Technical report E

Waste flow analysis for Greater Sydney

WASTE FLOW ANALYSIS FOR GREATER SYDNEY

Current and Future Waste Forecasts

18 September 2020

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CLEANAWAY WASTE MANAGEMENT AND MACQUARIE CAPITAL

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Current and Future Waste Forecasts

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Report No	10035923-08
Date	18/09/2020

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REVISIONS

Revision	Date	Description	Prepared by	Approved by
01	22/10/19	Draft for review	CW, RC	DS
02	08/04/2020	Revisions	CW	RC
03	27/04/2020	Incorporation of Sponsor comments	CW	RC
04	13/05/2020	Revisions	CW	RC
05	19/05/2020	Revisions	CW	RC
06	22/05/2020	Revisions	CW	RC
07	05/06/2020	Incorporation of Appendix B following on from release of new NSW EPA audits	CW	RC
08	18/09/2020	Incorporation of Appendix C	CW	RC

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EXECUTIVE SUMMARY

Cleanaway Waste Management (Cleanaway) and Macquarie Capital (Australia) Limited (Macquarie) (together the Sponsors) propose to develop a large-scale energy from waste facility in Western Sydney (the Project). To support development of the business case and waste supply strategy, they require analysis of the scale and availability of suitable feedstock within metropolitan Sydney over the indicative life of the Project.

Independent analysis by Arcadis adopts a base year for the investigation of 2017-18, with waste flows modelled forward for 30 years. Future feedstock modelling is considered within the context of the current NSW Energy from Waste Policy Statement (EfW Policy Statement), which seeks to ensure all higher order resource recovery opportunities are exhausted prior to conversion to energy. This is implemented through the Resource Recovery Criteria (RRC) within the EfW Policy, which incentivise source separation and pre-sorting of feedstock before sending to EfW.

The majority of Councils in the Sydney basin operate a 3-bin system including garden organics. Under the RRC limits, only 40% of the mixed waste stream can go to EfW. The conceptual logic of the limit, although not specified by the EPA, is that 60% of the mixed waste stream under this scenario could be recovered, with the most recovery likely components being the (average) 45% food waste and 15% recyclable or potentially recyclable. However this does not account for the actual resource recovery rates from mixed waste in best practice facilities, which is significantly less.

Analysis indicates the RRC limits on the proportion of feedstock eligible for EfW under different waste service configurations result in a lost opportunity for recovery. A review of mechanical sorting systems has established that best case recovery is approximately 5%, which leaves the balance of the non-EfW eligible feedstock for disposal to landfill as there are no alternative recovery opportunities for mixed waste streams.

Accordingly, where Councils do not operate a 3-bin FOGO system where 100% of the waste is eligible for thermal treatment, an exemption to the RRC limits is supportable under the ‘Note 1’ rule in the RRC framework. The Note 1 rule provides discretion to the NSW Environment Protection Authority (EPA) to amend or waive the limits for best practice facilities that are processing mixed municipal or commercial and industrial waste, including converting the biomass component into energy recovery feedstock rather than a compost for application to land.

The Project qualifies for the ‘Note 1’ rule because:

- All mixed waste streams subject to eligibility limits on the proportion to be combusted for energy recovery will be pre-sorted in a facility with best available mechanical sorting technologies
- The residual biomass component from mixed waste processing will be unsuitable for land application due to the regulatory reforms in 2018 on mixed waste organics outputs (MWOO), and will go to energy recovery.

The Waste Flow Analysis indicates there is sufficient feedstock in the Sydney basin to supply the Project, with or without the constraints of the RRC. However, waiving the RRC thresholds under Note 1 would significantly increase feedstock availability and facilitate better outcomes than landfilling residuals after all other resource recovery outcomes have been exhausted. This would provide metropolitan Councils with the opportunity to increase their resource recovery rates in the short term, and complement any longer-term uptake of Food and Garden Organics (FOGO) collection services if they are mandated, as discussed in the Issues Paper to inform the NSW 20-Year Waste Strategy currently under development.

Arcadis modelling incorporates the following scenarios:

- Note 1 exemption to the RRC and maximising recovery through best practice pre-sorting processes
- Councils continue business as usual bin configurations until contract expiry, with 50% of Councils adopting FOGO at the first renewal and the remaining Councils on the second contract renewal
- Progressively increasing at-source and pre-sorting capacity of C&I waste.

It is estimated that in 2020, under the current policy settings and related Municipal Solid Waste (MSW) bin configurations within the catchment and a conservative estimate of the availability of commercial and industrial (C&I) waste, metropolitan Sydney will generate approximately 900,000 tonnes of the eligible target wastes, once the percentage limits on different feedstocks under the EfW Policy have been applied (Section 2.3.3). Approximately 600,000 tonnes of that volume is MSW mixed waste available for long-term contracting.

Without the RRC constraints, approximately 1.4 million tonnes MSW and 1.2 million tonnes C&I waste could be considered eligible for energy recovery in the Sydney Basin in 2020. By 2030, this increases to approximately 2.9 million tonnes, of which 1.6 million tonnes is MSW and 1.3 million tonnes is C&I. Under the progressive FOGO adoption scenario and progressive at source separation scenario, approximately 2.2 million tonnes of combustion-ready MSW and C&I waste will be generated by 2030 in the Sydney basin. Of this, 1 million tonnes is MSW mixed waste. The assumptions and impacts are detailed in Section 4.

The waste flow model (provided under separate cover) encompasses the entire Greater Sydney Metropolitan Area, which is inclusive of the Hunter, Central Coast and South Coast regions, as well as the core Sydney basin catchment. This report, however, is primarily focused on the Sydney basin catchment based on proximity to the Project site, density of waste generation and rapidly emerging constraints on waste processing and disposal capacity, particularly for putrescible waste.

The MSW streams included in the model are mixed kerbside waste (red lid bins), bulky kerbside waste and relatively minor volumes of drop-off waste delivered to facilities by householders. The C&I waste disposed to landfill is largely a mixed putrescible stream (also described as ‘wet’), along with smaller quantities of non-putrescible (‘dry’) waste with limited value on the recycling market but high potential for energy recovery. Based on industry advice, it is estimated that approximately 60% of the C&I waste to landfill is putrescible and 40% is non-putrescible.

This report defines the modelling context, including all key data points, sources and assumptions and the alternative scenarios built into the model. It distils the results of the base scenario into a concise report.

While there are strong fundamental drivers to support the Project, including population and economic growth and the dynamics of waste infrastructure in the Sydney basin, there are also some key variables and uncertainties that need to be considered in any growth model. The key variables are:

- Varied growth rates in per capita and per employee waste generation
- Reforms to waste policy at the state and national level, including around co-collection of FOGO and increasing interest in the circular economy
- Specific future amendments to the NSW Energy from Waste Policy Statement, including the feedstock limits imposed by the policy’s Resource Recovery Criteria.

Some of these represent step-changes in the context, such as the mandating of FOGO systems across the catchment area at the first contract renewal opportunity, which can be tested in the model as alternative scenarios. Others are more evolutionary changes, such as different capture rates of food organics within a FOGO system, which has been presented as a sensitivity.

It shows the factors with the most material impact on waste generation and availability over time are:

- The change in unit residual waste generated (per person or per employee) as influenced by consumption and production patterns respectively, which compound over time to reduce overall waste generation
- Policies that influence source separation, notably the EfW Policy Statement and potential future FOGO policies
- The efficiency of waste generators in sorting their waste, notably the food capture efficiencies by householders that impacts the volume of waste in the remaining residual kerbside waste stream.

Modelling according to the base scenario produced the following forecasts of residual waste generation within the Sydney basin (Figure 1). These future waste estimates are based on current landfill disposal estimates.

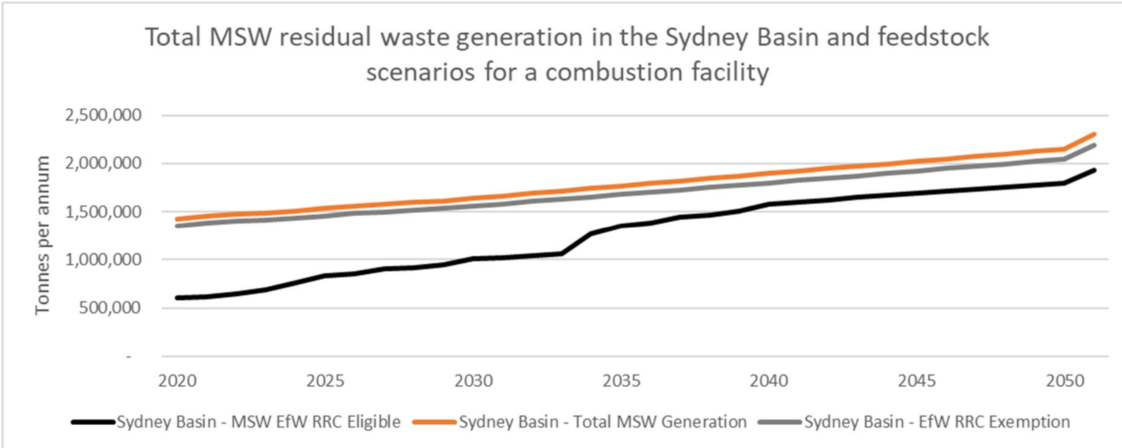

Figure 1: Estimations of future MSW that could be eligible for EfW under the scenarios

Figure 2 shows the quantity of residual C&I waste that could be eligible for EfW. This waste currently goes to landfill and is mostly putrescible.

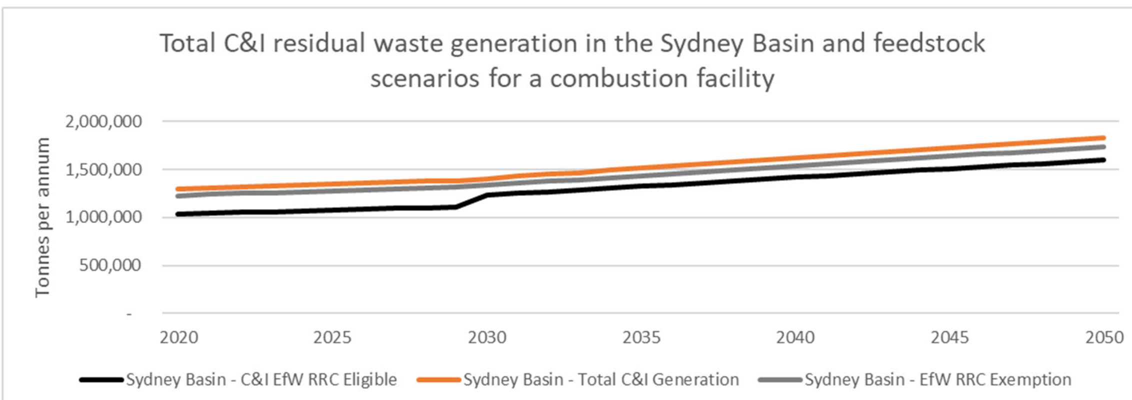

Figure 2: Estimations of future C&I waste that could be eligible for EfW under the scenarios

Secure council tonnages are required to underpin long-term investment in the Project. Arcadis has presented a snapshot of processing and disposal contracts across Sydney basin councils to further address availability of tonnes over time (Figure 3). It shows a cluster of contracts expire in the mid-2020s and become potential feedstock for the Project.

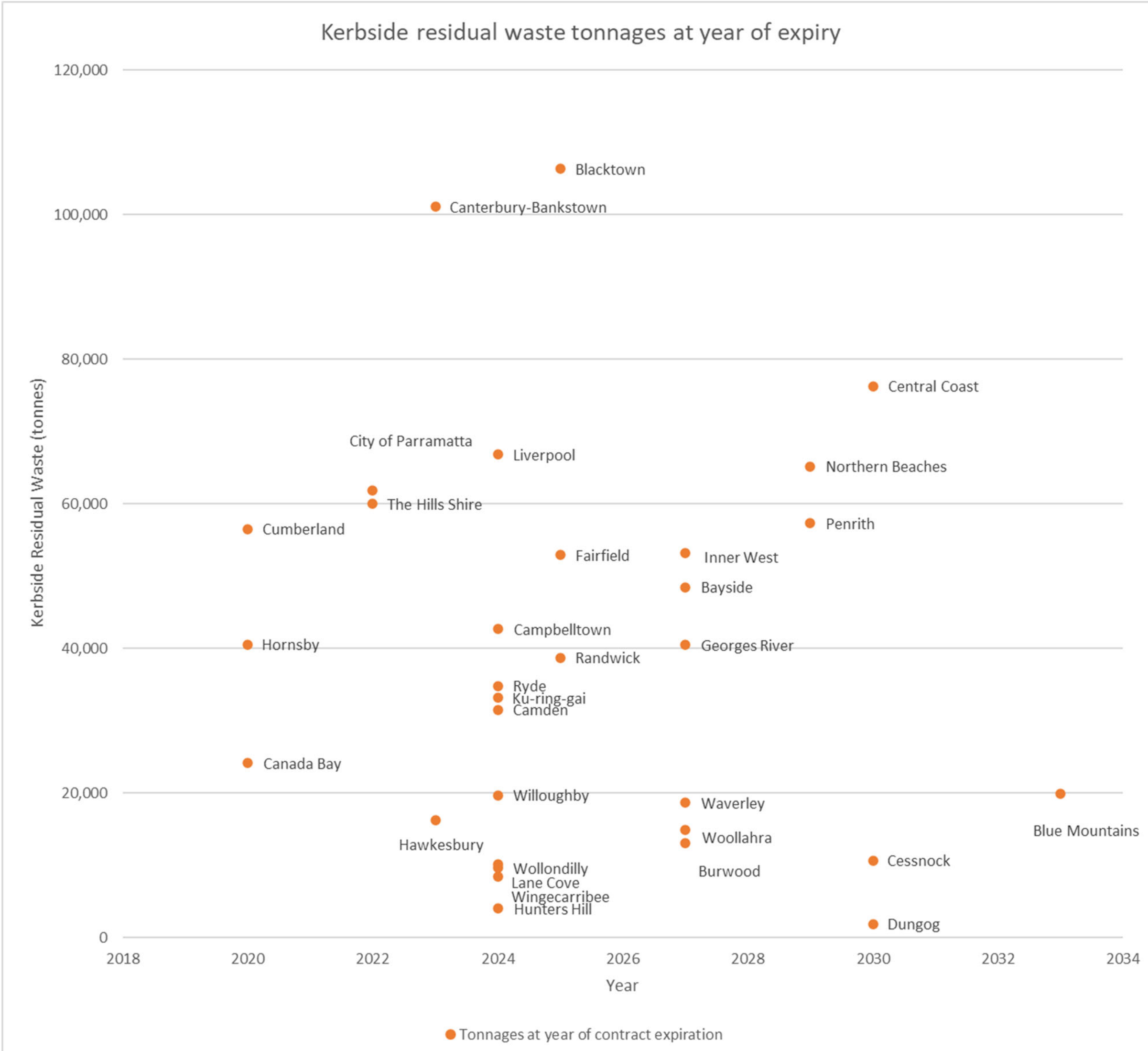

Figure 3: Available council residual MSW tonnages (modelled) at the time of processing/disposal contract expiry.

1 INTRODUCTION

Cleanaway and Macquarie Capital (the Sponsors) are seeking an independent estimation of current and future quantities of target waste streams in Greater Sydney for a proposed Energy from Waste (EfW) facility. Arcadis has been engaged to develop estimations of waste supply suitable for energy recovery to inform the early stages of business planning and financial modelling for the facility, as well as support the development approvals process.

As with all Australian states and territories, NSW waste data is not comprehensive. Regulatory authorities do not release information with sufficient frequency or level of granularity, while the waste industry has limited appetite to participate in data studies. However, on an aggregated basis the data is adequate for forecasting purposes, with full disclosure of data sources and limitations to allow and assessment of data quality.

Forecasts are also impacted by the level of confidence in future trends and drivers, including waste policy, environmental regulation, social and economic trends, waste industry issues and competition. The most notable uncertainty impacting this analysis is the current development of a 20-Year Waste Strategy for NSW by the Environment Protection Authority (EPA), which may influence waste generation rates, preference pathways, amend the *Energy from Waste Policy Statement* and seek to build end markets.

Given the potential impacts these changes could have on future tonnages available to an EfW facility, scenarios and sensitivity analysis becomes particularly relevant. The ability to adjust key assumptions and switch to alternative policy scenarios has been built into the Greater Sydney waste model to provide forecasts in a range of contexts.

This document aims to:

- Conceptualise the current waste system for residual municipal solid waste (comprising mixed waste and bulky clean-up waste) and commercial and industrial waste (aggregating wet and dry streams) within Greater Sydney, with particular focus on the Sydney basin
- Estimate current generation of the target wastes and define current destinations and contract expiry for MSW
- Forecast future waste generation over 30 years, with results analysed under different scenarios and factors that might influence future waste flows
- Assess availability by defining contract scale and expiry for local government wastes
- Document the approach taken to forecasting, including data sources, limitations and assumptions.

Discussion of the composition of different streams has also been provided to support analysis of their indicative moisture content and calorific value, but this draws on industry references for Sydney waste rather than specific sampling undertaken for this project. The Sponsors should continue to undertake sampling to ensure rigorous and contemporary analysis of potential feedstocks.

Limitations and Reliance

This report represents Arcadis's independent view of current and future waste volumes and market issues in Greater Sydney, based on the data that was available to us at the time. The data sources, assumptions and scenarios have been discussed with the Sponsors but have been sourced and modelled by Arcadis. The sources of information used by Arcadis are outlined in this document and in the accompanying Excel spreadsheet. Arcadis has made no independent verification of this information beyond the agreed scope of works and Arcadis assumes no responsibility for any inaccuracies or omissions.

The findings presented in this report are limited to the information that was publicly available at the time of writing this report or available to Arcadis through our work within the industry. Arcadis cannot confirm the reliability, accuracy, completeness or adequacy of the information provided to it during the compilation of this report. It is assumed that information is reliable, accurate, complete and adequate.

Arcadis has produced this report for use by the Sponsors to develop a waste supply strategy and business plan. It is understood that it will also form the basis for future stages of the project, with further refinement, including supporting the due diligence of potential investors and debt financiers. Arcadis will provide reliance on the report to selected third parties once their involvement in the project is confirmed, subject to all of the data quality caveats noted within this report and subject to specific reliance conditions which will be set out in our standard vendor due diligence reliance letter, which can be separately supplied for review.

The report has been prepared in accordance with the reasonable care and diligence of the consulting profession for a document of this nature, within the time frame and information available. This document is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this document.

2 ASSESSMENT CONTEXT

2.1 Defining the waste catchment

The waste flow modelling has drawn on a broad geographical definition of the Sydney Greater Metropolitan Area that extends from Shoalhaven Council in the south to Newcastle in the north. However, the primary interest and focus of this report is the Sydney basin, based on proximity to the Project site and the high concentration and scale of waste generation.

The Sydney basin stretches from Campbelltown in the south to Hornsby and Hawkesbury in the north, and from the coast to the Blue Mountains in the west. A detailed breakdown of the key Greater Sydney districts and sub-regions is shown in Figure 4.

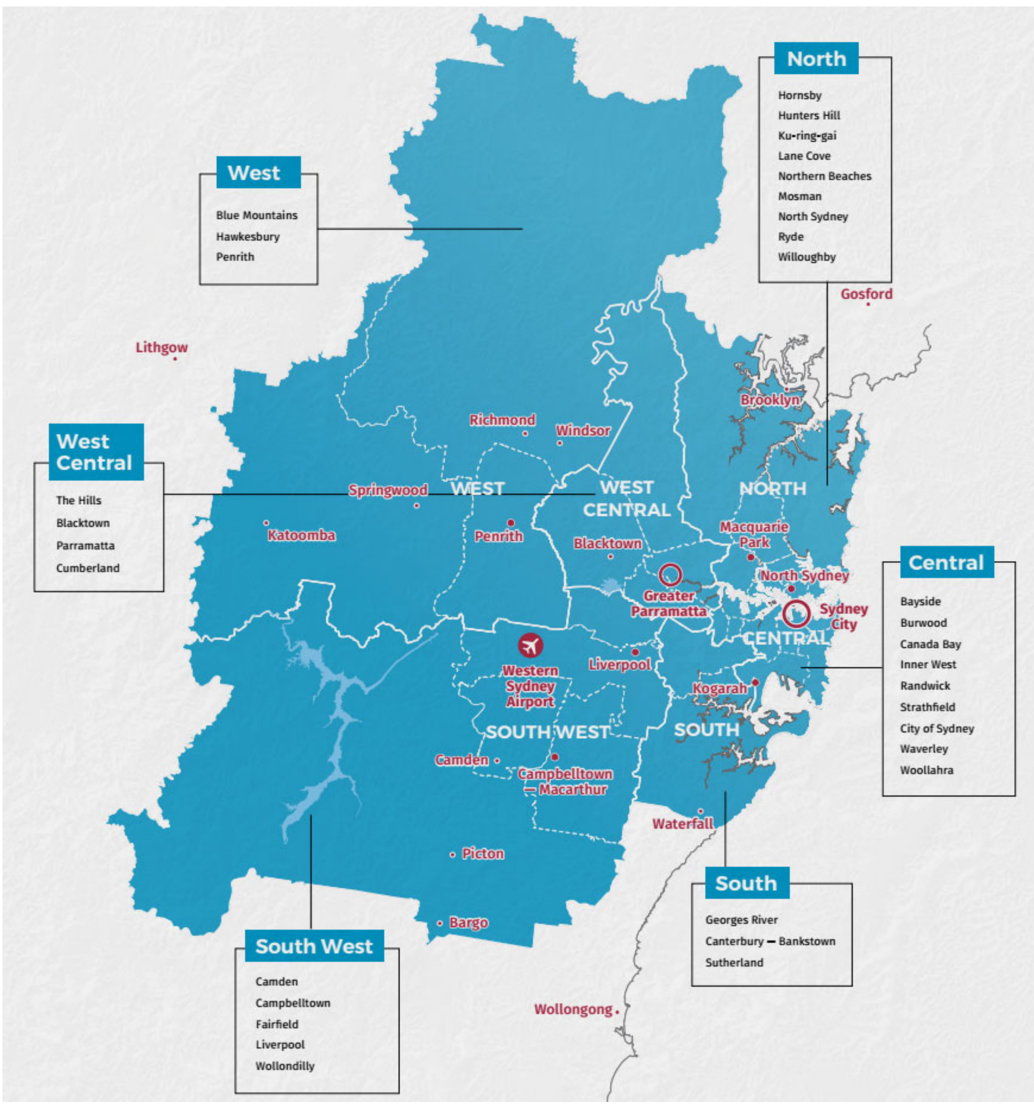

Figure 4: The Sydney basin regions and urban centres[1]

[1] Greater Sydney Draft District Plan, Map Atlas, Greater Sydney Commission (2016)

The Sydney basin comprises 60% of the state's population, with a total of 4,908,639 people across approximately 1.9 million private dwellings[2]. In 2014-15, the metropolitan basin accounted for 54% of the total MSW kerbside recyclables collected and 57% of total MSW kerbside residuals collected[3].

Within metropolitan Sydney there are significant variations in projected population growth between districts (Table 1), with the fastest growth in the West Central and South West regions. Note that these districts do not align with the boundaries of the Regional Organisations of Councils, which have been defined in the regional mapping (Section 4) due to the council-derivation of MSW data, but they do provide a broad correlation and high level indication of growth expectations.

Table 1: Population projections across metropolitan Sydney[4]

District	2020 population	2030 population (pa growth)	2040 population (pa growth)	2050 population (pa growth)	Broad ROC alignment
North	899,284	1,018,731 (1.25%)	1,129,700 (1.04%)	1,241,837 (0.95%)	SHOROC and Northern Sydney ROC
South	2,082,761	2,343,817 (1.19%)	2,650,090 (1.24%)	3,005,036 (1.26%)	Southern Sydney ROC
West	1,174,454	1,320,861 (1.18%)	1,485,667 (1.18%)	1,678,063 (1.23%)	Western Sydney ROC
South Waste	399,134	469,894 (1.65%)	545,381 (1.5%)	611,284 (1.15%)	Macarthur Councils

2.2 Defining the waste system

The waste infrastructure servicing the Sydney basin will help define feedstock availability for the Project, including current pathways, present and emerging constraints and key parties that manage the target waste streams.

The relevant infrastructure encompasses transfer stations (including road-rail intermodal), processing facilities for mixed MSW and for dry wastes, FOGO processing facilities and putrescible and non-putrescible landfill.

Table 2 provides market information on the key facilities servicing Sydney in each category, along with licenced annual capacity, owner and estimated closure timeframe for landfills. Non-putrescible landfills commonly target construction and demolition (C&D) waste given the large volume of material and relatively limited proportion of dry wastes within the C&I waste stream (Section 4.3.3), however, they have been listed where they are understood to actively include dry C&I waste as part of their waste mix.

Table 2: Key waste processing and disposal facilities servicing metropolitan Sydney

Facility type	Facility name (technology)	Input rate limits (tpa)	Estimated closure	Owner
Processing facilities - Mixed MSW	Eastern Creek UR-3R Facility (MBT)	220,000	-	Global Renewables, (contracted to Suez)
	Kemps Creek SAWT Facility (MBT)	134,000	-	Suez

[2] TfNSW released Population and Dwelling dataset
[3] NSW EPA, NSW Local Government Waste and Resource Recovery Data Report 2014-15
[4] TfNSW released Population and Dwelling dataset

Facility type	Facility name (technology)	Input rate limits (tpa)	Estimated closure	Owner
	Woodlawn MBT (MBT)	240,000[5]	-	Veolia
Processing facilities - Dry C&I and other wastes	Wetherill Park PEF Facility (refuse derived fuel production)	250,000	-	ResourceCo-Cleanaway
	Doyle Brothers Facility (Dirty MRF, plus RDF production)	29,000	-	Doyle Brothers
	WasteFree, Seven Hills (Dirty MRF)	15,000	-	WasteFree
Processing facilities - FOGO / FO	Blayney via Badgerys Creek (open windrow composting)	50,000	-	ANL
	Kembla Grange (in-vessel composting)	40,000	-	SoilCo
	Kemps Creek SAWT	Unknown	-	Suez
	EarthPower	50,000		Veolia and Cleanaway
Landfill - Putrescible	Lucas Heights	850,000	2033	Suez
	Woodlawn (ex-Sydney)	900,000	2046	Veolia
Landfill - Non-putrescible	Eastern Creek	700,000	2032	Bingo Industries
	Elizabeth Drive	No limit	2030	Suez
	Glenfield Waste	100,000	Unknown	Glenfield Waste Services
	Marsden Park	360,000	2024	Blacktown Waste Services
	Patons Lane	205,000	2040	Bingo Industries
	Sydney Recycling Park	250,000m^3	2043	Wanless Waste Management

The Sydney waste market is notable for the significant constraints on landfill airspace, particularly putrescible landfill. Table 2 indicates there is 1.75 million tonnes per annum of dedicated Sydney disposal capacity for putrescible waste.

