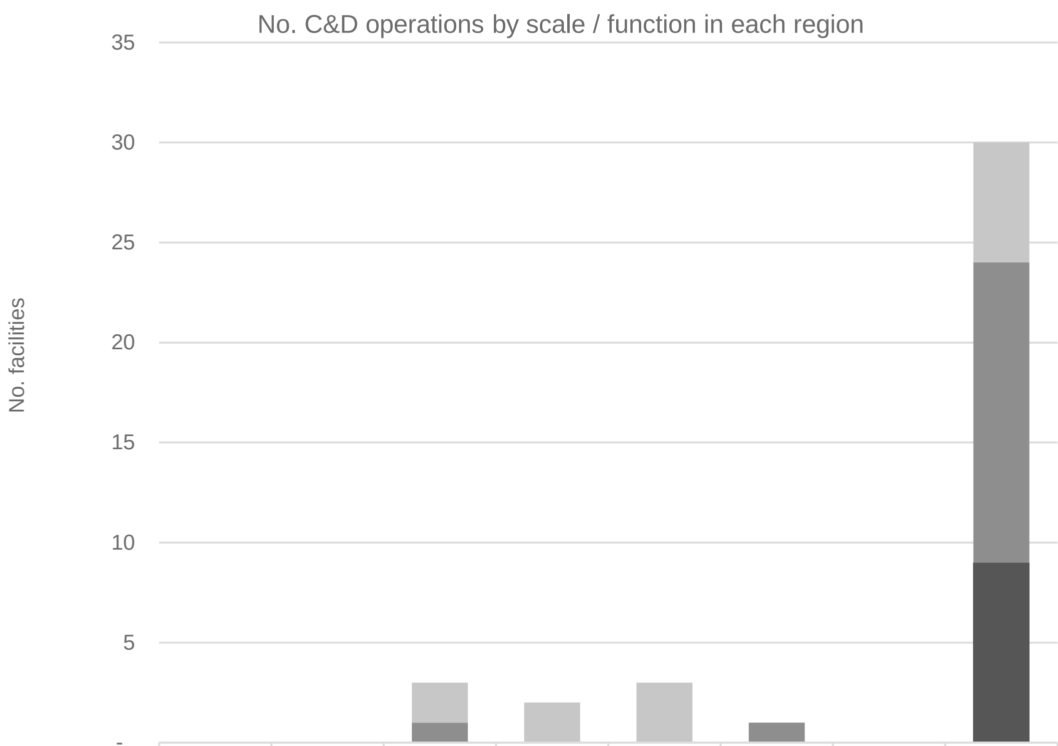
- As noted in 4.5.5 above, there are two large metal reprocessors in Brisbane which together process in excess of 80% of the metals collected in Queensland, into higher value smelter-ready feedstocks.

These facilities already play a significant role in supporting a circular economy in Queensland and are well aligned with the objectives of the Strategy and this Report to provide domestic capacity to reprocessing recyclable materials into high value commodities or products.

4.5.4 C&D Recycling

The majority of the state's existing C&D recycling capacity is located in SEQ, which is home to around 30 identified facilities of varying scales. The total estimated capacity of existing C&D recycling facilities in SEQ is around 5 million tonnes per annum, which is more than double the volume that was estimated to be recycled in the region in 2017-18. The apparent excess capacity likely reflects the high degree of flexibility that these facilities have, to respond to growing volumes and fluctuations that are common in the construction market.

C&D recycling capacity outside of SEQ is far more limited, although it is noted that a number of councils undertake varying levels of recycling of concrete and soils at landfill and transfer station facilities, as do some regional private inert landfill operators. There were no private, dedicated C&D recycling facilities identified in the Cairns and Wide Bay regions, or in Remote Queensland. Other regions have small numbers of facilities but with much smaller volumes available, it is more difficult to justify investment in processing equipment and challenging to find secure markets for the outputs.



	Remote Qld	Cairns	Darling Downs - Maranoa	Fitzroy	Mackay	Townsville	Wide Bay	SE Qld
C&D recycler - small	-	-	2	2	3	-	-	6
C&D recycler - medium	-	-	1	-	-	1	-	15
C&D recycler - large	-	-	-	-	-	-	-	9

Figure 23: Summary of C&D recycling facilities by number per region (excluding C&D transfer stations and depots)

Table 17: Summary of C&D recycling facilities - number and capacity by region

Region	No. dedicated C&D recycling facilities	Total C&D recycling capacity (tpa)
Remote Qld	-	-
Cairns	-	-
Darling Downs - Maranoa	3	100,000
Fitzroy	2	20,000
Mackay	3	50,000
Townsville	1	30,000
Wide Bay	-	-
SE Qld	30	4,970,000
Totals	**39**	**5,170,000**

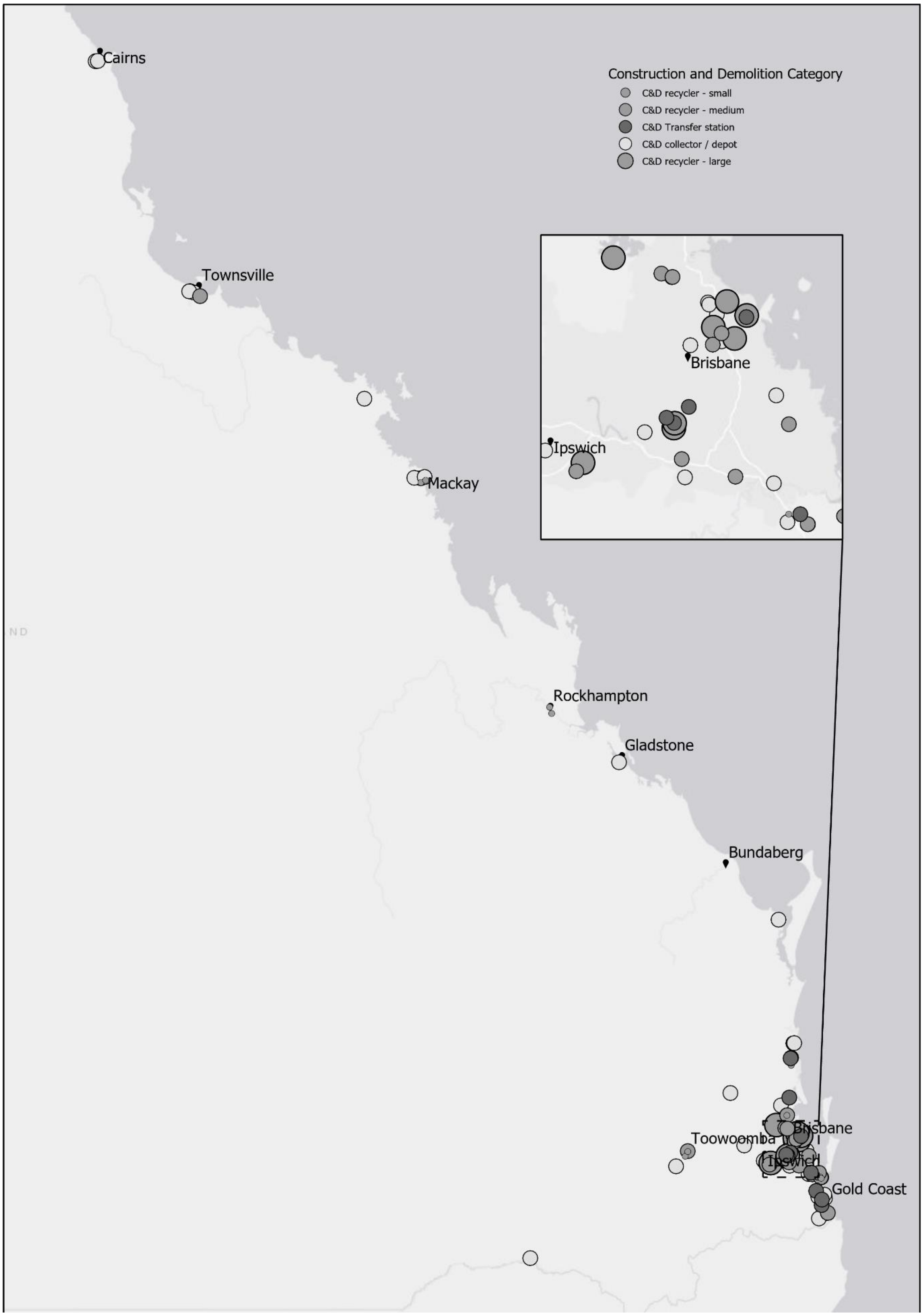


Figure 24: Statewide map of C&D recycling and transfer facilities

4.5.5 Metals recovery

Scrap metals are typically collected via networks of scrap metal yards of varying scales across the state as well as through council transfer stations and separate collections direct from commercial generators. Recycling facilities such as MRFs and C&D recyclers also recover metals. Scrap metal consolidation facilities are those sites that buy and receive metals from a range of sources and prepare them for sale onto a reprocessor, including some level of sorting by metal type and basic consolidation such as shearing, crushing or baling.

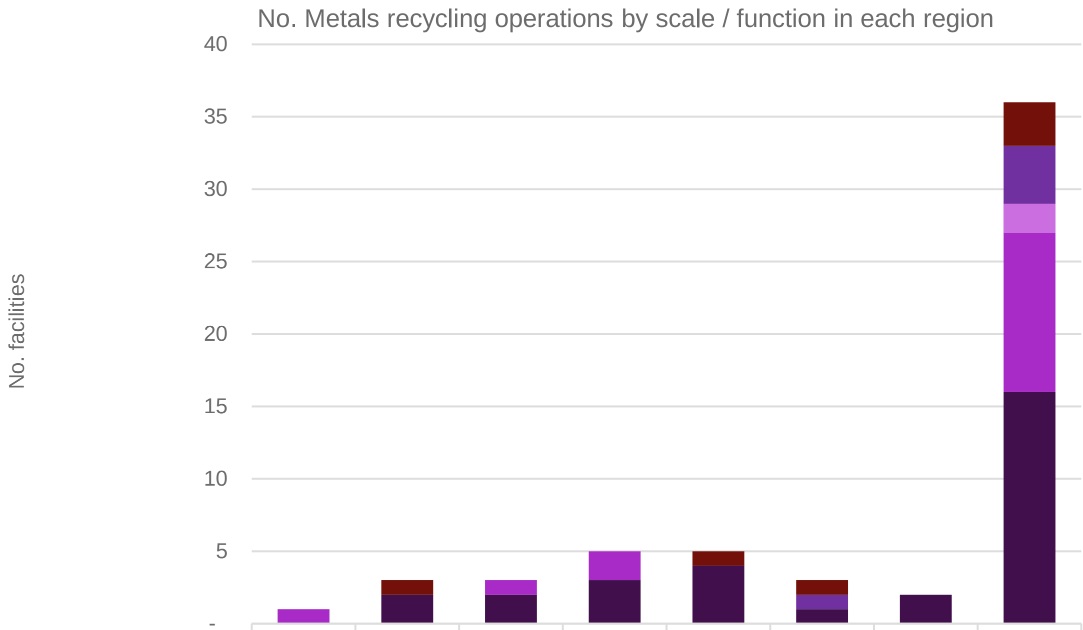
Scrap metal consolidation facilities have been classified in Figure 25 and Figure 26 below, where small facilities receive less than 10,000 tonnes per annum and large facilities receive more than 10,000 tonnes. It shows that there is a good distribution of small facilities and a few larger ones, across all regions, which is a reflection of the high value of metals which means that it is viable to recycle, even in regional areas where the volumes may be smaller.

Some scrap metal consolidation facilities bale the material and export it directly for further processing overseas. The majority of metals collected in Queensland (over 80%) are sent to one of two large metal shredding, or fragmentising, facilities which are the Sims Metal facility in Rocklea or the Infrabuild Recycling (formerly Liberty OneSteel) in Hemmant. At those facilities, the metal is shredded into small particle size and screened of contaminants to produce a higher value product which is ready to be sent to smelters, either interstate or overseas. Such metal shredding plants are high capital investment, high operating cost facilities and therefore need to attract high volumes of metal (several hundred thousand tonnes every year) to be viable.

Battery and e-waste recycling facilities have also been included in this category (and the figures below), as they primarily target recovery of the valuable metals from batteries and e-waste. A number of scrap metal collectors / consolidators also receive and consolidate batteries for recycling.

There will be other small scrap metal yards and similar operations which are not licensed or reporting to DES and therefore not captured in the data below.

It is difficult to quantify the capacity of existing metal recycling facilities, including battery and e-waste facilities, as very responded to the data survey with that information. In reality, the capacity of such facilities is likely to be somewhat flexible and they should be capable (within reasonable limitations) of growing to respond to any market growth.



	Remote Qld	Cairns	Darling Downs - Maranoa	Fitzroy	Mackay	Townsville	Wide Bay	SE Qld
E-waste recycling	-	1	-	-	1	1	-	3
Battery recycler	-	-	-	-	-	1	-	4
Metal reprocessing / shredding	-	-	-	-	-	-	-	2
Scrap metal consolidation - large	1	-	1	2	-	-	-	11
Scrap metal consolidation - small	-	2	2	3	4	1	2	16

Figure 25: Summary of metal, battery and e-waste recycling facilities by number of facilities

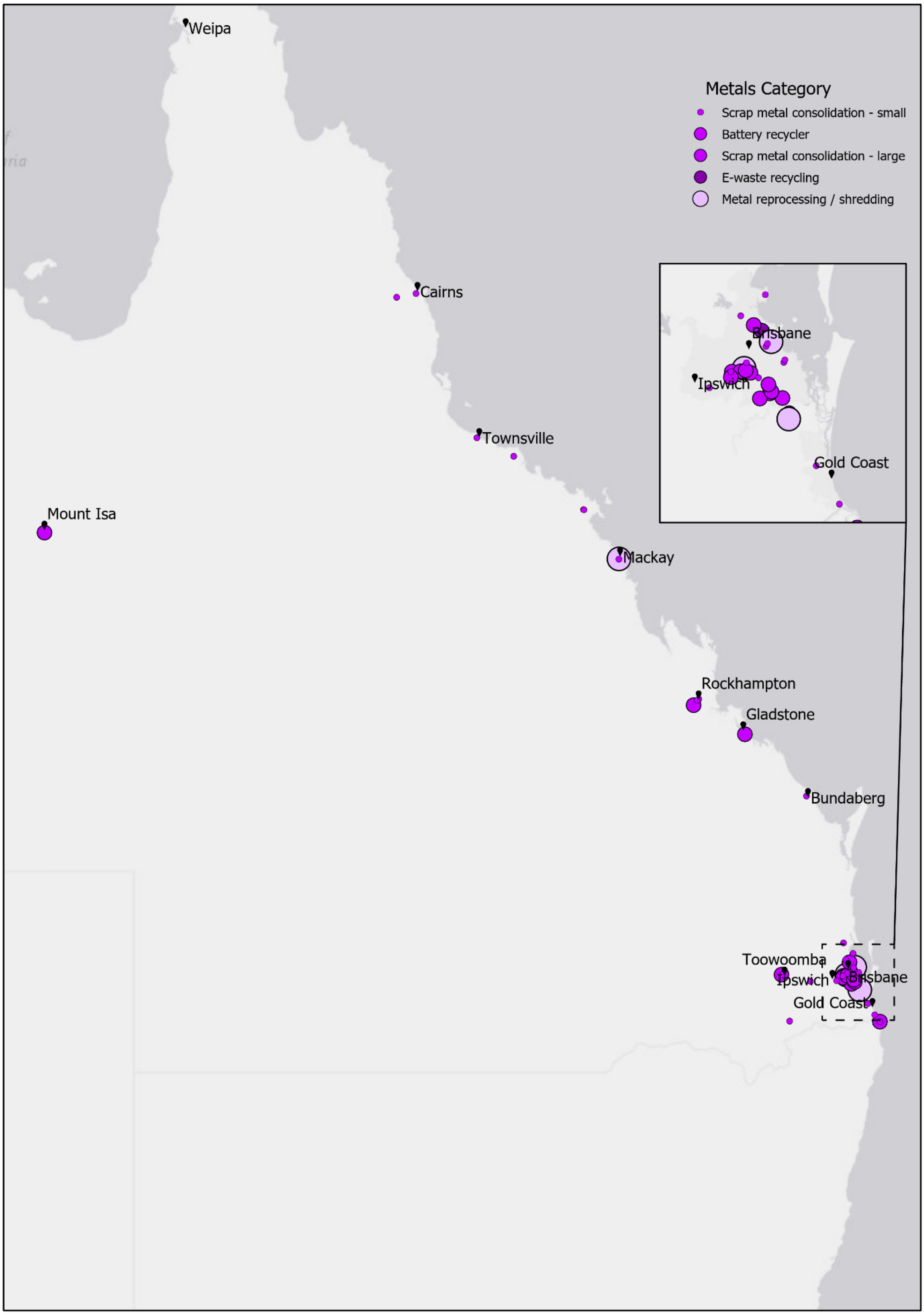


Figure 26: Statewide map of metal, battery and e-waste recycling facilities

4.5.6 Chemicals, oils and regulated waste

There are a number of facilities across the state which receive and process a range of regulated wastes to either recovery resources or to provide treatment to allow safe disposal. These facilities include:

- A number of facilities (10 identified), mostly in SEQ, which receive and recover vegetable oils and/or greasetrap waste through various means.
- A further 10 facilities of varying scales and sophistication, which receive and process mineral oils (such as waste lubrication oil) either for reprocessing back into oils, or for use as fuel. In addition, the Northern Oil refinery in Gladstone plays a key role in reprocessing a significant proportion of waste oil collected in Queensland and elsewhere. However, DES data indicates that a significant proportion of waste mineral oils are exported overseas, where they are likely used as low grade bunker fuel, which is a lower order recovery solution compared to domestic reprocessing back into a usable oil product.
- Three facilities which process paints, solvents and other chemicals to stabilise them for disposal or use them as fuel (for example in the Gladstone cement kiln).
- Two facilities which employ high temperature incineration to dispose of hazardous wastes – one which targets mostly clinical and oily waste, and another which targets highly toxic chemicals that cannot be treated in any other way.

The facility locations are shown in Figure 27 below.

Figure 27: Statewide map of chemical, oil and regulated waste facilities

4.5.7 Tyre reprocessing

Six facilities have been identified as focused on reprocessing tyres and other rubber into higher value products. Four of those facilities utilise mechanical processing to produce a range of rubber crumb and granule products from tyres, whilst recoverin the steel for recycling. A further two facilities are using innovative thermal processing technologies to recover liquid fuels and other products from tyres, both of which are ramping up to full scale commercial operations. For example, the Pearl Global facility at Stapylton (Gold Coast) uses its thermal desorption technology to convert tyre rubber into liquid hydrocarbons and carbon char, whilst recovering the steel[21].

All six of the reprocessing facilities are in SEQ, which means that recycling tyres in regional and remote areas is a challenge, requiring the tyres to be transported to SEQ at high cost. At least nine tyre consolidators were also identified, including four outside of SEQ, which collect and aggregate tyres and in some cases bale them, to either transport to SEQ for recycling or export directly as tyre derived fuel.

Table 18: Summary of tyre recycling facilities by type

Facility Type	Number sites
Tyre consolidation	9
Tyre reprocessing - mechanical	4
Tyre reprocessing - thermal	2
Total	**15**

[21] http://wastemanagementreview.com.au/tag/pearl-global/

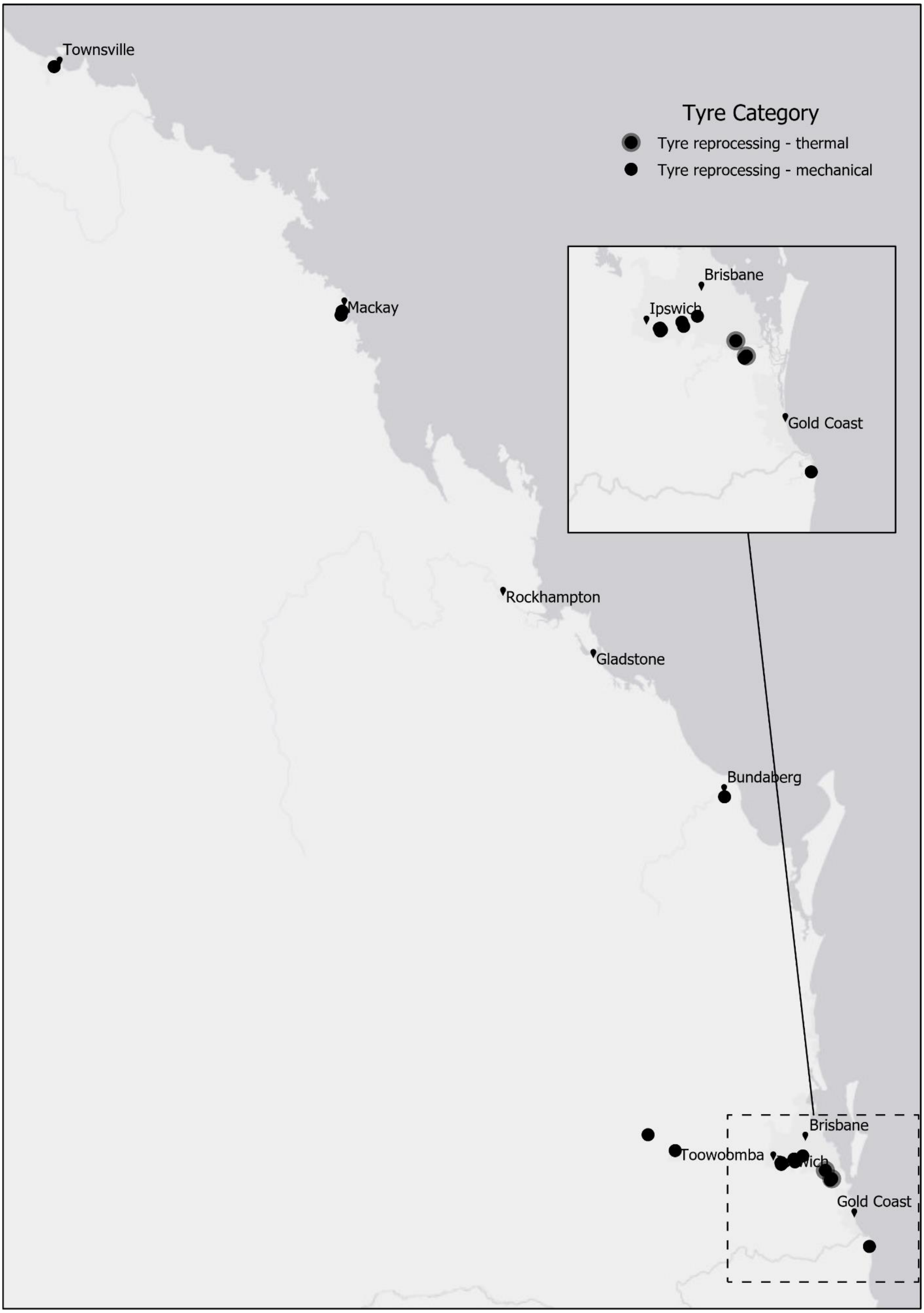


Figure 28: Statewide map of tyre recycling facilities

4.6 Organics processing infrastructure

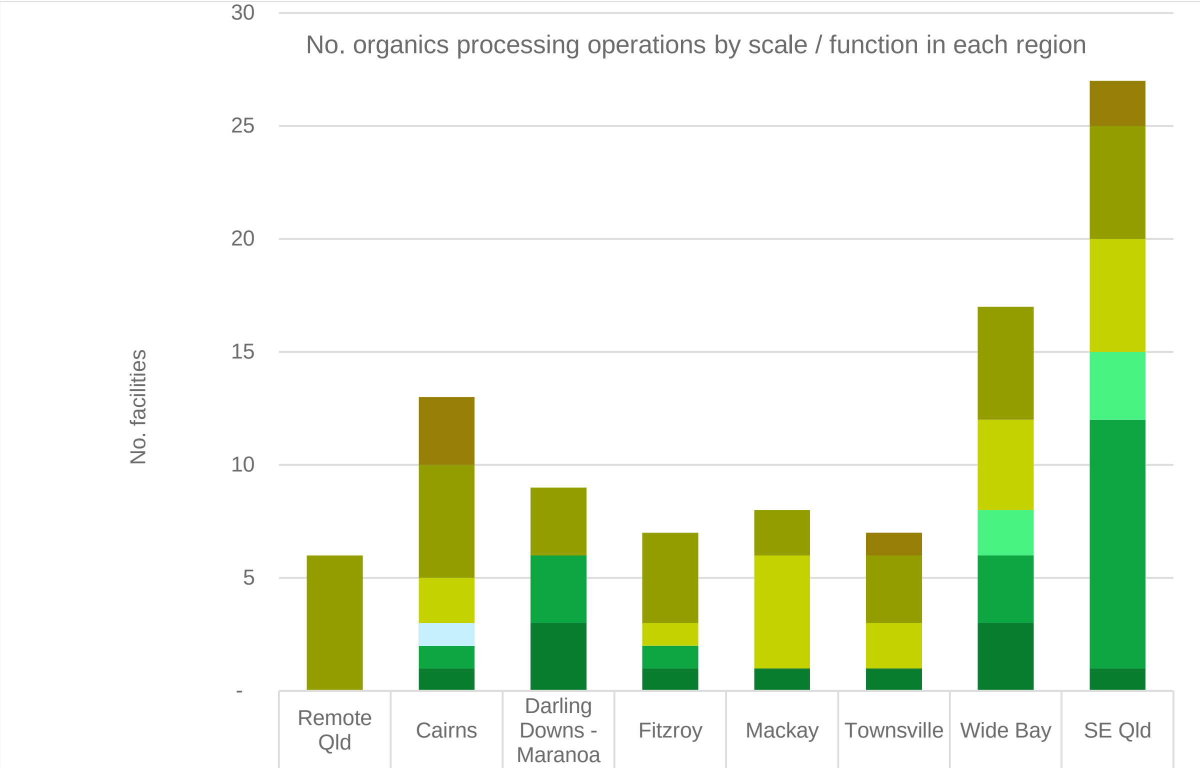
Queensland has a strong organics recovery sector, recovering a range of materials including green waste, food waste, food processing waste, other commercial and industrial organic residues, and a range of liquid waste streams such as grease-trap waste. Some composting facilities also blend in a range of inorganic materials such as coal ash and drilling muds, providing for beneficial reuse of those streams.

Around 80% of council landfills and around half of council transfer stations surveyed, receive and separate green waste for recovery. Around 42% of councils reported that they mulch green waste on site, with most councils either using it for internal works such as slope stabilisation or daily cover at landfill sites, or they sell or give it away to the community. A small number of councils give or sell their mulch to third parties for further processing, such as composters. Those councils that mulch their own green waste recovered in the order of 250,000 tonnes of green waste in 2017-18 which was around 40% of the total green waste recovered in the state.

Mulching of green waste without composting or pasteurisation is a lower order, lower value (economic and environmental) recovery pathway for this material. It diverts it from landfill which is positive, but it fails to realise the potential value of the carbon and nutrients within the green waste, which could be far more valuable and beneficial if composted into a soil conditioner product. There are exceptions and some councils have been able to find outlets for their mulch which are sustainable and make use of the nutrient value of the material. The distribution of unpasteurised mulch also presents significant biosecurity concerns, particularly in areas where invasive ant species are a concern (such as fire ants in the south east, or electric ants in the north). Hence there is a significant missed opportunity to add value to this material to use it to improve soil quality.

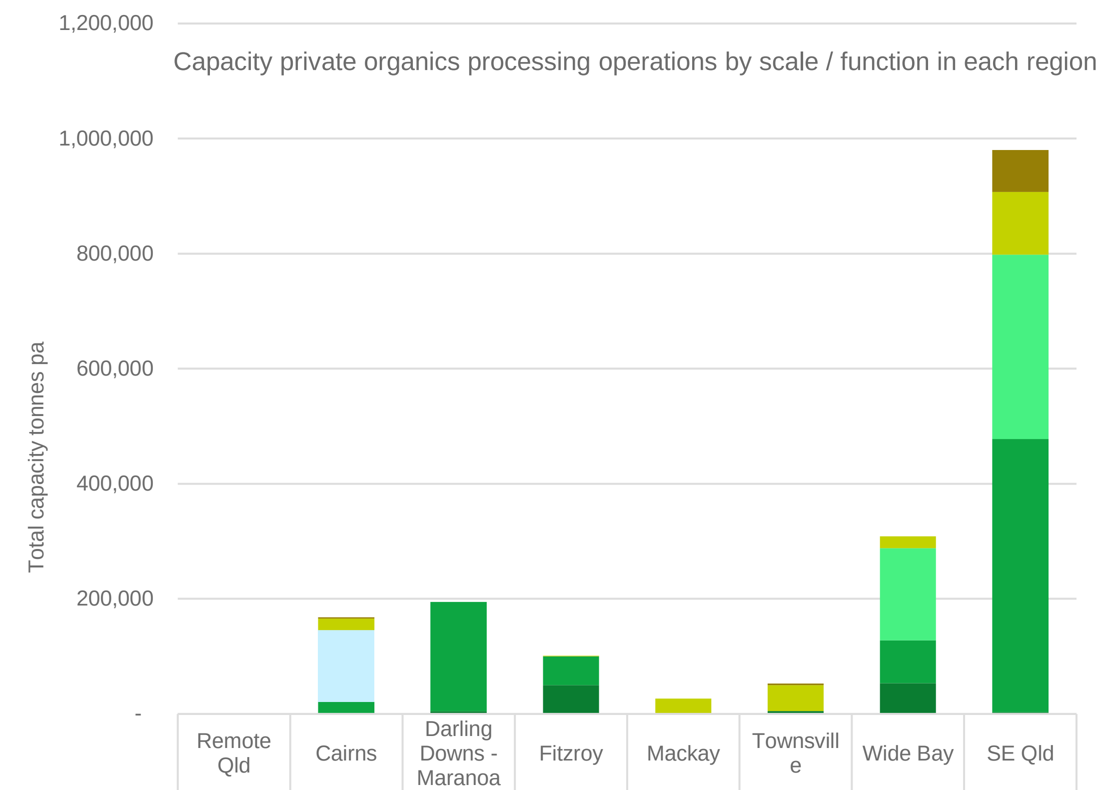
There are around 35 composting facilities of varying scales across the state that are thought to be operational and these are geographically spread across most regions. Some regions such as SEQ, Darling Downs-Maranoa and Wide Bay are well serviced with composting infrastructure. Other regions have more limited composting options and a higher reliance on mulching.

There is one existing alternate waste treatment (AWT) facility using MBT technology in Cairns, which processes kerbside MSW from Cairns, Douglas and Mareeba local government areas.



	Remote Qld	Cairns	Darling Downs - Maranoa	Fitzroy	Mackay	Townsville	Wide Bay	SE Qld
Land spreading	-	3	-	-	-	1	-	2
Mulching only - LG	6	5	3	4	2	3	5	5
Mulching only	-	2	-	1	5	2	4	5
AWT	-	1	-	-	-	-	-	-
Composting - large	-	-	-	-	-	-	2	3
Composting - medium	-	1	3	1	-	-	3	11
Composting - small	-	1	3	1	1	1	3	1

Figure 29: Statewide summary of organics processing facilities by number and type



	Remote Qld	Cairns	Darling Downs - Maranoa	Fitzroy	Mackay	Townsvill e	Wide Bay	SE Qld
Land spreading	-	2,000	-	-	-	3,000	-	73,000
Mulching only	-	20,000	-	1,000	26,500	45,000	20,500	109,100
AWT	-	125,000	-	-	-	-	-	-
Composting - large	-	-	-	-	-	-	160,000	320,000
Composting - medium	-	20,000	190,000	50,000	-	-	75,000	475,000
Composting - small	-	1,000	4,600	50,000	-	5,000	53,200	3,000

Figure 30: Statewide summary of organics processing capacity by region

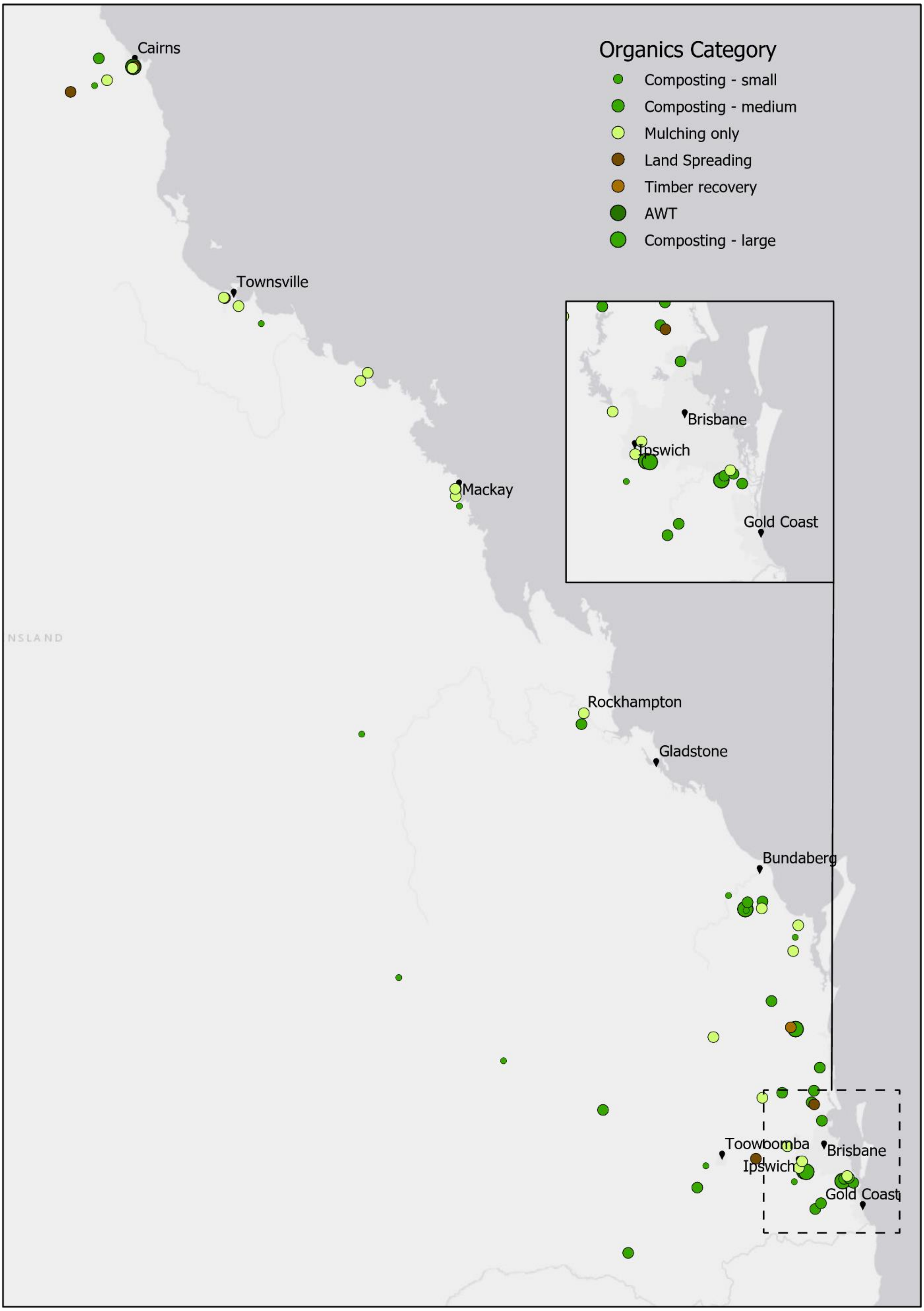


Figure 31: Statewide map of organics processing infrastructure

4.7 Energy recovery infrastructure

There is limited existing energy recovery infrastructure in Queensland but as noted above, there are existing facilities which recover energy from specific waste and biomass streams such as sugarcane waste. Such facilities are not covered in detail in this Report, as they tend to manage their own internal waste streams and play a minimal role in broader waste management networks.

One exception is the Rocky Point Green Energy facility within the Gold Coast local government area which is a bioenergy facility co-located with the Rocky Point sugar mill. Unlike other sugar mill-based energy facilities, the plant supplements sugarcane residue fuels with green waste and timber waste sourced from across the SEQ region. The Rocky Point facility has in the past, received a significant proportion of council green waste from SEQ councils and played a significant role in the management of that stream. In recent times, the facility has suffered technical issues which have limited its ability to receive wastes on a regular basis.

4.8 Disposal infrastructure

Landfill currently plays a major role in managing waste across Queensland and will remain an important part of the waste management system throughout the duration of the forward projection period of this Report (to 2050). They will continue to provide a disposal pathway for residual wastes which cannot be viably recovered and they provide the ultimate back-stop if the state is ultimately unsuccessful in achieving the ambitious waste avoidance and recovery targets set out in the Strategy.

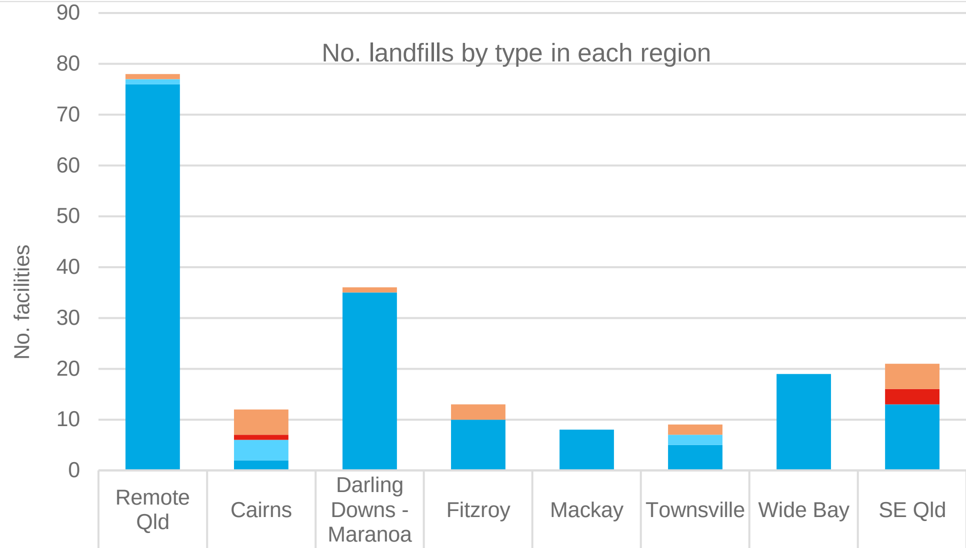
Analysis to support this Report has identified 196 active landfills of varying scales across the state. This ranges from small remote landfills with very basic containment receiving a few hundred tonnes of waste a year, through to massive landfills in SEQ receiving several hundred thousand tonnes per annum and one which received over a million tonnes.

The vast majority of landfills are council-owned (175) and the majority of those (168) are able to receive putrescible waste, as they are primarily intended to provide disposal of MSW. Seven council landfills have been classified as inert-only, most of which are in the Cairns region where the wet tropic climate and sensitive environment means that there are much tighter controls on where putrescible landfills can be located.

Over the last three years, the number of landfills has reduced by 13% from 226 (in 2016). The largest reduction in landfills has occurred in the Darling Downs-Maranoa region, reducing from 53 active landfills three years ago, down to 36 presently. This is due to a concerted effort by councils in that region to rationalise small rural landfills and replace them with transfer stations, and some councils are still in the midst of a longer term rationalisation program. In general, it was apparent from consultation with councils that a significant number of small landfills have been closed or are planning to close in the coming years, as part of rationalisation efforts. This is occurring in the absence of either pressure or support from the state government. In some cases, it is based on financial considerations, balancing the cost inefficiencies of operating multiple small landfill sites and provisioning for future closure liabilities. In other cases, councils are making a conscious effort to reduce the environmental impacts of landfills, by closing small sites and consolidating waste to one or two larger, better engineered sites, even though there is a significant cost impact on councils, including ongoing transport costs where a transfer station replaces a landfill.

In some regions, such as SEQ and Cairns, privately owned landfills play a significant role in regional waste management. In other regions, councils are the main providers of landfill capacity for both municipal and commercial wastes, other than inert landfills in some locations which receive C&D waste.

Figure 32 below shows the number of landfills in each region, split council and private ownership, as well putrescible versus inert-only. The inert-only landfills, while small in number, play an important role in conserving airspace in putrescible landfills, which are typically more expensive to run and very difficult to replace.



	Remote Qld	Cairns	Darling Downs - Maranoa	Fitzroy	Mackay	Townsville	Wide Bay	SE Qld
Private Inert Landfills	1	5	1	3	0	2	0	5
Private Putrescible Landfills	0	1	0	0	0	0	0	3
Council Inert Landfills	1	4	0	0	0	2	0	0
Council Putrescible Landfills	76	2	35	10	8	5	19	13

Figure 32: Statewide summary of landfill numbers by type and ownership

Landfills have also been categorised according to their scale (based on recent annual inputs) as noted in Table 13 above. This is summarised in Table 19 below and Figure 33 following. The data shows that the majority (60%) of the 196 landfills in Queensland are very small – receiving less than 2,000 tonnes per year, and the majority of those are in the Remote Queensland region. Councils in that region and other remote parts of the state face unique challenges in providing waste management services to their communities given the vast distances between communities. There may be opportunities for some rationalisation, but from an economic perspective, closing some of these landfills and replacing them with transfer stations is simply not a practical option. The future focus for those sites, should be on diverting as much putrescible and hazardous waste from landfill as possible, and improving the environmental management standards at the landfills.

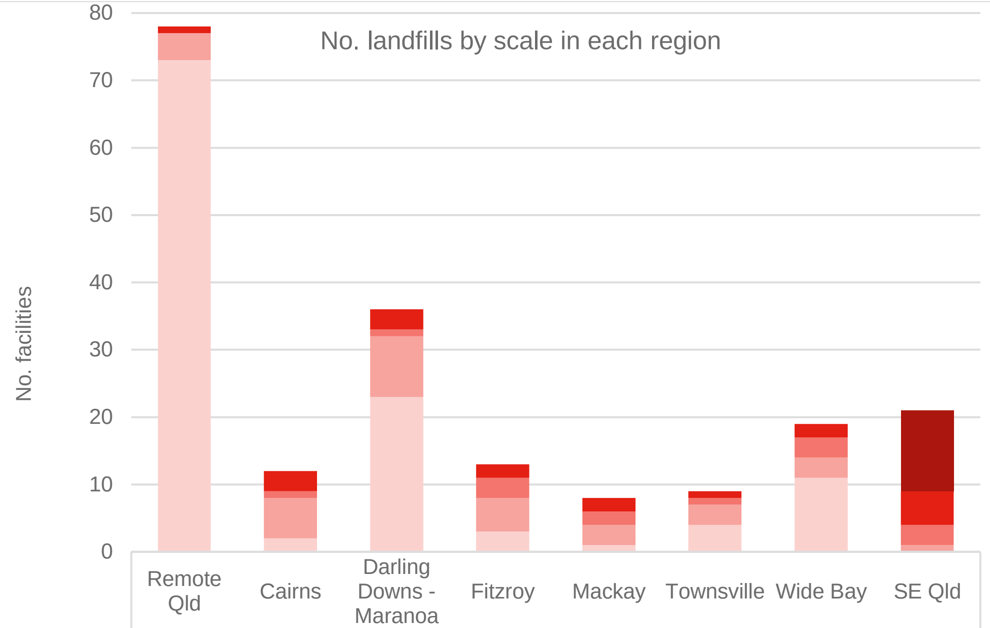
There are 12 landfills receiving more than 100,000 tonnes per annum and classified as very large, which are all located in SEQ. Seven of those landfills are privately owned, but councils in that region also operate some very large facilities.

The number of landfills across the state will continue to decline. Future capacity is discussed in further detail in in the regional profiles in section 6. However, data from landfill operators indicates that more than 50 sites are scheduled to close by 2025 (based on current inputs).

Table 19: Summary of landfills by scale

Scale Category	Annual tonnes to landfill*	Number LG landfill sites	Number Private landfill sites	% by number
Very Small / Remote	< 2,000	115	2	60%
Small	2,000 to 10,000	26	8	17%
Medium	10,000 to 25,000	13	1	7%
Large	25,000 to 100,000	16	3	10%
Very Large	> 100,000	5	7	6%
Total		**175**	**21**	**100%**

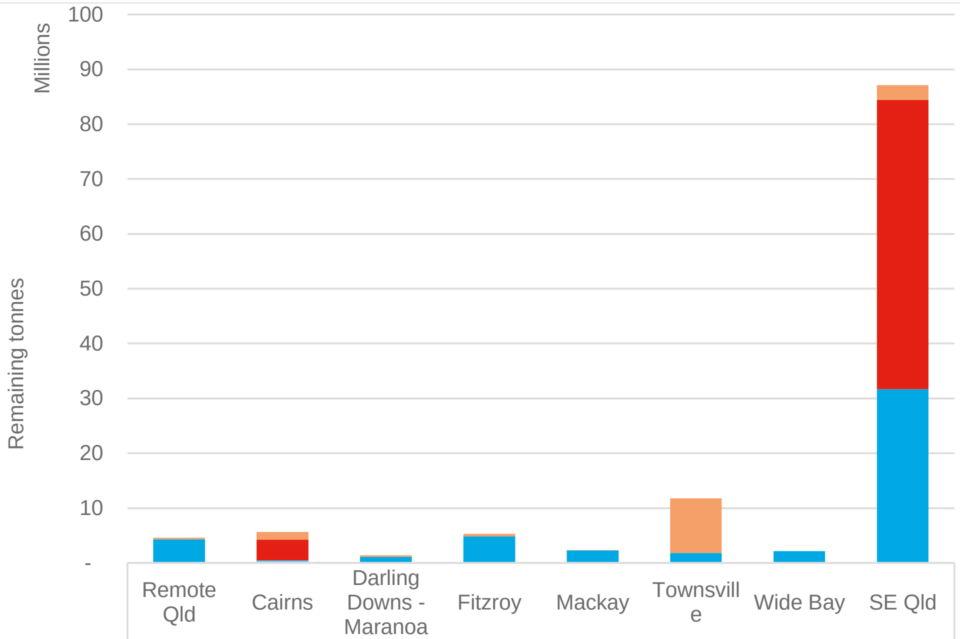
** Based on 2017-18 total tonnes waste to landfill and Arcadis estimates for smaller sites that did not report*



	Remote Qld	Cairns	Darling Downs - Maranoa	Fitzroy	Mackay	Townsville	Wide Bay	SE Qld
Very Large	0	0	0	0	0	0	0	12
Large	1	3	3	2	2	1	2	5
Medium	0	1	1	3	2	1	3	3
Small	4	6	9	5	3	3	3	1
Very Small / Remote	73	2	23	3	1	4	11	0

Figure 33: Statewide summary of landfill numbers by scale

Based on the estimate of existing remaining landfill capacity (as at July 2019) from operators and excluding the ‘very small’ landfills, Figure 34 below summarises the current approved capacity in each region by landfill type and ownership.



	Remote Qld	Cairns	Darling Downs - Maranoa	Fitzroy	Mackay	Townsville	Wide Bay	SE Qld
Private Inert Landfills	277,000	1,400,000	300,000	450,255	20,000	10,000,000	-	2,637,342
Private Putrescible Landfills	-	3,800,000	-	-	-	-	-	52,800,000
Council Inert Landfills	-	451,465	-	-	-	-	-	-
Council Putrescible Landfills	4,312,845	23,452	1,084,413	4,837,434	2,291,429	1,779,704	2,160,008	31,657,539

Figure 34: Statewide summary of landfill remaining capacities, by type and ownership

4.8.1 Putrescible landfill capacity

Table 20 below provides an overview the putrescible landfill capacity within each region. Across the state, there is approved capacity for an estimated 105 million tonnes of putrescible and general waste to be disposed. Around 80% of that capacity, or 84 million tonnes, is in SEQ. The Darling Downs-Maranoa region has the lowest overall stock of landfill capacity of any region, with just over 1 million tonnes remaining.

Across the state, landfill operators have identified an additional 27 million tonnes of capacity at existing sites that is not approved, but potentially developable. Finding appropriate sites for a new landfill, particularly a putrescible landfill, is a significant challenge so it is important to maximise the usage of existing sites where appropriate. For example, a number of councils have been able to extend the lifespan of their primary landfills by building vertical expansions on existing landfills (i.e. piggy-back cells) which have a number of environmental benefits over developing new landfills.

The base case projections as presented in section 3 suggest that over the next three decades to 2050, some 30 million tonnes of residual MSW and 25 million tonnes of residual C&I waste will be disposed to landfill. Some 38 million tonnes of residual C&D waste will also go to landfill, split between inert-only and putrescible facilities. As such, there would seem to be sufficient capacity at the state level if the Strategy targets are achieved, but this high level view has the potential to mask gaps in some regions or local areas which are discussed in the regional profiles in section 6.

In the low recovery scenario, where much greater volumes of waste are assumed to be landfilled, the statewide assessment suggests a shortage of landfill capacity beyond 2035. This highlights that there may be a need to develop new landfill capacity in some regions if the Strategy targets are not met, and challenges and costs of doing this will need to be weighed against the changes and infrastructure needed to achieve the targets.

Table 20: Summary of putrescible landfill capacity by region

Region	Current approved airspace capacity (‘000s tonnes)	Potential future capacity (unapproved) (‘000s tonnes)
Remote Qld	4,590	Insufficient data
Cairns	4,275	3,000
Darling Downs - Maranoa	1,084	435
Fitzroy	4,837	120
Mackay	2,291	5,687
Townsville	1,780	5,981
Wide Bay	2,160	325
SE Qld	84,458	11,202
Queensland (statewide)	**105,475**	**26,750**

4.8.2 Inert landfill capacity

With respect to inert-only landfills, the estimated capacity across the state is around 15 million tonnes (Table 21), however a significant proportion of that capacity is in one facility in the Townsville region and has not been independently verified. A further 16 million tonnes of additional capacity could potentially be developed across existing sites in SEQ, subject to approvals and a number of facilities are in the process of seeking approval for expansions.

Given some 38 million tonnes of C&D waste will be disposed to landfill across the state over the next three decades, the inert capacity will not be sufficient over this period and there is a mis-match between where the C&D waste is generated (mostly SEQ) and where most of the inert landfill capacity is located. As discussed further in section 6, there are significant capacity shortages for inert landfill in some regions.

If additional capacity is not developed, the result will be that putrescible landfill capacity will be consumed by C&D waste, which is factored into the capacity assessment for each region.

