

Queensland Waste Strategy – Key Performance Indicators



SEPTEMBER 2018

Executive Summary

The Department of Environment and Science (DES) engaged QTC to advise on the appropriate key performance indicators (KPIs) to be adopted in the *Waste Strategy for Queensland 2018-2050* (Waste Strategy)

Table 1 provides a summary of QTC’s recommended KPIs and targets overall and for the relevant headline waste streams: Municipal Solid Waste (MSW), Commercial and Industrial (C&I) and Construction and Demolition (C&D).

TABLE 1 SUMMARY OF KPI AND TARGET REVIEW

KPIs	Recommended new targets					Comments	
Diversion of waste	Waste diverted from landfill, targets by waste stream:					<ul style="list-style-type: none"> ▪ A readily calculated measure that shows diversion of waste from the least desired outcome on the waste hierarchy – landfill – and that higher order outcomes are therefore being achieved. ▪ Explicit targets for each headline waste stream are recommended given the difference in drivers, behaviours and technology that can be used to influence the diversion rate. ▪ C&D diversion is constrained by the volume of asbestos and contaminated soil, for which there is currently no alternative to landfill. ▪ The 2050 diversion targets represent ‘zero waste’ to landfill based on current technology. 	
		Current¹	2025	2030	2040		2050
	MSW	31%	55%	70%	90%		95%
	C&I	48%	65%	80%	90%		95%
	C&D	51%	75%	85%	85%		85%
Overall	45%	65%	80%	85%	90%		
Waste avoidance	Avoidance of waste is generally measured as a percentage or volume reduction on a per unit basis. Because of the heterogeneous nature of C&I and C&D waste, a reliable ‘per unit’ measure has not been identified. A per capita basis is relevant for driving reductions in MSW waste generation.					<ul style="list-style-type: none"> ▪ Avoidance targets on MSW waste stream only. ▪ Appropriate metrics to measure C&I and C&D avoidance should be considered in the development of the data collection system. The impact of the levy/other levers should lead to avoidance by commercial waste generators. ▪ A larger percentage reduction in earlier years assumes success in changing behaviours (particularly 	
		Current	2025	2030	2040		2050
	MSW	n/a	10%	15%	20%		25%

¹ Current is based on the FY2017 *Recycling and Waste in Queensland* report, issued by DES.

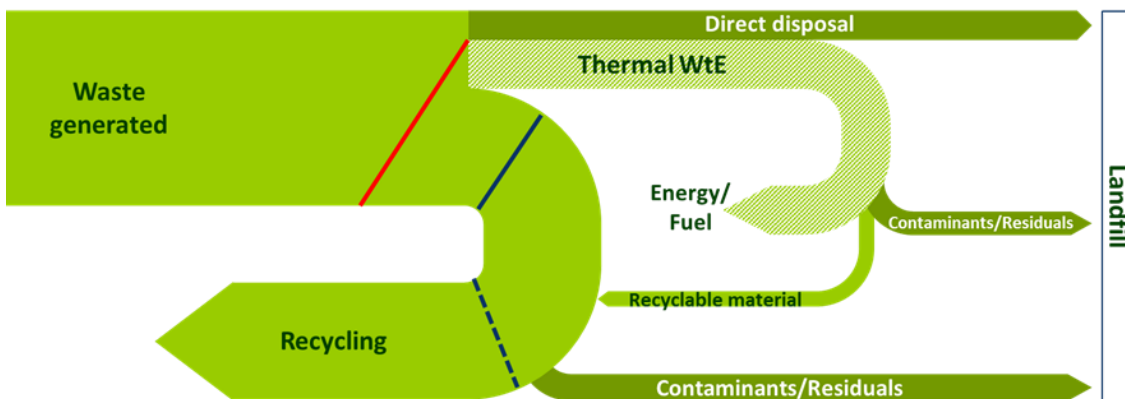
KPIs	Recommended new targets					Comments	
Recycling rate	Recycling targets by waste streams.					<p>realising 'low hanging fruit' opportunities).</p> <ul style="list-style-type: none"> Explicit recycling targets for each waste stream are recommended given the difference in drivers, behaviours and technology that can be used to influence the recycling rate. The target percentage and timeframe path is comparable with other jurisdictions and aligned with more progressive waste management strategies. 	
		Current ²	2025	2030	2040		2050
	MSW	31%	50%	60%	65%		70%
	C&I	48%	55%	60%	65%		>65%
	C&D	51%	75%	80%	>80%		>80%
	Overall	45%	60%	65%	70%		75%

The recommended targets have been established based on a set of data, assumptions and scenario modelling (refer to Appendix B). The targets are viewed as stretch targets for the State, acknowledging current performance and the Queensland Government's vision to become a national leader in waste reduction and material recovery. Achievement of them is highly dependent on having appropriate policy settings, successful partnering and collaboration between key stakeholders, infrastructure planning, development of end markets for recycled materials and effective education to deliver behavioural changes. Based on detailed analysis, the KPIs selected and the targets are compatible.

The recommended 2025 targets exceed the 2024 targets set in the current Waste Strategy, other than for C&D. In examining the breakdown of C&D waste types, the recycling target is constrained by the volume of asbestos and contaminated soil.

Figure 1 below depicts the general flow of materials in a conventional waste management system. The top flow on the right shows that some materials are directly disposed to landfill. All other flows (those passing through the red line) represent the diversion rate, for which the recommended overall target by 2050 is 90 per cent. Of that 90 per cent, some materials can be allocated to thermal Waste to Energy (WtE), the residuals from which potentially go to landfill or back into the system to be recycled. The material inputs for recycling are shown under the blue line, for which the recommended overall target by 2050 is 75 per cent.

FIGURE 1: WASTE FLOWS



Source: QTC

Data limitations

The recommended recycling targets are based on inputs rather than outputs (ie, residuals are not accounted for). As with many jurisdictions, Queensland's waste and recycling data is poor, both in terms of accuracy, level of detail and availability. As systems improve for data capture, the approach and/or methodology adopted may result in a different outcome being reported (eg, recycling outputs net of residuals). Future reporting of target outcomes should be mindful

² The current recycling rates are based on the FY2017 *Recycling and Waste in Queensland* report, issued by DES. These figures include waste to energy recovery (approximately 70,000 tonnes).

of this and reviews of the Waste Strategy should consider recalibration of the targets as the data availability and accuracy improves.

Other key supporting recommendations and conclusions are:

- **2025 interim target:** Setting the first target in 2025 balances the need to rapidly deliver improved outcomes with providing sufficient time for sustainable change to occur
- **Metro vs regional KPIs and targets:** While the Waste Strategy should have targets for the State overall, DES should consider likely differences in how the market will perform in SEQ and regional areas.
- **Baseline year:** The baseline year should be set immediately in order to include early progress made under strategy implementation
- **Implementation is crucial:** Establishing a waste strategy with clearly identified targets does not guarantee that desired outcomes will be met. Effective and coordinated implementation of a range of enablers is crucial to delivering the strategy's outcomes and achieving the targets.
- **Federal and other State initiatives:** As part of the implementation process, DES can consider expanding the targets to align with Federal and other State initiatives
- **Economic KPIs and measures:** A jurisdictional review for this report found no evidence of economic KPIs and targets being incorporated in waste strategies, though some Australian states do estimate and report on economic benefits.
- **Environmental KPIs and measures:** Similarly, the jurisdictional review identified only two environmental KPIs used in the jurisdictions examined (litter in NSW, greenhouse gas in Tokyo).
- **Reporting:** As part of the implementation process, DES should consider economic and environmental reporting as part of state-wide waste reporting process.

Objective of this report

To inform the development of the draft Waste Strategy, QTC was asked to provide DES with the following Project deliverables:

- An assessment of the appropriateness of the KPI measures selected and the targets and timeframes nominated by DES, considering Queensland’s current performance and the current performance and targets set by other jurisdictions.
- Confirmation that the proposed measures and targets are not incompatible with each other.
- Identification of additional measures for consideration, with appropriate targets and timeframes.

Context and background

What is the Government seeking?

Currently, Queensland has one of the lowest reported resource recovery rates in Australia. The draft Waste Strategy will reflect the Queensland Government’s vision to become a national leader in waste reduction and resource recovery. To support this vision, an early working draft of the Waste Strategy provided by DES to QTC on 9 August 2018 identified three KPIs measures and targets:

TABLE 2 “WORKING DRAFT” WASTE STRATEGY KPIS AND TARGETS

Theme	Ultimate target	Milestone
Diversion of waste	<ul style="list-style-type: none"> ▪ Zero avoidable waste to landfill by 2050 	<ul style="list-style-type: none"> ▪ Up to 20% of waste to landfill by 2030 ▪ Up to 10% by 2040
Waste avoidance	<ul style="list-style-type: none"> ▪ Per capita waste generation reduced by 25% by 2050³ 	<ul style="list-style-type: none"> ▪ 5% reduction by 2030 ▪ 15% reduction by 2040
Recycling or recovery	<ul style="list-style-type: none"> ▪ 75% of material recycled by 2050 	<ul style="list-style-type: none"> ▪ 65% by 2030 ▪ 70% by 2040

Table 3 summarises the 2024 targets set out in the current Waste Strategy (Queensland Waste Avoidance and Resource Recovery Productivity Strategy 2014-2024).

