Appendix I(i)

Waste feedstock analysis

WASTE FEEDSTOCK ASSESSMENT

Woodlawn Advanced Energy Recovery Centre

23 SEPTEMBER 2022

Incorporating

Hyder

CONTACT

RICHARD COLLINS
National Discipline Lead – Waste Advisory

T 02 8904 9180
M 0421 060 779
E Richard.collins@arcadis.com

Arcadis
Level 16, 580 George St,
Sydney, NSW, 2000

VEOLIA ENVIRONMENTAL SERVICES AUSTRALIA PTY LIMITED ADVANCED ENERGY RECOVERY CENTRE

Feedstock Assessment

Author Charlotte Wesley

Checker Gavin Hull

Approver Richard Collins

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CONTENTS

EXECUTIVE SUMMARY

Veolia Environmental Services (Australia) Pty Ltd (Veolia) owns and operates the Woodlawn Eco Precinct (the Eco Precinct), a purpose built facility to manage Sydney's residual waste. The Eco Precinct is licenced to receive 1.18 million tonnes of waste per year. At present, most of this waste is disposed of at the Woodlawn Bioreactor Landfill.

This landfill is essential infrastructure. As one of only two large putrescible landfills dedicated to servicing the Sydney Basin, it is a key component of the region's putrescible waste management system and, importantly, a receiver of last resort in unexpected circumstances, such as natural disaster. The critical need for residual waste infrastructure is recognised in the *Waste and Sustainable Materials Strategy 2041*, which indicates putrescible landfill capacity for the Greater Sydney basin will exhaust in 2036, under business as usual.

The Woodlawn Advanced Energy Recovery Centre (ARC) offers increased network resilience by increasing the capacity to manage residual waste at any given time and also extends the life of this critical asset by diverting waste from landfill to the energy from waste (EfW) facility. It also offers higher order resource recovery in alignment with the waste hierarchy and meets the growing appetite of waste generators to see further recovery of their residual waste.

This waste feedstock assessment forms part of Veolia's State Significant Development Application (SSD-21184278) and responds to the relevant Planning Secretary's Environmental Assessment Requirements (listed in Section 1 of this document).

This feedstock analysis confirms that where Veolia's current share of the Sydney Basin market remains stable over time, waste under management would be a comfortable surplus to the feedstock needs of the project. With total volumes of the target waste streams in the Sydney Basin shown to significantly exceed Veolia's market share, it is reasonably expected that any lost supply through contract expiry could be replaced by alternative supply. Further, analysis of proposed competing facilities indicates there remains sufficient waste supply for the ARC in the unlikely context of all receiving approval and progressing to development.

This analysis was undertaken in the context of the *Waste and Sustainable Materials Strategy 2041* and the *Energy from Waste Policy Statement*, which ensure all higher order resource recovery opportunities are maximised before any residual waste is sent for energy recovery.

Figure 1 shows the base case for residual waste arising in the Sydney Basin, which takes into account trendline reductions in waste generation per capita and per employee, mandatory policies under the *Waste and Sustainable Materials Strategy 2041* and growth in population and the economy. The base case (solid lines) is compared against current trajectory without the mandatory measures to be imposed under the *Waste and Sustainable Materials Strategy 2041* (broken lines). This report also presents scenarios relating to other ambitious scenarios presented in the NSW strategy, however they do not form part of the base case given the mixed record in NSW in achieving stretch waste targets without associated mandatory measures.

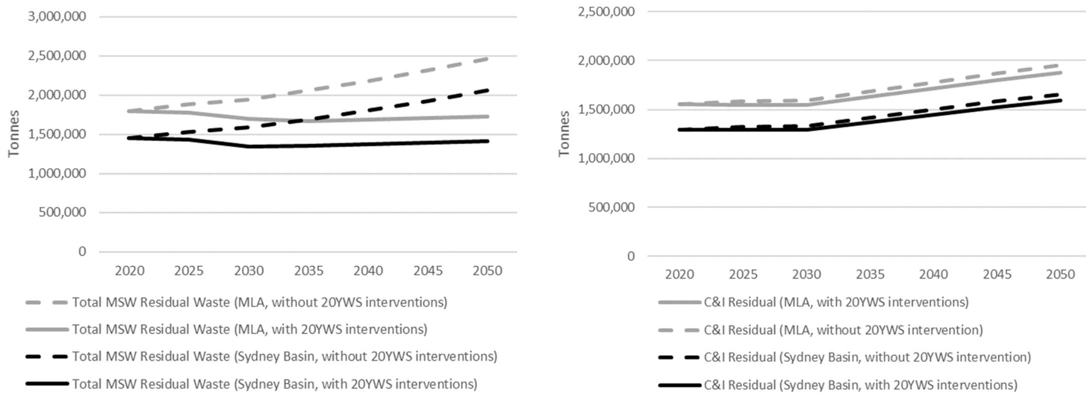

Figure 1: Residual waste generation base case estimates with and without mandatory policies in the Waste and Sustainable Materials Strategy 2041

Figure 2 compares Veolia's currently secured feedstock and indicative market share compared to net residual waste arising under the base case. This illustrates that Veolia currently receives 800,000 tonnes of the ARC's target waste streams and has relatively high security of supply given the significant surplus in aggregated generation in the Sydney Basin (approximately 50% kerbside MSW and the balance C&I residual waste). The capacity needs of the facility is 380,000 tonnes, which is approximately 50% of the supply estimated to be received at the Woodlawn Eco Precinct in 2030, and approximately 200,000 tonnes less than the total received waste considered eligible under the EfW Policy Statement.

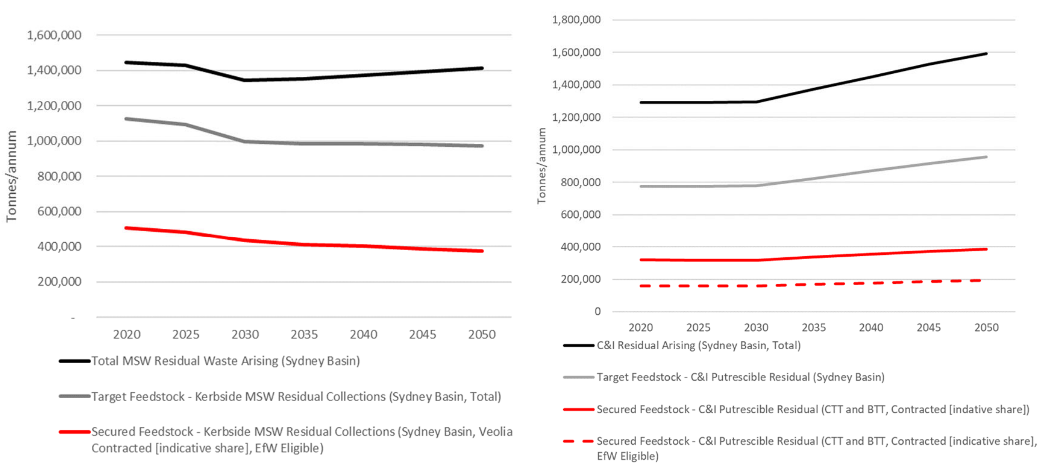

Figure 2: Secured feedstock within the context of total waste arisings, Waste and Sustainable Materials Strategy 2041 and the Energy from Waste Policy Statement

Figure 3 shows that even if all proposed EfW facilities that are in the planning system are approved and developed, there is still headroom for this project. It compares facilities that are competing for similar putrescible feedstock in the Sydney Basin, being kerbside collected MSW (assumed to be 100% putrescible) and C&I waste (assumed to be 60% putrescible). All MSW is considered eligible for provision to EfW under the NSW EfW Policy Statement given the mandatory transition to source-separated collection of food organics, while 60% (2020) - 80% (2030) of C&I is considered eligible with the balance partially eligible. Arcadis considers the approval of all pipeline facilities to be unlikely given the recently released *NSW EfW Infrastructure Plan* does not permit the development of the proposed EfW facilities within Greater Sydney, in their current form.

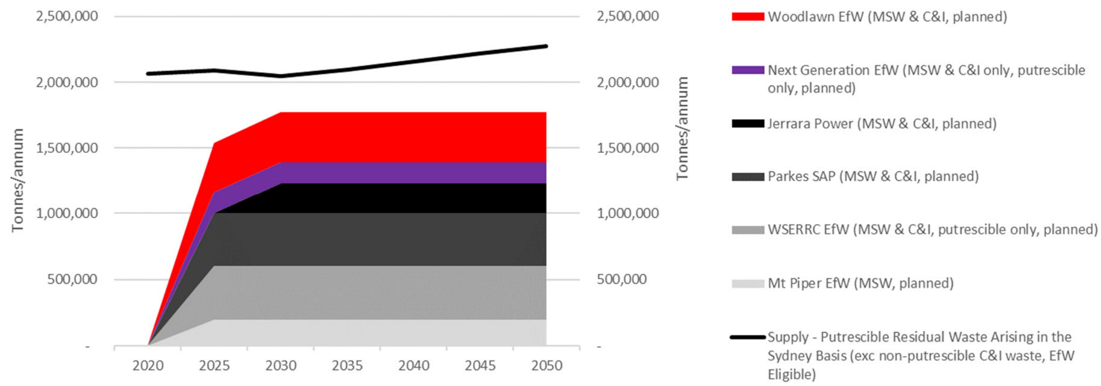

Figure 3: Target Sydney Basin waste that is eligible for EfW under the EfW Policy Statement compared to the cumulative capacity of competing facilities lodged with the NSW planning system

1 INTRODUCTION

Veolia Environmental Services (Australia) Pty Ltd (Veolia) is proposing to further increase resource recovery at their Woodlawn Eco Precinct through development of the Advanced Energy Recovery Centre (ARC). The Woodlawn Eco Precinct is an integrated waste management site that manages approximately 40% of putrescible residual waste generated in the Sydney Basin. Currently, the majority of this waste goes directly to landfill, with a small proportion processed through a mechanical biological treatment (MBT) facility prior to use of the organic output in a tailings dam rehabilitation trial.

Veolia is proposing to increase recovery of this residual waste by diverting it from the landfill to an energy recovery facility. This would support their customers in achieving resource recovery targets and extend the life of an essential landfill asset serving Greater Sydney, offering increased capacity and resilience within the NSW waste management network.

This report provides an independent estimation of current and future quantities of the potential feedstock for the ARC. This involves analysis of the residual waste currently contracted to the Woodlawn Eco Precinct as well as a review of total residual waste arising in the Sydney Basin. The waste flows are estimated within the context of the *Waste and Sustainable Materials Strategy 2041* and the *Energy from Waste Policy Statement*, which seeks to ensure resources with higher order recovery potential are not processed through energy recovery.

Arcadis Australia Pty Ltd (Arcadis) have been engaged to analyse current and future putrescible residual waste management needs in the Sydney Basin in light of these polices, including modelling available residual waste volumes. These needs are compared against the capacity of other proposed Energy from Waste (EfW) facilities that will compete for putrescible residual waste generated in the Sydney Basin.

This document aims to:

- Conceptualise and quantify current waste system for residual municipal solid waste (MSW) and commercial and industrial waste (C&I) within the Sydney basin
- Estimate quantities compliant under the Energy from Waste Policy Statement
- Forecast future waste generation over 30 years, with results analysed under different scenarios and factors that might influence future waste flows
- Document the approach taken to forecasting, including data sources, limitations and assumptions.

Scope

Arcadis has been engaged to respond to the Waste Feedstock requirements of the Department of Planning, Industry and Environment's (DPIE's) Secretary's Environmental Assessment Requirements (SEARs). Table 1 provides a guide as to where these requirements are addressed in this document.

Table 1: ARC waste feedstock criteria and responses

Planning Secretary's Environmental Assessment Requirements – Waste Feedstock	Section where this was addressed:
Details and a description of the sources, classes, quantities and composition of waste streams that would be thermally treated at the facility	Sources and classes – Section 2.4. Quantities - Sections 2.4,4.1,4.2 and 5. Expected waste fuel composition is covered in 5.5.1 of the Waste Acceptance Protocol (Appendix G)
A waste availability analysis that includes details of waste supply arrangements in the short and long term and an assessment of any competition for waste feedstock	Sections 4.1,4.2 and 5.

Planning Secretary's Environmental Assessment Requirements – Waste Feedstock	Section where this was addressed:
Detailed comparison of the proposed plant design, treatment technology and waste feedstock with the selected reference facility(ies) – details of the processing capacity of the facility including typical, maximum and minimum rates of processing, the maximum annual throughput of waste and the maximum volume of waste to be stored at the premises at any one time	Covered in Chapters 4, 6 and 8 of the EIS
Demonstration that waste used as a feedstock in the facility would be the residual from a resource recovery process that maximises the recovery of material in accordance with the NSW Energy from Waste Policy Statement (EPA, 2021)	Section 2.2.2 and 2.3
A detailed waste input sampling and monitoring program including a detailed description of waste processing procedures for each waste type received, how inappropriate materials will be excluded from the waste stream and contingency measures that would be implemented if inappropriate materials are identified.	Covered in the preliminary waste acceptance protocol (Appendix AC) of the EIS

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 available to us at the time. The data sources, assumptions and scenarios have been discussed with Veolia 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. It is assumed that information is reliable, accurate, complete and adequate.

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

The following section provides an overview of the context in terms of geography, infrastructure network and policy settings.

2.1 Defining the waste catchment

The Woodlawn Eco Precinct is a purpose built facility for waste generated in the Sydney Basin (and minor additional volumes). For the purpose of this analysis, Veolia defines the Sydney Basin as a group of 34 Councils listed in Table 2. This spans from the Northern Beaches in the North East, Hornsby to the North, the Hawkesbury to the North West, Blue Mountains to the West, Wingecarribee to the South West and Wollondilly to the far South. In 2020, the Sydney Basin represented approximately 62% of the NSW population of 5,181,267. This region is also the economic centre of NSW, employing approximately 67% of all employed people in NSW, which is approximately 2,722,954 people.

Within the next 30 years both population and employment are expected to grow within this region. This is illustrated in Figure 4 and Figure 5, which are from the NSW Open Data source that provides population and employment statistics used by all government agencies.