Table 21: Summary of inert landfill capacity by region

Region	Current approved airspace capacity ('000s tonnes)	Potential future capacity (unapproved) ('000s tonnes)
Remote Qld	-	-
Cairns	1,400	-
Darling Downs - Maranoa	300	-
Fitzroy	450	-
Mackay	20	-
Townsville	10,000	-
Wide Bay	-	-
SE Qld	2,637	15,770
Queensland (statewide)	**14,808**	**15,770**

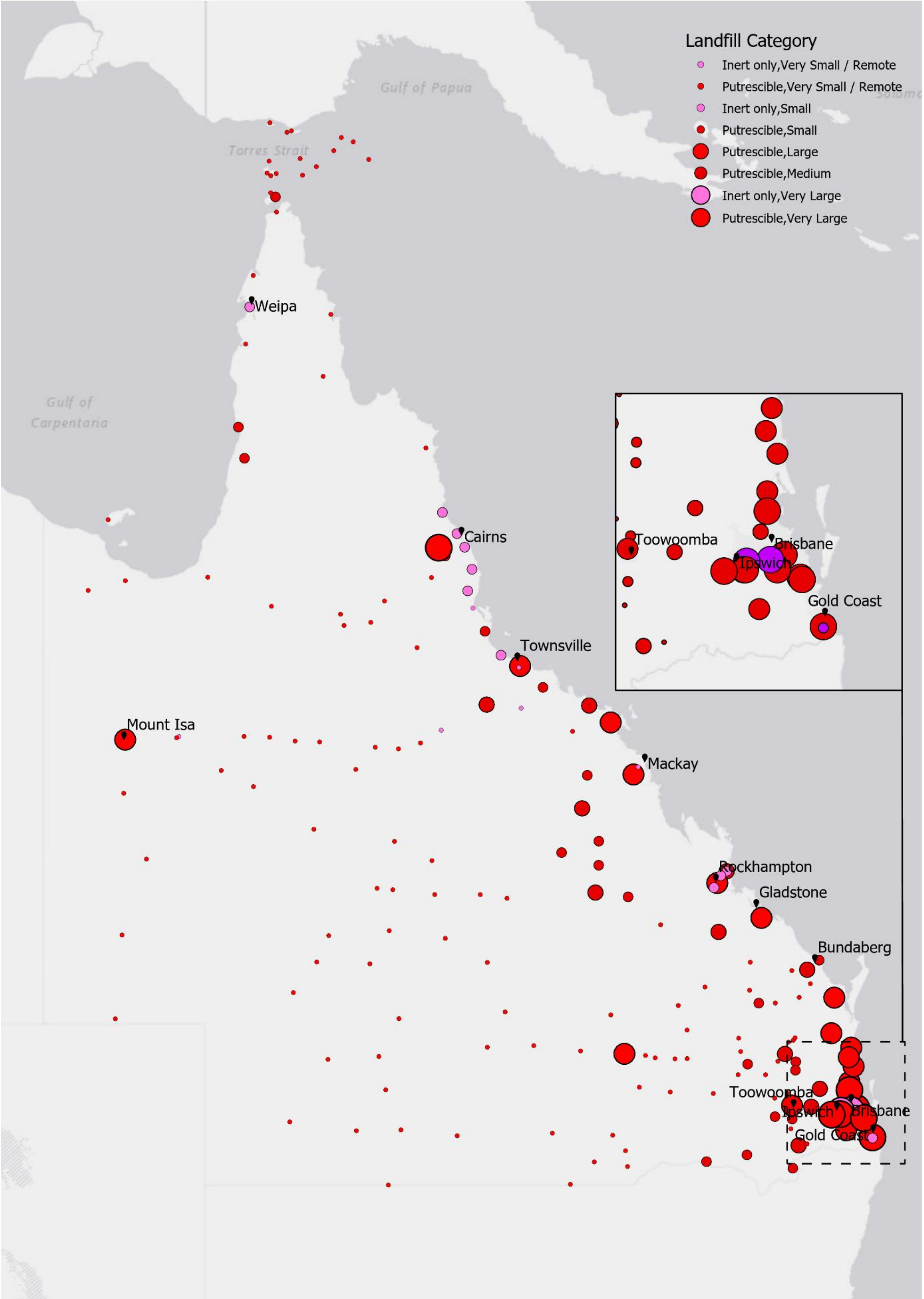


Figure 35: Statewide map of landfill infrastructure

5 FUTURE INFRASTRUCTURE OPPORTUNITIES

This section provides a qualitative discussion around the likely future infrastructure mix and opportunities by region type, based on consultation feedback, analysis of industry trends in other jurisdictions and assessment of the key opportunities evident from the materials currently being landfilled as discussed in section 0.

This Report is 'technology agnostic' – i.e. no particular technology solutions will be promoted over others and it will remain up to industry to determine the appropriate future mix of technological solutions that are required and viable. Any resource recovery solution which is technically and commercially viable and able to be delivered without adverse impacts on the environment and the community, is likely to be appropriate. However, it is important to understand the types of solutions and infrastructure that may be developed and which may be viable and appropriate in the Queensland context, in order to appropriately plan ahead for such infrastructure.

5.1 Potential future infrastructure mix

This section provides an overview of the types of infrastructure and solutions that may be developed in the future to address priority streams, based on an analysis of trends both globally and in other Australian jurisdictions, but also the government's insight into the types of projects that industry wants to invest in and considers to be viable, through its various industry engagement and support functions.

5.1.1 Recycling and reprocessing of packaging materials

To support a transition towards a circular economy and to mitigate against volatility in global markets, there needs to be ongoing investment in domestic reprocessing infrastructure which adds value to the materials that are recovered in MRFs, through the CRS and through other source separated recycling systems.

MRFs may need to be updated to improve the quality of outputs, or supplemented by separate beneficiation facilities which can take a mixed paper or mixed plastic stream and separate it into higher value, clean materials.

Reprocessing of plastics that have been separated by polymer type is relatively straight forward with existing technologies and there are a number of facilities in SEQ already doing. Operations including washing, flaking and/or pelletising the plastics to produce a manufacturing-ready feedstock.

For glass, the preferred option is to remanufacture recovered glass back into new glass containers which is currently done in Brisbane at the Owens-Illinois factory in South Brisbane. However the domestic production of glass bottles is limited by market constraints and for glass which unsuitable or excess to the capacity of that facility, other lower value recycling options need to be considered. There are a number of facilities across the state, including a number of regional MRFs, which are already crushing and washing glass for use as a sand or aggregate replacement with varying levels of success. For example, Brisbane City Council has been using recovered glass sand in its road construction for many years, while in Townsville a manufacturer of precast concrete blocks is now using a portion of recovered glass sand in its products. Further work is needed to establish broader market demand for these products, including modification of relevant engineering specifications, as well as investment in appropriate reprocessing equipment.

Reprocessing of paper and cardboard is more challenging and an aspect which needs to be further assessed, given fibre makes up around half of the kerbside recycling stream and the majority of commercial packaging. There is an existing recovered paper mill in Brisbane which makes a significant contribution to reprocessing paper and cardboard recovered in Queensland but its capacity is limited and significant volumes are still exported. Developing new capacity to reprocessing paper and cardboard will require a significant capital investment which needs to be led by the private sector, considering all the relevant market and commercial factors. The Government may be able to support such a project, but ultimately it will be determined by the market.

Reprocessing of metals is generally well catered for in Queensland. The majority of processed metal is exported, which is due to the simple fact that there are no smelters in Queensland which can process that material and that is unlikely to change in the foreseeable future, given the cost advantages that overseas smelters have.

5.1.2 Organics recovery

The Strategy identifies organics as a priority stream that has significant potential for improved recovery to contribute towards the recovery targets. Both household and commercial organics remain somewhat untapped as potential resources, as noted above.

The organics recovery sector in Queensland is well established and makes a significant contribution to existing resource recovery performance, accounting for almost 30% of total recovery in 2017-18 (of headline wastes). There is scope to do more, whether that be increasing organics processing capacity in regions where it is currently limited; adding value to organics which are currently diverted with minimal processing (e.g. unpasteurised green waste mulch, biosolids or manures spread directly on land); or shifting towards more advanced processing methods that are capable of processing a wider range of organic wastes and producing more diverse products (including energy).

Queensland’s existing organics processing infrastructure predominantly utilises open windrow composting technology which is a low tech, low cost approach that is suitable for converting a wide range of organic wastes into valuable compost products. However it can be problematic when processing highly odorous and putrescible wastes, particularly if the facility is in close proximity to sensitive receptors such as residential properties or when residential development is allowed to encroach on existing facilities, as has been the case for some sites.

There have been well publicised episodes of odour from Queensland composting facilities impacting on local communities, leading to a decline in the social license to operate for those particular operators within their communities, and for the industry more broadly. While these issues are complex, involving a range of factors across land use planning conflicts, regulatory challenges and operational management – the composting industry in Queensland generally accepts that it needs to operate to a high standard and in some cases, invest in new approaches, to restore and regain community confidence that organics can be recovered without adversely impacting on local communities.

Investment in more advanced processing systems has generally been constrained by market dynamics, with Queensland composting facilities receiving relatively low gate fees for feedstock (compared to other markets) and low prices for compost outputs that do not necessarily reflect the nutrient and beneficial value of the product (although there are exceptions).

Nevertheless, there is an appetite amongst existing operators and/or new entrants to invest in technologies such as in-vessel or covered composting, or anaerobic digestion. At the time of writing, a tunnel composting facility was under construction in the northern Gold Coast region and other operators are assessing options. Open windrow composting may continue to be an appropriate solution in rural and regional areas where the facility is adequately separated from sensitive receptors, but near urban areas, enclosed processing is likely to be required for more odorous streams such as food waste.

There is also significant interest in the broader use of anaerobic digestion to process organics. Wet AD systems can be applied to process high moisture materials such as separated food organics, biosolids, manures and food processing residues. Dry AD technologies also offer the potential to recovery energy from garden organics which is mixed with food, as may be collected through a kerbside FOGO collection system.

There are existing wet AD facilities at some sewage treatment facilities which may have potential to co-process other organics. Otherwise, there could be opportunities to establish new facilities to co-process a range of wet organics and supply energy, potentially within a resource recovery precinct or co-located with a high energy user. Biogas from AD is able to be upgraded with existing technologies for use in natural gas fuelled vehicles, injection of renewable methane into gas grids or further processing into fuels or hydrogen.

Expanding the recovery of organics must consider the end markets for the compost and other recovered products. Significant work is needed to develop new markets. In SEQ for example, most of the existing compost that is made goes into bulk urban landscaping markets but these are thought to be approaching saturation and other outlets are needed to support expansion of the industry. There is significant potential to use more compost in agricultural markets and there are several successful case studies where compost has been used successfully, particularly in horticulture applications. Along the eastern seaboard in the northern half of the state, compost use in agriculture has the potential to reduce nutrient and sedminent runoff blamed on chemical fertiliser use and declining soil quality.

Other future trends in organics recovery including the use of commercial insect farming (for example, Black Soldier Fly larvae) which has the potential to produce valuable protein meal as well as soil conditioners.

5.1.3 C&D recycling

The recovery of C&D waste in Queensland has generally hovered around 50% in recent years which lags behind other states. The proportion that is recovered is mostly confined to easily extractable materials such as source separated concrete or high value materials such as scrap metal. The recovery of C&D stream is expected to grow rapidly in response to the landfill levy due to a number of factors:

- In some parts of the state including SEQ, inert landfill has been available to the construction sector at relatively low cost which has been a barrier to investment in, or demand for, recovery facilities for C&D waste. In some cases, the levy will result in a three- or four-fold increase in landfill disposal costs for C&D waste which provides a strong incentive for the sector to recover as much as possible.
- A large proportion of the stream is relatively easy to recover (e.g. soils, concrete and other masonry products), particularly if it can be separated at the source. The equipment is commonly available and often mobile plant that can be used in outdoor processing facilities (e.g. screens and crushers) which minimises the required investment.
- The recovered products have broad applications and while some market development will be needed, there is significant potential demand for secondary aggregates to be used in roads and construction projects.

This is evident in the much higher recovery rates for this stream reported by other states which have had a landfill levy in place for some time and where the use of recovered aggregates and soil is commonplace.

In the near term, it is expected that construction and demolition contractors will be more diligent in separating soils and masonry materials on site and sending them to recycling facilities. The waste industry is expected to respond to the increased demand for recycling services by increasing throughput at existing facilities and establishing new recycling facilities utilising mobile processing plant. It is also possible that builders and contractors will look for opportunities to source separate other materials on site, such as plasterboard, metals, timber, styrofoam and packaging plastic. This in turn will lead to demand for new or expanded sorting, consolidation and reprocessing infrastructure for those materials.

In the medium to longer term, when the ‘low hanging fruit’ materials are well catered for, focus is expected to shift towards recovery of the more difficult mixed C&D waste streams, such as skip bin waste. This tends to contain a significant proportion of recoverable materials but mixed in with other difficult-to-recover materials, which requires a more advanced processing approach in order to mechanically separate out the valuable streams.

In other jurisdictions with well established landfill levies, there has been a wave of new advanced C&D processing facilities developed and in development, which are capable of processing the mixed C&D stream and recovering materials including soil, masonry, timber, metals and plastic, achieving recovery rates of up to 70-80%. Some facilities also recover a refuse derived fuel stream from the combustible fraction. That investment has been driven by a high landfill levy, reducing landfill capacity and high demand due to a boom in construction and major infrastructure projects. Therefore the technology is now well understood and it is expected that the trend will transfer to Queensland in the coming years.

5.1.4 Problem and regulated wastes

Tyre recovery is an area of particular focus for industry and some regional councils. Currently, all of the tyre recycling capacity sits within SEQ and is predominantly producing either rubber crumb products that have limited market applications, or shredded tyre-derived fuel which is mostly exported for use in overseas cement kilns. There is also a significant proportion of tyres that are landfilled in Queensland each year, as a result of the volatile and constrained markets for tyre-derived products.

For councils in many regional areas, the illegal dumping of tyres is a significant issue which is exacerbated by the high cost of sending tyres to be recycled in SEQ. It is also likely that the mining industry and other users of large, off-the-road tyres will be increasingly looking for recycling options for their waste tyres.

There has been a significant effort nationally to develop and test the use of crumb rubber from tyres in asphalt mixes for road construction with a number of successful trials interstate demonstrating that such roads are more durable and perform better than conventional asphalt mixes. Other states are now seeing investment in new asphalt mixing plants which are specifically designed to blend in crumb rubber and other recovered products such as glass sand, printer ink and film plastics. The adoption of this concept in Queensland could consume a significant proportion of waste tyres both in SEQ and regional areas. There is potential to develop new tyre reprocessing facilities or mobile crumbing plants, once this market demand is confirmed.

Given the market constraints for tyre-derived products and the volatile international markets for tyre-derived fuels, and the high energy content of tyre rubber, industry is also focusing significant attention on thermal processing and energy recovery approaches. Pyrolysis and other similar thermal decomposition processes seem well suited to processing tyres and are capable of recovering a number of potentially high value resources including oil which can be refined into fuels and other chemical products; char which has a range of uses as a fuel or high value product; combustible gas which can be used to generate power and high tensile steel which can be recycled by conventional pathways.

Queensland is home to Australia's first commercial facility processing tyres via thermal decomposition into various products, based within the Gold Coast region. Other similar projects are in varying stages of development. Such solutions have the potential to be modular and to be installed in regional areas, at relatively small scales, either as fixed or mobile plants. This could help to resolve the current high cost of transporting tyres from regional areas to SEQ by providing a local recovery option.

5.1.5 Energy recovery

Recovery of energy from various waste streams is likely to play an increasing role in waste infrastructure networks across Queensland over the coming decades and indeed achieving the Strategy recovery targets will likely require significant investment in energy-from-waste.

Energy recovery sits below reuse and recycling in the waste hierarchy and 'outside' of those options in the circular economy loop, but is still preferable to disposal by landfilling or incineration (with no energy recovery). Where it is not economically and practically viable to recycle wastes back into materials which can then re-enter the production supply chain, there is a valid and important role for energy recovery.

However, the delineation between recycling and energy recovery is not always simple or clear. Technologies such as anaerobic digestion can produce both an energy output in the form of biogas, which has many applications, as well as nutrient rich digestate (both solid and liquid) which can be recycled back to soils. A number of new and innovative technologies are emerging and in development which recover energy from waste streams in various forms (including solid, liquid and gaseous fuels) but can also produce high value bio-products and chemicals that may become feedstocks for downstream manufacturing processes.

An example is pyrolysis and similar thermal decomposition processes, which are predominantly considered energy recovery solutions producing fuel products but can also potentially produce high value recovered materials such as recovered carbon black or activated carbon (from the char) or various solvents and base chemicals that can be refined from the liquid outputs.

As noted above, Queensland is currently developing and Energy from Waste Policy which is grappling with some of these idiosyncrasies – on the one hand ensuring that energy recovery does not preclude or crowd-out genuine viable recycling options but also acknowledging that energy recovery and the production of high value recycled products can be intimately linked and that energy recovery has an important role in the circular economy.

Energy-from-waste provides a potentially attractive solution for non-recyclable mixed residual wastes. However there may also be opportunities to recover energy from single-stream materials such as waste timber, which is largely an untapped resource. The other option is to process mixed wastes to extract a combustible refuse derived fuel (RDF) or process engineered fuel (PEF). There are such facilities operating in other states, processing dry C&I or residual C&D waste and suppying the PEF to local cement kilns, which is a potential option in Queensland with the cement kiln in Gladstone.

5.1.6 Landfill disposal

Whilst increasing resource recovery and diverting waste from landfill is a core focus of the Strategy and therefore this Report, there will still be a need for significant landfill capacity across the state to manage the residual waste that cannot be viably recovered. The focus of this Report is on ensuring that there is adequate landfill capacity in each region, considering the significant challenges and long timeframes involved in identifying and developing new landfill sites. The analysis presented within this Report is largely focused on identifying the infrastructure required to achieve the Strategy recovery targets but in terms of planning for long-term landfill capacity, it is also prudent to take a pragmatic and more conservative view of the potential change in resource recovery, which is reflected in the low recovery scenario that has been modelled.

This Report also promotes the regionalisation of landfill capacity where that is beneficial in terms of environmental, economic and social impact outcomes. Regionalisation of landfills offers the potential to optimise operational costs, improve standards and minimise the impacts on the broader community and the environment by reducing the overall number of landfills and closing down small inefficient or sub-standard facilities. That will not always be practical or appropriate in some regional and remote areas, but as key facilities reach the end of their life, councils will be encouraged to explore the potential to share landfills with neighbouring councils or to utilise private facilities, before embarking on developing new localised landfills.

Given the significant challenges in identifying suitable sites for new landfill facilities that are acceptable to the community and able to meet the required engineering and environmental standards, there should be a particular focus on retaining and expanding existing landfills, where there is potential to do so.

In SEQ in particular, but also other regions, councils are progressively shifting away from owning and operating their own landfills and are now relying more heavily on large private sector facilities or landfills run by neighbouring councils. Councils including Ipswich and Redlands no longer own their own landfills, and others including Brisbane and Logan are planning for the impending closure of their facilities over the next decade. But this is not just confined to the south east – in the far north of the state, a number of councils do not have their own landfills or have landfills which can only take non-putrescible waste and they rely on a privately owned putrescible landfill (Springmount Landfill near Mareeba).

Whether they are owned by councils or private operators, many councils across the state are increasingly working with their neighbouring councils and looking at options to develop regionalised landfill facilities which service more than one council area and incorporate the latest modern engineering features and maximise efficiencies of scale in operations. This is driven by a number of factors, but the most prominent is the sheer difficulty in identifying suitable sites for new landfill facilities which are acceptable to the community and meet all the necessary environmental criteria for such a facility. The shift towards well placed regional landfills at least consolidates those impacts in one location where impacts can be controlled, and allows for investment in better engineering and operational controls. It also provides significant operational efficiencies compared to multiple smaller sites operating with their own separate staffing and plant requirements.

A number of regional councils have made significant progress in rationalising their networks of disposal facilities and achieving efficiencies by closing rural and remote satellite landfills, usually replacing them with some form of simple transfer station to maintain service for residents in those areas. This is an ongoing process and there are further such sites slated for closure in the coming years.

There are additional transport and servicing costs associated with aggregating residual waste into regional landfills and the ongoing challenge for regional councils and private operators is to design transfer networks and systems that can do this efficiently whilst still providing the requisite level of service and access for customers in rural and remote areas.

5.1.7 Transfer infrastructure

As identified below, there is a significant network of established waste transfer facilities across the state, both council owned and private sector, which play a critical role aggregating waste and recyclables for subsequent processing or disposal and providing accessible options for the community and businesses to drop-off wastes when they need to. Many of these facilities will play a greater role in the future, in terms of channelling materials to regional processing or disposal hubs but there may need to be changes to way that these facilities function, in order to achieve this in the most cost effective manner.

Many of the existing council-run transfer stations are primarily designed to gather waste from small vehicles, aggregate it and send it a short distance to a nearby landfill, in some cases on the same site. Only a relatively small proportion have the capability to 'bulk load' waste into large capacity trailers and bins with a reasonable degree of compaction, for efficient longer distance transport.

5.1.8 Collection systems

Although not strictly 'infrastructure' and not a core focus of this Report, waste collection systems are intrinsically linked with the future waste and resource recovery infrastructure mix. Many of the recycling and organics recovery opportunities identified above will require a change, and in some cases a significant shift, in current methods of separating waste materials at the source and the systems that collect and aggregate those materials for recovery.

As noted above, there is a separate program of work under the Strategy implementation to gather evidence and provide guidance to councils around the most appropriate kerbside collection methods for different regional contexts across the state. Therefore, this Report does not intend to provide detailed analysis of collection options and nor will it propose that certain collection systems should be implemented in each region. That will remain a decision for local governments based on assessment of their own local factors and requirements.

Nevertheless, there are likely to be changes in collection systems in different parts of the state which will increase the volume of recyclables and organics that are separately collected, which will require the parallel development of appropriate processing infrastructure.

In the survey of local governments that was undertaken in developing this Report, councils were asked to identify whether they were considering a change in their collection systems. The vast majority of SEQ councils and councils representing larger regional cities and centres along the east coast identified that they are actively considering and assessing options to introduce some form of separate collection service for organics, either garden organics only or food organics and garden organics combined (known as FOGO). This follows the trend in other states towards separate collection of household organics and supports the Strategy priorities to increase recycling of organics into high quality products.

In that same survey, there was limited interest from rural and remote councils to change current collection systems including introduction of kerbside recycling or organics collection services where they do not currently exist. There are significant challenges for such councils with small communities dispersed over large areas, to provide additional kerbside collection services and the distance from end markets makes it difficult to develop a sustainable business case. This may change over time - the government has committed to providing financial support to overcome some of the transport cost barriers to recycling in regional and remote areas and it is expected that the ongoing kerbside collections study will identify potentially viable approaches that can be applied in such areas. Part of the viability equation of those options, is having access to appropriate and efficient transfer and processing infrastructure as discussed in this Report.

Beyond household waste collections, commercial collections are also likely to evolve in the near future in response to the landfill levy. Source separation of commercial waste is likely to expand as a result of the levy although experience in other states suggests that a landfill levy does not always translate into significant or rapid changes in practices at the commercial waste generator level.

It is likely that collections of source separated commercial food waste and other commercial organics will increase as that is a gap in existing practices for many sectors and there is a strong focus on reducing food waste through the national Food Waste Strategy. Organics recovery already accounts for a significant proportion of recovery from the food processing sector, food service (e.g. grease-trap waste) and wastewater treatment sludges, as well as agriculture and forestry.

5.1.9 Community facing infrastructure

Councils across Queensland provide a range of different waste facilities which are accessed directly by the community (residents and small business users) including transfer stations, resource recovery centres and landfills. Most of these facilities are well established and operating successfully, but there may be opportunities to upgrade and optimise the facilities to maximise resource recovery performance. Each facility should be designed to suit local needs and site characteristics, but best practice features may include:

- A recycling drop-off facility, ideally at the front of the site and separate from the residual waste drop-off, where source separated recyclable materials can be dropped-off, ideally at no charge
- A separate garden waste collection pad or stockpile area to encourage garden waste to be separated by customers
- Facilities which allow for the safe deposit of a range of household hazardous and problem wastes, including e-waste, batteries, paint, chemicals and oil
- A one-way traffic flow system which encourages customers to utilise recycling and garden waste facilities first, prior to accessing the residual waste drop-off area.

Councils should also review their networks of facilities to assess whether existing facilities are optimally located to service the existing community and future growth areas. Often, community-facing transfer stations have been built on the sites of former landfills but these may not necessarily be the optimal locations in terms of accessibility for residents within the catchment area that they are intended to service. Such reviews may identify opportunities to relocate facilities to more accessible locations, to rationalise unnecessary facilities or to build new facilities to service emerging communities.

5.2 Regional differences

The future infrastructure needs and opportunities are likely to be very different across the state and these can be broadly categorised according to the region types as defined in 1.4.2:

- SEQ urban
- Regional cities and adjoining regional areas
- Rural and remote

The likely regional differences are highlighted below, and section 5.1 discusses the potential solutions that may be developed to address specific streams.

SEQ Urban

The scale and concentration of waste volumes in the urban areas of SEQ presents very different resource recovery opportunities to the rest of the state. Based on consultation and trends, the most likely opportunities are:

- Collaboration between councils in sub-regional groups to procure and share new significant processing infrastructure;
- Increased separate collection of household organics which may involve larger urban councils transitioning towards kerbside food and/or garden organics services in some form, with the most appropriate system to be determined following detailed options analysis by each each council. Most large urban councils have indicated they are in varying stages of assessing these options and a separate study of collection systems by DES will help to inform this process;
- More advanced organics processing infrastructure including enclosed composting and anaerobic digestion, with more integration and co-processing of feedstocks across sectors (household and commercial organics, biosolids, food processing residues, agricultural residues);
- Upgrade of existing MRFs to improve product quality to broaden offtake opportunities and support local remanufacturing, as well as new modern MRFs to meet future growth;
- Additional reprocessing capacity for materials such as plastics, glass, timber;
- Medium to large scale energy-from-waste facilities to manage residual MSW and C&I waste;
- Mechanical processing facilities (dirty MRFs) to produce refuse derived fuel (RDF), particularly from dry C&I and light mixed C&D waste;
- Moderate scale energy recovery facilities processing single stream materials such as waste timber;
- Expanded processing of source separated heavy C&D materials (concrete, brick, soils, etc) and new processing facilities for mixed C&D waste;
- New or upgraded transfer station infrastructure with bulk haulage capability to support efficient aggregation of waste in regional or sub-regional processing facilities;
- Organics-specific transfer stations in urban areas to help move organics efficiently out to urban fringe and agricultural areas for processing;
- Shift to more regionalised landfills as existing council landfills reach end of life;
- Development of new inert landfills as existing sites reach end of life (near term); and
- Development of new, planned waste and resource recovery precincts to provide synergies and reduce the impacts of new infrastructure on the community (see section 7.4 below).

Regional cities and surrounds

Regional cities are likely to become the hubs for regional processing infrastructure although there will be opportunities for rural hubs to emerge, for example around organics processing. The needs in each regional city vary, but some common opportunities include:

- Increased separate kerbside collections of household organics (food and/or garden organics) in some form, with the most appropriate system to be determined following a detailed options analysis by each each council;
- New regional and localised organics processing infrastructure as appropriate to produce high quality products with diverse end market options;
- Integration of household and commercial organics processing with recovery of biosolids or residues from agricultural and food processing (e.g. intensive farms, abattoirs, etc) to create organics processing hubs, potentially on the fringe or outside regional cities and close to offtakes for compost and energy;
- Upgrade and improvement of existing regional MRFs to improve product quality to broaden offtake opportunities and support local remanufacturing;
- Local reprocessing and remanufacturing solutions particularly for plastics, tyres, glass;
- Smaller scale energy-from-waste solutions for residual MSW and C&I waste, particularly in cities with landfill constraints and opportunities to co-locate with heavy industry (e.g. Townsville, Gladstone) and/or to co-process other biomass streams;
- Potential to integrate or build upon existing utilities, industrial and agricultural processing infrastructure to improve the viability of energy recovery – for example, the cement kiln in Gladstone, sugar mills in central and north Queensland, biofuels projects emerging in various regions;

- Small to medium scale C&D recycling hubs, perhaps using mobile processing to service rural areas where appropriate; and
- Upgraded transfer station infrastructure with bulk haulage capability to support efficient aggregation of waste in regional processing and diposal facilities.

Rural / remote areas

For rural and remote areas that are more isolated from urban centres, there a significant barriers to improving resource recovery which are acknowledged and will drive a very different set of opportunities and solutions, including:

- Maximising the capture of materials through the CRS and leveraging the collection and logistics networks established under the CRS to achieve efficiencies in consolidating and transporting non-beverage materials;
- Focus on high value recyclables where the value of the material is likely to outweigh the cost of consolidation and transport – for example clean cardboard, scrap metal, clean plastic;
- Establish local pre-sorting and consolidation facilities to compact and bale recyclables, to increase transport options (including back-loading opportunities on a broader range of vehicles) and improve product value;
- For other lower value materials where transport is an insurmountable barrier to financially sustainable recovery options, focus on local solutions to recover products which can be utilised locally such as glass crushing or mobile processing of concrete and green waste on a campaign basis;
- Where conventional centralised organics processing is not viable, councils could consider small scale or community-based or on-farm composting of organics; and
- Focus on improving environmental management standards at rural and remote landfill sites, including rationalisation of satellite landfills where practical.

5.3 Transport of Waste

The cost of transporting waste materials for recovery is a significant barrier to increasing recovery of some streams and investing in regionalised processing infrastructure, particularly in regional areas.

The transport issue is not easy to solve however there are approaches which can improve the viability of transporting wastes. A separate review of the economics of transporting waste and recyclables in regional areas found that:

- Compaction and density is key to cost effective transport of waste, and investment in compaction equipment will generally have a short payback period in terms of transport savings
- Large, consolidated loads will always be more cost effective
- For recyclables, the focus should be on separating and pre-sorting at source to minimise the unnecessary transport of low value materials or contaminants
- For some materials which are not economic to move (e.g. low density and low value) the focus should be on localised processing solutions (e.g. gar

Firstly, as noted above, investment in efficient transfer facilities which are capable of bulk-loading wastes into high capacity vehicles with some level of compaction, will lead to significant transport cost savings of the long term.

The adoption of a hub-and-spokes transport model may also support the regionalisation of some waste streams. The hub-and-spokes concept enables local transfer infrastructure to be harnessed as part of a planned network to consolidate materials in appropriately located regional hubs for sorting and recovery.

A hub is a facility where one or more waste streams from different sources are consolidated for sorting or processing, or transfer to the next hub for further consolidation with other waste streams. A spoke is any collection or transfer pathway which feeds waste from its source into the hub or from one hub to another. In the regional context, transfer stations are the hubs and the collection routes into and transfer routes between them are the spokes. Landfills and recovery facilities are also hubs. Hubs may have one function (e.g. landfill disposal) or serve multiple functions in one location. Hubs can be considered as:

- Local hubs – the main consolidation point at a local level, for example the primary transfer station and/or landfill within each local government area
- Regional hubs – the regional disposal or processing facility at which waste from across the region is consolidated, either directly or via the local hubs.

At present, there are multiple local waste hubs across the state, usually focused on the primary transfer station or landfill within each LGA, which may be fed by smaller hubs (satellite transfer stations). However, the connections between these hubs and to regional processing hubs, are often not well planned or defined, resulting in limited efficient connectivity.

The long term vision of this Report is that local hubs will evolve to link into the regional hubs for each waste stream and function (e.g. regional landfill, regional organics processing hub, etc). A waste and resource recovery precinct of the type discussed in section 7.4 below may act as a regional hub, but a regional hub may not necessarily be a precinct – it could be a single facility. Optimising future hub-and-spoke networks requires consideration of and alignment with current and future transport links within each region.

Hub-and-spoke networks should be planned and established for all major recyclable materials which cannot be readily processed at the local level. Alternative networks may be appropriate for different streams (e.g. organics) or it may be more efficient to have more than one sub-regional hub for some functions.

For small remote communities, the focus must be on developing efficient bulking and transfer mechanisms, possibly using compaction equipment where practical, or possibly feeding into an intermediate point in a neighbouring council. In considering how to plan new networks, regional and remote councils should look for opportunities to leverage existing logistics networks, such as those established under the CRS. Alternatively, by reviewing established logistics networks for other commodities, there may be opportunities to make use of backloading.

Maximising source separation to minimise the volume of residual waste that needs to be transported is also critical. In this respect, many of the transfer stations should consider investing in upgrades to encourage and facilitate greater source separation and consolidation of wastes.

While this Report is somewhat focused on opportunities to develop regionalised processing and disposal solutions, it also acknowledges that in some cases, local solutions will be more appropriate. It will be a matter for councils and operators to weigh up the costs of transferring waste to centralised processing hubs, against the benefits and efficiencies of processing at greater scale. This assessment will vary for different materials. With organics for example, most materials such as green waste are low density and difficult to compact, so inefficient to transport except over relatively small distances. For rural councils that would need to transfer their organics more than say 80-100 km, it may be better to consider a small scale local composting operation and whether there are opportunities to co-process household organics with other agricultural residues to boost scale, in a suitable rural location close to product offtakes. For household recycling, again it is not cost effective to transport uncompacted commingled recyclables over longer distances and rural councils may be better served to consider separate stream collections of higher value materials with basic local sorting and consolidation facilities (baling) to enable efficient transport.

6 REGIONAL PROFILES

This section provides a more detailed discussion on potential opportunities within each of the eight defined regions. The industries and activities that drive the regional economy in each region will have a significant impact on the types and volumes of waste that are generated in the region and future growth in both resident population and waste generation. It is also important to understand the major industries in the region as they could potentially be users of recovered resources, both in terms of materials and energy. This section provides an overview of the regional economy and the major industries as well as the environmental setting to the extent that it may influence future waste infrastructure and planning.

By comparing the future projected waste flows in each region with the capacity data for existing infrastructure, it is possible to identify where there will be gaps in future capacity, accounting for future growth and improved resource recovery. This chapter provides an overview of the capacity gap analysis in each region and the potential opportunities that will arise, with reference to the discussion in section 5 above.

The estimates of current capacity are indicative and based on information gathered from operators through the data survey. For facilities where no capacity information was provided by the operator, the capacity has been estimated based on public information, the throughput in recent years and/or information gathered during the previous 2016 study. It has not been possible to quantify the capacity of all types of waste and resource recovery infrastructure due to a lack of data and/or particular difficulty in quantifying capacity for some facility types (e.g. transfer stations).

6.1 Cairns Region

6.1.1 Regional Snapshot

The Cairns region includes six LGA's from Cassowary Coast in the south to Douglas in the north and taking in Mareeba and Tablelands to the west. The city of Cairns is the main population centre and is home to around 60% of the regional population.

The region has a total estimated population of around 260,000 (in 2019) which is forecast to grow to around 384,000 by 2050[22]. The strongest future growth is expected in Cairns with moderate growth in Douglas and Mareeba and slower but positive growth in other local government areas in the region.

The councils in the region have a history of collaboration and joint working on waste issues. They are part of the Far North Queensland Regional Organisation of Councils (FNQROC) which extends beyond the Cairns region and includes member councils to the north and west.

The regional climate is categorised as wet tropics and characterised by very heavy annual rainfall, with the town of Tully in the Cassowary Coast receiving an average of 4 metres of rainfall annually. The region is also prone to cyclones and monsoonal flooding. The region adjoins the Great Barrier Reef Marine Park, so managing environmental impacts within the Reef catchments is critical.

Yarrabah Aboriginal Shire has a population of around 2,700. As an indigenous council, it is considered in more detail within the Queensland Indigenous Waste Strategy.

Regional economy

Cairns is the main commercial hub for the Far North Queensland region and a significant tourism destination. Tourism is a major contributor to the economy, particularly in Cairns and Douglas, generating around $2.5 billion of gross regional product and supporting 18% of jobs in the region. Tourism is driven by two of the world's great natural wonders - the Great Barrier Reef and world heritage-listed Wet Tropics Rainforest in the Daintree, which attract more than a million visitors each year.

Otherwise, agriculture is also a key driver of the regional economy, particularly sugarcane but also tropical fruits, coffee, beef grazing, poultry, pork and dairy farms. There are around 21 poultry farms in the region, licensed to house over 3 million birds. The fishing industry is also a major contributor to the economy and supplies many Asian and domestic markets with fresh and frozen products.

Cairns is also a hub for supplying goods and services to mining operations in the north west and north east mineral provinces. The Port of Cairns supports the import and export of a range of goods including sugar, petroleum products and fertiliser and there is also a small military presence at the port, including the Australian Navy's north eastern operational base. Otherwise, the port is mostly servicing the commercial fishing and tourism industries (cruise ships and Reef tours) as well as supporting construction projects across the Cape region.

In terms of employment, the key industries in the region are agriculture, health care and social assistance, retail trade, accommodation and food services.

Transport infrastructure

Transport of waste and recyclables is a particular challenge for councils in the region given the distance from markets and the fact that most of the putrescible landfill capacity is in the Mareeba region, some 90km inland from Cairns. It is also a challenge for the surrounding remote communities such as Cook Town and Wujal Wujal (part of Remote Queensland region), which transport waste long distances (up to 300km) to Mareeba for disposal.

The majority of materials are moved by road and there are generally good road links between the main population centres. The Bruce Highway connects Cairns with the south, running 1,600km along

[22] Based on medium series projections by the Queensland Government Statisticians Office, extrapolated beyond 2041.

the east coast of Queensland down to Brisbane. The Kennedy Highway is the main link from Cairns to Mareeba and the Tablelands via the Kuranda Range, which can be a particularly troublesome stretch of road for heavy vehicle traffic. The range section is steep, of variable road quality and it is not uncommon for the road to be closed due to accidents, often involving heavy vehicles. This is a constraint on significant, regular movements of waste from Cairns to the Tablelands.

The various small communities spread across Cape York are accessible by roads of variable quality from Cairns and most goods pass through Cairns. There may be back-loading opportunities which could offer efficiencies in transporting materials into Cairns for processing from the Cape or western part of the region.

There is a rail freight connection from Cairns to the south connecting to Brisbane via the North Coast line. Containerised rail freight is currently used to move recovered recyclables from Cairns to markets in the south east. There is also a rail line from Cairns west to Forsayth which is part of the Tablelands system.

The Cairns Port is currently mostly used for tourism activities but is being expanded and upgraded which may provide opportunities to utilise sea transport in the future. There are containerised sea freight services to the north including to Weipa.

Regional constraints and opportunities

The Cairns region faces some unique waste management challenges as a result of the wet tropical climate and sensitive local environment, particularly its proximity to the Great Barrier Reef. As a result of these local sensitivities (e.g. reef catchments, high water table and high rainfall), options for developing new putrescible landfills are very limited and virtually non-existent near the coast (to the east of the Great Dividing Range). The lack of putrescible landfill sites was a driver for three of the councils (Cairns, Douglas and Mareeba) to develop Queensland’s first and only alternative waste treatment (AWT) facility in Cairns. The facility uses mechanical-biological treatment technology to process kerbside household waste and recover the organic fraction as a low grade compost product.

For the only two landfills which are situated on the coastal plain (run by Cassowary Coast Regional Council), unique conditions have been imposed which limit them to accepting ‘dry’ waste only, which is a slightly different definition to inert or non-putrescible waste.

Being 1,600 km from Brisbane, access to markets and transport costs are a significant challenge for recycling in the Cairns region. Rail provides an alternative to access markets to the south but does not provide significant financial savings in comparison to road.

However, the local environment presents opportunities in itself. Households in the region produce more garden organics than other parts of Queensland as a result of the local climate, but a significant proportion is mulched into a low value product rather than returned to agricultural soils. There are exceptions, including a composting operation near Mareeba which converts garden waste and other organics into compost for use on banana plantations. There is also a growing push to protect the Reef by reducing chemical fertiliser use on farms in the region and to improve soil quality to control sediment runoff. Whilst the use of compost and recovered organics soil conditioners has not been a major part of that conversation to date, these alternatives could support these endeavours. Hence, there is a significant potential market opportunity to recycle a range of organic wastes back into agriculture.

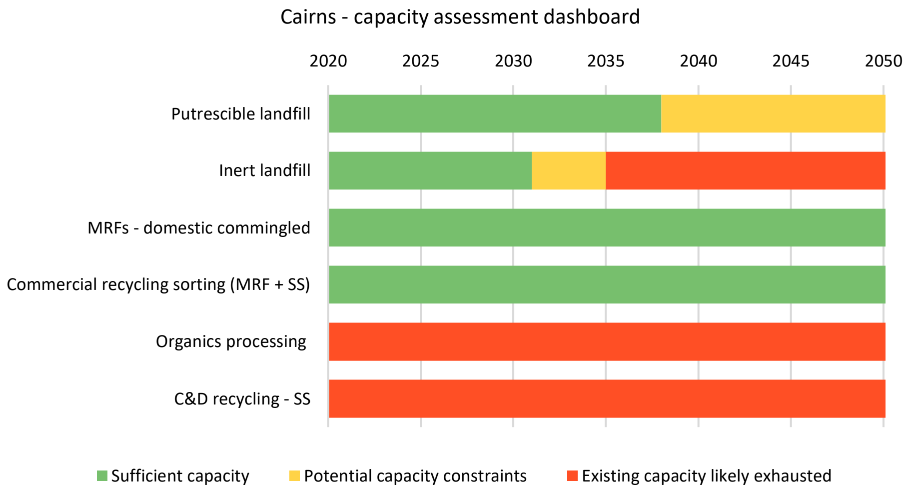
The limited landfills and the need for many councils to transport waste long distances to landfill, is a strong driver supporting resource recovery. Councils in the region have a history of working together to develop mutually beneficial waste solutions such as the AWT contract, a regional MRF and a successful regional metals recycling contract.

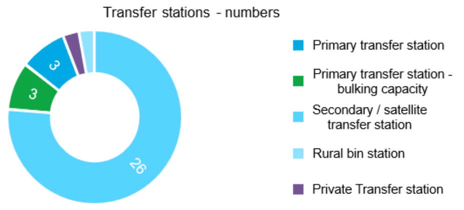
Overleaf is a one-page snapshot of existing key waste infrastructure, forecast waste flows and future infrastructure needs and opportunities for the Cairns region. Further detail is provided in the subsequent sections.

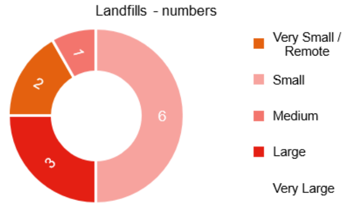
Cairns – Regional infrastructure snapshot

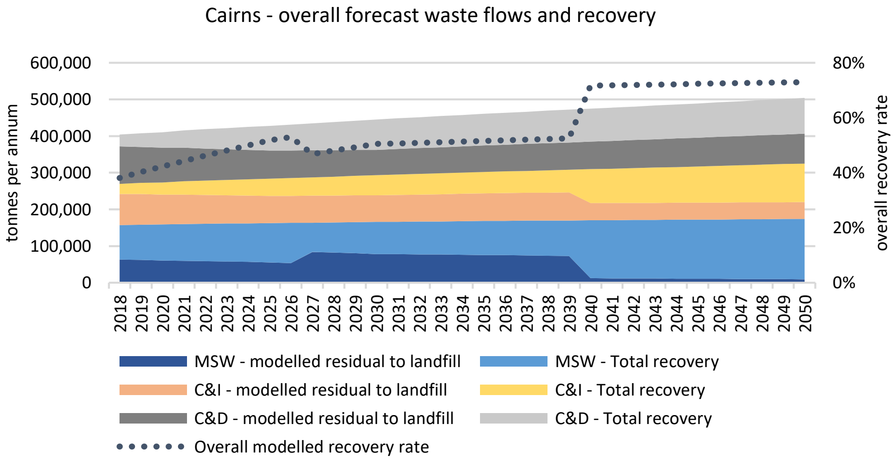
Landfill infrastructure	Ownership	No. facilities	Remaining void capacity (millions tonnes)
Putrescible landfills	Council-owned	2	0.0
	Privately owned	1	3.8
Inert landfills	Council-owned	4	0.5
	Privately owned	5	1.4
Recovery Infrastructure	**Sub-category**	**No. facilities**	**Annual capacity (tonnes per annum)**
Organics processing	Composting	2	21,000
	Mulching only	2	20,000
Recycling sorting	MRFs	2	32,500
	Source separated recycling facilities	2	13,500
C&D recycling facilities		0	-
Metals	Metals recycling	2	6,000
	Battery / e-waste processing	1	Insufficient data

** capacity estimate excludes 'very small' landfills*









Future infrastructure needs & opportunities

- *Progress with existing plans to upgrade and expand the Cairns MRF into a modern regional facility, including glass reprocessing capacity*
- *Develop local reprocessing capacity for plastics including domestic, commercial and agricultural, to supply local manufacturing*
- *New and expanded organics processing capacity, including facilities that can process domestic and commercial food organics*
- *Integrated treatment of various organics (e.g. domestic, food, food processing, biosolids, agricultrual waste) in a regional organics hub or precinct, including potential for energy recovery (AD)*
- *Localised composting solutions may also be appropriate in some rural areas*
- *Potential for small to medium scale thermal energy-from-waste as a long term solution to regional landfill limitations, or pre-processing into RDF and export to another region (e.g Townsville) for energy recovery*
- *New bulking transfer facilities to support regional infrastructure as primary landfills close*
- *New or enhanced processing of C&D masonry into high quality secondary aggregates*

6.1.2 The current situation

Waste flows

The Cairns region managed over 400,000 tonnes of waste across all three headline streams in 2017-18 and this is forecasted to grow to over 510,000 tonnes by 2050 in the base case (low growth) or as high as 600,000 tonnes if current per capita waste generation rates are maintained. Table 22 summarises the key waste streams that were disposed or recovered in the region in 2017-18, which serves as the baseline for forward projections.

The region achieved a relatively high recycling rate for MSW waste (60%) thanks in part to the AWT facility in Cairns which recovers organics from the mixed kerbside waste of three councils (Cairns, Mareeba and Douglas). C&D recycling on the other hand was quite low (less than 25%), as was C&I recovery (27%).

Table 22: Summary of regional current (2017-18) baseline waste flows

Stream	2017-18 tonnes
Disposal	
MSW - kerbside to landfill	20,319
MSW - non-kerbside to landfill	42,936
C&I - disposal to landfill	84,767
C&D - disposal to landfill	101,991
Recovery	
MSW - commingled recycling	13,696
MSW - other recycling	12,298
MSW - green waste recovery	36,445
MSW - AWT recovery	30,000+
C&I - recycling	2,433
C&I - organics & timber recovery	28,217
C&D - recovery of masonry materials	26,541
C&D - other recycling	5,728

Figure 36 below shows the estimated overall breakdown of key materials via disposal and recovery pathways, noting that the landfill breakdown is an estimate based on assumed composition (see 2.3.1). For this region, the current recovery of food and garden organics is relatively high on account of the Cairns AWT plant extracting this from household kerbside waste supplied by the three councils which are party to the AWT contract. With that contract due to expire in 2026, there is a need for a long term solution which maintains the current high diversion rate of household organics. Otherwise, the chart shows there are opportunities to improve the recovery of:

- Paper, cardboard, plastics and metals, households and commercial sources
- Over 110,000 tonnes of C&D masonry materials currently landfilled

- An estimated 60,000 tonnes of timber waste across all three streams which is currently landfilled.

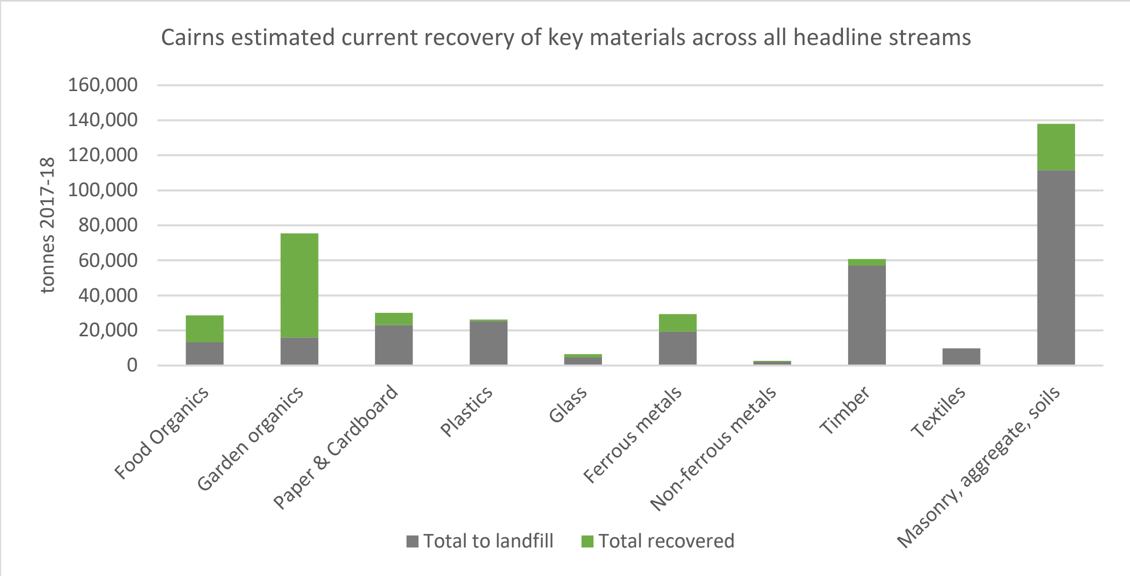


Figure 36: Summary of estimated regional disposal and recovery by material (MSW, C&I + C&D)

Collection systems

The Cairns region features a mix of household collection services. Cairns, Douglas and Tablelands Regional councils offer a conventional two bin service of waste and recycling, which accounts for around 81% of serviced households in the region. Mareeba and Yarrabah offer a single waste bin. Cassowary Coast runs a unique collection service of two bins – a wet and a dry waste bin, driven by the particular regulatory conditions on Council's two landfill sites as discussed below.

Table 23: Summary of regional kerbside collection services

Collection service	Councils	No. households serviced (estimated 17-18)
Single bin (residual waste only)	Mareeba, Yarrabah	6,600
Two bin – recycling + residual waste	Cairns, Douglas, Tablelands	85,600
Two bin – wet waste + dry waste	Cassowary Coast	13,000

Existing waste infrastructure

For household recycling, the region is serviced by a regional MRF in Cairns processing kerbside recyclables from Cairns and Douglas, as well as CRS materials and recyclables from other councils including Cook Shire to the north. Cairns Regional Council, which owns and runs the Cairns MRF, is planning a significant overhaul and upgrade of the MRF[23] which will improve its performance and provide capacity for future growth. Tablelands Regional Council also runs its own small, basic MRF at Atherton but it is understood this will likely discontinue once capacity becomes available in the Cairns MRF.

[23] http://statements.qld.gov.au/Statement/2019/4/16/cairns-recycling-on-the-rise-with-recovery-facility-expansion

As noted above, the Cairns AWT facility provides processing and recovery of organics from kerbside MSW. Otherwise, only one dedicated composting facility is operating in the region utilising garden organics and other streams and producing compost products for use in horticulture and agriculture. Springmount landfill also runs a small composting operation where a significant volume of garden organics is mulched and used in a range of applications.

There are no C&D recycling facilities that have been identified in the region. It is understood that the inert landfills may crush concrete but there is a need for dedicated C&D recycling to produce high quality products.

The Cairns region is home to 1212 active landfills that have been identified, including one large privately owned putrescible landfill and five privately owned inert landfills for C&D waste. Most of the six council owned landfills in the region are also only taking inert waste as a result of regulatory constraints or decisions by councils not to accept putrescible waste.

The largest landfill in the region is the privately owned Springmount landfill near Mareeba and a number of councils already send most or all of their putrescible waste to that site for disposal, other than the three councils that process kerbside MSW via the AWT facility.

The region is facing a number of landfill closures in coming years which will leave Springmount as the primary landfill servicing the entire region and beyond (it also receives waste from remote councils to the north of the region). The Springmount landfill is in a good location and has ample capacity (approved and potential) to service the broader region and cater for future growth, but the heavy reliance on a single disposal facility also presents some risks for councils.