TABLE 3 QLD WASTE AVOIDANCE AND RESOURCE PRODUCTIVITY STRATEGY 2014-2024 TARGETS

Theme	2024 Target			
Diversion of waste	<ul style="list-style-type: none"> ▪ Reduction in the amount of waste going to landfill by 15% (baseline year FY2013: 4.675 million tonnes to landfill. FY2024 target is therefore 3.97 million tonnes) 			
Waste avoidance	<ul style="list-style-type: none"> ▪ General waste reduction per capita by 5% to 1.8 tonnes (baseline year FY2013: 1.9 tonnes per capita) 			
Recycling rate	<table border="0"> <tr> <td> <ul style="list-style-type: none"> ▪ MSW: <ul style="list-style-type: none"> – 50% state (overall) – 55% metropolitan – 45% regional centre </td> <td> <ul style="list-style-type: none"> ▪ C&I: <ul style="list-style-type: none"> – 55% state (overall) </td> <td> <ul style="list-style-type: none"> ▪ C&D: <ul style="list-style-type: none"> - 80% state (overall) </td> </tr> </table>	<ul style="list-style-type: none"> ▪ MSW: <ul style="list-style-type: none"> – 50% state (overall) – 55% metropolitan – 45% regional centre 	<ul style="list-style-type: none"> ▪ C&I: <ul style="list-style-type: none"> – 55% state (overall) 	<ul style="list-style-type: none"> ▪ C&D: <ul style="list-style-type: none"> - 80% state (overall)
<ul style="list-style-type: none"> ▪ MSW: <ul style="list-style-type: none"> – 50% state (overall) – 55% metropolitan – 45% regional centre 	<ul style="list-style-type: none"> ▪ C&I: <ul style="list-style-type: none"> – 55% state (overall) 	<ul style="list-style-type: none"> ▪ C&D: <ul style="list-style-type: none"> - 80% state (overall) 		

Why are KPIs and targets important?

Setting KPIs and targets are important as they set quantifiable measures that an entity can use to gauge or compare performance in terms of meeting their strategic and operations goals. A number of the specific outcomes of setting KPIs are noted below:

- indicates to the market what government is seeking to achieve
- provides a means to assess proposed initiatives

³ Target baseline of 2 tonnes per capita based on 2017 data of 9.8 million tonnes of waste generated and population of 4.9 million.

- provides a tool to assess the effectiveness of current initiatives in achieving and maintaining the KPIs
- is a method to inform the market and community of progress/ achievement, and
- is a basis for refocusing efforts.

What are the benefits of the new Waste Strategy?

An improved waste management and resource recovery sector in Queensland can provide significant potential benefits, as outlined in Table 4. It is these benefits that the State should be seeking to focus on and measure.

TABLE 4 BENEFITS OF NEW WASTE STRATEGY

Economic opportunities	<ul style="list-style-type: none"> ▪ Employment growth ▪ Higher skilled workforce ▪ Innovation (eg, increase in IP) ▪ Deliver a positive ecological footprint to create comparative economic advantage 	<ul style="list-style-type: none"> ▪ Investment growth ▪ Increase productivity (eg, GSP growth) ▪ Reliable source of supply from local recycled materials ▪ Reduce costs
Environmental opportunities	<ul style="list-style-type: none"> ▪ Reduce greenhouse gas emissions ▪ Reduce pollution 	<ul style="list-style-type: none"> ▪ Land preservation ▪ Retain virgin materials

While these economic and environmental opportunities are commonly discussed in most waste strategies, measuring success can be quite complex. Most jurisdictions in Australia and overseas have attempted various unique quantitative measurements and reporting styles to show progression however none have incorporated them as a KPI. Accordingly, Queensland will need to look to proxy measures that support the achievement of both economic and environmental outcomes.

QTC's approach

Using the draft Waste Strategy⁴ with nominated measures and targets, QTC has undertaken:

- a qualitative assessment, comparing the proposed KPIs against selected Australian and international jurisdictions for reasonableness and appropriateness
- a quantitative assessment, through high-level modelling of predicted changes to composition of waste and recycling to assess compatibility and achievability of these KPIs, and
- research for alternative measurements to capture related economic and environmental benefits.

Benchmarking

Building on the work undertaken by DES, and assisted by Arup, QTC looked at a mix of Australian and international waste strategies to identify the most commonly used measures and targets (or KPIs), particularly from those jurisdictions that are deemed progressive and have considered transition towards circular economy. The selected international jurisdictions have set one or multiple ambitious targets in relation to recycling rates, diversion (eg, pursuing a zero waste target) and waste avoidance targets⁵.

The jurisdictions reviewed were:

Australian jurisdictions	International jurisdictions
South Australia (SA)	Scotland (National)
New South Wales (NSW)	Wales (National)
Victoria (Vic)	Finland (National)
Western Australia (WA)	Auckland (City)
	San Francisco (City)
	Tokyo (City)

⁴ Draft Waste Strategy provided by DES to QTC on 9 August 2018 (Waste_Strategy_20180802_v1.3_draft_recd 20180809.docx).

⁵ Many European jurisdictions achieve high diversion rates through thermal WtE, rather than high levels of recycling. The jurisdictions selected for this review are ones focused on delivering a high recycling rate rather than just diversion.

Modelling

In addition to the Waste Strategy target benchmarking review, we engaged Arup to assist in the development of a high level model to assess the achievability and compatibility of the waste strategy targets. Further details on the modelling and key assumptions are detailed in Appendix B.

Limitations

QTC and Arup completed a desktop review of other jurisdictions, relying on publicly available information. QTC has not independently verified the information.

Deficiencies in current data collection and the availability of suitably detailed waste flow and infrastructure information are barriers to robust options analysis and infrastructure investment decisions.

Summary of benchmarking results

Key findings

Table 5 provides a traffic light system that has been used to highlight the level of detail included within each of the relevant strategies. A 'limited' assessment does not mean the strategy has excluded any discussions of the theme, however it does mean there are no targets set.

TABLE 5 INDICATORS

Keys	Description
Adequate	Detailed coverage with clearly identified themes and targets that represent best practice
Moderate	Limited coverage with identified themes and targets that are not best practice
Limited	Limited coverage with no defined theme or targets

Table 6 depicts the types of measures used by other jurisdictions. Detailed information to support the traffic light assessment is contained in Appendix A.

TABLE 6 SUMMARY OF JURISDICTIONAL REVIEW

Jurisdiction	Type of measures					
	Waste avoidance	Recycled rate	Diversion of waste	Litter / illegal dumping	Environmental measures	Economic measures
Australia						
NSW	●	●	●	●	●	●
SA	●	●	●	●	●	●
Victoria	●	●	●	●	●	●
WA	●	●	●	●	●	●
International						
Scotland	●	●	●	●	●	●
Wales	●	●	●	●	●	●
Finland	●	●	●	●	●	●
San Francisco	●	●	●	●	●	●
Auckland	●	●	●	●	●	●
Tokyo	●	●	●	●	●	●

Across the selected jurisdictions

- All but one of the waste strategies have a strategy time horizon between 5 and 10 years. Where headline waste targets are set beyond the strategy time horizon (eg, SA and Auckland), the relevant strategies provide interim targets to clearly outline the trajectory.
- Most waste strategies considered economic and environmental factors to be crucial in setting targets, however only two jurisdictions set any specific targets in these areas (limited to NSW having an infrastructure target for the management of ‘problem waste’ and a target for reduced littering, and Tokyo with greenhouse gas emission targets). Some Australian jurisdictions provide estimates on economic contribution (eg, jobs and market value of the sector) through annual activity reports.

For selected Australian jurisdictions

- All waste strategies are based on 5 to 10 year outlook.
- Other than Victoria, which set none, each jurisdiction set targets on either waste avoidance or landfill diversion. Recycling is a common theme among all jurisdictions, but only WA and NSW have set targets for it. Acknowledging current data limitations, SA has set diversion rates for waste rather than recycling rates. SA is introducing mass balance reporting to enable it to accurately measure recycling outcomes.
- SA and NSW set targets for reducing per capita waste generation, with NSW the only state that set targets on reducing litter.
- While not a KPI, SA and NSW report on economic contributions and employment opportunities.
- Most jurisdictions provide regular waste and resource recovery reports. In particular, SA has published an annual report since FY2006, with the latest reports focusing on performance against targets, performance of key waste streams, and identifying economic and employment contributions.

For selected international jurisdictions

- Strategies are typically based on 5 to 10 year outlook, however specific targets can have longer lead time, eg zero waste extending up to 2040.
- Targets are generally set with a focus on diverting waste from landfill and increased material recovery through recycling.
- A number of jurisdictions stipulate targets for a reduction of waste generation as a percentage or per capita value.
- Three of the six jurisdictions examined have implied restrictions on incineration and waste to energy, specifying a limited or zero percentage of the waste streams that can be used for these activities.
- Performance against targets can be measured for strategies implemented within the past 10 years and indicate that the jurisdictions are generally on track to meet their targets.
- Comprehensive waste statistics and reporting are available.
- Most jurisdictions differentiate between the key waste streams, with MSW the focus.

Assessment of working draft waste measures and targets for Queensland

Initial draft waste targets

An early draft of the Waste Strategy developed by DES identified three KPIs, with the following explanations:

TABLE 7 DRAFT NOMINATED WASTE STRATEGY TARGETS

Theme	Target	Comments on nominated targets
Diversion of waste	<ul style="list-style-type: none"> ▪ Zero avoidable waste to landfill by 2050 ▪ Milestones: <ul style="list-style-type: none"> - Up to 20% by 2030 - Up to 10% by 2040 	<ul style="list-style-type: none"> ▪ The zero avoidable waste target was proposed in the Directions Paper. ▪ Under this target, waste disposed of to landfill is defined as unavoidable where it cannot be viably recycled or recovered. Therefore landfill treatment is the only economically, socially and environmentally acceptable alternative ▪ Headline target can be achieved through a combination of waste avoidance and recycling agenda.

