

## **ATTACHMENT B**

**REPORT FOR THE CITY OF SYDNEY,  
COMMERCIAL WASTE DATA REVIEW,  
EDGE ENVIRONMENT 2017**





Report for the City of Sydney  
**COMMERCIAL WASTE DATA REVIEW**

22<sup>nd</sup> February 2017



**edge** environment

**For: City of Sydney**

Gemma Dawson, Waste Strategy Manager

Town Hall House

Level 2, 456 Kent Street

Sydney NSW 2000

Email: [GDawson@cityofsydney.nsw.gov.au](mailto:GDawson@cityofsydney.nsw.gov.au)

T +61 (0) 476 842685

**By: Edge Environment Pty Ltd**

L5, 39 East Esplanade, Manly NSW 2095

T +61 (2) 9438 0100

Gary Foster

[gary@edgeenvironment.com.au](mailto:gary@edgeenvironment.com.au)

edgeenvironment.com.au

ABN 941 301 116 16

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## EXECUTIVE SUMMARY

Edge Environment Pty Ltd (Edge Environment) has been commissioned by the City of Sydney ('the City') to conduct a study to benchmark and forecast commercial and industrial ('C&I') and construction and demolition ('C&D') waste and recycling generation in the City.

In the *Sustainable Sydney 2030* plan, the City set goals to manage waste as a valuable resource and minimise the environmental impacts of its disposal. Further, *Sustainable Sydney 2030* also sets the objective of reducing GHG emissions across the entire local government area ('LGA') by 70% below 2006 levels by 2030, of which improved waste management will play a role.

Data from the following sources was used in this study; the Smart Green Business ('SGB') program, the Better Buildings Partnership ('BBP'), the Bin Trim program and the NSW C&I waste disposal audit (A. Prince Consulting, 2016). Further economic and land use data provided by the City has been utilised in modelling and forecasting in this project.

### Objectives of the study

The Commercial Waste Data Review intends to provide the City with updated information on waste generation (by sector) and total annual generation out to 2030. This study presents results for the following research objectives:

- provide updated waste and recycling generation rates per square metre (m<sup>2</sup>) for commercial premises
- define and estimate 2015/16 C&I waste, recycling and recovery generation for City of Sydney LGA
- define and estimate 2015/16 C&D waste and recycling generation for the City of Sydney LGA (including Buildings de-fit waste)
- identify likely resource composition for C&I and C&D waste and recycling generated within the City of Sydney LGA
- estimate likely waste sent to landfill and recycling figures for both C&I and C&D waste up to 2030

### C&I waste findings

Table 1 shows the updated waste and recycling generation (per m<sup>2</sup>) estimated for 34 of the City's C&I sub-sectors.

**Table 1 - C&I sub-sector waste and recycling generation rates**

Sector	Sub-sector	Landfill Intensity (kg/m <sup>2</sup> /yr)	Recycling Intensity (kg/m <sup>2</sup> /yr)	Total Waste Generation (kg/m <sup>2</sup> /yr)
Accommodation and entertainment	Hotels	13.4	3.0	16.4
	Backpackers	15.0	6.0	21.0
	Serviced apartments	13.4	3.0	16.4
	Convention/Conference/Event centres	23.0	48.6	71.6
	Entertainment Venues - large	6.2	15.1	21.3
	Entertainment Venues - other	46.9	25.3	72.2
	Restaurant/Eating	135.6	144.2	279.8
	Pubs/Clubs	56.8	33.8	90.6
Commercial Office	>20,000	5.7	6.1	11.8
	10,000 – 19,999	10.6	6.9	17.5
	5,000 – 9,999	3.2	3.6	6.8
	2,000 – 4,999	6.8	7.6	14.4
	1,000 – 1,999	4.9	3.7	8.6
	500 - 999	4.9	3.7	8.6

	<500	10.8	7.6	18.4
Retail	Supermarkets	39.9	101.5	141.4
	Specialised grocery	81.6	67.4	149.0
	Convenience store	15.4	55.6	71.0
	Bulky goods / department store	14.3	63.7	78.0
	General retailing	11.0	35.6	46.6
Community	Childcare	0.9	1.9	2.8
	Library	0.9	1.9	2.8
	Other (community)	18.7	5.0	23.7
Education	Primary	5.6	1.8	7.4
	Secondary	2.8	0.0	2.8
	Tertiary	0.3	1.8	2.2
Healthcare	Hospital	14.1	4.0	18.1
	Other healthcare	17.7	17.8	35.5
Industrial	Cold Store	4.9	12.4	17.3
	Light Industrial	15.1	8.0	23.2
	Warehouse	11.2	16.2	27.4
Other Sub-Sector	Other Sub-Sector	0.3	0.1	0.3
	Transport	11.9	7.2	19.1
	Utilities	36.9	17.0	54.0

Applying these updated waste intensity rates to the City's latest land use figures, total waste and recycling generated in the City for 2015-16 was calculated. Table 2 shows the waste generated by the C&I sector in 2015/16 broken into landfill and recycling components.

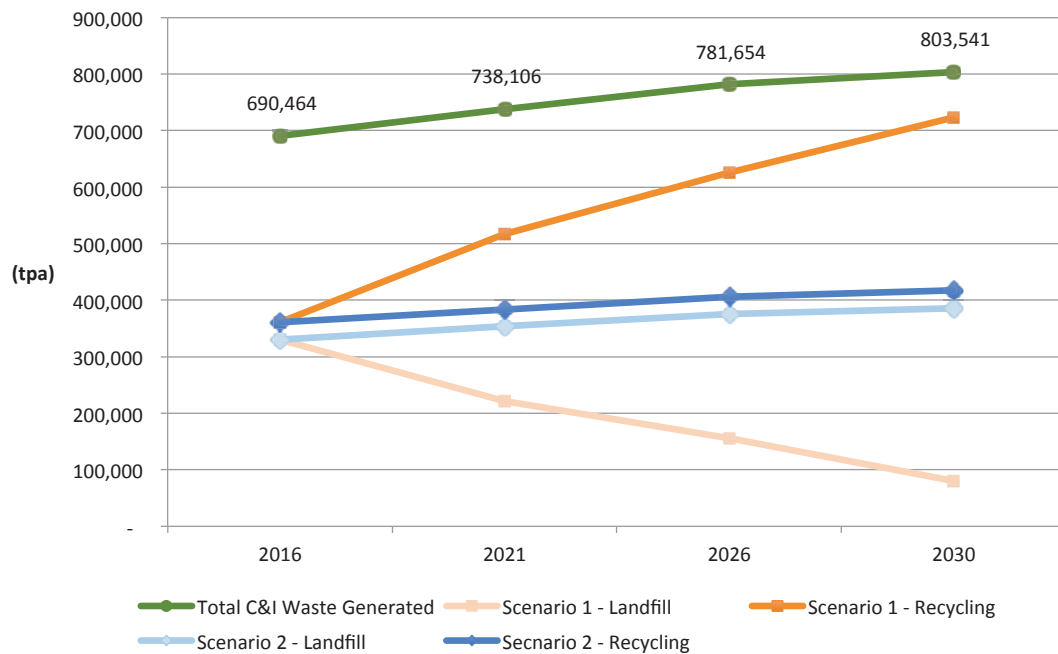
**Table 2 - Landfill, recycling and total C&I waste generation (2015-16)**

Sector	Total C&I Waste (t)	Landfill (t)	Recycling (t)
Accommodation and Entertainment	330,054	176,189	153,865
Commercial Office	128,550	68,167	60,383
Retail	161,708	41,735	119,974
Community	12,763	9,853	2,910
Education	5,037	2,353	2,684
Healthcare	19,561	11,195	8,366
Industrial	16,063	9,222	6,841
Other	16,727	10,909	5,819
<b>TOTAL</b>	<b>690,463</b>	<b>329,623</b>	<b>360,841</b>

Forecasts for C&I waste increases were made using the expected growth of the City's workforce to 2030 (City of Sydney, 2016). Two scenarios were considered:

- Scenario 1 - the adoption of state NSW state recycling targets, 70% by 2021 (NSW EPA, 2014), extrapolated to 80% by 2026 and 90% by 2030
- Scenario 2 - the application of current C&I recycling rates (52%) for the duration of the forecast period

Figure 1 shows the high level trends of the C&I forecast and the two scenarios.