Figure 37 overleaf provides a summary map of existing infrastructure in the region.

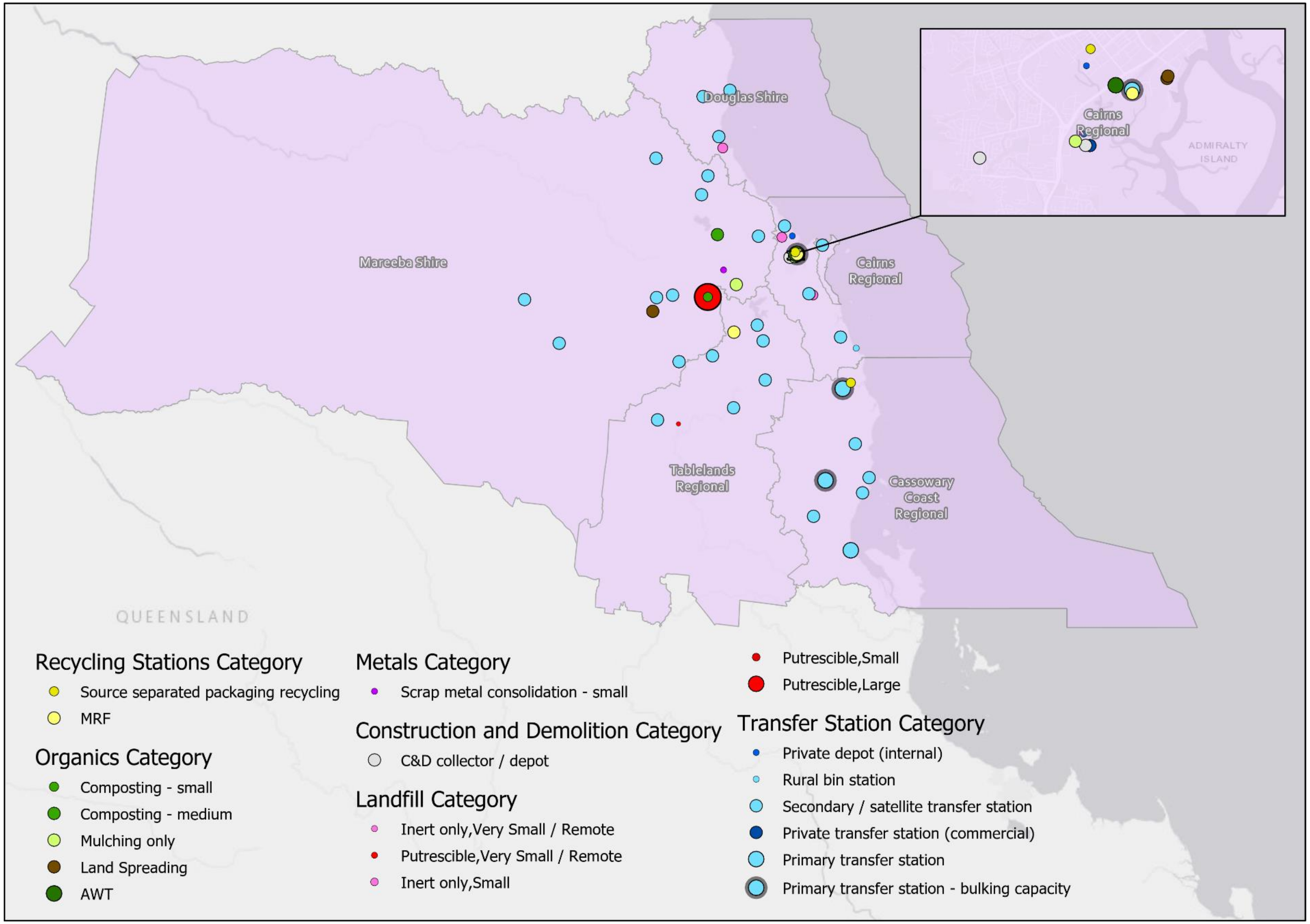


Figure 37: Cairns region map of existing waste and resource recovery infrastructure

6.1.3 Future needs and opportunities

Future waste flows

Figure 38 provides a summary of the forecast waste flows for the Cairns region under the base case. To achieve the Strategy recycling targets at a state level, the modelling assumes relatively optimistic but achievable capture rates of household food and garden organics and commercial organics, although councils will need to determine the best way to achieve this within their own contexts. There are also ambitious assumptions around future capture of recyclables from household and commercial waste and moderate assumptions for the recycling of C&D waste, mostly through further recovery of source separated masonry materials.

The waste flow modelling also assumes that residual MSW which is currently processed through the AWT facility in Cairns is sent to landfill beyond the expiry of that contract (other than improvements in source separation of recyclables and organics).

It also assumes a moderate scale regional energy recovery facility for residual MSW and C&I waste, nominally modelled as 90,000 tonnes per annum capacity and operational by 2040, resulting in a visible step change in the recovery profile at that time. As noted above, achieving the Strategy recovery targets will require the deployment of energy-from-waste in some form in most of the large regional centres but the exact timing and scale is not set and there are still significant further investigations and feasibility analyses to be undertaken to determine if or when such a solution may be viable in the region.

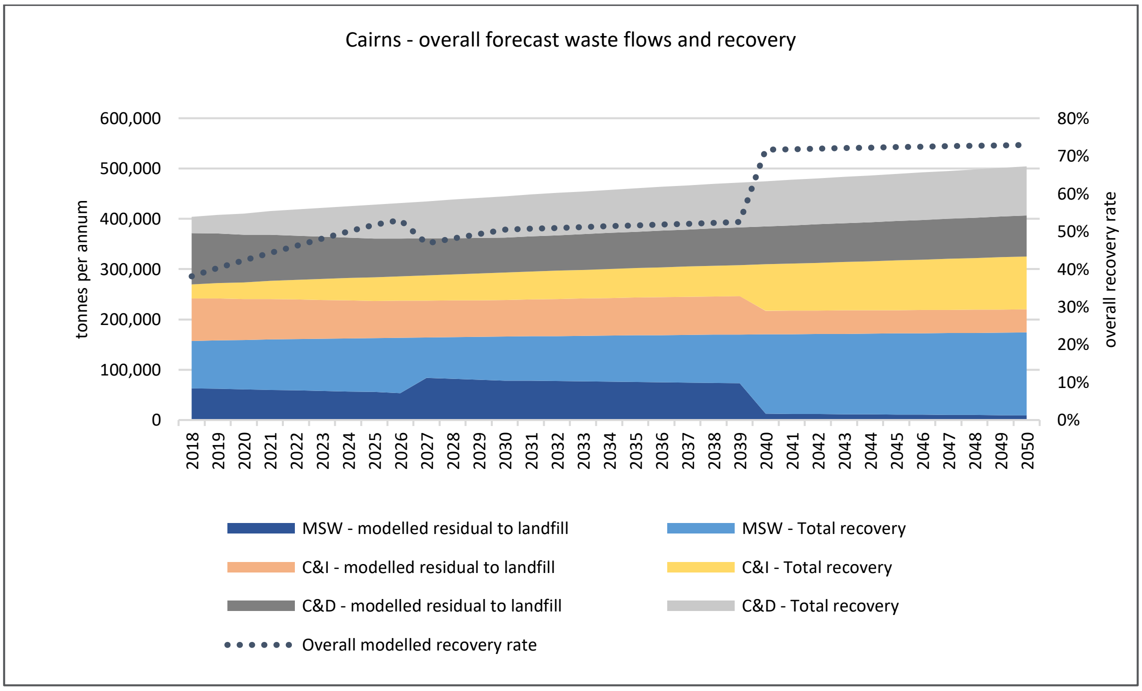


Figure 38: Forecast waste disposal and recovery by headline stream

Resource recovery infrastructure needs

The projected future waste flows, including the new resource recovery required to meet the Strategy targets, have been assessed against the existing available processing capacity in the region (based on available data) to identify future gaps in recovery capacity. Table 24 below provides a summary of future capacity needs and opportunities based on this analysis. Future landfill capacity needs have also been assessed under different recovery scenarios and are discussed separately below.

Table 24: Summary Cairns resource recovery infrastructure capacity needs assessment (under base case)

Capacity assessment	Comments
Domestic commingled recycling MRF capacity	Domestic commingled recycling is forecast to grow from almost 14,000 tonnes currently to 20,000 tonnes by 2030 and 26,000 tonnes by 2050. Assuming the Cairns MRF is upgraded and expanded as per current plans, there should be adequate capacity to service domestic recycling needs over the long term, as well as some commercial recycling.
Commercial packaging recycling capacity	There seems to be ample spare capacity between the MRF and existing commercial source separated recycling facilities to accommodate expected future growth in commercial recycling over the forecast period of this Report.
Organics recovery capacity	With total organics recovery (domestic and commercial) forecast to grow from 65,000 tonnes now to 86,000 tonnes by 2030 and almost 100,000 tonnes by 2050, there is a need for new organics processing capacity. There is limited existing composting capacity (one facility near Mareeba) and councils in the region are highly reliant on mulching of green waste. New composting or other processing capacity will be required to support the projected increase in organics capture, including facilities able to process domestic and commercial food. A regional or sub-regional processing facility may be appropriate, with potential to explore co-processing of domestic and commercial organics with agricultural residues and biosolids to boost scale. Depending on the location of the facility, enclosed processing may be required and there is potential to use anaerobic digestion to generate energy. A regional organics-based precinct could also be established linking with existing infrastructure such as food processing, sugar mills, poultry farms, the abattoir in Mareeba or sewage treatment facilities. There may also be benefits in one or two smaller localised composting operations in rural areas to minimise the transport of organics which is typically not cost effective. These may be new facilities or expansions and upgrades of existing composting and mulching operations. There is significant potential to develop new agricultural offtake markets for compost products, which should be strongly supported by farmers and government given the benefits to the Reef (reduced fertiliser use, improved soil quality).
C&D recycling capacity	There is an immediate need for new C&D recycling capacity in the region with only basic concrete crushing at local inert landfills. Cairns Regional Council has announced plans and received funding for a small C&D processing operation to convert clean masonry materials into secondary aggregates for road construction. With C&D recycling forecast to grow from 70,000 tonnes now to 90,000 tonnes by 2030 and 110,000 tonnes by 2050, there is likely enough demand in the region to support at least another medium scale C&D processing facility. Mobile processing to support recycling in rural areas may also be a good solution for the region.
Other resource recovery infrastructure	With additional capture of plastics into the recycling stream, including from commercial and agricultural sources, there could be potential for a local plastic reprocessing facility to add value to recovered plastics (e.g. washing and flaking). There is an existing manufacturer in Cairns already utilising recycled plastic resin to produce innovative new building products, but currently constrained by a lack of locally sourced recovered plastics.
Energy recovery infrastructure	As noted above, there is potential to deploy AD to co-process a range of organics and generate energy.

	There is potential for a small scale thermal energy-from-waste facility processing residual MSW and C&I waste in the region. The projections estimate that there will be 120,000 tonnes of residual MSW and C&I by 2030, rising to 145,000 tonnes by 2050. With limited regional landfills and significant constraints on new putrescible landfill development, EfW may be an appropriate long-term solution. An alternative option which should be considered is the potential to produce a refuse derived fuel and export it to an EfW plant in the south, such as in Townsville.

Landfill capacity

There is enough putrescible landfill capacity in the region to see it through most of the next three decades under the base case, with current approved capacity forecast to be exhausted by around 2048 (Figure 39). This will be brought forward by a decade to 2038 in the low recovery scenario. However, there is also good potential for the Springmount landfill to be expanded beyond its current approved airspace, subject to approval, which would provide capacity for a few decades more.

There are significant environmental constraints in the region which would make it very difficult to locate and develop any new putrescible landfill, and there is no pressing need to do so provided the Springmount landfill remains open and available to the region. There are risks in having the entire region reliant upon a single, privately owned facility, if that site were to become unavailable for any reason (including a natural disaster). This highlights the need for this region to be particularly focused on improving resource recovery and decreasing its future dependence on landfill.

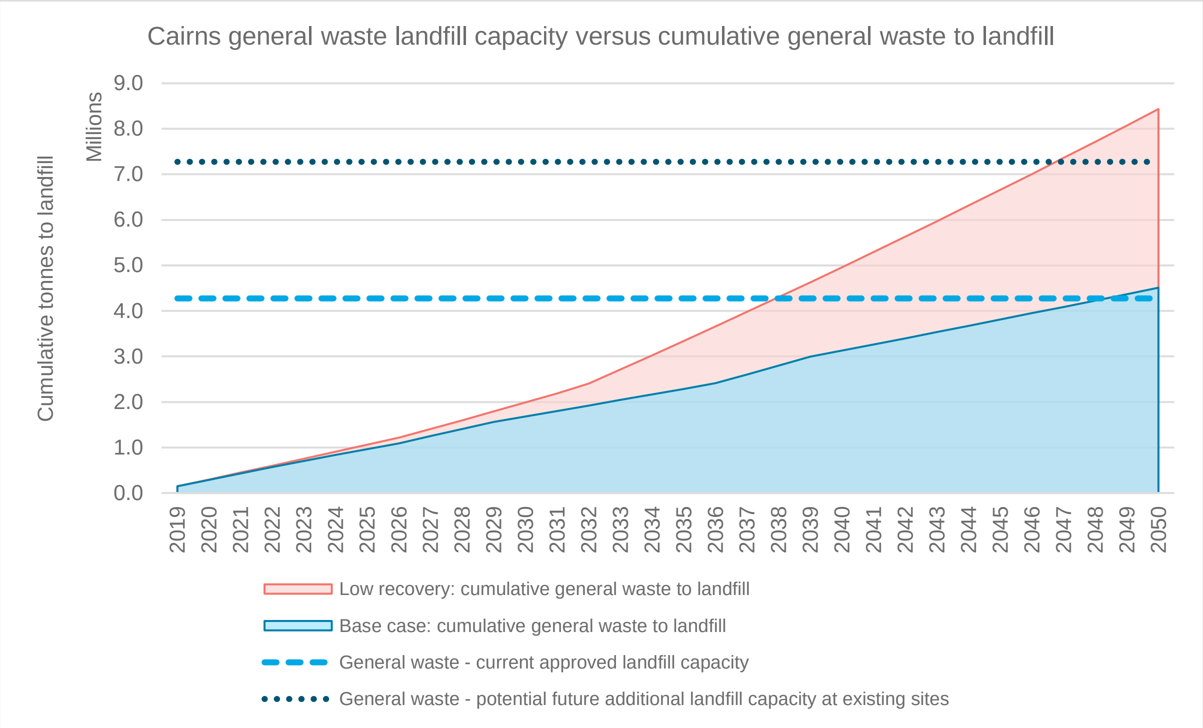


Figure 39: Cairns region putrescible landfill capacity assessment

Transfer Infrastructure

Efficient transfer infrastructure is relatively well established in most local government areas in the Cairns area, as most councils already haul residual waste moderate to long distances for disposal. As landfills close in Mareeba and Tablelands, there may be a need to develop new or improved bulking transfer facilities in each LGA. Depending on the future strategy adopted by Cairns beyond the current AWT contract, there may be a need for new bulk loading capacity to be developed in Cairns.

6.2 Darling-Downs Maranoa Region

6.2.1 Regional Snapshot

The Darling Downs - Maranoa region covers a large area bordering New South Wales from Southern Downs and Toowoomba Regional Councils in the south-east and stretching west to include Maranoa and Balonne Shire. It is primarily a rural region with a rich and diverse agricultural sector including grazing, cropping and intensive livestock rearing (feedlots, piggeries and poultry farms). It is also home to significant coal seam gas (CSG) fields and infrastructure, particularly in the western part of the region. Toowoomba is the main city in the region and serves as a hub for many regional services, including to the CSG industry.

The region has a total estimated population of around 267,000 (in 2019) which is forecast to grow to around 329,000 people by 2050[24]. Toowoomba is the main population centre in the region. Moderate growth is expected in Toowoomba, with only slightly positive growth forecast in Western Downs and Southern Downs local government areas. The other three LGAs of Balonne, Goondiwindi and Maranoa are all forecast to experience a decline in their populations to differing degrees over the coming decades.

Regional economy

Agriculture is one of the region's largest contributors to the regional economy and the region exports significant volumes of produce to other regions and overseas markets. The fertile soil and temperate climate has a reputation for producing a range of agricultural products including vegetables, tree and stone fruits, grains and pulses and meat via both intensive and broad scale grazing farms. Cotton is also an important crop in the south-west of the region.

The region is home to around 22% of Queensland's cattle and Australia's largest concentration of feedlots with around 160 feedlots and a total approved capacity of over 700,000 cattle. There is a similar number of piggeries (168) which are approved to house more than 670,000 animals and around 26 poultry farms licensed to house almost 7 million birds.

The diverse food processing sector includes flour millers, diary manufacturers, bakery and small goods manufacturers and meat processors (abattoirs). There is also a significant agricultural technology and equipment manufacturing sector based in Toowoomba, as well as broader construction and infrastructure industries.

Toowoomba is the main commercial hub and service centre for the region with key sectors such as education, professional services and food processing and manufacturing being major contributors to employment and the economy. Toowoomba is also a service centre and staging point for the coal seam gas industry operating across the Surat Basin, supported by significant energy and transport infrastructure across the region. For example, the main Roma-to-Brisbane natural gas transmission line runs through the region and through Toowoomba, supplying gas to the east coast market.

Toowoomba is also a hub for education and home to the University of Southern Queensland's main campus.

Transport infrastructure

The major road network in the region is reasonably well developed, but smaller rural roads can vary in quality.

The recently completed Toowoomba Second Range Crossing was a major new infrastructure development for the region providing a more efficient route for heavy vehicle traffic to move through the region and traverse the range between Toowoomba and SEQ, bypassing the centre of Toowoomba.

[24] Based on medium series projections by the Queensland Government Statisticians Office, extrapolated beyond 2041.

The region is also home to Australia’s newest private airport at Wellcamp on the western side of Toowoomba. While air transport is unlikely to play a direct role in resource recovery, the airport does support local producers and manufacturers to access export markets, which may have flow on effects for resource recovery.

In terms of rail, the Western system extends from Miles west to Quilpie and includes branches to Cunnamulla and Meandarra. The West Moreton system connects Miles to Rosewood near Ipswich providing a link through to SEQ. The South Western system extends from Toowoomba south to Thallon and includes a southern branch through Stanthorpe and Warwick.

The interstate Inland Rail line will pass through the region when complete, providing direct rail freight connections to SEQ (Brisbane via Bromelton in Scenic Rim LGA) and south to inland New South Wales and ultimately to Melbourne.

Regional constraints and opportunities

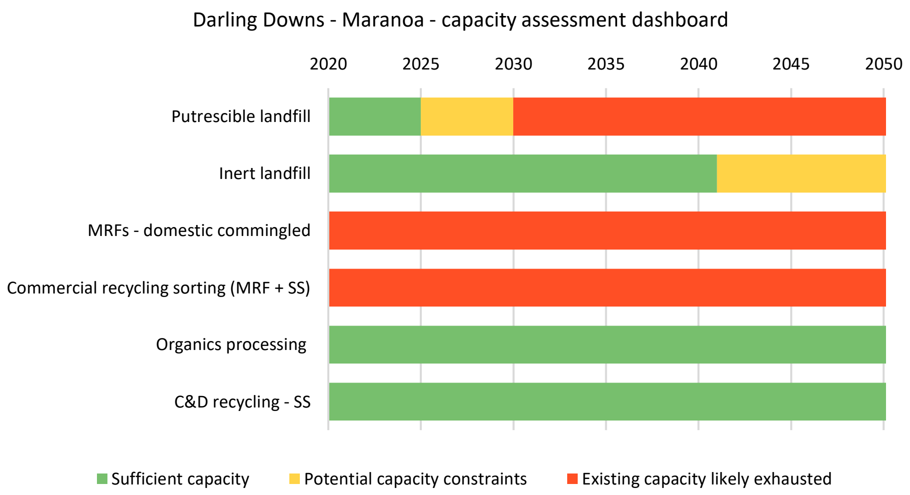
Like any other rural and regional part of Queensland, the small dispersed communities outside of Toowoomba make it challenging to deliver efficient waste and resource recovery services and infrastructure.

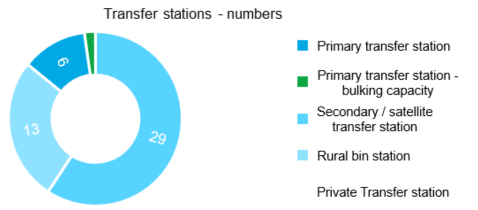
The strong agricultural industry provides potential opportunities for co-processing of domestic and commercial organics with agricultural residues (e.g. from feedlots or piggeries) and/or food processing residues. The well developed energy infrastructure, including natural gas transmission, provides potential opportunities for renewable gas and energy to be produced from waste materials and exported to the rest of the state.

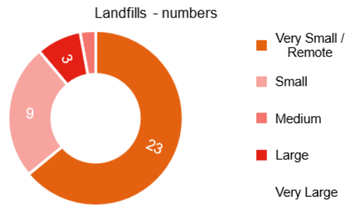
Overleaf is a one-page snapshot of existing key waste infrastructure, forecast waste flows and future infrastructure needs and opportunities for the Darling Downs-Maranoa region. Further detail is provided in the subsequent sections.

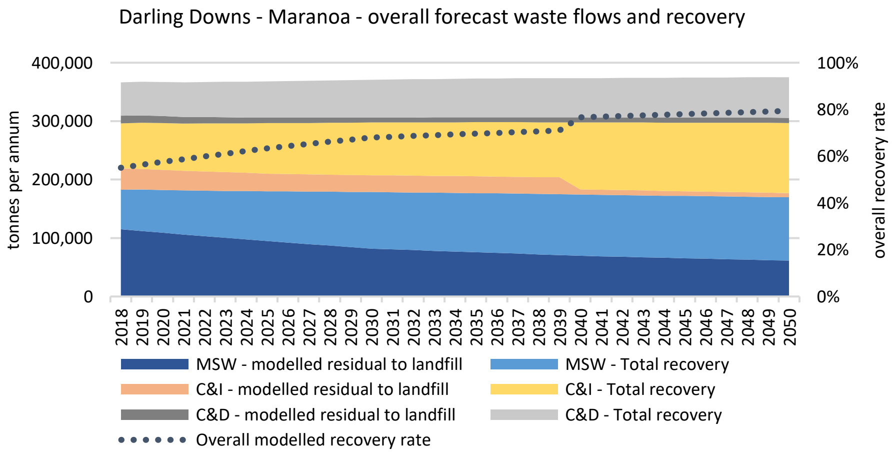
Darling Downs-Maranoa – Regional infrastructure snapshot			
Landfill infrastructure	Ownership	No. facilities	Remaining void capacity (millions tonnes)
Putrescible landfills	Council-owned	35	1.1
	Privately owned	0	-
Inert landfills	Council-owned	0	-
	Privately owned	1	0.3
Recovery Infrastructure	Sub-category	No. facilities	Annual capacity (tonnes pa)
Organics processing	Composting	6	194,600
	Mulching only	0	-
Recycling sorting	MRFs	0	-
	Source separated recycling facilities	3	5,000
C&D recycling facilities		3	100,000
Metals	Metals recycling	3	80,000
	Battery / e-waste processing	0	-

** capacity estimate excludes 'very small' landfills*









Future infrastructure needs & opportunities

- *New MRF in the short to medium term to support growth in domestic and commercial recycling*
- *New and expanded organics processing capacity, including facilities that can process domestic and commercial food organics*
- *Integrated treatment of organics (e.g. food, food processing, biosolids, agricultural waste), including energy recovery (AD) and co-location with energy user*
- *New facilities to process dry commercial waste into refuse derived fuels, subject to offtakes in SEQ*
- *Enhanced capacity to process C&D waste into high quality products*
- *Potential tyre processing facility in Toowoomba servicing the region, including CSG and farming sectors*
- *Short term need for some councils to either develop new landfill capacity or invest in bulk hauling transfer capability and send waste elsewhere for disposal (e.g. Toowoomba or SEQ)*
- *Medium term need to develop a regional plan to secure adequate landfill capacity*

6.2.2 The current situation

Waste flows

The Darling Downs – Maranoa region managed around 370,000 tonnes of waste across all three headline streams in 2017-18 and this is forecast to grow to modestly to 380,000 tonnes by 2050 in the base case (low growth) or as high as almost 450,000 tonnes if current per capita waste generation rates are maintained. Table 25 summarises the key waste streams that were disposed or recovered in the region in 2017-18, which serves as the baseline for forward projections.

The region achieved a high recycling rate for C&D waste (81%) and C&I waste (69%) but the recovery rate of MSW was lower at 37%.

Table 25: Summary of regional current (2017-18) baseline waste flows

Stream	2017-18 tonnes
Disposal	
MSW - kerbside to landfill	59,941
MSW - non-kerbside to landfill	55,172
C&I - disposal to landfill	36,353
C&D - disposal to landfill	13,169
Recovery	
MSW - commingled recycling	13,110
MSW - other recycling	5,779
MSW - green waste recovery	47,717
MSW - AWT recovery	-
C&I - recycling	61,699
C&I - organics & timber recovery	19,067
C&D - recovery of masonry materials	50,793
C&D - other recycling	6,189

Figure 40 below shows the estimated overall breakdown of key materials via disposal and recovery pathways, noting that the landfill breakdown is an estimate based on assumed composition (see 2.3.1). It shows there are opportunities to improve the recovery of:

- Food organics and to a lesser extent, garden organics, from both household and commercial sources, with an estimated 40,000 tonnes landfilled in 2017-18
- Paper, cardboard, plastics, glass and metals, from households and commercial sources
- An estimated 30,000 tonnes of timber waste across all streams which is currently landfilled.

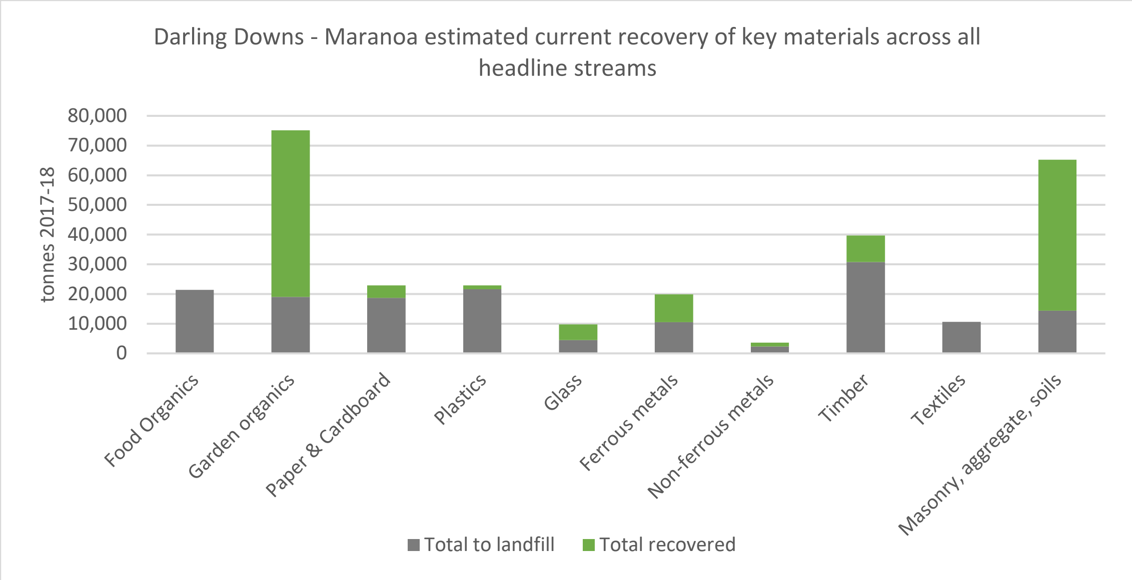


Figure 40: Summary of estimated regional disposal and recovery by material (MSW, C&I + C&D)

Collection systems

The Darling-Downs Maranoa region features a mix of household collection services. Toowoomba accounts for the majority of the population (67% of serviced households) and offers a three-bin service of waste, recycling plus an opt-in garden waste bin which has the highest uptake rate of any optional organics service in the state. Balonne, Southern Downs and Western Downs offer a conventional two bin service of waste and recycling, which accounts for around 27% of serviced households in the region. Goondiwindi and Maranoa regional councils offer a single waste bin and face significant challenges in servicing small dispersed rural communities.

Table 26: Summary of regional kerbside collection services

Collection service	Councils	No. households serviced (estimated 17-18)
Single bin (residual waste only)	Goondiwindi, Maranoa	4,800
Two bin – recycling + residual waste	Balonne, Southern Downs, Western Downs	23,700
Three bin – recycling + garden organics (opt-in) + residual waste	Toowoomba	59,200

Existing waste infrastructure

There is no MRF in the region and those councils that provide a kerbside recycling service are understood to be transferring recyclables to SEQ for processing via Toowoomba, in some cases after basic pre-sorting.

There are a number of composters in the region (6 identified) although they are mostly thought to process residues from agriculture and/or CSG operations. The majority of council collected garden organics is thought to be mulched. There were three C&D recyclers identified in the region with a combined capacity of 100,000 tonnes per annum.

The region is home to 36 identified active landfills including one privately owned inert only facility. 32 of those landfills are classified as small or very small and most are in rural and remote locations. A number of councils are facing imminent and near term closure of primary landfills and it is difficult to share landfills regionally, given the distances between population centres. There is just over a million tonnes of approved capacity in existing landfills according to the data available but potential for expansions at some sites.

The number of landfills has significantly reduced over the last decade as several councils in the region have made concerted efforts to rationalise landfills and convert them to transfer stations.

Figure 41 overleaf provides a summary map of existing infrastructure in the region.

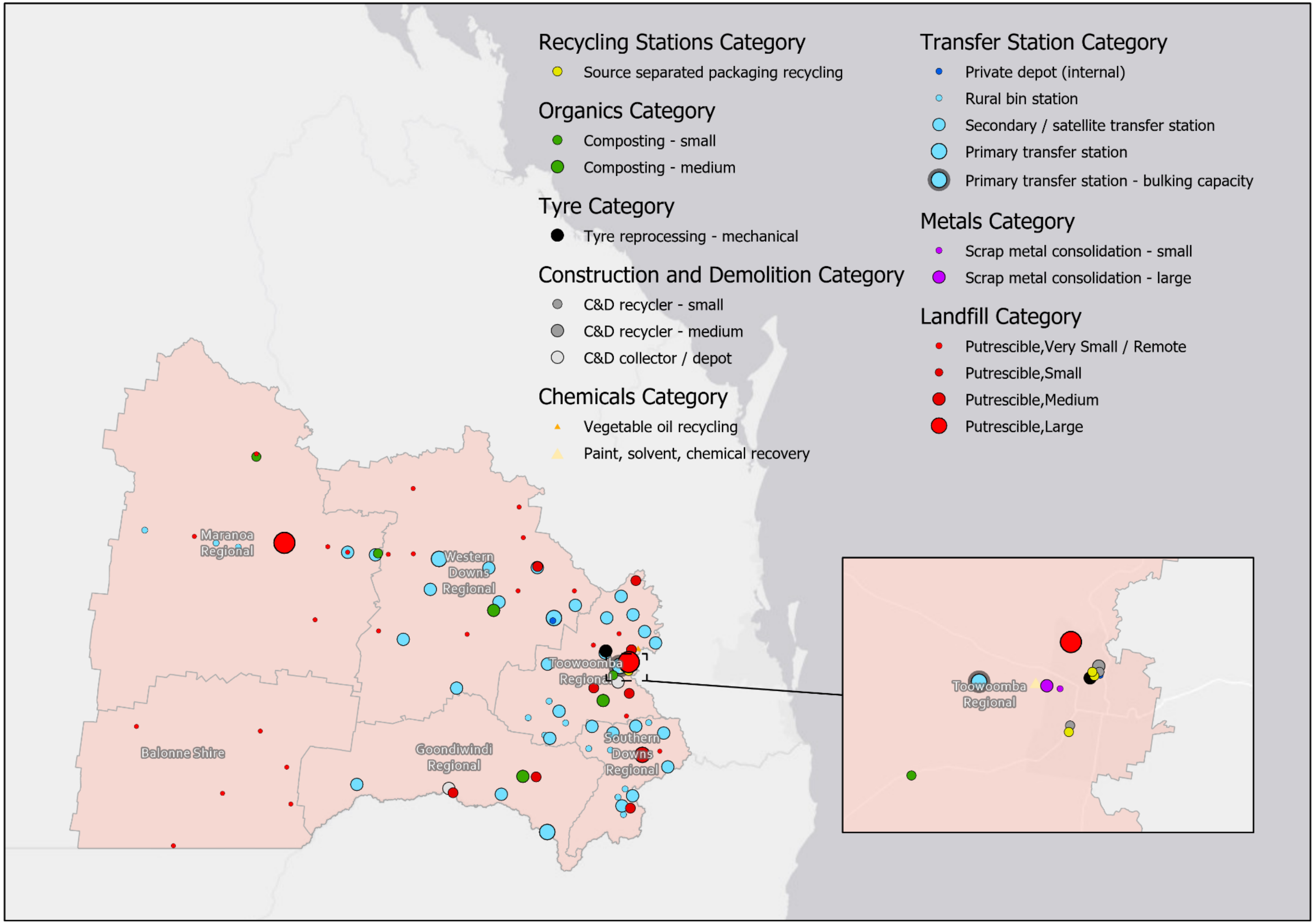


Figure 41: Darling Downs - Maranoa region map of existing waste and resource recovery infrastructure

6.2.3 Future needs and opportunities

Future waste flows

Figure 42 provides a summary of the forecast waste flows for the Darling Downs - Maranoa region under the base case. To achieve the Strategy recycling targets at a state level, the modelling assumes relatively optimistic but achievable capture rates of household food and garden organics and commercial organics, although councils will need to determine the best way to achieve this within their own contexts. There are also ambitious assumptions around future capture of recyclables from household and commercial waste and moderate assumptions for the recycling of C&D waste, mostly through further recovery of source separated masonry materials.

The waste flow modelling does not include a regional energy recovery facility although that is not to say it could not be considered. Achieving the Strategy recovery targets will require the deployment of energy-from-waste in some form in a number of regional centres and the modelling has nominally assigned those facilities to other regions, but there are still significant further investigations and feasibility analyses to be undertaken to determine where EfW may be viable.

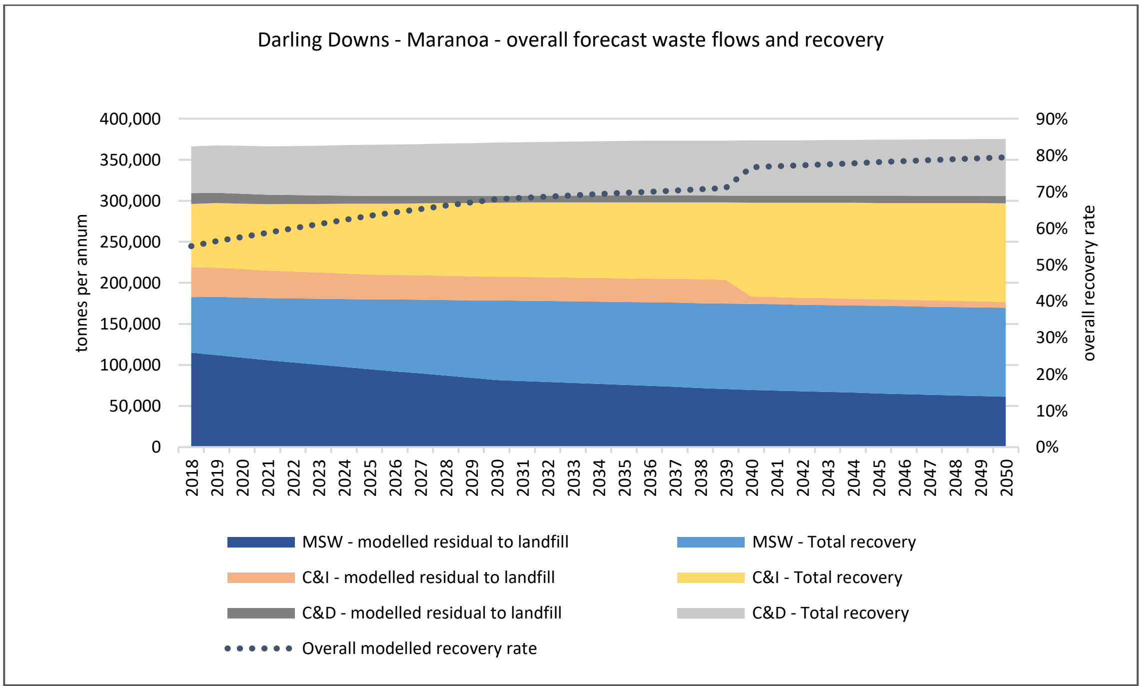


Figure 42: Forecast waste disposal and recovery by headline stream

Resource recovery infrastructure needs

The projected future waste flows, including the new resource recovery required to meet the Strategy targets, have been assessed against the existing available processing capacity in the region (based on available data) to identify future gaps in recovery capacity. Table 27 below provides a summary of future capacity needs and opportunities based on this analysis. Future landfill capacity needs have also been assessed under different recovery scenarios and are discussed separately below.

Table 27: Summary Darling Downs - Maranoa resource recovery infrastructure capacity needs assessment (under base case)

Capacity assessment	Comments
Domestic commingled recycling MRF capacity	With no existing MRF capacity in the region, there is an immediate gap in local recycling capacity and a new regional MRF may help support growth in recycling across the region. It may also be viable for some areas to continue sending recyclables to SEQ for processing, although noting that transporting uncompacted recyclables is generally quite inefficient. In any case, there needs to be an assessment of options from a regional perspective, with potential for Toowoomba to act as a regional processing hub. With domestic commingled recycling forecast to grow from almost 13,000 tonnes currently to 21,000 tonnes by 2030 and 27,000 tonnes by 2050, there may be sufficient demand to justify a new local MRF, consistent with other regional cities across Queensland.
Commercial packaging recycling capacity	There are source separated recycling facilities operating in the region but there seems to be a shortfall in recycling capacity for commercial recycling which may limit future growth. As with domestic recycling, it is likely that commercial recycling is currently being transferred to SEQ for sorting, via local depots. Development of a local MRF in Toowoomba could support the required increase in commercial recycling across the region.
Organics recovery capacity	There seems to be ample organics processing within the region. Total organics recovery (domestic and commercial) forecast to grow from 67,000 tonnes now to 87,000 tonnes by 2030 and then 91,000 tonnes by 2050, and the data suggests that existing facilities will be able to manage those volumes. However, most of the existing capacity is currently processing agricultural organics and various commercial and industrial streams (including from the CSG industry), so it is not clear whether the existing facilities are suited to processing the expected growth in future recovery of domestic food and garden organics. While overall existing capacity would seem to be adequate, it is likely that there will need to be a shift in the time of processing employed. Given the dispersed and mostly rural nature of the region (outside of Toowoomba) and the relative cost of transporting organics long distances, regional processing solutions may not be the most efficient approach. Local solutions may be more appropriate and co-processing of domestic and commercial organics with agricultural residues and biosolids may be one way to boost the scale of local facilities. Depending on the location of the facility, enclosed processing may be required, but if the facilities are relatively small scale and in rural areas, open composting methods may be adequate. There is good potential to establish an organics-based precinct in the region linking with existing infrastructure such as feedlots, piggeries, poultry farms, abattoirs and food processing facilities and/or urban sewage treatment facilities. There is significant potential to build on existing market opportunities for recovered organics to go into agriculture.
C&D recycling capacity	The data indicates that there seems to be adequate C&D recycling capacity at the regional level, but there may be a need for more localised solutions. With C&D recycling forecast to grow from 57,000 tonnes now to 65,000 tonnes by 2030 and 70,000 tonnes by 2050, the existing three recycling facilities that have been identified in the region should be capable of managing the growth. There may still be a need for improving existing facilities to ensure the output of high quality products with sustainable end markets.

Other resource recovery infrastructure	Tyres have been identified as a particular challenge in the rural parts of the region, so there may be scope to establish a tyre processing facility in the region, potentially in Toowoomba, to service domestic and commercial demand, but also agricultural and the resources sectors.
Energy recovery infrastructure	As noted above, there is potential to deploy AD to co-process a range of organics from different sectors to generate energy. Energy recovery from residual waste has not been modelled in the region, other than a small volume of commercial waste in the medium to long term, which would likely involve transfer to facilities in SEQ. The projections estimate that there will be 110,000 tonnes of residual MSW and C&I by 2030, declining to around 68,000 tonnes by 2050 as a result of slow or negative population growth in most parts of the region, assumed waste reduction per capita and improved recycling levels. EfW may be a viable solution in the region and should be assessed, but will be more challenging than other regions given the highly dispersed nature of the population and declining waste volumes.

Landfill capacity

Based on the information provided by councils for this Report, the Darling Downs-Maranoa region is facing a regional shortage of landfill capacity in the medium term and a number of local governments are facing more short-term issues. At a regional level, the estimated 1 million tonnes of existing approved putrescible capacity is forecast to be exhausted by 2026 under the base case and slightly earlier (2025) under the low recovery scenario (Figure 43). However in reality, given the regional population is dispersed over a large area, sharing of regional landfill capacity is not necessarily feasible, and a number of councils are facing acute local issues.

Southern Downs Regional Council is facing a particular challenge with its two largest landfills set to close in the short term. Goondiwindi Regional Council is also facing exhaustion of approved capacity at its two key landfills over the next decade but both have potential for significant expansion, which if implemented, will be enough to last the next 30 years. One of the larger landfills in the region, the Toowoomba Waste Management Centre has potential to expand within the current site, but subject to approval.

There is inert landfill capacity within a single private facility, which should be adequate for the next 30 years under the base case, or 20 years under the low recovery scenario.

There is a need for councils across the Darling Downs-Maranoa region to act soon, to formulate a plan at the regional level to secure adequate landfill capacity for the longer term.

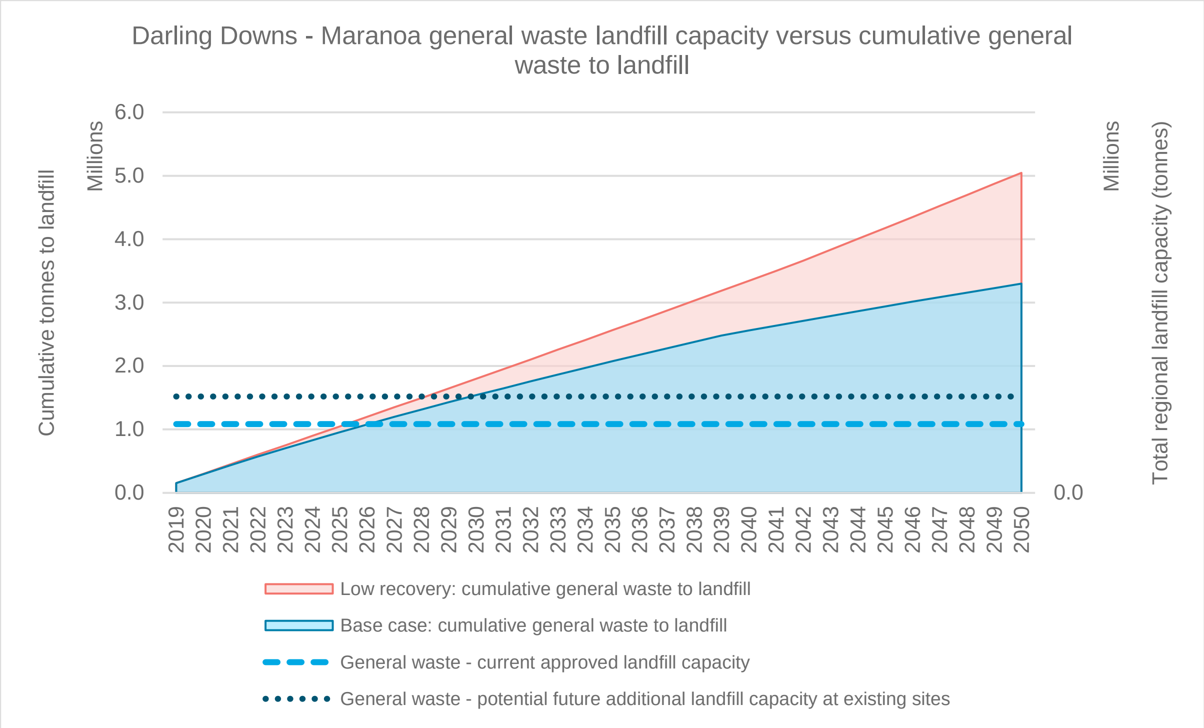


Figure 43: Darling Downs-Maranoa region putrescible landfill capacity assessment

Transfer Infrastructure

Depending on the solution to the impending landfill capacity issues in some local government areas, there may be a need to invest in new bulking transfer capability. There is a good network of transfer stations in the region, of varying scales. Given the history of transferring recyclables to SEQ for processing, there is good transfer infrastructure already in place with Toowoomba acting as a hub for many streams.

6.3 Fitzroy Region

6.3.1 Regional Snapshot

The Fitzroy region includes six LGA's around the main regional centres of Rockhampton and Gladstone, which are both similar sized major towns. Gladstone is home to significant heavy industry and minerals processing, and the recently constructed liquefied natural gas (LNG) processing facilities. There are a number of coal mines within the Central Highlands LGA. The rest of the region is largely agricultural with Rockhampton being known as the beef capital, with a concentration of beef grazing farms, feedlots and abattoirs.

The region has a total estimated population of around 226,000 (in 2019) which is forecast to grow to around 304,000 by 2050[25]. Moderate growth is expected in Rockhampton and Livingstone local government areas, as well as Gladstone following an initial decline. The other three LGAs of Banana Shire, Central Highlands and Woorabinda are all forecast to experience a decline in their populations to differing degrees over the coming decades.

Woorabinda Aboriginal Shire has a population of just under 1,000 people. As an indigenous council, it is considered in more detail within the Queensland Indigenous Waste Strategy.

Regional economy

Agriculture is a significant contributor to the regional economy and the region accounts for 11% of Queensland's total agricultural production. The subtropical climate, fertile soils and relative water security via the Fitzroy River are highly supportive of broad-acre and intensive agriculture. Beef production is one of the industries with three major abattoirs and around 54 feedlots in the region licensed to house over 70,000 cattle as well as 15 piggeries. There is also grain production and horticulture including vegetables and tree and tropical fruits. Around Emerald, cotton is one of the major crops and is processed at the Yamala Cotton Gin.

The resources sector is the other key component of the economy. The Bowen Basin contains the largest coal reserves in Australia, with 34 operational coal mines, producing 40% of Queensland's coal production. It spans across both the Central Highlands and Banana local government areas over 60,000 square kilometres in Central Queensland. The coal from the Bowen Basin is transported by rail to either the Port of Gladstone, Hay Point or Abbot Point Ports for export.

Rockhampton acts as a service centre for mines in the Bowen and Galilee basins, as does the town of Emerald. Gladstone is home to substantial minerals processing and other heavy industry, including two of the world's largest alumina refineries and a number of other major industrial giants. The Gladstone State Development Area continues to attract large industry to the region, including the recently developed Liquefied Natural Gas (LNG) industry.

The region is also home to Queensland's newest and most efficient and technically advanced coal-fired power plants, the Stanwell Power Station located 22km west of Rockhampton with a generating capacity of 4,100 MW.

The region is also home to education facilities, including Central Queensland University based in Rockhampton. There is a large military presence in Rockhampton with the Western Street Army Barracks whilst Livingstone is home to the Shoalwater Bay Military Training area.

Healthcare and social assistance as well as retail trade, are major employers in the region. Tourism is important in some areas including Livingstone Shire, with particular focus on Keppel Bay and nearby islands.

Transport infrastructure

The Bruce Highway passes through the region tracking the coast and providing the main connection to the north and south. The Capricorn Highway extends from Rockhampton to the west, linking with key

[25] Based on medium series projections by the Queensland Government Statisticians Office, extrapolated beyond 2041.

mining areas. Future developments include the Rockhampton Ring Road which is in early planning stages. The Dawson Highway also provides a vital east-west link from Gladstone to inland areas.

The North Coast rail line passes through the region connecting Brisbane and Cairns. The Central West line adjoins the Blackwater Coal Rail system at Emerald and runs from Emerald to Winton via Longreach. The Blackwater rail corridor runs from Rockhampton to Stanwell and on to mines in the west. The Moura rail corridor runs south-west from Gladstone to coal mines around Callide and Dawson.

The Port of Gladstone is Queensland's largest multi-commodity port and a key strategic facility supporting the coal mining and minerals processing sectors in the region.

Regional constraints and opportunities

Like other regional and rural parts of the state, the more rural LGAs in the region struggle with small dispersed communities, lack of scale and transport costs.

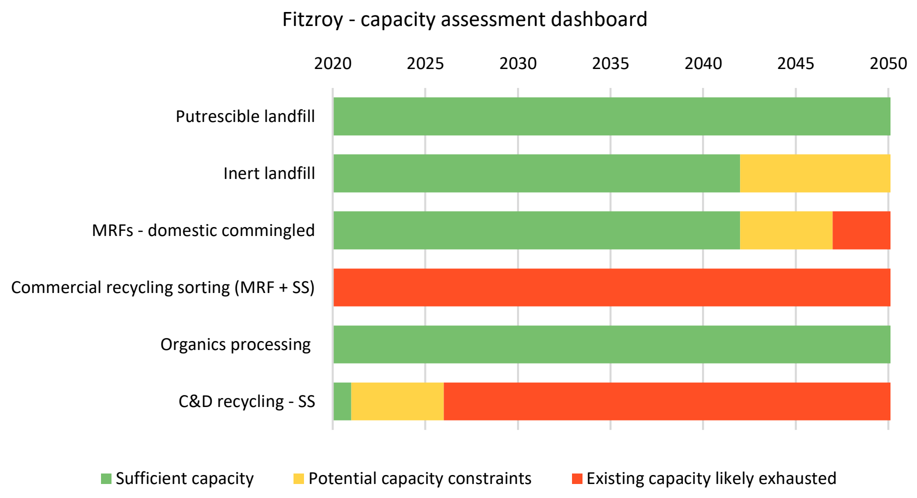
There may be potential for energy recovery from waste to support existing energy intensive industry in Gladstone, or power generation at Stanwell. Indeed, feedback received during the consultation workshop in the region indicated strong support from both local governments and Gladstone based industry to work in partnership to find mutually beneficial waste solutions. The cement kiln in Gladstone presents a particularly unique opportunity to utilise high quality refuse derived fuels directly in the existing kilns, as is commonly practiced elsewhere in Australia and globally. The RDF would most likely be derived from dry commercial and construction waste, either from within the region and/or elsewhere in Queensland and could be utilised with relatively minor modifications of infrastructure at the cement kiln. The concept of an energy precinct based around the Stanwell power station has been raised in the past and could potentially be revisited with a waste and resource recovery focus.

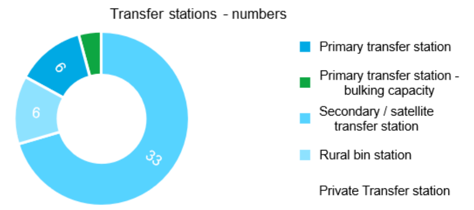
The strong agricultural industry in the region and associated processing facilities such as abattoirs, may also present opportunities for co-location of energy recovery and organics processing infrastructure, and co-processing of organics from a range of sectors.

