Waverley, Randwick and Woollahra Councils

Evaluation of home composting project

Final Report

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1 Executive Summary

This report was prepared by Hyder Consulting for Waverly, Randwick and Woollahra City Councils to document the evaluation of current residential waste management practices, the existing home composting project and the potential benefits of the expansion of the home composting programme across the three Councils. The report compares the financial costs, the climate impact (greenhouse gas (GHG) emissions) and a selection of Ecologically Sustainable Development (ESD) indicators for current waste management practice and explores the benefits of home composting based on the home composting trial programme.

Background

Randwick and Waverley Councils have jointly implemented a home composting trial with around 600 residents over a 12-month period as part of their Food Waste Reduction Project. Due to the high costs associated with using an external organic waste processor, the loss of potential organic product for local use, and the escalating problems associated with GHG emissions for waste transportation, the three Councils are interested in exploring alternatives to kerbside collection of organic wastes and centralised (external) processing.

Project methodology

Hyder based the evaluation on data provided by Councils relating to existing waste management systems, costs and current measured performance of the home composting trial, and estimated costs for expansion of the home composting programme. GHG emissions from waste disposal to landfill, waste collection/transfer, and the composting process itself were estimated using standard approaches and/or values obtained from a review of the literature. The financial assessment was conducted using available cost data and estimates based on existing system costs. In consultation with the food waste reduction officer, four Ecologically Sustainable Development (ESD) Indicators were selected for qualitative evaluation (Table 1).

Table 1: Selected ESD indicators and assessment approach

ESD indicator	Description	Measure of system/activity performance
ESD1	Avoidance of food waste, which is key point of interest and focus for the home composting project, and also part of DECCW's recently launched food avoidance programme	The system promotes and/or enables avoidance of food waste
ESD2	Increased interest in gardening, growing fruit and vegetables and food sustainability (i.e. reduced food miles)	The system encourages gardening activities, local production of food, and reduction of food miles
ESD3	Positive contribution to social capital through community strengthening and involvement in Council environmental/sustainable initiatives	The system helps to strengthen local community and stimulates interest and involvement in Councils' environmental/sustainable initiatives
ESD4	Enhanced source-separation, improved household resource recovery and waste management	The system encourages improved household management of resources and promotes positive behaviour change vis-à-vis waste

Key results of the evaluation

If the home composting programme is expanded across 20-40% of the Councils' households, total GHG emissions associated with waste management would decrease by approx. 7-14% (Figure 1).