While there are additional landfills in the broader region capable of receiving putrescible waste from Sydney, regional landfills in NSW are owned by councils (other than Suez's non-putrescible Newline Landfill at Raymond Terrace), and typically managed as long-term community assets rather than commercial operations. The only facility understood to be pricing to attract more waste is the Summerhill Landfill in Newcastle, which has an annual capacity of 220,000 tonnes and more than 50

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[5] Currently licensed for 144,000 tonnes per annum with an approved expansion for an additional 96,000 tonnes.

years' remaining life. Otherwise, regional landfills do not represent a mainstream option for Sydney's mixed waste.

The pressure on landfill airspace and annual capacity has been exacerbated by the undermining of the business case for the three MBT facilities servicing Sydney by a regulatory change in 2018 that has effectively closed the end markets for the organic outputs. This amendment has impacted 634,000 tonnes per annum of mixed waste processing capacity in the market (Section 2.3.6).

It is understood that the shortfall in processing / disposal capacity is being temporarily addressed by requiring the MBT operators to continue processing the waste to reduce its volume (with a short-term waiver on the landfill levy) and approving temporary increases in landfill acceptances at Lucas Heights and Woodlawn. However, these measures are a stop-gap only.

Advanced organics processing infrastructure is tangentially relevant to the feedstock analysis as it underpins the management pathway for FOGO, which captures the organic fraction in mixed waste. There is one dedicated FOGO facility in Sydney, at Suez's Kemps Creek SAWT facility, and a number of facilities located outside the urban area (Illawarra, Central West NSW), linked with dedicated metropolitan transfer operations.

There is growing interest in the Sydney market around processing dry waste, including C&I and council bulky waste, for conversion into a refused derived fuel (RDF). While there are only three existing recycling facilities for mixed C&I waste (Table 2), known plans for new facilities include:

- An upgrade to the existing Veolia facility at Camellia to process 150,000 tonnes a year. The proponent was awarded funding through Waste Less Recycle More in 2013 but there is significant uncertainty around its future given limited progress since then.[6]
- A new Bingo Industries facility at Eastern Creek to process about 126,000 tonnes a year, with claimed scope to increase to 455,000 tonnes a year over time[7].

Additional RDF production facilities are also likely to come on-stream to support two planned combustion facilities, being the Mt Piper Power Station project (Re-Group) and the Botany Cogeneration Plant at the Orora paper mill (Suez). The planned Orora facility will source RDF from a purpose-built RDF production plant proposed to be constructed at Suez's Chullora site processing non-putrescible wastes (as well as paper mill residues for 25% of combustion inputs). Re-Group is also likely to preference non-putrescible wastes due to market accessibility and waste characteristics. These streams are not the primary intended feedstock for the Project.

2.3 Policy context

In the following section we discuss the relevant policy and regulatory settings that have the potential to influence the generation or availability of the target wastes. The primary focus is the NSW context as the state and territory governments have the key responsibility for regulating waste management activities and setting strategic direction. A number of developments on the national agenda may also impact future industry dynamics.

2.3.1 NSW waste strategy

The NSW Waste and Resource Recovery (WARR) Strategy gives traction to *Waste and Avoidance Resource Recovery Act 2001* and the overarching *Protection of the Environment Operations (POEO) Act 1997* and associated Waste Regulation (2014). However, it will soon be superseded by a new 20-Year Waste Strategy for NSW (discussed below).

The WARR Strategy sets state-wide targets to achieve by 2021-22, with the relevant targets being:

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[6] www.environment.nsw.gov.au/funding-and-support/nsw-environmental-trust/grants-available/major-resource-recovery-infrastructure/grants-awarded-and-project-summaries#Veolia2013
[7] www.environment.nsw.gov.au/funding-and-support/nsw-environmental-trust/grants-available/major-resource-recovery-infrastructure/grants-awarded-and-project-summaries#Dialadump2014

- Reduce the rate of waste generation per capita
- Increase recycling rates for –
  - MSW to 70%
  - C&I waste to 70%
  - C&D waste to 80%
- Increase the waste diverted from landfill to 75%.

These targets are not mandatory and the WARR Strategy Progress Report[8] released in 2019 indicates the MSW and C&I waste targets are unlikely to be met, at 42% and 53% respectively in 2017-18. The landfill diversion rate was 65% in 2017-18, a two percentage point increase from 63% in 2015-16.

In order to close the gap to the recycling and broader landfill diversion targets, the NSW Government has been investing significantly in recycling infrastructure through two iterations of the Waste Less Recycle More grants scheme, with a total combined funding pool of $802 million. While a small number of grants have been handed back, the program is facilitating a pipeline of new and expanded recycling facilities of various sorts that will capture more material out of mixed waste.

2.3.2 Issues Paper: Cleaning Up Our Act

The NSW 20-Year Waste Strategy will set a new direction and actions to improve waste outcomes in NSW. Whilst the final document is not due for release until late 2021, the Department of Planning, Industry and Environment (DPIE) is seeking feedback from industry on several key directives and options in an Issues Paper released in March 2020. These are summarised in Figure 5.

Direction 1: **Generate less waste** by avoiding and 'designing out' waste, to keep materials circulating in the economy.

Option 1.1: State-wide targets

Option 1.2: Designing out waste

Option 1.3: Awareness and behavioural change

Option 1.4: Targets for government agencies

Option 1.5: Regulatory safeguards

Direction 2: **Improve collection and sorting** to maximise circular economy outcomes and lower costs.

Option 2.1: Recovering food and garden organics

Option 2.2: Standardise collection systems for households and businesses

Option 2.3: Network-based waste drop-off centres

Option 2.4: Waste benchmarks for the commercial sector

Option 2.5: Innovation and 'waste-tech'

Option 2.6: Joint local council procurement

Option 2.7: Combining commercial and industrial waste collection services

Option 2.8: Economic incentives and the waste levy

Direction 3: **Plan for future infrastructure** by ensuring the right infrastructure is located in the right place and at the right time.

Option 3.1: Long-term waste and resource recovery infrastructure needs

Option 3.2: Place-based development

Option 3.3: Making it easier to do business

Option 3.4: Innovative financing models

Direction 4: **Create end markets** by fostering demand for recycled products in NSW (particularly glass, paper, organics, plastics and metals) so that recovered materials re-enter our economy and drive business and employment opportunities.

Option 4.1: Recycled content in government procurement

Option 4.2: Standards for recycled content and materials

Option 4.3: Match suppliers with markets

Option 4.4: Best-practice regulatory environment for energy from waste projects

The implementation and progress of the four directions will be underpinned by an Implementation Framework that sets out the information and monitoring and reporting arrangements for the strategy.

Figure 5: Potential directions and options from the Issues Paper for the 20-Year Waste Strategy

The following options are of particular relevance to this study:

- Joint Council procurement for waste infrastructure in metropolitan areas
- Mandating source separation for household food waste through FOGO collection systems

[8] Waste Avoidance and Resource Recovery Strategy Progress Report 2017-18, EPA NSW

- Standardise collection systems for households and businesses across regions
- Review of economic incentives and the waste levy
- 'Place-based development' with consideration of waste management and industrial symbiosis opportunities
- Potential reform to the Energy from Waste (EfW) Policy Statement.
- The Issues Paper has signalled to industry that there may be some changes to policy, which would offer certainty to the Project Sponsors and also improve resource recovery outcomes. The scenarios presented in this analysis present both ends of the spectrum, policy reform on one end and stringent application and adoption on the other:
  - Note 1 exemption, which also simulates a scenario in which the RRC limits are linked to actual recovery potential as oppose to theoretical thresholds which don't align with best practice residual waste treatment resource recovery rates and the constraints of the Mixed Waste Organic Output (MWOO) ban on land application
  - Mandatory FOGO adoption, which has been presented based on a less prescriptive uptake model where half the Councils transition to FOGO on the expiration of their first contract and the balance transition on expiry of their second contract.

2.3.3 Energy from Waste Policy Statement

The NSW Energy from Waste Policy Statement outlines the criteria that facilities must meet in order to recover energy from waste in NSW. It has not been amended since implementation in March 2014, despite concerns from the waste industry that it is overly restrictive, but is understood to be included for review as part of the 20-Year Waste Strategy process.

From a feedstock perspective, the critical feature is alignment with the waste hierarchy, which plays out through the application of a Resource Recovery Criteria framework that defines the proportion of materials that can be combusted under different collection scenarios. These criteria are designed to ensure that EfW is only applied where "further material recovery through reuse, reprocessing or recycling is not financially sustainable or technically achievable".

The Sponsors must be able to demonstrate that the waste presented for energy recovery has already been depleted of materials with a higher order resource recovery value.

Energy recovery facilities may only receive feedstock from "authorised" waste facilities or collection systems that meet the criteria reproduced in Table 3. For mixed wastes, it specifies the percentage of waste that can be sent to energy recovery under different bin configurations, which it uses as a proxy indicator of initial recovery. The policy also permits a range of source separated wastes and process residuals beyond the target wastes of this report, some of which may be attractive as top-up feedstocks for an EfW facility.

Table 3: Resource recovery criteria for energy recovery facilities.

Waste stream	Processing facility	% residual waste allowed for energy recovery
Mixed wastes		
Mixed municipal waste (MSW)	Facility processing mixed MSW waste where a council has separate collection systems for dry recyclables and food and garden waste	No limit by weight of the waste stream received at a processing facility
	Facility processing mixed MSW waste where a council has separate collection systems for dry recyclables and garden waste	Up to 40% by weight of the waste stream received at a processing facility
	Facility processing mixed MSW waste where a	Up to 25% by weight of the

Waste stream	Processing facility	% residual waste allowed for energy recovery
	council has a separate collection system for dry recyclables	waste stream received
Mixed commercial and industrial waste (C&I)	Facility processing mixed C&I waste	Up to 50% by weight of the waste stream received at a processing facility
	Facility processing mixed C&I waste where a business has separate collection systems for all relevant waste streams	No limit by weight of the waste stream received at a processing facility
Mixed construction and demolition waste (C&D)	Facility processing mixed C&D waste	Up to 25% by weight of the waste stream received
Residuals from source-separated materials		
Source-separated recyclables from MSW	Facility processing source-separated recyclables from MSW	Up to 10% by weight of the waste stream received at a processing facility
Source-separated garden waste	Facility processing garden waste	Up to 5% by weight of the waste stream received at a processing facility
Source-separated food waste (or food and garden waste)	Facility processing source-separated food or source-separated food and garden waste	Up to 10% by weight of the waste stream received at a processing facility
Separated waste streams	**Feedstock able to be used at an energy recovery facility**	
Waste wood	Residual wood waste sourced directly from a waste generator e.g. manufacturing facility	
Textiles	Residual textiles sourced directly from a waste generator	
Waste tyres	End-of-life tyres	
Biosolids	Used only in a process to produce a char for land application	
Source-separated food and garden organics	Used only in a process to produce a char for land application	

Where multiple sources are received at the facility, the total recovery rate from the processing facility should be an average of the applicable resource recovery criteria for each source, weighted by the percentage of waste from each source.

The only large-scale facility operating under the EfW policy is Boral's Berrima Cement kiln, which sources RDF from ResourceCo-Cleanaway at Wetherill Park in Sydney. To secure development approval for the Wetherill Park facility, ResourceCo developed a process of pre-approved waste collection operators and sources that allowed it to verify the average collection context.

2.3.4 Resource Recovery Criteria Note 1 Exemption

As specified in 2.3.3, the Resource Recovery Criteria are designed to ensure that EfW is only applied where “further material recovery through reuse, reprocessing or recycling is not financially sustainable or technically achievable”. The EPA has included an option to adjust the limits on a case-by-case basis, for known as ‘Note 1’, which states:

> *The EPA may give consideration to increases to the maximum allowable percentage of residuals from facilities receiving mixed municipal and commercial and industrial waste where a facility intends to use the biomass component from that process for energy recovery, rather than land application and the facility can demonstrate they are using best available technologies for material recovery of that stream.*

This is even more relevant after the 2018 provisional repeal of the Resource Recovery Order and Exemption allowing application to land of Mixed Waste Organic Outputs (MWOO), which is the major product from Mechanical Biological Treatment (MBT) facilities (refer to Section 2.3.6). Since then, all outputs derived from the three MBTs serving Sydney is going to landfill other than a small portion (approximately 5%) of commingled recyclables and metals recovered from this mixed waste stream. The only other landfill diversion delivered by Sydney’s MBTs is moisture loss from organics during the process, typically up to 30% of the mixed waste stream by weight, but this cannot readily be defined as resource recovery and would effectively occur in the energy from waste process.

The commingled and metal recycling performance of Sydney’s MBTs is consistent with international best practice for MBTs (Table 4), which is the only mature technology for sorting MSW mixed waste. The only other technologies that that have been applied to manage this waste stream include mixed waste Materials Recovery Facility (or ‘dirty MRF’) and mechanical heat treatment/autoclaving (MHT).

Dirty MRFs have a limited track record for processing municipal residual waste due to constraints around contamination, low recovery rates and high reject disposal costs. A dirty MRF broadly applies the mechanical separation processes of an MBT facility and therefore we would expect a consistent recovery rate with other MBT’s in NSW and internationally (see figures overleaf). In practice we do not consider a stand alone Dirty MRF be developed to process putrescible MSW in Sydney because of the challenges listed above.

MHT/autoclaving has a limited track record of operating commercially on mixed residual waste, with issues around markets/outlets for products and worker safety resulting in several failed projects overseas[9].

There is only one MHT/autoclaving facility in Australia, which is Biomass Solutions in Coffs Harbour. Prior to the MWOO ban, it was recovering between 43% and 49%[10] of the kerbside residual waste stream. After discounting moisture loss and MWOO, we’d expect a recovery rate of recyclables to be around 5% of the incoming load, consistent with the MBTs.

Arcadis is aware of a proposed MHT/autoclaving facility in the Shoalhaven with the proponent claiming to recover 18% of unsegregated MSW. Should only kerbside putrescible waste be processed in this system, we’d expect the recovery rates to be much lower.

Arcadis considers the benchmark resource recovery rate to support eligibility for Note 1 exemption is 5%, which is consistent with local and international best practice. This is demonstrated in Table 4 and Table 5, where a sample of local and international best practice MBTs is listed to support this assumption.

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[9] Resource Recovery Technology Guide, 2018, Arcadis for Sustainability Victoria
[10] Waste Avoidance and Resource Recovery Local Government Survey, 2017-2018, Department of Planning, Industry and Environment

Table 4: Typical recovery rates for recyclables in Australian MBTs

Facility	Location	Recovery rate for recyclables[11]
Global Renewables Eastern Creek UR3R Plant	Sydney, NSW	Average 3-5% (ferrous and non-ferrous metals, plastic (PET, PP and HDPE) and recyclable glass)
Suez Neerabup Facility	Perth, WA	
Suez Kemps Creek MBT Facility	Sydney, NSW	
Veolia Woodlawn MBT Facility	Sydney, NSW	

To confirm this is consistent with international best practice, several reference facilities and two broad studies are cited. According to *Mechanical Biological Treatment – 15 Years of UK Experience*, the recovery rates range between 1-18%[12], with the higher estimates inclusive of organic fines which aren't feasible for recovery in the NSW regulatory environment. The average of 9% recovery is inclusive of 2.5% metals (ferrous and non-ferrous), 2.5% heavies (glass and stone) and 4% plastics.

Performance of mechanical biological treatment of residual municipal waste in Poland, which involved a review of 20 MBTs, captured a similar range of 0-15% recovery of recyclables, with an average of 6%[13].

Table 5: Typical recovery rates for recyclables in international MBTs

Facility	Location	Recovery rate for recyclables
Barnsley, Doncaster and Rotherham (BDR) MBT Facility[14]	Rotherham, UK	5.93%, which is broken down into: • 1.11% metals (ferrous and non-ferrous) • 1.45% heavies (glass and stone) • 3.37% plastics
Allerton Waste Recovery Park MBT	North Yorkshire, UK	Designed to recover 5%[15] recyclate, with a capture efficiency rate of 91-93% depending on which product (PP, HDPE, non-ferrous metal, ferrous metal, rubble and some cardboard)
Eko Mazury MBT	Siedliska, Poland	11%[16]

According to Sustainability Victoria's *Resource Recovery Guide*:

[11] There are no published figures on these resource recovery rates. These recovery rates for recyclables are known from Arcadis' experience working with Councils who supply the MBTs.
[12] Tolvik Consulting, Mechanical Biological Treatment – 15 Years of UK Experience, Briefing Report (2017)
[13] Den Boer. E. and Jedrczak. A., Performance of mechanical biological treatment of residual municipal waste in Poland (2017)
[14] Tolvik Consulting, Mechanical Biological Treatment – 15 Years of UK Experience, Briefing Report (2017)
[15] Operational data provided by AMEY to Cleanaway, March 2020.
[16] Den Boer. E. and Jedrczak. A., Performance of mechanical biological treatment of residual municipal waste in Poland (2017)

> The recyclables extracted by MBT plants are typically limited to high value materials including metals and rigid plastics and typically account for less than 5 per cent of the throughput. The quality and value of recyclables is low due to high contamination[17].

This assessment is consistent with Arcadis' analysis of compositional audit data of potential feedstock for the potential facility. As illustrated in (Appendix A), capacity for recovery is limited by the contamination rates and constraints around acceptance criteria for key international markets. It is common for audits of NSW council residual waste streams to identify up to 15% of the material is recyclable, however this identifies material that could be recovered if deposited in the recycling bin rather than sorted once in the mixed waste stream and subject to contamination.

For the low-grade recyclables recovered from mixed waste, the tightening of contamination rates in global recyclate markets in recent years reduces export markets waste and further local beneficiation would be cost-prohibitive. It makes more sense from an economic, environmental and social perspective to focus on education to facilitate at-source separation rather than additional infrastructure to address incorrect disposal of recyclables.

This is also applies to food organics, which represent approximately 35% of the MSW mixed waste stream and should be separated at source through FOGO services to maximise higher order recovery and the efficiency of residual waste processing.

It should also be noted that while metals can be recovered at the pre-sorting stage of the energy from waste project, these products have a higher level of contamination compared to metals that are extracted from the ash post the combustion process.

For both MSW and C&I putrescible waste, a 5% recovery rate has been assumed based on the capture efficiency rates of best practice technologies and the composition and strength of domestic and international end markets for these recyclables. A similar assumption, 15% has been adopted for non-putrescible C&I. This assumption is made because this waste stream currently goes to landfill (modelled from WARR Progress Update disposal estimates). This waste is the residual from dry C&I sorting facilities, where all resources with local and international end markets are extracted.

2.3.5 Food Organics and Garden Organics (FOGO)

Co-collection of food and garden organics from households is an alternative model to the conventional municipal bin services, with weekly FOGO collection and either weekly or fortnightly collection of the organics-depleted mixed waste bin.

The model has significant implications for EfW-available waste supply. As noted above, under the EfW Policy Statement councils with FOGO services are permitted to provide 100% of their mixed waste residual to an EfW facility, with no requirement for pre-processing.

However, that residual will have a portion of the food organics removed. It is notable that the average organics capture rate for FOGO services in NSW is only 41%,[18] for a total average diversion of 14% (given food organics in NSW is typically around 35% of the mixed waste bin). That leaves 86% of the contents of the mixed waste bin available for EfW. According to *Analysis of NSW Food and Garden Bin Audit Data,* the range of food capture efficiency (diversion from the mixed waste bin) is 14% to 54%, which translates to diversion rates from the mixed waste streams of between 5% and 19%.

While the average capture rate will improve over time as familiarity improves, the maximum potential diversion is around 35%[19] (based on typical organics content), with the remaining 65% of the residual bin contents available for EfW. Arcadis has provided low, medium and optimistic scenarios of the capture rate to illustrate the impact of different capture rates.

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[17] Resource Recovery Technology Guide, 2018, Arcadis for Sustainability Victoria
[18] Analysis of NSW Food and Garden Bin Audit Data, 2018, Rawtec for EPA NSW
[19] Food and Garden Organics Best Practice Manual, 2020, Arcadis (formerly Hyder) for Department of Agriculture, Water and Environment (formerly Department of Sustainability, Environment, Water, Population and Communities)

It is not clear what the uptake rate of FOGO systems will be by councils across the metropolitan area. There is significant reluctance among metropolitan councils to adopt FOGO due to the limited benefit in terms of additional diversion, concerns about contamination and community resistance to fortnightly residual service. Despite that, the NSW EPA consistently pushes FOGO and, as discussed in section 2.3.2, mandatory FOGO has been presented as an option in the Issues Paper for the 20 Year Waste Strategy. Whilst it would be a significant departure from DPIE's previous approach of encouragement over enforcement, it would not be unprecedented for state governments to mandate collection models, with Western Australia also pushing FOGO for metropolitan councils and Victoria establishing a goal for 100% of households to have access to a FOGO service or local composting by 2030[20].

Arcadis has developed a number of scenarios in the waste flow model that reflect different levels of FOGO uptake across the Sydney basin:

- Mandatory uptake by all councils
- Progressive uptake at contract renewal
- Roll out only to SUDs, as in the Penrith Council model.

At-source separation is the best outcome for the community in terms of environmental benefits and it is expected that capture efficiencies for food will improve over time. In the interim, however, the only resource recovery opportunity for the residual waste stream is 5% (recyclables). In the absence of a Note 1 exemption for the Project, the RRC framework is constraining recovery opportunity for the mixed waste stream.

2.3.6 Mixed Waste Organic Outputs

In 2018 the EPA changed the rules regarding land application of the mixed waste organic outputs (MWOO) from alternative waste treatment facilities, banning application to agriculture and suspending application to forestry and mining land. In October 2019 the EPA confirmed its intention to remove the general Resource Recovery Exemptions on application of MWOO to any land types.

It is not clear how the operators of the three mechanical biological treatment (MBT) facilities servicing Sydney will respond, but it is likely they will seek to salvage some value from their facilities and current council contracts. The impact on waste availability remains unclear, however any significant reconfiguration to the facility or business model is likely to increases costs, reducing long-term competitiveness.

The primary ways in which value could be recovered from these facilities include:

- Targeting FOGO tonnages for in-vessel composting
- Production of an organic rich RDF for combustion for a high temperature industrial facility, which is undertaken throughout Europe.

At present, it is understood that the MBTs are only delivering moisture loss from the biological component (20-30%) and recovery of recyclables (3-5%). Arcadis understands the following Sydney metropolitan councils have contracts with MBT facilities and are therefore may be exposed to changing recovery rates and costs:

- Kemps Creek – Liverpool, Penrith and Macarthur region councils (4)
- UR-3R – Blacktown, Cumberland (Holroyd area), Fairfield, Parramatta, Northern Beaches
- Woodlawn – partial SSROC councils (6), partial NSROC councils (5).

The specific councils exposed to the MWOO issue have been flagged within the list of council contracts (Section 4.4).

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[20] Recycling Victoria - A new economy, 2020, Victorian Department of Environment, Land, Water and Planning

2.3.7 Other potential policy impacts

A range of other pending policy decisions may impact waste generation and availability. However, there is insufficient data at this stage to account for the impact:

Export ban on recyclables – An action plan is being developed by the state and federal governments to implement the National Waste Policy and the federally proposed export ban, which will among other things define the material specifications governing the ban on "waste" exports. While focused on commingled recycling and tyres, which are not target materials for this project, there is potential for an increased volume of residual from MRF processes as output quality standards tighten up and a higher degree of refinement is applied.

Circular Economy – The above agenda has also generated significant policy discussion and activity at state and federal levels around the concept of a circular economy, including within the National Waste Policy, the NSW Circular Economy Policy Statement and the 20-Year Waste Strategy for NSW. It is also noted that Victoria has rolled development of its EfW policy into an overarching circular economy policy, which was released in early 2020. Over time, the focus on rethinking product and packaging design (e.g. reducing single-use products) may lead to a plateau or decline in generation per capita.

3 MODELLING METHODOLOGY

This section of the report provides an overview of the approach taken for estimating future waste generation in the Greater Sydney Metropolitan Area, which is inclusive of the Hunter, Central Coast and South Coast regions outside the Sydney Basin. The base year for the investigation is 2017-2018, with waste flows modelled forward for 30 years.

The focus of the modelling is the proportion of the MSW and C&I streams which are currently being sent to landfill, which for MSW is the kerbside residual waste stream, as well as other residual waste streams managed by councils through drop off and clean-up services offered. The C&I waste that currently goes to landfill is largely a mixed putrescible stream (also described as 'wet') and well as smaller quantities of 'dry' C&I with limited value on the recycling market, and therefore no higher order resource recovery opportunities at this time.

Commentary is provided for the data context in which waste modelling is undertaken. The key data sources that provide the basis for modelling have been documented in the following sections of this report, as well as the reasoning for omitting other relevant data sources. The strengths and weakness of the waste generation estimates are discussed in terms of adequacy for infrastructure planning. As noted previously, the analysis is limited by the data which is publicly available. For some streams, there is a lack of recent, granular data, with estimates developed based on the data that is available.