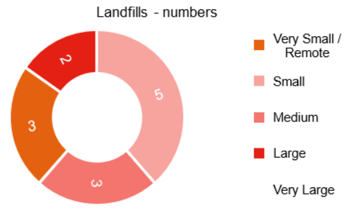
Overleaf is a one-page snapshot of existing key waste infrastructure, forecast waste flows and future infrastructure needs and opportunities for the Fitzroy region. Further detail is provided in the subsequent sections.

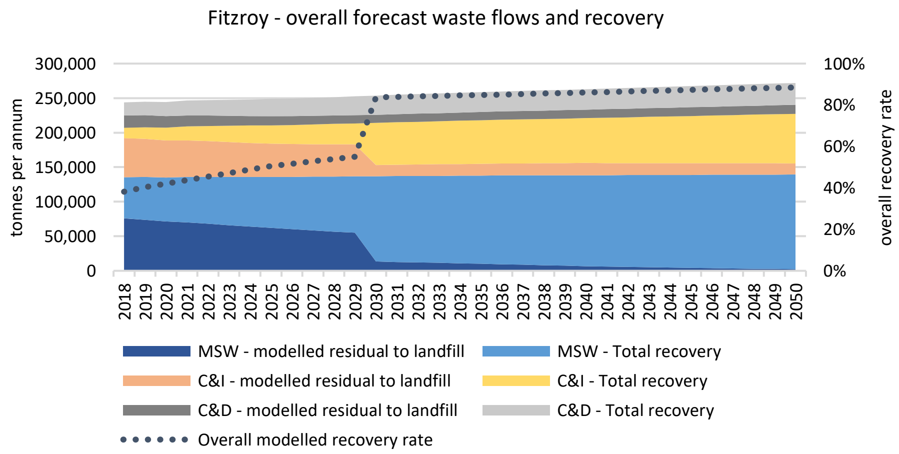
Fitzroy – Regional infrastructure snapshot			
Landfill infrastructure	**Ownership**	**No. facilities**	**Remaining void capacity (millions tonnes)**
Putrescible landfills	Council-owned	10	4.8
	Privately owned	0	-
Inert landfills	Council-owned	0	-
	Privately owned	3	0.5
Recovery Infrastructure	**Sub-category**	**No. facilities**	**Annual capacity (tonnes pa)**
Organics processing	Composting	2	100,000
	Mulching only	1	1,000
Recycling sorting	MRFs	1	16,800
	Source separated recycling facilities	3	-
C&D recycling facilities		2	20,000
Metals	Metals recycling	5	86,000
	Battery / e-waste processing	0	-

** capacity estimate excludes 'very small' landfills*









Future infrastructure needs & opportunities

- *Upgrade existing MRF to ensure compliance with market product standards*
- *Potential upgrades to organics processing capacity to be able to process domestic and commercial food organics*
- *Upgrade and expand existing C&D recycling facilities to accommodate expected modest growth in future C&D recovery*
- *Small scale energy-from-waste capacity for MSW & C&I over the medum to long term, ideally co-located with industry in Gladstone, or production of RDF to use in the cement kiln*
- *New bulking transfer facilities to support regional landfills and processing infrastructure*

6.3.2 The current situation

Waste flows

The Fitzroy region managed almost 250,000 tonnes of waste across all three headline streams in 2017-18 and this is forecast to grow to over 275,000 tonnes by 2050 in the base case (low growth) or as high as 335,000 tonnes if current per capita waste generation rates are maintained. Table 28 summarises the key waste streams that were disposed or recovered in the region in 2017-18, which serves as the baseline for forward projections.

The region achieved moderate recycling rates for MSW (44%) and C&D waste (51%) but a lower recovery rate for C&I waste (around 24%).

Table 28: Summary of regional current (2017-18) baseline waste flows

Stream	2017-18 tonnes
Disposal	
MSW - kerbside to landfill	53,966
MSW - non-kerbside to landfill	21,937
C&I - disposal to landfill	56,882
C&D - disposal to landfill	17,994
Recovery	
MSW - commingled recycling	11,632
MSW - other recycling	20,475
MSW - green waste recovery	26,190
MSW - AWT recovery	-
C&I - recycling	10,067
C&I - organics & timber recovery	7,718
C&D - recovery of masonry materials	15,570
C&D - other recycling	3,242

Figure 44 below shows the estimated overall breakdown of key materials via disposal and recovery pathways, noting that the landfill breakdown is an estimate based on assumed composition (see 2.3.1). It shows there are opportunities to improve the recovery of:

- Food and garden organics from both household and commercial sources, with an estimated 34,000 tonnes landfilled in 2017-18
- Paper, cardboard, plastics and metals, from both household and commercial sources
- An estimated 25,000 tonnes of timber waste across all sectors which is currently landfilled
- Around 20,000 tonnes of C&D masonry materials currently landfilled.

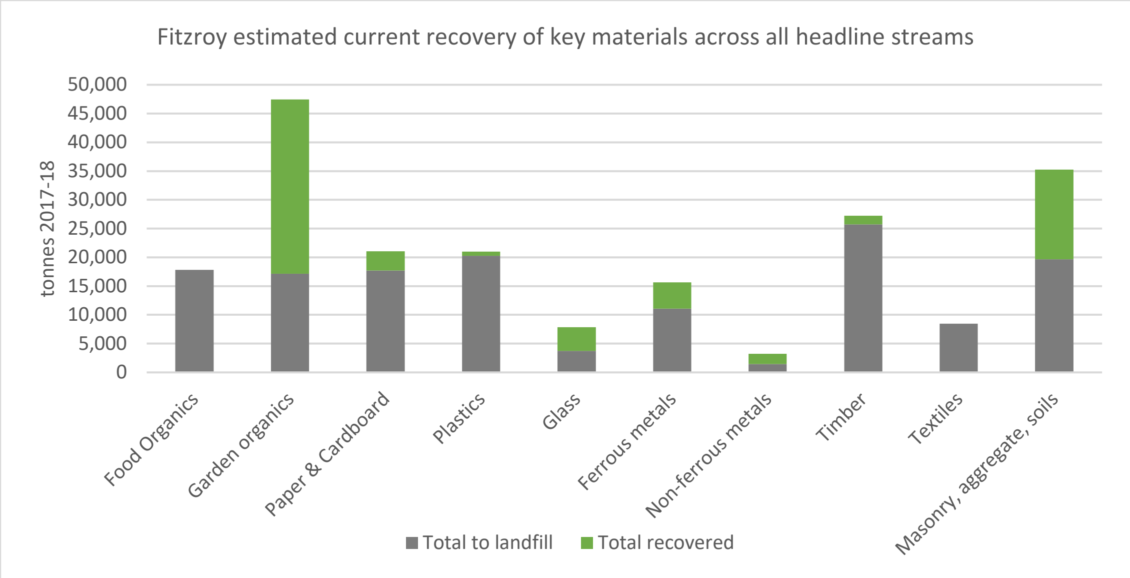


Figure 44: Summary of estimated regional disposal and recovery by material (MSW, C&I + C&D)

Collection systems

The majority of the Fitzroy region is serviced by a conventional two bin service of waste and recycling, including Central Highlands, Gladstone, Livingstone and Rockhampton councils, accounting for around 94% of serviced households in the region. The rural shires of Banana and Woorabinda offer a single waste bin to their small communities.

Table 29: Summary of regional kerbside collection services

Collection service	Councils	No. households serviced (estimated 17-18)
Single bin (residual waste only)	Banana, Woorabinda	4,400
Two bin – recycling + residual waste	Central Highlands, Gladstone, Livingstone, Rockhampton	77,600

Existing waste infrastructure

For household recycling, the region is serviced by a regional MRF in Rockhampton processing kerbside recyclables from Rockhampton, Gladstone, Livingstone and Central Highlands. The MRF includes a glass reprocessing plant to produce glass sand and aggregate.

Two composters were identified in the region with significant combined capacity. There is still a significant volume of garden waste that is recovered through simple mulching at the council landfill sites. There were two C&D recyclers identified in the region.

Fitzroy region is home to 13 active landfills, including three privately owned inert-only landfills. With over 5 million tonnes of existing approved capacity and current landfill inputs of around 150,000 tonnes per annum (2017-18) there is no pressing need for additional capacity in the near term. The majority of the landfill capacity is held within the main landfills of Rockhampton and Gladstone Regional Councils, which are both expected to have long lifespans (beyond 2050). Banana Shire Council would appear to be facing a short term capacity issue with its three landfills slated to close in the short to medium term.

Figure 45 overleaf provides a summary map of existing infrastructure in the region.

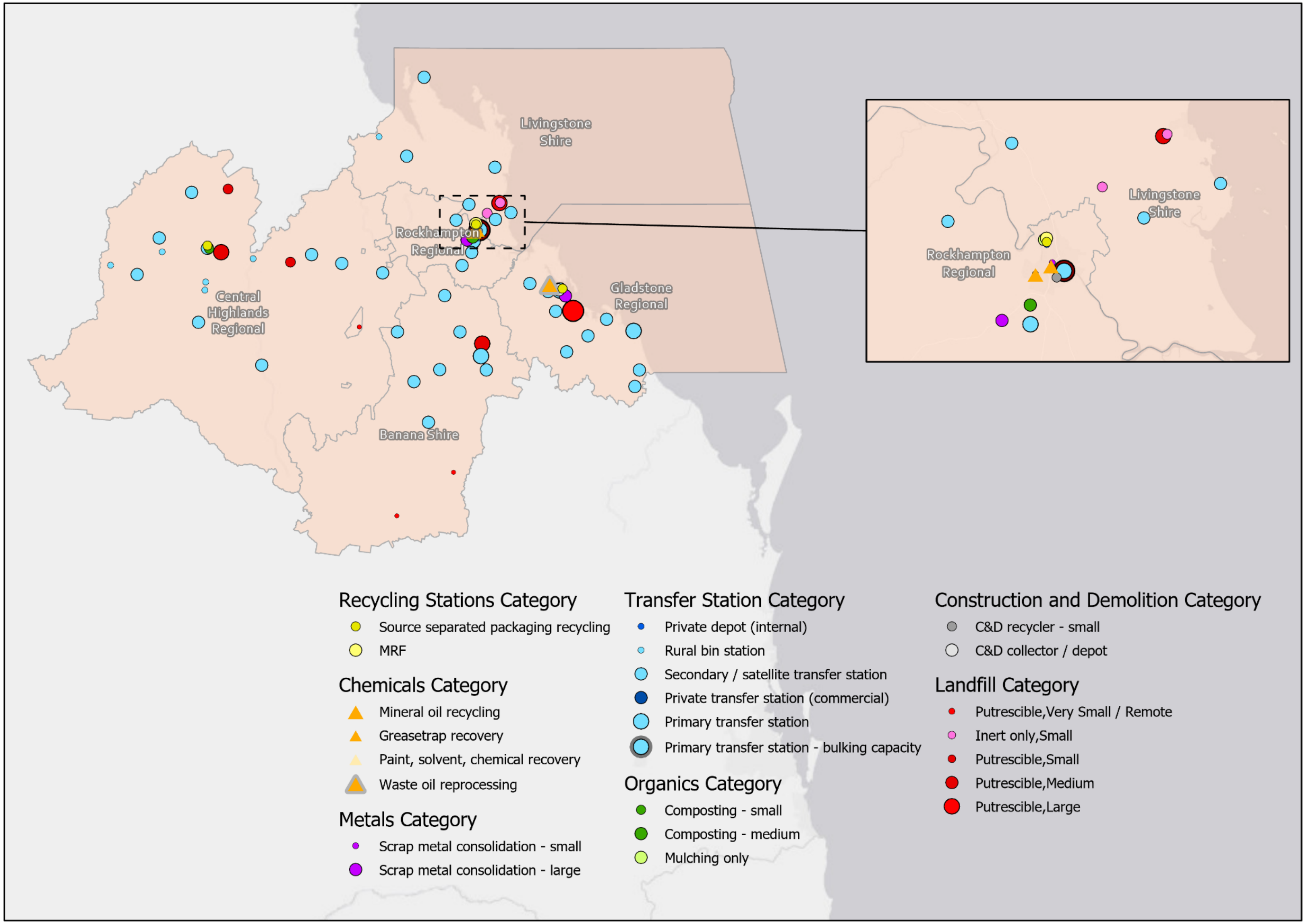


Figure 45: Fitzroy region map of existing waste and resource recovery infrastructure

6.3.3 Future needs and opportunities

Future waste flows

Figure 46 provides a summary of the forecast waste flows for the Fitzroy region under the base case. To achieve the Strategy recycling targets at a state level, the modelling assumes relatively optimistic but achievable capture rates of household food and garden organics and commercial organics, although councils will need to determine the best way to achieve this within their own contexts. There are also ambitious assumptions around future capture of recyclables from household and commercial waste and moderate assumptions for the recycling of C&D waste, mostly through further recovery of source separated masonry materials.

The waste flow modelling also assumes a moderate scale regional energy recovery facility for residual MSW and C&I waste, nominally modelled as 70,000 tonnes per annum capacity and operational by 2030, resulting in a visible step change in the recovery profile at that time. As noted above, achieving the Strategy recovery targets will require the deployment of energy-from-waste in some form in most of the large regional centres but the exact timing and scale is not set and there are still significant further investigations and feasibility analyses to be undertaken to determine if or when such a solution may be viable in the region.

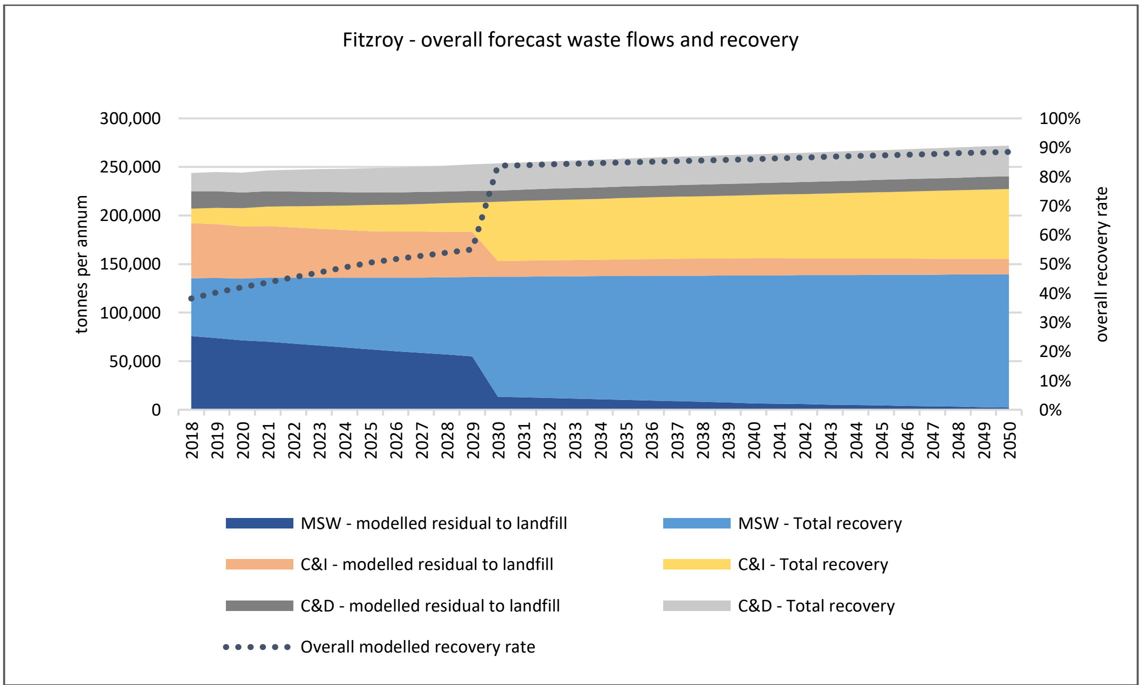


Figure 46: Forecast waste disposal and recovery by headline stream

Resource recovery infrastructure needs

The projected future waste flows, including the new resource recovery required to meet the Strategy targets, have been assessed against the existing available processing capacity in the region (based on available data) to identify future gaps in recovery capacity. Table 30 below provides a summary of future capacity needs and opportunities based on this analysis. Future landfill capacity needs have also been assessed under different recovery scenarios and are discussed separately below.

Table 30: Summary Fitzroy resource recovery infrastructure capacity needs assessment (under base case)

Capacity assessment	Comments
Domestic commingled recycling MRF capacity	Domestic commingled recycling is forecast to grow from 11,600 tonnes currently to 14,500 tonnes by 2030 and 18,000 tonnes by 2050. The existing MRF is likely to have adequate capacity for that growth, although it will likely need to be upgraded to keep up with changing product quality standards.
Commercial packaging recycling capacity	There are facilities taking source separated commercial recycling but there is limited information on capacity. The MRF will be less able to take commercial recyclables as domestic inputs grow.
Organics recovery capacity	With total organics recovery (domestic and commercial) forecast to grow from 34,000 tonnes now to 53,000 tonnes by 2030 and almost 62,000 tonnes by 2050, the existing composting capacity between two facilities would seem to be adequate for future growth. Confirmation is required as to whether the existing facilities are appropriately set up and located to process domestic and commercial food organics. Upgrading to enclosed processing may be required in the future.
C&D recycling capacity	There is likely to be demand for additional C&D recycling capacity in the region which could be through expansion of the existing facilities or new facilities. With C&D recycling forecast to grow from 19,000 tonnes now to 28,000 tonnes by 2030 and 31,000 tonnes by 2050, there may not be sufficient demand in the region to support a new facility, but there may be a need for localised capacity in some areas. Mobile processing to support recycling in rural areas may also be a good solution for the region.
Energy recovery infrastructure	There is potential for a small scale thermal energy-from-waste facility processing residual MSW and C&I waste in the region. The projections estimate that there will be 100,000 tonnes of residual MSW and C&I by 2030, dropping to around 90,000 tonnes by 2050. Despite this, EfW could be a viable long-term solution given the potential to co-locate with industry or produce RDF for the cement kiln in Gladstone.

Landfill capacity

The landfill capacity in the Fitzroy region, as quantified based on operator information, would seem to be adequate for the duration of the Report forecast period, under both the base case and the low recovery scenario. However, Banana Shire is likely to face a localised capacity shortage in the near term.

There would also seem to be adequate inert landfill capacity amongst the three existing sites, to support the ongoing C&D disposal needs of the region over the next 30 years under the base case (slightly less under the low recovery scenario).

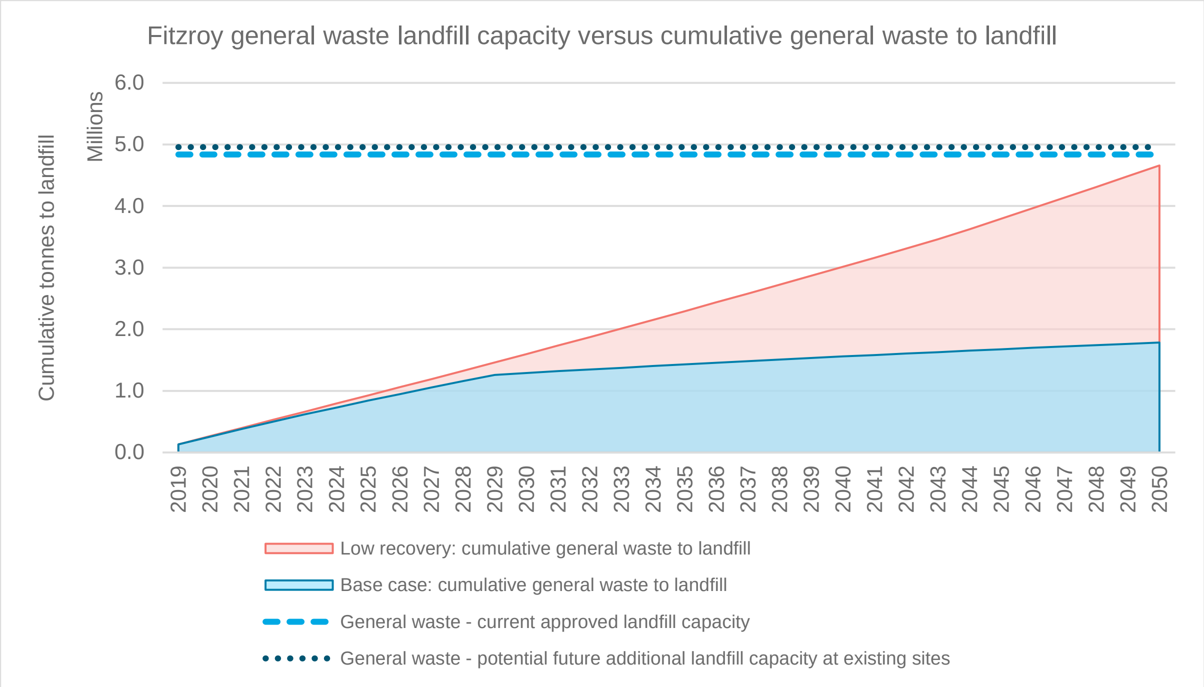


Figure 47: Fitzroy region putrescible landfill capacity assessment

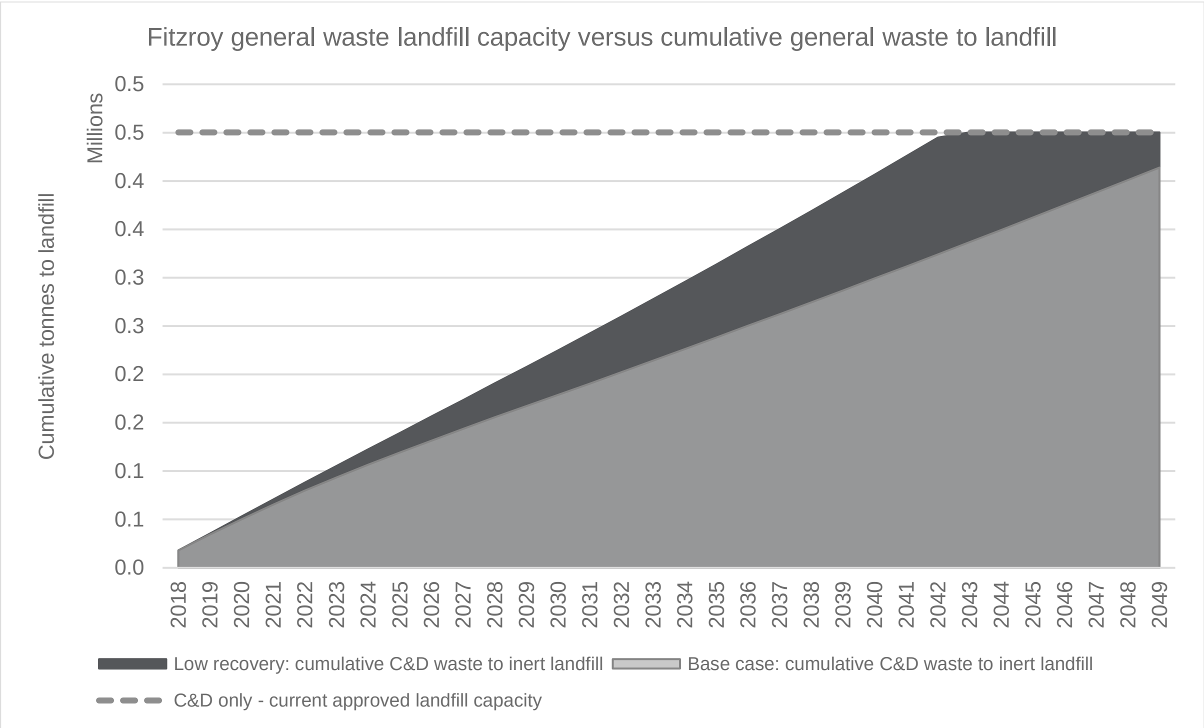


Figure 48: Fitzroy region inert landfill capacity assessment

Transfer Infrastructure

There are some good transfer facilities in the region already, including a bulk loading facility in Rockhampton. As local landfills close and regional landfill capacity becomes concentrated in a smaller number of large landfills, the region will need to develop appropriate transfer facilities to support use of those landfills.

6.4 Mackay Region

6.4.1 Regional Snapshot

The Mackay region covers three LGAs in central Queensland, namely Mackay, Whitsunday and Isaac. Mackay is the main population centre and regional commercial hub. The area has a diverse range of industries from tourism in the Whitsunday area to mining in the Galilee basin and agriculture across the region. Mackay is around 1,000 km north of Brisbane.

The region has a total estimated population of around 174,000 (in 2019) which is forecast to grow to around 255,000 by 2050[26]. Moderate growth is expected in Mackay and Whitsunday local government areas. Isaac Region is forecast to decline in the short term before returning to slight positive growth.

The region adjoins the Great Barrier Reef Marine Park so managing environmental impacts within the Reef catchments is critical. The sensitive local environment has proven challenging in terms of locating and designing disposal facilities on the coastal plain. For example, the Hogan's Pocket Landfill which services Mackay is located some distance from the city and designed with a very high level of containment to protect local groundwater.

Regional economy

Mining is a significant driver of the regional economy with some of the world's richest and largest coal deposits in the Bowen and Galilee basins. The town of Moranbah in Isaac Regional LGA is considered the centre of Queensland's coal mining industry but Mackay is also the primary service hub and a key staging point for employees and equipment flowing inland to the mines.

Agriculture is also significant across the region. The region is Queensland's largest sugar region producing around 1.5 million tonnes of raw sugar, mostly for export markets. There are five operational sugar mills in the region and there has also been a recent shift to diversify into biofuels production with a number of research and commercial projects supporting the government's Biofutures Roadmap. There is also substantial beef grazing land and smaller aquaculture, forestry and horticulture industries. Commercial fishing in the fertile waters surrounding the Reef is also a significant industry.

Tourism is also a significant contributor to the regional economy with the region, particularly the Whitsundays area being the gateway to the Whitsunday islands chain and Great Barrier Reef.

Transport infrastructure

Road networks in the region are generally well developed to support heavy vehicle traffic associated with mining and agriculture. Mackay is around mid-way on the Bruce Highway which runs from Brisbane to Cairns. The Peak Downs Highway also runs out to the south-west from Mackay, servicing many of the mining areas. Improvements to local road networks include the Mackay Ring Road which is currently under construction and provide more efficient movement of heavy vehicle traffic around Mackay as well as better access to the port. The Walkerston Bypass will provide a new 10km link between the Peak Downs Highway and Mackay Ring Road.

The North Coast rail line also runs through the region tracking the coastline and connecting the region with Cairns and Townsville to the north and SEQ to the south. Numerous rail lines also run inland servicing various coal mines through the Goonyella and Newland rail corridors.

Three ports in the region (Mackay, Abbot Point and Hay Point) provide an export pathway for the sugar and coal mining sectors. The Port of Mackay is Queensland's fourth largest multi-commodity bulk port and home to one of the world's largest bulk sugar terminals. The other two ports (Abbot Point and Hay Point) service the coal industry.

Regional constraints and opportunities

[26] Based on medium series projections by the Queensland Government Statisticians Office, extrapolated beyond 2041.

The mining industry manages some of its own waste with on-site disposal facilities, which are not assessed in this Report but do make a notable contribution to managing the region's waste. However, the industry still utilises external services and infrastructure, including council landfills, which can place significant strain on resources. There is an opportunity for the mining industry to work more closely with local councils and other stakeholders to support the development of efficient regional waste infrastructure, including both disposal facilities and recycling systems. The mining sector also presents other potential opportunities for resource recovery, given the substantial existing rail freight and power infrastructure, as well as the long term need to rehabilitate mine sites which may provide a demand for recovered organics from the region.

The 'boom and bust' cycles associated with the mining industry are an economic challenge for the region, affecting populations and waste generation, whilst making it difficult to plan future services. The transient population of mine workers, including fly-in-fly-out workers, also places strain on waste infrastructure.

Mackay Regional Council has also specifically identified legacy landfills as a constraint. Whilst all councils have potential liabilities and risks to manage around legacy landfill sites, Mackay has estimated its liability for rehabilitation to run into the tens of millions which is a significant strain on any council and a significant funding drain, diverting funds that could be invested in new resource recovery infrastructure.

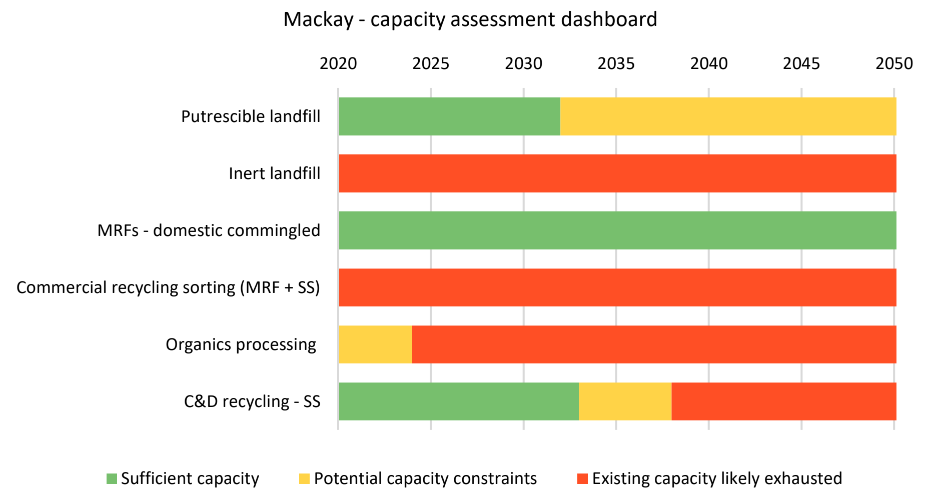
The strong agricultural sector provides a ready market for recovered organics to support a significant uplift in organics processing.

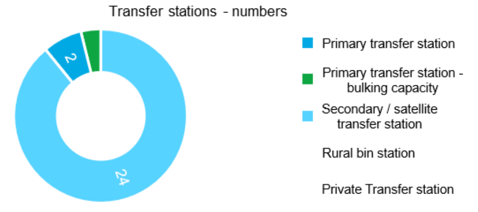
Overleaf is a one-page snapshot of existing key waste infrastructure, forecast waste flows and future infrastructure needs and opportunities for the Mackay region. Further detail is provided in the subsequent sections.

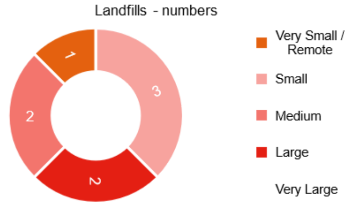
Mackay – Regional infrastructure snapshot

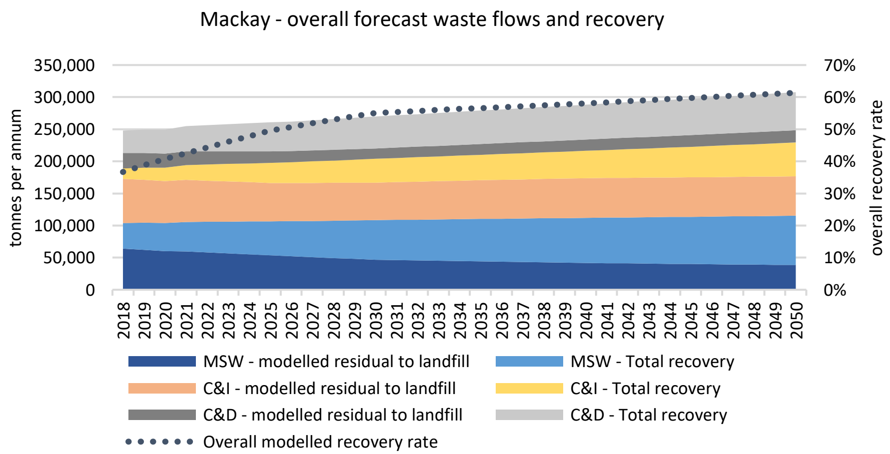
Landfill infrastructure	Ownership	No. facilities	Remaining void capacity (millions tonnes)
Putrescible landfills	Council-owned	8	2.3
	Privately owned	0	-
Inert landfills	Council-owned	0	-
	Privately owned	0	0.0
Recovery Infrastructure	**Sub-category**	**No. facilities**	**Annual capacity (tonnes pa)**
Organics processing	Composting	1	-
	Mulching only	5	26,500
Recycling sorting	MRFs	1	20,000
	Source separated recycling facilities	1	-
C&D recycling facilities		3	50,000
Metals	Metals recycling	4	19,000
	Battery / e-waste processing	1	Insufficient data

** capacity estimate excludes 'very small' landfills*









Future infrastructure needs & opportunities

- *New MRF capacity in the short to medium term to support growth in domestic and commercial recycling*
- *New or expanded organics processing capacity, including facilities that can process domestic and commercial food organics*
- *Regional processing and potential integrated co-processing of organics (e.g. food, food processing, biosolids, agricultural waste)*
- *Assess potential for energy-from-waste particularly if co-location opportunities or existing infrastructure can be utilised (e.g. a sugar mill power station)*
- *Assess potential to produce RDF and export to an EfW in another region*
- *Progress potential landfill expansions at existing facilities*

6.4.2 The current situation

Waste flows

The Mackay region managed around 250,000 tonnes of waste across all three headline streams in 2017-18 and this is forecast to grow to over 310,000 tonnes by 2050 in the base case (low growth) or as high as 370,000 tonnes if current per capita waste generation rates are maintained. Table 31 summarises the key waste streams that were disposed or recovered in the region in 2017-18, which serves as the baseline for forward projections.

The region achieved a moderate recycling rate for C&D waste (59%) but lower rates for MSW (38%) and C&I waste (21%).

Table 31: Summary of regional current (2017-18) baseline waste flows

Stream	2017-18 tonnes
Disposal	
MSW - kerbside to landfill	46,293
MSW - non-kerbside to landfill	17,767
C&I - disposal to landfill	68,859
C&D - disposal to landfill	24,022
Recovery	
MSW - commingled recycling	10,180
MSW - other recycling	14,291
MSW - green waste recovery	14,375
MSW - AWT recovery	-
C&I - recycling	5,814
C&I - organics & timber recovery	11,988
C&D - recovery of masonry materials	32,493
C&D - other recycling	2,461

Figure 49 below shows the estimated overall breakdown of key materials via disposal and recovery pathways, noting that the landfill breakdown is an estimate based on assumed composition (see 2.3.1). It shows there are opportunities to improve the recovery of:

- Food and garden organics from both household and commercial sources, with some 32,000 tonnes landfilled in 2017-18
- Paper, cardboard, plastics and metals, particularly from commercial sources but also from households
- An estimated 26,000 tonnes of C&D masonry materials
- An estimated 28,000 tonnes of timber waste which is currently landfilled.

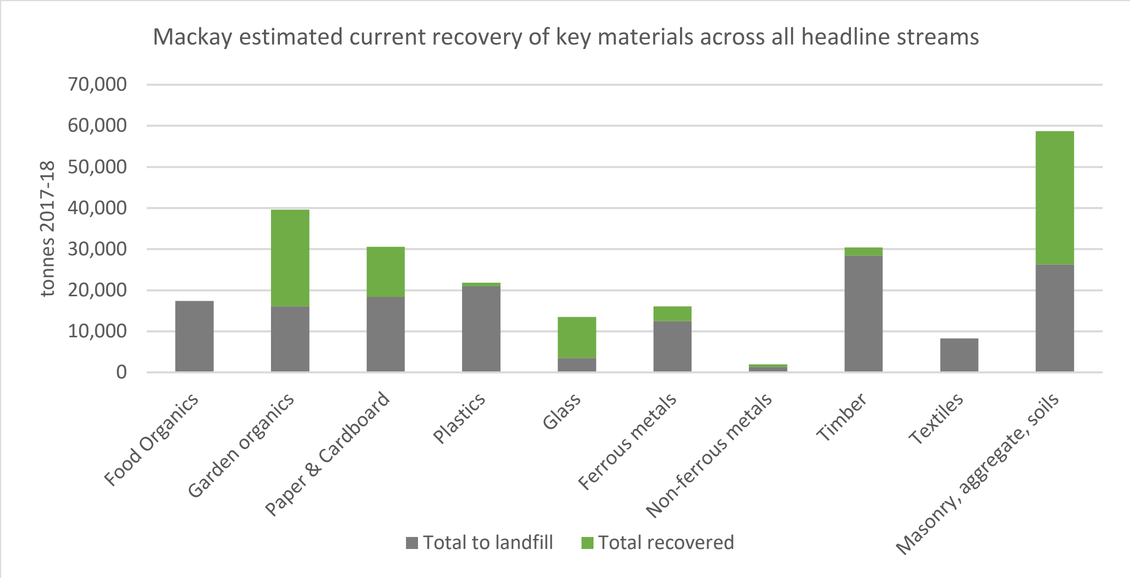


Figure 49: Summary of estimated regional disposal and recovery by material (MSW, C&I + C&D)

Collection systems

All three councils in the Mackay region offer a conventional two bin service of waste and recycling.

Table 32: Summary of regional kerbside collection services

Collection service	Councils	No. households serviced (estimated 17-18)
Two bin – recycling + residual waste	Isaac, Mackay, Whitsunday	71,000

Existing waste infrastructure

For household recycling, the region is serviced by a single regional MRF in Mackay processing kerbside recyclables from Mackay, Isaac and Whitsunday (except Bowen), as well as commercial and CRS materials. The MRF was substantially refurbished in 2015 and includes a glass reprocessing plant to produce glass sand and aggregate.

Only one composter was identified in the region of unknown capacity. The majority of garden waste is recovered through simple mulching, including at council landfill sites. There were three C&D recyclers identified in the region.

Mackay region is home to eight active landfills, all council owned, and is already quite efficient in terms of rationalised landfill networks. Three of those sites are slated to close in the short term. Total existing putrescible landfill capacity is around 2.3 million tonnes but with more than double that in potential expansion capacity within existing sites.

Figure 50 overleaf provides a summary map of existing infrastructure in the region.

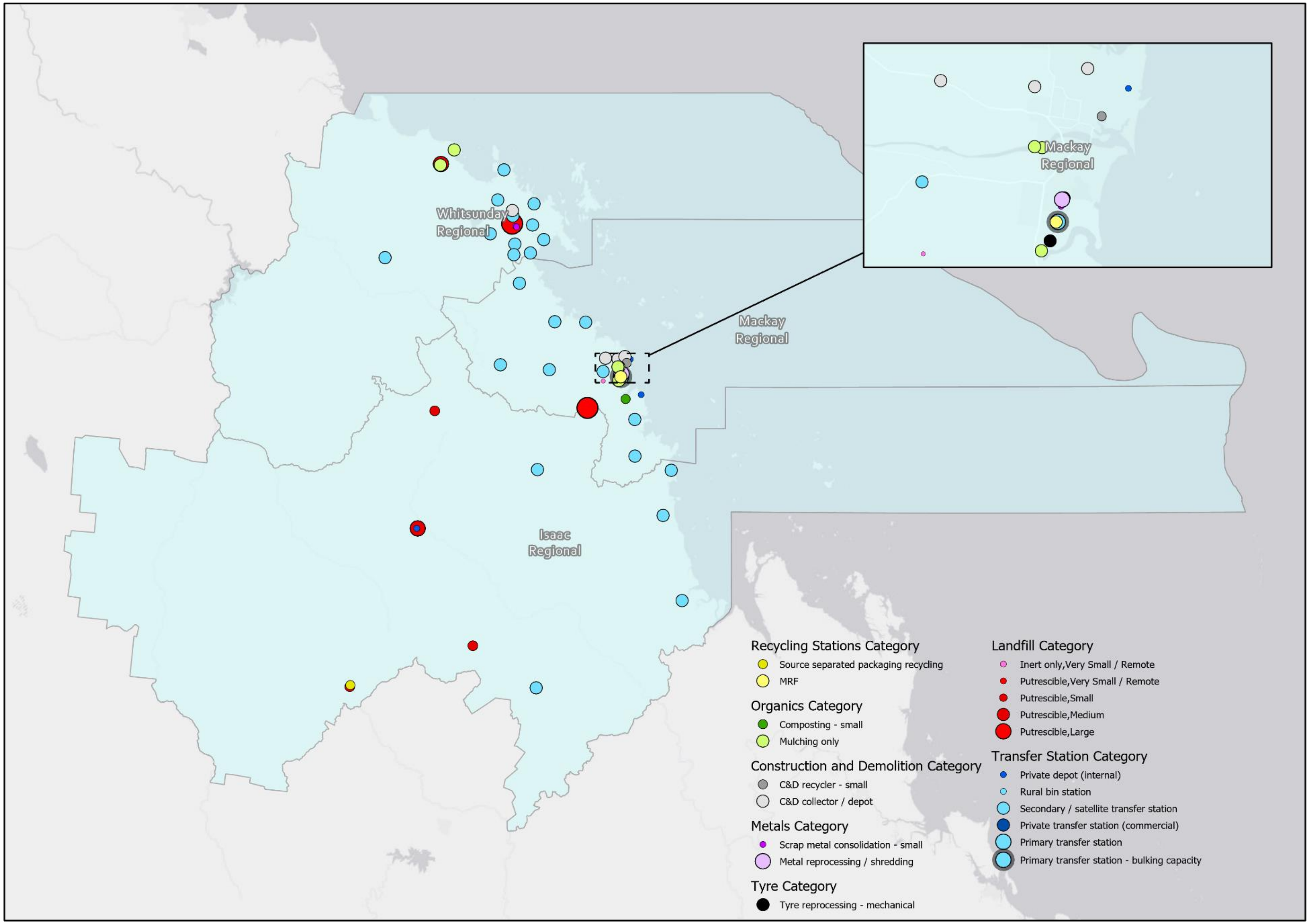


Figure 50: Mackay region map of existing waste and resource recovery infrastructure

6.4.3 Future needs and opportunities

Future waste flows

Figure 51 provides a summary of the forecast waste flows for the Mackay region under the base case. To achieve the Strategy recycling targets at a state level, the modelling assumes relatively optimistic but achievable capture rates of household food and garden organics and commercial organics, although councils will need to determine the best way to achieve this within their own contexts. There are also ambitious assumptions around future capture of recyclables from household and commercial waste and moderate assumptions for the recycling of C&D waste, mostly through further recovery of source separated masonry materials.

The waste flow modelling does not include a regional energy recovery facility in Mackay although that is not to say it could not be considered. Achieving the Strategy recovery targets will require the deployment of energy-from-waste in some form in a number of regional centres and the modelling has nominally assigned those facilities to other regions, but there are still significant further investigations and feasibility analyses to be undertaken to determine where EfW may be viable.

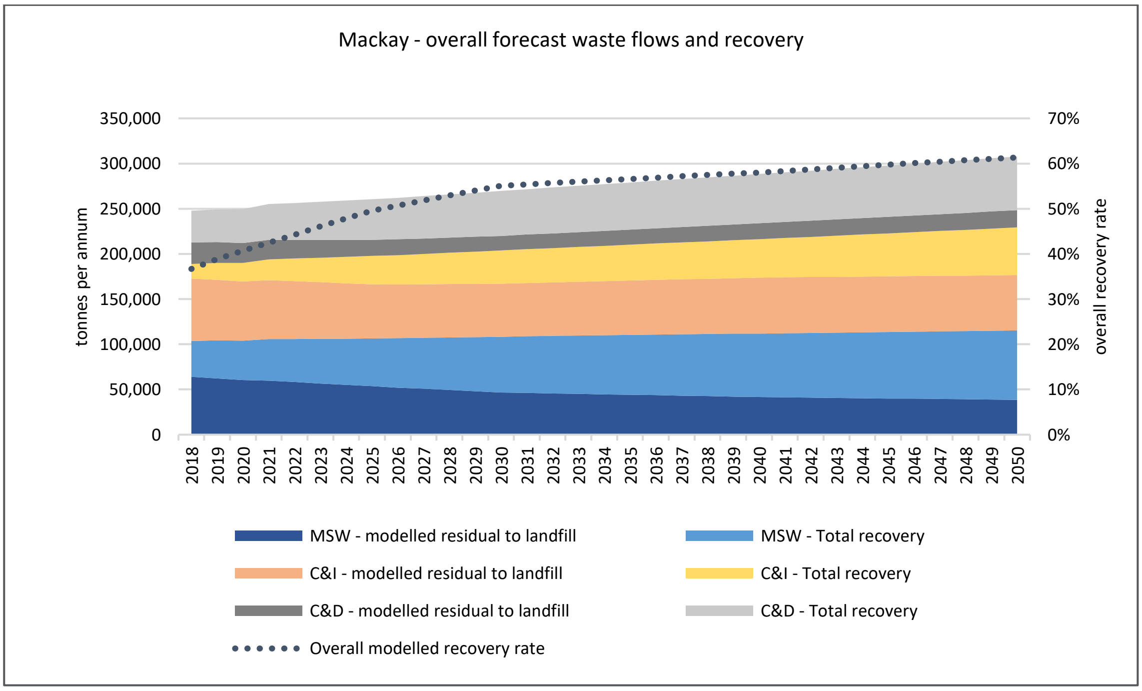


Figure 51: Forecast waste disposal and recovery by headline stream

Resource recovery infrastructure needs

The projected future waste flows, including the new resource recovery required to meet the Strategy targets, have been assessed against the existing available processing capacity in the region (based on available data) to identify future gaps in recovery capacity. Table 33: Summary Mackay resource recovery infrastructure capacity needs assessment (under base case)Table 33 below provides a summary of future capacity needs and opportunities based on this analysis. Future landfill capacity needs have also been assessed under different recovery scenarios and are discussed separately below.

Table 33: Summary Mackay resource recovery infrastructure capacity needs assessment (under base case)

Capacity assessment	Comments
Domestic commingled recycling MRF capacity	Domestic commingled recycling is forecast to grow from around 10,000 tonnes currently to 13,500 tonnes by 2030 and 17,000 tonnes by 2050. The existing Mackay MRF would seem to have adequate capacity to accommodate that growth although it may need to be upgraded in that time to keep up with market standards on product quality.
Commercial packaging recycling capacity	There is no information on capacity for managing source separated commercial recyclables, but it is likely there is enough between the MRF and the one existing commercial source separated recycling facility. As domestic volumes grow, the proportion of commercial material that the MRF can accept may need to decrease.
Organics recovery capacity	With total organics recovery (domestic and commercial) forecast to grow from 26,000 tonnes now to 47,000 tonnes by 2030 and almost 57,000 tonnes by 2050, there is a need for new organics processing capacity. There is limited existing composting capacity (one facility identified of unknown capacity) and councils in the region are highly reliant on mulching only of green waste. New composting or other processing capacity will be required to support the projected increase in organics capture, including domestic and commercial food. A regional processing facility may be appropriate given the relatively small volumes and smaller region. There is potential to explore co-processing of domestic and commercial organics with agricultural residues and biosolids to boost scale[27]. Depending on the location of the facility, enclosed processing may be required and there is potential to use anaerobic digestion to generate energy. There is significant potential to develop new agricultural offtake markets for compost products, which should be strongly supported by farmers and government given the benefits to the Reef (reduced fertiliser use, improved soil quality).
C&D recycling capacity	Three existing C&D recycling facilities have been identified in the region which are likely to have sufficient capacity for the short to medium term and probably potential to expand in the future. With C&D recycling forecast to grow from 35,000 tonnes now to 50,000 tonnes by 2030 and 60,000 tonnes by 2050, the demand is relatively modest. Mobile processing to support recycling in rural areas may also be a good solution for the region.
Other resource recovery infrastructure	With additional capture of plastics into the recycling stream, including from commercial and agricultural sources, there could be potential for a local plastic reprocessing facility to add value to recovered plastics (e.g. washing and flaking).
Energy recovery infrastructure	Energy recovery from residual waste has not been modelled in the region, but it could still be assessed. The projections estimate that there will be 105,000 tonnes of residual MSW and C&I by 2030, declining slightly to around 100,000 tonnes by 2050 based on assumed waste reduction per capita and improved recycling levels. EfW may be a viable solution in the region and should be assessed, particularly if there is an opportunity to co-locate or use existing infrastructure (such as one of the sugar mills). Alternatively, producing RDF and exporting it to another region (e.g. Gladstone or Townsville) may be a viable long-term alternative.

[27] It is noted that Mackay Regional Council recently awarded a new contract to jointly process garden organics with biosolids, but it is not clear what sort of facility will be developed to service that contract.

Landfill capacity

The landfill capacity assessment at the regional level shows that existing approved capacity could be exhausted by around 2035. However, there is significant potential expansion capacity at a number of existing landfills which, if realised, would be more than adequate for the duration of the forecast period, including under the low recovery scenario. The three councils in the region are likely to have adequate landfill capacity for most of the forecast period, although Whitsunday Regional council will need to consider its options for disposal as one of its larger landfills reaches end of life from around 2034.

Hence there is no pressing need for new landfills to be developed in the region, but councils should be preparing to seek approvals for landfill expansions at the appropriate time, to maintain an adequate stock of landfill capacity in the region.

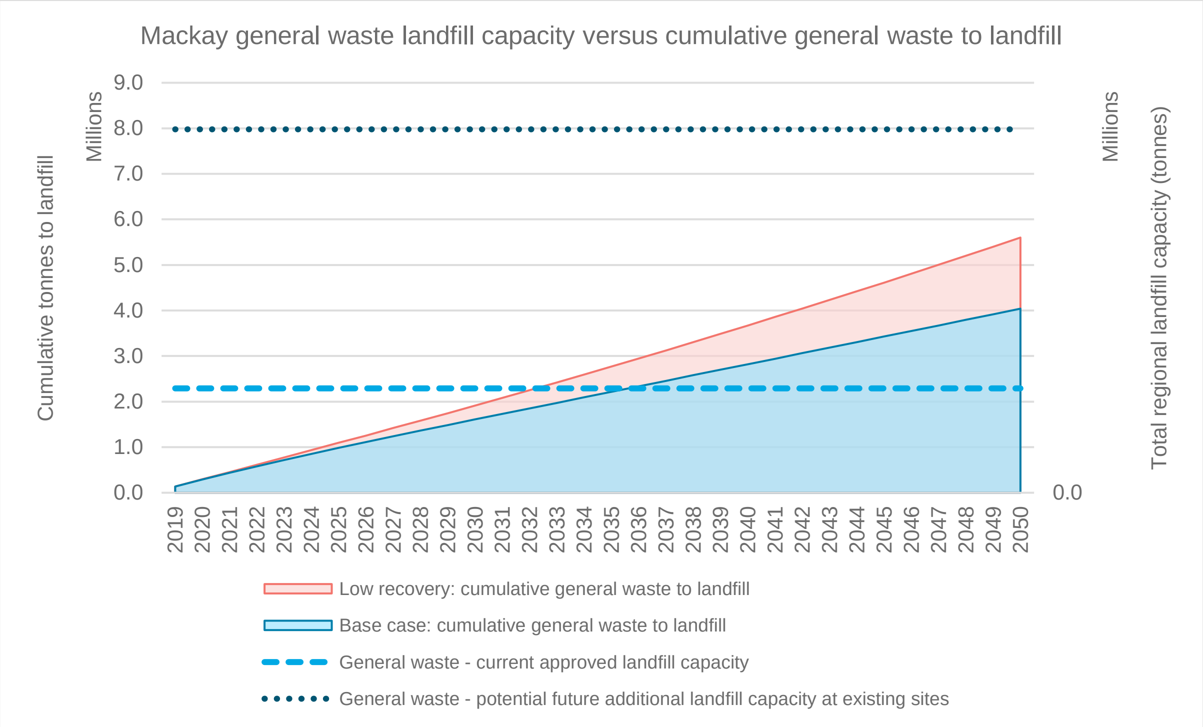


Figure 52: Mackay region landfill capacity assessment

Transfer Infrastructure

Transfer infrastructure seems relatively well developed, with Mackay already long-hauling waste for disposal to landfill. With each council seeming to be self-sufficient in landfill capacity, there is no pressing need for new bulk loading facilities.