Theme	Target	Comments on nominated targets
Waste avoidance	<ul style="list-style-type: none"> Per capita waste generation reduced by 25% by 2050⁶ Milestones: <ul style="list-style-type: none"> - 5% reduction by 2030 - 15% reduction by 2040 	<ul style="list-style-type: none"> The target is based on Queensland aiming to be a 'leader' in waste performance. The public are already engaged and enthusiastic about reducing waste in Queensland. Therefore the 2050 target is to reduce per capita waste generation by 25%. This target can be achievable with the delivery of improved education on food waste avoidance, policies to design out unsustainable packaging and the encouragement of material reuse.
	<ul style="list-style-type: none"> 75% of material recycled by 2050 Milestones: <ul style="list-style-type: none"> - 65% by 2030 - 70% by 2040 	<ul style="list-style-type: none"> The 75% recycling target is based on the assumption that at most 20% of waste is used for energy in 2050, and there would be still be around 5% residuals/contaminated material going to landfill, therefore the rest is recycled. The active development and growth of recycling markets in Queensland will mean that recycling rates of 75% for all materials will be possible by 2050. 'Recycled' includes material being reused, remanufactured, recycled or composted. The residual material may still be recovered through non-hazardous waste-to-energy processes.

Assessment of working draft waste measures and targets

QTC assessed each of these initial KPIs based on eight questions. Those questions and the assessment made are summarised in the following tables.

Diversion of waste

Question	Commentary
<i>How should avoidable waste be defined and measured? Is it reasonable to have this as a target?</i>	<p>If used, the term 'avoidable waste' would need to be explicitly defined. The current proposal defines the inverse – unavoidable waste – as 'waste disposed to landfill where it cannot be viably recycled or recovered. Therefore landfill treatment is the only economically, socially and environmentally acceptable alternative'. Defining what waste is determined to be avoidable - the waste that is subject to diversion - rather than the waste that is determined to be unavoidable would provide clarity for the definition of this target and help prevent misinterpretation.</p> <p>The UK Clean Growth Strategy states 'zero waste equates to eliminating all waste where it is technologically, environmentally and economically practicable to do so and working to support innovation in new materials, products and processes that extend the range of materials covered by this categorisation'. Technology, environmental and economic aspects are important to the viability of waste recovery and it is recommended that these are incorporated into the definition of avoidable waste. Another factor that could be considered is social acceptability.</p> <p>The proposed measure does not specify which waste streams the target applies to. It is assumed it encompasses the three headline waste streams (MSW, C&D and C&I) but this is not stipulated. Some other jurisdictions have waste targets that focus on specific streams such as MSW. It is recommended that clarity is provided on which waste streams are incorporated, and whether it includes hazardous and regulated wastes.</p>
<i>What date should the baseline to measure performance be?</i>	<p>All targets should utilise a baseline at the start of the strategy period to fully capture impacts made by the new Waste Strategy, the waste levy and other interventions as they come into play. This approach would align with that typically outlined in waste strategies of progressive international jurisdictions. The ability to do this will be determined by the availability of data and the need to adjust for any abnormalities. To capture impacts made by the waste levy and other interventions as they come into play, FY2018 should be used as the baseline year.</p>
<i>Is this a reasonable measure and target?</i>	<p>Measurement of 'avoidable' waste is challenging. By way of example, in the UK, England and Wales implemented regulations in 2015 that stipulated the separate collection of recyclable materials by businesses and councils, unless they could demonstrate separate collection was not 'technically, environmentally or economically practicable (TEEP)'. By 2016, the majority of councils had undertaken TEEP assessments (283 out of 321 collection authorities), but reportedly only eight had changed their collection services as a result. It would therefore appear that the</p>

⁶ Target baseline of 2 tonnes per capita based on 2017 data of 9.8 million tonnes of waste generated and population of 4.9 million.

Question	Commentary
	majority of councils determined that separate collection was not technically, environmentally or economically practical.
<i>Will the target drive the right behaviours?</i>	A landfill diversion target is a very simple measure to drive higher order outcomes. Many international jurisdictions do not use the term ‘avoidable’ to define waste to landfill targets and instead measure progress on total waste generation. Scotland implemented a target for a maximum of 5% of waste disposed to landfill by 2025. To assist with this approach, the Scottish strategy outlines a mandatory pre-sort of materials, a limit on landfill of biodegradable content, and restrictions on what can be incinerated. The majority of strategies outlining plans toward zero waste societies understand that there will always be a small element of the waste stream that may not be recovered. Based on the modelling work done on Queensland’s waste data to 2050, it is expected that 5% of most waste generated will be unsuitable for recycling or energy recovery, and will need to be landfilled. In the case of C&D, this percentage rises to 15% because of contaminated soil and asbestos, for which no viable alternative currently exists. Overall, Queensland’s ‘zero waste’ target is therefore approximately 10% of all waste generated.
<i>What are the challenges in capturing the data? How should we define this measurement?</i>	See above, with the issues around defining avoidable waste.
<i>Is baseline data available and if not, what would the baseline period be?</i>	Baseline data is unlikely to be available to adequately define avoidable waste. Data required includes compositional data, collection data, infrastructure capacity and type data as well as cost and economic data.
<i>Should there be an interim target before 2030? If so what should it be? What period is appropriate?</i>	The selected benchmarks show that short to medium term interim targets are common place. This helps gauge progress and drive early change and momentum towards achieving targets. Most jurisdictions examined have ten year strategies with targets set for 5 and 10 year timelines.
<i>Review of the 2030, 2040, and 2050 targets</i>	The target review is captured in the waste modelling outlined in Appendix C. It is recommended that this KPI is changed to waste diversion from landfill given that this is a commonly used by other jurisdictions. The ‘avoidable’ waste target is difficult to define and measure and is not a commonly used KPI based on jurisdictional review. The proposed targets for 2025, 2030, 2040 and 2050 are outlined in Table 8.

Waste avoidance

Question	Analysis
<i>How should waste avoidance be defined and measured? Is it reasonable to have this as a target?</i>	This target is based on a generation rate of two tonnes of waste per capita per year, which is a measurement from the total waste stream divided by the Queensland population. It is expected that there would be a lower correlation between population and C&I/C&D waste generation than for MSW. Driven by other factors, such as economic growth, a per capita measure is less appropriate for C&I and C&D waste streams. While other criteria could be adopted to measure waste avoidance for non-MSW waste, the financial incentive of the levy and general move towards a circular economy is potentially sufficient to drive the right behaviour for such streams. This approach can be reconsidered in three years’ time, when the Waste Strategy is reviewed. To drive a change in behaviour for households, a KPI based on MSW per capita is appropriate and, due to the lack of direct financial incentive for the waste generator, necessary.
<i>What date should the baseline to measure performance be?</i>	All targets should utilise a baseline towards the start of the strategy period to capture impacts made by the waste levy and other interventions as they come into play.
<i>Is this a reasonable measure and target?</i>	The reduction targets appear achievable.
<i>Will they target drive the right behaviours?</i>	Yes, this should drive the right behaviour of waste avoidance for MSW but could lead to perverse outcomes for C&I and C&D in a period of economic growth. An alternative based on absolute volume could be problematic during growth periods.
<i>What are the challenges in capturing</i>	No challenges identified. Headline waste tonnages per capita is data that is already collected and straightforward to calculate. An alternative per unit basis for measuring waste avoidance for C&I

Question	Analysis
<i>the data? How should we define this measurement?</i>	and C&D would require detailed analysis of the activities that generate the waste, and this data is not currently available in a reliable, comprehensive form.
<i>Is baseline data available and if not, what would the baseline period be?</i>	Baseline data is already available for headline waste tonnages for each stream.
<i>Should there be an interim target before 2030? If so what should it be? What period is appropriate?</i>	<p>Similar to the waste diversion KPI, it is recommended to have an interim target in 2025 to help gauge progress and drive early change and momentum towards achieving targets.</p> <p>A larger percentage reduction in earlier years can be achieved assuming success in changing behaviours (particularly realising ‘low hanging fruit’ opportunities).</p>
<i>Review of the 2030, 2040, and 2050 targets</i>	<p>The 2040 target of 15% reduction requires a 1% decrease per year. The 2050 target of 25% reduction by 2050 requires the same 1% reduction per year. These are significant year-on-year reductions to achieve over an extended period across all streams. We note Auckland is targeting 2% year on year reduction, though this is only for MSW.</p> <p>A larger percentage reduction in earlier years can be achieved assuming success in changing behaviours (particularly realising ‘low hanging fruit’ opportunities and harnessing the current public awareness and momentum on waste management and recycling).</p> <p>The new targets for 2025, 2030, 2040 and 2050 are outlined in Table 8. Details on achievability and compatibility are further discussed on Appendix C.</p>

Recycling or recovery

<i>How should recycling be defined and measured? Is it reasonable to have this as a target?</i>	Typically, individual targets are set for different waste streams, as MSW, C&D and C&I comprise different waste types that have varying recovery rates. Recycling rates for C&D and C&I are typically around 70% in the medium term with MSW around 50-60%. It is suggested that different targets are outlined within the strategy for the three main waste streams, to ensure improved outcomes are achieved in each stream. High level modelling indicates that a 3% increase in recycling per year would be required to meet the proposed 2030 target and is considered achievable given the actions proposed under the new Waste Strategy.
<i>What date should the baseline to measure performance be?</i>	A starting point for target measuring would be most appropriately implemented from the commencement date of the strategy.
<i>Is this a reasonable measure and target?</i>	Based on the review of selected international benchmarks, the targets for recycling recovery are in line with those outlined by the most progressive waste management strategies.
<i>Will the target drive the right behaviours?</i>	Recycling targets assist in driving recovery of material for reuse and remanufacture and recovery of biodegradable waste for composting. They also facilitate reduced reliance on virgin resources and limit diversion to WtE. Market development is required to support remanufacture and recycling of recovered resources to the necessary standards. Furthermore, public awareness, education and community engagement is central to achieving recycling targets and economic incentives for not disposing waste to landfill.
<i>What are the challenges in capturing the data? How should we define this measurement?</i>	<p>The benchmarking exercise of international jurisdictions implementing a zero waste policy indicated that a comprehensive waste tracking and data collection system was integral to the success of the waste strategy. For the EU, data collection is required under the EU Waste Statistics Regulation. Economic drivers provide business opportunities for the capture of data, with planning expected to reduce the risk of overlapping information gathering systems. Annual reports are essential.</p> <p>The challenge with this target is to ensure collected material is ultimately being either reused, remanufactured, recycled or composted. One mechanism to report on this would be a mass balance approach that provides a measurement on both input and output streams from a facility, quantifying the actual amount of material ‘recycled’ as opposed to the amount received or collected. This is important as a proportion of the input stream will</p>

end up as residual waste and is therefore not recycled (it would either go to WtE or landfill). SA are working towards a mass balancing approach.

