SITA Australia Pty Ltd
16 January 2013

Expansion of the Advanced Waste Treatment Facility, Kemps Creek Resource Recovery Precinct

Greenhouse Gas Assessment

Expansion of the Advanced Waste Treatment Facility, Kemps Creek Resource Recovery Precinct

Prepared for

SITA Australia Pty Ltd

Prepared by

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Table of Contents

Executive Summary

Greenhouse gas (GHG) emissions would be generated during the construction and operation of the proposed expansion of SITA's existing SAWT facility at Kemps Creek (referred to as the Development).

During the construction stage, electricity, fuel and materials would be consumed. These activities would generate GHG emissions directly (for example, as the diesel fuel is combusted on-site by construction equipment) and indirectly (for example, the embodied GHG emissions associated with the production and transportation of construction materials).

Operation of the Development would also generate GHG emissions, for example from the consumption of diesel fuel and electricity to run the facility. As a result of the Development an additional 100,000 tonnes per annum (tpa) of waste would be transported to the facility during operation. The majority of this waste would be classified as Municipal Solid Waste (MSW), the remainder being Source Separated Organic (SSO) waste and a small proportion of biosolids. Approximately 55,000 tpa of waste would be composted (in a climate controlled and aerated environment) and approximately 55,000 tpa of waste (known as residual waste) would be sent to landfill. Landfilling of MSW and SSO generates GHG emissions as the organic matter within the waste decomposes in an anaerobic environment (an oxygen deprived environment) and produces methane and nitrous oxides. However, composting the organic fraction of the waste in a climate controlled and aerated environment prevents the generation of methane. The GHG emissions associated with composting, rather than landfilling (Business as usual) waste during the operational stage has also been estimated as part of this GHG assessment.

GHG emissions are categorised into three different Scopes (either Scope 1, 2 or 3) in accordance with the Greenhouse Gas Protocol (World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD), 2004), Intergovernmental Panel on Climate Change (IPCC) and Australian Government GHG accounting/classification systems. Emissions are categorised into the different scopes to help delineate between direct emissions from sources that are owned or controlled by the Development, and indirect emissions that are a consequence of Development activities but occur at sources owned or controlled by another entity. The three GHG scopes are:

- Scope 1 emissions, also called "direct emissions". These emissions are generated directly by the project, e.g. methane emissions generated as waste decomposes in an anaerobic environment.
- Scope 2 emissions, also referred to as "indirect emissions". Scope 2 emissions are generated outside of the project's boundaries to provide energy to the project, e.g. the use of purchased electricity from the grid.
- Scope 3 emissions, are all indirect emissions (not included in Scope 2) due to upstream or downstream activities. For example indirect upstream emissions associated with the extraction, production and transport of purchased construction materials.

It is estimated that the construction stage of the Development would generate approximately:

- 720 tonnes of carbon dioxide equivalent (tCO_2-e) of direct Scope 1 GHG emissions.
- 16 tCO_2-e of indirect Scope 2 GHG emissions.
- 2,068 tCO_2-e of indirect upstream Scope 3 GHG emissions.

The total construction stage (Scope 1, 2 and 3) GHG emissions would be approximately 2,805tCO_2-e. This is approximately equivalent to 0.002 percent of NSW's annual GHG emissions (in 2009 to 2010).

GHG emissions are reported as tonnes of carbon dioxide equivalent (tCO_2-e). There are numerous GHGs which contribute to the Greenhouse Effect. These gases have varying Global Warming Potential (GWP). The higher GWP, the higher the intensity of effect each tonne of that gas has on the Greenhouse Effect. GHGs are standardised by expressing them as carbon dioxide equivalent emissions (CO_2-e) and carbon dioxide has a GWP of 1. From 2017 onwards the Australian Government has committed to adopt updated GWPs in accordance with updated international GHG accounting (DCCEE, 2012D). Hence from 2017 onwards the GWP of methane, for example, will increase from 21 to 25. For this reason the operational emissions have been presented below as pre- and post- 2017.

It is estimated that the annual operation of the Development pre-2017 would generate approximately:

- 10,129 tCO_2-e of direct Scope 1 GHG emissions.
- 3,960 tCO_2-e of indirect Scope 2 GHG emissions.
- 52,595 tCO_2-e of indirect upstream/downstream Scope 3 GHG emissions.

The total annual operational (Scope 1, 2 and 3) GHG emissions pre-2017 would be approximately 66,684 tCO_2-e. This is approximately equivalent to 0.042 percent of NSW's annual GHG emissions (in 2009 to 2010).

It is estimated that the annual operation of the Development post-2017 would generate approximately:

- 10,811 tCO_2-e of direct Scope 1 GHG emissions.
- 3,960 tCO_2-e of indirect Scope 2 GHG emissions.
- 62,426 tCO_2-e of indirect upstream/downstream Scope 3 GHG emissions.

The total annual operational (Scope 1, 2 and 3) GHG emissions post-2017 would be approximately 77,197tCO_2-e. This is approximately equivalent to 0.049 percent of NSW's annual GHG emissions (in 2009 to 2010).

Fugitive GHG emissions from the composting process represent the major source (96 percent) of the estimated annual operational Scope 1 GHG emissions (pre and post-2017). The Development would use fully automated enclosed composting methodology; however this assessment conservatively uses the Australian Government's National Greenhouse Accounts factors for composting, which assumes that some anaerobic decomposition occurs (for example, that fugitive emissions of methane and nitrous oxide would be generated from the composting process).

MSW releases methane as the waste decomposes in a landfill over a period of decades. One tonne of MSW releases methane approximately equivalent to 1.2 tCO_{2}-e pre-2017 and 1.4 tCO_{2}-e post-2017 (NGA Factors, DCCEE, 2012). Therefore the lifetime methane generation potential of landfilling 100,000 tonnes of MSW is approximately equivalent to 120,000 tCO_2-e pre-2017 and 142,000 tCO_{2}-e post-2017.This would be approximately equivalent to 0.1 percent of NSW's annual GHG emissions (in 2009 to 2010).

It should be noted that the estimated GHG emissions results provided above are an estimate only, and subject to the accuracy of the estimated construction and operational project data and all other project assumptions.

To avoid/reduce GHG emissions associated with the Development, mitigation measures are recommended which relate to:

- minimising the quantity and/or emissions intensity of:
  - electricity used;
  - fuel used by plant and equipment;
  - fuel used in the transport of materials;
- minimising the quantity and/or embodied carbon of materials used; and
- avoiding the generation of fugitive GHG emissions.

1.0 Introduction

1.1 Project Description

SITA is seeking approval for the expansion of the existing SAWT facility at its Kemps Creek site in western Sydney. The Development would comprise an expansion of the existing SAWT facility only and would not involve alterations to the landfill.

The existing SAWT facility site (referred to herein as the Site) currently accepts up to 120,000 tonnes per annum (tpa) of municipal solid, organic and commercial and industrial waste, plus up to 14,400 tpa of biosolids. This material is processed using a combination of mechanical separation, manual sorting, and biological composting technologies to produce approximately 41,000 tpa of compost.

The Development would result in the following key changes:

- A 100,000 tpa increase in the capacity of waste entering the facility (55 percent of this waste is expected to be unsuitable as compost and would be transported to the adjacent Kemps Creek landfill).
- Modifications to the current layout of operations on the Site and enhancements to the management of composted material, including the use of internal composting for all stages.
- An increase in operating hours for indoor operations from the existing 7 am to 11 pm Monday through Saturday to 24 hours per day, seven days a week.