6.5 SEQ Region

6.5.1 Regional Snapshot

Brisbane and the South East Queensland region is Australia's third largest capital and home to some of the largest local government areas in the country. The region is growing rapidly – with a current total estimated population of around 3.55 million (in 2019) which is forecast to grow to over 6 million by 2050[28]. This growth is driving the development of brand new communities and suburbs in urban fringe areas. The local government areas with the highest expected annual growth are Ipswich (4.2%), followed by Logan (2.3%), Sunshine Coast (2.2%) and Gold Coast (2%).

All eleven LGAs in the region are forecast to grow to varying degrees. In addition to new communities and greenfield residential development, it is expected that there will be significant infill development and densification across the region to accommodate future population growth.

Regional economy

Being the economic and commercial hub of the state, there is a diverse range of industry sectors which make significant contributions to the SEQ economy. The top 5 industries for employment are health and social assistance, retail trade, construction, manufacturing and education and training.

SEQ is a major exporter of services including education and professional services, and it is positioning as a technology and entrepreneurial hub. The region is home to world-class knowledge and technology precincts linked to high-quality research and development facilities and educational institutions including the University of Queensland (UQ), Queensland University of Technology (QUT), Griffith University, the University of the Sunshine Coast, TAFE Queensland, Bond University and Southern Cross University. Many of these institutions have multiple campuses across the region.

Agriculture is also an important contributor to the economy, particularly in the fringe areas including Scenic Rim, Lockyer Valley and Redlands. SEQ is one of Australia's premium food bowls with fertile land, successful productive industries and ready freight and air access to domestic and global markets. There are around 124 poultry farms, many in the Sunshine Coast and Redlands areas, licensed to house around 24 million birds. Beef cattle are also significant while to the west, in the Lockyer Valley and Scenic Rim, fertile soils produce a significant proportion of Queensland's fruit and vegetables. In the northern part of the Gold Coast region, there is sugarcane and extensive aquaculture including prawn farms.

Tourism is key contributor to the regional economy with varying types of attractions in different areas. In the Gold Coast, Sunshine Coast and Noosa regions, the focus is on beach and hinterland tourism with millions of visitors from across Queensland, interstate and internationally. Brisbane and surrounds are also home to a range of tourist attractions including restaurants, art galleries, music and sporting events and outdoor recreational attractions such as water sports, islands (in Moreton Bay) and national parks.

Construction is an ever present industry, catering for the ongoing population growth and supporting infrastructure and commercial developments. Major projects currently underway include Cross River Rail and the Queens Wharf Precinct in the Brisbane CBD.

Coal mining was historically significant in the Ipswich area but most of the mines are now closed or approaching the end of their economic lives. With the closure and demolition of the region's only coal fired power station at Swanbank, the limited ongoing coal production is mostly for export markets. The historic coal mining industry in the region left a legacy of open cut voids, many of which have not been rehabilitated which has provided ample opportunities to develop landfill infrastructure in those voids. As a result, the Ipswich area is home to several very large scale landfills which receive waste from across the SEQ as well as from interstate sources.

Transport infrastructure

[28] Based on medium series projections by the Queensland Government Statisticians Office, extrapolated beyond 2041.

South East Queensland has extensive and well developed transport networks that allow efficient movement of goods and materials within the region and link the region with the rest of Queensland and interstate and global markets. Some of the major road networks in the region include:

- Pacific highway (national highway), links the state capitals Brisbane and Sydney and travels parallel to the coastline;
- Logan Motorway, which provides access from Brisbane and Logan to the Gold Coast and to the rural areas of the Darling Downs to the west;
- Brisbane Valley Highway (state highway) which links Ipswich to northern SEQ and to the D'Aguilar Highway near Harlin;
- Cunningham Highway which links the darling downs region with the outskirts of Ipswich;
- Warrego Highway which connects the coastal towns to the south western areas;
- Bruce highway, as mentioned earlier in the report; and
- Mount Lindesay Highway (national highway) which runs south west from Brisbane to the border of NSW.

The rail freight infrastructure is also well developed in the region including a major rail freight terminal in Acacia Ridge in south Brisbane and lines to the west via Rosewood near Ipswich, primarily moving coal. The North Coast line commences in Brisbane and ends in Cairns. The nationally significant Inland Rail project, when completed, will pass through the SEQ region providing direct rail freight connections to the Darling Downs (via Bromelton in Scenic Rim) and south to inland New South Wales and Melbourne.

Scenic Rim Regional Council is developing a $30 million freight precinct at the Bromelton State Development Area (SDA) to the south of Brisbane. It will be adjacent to the inland rail line and existing Sydney-Brisbane line and offer domestic rail freight services, warehousing and property options, as well as providing access to intrastate and interstate markets. Further development is planned for industrial uses.

The Port of Brisbane is the third busiest port in Australia, and the closest capital city port to markets in Asia. It handles almost $50 billion in trade, which includes 95% of Queensland's international container trade and around 50% of its agricultural exports[29]. It is the main pathway for export of recyclable materials to global markets.

Regional constraints and opportunities

The SEQ region faces far less constraints than regional and rural parts of the state and enjoys well developed waste infrastructure and networks, efficient transport systems, a diverse range of resource recovery facilities, ready access to end markets including local reprocessing and manufacturing facilities and export routes. In the past, one of the main constraints on investment in resource recovery infrastructure has been abundant and cheap landfill which is now being addressed through the landfill levy.

Land use constraints on locating waste facilities which are perceived to be noxious, are also an ongoing challenge for new and existing facilities, particularly as population growth means that sensitive land uses such as residential developments start to encroach on waste infrastructure sites.

The scale and diversity of the economy presents numerous opportunities to develop innovative and efficient waste and resource recovery infrastructure, spanning reprocessing and remanufacturing opportunities; energy recovery co-located with energy intensive industry; organics processing associated with agricultural production food processing or wastewater utilities; or production of construction materials using secondary resources.

The large scale of some of the local governments means that cost effective resource recovery solutions can be developed without the potential complexity of large groupings of councils collaborating.

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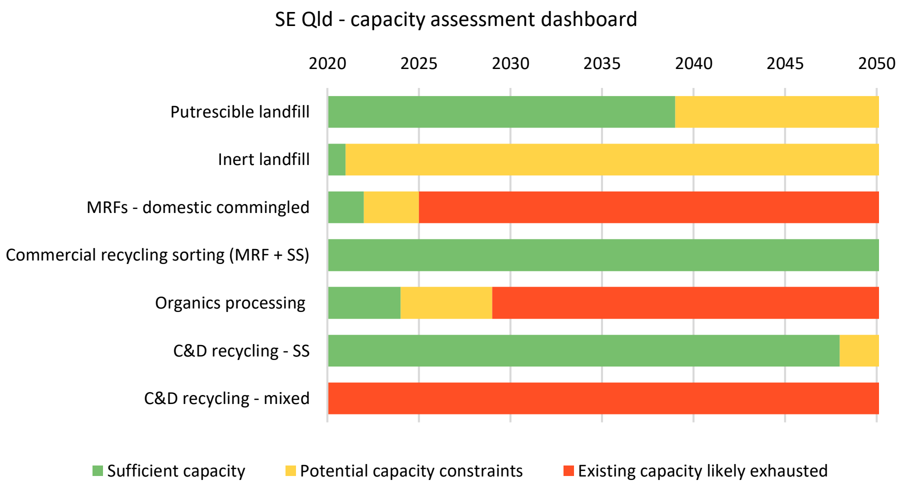
[29] https://www.tiq.qld.gov.au/invest/regional-investment-opportunities/south-east-greater-brisbane/

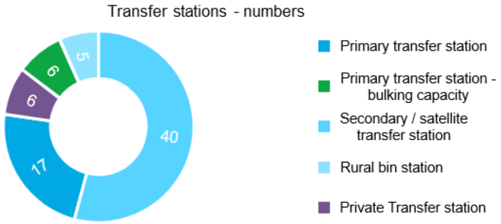
Nevertheless, there will be benefits in councils working together in regional or sub-regional groups to procure new solutions.

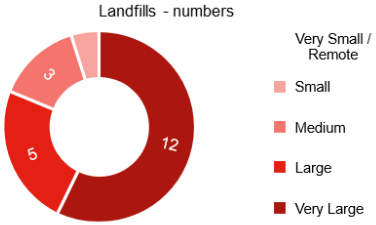
There are a number of waste precincts in the region which have evolved naturally and opportunistically due to favourable land characteristics and zoning, and in the future the development of new or expanded waste precincts in a more planned fashion may be one way to manage the challenges of locating new waste and resource recovery facilities.

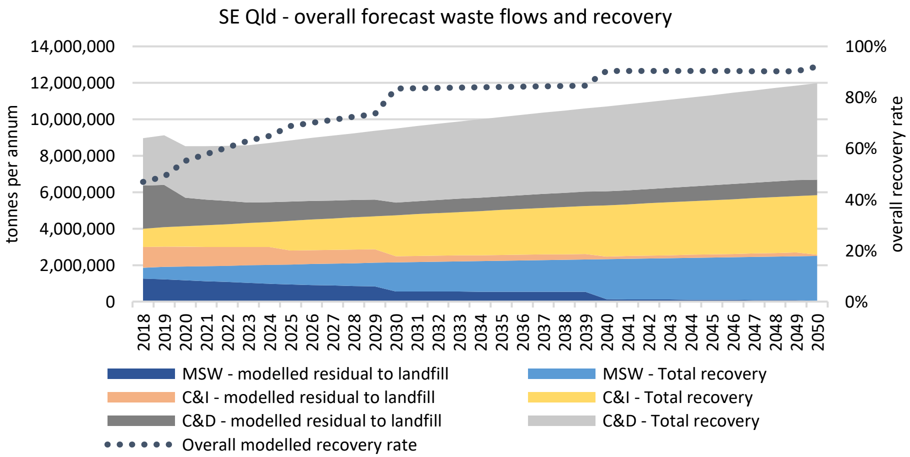
Overleaf is a one-page snapshot of existing key waste infrastructure, forecast waste flows and future infrastructure needs and opportunities for the SEQ region. Further detail is provided in the subsequent sections.

SEQ – Regional infrastructure snapshot			
Landfill infrastructure	Ownership	No. facilities	Remaining void capacity (millions tonnes)
Putrescible landfills	Council-owned	13	32
	Privately owned	3	53
Inert landfills	Council-owned	0	-
	Privately owned	5	3
Recovery Infrastructure	Sub-category	No. facilities	Annual capacity (tonnes pa)
Organics processing	Composting	15	798,000
	Mulching only	5	109,100
Recycling sorting	MRFs	7	419,000
	Source separated recycling facilities	23	584,000
C&D recycling facilities		30	4,970,000
Metals	Metals recycling	27	494,500
	Battery / e-waste processing	7	Insufficient data









Future infrastructure needs & opportunities

- *New MRF capacity in the short to medium term to support growth in domestic and commercial recycling*
- *New and upgraded reprocessing capacity for packaging materials - plastics, paper / cardboard, glass fines*
- *New and expanded organics processing capacity, including facilities that can process domestic and commercial food organics*
- *Integrated treatment of organics (e.g. food, food processing, biosolids, agricultural waste) in urban fringe areas, including energy recovery (AD)*
- *Significant new energy-from-waste capacity for MSW & C&I over the medium to long term*
- *New bulking transfer facilities to support sub-regional recovery and disposal infrastructure*
- *New facilities to produce refuse derived fuels from dry C&I waste and C&D residuals, subject to offtakes*
- *New capacity to process mixed C&D waste*
- *New or modified facilities to utilise secondary aggregates, glass sand, tyre crumb, etc, in asphalt and pre-cast concrete products*
- *New dedicated single-stream energy recovery facilities for waste timber, tyres, mixed plastics*
- *Short-term need for additional inert landfill capacity, noting several new and expansion projects are seeking approval*

6.5.2 The current situation

Waste flows

The SEQ region managed almost 9 million tonnes of waste across all three headline streams in 2017-18 and this is forecast to grow to 12 million tonnes by 2050 in the base case (low growth) or as high as 13.7 million tonnes if current per capita waste generation rates are maintained. Table 34 summarises the key waste streams that were disposed or recovered in the region in 2017-18, which serves as the baseline for forward projections.

The region achieved a moderate recycling rate for C&D waste (52%) and C&I waste (47%) but lower recycling of MSW (32%).

Table 34: Summary of regional current (2017-18) baseline waste flows

Stream	2017-18 tonnes
Disposal	
MSW - kerbside to landfill	892,580
MSW - non-kerbside to landfill	371,590
C&I - disposal to landfill	1,129,659
C&D - disposal to landfill	2,368,695
QLD C&D - to landfill	1,334,678
Interstate C&D - to landfill	1,034,017
Recovery	
MSW - commingled recycling	236,465
MSW - other recycling	68,736
MSW - green waste recovery	277,941
MSW - AWT recovery	-
C&I - recycling	799,511
C&I - organics & timber recovery	213,637
C&D - recovery of masonry materials	2,250,751
C&D - other recycling	353,172

Figure 53 below shows the estimated overall breakdown of key materials via disposal and recovery pathways, noting that the landfill breakdown is an estimate based on assumed composition (see 2.3.1). It shows there are opportunities to improve the recovery of:

- Food organics from both household and commercial sources, with an estimated 380,000 tonnes landfilled in 2017-18
- Garden organics from household and to a lesser extent, commercial, sources with an estimated 270,000 tonnes landfilled

- Paper and cardboard (over 300,000 tonnes landfilled), plastics (346,000 tonnes landfilled) and metals (over 200,000 tonnes landfilled) from both household and commercial sources
- An estimated 1.46 million tonnes of C&D masonry materials landfilled in 2017-18
- An estimated 700,000 tonnes of timber waste which was thought to have been landfilled in 2017-18
- An estimated 140,000 tonnes of textiles thought to have been landfilled in 2017-18.

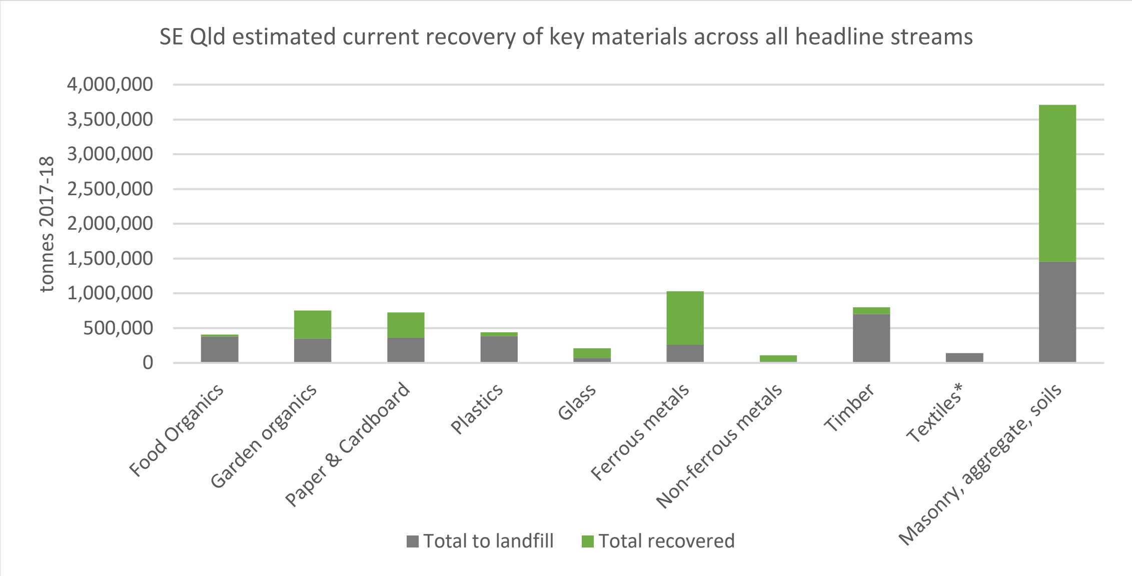


Figure 53: Summary of estimated regional disposal and recovery by material (MSW, C&I + C&D)

Collection systems

The SEQ region features a mix of two and three bin household collection services. Six councils accounting for 77% of serviced households, offer a garden waste bin in addition to the conventional waste and recycling bins – most offer garden bin on an opt-in basis except for Noosa which provides it to all urban households. The other five councils all provide a conventional two bin waste and recycling service.

Table 35: Summary of regional kerbside collection services

Collection service	Councils	No. households serviced (estimated 17-18)
Two bin – recycling + residual waste	Lockey Valley, Logan, Moreton Bay, Scenic Rim, Somerset	302,400
Three bin – recycling + garden organics (opt-in) + residual waste	Brisbane, Gold Coast, Ipswich, Redland, Sunshine Coast	960,200
Three bin – recycling + garden organics (mandatory) + residual waste	Noosa	26,400

Existing waste infrastructure

As would be expected of the state capital, the SEQ is home to diverse range of resource recovery facilities. Seven MRFs have been identified along with 23 different facilities receiving source separated commercial recyclables. SEQ is a hub for consolidation and reprocessing of recyclables from across the state and it is also home to a recovered paper mill, glass bottle factory and glass fines beneficiation plant, two large metal shredding / fragmentising plants, and numerous smaller scale plastics and specialist reprocessing facilities.

There is substantial organics processing capacity with 15 operational facilities identified and a total capacity of around 800,000 tonnes per annum, plus a further five mulching operators. The region is also home to most of the state's tyre recycling capacity.

SEQ is home to 21 active landfills of varying capacities with a mix of private and council owned facilities. In terms of capacity which is capable of receiving putrescible waste, the SEQ region currently has airspace equivalent to around 85 million tonnes (estimated) of waste, with a further 11 million tonnes identified by operators as potential expansion capacity at existing sites (not yet approved).

However, inert-only landfill capacity is far more constrained. Based on information provided by operators, there is just 2.6 million tonnes of inert capacity as at July 2019 with the potential impending closure of some very large inert landfills. There is potential for expansion of those sites and new sites in development, but all still subject to approvals.

The figures overleaf (Figure 54, Figure 55 and Figure 56) provide a summary of existing infrastructure in the SEQ region.

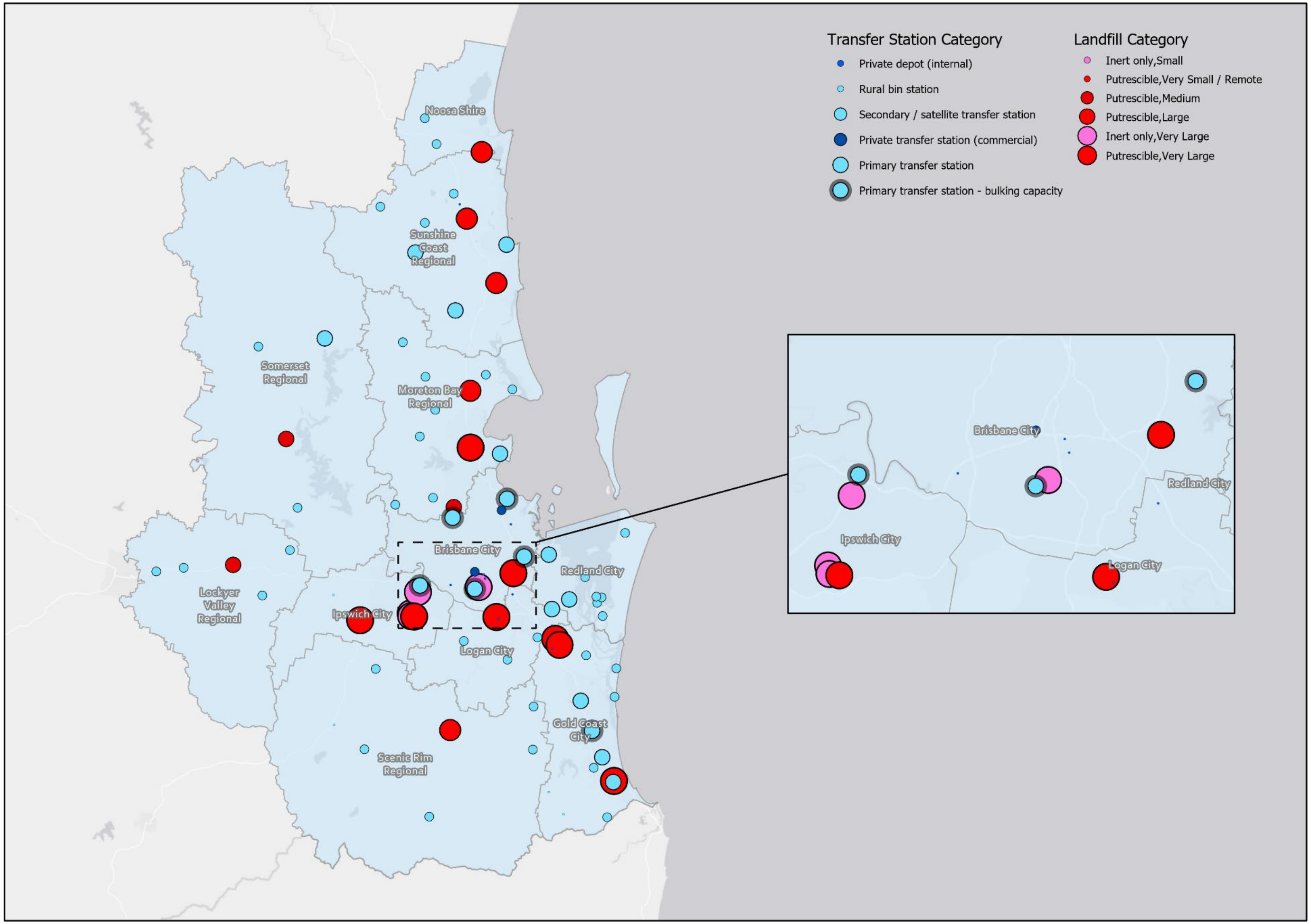


Figure 54: SEQ region map of existing landfill and transfer infrastructure

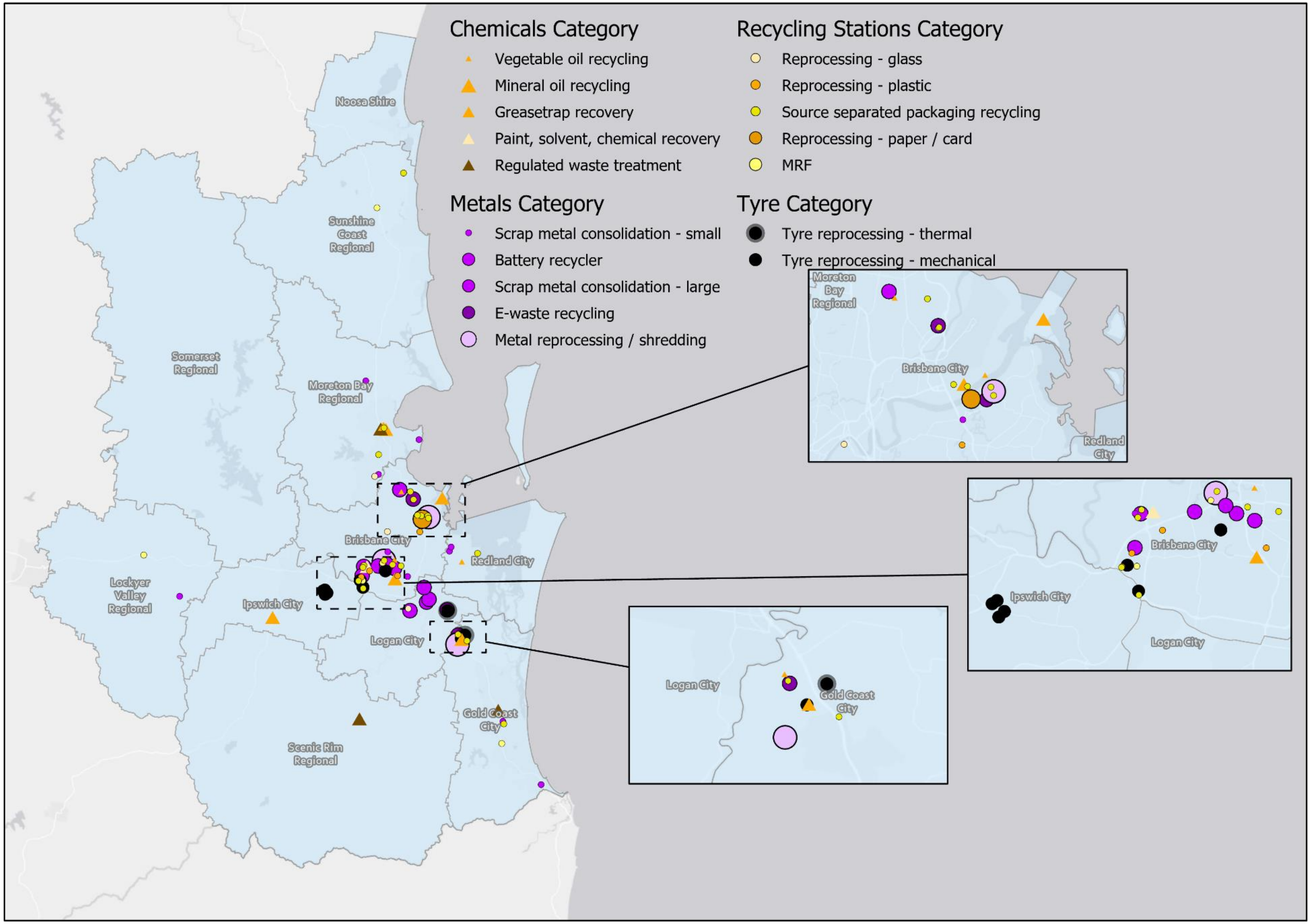


Figure 55: SEQ region map of existing recycling infrastructure

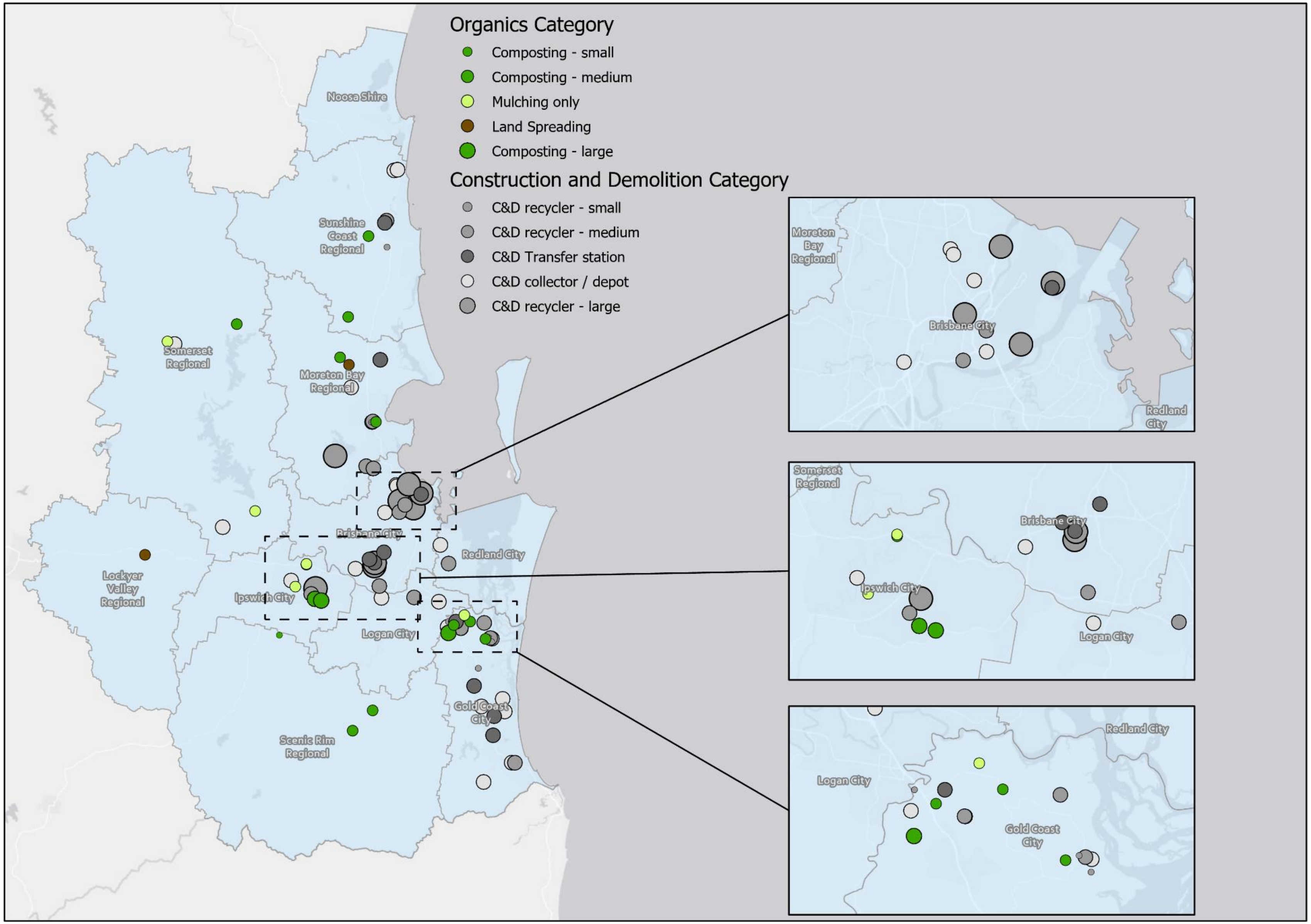


Figure 56: SEQ region map of existing organics and C&D recycling infrastructure

6.5.3 Future needs and opportunities

Future waste flows

Figure 57 provides a summary of the forecast waste flows for the SEQ region under the base case. To achieve the Strategy recycling targets at the state level, and given the constraints on regional and remote areas, the SEQ region is assumed to 'do the heavy lifting' for the state and achieve above the state targets in order to make up for shortfalls in other regions. As such, the modelling assumes quite optimistic but achievable capture rates of household food and garden organics and commercial organics, although councils will need to determine the best way to achieve this within their own contexts. There are also ambitious assumptions around future capture of recyclables from household and commercial waste and aggressive assumptions for the recycling of C&D waste, including both source separated masonry materials and mixed streams.

The waste flow modelling also assumes a significant uptake of energy recovery as a means for managing the majority of residual MSW and C&I waste and a small proportion of combustible C&D waste. Total EfW capacity in the region is nominally modelled at 1.05 million tonnes per annum by 2030, 1.65 million tonnes by 2040 and 1.9 million tonnes by 2050. This could be a combination of direct EfW capacity in the region as well as RDF production for export and use elsewhere. The capacity will necessarily be developed as a series of medium to large scale facilities with a step change up in capacity with each new facility. The exact timing and scale of each facility is not set and there are still significant further investigations and feasibility analyses to be undertaken to determine if or when such a solution may be viable in the region, for the different feedstock streams.

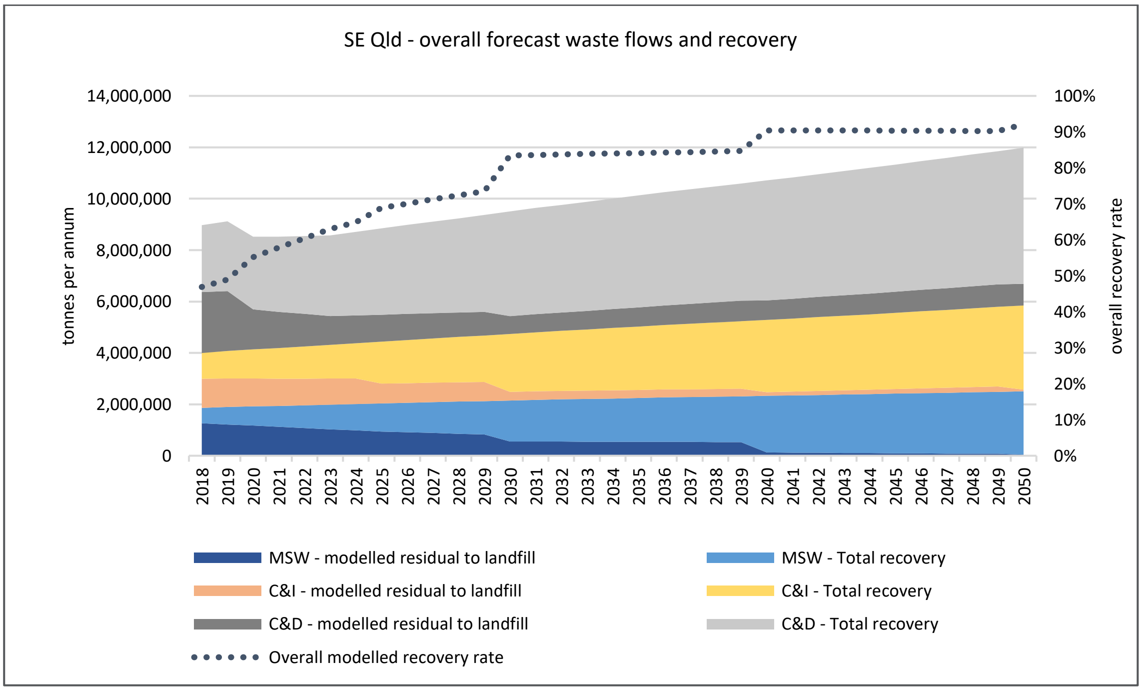


Figure 57: Forecast waste disposal and recovery by headline stream

Resource recovery infrastructure needs

The projected future waste flows, including the new resource recovery required to meet the Strategy targets, have been assessed against the existing available processing capacity in the region (based on available data) to identify future gaps in recovery capacity. Table 36 below provides a summary of future capacity needs and opportunities based on this analysis. Future landfill capacity needs have also been assessed under different recovery scenarios and are discussed separately below.

Table 36: Summary SEQ resource recovery infrastructure capacity needs assessment (under base case)

Capacity assessment	Comments
Domestic commingled recycling MRF capacity	The available data suggests there is a looming shortage in MRF capacity to process domestic commingled recycling from around 2021. The domestic commingled stream is forecast to grow from 236,000 tonnes currently to 443,000 tonnes by 2030 and 630,000 tonnes by 2050. While there may be some scope for substitution of current commercial recycling inputs and expansions of existing plants, it is likely that one or two new MRFs will need to be developed in the short to medium term and over the longer term to accommodate expected growth. There may also be a need to upgrade existing MRFs to meet changing market standards on product quality.
Commercial packaging recycling capacity	There seems to be ample spare capacity within existing commercial source separated recycling facilities although the modelling does not fully account for materials that are sent from other regions to SEQ for consolidation and processing, so this is subject to some uncertainty.
Organics recovery capacity	With total organics recovery (domestic and commercial) forecast to grow from 490,000 tonnes now to 1.1 million tonnes by 2030 and almost 1.4 million tonnes by 2050, there is a need for new organics processing capacity in the region. Demand is forecast to exceed existing known composting capacity from around 2024. In any case, there may be a need to upgrade existing facilities or develop new ones to support the projected increase in the capture of domestic and commercial food organics. A number of the existing composters in the region are unlikely to be able to receive significant inputs of food organics with current open windrow methods. There is one facility (in commissioning at the time of writing) employing advanced enclosed composting technology. A number of sub-regional processing facilities servicing multiple councils or single larger councils may be needed. There is potential to explore co-processing of domestic and commercial organics with biosolids from major water utilities as well as agricultural and food processing residues in urban fringe areas. Anaerobic digestion may be a viable alternative to open windrow composting which could also generate energy. In regional parts of SEQ with significant agriculture and food production, an organics-based precinct could also be established linking with existing infrastructure. New offtake markets will need to be developed for compost products including agricultural markets, as current urban landscaping markets are thought to be nearing saturation.
C&D recycling capacity	The available data indicates that there is sufficient spare capacity within existing CD& recycling facilities, to accommodate the forecast growth in C&D recovery for most of the next three decades. However, most of the existing capacity is designed to process clean source separated masonry materials so there will still be opportunities to new facilities to target mixed C&D streams (e.g. skip bin waste). With total C&D recycling forecast to grow from 2.6 million tonnes currently, to 3.9 million tonnes per annum by 2030 and 5 million tonnes by 2050, there are ample opportunities for new and existing market players.
Other resource recovery infrastructure	There is a strong reprocessing sector in SEQ already but with a particular future focus on avoiding the export of recyclables, there will be a need for new capacity to reprocess and remanufacture plastics and glass (once the capacity of the existing glass bottle factory is exceeded).

	There is significant potential for glass as well as some plastics, crumb rubber from tyres and/or recovered asphalt, to be incorporated into new asphalt mixes and used in roadworks. Following the trends in other states, there may be demand for one or two specialised asphalt mixing plants which are capable of using these secondary resources. There will also be a need for additional paper and cardboard reprocessing capacity which will be far more challenging to implement. Constructing a new paper mill is a significant undertaking and capital investment, which needs to be market led. Governments can support but it will likely need to be coordinated with other state governments and at the national level, given the potential to process interstate flows. It is not clear whether there is potential to expand the existing recovered paper mill in Brisbane but this should be explored. There may be demand for new specialised recycling infrastructure to manage streams such as timber and textiles given the significant volumes landfilled.
Energy recovery infrastructure	As noted above, there is potential to deploy AD to co-process a range of organics and generate energy. There will also be a need for significant investment in several medium and large scale thermal energy-from-waste facilities to process residual MSW and C&I waste across the region, as well as some combustible C&D. Some of that will likely be RDF production and export to another region or overseas, subject to offtakes. As noted above, the total EfW capacity modelled in the region is 1.05 million tonnes per annum by 2030, 1.65 million tonnes by 2040 and 1.9 million tonnes by 2050. The sizing and location of those facilities is to be determined, but there will be sufficient residual waste to support multiple facilities. Plants in the range 250,000 to 500,000 tonnes per annum are likely to be more viable in terms of the cost of transporting waste to them, and probably more palatable to the community than very large capacity plants beyond this range. As such, there is scope for at least 4-5 facilities and possibly more, to be developed across the region over the long-term. There will also likely be demand for some single-stream energy recovery facilities, such as those processing waste wood, given an estimated 700,000 tonnes of timber waste is thought to be landfilled now, which will only grow in the future.

Putrescible landfill capacity

Overall, there is more than enough approved putrescible capacity to service the needs of the region for the next 30 years and beyond under the base case projections (see Figure 58 below). However, under the low recovery scenario, existing capacity will be consumed much faster and potentially by around 2040. In both modelling scenarios presented below, most future C&D waste is assumed to be disposed to putrescible sites, given the shortage in approved inert landfill capacity in the region as discussed below. This makes the low recovery scenario particularly pessimistic.

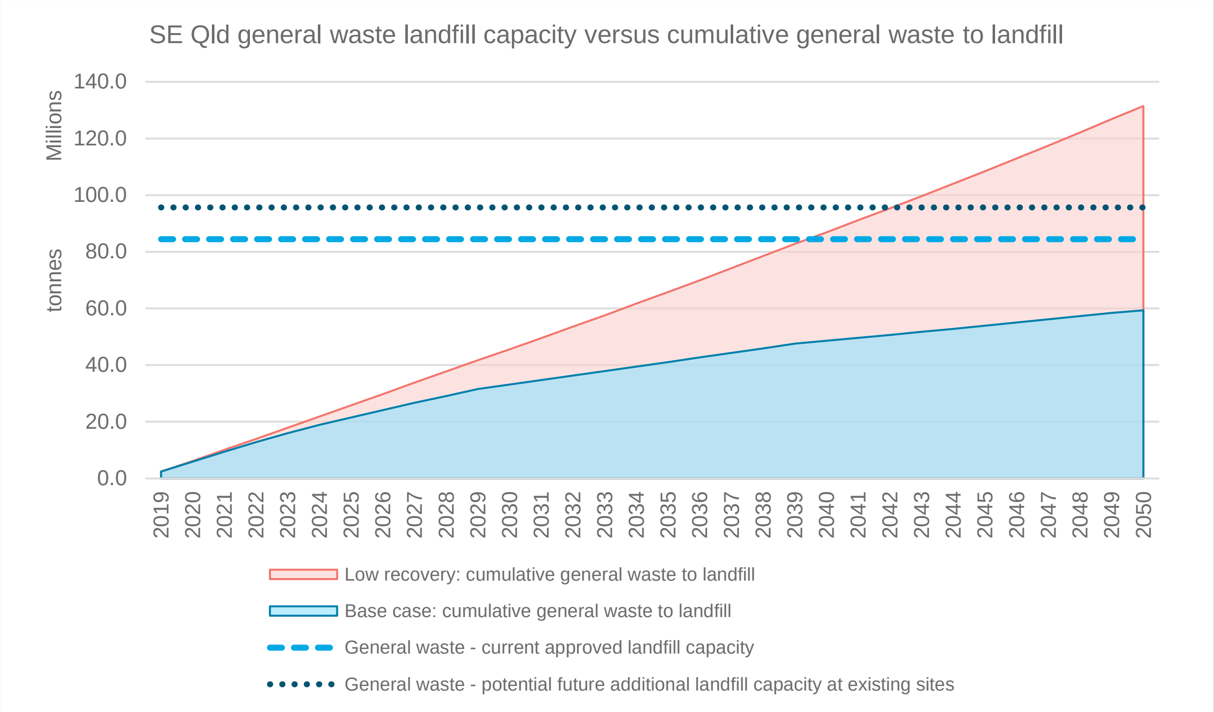


Figure 58: SEQ general waste (putrescible) landfill capacity against future demand

The number of landfills will reduce over time. Unlike other regions (except Cairns), the majority of the long-term landfill capacity is owned by the private sector and concentrated into two large sites. A number of councils including Redlands and Ipswich are already entirely reliant on external landfill capacity and other councils will be in a similar situation in the short to medium term. The region is facing the closure of a number of large council owned landfill facilities over the next 30 years which will present localised challenges for some councils. For example, Brisbane and Logan City Councils are preparing for the imminent closure of their only remaining landfills (Rochedale and Browns Plains respectively) within the next decade, whilst Lockyer Valley Regional Council is also expecting its Gatton Landfill to be exhausted within that timeframe.

The City of Gold Coast has two large operational landfills which receive significant volumes of MSW and C&I waste from across the Gold Coast region, with current approved airspace set to last over the forward projection period under the base case modelling, however closure will be brought forward if resource recovery levels are below the base case strategy targets. Similarly, Sunshine Coast Regional Council operates two large landfills which will start to reach end of life in the latter part of the forward projection period in the base case, or sooner under a lower recovery scenario. Moreton Bay Regional Council operates three large landfills which are expected to reach end of life at staggered times over the next three decades.

Scenic Rim Regional Council also has significant capacity at its Bromelton Landfill with potential to play more of a regional role. The site already receives some waste from neighbouring Logan City Council but its potential to take in more of the region's waste will be a function of transport economics, with the Ipswich landfills being closer for most SEQ councils. Noosa and Somerset councils have their own landfill capacity which would seem to be sufficient for the projection period.

The majority of the available approved airspace is shared between the two large privately owned putrescible landfills in the Ipswich area – Remondis' Swanbank Landfill and the TiTree Landfill at Willowbank operated by Veolia. These facilities already play a significant regional role, receiving commercial waste from across SEQ and MSW from a number of councils. Given their large airspace reserves and the pending closure of numerous council-owned landfills, both sites are likely to play an increasing role in managing MSW residual waste from the region over the next three decades.

Most of the remaining capacity is located in the Ipswich LGA which may present ongoing challenges for that community and increasing reliance on privately owned landfills may be a challenging concept for some other councils, which may drive significant interest in alternative solutions to manage residual MSW, such as energy-from-waste (see below).

Despite the large number of potential voids in the region from former mining and quarrying activities, it is very difficult to find sites which are both technically suitable for development of a putrescible landfill and likely to be accepted by the community. The available data and analysis suggests there should be no need to develop new putrescible landfill capacity in the SEQ region within the next 30 years but this is highly contingent on significant increases in resource recovery across all streams, in line with the Strategy. If that is not achieved, there will be a need to commence planning for identification and development of new sites from around 2030.

Inert landfill capacity

The SEQ region is also home to a number of inert-only landfills which predominantly receive C&D waste from across the region and interstate, as well as smaller quantities of inert C&I waste, soils and other wastes. The interstate flows of C&D waste into these facilities are expected to decline significantly with the introduction of the Queensland landfill levy from July 2019 but may not cease entirely given the continued high cost of landfill in Sydney[30].

In terms of inert landfill capacity in SEQ, the region is facing a very short term, particular capacity challenge in that many of the existing large inert landfills are approaching the limit of their current approved airspace within the next 2 to 3 years. Some of those existing facilities are in the process of seeking approval for expansions which were in various stages of assessment and determination at the time of writing and could add around 16 million tonnes of airspace for the region if all approved. However, if those expansions are not approved, SEQ faces a significant imminent shortage of inert landfill capacity and the likely impact is that C&D waste would divert to putrescible landfills, meaning that airspace in those facilities will be consumed more quickly than it otherwise would have.

Given inert C&D waste has a different level of potential impact on the environment compared to putrescible waste and generally requires a lower level of containment, there are benefits in disposing of it separately in dedicated inert-only landfills. Both industry and governments (state and local) need to find the right balance between approving and developing new inert landfill capacity to meet the future needs of the region, but with the challenge of significant uncertainty in the short term as to how quickly C&D recycling efforts will ramp up and how imports of C&D waste from interstate will respond to the landfill levy.

It is also noted that a number of new inert landfills are in various stages of development and seeking approval. At the time of writing, three large scale landfills were seeking approval (all in Ipswich LGA including two in the Jeebropilly area and one in New Chum) which together would provide potential additional airspace of around 90 million cubic metres. Between the proposed expansions and new landfills, it is estimated that the potential airspace currently working through the approvals process is approximately three times that which is forecast to be required to dispose of SEQ's C&D waste over the next 30 years under the base case scenario (assuming the Strategy recycling targets are achieved).

Whilst there is a looming shortage of approved inert landfill capacity in the short term, there is significant potential capacity that could be developed, subject to approvals. Unfortunately, most of that capacity is located in the Ipswich LGA which presents a number of challenges for the community of Ipswich.

Transfer Infrastructure

With the future regionalisation of processing and disposal infrastructure across all sectors, there will be a need for councils and industry to invest in new transfer facilities that are capable of moving large volumes of waste in bulk, in large efficient loads. In addition to bulking facilities for residual waste, and depending on the location of future organics processing capacity, there may also be a need for transfer facilities which specialise in consolidating and pre-processing organics before bulk loading to processing facilities on the urban fringe or in regional areas.

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[30] No data was available at the time of writing on the impact of interstate waste transfers since 1 July 2019

6.6 Townsville Region

6.6.1 Regional snapshot

The Townsville region consists of five local government areas: three councils along the coast, a large inland rural council (Charters Towers) and Palm Island Aboriginal Shire. The city of Townsville is the main population centre in the region and the largest city in Queensland outside of the south-east corner as well as the main commercial hub for North Queensland. It is home to over 200,000 people and more than 80% of the regional population.

The region has a total estimated population of around 240,000 (in 2019) which is forecast to grow to around 364,000 by 2050[31]. The majority of future growth is expected in Townsville – both Burdekin and Hinchinbrook are forecast to shrink in population while Charters Towers and Palm Island are forecast to experience modest growth.

The five councils of the region are members of North Queensland Regional Organisation of Councils (NQROC) and have a history of active collaboration on waste management issues. Burdekin Shire Council is one the few regional councils outside of the south east to offer a third kerbside bin for green waste and one of only two councils in the state to make it mandatory for urban residents (together with Noosa).

Most of the Townsville region is categorised as dry tropics, whilst the northern part (Hinchinbrook) is the start of the wet tropics region. The region adjoins the Great Barrier Reef Marine Park so managing environmental impacts within the Reef catchments is critical.

Palm Island is 65km north-west from Townsville and home to around 2,700 people. As an indigenous council, it is considered in more detail within the Queensland Indigenous Waste Strategy.

Regional economy

Agriculture and resources are the key drivers of the regional economy supported by a major international port in Townsville exporting a range of commodities produced across the broader region and handling around $8 billion in annual trade. Townsville city is home to significant heavy industry including minerals processing infrastructure and the region is the gateway to the North-Western Minerals Province, with significant goods and services for the mining industry passing through the city and its port. Townsville is also home to Australia's largest military base (over 15,000 defence personnel), a significant university with over 11,500 students as well as other educational and scientific research institutions.

In surrounding areas around Townsville city, agriculture is the primary industry including cattle, sugarcane and horticulture, but tourism is also important.

Sugarcane is the main agricultural product in the region accounting for 70% of farms, followed by beef cattle (20% of farms). The region is home to six sugar mills which use the cane residue (bagasse) to generate bioenergy. Burdekin Shire is a fertile agricultural region, with irrigation supplied by the Burdekin River. Sugarcane is the foundation of the local economy in Burdekin with four operational sugar mills. Fruit and vegetable horticulture is also a significant industry.

Hinchinbrook Shire, in the northern part of the region, also has a local economy largely based on agriculture, particularly sugarcane but also grazing and horticulture. Tourism is also significant in the local economy.

In the Charters Towers region, beef grazing is a key industry as well as some mining activity. The Charters Towers local government area covers 85% of the land area of the Townsville region, but is home to only 5% of the population so it is a sparsely populated, rural area.

There are also intensive livestock operations across the region including four cattle feedlots, two poultry farms and three piggeries, as well as a large abbattoir in Townsville. These facilities produce a range of organic residues and present opportunities for co-processing with other organic streams in the region.

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[31] Based on medium series projections by the Queensland Government Statisticians Office, extrapolated beyond 2041.

Across the region, other major employment industries include healthcare and social assistance, manufacturing, retail and public administration.

Transport infrastructure

The road networks in the region, which move the majority of waste materials, are generally well developed with a number of major upgrade projects completed in recent years including the Townsville Ring Road. The Bruce Highway, which connects the region with the north and south of the state, has been upgraded in places and further projects are planned. Upgrades are also planned for the Flinders Highway which runs west from Townsville through Charters Towers and on towards Mount Isa.

The Townsville port is Australia's largest port for bulk commodities including sugar, metals (zinc, lead, copper) and fertiliser. It is also a significant container port and container traffic has grown significantly, tripling over the past decade. It has been used to limited extent to direct export recyclables, providing a direct connection to markets in Asia, with potential for low-cost 'back-loading' opportunities given the level of containerised import traffic. The port is planning a major expansion and upgrade program with a proposed investment of $1.6 billion over the next three decades. The port expansion will support economic development in the region, driving growth in exports of agricultural produce and resources.

There are also regular freight barges to Palm Island from both Townsville and Lucinda (Hinchinbrook Shire). These are currently used to barge waste from Palm Island to the mainland for disposal.