Is baseline data available and if not, what would the baseline period be?

Currently, baseline data is collected for the recycling and composting component of the waste stream. However this data may overestimate the recovery rates as residual components from MRFs and remanufacturers are not captured. In addition, there would be little data capture on reuse and remanufacturing. Information gathering for these stream flows require development to ensure tracking against targets can be undertaken. Improved data capture prior to performance reporting is essential.

Should there be an interim target before 2030? If so what should it be? What period is appropriate?

Typically waste strategies are set for a period of 10 years, with incremental targets set at intervals within this period to assist in achieving the overall long term goal. More ambitious targets are set within the short term with target percentages reducing over time as 'low hanging fruit' is harvested and recovery becomes more difficult. Initial targets should allow for any 'ramping up' period, before which minimal change can occur. As a comparison, to achieve a recycling/composting target of 70% by 2025, Scotland and Wales's waste strategies outlined high interim targets for the 15 years prior, including 40% in 2010 and around 60% in 2015.

Review of the 2030, 2040, and 2050 targets

Based on the benchmarking exercise, the Queensland recycling target percentages outlined in the draft Waste Strategy are numerically comparable to those identified in other waste strategies, however the timelines for delivery are not as ambitious as some world leaders committed to zero waste plans. This recognises the low base Queensland is starting from, with a recycling rate in Queensland of 44.5% in FY2017. It is noted however that this magnitude of change did occur in Scotland, which increased its recycling rate from 40% to 70% over a period of just 15 years.

The waste modelling (refer to Appendix C) was structured to analyse performance by waste types within waste streams to enable a rigorous assessment of what can be achieved but still represents a stretch target.

The introduction of intermediate targets eg, a 2025 target would provide great assurance that long term targets can be met and provide the opportunity for recycling percentages to be brought forward to provide incentive, continue momentum and account for the early increases expected in the implementation of the waste strategy.

Other considerations

Should there be specified targets for waste streams?

- The current targets lack definition around which waste streams are included. Targets for waste streams would be beneficial as the three headline waste streams comprise different waste types, are generated, managed and collected in different ways, and have different barriers, drivers and opportunities.

Should any other targets be included?

- Some jurisdictions have focused on specific waste, such as packaging, plastics or littering. While such targets may be useful to ensure specific focus, they are not recommended as KPIs for a broader Waste Strategy. They may be more appropriate as part of an implementation plan.
- Due to the smaller population centres and vast distances in regional Queensland, the waste and recovery outcomes achievable by the market in other coastal metropolitan areas and rural and remote areas will be different to those that can be achieved in SEQ. The Government will therefore need to identify special measures to assist the market in non-SEQ markets. The jurisdictional review did not discover evidence of differential targets for regions. It is recommended that any regional allowances should be addressed separately, following detailed analysis, and not be reflected in the KPIs for the Waste Strategy.

What economic measures should be included/considered?

- The jurisdictional review found no evidence of economic targets being incorporated into waste strategies. Data capture will be the key challenge in enabling economic measures to become reliable targets. Waste levy money that is returned to industry should be tracked and the outcomes publicly reported.

The recommended 2025 targets exceed the 2024 targets set in the current Waste Strategy, other than for C&D. In examining the breakdown of waste volumes, the proposed 2025 C&D diversion and recycling targets are constrained by the volume of asbestos and contaminated soil.

Recommendations

Table 8 provides a summary of recommended changes to KPIs and targets, with rationale for DES to consider.

TABLE 8 SUMMARY OF TARGETS ASSESSMENT

KPIs	Recommended new targets					Comments	
Diversion of waste	Waste diverted from landfill, targets by waste stream:					<ul style="list-style-type: none"> ▪ A readily calculated measure that shows diversion of waste from the least desired outcome on the waste hierarchy – landfill – and that higher order outcomes are therefore being achieved. ▪ Explicit targets for each headline waste stream are recommended given the difference in drivers, behaviours and technology that can be used to influence the diversion rate. ▪ C&D diversion is constrained by the volume of asbestos and contaminated soil, for which there is currently no alternative to landfill. ▪ The 2050 diversion targets represent ‘zero waste’ to landfill based on current technology. 	
		Current⁷	2025	2030	2040		2050
	MSW	31%	55%	70%	90%		95%
	C&I	48%	65%	80%	90%		95%
	C&D	51%	75%	85%	85%		85%
Overall	45%	65%	80%	85%	90%		
Waste avoidance	Avoidance of waste is generally measured as a percentage or volume reduction on a per unit basis. Because of the heterogeneous nature of C&I and C&D waste, a reliable ‘per unit’ measure has not been identified. A per capita basis is relevant for driving reductions in MSW waste generation.					<ul style="list-style-type: none"> ▪ Avoidance targets on MSW waste stream only. ▪ Appropriate metrics to measure C&I and C&D avoidance should be considered in the development of the data collection system. ▪ The impact of the levy/other levers should lead to avoidance by commercial waste generators. ▪ A larger percentage reduction in earlier years assumes success in changing behaviours (particularly realising ‘low hanging fruit’ opportunities). 	
		Current	2025	2030	2040		2050
	MSW	n/a	10%	15%	20%		25%
Recycling rate	Recycling targets by waste streams.					<ul style="list-style-type: none"> ▪ Explicit recycling targets for each waste stream are recommended given the difference in drivers, behaviours and technology that can be used to influence the recycling rate. ▪ The target percentage and timeframe path is comparable with other jurisdictions and aligned with more progressive waste management strategies. 	
		Current⁸	2025	2030	2040		2050
	MSW	31%	50%	60%	65%		70%
	C&I	48%	55%	60%	65%		>65%
	C&D	51%	75%	80%	>80%		>80%
Overall	45%	60%	65%	70%	75%		

The recommended targets have been established based on a set of data, assumptions and scenario modelling (refer to Appendix B). The targets are viewed as stretch targets for the state, acknowledging current performance and the Queensland Government’s vision to become a national leader in waste reduction and material recovery. Based on detailed analysis, the KPIs selected and the targets set are compatible with each other. Achievement of the targets is

⁷ Current is based on the FY2017 *Recycling and Waste in Queensland* report, issued by DES.

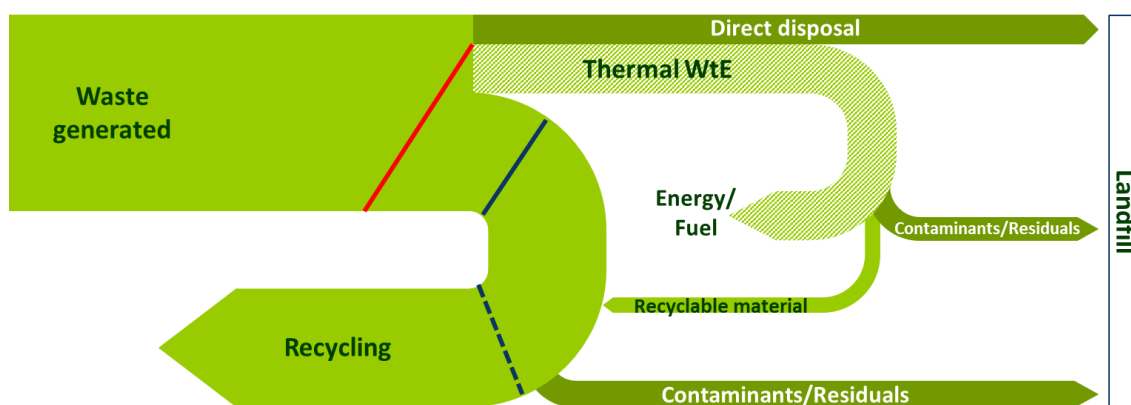
⁸ The current recycling rates are based on the FY2017 *Recycling and Waste in Queensland* report, issued by DES. These figures include waste to energy recovery (approximately 70,000 tonnes).

highly dependent on having appropriate policy settings, successful partnering and collaboration between key stakeholders, infrastructure planning, development of end markets for recycled materials and effective education to deliver behavioural changes.

These and other enablers are discussed in QTC's report *Economic opportunities for the Queensland waste industry: final report (June 2018)*. To achieve the nominated targets, the modelling assumes an operating environment of continuous improvement, investment (both industry and government) and a proactive approach to innovation in all elements of waste management and resource recovery. The recommended 2025 targets exceed the 2024 targets set in the current Waste Strategy, other than for C&D. In examining the breakdown of C&D waste types, the recycling target is constrained by the volume of asbestos and contaminated soil.

Figure 2 below depicts the general flow of materials in a conventional waste management system. The top flow on the right shows that some materials are directly disposed to landfill. All other flows (those passing through the red line) represent the diversion rate, for which the recommended overall target by 2050 is 90 per cent. Of that 90 per cent, some materials can be allocated to thermal Waste to Energy (WtE), the residuals from which potentially go to landfill or back into the system to be recycled. The material inputs for recycling are shown under the blue line, for which the recommended overall target by 2050 is 75 per cent. Recycling will produce some residual waste that will be landfilled and when data quality permits, recycling should ideally be measured on a net basis (ie, the flow under the blue dashed line).

FIGURE 2: WASTE FLOWS



Source: QTC

Data limitations

The recommended recycling targets are based on inputs rather than outputs (ie, residuals are not accounted for). As with many jurisdictions, Queensland's waste and recycling data is poor, both in terms of accuracy, level of detail and availability. As systems improve for data capture, the approach and/or methodology adopted may result in a different outcome being reported (eg, recycling outputs net of residuals). Future reporting of target outcomes should be mindful of this and reviews of the Waste Strategy should consider recalibration of the targets as the data availability and accuracy improves.