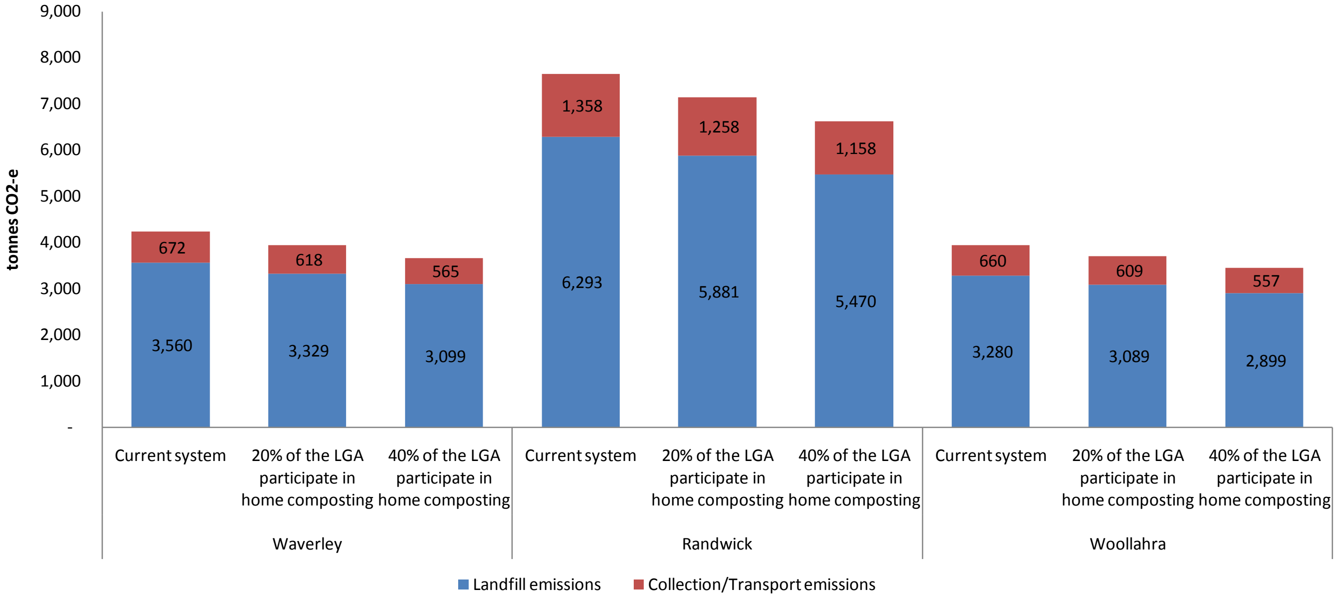

Figure 1 : Landfill CO2-e emissions for the current system, 20% of the LGA participate in home composting and 40% of the LGA participate in home composting

If the home composting programme is expanded across 20-40% of Councils households, approx. 6-15% decrease in total operational costs compared to current waste management system. After a four-year period to establish the composting programme, assuming annual 'maintenance costs' for the home composting programme of $98,000 per annum (across the three LGAs) an estimated annual saving of $979,559 (at a 20% participation rate) to $2,057,117 (at a 40% participation rate) could be achieved through diversion of food waste from the current residual waste management system. The table below shows the annual cost savings that could be achieved for each Council after the four-year home composting implementation period.

Table 2: Costs saved per year for each Council after the four-year home composting implementation period

Council	Annual saving at 20% participation rate	Annual saving at 40% participation rate
Waverley	$302,256	$637,179
Randwick	$376,055	$784,766
Woollahra	$301,247	$635,162
Total	**$979,558**	**$2,057,117**

There is evidence that the home composting programme has resulted in positive behavioural change and community strengthening, including a significant reduction in food waste (Table 3).

Table 3: Reduction of avoidable and unavoidable food waste in the residual waste bin between Audit 1 and Audit 2

	Weight (kg)	Weight (kg) per household	Percentage (%) reduction
Avoidable food waste	69.69	1.16	33%
Unavoidable food waste	68.28	1.14	61%
All food waste	137.97	2.30	43%

Avoidable = unused/still packaged food items and leftovers

Unavoidable = preparatory and meat/bones

Using the participants' responses to questionnaires, anecdotal evidence provided by the food waste reduction officer, and information from the literature, the performance of the current waste management system, the home composting project, and an extension of home composting across the LGA were assessed. The ESD assessment is summarised in the table below.

Table 4: Qualitative assessment of ESD indicators – expansion of the home composting programme across 20% or 40% of the Councils' households

ESD indicator	System performance
ESD1: Food waste avoidance	Excellent
ESD2: Gardening and local food production	Excellent
ESD3: Social capital	Excellent
ESD4: Enhanced household waste management	Excellent

The home compost trial has generated community enthusiasm and momentum for broader sustainability initiatives and Councils' environmental projects.

DEFINITIONS

Landfill Emissions – This includes greenhouse gas emissions resulting from waste management activities in landfills (adapted from UNFCCC, no date).

Inert waste – Waste that does not generate emissions. Any waste with a DOC of 0 such as such as asbestos and concrete.

Emissions Factor – A coefficient that relates activity data to the amount of chemical compound which is the source of later emissions. Emission factors are often based on a sample of measurement data, averaged to develop a representative rate of emission for a given activity level under a given set of operating conditions (adapted from UNFCCC, no date).

Carbon Stock – The quantity of carbon contained in a “pool”, meaning a reservoir or system which has the capacity to accumulate or release carbon. In a landfill some of the carbon contained in the waste is released in the first year of deposition while the remaining is next year’s opening stock. Emissions represent losses from the “pool” while waste inputs represent additions.

CO_2-e – Carbon dioxide equivalence is a quantity that describes, for a given mixture and amount of greenhouse gas, the amount of CO_2 that would have the same global warming potential (GWP), when measured over a specified timescale (generally 100 years). Carbon dioxide equivalence thus reflects the time-integrated radiative forcing of a greenhouse gas.