Two major freight rail lines also run through the region: the Mount Isa to Townsville rail line and the North Coast rail line, providing efficient connections to markets in the north and south, and potential to bring in waste and recyclable materials from the west by rail. The Stuart Intermodal Facility has recently been developed in the Stuart industrial area, 20 minutes south of Townsville centre and less than 4km from the regions main Stuart Landfill. The intermodal freight hub provides an efficient transition between truck and rail freight, with direct rail access to both main rail lines and a proposed future rail connection to the Port of Townsville.

Regional constraints and opportunities

The Townsville region faces the same challenges as other regional parts of northern and western Queensland, including significant distances between population centres and to end markets. In the rural parts of the region, small dispersed populations present additional challenges in providing efficient, financially sustainable waste and resource recovery services.

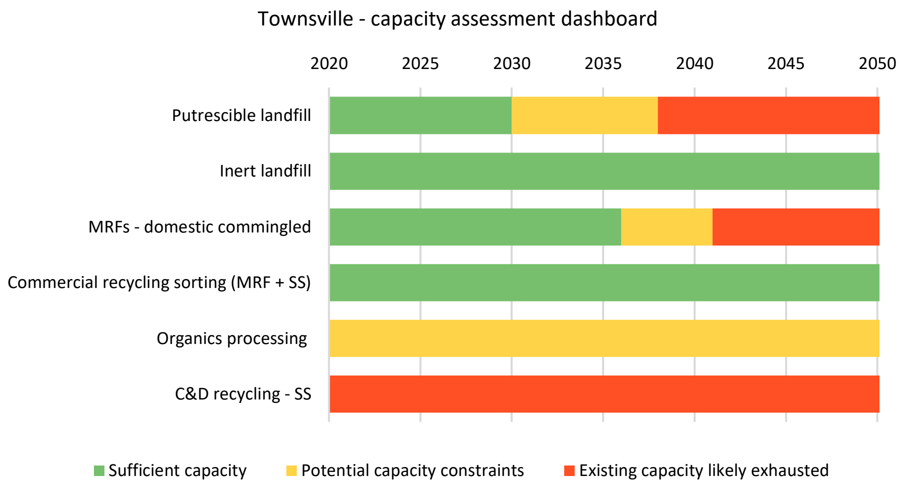
However, the region also has a number of advantages and opportunities. Well developed transport infrastructure including road, rail and the port, provide opportunities for Townsville to act as a major hub for waste processing and resource recovery activities, servicing the surrounding Townsville region but also potentially receiving materials from other regions to the north and west. The density of high impact, high energy using industry in Townsville also presents potential opportunities to co-locate energy recovery infrastructure with existing heavy industry to harness renewable, low carbon baseload energy in various forms, from waste sources. There is significant available industrial zoned land in Townsville, including the State Development Area in Stuart to the south of Townsville.

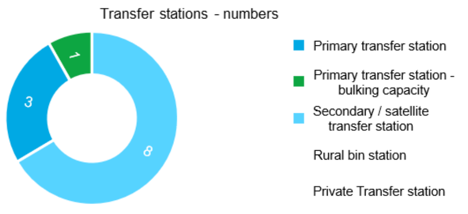
Outside of Townsville itself, the prominence of agriculture including sugarcane, horticulture and livestock, as well as the processing of those commodities, presents opportunities to established hubs which are focused on recovering value from organic residues. The co-processing of those agricultural residues with other organic wastes such as domestic food and garden organics, or commercial food, presents opportunities to achieve significant economies of scale that would not be otherwise possible. As such, partnerships are going to be important – between councils, the waste industry and broader industry and farmers. The proximity to the Reef provides additional impetus to manage waste in the most environmentally sustainable way to prevent potential impacts on surface and groundwater. It also provides an incentive to use more recycled organics products as soil conditioners in agriculture to improve local soil quality and minimise the use of chemical fertilisers.

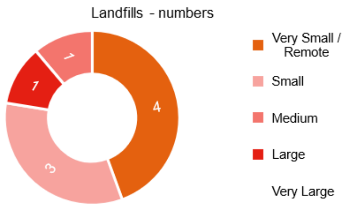
Overleaf is a one-page snapshot of existing key waste infrastructure, forecast waste flows and future infrastructure needs and opportunities for the Townsville region. Further detail is provided in the subsequent sections.

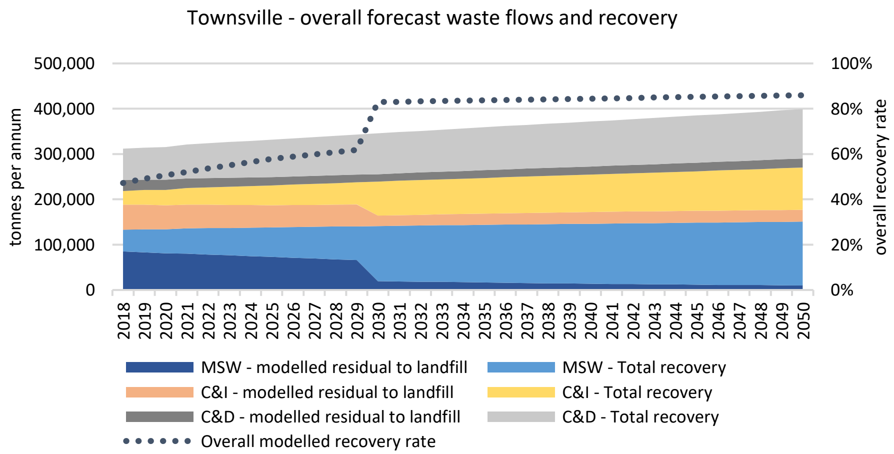
Townsville – Regional infrastructure snapshot			
Landfill infrastructure	**Ownership**	**No. facilities**	**Remaining void capacity (millions tonnes)**
Putrescible landfills	Council-owned	5	1.8
	Privately owned	0	-
Inert landfills	Council-owned	2	-
	Privately owned	2	10.0
Recovery Infrastructure	**Sub-category**	**No. facilities**	**Annual capacity (tonnes pa)**
Organics processing	Composting	1	5,000
	Mulching only	2	45,000
Recycling sorting	MRFs	1	18,000
	Source separated recycling facilities	2	13,500
C&D recycling facilities		1	30,000
Metals	Metals recycling	1	5,000
	Battery / e-waste processing	2	Insufficient data

** capacity estimate excludes 'very small' landfills*









Future infrastructure needs & opportunities

- *Upgrades to regional MRF to produce high quality outputs and value-added commodities*
- *Local reprocessing capacity for plastics including commercial and agricultural films and soft plastics, supported by local remanufacturing into new products*
- *New organics composting capacity and shift away from low-value mulching of green waste*
- *Integrated co-processing of domestic, commercial and agricultural organics (e.g. food, food processing, biosolids, agricultural waste) in rural or urban fringe areas, including potential for energy recovery via AD*
- *Good potential for moderate scale regional energy-from-waste co-located with industry in Townsville, to prolong limited regional landfill airspace, subject to feasibility and efficient aggregation of feedstock*
- *Potential to receive materials from other regions via rail for processing or energy recovery*
- *Expect significant consolidation of landfill capacity into one main regional landfill with a number of facilities reaching end of life, most likely at Stuart Landfill in the medium term*
- *New bulking transfer facilities in key population centres to support regional disposal and processing infrastructure*
- *New or enhanced processing of C&D masonry into high quality secondary aggregates*
- *Potential for a local tyre processing solution servicing the northern region and mining industry, either for recovery of energy products or as crumb rubber for road construction*

6.6.2 The current situation

Waste flows

The Townsville region managed over 300,000 tonnes of waste across all three headline streams in 2017-18 and this is forecast to grow to over 400,000 tonnes by 2050 in the base case (low growth) or as high as 480,000 tonnes if current per capita waste generation rates are maintained. Table 37 summarises the key waste streams that were disposed or recovered in the region in 2017-18, which serves as the baseline for forward projections. The region achieved a relatively high recycling rate for C&D waste (74%) thanks to concrete crushing activities by recyclers and landfill operators in the region. Recovery rates for commercial and municipal wastes were much lower (around 36%).

Table 37: Summary of regional current (2017-18) baseline waste flows

Stream	2017-18 tonnes
Disposal	
MSW - kerbside to landfill	56,843
MSW - non-kerbside to landfill	28,250
C&I - disposal to landfill	55,270
C&D - disposal to landfill	24,079
Recovery	
MSW - commingled recycling	10,966
MSW - other recycling	12,361
MSW - green waste recovery	23,447
MSW - AWT recovery	-
C&I - recycling	21,766
C&I - organics & timber recovery	12,665
C&D - recovery of masonry materials	67,929
C&D - other recycling	1,190

Figure 59 below shows the estimated overall breakdown of key materials via disposal and recovery pathways, noting that the landfill breakdown is an estimate based on assumed composition (see 2.3.1). It shows there are opportunities to improve the recovery of:

- Food and garden organics from both household and commercial sources, with some 37,000 tonnes landfilled in 2017-18
- Paper, cardboard, plastics and metals, particularly from commercial sources but also from households
- Just under 30,000 tonnes of timber waste which is estimated to be landfilled.

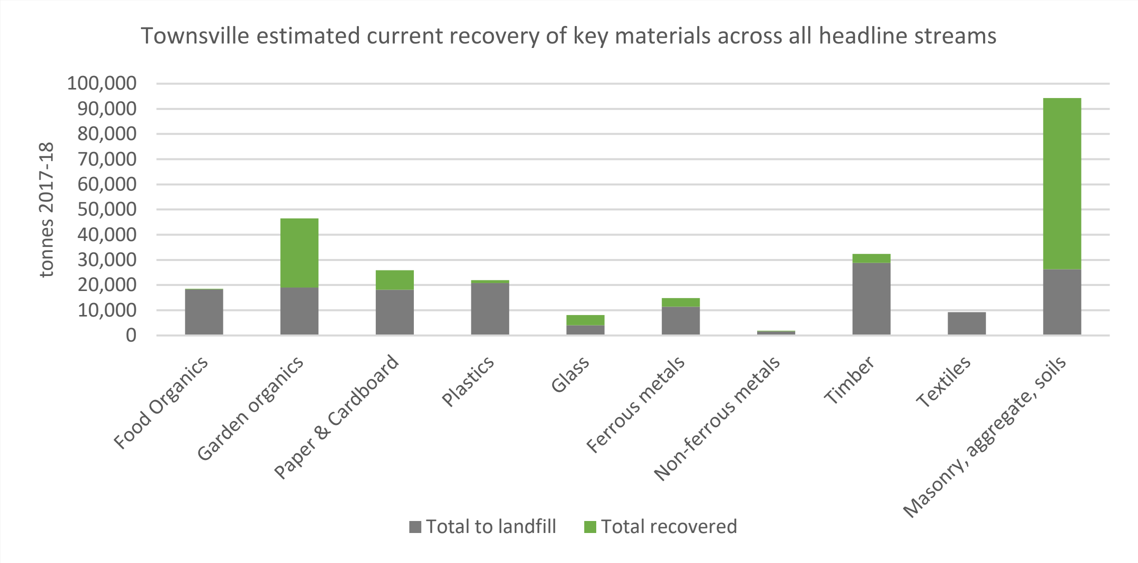


Figure 59: Summary of estimated regional disposal and recovery by material (MSW, C&I + C&D)

Collection systems

The Townsville region features a mix of household collection services. Townsville and Hinchinbrook offer a conventional two bin service of waste and recycling, which accounts for around 86% of serviced households in the region. Charters Towers and Palm Island offer a single waste bin and both face particular challenges in servicing small, isolated communities.

Somewhat unusually, Burdekin is the only council outside of the south-east to offer a third bin for garden organics and it is mandatory for residents in the main towns. The system is very effective at capturing garden organics, with less than 2% garden waste still in the general waste bin. In that respect, Burdekin serves as an example for other rural and regional councils wanting to divert household organics from landfill.

Table 38: Summary of regional kerbside collection services

Collection service	Councils	No. households serviced (estimated 17-18)
Single bin (residual waste only)	Charters Towers, Palm Island	5,800
Two bin – recycling + residual waste	Townsville, Hinchinbrook	85,400
Three bin – recycling + garden organics + residual waste	Burdekin	7,900

Existing waste infrastructure

For household recycling, the region is serviced by a single regional MRF processing kerbside recyclables from Townsville, Hinchinbrook and the northern part of Whitsunday Regional Council (in the Mackay region), as well as commercial and CRS materials. The MRF was opened in 2017 and includes a glass reprocessing plant to produce high quality glass sand and aggregate. There are also two commercial recycling facilities handling mostly source separated recyclables.

Only one small composter was identified in the region. The majority of garden waste is recovered through simple mulching at the council landfill sites. There was a single C&D recycler identified in the region although landfills are also crushing significant volumes of concrete for reuse.

The Townsville region is home to nine identified active landfills of which seven are classified small or very small. Two landfills are privately owned inert-only landfills with relatively small inputs of C&D waste.

Townsville City Council has recently closed two of its landfills and consolidated disposal operations to its main site, Stuart Landfill. Other landfills are facing closure in the short to medium term. There is only around 1.8 million tonnes of approved putrescible landfill capacity in the region but significant additional potential capacity (6 million tonnes) which could be realised through expansions. There is ample inert landfill airspace in the region within the private facilities.

Figure 60 overleaf provides a summary of existing infrastructure in the region.

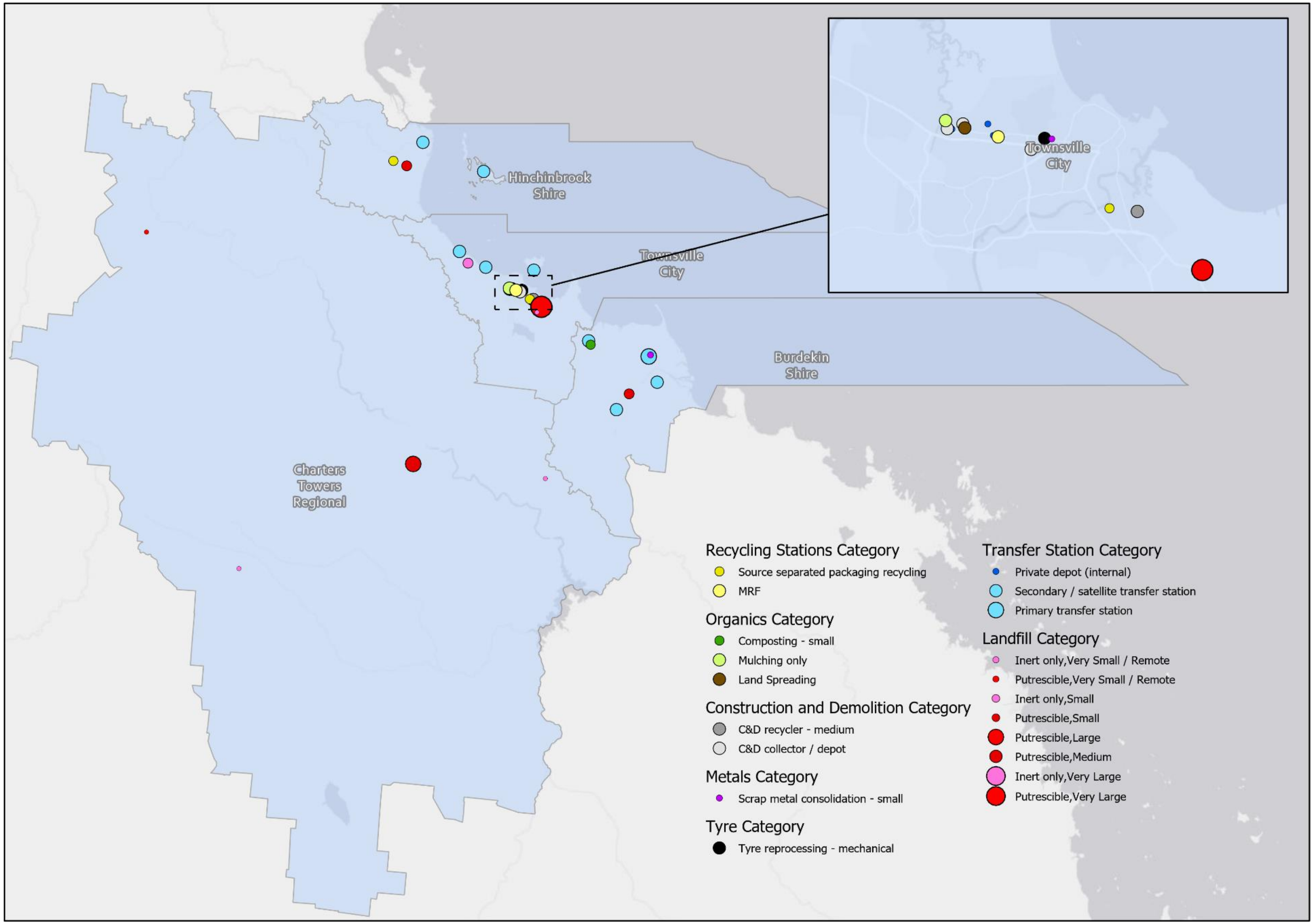


Figure 60: Townsville region map of existing waste and resource recovery infrastructure

6.6.3 Future needs and opportunities

Future waste flows

Figure 61 provides a summary of the forecast waste flows for the Townsville region under the base case. To achieve the Strategy recycling targets at a state level, the modelling assumes relatively optimistic but achievable capture rates of household food and garden organics and commercial organics, although councils will need to determine the best way to achieve this within their own contexts. There are also ambitious assumptions around future capture of recyclables from household and commercial waste and moderate assumptions for the recycling of C&D waste, mostly through further recovery of source separated masonry materials.

The waste flow modelling also assumes a moderate scale regional energy recovery facility for residual MSW and C&I waste, nominally modelled as 70,000 tonnes per annum capacity and operational by 2030, resulting in a visible step change in the recovery profile at that time. As noted above, achieving the Strategy recovery targets will require the deployment of energy-from-waste in some form in most of the large regional centres but the exact timing and scale is not set and there are still significant further investigations and feasibility analyses to be undertaken to determine if or when such a solution may be viable in the region.

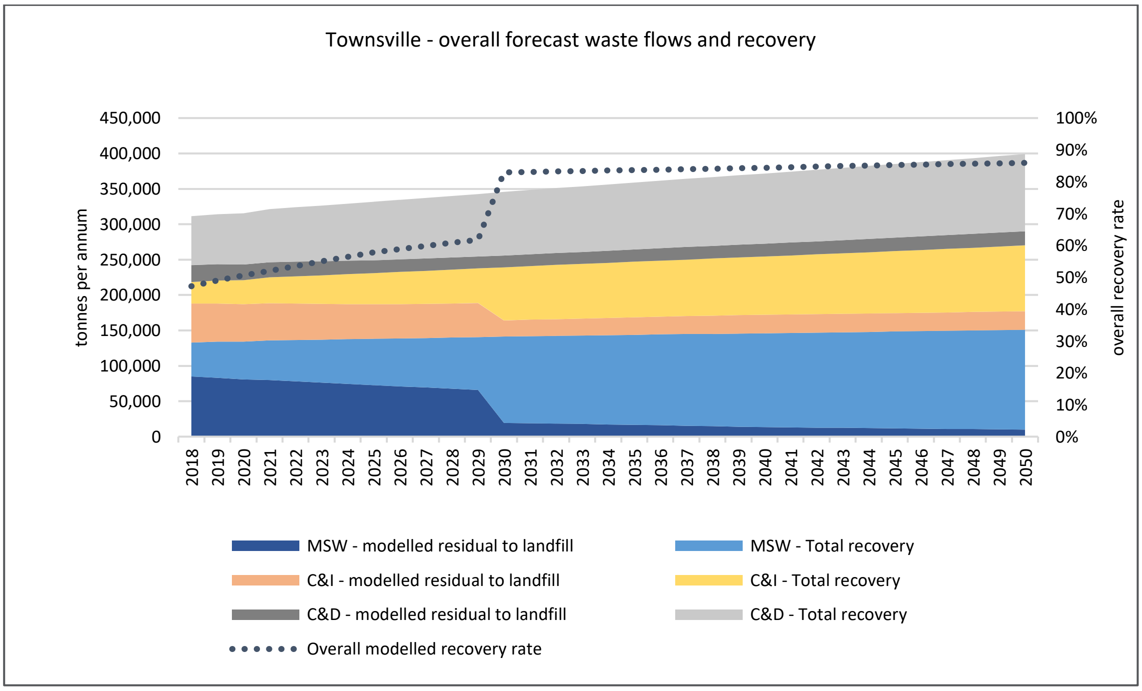


Figure 61: Forecast waste disposal and recovery by headline stream

Resource recovery infrastructure needs

The projected future waste flows, including the new resource recovery required to meet the Strategy targets, have been assessed against the existing available processing capacity in the region (based on available data) to identify future gaps in recovery capacity. Table 39 below provides a summary of future capacity needs and opportunities based on this analysis. Future landfill capacity needs have also been assessed under different recovery scenarios and are discussed separately below.

Table 39: Summary Townsville resource recovery infrastructure capacity needs assessment (under base case)

Capacity assessment	Comments
Domestic commingled recycling MRF capacity	Domestic commingled recycling is forecast to grow from 11,000 tonnes currently to 16,000 tonnes in 2030 and 22,000 tonnes by 2050. The available data and assessment suggests the existing regional MRF has adequate capacity for the medium term around 2036 when it may start to become constrained, but it is likely that the existing MRF is able to expand to some extent.
Commercial packaging recycling capacity	There seems to be ample spare capacity between the MRF and existing commercial source separated recycling facilities to accommodate expected future growth in commercial recycling over the forecast period of this Report. Commercial inputs to the regional MRF are assumed to decline as domestic inputs grow, but this is uncertain and could impact future capacity for commercial recycling.
Organics recovery capacity	With total organics recovery (domestic and commercial) forecast to grow from 36,000 tonnes now to 60,000 tonnes by 2030 and 74,000 tonnes by 2050, there is a need for new organics processing capacity. There is significant mulching capacity in the region but limited composting facilities, with most councils reliant on mulching only of green waste. New composting or other processing capacity will be required to support the projected increase in organics capture, including domestic and commercial food. This could be developed as a single regional or sub-regional processing facility with potential to explore co-processing of domestic and commercial organics with agricultural residues to boost scale. Depending on the plant location, enclosed processing may be required and there is potential to use anaerobic digestions to generate energy. An organics recovery precinct could be established linking with existing infrastructure such as intensive livestock, food processing, sugar mills, the abattoir or sewage treatment facilities. However, there may be benefits in one or two smaller localised composting operations in rural areas to minimise transport of organics, which is generally not cost effective. This could be new facilities or an expansion and upgrade to existing facilities. There are ample potential agricultural offtake markets for compost products, which should be strongly supported given the benefits to the Reef (reduced fertiliser use, improved soil quality).
C&D recycling capacity	There is aa short term need for additional C&D recycling capacity in the region to meet current requirements, and further expansion in the future. Landfills are currently filling a gap to provide basic concrete crushing but with a question over whether the outputs are of sufficient quality to secure sustainable offtake markets. With C&D recycling forecast to grow from 70,000 tonnes now to 90,000 tonnes by 2030 and 110,000 tonnes by 2050, there is enough material to support one large or two medium scale C&D processing

	facilities. Mobile processing to support recycling in rural areas may also be a good solution for the region.
Other resource recovery infrastructure	With additional capture of plastics into the recycling stream, including from commercial and agricultural sources, there could be potential for a local plastic reprocessing facility to add value to recovered plastics (e.g. washing and flaking) and potentially support local remanufacturing industries. There is also potential for a tyre processing facility to service the broader north, far north and north west regions of Queensland, including the mining industry, and avoid transporting tyres to SEQ for recycling.
Energy recovery infrastructure	Potential for deployment of AD to co-process a range of organics as noted above. Potential for a small scale thermal energy-from-waste facility processing residual MSW and C&I waste. The projections estimate that there will be around 110,000 tonnes of residual MSW and C&I by 2030 and this is projected to remain relatively steady through to 2050 (improvements in recycling are forecast to offset growth). Conditions which may favour EfW include constrained long-term regional landfill capacity, potential to co-locate with energy intensive industry in Townsville, potential to import waste fuel from other regions by rail and ample industrial land in Townsville including in the State Development Area.

Landfill capacity

The landfill capacity assessment and data from operators shows that for the region as a whole, existing approved regional capacity will start to approach exhaustion from around 2030 in the low recovery scenario, but this would be extended to around 2040 if an energy-from-waste facility is developed in the region, as modelled in the base case. However, there is significant potential expansion capacity between two of the landfills which would be more than adequate to service the region for the forecast period in both modelled scenarios.

Hinchinbrook and Charters Towers councils are facing short to medium term landfill shortages with impending closure of their primary local landfills over the next decade. Townsville's Stuart Landfill is likely to play a growing regional role in the medium to long term. It is facing exhaustion of existing approved capacity in the next decade but there is a viable opportunity to significantly expand the void and extend its life beyond 2050. While other sites may be considered for development of a new regional landfill, a new site will be significantly more challenging to develop than expanding the existing facility and the Stuart landfill is the most likely destination for residual waste from the region as other key facilities close.

Burdekin would seem to have ample landfill capacity for its own local needs over the forecast period of this Report, but it would be consumed quickly if used as a regional landfill. Palm Island has no operational local landfill capacity (there is a landfill which is not currently used for general waste) and is relying on shipping general waste to Hinchinbrook for disposal, which is likely to continue for the near term until Hinchinbrook landfill is exhausted, at which time they would likely redirect to Stuart Landfill.

Provided the potential expansion capacity that has been identified is able to be realised, there is no pressing need for a new putrescible landfill over the forecast period of this Report.

There are two single private inert landfills in the region, one of which claims to have substantial approved capacity, although its current inputs of C&D waste are relatively low.

For the seven landfills classified as small or very small, the operators should assess the viability of continued operation of those facilities but it is noted that some are servicing quite remote communities (in the Charters Towers area) and ongoing landfill operation may be an appropriate solution for those communities. In those cases, the operators should work to improve environmental standards and manage any potential environmental risks appropriately.

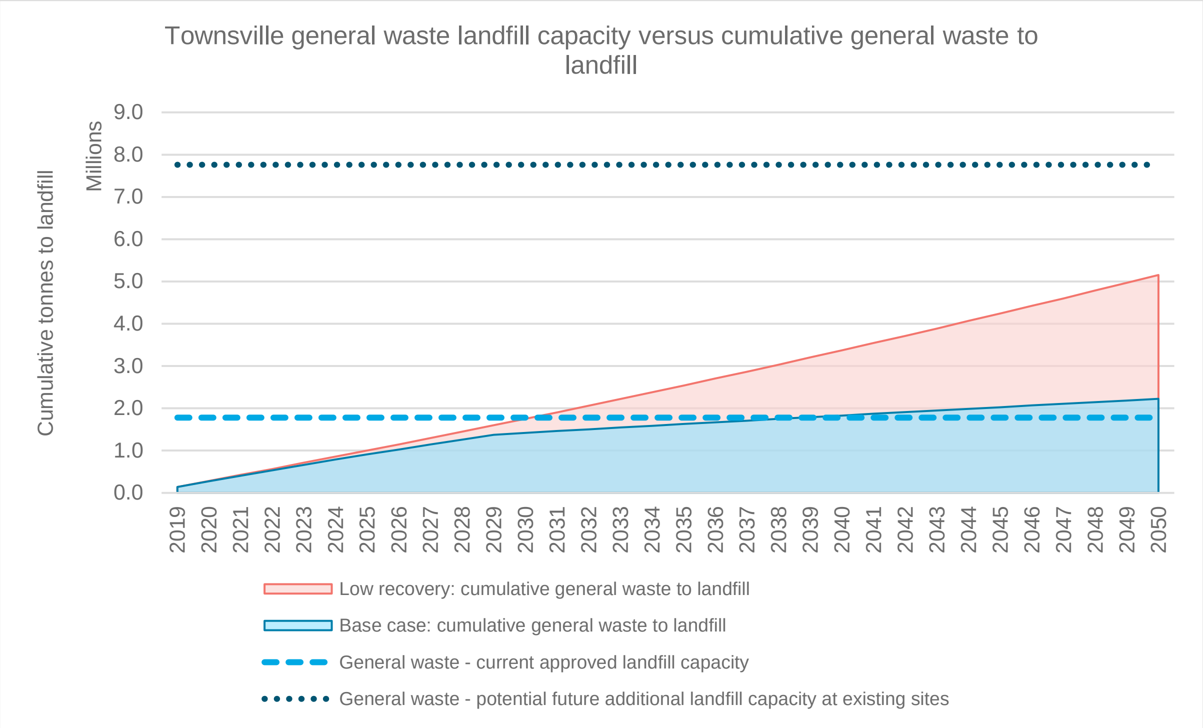


Figure 62: Regional landfill capacity (approved and potential) versus projected residual waste arisings (base and low recovery scenarios)

Transfer Infrastructure

Townsville City Council has recently developed a bulking transfer station at Hervey Range, when it closed the landfill operation on that site, to facilitate efficient transfer to Stuart Landfill. There will be a need for other councils in the region to invest in similar transfer infrastructure to allow them to cost effectively transfer waste in bulk by road to either a regional landfill (likely to be at Stuart) or a future EfW facility. Such facilities would need to be developed ahead of expected closure of the relevant primary local landfills.

6.7 Wide Bay Region

6.7.1 Regional Snapshot

The Wide Bay region includes six local government areas and has the largest regional population outside of SEQ. Unlike other regions, there are multiple main centres within the region including Bundaberg, Gympie and Hervey Bay (Fraser Coast).

The Wide Bay region has a total estimated population of around 300,000 (in 2019) which is forecast to grow to around 382,000 by 2050[32]. The local government areas of Bundaberg, Fraser Coast and Gympie are forecast to experience moderate population growth. Cherbourg and South Burnett are forecast to grow more modestly, while North Burnett is expected to decline in population over the long term.

Key industries include agriculture, forestry and tourism. The region is immediately north of and adjoining South East Queensland, so benefits from being relatively close to markets and major processing infrastructure in the south east corner.

All six councils in the region are active members of the Wide Bay Burnett Regional Organisation of Councils (WBBROC) which collaborates on waste management issues.

Regional economy

Agriculture is the core of the regional economy and the region is emerging as one of Queensland's major food-bowls, specifically for livestock, sugar, fruit, nuts, vegetables, tree crops (mostly avocadoes and macadamias) and seafood. The region is known for its arable land, subtropical climate and irrigation water supply, making it favourable for a large variety of crops. Dairy is also a significant industry in the region and the region has the second highest number of piggeries (after Darling Downs) with 118 licensed farms approved to house 285,000 animals as well as 34 cattle feedlots.

Forestry is also a significant contributor and the region is home to the state's largest timber plantations, both soft and hardwood. There are also significant timber processing facilities and associated timber product manufacturers.

In addition, the fishing industry is quite prominent in this region led by the export of fresh and frozen products, specifically; scallops, prawns, spanner crabs, mackerel, mullet and reef fish.

Tourism is also important to the regional economy with natural attractions such as Fraser Island and access to the southern Great Barrier Reef. The Defence Force has a presence with the Wide Bay Military Training Area near Tin Can Bay.

A minerals and mining sector is also emerging with a number of projects in development, including in the North Burnett Mineral Province.

Transport infrastructure

Road infrastructure is generally well developed and includes the Bruce Highway passing through the region south to north, and the Burnett Highway which also runs south-north but further inland through the North Burnett and South Burnett regions. The D'Aguilar Highway connects towns in the South Burnett region to SEQ.

The North Coast rail line passes through the region tracking along the coast. The Port of Bundaberg is less than 20km from the town centre of Bundaberg and is predominantly used for exporting raw sugar, as well as other goods such as rum and molasses.

Regional constraints and opportunities

The Wide Bay region is more fragmented than other regions in terms of its main population centres. The two largest local government areas (Bundaberg and Fraser Coast) are each home to around one third of

[32] Based on medium series projections by the Queensland Government Statisticians Office, extrapolated beyond 2041.

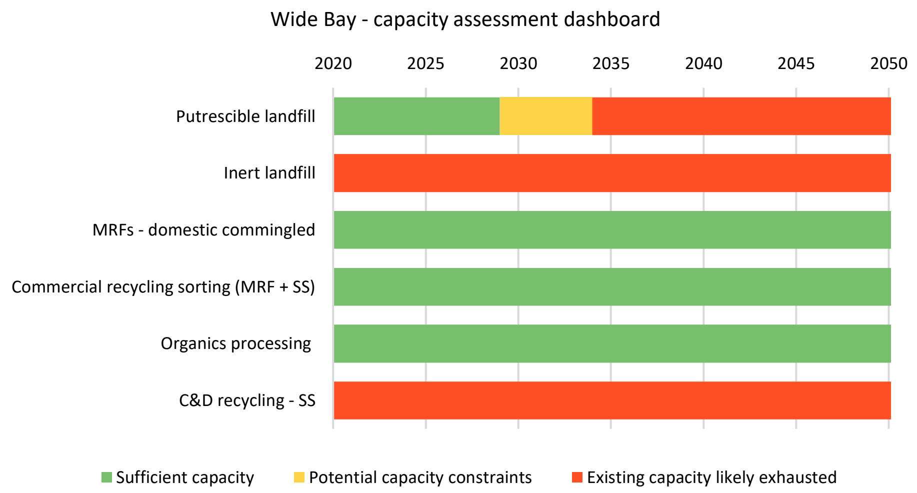
the region's residents and Gympie also has a reasonable concentration of residents. It means that no single city or LGA has a significant critical mass to support investment in new infrastructure. Regional collaboration is likely to be beneficial but will likely result in a significant proportion of waste being transported, more so than in other regions.

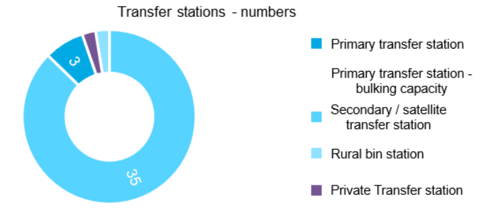
The strong agricultural and food processing sector suggests opportunities to improve organics recovery and to co-process domestic and commercial organics with residues from agricultural and food processing. Indeed, a project is already underway to develop a 'biohub' in Bundaberg which will convert a disused wastewater treatment plant into a facility which uses anaerobic digestion to process a range of commercial and agricultural organics, including residues from the Bundaberg Rum Distillery, and then provide energy back to the distillery.

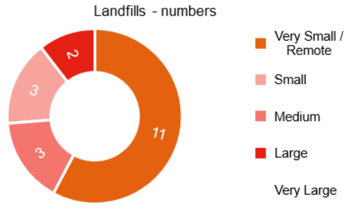
Overleaf is a one-page snapshot of existing key waste infrastructure, forecast waste flows and future infrastructure needs and opportunities for the Wide Bay region. Further detail is provided in the subsequent sections.

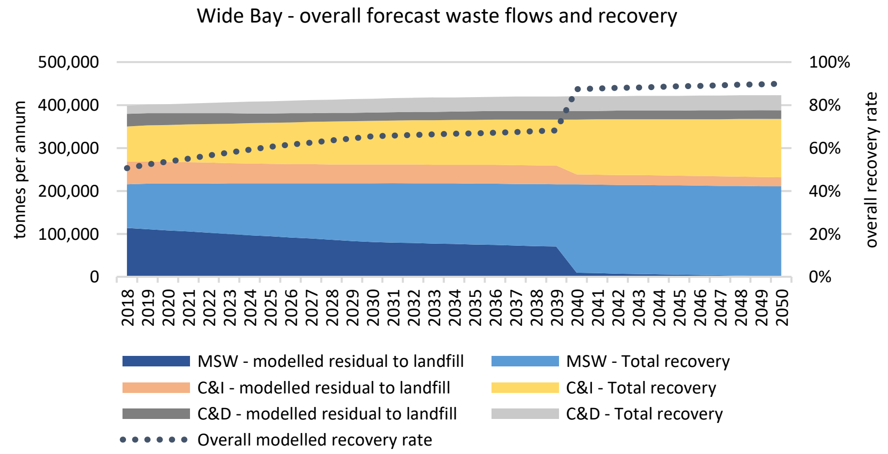
Wide Bay – Regional infrastructure snapshot			
Landfill infrastructure	Ownership	No. facilities	Remaining void capacity (millions tonnes)
Putrescible landfills	Council-owned	19	2.2
	Privately owned	0	-
Inert landfills	Council-owned	0	-
	Privately owned	0	-
Recovery Infrastructure	Sub-category	No. facilities	Annual capacity (tonnes pa)
Organics processing	Composting	8	288,200
	Mulching only	4	20,500
Recycling sorting	MRFs	3	35,000
	Source separated recycling facilities	2	-
C&D recycling facilities		0	-
Metals	Metals recycling	2	7,000
	Battery / e-waste processing	0	-

** capacity estimate excludes 'very small' landfills*









Future infrastructure needs & opportunities

- *Consider consolidating MRF capacity into a single modern regional facility*
- *Upgrade organics processing capacity to provide facilities that can process domestic and commercial food organics*
- *Integrated treatment of organics (e.g. food, food processing, biosolids, forestry, agricultural waste) including energy recovery (AD)*
- *Potential small scale energy-from-waste capacity for MSW & C&I over the long term, potential to co-process forestry residues to boost scale*
- *New bulking transfer facilities to support regional disposal and processing infrastructure*
- *New capacity to process source separated C&D waste*
- *New regional landfill capacity in the medium term*

6.7.2 The current situation

Waste flows

The Wide Bay region managed almost 400,000 tonnes of waste across all three headline streams in 2017-18 and this is forecast to grow modestly to over 420,000 tonnes by 2050 in the base case (low growth) or as high as 515,000 tonnes if current per capita waste generation rates are maintained. Table 40 summarises the key waste streams that were disposed or recovered in the region in 2017-18, which serves as the baseline for forward projections.

The region achieved a relatively high recycling rate for C&I waste (60%) and moderate rates for MSW (47%) and C&D waste (38%).

Table 40: Summary of regional current (2017-18) baseline waste flows

Stream	2017-18 tonnes
Disposal	
MSW - kerbside to landfill	81,392
MSW - non-kerbside to landfill	32,260
C&I - disposal to landfill	53,124
C&D - disposal to landfill	29,864
Recovery	
MSW - commingled recycling	13,737
MSW - other recycling	1,912
MSW - green waste recovery	85,138
MSW - AWT recovery	-
C&I - recycling	2,663
C&I - organics & timber recovery	78,195
C&D - recovery of masonry materials	13,867
C&D - other recycling	4,442

Figure 63 below shows the estimated overall breakdown of key materials via disposal and recovery pathways, noting that the landfill breakdown is an estimate based on assumed composition (see 2.3.1). It shows there are opportunities to improve the recovery of:

- Food and garden organics from both household and commercial sources, with some 46,000 tonnes landfilled in 2017-18
- Paper, cardboard, plastics and metals, particularly from commercial sources but also from households
- An estimated 32,000 tonnes of C&D masonry materials landfilled
- An estimated 31,000 tonnes of timber waste which is currently landfilled.

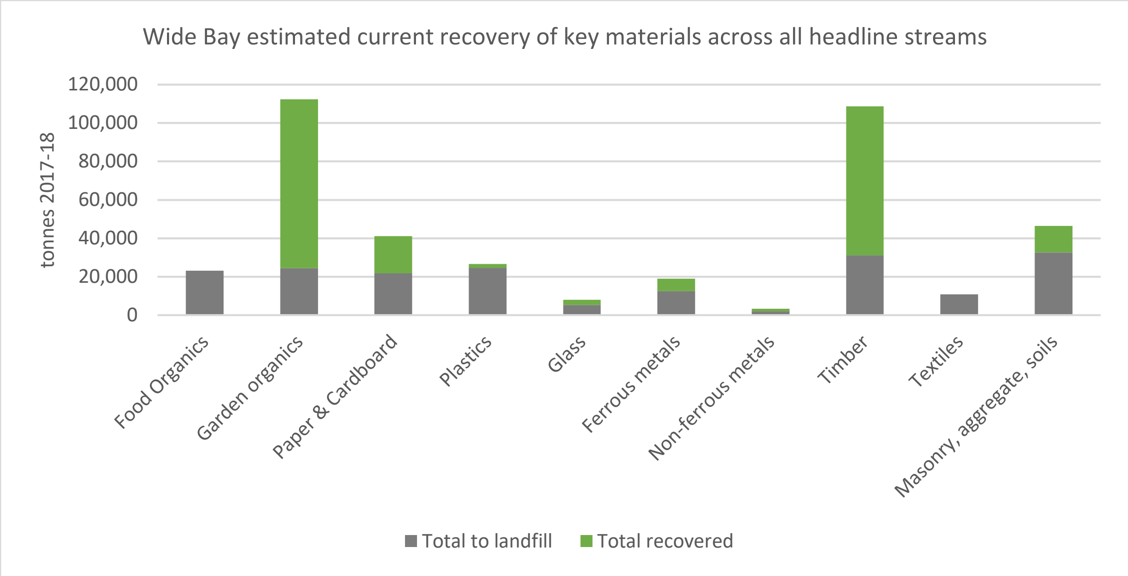


Figure 63: Summary of estimated regional disposal and recovery by material (MSW, C&I + C&D)

Collection systems

The Wide Bay region features a mix of household collection services. Four councils (Bundaberg, Fraser Coast, Cherbourg and Gympie) offer a conventional two bin service of waste and recycling, which accounts for around 86% of serviced households in the region. North and South Burnett offer a single waste bin.

Table 41: Summary of regional kerbside collection services

Collection service	Councils	No. households serviced (estimated 17-18)
Single bin (residual waste only)	North Burnett, South Burnett	16,900
Two bin – recycling + residual waste	Bundaberg, Cherbourg, Fraser Coast, Gympie	104,100

Existing waste infrastructure

For household recycling, the region is serviced by three separate small MRFs in Bundaberg, Hervey Bay and Cherbourg. The MRFs vary in age and will likely need to be upgraded to meet new product specifications.

The region is also home to numerous composters (eight identified) with substantial capacity, although it is understood that some process significant quantities of sawdust and forestry residues, as well agricultural residues. No existing C&D recyclers were identified.

The Wide Bay region is home to 19 active putrescible landfills, all council owned and of which 14 are small or very small rural facilities. Together they have a total approved remaining capacity of around 2.2 million tonnes and minimal identified potential for expansions. Some councils are facing short-term disposal capacity issues. There are no inert landfills that have been identified in the region.

Figure 64 overleaf provides a summary of existing infrastructure in the region

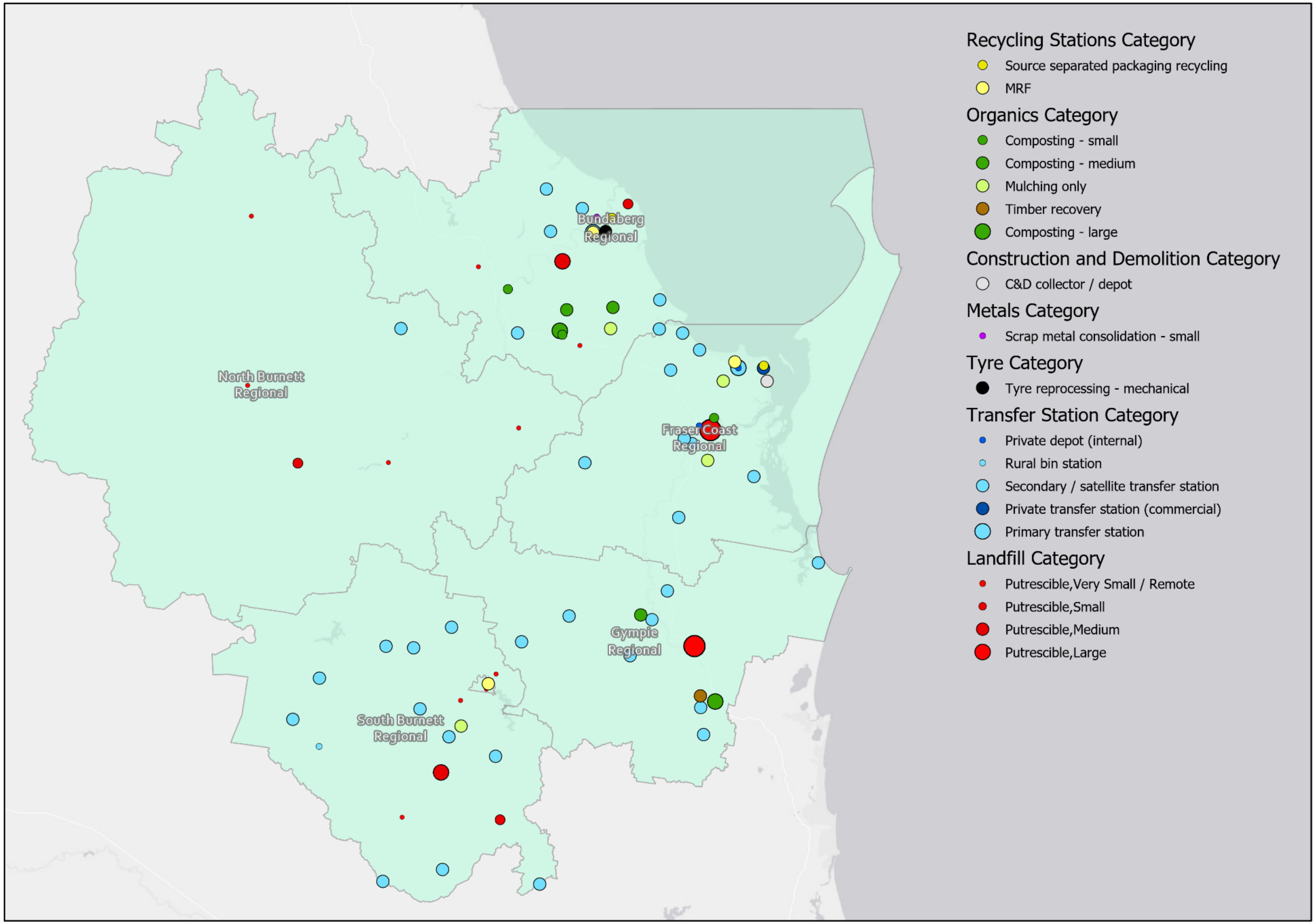


Figure 64: Wide Bay region map of existing waste and resource recovery infrastructure

6.7.3 Future needs and opportunities

Future waste flows

Figure 65 provides a summary of the forecast waste flows for the Wide Bay region under the base case. To achieve the Strategy recycling targets at a state level, the modelling assumes relatively optimistic but achievable capture rates of household food and garden organics and commercial organics, although councils will need to determine the best way to achieve this within their own contexts. There are also ambitious assumptions around future capture of recyclables from household and commercial waste and moderate assumptions for the recycling of C&D waste, mostly through further recovery of source separated masonry materials.

The waste flow modelling also assumes a moderate scale regional energy recovery facility for residual MSW and C&I waste, nominally modelled as 80,000 tonnes per annum capacity and operational by 2040, resulting in a visible step change in the recovery profile at that time. As noted above, achieving the Strategy recovery targets will require the deployment of energy-from-waste in some form in most of the large regional centres but the exact timing and scale is not set and there are still significant further investigations and feasibility analyses to be undertaken to determine if or when such a solution may be viable in the region.

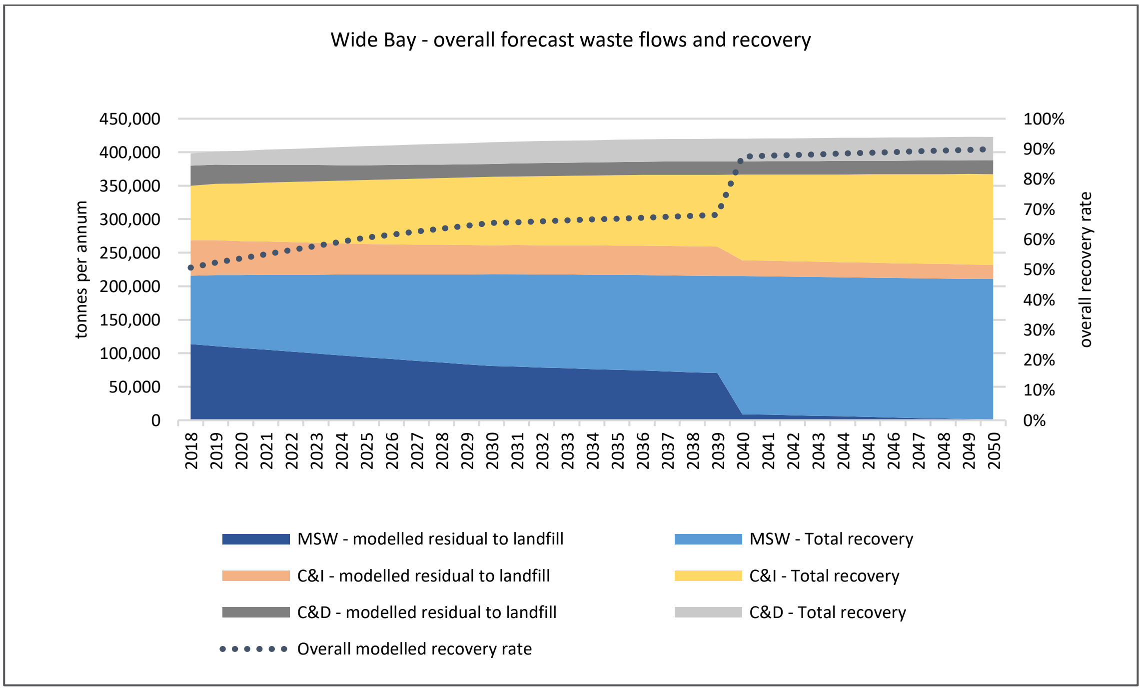


Figure 65: Forecast waste disposal and recovery by headline stream

Resource recovery infrastructure needs

The projected future waste flows, including the new resource recovery required to meet the Strategy targets, have been assessed against the existing available processing capacity in the region (based on available data) to identify future gaps in recovery capacity. Table 42 below provides a summary of future capacity needs and opportunities based on this analysis. Future landfill capacity needs have also been assessed under different recovery scenarios and are discussed separately below.

Table 42: Summary Wide Bay resource recovery infrastructure capacity needs assessment (under base case)

Capacity assessment	Comments
Domestic commingled recycling MRF capacity	Domestic commingled recycling is forecast to grow from almost 14,000 tonnes currently to 24,000 tonnes by 2030 and 33,000 tonnes by 2050. The available data suggests that existing MRF capacity is adequate for future growth, although it will likely need to be upgrade in the future and it would be worth the regional councils assessing whether a single regional MRF would be more efficient than three small MRFs.
Commercial packaging recycling capacity	There seems to be ample spare capacity between the MRF and existing commercial source separated recycling facilities to accommodate expected future growth in commercial recycling over the forecast period of this Report.
Organics recovery capacity	With total organics recovery (domestic and commercial) forecast to grow from 178,000 tonnes now to 210,000 tonnes by 2030 and around 222,000 tonnes by 2050, the existing organics processing capacity would seem to be adequate, but subject to it being able to process the expected volumes of domestic and commercial food organics. There may need to be new facilities or upgrades to existing open composting facilities to accommodate this.
C&D recycling capacity	There is an immediate need for new C&D recycling capacity in the region with no existing facilities identified and only basic concrete crushing at local landfills. C&D recovery is forecast to grow to 32,000 tonnes per annum by 2030 and 35,000 tonnes by 2050.
Energy recovery infrastructure	As noted above, there is potential to deploy AD to co-process a range of organics and generate energy. There is potential for a small scale thermal energy-from-waste facility processing residual MSW and C&I waste in the region. The projections estimate that there will be 110,000 tonnes of residual MSW and C&I by 2030, dropping slightly to 100,000 tonnes by 2050. With regional landfill challenged and potential to co-process forestry and sawmill residues, EfW may be an appropriate long-term solution.