The Development would comprise an expansion of the existing SAWT facility, which would involve:

- an upgrade to the Resource Recovery Building plant
- a new enclosed Composting Hall
- a new Refining Building
- reconfiguration of the existing Biofilters
- installation of new Biofilters
- extension of the existing Compost Pad for storage of both MSW and SSO compost material
- associated Site infrastructure upgrades to:
  - access roads and car parking
  - water storage and reuse infrastructure, including stormwater ponds, leachate tanks and ponds.

It is anticipated that construction of the Development would commence in the latter half of 2013 and would be completed in early 2015. The Development would not immediately accept an additional 100,000 tpa of waste, but would accept a gradual increase in volume over time as new contracts become available. It is anticipated that the Development would commence operations in mid-2015 and ramp up to full capacity in 2016.

The Development would provide long term employment for 60 people (an additional 22 FTE positions) with a peak employment during construction expected to be approximately 130 people.

It is anticipated that during the composting process approximately 55 percent of incoming waste (by weight), originally transported to the SAWT Facility, would be removed as residual material and transferred to the adjacent Kemps Creek landfill.

1.2 Climate Change and Greenhouse Gases

GHGs are emitted into the Earth's atmosphere as a result of natural processes (for example carbon dioxide released from leaf litter decomposing on a forest floor) and human activities (for example methane released from organic waste decomposing in a capped landfill). GHGs absorb and re-radiate heat from the sun.

Since the industrial revolution there has been an increase in the amount of GHGs emitted which has increased the concentration of GHG emissions in the atmosphere. This has led to an increase in the Earth's average temperature (surface temperature) and has caused Climate Change (or global warming) to occur.

The recent State of the Climate 2012 report (CSIRO and Bureau of Meteorology, 2012) confirms the long term warming trend over Australia's land and oceans, showing that in Australia, each decade has been warmer than the previous since the 1950s. Other observed trends include an increase in record hot days, a decrease in record cold days, ocean warming, sea-level rise and increases in global GHG concentrations (IPCC, 2007).

The predicted future effects of climate change for the environment and for human life are numerous and varied. The main effect is an increasing global average temperature. From this flow a variety of resulting impacts, such as rising sea levels, increased extreme weather and extreme weather events.

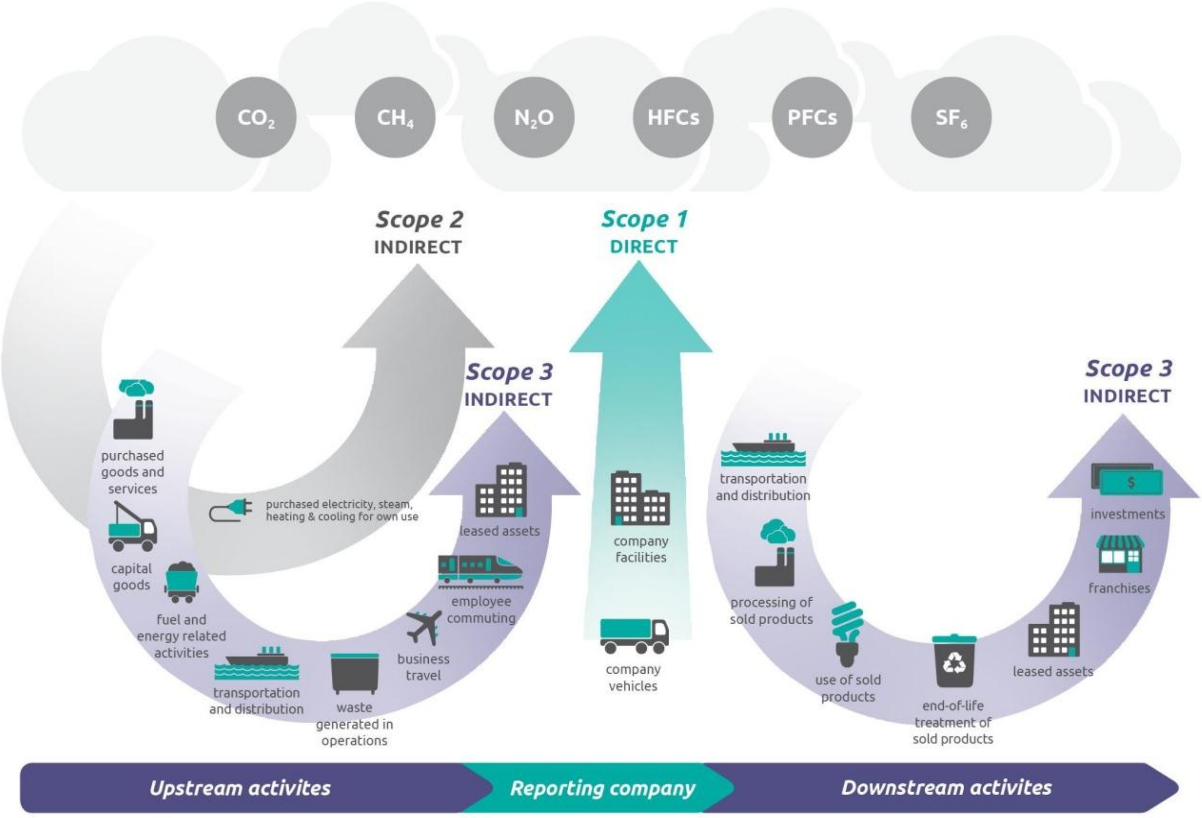
The two key responses to climate change are:

- climate change adaptation – that is, adapting to the physical impacts (for example more frequent and longer heatwaves) of climate change
- climate change mitigation – that is, reducing the amount of GHG emissions emitted into the atmosphere.

GHG emissions are reported as tonnes of carbon dioxide equivalent (tCO_2-e). There are numerous GHGs which contribute to the Greenhouse Effect. These gases have varying Global Warming Potential (GWP). The higher GWP, the higher the intensity of effect each tonne of that gas has on the Greenhouse Effect. GHGs are standardised by expressing them as carbon dioxide equivalent emissions (CO_2-e) and carbon dioxide has a GWP of 1. For example, the GHG methane (CH_4) has a GWP of 21, thus one tonne of methane has a Greenhouse Effect equivalent to 21 tonnes of carbon dioxide. However it should be noted that from 2017 onwards the Australian Government has committed to adopt a methane GWP of 25, in accordance with updated international GHG accounting (DCCEE, 2012D).

GHG emissions are categorised into three different scopes (either Scope 1, 2 or 3) in accordance with the Greenhouse Gas Protocol (World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD), 2004), IPCC and Australian Government GHG accounting/classification systems. Emissions are categorised into the different scopes to help delineate between direct emissions from sources that are owned or controlled by the project and indirect emissions that are a consequence of project activities but occur at sources owned or controlled by another entity. The three GHG scopes, illustrated in Figure1 below, include:

- Scope 1 emissions, also called "direct emissions". These emissions are generated directly by the project, e.g. methane emissions generated as waste decomposes in an anaerobic environment.
- Scope 2 emissions, also referred to as "indirect emissions". Scope 2 emissions are generated outside of the project's boundaries to provide energy to the project, e.g. the use of purchased electricity from the grid.
- Scope 3 emissions, are all indirect emissions (not included in Scope 2) due to upstream or downstream activities. For example indirect upstream emissions associated with the extraction, production and transport of purchased construction materials.