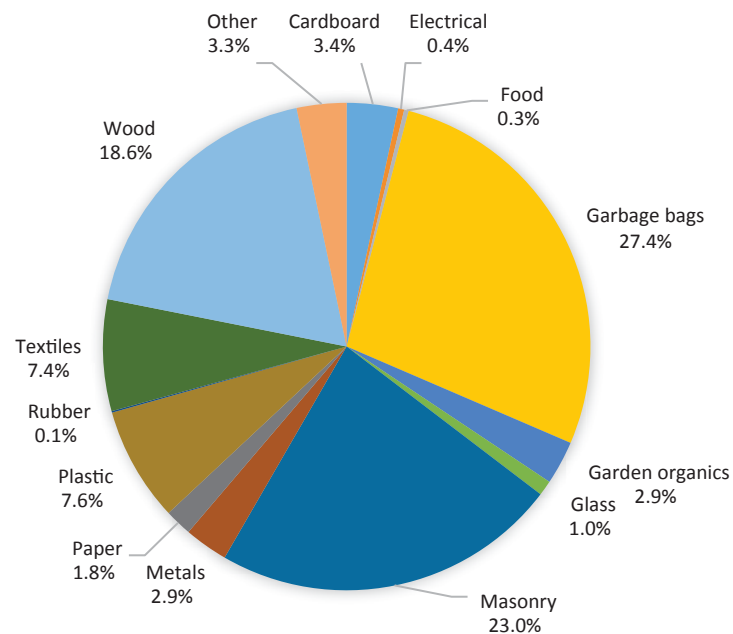


**Figure 1 - C&I landfill, recycling and total waste generation forecast to 2030**

Data from the NSW EPA was used to estimate the composition of C&I waste disposed to landfill from the City (A. Prince Consulting, 2016) and showed the following primary constituents:

- Bagged waste (27%) - consisting of primarily; paper (26%), food (23%), plastic (21%)
- Masonry (23%)
- Wood (18.6%)

Figure 2 shows the composition of landfill waste from the City.



**Figure 2 - City of Sydney C&I waste composition (A. Prince Consulting, 2016)**

## C&D waste findings

The majority of C&D waste is generated by large infrastructure projects and building demolitions. The total C&D waste generation in the City (2015/16) was **1,288,000t**, Figure 3 shows the breakdown of this into landfill (31%) and recycling (69%).

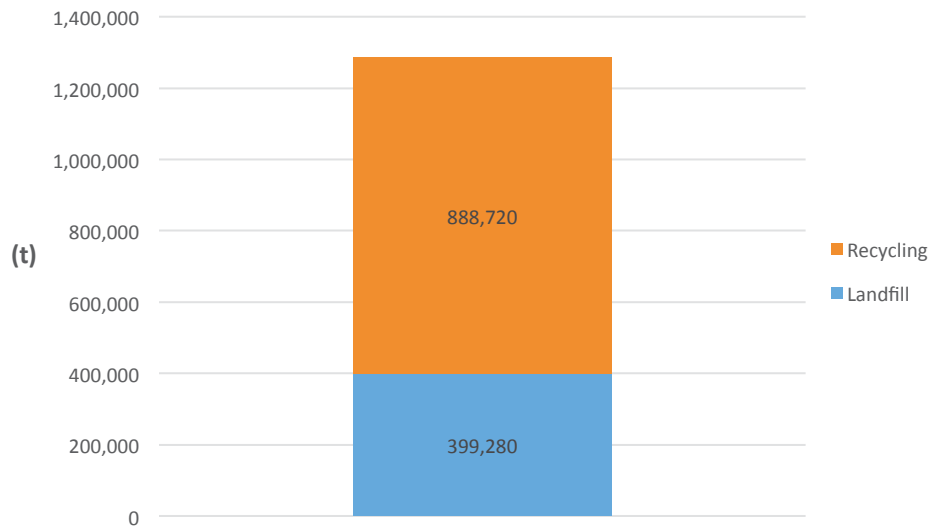


Figure 3 - C&D waste, landfill and recycling in the City (2015-16)

Forecast increases to the C&D waste generated in the City were made through the application of workforce growth projects supplied by the City (City of Sydney, 2016). Two scenarios for recycling were assessed:

- Scenario 1 - the adoption of state NSW state recycling targets, 80% by 2021 (NSW EPA, 2014), extrapolated to 85% by 2026 and 90% by 2030
- Scenario 2 - the application of current C&I recycling rates (69%) for the duration of the forecast period

Figure 4 shows the high level trends of the C&D forecast and the two scenarios.

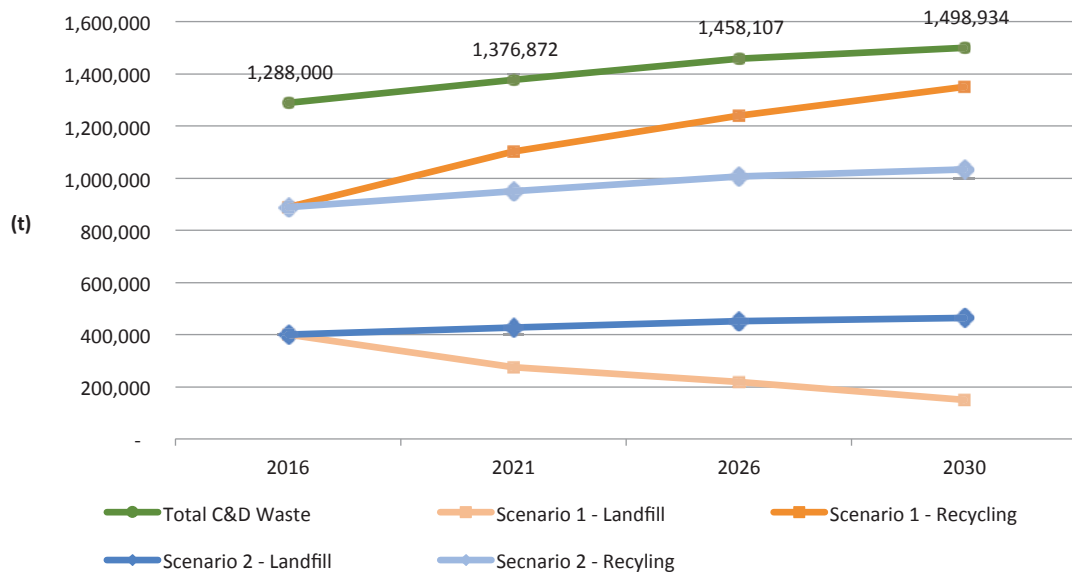


Figure 4 - C&D Waste forecast to 2030



## Outcomes of the study

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There are a number of sub-sectors generating significant volumes of C&I waste, and with opportunity to improve. The sectors creating the greatest amount of landfill (in 2015-16) were:

- Accommodation and Entertainment – **176,189t**
  - food waste remains a significant component, and opportunity to recycle from this sector. Further, recovery of simple recyclables (cardboard & co-mingled streams) still has further opportunity for improvement in this sector.
- Commercial Office – **68,167t**
  - data from the SGB and BBP programs showed that the commercial office sector has well established recycling streams, that typically suffer from poor behaviours. There is good opportunity to drive recycling significantly higher in this sector.
- Retail – **41,735t**
  - while retail is a significant generator of waste, their recycling rates are already over 70% on average. Due to the sheer volume of this land use in the City, behaviour change and access to soft plastic and cardboard recycling services will improve recycling outcomes

In C&D waste, recycling of heavy demolition waste and inert materials is driven by market price differentials between landfill and recycling and is likely to continue being recovered at higher rates than C&I waste. However, the BBP's stripout program, which to date has been focused on the largest market players, will benefit from a broader application to smaller building owners.