Landfill capacity

The Wide Bay region is facing some landfill capacity challenges with half of the region's landfills planned to close by 2030 including some of the larger sites. At the regional level, the assessment indicates there is enough existing capacity to last until around 2030, but at the local level a number of councils are facing more short term issues. Gympie Regional Council is preparing for the imminent closure of its only landfill and Fraser Coast Regional Council is also facing the closure of its main landfill in the medium term. Both North and South Burnett Regional Councils are facing the closure of several small rural landfills in the medium term (by around 2030) which will require a rethink of their transfer station networks.

There is a need for councils in the region to collaborate to develop a regional landfill solution that will serve the region's needs both in the short and long term.

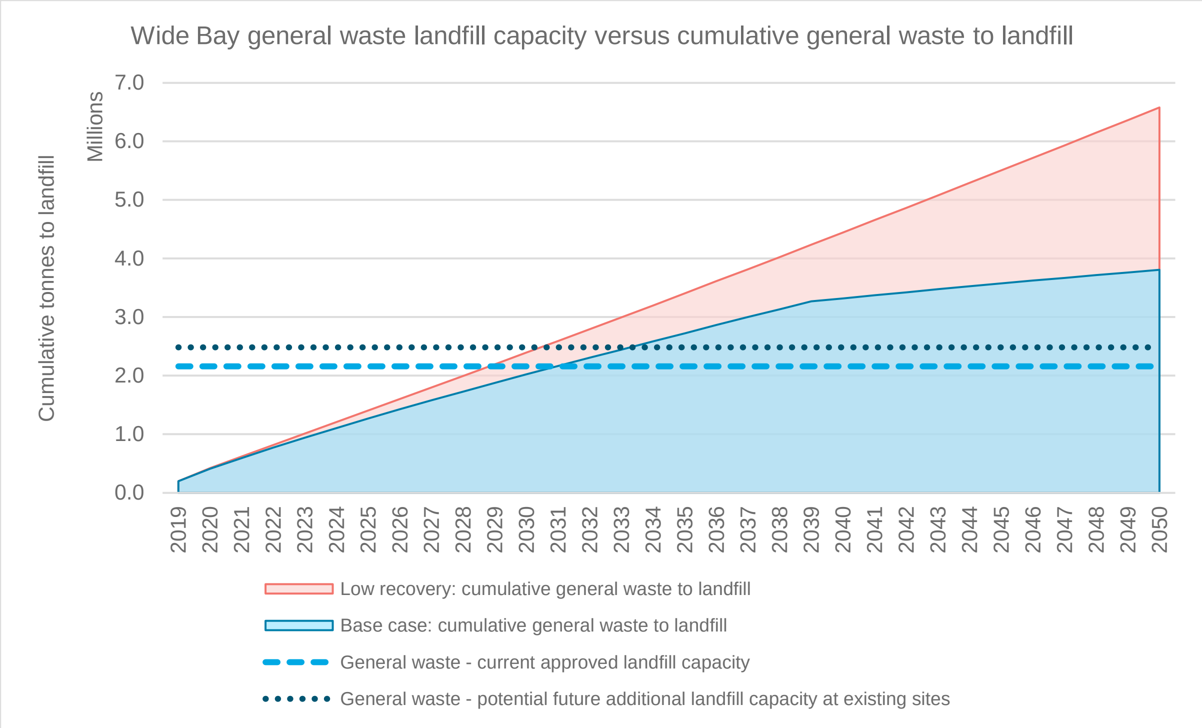


Figure 66: Wide Bay region landfill capacity assessment

Transfer Infrastructure

Depending on the ultimate regional landfill solution and long-term EfW plans, councils in the region will need to invest in new transfer infrastructure to facilitate efficient bulk transport of waste to regional facilities.

6.8 Remote Queensland

6.8.1 Regional Snapshot

The Remote Queensland region covers a vast land area spanning western and northern Queensland, encompassing a total of 34 separate local government areas (plus the privately run Weipa Town Authority), of which 12 are indigenous councils. While the region covers 60% of the land area of the state, it is home to just 1.4% of the total population. Mount Isa is the largest and only large regional centre and is a significant hub of commercial activity and services for the north-west region.

The Remote Queensland region has a total estimated population of around 71,000 (in 2019) which is forecast to slightly decline over the long term to around 69,000 by 2050[33]. Mount Isa is the largest LGA by population (just under 19,000 people), accounting for around one quarter of the total region. Other LGAs range in population from a few hundred people up to 4,000-5,000.

Most of the 34 local government areas in the region are forecast to decline in population over the long term but there are exceptions including a number of the indigenous councils and shires such as Cook and Burke, which are expected to experience moderate growth.

Regional economy

Mt Isa is the largest local economy and population hub in this region, with agriculture and resources being the key drivers of the regional economy supported by three major ports, exporting a range of commodities, in particular Bauxite, silica sand and live cattle. Across the region, key employment industries include mining, public administration, agriculture and health care and social assistance.

With the downturn in the mining and resources sector in recent years, the region has been particularly affected resulting in high local unemployment rates with an average of 12.1%.

The region is a major producer of beef, including for export markets and there are Cattle Export Quarantine Depots at Karumba and Weipa, with around 90,000 head being exported annually[34].

Transport infrastructure

There are a number of national and state highways traversing the region and providing connections to major centres such as Mt Isa or along the east coast. The Mitchell Highway connects Bourke and Mount Isa making it an important road link for the transport of passengers and freight. It passes through the Paroo and Murweh LGAs. Another major road is the Landsborough Highway, which goes between Morven and Cloncurry, it is part of the national highway system which links Darwin and Brisbane. In rural and remote parts of the region, road quality is variable and can be poor, which can be a constraint on the safe and cost effective movement of waste. The poor quality of roads is often part of the justification for councils to continue ongoing local landfill disposal in remote areas, rather than developing transfer stations and consolidating landfill infrastructure.

In terms of rail access, it is mostly focused around resource areas. The Mt Isa line runs from Townsville to Mt Isa and mostly carries bulk fertilisers, acids and minerals from the Mt Isa region.

Regional constraints and opportunities

All of the LGA's within this region share a number of common challenges and traits in their waste management systems, as a result of:

- Distance from key markets in South East Queensland
- Small, highly dispersed populations

[33] Based on medium series projections by the Queensland Government Statisticians Office, extrapolated beyond 2041.

[34] https://www.tiq.qld.gov.au/wp-content/uploads/2017/10/NORTHERN-AUSTRALIA-MAP_TIQ_A3_f.pdf

- Low rate bases with competing service and infrastructure priorities (including maintenance of significant road networks)

Most of the existing waste infrastructure is basic with a focus on landfill disposal, often in unlined and unmanned tips.

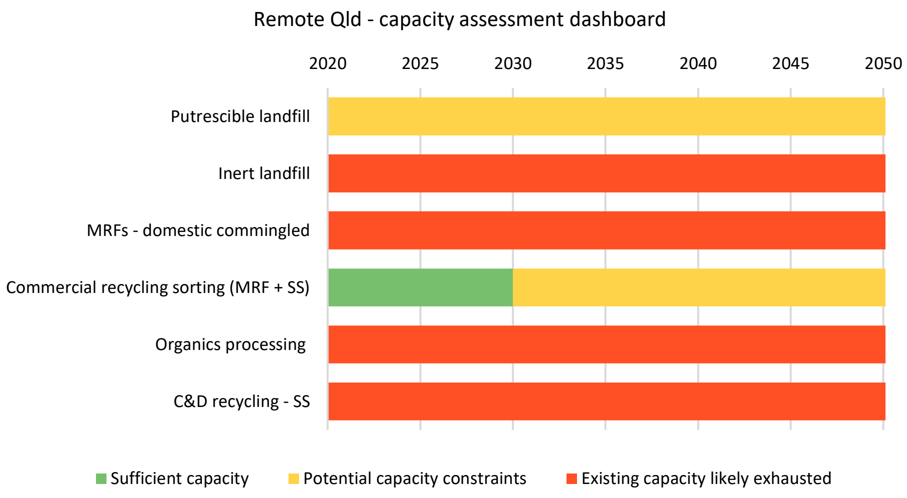
The future opportunities around resource recovery are likely to be less ambitious than other regions, given the significant challenges in delivering recycling services. The container refund scheme is providing subsidised recycling options and logistics routes where previously there were none, and remote communities should seek to leverage those and maximise the potential benefits and value from the CRS. Any other recycling efforts should focus on materials that can be reused locally (e.g. crushed glass) or which have sufficient value to be worth transporting (e.g. scrap metal).

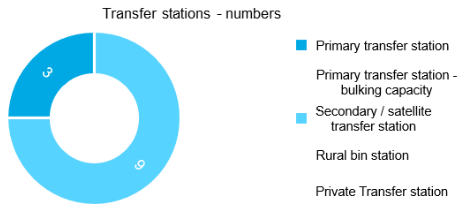
In terms of organics recovery, it is likely that most households already recover much of their organics by composting garden waste and using food scraps as animal feed. However, in the towns there may be opportunities to establish small community based composting schemes attached to community gardens or schools.

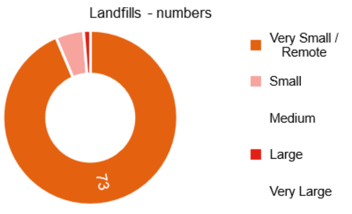
Overleaf is a one-page snapshot of existing key waste infrastructure, forecast waste flows and future infrastructure needs and opportunities for the Remote Queensland region. Further detail is provided in the subsequent sections.

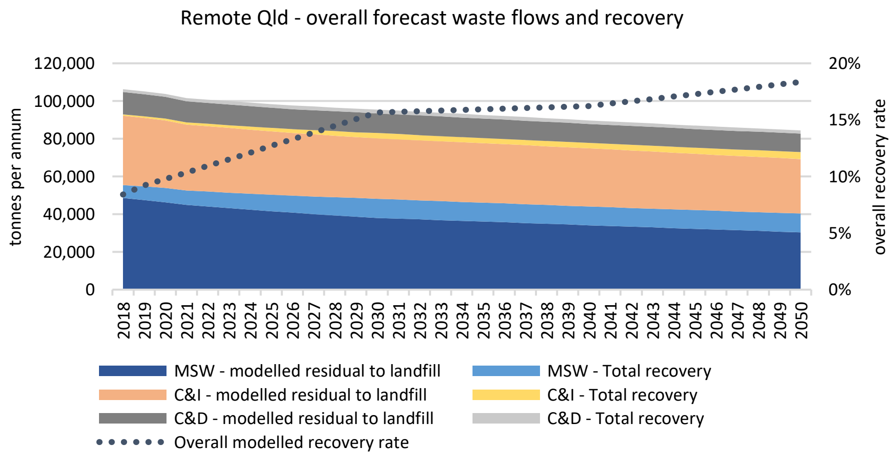
Remote Queensland – Regional infrastructure snapshot			
Landfill infrastructure	**Ownership**	**No. facilities**	**Remaining void capacity (millions tonnes) ***
Putrescible landfills	Council-owned	76	4.3
	Privately owned	0	-
Inert landfills	Council-owned	1	-
	Privately owned	1	0.3
Recovery Infrastructure	**Sub-category**	**No. facilities**	**Annual capacity (tonnes pa)**
Organics processing	Composting	0	-
	Mulching only	0	-
Recycling sorting	MRFs	0	-
	Source separated recycling facilities	1	500
C&D recycling facilities		0	-
Metals	Metals recycling	1	-
	Battery / e-waste processing	0	Insufficient data

** capacity estimate excludes 'very small' landfills*









Future infrastructure needs & opportunities

- *Focus on improving the environmental management of rural landfills*
- *Maximise the recovery of beverage containers through the CRS and leverage the subsidised logistics networks to potentially support other recycling initiatives*
- *For other recycling, focus on high value materials and efficient methods of collecting and transporting them, which may require investment in equipment such as balers and compactors*
- *In the towns, consider development of community composting projects attached to community gardens or schools, or on-farm composting schemes*
- *In areas where there are potential back-loading opportunities, or access to rail, which will be mostly mining areas, councils should work with mining companies to explore the potential to compact and bale recyclables and transport them to a regional hub*

6.8.2 The current situation

Waste flows

The Remote Queensland region managed over 106,000 tonnes of waste across all three headline streams in 2017-18 and this is forecast to decline to around 85,000 tonnes by 2050 in the base case (low growth) as a result of falling populations in most remote areas and assumed waste avoidance. Under the low recovery scenario, total waste generation is forecast to remain steady at 103,000 tonnes by 2050, with current per capita waste generation rates maintained. Table 43 summarises the key waste streams that were disposed or recovered in the region in 2017-18, which serves as the baseline for forward projections.

The region achieved very low recycling rates across three streams (less than 15% of each stream) which reflects the significant challenges of distance from markets and highly dispersed, small populations.

Table 43: Summary of regional current (2017-18) baseline waste flows

Stream	2017-18 tonnes
Disposal	
MSW - kerbside to landfill	28,082
MSW - non-kerbside to landfill	20,518
C&I - disposal to landfill	36,801
C&D - disposal to landfill	11,938
Recovery	
MSW - commingled recycling	105
MSW - other recycling	973
MSW - green waste recovery	5,503
MSW - AWT recovery	-
C&I - recycling	556
C&I - organics & timber recovery	-
C&D - recovery of masonry materials	320
C&D - other recycling	1,174

Figure 67 below shows the estimated overall breakdown of key materials via disposal and recovery pathways, noting that the landfill breakdown is an estimate based on assumed composition (see 2.3.1). It shows there are opportunities to improve the recovery of most streams but there are also significant practical and financial challenges in doing so. Resource recovery efforts should focus on higher value materials such as source separated cardboard, metals and rigid plastics; where the commodity value will be more likely to recoup the collection and transport costs. There may also be opportunities to encourage household and community composting programs to address the 15,000 tonnes of food and garden organics currently landfilled.

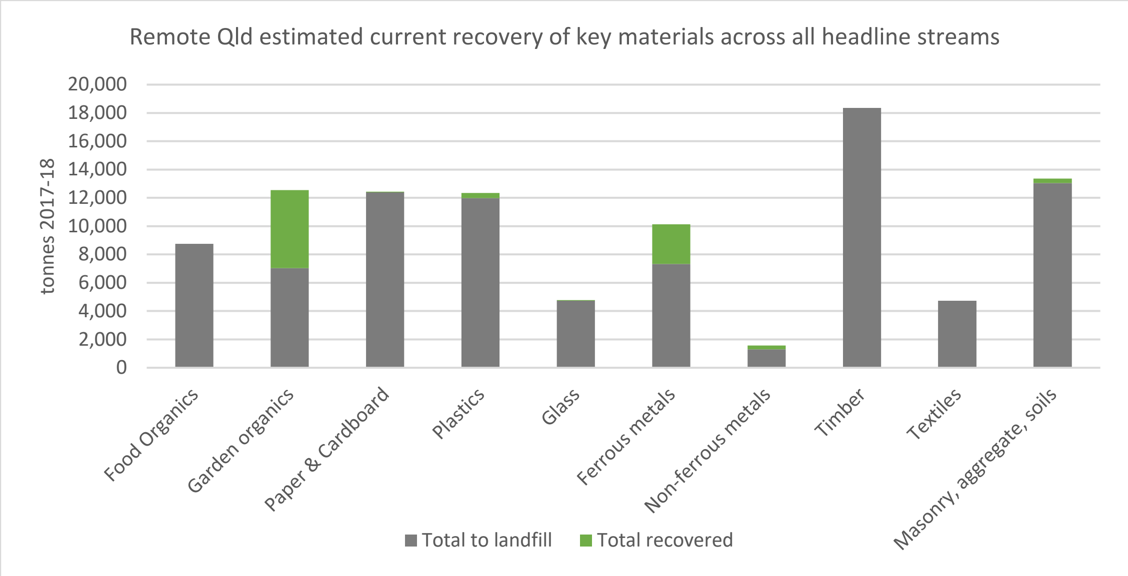


Figure 67: Summary of estimated regional disposal and recovery by material (MSW, C&I + C&D)

Collection systems

All 34 councils in the Remote Queensland region offer a single waste bin to those households which are serviced, but almost 40% of households have no kerbside service at all. This reflects the nature of the region – small, dispersed rural communities including some houses which are very isolated and difficult to service. As noted above, the lack of kerbside recycling reflects the significant constraints on recycling across the region.

Table 44: Summary of regional kerbside collection services

Collection service	Councils	No. households serviced (estimated 17-18)
Single bin (residual waste only)	All 34 councils	23,000

Existing waste infrastructure

Only 12 transfer stations have been identified in the Remote region, of which four are in Cook Shire. On the other hand, 78 landfill sites were identified reflecting that the dispersed nature of the population in the region makes it more challenging to rationalise landfills and replace them with transfer stations. Cook Shire has made a deliberate effort to close small rural landfills in the far north, but this has come at a high cost with most of the Shire's waste now transported 300 km south from Cooktown to a private landfill.

Of the 78 active landfills identified across the region, only one was classified as large with the rest small or very small. All but one are council owned apart from the Weipa landfill run by Rio Tinto Aluminium.

There is little benefit in assessing the total regional capacity for the Remote region and it is difficult to do with the data available, given the significant number of councils that have not reported data to either DES or this study.

Figure 68 overleaf provides a summary of existing infrastructure in the region.

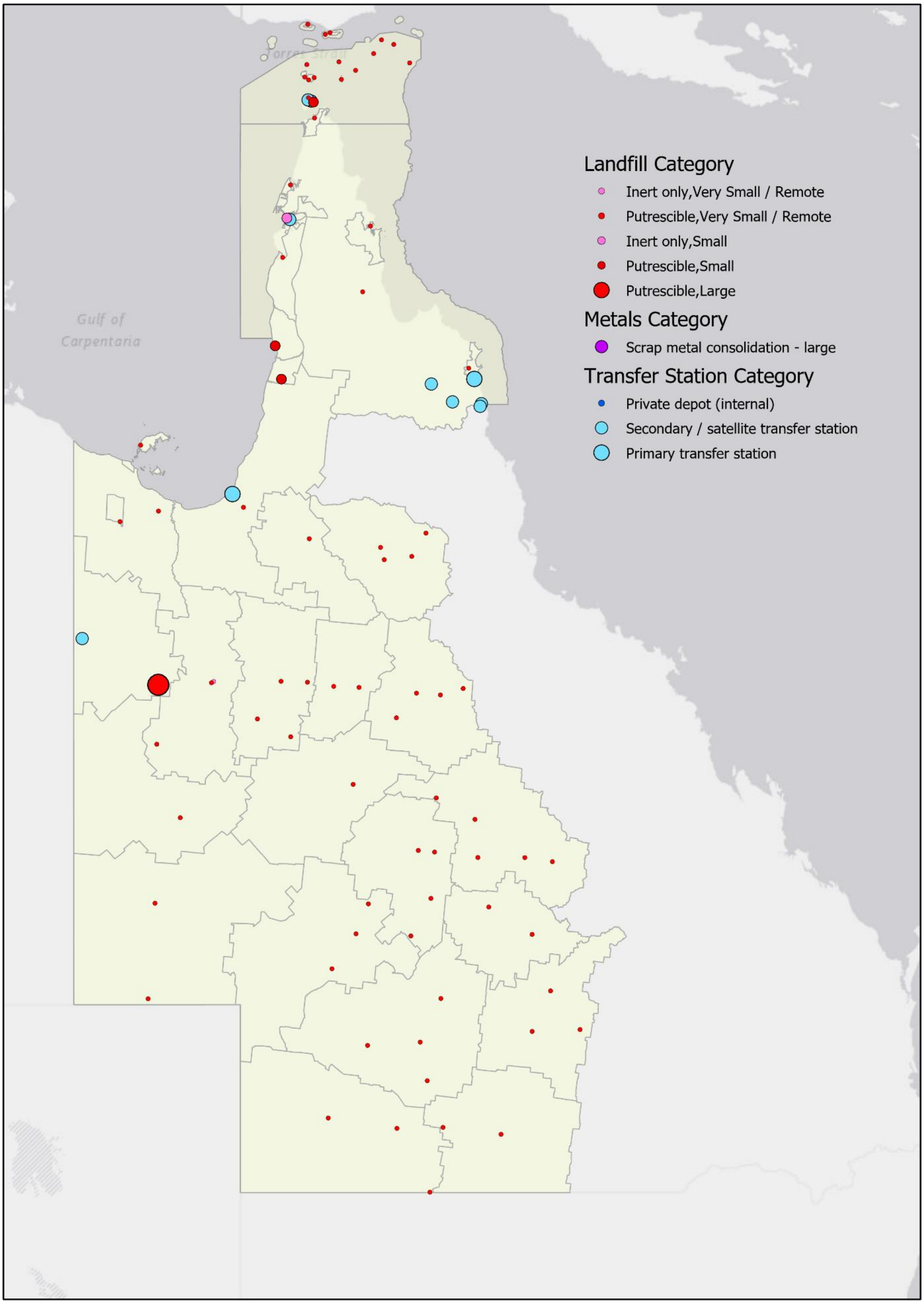


Figure 68: Remote Queensland region map of existing waste and resource recovery infrastructure

6.8.3 Future needs and opportunities

Future waste flows

Figure 69 provides a summary of the forecast waste flows for the Remote Queensland region under the base case. Given the significant constraints on recycling and small contribution to the Strategy recycling targets, the modelling assumes modest improvements in recycling or household and commercial waste. The overall recovery rate for the region is forecast to rise from around 8% currently to around 18% by 2050, through minor improvements in the capture of domestic and commercial recyclables and organics. As discussed below, the waste and resource recovery priorities and opportunities are very different from other regions.

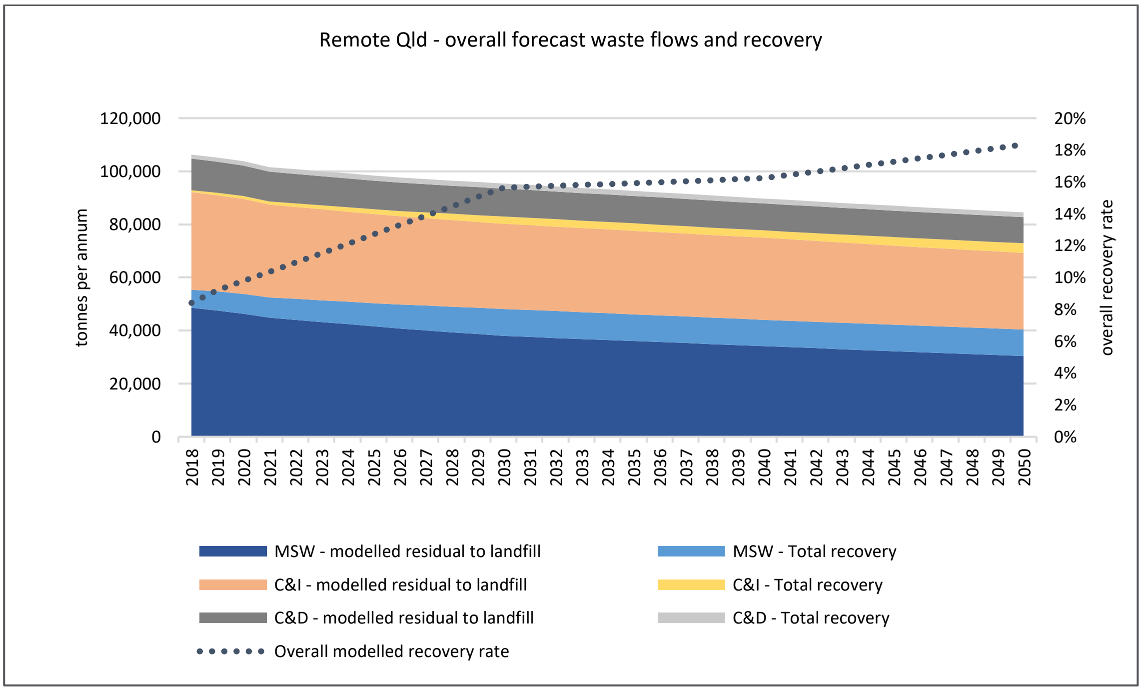


Figure 69: Forecast waste disposal and recovery by headline stream

Resource recovery infrastructure needs

Given there is limited existing resource recovery capacity in the region, or it is highly dispersed and only able to service a local demand, there is little benefit in assessing future regional waste flows against existing capacity as in other regions. Instead, Table 45 below provides a discussion on potential future priorities and opportunities. Future landfill needs are discussed separately below.

Table 45: Summary Remote Queensland resource recovery infrastructure capacity needs assessment

Capacity assessment	Comments
Recycling	It is unlikely that conventional kerbside commingled recycling systems will ever be viable in this region as it is not financially viable or efficient to transport commingled materials to a processing hub. Rather, the focus should be on developing systems to collect clean separate streams of high value materials such as metals or cardboard, as well as maximising the uptake of the CRS for beverage containers. Councils should investigate establishing drop-off points for higher value materials and investing in compaction and baling equipment to allow more cost effective transport to a processing hub, potentially using back-loading options or rail.
Organics recovery capacity	It is likely that there is a relatively high recovery rate of household organics occurring in the home, which is not recorded or captured in the data, through home composting and feeding food organics to animals. This

	should be encouraged and supported with information and education and where appropriate, equipment such as subsidised compost bins. In some towns, there may be potential to establish community composting schemes where residents can bring their organics to a facility in a community garden or school for composting.
C&D recycling	It is unlikely that C&D recycling will ever be viable given the relatively small volumes, low value of materials and high cost to transport to a processor. The one potential exception is scrap metal which could be consolidated and compacted for transport to market. When there is a large construction or demolition project, the use of mobile crushing plant should be considered to allow reuse of the materials in the project.

Landfill capacity

It is difficult to undertake a detailed capacity assessment across this region with the data that is available. However, from the councils that have provided data there are a number which are facing short term landfill capacity issues including Burke and Torres Shire Councils.

Mt Isa landfill is nearing the end of current approved capacity but has ample potential future expansion capacity (subject to approval).

A number of indigenous councils are facing landfill challenges which will be further assessed as part of the separate Indigenous Waste Strategy. Torres Strait Island Regional Council is facing a unique set of challenges with 15 different landfill sites spread across 15 islands and all at or near capacity, with no alternative but to continue using the facilities.

Transfer Infrastructure

Given waste will likely continue to be managed locally in most cases, there is no general need to develop new transfer infrastructure. There will be localised needs, where a landfill must close or where there is an opportunity to share a landfill with a neighbouring region.

Otherwise, as noted above, councils should investigate establishing drop-off points for high value recyclables and undertaking basic pre-sorting and densification (compaction and baling) to allow transport on backloads or via containerised rail (where available).

This section provides a more detailed discussion of the context and potential opportunities within each of the eight defined regions. The industries and activities that drive the economy in each region will have a significant impact on the types and volumes of waste that are generated in the region and future growth in both resident population and waste generation. It is also important to understand the major industries in the region as they could potentially be users of recovered resources, both in terms of materials and energy. This section provides an overview of the regional economy and the major industries as well as the environmental setting to the extent that it may influence future waste infrastructure and planning.

By comparing the future projected waste flows in each region with the capacity data for existing infrastructure, it is possible to identify where there will be gaps in future capacity, accounting for future growth and improved resource recovery. This chapter provides an overview of the capacity gap analysis in each region and the potential opportunities that will arise, with reference to the discussion in section 5 above.

The estimates of current capacity are indicative and based on a combination of information gathered from operators through the data survey and estimates. For facilities where no capacity information was provided by the operator, the capacity has been estimated based on public information, the throughput in recent years and/or information gathered during the previous 2016 study. It has not been possible to quantify the capacity of all types of waste and resource recovery infrastructure due to a lack of data and/or particular difficulty in quantifying capacity for some facility types (e.g. transfer stations).

7 LAND USE PLANNING

Good land use planning is critical to attracting investment and supporting future waste and resource recovery infrastructure and this chapter provides a discussion around key opportunities within the existing land use planning framework to help facilitate the development of new infrastructure. It is noted that the Waste Strategy and Resource Recovery Industries Roadmap both identify actions that relate to reviewing how the Queensland statutory planning framework can enable the growth of the resource recovery industries. This Report supports and complements those actions without overlapping with the other workstreams that are in progress.

7.1 Overview

Queensland's population is growing, at a rapid rate in some urban areas. There is an ongoing need to provide additional housing through development of greenfield land and by redevelopment or infill of existing urban areas, to create healthy, liveable spaces that are well connected to the areas where people need to go for work or study. At the same time, the growth in communities and local economies results in more waste being generated and there is an expectation that waste will be managed safely, sustainably and cost effectively.

To ensure that waste can be collected and managed effectively, efficiently and sustainably, it is important that waste infrastructure be located close to communities where the waste is generated. Queensland is a state that is fortunate to have ample land resources but with the majority of the population concentrated in urban areas which account for a relatively small part of the land mass, there is potential to create tensions between existing and future communities and waste facilities, if the planning framework does not effectively cater for these essential services. These tensions can amplify over time as housing expands and grows into areas that were not previously used for residential purposes and as community expectations change.

Queensland communities generally recognise that waste management is an essential service that provides significant environmental, social and economic benefits. But it is not without its own potential impacts and those impacts need to be carefully managed and controlled to ensure the long-term sustainability of the sector and to build and maintain the essential social license to operate from the community. The concept of 'not in my backyard', or NIMBY, is all too familiar and has long been a challenge for the waste industry, as it has been for other high impact industries such as manufacturing and resource extraction.

Different types of waste facilities have varying types and degrees of impact, depending on factors such as the waste materials being managed, location, technology and scale of the facility. If not planned or managed appropriately, waste facilities have the potential to impact:

- The environment – including air quality impacts such as emissions of dust, odour and gaseous contaminants; water quality impacts such as emissions to surface water and groundwater; and deposit of potential contaminants to land;
- Communities and sensitive receptors – including impacts on health and amenity value for communities (i.e. enjoyment of their surrounds and quality of life), such as visual amenity, litter, noise, odour, dust and traffic impacts. Increased heavy vehicle movements can also lead to safety concerns while perceptions about waste facilities can impact on surrounding property values.

For further context, details on the impacts of specific types of infrastructure are provided below.

Land use planning plays an important role in managing the potential impacts and risks associated with the location of waste management and resource recovery industries by ensuring appropriate zoning and allocation of land uses as well as providing appropriate buffers. An effective land use planning system is one that manages potential conflicts and provides adequate separation between waste and resource recovery activities and other land-users. However, despite these efforts, it may not always be possible to manage all impacts. Indeed waste facility operators should not rely on buffers to avoid impacts on the community - regulation, investment in best available technologies and good operational management should be the first line of defence to protect communities.

There will always be the potential for tension when trying to locate waste and resource recovery services sufficiently close to the main sources of waste, given the reluctance of people to have those facilities near their own house. That tension can be managed and the extent to which it manifests will be a function of factors such as growth pressures, planning provisions, regulation of industry and the extent to which operators foster a social license to operate within their communities.

The land use planning system needs to consider and account for the various activities that contribute to a productive economy find a balance between allocating sufficient land for growing communities whilst also providing for the infrastructure to service those communities, including waste and resource recovery facilities. Land use planning also needs to integrate those functions with current and future transport infrastructure to ensure that materials, including wastes and recovered resources, can move efficiently from their source to management facilities, and then on to end markets.

One approach to manage the land use planning challenges around waste and resource recovery infrastructure is to concentrate facilities into a precinct and this is discussed in section 7.4 below. A well planned precinct can support the transition to a circular economy by encouraging and supporting the co-location of synergistic industries where the output of a resource recovery process becomes the input to an adjacent manufacturing process.

7.1.1 The Queensland planning system

The Queensland land use planning system has been through a period of reform recently with the enactment of the *Planning Act 2016*, which came into force 3 July 2017. The Act establishes the legal framework for Queensland's land use planning and development assessment system and the changes aim to create a more effective, efficient, transparent, integrated, coordinated and accountable system of land use planning and development assessment.

The land use planning system has two main aspects: plan-making and development assessment. The system is generally described as performance-based, meaning state and local governments clearly establish what they want to achieve but do not mandate how it will be achieved. The state government's role in the planning system, led by the Department of State Development, Manufacturing, Infrastructure and Planning, is to administer and coordinate land use planning across the state. The state does not generally get involved in determining local planning decisions unless there is cause to do so through a Ministerial call-in, but it does approve local planning schemes and advise on aspects of development applications that trigger state planning matters. The state develops the state planning instruments such as State Planning Policy (SPP) and Regional Plans.

Local governments are the key enablers of planning and development – they are responsible for developing local planning instruments including local planning schemes and assessing the majority of development applications against the planning scheme. Local planning schemes are developed in consultation with communities to ensure they align with the land use aspirations of the community. They also outline how development applications will be assessed and take into account the state interests outlined in the state planning instruments.

Most waste and resource recovery facilities will require a development approval which in most circumstances will be assessed and determined by the relevant local government, in accordance with the local planning scheme. If the development triggers state interests, an assessment will be undertaken by the State (i.e State Assessment and Referral Agency – SARA).

The majority of waste facilities also require an *Environmental Authority* (EA) which is effectively a license to undertake activities which are likely to have an impact on the environment or community. An EA is required if the proposed activities at a facility fit within the criteria and definitions of *Environmentally Relevant Activities* (ERAs) as set out in the *Environmental Protection Act, 1994* which the majority of waste and resource recovery facilities do. The EA will set out the conditions under which the activities may be undertaken and the Department of Environment and Science is responsible for issuing EAs and regulating to ensure they are complied with.

Large scale, significant infrastructure projects which are strategically significant to a region or the state and which have complex approval requirements and potentially significant environmental impacts, can apply to be assessed by the state government as a 'coordinated project' under the *State Development and Public Works Organisation Act 1971* (SDPWO Act). The decision to declare a project as a coordinated project, rests with the Coordinator General based on a number of criteria. Coordinated projects go through a rigorous impact assessment process which involves coordination of inputs from multiple government agencies, and still need to obtain a development approval, but the state's evaluation report serves to streamline subsequent approvals processes.

To date, no waste infrastructure proposal has been progressed under the 'coordinated project' pathway. However, this may change as larger more complex resource recovery facilities are proposed in the future, such as regionally significant energy-from-waste and advanced processing technologies.

The vast majority of development applications for waste and resource recovery infrastructure will be assessed by the relevant local government. Other than potential declaration as a coordinated project for large and complex industry proposals, other assessment pathways may be relevant. For example, if the industry proposal is within a Priority Development Area (PDA) or State Development Area (SDA) the state government may play a more significant role in assessing an application under the following legislative mechanisms:

- Assessment under the *Economic Development Act 2012* for projects located in a PDA
- Assessment under the *State Development and Public Works Organisation Act 1971* (SDPWO Act) for projects located in a SDA.

7.1.2 Opportunities for land use planning to facilitate waste infrastructure development

An effective land use planning framework can help facilitate growth and development of new waste and resource recovery industries across the state. Feedback from industry has identified a number of opportunities to improve current processes around land use planning and approvals for waste infrastructure.

Consultation with industry, particularly private sector operators and the industry bodies which represent them, which was undertaken during the development of this Report, has identified concerns and perceived barriers around aspects such as navigating the planning system and being able to obtain approvals within a timely manner and at a reasonable cost. It is not clear whether some of the industry concerns about the planning system are based on experiences of the previous system, prior to implementation of changes under the *Planning Act 2016*. Nevertheless, the feedback from industry has been helpful in understanding how the land use planning system could further support and attract investment in new waste and resource recovery infrastructure.

Below is a summary of some of the key concerns raised by industry during consultation to support development of this Report and the perceived barriers within the land use planning system to new infrastructure development. Based on this feedback, potential opportunities have been identified whereby the land use planning system can address these concerns and facilitate waste infrastructure development.

Many of the opportunities are around improving access to information and optimising the access to and delivery of existing support services, rather than further significant structural changes to the planning framework. It is noted that there is a separate workstream being led by DSDMIP in response to actions under the Waste Strategy and Resource Recovery Roadmap, which is exploring how land use planning can better facilitate and enable development of waste and resource recovery infrastructure. That work is expected to address some of the concerns and opportunities identified by industry.

Table 46: Summary of key concerns and barriers identified by industry and opportunities for land use planning to facilitate waste infrastructure development

Industry consultation feedback	Opportunities to facilitate infrastructure development
Critical waste and resource recovery infrastructure needs to be acknowledged in land use planning systems and instruments for the essential service that it provides and protected from future encroachment by	Critical waste infrastructure, whether council or privately owned, should be consistently acknowledged in local and regional planning schemes as providing an essential community service, in much the same way as other critical utilities Local planners should have the tools and knowledge to be able to maintain and protect adequate buffers around existing and future

Industry consultation feedback	Opportunities to facilitate infrastructure development
incompatible land uses, to avoid potential constraints on future operations	critical waste infrastructure, to manage encroachment and avoid future land use conflicts which may threaten the ongoing operation of those facilities Local planning schemes should allocate sufficient, appropriately located and industrial-zoned land for development of new waste infrastructure where it is likely to be needed in the future, with the establishment of waste and resource recovery precincts identified as one option to achieve this
A lack of information and understanding amongst some stakeholders and the broader community about the need for waste infrastructure and its impacts, may lead to negative feelings within the community and become a barrier to approval of otherwise worthy projects	All levels of government and industry should promote and support the need for early and ongoing community engagement by proponents to build a social license throughout the development phase and into operations All stakeholders, including the community and elected officials, should have access to adequate information about the need for waste and resource recovery facilities, and the benefits that they provide (economic, environmental and social)
Potential for inconsistency in the way that different local governments assess waste infrastructure development approvals	Planning officers and elected officials who determine approvals for waste infrastructure, should have the knowledge and tools to ensure that there is consistency and transparency in the decision-making processes across the state
Potential for confusion around the most appropriate approval pathway for different types of waste infrastructure	Proponents should have access to clear guidance about the most appropriate approval pathway for different types of waste infrastructure, including promotion of existing approvals support and facilitation services on offer such as pre-lodgement meetings to obtain advice on most appropriate pathway Local planning officers should be supported with appropriate guidance to help inform consistent and accurate advice on approval pathways and processes to proponents
The development approval process for waste facilities can be lengthy, subject to delays and difficult to predict	Promotion of pre-lodgement meetings as a tool to ensure that requirements and timelines are well understood All parties should be clear from an early stage on the expectations around the information that needs to be provided to determine a development application for a waste facility in a timely manner. There should be clear guidance for planners and proponents and local government planners and other agencies should be providing consistent advice in this regard, to avoid subsequent delays through requests for further information
Perceived lack of technical understanding of new or complex resource recovery processes amongst those assessing development applications and environmental authorities	Assess how new and emerging or complex waste and resource recovery technologies fit within the planning framework and develop guidance material as necessary for planning officers and regulators Provide officers with adequate technical guidance or access to specialist advice on such technologies when making determinations and setting conditions on approval applications

7.2 Managing impacts and protecting essential infrastructure

The waste and resource recovery industry provides an essential service to communities and businesses across Queensland but it is acknowledged that waste facilities can have impacts on communities and the environment, to varying degrees. Mitigation of those impacts through good design and best practice operational management is essential. However, insufficient forward planning or ineffective planning controls may lead to situations where the tension between waste facilities and residential development or other land uses, is not adequately managed. At a minimum, this results in community angst and perpetuates the negative perceptions of the waste industry, but in more extreme cases it leads to unacceptable impacts on local communities despite best practice operations and regulation, imposing significant operational constraints on waste facility operators as well as constraints on future expansion.

As noted above, in order for existing and future critical waste infrastructure to operate efficiently and be able to grow to meet community needs, there needs to be protections in place through the land use planning system, particularly around adequate buffers. There are various ways to provide these protections and existing tools available to state and local governments. Section 7.3 below provides an overview of the impacts that may need to be considered for different waste and resource recovery activities.

Different types of waste facilities need varying levels of consideration and protection within land use planning framework, depending on the extent of their impacts but also on the role they play in the broader network. Some waste facilities have relatively minor impacts and are somewhat flexible and moveable – they can potentially change their process or relocate as market or community requirements change. Other facilities play a critical role in the waste and resource recovery network and supply chain, at either a local, regional or state level, and are far more difficult to replace or relocate. Such facilities need to be acknowledged in Regional Waste and Resource Recovery Infrastructure Plans which will be developed in the future. It will then be up to each local government to determine what appropriate protection and support measures, if any, can be implemented through local planning instruments.

As such, this Report defines different levels of significant waste and resource recovery infrastructure which are worthy of specific consideration. Three levels of significant infrastructure have been defined:

- State significant infrastructure
- Regionally significant infrastructure
- Locally significant infrastructure

The specific characteristics of each category of facility are discussed further in the following sections. State significant facilities are identified in 7.2.1 below, while regionally significant facilities are identified within the regional profiles in chapter 6. Locally significant facilities will be identified and detailed in subsequent Regional W&RR Infrastructure Plans and classification of regional significant facilities may also be amended or refined in those regional plans.

The table below provides an overview of the three categories, while further detail on the specific criteria for each is provided in the following sections.

Table 47: Overview of significant waste infrastructure categories

Infrastructure category	General overview	Likely infrastructure types
State significant infrastructure	These facilities are typically one of only one or two facilities of their kind in the state, and usually large scale taking in a significant proportion of a particular waste stream from across the state. They are likely to process higher value materials or wastes that have very specific processing requirements due to their potentially hazardous or difficult nature, or end market requirements. They typically involve large capital investments and/or complex operations, which would not be viable to replicate within each region.	▪ Significant reprocessing operations such as metal shredders / fragmentisers, recovered paper mills ▪ Complex centralised treatment facilities for hazardous and regulated wastes including high temperature incinerators and waste oil re-refineries
Regionally significant infrastructure	These are typically moderate or larger scale facilities which receive waste from across a particular region (i.e. multiple local government areas) and in doing so, achieve efficiencies of scale and investment in technologies that would not be viable at local scale.	▪ Regional landfills ▪ Regional MRFs ▪ Regional organics processing facilities ▪ Regional specialist reprocessing facilities such as for e-waste

Infrastructure category	General overview	Likely infrastructure types
Locally significant infrastructure	These are facilities which mostly receive waste from the local area (e.g. a single local government area). They are the primary facility of their type in that local area and are still significant facilities in that their closure would cause significant upset and challenges in the local waste market and they would be difficult to replace or relocate.	▪ Local primary landfills ▪ Local organics processing facilities ▪ Local recycling facilities

7.2.1 State significant infrastructure

State significant facilities are those that provide an essential recovery or treatment service for specific waste streams that are generated across the state or across multiple regions, which if closed, would have significant flow-on impacts for industry across the state including economic impacts. State significant facilities typically:

- Undertake higher order processing and recovery and involve significant capital investment that would not be viable or practical to implement at a smaller, regional scale
- Have good transport links and receive materials that have been consolidated, pre-processed and/or sorted at regional or local hubs
- Make a significant contribution to statewide resource recovery performance
- Provide an essential service which if lost, would have a significant impact on industry and services in the region
- Are well located in terms of zoning and surrounding land uses but also access to offtake markets
- Have a long expected lifespan (typically several decades) with potential to upgrade or expand to meet future growth

By way of example, the table below identifies those facilities which have initially been identified as being of state significance. This is not an exhaustive list and identification of these facilities here does not bestow any new advantage or requirements for the relevant operators.

Table 48: State significant waste and resource recovery facilities

Operator / facility / location	Description
Visy recovered paper mill, Gibson Island Brisbane	The Visy paper mill manufactures a range of paper and cardboard products using only recovered fibre feedstock which is supplied by MRFs and source separated commercial recyclers across the state. Paper mills are complex, capital intensive operations that are difficult to viably replicate at smaller scales. The Gibson Island plant is the only facility in Queensland capable of reprocessing recovered paper and cardboard so it plays a significant role in supporting kerbside recycling services for household and paper and cardboard collections from businesses. In 2017-18, it played a key role in reprocessing some 200,000 tonnes or 40% of the total recovered paper and cardboard, within the state[35]. It competes with overseas and interstate mills for feedstock and if it were to close, councils, MRF operators and commercial recyclers would become entirely reliant on interstate or overseas markets, which can be volatile the export of such material is not consistent with the circular economy intentions of this Report.

[35] https://www.qld.gov.au/__data/assets/pdf_file/0021/93711/recycling-waste-qld-report-2018.pdf

Operator / facility / location	Description
	Visy also operates its largest MRF on the same site, which receives commingled recycling from across SEQ and beyond, for sorting and recovery.
Owens Illinois glass bottle factory, South Brisbane	This glass bottle manufacturing facility utilises significant volumes of recovered glass from across the state supplied by MRFs, the container exchange program and commercial recyclers, together with virgin materials. It is responsible for reprocessing the majority of Queensland's recovered glass back into valuable products which further support other Queensland industries such as breweries and beverage production. The plant employs 245 staff and produces over 2 million bottles a day or up to 150,000 tonnes of glass containers each year[36]. If it were to close, given the challenging economics of transporting glass outside of the state for reprocessing, significant volumes of glass would likely be diverted to lower value recovery outcomes (e.g. glass sand) or landfill. There would be a significant impact on kerbside and commercial recycling services as well as the container exchange program. The main glass manufacturing facility in South Brisbane is supported by a separate glass fines beneficiation facility at Crestmead, Logan which processes fines from a number of Queensland MRFs to recover usable glass cullet and other recyclables.
Northern Oil waste oil refinery, Gladstone	The Northern Oil facility in Gladstone is the only facility in Queensland capable of recycling waste lubrication oil back into base lube oil. It receives waste oil from across the state and beyond, via networks of collection and consolidation depots operated by a number of different waste collectors. The plant is capable of processing up to 100 million litres of waste lube oil each year[37], which is The facility competes with export markets and lower value recovery outcomes for waste oil such as bunker fuel. Without the plant, all of the waste oil generated in Queensland would be flow to these lower value outlets, which is inconsistent with the circular economy objectives of this Report. The site in Gladstone is also home to the Northern Oils Advanced Biofuels Pilot Facility which represents a significant investment in testing of a number of innovative technologies aimed at producing biofuels from a range of waste streams.
Sims Metal metal reprocessing facility, Rocklea Brisbane and Infrabuild Recycling (formerly Liberty OneSteel) metal reprocessing facility, Hemmant Brisbane	These two facilities reprocess significant volumes of recovered metals (ferrous and non-ferrous) collected from across the state. The metals are shredded and processed into a higher value feedstocks which are sent to smelters interstate and overseas. Between the two facilities, they reprocess over 80% of scrap metal recovered in Queensland. The rest is directly exported with little or no reprocessing. If one or both of these facilities were to close, MRF operators, councils and scrap metal collectors would be reliant on export markets to manage the significant volume of recovered metals which is

36 http://recycleglass.com.au/o-i-australia/history/
37 http://www.sor.com.au/northern-oil-refinery

7.2.2 Regionally significant infrastructure

Regionally significant infrastructure includes those facilities that manage a specific type of waste from across a region (more than one local government area). These facilities typically:

- Manage a significant proportion of a particular stream / material from a region
- Have good transport links and may receive materials directly or via local hubs including local transfer stations with bulking capacity where relevant
- Provide an essential service which if lost, would have a significant impact on industry and services in the region, including flow-on economic impacts
- Provide efficiencies that would not be possible at smaller, localised scale
- In the case of resource recovery facilities, they make a significant contribution to regional resource recovery performance but limited impact outside the region which they service
- May include regional landfills taking waste from multiple local government areas
- Are well located in terms of zoning and surrounding land uses
- Are readily accessible to both waste generators and offtake markets
- Have a long expected lifespan with potential to upgrade or expand to meet future growth

Examples of regionally significant facilities are likely to include:

- Regional landfills servicing multiple local government areas for municipal waste or the broader region for commercial waste streams
- Regional MRFs receiving recyclables from multiple local government areas, of which there are several existing examples in Queensland
- Larger scale (relative) organics processing facilities which receive organics wastes from across a region for processing
- In the future, regional energy-from-waste facilities receiving waste from across a region

These facilities are likely to play a significant role in the future management of waste in the region and should be acknowledged and considered for protection in future local and regional planning schemes, if not already.

7.2.3 Locally significant infrastructure

Locally significant facilities are those that service a local need and receive the majority of a particular waste stream from the local area. These facilities would be difficult to replace or relocate and their closure would have a significant impact on local waste management services. Locally significant facilities typically also:

- Are efficient despite their localised scale
- Make a significant contribution to local resource recovery systems and performance (for resource recovery facilities)
- Act as a local hub, supported by satellite transfer stations and depots
- May act as an intermediate facility sending waste to regional processing / disposal facilities
- Are well located in terms of zoning, surrounding land use and transport connections
- Have a long expected lifespan and potential to expand to meet future local growth

Examples of facilities which may be considered to be regionally significant include:

- The primary landfill in a local government area, if it meets most of the criteria above
- A primary transfer station and resource recovery centre servicing a local government area
- An organics processing facility which plays a key role in managing organics within the local area

These facilities are likely to play a significant role in the future management of waste in the local area and should be acknowledged and considered for protection in local planning schemes, if not already.

7.3 Planning for new waste infrastructure

Consideration of future waste and resource recovery infrastructure in land use planning needs to take into account a range of factors including:

- The policy and strategic drivers at a local and state level, which will determine the types of infrastructure needed
- Expected population growth in the local or regional area, which will drive waste generation but may also lead to land use tensions
- Expected economic growth in the region and any changes to the economic profile of the region, which may alter the waste generation mix and the need for certain types of infrastructure
- Other future land use demands in the local area and region, including other hard-to-locate industries and potential co-location or precinct opportunities
- Providing adequate separation between waste facilities and sensitive land uses
- Locating facilities in reasonable proximity to the major sources of waste that will be managed
- Proximity or access to markets for recovered products and other offtakes (e.g. energy)
- Land requirements and the footprint of likely future solutions
- The locations and likely interactions with existing long-term waste infrastructure including transfer hubs and networks
- Integration with transport systems and consideration of future plans around transport infrastructure
- Local environmental factors and constraints including proximity to sensitive environments

Buffers may contain greenspace or other complementary land uses such as industrial or extractive industries. Buffers are not a substitute for appropriate control measures within the facility design and operational management, but rather a contingency plan if the primary control measures prove to be inadequate over time.

To inform adequate consideration of waste and resource recovery infrastructure in future land use planning instruments, the table below provides an overview of the potential impacts associated with different types of waste infrastructure, and the criteria or considerations that may be relevant in identifying suitable locations for future infrastructure. The potential impacts which have been identified should be largely mitigated through good design and best practice operational management within the facility, but there will be potential for residual impact which can be managed through effective land use planning.