Source: WRI&WBCSD, 2011

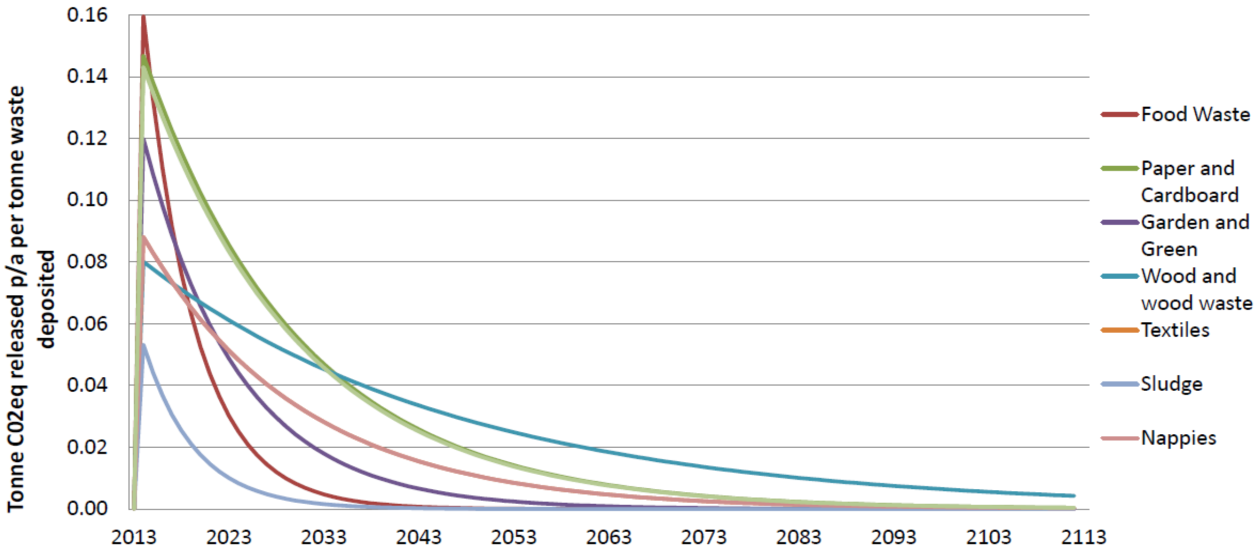
Figure 1 GHG Scopes

1.3 GHG Emissions from Landfill

Landfilling of MSW and organic waste generates GHG emissions as the organic matter within the waste decomposes in an anaerobic (oxygen deprived) environment and produces methane and nitrous oxides. In the period from 2010 to 2011 solid waste disposal to landfill generated approximately 11.3 million tCO_2-e nationally (equivalent to around three percent of Australia's national emissions) (DCCEE, 2012A).

Source: Bygrave (Clean Energy Regulator), 2012

Figure 2 illustrates the GHG emissions released over time for different waste types in a typical landfill in the NSW region. As shown, landfill waste continues to generate GHG emissions decades after initial placement in a landfill.



Source: Bygrave (Clean Energy Regulator), 2012

Figure 2 GHG emissions released of over time for different waste types (NSW region)

Two strategies to reduce GHG emissions associated with solid waste disposal include:

1) diverting the organic fraction of waste from landfills (to avoid methane generation)

2) collecting and burning methane produced from landfills (Bygrave (Clean Energy Regulator), 2012).

1.4 Director-General's Requirements

The Director-General's Requirements (DGRs), dated 16 May 2012, include the following environmental assessment requirements:

The EIS must address the following specific issues:

Greenhouse Gas – including:

- *a quantitative assessment of the potential Scope 1, 2 and 3 greenhouse gas emissions of the project, and a qualitative assessment of the potential impacts of these emissions on the environment; and*
- *a detailed description of the measure that would be implemented on site to ensure that the project is energy efficient.*

1.5 Assessment Objective

The objective of this GHG Assessment is to:

1) quantitatively assess the potential Scope 1, 2 and 3 GHG emissions of the construction and operational stages of the Development

2) qualitatively assess the potential impacts of these emissions on the environment

3) describe the measures which would be implemented to mitigate GHG emissions and identify measures to improve the energy efficiency of the Development.

1.6 Legislative and Policy Context

An increasing number of legislative and policy mechanisms include considerations and requirements relating to reducing GHG emissions. The following provides a summary of these legislative and policy mechanisms:

- the Australian Government has committed to reducing GHG emissions and the Clean Energy Plan (Securing a clean energy future: the Australian Government's climate change plan, 2011) includes the following targets:
  - five percent emission reduction from 2000 levels by 2020, irrespective of commitments made by other countries
  - 15 percent or 25 percent emission reduction from 2000 levels by 2020, if commitments are made by other countries
  - 80 percent emission reduction from 2000 levels by 2050.
- the Carbon Price Mechanism (CPM) set out in the *Clean Energy Act 2011* is the central national climate change mitigation instrument which will put a price on Scope 1 GHG emissions and provide a financial incentive for reducing GHG emissions
- the CPM is underpinned by the *National Greenhouse and Energy Reporting Act, 2007* (NGER). NGER is the national framework for reporting and disseminating information on GHG emissions, energy use and energy production associated with the activities of Australian corporations
- the *Energy Efficiency Opportunities Act 2006* (EEO Act) requires users (corporations or corporate groups) of more than 0.5 petajoules of energy per year to assess their energy use, identify cost-effective energy efficiency opportunities, and report publicly on the outcomes.

GHG emissions reduction is one of the four key objectives of the *National Waste Policy*. The *National Waste Policy* (developed in 2009 and endorsed by the Council of Australian Governments in 2010) sets the direction for Australia's waste management from 2010 to 2020.The *National Waste Policy Implementation Plan*, developed in 2010, includes 16 priority strategies. Strategy 7[1] of the plan focuses on reducing the amount of biodegradable material disposed of to landfills.

The NSW *Waste Avoidance and Resource Recovery Strategy 2007* provides NSW's waste management framework and includes waste avoidance and resource recovery goals and targets for the year 2014. The strategy was reviewed by the NSW Government in 2010 (*Review of Waste Strategy and Policy in New South Wales*). The review noted that to meet the 2014 MSW diversion from landfill disposal target of 66 percent, an additional 1.3 million to 1.7 million tonnes of resources needs to be recovered [and that] there will need to be significant improvements in source separation and/or processing of household waste (including construction of additional or enhanced AWT facilities, or new technologies including dedicated energy from waste facilities)'.

2.0 Methodology

This GHG assessment was conducted in accordance with the general principles outlined in:

- *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard* (Revised Edition), WRI and WBCSD (2004)
- *National Greenhouse Accounts (NGA) Factors*, Australian Department of Climate Change and Energy Efficiency (2012).

The assessment was guided by the following generally accepted GHG accounting and reporting principles (WRI and WBCSD, 2004):

- relevance – ensure that the GHG inventory appropriately reflects the activities and GHG emissions of the Development and contains information to support decision making by stakeholders internal and external to the Development
- completeness – inclusion of all relevant GHG emission sources within the chosen inventory boundary and the disclosure and justification of omissions and instances where estimates have been made with an insufficient level of quality
- consistency – use consistent calculation methods, data, criteria and assumptions to enable valid comparisons

[1] Strategy 7: Building on existing commitments, continue to phase down the amount of biodegradable material sent to landfill. *National Waste Policy Implementation Report 2011*.