Other key supporting recommendations and conclusions are:

- **2025 interim target:** Setting the first target in 2025 balances the need to rapidly achieve improvement while providing sufficient time for sustainable change to occur. A six year timeframe to the first target drives progress and provides greater certainty of the State Government's commitment to improving waste management and resource recovery.
- **Metro vs regional KPIs and targets:** While the Waste Strategy should have targets for the State overall, DES should consider likely differences in how the market will perform in SEQ and regional areas. Without appropriate support the waste and recovery outcomes achievable in regional, rural and remote areas will be different to those that can be achieved in SEQ. By identifying the market constraints in advance, appropriate measures can be adopted as part of the implementation planning process to help minimise these differences.
- **Baseline year:** While data capture and availability can be challenging for some KPIs, the baseline year should be set immediately in order to include early progress made under strategy implementation (eg, impact of the waste levy). The review and waste modelling have been undertaken assuming baseline year is FY2018.

- **Implementation is crucial:** Establishing a waste strategy with clearly identified targets does not guarantee that desired outcomes will be met. Effective and coordinated implementation of a range of enablers is crucial to delivering the strategy's outcomes and achieving the targets.
- **Federal and other State initiatives:** As part of the implementation process, DES can consider expanding the targets to align with Federal (eg plastic packaging, national litter programs or other policy initiatives in energy, sustainability and climate change) and other State initiatives (eg, renewables targets and biofuels)
- **Economic KPIs and measures:** A jurisdictional review for this report found no evidence of economic KPIs and targets being incorporated in waste strategies. While achieving a consistent data and measurement approach will be challenging, the jurisdictional review found that some Australian states do estimate and report on economic benefits such as:
 - annual turnover in the waste management industry,
 - number of people employed, and
 - direct market value of resource recovered materials (eg, survey method used by South Australia).
- **Environmental KPIs and measures:** Similarly, the jurisdictional review identified only two environmental KPIs used in the jurisdictions examined (litter in NSW, greenhouse gas in Tokyo). However, the review found that some jurisdictions have estimated environmental benefits such as reduction in greenhouse gas emissions, lower pollution and retention of virgin materials (including water and energy savings).
- **Reporting:** As part of the implementation process, DES should consider economic and environmental reporting as part of state-wide waste reporting process. This will provide opportunity for the State to establish a baseline or benchmarks that can be considered in the next strategy.

Appendix A: Summary of jurisdictional review

Jurisdiction	Waste avoidance (per capita waste generated)	Recycled / recovered (recovery rate)	Diversion of waste (landfill diversion rate)	Litter / illegal dumping	Wider environment	Economic
Australia						
New South Wales	Reduce waste generation per capita (no specific target mentioned)	MSW – 70% by FY2022 (52% in FY2011) C&I – 70% by FY2022 (57% in FY2011) C&D – 80% FY2022 (75% in FY2011)	Divert 75% by FY2022 (63% in FY2011)	Litter - by FY2017, reduce the number of litter items by 40% compared with FY2012 levels and then continue to reduce litter items to FY2022	Problem wastes: establish/ upgrade 86 drop off facilities by FY2022 for problem wastes	No targets, but commentary on economic measurements (jobs, GDP, cost savings/ efficiencies)
South Australia (released on 2015 for 2015-2020 period)	↓ 5% by 2020	No targets due to limited reliable data available.	Overall: ↓ 35% landfill disposal by 2030 MSW Metro: 70% by 2020 ⁹ C&I: 80% by 2020 C&D: 90% by 2020	No target but has been considered as part of strategy and implement plan	No targets, but provide annual reporting on reduction on greenhouse gas emissions, energy savings and water savings	No targets, but estimates the market value of the recycling sector and jobs through annual surveys
Victoria	No target, but emphasis on the use of resources wisely.	No target, but emphasis on the use of resources wisely.	No target, but emphasis on the use of resources wisely.	No target, however programs in place to work with community groups and LG to avoid waste and reduce litter.	No target, but emphasis on helping Victorians act on climate change.	No target, strategy has a focus on supporting new infrastructure, investment in jobs, technology etc to drive the economy.
Western Australia (released on March 2012)	No target, but provide commentary on per capita recycling and landfill on annual recycling activity reports	Perth Metro MSW: 65% by 2020 C&D: 75% by 2020 C&I: 70% by 2020	No target	No target	No target	No targets, but provide some commentary on market activities on the annual recycling reports

⁹ According to the South Australian Waste Strategy, the MSW target is comprised of 60% kerbside bin diversion target and other MSW waste for a combines 70% diversion target for MSW Metro.

Jurisdiction	Waste avoidance (per capita waste generated)	Recycled / recovered (recovery rate)	Diversion of waste (landfill diversion rate)	Litter / illegal dumping	Wider environment	Economic
Europe						
Scotland	No target	70% C&D waste by 2020 60% from households by 2020 70% recycling by 2025	Max 5% of waste to landfill by 2025 35% of 1995 baseline of Biodegradable Municipal Waste (BMW) to landfill by 2020	No target	No target however environmental objectives of the waste plan include carbon metric mechanisms and opportunity to assist in meeting climate change delivery targets.	No target however circular economy investment fund contributes to Scotland's Economic Strategy.
Wales	Municipal sector waste prevention annual targets of 1.2% of household waste (of 2006/07 baseline), 1.2% for commercial and around 1.4% for industrial waste. Impact of growth not addressed.	Minimum levels of preparing for reuse/recycling/composting (or AD) for municipal waste to be 70% by 2024/25 Commercial waste and industrial waste to achieve 70% recycling rate by 2024/25.	Increase the reuse, recycle and material recovery on non-hazardous C&D waste to a minimum of 90% by weight by 2019/20 Achieve zero waste by 2050	No target	Maximum level of 30% of MSW diversion to WtE	No target - funding to boost recycling and recovery
Finland	No target – indicated that municipal waste per inhabitant has stabilised.	70% of C&D by 2023 55% municipal including biodegradable by 2023 60% biodegradable waste by 2023	No target – municipal waste to landfill predominately replaced with waste recovery.	No target	No target – outlined response of environmental benefit to reaching targets.	No target- focus on job creation, sustainable circular economy and value of materials
USA and Canada						
San Francisco	No target	No target – landfill diversion targets encourage recycling and recovery. Zero waste defined as zero waste to landfill or incineration.	Target of 75% landfill diversion by 2010 (in 2013 landfill diversion was at 80%) Target of zero waste by 2020	No target – Plastic and Litter Reduction Ordinance to eliminate litter and reduce pollution.	No target – outline to conserve valuable resources and reduce environmental impact.	No target – strategy underlined by a cost benefit analysis outlining the true cost of landfill and incineration.

Jurisdiction	Waste avoidance (per capita waste generated)	Recycled / recovered (recovery rate)	Diversion of waste (landfill diversion rate)	Litter / illegal dumping	Wider environment	Economic
Asia and Oceania						
Auckland	Reduce domestic kerbside refuse by 30% (160kg to 110kg per capita per year) by 2018 (current plan extends target to 2021) Reduce domestic kerbside refuse by 20% (110kg to 88kg per capita per year) by 2028	No specific target, however diversion from landfill underpinned by resource recovery.	95% of garden waste by 2010 30% from baseline of 0.8t/capita/year by 2027 Zero waste to LF by 2040	No specific target however economic driver includes reduction of illegal dumping.	No target however driver to decrease plastic pollution within the oceans.	No target, however high level estimates indicating economic benefits of resource recovery and increase in levy costs.
Tokyo	No target	Improve the recycling rate of general waste from 23% (in FY2013) to 37% by FY2030.	Final disposal amount of waste generated in Tokyo reduced by 25% by FY2030 compared to FY2012. Also, Policy Directions covered promotion of resource loss reduction and use of eco materials and furtherance of cyclic use of waste.	No target – however prevent illegal dumping and Tokyo Metropolitan Government(TMG) formed a council named Regional Liaison Council for Prevention of Improper Disposal of Industrial Waste to prevent illegal with other governments dumping of industrial waste.	30% reduction of greenhouse gas emission by FY2030 compared to FY2000 level.	No target – policy directions set up for development of business to contribute to sustainable use of resource can be competitive.

Appendix B: Summary of modelling assumptions

Data Sourcing

- Total tonnages for C&D and C&I disposal and recovery sourced from the Department of Environment and Science (DES) annual *QLD Recycling and Waste in QLD 2017* report.
- Total tonnage of MSW disposed and recovered sourced from the calculation used in the State Budget with green bin waste collection tonnage provided by the 2015-16 Department of Environment and Heritage annual *Recycling and Waste in Queensland Report (2016)*.
- Overall MSW waste composition data determined from waste compositions within the red bin (disposal) and yellow bin (recycling), sourced from an average of 10 regional councils' waste and recycling assessment reports (as provided by DES) across the state¹⁰.
- C&I waste composition data and existing recovery percentages determined from waste type disposed breakdowns, sourced from two regional council audit reports¹¹ and waste types recycled sourced from the DES *Recycling and Waste in QLD 2017* report.
- C&D waste composition data and existing recovery percentages determined from waste type disposed breakdowns, sourced from *Construction and Demolition Waste Status Report 2011* and waste types recycled sourced from DES *Recycling and Waste in QLD 2017* report.
- Population data projections sourced from the medium case of the Queensland Government population projection, 2015 edition; Australian Bureau of Statistics, Australian demographic statistics, March 2015 (Cat no. 3101.0).