3.1 Data context

The NSW waste tracking and data collection requirements are the most comprehensive of any state, covering all licensed waste facilities and designed to provide the intelligence to underpin enforcement and target policy interventions. However, the NSW EPA is unable to share its detailed data from licenced waste facilities in the state due to confidentiality restrictions around the use of waste levy-derived data.

The EPA's data quality improvements in recent years through enhanced facility level reporting should be taken into consideration when comparing recent estimates, such as the latest WARR Strategy Progress Report, with historical datasets (verified using self-reported industry survey data). As the estimates are largely consistent across this time period, these figures are considered suitable for modelling purposes despite the minor data quality issues.

NSW EPA has recently released an update to the NSW Local Government Waste Data Report 2017-18, five years since the last publication. The year of the data release is consistent with the Waste Avoidance and Resource Recovery Strategy Progress Report 2017-18 (NSW EPA). However, the estimated generation and disposal tonnages differ. The magnitude of the difference and the reasons behind the inconsistencies are presented in Table 6.

Table 6: Comparison of NSW EPA data sets for 2017-2018 for MSW

	Generation in Metropolitan Levy Area	Disposal in the Metropolitan Levy Area
Waste Avoidance and Resource Recovery Strategy Progress Report 2017-18 (NSW EPA)	3 million tonnes	1.7 million tonnes
NSW Local Government Waste Data Report 2017-18	2.6 million tonnes	1.5 million tonnes

	Generation in Metropolitan Levy Area	Disposal in the Metropolitan Levy Area
(NSW EPA)		
Circumstances for the inconsistencies	• The allocation of scrap metal from cars is material to the difference generation estimates. This is less relevant to modelling as the focus is disposal quantities only. • The interstate waste flows for both disposal and recycling also add to difference between WARR Strategy Progress Update but not the Local Government Waste Report.	• Partially due to interstate waste flows, which are accounted for in the WARR Strategy Progress Update but not the Local Government Waste Report. The MLA disposal estimates in the Progress Update captures interstate flows, to account for waste arising in the MLA that is processed outside of Greater Sydney. However, it does not exclude waste arising from interstate that is processed in the MLA, which is likely to be a key difference between the two estimates. • Partially due to errors in reporting by Local Government, that are reconciled by NSW EPA in WARR Strategy Progress Update through comparison with facility level data.

The data sources reviewed and relied upon for the waste flow model are outlined in Table 7.

Table 7: Data sources for Greater Sydney area waste flow forecasting

Data Source	Reviewed	Used in this model	Notes
Waste Avoidance and Resource Recovery Strategy Progress Report 2017-18 (NSW EPA)	✓	✓	MSW and C&I waste disposal estimates were used to develop waste generation per capita or per employee rates.
Waste Avoidance and Resource Recovery Strategy Progress Report 2014-15 (NSW EPA)	✓	✓	Waste disposal data used for estimating growth rates
NSW Local Government Waste Data Report 2017-18 (NSW EPA)	✓	✓	Used alternate waste generation per capita estimates. Whilst relying on self-reporting it's a more accurate representation of available tonnages for waste contracts (refer to Table 6).
NSW Local Government Waste Data Report 2014-15 (NSW EPA)	✓	✗	Used for comparison of different waste generation per capita rates for MSW.
Pilot generator site-based audit of commercial and industrial waste in NSW (NSW EPA)	✓	✗	The NSW EPA has released audits of C&I waste at the place of generation and disposal. Whilst these documents provide some great insights into composition, the generation estimates

Data Source	Reviewed	Used in this model	Notes
Disposal-based audit of Commercial and Industrial Waste Stream in the Regulated Areas of NSW (NSW EPA)	✓	✗	by industry do not correlate well to the overall C&I waste generation estimates when modelled for 2017-2018 by employee.
National Waste Report 2018 (Department of the Environment and Energy)	✓	✓	Provides one of the growth rate options for MSW and C&I modelling.
Waste Account, Australia, Experimental Estimates, 2016-2017 (Australian Bureau of Statistics)	✓	✓	C&I waste data to inform waste generation/employee base rates.
Census 2016 (Austwlian Bureau of Statistics)	✓	✓	Dwelling structures were used to inform scenario analysis of application of a FOGO policy to single unit dwellings only.
Population Projections (Open Data, NSW Government)	✓	✓	Estimated resident population projections adopted for modelling. These projections are used by the government agencies and informed by the NSW Department of Planning and Environment Population and Household Projections and the 2016 ABS Census of Population and Housing.
Employment Projections (Open Data, NSW Government)	✓	✓	Estimated employment statistics adopted for modelling. These projections are used by the government agencies and informed by the NSW Department of Planning and Environment Population and Household Projections, the 2016 ABS Census of Population and Housing, the 2016 ABS Census data on population growth, employment by industry/region/place, and journey to work, 2018 ABS Labour Force Survey

In addition to these data sets, Arcadis also undertook a desktop review of each local council's annual reports, strategies, recent tenders and other public documents to capture any more recent local government data. Some of this data has been incorporated in one of the modelling scenarios.

Historical data sets were compared to waste generation growth rates in NSW as a whole to ascertain general trends. As shown in Figure 6 and Figure 7, there has been a recent downward trend in MSW waste generation per capita over the past decade and in C&I waste generation per employee since around 2013. There is a clearer downward trend in unit disposal rates of both streams as a result of both declining waste generation and growing recovery.

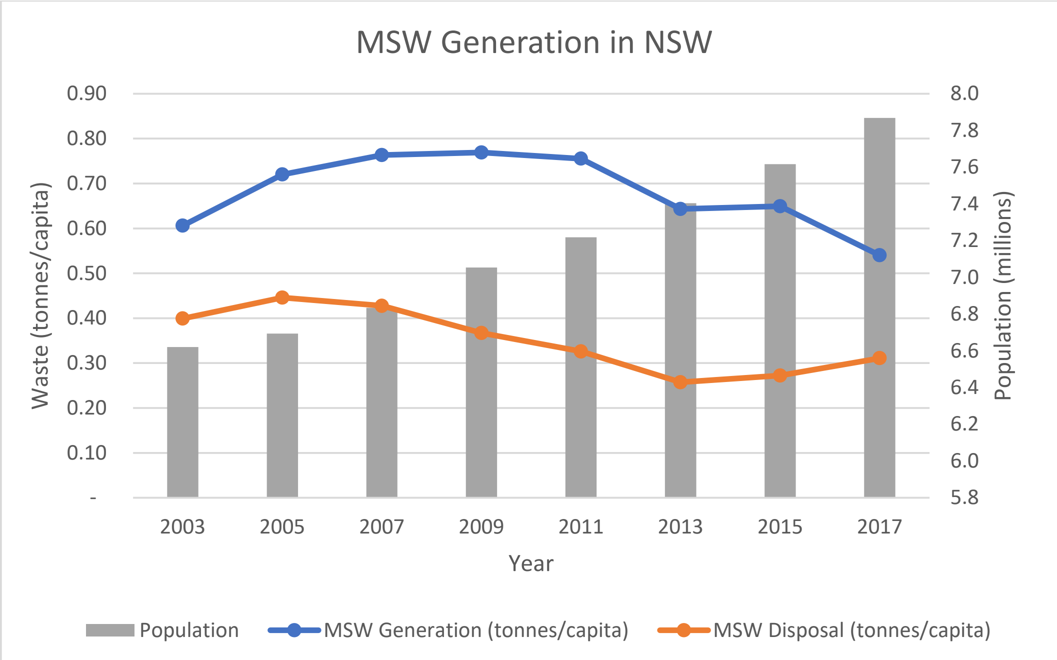


Figure 6: MSW generation and disposal per capita compared to population (WARR data and ABS Population estimates)

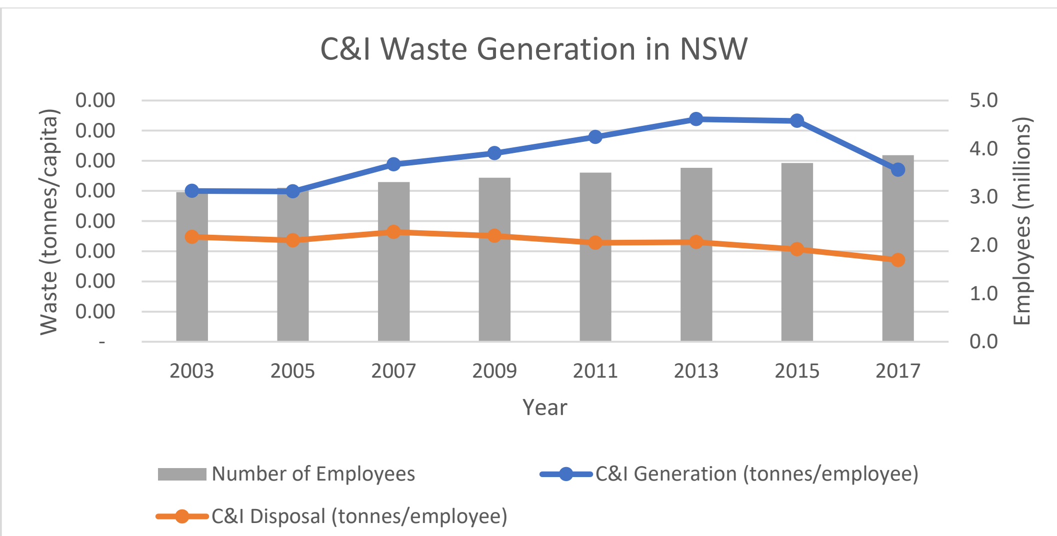


Figure 7: C&I waste generation and disposal per employee compared with employment estimates (WARR Data and ABS Employment statistics)

The figures above show the downward trend in waste generation is most pronounced in MSW from 2011 and more variable in C&I. In this year, the waste levy began a four-year period of annual increases of $10 plus CPI, significantly amplifying the price signal to recover waste, as well as avoid it. However, there is also a high level of volatility in annual waste generation across the period, as shown in Figure 8 and Figure 9, which makes trend lines more difficult to determine. Changes in growth rates are presented over a two-year period as the historical WARR reports only provide estimates every two years.

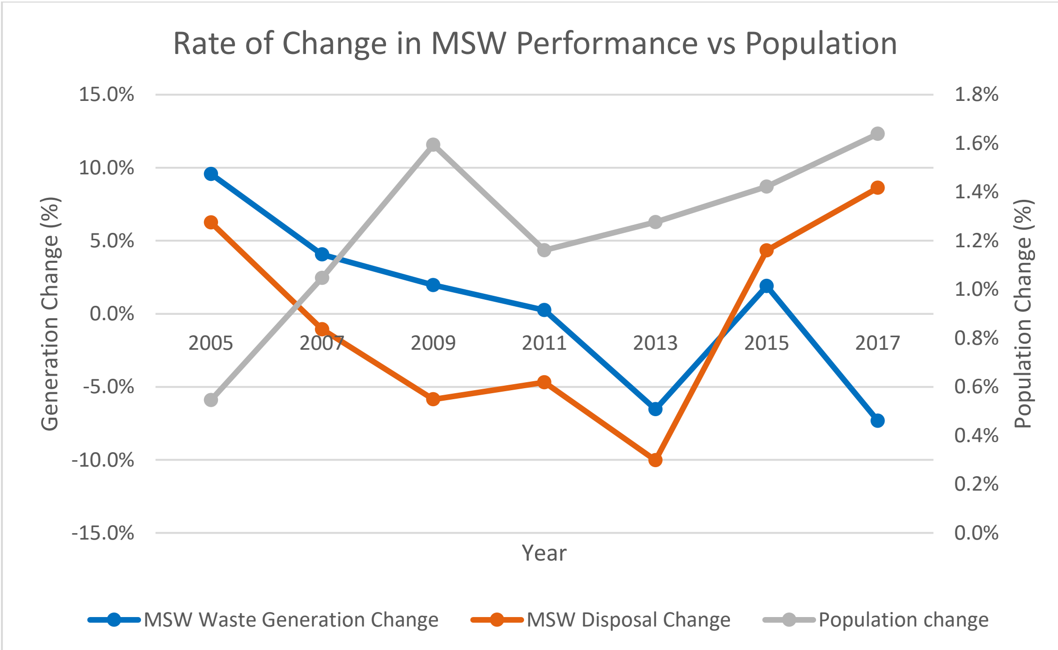


Figure 8: Changes in MSW waste generation and disposal published figures, and compared with population changes (WARR data and ABS population estimates)

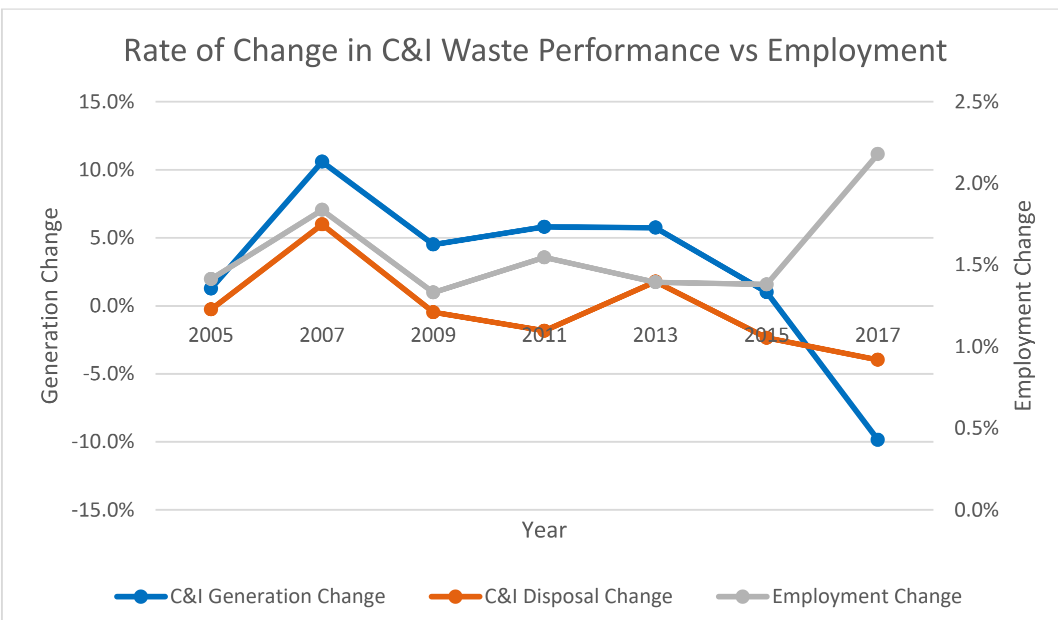


Figure 9: Changes in C&I waste generation and disposal published figures, compared with employment changes (WARR data and ABS employment statistics)

Based on the historic trends and potential future changes, a range of estimates for waste growth per capita (MSW) and per employee (C&I waste) have been developed for testing as sensitivities in the modelling. The following growth rates were developed based on specific average NSW growth rates between 2011 and 2017:

- MSW

  - -1.5% per annum (decline), which reflects the overall decline in MSW generation in NSW in recent years and is useful in modelling waste avoidance behaviour in the home and industry trends towards reduced packaging and waste which are expected to continue in the future.
  - -0.2% per annum (decline), which is based on the more moderate decline in MSW waste to landfill in NSW over this period.
- C&I waste
  - 0.3% per annum (growth) based on the moderate increase in C&I generation in NSW, which provides a basis for modelling potential increases in C&I waste generation/employee where industry maintains or grows productivity but reduces labour and resource use (e.g. in manufacturing) through more efficient processes.
  - -0.8% per annum (decline), which is reflective of the reduction in C&I waste disposal in NSW, and is adopted to simulate potential improvements in resource recovery and disposal practices in the commercial sector.

Both MSW and C&I forecasts are also analysed under a zero-growth scenario and the overall Australian waste growth rates (National Waste Report). C&I is also forecast with a growth rate aligned to short-term GSP growth forecasts to reflect economic productivity.

It is noted that the growth rates are applied to 2030 only and then assumed to plateau (zero growth beyond 2030). While there is a high level of uncertainty about the long-term waste behaviour of individuals and businesses, it is assumed there will be continued investment in waste programs and recycling infrastructure for at least the next 10 years, given the NSW is significantly short of the WARR Strategy 2021-22 targets. Arcadis is of the view that unit growth rates must plateau at some point in the future (they can neither grow or decline indefinitely) and whilst we acknowledge that it is impossible to predict when that will occur, the current policy trends suggest it could be within the next decade.

The model allows each of the above growth rates to be applied and the impact of these different per capita and per employee growth rates is shown in Section 4.2. In Arcadis' view, the most plausible per capita/employee growth scenarios are -1.5% per annum for MSW and -0.8% per annum for C&I. These have been adopted for the base forecasts.

3.2 Waste forecasting methodology

The clear correlation between MSW generation and population supports waste generation forecasting using a historic waste generation per capita rate, future population projections and a separate waste generation per capita growth rate related to expected consumption behaviour.

The general process for waste generation forecasting involves the following steps:

- Divide the waste quantity by the preferred forecasting metric such as population or employment to develop a waste generation rate (e.g. waste per capita or waste per employee). Both data sets need to be over the same time period.
- The waste generation rate is compounded annually to calculate an annual growth rate. This growth rate may be determined by historical data or other growth rates where there is an observed correlation.
- Multiply the waste generation rate by the forecasted statistics (e.g. waste per capita multiplied by the population in 2019-2020).

For this investigation, the forecasts were tested under a number of different future waste system scenarios to test the sensitivity of results to different growth scenarios. These scenarios essentially simulate the impacts of potential policy decisions or industry trends.

Table 8: Scenario analysis

Policy	Description
Waste avoidance policies	• Tested through negative and no growth waste generation rates

Policy	Description
Implementation of a FOGO policy	• Demonstrated through low, medium and high food capture scenarios for the kerbside residual waste bin (based on data from existing FOGO systems) • FOGO is assumed to be mandated only in single unit dwellings (SUDs), modelled by multiplying the expected food waste recovery rate by the proportion of persons living in a SUDs, including the changing housing density over time
Energy from Waste Policy Statement	• Modelling of the Note 1 exemption to the RRC, and recovery of uncontaminated/high value recyclables only in line with best practice. • The RRC have been applied to MSW tonnages relative to the bin configuration of each council. The model allows for application of FOGO policies, which increases the availability of EfW eligible feedstock from the residual waste stream (i.e. the RR criteria becomes unlimited). FOGO adoption is progressive according to first and second contract renewal opportunities. • Modelling the impact of the Resource Recovery Criteria that govern C&I waste availability is more difficult to model due to the challenge in defining the feedstock context. Using Cleanaway's customer data, which is considered broadly reflective of the industry, it's been assumed that 60% of customers source separate their waste and this will progressively improve to 75% by 2030. Based on information provided by industry contacts, the split of putrescible and non-putrescible going to landfill is assumed to be approximately 60:40.

4 CURRENT WASTE FLOWS AND DESTINATIONS

Forecasts on the availability of future feedstock for the Project are influenced by the waste generating behaviour of households and the commercial and industrial sector. As noted above, historical waste generation rates for NSW were analysed to inform development of conservative growth rates. These were compared against no-growth and other scenarios, including alignment with national trends and NSW Gross State Product (GSP).

Future policy changes by the NSW Government also have the potential to influence the availability of feedstock, in particular the Resource Recovery Criteria of the EfW Policy Statement (Section 2.3.3). The requirements to comply with the current Resource Recovery Criteria framework can be simulated in the waste model.

4.1 Volumes

The results of the base modelling scenario are presented in this section. The assumptions for the base modelling scenario for the Sydney Basin area are summarised in Table 9.

Table 9: Preferred scenario for Sydney Basin waste forecasting

Scenario	Description
Base data	2017-2018 WARR Progress Update Two other MSW base data sources are provided in the Model – an extrapolation of the 2014-15 Local Government Waste and Resource Recovery Data Report, and compilation of data from publicly available sources (strategies and council reports). These alternate sources provide a greater sense of the different waste generating behaviour of demographics per Council. However, these figures have required extrapolation with estimated growth rates to 2017-2018 rates as the data is dated. Therefore, for aggregated figures, the 2017-2018 WARR Progress Update is considered the more reliable and adopted for this analysis. One other data source is provided in the Model, which allows for different waste generation rates per industry as per the ABS experimental estimates for the waste accounts (using National Waste Report data).
Growth rates	• Variable growth for different LGA's from Open Data, which utilises 2016 NSW Department of Planning and Environmental Population and Household Projections (main series) and the 2016 ABS Census of Population and Housing. • -0.2 % for MSW for the base scenario (NSW WARR data trends), with sensitivities of -1.5% (NSW WARR data trends), 0% (former NSW EPA modelling scenarios) and -2.8% (National trend, DoEE). • -0.8 % for C&I for base scenarios (NSW WARR data trends), with sensitivities of 0.3%, (NSW WARR data trends), 0% (former NSW EPA modelling scenarios), -1.8% (National trend, DoEE) and variable positive rates with gross state product. Growth rates applied to 2030 and then a zero growth rate there. Findings of the sensitivity analysis impacts presented in Section 4.2.
EfW Eligibility	• For the reasons specified in Section 2.3.4, it's assumed that the Project qualifies for the Note 1 exemption and this is modelled for both MSW and C&I. • As an alternate scenario, Business as usual EfW eligibility based on current policy and bin configurations of the councils (ranging between 25% and 40% for two and three bin systems, except for Penrith and Woollahra which is 100%). Under this scenario it's assumed that FOGO will be adopted by 50% of councils at the first opportunity for contract renewal, and the balance by second contract renewal. It is assumed that the same eligibility threshold is applied to kerbside collection, drop off and clean up waste respectively. The justification for this scenario is discussed in section 2.3.2 and section 2.3.5. • From Cleanaway's data, which is considered to be broadly representative of the industry,

Scenario	Description
	approximately 60% of C&I waste generators undertake source separation for all relevant waste streams. Therefore, it's assumed to comply with the second clause of the RRC for C&I waste. By 2030 this is expected to rise to 75%. The eligibility of the remaining waste is relates to the first clause, which limits EfW eligibility to 50% by weight of the waste received at a facility processing mixed C&I waste. This is split out by putrescible and non-putrescible waste streams, assumed to approximately 60% and 40% respectively. Whilst there is no putrescible sorting capacity for C&I waste Sydney currently, it's expected to come online with proposed combustion facilities targeting this gap in the market.

Despite the negative unit growth rates of the base scenario, waste generation will continue to increase in the Sydney Basin and Sydney Metropolitan Area due to population and economic growth outstripping any decline in unit waste generation. As discussed in Section 2, the Sydney Basin is inclusive of the SSROC, WSROC, SHOROC, NSROC and Macarthur regional waste groups. The Sydney Metropolitan Area includes these groupings as well as councils and regional waste management groups in the Hunter, Central Coast and South Coast regions.

The estimated total residual waste tonnages for MSW and C&I are shown in Figure 10 and Figure 11.

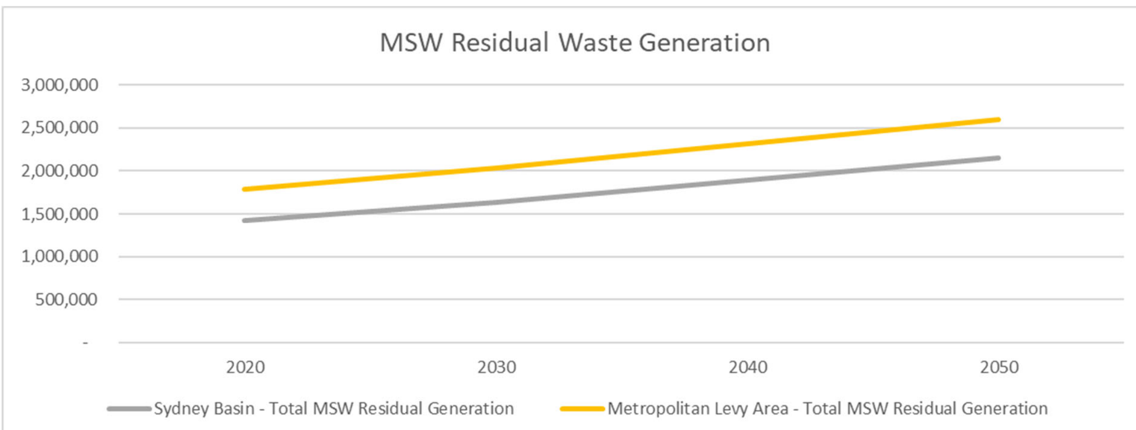


Figure 10: MSW Residual Waste Generation Forecasts

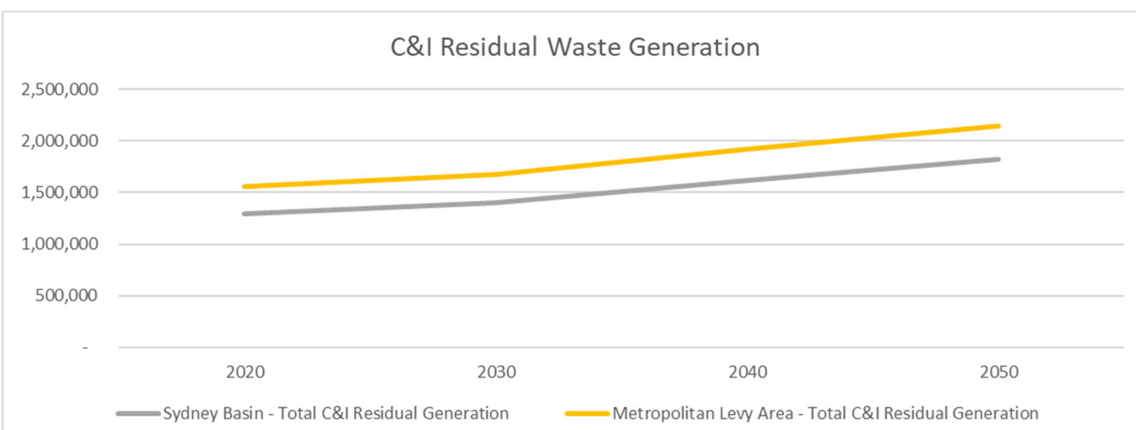


Figure 11: C&I Residual Waste Generation Forecasts

Despite the majority of this waste going to landfill, under the current EfW Policy statement most of this waste is considered ineligible for energy recovery. As shown in Figure 10 and Figure 11, approximately 1.4 million tonnes of residual MSW and 1.3 million tonnes of residual C&I is estimated to be generated in the Sydney basin in 2020.