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## DEFINITIONS AND ABBREVIATIONS

Abbreviation	Expansion
BAU	Business as usual
BBP	Better Buildings Partnership
C&I	Commercial and Industrial
C&D	Construction and Demolition
LGA	Local Government Area
The City	The City of Sydney
tpa	Tonnes per annum

Term	Definition
Waste generation	The sum of all waste materials generated, including those sent to landfill and also those recycled, over a given period.
Waste to landfill	The portion of total waste generated sent to landfill
Waste recycled	The portion of total waste generated that is recycled
Stripout waste	Waste generated from the demolition component of refurbishment projects. This occurs primarily in commercial office and retail situations.

## 1. INTRODUCTION

Edge Environment Pty Ltd (Edge Environment) has been commissioned by the City of Sydney ('the City') to conduct a study to benchmark and forecast commercial and industrial ('C&I') and construction and demolition ('C&D') waste and recycling generation in the City.

### 1.1 Project background

This project seeks to update existing estimates of waste and recycling generated in the City.

Total landfill and recycling totals were determined for both the C&I and C&D sectors and estimates were also made to forecast the likely waste and recycling figures for these sectors out to 2030.

#### 1.1.1 Sustainable Sydney 2030 objectives

The City's *Sustainable Sydney 2030* plan (City of Sydney, 2014) includes an objective to:

*Reduce waste generation, the impact of disposal and improve resource recovery from waste across the local government area*

Further, *Sustainable Sydney 2030* also sets the objective of reducing GHG emissions across the entire local government area (LGA) by 70% below 2006 levels by 2030. Waste management measures will play a role in reaching this target. By 2030, the City's vision is to manage its waste as a valuable resource in which associated environmental impacts of its generation and disposal are minimised (City of Sydney, 2014). The City proposes to adopt state targets to (City of Sydney, 2016):

- Reduce the rate of waste generation per capita
- Increase recycling rates for municipal solid waste (MSW) from 52 per cent (in 2010–11) to 70 per cent by 2021
- Increase recycling rates for commercial and industrial (C&I) waste from 57 per cent (in 2010–11) to 70 per cent by 2021
- Increase recycling rates for construction and demolition (C&D) waste from 75 per cent (in 2010–11) to 80 per cent by 2021

This project has been scoped to inform the City of current waste generation and recycling performance across its various land uses in order to inform future waste management planning.

#### 1.1.2 C&I and C&D sectors

This project separately assesses waste from the C&I and C&D sectors due to the following:

- C&I waste generation is typically operational and easily annualised and highly variable depending on sectors (and sub-sectors)
- C&D waste can be both ongoing (as is the case of office stripout waste) but also isolated in the case of large infrastructure tunnelling projects
- different management approaches by the City

The City does not provide waste collection services to commercial customers and as such has little insight to waste generation and recycling rates across each of the land uses in the council area. To inform the results of this study data from a range of state and local government programs was used.

### 1.2 Report attachment

This report is accompanied by a spreadsheet based tool, in which all key data, assumptions and analysis is available. This report should be used as a high level overview of results, with detailed analysis and information available in the spreadsheet.

## 2. PROJECT OBJECTIVES

The core objective of this study was to calculate and forecast waste and recycling generation rates and amounts across the C&I and C&D sectors within the City.

To achieve this objective, the study undertook the tasks shown in the table below.

**Table 3 - Project tasks**

Information requirement	Where requirement is addressed
Provide updated waste and recycling generation rates per square metre for commercial premises	Section 4.1
Define and estimate 2015/16 C&I waste, recycling and recovery generation for City of Sydney LGA	Section 4.2
Define and estimate 2015/16 C&D waste and recycling generation for the City of Sydney LGA (including Buildings de-fit waste)	Section 4.3
Identify likely resource composition for C&I and C&D waste and recycling generated within the City of Sydney LGA	Section 4.4
Estimate likely waste sent to landfill and recycling figures for both C&I and C&D waste up to 2030	Section 4.5

### 3. PROJECT METHODOLOGY

The project comprised of two main elements:

- calculation of waste and recycling generation benchmarks in the City for each C&I sub-sector, and the C&D sector
- forecasting of annual waste and recycling generation to 2030

#### 3.1 C&I waste and recycling benchmarks

The following method was adopted to determine waste and recycling generation rates for the C&I land uses.

##### 3.1.1 Data inputs

This project has utilised data from the following sources to estimate waste and recycling generation rates:

- City of Sydney Smart Green Business ('SGB')
  - Smart Green Business is a program designed to help medium and large enterprises improve their environmental performance by reducing energy, water and waste costs
  - data from 117 audits of businesses in 2015-16 were available for this study. Where some data was only valid for 3 months, it was annualised accordingly
- NSW EPA Bin Trim Business Grants program<sup>1</sup>
  - the Bin Trim program provides small to medium enterprise visual waste assessments by trained assessors and a tailored action plan to reduce business waste. A second follow up assessment is used to track waste reductions
  - 15,535 completed assessments were provided in the Bin Trim dataset (9,765 1<sup>st</sup> assessments and 5,770 2<sup>nd</sup> assessments), of which 1,496 included floor space data and 313 were located in the City of Sydney area<sup>2</sup>.
  - first assessment data was used for each business as the business as usual case was considered to be more representative of recycling behaviours and generation across the City.
  - Bin Trim classifies business types according to ANZSIC classifications, the attached spreadsheet shows the allocation of ANZSIC codes to subsectors
- Better Buildings Partnership ('BBP')
  - an environmental leadership group of the City's 14 largest property owners
  - data from 14 premises which was used to generate waste and recycling generation rates for the commercial office sector
  - details of office refurbishment waste generation and recycling from several years of data collection
- *Disposal-based audit: Commercial and Industrial waste stream in the regulated areas of NSW 2014* (NSW EPA, 2015)
  - this data set informed the composition of waste sent to landfill from the City, however, it does not have the granularity to assign waste to different subsectors and thus was not used in benchmark estimation

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<sup>1</sup> Bin Trim data provided was extracted on the 16<sup>th</sup> September 2016, using data from 12 months of the programs second round. Edge Environment was a Bin Trim grantee under rounds one and two of the program, details for these grants are available at <http://www.epa.nsw.gov.au/wastegrants/bin-trim-business.htm>

<sup>2</sup> Reporting floor space data was not mandatory to complete a Bin Trim assessment, and as such only a subset of assessments had this data attached. Further, there is no way to cross-reference or ensure the accuracy of this data with property databases

- *Better Practice Guidelines for Waste Management and Recycling in Commercial and Industrial Facilities* (NSW EPA, 2012)
  - this publication was used when more recent sub-sector data from Bin Trim, SGB or BBP was lacking.
  - it is noted that in some instances this data was reliant on only a single site audit, and as such it was used cautiously in this project and compared with other data wherever possible

### 3.1.2 Benchmark calculation

A benchmark for each sub-sector was determined (kg/m<sup>2</sup>/annum) following consideration of:

- availability of data (each data source had several gaps across sub-sectors)
- number of records in each source for each sub-sector
- influence (and accuracy) of floor area assessment
- consistency across data sets (identification of outliers)

### 3.1.3 Calculation of total waste and recycling figures

Sub-sector landfill and recycling benchmarks were multiplied by floor area data supplied by the City to determine the total landfill and recycling figure.

Results were modelled with an upper and lower range, and the 'Best Available' data chosen as a conservative estimate of waste and recycling generation rates.

## 3.2 C&D waste and recycling benchmarks

The C&D waste stream was comprised of construction and demolition waste from infrastructure and building projects as well as office stripout waste.

### 3.2.1 Waste from construction and demolition

Due to the intermittent nature of construction projects and poor availability of data, the generation of C&D waste from the City was derived from statewide EPA data. The daytime employment population figure of the City area was chosen for a pro-rata figure to apply to the total C&D waste generation of NSW.