Global warming potential (GWP) **–** is a measure of how much a given mass of greenhouse gas is estimated to contribute to global warming. It is a relative scale which compares the gas in question to the same mass of carbon dioxide (whose GWP is by definition 1). A GWP depends on the time before the gas is removed from the atmosphere and thus is calculated over a specific time interval and the value of this must be stated whenever a GWP is quoted or else the value is meaningless. In this report a 100 years time interval is assumed, consistent with IPCC standards.

ABBREVIATIONS

CO_2-e	Carbon dioxide equivalent
C&D	Commercial and Demolition Waste
C&I	Commercial and Industrial Waste
CPRS	Carbon Pollution Reduction Scheme
DCC	Department of Climate Change
DOC	Degradable Organic Carbon
ESD	Ecologically Sustainable Development
FOD	First Order Decay
GHG	Greenhouse Gas
GWP	Global Warming Potential
IPCC	International Panel on Climate Change
kt	Kilotonnes (1 kt = 1000 t)
MSW	Municipal Solid Waste
NGER	National Greenhouse and Energy Reporting
UNFCCC	United Nations Framework Convention on Climate Change

2 Introduction

This report has been prepared for Waverly, Randwick and Woollahra City Councils (the Councils) to document the evaluation of current residential waste management practices, the existing home composting project (a one-year project involving Waverley and Randwick Councils), and the potential benefits of the expansion of the home composting programme across the three Councils. This report compares the financial costs, the climate impact (greenhouse gas (GHG) emissions), and a selection of Ecologically Sustainable Development (ESD) indicators for current practice and explores the benefits of home composting based on the home composting trial programme.

2.1 Background

Waverley, Randwick and Woollahra City Councils received a grant from the NSW Environmental Trust for their '3-Council Ecological Footprint Project'. The 'Food Waste Reduction Project' (involving Randwick and Waverley Councils only) is a major sub-project of the three Councils' project with the objective being to trial, research and analyse effective methods for reducing household food waste, primarily through home composting. Woollahra Council is currently running a residential garden and food waste collection. The organics are composted in windrows at WSN's Castlereagh facility and the compost is mainly used to rehabilitate the site, which used to be a landfill, or as fill for development.

Randwick and Waverley Councils have jointly implemented a home composting trial with around 600 residents over 12 months as part of their Food Waste Reduction Project. Due to the high costs associated with using an external organic waste processor, the loss of potential organic product for local use, and the escalating problems associated with GHG emissions for waste transportation, the three Councils are interested in exploring alternatives to kerbside collection of organic wastes and centralised (external) processing. Home composting diverts food and garden waste from residual waste bins, avoids the need to find centralised organic waste treatment solutions, and reduces the impact of waste collection and transportation.

The home composting project was initiated in August 2009 with an initial intake of 287 Participants (Group 1). A second intake of an additional 305 participants (Group 2) took place in November 2009. Waverley and Randwick Councils had a target of 600 participants, including residents of both single unit dwellings (SUDs) and multi-unit dwellings (MUDs). In the current evaluation, SUDs are defined as separate houses, semi-detached, row or terrace houses and townhouses and MUDs are defined as flats, units or apartments. Each participating household was provided with a compost bin (or access to a communal compost bin in some MUDs) and a 7.5 L kitchen 'tidy' to transfer material collected in the kitchen to the compost bin. Training sessions and written material were also given to each group. Participants chose either standard backyard compost bins or a vermiculture composting system (worm bin) – where space was available in MUDs, a communal backyard bin was installed.

Participants received training through Council-run home composting workshops, free compost bins and kitchen tidies, and information packages. The information packages included a booklet, a sticker for the general waste bin saying 'this home turns food scraps into fertiliser', and a 'Tally''. The tally is a branded cardboard sheet with a magnetic strip and is part of the monitoring system, which is marked off every time the kitchen bin is emptied. The totals are entered for each month in the 3 monthly surveys. Every 3 months an on-line survey with 8 questions is sent to participants in order to collect the data on the amount of food waste diverted and to obtain information and feedback on any problems encountered and the diversion of food waste.