Assumptions

- For MSW, all waste reported in the red bin is assumed to be waste disposed to landfill. All waste in the yellow bin and green bin is classified as waste recovered.
- Waste generation growth for MSW, C&I and C&D is assumed to be at 2.5% per year to FY2023 and reduced to 1.75% per year from then until FY2050. The decrease in growth assumes long-term convergence of waste generation growth with the medium series population growth for Queensland.
- Waste reduction per capita applied to MSW stream only. This reduction is applied to the total waste stream, prior to calculation of landfill diversion and recycling quantities. No waste per capita reduction applied to C&I and C&D.
- Recycling rates and targets assume recovery of 100% of the material. Contamination and residual quantities that may go to landfill have not been modelled because of the absence of reliable data.
- Due to varying input data sources and waste stream classification, some waste type composition data does not equal 100%, therefore an adjustment has been applied evenly to each waste type resulting in a consistent 100% breakdown to apply through to forward projection calculations.
- Diversion from landfill can be achieved via recycling and implementation of WtE infrastructure, assumed to be operational until at least 2050. WtE feedstock is assumed to be obtained from the residual tonnages only, and therefore the volume of material is determined once recycling target quantities have been subtracted from the overall tonnage diverted from landfill.
- Baseline year assumed to be FY2018.
- Introduction of the landfill levy in FY2019.
- Implementation of the national target of 100% recyclable, reusable or compostable packaging by FY2025.
- WtE infrastructure is assumed to commence coming online from FY2028.
- WtE is assumed to be mass burn grate incineration for estimation of residual ash quantities as part of sensitivity analysis.
- Landfill ban for organic (compostable material) is assumed to be in place from FY2030.
- Total waste generation has been normalised to exclude the interstate waste tonnages on the basis the landfill levy materially reduces the interstate waste flows.

¹⁰ Including Brisbane City Council (2016), Ipswich City Council (2015), Lockyer Valley Regional Council (2016), Mackay Regional Council (2016), Scenic Rim Regional Council (2016), Sunshine Coast Council (2016), Townsville Regional Council (2015) and Western Downs Regional Council (2016).

¹¹ Lockyer Valley Regional Council (2016) and Sunshine Coast Regional Council (2016)

- Hazardous waste, contaminated soil and asbestos are assumed to be always disposed of to landfill.
- WtE bottom ash, boiler ash and metal can be recycled and could be potentially make up the recycling target percentages, however for the base case modelling these are not included in the targets.

Methodology

1. Forecasting the anticipated waste generation rates for MSW, C&I and C&D through to the year 2050 were all modelled via a similar method. The current total waste generation quantities were obtained based on the data for the State Budget, with a growth rate applied to project annual waste generation tonnages up to the year 2050.
2. The waste type composition and current recycling rates of each waste stream were calculated based on the data sources detailed above. These averaged percentages were multiplied by the total waste generated for each year to provide a percentage breakdown per waste type. This calculation also provided an indication of current recycling rates for each waste type, as a base for target setting projections. Some of the recycling percentages applied to waste types have been adjusted based on sense check, e.g. contamination and hazardous waste are assumed not to be recyclable, and therefore zero per cent is set for the diversion and recycling rate. Comparison against relevant industry reporting for key streams, e.g. tyres¹² and glass was also undertaken where available to confirm calculated production and recycling percentages were comparable.
3. Reduction of waste generation per capita for MSW was determined by applying milestone targets based on timing of key strategy drivers. Total waste generation data per year, using population forecast data, was applied as a reduction factor based on per capita target milestones.
4. Target diversion rates and recycling rates have been defined in four milestones, set for fiscal year FY2025, FY2030, FY2040 and FY2050, with incremental percentages provided in the years between. The projected diversion rates and recycling rates in each fiscal year are set from a baseline of current recycling rates, and consider implementation of key drivers and what can be realistically and sustainably achieved. This process provided targets for each milestone year for each waste stream.
5. Target percentages for recycling and landfill diversion are applied back to waste generation and type breakdown percentages to determine the quantity of waste diverted, recycled and residual for each key waste stream for each financial year.
6. Diversion, recycling and residual rate percentages for each headline waste stream (MSW, C&I and C&D) were summarised to provide an overall target percentage for each milestone year, based on the total tonnage of each headline waste stream relative to the overall waste generation tonnage for the state.
7. The residual waste remaining indicates the quantity available for WtE (assumed to be mass burn grate incineration) within that waste stream.
8. The main outputs from a WtE facility (assuming mass burn grate incineration) include the bottom ash, which can contain recoverable metals, boiler ash and air pollution control residue (APCR). As a sensitivity check the target recycling and diversion rates were recalculated under the assumption that bottom ash and boiler ash, including residual metals, would be recovered from the WtE process and recycled. The WtE output of bottom ash and boiler ash is calculated by applying an output percentage rate of 20% (determined through industry experience) of the incoming waste input. The potential quantity of metal captured was calculated by a similar method, by applying an output rate of 80% of the input quantity of metal diverted through WtE infrastructure. This input metal quantity was based on the residual metal quantities are diverted from landfill in MSW, C&I and C&D but not recovered for recycling.
9. Should the waste strategy wish to include WtE outputs in the calculation of diversion and recycling targets, results from the above process indicate that this would impact targets by up to 2%.
10. The Air Pollution Control residue (APCr) from WtE is not recyclable, and it is calculated by applying the assumed percentage (ie, 3%) of the incoming waste to the facility. Should the waste strategy include WtE products within the target percentages, the APCr tonnage would marginally impact landfill diversion targets.

¹² Australian Government Department of the Environment (2014) Factsheet – Product stewardship for end-of-life tyres

Appendix C: Forecast recovery by waste stream

- Overall the forecast recovery rates assume an operating environment of continuous improvement, investment (both industry and government) and a proactive approach to innovation in all elements of waste management and recovery. This approach will be required to meet the Queensland Government’s vision for the State to become a national leader in waste reduction and material recovery. The following actions are assumed to occur and have an impact on all waste streams:
 - Introduction of landfill levy in March 2019 will provide the economic signal to the market (not households, who will have the levy amount rebated) for alternative options to landfill.
 - Rollout of education/training and funding programs.
 - Increase in consumer awareness through advertising.
 - Support for the development of end markets.
 - Promotion of the use of recycled product in procurement and consideration of the future waste being produced.
 - Improved processes around planning and requirements for infrastructure.
 - Harmonisation strategies for waste collection and recycling.
 - Progressive approach to landfill bans (eg, organics).
 - Increase in product stewardship programs.
 - Introduction of the container refund scheme November 2018
 - WtE facilities forecast to come online from FY2028, resulting in higher recovery for residual wastes (ie, after reduction, reuse and recycling options).
 - Annual increases in landfill levy rate to further provide economic signals for higher recovery, moving up the waste hierarchy

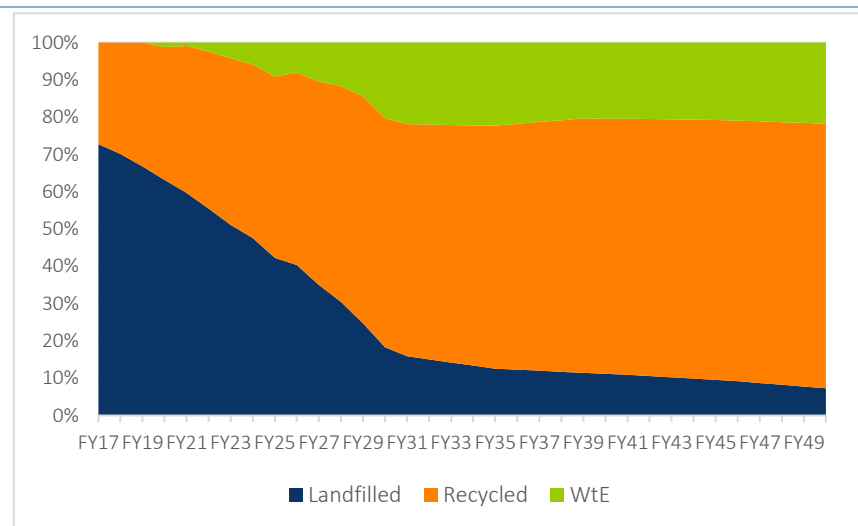
Municipal Solid Waste

Figure 3 provides a summary of the forecasted split of landfill, recycling and thermal WtE¹³ rates for MSW for the period FY2017 to FY2050. Key observations are:

- The amount of waste being disposed to landfill is forecast to decrease from around 70 per cent to 7 per cent over the forecast period

- In addition, recycling rates are forecast to increase to 71 per cent by 2050 due to:
 - Introduction of the container refund scheme November 2018
 - APCO-led packaging changes in place by FY2025
 - Landfill ban on organics by FY2030 with introduction of food organics/garden organics collection assumed to occur in earlier years
 - As a response to levy and landfill organics ban, forecast incremental increase in diversion of food and garden organics waste from the onset.

FIGURE 3: FORECASTED MSW RECOVERY (%) TO 2050



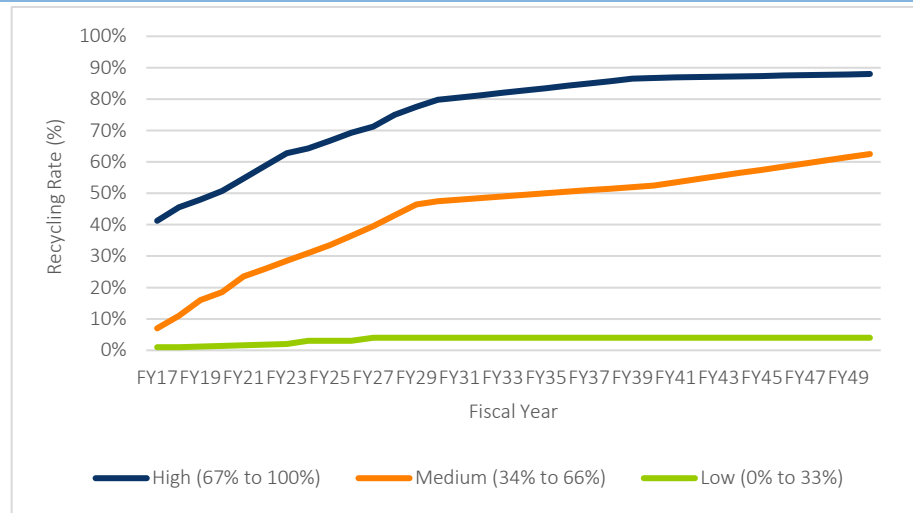
Arup modelling, figures normalised to remove interstate waste

MSW	Current	2025	2030	2040	2050
Landfilled	69%	42%	19%	10%	7%
Recycled (%)	31%	49%	61%	69%	71%
WtE (%)	0%	9%	20%	21%	22%

¹³ For clarity, anaerobic digestion is classified as a form of recycling for the purposes of this report.