Further, it should be noted that actual C&D waste generation can be significantly impacted by single large projects, such as the Green Square re-development and Barangaroo. The figures for C&D waste used in this project have been annualized for simplicity and take into account expected project related spikes.

### 3.2.1 Waste from office stripout

Office stripout waste data was provided by the BBP and refers to waste generated by the refurbishment of office space. Calculation of stripout waste and recycling in this report are based on the following information:

- total City of Sydney office space – 10,720,261m<sup>2</sup> (City of Sydney floor space data)
- annual rate of refurbishment – 8% (Property Council of Australia , 2015)
- waste generation of 63 tonnes/1000m<sup>2</sup> (Institute of Sustainable Futures, 2014)

Recycling rates have been determined using data from the BBP Members conducting stripout projects<sup>3</sup>. BBP members are now implementing recycling targets of 60% or more across standard contract documents and have played a crucial role in increasing resource recovery across this sector over the past 3 years (Better Buildings Partnership, 2016). Reports from 2015-16 indicate that

<sup>3</sup> Edge Environment has been working with the BBP through grant funding from the NSW EPA Circulate program to improve resource recovery from office stripout and has used first hand experience to inform likely recycling rates.

contractors are not yet reaching the 60% target and as a result 50% is adopted for large tenancies in this study.

It is also recognised that the properties managed through the BBP Members are not representative of the City as a whole. Due to space constraints and different market operators, resource recovery tends to be lower in smaller projects, hence the following recycling rates have been used:

- 50% for commercial office tenancies greater than 1000m<sup>2</sup>
- 35% for commercial office tenancies less than 1000m<sup>2</sup>

### 3.3 Forecasting

Forecasting methodologies for waste volume and recycling rates are addressed separately in the following sections.

#### 3.3.1 Forecasting increases to waste amounts

The report adopts the employment population forecasts from City of Sydney (City of Sydney, 2016) as a proxy for increase in C&I and C&D waste volumes to 2030. Broadly, population is forecast to continue to rise over the period to 2030, most rapidly in the first half of this period.

#### 3.3.2 Forecasting recycling rates

Forecasting methods for recycling rates are outlined in Table 4 below.

**Table 4 - Tasks and methodology**

Project Component	Methodology
C&I recycling rate	Forecasting for C&I waste adopts two scenarios: <ul style="list-style-type: none"> <li>○ continuation of current business-as-usual (BAU) recycling rates, as determined by the data in this study</li> <li>○ adoption of a best-case scenario, where the City will reach the current state recycling target of 70% by 2021 and see continued improvement to 80% by 2026 and 90% by 2030.</li> </ul>
C&D recycling rate	Forecasting for C&D waste adopts two scenarios: <ul style="list-style-type: none"> <li>○ continuation of current business-as-usual (BAU) recycling rates, as determined by the data in this study</li> <li>○ adoption of a best case scenario, where the City will reach the current state recycling target of 80% by 2021 (NSW EPA, 2014), and see incremental improvements of to 85% by 2026 and 90% by 2030.</li> </ul>
Building Stripout recycling rate	Given currently available recycling infrastructure, 60-70% recycling is the maximum achievable rate of recovery (including a 5-10% reuse component). Technology is held constant for the purpose of this study and thus there is only incremental increase in recycling rates to 2030.  Recycling rates are increased at different rates for tenancies above and below 1000m <sup>2</sup> in size (as per the explanation in Section 3.2.1).

### 3.4 Data limitations

Data used in this study was from a range of sources which each had their own strengths and weaknesses. Below is a summary of known issues.

#### Data availability

Of the 34 sub-sectors used by the City, Bin Trim data within the area was available for 14 of these, while Smart Green Business data was available for four.



Appendix A outlines the number of data points for each sub-sector. The most visited sub-sector in the Smart Green business program was the hospitality sector, followed by restaurant/eating, pubs & clubs. In the Bin Trim data, small commercial offices (<500 m<sup>2</sup>), general retailing or restaurant/eating places were most common.

### **Floor area**

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Floor area estimates for Bin Trim data was made visually by Bin Trim assessors during site visits. As a result, there is some reason for concern over the accuracy of these figures, due to the difficulty of estimating floor space visually during brief site visits.

### **Usability of state-wide data**

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The NSW EPA publishes annual waste generation for C&I, C&D and municipal and recycling rates in the State of the Environment reports, available from 2002/03 to 2012/13. However, the results of this study show that recycling rates in the City are lower than the State average, a likely result of proportionally more hospitality venues in the City (compared to the state average).

## 4. PROJECT RESULTS

### 4.1 C&I waste and recycling generation rates

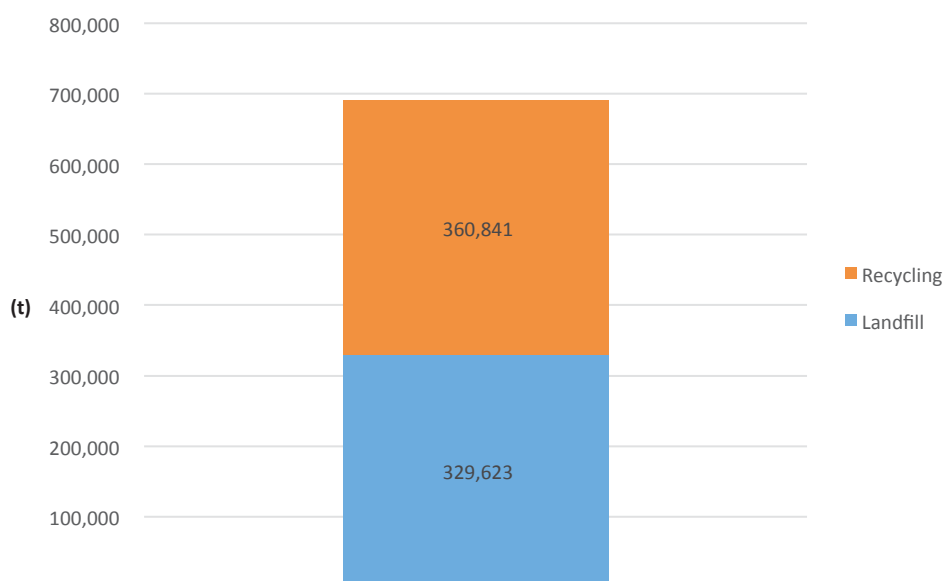
Table 5 shows the waste and recycling intensities calculated for each subsector using the collective data from Bin Trim, Smart Green Business and BBP Members.

**Table 5 - C&I sub-sector waste and recycling intensities**

Sector	Sub-sector	Landfill Intensity (kg/m2/yr)	Recycling Intensity (kg/m2/yr)	Total Waste Generation (kg/m2/yr)
Accommodation and entertainment	Hotels	13.4	3.0	16.4
	Backpackers	15.0	6.0	21.0
	Serviced apartments	13.4	3.0	16.4
	Convention/Conference/Event centres	23.0	48.6	71.6
	Entertainment Venues - large	6.2	15.1	21.3
	Entertainment Venues - other	46.9	25.3	72.2
	Restaurant/Eating	135.6	144.2	279.8
	Pubs/Clubs	56.8	33.8	90.6
Commercial Office	>20,000	5.7	6.1	11.8
	10,000 – 19,999	10.6	6.9	17.5
	5,000 – 9,999	3.2	3.6	6.8
	2,000 – 4,999	6.8	7.6	14.4
	1,000 – 1,999	4.9	3.7	8.6
	500 - 999	4.9	3.7	8.6
	<500	10.8	7.6	18.4
Retail	Supermarkets	39.9	101.5	141.4
	Specialised grocery	81.6	67.4	149.0
	Convenience store	15.4	55.6	71.0
	Bulky goods / department store	14.3	63.7	78.0
	General retailing	11.0	35.6	46.6
Community	Childcare	0.9	1.9	2.8
	Library	0.9	1.9	2.8
	Other (community)	18.7	5.0	23.7
Education	Primary	5.6	1.8	7.4
	Secondary	2.8	0.0	2.8
	Tertiary	0.3	1.8	2.2
Healthcare	Hospital	14.1	4.0	18.1
	Other healthcare	17.7	17.8	35.5
Industrial	Cold Store	4.9	12.4	17.3
	Light Industrial	15.1	8.0	23.2
	Warehouse	11.2	16.2	27.4
Other Sub-Sector	Other Sub-Sector	0.3	0.1	0.3
	Transport	11.9	7.2	19.1
	Utilities	36.9	17.0	54.0

### 4.2 C&I waste and recycling generation (2015/16)

C&I waste generation for 2015/16 was generated by applying the waste intensity factors developed in Section 4.1 to the City's floor space breakdown. The total C&I waste generation in the City (2015/16) was **690,463t**, Figure 5 shows the breakdown of this into landfill (47.7%) and recycling (52.3%).