- transparency – include clear and sufficient information on the procedures, assumptions and limitations of the GHG inventory, to enable others to understand the basis of the results and to make decisions regarding the use of GHG inventory results with reasonable confidence
- accuracy – reduce bias and uncertainties, as much as practical, to enable users to make decisions with reasonable confidence in the integrity of the results.

To calculate the GHG emissions associated with the construction and operational stages of the Development, the following four steps were undertaken:

1) the GHG assessment boundary was determined for the Development
2) GHGs relevant to the Development were identified
3) the emission sources were classified according to scope
4) the quantity of GHG emissions was calculated.

It should be noted that the estimated GHG emissions are based on data provided by the project design team and SITA at the 30 percent complete design stage of the Development. Hence the estimated GHG emissions results provided are an estimate only, and subject to the accuracy of the estimated operational project data / construction material / resource quantities and current project design stage and all other project assumptions.

Refer to Appendix A for further details on the GHG calculations and assumptions used in the assessment.

2.1 Assessment Boundary

The GHG assessment boundary defines the scope of GHG emissions and activities included in the GHG assessment. The principal of relevance is an important consideration in development of the boundary. This relates to selection of an appropriate boundary that considers (WRI and WBCSD, 2004):

- the intended use of the GHG assessment results
- the needs of decision makers
- the activities of the Development that generate GHG emissions
- construction and operational boundaries relating to the Development and the activities that incur GHG emissions.

The next section summarises the GHG emissions sources which have been included within the GHG Assessment boundary.

2.2 GHG Emission Sources and Scope

GHG emissions would be generated during the construction and operation of the Development. During the construction stage, electricity, fuel and materials would be consumed. These activities would generate GHG emissions directly (for example, as the diesel fuel is combusted on-site by construction equipment) and indirectly (for example, the embodied GHG emissions associated with the production and transportation of construction materials). It is assumed that no vegetation would be cleared during the construction of the Development.

Operation of the Development would also generate GHG emissions, for example from the consumption of diesel fuel and electricity to run the facility. The facility includes composting of the organic fraction of the waste in a climate controlled and aerated environment, which avoids the generation of methane and nitrous oxides.

2.2.1 Construction

The GHG emission sources which were included in the assessment boundary for the construction of the Development and the relevant GHG scope are listed in Table1.

Table 1 GHG Assessment Boundary – Construction Stage

Emission Source	Activity	Emission Scope		
		1	2	3
Fuel used for transport purposes	Transport of construction materials to site			✓
Fuel used	Operation of construction equipment and site vehicles	✓		✓
Materials	Use of construction materials (embodied emissions)			✓
Electricity used	Operation of site infrastructure including site offices, etc.		✓	✓

2.2.2 Operation

The GHG emission sources which were included in the assessment boundary for the operational stage of the Development and the relevant GHG scope are listed in Table 2.

Table 2 GHG Assessment Boundary – Operational Stage

Emission Source	Activity	Emission Scope		
		1	2	3
Fuel used for transport purposes	Transport of materials (residual waste / recovered recyclables / compost) from site			✓
Fuel used	Operation of stationary equipment	✓		✓
	Operation of mobile equipment	✓		✓
	Operation of site vehicles	✓		✓
Electricity used	Operation of facility		✓	✓
Fugitive composting emissions	Methane and nitrous oxides generated during composting	✓		
Materials	Use of materials (embodied emissions)			✓
Residuals to landfill	Emissions generated from residual waste sent to landfill			✓

2.2.3 Exclusions

The following emission sources have been excluded from the GHG inventory boundary for the reasons stated below:

- emission sources that are less than five percent of total construction/operational emissions are considered immaterial and may be excluded from the assessment
- fuel used by construction and operational workers travelling to/from the site. These GHG emissions would be less than five percent of the total emissions associated with the Development (i.e. immaterial).
- fuel used to transport waste to the site during operation. Comparable emissions would also be generated in the 'business as usual' scenario, for example, landfilling of the waste
- emissions associated with works carried out prior to the construction stage (for example, to power design offices and office supplies). These GHG emissions have already been generated and would be a small percentage of total emissions associated with the Development
- emissions associated with the transport, placement and decomposition of construction waste –construction waste emissions are considered negligible as this waste is inert and does not decompose in a landfill and generate GHG emissions (specifically methane).

3.0 Results

3.1 Construction

It is estimated that the construction stage of the Development would generate approximately:

- 720 tCO_2-e of direct Scope 1 GHG emissions
- 16 tCO_2-e of indirect Scope 2 GHG emissions
- 2,068 tCO_2-e of indirect upstream Scope 3 GHG emissions.

The total (Scope 1, 2 and 3) construction GHG emissions would be approximately 2,805 tCO_2-e.

The estimated construction GHG emissions for each of the key emission sources are given in Table3.

Table 3 GHG Emissions for the Construction Stage of the Development

Emission Category Emission Source	Quantity	Units	GHG Emissions (tCO_2-e)		
			Scope 1	Scope 2	Scope 3
Fuel use - construction equipment and site vehicles	267	kL	720	NA	55
Fuel use –transport of construction materials	16	kL	NA	NA	43
Electricity use – site offices	18,200	kWh	NA	16	3
Material use - Aggregate	15,264	T	NA	NA	61
Material use - Asphalt	953	T	NA	NA	53
Material use - Concrete	11,002	T	NA	NA	984
Material use - Steel	756	T	NA	NA	869
Sub total			**720**	**16**	**2,068**
Total			**2,805**		

Note: The estimated GHG emissions are based on data provided by the project design team and SITA at the 30 percent complete design stage of the Development. Hence the estimated GHG emissions results provided are an estimate only, and subject to the accuracy of the estimated construction material / resource quantities and current project design stage and all other project assumptions.

The fuel used on-site by construction equipment is the only source of direct Scope 1 GHG emissions. The use of electricity to power a site office is the only source of Scope 2 GHG emissions.

The major source of Scope 3 emissions is from the use of construction materials, with the most significant sources being the use of concrete and steel.

3.2 Operation

3.2.1 Annual Emissions from the Development

The estimated annual operational GHG emissions associated with the Development are given in Table 4. The table identifies the estimated GHG emissions pre and post 2017 as the Australian Government has committed to using updated GWPs from 1 July 2017 onwards.