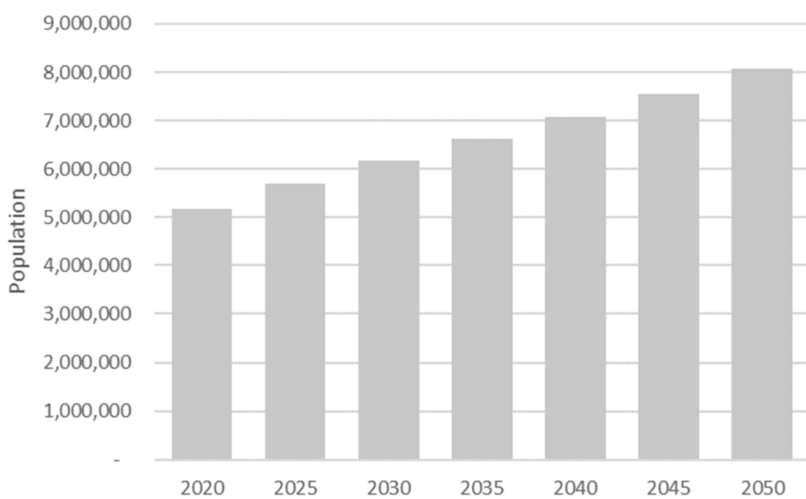

Figure 4: Population growth for Sydney Basin Councils from 2020-2050 (based on Common Planning Assumptions 2019, Department of Planning, Industry and Environment)

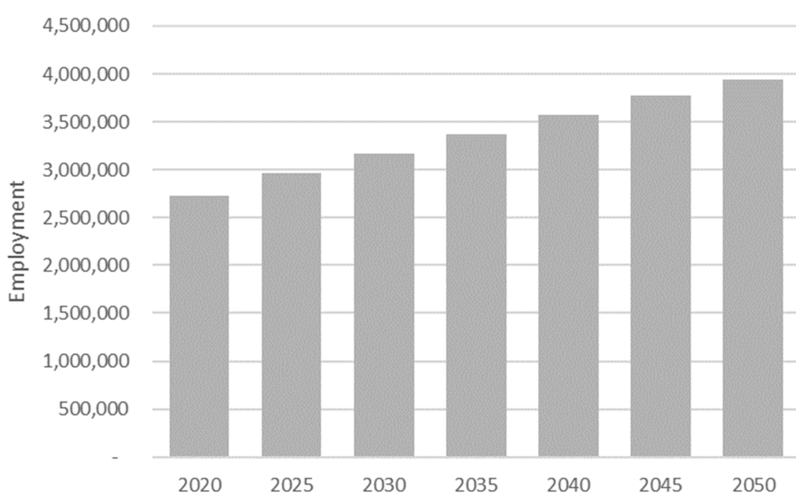

Figure 5: Employment growth rates for Sydney Basin Councils from 2020-2050 (based on the TfNSW released Population and Dwelling dataset)

Within the Sydney Basin there are significant variations in projected population growth between Regional Organisation of Councils (ROCs (Table 2), with the fastest growth in the Macarthur region organisation of councils (MACROC), with the lowest in the North Sydney region organisation of councils (NSROC). Note that these ROCs have been defined in Table 3.

Table 2: Population projections across metropolitan Sydney[1]

ROC	2020 population	2030 population (pa growth)	2040 population (pa growth)	2050 population (pa growth)
Macarthur region councils[2]	395,619	498,895 (2.35%)	668,852 (2.98%)	940,993 (3.47%)
NSROC[3]	940,156	1,043,943 (1.05%)	1,117,867 (0.69%)	1,182,881 (0.57%)
SSROC[4]	1,891,600	2,159,626 (1.33%)	2,342,183 (0.81%)	2,538,182 (0.81%)
WSROC	2,274,430	2,814,626 (2.15%)	3,310,768 (1.64%)	3,818,149 (1.44%)

The following table includes a list of all Councils included within Veolia's definition of the Sydney Basin. Not all of them are within the NSW EPA's definition of the 'metropolitan levy area' and this is noted in the table below as it this is relevant to the data analysis in subsequent chapters.

Table 3: List of all Councils included within Veolia's definition of the Sydney Basin.

Regional Group of Councils	Council	Levy Area
Canberra Region Joint Organisation (CRJO)	Wingecarribee (A)*	MLA
MACROC	Camden (A)	MLA
	Campbelltown (C) (NSW)	MLA
	Wollondilly (A)	RLA
NSROC	Hornsby (A)	MLA
	Hunters Hill (A)	MLA
	Ku-ring-gai (A)	MLA
	Lane Cove (A)	MLA
	Mosman (A)	MLA
	North Sydney (A)	MLA
	Ryde (C)	MLA
	Willoughby (C)	MLA
Unaffiliated	Northern Beaches (A)**	MLA
SSROC	Bayside (A)	MLA
	Burwood (A)	MLA
	Canada Bay (A)	MLA

[1] TfNSW released Population and Dwelling dataset
[2] Includes Wingecarribbee
[3] Includes Northern Beaches
[4] Includes Strathfield

Regional Group of Councils	Council	Levy Area
	Canterbury-Bankstown (A)	MLA
	Georges River (A)	MLA
	Inner West (A)	MLA
	Randwick (C)	MLA
	Sutherland Shire (A)	MLA
	Sydney (C)	MLA
	Waverley (A)	MLA
	Woollahra (A)	MLA
Unaffiliated	Strathfield (A)***	MLA
WSROC****	Blacktown (C)	MLA
	Blue Mountains (C)	RLA
	Cumberland (A)	MLA
	Fairfield (C)	MLA
	Hawkesbury (C)	MLA
	Liverpool (C)	MLA
	Parramatta (C)	MLA
	Penrith (C)	MLA
	The Hills Shire (A)	MLA

*Wingecarribee is part of 'Project 24' with the other Macarthur region Councils.

** Northern Beaches is not currently affiliated with any ROC. Where Councils need to be grouped by geography, it makes sense for the Northern Beaches to be grouped with the other Northern Sydney Councils.

*** Strathfield is not currently affiliated with any ROC. Where Councils need to be grouped by geography, it makes sense for Strathfield to be grouped with the other Southern Sydney Councils.

****Lithgow joined WSROC, but it is not included within Sydney Basin.

2.2 Policy Context

In the following section the relevant policy and regulatory settings that have the potential to influence the generation or availability of the target wastes is discussed. 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.

2.2.1 Waste and Sustainable Materials Strategy 2041

In June 2021, the NSW Department of Planning, Industry and Environment (DPIE) released the *Waste and Sustainable Materials Strategy 2041 (Stage 1: 2021-2027)* and separate NSW Plastics Action Plan.

The Strategy replaced the *Waste Avoidance and Resource Recovery Strategy 2014–2021* and established new state-wide actions and targets. The key recycling target is to achieve an average resource recovery rate of 80% (all streams) by 2030[5], which is an increase from 65% in 2018/19. Notably, there are no specific targets for the individual streams of MSW, C&I waste and construction and demolition (C&D) waste.

Other key targets in the Strategy with potential to materially impact residual putrescible waste volumes and/or composition are:

- Reduce total waste generated by 10% per person by 2030
- Phase out problematic and unnecessary plastics by 2025[6]
- Halve the amount of organic waste sent to landfill by 2030.

In addition to these targets, the NSW Government will:

- Set a goal to triple the plastics recycling rate by 2030, as set out in the NSW Plastics Action Plan
- Reaffirm the commitment to the goal of net zero greenhouse emissions from organic waste by 2030, as laid out in the NSW Net Zero Plan Stage 1: 2020–2030.
- There is a notable focus on greenhouse emissions to respond to climate change, including development of a new measure of the greenhouse emissions performance of waste and materials management to help track carbon performance across the lifecycle of materials.
- The NSW Plastics Action Plan provides specific focus on the objective to triple the recycling rate for plastic, from the current rate of approximately 11%[7].

2.2.2 Energy from Waste Policy Statement

The *Energy from Waste Policy Statement* was also updated in June 2021, largely pertaining to emissions standards and operational and monitoring requirements rather than the feedstock eligible under the Resource Recovery Criteria.

The NSW Energy from Waste Policy statement (EfW Policy statement) sets out the policy framework and overarching criteria that apply to facilities in NSW proposing to thermally treat waste or waste-derived materials for the recovery of energy . Proposed facilities in NSW are encouraged to comply with three criteria: the Technical Criteria, Thermal Efficiency Criteria and the Resource Recovery Criteria (RRC). The RRC underpins the Waste Feedstock Analysis and is thus discussed in this section in detail, with the Technical Criteria and the Thermal Efficiency Criteria explored in other chapters of the EIS.

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[5] This is included as a scenario Section 4.2.
[6] It is not known how this phase out will occur, including any balance between ‘avoidance’ and ‘substitution’ with non-problematic alternatives. This target has not been included in modelling as it is of low materiality to overall residual waste volumes.
[7] This is included as a scenario Section 4.2.

The Resource Recovery Criteria framework defines the proportion of materials that can be combusted under different collection scenarios, in alignment with the waste hierarchy. 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 specific terms of the RRC are directly inserted into this section to support subsequent discussion.

- *This policy statement's objectives in setting resource recovery criteria are to:*
  - *Promote the source separation of waste where technically and economically achievable*
  - *Drive the use of best practice material recovery processes*
  - *Ensure only the residual from genuine resource recovery operations are eligible for use as a feedstock for an energy recovery facility.*
  - *Energy recovery facilities may only receive feedstock from waste processing facilities or collection systems that meet the criteria outlined in Tables 4 and 5[8].*

Table 4: Resource recovery criteria for energy recovery facilities – mixed waste streams (Table 4 of the EfW Policy Statement)

Mixed waste stream	Processing facility	% residual waste allowed for energy recovery
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 council has a separate collection system for dry recyclables	Up to 25% by weight of the waste stream received at a processing facility
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 processingfacility
Mixed construction anddemolition waste (C&D)	Facility processing mixed C&Dwaste	Up to 25% by weight of the waste stream received at a processing facility
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 processingfacility
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

[8] NSW Energy from Waste Policy Statement

Table 5 of the EfW Policy Statement relates to specific separated waste streams, none of which are target feedstocks for Woodlawn ARC and therefore not included here.

2.3 Target feedstock and compliance with the Energy from Waste Policy Statement

The ARC will receive putrescible waste in the form of residual MSW and C&I waste. Waste supply will be sourced entirely from the Sydney Basin through Veolia's key intermodal Transfer Terminals in the Sydney suburbs of Banksmeadow and Clyde. This strategy provides a number of benefits in terms of compliance with the EfW Policy:

- Leverages existing facilities that currently receive significant volumes of MSW and C&I waste from the Greater Sydney market, providing comfort around long-term access to feedstock
- Provides greater certainty of waste supply composition and eligibility through defined pathways for acceptance of EfW feedstock
- Enhances feedstock control through establishment of specific waste acceptance and quality control procedures, including potential to remove halogenated substances such as PVC piping and other items.

The Transfer Terminals provide the first control point in an integrated system that features second phase sorting at the ARC itself. The Terminals provide an opportunity to separate gross recyclables for recovery and to divert materials that are not suitable for energy recovery into the landfill stream. Waste acceptance and sorting procedures at both the Transfer Terminals and the ARC will target recoverable materials and screen non-combustible and undesirable waste, including halogenated substances, ensuring waste sent to energy recovery is both suitable and eligible.

The Eco Precinct is licenced to receive up to 1,180,000 tpa of waste by rail from Greater Sydney. In 2020, Veolia managed almost 800,000 tonnes through the network from Sydney, comprising just over 50% MSW and the remainder C&I waste. This is almost three times the annual quantity targeted for delivery to the ARC, a buffer in tonnes under management that provides significant comfort in achieving long-term compliance with the RRC.

Municipal solid waste

Approximately 80% of Veolia's target feedstock (304,000 tonnes per annum) is expected to come from kerbside residual waste from Greater Sydney Councils. The 'no limit' criteria is expected to apply to a significant proportion of the waste stream by the commissioning of the ARC in 2025 and all MSW residual by 2030.

All metropolitan Councils currently offer a commingled recycling service and, under the recently released *NSW Waste and Sustainable Materials Strategy 2041*[9], are required to transition by 2030 to collection of food organics in a discrete service or as part of a combined food organics and garden organics (FOGO) service. This means all residual kerbside MSW in Greater Sydney will be fully source separated by 2030 and meet the 'no limit' criteria for EfW.

The Greater Sydney feedstock analysis has mapped the likely transition pathway to 2030 by assuming all Councils adopt FOGO / FO services at the end of their current waste processing / disposal contract. Under this approach, 21 Councils will be transitioning at the same time as commissioning of the ARC in 2025. With full roll out in the following year, it is expected they may generate around 750,000 tonnes, 70% of Sydney Basin residual MSW.

[9] Released in June 2021

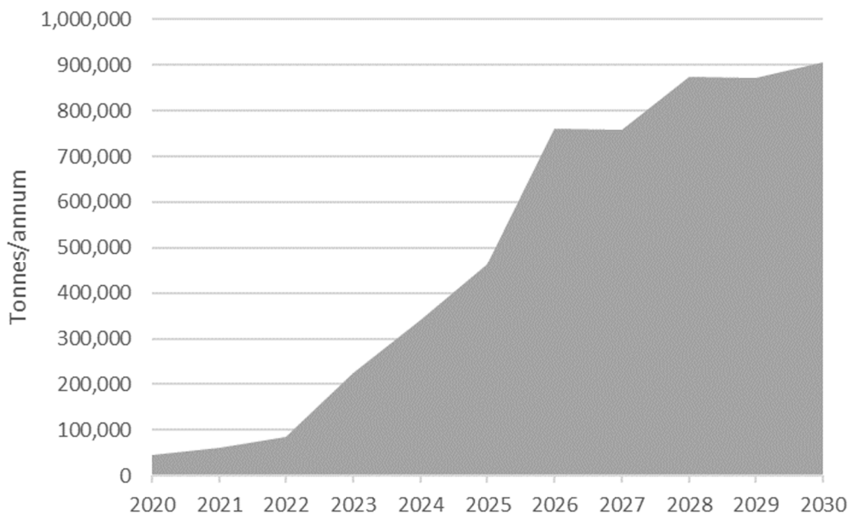

Figure 6: Short term forecast of RRC compliant kerbside residual waste

Veolia will preferentially target residual waste contracts from Councils with FOGO / FO services to meet the ARC feedstock needs. However, under a conservative assumption that by 2025 Veolia has secured only a market average of available residual waste from FOGO / FO Councils, this provides an indicative 310,000 tonnes of ‘no limit’ EfW feedstock within the total MSW residual delivered to the Woodlawn Eco-Precinct.

In the unlikely case there is insufficient ‘no limit’ residual waste to meet the full EfW feedstock requirement, the MSW residual delivered to the Banksmeadow and Clyde from non-FOGO Councils is 40% eligible (by weight). This provides flexibility in the short-term if needed to manage the transition period.

It is noted the EfW Policy states that “*where a council has a separate collection systems for dry recyclables and food and garden waste*”, there is “*no limit by weight of the waste stream received at a processing facility*” for transfer to an energy recovery facility. Without any limit on a feedstock’s EfW eligibility, direct transfer from the point of generation to the energy recovery facility must be permissible, without requiring additional pre-processing.

Commercial & Industrial waste

The balance (20%) of target feedstock for the Woodlawn ARC is putrescible residual C&I waste (76,000 tpa) aggregated at the Banksmeadow and Clyde Transfer Terminals.

No more than 50% of C&I waste received at the transfer terminals will be sent to the Woodlawn ARC, meeting the minimum eligibility scenario in the EfW Policy Statement for mixed C&I waste from any source. The low recycling potential for putrescible C&I waste means this represents a significant diversion from landfill to a defined recovery outcome, including initial sorting and energy recovery..

The 50% limit is a conservative position. Given approximately 20% of C&I waste received will be directed to EfW, Veolia will be highly selective of loads for delivery to the energy recovery facility. This facilitates selection according to operational suitability but also preferential targeting of loads from commercial customers eligible for the ‘no limit’ C&I waste category.