Regular updates on the programme with advice, tips and upcoming events or activities have been sent to participants. The participants have been offered a range of additional workshops and events such as 'organic gardening' and 'compost party'. Participants regularly ask the food waste reduction officer for advice. The food waste reduction officer also offers on-site help for joint home composters in MUDs. The project has experienced some loss of participants, which has mainly been due to people moving houses.

The project will finish in September 2010 when a survey will be conducted corresponding to the initial baseline survey which investigated people's attitudes and knowledge of composting and people's food habits and other environmental customs.

The current report documents the high-level assessment of the cost and environmental impact of existing Council management of residential organic waste and potential benefits of home composting programs for the three Councils. It responds to the Councils' objectives by providing estimates of GHG emissions (direct and net) and financial costs. The report also provides a qualitative assessment of the following ESD values for current residual waste management practices (i.e. excluding dry recyclables and green waste collections):

1 Avoiding food waste, which is key point of interest and also part of DECCW's food avoidance programme

2 Increased interest in gardening, growing fruit and vegetables and food sustainability (i.e. reduced food miles)

3 Social capital - community strengthening, positive opinion of Council

4 Enhanced source-separation, improved household resource (waste) management/behaviour

2.2 The local government areas

Woollahra

As of the 2006 Census, Woollahra local government area had a population of 50,161 residents. Of the total residents, 22 476 occupied private dwellings, of which 24.2% were separate homes, 20.9% were semi-detached, row or terrace houses, townhouses etc. The remaining 27,685 residents occupied flats, units or apartments (54.0% of total residents) or other dwellings (0.7% of total residents). Of the occupied private dwellings in Council's area, 32.9% were fully owned and 32.9% were rented (ABS, 2007).

Randwick

As of the 2006 Census, Randwick local government area had a population of 119,884 residents. In the 2006 Census there were 48,958 occupied private dwellings of which 32.3% were separate homes, and 14.7% were semi-detached, row or terrace houses, townhouses etc. The remaining population occupied flats, units or apartments (52.1%) or other dwellings (0.7%). Of the occupied private dwellings in Council's area, 27.2% were fully owned, while a majority, 42.3% were rented at the time of the census (Food waste reduction officer, 2010).

Waverley

As of the 2006 Census, Waverley local government area had a population of 60,715 residents. In the 2006 Census there were 27,389 occupied private dwellings, of which 21.2% were separate homes, 16.7% were semi-detached, row or terrace houses, townhouses etc. The remaining population occupied flats, units or apartments (52.1%) or other dwellings (0.7%). Of the occupied private dwellings in Council's area, 24.2% were fully owned, while a majority, 38.1% were rented at the time of the 2006 census (Food waste reduction officer, 2010).

3 Project methodology

The following methodology was used in order to meet the requirements of the project objectives. Data was largely provided by the food waste reduction officer.

3.1 Provision and review of documentation

Comprehensive reviews of all documentation and data (waste composition and tonnage, fleet specifications, routes, Waverley and Randwick Council's Home Compost Project and existing costs collection and treatment) provided by the Councils have been conducted by Hyder and are referred to throughout this report. Also detailed reviews have been conducted of relevant reports and data on municipal organic wastes studies, both within Australia and internationally, as well as the recent region-wide waste audit commissioned by the Southern Sydney Regional Organisation of Councils (SSROC).

3.2 Cost assessment

The food waste reduction officer provided cost data relating to the current waste management systems in each Council, the home composting project, and cost estimates for an extension of home composting across the local government area (LGA). Using amalgamated collection and disposal costs, a 'cost per tonne of residual waste managed' was calculated.

3.3 Assessment of climate impact

Climate impact is assessed in terms of GHG emissions from landfill disposal of waste, from the collection/transport of waste, and from the composting process itself. In the present report, only direct, process-related GHG emissions from home composting are considered. Additional, indirect emissions can be attributed to, for example, manufacture of the composting bins, and indirect GHG savings can be attributed to replacement of synthetic fertilisers or other soil amendment products by home-produced compost. Typically, in life-cycle assessments of waste management systems, indirect GHG savings from substitution of raw materials outweigh both direct and indirect emissions. However, the assumptions found in the literature regarding substitution of synthetic fertilisers pertain to agricultural applications of compost, rather than home use. Due to limitations of data and project scope, indirect GHG savings are not evaluated in the present report.