Table 4 GHG Emissions (annual) for the Operation Stage of the Development

<table>
<tr><th rowspan="2">Emission Category Emission Source</th><th rowspan="2">Quantity</th><th rowspan="2">Units</th><th colspan="6">Annual GHG Emissions (tCO_2-e)</th></tr>
<tr><th colspan="2">Scope 1</th><th colspan="2">Scope 2</th><th colspan="2">Scope 3</th></tr>
<tr><td>Electricity use</td><td>4,500,000</td><td>kWhr/yr</td><td colspan="2">NA</td><td colspan="2">3,960</td><td colspan="2">810</td></tr>
<tr><td rowspan="2">Fugitive composting emissions</td><td rowspan="2">55,000</td><td rowspan="2">t waste/yr</td><td>Pre-2017</td><td>Post-2017</td><td colspan="2" rowspan="2">NA</td><td colspan="2" rowspan="2">NA</td></tr>
<tr><td>9,735</td><td>10,417</td></tr>
<tr><td rowspan="2">Residuals to landfill</td><td rowspan="2">55,000</td><td rowspan="2">t waste/yr</td><td colspan="2" rowspan="2">NA</td><td colspan="2" rowspan="2">NA</td><td>Pre-2017</td><td>Post-2017</td></tr>
<tr><td>51,755</td><td>61,586</td></tr>
<tr><td>Fuel use - removal of residuals/ products from SAWT</td><td>119</td><td>kL/yr</td><td colspan="2">322</td><td colspan="2">NA</td><td colspan="2">24</td></tr>
<tr><td>Fuel use - operational equipment onsite vehicles</td><td>26.5</td><td>kL/yr</td><td colspan="2">71</td><td colspan="2">NA</td><td colspan="2">5</td></tr>
<tr><td colspan="3" rowspan="2">Sub total</td><td>Pre-2017</td><td>Post-2017</td><td colspan="2" rowspan="2">3,960</td><td>Pre-2017</td><td>Post-2017</td></tr>
<tr><td>10,129</td><td>10,811</td><td>52,595</td><td>62,426</td></tr>
<tr><td colspan="3">Total Pre-2017</td><td colspan="6">66,684</td></tr>
<tr><td colspan="3">Total Post-2017</td><td colspan="6">77,197</td></tr>
</table>

Notes: 1) Post 2017 the GWP of methane will change from 21 to 25 and the GWP of nitrous oxide will change from 310 to 298. These changes have been included in the calculated estimates of operational GHG emission from the sources: fugitive composting emissions; and residuals to landfill. 2) The estimated GHG emissions are based on data provided by the project design team and SITA at the 30 percent complete design stage of the project. Hence the estimated GHG emissions results provided are an estimate only, and subject to the accuracy of the estimated operational project data and all other project assumptions.

The Development would use fully automated enclosed composting methodology to maintain aerobic conditions. However, the composting emissions were calculated using the standard NGA emissions factors (DCCEE, 2012), which are based on the open windrow composting process. Fully automated enclosed composting generates less GHG emissions than open windrow composting as aerobic conditions are maintained throughout the composting process. Hence, the estimate conservatively assumes that some anaerobic decomposition occurs and fugitive emissions of methane and nitrous oxide would be generated from the composting process (however this is not representative of the Development's composting process).

As shown in Table 4, the fugitive composting GHG emissions would be the major source of annual operational Scope 1 GHG emissions. However, it is expected that process monitoring and control measures would ensure aerobic composting conditions at the facility. Hence, these emissions have been included as a conservative measure only.

The use of electricity to power the facility is the only source of Scope 2 GHG emissions and a minor source of Scope 3 emissions.

The generation of emissions from the decomposition of residual waste landfilled is the major source of annual operational Scope 3 emissions. However, the residuals to landfill would have a lower organic content than standard MSW, due to the SAWT sorting process, and their GHG emissions generation potential is expected to be less than the 0.94 tCO_2-e/t (based on non-putrescible Construction and Industrial waste landfilled in Kemps Creek) which has been conservatively used to estimate these emissions.

3.2.2 Annual Business as Usual Emissions

The following provides an estimate of the annual business as usual (BAU) emissions which would be generated from the decomposition of 100,000 tpa of waste in a landfill in NSW. It should be noted that this estimate does not include GHG emissions associated with operating a landfill, for example onsite electricity or fuel used to transport, deposit and compact waste, liner and fill material.

Landfilling of MSW generates GHG emissions as the organic matter within the waste decomposes in an anaerobic (oxygen deprived) environment and produces methane. The GHG emissions are released over many years, as shown in Figure 2.

The GHG emissions are classified as 'anthropogenic' (human induced) as burying the waste creates the unnaturally low oxygen environment (anaerobic conditions). The natural aerobic decomposition that occurs when waste is not buried does not produce methane, therefore methane produced in landfill decomposition is considered to be anthropogenic.

One tonne of MSW releases methane approximately equivalent to 1.2 tCO_2-e as the waste decomposes in a landfill over a period of decades (NGA Factors, DCCEE, 2012). Therefore the lifetime GHG generation potential of landfilling 100,000 tonnes of MSW is approximately equivalent to 120,000 tCO_2-e (100,000 t x 1.2 tCO_2-e) pre-2017 and142,000 tCO_2-e (100,000 t x 1.42 tCO_2-e) post-2017.

If landfill gas capture and combustion (e.g. flaring or electricity generation) was implemented approximately 55percent[2] of the landfill gas would be captured and combusted to form carbon dioxide, which is considered part of the natural carbon cycle, and not included in national GHG inventories. The default methane destruction efficiency of a standard landfill gas flare is 98 percent. Hence, the lifetime GHG emissions associated with landfilling 100,000 tonnes of MSW waste, with a landfill gas capture and combustion system in place, would be equivalent to approximately 55,320 tCO_2-e pre-2017 and 65,462 tCO_2-e post-2017.

3.3 Comparison with Emissions in NSW

3.3.1 Construction

The annual GHG emissions (including emissions and removals from land use and land use change) for NSW were 157.4 million tCO_2-e in the year 2009 to 2010.

The estimated total (Scope 1, 2 and 3) GHG emissions associated with the construction of the Development (approximately 2,805 tCO_2-e) are approximately equivalent to 0.002 percent of NSW's annual GHG emissions (in 2009 to 2010).

3.3.2 Operation

The estimated total annual operational (Scope 1, 2 and 3) GHG emissions associated with the Development (approximately 66,000 to 77,000 tCO_2-e) are approximately equivalent to 0.05 percent of NSW's annual GHG emissions (in 2009 to 2010).

Solid waste disposal on land in NSW generated approximately 4.2 million tCO_2-e in the year 2009 to 2010.The estimated total annual operational (Scope 1, 2 and 3) GHG emissions associated with the Development are approximately equivalent to 0.3 percent of NSW's annual (2009 to 2010) waste sector (solid waste disposal on land) GHG emissions.

However, as discussed above, the BAU lifetime GHG emissions (approximately 120,000 to 142,000 tCO_2-e) associated with landfilling 100,000 tonnes of MSW (assuming no landfill gas capture) would be approximately equivalent to 3.4 percent of NSW's annual (2009 to 2010) waste sector (solid waste disposal on land) GHG emissions (post-2017). If landfill gas capture and combustion were in place the BAU lifetime GHG emissions with landfilling 100,000 tonnes of MSW, would be approximately equivalent to 1.6 percent of NSW's annual (2009 to 2010) waste sector (solid waste disposal on land) GHG emissions (post-2017).

[2] 55% is an approximate national average 'whole-of-life' landfill gas capture efficiency rate. Source: Warnken ISE, 2007. *The Potential Greenhouse Gas Liability from Landfill in Australia: An Examination of the Climate Change Risk from Landfill Emissions to 2050.*

4.0 Mitigation Measures

The following mitigation measures could be implemented during construction and operation to reduce the GHG emissions associated with the Development, where reasonable and feasible:

- preferential use of local materials to reduce fuel consumption associated with material transportation
- minimise fill and construction materials handling to reduce quantity of fuel consumption
- use low GHG intensive alternative fuels (for example biofuels) in equipment and vehicles
- preferential use/purchase of vehicles with low fuel consumption ratings and energy efficient equipment/plant
- train staff in practices to reduce fuel consumption in use equipment and vehicles such as eliminating idling
- regularly maintain equipment and vehicles to maximise fuel efficiency
- preferential selection of materials with lower embodied emissions, such as:
  - low carbon concrete (where Portland cement is substituted with waste products including granulated blast furnace slag and fly ash)
  - recycled material as aggregate
  - demolition waste as fill material
- use of electricity generated by the landfill gas powered generator proposed at the Resource Recovery Precinct (subject to a separate DA, and undetermined at the time of writing this EIS)
- manage and monitor the composting process to ensure that aerobic conditions are maintained (thereby avoiding the generation of fugitive GHG emissions associated with anaerobic decomposition of organic waste).