As a tier one collector, Veolia has a relatively high proportion of large scale commercial customers in its portfolio, which are more likely to have separate collections for all “relevant waste streams”, at minimum expected to include paper/cardboard, organic collection and residual waste collection (as per the “notes” under Table 5 of the EfW Policy Statement).

Source separation of C&I streams is expected to increase over time in response to organisational commitments to sustainability and climate change, the rising cost of putrescible landfill and government policies addressing the circular economy, product stewardship and the mandate for food organics collection for key sectors in the *NSW Waste and Sustainable Materials Strategy 2041*.

Waste hierarchy

The proposed approach aligns with the waste hierarchy. MSW residual waste sourced from the kerbside collections of FOGO Councils (80% of total feedstock) has been subject to source separation of dry recyclables and the key organics fraction, facilitating recycling of these materials at their highest order use.

C&I putrescible residual waste from Sydney businesses (20% of total feedstock) will be selected and sorted for its suitability for EfW, supporting higher order recycling uses.

The remaining mixed, putrescible waste in these streams has no technically and financially viable recovery pathway. The ARC is proposing to capture energy value from waste that would otherwise go to landfill, losing much of the inherent value in the materials.

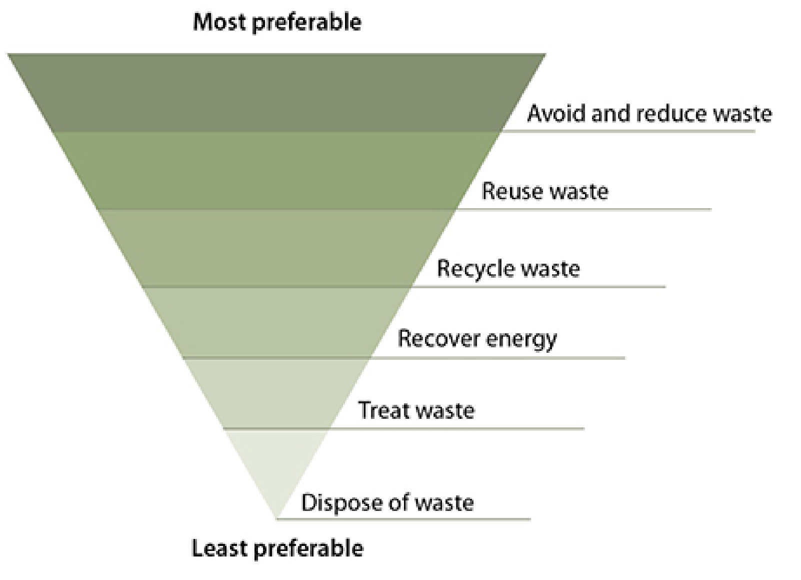

Figure 7: Waste Hierarchy (NSW EPA)

In summary response to the SEARs (Table 1), the feedstock strategy proposed by Veolia is consistent with EPA guidelines and the NSW EPA's Energy from Waste Policy Statement through a resource recovery process that:

- Actively preferences the residual waste from complying source separated collection configurations
- Subsequently maximises the recovery of material from this mixed putrescible stream to the extent that is financially sustainable and technically achievable.

2.4 Target feedstock and current pathways

Veolia has a significant share of the MSW and C&I waste collections market in Greater Sydney, with a collections portfolio that includes both long-term council contracts and shorter-term contracts with commercial and industrial customers. This share of the market provides confidence in the ability to retain or replace contracts over the long term in order to maintain the quantity and quality of feedstocks.

The Eco Precinct is licensed to receive 1.18 million tonnes of waste per year. Approximately 800,000 tonnes is currently disposed at the Woodlawn Bioreactor Landfill, while approximately 144,000 tonnes is processed through the Mechanical Biological Treatment (MBT) facility, with organic outputs used in a tailings dam rehabilitation trial.

Just over 50% of waste by rail from Sydney to Woodlawn is derived from kerbside collections contracts with Sydney Councils, with the balance sourced from commercial customers. Veolia has commissioned recent compositional audits of both waste streams.

Audits were undertaken of waste received at Banksmeadow Transfer Terminal from C&I customers in June 2021 and Sydney councils (MSW) in November and December 2021. The samples contained a large fraction of organics (Figure 8 and Figure 9), which is consistent with the national average of 35% food content, followed by paper and plastic (excluding PVC).

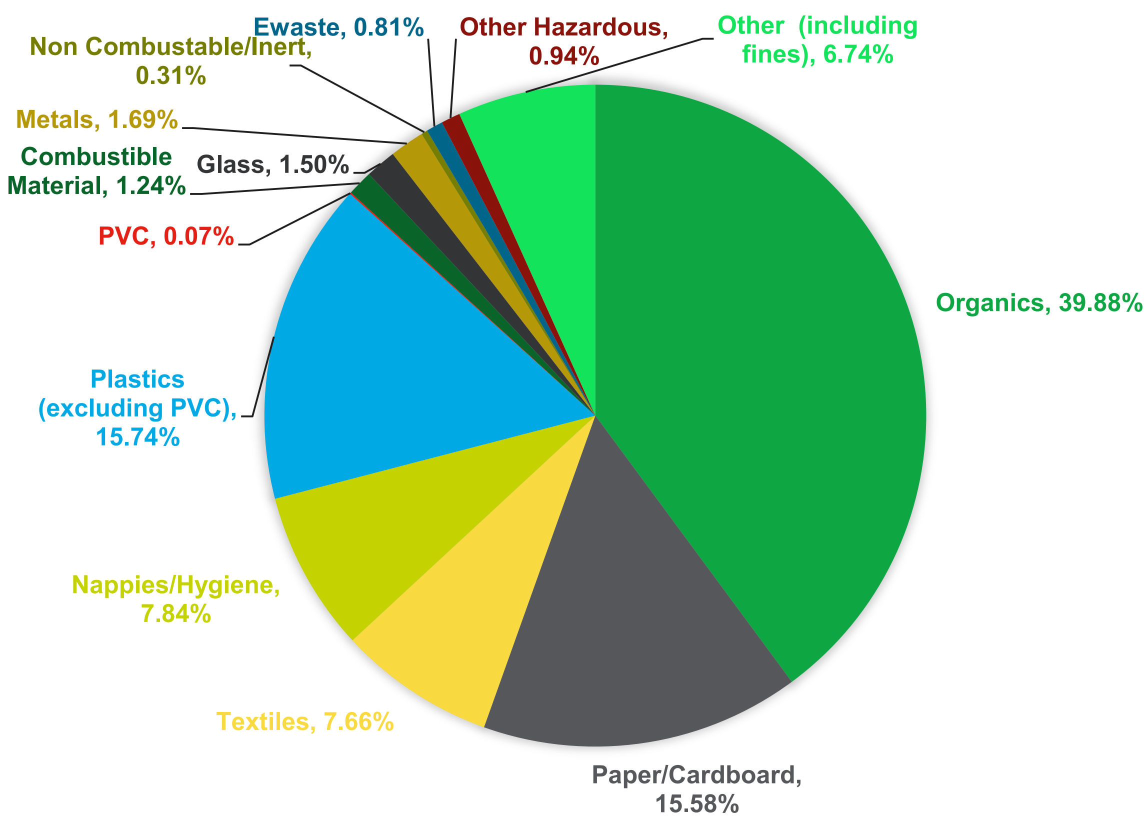

Figure 8: Composition of MSW of Banksmeadow Transfer Terminal (based on the mean average of 5 samples, November/December 2021)

The C&I mixed waste stream is similar in its primary fractions, with organics, paper and plastic (excluding PVC) accounting for the major fractions (Figure 9).

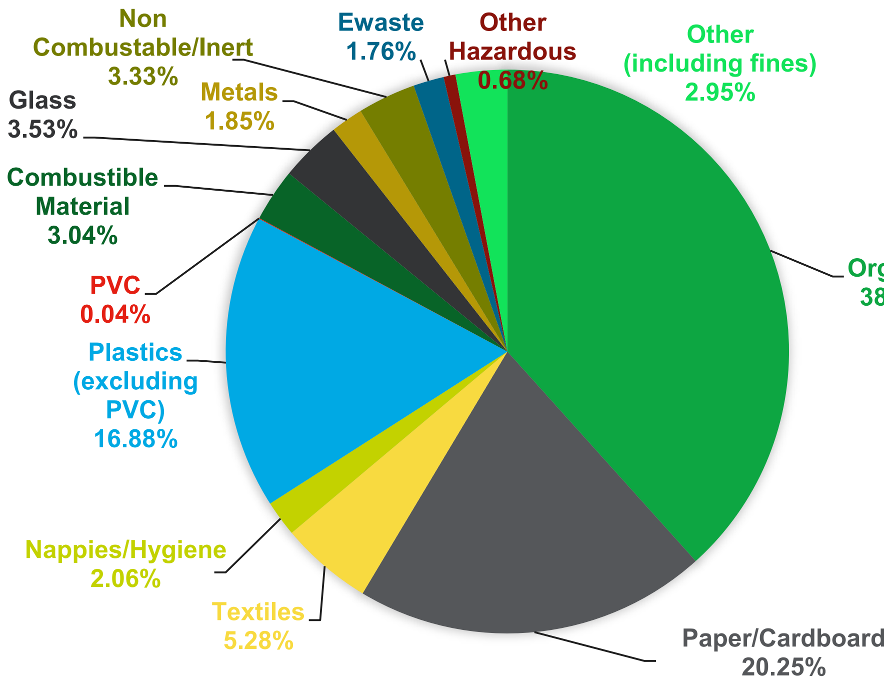

Figure 9: Composition of C&I waste received at the Banksmeadow and Clyde Transfer Terminals (based on the mean average of 20 samples, June 2021)

These compositional audits show the key impact of the increasing policy and industry focus on food organics and plastics, which will optimise the source separation potential of both MSW and C&I waste. It is expected that the proportion of these two materials will fall over time through mandatory collection of food organics and the goal to triple the NSW plastics recycling rate. These changes are well understood and have been integrated as sensitivities in the waste flow modelling and considered by Veolia in their assessment of residual calorific value.

The above figures and Table 5 also illustrate the volume of PVC present in MSW and C&I waste, which is a key focus for waste acceptance and quality control processes given the EfW Policy focus on halogenated substances. Please note numbers in the table below do not sum precisely due to rounding.

Table 5: Detailed compositional analysis

Category	MSW (Banksmeadow Transfer Terminal)	MSW* (Sydney Metropolitan Area)	C&I (Banksmeadow Transfer Terminal)	C&I** (Sydney Metropolitan Area)
Organics	39.88%	54.40%	38.34%	28.70% (including wood)
Paper/Cardboard	15.58%	18.40%	20.25%	16.10%
Textiles	7.66%	(included in organics)	5.28%	5.60%
Nappies/Hygiene	7.84%	(included in paper/cardboard)	2.06%	(included in other)

Category	MSW (Banksmeadow Transfer Terminal)	MSW* (Sydney Metropolitan Area)	C&I (Banksmeadow Transfer Terminal)	C&I** (Sydney Metropolitan Area)
Plastics (excluding PVC)	15.74%	12.10%	16.88%	12.80%
PVC	0.07%		0.04%	
Combustible Material	1.24%	(included in other)	3.04%	(included in other)
Glass	1.50%	2.90%	3.53%	1.40%
Metals	1.69%	2.50%	1.85%	2.60%
Non Combustible/Inert	0.31%	(included in other)	3.33%	32.80%
E-waste	0.81%		1.76%	
Other Hazardous	0.94%		0.68%	
Other (including fines)	6.74%	9.60%	2.95%	
TOTAL	**100.00%**	**100.00%**	**100.00%**	**100.00%**

*Table 4 of *Analysis of NSW Kerbside Red Lid Bin Audit Data Report, March 2020 (NSW EPA)*

** Table 6 of *Disposal-based audit Commercial and industrial waste stream in the regulated areas of New South Wales, 2015 (NSW EPA)*

Appendix A contains further information on the audit sorting and sampling methods. It is noted that the composition of Veolia's waste has not been used in Arcadis' feedstock modelling. Arcadis has instead opted for the 35% food content average specified within the *Food and Garden Organics Best Practice Collection Manual*, which is consistent with recent findings in the *NSW Kerbside Red Lid Bin Audit Data Report* for 3 bin (GO) Councils (which is the predominant system in Sydney). The reason for using this assumption as opposed to Veolia's own C&I and MSW data is because the focus of this report is on net feedstock arising in Greater Sydney.

3 MODELLING METHODOLOGY

This section provides an overview of the approach for estimating future MSW and C&I residual waste generated in the Sydney Basin. The base year for the investigation is 2019/2020, with waste flows modelled over a 30-year period to 2050.

The focus is on putrescible residual MSW and C&I waste only. Other MSW streams including clean-up and drop-off are excluded from this analysis.

For C&I waste, the NSW EPA only provides aggregated disposal volumes encompassing both putrescible and non-putrescible waste. Therefore, an industry estimate of the proportion of putrescible and non-putrescible waste arising has been applied to support forecasting of Veolia's target stream of putrescible C&I waste.

This section provides an overview of the data context in which modelling was undertaken and the method in which these estimates were developed.

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. The Waste Avoidance and Resource Recovery Strategy Progress Reports compile all facility level data for macro estimates of total residual waste and recycling occurring

Table 6: List of key data sources used in this analysis

Modelling aspect		Data source
Base waste generation estimates	MSW residual kerbside collections	• 2019-20 Local Government Waste and Resource Recovery Data Report (NSW EPA)
	C&I putrescible residual waste received at Clyde and Banksmeadow Transfer Terminals	• Data supplied by Veolia.
	Total MSW residual waste disposed to landfill	• Waste Avoidance and Resource Recovery Strategy Progress Report 2017-18 (NSW EPA)
	Total C&I residual waste disposed to landfill	
Population forecasts		NSW 2019 Population Projections (Common Planning Assumptions), including ASGS 2019 LGA Scenarios (Planning Industry & Environment). These populations estimates were available until 2041 only. Population forecasts were extrapolated to 2050 the 2036-2041 growth rates per LGA.
Employment forecasts		Employment Projects (TZP16.v1.51) Open Data (Transport for New South Wales)
Change rate for waste generation per capita.	MSW kerbside residuals collections per capita	Local Government Waste and Resource Recovery Data Reports (NSW EPA) – 2016/2017, 2017/2018, 2018/2019 and 2019/2020.