Given the limitations on alternate applications for the organics component of mixed waste, a Note 1 exemption to the RRC limits has been applied increasing the maximum allowable percentage of mixed waste residuals for energy recovery. Therefore the first scenario illustrates eligible feedstock after materials recovery[21] has been undertaken using best available technologies, which has been demonstrated to be approximately 5% in Section 2.3.4.

For the second scenario, Two and three bin systems (GO only) restrict the eligibility of residual waste to 25% and 40% respectively. Progressive adoption by all councils of a three-bin system (with FOGO) would decreases the volume of residual MSW but significantly increases the proportion of residual waste available for an EfW facility under the current Policy Statement. This has been modelled under a moderate capture rate for food waste.

Even under a high food capture scenario it would only reduce the amount of available feedstock in the order of 5%. These capture scenarios are based on the Analysis of *NSW Food and Garden Bin Audit Data*, which reflect current practices of NSW residents with a FOGO service. Over time it is expected that these rates will improve, consistent with Australia's commingled recycling education which has been a 30-year journey. If a mandatory FOGO policy was applied to single unit dwellings only, it would reduce the FOGO capture by on average 5% (which in turn increases the quantity of residual waste available to EfW).

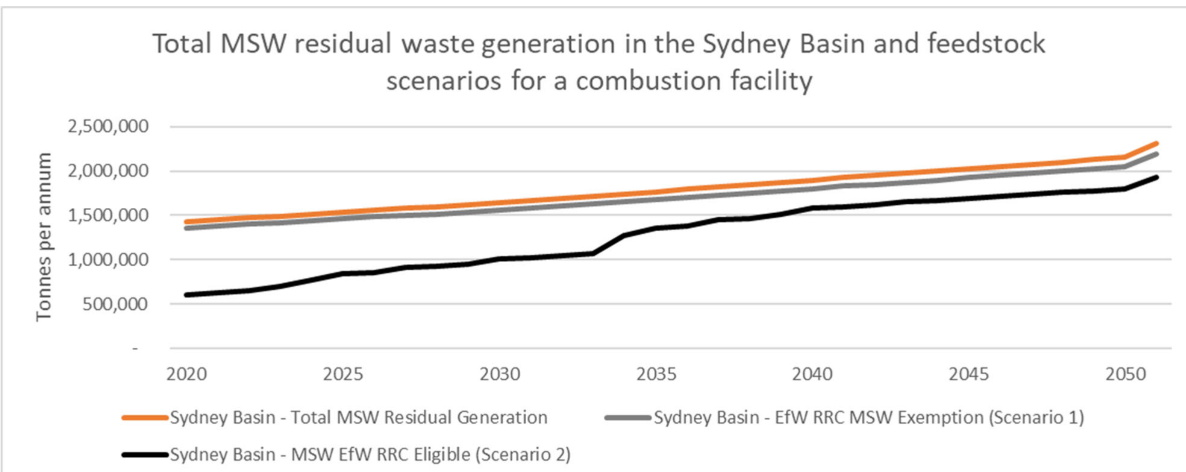


Figure 12: Estimation of future MSW waste that could be eligible for EfW (under Note 1 scenario and the RRC scenario, assuming progressive adoption of FOGO)

Figure 13 shows the potential breakdown of EfW eligible mixed waste arising from 3 bin (FOGO), 3 Bin (GO) and 2 Bin systems, based on the EFW RRC and progressive uptake of FOGO scenario. The quantity of eligible feedstock is constrained under the 3 Bin (GO) and 2 Bin systems, while eligible mixed waste quantities under FOGO systems are unconstrained and subsequently represent the largest proportion of target feedstock.

[21] Noting 'materials recovery' as per the EfW Policy Statement, which differs from reported landfill diversion rates currently being reported by the MBTs, which are inclusive of moisture loss, . This moisture loss would also occur in a combustion facility, and therefore considered inappropriate as a point of difference.

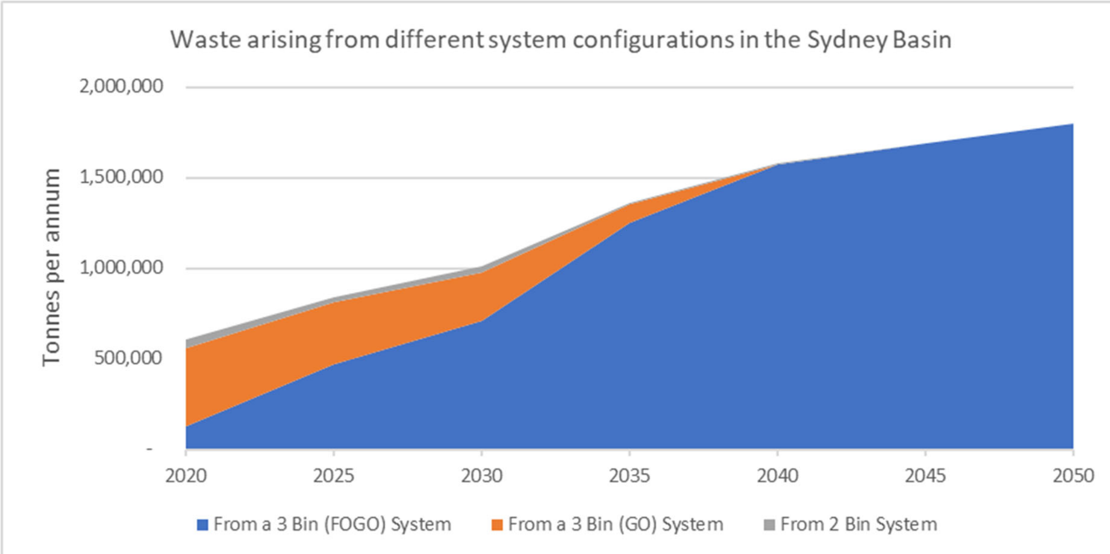


Figure 13: Breakdown of potential sources under the EFW RRC Scenario for MSW residual waste

Figure 14 shows the quantity of residual C&I waste that could be eligible for EfW (assuming 88% from 2030 based on the proportion of putrescible and non-putrescible waste and best practice source separation and recovery rates for each). This waste currently goes to landfill and is mostly putrescible, which limits conventional resource recovery potential due to contamination.

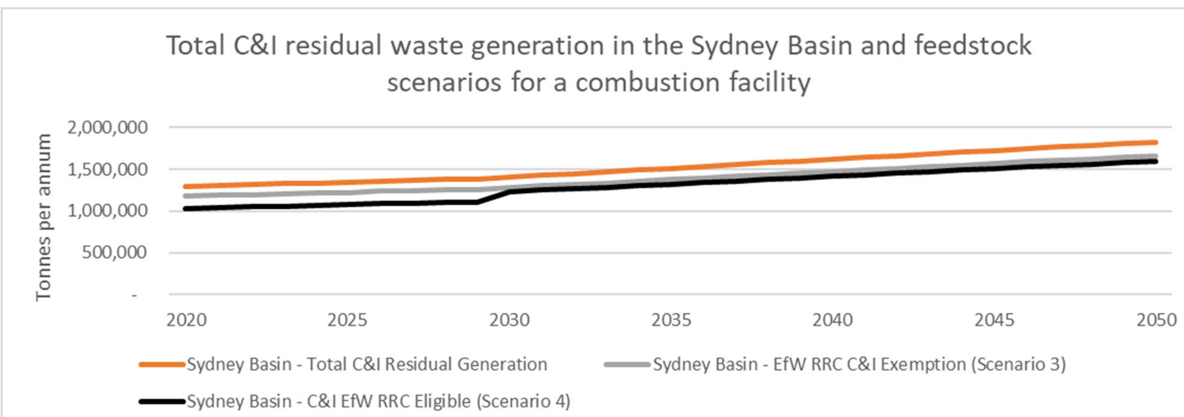


Figure 14: Estimations of future C&I waste that could be eligible for EfW (assuming source separation growing from 60% in 2020 to 75% by 2030 and a Note 1 exemption)

Under the EFW RRC framework, the majority of target C&I waste would be derived from customers with a comprehensive at-source separation system. The balance would be derived from sorting facilities, which places constraints around output eligibility for EfW. Arcadis acknowledges that there is limited C&I putrescible waste sorting capacity in Sydney currently, however it is expected that additional capacity will come online to meet this infrastructure gap and this assumption has been incorporated in the analysis.

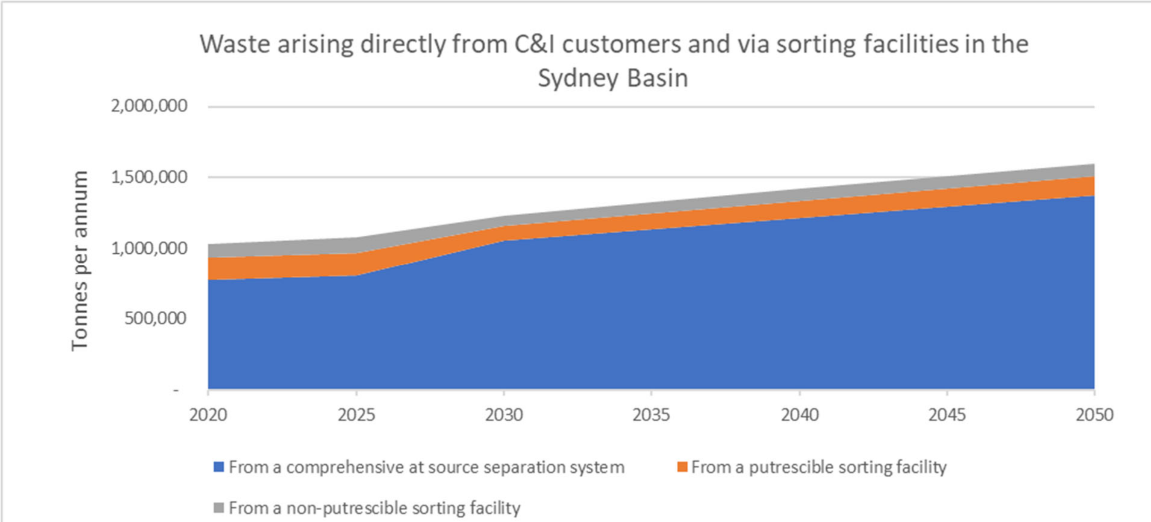


Figure 15: Breakdown of potential sources under the EFW RRC for C&I residual waste

Table 10 and Table 11 provide a breakdown of estimates under the standard application of the RRC framework and the RRC exemption pathway. They show that over the long term the differential in EfW-eligible volumes for MSW narrows but remains material, with 10% more feedstock in 2050 under the exemption scenario, while for C&I waste the difference is negligible by 2030, at just 4% higher under the exemption route. Table 10: Estimation of residual MSW that could be eligible for EfW

Sydney Basin Feedstock		2020	2025	2030	2035	2040	2045	2050
MSW Residual Generation		**1,425,415**	**1,533,756**	**1,640,237**	**1,766,821**	**1,895,898**	**2,024,030**	**2,152,763**
MSW EfW RRC Exemption (Scenario 1)		**1,354,144**	**1,457,069**	**1,558,226**	**1,678,480**	**1,801,103**	**1,922,828**	**2,045,125**
MSW RRC Eligible (Scenario 2)	From a 3 Bin (FOGO) System	125,460	471,205	711,062	1,253,681	1,572,625	1,691,901	1,799,523
	From a 3 Bin (GO) System	433,712	342,106	267,255	101,391	-	-	-
	From 2 Bin System	47,948	28,705	30,362	3,320	3,554	-	-
	Total	**607,120**	**842,016**	**1,008,679**	**1,358,392**	**1,576,179**	**1,691,901**	**1,799,523**

Table 11: Estimation of residual C&I waste that could be eligible for EfW

Sydney Basin Feedstock		2020	2025	2030	2035	2040	2045	2050
C&I Residual Generation		**1,292,892**	**1,345,143**	**1,406,004**	**1,512,601**	**1,620,595**	**1,725,272**	**1,826,758**
C&I EfW RRC Exemption (Scenario 3)		**1,176,532**	**1,224,080**	**1,279,464**	**1,376,467**	**1,474,741**	**1,569,997**	**1,662,350**
C&I EfW Eligible (Scenario 4)	From a comprehensive at source separation system	775,735	807,086	1,054,503	1,134,451	1,215,446	1,293,954	1,370,069
	From a putrescible sorting facility	155,147	161,417	105,450	113,445	121,545	129,395	137,007
	From a non-putrescible sorting facility	103,431	107,611	70,300	75,630	81,030	86,264	91,338
	Total	**1,034,314**	**1,076,114**	**1,230,254**	**1,323,526**	**1,418,021**	**1,509,613**	**1,598,413**

4.1.1 MSW

EfW eligible quantities of kerbside, drop off and clean up waste have been summarised for MSW scenarios 1 and 2 in the subsequent figures tables. Further compositional analysis is required to assess the suitability of components of the drop-off and clean-up streams as discussed below in 4.3.2. Existing data suggests significant pre-sorting would be required. The extent to which a FOGO policy and capture efficiencies could impact eligible feedstocks is discussed in 4.2.

Scenario 1: Note 1 Exemption for MSW

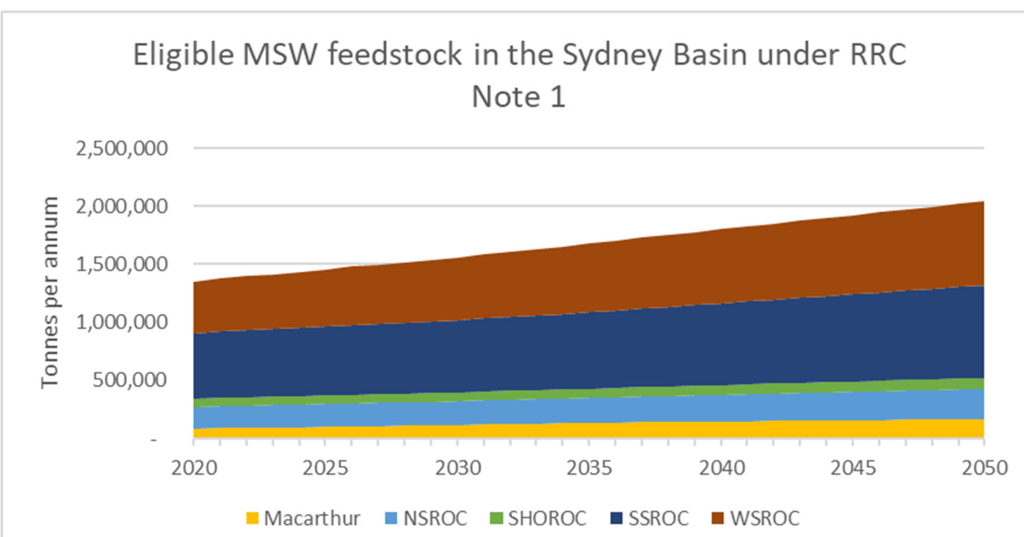


Figure 16: Eligible MSW feedstock estimates (Scenario 1)

Table 12: Estimates of MSW kerbside residual waste eligible for EfW (Scenario 1)

Region	2020	2030	2040	2050
Macarthur	69,889	95,319	120,018	136,758
NSROC	149,215	165,917	187,181	211,757
SHOROC	67,558	69,817	76,671	86,949
SSROC	493,386	545,002	616,504	699,030
WSROC	393,138	476,100	563,425	641,052
Total	**1,173,186**	**1,352,154**	**1,563,799**	**1,775,546**

Table 13: Estimates of MSW drop off waste eligible for EfW (Scenario 1)

Region	2020	2030	2040	2050
Macarthur	4,507	5,391	6,544	7,437
NSROC	-	-	-	-
SHOROC	-	-	-	-
SSROC	632	675	754	856
WSROC	10,364	11,556	13,234	15,065
Total	**15,504**	**17,621**	**20,532**	**23,358**

Table 14: Estimates of MSW clean up waste eligible for EfW (Scenario 1)

Region	2020	2030	2040	2050
Macarthur	13,967	18,363	22,766	25,936
NSROC	26,490	29,458	33,184	37,513
SHOROC	13,786	14,266	15,681	17,788
SSROC	69,143	75,739	85,360	96,838
WSROC	42,069	50,624	59,780	68,147
Total	**165,455**	**188,450**	**216,771**	**246,221**

Scenario 2: Application of current RRC limits and progressive adoption of FOGO

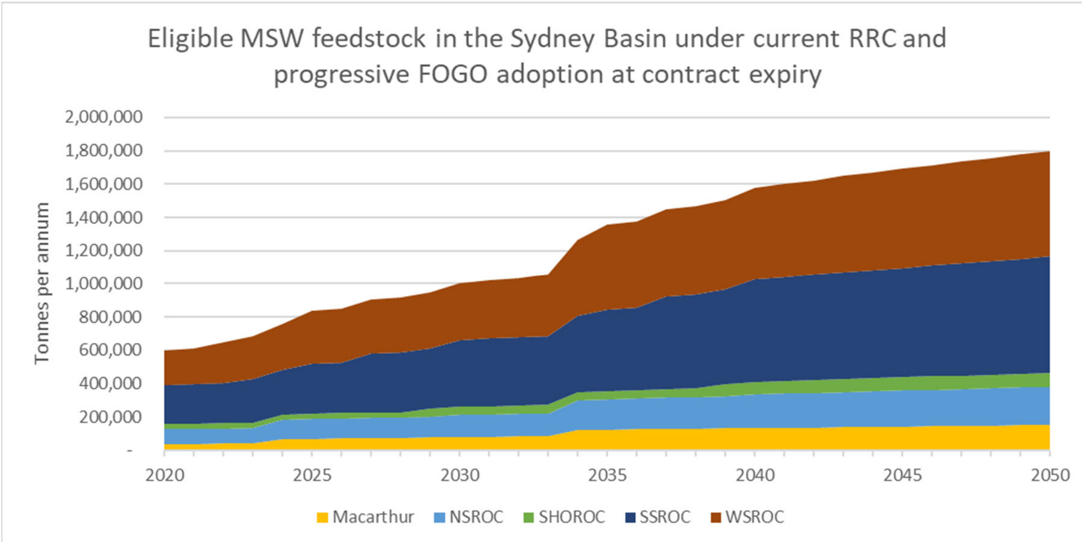


Figure 17: Eligible MSW feedstock estimates (Scenario 2)

Table 15: Estimates of MSW kerbside residual waste eligible for EfW (Scenario 2)

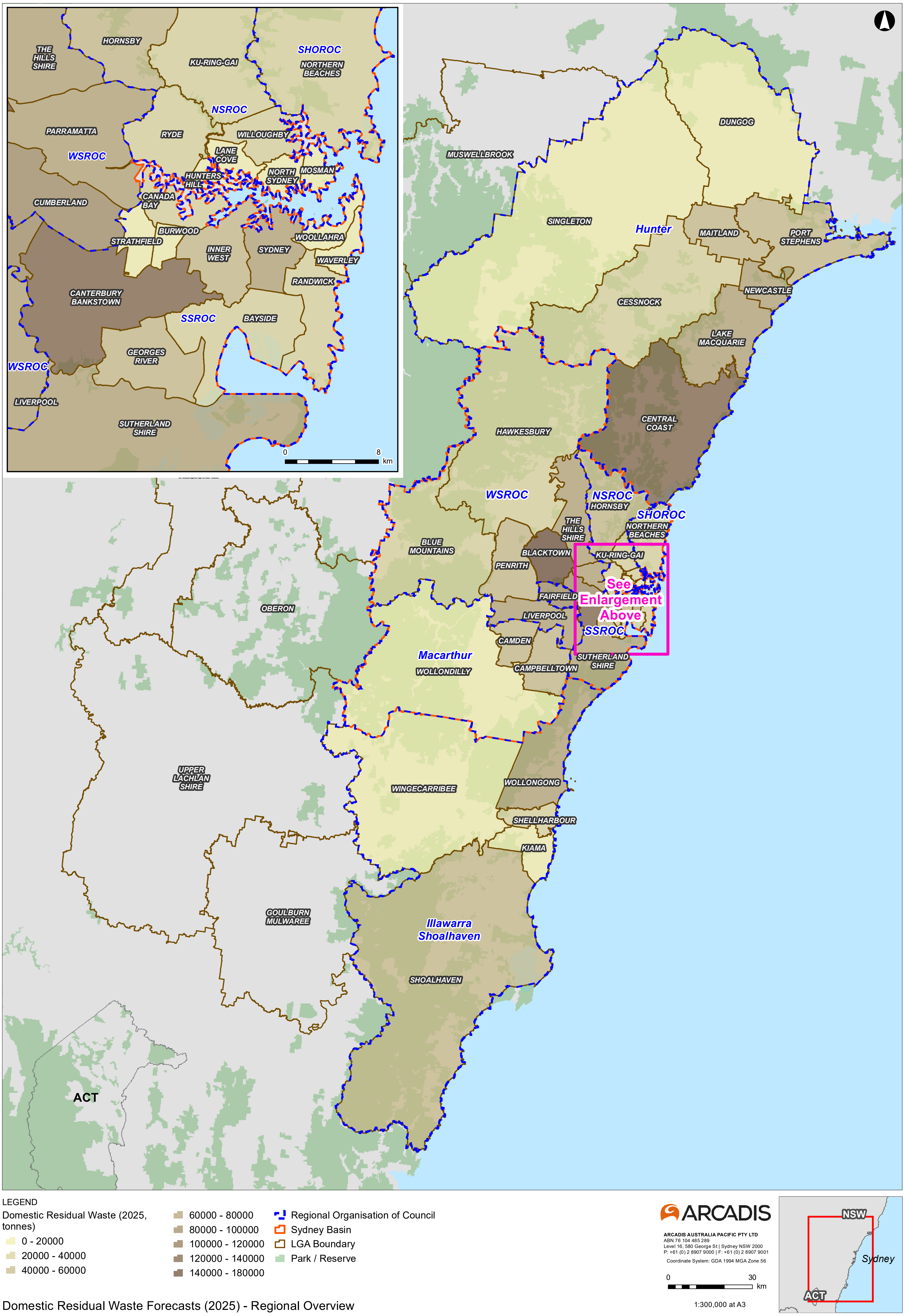
Region	2020	2030	2040	2050
Macarthur	29,427	60,753	102,458	116,748
NSROC	71,153	105,750	159,793	180,774
SHOROC	28,445	44,499	65,453	74,227
SSROC	210,949	346,435	526,300	596,751
WSROC	180,983	299,802	474,879	547,256
Total	**520,958**	**857,239**	**1,328,883**	**1,515,755**

Table 16: Estimates of MSW drop off waste eligible for EfW (Scenario 2)

Region	2020	2030	2040	2050
Macarthur	1,898	3,972	6,888	7,828
NSROC	-	-	-	-
SHOROC	-	-	-	-
SSROC	259	494	794	901
WSROC	4,918	6,656	12,185	15,858
Total	**7,075**	**11,121**	**19,867**	**24,587**

Table 17: Estimates of MSW clean up waste eligible for EfW (Scenario 2)

Region	2020	2030	2040	2050
Macarthur	5,881	13,530	23,964	27,301
NSROC	14,312	21,706	34,931	39,487
SHOROC	5,805	10,512	16,507	18,724
SSROC	30,074	55,808	89,852	101,935
WSROC	23,015	38,763	62,175	71,733
Total	**79,087**	**140,319**	**227,429**	**259,180**



Domestic Residual Waste Forecasts (2025) - Regional Overview

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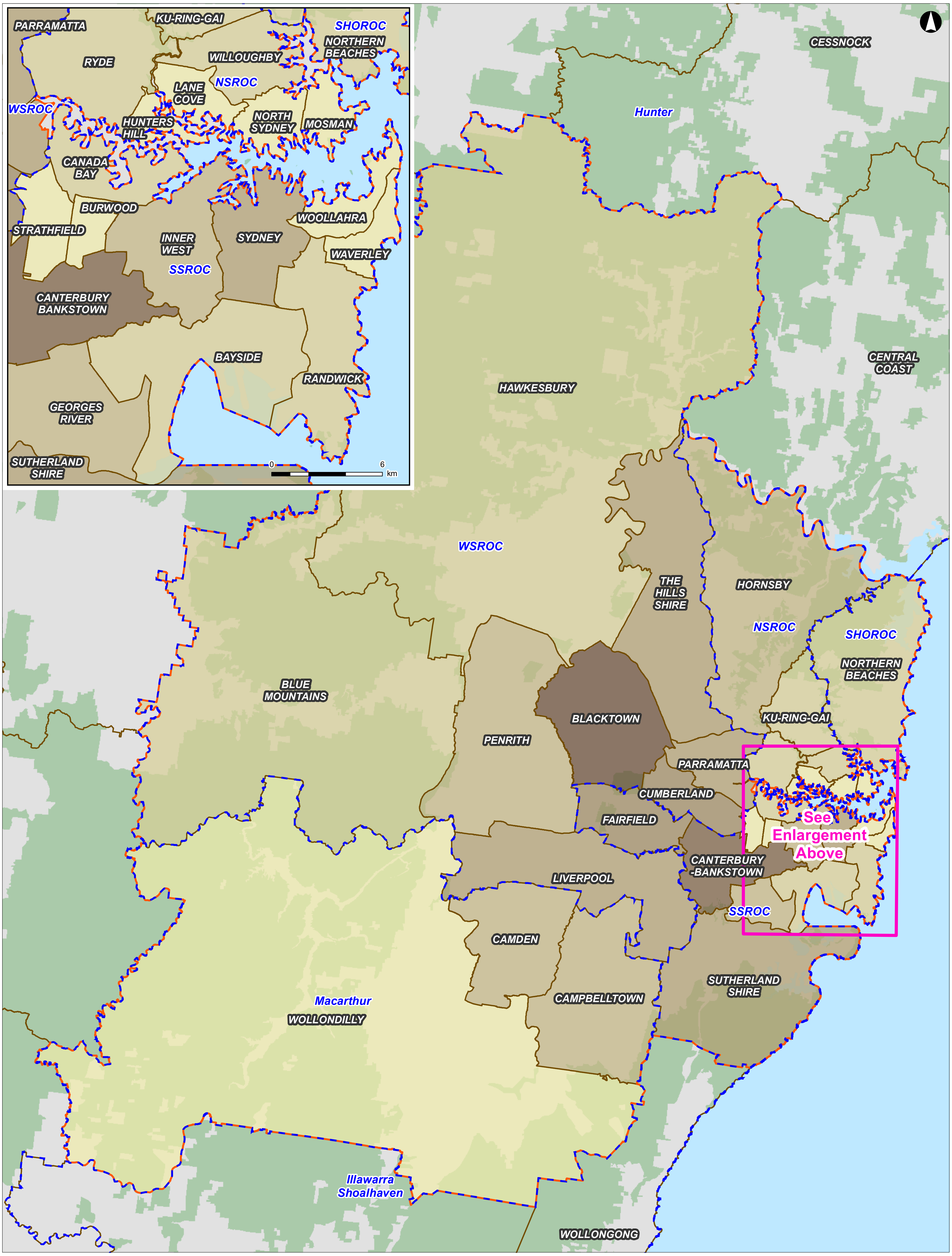
QA by : EM



LEGEND

Domestic Residual Waste (2025, tonnes)

- 0 - 20000
- 20000. - 40000
- 40000 - 60000
- 60000 - 80000
- 80000 - 100000
- 100000 - 120000
- 120000 - 140000
- 140000 - 180000
- Regional Organisation of Council
- Sydney Basin
- LGA Boundary
- Park / Reserve

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Coordinate System: GDA 1994 MGA Zone 56

0 10 km

1:200,000 at A3

Domestic Residual Waste Forecasts (2025) - Sydney Basin

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Created by : CA
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4.1.2 C&I

Estimate of EfW eligible C&I waste under scenarios 3 and 4 have been summarised the following figures and subsequent tables.