Table 49: Overview of potential impacts and siting criteria / land use consideration for different infrastructure types

Infrastructure type	Potential impacts on surrounding land uses	Typical siting / land use considerations
Landfills	▪ Groundwater impacts from potential leachate seepage ▪ Surface water impacts from sediment runoff, leachate releases, litter ▪ Air quality – dust and odour (particularly putrescible landfills) ▪ Landfill gas – both odour and safety risks of off-site gas migration (heightened risk for putrescible landfills) ▪ Traffic – increased heavy vehicle movements, potential queuing during peak periods ▪ Amenity impacts – visual amenity, windblown litter, property value impacts ▪ Noise from plant and machinery ▪ Vermin – attraction of pest birds and other vermin	▪ Often built in existing voids of former quarries or mines which have a history of heavy vehicle traffic, dust, noise impacts ▪ Maintain significant protected buffers between landfill footprint and sensitive receptors (residential), both current and future, over life of the landfill – buffer distance based on risk assessment. Buffers may be green space and/or other compatible industrial / extractive uses ▪ Control over final landform height / impact to control visual amenity and landscape impacts ▪ Geologically suitable ground – naturally low hydraulic permeability, avoiding fractured geology ▪ Geotechnically stable ground (e.g. consider risk of underground mine workings) ▪ Avoid high water table areas to allow a minimum clearance between peak local groundwater levels and the base of the landfill ▪ Clear separation from waterways, surface water bodies, wetlands, flood zones, groundwater extraction areas and habitats of vulnerable flora and fauna (distance based on risk assessment) ▪ Avoid extremely high rainfall areas where possible ▪ Clear separation from underground / subsurface and enclosed structures susceptible to landfill gas migration risk ▪ Proximity to arterial roads and local access by sealed heavy vehicle rated roads with ample traffic capacity and avoiding access through residential areas ▪ Significant separation from airports / air bases due to bird attraction risks (particularly putrescible landfills) ▪ Refer to Landfill Siting Guidelines for further details[38]

[38] https://environment.des.qld.gov.au/assets/documents/regulation/pr-gl-landfill-siting.pdf

Infrastructure type	Potential impacts on surrounding land uses	Typical siting / land use considerations
MRFs / Reprocessing facilities	▪ Noise and dust ▪ Fire risk from stockpiled materials and fire-water runoff ▪ Stormwater runoff from external stockpile areas ▪ Traffic – increased heavy vehicle movements, for both deliveries and product removal	▪ Usually located within established industrial precincts / areas with similar compatible industrial / manufacturing type uses ▪ Proximity to the main sources of recyclable feedstock ▪ Maintain moderate buffers between facility and sensitive receptors ▪ Enclosed within a standard warehouse-type shed ▪ Proximity to arterial roads and local access by heavy vehicle rated roads with ample traffic capacity, avoiding access routes through residential areas
Transfer stations	▪ Noise, dust and odour (particularly putrescible waste) ▪ Vermin – attraction of pest birds and other vermin ▪ Amenity impacts – visual amenity (note often high roofed structures), windblown litter, property value impacts ▪ Fire risk from stockpiled materials and fire-water runoff ▪ Stormwater runoff from external stockpile areas (e.g. C&D waste, green waste) ▪ Traffic – increased light and heavy vehicle movements, for both incoming and outgoing, particularly on weekends for community facing facilities	▪ Often located within established industrial precincts with similar surrounding uses, or on existing and former landfill sites ▪ Maintain moderate buffers between facility and sensitive receptors ▪ Enclosed within a suitable structure to contain waste and exclude weather ▪ Proximity to arterial roads and local access by heavy vehicle roads with ample capacity, avoid access through residential areas
Organics processing	▪ Odour – more significant for open composting systems, but a risk for any facility ▪ Dust from handling and screening product, soil blending ▪ Surface water impacts from sediment runoff, leachate releases	▪ Siting will depend on feedstocks and technology: – Open windrow composting of highly odorous feedstocks may not be appropriate near sensitive receptors / urban areas – Enclosed processing technologies should be considered for higher odour risk operations which is a function of feedstocks, operational methods, location, proximity to receptors, climate, topography

Infrastructure type	Potential impacts on surrounding land uses	Typical siting / land use considerations
	▪ Groundwater impacts from potential leachate seepage ▪ Amenity impacts – visual amenity, windblown litter, property value impacts ▪ Noise from plant and machinery ▪ Traffic – increased heavy vehicle movements, for both deliveries and product removal ▪ Vermin – attraction of pest birds and other vermin	▪ Maintain protected buffers between processing area footprint and sensitive receptors (residential), both current and future. Buffer distances will vary based on risk assessment – enclosed facilities may not need the same buffers as open facilities. Buffers may be green space and/or other compatible industrial / extractive uses. ▪ Clear separation from waterways, surface water bodies, wetlands, flood zones, areas of groundwater extraction and use and habitats of vulnerable flora and fauna (distance based on risk assessment) ▪ Refer Composting Guidelines for further advice[39]
C&D Recycling	▪ Dust from processing (screening / crushing) ▪ Noise from plant and machinery (e.g. crushers) ▪ Traffic – increased heavy vehicle movements, for both deliveries and product removal ▪ Stormwater runoff from external stockpile and processing areas	▪ Usually located within established industrial or extractive precincts with similar surrounding uses ▪ Maintain moderate buffers between facility and sensitive receptors, which may include other industrial uses ▪ Enclosed processing operations may be appropriate when in closer proximity to noise / dust sensitive receptors ▪ Proximity to arterial roads and local access by heavy vehicle rated roads with ample capacity, avoiding access through residential areas
Regulated waste treatment / oil recovery	▪ Air quality – dust / particulates, volatile compounds, odour ▪ Safety risks from storage / handling of dangerous goods ▪ Fire and explosion risk from combustible / volatile materials ▪ Noise from plant and machinery ▪ Surface water impacts from contact with wastes, spillages, leachate	▪ Locate within high impact industrial precincts with similar noxious industry surrounding uses ▪ Maintain safety buffers between facility and neighbouring properties, plus significant amenity buffers to sensitive receptors which may include other commercial / industrial uses ▪ Proximity to arterial roads and local access by heavy vehicle rated roads with ample capacity, avoiding access through residential areas ▪ Clear separation from waterways, surface water bodies, wetlands, flood zones, areas of groundwater extraction and use and habitats of vulnerable flora and fauna (distance based on risk assessment) ▪

[39] https://environment.des.qld.gov.au/assets/documents/regulation/pr-gl-open-windrow-composting.pdf

Infrastructure type	Potential impacts on surrounding land uses	Typical siting / land use considerations
	▪ Groundwater impacts from spillages, leachate seepage ▪ Traffic – increased heavy vehicle movements, for both deliveries and product removal ▪ Amenity impacts – visual amenity	
Energy from waste	▪ Air quality – dust / particulates, trace metals and organic pollutants ▪ Noise from plant and machinery ▪ Traffic – increased heavy vehicle movements, for both deliveries and product removal ▪ Amenity impacts – visual amenity	▪ Elevated flue stack will be required to provide sufficient dispersion – consider visual impacts, proximity to airports ▪ Locate within high impact industrial precincts with similar surrounding uses ▪ Maintain significant protected buffers between processing plant footprint and sensitive receptors (residential), both current and future, over full life of the facility – buffer distance based on risk assessment. Buffers may be green space and/or other compatible industrial / extractive uses ▪ Proximity to arterial roads and local access by sealed heavy vehicle rated roads with ample capacity, avoiding access routes through residential areas ▪ Consider proximity to rail infrastructure for larger regional facilities ▪ Proximity to energy distribution infrastructure and/or high energy using industries ▪ Clear separation from waterways, surface water bodies, wetlands, flood zones, areas of groundwater extraction and use and habitats of vulnerable flora and fauna (distance based on risk assessment) ▪

7.4 Waste and Resource Recovery Precincts

7.4.1 Overview of precincts

Since the early 2000s, Waste and Resource Recovery Precincts (Precincts) have evolved from visionary concepts in industrial planning to there being now hundreds of projects globally that have implemented principles into community developments, industrial developments, and even mixed-use precincts.

Although Waste and Resource Recovery Precincts are known by various other terms and definitions, ranging from Eco-Industrial Parks, Sustainable Industrial Parks, Circular Economy Precincts, and Cradle to Cradle® (C2C) Business Parks; the definition of an Eco-Industrial Parks (EIP) by Lowe (1997) is accepted by many international organisations active in this area:

> "*A community of manufacturing and service businesses located together on a common property. Member businesses seek enhanced environmental, economic, and social performance through collaboration in managing environmental and resource issues. By working together, the community of businesses seeks a collective benefit that is greater than the sum of individual benefits each company would realise by only optimising its individual performance*."[40]

Precincts function in a manner where participating industries collaborate together and with the local community to maximise the use of resources, reduce waste and pollution, and contribute to sustainable development objectives, with the intention of increasing economic gains and improving environmental quality[41]. Collaborative synergies between industries within a precinct not only include the utilisation on by-products and "waste to feed" exchanges but can also include significant efficiencies through sharing of feedstocks, utilities and common infrastructure.

Aside from the terminology used, the overall goal of a Waste and Resource Recovery Precinct is to improve the economic and social outcomes while minimising environmental impacts. Basic components of precincts include green infrastructure and plants (new or retrofitted); cleaner production, pollution prevention; energy efficiency; and collaboration between industries.

Common aspects of a successful Waste and Resource Recovery Precinct include:

- A mix of co-located industries and technologies
- Often focused around single or multiple environmental themes and sectors – organics recovery and reuse, building materials, energy recovery and industry, manufacturing, intensive agriculture
- Facilitates by-product exchange or a network of exchanges between tenants
- Focus on environmental technology and innovation companies
- A park with sustainable infrastructure and construction

The majority of existing precincts have evolved naturally and opportunistically, rather than being carefully planned from the outset. But there is a good opportunity to learn from the successes and failures of existing precincts elsewhere in the world, to develop well planned precincts that facilitate and attract relevant participating industries.

Beyond precincts being an efficient collaboration among co-located industries, they also are a better urban neighbour. Clustering potentially noxious waste and other manufacturing industries within a single well-located precinct, reduces to overall impact of those industries on the local community compared to numerous disparate locations. The emphasis on material, energy and water use efficiency reduces demands on the environment for resources and cuts pollution and other impacts when compared to a traditional industrial park.

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[40] Lowe, Ernest A. 1997. "Creating By-Product Resource Exchanges for Eco-Industrial Parks, Journal of Cleaner Production, Volume 4, Number 4, an industrial ecology special issue, Elsevier, Oxford.

[41] AM Hein, M Jankovic, R Farel, B Yannou 2015. A Conceptual Framework For Eco-Industrial Parks. Proceedings of the ASME 2015 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference IDETC/CIE 2015

This broad definition of Precincts yields many more strategies that can support the transition to the Circular Economy by identifying the precinct as a hub for regional economic development. Precincts therefore play a very active role in creating or expanding resource recovery industries and creating employment opportunities while increasing productivity of resource use and lowering environmental impacts.

The exchange of by-products between industries is one system of strategies that can be used achieve full optimisation of resource utilisation. The vision of the circular economy emphasises full implementation of resources through cleaner production programs to reduce, reuse, and recycle waste materials within a precinct.

7.4.2 Factors that make a good precinct

Traditionally, Waste and Resource Recovery Precincts involve a combination of traditional waste and recycling industries, including reuse, recycling, remanufacturing, organics recovery and/or energy recovery, as well as the marketing and end-use of reclaimed materials. Complimentary industries are also commonly integrated into precincts, that can benefit from the industrial outputs, such as manufacturers using recovered/recycled feedstocks, building materials (e.g. pre-cast concrete, asphalt) and others involved in the production of renewable energy and energy efficiency equipment; companies pioneering the use of bio-materials; firms providing services and products for sustainable agriculture industry; and business providing industrial ecology and other environmental services.

Waste and Resource Recovery Precincts can serve as a coordinating hub in delivering a resource recovery strategy that includes the:

- Coordinating firm or agency that integrates management waste streams within the precinct and the broader region, for maximum resource recovery
- By-product exchange networks among industries
- A resource recovery industrial cluster
- Research and development to improve value of recovery and include more materials
- An investment capital network committed to this industry (both public and private funding)

The precinct or resource recovery cluster may often be as important as the industry exchange networks in achieving improving regional waste and resource use. The cluster can include:

- Niche collectors to separate and preserve the value of materials
- Recycling firms to manage processing and distribution
- Manufacturing firms to utilise recycled materials.
- Reuse firms to sell used equipment, materials & products.
- Re-manufacturing firms to rehabilitate used equipment.
- Composting firms to process biomaterials for nutrients.
- Energy companies to generate fuel or power from biomass.
- A firm that supports companies in creating by-product exchanges and eco-industrial networks and integrates efforts into the larger systems.
- Some precincts are also accessible to smaller businesses involved in buying or selling recovered goods and materials, or niche recycling activities.

The key factors that will contribute to a successful precinct will vary depending on its purpose and focus but may include:

- Separation from sensitive receptors with significant protected buffers, ideally integrated into the precinct, which may comprise a combination of green space and/or light commercial and industrial use land

- The location of the precinct should have good transportation access for moving materials in and out (rail and/or roads that can accept high mass trucks) and ensure that additional traffic to the site does not impact on the local community. Access to a port, via rail or good road links, is also likely to be important. If waste is to be moved by rail, it will need to be supported by intermodal transfer stations at either end of the journey.
- Local proximity to waste and material sources and end users
- Ideally, some existing waste and industry uses and reasonable level of social license (i.e. acceptance or support for the existing uses)
- Appropriate zoning (e.g. industrial land use) or a declared State Development Area (SDA)
- Good energy transmission infrastructure and offtake opportunities in or near the precinct

7.4.3 What are the benefits of precincts

For the industries and community involved, precincts offer many opportunities and benefits from the responsible management of waste, decreased waste management costs, increases in resource and energy efficiency, and elimination of practices that incur regulatory penalties. Increased efficiency may also enable precinct industries to produce new and competitive products.

Precincts can benefit its whole community by hosting such a cluster of resource recovery companies, as well as promoting circular economy principles to increase efficiency and productivity of major companies and government facilities.

Precincts also allow for common business services to be shared across the participating industries. Including training, purchasing, emergency management teams, environmental information systems, and other support services. Such industrial cost sharing could help participants achieve greater economic efficiency through their collaboration.

Tenants in the precinct can share common utilities and services including power supply, natural gas and other fuels, heat and steam generation, water and wastewater treatment, pollution control measures including stormwater treatment. There may also be opportunities for reuse of recycled water which is produced by one tenant and utilised by others.

These benefits for industries participating in the precincts and the services they provide can generate new revenue streams and customers. Overall, precincts can help organisations (both public and private) gain a competitive advantage.

A key significant benefit for both industries and government, is the opportunity that precincts that offer in increasing business, industrial competitiveness and sustainable growth.

Precincts can offer a combination of social-economic and environmental benefits. The resource recovery foundation for a precinct increases the local economic value of these returns, which include:

- Expansion of existing companies and creation of new local businesses
- Job development across a broad range of skill levels
- Utilisation of industrial by-products
- Recovery of economic value of many materials and products, that would otherwise be sent to landfill
- High environmental standards for the tenants with particular focus on sustainability
- Staff mobility between tenant industries

The enhanced economic performance of participating businesses and industries will make precincts a powerful economic development tool for communities. Such parks are likely to attract leading-edge industries and open niches for new or expanded local businesses, securing and creating new jobs. Companies in the region can gain new customers for services and markets for products created from the precinct.

Development of precincts can create new or expanded programs for extending their economic and environmental benefits across the community's whole industrial sector. The benefits of responsible waste management, energy recovery, cleaner air, land, and water, generally creates a more attractive environment to the community.

Precincts can also ignite the creation of an enhanced social infrastructure including, research organisations vocational training opportunities, and broader community services. Indirect benefits are often difficult to quantify but are increasingly important for the long-term economic sustainability of the park and resident industries.

7.4.4 Precinct Case Studies

Wingfield Waste & Recycling Centre

The Wingfield Waste and Recycling Centre in South Australia is an internationally recognised resource recovery and waste precinct that contains a cluster of collaborative private resource recovery businesses.

Wingfield Landfill closed at the end of 2004, before reopening as the Wingfield Waste & Recycling Centre, a 94 hectare waste recovery and recycling precinct that makes a significant contribution to Adelaide's waste sector.

Within four years of closing as a landfill operation, the Wingfield Waste & Recycling Centre was employing more than 80 people across the site, further reinforcing the significant environmental and economic benefits the site has provided: building a sustainable recycling sector that delivers jobs, profits and positive environmental impacts for the region.

The precinct has four core tenants on site – Orora, Jeffries Group, Adelaide Resource Recovery (ARR) and Cleanaway – which are each involved in providing waste recovery and recycling services for the various waste streams:

- Orora recycles 50,000 tonnes a year of paper and cardboard waste
- Jeffries recycles 100,000 tonnes of green waste annually through composting
- ARR transforms C&D waste into recovered aggregate products as well as operating a cleanfill operation distributing clean soils, clays and mixed materials
- Cleanaway accepts residual waste for transfer to landfill outside the city.

The precinct also houses a waste education centre for school and community groups.

The precinct enables the recycling businesses to collaborate to ensure waste materials are delivered to the business best equipped to manage them, helping to recycle and recover approximately 90% of the nearly one million tonnes of waste materials delivered to the precinct every year.

Kwinana Industrial Precinct, Perth

Kwinana Industrial Area (KIA), located 35km south of Perth, boasts a highly diverse range of major process, utility and service industries. These include a range of refineries and chemical producers, power stations, cogeneration plants, port facilities, and water and waste-water treatment plants. The industrial symbioses at Kwinana have evolved opportunistically, rather than by design. However, a recent study has identified 47 industrial synergies currently in place – 32 by-product synergies, involving the reuse of solids, liquids or gasses, and 15 synergies involving the shared use of utility infrastructure.

The KIA was established following the signing of the Oil Refinery Act in 1952 and the rezoning of around 2,400ha of coastal land dedicated for industrial development. The land has now become the primary area of industrial development in Western Australia.

KIA provides the ideal location in terms of separation from sensitive receptors and access to port and transport infrastructure, which together with proximity to skilled labour, have made the KIA a thriving industrial base for the State's economy.

KIA is a significant contributor to the Western Australian economy with direct sales of $14.7 billion per annum. The area employs over 11,500 people directly, of which 64% live locally. The indirect inter-industry flow-on effects of the area are estimated at $10.3 billion in annual output and over 18,000 jobs.

The Kwinana Waste to Energy Project is a recent addition to the KIA, which was in the early stages of construction at the time of writing. It will be the first plant of its kind in Australia, processing mixed MSW and commercial waste and integrating the generation of energy for input to the local grid.

Underpinning the project are 20-year waste supply agreements with a number of local governments including seven councils under the Rivers Regional Council contract plus a separate agreement with the City of Kwinana. Under these agreements all eight councils will supply residual MSW waste to the plant, which has approval to receive and process up to 400,000 tonnes per annum.

The facility will generate and export 36MW of low carbon, partly renewable electricity to the local grid every year, sufficient to power more than 50,000 households. It is expected to create more than 800 jobs during construction and 60 positions once fully operational. Construction of the facility has commenced and is expected to be operational by the end of 2021.

Woodlawn Eco-precinct, NSW

The Woodlawn Eco-precinct was built on the site of a former mine around 200km south of Sydney by private operator Veolia.

A large capacity bioreactor landfill is the centrepiece of the site, which takes a significant proportion of Sydney's household and commercial waste for disposal to fill the former mine void. Landfill gas production is optimised by recirculating leachate and the gas is captured and used to generate renewable electricity.

Veolia recently commissioned a mechanical biological treatment (MBT) facility on the site to process kerbside MSW from a number of Sydney councils under long-term agreements. The MBT plant will produce a compost product that is intended to be used to support rehabilitation of the former mine and landfill (subject to potential change in regulation).

The site receives containerised waste by rail from Sydney and is supported by two intermodal rail transfer terminals in Sydney (at Clyde and Banksmeadow), which are also operated by Veolia and built specifically to service the Woodlawn site.

In addition to the landfill and MBT plant, the Woodlawn Eco-precinct incorporates:

- 7 landfill gas engines that recover up to 7 MW of clean energy from what would otherwise be gas-emitting waste material.
- Aquaculture – waste heat produced from the landfill gas power generation process is utilised to heat water to 28 degrees Celsius which is the optimal temperature for fish farming (Barramundi). The fish farm produces around 2.5 tonnes per annum, which is sold to a fish wholesaler in Canberra for local restaurants.
- Excess nutrients in the aquaculture water are fed into a hydroponic horticulture system
- Agriculture incorporating a working farm that applies nutrient and grazing rotation to help manage and understand impacts on the site.
- There is a windfarm on the site with 50MW capacity operated by Infigen Energy and a solar farm on cleared land producing 2.5MW.

Kalundborg Eco-industrial Park, Denmark

Kalundborg Eco-Industrial Park is an industrial symbiosis network located in Kalundborg, Denmark, in which local companies collaborate to use each other's by-products and otherwise share resources. These exchanges of waste, water and materials have greatly increased environmental and economic efficiency for tenants.

The industrial symbiosis arose opportunistically through private initiatives. The Kalundborg network involves nine private and public enterprises, including:

- Novo Nordisk – a Danish company and largest producer of insulin in the world
- Novozymes – a Danish company and largest enzyme producer in the world
- Gyproc – French producer of gypsum board
- Kalundborg Municipality
- Ørsted A/S – owner of Asnaes Power Station, Denmark’s largest power plant
- RGS 90 – Danish soil remediation and recovery company
- Statoil – a Norwegian company which owns Denmark's largest oil refinery
- Kara/Novoren – a Danish waste treatment company
- Kalundborg Forsyning A/S – a water and heat supplier, as well as waste disposer, for Kalundborg citizens.

The symbiosis involves around 30 exchanges of materials throughout Kalundborg. The facility revolves around the Asnæs Power Station, a 1500MW coal-fired power plant:

- The power company provides waste steam to the Statoil Refinery in exchange for waste gas from the refinery. The power plant combusts the gas to create electricity and steam, which is then provided to a fish farm and Novo Nordisk, as well as a district heating system that supplies 3500 homes at a low cost to the homeowner.
- Fly ash from Asnaes is sent to a cement company, and gypsum from its desulfurisation process is sent to Gyproc for use in gypsum board.
- Statoil Refinery removes sulfur from its natural gas and sells it to sulfuric acid manufacturer Kemira.
- The fish farm sells sludge from its ponds as fertilizer to nearby farms, while Novo Nordisk gives away its own sludge, of which it produces 3,000 cubic metres per day, to be refined for biogas for the power plant.

8 ECONOMIC ASSESSMENT

Landfill disposal of waste may seem like the lowest cost and easiest option in some areas and there has certainly been a perception that landfill in Queensland is cheap. From a purely financial perspective, that may have been true in some regions of the state, although not all. Resource recovery typically requires investment in processing plant and higher operational costs, which means that landfill often (not always) costs less.

In terms of value though, landfilling of waste delivers no other value from that material and in fact creates a liability which will need to be managed for several decades into the future. Resource recovery adds value to materials, returning them into productive use and avoiding those ongoing, long term liabilities and risks associated with landfilling. However, this is rarely reflected in the pure financial cost which is passed back to the waste generator.

In a financial sense though, landfill is becoming more expensive as regulatory standards get tighter, community expectations evolve, and landfill technologies and practices improve. The cost of a 'new' landfill is inevitably more expensive than an old landfill, which may operate under more lax regulatory conditions and lower engineering and containment standards. Therefore, as old landfills reach end-of-life and close, they will need to be replaced with more expensive new landfills of a higher standard.

This has already played out in a number of regions across Queensland where councils have had to invest in new landfills and costs have increased substantially. Many councils have also found it very challenging to identify locations for new landfill sites which are technically suitable and acceptable to the local community, which may result in landfills being further removed from population centres, further adding to the cost when transport is factored in. Overall, there is a trend of rising landfill costs as a result of these factors. The landfill levy also helps to address the imbalance between the recovery and disposal by closing the price gap.

The Waste Strategy and Resource Recovery Industry Roadmap both acknowledge the significant potential economic benefits of shifting from a heavy reliance on landfill disposal to investing in resource recovery infrastructure. Those benefits include:

- Attracting capital investment to the state and to regional areas, by making Queensland an attractive place to invest in new infrastructure;
- Creation of new jobs in both construction and long-term operations, including new skilled jobs and associated training benefits;
- Maximising the use and extraction of resources (materials and energy) and keeping those resources in the regional and state economy local, reducing the need to extract or import virgin resources and fossil fuels;
- Creation of value of waste materials where previously only liabilities existed (e.g. long-term environmental liabilities associated with landfilled waste);
- In the case of organics recovery, creating products which improve soil quality and contributing to boosting productivity of agricultural industries whilst reducing the use of chemical fertilisers;
- Improving the environment by reducing the impacts of landfills, producing renewable and low carbon energy, reducing greenhouse gas output and reducing the impacts of extracting and manufacturing new materials;
- Reducing impacts on communities by investing in modern infrastructure which better controls impacts and is carefully planned and located.

8.1 Employment

According to data reported to DES, in 2017-18 local governments employed 1,340 people directly to operate, manage and administer waste management services. It is likely that this figure underestimates the total number of people involved in delivering council waste services as it likely excludes most contractors engaged by councils to provide these services.

Councils were asked the same question as part of the data survey for this Report but asked to specifically include contractors, and the responses given by those that answered were on average, 50% higher than reported to DES. On that basis, the total number of people employed in providing waste and resource recovery services to local government is estimated to be around 2,000. Councils were also asked the split of workers between collection / transport, landfill and other resource recovery activities. Around 40% of council workers and contractors were engaged in collection and transport of waste, while around one third were supporting landfill operations. The remainder were supporting other functions such as transfer station operations, MRF and green waste processing, or tip shops.

Private sector operators reported to DES a total of 3,430 people employed directly across all sectors of waste and resource recovery (that report to DES). Again this underestimates total employment in the sector and only covers employees associated with operation those licensed facilities. It does not generally cover employees involved in the collection and transport of waste, which is a significant number. It also does not reflect the number of people employed in downstream industries which benefit from recovered waste resources or rely on the essential services provided by the industry.

Overall, the data suggests that over 5,400 people are directly employed in running waste and resource recovery facilities across Queensland but the real figure of total people employed in the sector is likely to be much higher.

The number of employees in core sectors has also been assessed, relative to the throughput of the relevant facilities. A 2009 study by Deloitte Access Economics previously estimated that there were 9.2 jobs in recycling for every 10,000 tonnes processed, versus 2.8 jobs for every 10,000 tonnes of waste landfilled. However, the conclusions of that study, which have been regularly quoted to demonstrate the employment upside of recycling, are a significant simplification of what is a more complex industry. The general concept that resource recovery provides more jobs than landfill is still valid, but it is difficult to distill this down to two figures.

The data received in developing this Report and through the annual DES survey has been analysed and is summarised in Table 50 below, noting that data was not available for every type of resource recovery facility.

The analysis shows that:

- The ratio of employees to waste throughput is a function of scale – larger facilities can be run more efficiently on proportionately less staff
- As in the previous study, landfill has one of the lowest employment rates (per throughput) although in this case, the data suggests it varies significantly. Very small landfills are particularly inefficient on this metric given their small tonnages although there was limited data available. For other landfills, the staffing rate varies from 4.3 per 10,000 tonnes for a small landfill down to 0.5 staff per 10,000 tonnes for very large landfills. As a weighted average across all Queensland landfills (for which there is tonnage data), the rate is 1.0 staff per 10,000 tonnes input. This is significantly lower than the 2009 Deloitte figure of 2.8.
- Only C&D recycling was slightly lower than landfill at 0.9 staff per 10,000 tonnes, reflecting the typical high tonnage throughputs and low labour requirements of C&D recycling facilities. It is noted that the majority of existing C&D recycling capacity in Queensland is basic processing of source separated, single stream materials. As new capacity is developed in the future to process mixed C&D waste, it is likely this sector will become more labour intensive. Data from interstate and proposed mixed C&D recycling facilities suggests that even a large scale facility would require 1.2 to 1.5 staff per 10,000 tonnes processed.
- Organics processing also has a relatively low labour intensity, but still higher than landfill, averaging 1.7 staff per 10,000 tonnes processed.
- Recycling of packaging through a MRF or source separated processing facility, requires around 3.9 staff per 10,000 tonnes processed – nearly four times that of landfill. Reprocessing those packaging materials in Queensland generates a further 4.7 jobs for every 10,000 tonnes processed, which suggests that processing and keeping recyclable materials in the Queensland economy creates 8.6 times more jobs than landfilling that waste.
- For local metal consolidation and recycling, the figure is higher again at 7.5 jobs per 10,000 tonnes processed while for tyre recycling it is 11 jobs.
- For very niche, small volume resource recovery pathways such as e-waste recycling, the rate is significantly higher. The data from three Queensland e-waste recyclers indicates that 93 staff are

required to process 10,000 tonnes, noting that most facilities only typically process between 500 and 2,500 tonnes per year.

While not evident in the Queensland data, experience from international energy-from-waste facilities indicates they are likely to create in the order of 3 to 3.5 jobs per 10,000 tonnes for a smaller scale facility and around 1.3 to 1.5 jobs per 10,000 tonnes in a large scale EfW plant. Processing mixed waste into refuse derived fuel in a dirty MRF is likely to require around 3 jobs per 10,000 tonnes processed per annum.

The assessment confirms that resource recovery generates more jobs than landfilling and substantially more in some sectors, particularly those which are more niche and specialised.

Table 50: Average employment by facility type, per 10,000 tonnes processed

Core activity	Employees per 10,000 tonnes processed	Weighted average by category (employees per 10,000 tpa)
Landfills - very small	31	1.0
Landfills - small	4.3	
Landfill - medium	1.8	
Landfills - large	1.6	
Landfills - very large	0.5	
Organics composting - small	3.5	1.7
Organics composting - medium	1.9	
Organics composting - large	1.4	
C&D recycling - small	3.2	0.9
C&D recycling - medium	1.8	
C&D recycling - large	0.2	
Recycling - MRF	3.4	3.9
Recycling - SS	4.5	
Reprocessing	4.7	-
Metals - consolidation	7.5	-
Tyre recycling	11	-
E-waste recycling	93	-
Future facilities – estimated from other jurisdictions		
Small energy-from-waste (thermal) - *estimated*	3 - 3.5	-
Large energy-from-waste (thermal) - *estimated*	1.3 – 1.5	-
Mixed C&D recycling	1.2 – 1.5	-

Dirty MRF / mixed waste processing to RDF	3

Using the employment rates above and correlating with the future projections of waste and resource recovery under the base case (Strategy targets), it is possible to estimate the potential direct new jobs that will be created to process and dispose of future waste across Queensland. The chart below shows this correlation, but it is indicative and only shows the change in direct jobs associated with processing and disposal of the main waste streams that have been projected. It does not include jobs associated with niche recycling activities such as e-waste or specialised processing of regulated and hazardous wastes. It also does not include jobs associated with the collection and transport of waste, or the operations and management of transfer stations, which are significant contributors to employment in the waste sector which will also grow as more waste streams are separated for recovery and as more products are recovered from waste. Finally it does not include indirect jobs associated with supporting these processing and disposal facilities, or utilising the recovered outputs from new resource recovery facilities (e.g. downstream manufacturing jobs).

The chart (Figure 70) shows that jobs associated with landfill operations will decline as landfill inputs decline and sites gradually close. However, this is more than offset by the increase in jobs associated with resource recovery activities.

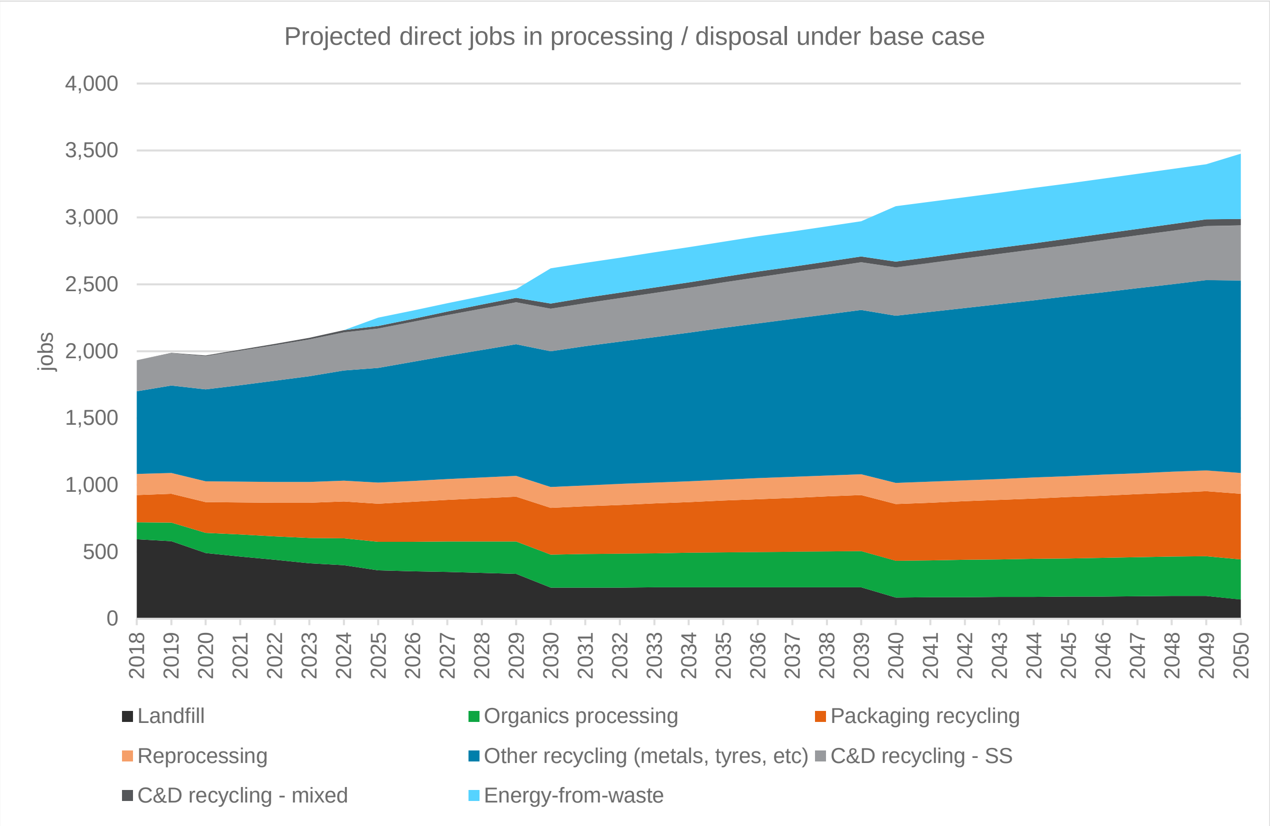


Figure 70: Summary of projected direct job for processing / disposal or core waste streams

Modelling assumptions & sensitivity analysis

APPENDIX A

METHODOLOGY FOR DATA ANALYSIS AND FORECASTING

As part of Arcadis' engagement, waste data was provided by DES from the annual 2017-2018 local government, landfill and recycler surveys to understand and quantify existing waste flows and develop a baseline for forecasting future infrastructure needs.

The first task was to understand how the Department consolidated this data for developing waste disposal and recovery estimates for municipal solid waste (MSW), commercial and industrial waste (C&I) and construction and demolition waste (C&D) for Recycling and Waste in Queensland 2018.

DES' definition of recovery is inclusive of energy recovery, local reprocessing (where products are refined and sent to an end user) and interstate or international transfers of resources for further recovery. This approach is consistent with other Australian states and territories, but risks overstating the actual resource recovery rate as the interstate and international recovery is not easily verifiable. The local reprocessing rate is better understood, with surveys requiring industry to state actual quantities to end users and to landfill.

Without the opportunity to specify downstream recyclers in the surveys, there is risk of double counting recovery tonnages. DES has overcome this with unique values for quantities of recyclables sent to other recycling facilities in QLD, and this was discounted from estimates.

Arcadis' approach has been to work backwards by understanding quantities of recyclables sent to end users, transfers within Queensland, interstate and internationally, and quantities of unrecycled materials to landfill at the end destinations. Onsite reprocessing is what separates the reprocessing facilities from materials recovery facilities (MRFs) and transfer stations or equivalent.

In addition to the challenge of tracking waste transfers, the sources of waste are not consistently captured in the data. For some instances the source is obvious and for other instances DES has had to apply assumptions about the origin of the incoming waste to the facilities. These estimates have been developed through targeted consultation, which is similar to the approach of other states. This however is an opportunity for improvements to the surveys in future.

The excel spreadsheets provided to Arcadis show the relevant questions, alias and origin assumptions used to develop disposal and recovery estimates. The sum totals of material streams are manually inputted into the spreadsheets, so the mode of analysis currently used is not fully documented. The use of alias' which are not unique suggests that data was sorted by survey and then by alias to retrieve the relevant quantities.

To avoid having to sort by survey, Arcadis has concatenated survey type and question number or sort order number, which provides a means to link two separate survey values. Arcadis has then selected the relevant references for disposal, incineration, organics processing (for both source separated and mixed) and recovery facilities. The data was then conditionally summed for the relevant facilities and data references, and presented in a matrix. The relevant facilities for each waste recovery activity are known through the sorting data sets by survey type using pivot tables. The output of this analysis was quantities of waste associated with the unique reference for each facility.

This data was then consolidated by region and sector of origin. This was undertaken by retrieving data on region and origin (proportional split for MSW, C&I and C&D). Through a detailed review of DES' findings, Arcadis has consolidated all relevant assumptions for sector of origin for each relevant question in a matrix. The values are conditionally summed for region and question type, and then the origin assumption was applied.

The next refinement of data was to retrieve data on material type, facility type and material flow for the purpose of understanding the movements of particular material types in the Queensland economy. For the relevant data additional values material type, facility type and material flow are provided for simpler analysis. These assumptions can be easily modified, with outputs automatically adjusted. Analysis involves conditionally summing values for these relevant variables. For example, this would enable observation of the quantities of tyres from the C&I sector that are locally reprocessed, recovered for energy or exported at Queensland resource recovery facilities.

The final task in this data analysis exercise was to reconcile data findings with the actual Queensland waste and resource recovery network. The data is self-reported and therefore some of the values which are material to Queensland's disposal and recovery estimates need to be corrected. Arcadis' has undertaken targeted industry consultation to collect the relevant information to check and refine the self-reported data. The other key correction is the locations of recovery activities. Organisations with multiple facilities are required only to submit one survey with consolidated quantities. This means that some of the data needs to be disaggregated. This only affects a relatively small number of larger entities that operate multiple sites across different regions.

To understand the future needs of the state, Arcadis has prepared future projection models for disposal and recovery for MSW, C&I and C&D waste. These models are agile and enable to incorporate sensitivity analysis with respect to key variables such as population rates, waste generation growth rates and the year in which waste generation rates may plateau.

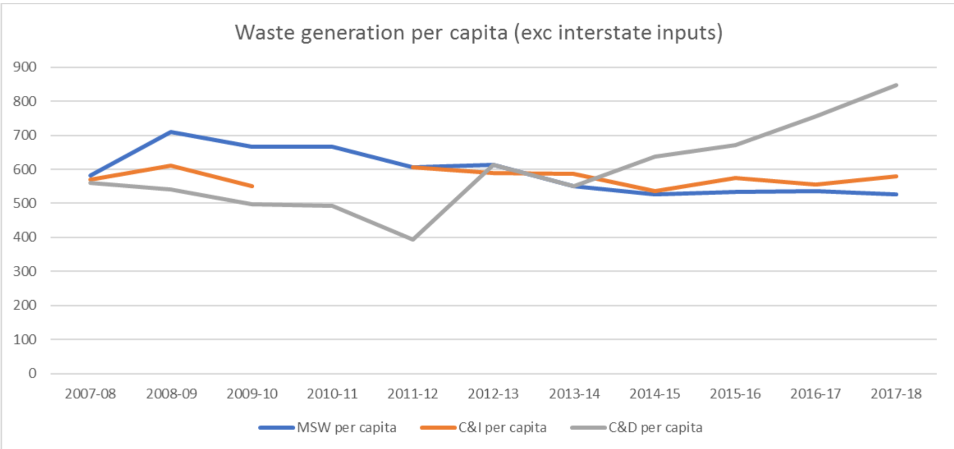
Recent analysis by statisticians for the NSW EPA have found that the strongest correlation with waste growth is population, with other statistical references less conclusive. The correlation is much easier to demonstrate with MSW, with C&I and C&D less consecutively linked to changes in gross state product. Arcadis is utilising historical data for understanding waste generation growth rates as well as policy to forecast future waste generation scenarios.

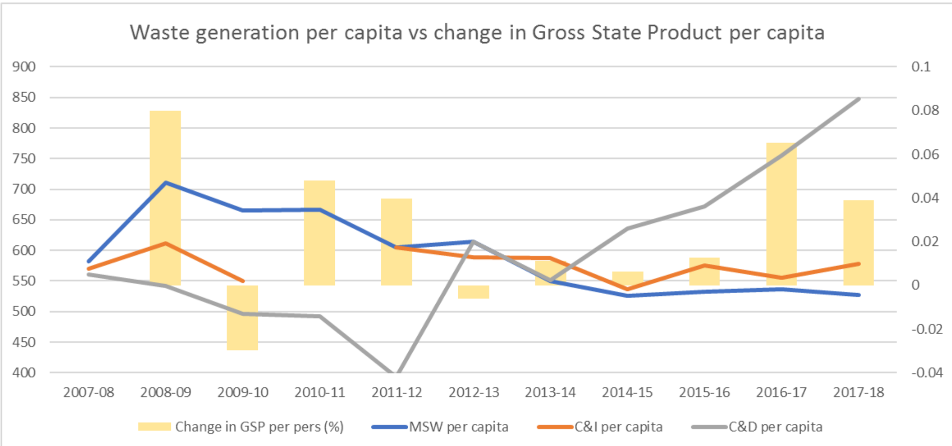
The models essentially involve estimating future waste generation by applying waste generation per capita rates (by LGA for MSW, and by region for other sectors) to future population estimates (low, medium and high), with the waste generation rate adjusted to the relevant growth scenario. The population forecasts by local government area for the period 2016-2041 are from the Queensland Government Statistician's Office . In order to forecast to 2050, the same growth rate for 2036-2041 has been extended across the remaining period for the low, medium and high scenarios. Clearly, such long-term forecasts are subject to a high margin or error and uncertainty and should be viewed with this in mind.

Key modelling assumptions:

Scenario	Description / assumptions
Waste generation – by sector and material	
Baseline data	Generally baseline from 2017-18 tonnes Noting for C&D waste, even with NSW waste taken out, per capita generation has increased 54% since 2013-14, which is assumed to be due to large infrastructure projects and an uplift in residential construction, or previously under-reported waste. In the absence of a clear explanation, the 2017-18 data is assumed to be most accurate and is the baseline for future projections.
Low growth scenario (base)	Assuming MSW waste avoidance targets from Strategy (25% per capita reduction by 2050) are met (note, already had 26% reduction over last decade) Smaller drop in C&I / C&D (no Strategy target) – no historic trend (C&I steady, C&D fluctuating). Propose steady 10% decline in per capita generation by 2050.
High growth scenario	No change in per capita generation – all streams. Growth in line with population only.
Resource recovery	
High recovery scenario (base)	Meeting Strategy recycling / diversion targets at statewide level Different rates for different regions (e.g. SEQ likely to do heavy lifting, less change in rural / remote areas) Assumes EfW is implemented as much as possible / reasonably viable, plus widespread source separation of organics. High recovery of C&D including mixed C&D processing. High C&I recovery including heavy organics focus and mixed waste processing to RDF and EfW.
Low recovery scenario	Conservative estimate of recovery based on levy impact, no EfW and minimal new MSW organics recovery. Modest improvement over time in C&I recovery due to levy (organics, recycling) More significant improvement for C&D due to levy – low hanging fruit
Mid recovery scenario	Mid-way between low and high (above) Strategy target timelines extended out by say 10 years Most improvement in SEQ, with moderate uptake of EfW and partial uptake of source separated organics. Moderate improvements in regional cities.
Breakdown of recovery	In each scenario, the breakdown of new recovery will be predicted based on current performance / systems in each region; opportunities identified through analysis of landfill waste composition and consideration of economics / viability (with levy impacts)

Scenario	Description / assumptions
Landfill tonnes / capacity	
Low / Mid / High residual waste projections	Range of residual waste flows corresponding with high / mid / low recovery scenarios (generation – recovery) and low / high generation growth
Landfill capacity staging	▪ Quantify remaining capacity of each site in tonnes (based on survey responses, estimates using compaction rates, previous work, or assumptions for small / rural sites) ▪ For MSW estimate the allocation of residual waste to each LF based on DES data, survey responses and knowledge, e.g. for BCC, might be 30% to Rochedale, 70% to Swanbank. Manual input % of LGA tonnes. ▪ For C&I and C&D – in regional areas - allocate to main LF; in SEQ - split between existing landfills according to current splits / inputs. ▪ Multiply % allocations x forecast residual waste tonnes under each scenario. Once a site fills current capacity, it becomes 0% and its allocation shifts to another site ▪ Check that total inputs match with remaining capacity.





Sensitivity scenarios

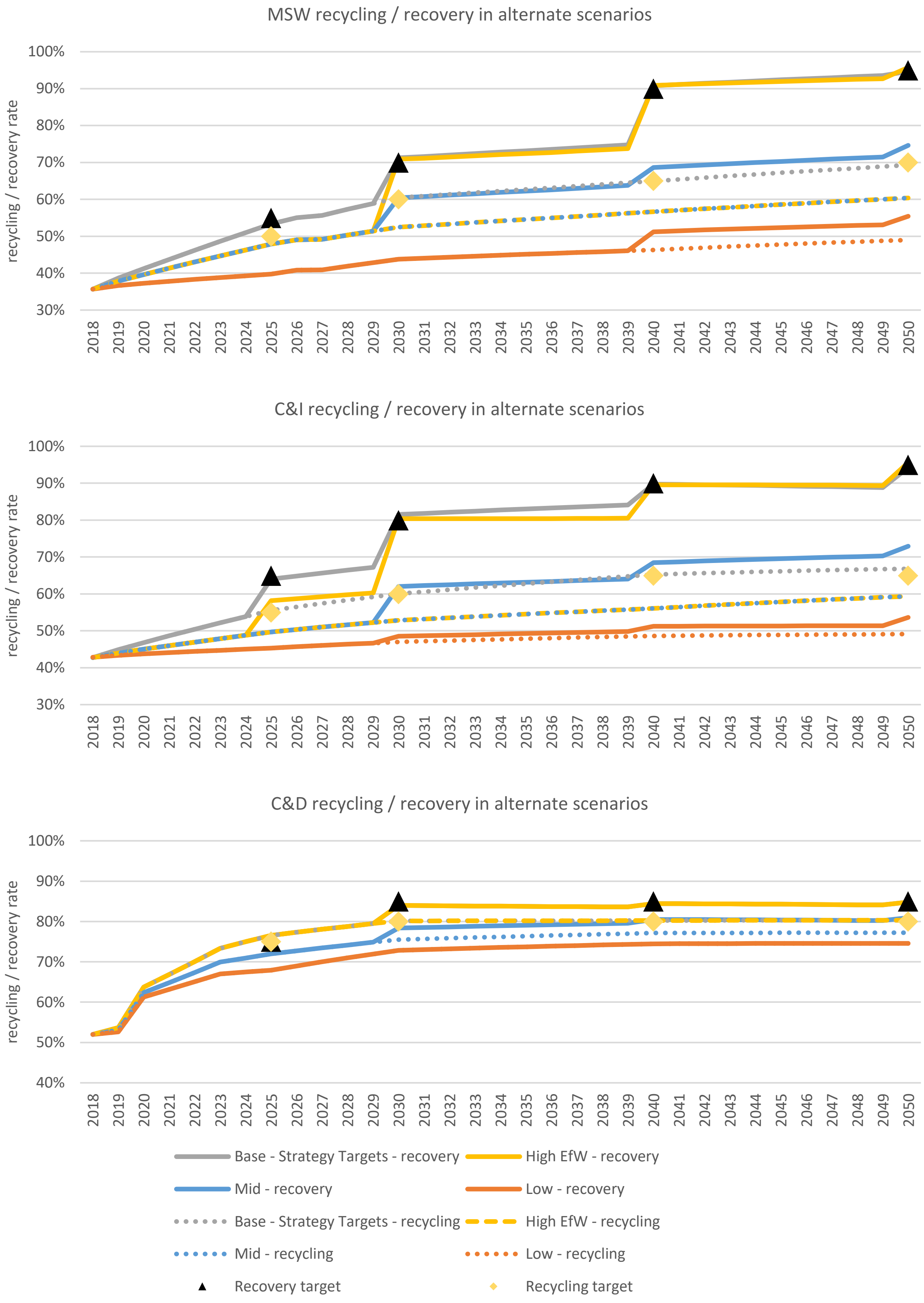


Figure 71: Summary of resource recovery performance under the sensitivity modelling scenarios

Landfill capacity assessment

To assess future landfill needs, the following approach has been followed:

- The remaining airspace of each landfill has been quantified or estimated, as at July 2019. Landfill operators were asked to identify the remaining airspace at each site (in tonnage terms), including:
  - Already constructed cells
  - Approved but yet-to-be-constructed cells, and
  - Potential future cells which may reasonably be developed at the site but are not yet approved.

  The first two figures comprise the current capacity. Potential future capacity has not been factored into the assessment directly but is considered in the capacity discussion. Where no capacity data was provided in the current data survey, gaps have been filled using data reported to DES through the annual survey and data gathered in the previous 2016 study. There was no capacity data available for a large proportion of the landfills classified as 'very small'. In those cases, where a closure date was specified by the relevant council operator, that has been adopted, otherwise those facilities have been assumed to remain open for the duration of the forecast period.
- For each landfill, the future inputs have been modelled by allocating a proportion of the total local or regional projected residual waste volume to each individual site. For MSW, residual waste volumes have been projected at the LGA level and split amongst the existing landfills based on the estimated splits in 2017-18. Where waste from a particular LGA is known to be disposed to a landfill in another LGA or to a private landfill, this has been accounted for.
- For residual C&I and C&D wastes, which are more likely to move across LGA borders, residual waste volumes have been allocated to each landfill based on the proportion of the total regional volume that was received at that landfill in 2017-18. Where there are inert landfills within a region, the capacity has of those facilities has been modelled separately from the putrescible landfills and C&D waste preferentially flows to inert facilities. However, once the inert airspace is exhausted, any excess C&D waste is assumed to flow to putrescible landfills.
- When an individual landfill is predicted to close because it reaches capacity (cumulative waste inputs equal the existing approved capacity), the allocation from that landfill is transferred to another facility within that region which is mostly likely to receive that waste, with a level of judgement and assumption involved in that process. If there are no existing landfills that can take that waste, this will show as a gap in capacity (less than 100% of waste allocated to landfills within a region).
- The assessment of landfill capacity is presented at the regional level but with commentary on local level dynamics, acknowledging that it is not always practical for waste to move across a region and some landfills are not appropriate to used as regional facilities.
- Landfill capacity has been assessed in the two extreme projection scenarios:
  - The base case, which assumes Strategy avoidance and recovery targets are met, which results in the lowest demand for landfill capacity, and
  - The low recovery scenario, which still assumes some improvement in resource recovery, but results in the highest demand for landfill capacity.

The results of the landfill capacity analysis are discussed at a high level below but in more detail for each region in section 6.

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