Modelling aspect		Data source
	Total MSW residual waste per capita	Historic trends in disposal data were calculated using the following data sets: • Waste Avoidance and Resource Recovery Strategy Progress Report 2017-18 (NSW EPA) • Waste Avoidance and Resource Recovery Strategy Progress Report 2014-15 (NSW EPA) The corresponding datasets for population and employment are listed above. The rates were compared against changes in MSW residual/capita and C&I residual/capita in the National Waste Report 2020 (Department of Agriculture, Water and Environment).
	Total C&I residual waste per capita	
Improvement rates	Food content and capture efficacy rates MSW	Analysis of NSW Kerbside Green Lid bin Audit Data Report, March 2020 (NSW EPA)
	Improving recycling leakage	No data. It is assumed that Councils will continue to try to improve leakage of recyclables in the residual waste stream through education. The rate of improvement is assumed to be modest in the order of 0-5% at this point in time.
	Food content and capture efficiency rates C&I	National Food Waste Baseline 2017/2018 (Department of Agriculture, Water and Environment). Analysis of NSW Kerbside Green Lid bin Audit Data Report, March 2020 (NSW EPA)
	FO capture efficiency improvement rate over time.	No data. The rate of improvement is assumed to be modest in the order of 0-1% per annum at this point in time.
FOGO transition rates		It cannot be known precisely when each Council in the Sydney Basin may transition to a FOGO system, if they have not done so already. It was assumed that Councils will transition to FOGO when their residual waste contracts are up for renewal. This information is based on Arcadis' review of ROC and individual Council's waste strategies. Whilst it cannot be known precisely when Councils will transition to FOGO, it is known that they all will have transitioned by 2030 as per NSW Government Policy.

Historical data sets were compared to waste generation growth rates in the Metropolitan Levy Area to ascertain generation trends. These changes in waste generation rates are important because they reflect behaviour changes, which need to be incorporated in forecast estimates.

The following figures illustrate changes in MSW and C&I residual waste managed within the MLA. The figures show a negative trend change compared to the positive trajectory of population and employment estimates. Data between 2012/2013 and 2016/2017 is by increments of two years as per the previous reporting cycles of the Waste Avoidance and Resource Recovery Strategy Progress Report. This has now been replaced with annual reporting cycles, but the most recent release of data was for 2017/2018.

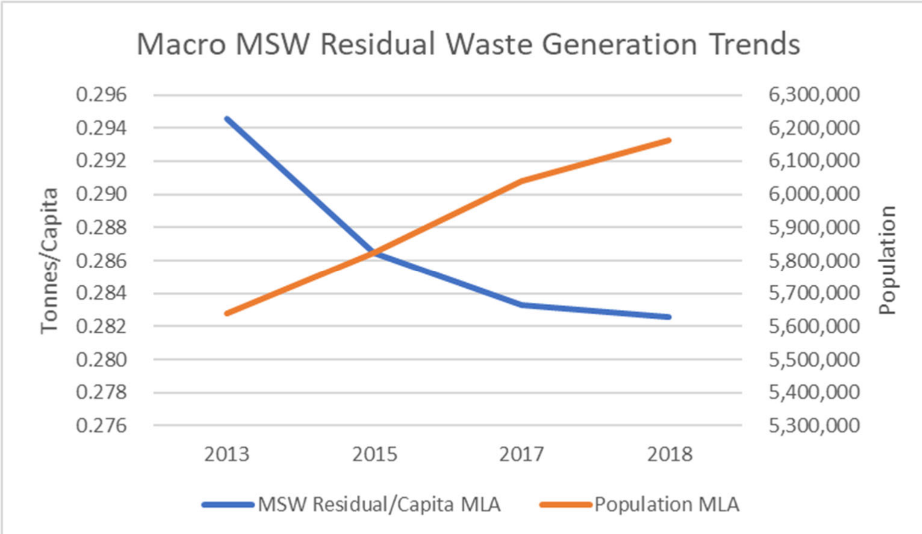

Figure 10: MSW disposal per capita compared to population (WARR data and Common Planning Estimates for the MLA)

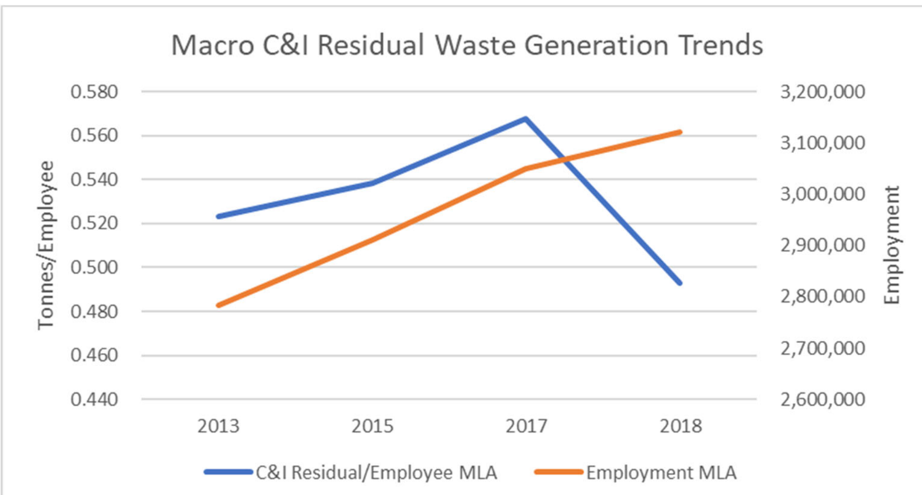

Figure 11: C&I disposal per capita compared to employment (WARR data and Open Data employment estimates)

Based on the historic trends and potential future changes, a range of estimates for residual waste generation rates 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 MLA growth rates between 2013 and 2018:

- MSW -0.8% per capita per annum (decline), which reflects a decline in residual waste generated in the MLA in recent years. This 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.
- C&I -1.2% per employee per annum (decline). This has been adopted to reflect improvements in resource recovery and disposal practices in the commercial sector.

These changes are considered conservative compared to other datasets. The *National Waste Report 2020* estimates for the whole of Australia are an annual change in generation rates of -2.5% per capita for MSW and -1.4% per capita for C&I (excluding ash). Kerbside collections data in the MLA was also analysed between 2016/2017 and 2019/2020 and showed a negative trend of -2.8% (Local Government Waste and Resource Recovery Data Reports). These change rates for MSW and C&I were compared against each other and compared to a 0% change rate.

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 NSW is significantly short of its 80% aggregated recycling target by 2030. 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 4.3.

3.2 Waste forecasting methodology

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 residual 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 change rate may be determined by historical data or other growth rates where there is an observed correlation (refer to Section 4.1).
- Multiply the waste generation rate by the forecasted statistics (e.g. waste per capita multiplied by the population in 2019-2020).
- Estimate quantities of food or commingled recycling that may diverted from the residual waste stream through system changes. It is assumed that these changes will come into effect when residual waste contracts are up for renewal. It is assumed that further improvements over time may take place.

3.3 Key assumptions

The following table lists the key assumptions and the rates adopted for the base case. These assumptions are considered conservative for the feedstock analysis.

Table 7: Key assumptions

Key Assumptions	Adopted rate for the base case	Other variables for sensitivity analysis
Population Scenario	Common Planning Assumptions (2019)	Low and high scenarios to the Common Planning Assumptions
Employment Scenario	Employment Projects (TZP16.v1.51)	Alternate scenario data not available
Changes in waste generation per capita per annum	Low: - 0.8% (WARRP, MLA Disposal Data, 2013-2018)	Medium: -2.5% (National Waste Report 2020) High: -2.8% (Local Government Waste and Resource Recovery Data Reports 2017 – 2020, analysis of kerbside collections data in the Sydney Basin,) Zero: 0%
Changes in generation per employee per annum	Low: - 1.2% (WARRP, MLA Disposal Data, 2013-2018)	Medium: -1.4% (National Waste Report 2020) Zero: 0%
MSW diversion rate	Medium: 16% 35% food content assumption multiplied by a 38% food capture efficiency rate (Analysis of NSW Kerbside Green Lid bin Audit Data Report, 2020) and adding estimate for improved capture of recycling leakage of 3%.	High: 25% 35% food content assumption multiplied by a 57% food capture efficiency rate (Analysis of NSW Kerbside Green Lid bin Audit Data Report, 2020) and adding estimate for improved capture of recycling leakage of 5%. Low: 5% 35% food content assumption multiplied by a 14% food capture efficiency rate (Analysis of NSW Kerbside Green Lid bin Audit Data Report, 2020) and adding estimate for improved capture of recycling leakage of 0%.
C&I diversion rate	Medium: Food capture rate of 38% multiplied by quantity of target food waste in hospitality and retail sectors.	High: Food capture rate of 57% multiplied by quantity of target food waste in hospitality and retail sectors. Low: Food capture rate of 14% multiplied by quantity of target food waste in hospitality and retail sectors.
Improvement Rate (% increased diversion rate per annum, MSW and C&I)	High: 1%	Medium: 0.5% Low: 0% The MSW improvement rate is applied to total residual waste. As this policy change is to be implemented at a local government level, it is assumed that Council Waste Education Officers will drive improvements in both food capture efficiency rates as well as leakage of recyclables, as another priority area for Councils. The C&I policy will be lead at a state government level and implemented by individual businesses.

Key Assumptions	Adopted rate for the base case	Other variables for sensitivity analysis
		Therefore, the focus is likely to be exclusively on FO, which is why the improvement rate is only applied to the FO content. It is acknowledged that some businesses such as the major food retailers have Sustainability Officers which drive improvements across all waste streams, but these businesses are not the target of this policy as they are already very successful in maximising resource recovery.

3.4 Uncertainty with key data sets

Arcadis acknowledges there is significant uncertainty in a 30 year forecast, and for this reason has presented alternate scenarios in Section 4.2, as well as a sensitivity analysis of key assumptions is shown in Section 4.3. These assumptions largely relate to waste generating and sorting behaviour only. Changes in population and economic growth also have a material impact on forecasts of waste arising, as these are the key drivers of growth.

The population and employment forecasts used to support this analysis are the 2019 NSW population projections and the Travel Zone Projects 2019 Employment Projects, which are the NSW Government Common Planning Assumptions. These datasets do not include the impacts of the Covid-19 pandemic, and are not due for update until 2022. The Australian Bureau of Statistics (ABS) has released some data on the current impacts of Covid-19, which take into account changes in overseas migration estimates, which are expected to inform the updated Common Planning Assumptions in 2022.

Without updated NSW forecasts, Arcadis cannot quantify the potential impacts of the global pandemic but can identify factors that may influence population, the economy and waste generation. The Centre for Population provided the following observations:

- Australia's population is estimated to be about 4% smaller by 2031, compared to the predictions without the global pandemic. This change is expected to impact the capital cities at a rate of 5%.
- Despite the reduction in net overseas migrations, Australia's population is still expected to grow and will reach 28 million in 2028/2019, three years later than predicted (in the absence of Covid-19).

In addition to these macro population estimates, Arcadis makes the following observations in relation to waste and Covid-19:

- Potential growth in MSW residual as more people work from home in the short and long term, resulting in a redistribution of waste previously arising in the C&I sector.
- Growth in some C&I sectors and decline in others will result in changes in the locations and types of waste arising. For example, decline in in-store retail gives rise to growth in online retail and logistics services.

Arcadis considers it conservative to assume a minor net reduction in combined MSW and C&I waste volumes due to the impacts of Covid-19. However, the evidence base is yet to be assembled by the Federal and State Government agencies as the pandemic is ongoing and the long-term outcomes are unknown. Without the data to support these predictions, Arcadis is unable to incorporate the impacts of Covid-19 into this feedstock model.

4 CURRENT WASTE FLOWS

This section provides estimates for future MSW and C&I residual waste arising within the waste catchment of the model, the Sydney Basin. As discussed in the Section 2.2, significant changes are expected for MSW and minor changes for C&I waste, therefore the base case (Section 4.1) is inclusive of the mandatory policies under the *Waste and Sustainable Materials Strategy 2041*. The base case therefore is not a continuation of 'business as usual', which would assume the same current rates of participation in food and garden organics (FOGO) collection. Other targets within the *Waste and Sustainable Materials Strategy* are presented as scenarios in Section 4.2. The uncertainty in the key assumptions of the base case is explored in Section 4.3.

4.1 Feedstock baseline

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. It is also influenced by population and economic growth, with the impacts of the current pandemic discussed it section 3.4.

The forecasts presented in sections 4.1.1 and 4.1.2 (and summarised in Section 4.1.3) present a base case of, respectively, MSW and C&I waste arising under the new mandatory NSW policy settings as well as their impacts on waste streams currently received at the Woodlawn Eco-Precinct, which form the target feedstock for the Advanced Energy Recovery Centre (ARC). The base case is built on the key assumptions presented in Section 3.3, which are informed by historical data, industry trends and optimistic view of the potential benefits of new policy. These assumptions are tested in Section 4.3 to understand the potential variance in future waste arisings compared to the base case assumptions.

The base case represents what Arcadis considers to be the most plausible scenario in the coming years. It includes only the mandatory policies within the *NSW Waste and Sustainable Materials Strategy 2041*, with the other targets discussed as part of the scenarios analysis in Section 4.2. Given NSW fell significantly short of the *WARR 2014-2021 Strategy* targets, Arcadis considers it a conservative position to include only evidence-based trends and mandatory policies in the base case.

Table 8: Incorporation of Waste and Materials Strategy 2041 mandatory policies and strategies in feedstock modelling

Modelling aspect	Policies under the *Waste and Sustainable Materials Strategy 2041*
Base Case	To help achieve targets of halving food waste to landfill and achieving net zero emissions from organics in landfill by 2030, the Government will require the separate collection of: • Food and garden organics from all NSW households by 2030 • Food waste from targeted businesses and other entities that generate the highest volumes of food waste, including large supermarkets and hospitality businesses, by 2025. Modelling of C&I food waste assumed the mandatory measure applied solely to the hospitality and retail sectors, with food waste tonnages for these sectors derived from the National Food Waste Baseline. The goal to reduce waste generation per person or per employee by 10% by 2030 is assumed to be achieved, based on the evidence base for changes in residual. The change rate of assumptions of -0.8% for MSW results in net reduction of almost 10% over 10 years, while the change rate assumption of -1.2% for C&I exceeds the 10-year reduction target.
Other scenarios	• Have an 80% average recovery rate from all waste streams by 2030 • Set a goal to triple the plastics recycling rate by 2030, as set out in the NSW Plastics Action Plan

4.1.1 Municipal Solid Waste

Despite some reductions in the rate of MSW residual generation per capita, the trajectory for this waste stream would be net positive without the interventions recently announced under the *NSW Waste and Sustainable Materials Strategy 2041*. The following graph shows the new MSW residual waste generation base case, with a significant reduction in comparison to forecasts without the mandatory policy interventions. This analysis highlights how higher order resource recovery opportunities are being maximised through the *NSW Waste and Sustainable Materials Strategy 2041*, supporting the goals and tiered eligibility framework of the EfW Policy Statement.