Error! Not a valid bookmark self-reference. provides a summary of the forecasted recycling rates for each of the waste types summarised into categories (high, medium and low recycling bands) within MSW for the period FY2017 to FY2050.

FIGURE 4: FORECASTED MSW RECYCLING RATES (%) TO FY2050

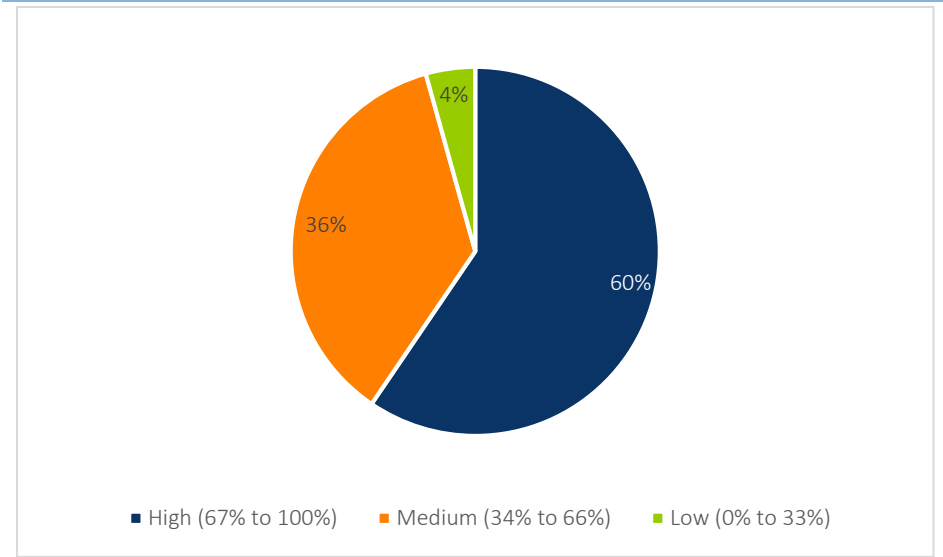


Arup modelling, figures normalised to remove interstate waste

Recycling category	Recycling rate range (by FY2050)	Waste types included
High	67% to 100%	Garden Organics, Paper and Cardboard, Metals and Glass
Medium	34% to 66%	Food Organics and Plastics
Low	0% to 33%	Other organics and timber, masonry materials, glass fines, contamination

Figure 5 provides a summary of the composition of the total waste generated in FY2050 split by the recycling categories (high, medium and low).

FIGURE 5: MSW RECYCLING SPLIT (MEASURED BY TOTAL WASTE GENERATED AT FY50)

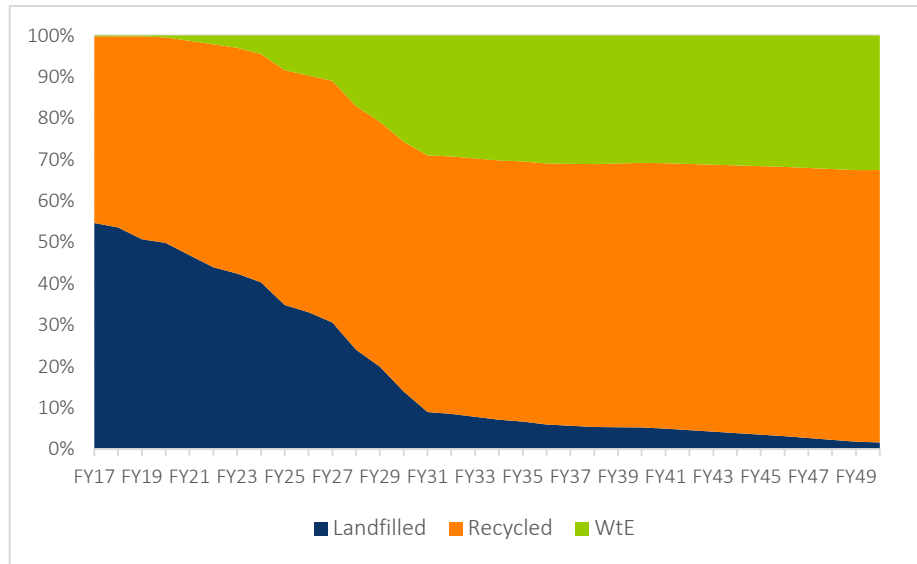


Arup modelling, figures normalised to remove interstate waste

Commercial and Industrial

Figure 6 provides a summary of the forecasted split of landfill, recycling and WtE rates for C&I for the period FY2017 to FY2050.

FIGURE 6: FORECASTED C&I RECOVERY (%) TO FY2050



Arup modelling, figures normalised to remove interstate waste

C&I	Current	2025	2030	2040	2050
Landfilled	52%	35%	14%	5%	2%
Recycled (%)	48%	57%	60%	64%	66%
WtE (%)	0%	8%	26%	31%	32%

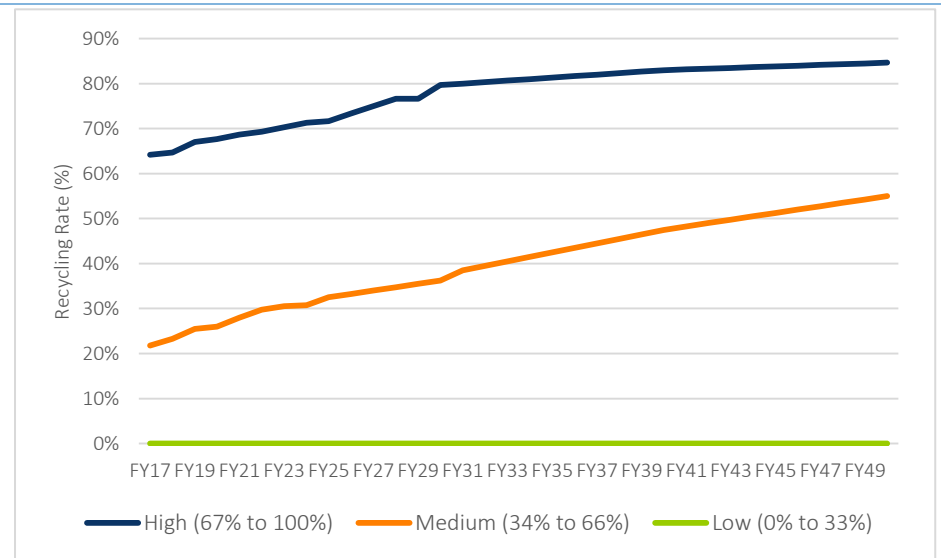
Key observations are:

- The amount of waste being disposed to landfill is forecast to decrease from 52 per cent to 2 per cent over the forecast period.

- In addition, recycling rates are forecast to increase to 66 per cent by 2050 due to:
 - Introduction of the container refund scheme November 2018
 - Recyclable packaging scheme introduced FY2025
 - Landfill ban on organics by FY2030 with introduction of commercial food organics/garden organics collection assumed to occur in earlier years
 - As a response to levy and landfill organics ban, forecast incremental increase in diversion of food and garden organics waste from the onset
 - Anaerobic digester plants forecast to come on line resulting in higher recycling rate
- In comparison to MSW, the total recycling and recovery rate (eg, sum of recycling and WtE) is higher and can be achieved at a faster rate. This is because the C&I waste type and composition lends to relatively easier and more commercial recycling and recovery options.

Figure 7 provides a summary of the forecasted recycling rates for each of the waste types summarised into categories (high, medium and low recycling bands) within C&I for the period FY2017 to FY2050.

FIGURE 7: FORECASTED C&I RECYCLING RATES (%) TO FY2050

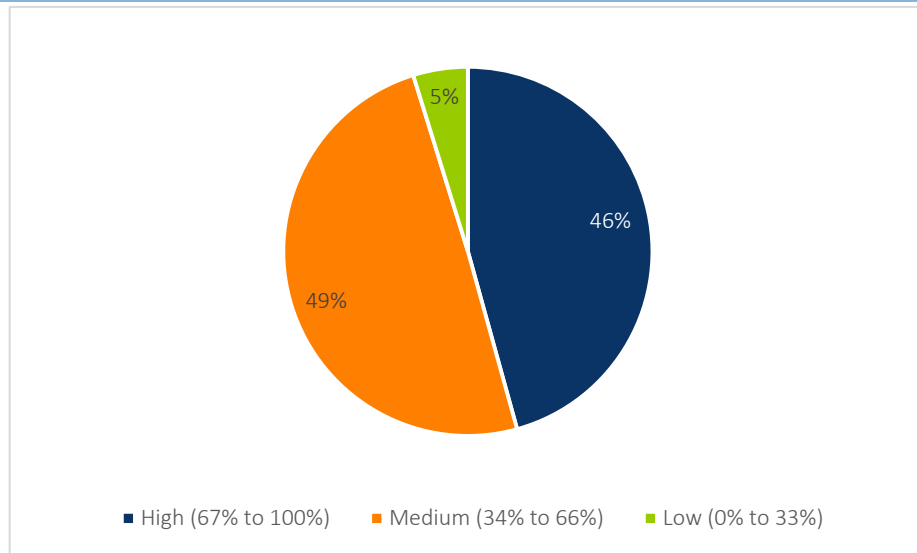


Arup modelling, figures normalised to remove interstate waste

Recycling category	Recycling rate range (by FY2050)	Waste types included
High	67% to 100%	Paper and Cardboard, Metals and Glass
Medium	34% to 66%	Other Organics and Timber, Organics Compostable, Plastics and Tyres
Low	0% to 33%	Masonry, Hazardous, Glass Fines

Figure 8 provides a summary of the composition of the total waste generated in FY2050 split by the recycling categories (high, medium and low).