**Figure 5 – C&I waste and recycling generation (2015-16)**

The total volumes of C&I waste generation per sector are given in Table 6. Full land area breakdowns and waste generation and rates of recycling by sub-sector are given in the spreadsheet attached to this report.

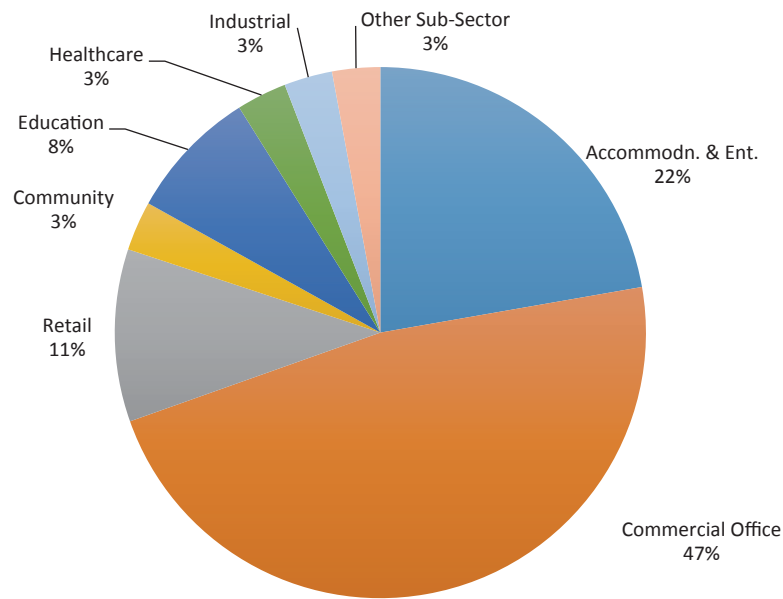
**Table 6 - C&I total waste, landfill and recycling (2015/16)**

Sector	Total Waste (t)	Landfill (t)	Recycling (t)	Landfill (%)	Recycling (%)
Accommodation and Entertainment	330,054	176,189	153,865	53%	47%
Commercial Office	128,550	68,167	60,383	53%	47%
Retail	161,708	41,735	119,974	26%	74%
Community	12,763	9,853	2,910	77%	23%
Education	5,037	2,353	2,684	47%	53%
Healthcare	19,561	11,195	8,366	57%	43%
Industrial	16,063	9,222	6,841	57%	43%
Other	16,727	10,909	5,819	65%	35%
<b>TOTAL</b>	<b>690,463</b>	<b>329,623</b>	<b>360,841</b>		

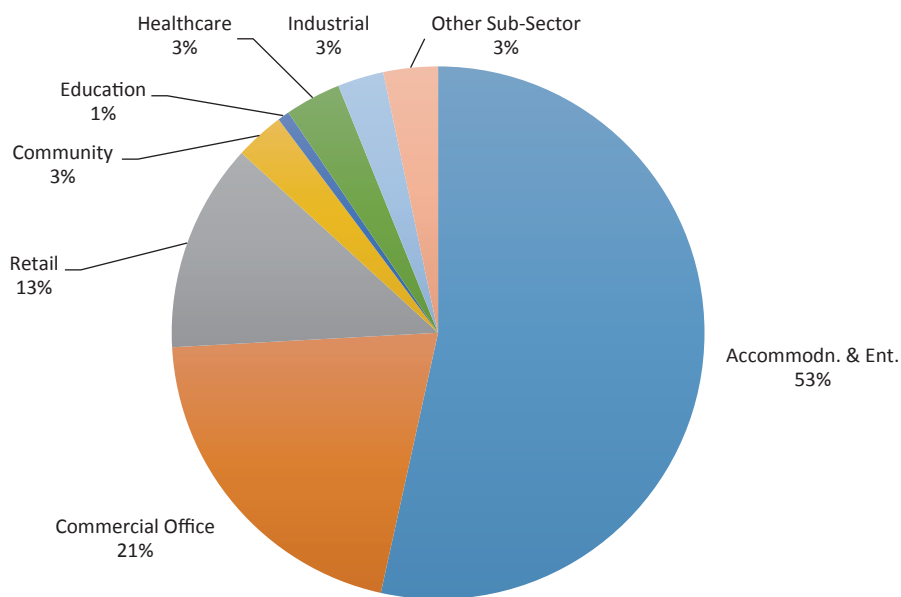
To generate the results above, 'high', 'low' and 'best available' estimates of waste intensity were estimated. The results presented above are those for the 'best available' scenario. The attached spreadsheet includes the waste generation scenarios for the high and low range waste intensity estimates.

The contribution of individual sectors to total waste generation is not proportionate to their share of total land use. Figure 6 shows the percentage breakdown of land use in the City (by sector)<sup>4</sup> and Figure 7 shows the percentage of landfill waste generated by sector, with noticeable variation evident.

<sup>4</sup> Note that this does not include either car parks or public open spaces, which were judged to be outside the remit of this report.



**Figure 6 – Comparative floor areas (by sector) in the City of Sydney**



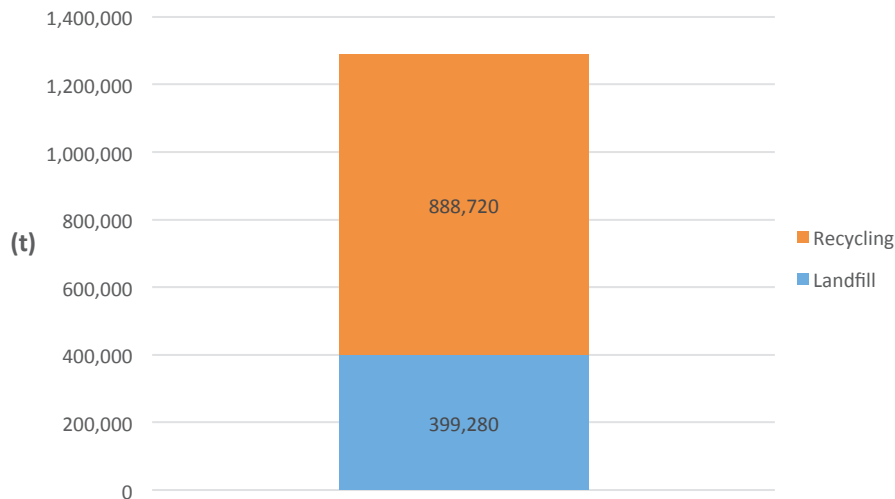
**Figure 7 – Landfill generated by sector (2015-16)**

The relative share of recycling and total waste generation for each sector is included in the attached spreadsheet.

#### **4.3 C&D waste and recycling generation (2015/16)**

Total C&D waste generation; landfill and recycling for 2015/16 have been calculated by combining construction and demolition waste from infrastructure projects, along with building stripout waste. Building stripout waste from the City is addressed as a sub-set of total C&D waste in Section 4.3.1.

The total C&D waste generation in the City (2015/16) was **1,288,000t**, Figure 8 shows the breakdown of this into landfill (31%) and recycling (69%).