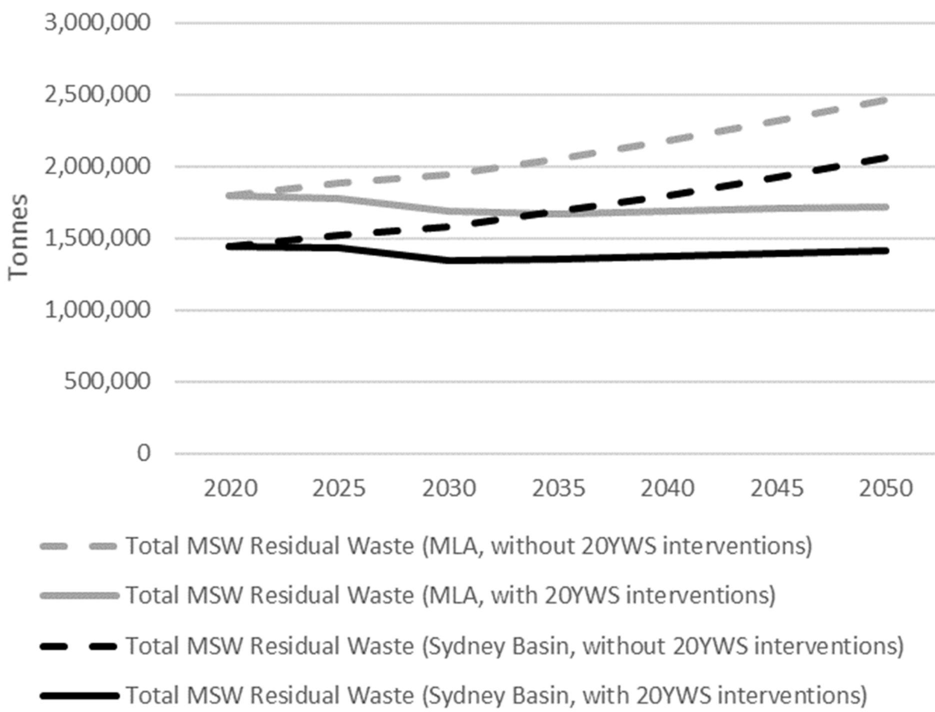

Figure 12: Total MSW Residual Waste Forecast (WARRP Data)

Table 9: Total MSW Residual Waste Forecast (WARRP Data)

	2020	2030	2040	2050
Total MSW Residual Waste (MLA, without 20YWS interventions)	1,799,052	1,941,677	2,179,348	2,462,047
Total MSW Residual Waste (MLA, inclusive of 20YWS interventions)	1,799,052	1,691,709	1,687,468	1,721,343
Total MSW Residual Waste (Sydney Basin, without 20YWS interventions)	1,447,060	1,585,072	1,800,427	2,060,291
Total MSW Residual Waste (Sydney Basin, inclusive of 20YWS interventions)	1,447,060	1,343,445	1,374,488	1,414,311

Veolia's target feedstock is kerbside residual waste from Councils with FOGO / FO collections, which will include all NSW Councils by 2030. The following figures and tables show total available kerbside residual waste volumes in the Sydney Basin, as well as quantities currently contracted to Veolia. These contracts are expected to be renewed or replaced in the coming years, particularly with the transition to improved FOGO / FO service offerings.

The residual waste trajectory shows a significant decline to 2030 as FOGO / FO services are introduced and the negative generation/capita change rate is applied. The volumes gradually decline after 2030 as it is assumed that diversion rates will improve by 1% per annum. For MSW the improvement rate is inclusive of both higher capture efficiency rates for organics as well as commingled recycling as Councils continue their drive to correct the usage of the commingled recycling stream. The C&I improvement relates to organics only as it is the only mandatory policy included in the *Waste and Sustainable Materials Strategy 2041*. This reduction trend offsets the positive growth rate in population for the Sydney Basin.

Figure 13 shows total MSW residual waste generated in the Sydney Basin (black), inclusive of kerbside collections, clean-up, drop-off waste and other MSW streams included with the NSW EPA's WARRP estimates. Only putrescible kerbside residual waste (grey line) is a target feedstock, with data informed by the LG WARR Survey data. The red line represents the sum of all kerbside residual waste currently contracted to the Woodlawn Eco Precinct, with Veolia assumed to maintain their current share of the Greater Sydney putrescible waste market given factors of scale, reputation and access to increasingly critical transfer capacity.

As all Councils are required to transition from a garden organics (GO) service to a FOGO / FO service, the putrescible waste stream is considered fully eligible under the Resource Recovery Criteria of the EfW Policy Statement. As discussed in Section 2.3, the time at which these Councils transition is similar to the expected commissioning period for the ARC.

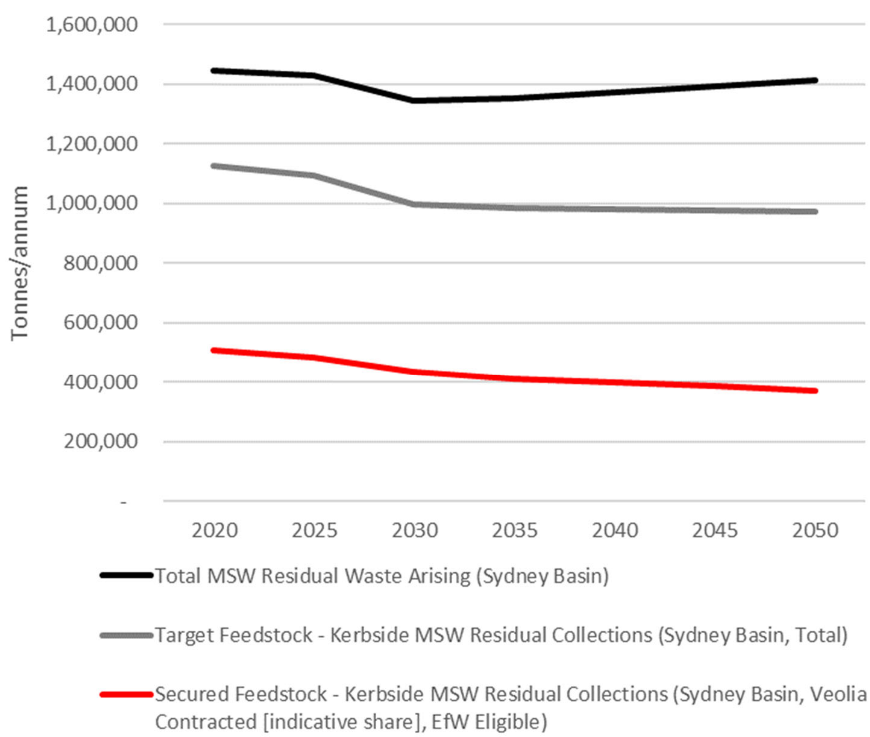

Figure 13: Sydney Basin total MSW residual waste and the kerbside collected putrescible stream, with Veolia's share of market (assumed constant)

Table 10: Underlying data for MSW in the Sydney Basin and Veolia's tonnes under contract based on indicative market share

	2020	2030	2040	2050
Total MSW Residual Waste Arising (Sydney Basin)	1,447,060	1,343,445	1,374,488	1,414,311
Target Feedstock - Putrescible Kerbside MSW Residual Collections (Sydney Basin, Total)	1,125,588	997,071	983,211	971,544
Secured Feedstock - Putrescible Kerbside MSW Residual Collections (Sydney Basin, Veolia Contracted [indicative share], EfW eligible)	509,524	434,243	400,675	372,676

The forecast shows that even under this optimistic base case, where Councils improve their recycling by diverting an extra 1% per annum per year from the residual waste stream into the FOGO / FO and commingled recycling stream, there remains a need for residual waste solutions. Table 10 also shows that if Veolia maintains their market share for kerbside residual services, then the quantity of EfW eligible MSW received at the Woodlawn Eco-Precinct will by itself exceed the total feedstock needs of the Advanced Energy Recovery Centre (including C&I waste).

4.1.2 C&I waste

Even with the interventions announced under the *Waste and Sustainable Materials Strategy 2041*, and the negative change rate for C&I residual waste generation per employee, the total C&I waste forecast is net positive. The policy intervention of mandatory FO collection for businesses in 2025 (assumed to target hospitality and retail sectors) does not achieve the same magnitude of impact as the MSW policy interventions. The following graph shows the new C&I residual waste generation base case with a comparison to the trajectory without the mandatory interventions. These estimates are inclusive of both putrescible and non-putrescible C&I residual waste streams.

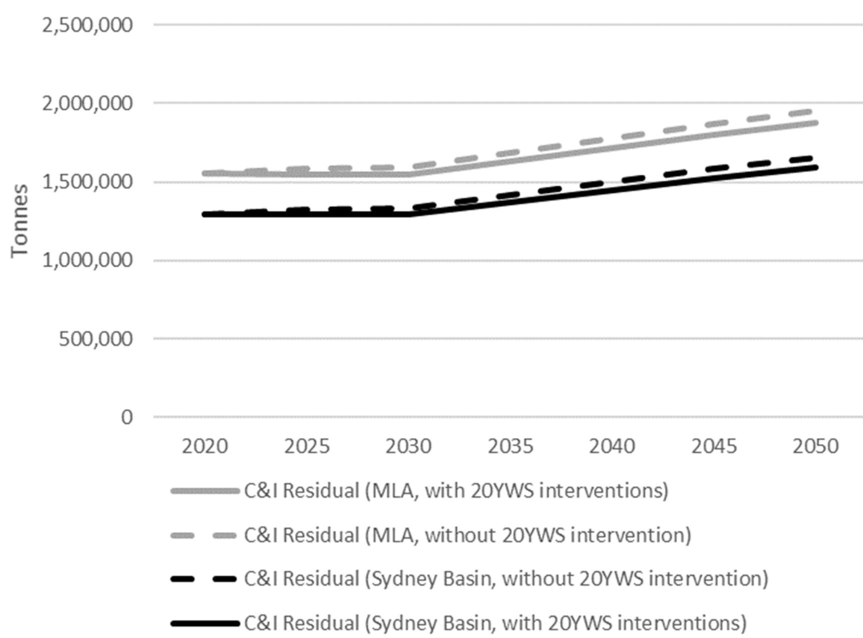

Figure 14: Total C&I residual waste forecast (WARRP Data)

Table 11: Total C&I residual waste forecast (WARRP Data) (tonnes)

	2020	2030	2040	2050
Total C&I Residual Waste (MLA, without 20YWS interventions)	1,554,439	1,543,771	1,714,651	1,873,395
Total C&I Residual Waste (MLA, inclusive of 20YWS interventions)	1,554,439	1,589,453	1,777,622	1,949,041
Total C&I Residual Waste (Sydney Basin, without 20YWS interventions)	1,291,655	1,333,101	1,501,661	1,656,645
Total C&I Residual Waste (Sydney Basin, inclusive of 20YWS interventions)	1,291,655	1,295,142	1,449,336	1,593,787

Figure 14 and Figure 15 show slow growth to 2030 and more rapid growth thereafter. This is because the change rate for residual waste generation per employee was applied to 2030 only, after which positive economic growth continues to drive C&I residual waste generation. These figures also show only a marginal impact of the mandatory FO collection on net C&I residual waste generation, based on the assumptions in Section 3. The model assumes the C&I waste diversion rate achieved through the mandatory FO policy will increase at 1% per annum.

The following figures and tables show Veolia's current market share of total C&I residual waste generation, including putrescible and non-putrescible waste. This waste already passes through the Banksmeadow and Clyde Transfer Terminals prior to disposal at the Woodlawn Eco-Precinct.

The C&I waste services sector does not benefit from the same long term contracts as the MSW sector, however Veolia's access to the putrescible stream remains relatively secure because there are only two private sector putrescible landfills dedicated to Sydney Basin waste – Woodlawn and Lucas Heights landfills. While there is greater competition for non-putrescible C&I waste, industry estimates indicate the putrescible portion is approximately 60% of C&I waste disposal volumes. Veolia therefore has a significant share of the disposal market for the ARC's target C&I waste. The impact of potential new competition has been assessed in Section 5.

The following figure shows total residual C&I waste forecast to be generated in the Sydney Basin (grey line). This value is inclusive of both putrescible and non-putrescible waste. The red line shows the amount of putrescible residual C&I waste that currently goes through Banksmeadow and Clyde Transfer Terminals (labelled CTT and BTT). It is assumed that Veolia's market share of this waste stream will remain constant. The red dotted line shows the quantity considered compliant under the Resource Recovery Criteria of the EfW Policy Strategy.

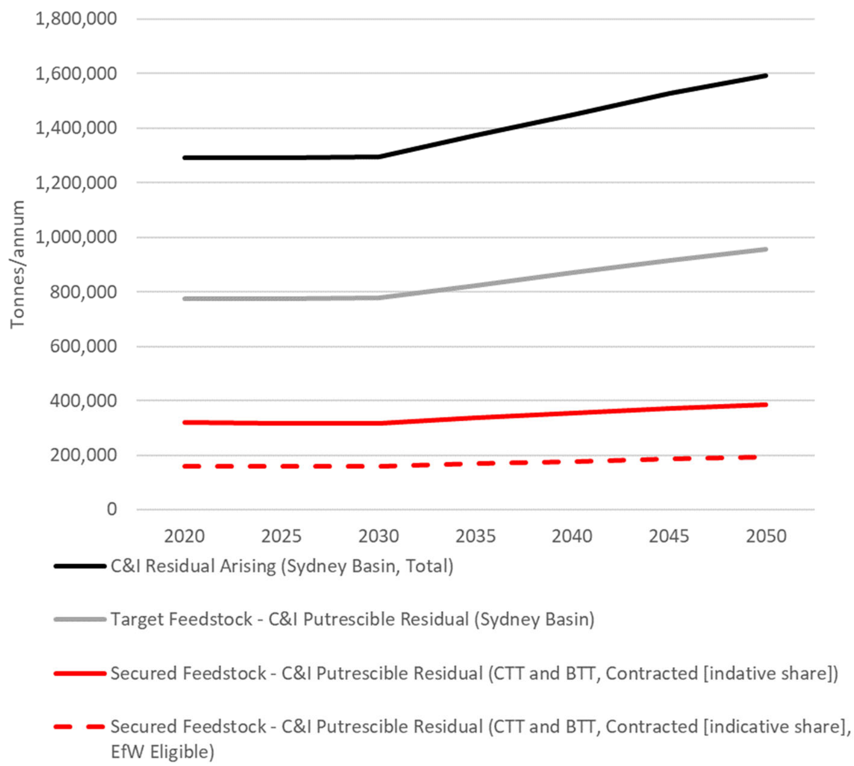

Figure 15: Sydney Basin total C&I residual waste and Veolia's share of market (assumed constant), with indicative 50% EfW eligibility

Table 12: Underlying data for C&I waste in the Sydney Basin and Veolia's tonnes under contract based on indicative market share

	2020	2030	2040	2050
C&I Residual Arising (Sydney Basin, Total)	1,291,655	1,295,142	1,449,336	1,593,787
Target Feedstock - C&I Putrescible Residual (Sydney Basin, Putrescible only)	774,993	777,085	869,601	956,272
Secured Feedstock - C&I Putrescible Residual (Veolia Contracted [indicative share])	319,600	317,407	352,540	385,179
Secured Feedstock - C&I Residual (Veolia Contracted [indicative share], EfW eligible)	159,800	158,703	176,270	192,589

4.1.3 Feedstock summary

Veolia's target feedstock is putrescible residual waste received at Banksmeadow and Clyde Transfer Terminals after source separation and onsite recovery opportunities have been maximised.