Scenario 3: Note 1 Exemption for C&I

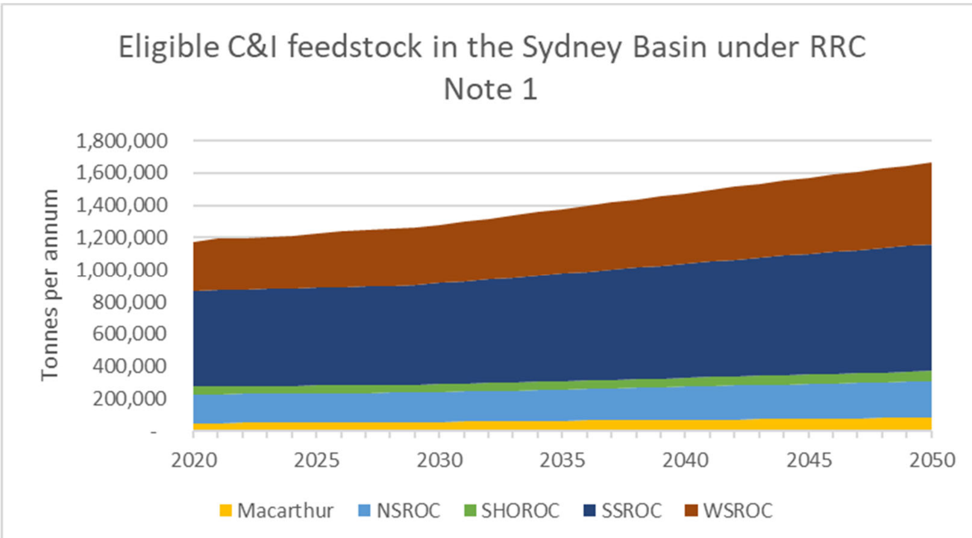


Figure 18: Eligible C&I feedstock estimates (Scenario 3)

Table 18: Estimates of C&I waste eligible for EfW (Scenario 3)

Region	2020	2030	2040	2050
Macarthur	47,869	56,844	69,352	83,466
NSROC	173,510	179,306	199,508	220,385
SHOROC	53,154	53,962	60,905	68,231
SSROC	590,166	625,727	708,696	788,521
WSROC	311,833	363,626	436,280	501,747
Total	**1,176,532**	**1,279,464**	**1,474,741**	**1,662,350**

Scenario 4: Application of the RRC limit and increasing source separation activities for C&I waste generators

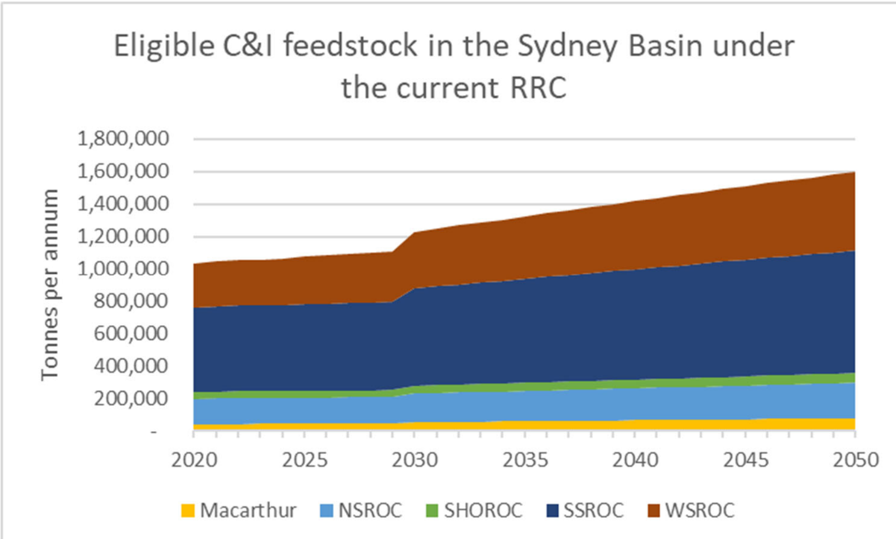
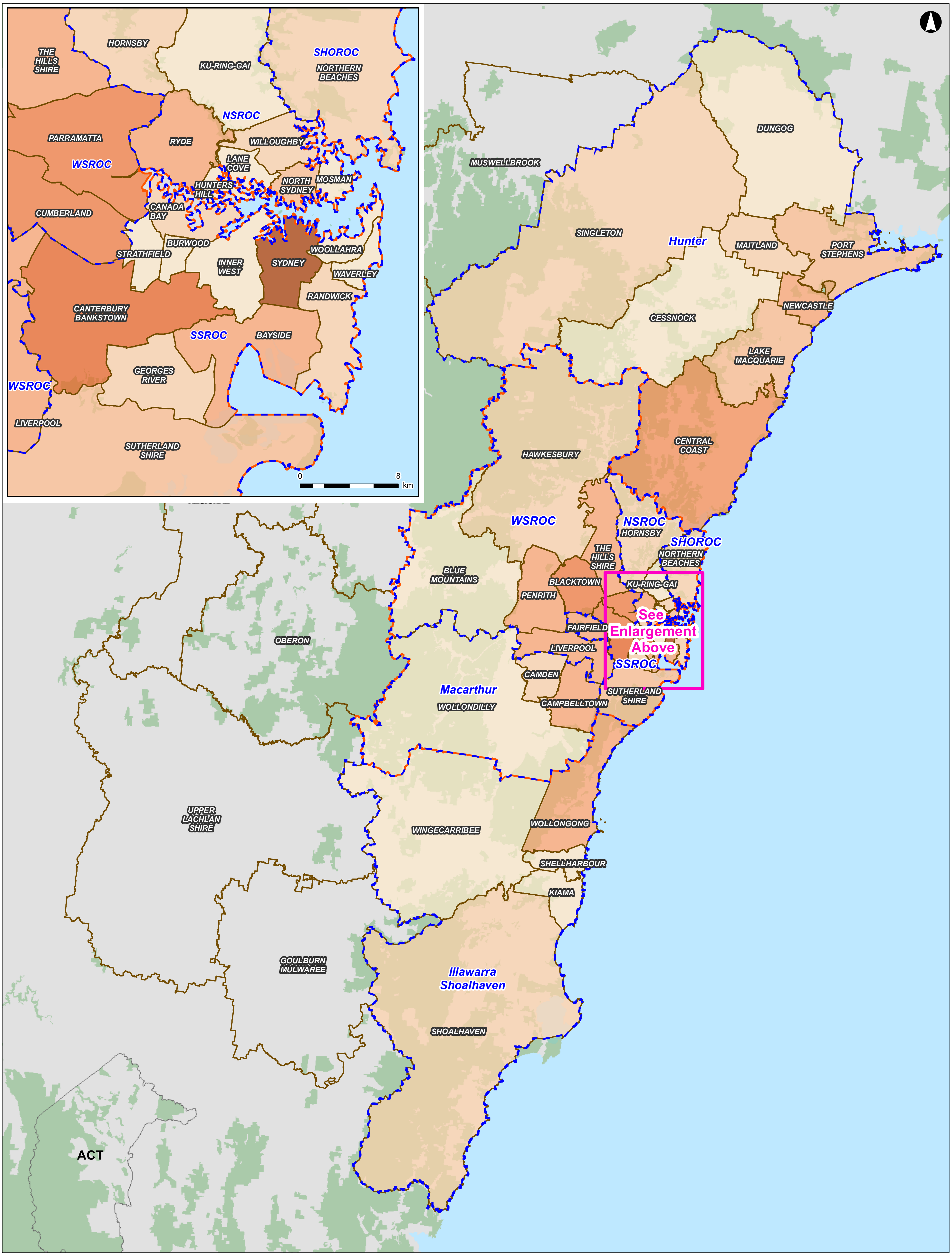


Figure 19: Eligible C&I feedstock estimates (Scenario 4)

Table 19: Estimates of C&I waste eligible for EfW (Scenario 4)

Region	2020	2030	2040	2050
Macarthur	42,083	54,657	66,685	80,256
NSROC	152,536	172,409	191,835	211,908
SHOROC	46,729	51,886	58,563	65,607
SSROC	518,827	601,661	681,438	758,193
WSROC	274,139	349,640	419,500	482,449
Total	**1,034,314**	**1,230,254**	**1,418,021**	**1,598,413**



LEGEND

Commercial and Industrial Residual Waste (2025, tonnes)

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- 20000 - 40000
- 40000 - 60000
- 60000 - 80000
- 80000 - 100000
- 100000 - 150000
- 150000 - 200000
- 200000 - 300000

- Regional Organisation of Council
- Sydney Basin
- LGA Boundary
- Park / Reserve

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Coordinate System: GDA 1994 MGA Zone 56

0 30 km

1:1,250,000 at A3

Commercial and Industrial Residual Waste Forecasts (2025) - Regional Overview

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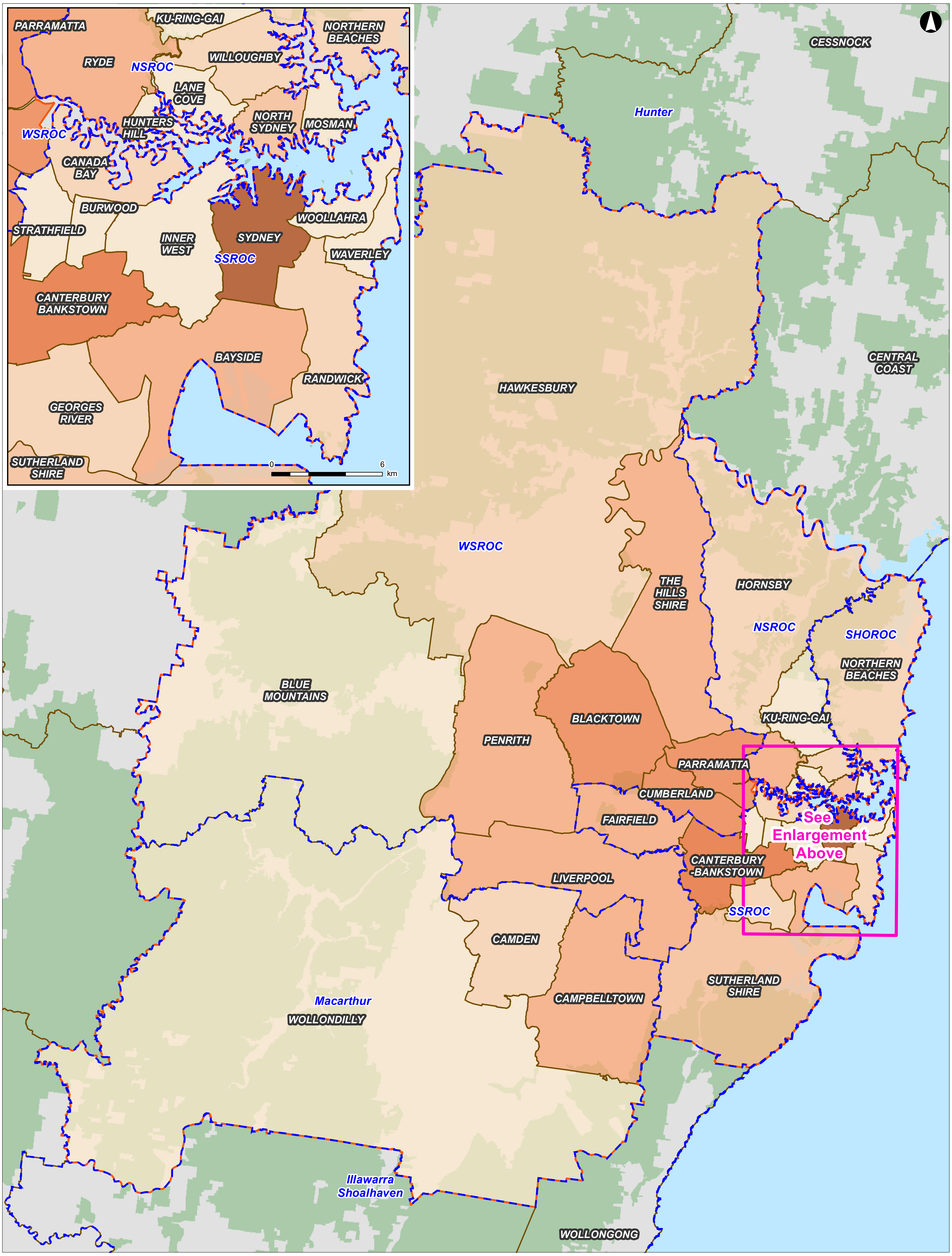

LEGEND

Commercial and Industrial Residual Waste (2025, tonnes)

- 0 - 20000
- 20000 - 40000
- 40000 - 60000
- 60000 - 80000
- 80000 - 100000
- 100000 - 150000
- 150000 - 200000
- 200000 - 300000

- Regional Organisation of Council
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0 10 km

1:500,000 at A3

Commercial and Industrial Residual Waste Forecasts (2025) - Sydney Basin

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Created by : CA
QA by : EM

4.2 Sensitivity Analysis

The following figures illustrate the impact that key modelling assumptions have on future waste flow estimates. These figures show that the waste growth rates adopted for both MSW and C&I have a moderate impact on future volumes, partly because all scenarios assume a plateau (zero further growth) from 2030. The high and low scenarios however should be taken into account to understand best case and worst-case scenarios for infrastructure planning.

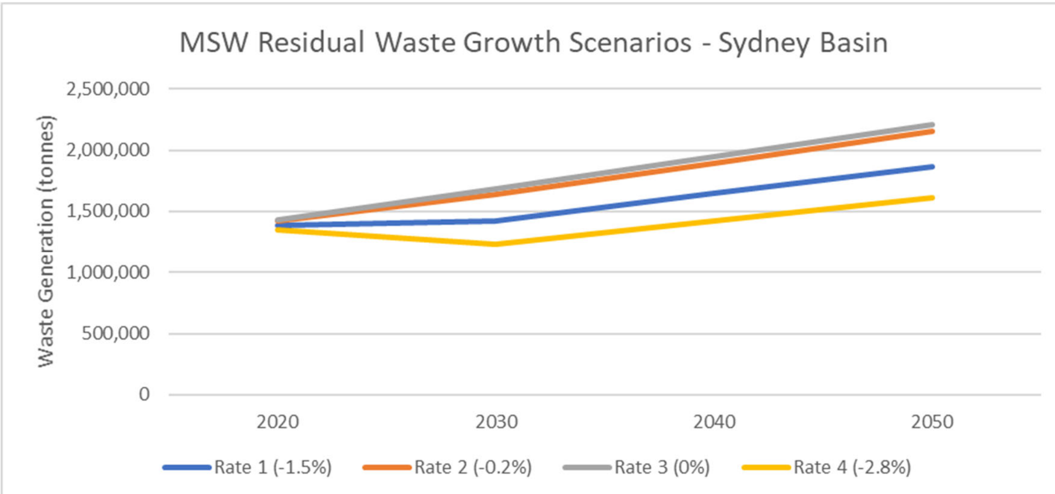

Figure 20: Impact of different unit growth rates (per capita, to 2030) on overall MSW residual waste tonnages in the Sydney Basin

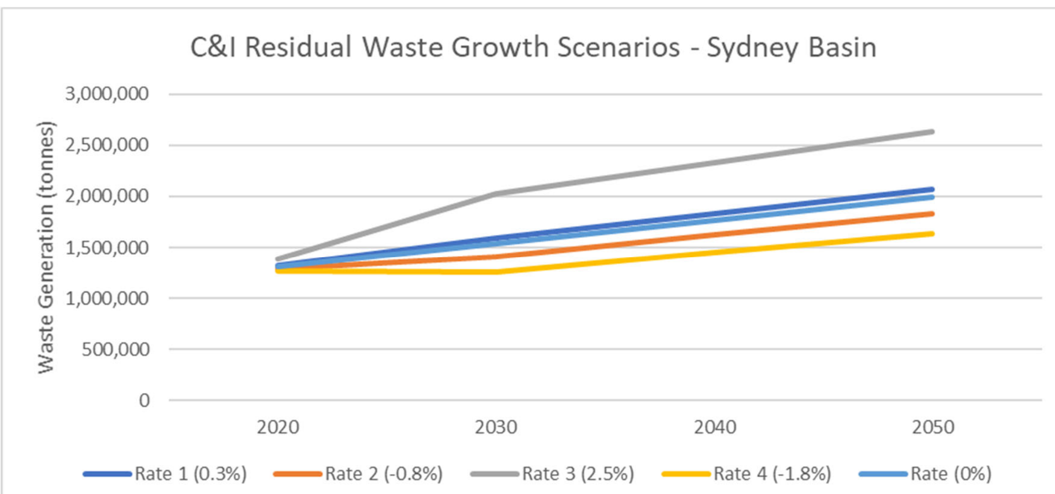

Figure 21: Impact of different unit growth rates (per employee, to 2030) on overall C&I residual waste tonnages in the Sydney Basin

The extent to which different capture efficiencies affect the residual kerbside stream is shown in Figure 22 (assuming implementation of new systems by 2030). The ‘no FOGO’ assumption shows that significantly less waste would be available to an EfW facility under the current Resource Recovery Criteria. If all councils implemented a FOGO system, the remaining MSW residual kerbside stream could be accessed without restriction. If it were a policy for FOGO to be mandated for single unit dwellings (SUDs) only, less food waste would be recovered from the residual waste stream and therefore the eligible quantities are higher. Figure 18 also shows potential tonnages under a Note 1 exemption with best practice resource recovery rates from the mixed waste stream (refer to Section 2.3.4).

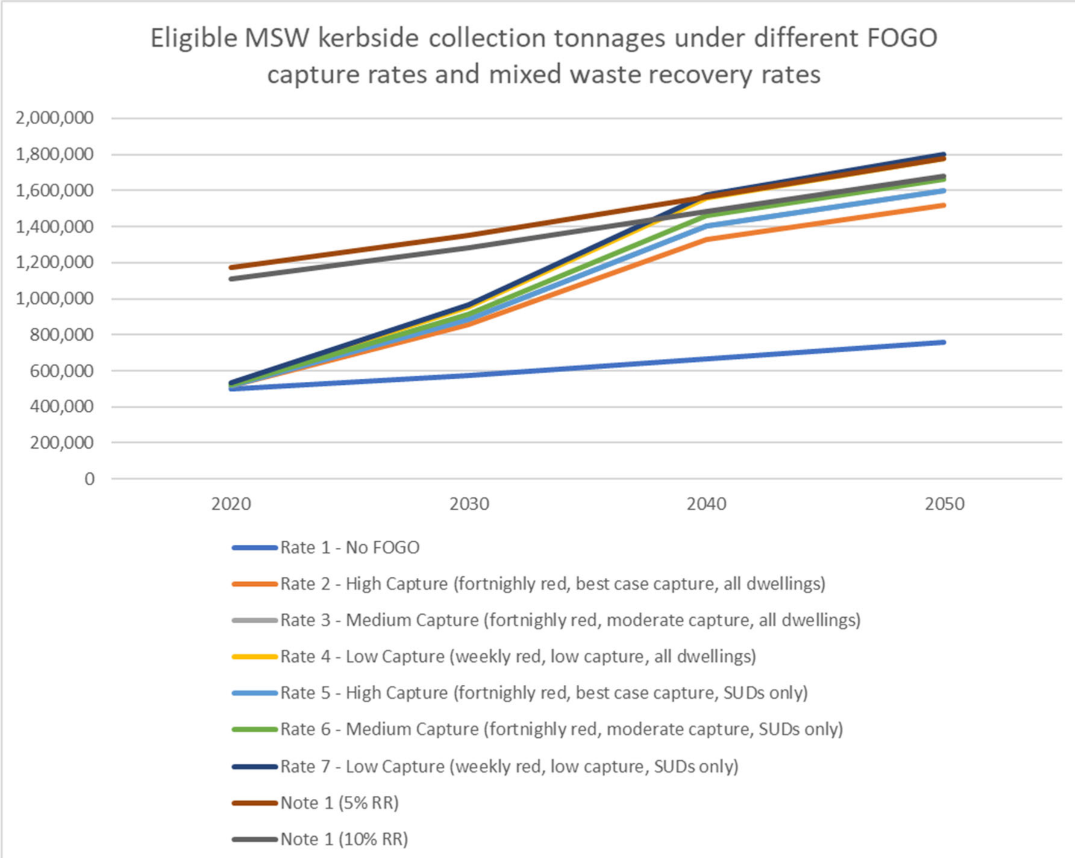

Figure 22: The impacts of different capture efficiencies (from 2030) on the MSW kerbside residual waste stream

4.3 Composition

The Sponsors have undertaken compositional analysis of municipal and commercial mixed putrescible waste streams currently managed by Cleanaway at its Erskine Park facility in western Sydney (Appendix A). This section provides a broader overview of the expected composition of key streams and high level comparison with the Cleanaway data, primarily to inform considerations around how opportunities for recycling may impact the future target feedstock stream.

The composition of future feedstocks is essential to understand as the design of the proposed EfW facility is developed and as the waste supply strategy is refined. Understanding the potentially recyclable and organic materials that are in each stream will help the Sponsors to take a view on potential future reductions or improvements in diversion of those materials (e.g. to the yellow or green bins).

The waste composition also determines the energy content (calorific value) of the feedstock, which is an essential parameter to understand in setting the design basis for the EfW process. The core of the plant (the furnace and boiler) will be designed for a defined thermal input range, which is a function of both waste tonnage and calorific value. While the plant will be flexible and have a wide operating envelope, over-estimation of the feedstock calorific value could result in a plant which is oversized for the planned tonnage and therefore more expensive to build and less efficient to run. Under-estimating the calorific value at an early stage could result in future tonnage inputs being constrained in the future, which will have a significant impact on project revenues.

Estimating waste CV from compositional data is possible but subject to a significant error margin, given discrepancies in published CVs for individual materials and the impact of assumptions around moisture content. An analysis of the likely calorific value of each stream is beyond the scope of this report but will need to be done as the waste sourcing strategy is further developed.

The calorific value of a particular waste stream should also inform the pricing strategy for that feedstock. A feedstock that has a high calorific value will consume (proportionally) more of the plant capacity than one with a lower calorific value and therefore should be sourced at a higher gate fee, but the market may not necessarily allow that depending on the alternative options that are available for that waste stream. This is discussed further below.

4.3.1 MSW kerbside residual waste

Most councils undertake occasional compositional audits on the kerbside residual waste stream, but the detailed data is not typically published. Arcadis has reviewed a number of recent datasets held internally as well as summary data presented in various council and regional strategies published over the last 3 years. This review determined a close alignment with the Cleanaway compositional data.

The internal data indicates:

- The proportion of food and garden organics varies between 36% and 55%. Given most Sydney councils offer some form of third kerbside bin for garden organics, garden waste is the minor portion (typically around 6-11% of residual). Food waste is therefore the largest single material category within the MSW residual stream and the main target of any future FOGO collection schemes, although experience shows that even well-designed FOGO systems are only likely to capture 30-50% of food from the red bin. Penrith and Woollahra are the only Sydney metropolitan councils that currently operate a FOGO service and a 2017 audit of Penrith's residual stream identified there was still 37% food and garden organics left in the red bin.
- The kerbside residual bin consistently contains between 11% and 15% dry recyclables which should be in the yellow bin, across most councils. There is potential for some of this material to be captured in the future through continued education of the community, but the impact is likely to be minor. There is also potential for packaging materials which are currently not recyclable in the yellow bin (e.g. composite materials or soft plastics) to be replaced with recyclable alternatives which could then transfer to the yellow bin.

In 2011, NSW EPA commissioned an extensive program of MSW audits across the state. Whilst somewhat dated now, the results were not substantially different to an earlier audit program from 2007. That study found an average 22% recyclables in the Sydney Metropolitan MSW residual stream which, compared to more recent datasets, suggests there has been an improvement in the capture of recyclables. It also found 6.8% garden organics and 38.5% food in residual MSW in the Sydney region which is generally consistent with more recent data.