5.0 Energy Efficiency

The Development would improve the energy efficiency of operations at the existing SAWT facility. A summary of the key energy efficiency advantages of the Development, relative to existing operations, is provided below:

- a reduction in the amount of front end loader operations and manual handling would reduce fuel and electricity consumption
- the exhaust air from the pre-treatment buildings would be reused in the composting process, thereby minimising energy usage
- the roof of the enclosed composting hall would include translucent panel sheeting to maximise natural light within the building, thereby minimising energy used for lighting
- all leachate produced as a result of operations in the Composting Hall and Tunnel Composting System would be directed to enclosed leachate tanks, reducing the need for electricity powered aeration of leachate ponds
- enclosed composting for the entire process reduces fugitive emissions from composting material outdoors.

6.0 Conclusion

During the construction stage, electricity, fuel and materials would be consumed. These activities would generate GHG emissions directly and indirectly. The total construction stage (Scope 1, 2 and 3) GHG emissions would be approximately 2,805 tCO_2-e. This is approximately equivalent to 0.002 percent of NSW's annual GHG emissions (in 2009 to 2010).

Operation of the Development would also generate GHG emissions, for example from the consumption of diesel fuel and electricity to run the facility and the generation of fugitive emissions. It is estimated that the total annual operational (Scope 1, 2 and 3) GHG emissions associated with the Development (approximately 66,000 to 77,000 tCO_2-e) are approximately equivalent to 0.05 percent of NSW's annual GHG emissions (in 2009 to 2010).

The Development would use fully automated enclosed composting methods, however this assessment conservatively assumes that some anaerobic decomposition occurs (for example, that fugitive emissions of methane and nitrous oxide would be generated from the composting process). Fugitive GHG emissions from the composting process represent the major source (96 percent) of the estimated annual operational Scope 1 GHG emissions. However the Development includes composting of the organic fraction of the waste in a climate controlled and aerated environment, which prevents the generation of GHG emissions (e.g. methane). The Development would compost 55,000 tpa of waste each year. The majority of this waste would be MSW, the remainder being SSO and a small volume of biosolids. MSW releases methane as the waste decomposes in a landfill over a period of decades. One tonne of MSW releases methane approximately equivalent to 1.2 tCO_{2}-e pre-2017 and 1.4 tCO_{2}-e post-2017 (NGA Factors, DCCEE, 2012). Therefore the lifetime methane generation potential of landfilling 100,000 tonnes of MSW is approximately equivalent to 120,000 tCO_2-e pre-2017 and 142,000 tCO_{2}-e post-2017.This would be approximately equivalent to 3.4 percent of NSW's annual (2009 to 2010) waste sector (solid waste disposal on land) GHG emissions (post-2017). If landfill gas capture and combustion (for example, flaring or electricity generation) was implemented approximately 55 percent[3] of the landfill gas would be captured and combusted to form carbon dioxide, which is considered part of the natural carbon cycle, and not an anthropogenic GHG emission.

It should be noted that the estimated GHG emissions results provided above are an estimate only, and subject to the accuracy of the estimated construction and operational project data and all other project assumptions.

To avoid/reduce GHG emissions associated with the Development, mitigation measures are recommended which relate to:

- minimising the quantity and/or emissions intensity of:
  - electricity used;
  - fuel used by plant and equipment;
  - fuel used in the transport of materials;
- minimising the quantity and/or embodied carbon of materials used; and
- avoiding the generation of fugitive GHG emissions.

[3] 55 percent is an approximate national average 'whole-of-life' landfill gas capture efficiency rate. Source: Warnken ISE, 2007, *The Potential Greenhouse Gas Liability from Landfill in Australia: An Examination of the Climate Change Risk from Landfill Emissions to 2050.*

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Appendix A

GHG Assessment Calculations

Construction

Emission Category Emission Source	Quantity	Units	GHG Emissions (tCO_2-e)			
			Scope 1	Scope 2	Scope 3	
Fuel use - construction equipment & site vehicles	267	kL	720		55	
Fuel use – transport of construction materials	16	kL			43	
Electricity use – site offices	18200	kWhr		16	3	
Material use - Aggregate	15,264	T			61	
Material use - Asphalt	953	T			53	
Material use - Concrete	11,002	T			984	
Material use - Steel	756	T			869	**Total**
Totals			**720**	**16**	**2,068**	**2,805**

Operational (annual) Pre 2017

Emission Category Emission Source	Quantity	Units	Annual GHG Emissions (tCO_2-			
			Scope 1	Scope 2	Scope 3	
Electricity use	4,500,000	kWhr / yr		3,960	810	
Fugitive composting emissions	55,000	t waste / yr	9,735			
Residual waste emissions	55,000	t waste / yr			51,755	
Fuel use - removal of material (residual/recyclables/compost) from site	119	kL / yr	322		24	
Fuel use - operational equipment	26.5	kL / yr	71		5	**Total**
Total			**10,129**	**3,960**	**52,595**	**66,684**

Operational (annual) Post 2017

Emission Category Emission Source	Quantity	Units	Annual GHG Emissions (tCO_2-			
			Scope 1	Scope 2	Scope 3	
Electricity use	4,500,000	kWhr / yr		3,960	810	
Fugitive composting emissions	55,000	t waste / yr	10,417			
Residual waste emissions	55,000	t waste / yr			61,586	
Fuel use - removal of material (residual/recyclables/compost) from site	119	kL / yr	322		24	
Fuel use - operational equipment	26.5	kL / yr	71		5	**Total**
Total			**10,811**	**3,960**	**62,426**	**77,197**

NSW's annual GHG emissions (including emissions and removals from land use and land use change) were 157.4 million tCO_2-e in the year 2009-20110.

Solid waste disposal on land in NSW generated approximately 4.2 million tCO_2-e in the year 2009-20110.

Source: Department of Cllimate Change, 2011.