In summary, the baseline feedstock analysis of the Sydney Basin estimates total generation of approximately 1.8 million tonnes across the target waste streams in 2030, with net positive growth over the forecast period (Table 13). The analysis also shows 590,000 tonnes in secure EfW eligible waste (assuming a conservative 50% C&I waste eligibility) in 2030, which is 210,000 tonnes surplus to the requirements of the ARC with a capacity of 380,000 tonnes per annum.

Table 13: Underlying data for combined MSW and C&I waste in the Sydney Basin and Veolia's tonnes under contract based on indicative market share (tonnes)

	2020	2030	2040	2050
Total MSW and C&I Arising Waste (Sydney Basin)	2,738,715	2,638,587	2,823,824	3,008,098
Combined Target Waste (Kerbside Residual MSW and Putrescible Residual C&I)	1,900,581	1,774,156	1,852,812	1,927,816
Combined Target Waste (Veolia Contracted [indicative share])	829,124	751,650	753,215	757,855
Combined Residual (Veolia Contracted [indicative share, EfW eligible)	669,324	592,942	576,952	565,331

4.2 Other Scenarios – 20-Year Waste Strategy Targets

The base case included mandatory policies only. This section discusses how targets within the *NSW Waste and Sustainable Materials Strategy 2041* may influence MSW and C&I residual waste forecasts.

4.2.1 80% average recovery from all waste streams by 2030

The *Waste and Sustainable Materials Strategy 2041* acknowledges the limited progress against the previous targets in the WARR Strategy 2014-2021. The previous targets are now superseded with a target of an “80% average recovery rate from all waste streams by 2030”, which is compared to the current overall recovery rate of 65%, a total target increase of 15 percentage points.

Given the waste generation split in NSW is 60% C&D waste, 20% MSW and 20% C&I waste, progress on C&D recovery has a threefold impact on the net target compared to each of MSW and C&I waste, providing a greater weighting on C&D waste recovery in achieving the Strategy’s overall recovery target. However, if the 15 percentage point net improvement requirement is applied equally to each of the three streams, MSW and C&I waste recovery would increase to 58% and 68% respectively, which is less than the previous WARR Strategy targets of 70% for each. The MSW recycling rate in the Metropolitan Levy Area in the base year of this assessment was slightly lower than the rest of NSW at 41% (WARRP Progress Update 2017/2018). The 15 percentage point improvement target is applied to that rate, and therefore increased over the 10-year period to 56%.

Figure 16 shows the trajectory of MSW residual waste under three scenarios; no change (black line), base case (grey line) and the 80% target (purple line). These residual waste volumes exceed the feedstock needs of the project (red line), which indicates that even with all the positive changes there remains sufficient feedstock to supply the project.

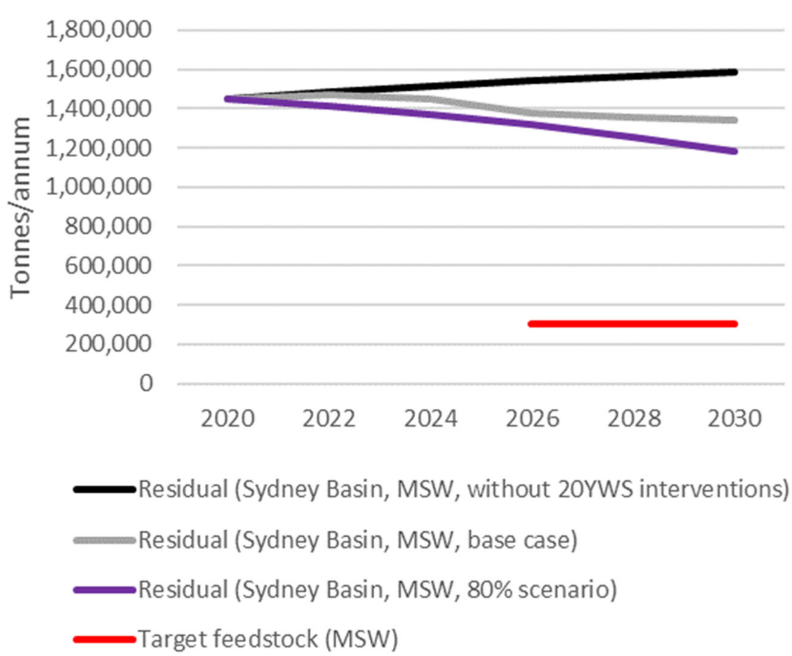

Figure 16: The forecast impact of the 80% average recycling rate target on MSW recycling and residual volumes[10].

[10] The recycling rate uplift was applied to an estimate of both residual and recycling volumes in the Sydney Basin to determine the subsequent split over the forecast period. For simplicity, the same negative change rate and population statistics were applied to that of the base case.

The same estimation methodology and assumptions apply to the C&I waste scenario. In the base year for this assessment, the C&I recycling rate in the MLA was 49% (WARRP Progress Update 2017/2018). Therefore, the 15 percentage point increase results in a C&I waste target of 64%. Figure 17 shows the trajectory of C&I residual waste under three scenarios; no change (black line), base case (grey line) and the 80% target (purple line). Consistent with the findings for MSW, the residual waste volumes under the different scenarios exceed the feedstock needs of the project (red line).

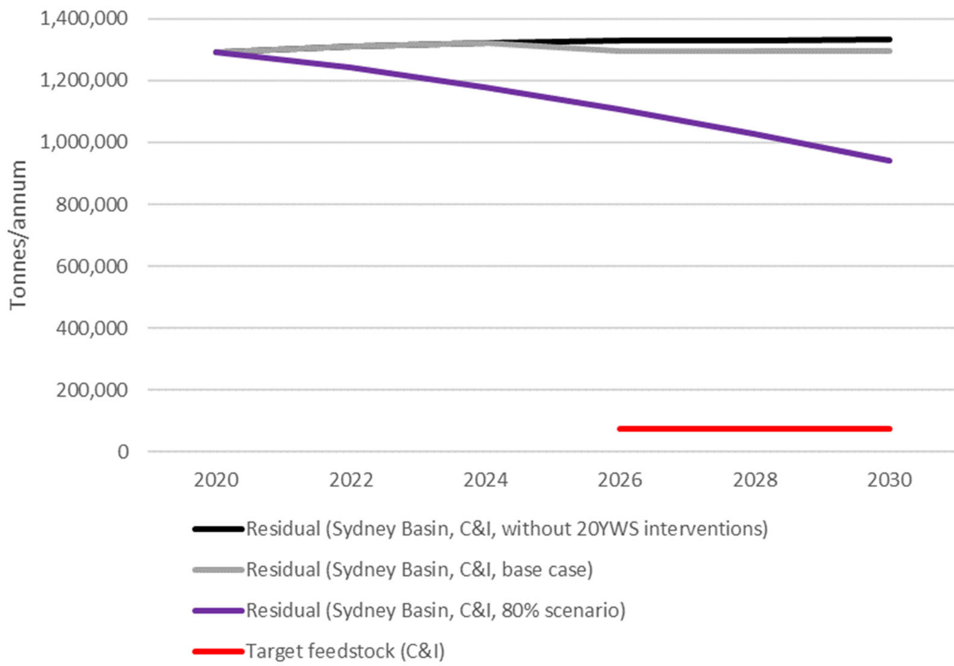

Figure 17: The forecast impact of the 80% average recycling rate target on C&I recycling and residual volumes.

In summary, achieving the average 80% recycling target across all streams by 2030 would decrease the quantity of residual waste in MSW and C&I waste in the Sydney Basin by a collective 500,000 tpa compared to the base case in 2030. This is equivalent to a reduction of approximately 20% between this scenario and the base case. This would be a material risk to the project if Veolia's secure tonnages [indicative share] weren't twice the capacity needs of the project, or its EfW eligible tonnages were not 50% more than the needs of the project (Section 4.1.3). It is also noted that any repeat of the recycling rate shortfall from the previous WARR Strategy would further weaken the diversion from residual waste into the recycling stream.

4.2.2 Tripling the recycling rate for plastic

The *NSW Waste and Sustainable Materials Strategy 2041* included an intention to "set a goal to triple the plastics recycling rate by 2030, as set out in the NSW Plastics Action Plan".

The current plastics recycling rate from MSW, C&I and C&D waste (excluding RDF) is approximately 11% (87,000 tonnes)[11], with an appetite to triple it to 33% by 2030. Total recyclable plastic (including estimates of what goes to landfill) is forecast under BAU to reach 926,000 tonnes in 2030 (inclusive of C&D waste), with recycling required to increase to 290,000 tonnes to meet the target rate. This is a significant increase in terms of plastic recycling, but not a large number in terms of overall waste disposal. For the purposes of modelling, it was assumed that recycling efforts were split evenly between the three streams.

The following figure illustrates the additional tonnages of recyclable plastics that need to be diverted from the MSW and C&I residual waste streams to achieve the target. The above values, taken from the analysis for the 20 Year Waste Infrastructure Needs Assessment, were divided evenly between the three waste streams, and based on the relative proportion of the Sydney Basin compared to NSW.

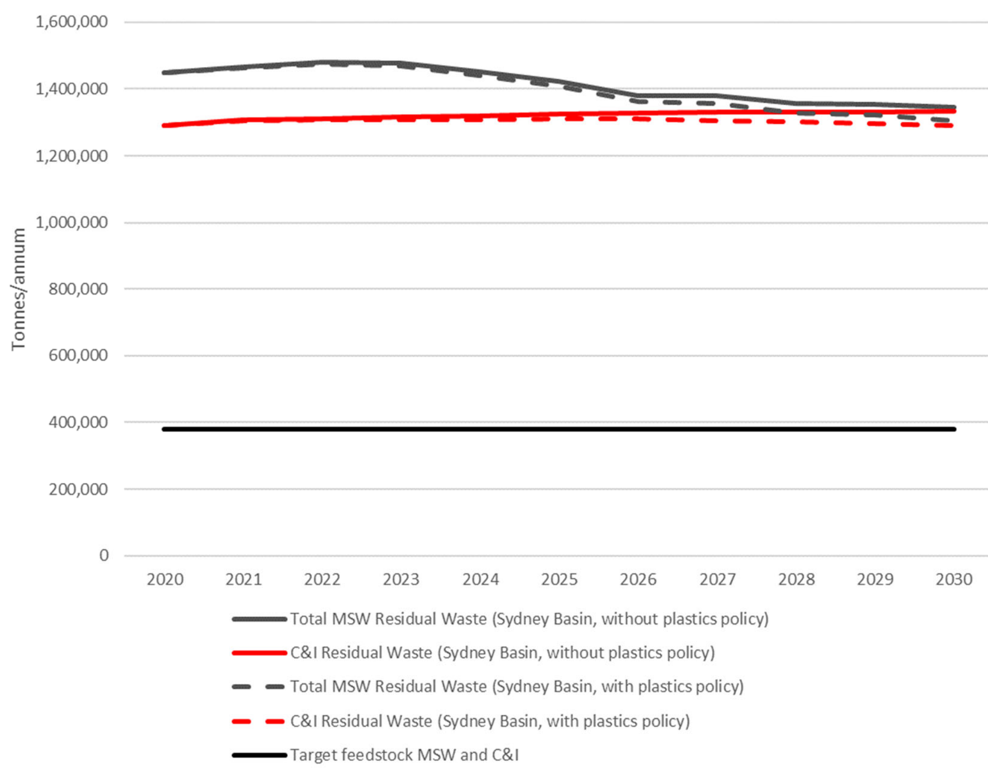

Figure 18: Tripling plastics recycling rate and impact on the MSW and C&I residual waste streams.

It is noted that there is another plastics target in the *NSW Waste and Sustainable Materials Strategy 2041*, to phase out 'problematic single-use plastics'. This is not modelled because it is low volume in terms of overall residual waste arising in the Sydney Basin, and may even be met by substitution with non-plastic materials that still end up in the residual waste stream, with no resulting change in volumes.

[11] https://www.awe.gov.au/sites/default/files/documents/australian-plastics-recycling-survey-report-2017-18.pdf

4.3 Sensitivity Analysis – Key assumptions

The following section presents the results of a sensitivity analysis of the key assumptions used to inform the base case. Sensitivity analysis refers to the process of changing the key assumptions to understand the extent to which these affect the results. The magnitude of their impact on the results is shown through the following box and whisker graphs. The box shows the interquartile range, which is where 50% of the results fall. The whiskers represent the upper and lower 25% of results and the maximum and minimum values. The purpose of this task is to understand potential variation from the base case and identify the median of this large set of results. The median is considered a more likely outcome than the outer ranges of estimates.

This analysis looked at total MSW residual waste, MSW residual collections and total C&I residual waste within the Sydney Basin under the new NSW policy settings. The observed variance and consistency are directly proportional to the expected volumes of RRC compliant feedstock to the facility.

This analysis related to key assumptions used in the base case only and excluded the separate scenarios discussed in Section 4.2.

4.3.1 MSW

The key variables of population growth rates, changes in waste generation per capita, diversion rates and improvements to the diversion rates creates a large number of waste generation scenarios to test through sensitivity analysis. The various combinations of factors result in 108 scenarios for MSW residual waste generation.

The following figures and tables illustrate the median and quartile range[12] for MSW kerbside residual waste collections and total MSW residual waste arising. The results show the median values in 2020, 2030, 2040 and 2050 are approximately consistent with the base case for both residual kerbside collections and total residual waste. This indicates that the base case is a probable result under a range of different assumptions. Unsurprisingly the interquartile range widens in the subsequent decades, which corresponds to a greater degree of uncertainty in the forecast as the impacts of system changes and generation/capita change rates in the first 10 years compounded annually.

Figure 19 (and data) illustrates the distribution of waste supply outcomes for residual kerbside collection scenarios, while Figure 20 (and data) shows total MSW residual waste arising. The results are compared against the base case in Table 14 and Table 15.