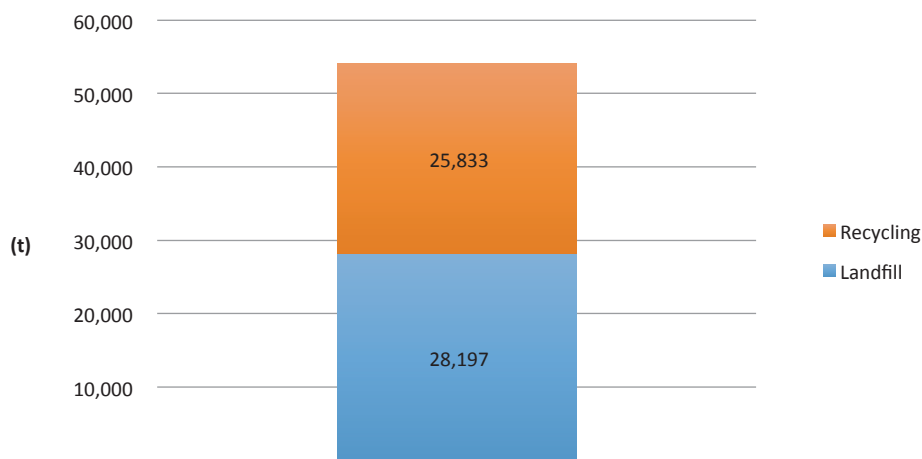
**Figure 8 - Total C&D waste and recycling generation (2015-16)**

Included in the C&D waste generation figures above is a small subset of waste from retail stripout, which is documented in the attached spreadsheet.

It should be noted that C&D will typically arise in concentrated, high volume waste outputs as projects stage their construction. Tunnelling projects (for example Westconnex – Stages 2/3) will generate huge quantities of inert material over short periods, while other road widening projects (i.e. Westconnex – Stage 1) may demand fill at different stages. Matching the timing of these projects to maximise local reuse will facilitate improved recycling.

#### 4.3.1 Building stripout waste

It is estimated that 857,621m<sup>2</sup> of commercial office space is refurbished in the City each year, generating **54,030t** of waste, of which 52% is sent to landfill and 48% is recycled. Figure 9 shows the breakdown of stripout waste sent to landfill and recycled in 2015-16.



**Figure 9 - Building stripout waste and recycling generation (2015-16)**

The building stripout program is being driven by the BBP and has already delivered significant improvement to this portion of the C&D waste stream in recent years, with foundation reports indicating a market average recycling rate of 21% in 2014 (Institute of Sustainable Futures, 2014).

Stripout waste from the entertainment and retail sectors was also estimated based on a nominal 20% recycling rate and UK data on waste intensities from these activities due to a lack of local information (Waste and Resource Action Programme, 2014).

Stripout and refurbishment waste was estimated to be:

- 10,480t for the entertainment sector, and
- 23,055t for the retail sector

## 4.4 Composition of C&I and C&D waste

### 4.4.1 C&I waste composition

The most recent weight based data available from the NSW EPA was used to estimate the composition of C&I waste disposed of to landfill from the City (A. Prince Consulting, 2016), analysis showed the following primary constituents:

- Bagged waste (27%) - consisting of primarily; paper (26%), food (23%), plastic (21%)
- Masonry (23%)
- Wood (18.6%)

Figure 10 shows the composition of landfill waste from the City of Sydney.

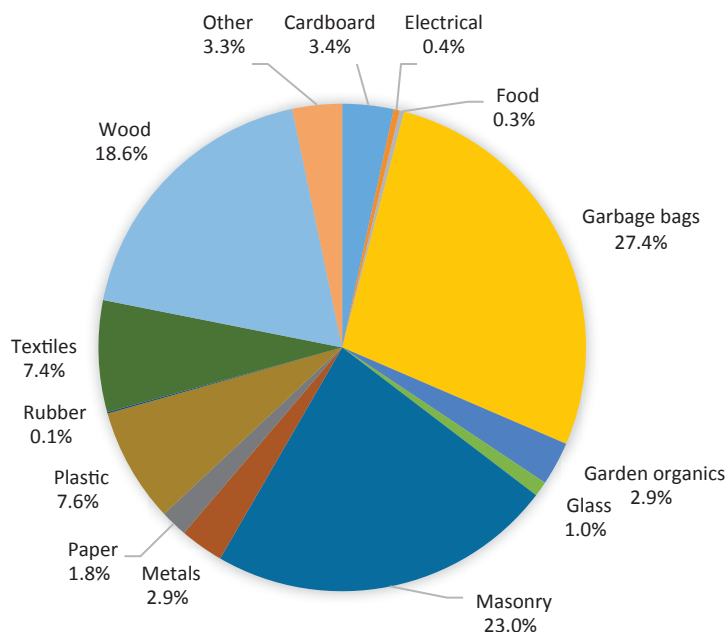


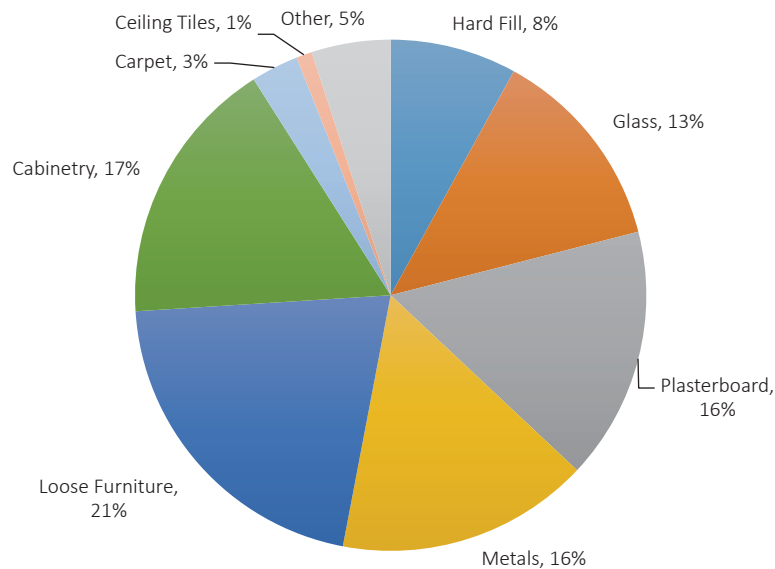
Figure 10 - City of Sydney C&I waste composition (A. Prince Consulting, 2016)

### 4.4.2 C&D waste composition

C&D waste is typically comprised of inert materials including contaminated/non-contaminated soils, rubble and other large fills. A standard composition for this stream is difficult to establish, as individual projects will have variable waste streams that may occur in concentrated bursts.

#### 4.4.1 Office stripout waste composition

The work of the BBP has resulted in a clear picture of the standard materials streams, and their relative proportions being removed from office stripout projects. Figure 11 presents the average composition of a typical stripout waste project, derived from a range of stripout reporting provided to BBP members.



**Figure 11 - Composition of strip-out waste from office refurbishment**

While this is used as an average, for the purpose of this project, newer fitouts lean toward a more open plan design, likely to increase the relative proportion of furniture and cabinetry, and reduce those of plasterboard and glass.

## 4.5 Waste generation forecast to 2030

Waste generation forecasts have been made for the C&I sector, C&D sector and separately for the office stripout waste component.