MSW waste composition will change over time as a result of changes in collection systems, products and packaging design, and resident behaviour and habits. The adoption of kerbside FOGO collection systems is likely to grow and could have a significant impact but is difficult to predict as discussed above. Other future trends which may have an impact include:

- Ongoing improvements and efficiencies in packaging, including reduced usage of single use and disposable packaging and reduced use of non-recyclable packaging such as composite materials (in line with national commitments to make all packaging reusable, recyclable or compostable);
- Reductions in household food waste through consumer awareness and education, improved lifespan of food products, as well as growth in home / community composting;
- Trend towards outsourcing the preparation of meals to third parties through the growth in home delivery services, which then shifts the food waste to the commercial sector, but increases household packaging waste; and
- Increasing activation of circular economy business models, such as repairable and reusable products, returnable packaging (e.g. current trials in food delivery and coffee cup exchanges) and packaging-free bulk grocery stores.

There is limited existing data on the calorific value of Sydney residual household waste, although it is typically in the range 8-10 MJ/kg. It is also difficult to predict the impact that future changes, such as those outlined above, will have on calorific value. Reduced usage and increased recycling of plastic packaging will reduce the calorific value of the residual stream, while increased recovery of wet food waste will likely improve the overall CV of household waste. Any additional removal of inert materials such as glass and metals through improved recycling (including the CDS) will also increase the CV.

4.3.2 Bulky / Clean-up household waste

As noted above, other MSW waste streams such as bulky waste from transfer stations or kerbside clean-up collections, could be a potential feedstock for the facility. Few councils have undertaken audits of the composition of this stream, but a 2014 assessment commissioned by SSROC audited the clean-up waste of 12 of its member councils.

- At the time, 16% of clean-up waste was being recycled – mostly mattresses, white goods, vegetation, e-waste and metals;
- An additional 28% was identified as recoverable (13% via re-use and 15% via recycling), particularly though re-use of furniture and recycling of e-waste;
- There was a significant proportion of wood waste (19.5%) of which around 4% was treated timber. Vegetation was 14% while general bagged waste was 22%.
- The stream contains a number of materials which are unlikely to acceptable or desirable in a conventional EfW facility such as e-waste (12.6%), rubble (15.8%), paint (3.6%), batteries (0.5%), whitegoods (0.7%), mattresses (0.33%), and gas bottles and fire extinguishers (1.1%).

The data suggests that there are significant combustible materials within the clean-up stream and the report estimated that the calorific value of the waste varies between 11 and 18 MJ/kg, which is notably higher than typical kerbside waste. The main contributors to the calorific value of the clean-up stream are furniture, plastic, wood and vegetation. However, given the variety of materials which are likely to be unacceptable or undesirable in EfW for different reasons, it would need to go through a pre-sorting process before being utilised as a feedstock.

It is assumed that bulky waste which is dropped off at transfer stations (drop-off waste) would be of a similar composition. Arcadis understands that, after basic recyclables are extracted (in some cases), the majority of council clean-up and bulky waste goes to non-putrescible landfills, which provides slightly lower priced competition (than putrescible kerbside waste).

Given the higher calorific value, the Sponsors may need to price this stream higher than kerbside putrescible MSW. Considering the benchmark market prices are already lower for this stream and the need for pre-sorting, it may be a less attractive feedstock.

4.3.3 C&I waste

The mixed C&I waste stream may be broadly classified as either wet or dry (putrescible versus non-putrescible), depending on the presence of putrescible waste. Both are compatible with EfW, however, the competitive contexts for each stream vary, with dry waste streams going to non-putrescible landfills or a refuse derived fuel outcome, and wet C&I waste disposed to putrescible landfills at higher gate fees (indicatively $250/tonne for non-putrescible versus $300-350/tonne for putrescible landfill in Sydney).

Dry C&I waste will also have a higher calorific value than wet waste which may require slightly higher gate fees in an EfW facility. There are more outlets and therefore more competition for dry C&I waste, including non-putrescible landfills and existing or planned RDF production facilities, which will drive higher demand and lower gate fees.

However, supply of dry mixed waste (as a proportion of the total C&I stream) is difficult to estimate as C&I waste is typically collected in mixed loads with no consideration of separating wet and dry. As a result, Arcadis understands the majority is treated as wet waste and sent to putrescible landfills.

There is limited recent, public data available on the composition of the C&I stream. NSW EPA commissioned comprehensive audits of mixed (putrescible) C&I waste across a range of generators (covering all main industry sectors) and disposal facilities in 2014[22]. While the data is becoming dated, in Arcadis view the generation dynamics of C&I waste are unlikely to have changed significantly since 2014, although recycling may have improved. The data is still likely to provide a good indication of current composition of the residual stream (see Figure 23). The average across the Sydney Metropolitan Area showed:

- Waste wood was a significant proportion (14.5%) which is likely to be mostly clean packaging (e.g. pallets and reels) or offcuts;
- Plastics were also significant at 12.8% while paper and cardboard were 16.1% and textiles 5.6%.
- Food organics were only 9% overall but clearly this will vary between different business types and may be much higher for some sectors.

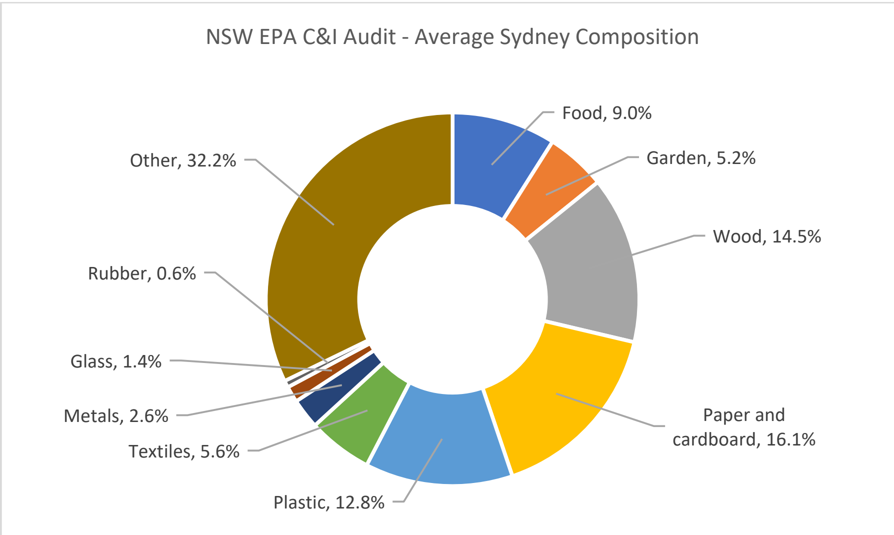

Figure 23: Summary of average Sydney C&I residual waste composition data based on NSW EPA C&I audits 2014

The more recent Cleanaway dataset on mixed putrescible C&I waste has some differences with the 2014 state audit, which may in part reflect a more granular breakdown of the significant 'Other' fraction in the EPA data. Notable differences in the Cleanaway data are:

- Food and garden organics are significantly higher (41.5%)
- Paper and cardboard is higher (25%), although only 9% is potentially recyclable
- Plastic is higher (21%), although only 5% is potentially recyclable
- Wood is significantly lower and categorised with textiles, rubber and other organics (6.5%).

The EPA study also specifically assessed the waste generation by different sectors through generator audits. It found the industry sectors disposing the most C&I waste in Sydney overall were manufacturing (26%), small businesses (17%), retail (12%) and healthcare/social assistance (7%).

The future composition of C&I waste will change, driven by macro trends such as reduced usage of disposable / single use packaging for materials and goods including intermediate transport packaging; and reduction and reuse of manufacturing wastes at source through more efficient production.

In the Waste Management Assessment report supporting the The Next Generation EfW proposal, consultants Ramboll estimated the likely chemical composition of dry, pre-processed C&I waste in Sydney (based on EPA audit data) and estimated the CV to be around 13.8 MJ/kg. This is an average and clearly there will be a wide range of potential values, depending on the mix of source industries.

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

4.4 Current MSW disposal / processing contracts

The scale and potential longevity of local government contracts for disposal/processing of MSW residual makes councils the key feedstock supplier for any EfW project. It is therefore critical to identify the existing contract arrangements of each council within the potential feedstock catchment that might supply the target waste to the Project.

Contracted waste gate fees are not typically disclosed due to commercial sensitivities and Arcadis is not privy to specific gate rates paid by individual councils and companies. The exception is Penrith City Council, which in 2018 published its new per tonne rate for disposal of mixed waste within its council minutes, being $300 per tonne with Suez.

Councils and large waste generators achieve volume discounts on published rates, which for Lucas Heights landfill is $363 per tonne for putrescible waste, including the waste levy (effective March 2019). Benchmark industry discount rates for councils are typically 15-30%[23], which implies a gate fee in the order of $250-310 per tonne for disposal at Lucas Heights.

Benchmark rates for non-putrescible waste disposal in Sydney are around $250 per tonne, with volume discounts reducing that for large generators.

Key parameters for each council are tonnes of each target residual stream, current destinations and contract expiry. Table 20 – Table 24 provide these details for Sydney basin councils, aggregated by Regional Organisation of Councils (ROC), along with notes on their interest in alternative waste services, based on Arcadis' market knowledge. The processing/disposal contract expiry dates and tonnes under management have been consolidated in Figure 24 to indicate the pipeline of feedstock as it becomes available over time.

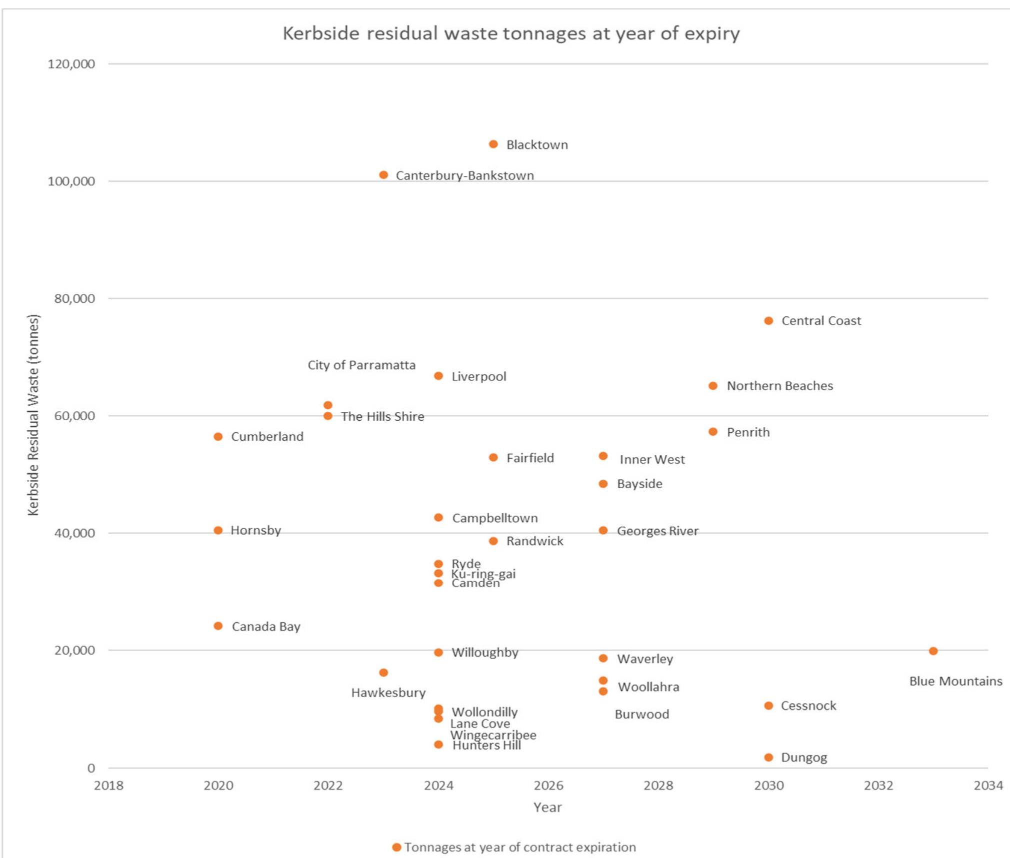

Figure 24: Summary of available council residual waste tonnages and contract expiry.

23 Based on Arcadis experience working with local government

The Western Sydney Regional Organisation of Councils (WSROC) is the only ROC in Sydney that has not undertaken a regional procurement for mixed waste. However, there is interest among some member councils in a regional contract to aggregate enough tonnes to attract waste market interest in alternative solutions. In 2018, Arcadis undertook a preliminary assessment of options for WSROC councils around collective procurement and subsequently identify suitable locations for a waste processing or transfer facility.

Where the contracted destination or expiry dates are not known, this has been left blank. Councils currently sending their waste to an alternative waste treatment facility are impacted by the recent regulatory changes to the treatment of mixed waste organics outputs (MWOO) that weakens the viability of these facilities (Section 2.3.6).

Table 20: Western Sydney councils residual waste disposal / processing contracts

Council	Processing / Disposal Facility	Service Provider	Contract Expiry Date	Notes
Blacktown	UR-3R, Eastern Creek	Suez	2025	Impacted by MWOO, considering options
Blue Mountains	Blaxland Landfill	Council	2033 (estimated landfill capacity)	Considering FOGO
Cumberland (Auburn)	Woodlawn Landfill	Veolia	2020	Will merge contracts in the near term
Cumberland (Holroyd)	UR-3R, Eastern Creek	Suez	2020 (2+2)	
Fairfield	UR-3R, Eastern Creek	Suez	2025	-
Hawkesbury	Hawkesbury City Waste Management Facility	Council	2023	Considering options
Lithgow	Lithgow Solid Waste Facility	Council	-	-
Parramatta	UR-3R, Eastern Creek	Suez	2018 (Options: 2+2=2022)	Impacted by MWOO
Penrith	FOGO: Badgerys Creek / Blayney (SUDs + Rural)	ANL	2029	-
	Mixed and bulky waste: Lucas Heights Landfill	Suez	2029	
The Hills	Lucas Heights Landfill	Suez	2022 (Option: up to 5 years=2027)	Considering options

While the south-west Sydney councils of the Macarthur region also participated in the WSROC regional procurement analysis, they have previously undertaken regional procurement for waste processing and disposal that supported development of a new processing facility (the failed Arrowbio project). The Macarthur region councils, and Liverpool Council, are currently preparing to go to tender and it is anticipated they will again be looking to support an alternative waste facility.

Table 21: South-western Sydney councils residual waste disposal / processing contracts

Council	Processing / Disposal Facility	Service Provider	Contract Expiry Date	Notes
Camden	Spring Farm, SAWT	Suez	2024	Currently preparing to tender
Campbelltown	Spring Farm, SAWT	Suez	2024	Currently preparing to tender
Wollondilly	Spring Farm, SAWT	Suez	2024	Currently preparing to tender
Wingecarribee	Spring Farm, SAWT	Suez	2024	Currently preparing to tender
Liverpool	Kemps Creek SAWT	Suez	2019 (+ 5)	Currently preparing to tender

Six of the eight member councils of the Southern Sydney Regional Organisation of Councils (SSROC) are part of a regional contract with Veolia to process and dispose of their waste at the Woodlawn MBT facility. Other SSROC councils did not join for a range of reasons, including a perception the recovery rate was too low and a preference to develop a council site (Canterbury Bankstown has long considered developing an AWT at its Kelso site). The current processing/disposal contracts for each council are listed below, where known.

Table 22: Southern Sydney councils residual waste disposal / processing contracts

Council	Processing / Disposal Facility	Service Provider	Contract Expiry Date	Notes
Bayside	Woodlawn MBT and Landfill	Veolia	2027	Impacted by MWOO
Burwood	Woodlawn MBT and Landfill	Veolia	2027	Impacted by MWOO
Canterbury Bankstown	Woodlawn Landfill	Veolia	2023	Interested in AWT at a council site
Canada Bay	Woodlawn Landfill	Veolia	2020 (+5)	-
City of Sydney	Kemps Creek MBT	Suez	-	Trialing FO in high rise. Impacted by MWOO
Georges River	Woodlawn MBT and Landfill	Veolia	2027	Impacted by MWOO
Inner West	Woodlawn MBT and Landfill	Veolia	2027	Impacted by MWOO
Randwick City	Kemps Creek SAWT	Suez	2025 (+3)	Trialing FO in high rise, Impacted by MWOO

Sutherland	Lucas Heights	Suez	2029	Part of landfill Planning Agreement
Waverley	Woodlawn MBT and Landfill	Veolia	2027	Impacted by MWOO
Woollahra	Woodlawn MBT and Landfill	Veolia	2027	Impacted by MWOO; trialing FOGO

Five of the six NSROC councils followed SSROC to secure a regional contract with Veolia that also relies on Woodlawn for processing and disposal. Hornsby opted out of the process and recently extended its contracts to delay any long-term decision on processing or disposal.

Table 23: Northern Sydney councils residual waste disposal / processing contracts

Council	Processing / Disposal Facility	Service Provider	Contract Expiry Date	Notes
Hunters Hill	Woodlawn MBT and landfill	Veolia	2024 (+ 5)	Impacted by MWOO
Ku-ring-gai	Woodlawn MBT and landfill	Veolia	2024 (+ 5)	Impacted by MWOO
Lane Cove	Woodlawn MBT and landfill	Veolia	2024 (+ 5)	Impacted by MWOO
Hornsby	Woodlawn landfill	Veolia	2020 + 3	Watching brief on AWT
Ryde	Woodlawn MBT and landfill	Veolia	2024 (+ 5)	Impacted by MWOO
Willoughby	Woodlawn MBT and landfill	Veolia	2024 (+ 5)	Impacted by MWOO

The SHOROC councils undertook a lengthy procurement process for an AWT facility in 2017 that ultimately saw them contract with Suez to use the existing UR-3R facility at Eastern Creek.

Table 24: SHOROC councils residual waste disposal / processing contracts

Council	Processing / Disposal Facility	Service Provider	Contract Expiry Date	Notes
Northern Beaches	UR-3R, Eastern Creek	Suez	2029	Impacted by MWOO
Mosman	UR-3R, Eastern Creek	Suez	2029	Impacted by MWOO

5 COMPETITOR ANALYSIS – MIXED PUTRESCIBLE WASTE

This section of the report addresses the competitive context for the Project in terms of forecasting the long-term supply and demand for processing and disposal of putrescible mixed waste within the Sydney Basin.

To quantify supply of processing and disposal capacity, the report profiles the existing portfolio of waste facilities dedicated to serving Sydney's putrescible waste flows and considers the known potential for new facilities over the life of the Project. The focus is on facilities dedicated to managing Sydney's waste as they provide the only secure long-term capacity for metropolitan waste, given the putrescible landfills in the broader region are all owned by councils and typically managed as a community asset for the long term. They do not represent a reliable mainstream option for Sydney's mixed waste.

The demand and supply of waste management capacity over the likely life of the Project are compared in order to estimate the scale and availability of long-term waste feedstocks.

Non-putrescible waste and all waste from the construction and demolition (C&D) sector is excluded from the analysis as these streams are not target feedstock for the Project.

This section of the report represents Arcadis' independent view of current and future waste volumes and market issues in Greater Sydney, based on the data that was available to us at the time. The data sources, assumptions and scenarios have been discussed with the Sponsors but have been sourced and modelled by Arcadis.

This analysis has been prepared in accordance with the reasonable care and diligence of the consulting profession for a document of this nature, within the time frame and information available. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this document.

5.1 Current Demand

In 2018/19, the Sydney Basin[24] generated approximately 1.9 million tonnes of putrescible MSW and C&I waste, 60% stemming from municipal sources (1.1 million tonnes[25]) and 40% from commercial and industrial sources (800,000 tonnes[26]).

Under a business as usual scenario assuming conservative but realistic waste generation growth rates, the target putrescible waste is forecast to grow over the indicative 30-year life of the Project, to 2.4 million tonnes in 2035 and 2.9 million tonnes by 2050 (Figure 25). The BAU forecast does not include future food and garden (FOGO) collection, which would divert more organics away from the mixed waste stream. A reference FOGO scenario has also been developed.

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[24] The Sydney Basin is smaller than the Metropolitan Levy Area, which includes the Hunter, South Coast and Central Coast.

[25] We have assumed the MSW drop off and clean up streams are largely non-putrescible and as such only the kerbside collection tonnages are incorporated in this estimate.

[26] We have assumed that approximately 60% of C&I waste to landfill is putrescible, based on industry knowledge.

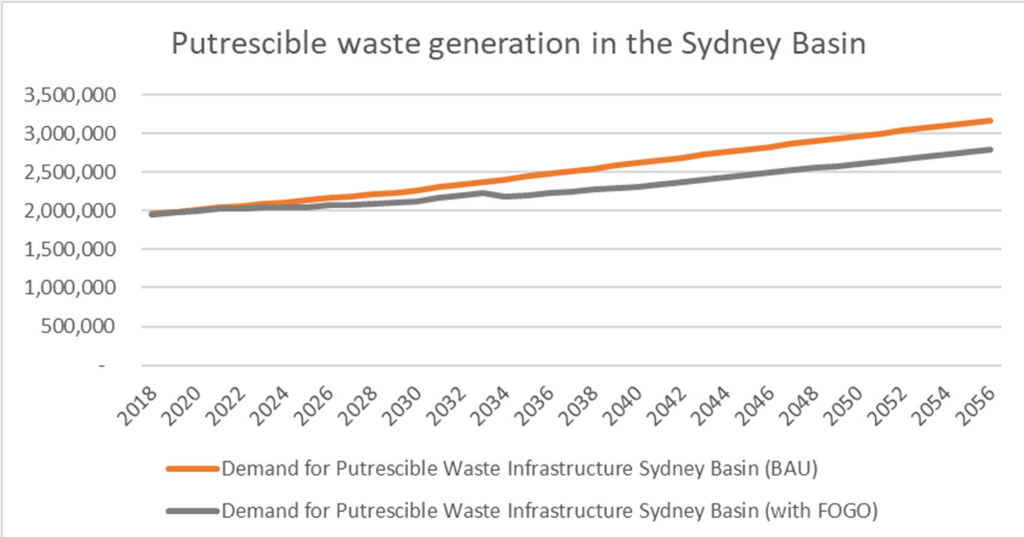

Figure 25: Forecast putrescible waste generation in the Sydney Basin

5.2 Current and Potential Supply

This section analyses the licensed capacity of putrescible waste landfill assets and design or licenced capacity of MSW AWT facilities that compete with the Project for Sydney basin putrescible waste.

5.2.1 Existing facilities

The waste facility fleet dedicated to Sydney putrescible waste is highly constrained. Just two landfills and three AWT facilities are designated to the task of managing Sydney's mixed waste, providing limited redundancy in the system should any of the facilities fail.

The five putrescible waste facilities provide annual capacity of 2.25 million tonnes:

- Lucas Heights Landfill – 850,000 tpa
- Woodlawn Landfill – 900,000 tpa (Sydney waste)
- Elizabeth Drive MBT – 134,000 tpa
- UR-3R MBT – 220,000 tpa
- Woodlawn MBT – 144,000 tpa (total development approval for 240,000 tpa of putrescible waste).

Key vulnerabilities in the Sydney waste system include reliance of the Woodlawn waste facility 250km south of Sydney to manage 50% of metropolitan putrescible waste, and the regulatory risk of the MBT facilities' dependence on a Resource Recovery Exemption to apply their mixed waste organics outputs (MWOO) to land, which was rescinded in late 2018 effecting 26% of metropolitan putrescible waste capacity.

The limitations of Sydney's putrescible airspace is demonstrated in Figure 26. The figure illustrates known airspace capacity and licenced throughput for Woodlawn and Lucas Heights. As illustrated, Woodlawn could still be operating in the early 2040s, but Lucas Heights will have depleted its airspace capacity by 2030. The 850,000 tonnes currently serviced by Lucas Heights represents an opportunity for the Proposal.

Developing an EfW facility to process putrescible waste will divert waste away from landfill, which contribute towards deferring landfill capacity issues, as well as providing redundancy to the waste management system.

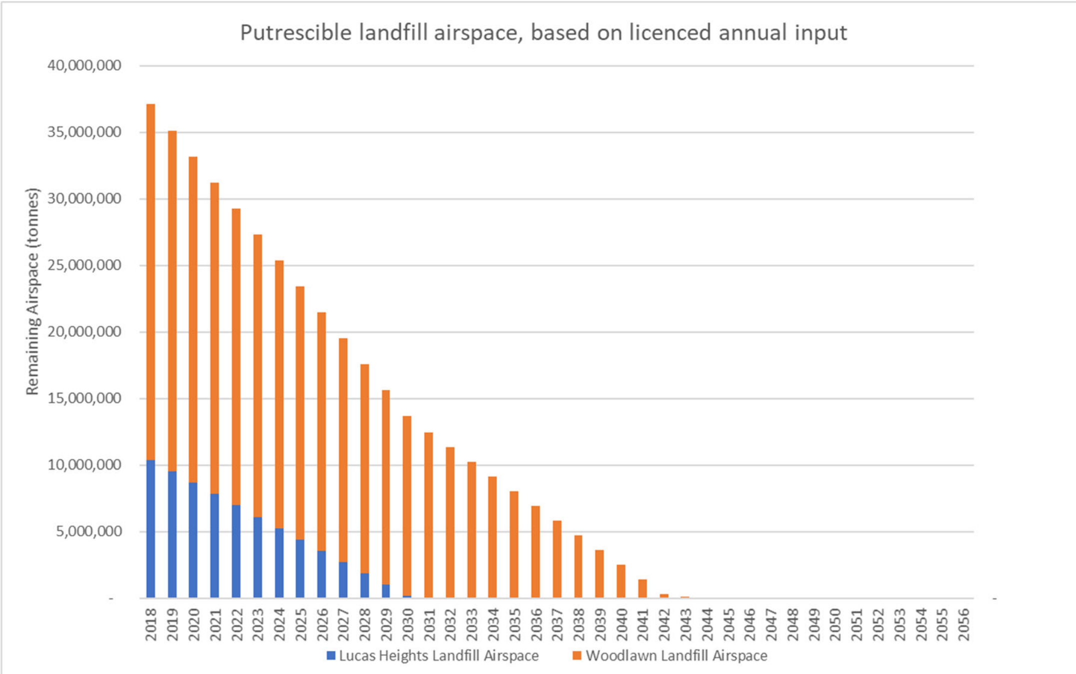

Figure 26: Disposal capacity for Sydney Basin putrescible waste, declining by approved annual input[27].