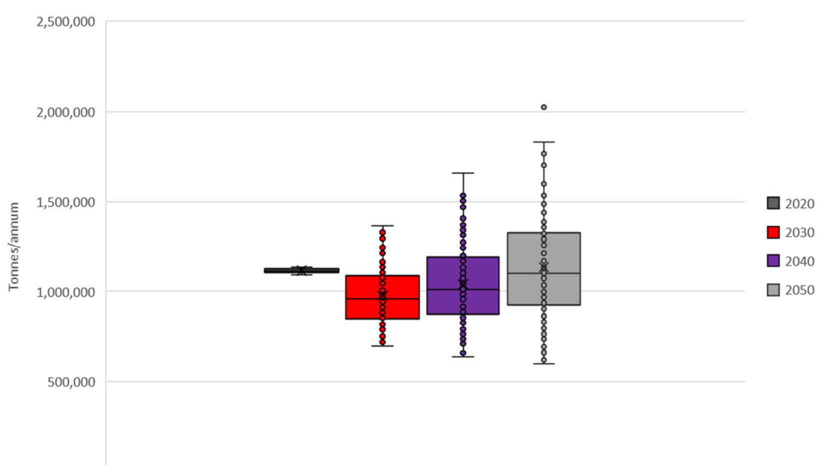

Figure 19: Results of the sensitivity analysis organised into an interquartile range (kerbside putrescible residual waste collections)

[12] Middle 50% of results

Table 14: Median values within a range of sensitivity analysis estimates and the comparison with the base case (kerbside putrescible residual waste collections)

	2020	2030	2040	2050
Median of sensitivity analysis results	1,115,312	957,470	1,011,379	1,099,743
Base case	1,125,588	997,071	983,211	971,544

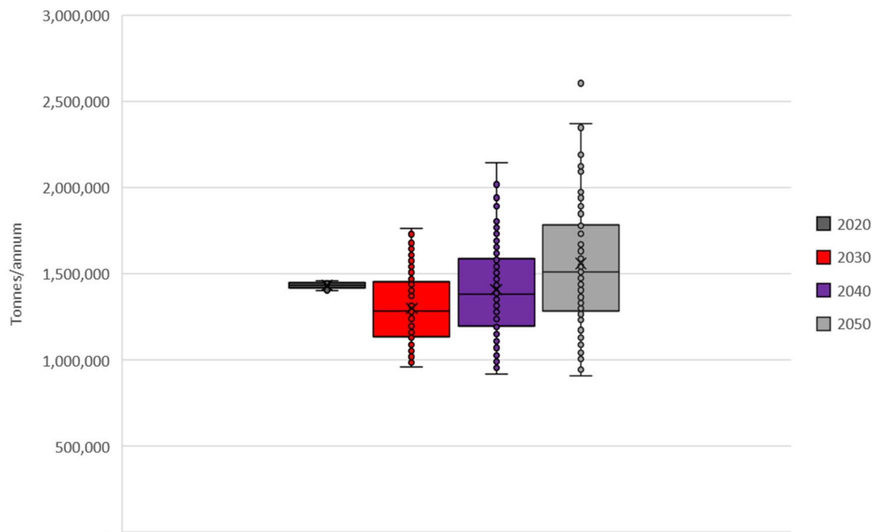

Figure 20: Results of the sensitivity analysis organised into an interquartile range (total MSW residual waste generation)

Table 15: Median values within a range of sensitivity analysis estimates and the comparison with the base case (total MSW residual generation)

	2020	2030	2040	2050
Median of sensitivity analysis results	1,433,862	1,282,346	1,383,204	1,509,094
Base case	1,447,060	1,343,445	1,374,488	1,414,311

4.3.2 C&I waste

The key variables for C&I waste sensitivity analysis involved fewer variables compared to MSW because there was only one scenario for employment estimates and there are fewer C&I waste data sources available to determine different change rates. The combined variations of waste generation per employee, diversion rates and improvements to the diversion rates amounted to 27 different scenarios for C&I waste.

Figure 21 (and data) illustrates the median and quartile range for C&I residual waste arising. The results show the median values in 2020, 2030, 2040 and 2050 are approximately consistent with the base case, which indicates the base case is a probable outcome under a range of variations to the key assumptions.

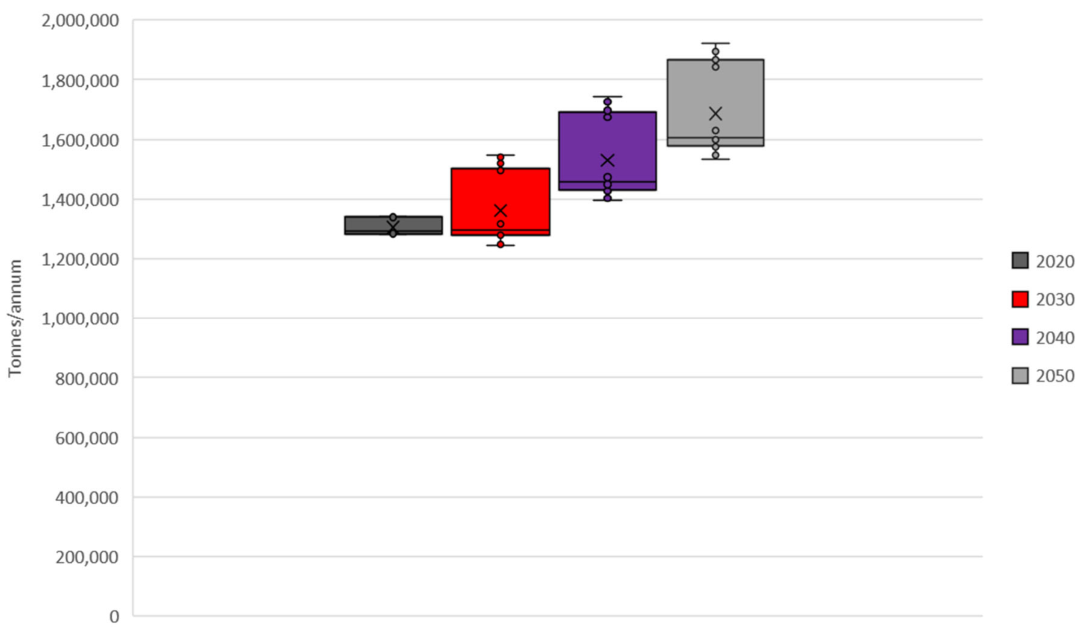

Figure 21: Results of the sensitivity analysis organised into an interquartile range (total C&I residual generation)

Table 16: Median values within a range of sensitivity analysis estimates and the comparison with the base case (total C&I residual generation)

	2020	2030	2040	2050
Median of sensitivity analysis results	1,291,655	1,297,349	1,456,740	1,606,259
Base case	1,291,655	1,295,142	1,449,336	1,593,787

4.3.3 Sensitivity summary

In summary, the median result of the sensitivity analysis of each stream shows consistency with the base case estimate and a minor reduction in generation, in the aggregate. Total generation of the targets wastes in 2030 would be 2.56 million tonnes compared to 2.64 million tonnes in the base case, a 3% reduction. The potential range of values increases with time, which is consistent with any forecasting methodology where small different in the short term compound to significantly different outcomes in the long term.

5 COMPETITION

Potential competition for the ARC has been assessed through analysis of the putrescible waste energy recovery projects currently seeking approval from the Department of Planning, Industry and Environment (DPIE), plus the NSW Government-facilitated competitive tender to develop a facility at the Parkes Special Activation Precinct. There are six putrescible waste processing projects seeking to service Greater Sydney, including the ARC (Table 17). Projects dedicated to non-putrescible waste are not included as they are not targeting ARC waste streams.

Table 17: EfW projects targeting Greater Sydney putrescible waste, seeking approval or under tender

Status	EfW Facility (Combustion only, not including RDF production)	Capacity (tonnes per annum)	Target waste streams	Competitive position
Seeking development approval[13]	Woodlawn ARC (direct combustion)	380,000	MSW and C&I	Targeting putrescible residual waste from the Sydney Basin.
	Mount Piper (RDF combustion)	200,000	MSW and C&I	Able to accept RDF derived from both putrescible and non-putrescible waste streams, primarily from the Sydney Basin.
	The Next Generation (direct combustion)	300,000 (all wastes)	MSW, C&I and C&D	Assuming even split of MSW, C&I and C&D. With an indicative 60% of residual being putrescible, it is assumed the contested tonnes are approximately 160,000 tpa.
	Jerrara Power (direct combustion)	330,000 (all regions)	MSW and C&I	Targeting putrescible residual waste in the Sydney Basin and neighbouring south coast NSW regions. Assumed south coast input of 100,000 tpa, with contested tonnes of 230,000 tpa.
	Western Sydney Energy Recovery Centre (direct combustion)	500,000	MSW and C&I	Targeting putrescible and non-putrescible residual waste from the Sydney Basin. To facilitate comparison with this putrescible competitor analysis, it is assumed that the contested tonnes are approximately 400,000 tonnes.
NSW Government competitive tender	Parkes SAP (direct combustion)	400,000	MSW and C&I	Targeting putrescible residual waste, primarily from the Sydney Basin. Scale is assumed, but subject to final tender.

[13] Arcadis notes that Boral is proposing to increase their RDF consumption capacity by an extra 100,000 tonnes from MSW, C&I and C&D waste. As per current practice, it is assumed that this will continue to be sourced from non-putrescible waste, which is non-target feedstock. Arcadis notes that a small proportion of MSW is non-putrescible, but this is considered of low materiality and hasn't been excluded from total MSW arising forecasts. If this new proposal were to be included in the competitor analysis it would only have a materiality of 30,000 tonnes, assuming an even split of the three streams and excluding non-putrescible C&I.

The proposed facilities' aggregated capacity to process putrescible waste from the Sydney Basin is 1.77 million tpa, with cumulative capacity and generation of the target waste streams illustrated in Figure 22.

While it is very unlikely that all six of the projects will be developed given significant planning approval constraints and competition to secure Sydney Basin putrescible waste feedstock, the analysis shows there is sufficient demand for putrescible waste management options under the most competitive scenario. In 2030, where the supply and demand gap is at its narrowest, there is an additional 270,000 tpa headroom in the Sydney Basin market beyond aggregated EfW capacity.

'Supply' in the following figure is inclusive of all MSW residual waste and 60% of C&I residual which is assumed to be putrescible. The MSW residual waste is expected to be eligible under the EfW Policy Statement. Estimates of EfW eligibility of C&I putrescible residual waste is not known. Current industry knowledge would place comprehensive at source separation at 60% with this expected to increase as mandatory FO is introduced in 2025 and further improvements expected to occur in line with the NSW Waste and Sustainable Materials Strategy[14]. 'Planned' in the following figure refers to projects that are within the NSW planning system, and therefore could represent competition for feedstock.

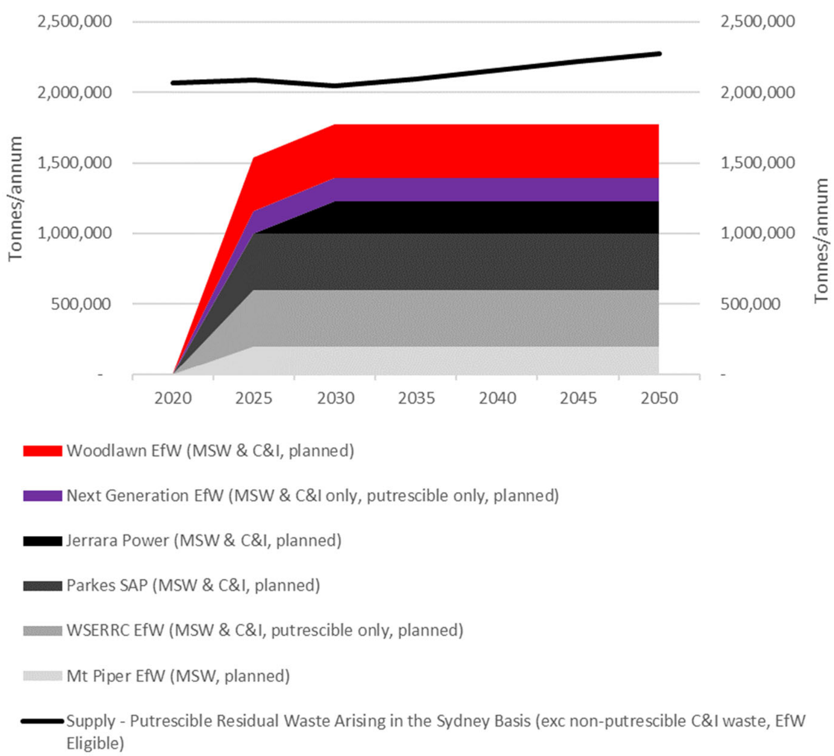

Figure 22: Putrescible waste supply and cumulative capacity of proposed EfW facilities (assuming all facilities are developed)

Given that it cannot be known at this stage which facilities may ultimately be developed, a median scenario was developed that assumes 50% of competitive capacity is developed, regardless of the individual facilities. The assumption was not applied to the Woodlawn ARC in order to show the headroom for the full project within a more realistic competitive context.

[14] Without alternate available information, Arcadis relies on industry estimates, which indicate approximately 60% of C&I residual waste is from generators with comprehensive source separation, and is therefore fully eligible for EfW. This is assumed to increase to 70% in 2025 and 80% in 2030, plateauing thereafter. The balance of C&I residual waste is 50% eligible for EfW.

This scenario is considered more plausible than the first scenario because the future of the Next Generation, Jerrara Power and WSERRC projects is considered uncertain. The recently released *EFW Infrastructure Plan* does not permit the proposed EfW facilities in Greater Sydney, in their current form. The proponents would need to re-locate or amend their proposed facilities in order to comply with this plan. Arcadis therefore considers it unlikely that all projects in the planning systems will be approved.

Figure 23 indicates that under this scenario, in 2030 there is additional headroom of 970,000 tpa between cumulative EfW capacity (1,075,000 tpa) and target putrescible waste supply.

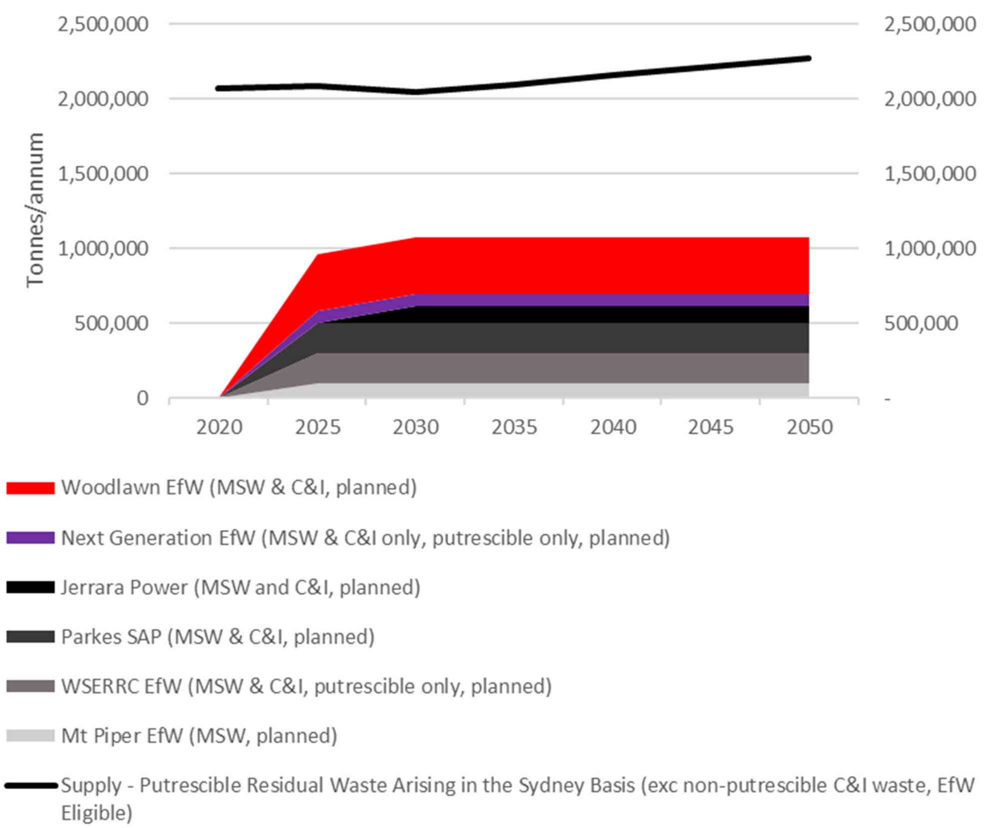

Figure 23: Putrescible waste supply and cumulative capacity of proposed EfW facilities (assuming 50% capacity)

6 CONCLUSION

The ARC target feedstocks are putrescible MSW and C&I residual waste from the Sydney Basin. The analysis of waste generation and flows has shown there is continued demand for putrescible residual waste solutions for the Sydney Basin. Waste volumes will collectively continue to grow over the 30 year horizon, including in the context of the recently released *NSW Waste and Sustainable Materials Strategy 2041* and the *Energy from Waste Infrastructure Plan*. The feedstock strategy proposed by Veolia is consistent with the *Waste Avoidance and Resource Recovery Act 2001* which encourages diversion of waste from landfill.