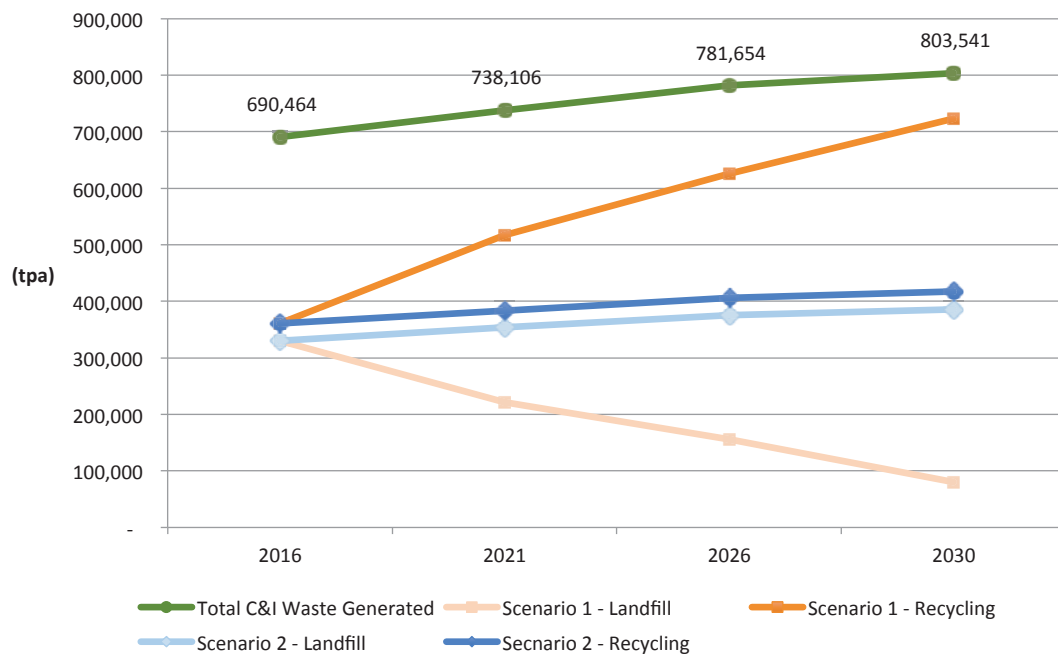
### 4.5.1 C&I waste forecast

C&I waste forecasts have been made for two scenarios:

*Scenario 1: Increase recycling rates to meet EPA targets for 2021 (70%), and aspirational targets for 2026 (80%) and 2030 (90%)*

*Scenario 2: Adopt existing C&I recycling rate (52%) at the same level out to 2030*

By 2030, an estimated **803,541t** of C&I waste will be generated, approximately 16% more than 2015-16 levels. Figure 12 outlines the likely annual rates of landfill and recycling generation each year to 2030 under the scenarios outlined above, the full tabulated version of this chart is available in the attached spreadsheet.



**Figure 12 - C&I landfill and recycling forecasts to 2030**

The chart shows an increasing trend in the generation of C&I waste, linked to the forecast increase in daytime population of the City.

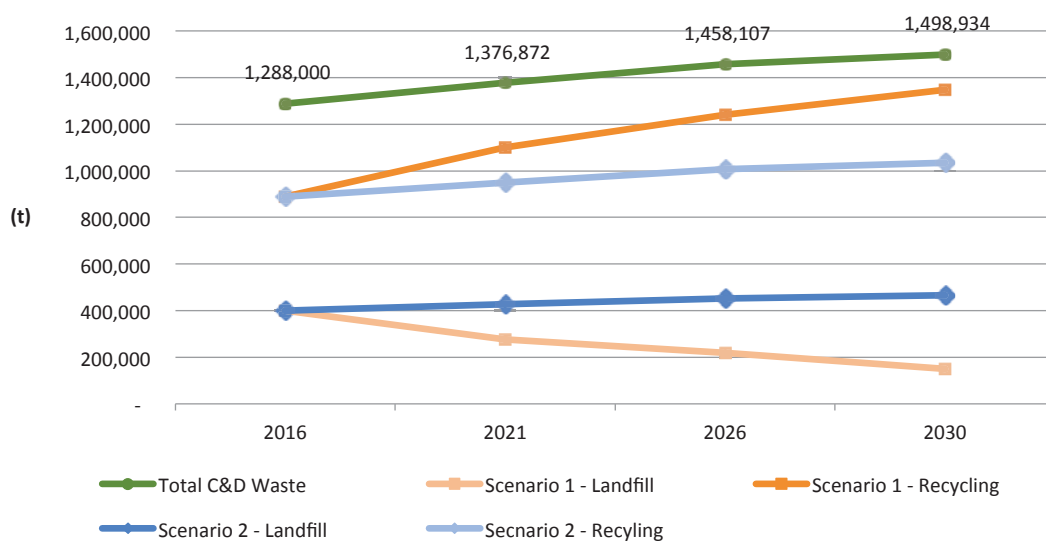
#### 4.5.2 C&D waste forecast

C&D waste forecasts have been made for two scenarios:

*Scenario 1: Increase recycling rates to meet EPA targets for 2021 (80%), and aspirational targets for 2026 (85%) and 2030 (90%)*

*Scenario 2: Adopt existing C&I recycling rate (69%) at the same level out to 2030*

Figure 13 outlines the likely annual rates of C&D landfill and recycling generation each year to 2030, when an estimated **1,498,934t** will be generated. This increase, while smoothed for the purpose of this study will likely be inconsistent. Refer to the attached spreadsheet for further data.



**Figure 13 - C&D landfill and recycling forecasts to 2030**



#### 4.5.3 Stripout Waste forecast

Stripout waste is forecast to increase annually in line with the increase to daytime population growth of the City. Additionally, market leaders such as the BBP will drive continued improvements to onsite process as will the influence of increases to the waste levy.

Recycling rates by 2030 are expected to be 65% for commercial office space greater than 1000m<sup>2</sup> and 60% for office space less than 1000m<sup>2</sup>. The annual waste from office stripout is estimated to be **62,886t** by 2030.

This waste is incorporated into the figures provided for total C&D waste in Section 4.5.2.

Figure 14 shows the increase to total waste generation from office stripout and the comparative increase to recycling rates expected. The attached spreadsheet provides this forecast in tabulated form.

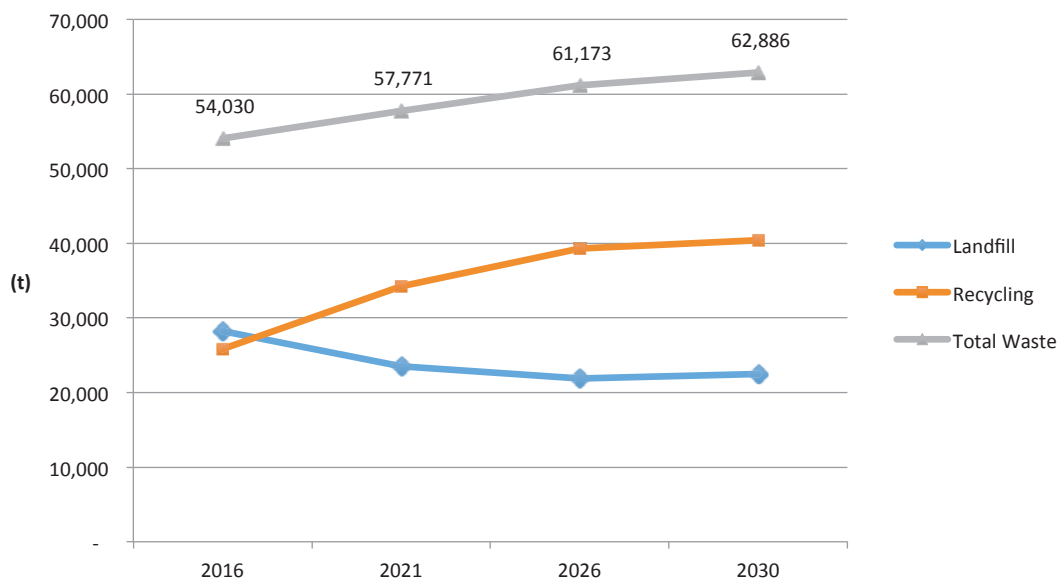


Figure 14 - Stripout Waste Forecast to 2030

## 5. DISCUSSION

This project presents clear estimates of waste and recycling generation in the City and simple forecasting to 2030.