NSW GHG emissions (incl. LULUC) 2009/10	157.4	million tCO2-e	
NSW GHG emissions (incl. LULUC) 2009/10	157,400,000	tCO2-e	
Construction Scope 1, 2 &3 as a % of NSW	0.002	%	
NSW Solid Waste Emissions (2009-2010)	4.2	million tCO2-e	
NSW Solid Waste Emissions (2009-2010)	4,200,000	tCO2-e	
	Pre-2017	**Post 2017**	
Operational Scope 1, 2 &3 as a % of NSW	0.04	0.05	%
Operational Scope 1 as a % of NSW Waste	0.2	0.3	%
Operational Scope 1, 2 &3 as a % of NSW Wast	1.6	1.8	%
Landfilling of 100,000t MSW as a % of NSW (without landfill gas capture)	0.1	0.1	%
Landfilling of 100,000t MSW as a % of NSW (with landfill gas capture & combustion)	0.04	0.04	%
Landfilling of 100,000t MSW as a % of NSW Waste (without landfill gas capture)	2.9	3.4	%
Landfilling of 100,000t MSW as a % of NSW Waste (with landfill gas capture & combustion)	1.3	1.6	%

Construction GHG Emissions Calculations

Construction Material Use - Embodied Emissions

Construction Material	Amount	Units	conversion factor	unit	Assume	Amount	Units	**Material Type**	**Tonnes**	S3 Emissions Factor (EF) (tCO2-e/t)	EF notes	**S3 GHG Emissions (tCO2-e)**	
DGS20	1,553.10	m3	2.25	t/m3		3,494	t			0.004	1	14	
DGB20	5,231.09	m3	2.25	t/m3		11,770	t	**Aggregate**	**15,264**	0.004	1	47	**61**
Asphalt	414.16	m3	2.3	t/m3		953	t	**Asphalt**	**953**	0.056	2	53	**53**
Concrete	4,362.80	m3	2.4	t/m3		10,471	t			0.089	3	932	
Blocks	32,984.00	#	0.01388	t/#	290x190x190. (80%)	366	t			0.098	4	36	
			0.025	t/#	290x290x190. (20%)	165	t	**Concrete**	**11,002**	0.098	4	16	**984**
Reinforcement - bar	100.07	t	1	NA		100	t			1.05	5	105	
Reinforcement - mesh	15,277.00	m2	0.00229	t/m2	SL62 33kg/14.4m2	35	t			1.05	5	37	
Structural Steel	347.19	t	1	NA		347	t			1.05	5	365	
Steel Prurlins	17,783.00	m	1	t/m	varies 4.5-7.2 t/m	209	t			1.05	5	219	
Roof Sheeting	11,723.00	m2	0.0056	t/m2	provided by SITA	66	t	**Steel**	**756**	2.19	6	144	**869**

Construction Material Use - Transport Fuel Use

Construction Material	Supplier	Location	Distance (km)	Haul load (t /truck)	# Trips	Distance travelled (km) to&fro	Rate of fuel use (L/km)	Total Fuel Use (kL)	S3 EF (t CO2-e / kL)	**S3 GHG Emissions (tCO2-e)**		**Material Type**
DGS20	Boral	Prestons	15	30	116	3,494	0.562	1.963895	2.6981	5.30		
DGB20	Boral	Prestons	15	30	392	11,770	0.562	6.614707	2.6981	17.85	**23.15**	**Aggregate**
Asphalt	Boral	Prestons	15	20	48	1,429	0.562	0.803	2.6981	2.17	**2.17**	**Asphalt**
Concrete	Boral	Prestons	15	30	349	10,471	0.562	5.885	2.6981	15.88		
Blocks	Austral	Wetherill Pa	15	30	18	531	0.562	0.299	2.6981	0.81	**16.68**	**Concrete**
Reinforcement - bar	Ausreo	Wetherill Pa	15	30	3	100	0.562	0.056	2.6981	0.15		
Reinforcement - mesh	Ausreo	Wetherill Pa	15	15	2	70	0.562	0.039	2.6981	0.11		
Structural Steel	TBA	Wetherill Pa	15	30	12	347	0.562	0.195	2.6981	0.53		
Steel Prurlins	Stramit	Erskin Park	5	15	14	139	0.562	0.078	2.6981	0.21		
Roof Sheeting	Stramit	Erskin Park	5	15	4	44	0.562	0.025	2.6981	0.07	**1.06**	**Steel**
								16			**43**	**TOTAL**

Notes: Scope 3 (S3). Emissions Factors sourced from TAGG Workbook 2012 (these have been tailored to Aust. From EcoInvent database)

1) Aggregate
2) Hot Mix Asphalt (400Mj/t) 20% RAP
3) Concrete 20MPa 10% Fly Ash
4) Block 13MPa
5) Structural Steel
6) Steel sheet
7) Heavy goods vehicle

Construction GHG Emissions Calculations

Construction Equiptment - Fuel Use

Construction Equiptment	Number	Duration (Days)	Total Days	Total Hrs	Fuel Use (L/hr)	Fuel Use (kL)
30t Excavators (Earthworks)	2	30	60	480	45	21.6
Truck & Dog or 30T Dump Trucks (Earthworks Stockpiling)	4	30	120	960	16	15.36
20KL Water Cart (Earthworks)	1	30	30	240	25	6
30t excavators (Building Works Stage)	2	40	80	640	45	28.8
Trucks (Building Works Stage)	2	30	60	480	16	7.68
20t excavator (Hydraulic Works Stage)	1	90	90	720	30	21.6
5t Excavator (Hydraulic Stage)	1	90	90	720	6	4.32
Stage)	2	10	20	160	16	2.56
5t Excavator (Electrical Cabling/Trenching Stage)	1	90	90	720	6	4.32
Trucks (Electrical Cabling/Trenching Stage)	2	10	20	160	16	2.56
Concrete pump truck	1	20	20	160	20	3.2
Scissor Lifts (Building Works Stage)	4	90	360	2880	6	17.28
Frannas Cranes (Any Stage)	3	260	780	6240	20	124.8
50-100T cranes (Building Works Stage)	1	20	20	160	45	7.2
					TOTAL	**267.28** kL

Total Fuel use (kL)	EF (tCO2-e/kL) Scope 1	Scope 3	**GHG Emissions (tCO2-e) Scope 1**	**Scope 3**
267	2.698	0.20458	**720**	**55**

Construction Electricity Use

Construction months	Electricity use (KWh/mth)	Total Electricity use (KWh)	EF (S2) (kgCO2-e/kWh)	EF (S3) (kgCO2-e/kWh)	**S2 GHG emissions (tCO2-e)**	**S3 GHG emissions (tCO2-e)**
14	1300	18200	0.88	0.18	**16**	**3**

Annual Operational GHG Emissions Calculations

Waste Type	Annual amount (t)	% residual sent to landfill
MSW & Organic	100,000	55%

GHG	Chemical formul	GWP pre-201	GWP post-2017
Methane	CH_4	21	25
Nitrous Oxide	N_2O	310	298

Electricity use	Units	EF (S2)	EF (S3)	Units	S2 Annual GHG emissions (tCO2-e)	S3 Annual GHG emissions (tCO2-e)
4,500,000	Annual KWhr	0.88	0.18	kg CO2-e/KWh	**3,960**	**810**

Emissions from composting

Pre- 2017

Waste treated (approx. annual t degradable)	Waste treated (annual kg)	CH4 EF (g CH4/kg waste treated)	N2O EF (g N2O/kg waste treated)	CH4 (g CH4/ annual waste treated)	N2O (g N2O/ annual waste treated)	S1 Annual GHG emissions (tCO2-e)	
55,000	55,000,000	4	0.3	220,000,000	16,500,000	**9,735**	
		Source: Default EFs - 2006 IPCC Guidelines for National GHG Inventories		CH4 (t CH4/ annual waste treated)	N2O (t N2O/ annual waste treated)		
				220	17		0.094
				CH4 (t CO2-e/ annual waste treated)	N2O (t CO2-e/ annual waste treated)		5170
				4,620	5,115		