The first 10 years under the base case results in a very minor decline of net residual waste arising, from 2.7 million tonnes in 2020 to 2.6 million tonnes in 2030. Beyond 2030, waste generation is forecast to be net positive in line with population and economic growth. It is possible further reduction measures will be imposed by the regulatory agencies, but these cannot be known at this time.

The analysis has considered the general dynamics around MSW and C&I waste collection in the Sydney Basin to inform the eligibility of residual waste for provision to an energy from waste facility. Based on the government-mandated transition to the source separated collection of FOGO / FO by 2030, it has been assumed MSW is 100% eligible under the EfW Policy Statement. For C&I waste, it has been assumed 60% (2020) - 80% (2030) of C&I is considered eligible with the balance partially eligible. Under these respective MSW and C&I waste conditions, approximately 80% of Veolia's contracted supply (indicative market share) is estimated to be EfW eligible waste in 2030.

The feedstock strategy proposed by Veolia is consistent with EPA guidelines and the EfW Policy Statement through a resource recovery process that selects less than 50% of received waste for energy recovery. This allows Veolia to actively preference loads from complying source separated collection configurations, to maximise the recovery of materials to the extent practical, and to ensure waste is operationally suitable for a thermal EfW process. The competitive analysis of EfW proposals for Greater Sydney has shown there is adequate feedstock to supply all proposed facilities through their life, with particularly significant headroom in the likely scenario where the full suite of projects is not developed.

This indicates the ARC has a critical role in supporting the maturation of a resilient and integrated waste management system for the Sydney Basin that optimises higher order outcomes, diverts unrecyclable materials to energy recovery and extends the life of current landfills in their role of receiver of last resort.

APPENDIX A

Waste Audit Methodology

1.0 Introduction

Veolia engaged consultants to undertake two campaigns of auditing and characterisation of the potential feedstock for the Woodlawn ARC.

The waste characterisation project involved:

- Sampling and sorting of residual municipal solid waste (MSW) and commercial and industrial (C&I) waste from incoming loads to Veolia's Banksmeadow Transfer Terminal;
- Establishment of calorific value (CV);
- Chemical analysis at a NATA accredited laboratory.

Campaign 1 was conducted from 8 June 2021 to 17 June 2021.
Campaign 2 was conducted from 29 November to 3 December 2021.

Learnings from campaign 1 were implemented in campaign 2, and as a result, the sampling and testing methodology was refined between the two campaigns.

1.1 Summary

For campaign 1, a single composite sample was compiled each day for laboratory testing, from each of the 16 individual waste categories mixed in the proportions of the day's sampling. At the laboratory, the individual categories were tested for moisture content, and eight composite samples were subjected to CV and chemical analysis.

For campaign 2, individual waste categories were kept separate and a sample of each was sent to the laboratory for moisture content, CV and chemical testing. Campaign 2 also included an additional six waste categories (22 in total) and sieving of samples to establish the particle distribution.

The Sampling, Analysis and Quality Plan (SAQP) uses a method based on that used in campaign 2.

2.0 Campaign 1

2.1 Method

Samples were collected from incoming vehicles at the Banksmeadow Transfer Terminal. Samples from municipal kerbside loads from two local government areas were taken, as well as samples from incoming loads of commercial and industrial waste from various waste collection companies. The two councils were picked to assess FOGO diversion rates.

Council 1 has a voluntary FOGO collection, whereas council 2 does not. No significant variance was found in the organics proportions between the two councils.

Veolia supplied a suitable area for the duration of the on-site works, barricaded off from the main activities at the Banksmeadow Transfer Terminal.
The Veolia loader operator brought each 100 kg sample to the sorting area where each one was tipped onto a tarp. Each sample was labelled with its source, truck rego number, sample weight and time of sample extraction. The weight of the entire load over the incoming weighbridge was also recorded. Five samples per day were taken over the 8 days of the audit.

2.1.1 Sorting

Sorting staff sorted each 100 kg sample into the 16 categories as shown in Table 2, placing each different category in a separate tub. The tubs of separated material were then emptied into mobile garbage bins (MGBs) with tared weights. The MGBs were weighed on calibrated scales and the weight recorded. The samples were sent to the NATA accredited laboratory for analysis.

Table 1 shows the number and weight of samples. The fieldwork achieved the proposed number of samples from each source and was in accordance with the proposed total weights audited.

Table 1 Waste sampled for sorting

		Samples per day	Number of sampling days	Total number of samples	Total kilograms delivered	Total kilograms audited	% sampled vs delivered
MSW	Council 1	5	2	10	59,900	1,075.8	1.8%
	Council 2	5	2	10	54,280	1,038.1	1.9%
	Total	5	4	20	114,180	2,113.9	1.9%
C&I	Mixed C&I	5	4	20	131,160	2,045.7	1.6%
Total	MSW and C&I	5	8	40	245,340	4,159.6	1.7%

2.1.2 Sample Preparation

For laboratory testing, the laboratory specified that the consultants prepare a composite sample of each sort category (e.g. organics, paper etc) from the loads audited each day. The specified extracted sample would be theoretically 24 kg from each 100 kg load, in 15 sort categories. The sort categories were then combined by day and sent to the laboratory. Each sort category would be nominally 5 kg or 10 kg each (refer Table 2 below). For example, 2 kg of organics from each of the day's five piles, combined to make a 10 kg organics sample for that day. The total daily sample to be sent for laboratory testing would theoretically weigh 120 kgs (5 x 24 kg). The sampling regime for laboratory samples is shown in Table 2.

Not all sort categories had sufficient material to meet the specified extracted sample size of 1 or 2 kg, and consequently the total weight of material sent to the laboratory for testing was 614.9 kg versus a maximum theoretical weight of 960 kg (the product of 40 loads and each extracted sample of 24 kg). Or put another way, eight days of sampling, each day being 120 kgs (being 5 loads x 24 kg). Over eight days, the weight shipped to the laboratory was 614.9 kg, with an average weight per laboratory sample of 76.9 kg.

Each of the 15 materials were bagged separately, giving 15 bags per day sent to the laboratory over each of the eight audit days, resulting in 120 bags of material sent for testing.

Table 2 Sampling regime for selecting laboratory samples

Category	Amount to sub-sample to send to laboratory	Total kg per day
1. Organics	Approx. 5 – 10 kg by end of day. Approx. 2 kg representative portion per pile audited.	10
2. Paper / cardboard	Approx. 5 – 10 kg by end of day. Approx. 2 kg representative portion per pile audited.	10
3. Cartons	Approx. 5 – 10 kg by end of day. Approx. 2 kg representative portion per pile audited.	10
4. Composite	Approx. 5 – 10 kg by end of day. Approx. 2 kg representative portion per pile audited.	10
5. Textiles	Approx. 5 – 10 kg by end of day. Approx. 2 kg representative portion per pile audited.	10
6. Nappies and hygiene products	Approx. 5 kg by end of day. Approx. 1 kg representative portion per pile audited.	5
7. Plastic excluding PVC	Approx. 5 – 10 kg by end of day. Approx. 2 kg representative portion per pile audited.	10
8. PVC	Approx. 5 kg by end of day. Approx. 1 kg representative portion per pile audited.	5
9. Combustible material (wood)	Approx. 5 – 10 kg by end of day. Approx. 2 kg representative portion per pile audited.	10
10. Glass	Approx. 5 kg by end of day. Approx. 1 kg representative portion per pile audited.	5
11. Metals	Approx. 5 kg by end of day. Approx. 1 kg representative portion per pile audited.	5
12. Incombustible/Inert	Approx. 5 kg by end of day. Approx. 1 kg representative portion per pile audited.	5
13. E-waste	Approx. 5 – 10 kg by end of day. Approx. 2 kg representative portion per pile audited.	10

14. Other hazardous	Approx. 5 kg by end of day. Approx. 1 kg representative portion per pile audited.	5
15. Fines	Approx. 5 – 10 kg by end of day. Approx. 2 kg representative portion per pile audited.	10
16. Other	Sorted for composition but not sent to laboratory	N/A
	APPROX. Total mass per day of sample(s) – kg	120

All laboratory samples were sealed in thick plastic bags to prevent moisture loss. Each sample was individually labelled with the source, date, transfer terminal location and a unique sample identification number. The consultant organised transport of the sealed labelled laboratory samples to the NATA-accredited laboratory.

The final total amounts of waste from each source sent for laboratory testing are shown in Table 3.

Table 3 Samples taken for laboratory testing

	Source	**Kilograms sent for laboratory testing**
MSW	Council 1	178.0
	Council 2	167.9
	Total	345.8
C&I	Mixed C&I	269.1
	Total MSW and C&I	614.9

Table 4 summarises the number of samples taken for sorting, and sub-samples for laboratory testing, by date.

Table 4 Summary of number of samples taken, by date

Date	**Council 1**		**Council 2**		**C&I**	
2021	Loads Sorted	Bags sent to Lab	Loads Sorted	Bags sent to Lab	Loads Sorted	Bags sent to Lab
08 June	5	15				
09 June	5	15				
10 June			5	15		
11 June			5	15		
15 June					5	15
16 June					5	15
17 June					5	15

18 June					5	15
Total	10	30	10	30	20	60

3.0 Campaign 2

3.1 Method

The waste characterisation audit was conducted over five days. Between 5:30 am and 8:00 am on each day, six trucks delivering municipal waste were selected. Table 5 shows the number of trucks sampled and which Councils they were from. In total 30 trucks delivering municipal solid waste (MSW) were sampled over the five days.

3.1.1 Sorting

Table 5 MSW sampled for sorting

Council	**Number of trucks sampled**				
	29 Nov 2021	30 Nov 2021	01 Dec 2021	02 Dec 2021	03 Dec 2021
Council 3	2	3	5	3	3
Council 4	1	2	0	2	1
Council 5	3	0	1	0	2
Council 6	0	1	0	0	0
Council 7	0	0	0	1	0
Total	6	6	6	6	6

After each selected collection vehicle tipped residual MSW onto the waste tipping floor. A front end loader bucket of the selected waste was collected and set aside and marked as to its origin. In total approximately 2.5 tonnes of material was collected from the six trucks each day.

Once six samples (approx. 2.5 tonnes) were collected, the waste was mixed using a front end loader, then coned and quartered to extract a sample of 500 kg (approximately 1.5 - 2 loader buckets of waste). The 500 kg subsample was set aside in a demarcated safe area. A Veolia representative then visually inspected the sub sample to ensure it was representative of the original sample.

Once the 500 kg sample was approved, sorting staff un-bagged the contents of garbage bags and decanted packaged food waste from containers. This daily 500 kg sample was then sieved by sorting staff into particle sizes of >100 mm, 20-100 mm and <20 mm (fines). The >100 mm fraction was weighed then manually sorted into 22 categories. All categories are weighed and recorded. The 20-100 mm fraction was coned and quartered to the same mass as the >100 mm fraction and manually sorted into 22 categories. The <20 mm (fines) fraction was not sorted.

Note that initially, it was assumed the 20-100 mm (the middle fraction) was going to be the largest amount, and so the original methodology was to cone and quarter this sample several times. This approach and methodology were changed such that the equivalent amount to the >100 mm fraction was sorted. For example, the 20-100 mm was 300 kg and the >100 mm was 100 kg, so 100 kg of each size fraction was sorted. As it turned out, the two fractions were similar in size – with them both generally being over 200 kg each. So everything >100 mm in the first sample (280 kg) was sorted, but after the first day the sorting was capped at 100 kg of each fraction.

The sorting categories for the >100 mm and 20 – 100 mm fractions are shown below.

Table 6 Sorting categories

1. Organics	12. Plastics - Film
2. Recyclable paper	13. Plastics - Other
3. Recyclable cardboard	14. Combustible Material
4. Other paper and cardboard	15. Glass
5. Cartons	16. Metals - ferrous
6. Composite	17. Metals – non-ferrous
7. Textiles	18. Non-combustible / inert
8. Nappies / hygiene	19. E-waste
9. Plastics - PET	20. Other hazardous
10. Plastics - HDPE	21. Fines
11. Plastics - PVC	22. Other (specify)

In total, 2,659 kg were sampled over the 5 days as shown in Table 7.

Table 7 Weight of sampled and sorted materials

Sample No.	**1**		**2**		**3**		**4**		**5**		**Total**	
Date	29 Nov 2021		30 Nov 2021		01 Dec 2021		02 Dec 2021		03 Dec 2021			
Sample weight (kg)	538.1		506.7		517.9		554.0		509.4		2612.5	
Total weight delivered (kg)	41,540		37,980		49,240		45,280		43,100		217,140	
% sampled vs delivered	1.3%		1.3%		1.1%		1.2%		1.2%		1.2%	
	Total	Sorted	Total	Sorted	Total	Sorted	Total	Sorted	Total	Sorted	Total	Sorted
>100mm (kg)	281.1	281.1	270.3	105.1	276.5	106.4	330.8	115.2	295.3	101.4	1453.9	709.2
20mm-100mm (kg)	221.5	133.2	205.5	101.6	205.7	101.4	197.2	102.1	186.1	102.9	1016.0	541.2

<20mm (kg), not sorted	35.4	28.5	24.6	26.0	28.1	142.7

3.1.2 Sample Preparation

The laboratory requested a 5 to 10 kg sample of each sorting category for laboratory testing. To achieve this, the following was selected each day from each of the 22 sorted categories:

- 500 g to 1 kg of the > 100 mm fraction
- 500 g to 1 kg of the 20 – 100 mm fraction

This resulted in 1 to 2 kg per category per day, which over the 5 days achieved the required 5 to 10 kg for each category.

For some categories (e.g. PVC) where there was less than 1 kg per day available in the sorted sample,the whole sorted amount was collected for laboratory testing. If no fines were sorted from the >100 mm and 20 – 100 mm samples, the fines for the laboratory sample were topped up with fines from the <20 mm fines pile.

The remaining < 20 mm fines were coned and quartered to make a 10 kg laboratory sample. All laboratory samples were sealed in thick plastic bags to prevent moisture loss. Each sample was individually labelled with the source, date and a unique sample identification number. At the end of the week, the 5 – 10 kg samples of each of the 22 categories, as well as the 10 kg fines sample, were sent to the NATA accredited laboratory for analysis.

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