5.2.2 Future facilities

There are significant barriers to developing new waste infrastructure or expanding existing waste infrastructure in the Sydney basin. Issues include a community that is highly sensitised to waste facilities, residential encroachment on industrial lands, high land prices and long statutory approvals times (up to five years for designated 'state significant' waste infrastructure).

Arcadis has assessed the challenges for each of the management pathways for putrescible mixed waste in Sydney – disposal to landfill or processing in an alternative waste treatment facility (AWT).

Landfill

Landfill development is particularly challenging given the correlation with a larger footprint, outdoor operations and higher potential impacts on amenity.

While three significant Sydney putrescible landfills have closed in the last 15 years, the only new landfill developed in Sydney is the 200,000 tpa, non-putrescible Patons Lane Landfill, which was approved by the NSW Land and Environment Court in 2012 after receiving a NSW record 11,500 submissions[28], significant political opposition, multiple legal challenges and bankrupting the original proponent (Dellara). Patons Lane is not a competitor for putrescible waste flows, but this demonstrates the significant challenge to secure approval for any new landfill in Sydney.

The Woodlawn Landfill approved in 2000 is well outside the Sydney basin, but the Sydney transfer station to mode shift the waste to rail was subject to media and political opposition, and was only approved after the government of the day over-ruled the Land and Environment Court.[29]

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[27] Landfill closure dates are estimated based on approved airspace and licensed throughput limits. There are uncertainties in these estimates as actual throughput and compaction rates are not known due to the high level of commercial sensitivity in the information.

[28] https://westernweekender.com.au/2012/07/green-light-for-dump/

[29] www.smh.com.au/national/secrecy-over-site-of-waste-transfer-depot-20070313-gdpnqo.html

The Lucas Heights Landfill has already been increased twice and it is considered unlikely that a further expansion would be approved given the height profile compared to the surrounding region and the commitment to convert it to community parklands.

Given the above history and urban challenges, it is even less likely that a new putrescible waste landfill will be developed in Sydney.

Alternative Waste Treatment (AWT)

The barriers to development of a putrescible waste AWT facility are significant and broadly mirror those for landfill, although they are likely to be less intensive where the processing and emissions are fully enclosed.

The MBT approach that has been favoured for the last decade was in part due to the lower deliverability risks at the time compared to other approaches, such as thermal processing. This helped support development of the three existing AWT facilities.

It also informed approval for another MBT at Lucas Heights Landfill (200,000 tpa). However, it is far from clear that it will be developed due to the NSW EPA decision to rescind the Resource Recovery Exemption for MWOO, which eliminates the end market for the major product output from the process.

The primary alternative to MBT is energy from waste (EfW). The current regulatory settings act as an inhibitor to development of an EfW facility, in part due to the limitations on waste feedstocks under the EfW Policy and the current kerbside collection practices, as discussed in the companion report. The conservative settings have until now contributed to the limited development of EfW facilities in NSW, including Sydney.

Apart from the Project, the only other planned EfW facility including putrescible waste as a feedstock is the Mt Piper Power Station Energy Recovery Project, which aims to produce an RDF from Sydney Basin putrescible and non-putrescible waste to co-combust in the power station near Lithgow.

While Suez are planning a co-generation energy from waste plant at the Orora paper mill at Botany, its feedstock is PEF produced from dry C&I and also residuals from the mill. Given this mix of feedstock, the Suez facility will not compete with the Project.

In 2018, the NSW Independent Planning Commission refused an application to develop an Energy from Waste facility to process up to 550,000 tonnes of mixed waste from C&I and C&D waste streams. A 2019 appeal to the NSW Land and Environment Court to amend and approve the proposal – included reduced throughput to 300,000 tonnes per annum and expanded target feedstock to include “Municipal Organic Waste” – was refused in 2020. However, the original project has been included in the modelling as a worst case scenario (C&I waste only) as the final status of any potential appeal process is not determined.

Arcadis is not aware of any other proposals targeting Sydney basin putrescible waste thus the competition is low. Arcadis considers this attributable to the low industry appetite to develop new waste infrastructure for the Sydney putrescible waste market, given the general development barriers, the heightened level of regulatory risk from the MWOO decision and the intended release in 2020 of a 20-Year Waste Strategy for NSW that could alter the context for waste management in the state.[30]

5.3 Supply and Demand Balance

Figure 27 overlays forecast waste generation with the capacity of current and planned facilities to receive Sydney Basin putrescible waste.

The estimated supply capacity aggregates the approved annual throughput of existing and known planned AWT facilities with the annual limits and remaining life of landfill assets, based on current

[30] www.epa.nsw.gov.au/your-environment/recycling-and-reuse/20-year-waste-strategy-for-nsw

waste flows and service configurations. It conservatively assumes the existing MBT facilities will be repurposed to retain their current contracts and that two approved facilities may be developed.

There is a clear long-term decline in overall capacity, with analysis indicating a shortfall in processing and disposal capacity for putrescible waste by the early 2030s under business as usual collection (no FOGO) and existing facilities only. By 2031, annual demand for processing and disposal is 850,000 tonnes per annum above supply.

The shortfall in capacity remains even with a positive trend towards FOGO adoption and a high organics capture rate that diverts food from mixed waste. The demand line under the FOGO scenario indicates a 720,000 tonne shortfall in annual capacity in 2031.

We have not included the Dial A Dump or Suez energy from waste projects in the below figure as they are not competing for the same feedstock. Similarly, the proposed Mount Piper EfW Facility is not included as it is assumed to source putrescible feedstock from MBTs. Existing and approved MBTs have been included in this analysis. However, the future of these facilities is uncertain since the MWOO Resource Recovery Order and Exemption were rescinded.

In addition to highlighting uncertainties in future capacity, Figure 27 also shows the significant landfill diversion opportunity. This in turn demonstrates the need for infrastructure that offers higher order resource recovery opportunity in line with the NSW Waste Avoidance and Resource Recovery Strategy.

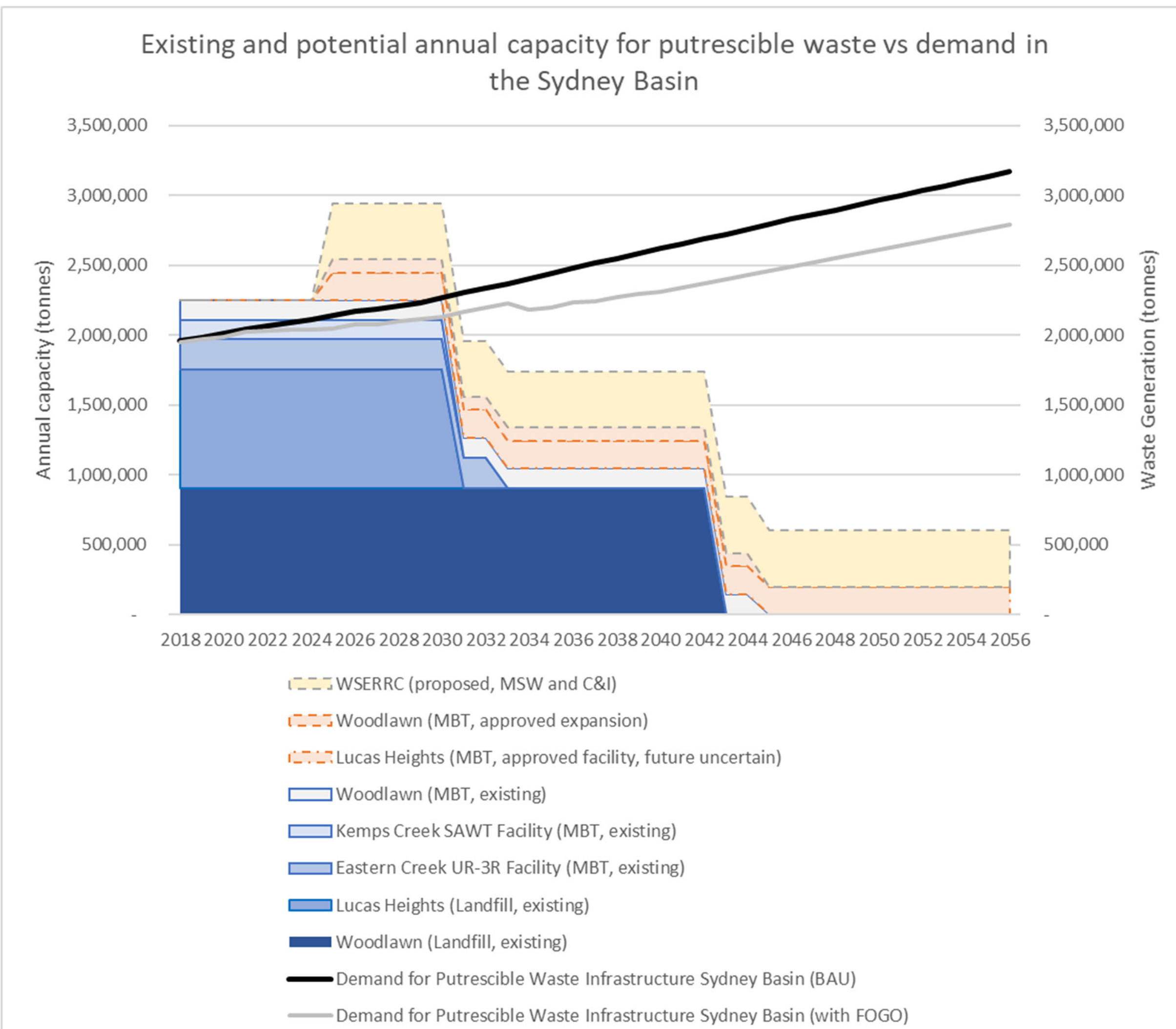

Figure 27: Existing and approved capacity to process or dispose of Sydney Basin putrescible waste, under BAU, with the Project.

With no transition to FOGO but development of the Project and all competing projects and successful repurposing of the existing MBT facilities in light of the MWOO decision, processing capacity would still fall short of demand by approximately 150,000 tonnes in 2031.

Under the worst case scenario of progressive uptake of FOGO collection together with high food diversion rates, and all facilities developed and retained, demand would meet capacity in 2031.

However, there is a high level of uncertainty around the long-term viability of the MBT fleet given it is currently delivering little landfill diversion (limited to moisture loss) at relatively high cost to councils. Local government is likely to consider alternative options in order to either return to higher diversion rates or reduce costs. Under the BAU collection scenario without competing MBT facilities[31], demand exceeds supply by 1.3 million tonnes in 2031, providing very significant headroom in the Sydney market for the Project.

The capacity gap for putrescible waste is also greater when adopting more realistic organics capture efficiency scenarios compared to the best case presented above. Under the typical low capture rate of the poorer performing FOGO councils in NSW, which may be more representative of the metropolitan context, the existing fleet of facilities will be 820,000 tonnes short of demand in 2031.

A range of additional waste generation and EfW eligibility scenarios have been developed to provide additional confidence in the analysis above. These are included in the full technical document and incorporate food capture efficiency scenarios and variable waste generation per capita rates.

[31] Woodlawn Landfill is the only operating putrescible waste facility in 2031 under this scenario.

6 CONCLUSION

In pursuit of the WARR resource recovery targets of 75% overall waste diversion from landfill, it is considered that greater levels of at-source separation is required, as well as infrastructure that provides higher order resource recovery beyond landfill. These background assumptions underpin this waste flow analysis for an EfW facility in the Sydney Basin. Approximately, 1.4 million tonnes of MSW and 1.3 million tonnes of C&I waste currently goes to landfill. With active strategies and policy instruments to incentivise diversion of waste from landfill, it is expected that demand will increase for infrastructure delivering best practice resource and energy recovery.

The opportunity for an alternative to landfill is highlighted in Figure 28, which compares total annual demand for Sydney putrescible waste infrastructure and the capacity of alternatives to landfill.

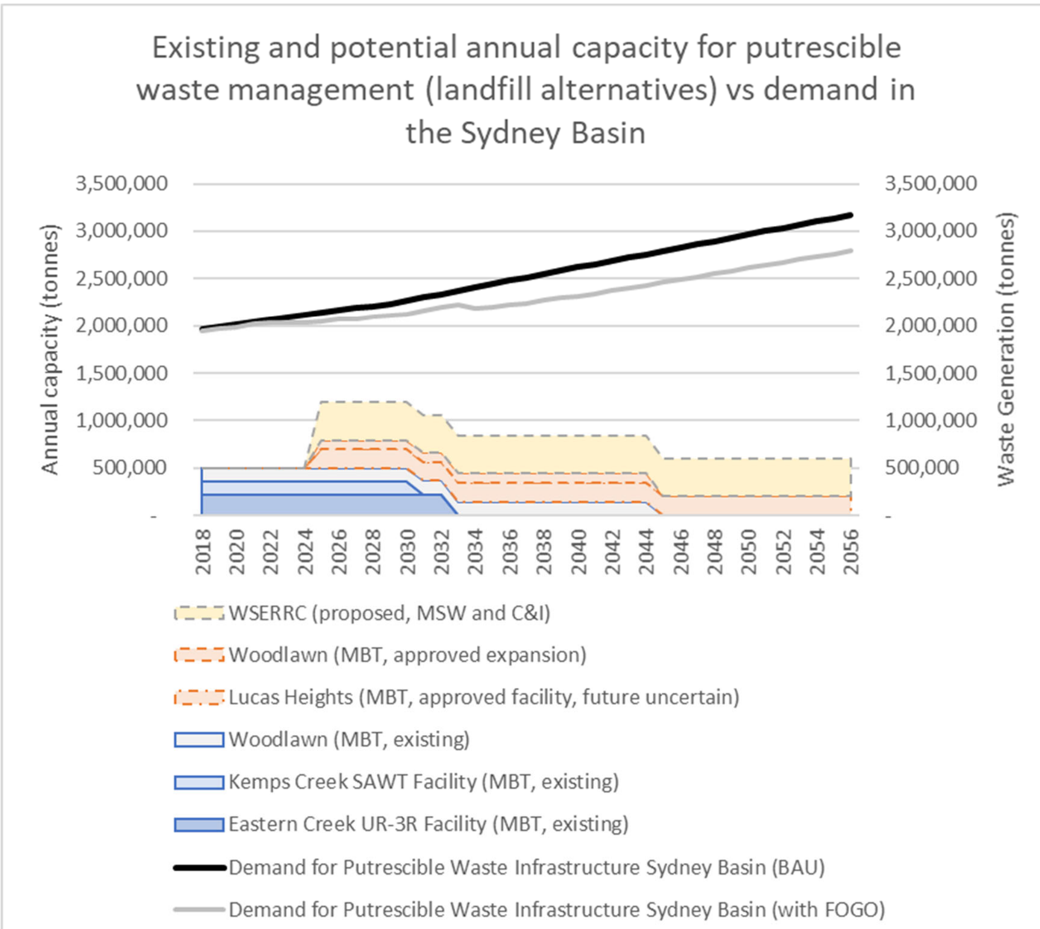

Figure 28: Demand for putrescible waste infrastructure versus capacity of alternatives to landfill

It indicates a significant and growing gap in diversion capacity, falling far short of the current WARR targets. The uncertain future of MBTs could force earlier closure than estimated above and further widen the gap. This analysis identifies a clear role for EfW infrastructure, in tandem with a progressive roll out of FOGO across the Sydney basin, to support the NSW Government policy objectives for waste and resource management.

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APPENDIX A: RECOVERY POTENTIAL OF MSW & C&I RESIDUAL WASTE

The following table uses data from Cleanaway's recent audits of kerbside MSW and mixed putrescible C&I received at Erskine Park. This data is broadly reflective of the standard composition of kerbside MSW and mixed putrescible C&I generated in the Sydney Basin.

Table 25: Commentary on recovery potential of MSW kerbside residual

Consolidated material type for MSW kerbside residual waste stream	Material details	Notes on recovery potential
Recyclable glass (1.4%)	Packaging glass /containers Glass fines	Unbroken glass in its original form is recyclable, however is of much lower value when collected through the residual kerbside system. Broken glass and glass cullet is not easily recoverable and has low value.
Non-recyclable glass (0.4%)	Miscellaneous glass (plate glass) Other glass	These are glass types which have variable melting points (temperatures) and/or are coated / treated with other substances (chemicals). These glass types become problematic when mixed with recyclable glass and melted down at recycling facilities for reprocessing. E.g. glass cookware and pyrex is manufactured to withstand higher temperatures than recyclable glass and window panes are coated with substances to ensure they are more durable, laminated, tinted etc. Mixing non-recyclable glass with recyclable glass can compromise the standard and form of recovered glass products.
Recyclable metals (1.4%)	Steel packaging (cans) Aerosols and paint cans Aluminium (cans) Foil	These metals are recyclable, however there is an uptake in the recycling of steel and aluminium cans recycling through CDS schemes. Ferrous and non-ferrous metals are recovered through an MBT.
Non-recyclable metals (3.1%)	White goods Appliances E-waste Paint tins / butane canister	These metals are not recyclable through an MBT. Some of these items are suited for recovery through at-source separation and under an alternative service or facility e.g. community recycling centre and e-waste drop-off days.
Recyclable paper (8.7%)	Newspaper Magazine Corrugated cardboard Package board Liquid paper containers Printing & writing paper (incl. books)	Mixed waste paper and cardboard is recyclable. However, in a mixed waste stream it's likely to be highly contaminated and therefore of little value to recyclers.
Non-recyclable paper (14.4%)	Miscellaneous packaging Coffee cups Disposable paper products Composite (mostly paper) Nappies	These types of paper are not recyclable.

Consolidated material type for MSW kerbside residual waste stream	Material details	Notes on recovery potential
Recyclable plastic (4.8%)	1 PET packaging 2 HDPE packaging 3 PVC packaging 4 LDPE packaging 5 Polypropylene packaging 6 Polystyrene packaging	These types of plastic are recyclable, however types 3 – 6 have a limited end market (not as consistent nor stable) when compared to types 1 and 2, and types 4 – 6 are more susceptible to disrupting machinery due to their weaker nature. Rigid plastic packaging (type 1 and 2) are the most recovered through an MBT, however prices of sorted rigid plastic packaging have dropped significantly.
Non-recyclable plastic (16.4%)	6 EPS Plastic foam Shrink wrap Plastic bags and chip packets Other plastics 8 Composite (mostly plastic)	Whilst some of these plastics are theoretically recyclable, stringent contamination thresholds constrain end market opportunities. Recycling intervention measures should focus on at-source separation to facilitate clean streams such as soft plastic collections at major supermarkets, and EPS recovery at electronics and white good stores. This is because it's more energy and resource intensive to wash recyclables from a mixed stream than to keep them out of the mixed waste stream in the first place.
Organics compostable (41.5%)	Food Garden Other putrescible	MWOO restrictions eliminate the recovery of food waste which represents a significant part of the residual stream. Absorbent sanitary products which are considered as 'other organics' are also not recyclable as there isn't the technology available in Australia for recovery of this waste type.
Organic other (6.6%)	Wood furniture Wood packaging and offcuts Textile/rags Leather Rubber footwear Rubber tyres and tubes Engine lubricating oils Cooking oils	These materials can damage processes in advanced sorting facilities for mixed waste. These items are suited for recovery through at-source separation and under an alternative service or facility. There are no recovery opportunities apparel and footwear waste in Australia when these materials are no longer suitable for donation to charity stores.
Hazardous (<1%)	Paint Fluorescent globes Dry cell batteries Car batteries Household chemicals and pharmaceuticals Asbestos containing materials	These items are hazardous and Councils actively discourage disposal via the kerbside red bin. These items are suited for disposal via chemical cleanout days and community recycling centres. These items are hazardous in an advanced sorting facility.
Others (<1%)	Ceramics Dust/dirt/rock/inert Bricks and concrete Ash and coal lumps Other inert building materials Other special pathogenic and infectious Mattresses (incl. foam and	There is limited recovery potential for these waste types when they are in small volumes in the mixed MSW residual waste stream. These materials can damage processes in advanced sorting facilities for mixed waste. These items are suited for recovery through at-source separation and under an alternative service or facility e.g. soft landing mattress recycling, construction and demolition waste facility, landfill for special wastes.

Consolidated material type for MSW kerbside residual waste stream	Material details	Notes on recovery potential
	innersprings) Fine materials <25mm	

Table 26: Commentary on recovery potential of C&I residual (putrescible)

Consolidated material type for C&I putrescible waste stream	Material details	Notes on recovery potential
Recyclable glass (2.04%)	Packaging glass /containers Glass fines	Unbroken glass in its original form is recyclable, however is of much lower value when collected in a mixed putrescible stream. Broken glass and glass cullet is not easily recoverable and has low value.
Non-recyclable glass (0.18%)	Miscellaneous glass (plate glass) Other glass	These are glass types which have variable melting points (temperatures) and/or are coated / treated with other substances (chemicals). These glass types become problematic when mixed with recyclable glass and melted down at recycling facilities for reprocessing. E.g. glass cookware and pyrex is manufactured to withstand higher temperatures than recyclable glass and window panes are coated with substances to ensure they are more durable, laminated, tinted etc. Mixing non-recyclable glass with recyclable glass can compromise the standard and form of recovered glass products.
Recyclable metals (1.73%)	Steel packaging (cans) Aerosols and paint cans Aluminium (cans) Foil	These metals are recyclable, however there is an uptake in the recycling of steel and aluminium cans recycling through CDS schemes. Ferrous and non-ferrous metals are recovered through an MBT.
Non-recyclable metals (2.94 %)	E-waste Other ferrous	These metals are not recyclable through an MBT. Some of these items are suited for recovery through at-source separation and under an alternative service or facility.
Recyclable paper (15.63%)	Newspaper Magazine Corrugated cardboard Package board Printing & writing paper (incl. books)	Mixed waste paper and cardboard is recyclable. However, in a mixed waste stream it's likely to be highly contaminated and therefore of little value to recyclers. It's more efficient to focus on at-source separation rather than beneficiation, which is more resource intensive for these low value materials.
Non-recyclable paper (14.13%)	Miscellaneous packaging Coffee cups Disposable paper products	These types of paper are not recyclable. The disposal paper product represents over half of this segment.

Consolidated material type for C&I putrescible waste stream	Material details	Notes on recovery potential
	Composite (mostly paper) Nappies	
Recyclable plastic (3.51%)	1 PET packaging 2 HDPE packaging 3 PVC packaging 4 LDPE packaging 5 Polypropylene packaging 6 Polystyrene packaging	These types of plastic are recyclable, however types 3 – 6 have a limited end market (not as consistent nor stable) when compared to types 1 and 2, and types 4 – 6 are more susceptible to disrupting machinery due to their weaker nature. Rigid plastic packaging (type 1 and 2) are the most recovered through an MBT, however prices of sorted rigid plastic packaging have dropped significantly.
Non-recyclable plastic (21.7%)	6 EPS Plastic foam Shrink wrap Plastic bags and chip packets Other plastics 8 Composite (mostly plastic)	Whilst some of these plastics are theoretically recyclable, stringent contamination thresholds constrain end market opportunities. Recycling intervention measures should focus on at-source separation to facilitate clean streams such as soft plastic collections at major supermarkets, and EPS recovery at electronics and white good stores. This is because it's more energy and resource intensive to wash recyclables from a mixed stream than to keep them out of the mixed waste stream in the first place. The largest portion of this segment is plastic bags and chip packets.
Organics compostable (29.52%)	Food Garden Other putrescible	MWOO restrictions eliminate the recovery of food waste which represents a large part of the residual stream. Absorbent sanitary products which are considered as 'other organics' are also not recyclable as there isn't the technology available in Australia for recovery of this waste type.
Organic other (6.41%)	Wood packaging and offcuts Textile/rags Leather Rubber footwear Rubber tyres and tubes	These materials can damage processes in advanced sorting facilities for mixed waste. These items are suited for recovery through at-source separation and under an alternative service or facility. There are no recovery opportunities apparel and footwear waste in Australia when these materials are no longer suitable for donation to charity stores.
Hazardous (0.17%)	Household chemicals and pharmaceuticals	These items are hazardous in an advanced sorting facility, and at-source separation and disposal at an appropriately licenced facility is the safer waste management pathway.
Others (2.03%)	Ceramics Dust/dirt/rock/inert Fine materials <25mm	These materials can damage processes in advanced sorting facilities for mixed waste. These items are suited for recovery through at-source separation and under an alternative service or facility.

APPENDIX B: REVIEW OF INFORMATION SOURCES POST COMPLETION OF THE WSERRC FEEDSTOCK ASSESSMENT

Overview

In May 2020, NSW EPA uploaded two new studies –

- Analysis of NSW Red Lid Bin Audit Data Report 2011-2019 (Rawtec, 2020a)
- Analysis of NSW Green Lid Bin Audit Data Report 2020 (Rawtec, 2020b)

These studies were released after the Feedstock Assessment and Environmental Impact Statement for the Project was substantially completed. Arcadis has reviewed these documents for pertinence to feedstock modelling for the Western Sydney Energy and Resource Recovery Centre (WSERRC).

Arcadis' view is that the Red Lid Bin Audit Report offers some useful compositional findings from this longitudinal study. However, there are other more suitable resources for application to the Sponsors Feedstock Assessment.