### 5.1 Project Outcomes

#### 5.1.1 Highest and lowest recycling rates by sub-sector

The sub-sectors with the highest recycling rates in 2015-16 were:

- Education – Tertiary: 85% and 2,371t recycled<sup>5</sup>
- Retail – Bulky goods / department store: 82% and 56,428t recycled
- Retail – Convenience Store: 78% and 1,989t recycled
- Retail – General Retailing: 76% and 43,924t recycled
- Retail – Supermarkets: 72% and 7,849t recycled

Those with the lowest recycling rates in 2015-16 were<sup>6</sup>:

- Accommodation and Entertainment – Hotels: 18% and 3,998t recycled
- Accommodation and Entertainment – Serviced Apartments: 18% and 1,459t recycled
- Community – Other (community): 21% and 2,600t recycled
- Healthcare – Hospital: 22% and 1,150t recycled
- Education – Primary: 25% and 313t recycled

#### 5.1.2 Highest landfill generation by sector

The sectors creating the greatest amount of landfill (in 2015-16) were:

- Accommodation and Entertainment – **176,189t**
- Bin Trim composition data shows that food waste remains a significant component, and opportunity to recycle from this sector
- Simple recyclables (cardboard & co-mingled streams) still have further opportunity for improvement in this sector as well
- Commercial Office – **68,167t**
- Data from the SGB and BBP programs showed that the commercial office sector has well established recycling streams, that typically suffers from poor behaviours. There is good opportunity to drive recycling significantly higher in this sector.
- Retail – **41,735t**
- Bintrim data showed that while retail is a significant generator of waste, their recycling rates are already close to 70% on average. Due to the sheer volume of this land use in the City, behaviour change and access to soft plastic and cardboard recycling services will improve recycling outcomes

In the C&D space, recycling of heavy demolition waste and inert materials is driven by market price differentials between landfill and recycling and is likely to continue to be better managed than C&I waste.

However, the BBP's stripout program, which to date has been largely focused on the largest building owners, will benefit from a broader application to smaller building owners.

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<sup>5</sup> In this instance data was available from only one institution

<sup>6</sup> The 'Other Sub-sector' category scored the lowest recycling rate (16%) but has been omitted for this list due to very small volumes of waste and no clear business classification.

## 5.2 Opportunities for further research

### Focus sectors for data collection

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The data collated by this project suggests that the City's programs for data collection have been well focused on the most waste intensive sub-sectors. Continued effort in data collection will better inform the City in future, and particular attention should be given to:

- Accommodation/Entertainment – Restaurant/Eating
- Pubs/Clubs
- Entertainment Venues – other
- Specialised grocery
- Commercial offices 10,000-20,000 m<sup>2</sup>.

### Connection to industry benchmarks

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It is understood that the National Australian Built Environment Rating System (NABERS) waste tool is currently being redesigned and will be applicable to offices and retail centres, which will provide further data for inclusion.

Further, Tertiary Education Facilities Management Association (TEFMA) was found to be collecting similar benchmarks for waste generation with possible applications to the City.

### Working with existing programs

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The SGB and Bin Trim programs both provide a spread of data for different sub-sectors; however, the collection of floor area is not mandatory in either case. To further inform waste and recycling intensity studies in future, it is essential that accurate floor area data is captured.

### Civil infrastructure project data

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There are opportunities to significantly reduce C&D waste from excavation and demolition through a structured approach to resource management across the industry. Currently contractors have little means of communicating needs for various materials, or looking beyond their own operations, thus hindering their local reuse.

The City's planning systems may be able to make use of available spoil from infrastructure projects fulfil its own needs and also provide potential reuse options to the consortia performing large civil projects. Links could be made with the Sydney based Responsible Construction Leadership Group, who are seeking to improve the sectors' performance in this way.

### Remote data collection

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Electronic data collection by contractors at the point of collection is becoming more common, and increasingly simple to collect. The 'Smart Cities' strategies, policies and programs could be used to address emergent means of data collection moving toward 2030.

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## 7. APPENDIX A – AVAILABLE DATA SOURCES

Sector	Sub-sector	Bin Trim (City of Sydney) 2015-16	Smart Green Business	BBP	Bin Trim (NSW) 2015-16	Better Practice Guidelines (NSW EPA, 2012)	Confidential CoS Data 2015-16	Confidential University Data 2015-16
Accommodation and entertainment	Hotels	1			1	1		
	Backpackers		79			2		
	Serviced apartments					1		
	Convention/Conference/Event centres						1	
	Entertainment Venues - large						2	
Commercial Office	Entertainment Venues - other		2					
	Restaurant/Eating	66	18		370	7		
	Pubs/Clubs	10	18		57	4		
	>20,000					2		
	10,000 – 19,999					2		
	5,000 – 9,999	37				2		
	2,000 – 4,999					2		
	1,000 – 1,999					2		
	500 - 999					2		
	<500	79				2		
Retail	Supermarkets	4			41	1		
	Specialised grocery	5			66	6		
	Convenience store					6		
	Bulky goods / department store	5			71	6		
	General retailing	72			295	111		
Community	Childcare							
	Library				3			
	Other (community)	18			46			
	Primary	1			16	1		
Education	Secondary				2			
	Tertiary					3		1
	Hospital				1			
Healthcare	Other healthcare	8			60	3		
	Cold Store							
Industrial	Light Industrial	4			67			
	Warehouse				6			
	Other Sub-Sector				7			
Other Sub-Sector	Transport	3			13			
	Utilities				9			
	TOTAL	313	117	14	1,131	166	3	1

## 8. APPENDIX B – WASTE AND RECYCLING GENERATION (2015-16)

Sector	Sub-sector	CoS 2015-16 Areas (m2)	Landfill Intensity (kg/m2/yr)	Recycling Intensity (kg/m2/yr)	Landfill 2015-16 (tonnes)	Recycling 2015-16 (tonnes)
Accommodation and entertainment	Hotels	1,355,257	13.4	3.0	18,204	3,998
	Backpackers	97,389	15.0	6.0	1,458	588
	Serviced apartments	494,498	13.4	3.0	6,642	1,459
	Convention/Conference/Event centres	131,881	23.0	48.6	3,036	6,408
	Entertainment Venues - large	1,305,162	6.2	15.1	8,145	19,692
	Entertainment Venues - other	595,621	46.9	25.3	27,935	15,069
	Restaurant/Eating	641,394	135.6	144.2	86,973	92,489
Commercial Office	Pubs/Clubs	418,957	56.8	33.8	23,797	14,161
	>20,000	2,987,326	5.7	6.1	16,074	17,202
	10,000 – 19,999	1,822,947	10.6	6.9	18,241	11,874
	5,000 – 9,999	1,672,322	3.2	3.6	5,052	5,683
	2,000 – 4,999	1,892,853	6.8	7.6	12,151	13,580
	1,000 – 1,999	781,645	4.9	3.7	3,628	2,736
	500 - 999	517,414	4.9	3.7	2,401	1,811
	<500	1,045,754	10.8	7.6	10,620	7,496
	Supermarkets	77,348	39.9	101.5	3,090	7,849
	Specialised grocery	145,081	81.6	67.4	11,839	9,784
Retail	Convenience store	35,761	15.4	55.6	549	1,989
	Bulky goods / department store	886,039	14.3	63.7	12,684	56,428
	General retailing	1,234,062	11.0	35.6	13,573	43,924
	Childcare	71,625	0.9	1.9	64	136
Community	Library	91,458	0.9	1.9	82	174
	Other (community)	519,870	18.7	5.0	9,706	2,600
Education	Primary	172,399	5.6	1.8	958	313
	Secondary	348,715	2.8	0.0	988	-
	Tertiary	1,289,808	0.3	1.8	408	2,371
Healthcare	Hospital	287,563	14.1	4.0	4,055	1,150
	Other healthcare	404,448	17.7	17.8	7,140	7,215
Industrial	Cold Store	16,530	4.9	12.4	81	205
	Light Industrial	475,214	15.1	8.0	7,192	3,816
Other Sub-Sector	Warehouse	174,184	11.2	16.2	1,949	2,820
	Other Sub-Sector	54,724	0.3	0.1	15	3
	Transport	459,382	11.9	7.2	5,467	3,314
	Utilities	146,923	36.9	17.0	5,427	2,501
	<b>Total</b>	<b>22,651,555</b>		<b>Percentage</b>	<b>329,623</b>	<b>360,841</b>
					<b>48%</b>	<b>52%</b>