FIGURE 8: C&I RECYCLING SPLIT (MEASURED BY TOTAL WASTE GENERATED AT FY50)

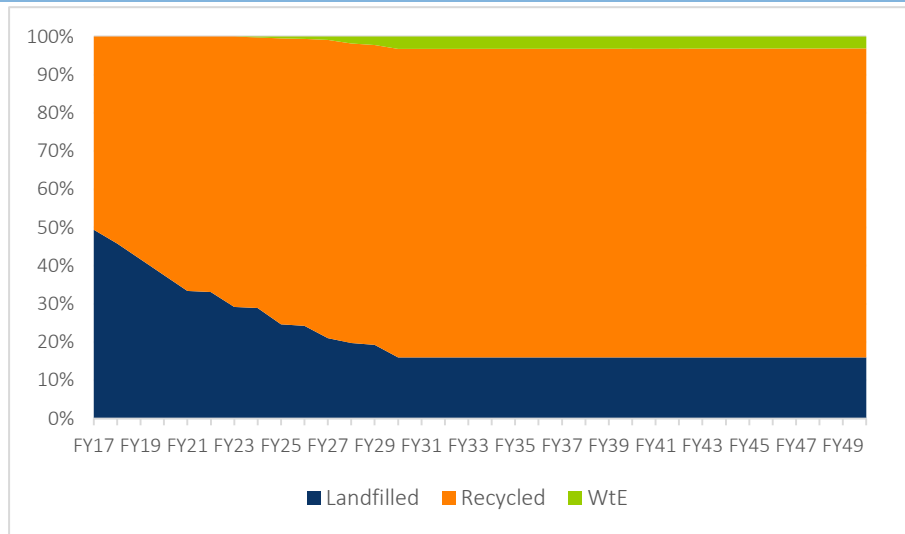


Arup modelling, figures normalised to remove interstate waste

Construction and Demolition

Figure 9 provides a summary of the forecasted split of landfill, recycling and WtE rates for C&D for the period FY2017 to FY2050.

FIGURE 9: FORECASTED C&D RECOVERY (%) TO FY2050



Arup modelling, figures normalised to remove interstate waste

C&D	Current	2025	2030	2040	2050
Landfilled	49%	25%	16%	16%	16%
Recycled (%)	51%	75%	81%	81%	81%
WtE (%)	0%	0%	3%	3%	3%

Key observations are:

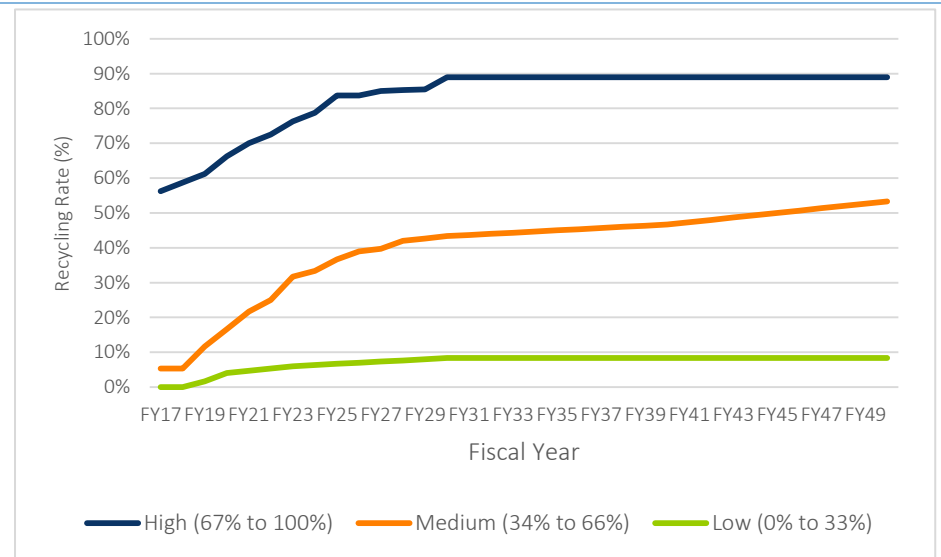
- Experience from other states suggests that the C&D sector is likely to respond quickly to the landfill levy by lifting recovery performance. As C&D waste is

generated in large volumes and is dense / heavy (predominantly concrete, brick, soils) it is particularly sensitive to weight-based measures such as the landfill levy.

- The amount of waste being disposed to landfill is forecast to decrease 49 to 16 per cent
- Recycling rates are forecast to increase to 81 per cent by 2050.
- WtE facilities are forecast to come online by FY2028, however C&D is expected to provide minimal feedstock for WtE, as it has low calorific value and it is expected the majority can be recycled.
- In comparison to MSW and C&I, landfill diversion for C&D is capped because of the significant volume of waste types for which there is no viable alternative, namely contaminated soil and asbestos. These two items currently represent 14 per cent of C&D waste generated, and 6 per cent of all waste.

Figure 10 provides a summary of the forecasted recycling rates for each of the waste types summarised into categories (high, medium and low recycling bands) within C&D for the period FY2017 to FY2050.

FIGURE 10: FORECASTED C&D RECYCLING RATES (%) TO FY2050

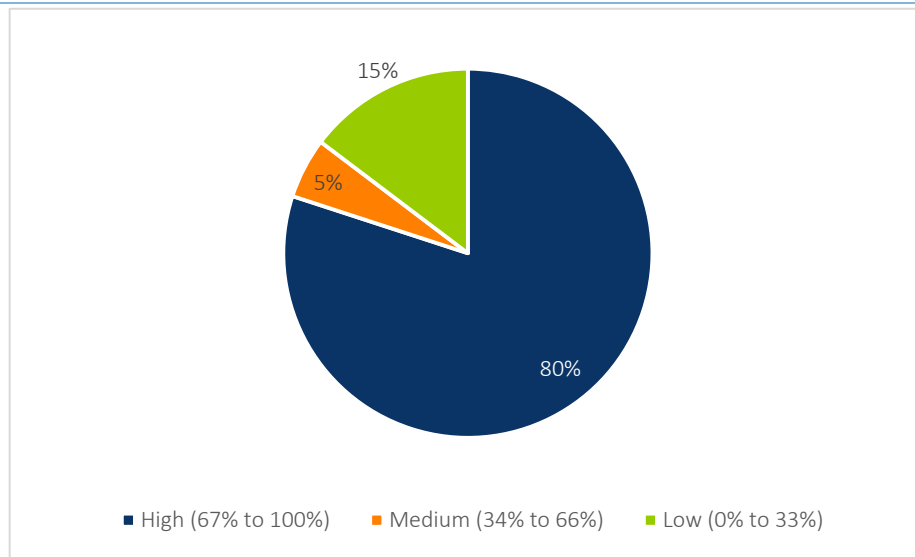


Arup modelling, figures normalised to remove interstate waste

Recycling category	Recycling rate range (by FY2050)	Waste types included
High	67% to 100%	Masonry (asphalt, bricks, concrete), Metals, Paper and Cardboard and Glass
Medium	34% to 66%	Organics and Plastics, Tyres and Rubber
Low	0% to 33%	Leather and Textiles, Contaminated Soil and Asbestos

Figure 11 provides a summary of the composition of the total waste generated in FY2050 split by the recycling categories (high, medium and low).

FIGURE 11: C&D RECYCLING SPLIT (MEASURED BY TOTAL WASTE GENERATED AT FY50)

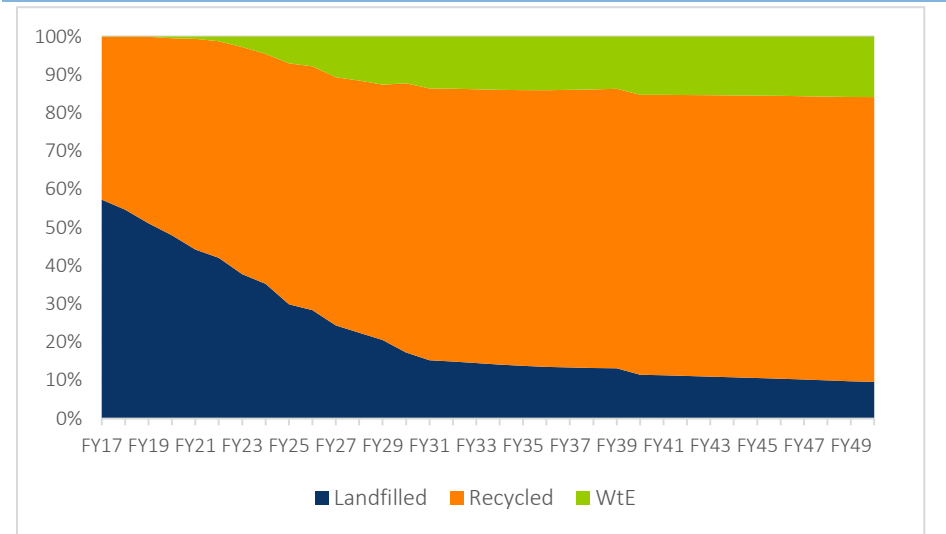


Arup modelling, figures normalised to remove interstate waste

Whole of state view

Figure 12 provides a summary of the forecasted split of landfill, recycling and WtE rates for the combined waste stream (MSW, C&I & C&D) for the period FY2017 to FY2050.

FIGURE 12 QUEENSLAND FORECASTED RECOVERY (%) TO FY2050



Arup modelling, figures normalised to remove interstate waste