The key findings that could be considered relevant to this project include –

- Change in residual waste generation in the Sydney Basin (former 'Sydney Metropolitan Area') from 10.2 kg/hh/week to 11.7 kg/hh/week, which differs from the declining waste generation/capita rates in other datasets
- The magnitude of reduction rates for residual waste quantities following transitioning from a GO system to a FOGO system, (ie. GO councils generate 10.6 kg/bin/week and FOGO councils generate 6.5 kg/bin/week of kerbside residual waste)
- Potential supplementary benefits beyond food capture, after introduction of FOGO, including additional diversion of GO and other organics, and additional capture of recyclables from the residual waste stream.

However, Arcadis cites the following notes directly from the report as reasons for not applying the findings of this study to WSSREC's Feedstock Assessment -

- *In line with 2011* [red bin audit]*, the 2019 audit does not consider* [bin] *presentation rate and therefore* [growth in residual waste generation at an individual household level between this period] *cannot be extrapolated out to a wider population's waste generation tonnages*
- *Matching recycling and FOGO bin audit data was not available to confirm if the material has been avoided, recycled or become contamination in the FOGO bin*.

Arcadis' review has also identified several other issues that could affect the findings –

- Potentially significant regional differences in income, consumption and housing have not been considered in waste generation rates, when considering the performance of FOGO, GO and 2 bin systems (i.e. the analysis primarily compared regional councils with a FOGO system against metropolitan councils with only a GO system)
- There is no analysis to compare performance of an LGA both before and after FOGO was introduced
- Challenges around incorporation of Multi-Unit Dwellings in the Sydney Basin (referred to as the Sydney Metropolitan Area in the NSW Red Lid Bin Audit Data Report 2011-2019 (Rawtec, 2020a)

It is Arcadis' recommendation that state-wide Waste Avoidance and Resource Recovery (WARR) Status Reports are used for analysing waste generation trends over time. These reports incorporate weighbridge data from levy accounting and internal quality assurance processes to ensure generation, disposal and recycling estimates are representative of the waste management practices in New South Wales. They also capture waste flows across a full year rather than point-in-time audits that may be impacted by seasonal and other factors[32].

For food capture efficiency estimates, it is recommended that audited bins are matched against other bins types, and therefore NSW Green Lid Bin Audit Data Report (2020) and the Analysis of NSW Food and Garden Bid Audit Data (2018) are more suitable references for modelling potential diversion of food organics from the residual waste stream. These are considered superior data sources because they compare waste behaviour by household by council, as opposed to across councils with different demographics (Table 7 findings of the Analysis of NSW Red Bin Audit Data 2011-2019).

Arcadis used the Analysis of NSW Food and Garden Bid Audit Data (2018) for food capture efficiency rates, and the Food and Garden Organics Best Practice Collection Manual for the typical food content assumptions. Arcadis considers the findings from the new reports substantially the same as the assumptions incorporated in the current modelling, and therefore we consider any updates to be of limited materiality to feedstock estimates.

Table 27: Comparison of compositional assumptions

	Arcadis Assumption derived from Analysis of NSW Food and Garden Bin Audit Data (2018)	Analysis of NSW Garden Bin Audit Data (2020)	Notes
Proportion of food waste in the residual waste stream (red bin) without a FOGO service	35%[33]	35%[34]	Analysis of NSW Red Bin Audit Data 2011-2019 showed that food represented approximately 38% of the content of the residual waste stream. By quantity (kg/bin/week) this was consistent with 2 bin systems. As 26/30 of the Sydney Metropolitan Area Councils are 3 bin (GO), the 35% food content assumption is considered suitable. Arcadis proposes no further changes to the feedstock analysis. It should be noted that Arcadis' choice of waste generation metric for WSERRC feedstock base case limits opportunity for application of a different food composition assumption for Councils with a 2 bin system. The average waste generation per capita rate in the Feedstock Analysis has been derived from the WARR Progress Update 2017-2018 rather than individual council data (WARR Local Government Surveys 2017-2018). This approach was taken because the WARR Progress Update 2017-2018 incorporated quality assurance processes that includes cross checking Council self-reported data with quantities received at facilities. Therefore, there wasn't the opportunity for incorporation of higher organic reduction rates for Councils with a 2 bin system, but this applied to only 2 Councils in the Sydney Basin. It is considered within the acceptable margin of error to not discount the garden organics component from these particular councils. Detailed compositional analysis was not included within the scope of this assessment.

[32] To account for seasonal variation, audits would need to be undertaken at least twice throughout the year. The auditing months would need to be consistent for both the 2011 and 2019 samples to account for the seasonal factors, which can affect organic waste composition in particular.
[33] Department of Agriculture, Water and Environment (formerly Department of Sustainability, Environment, Water, Population and Communities), Food and Garden Organics Best Practice Manual, Arcadis (formerly Hyder), http://www.environment.gov.au/system/files/resources/8b73aa44-aebc-4d68-b8c9-c848358958c6/files/collection-manual.pdf
[34] Environment Protection and Heritage Council (2010), National Waste Report, https://www.environment.gov.au/system/files/resources/af649966-5c11-4993-8390-ab300b081f65/files/national-waste-report-2010.pdf

	Arcadis Assumption derived from Analysis of NSW Food and Garden Bin Audit Data (2018)	Analysis of NSW Garden Bin Audit Data (2020)	Notes
Food capture efficiency rates	Average 38%[35] Other values for sensitivity analysis: • Low 14% • Medium 41% • High 54% Modelling Assumption: 54%	Average 44% Other values for sensitivity analysis: • Low 14% • Medium 38% • High 57%	The modelling incorporates food capture efficiency at a static rate over time, and therefore a more optimistic scenario of 54% was assumed given Councils and contractors offering this service would have an interest in improving participation and performance over time. If the high rate from the 2020 Audit update was incorporated it would reduce the residual waste volumes, eligible for EfW by 1% from the base case (ie. 57% capture efficiency by 35% food content = 20% red bin diversion). If the average rate in 2020 were incorporated it would increase residual waste quantities for EfW by 4% (as the expected food capture quantities in FOGO would be lower). As the Project team consider the higher food capture efficiency rate to be more realistic over time, the difference between the 2018 report and 2020 update is considered immaterial and Arcadis proposes no further updates to the modelling. Arcadis has not applied a GO capture rate to residual waste quantities as 28/30 Sydney Basin Councils already collect garden organics. Therefore, it is assumed that the residual GO volumes in residual kerbside waste would be broadly the same when transitioning to a FOGO system. In addition, the residual GO quantities in the residual waste stream are small hence any marginal impacts is not material to the feedstock assessment.

In summary, Arcadis has reviewed the new audits provided by the NSW EPA and considers the findings in the Analysis of NSW Kerbside Green Lid bin (2020) to be consistent with the assumptions of the base case modelling. Arcadis considers the findings of the Analysis of NSW Red Lid Bin Audit Data Report 2011-2019 to be unsuitable for informing key modelling assumptions. To demonstrate why we consider this to the case, further analysis is provided in the following section.

[35] Analysis of NSW Food and Garden Bin Audit Data (2018), https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/managewaste/nsw-fogo-analysis.pdf?la=en&hash=F2F341DB7CF6C517801CD04DBBCFA389C03DF82A

Analysis of NSW Red Lid Bin Audit Data Report

1. Positive Growth Trends

The average waste generation per residual waste bin per week has not changed between 2011 and 2019 across a sample of councils within the Metropolitan Levy Area (incorporating the former categorisations of “Sydney Metropolitan Area” and “Extended Regulated Area”) and the Regional Levy Area (previously known as the Regional Regulated Area, RRA). However, when comparing bin volumes by region, significant changes were observed between the regions, and notably an increase for the SMA (Sydney Basin). Based on these findings, inferences have been drawn in the Red Lid Bin Audit (2020) that initiatives implemented outside of the metropolitan area are reducing quantities of residual waste disposed.

This makes sense given 11/19 Councils in the RLA have implemented FOGO systems. However, Arcadis recommends using the findings in the below table with caution for reasons discussed below.

Table 1: Kg/bin/wk residual waste figures overall and by region compared to previous reports

Category	Waste levy area		SMA		ERA		RRA	
	2011	**2019**	2011	**2019**	2011	**2019**	2011	**2019**
Kg/bin/wk[9]	10.1	**10.1**	10.2	**11.7**	10.2	**9.3**	9.9	**8.0**

According to Rawtec’s methodology,

> *The household residual waste generation (kg/bin/wk) is based on the average weight (in kilograms) per residual bin per week equivalent. It is not adjusted for presentation rate and is therefore based on the bins audited, not the number of households visited to collect those bins.*
>
> *In line with 2011, kg/bin/wk is calculated by using the total weight of the residual bin contents collected for each council audit in kilograms and normalised for weekly collection. This is then divided by the number of bins the material was collected from in the audit.*

These figures therefore cannot be accurately extrapolated out to a wider population to estimate waste generation tonnages per capita. The margin for error is increased by the use of audit, rather than annual, data.

The other limiting factor for use of these figures in extrapolating growth trends in the Sydney Basin is the way in which MUDs are managed in the data set.

Where MUDs were included in the sample, the bins audited were calculated to the single unit dwelling equivalent. According to the report -

> *If multi-unit dwellings (MUDs) were included in the audit sample, the total residual waste bins audited at MUDs was calculated to the single unit dwelling equivalent. For example, if two MUD households share a 240-litre (240L) residual waste bin, and each SUD has a 240L bin, the total MUD bins included in the sample would be half the number of MUD households included in the audit (so in this example if 10 MUD household bins were audited, this counts as a bin sample size of five).*

The assumption that two units share one bin is referenced throughout the document. It’s not clear whether this assumption was applied to all samples, or whether the whole contents of communal bins were collected and divided by the number of households, as per the Guidelines for Conducting Household Kerbside Residual Waste, Recycling and Garden Organics Audis 2007.

According to the Rawtec report, approximately 17% of all dwelling types in the sample were MUDS. Given MUDs are likely to be skewed towards the SMA, the implications of this key assumption may lead to a greater margin for error in the SMA findings than the ERA and RRA.

It is Arcadis’ recommendation therefore not to differentiate the SMA by including a positive growth trend in per capita generation. Arcadis has instead trialled two negative and one non-growth rate for

MSW until 2030, and then a plateau thereafter. These rates were derived from waste generation and disposal quantities measured from 2003 – 2017, which are based on weighbridge data from the levied areas. Whilst aggregated quantities for the levy paying area increase, the quantities per capita are declining.

2. Potential Compositional Changes

Potential uncertainty around quantity estimates across different regions has a flow on effect to the claims around FOGO benefits. The side-by-side presentation of data for each bin configuration implies the bin system determines bin composition and weight (figure below, Table 7 of the Red Bin Audit Report 2011-2019). It suggests –

- There is less GO and ‘other organics’ in the residual bin following transitioning from a GO system to a FOGO system
- There is less paper, plastic and glass in the residual waste stream after a FOGO system has been implemented
- The magnitude of residual waste reduction is in the order of 4 kg/household/week after implementing FOGO (compared to residual quantities in a GO system)

Table 7: Composition of the residual waste bin for Councils offering a FOGO service and Councils that offer GO or no service

	FOGO Councils		GO Councils		Councils with no organics	
	% breakdown	Kg/bin/ wk	% breakdown	Kg/bin/ wk	% breakdown	Kg/bin/ wk
Total paper and paper products	21.2%	1.4	19.0%	2.0	14.3%	2.1
Total organics	36.3%	2.3	51.0%	5.4	61.3%	9.1
Total food	*22.7%*	*1.5*	*37.6%*	*4.0*	*26.9%*	*4.0*
Total garden	*2.1%*	*0.1*	*3.5%*	*0.4*	*26.7%*	*4.0*
Total other organics[23]	*11.5%*	*0.7*	*9.9%*	*1.0*	*7.7%*	*1.1*
Total glass	3.3%	0.2	3.3%	0.3	3.1%	0.5
Total plastics	17.2%	1.1	12.7%	1.3	9.1%	1.4
Total ferrous material	2.9%	0.2	2.1%	0.2	1.9%	0.3
Total non-ferrous material	0.7%	0.04	0.8%	0.1	0.7%	0.1
Total other	18.5%	1.2	11.1%	1.2	9.7%	1.4
Total	**100%**	**6.5**	**100%**	**10.6**	**100%**	**14.9**
Total audits	16		39[24]		9	
Total bins	3,399		7,889		1,909	

**Sums may not equate due to rounding.*

The above conclusions are open to question. The key assumption that the bin configuration is the primary influence on performance is not adequately substantiated and ignores the fact that the particular configurations are more prevalent in different regions, with substantially different profiles.

The FOGO Councils are predominantly from the RLA, and the GO councils are predominantly from the MLA. Waste composition is different between the MLA and RLA due to a number of factors including demographics and dwelling types.

For example, FOGO communities in NSW are predominantly regional and rural, which by virtue of lower density are also more likely to manage organics at home through compost heaps, worm farms and perhaps chickens.

Similarly, occupants per household will vary between regions, with metropolitan areas more likely to have fewer people per household than regional and rural areas. No attempt has been made to normalise the data for average household size.

Arcadis considers the above table unsuitable for measuring benefits of FOGO for metropolitan Sydney Councils. According to the report, of the 64 councils that participated in the study, 16 offered a FOGO service and 40 had a GO service. However, only 2 Councils in metropolitan Sydney have a permanent FOGO service – Penrith and Woollahra and therefore FOGO findings in this report are largely representative of the regional areas as opposed to the metropolitan area. The difference between these regions in terms of waste composition and sorting behaviour is very different. The influence on the regional areas on FOGO and GO findings is demonstrated in Table 28.

Table 28: Potential influence of regional circumstance on FOGO, GO and 2 Bin System findings

<table>
<tr><th></th><th colspan="2">MLA[36]</th><th>RLA[37]</th><th></th></tr>
<tr><td></td><td>SMA</td><td>ERA</td><td>RRA</td><td>Total Surveyed</td></tr>
<tr><td>Number of Councils Post Amalgamation</td><td>30</td><td>12</td><td>19</td><td rowspan="3">64. Between 2011 and 2019 there have been amalgamations and re-categorisations of the levy areas which is likely to effect the count of councils.</td></tr>
<tr><td>Number of Councils Pre Amalgamation</td><td>38</td><td>13</td><td>21</td></tr>
<tr><td>Total Surveyed</td><td>32</td><td>13</td><td>19</td></tr>
<tr><td>Councils with a permanent FOGO service[38]</td><td>2/30</td><td>2/12</td><td>11/19</td><td>16</td></tr>
<tr><td>Councils with GO service</td><td>26/30</td><td>8/12</td><td>5/19</td><td>40</td></tr>
<tr><td>Councils with a 2 Bin System</td><td>2/30</td><td>2/12</td><td>3/19</td><td>8</td></tr>
<tr><td rowspan="2">Estimated representation in the FOGO sample</td><td colspan="2">25%</td><td rowspan="2">75%</td><td rowspan="2">N/A</td></tr>
<tr><td>12.5%</td><td>12.5%</td></tr>
<tr><td rowspan="2">Estimated representation in the GO sample</td><td colspan="2">85%</td><td rowspan="2">15%</td><td rowspan="2">N/A</td></tr>
<tr><td>65%</td><td>20%</td></tr>
<tr><td>Estimated representation in the 2 bin sample</td><td colspan="2">50%</td><td>50%</td><td>N/A</td></tr>
</table>

The percentage reductions of FO between the GO system and FOGO system in Table 7 of the Red Lid Audit Report are plausible. However, the weight reduction is potentially overstating the benefits, given the GO Councils are largely representative of the MLA (SMA and ERA) which according to the

[36] The SMA and ERA are now collectively known as the Metropolitan Levy Area.
[37] The RRA is now known as the Regional Levy Area.
[38] Waste Avoidance and Resource Recovery Local Government Survey 2017-2018

findings of the study generate more residual waste than the RLA. Given the FOGO Councils are predominantly located in the RLA, which according to this study generate less waste, then the residual FO quantities may not only be reduced by implementation of a FOGO system but by the potentially smaller waste footprint of these residents in general.

Arcadis is not aware of any other studies to suggest that transitioning from a GO system to a FOGO system increases the capture efficiency of GO and ‘other organics’, or improves correct usage of the commingled recycling stream. The NSW Red Lin Bin Audit Data Report (Rawtec, 2020a) also notes that it is difficult to substantiate these findings without a matched bin audit.

Without a service for ‘other organics’ or changes to acceptance criteria for FOGO, it does not practically follow that transitioning from a GO system to a FOGO system offers a solution for ‘other organics’, which is likely to include timber, textile/rags, leather, rubber and oils.

Arcadis considers the NSW Green Lid Bin Audit Data Report (Rawtec, 2020b) and Analysis of NSW Food and Garden Bin Audit Data (Rawtec, 2018) more suitable for capturing the benefits of FOGO because it compares the contents of the FOGO bin with the contents of the matching residual waste bin per Council, and comparisons are made only for Councils of similar bin and collection frequency configurations, which is known to influence food capture efficiency.

Consistent with Arcadis’ previous approach prior to release of the NSW Red Lid Bin Audit Data Report, Arcadis proposes to only discount a proportion of FO from the residual waste stream when SMA Councils transition to FOGO, which predominantly consists of Councils with a 3 Bin (GO) system.

Conclusion

Although providing a valuable contribution to compositional analysis studies, Arcadis considers the NSW Red Lin Bin Audit Data Report (Rawtec, 2020a) to be unsuitable resource for updating the Feedstock Analysis Report. Arcadis considers the findings of Analysis of NSW Garden Bin Audit Data (Rawtec, 2020b) consistent with the previous iteration, Analysis of NSW Food and Garden Bin Audit Data (Rawtec, 2018). The magnitude of difference would be in the order of a 1% reduction in kerbside residual waste feedstock eligibility, should the same optimistic food capture efficiency estimate be incorporated. Arcadis considers this immaterial and within the acceptable margin of error for waste generation forecasting, and therefore proposes no further updates to the modelling.

APPENDIX C: RESPONSE TO DPIE’S ADEQUACY REVIEW

The following responses are made to the request for further information under the SEARs issued following DPIE’s adequacy review of waste modelling and other documents supporting the WSERRC project.

Details a description of the sources, classes, quantities and composition of waste streams that would be thermally treated at the facility

As well as the relevant material:

The full modelling report is provided in Technical Report E: Waste flow analysis for Greater Sydney.

Comments	Further information needed from applicant	Response
In respect of recycling, Applicant modelling includes two scenarios: • Scenario 1, contingent on a ‘Note 1’ exemption as indicated above, effectively assuming that all residual waste remaining after recycling (potentially less a further 5% recycling via mixed waste treatment) is available for treatment in the plant. As noted above, Scenario 1 is arguably imprudent, in that it effectively assumes that the EPA does not impose Resource Recovery Criteria on the WSERRC. • Scenario 2, purportedly applies Resource Recovery Criteria defined in the NSW EfW policy. This more conservative case is arguably a more suitable basis for assessment of need for the WSERRC scheme.		The EfW Policy Statement 2015 provides a ‘Note 1’ exemption mechanism to the Resource Recovery Criteria (RRC) that permits the EPA to increase the maximum percentage of residuals stipulated under the RRC. With a strong demonstration of technical compliance with the Note 1 exemption in Section 2.3.4, based on best available technology and recovery of the mixed waste stream prior to energy recovery, the Proponent considers it reasonable for the EPA to consider granting a Note 1 exemption. However, to be conservative two scenarios have been provided, with and without the Note 1 exemption. It demonstrates there is sufficient feedstock under both scenarios for the project. Please refer to Section 4.
The means by which feedstock tonnages are derived are not fully articulated. Areas where relevant detail is arguably lacking include the following: • Lack of any detail around total MSW and C&I tonnages (typically, total tonnages would be projected before applying recycling rates).		It is very deliberate that current disposal tonnages are modelled as opposed to total waste generation inclusive of recycling. There is a community misconception that ‘thermal treatment cannibalises recycling’. It is for this reason that recycling tonnages have not been modelled, and only quantities currently sent to landfill or AWT are modelled.

Comments	Further information needed from applicant	Response
• Ambiguity around the approach to accounting for materials recycling - for example it is unclear whether State recycling targets are assumed to be achieved for MSW and C&I waste.		As expressed above, only disposal tonnages are modelled to avoid any confusion about target feedstock. To account for positive step changes in waste reduction in line with the Waste Avoidance and Resource Recovery Strategy 2014-2021, a negative growth rate has been applied to residual waste generation per capita or employee for MSW and C&I in the first 10 years of the project. This negative growth rate was derived from NSW WARR data trends in recent years, during which time the WARR Strategy was implemented. This is the only available evidence base to inform modelling assumptions for alignment with the WARR Strategy and resource recovery targets. There is no evidence-based assumption set that would reliably inform a trajectory to achieve the 2021-22 recycling targets, noting the limited progress on the current targets and current absence of any longer-term targets. Application of any such assumptions would significantly increase uncertainty in the model. This analysis is shown in full in Section 3.1. The negative growth rates used for the base scenario are specified in Section 2.1.
• Lack of clarity around the approach to quantification of the impact of FOGO collections in reducing the residual waste tonnage.		Comprehensive analysis of the impacts of different food capture efficiency rates within a FOGO system is provided in Section 4.2 and a technical review of the current performance of FOGO systems in NSW is provided in Section 4.3.1 and Appendix B. The modelling assumption for food content and food capture efficiency is cited in Sections 2.3.5 and Table 27 of Appendix B. The most conservative rate in terms of feedstock impacts has been adopted, which is the higher rate for average food capture efficiencies in NSW FOGO Councils. For certainty, the average food capture efficiency rate in NSW is approximately 44% but a higher modelling assumption has been adopted as the industry expects households to improve their waste separation practices over time (refer to subsequent commentary on assumptions around the timing of FOGO adoption).

Comments	Further information needed from applicant	Response
	Additional details / clarification on waste flows for the proposed geographical feedstock catchment area should be provided as noted below: • Baseline total generation of MSW and C&I waste;	As specified above, only waste that is currently disposed to landfill is considered suitable feedstock for this project. Estimates of total residual waste generation from MSW and C&I sectors are provided throughout the document. Inclusion of forecasted total waste generation and recycling tonnages is considered irrelevant to this project and lacking in rigour.
	Proxy variable used to project waste quantities (e.g. population, employment forecast);	Refer to sections 3.1 and 4.1 for proxy variables. The 2017/2018 WARR Progress Update was used for waste generation rates. The New South Wales Open Data source was used for population and employment projections.
	• Recycling rates currently achieved for MSW and C&I waste in the region; and Projected future rates of recycling against relevant targets; and	As discussed in the above sections: • Only disposal tonnages are forecasted as these are the target feedstock • A waste reduction rate for disposal tonnages has been incorporated in the model • The only evidence base for reduction of landfill tonnages is the WARR data of recent years, and this has formed the evidence base for the feedstock model. Whilst these are only modest gains, they form the only evidence for improvements during the implementation period of the WARR Strategy 2014-2021 • There is only clarity on resource recovery targets up to 2021 when the WARR strategy expires. Please referred to section 2.1 and 3.1

Comments	Further information needed from applicant	Response
	• Where impacts of FOGO are modelled, specifics including the geographical areas where services are assumed to be provided, proportion of households served by collections, and the consequent ultimate tonnage of food and garden waste modelled as diverted from the residual waste stream.	For potential FO capture from residual waste stream under a FOGO system, refer to sections 2.3.5, 4.2, 4.3.1 and Appendix B. For progressive FOGO adoption discussion, please refer to Section 2.3.2, Section 2.3.5, Table 8 of Section 3.2 and Section 4.1. As discussed in the document Scenario 2, it has been assumed that FOGO is progressively adopted by Councils in the Sydney Basin, which is the defined feedstock catchment for the Project. DPIE encourages FOGO adoption through the WARR Strategy. Through the 20 Year Waste Strategy Issues Paper, EPA expresses commitment to a 'net zero emissions from organic waste by 2030' and is seeking feedback from stakeholders on 'mandatory food and garden organics separation' and 'standardised collection systems for households'. This, along with a numbers of Sydney Councils issuing FOGO EOIs to market, have informed a modelling assumption that Councils are likely to transition to FOGO. As it cannot be known which Councils are likely to transition first, it has been assumed that 50% of Councils may transition at first residual waste contract renewal opportunity and the balance will transition at the second contract renewal opportunity. Known contract expiry years has informed the staging of this change, and this has influenced estimates around feedstock availability. Refer to figure 3 of the Executive Summary and Section 4.4. Further, it is assumed that Councils will implement FOGO systems across their entire population regardless of housing type as opt-in or partial coverage significantly increases the unit cost of the service. It is considered that a state-wide FOGO policy would enable a consistent service configuration and education, which supports this full roll-out across all housing types.

Comments	Further information needed from applicant	Response
Since a proportion of residual waste remaining after recycling may not be suitable as EfW feedstock, it also necessary to understand any assumptions in this area – this is particularly the case for C&I waste where there may be a need to deduct specific wastes (e.g. hazardous, inert).		As discussed in the EIS, the proposed technology involves pre-processing to remove any materials considered unsuitable from the residual MSW and C&I waste streams for the thermal treatment processes. In terms of materiality to available feedstock, hazardous waste accounts for less than 1% of C&I waste. This evidence based is from Cleanaway's recent detailed audits of its Erskine Park facility, which is considered to be broadly representative of C&I waste generated in the Sydney Basin. It is noted that the NSW EPA's C&I Disposal Based Audit groups inert waste with masonry and suggests that this represents about 8.8% of content (Table 3), while hazardous items account for around 1% (Table 4), which is consistent with the Esrkine park audit findings. However, this audit did not distinguish between putrescible and non-putrescible C&I landfills. It would be expected that the inert waste would feature more prominently in the non-putrescible C&I waste stream.
As noted above, while the overarching approach to modelling the tonnage outcome of these scenarios is described in Technical Report E, and appears to be valid, however information provided is not sufficient to allow an assessor to fully validate findings. As such it is not possible to conclude definitively that stated residual waste tonnages reflect the application of resource recovery process that maximises the recovery of material in line with the requirements of the NSW EfW Policy.	Refer to earlier comment seeking additional information on waste flows.	Refer to responses above.

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