Post- 2017

Waste treated (approx. annual t degradable)	Waste treated (annual kg)	CH4 EF (g CH4/kg waste treated)	N2O EF (g N2O/kg waste treated)	CH4 (g CH4/ annual waste treated)	N2O (g N2O/ annual waste treated)	S1 Annual GHG emissions (tCO2-e)	
55,000	55,000,000	4	0.3	220,000,000	16,500,000	**10,417**	
		Source: Default EFs - 2006 IPCC Guidelines for National GHG Inventories		CH4 (t CH4/ annual waste treated)	N2O (t N2O/ annual waste treated)		
				220	17		0.094
				CH4 (t CO2-e/ annual waste treated)	N2O (t CO2-e/ annual waste treated)		5170
				5,500	4,917		

Note: The GHG emissions from composting calculated above assume that some anaerobic decomposition occurs.
However this is included as a conservative measure, as the proposed SAWT facility would use fully automated
enclosed tunnel composting. It is expected that process monitoring and control measures would ensure

Generation Potential Tool	Composition	DOC	DOCf	F	Conversion	Ox	GWP pre2017	GWP post2017	EF pre 2017	EF post2017
Food	0.0%	0.15	0.84	0.5	1.336	0.1	21	25	0.000	0.000
Paper	19.7%	0.4	0.49	0.5	1.336	0.1	21	25	0.487	0.580
Garden & park	5.1%	0.2	0.47	0.5	1.336	0.1	21	25	0.061	0.072
Wood & wood waste	15.9%	0.43	0.23	0.5	1.336	0.1	21	25	0.199	0.236
Textiles	5.1%	0.24	0.5	0.5	1.336	0.1	21	25	0.077	0.092
Sludge	1.9%	0.05	0.5	0.5	1.336	0.1	21	25	0.006	0.007
Nappies	0.0%	0.24	0.5	0.5	1.336	0.1	21	25	0.000	0.000
Rubber & leather	4.5%	0.39	0.5	0.5	1.336	0.1	21	25	0.111	0.132
Inert	47.8%	0	0	0.5	1.336	0.1	21	25	0.000	0.000
	100%								**0.941**	**1.120**

Residual waste - disposal to landfill - operational

Waste	Tonnes per annum	EF (tCO2-e/t) pre 2017 Scope 3	**GHG Emissions (tCO2-e) pre 2017 Scope 3**	EF (tCO2-e/t) post 2017 Scope 3	**GHG Emissions (tCO2-e) post 2017 Scope 3**
Residual waste - disposal to	55,000	0.941	51,755	1.120	61,586

Fuel use - on-site operational

Equiptment	Movements/da	Ave operating	Ave. operatin	Fuel use (L/hr)	Operational fuel use (L/yr)
Trucks - deliveri	16	1.25	456.25	16	7,300
Landfill delivery t	42	3	1095	16	17,520
Light truck	10	0.75	273.75	6	1,643

26,463 Total (L/yr)
26.5 Total (kL/yr)

Total Fuel use (kL)	EF (tCO2-e/kL)		**GHG Emissions (tCO2-e)**	
	Scope 1	Scope 3	**Scope 1**	**Scope 3**
26.5	2.698	0.20458	**71**	**5**

Fuel use - removal of residual waste, recyclables and compost from SAWT facility

Material	Tonnes per annum	Haul load (t /truck)	# Trips per yr	Distance (km)	travelled (km/yr) to&fro	Rate of fuel use (L/km)	Fuel Use
Residual waste sent to landfill	55,000	10	5,500	2.5	27,500	0.562	**15**
Metals, glass, plastics	17,500	10	1,750	30	105,000	0.562	**59**
Compost	20,000	10	2,000	20	80,000	0.562	**45**
						Total (kL/yr)	**119**

Total Fuel use (kL)	EF (tCO2-e/kL)		**GHG Emissions (tCO2-e)**	
	Scope 1	Scope 3	**Scope 1**	**Scope 3**
119	2.698	0.20458	**322**	**24**

Note: It has been assumed that the trucks used to transport residual/recyclable materials and compost would be owned and operated by SITA.

Annual Operational 'Business as usual' GHG Emissions Comparison Calculations

Waste Type	Emissions Factor (t CO2e/ t waste)	Source
MSW (Municipal Solid Waste)	1.2	NGA Factors, 2012, derived from NGER (Measurement) Determination 2008
MSW post 2017	1.4	derived from NGER (Measurement) Determination 2008 using updated GWPs
Food	1.6	NGA Factors, 2012, derived from NGER (Measurement) Determination 2008
Garden & green	1.2	NGA Factors, 2012, derived from NGER (Measurement) Determination 2008

Material	**SAWT - Est. Avg**	**SAWT Est. Range**	EF Source: NGA Factors 2012	Waste (tpa)	Lifetime GHG Potential (tCO2-e)	Recyclable Waste (t/yr)
Food & other compostables	**35.0%**	25 - 40%	1.6	35,000	56,000	0
Green waste and wood	**4.0%**	3 - 6%	1.2	4,000	4,800	0
Other organics (non compostable)	**1.5%**		0	1,500	0	0
Nappies	**6.0%**	4 - 8%	1.5	6,000	0	0
Paper & cardboard	**15.0%**	10 - 18%	2.5	15,000	37,500	0
Bricks, concrete, ceramics etc	**2.0%**		0	2,000	0	0
E-waste, batteries, other special waste	**1.0%**	0 - 2%	0	1,000	0	0
Ferrous metals	**3.0%**	2 - 4%	0	3,000	0	3,000
Non-ferrous metals	**1.0%**	0.5 - 1.5%	0	1,000	0	1,000
Glass	**4.0%**	2 - 6%	0	4,000	0	4,000
Rigid plastics	**8.0%**	8 - 12%	0	8,000	0	8,000
PET	**1.5%**	0.5 - 2.5%	0	1,500	0	1,500
Plastic films	**10.0%**	8 - 12%	0	10,000	0	0
Textiles, clothing	**4.0%**	3 - 9%	1.5	4,000	0	0
Other	**4.0%**		0	4,000	0	0
Total	**100.0%**			**100,000**	**98,300**	**17,500**

64,000 tpa of which is degradable
Note: rounded up to **29,000tpa**

BAU (pre-2017)		**EF pre 2017 (Source: NGA Factors 2012)**	**Lifetime GHG Potential (tCO2-e)**
MSW Waste landfilled (tonnes per a	**100,000.0**	1.2	120,000

Approximate GHGe	**120,000**	**BAU (without landfill gas capture & combustion)**
LFG capture efficiency	55	% (Source: Warnken, ISE, 2007)
Fugitive GHGe	54,000	
Methane destruction efficiency	98	% (DCCEE, 2012, The Carbon Farming Methodology Determination 2012)
Fugitive GHGe (destruction)	1,320	
Total fugitive GHGe	**55,320**	**BAU (with landfill gas capture & combustion)**

BAU (post-2017)		**EF post 2017**	**Lifetime GHG Potential (tCO2-e)**
MSW Waste landfilled (tonnes per a	**100,000.0**	1.42	142,000

Approximate GHGe	**142,000**	**BAU (without landfill gas capture & combustion)**
LFG capture efficiency	55	% (Source: Warnken, ISE, 2007)
Fugitive GHGe	63,900	
Methane destruction efficiency	98	% (DCCEE, 2012, The Carbon Farming Methodology Determination 2012)
Fugitive GHGe (destruction)	1,562	
Total fugitive GHGe	**65,462**	**BAU (with landfill gas capture & combustion)**