3.3.1 Waste generation and composition

Table 5 presents the composition and quantity of municipal solid waste (MSW) disposed in the Waverley, Randwick and Woollahra LGAs in 2008/09. Waste composition greatly influences the estimates of methane emissions from landfill, as explained in the following sections.

Table 5: Waste generation and composition (SSROC, 2008; Waverley Council, 2010)

	Waverley	Randwick	Woollahra
Tonnes of MSW disposed in 2008-09	13,574	26,286	11,518
Tonnes of MSW per household per year	0.50	0.54	0.51
Composition			
Food	42%	38%	40%
Paper and cardboard	10%	7%	15%
Garden organics	2%	3%	4%
Recyclable containers	9%	9%	11%
Other[1]	38%	42%	30%

3.3.2 GHG emissions - landfill

Waste contains organic material, such as food, paper, wood, and garden trimmings. Once waste is deposited in a landfill, microbes begin to consume the carbon in organic material, which causes decomposition. There are a number of complex, sequential microbial phases that develop. As anaerobic conditions prevail in landfills, the microbial communities contain methane-producing bacteria. As the microbes gradually decompose organic matter over time, methane (approximately 50%), carbon dioxide (approximately 50%), and other trace amounts of gaseous compounds (< 1%) are generated and form landfill gas. The gradual decay of the carbon stock in a landfill generates emissions even after waste disposal has ceased. This is because the chemical and biochemical reactions take time to progress and only a small amount of the carbon contained in waste is emitted in the year this waste is disposed. Most is emitted gradually over a period of years.

Methane and carbon dioxide (CO_2) are greenhouse gases (GHG), whose presence in the atmosphere contribute to global warming and climate change. Methane is a particularly potent GHG, and is considered to have a global warming potential (GWP) at least 21 times that of CO_2 (see Table 7)[2]. In terms of reporting landfill emissions, the Intergovernmental Panel on Climate Change (IPCC) has set an international convention to not count CO_2 released due to the decomposition or incineration of biogenic sources of carbon (i.e. organic waste) for the waste sector[3]. Therefore, only methane emissions from landfill are measured and reported, expressed

[1] Concrete, metal, plastics, glass, other inert, wood, textiles, nappies, rubber, leather

[2] Australia has elected to use a GWP of 21 for methane. The current IPCC convention is a GWP of 23 for methane, which is due to be updated to 25.

[3] It should be noted that this convention is under increasing debate. The argument used by the IPCC is that CO_2 released from biogenic sources is balanced by CO_2 taken up by growing biomass. However, the logic is questionable.

as tonnes of CO_2 equivalent (i.e. 1 tonne of methane is expressed as 21 tonnes of CO_2-e, as per the current methane GWP adopted for use by the Australian Government).

There is currently no accepted method to directly measure the methane emitted from a landfill. Therefore, methane emissions must be estimated using calculations or mathematical models, which apply various assumptions to simplify the extremely complex landfill environment. Following the Department of Climate Change's Technical Guidelines for NGER (2009[4]), Hyder has estimated solid waste emissions using a carbon mass balance approach consistent with the IPCC Tier 2 first order decay (FOD) model (IPCC 2006). The calculation takes into account the total estimated methane generated by the landfilled waste and methane that may be oxidised to CO_2 through bacterial processes in the landfill cover material. The calculation also takes landfill gas capture of 75% at Lucas Heights landfill into account.

3.3.3 GHG emissions – collection/transport of waste

The GHG emissions from the collection/transport of residual waste from residential properties to the transfer stations, and from transfer stations to the landfill are estimated based on fuel usage data and distance travelled provided by Councils' waste services. The emissions from kerbside collection vehicles were calculated using yearly diesel consumption. Emissions associated with haulage of waste from the transfer station in Rockdale to Lucas Heights landfill were estimated based on distance travelled.

The degree of difficulty in calculating transportation emissions depends largely on which gases are included in the analysis. In most cases, CO_2 emissions are relatively straightforward to estimate, since they are primarily dependent on only two factors: the type and quantity of fuel burned. Estimates of emissions from the combustion of fuel are made by multiplying a (physical) quantity of the fuel combusted by a fuel-specific energy content factor and a fuel specific emission factor. This is performed for each relevant greenhouse gas presented in Table 6 (in this case, carbon dioxide, methane and nitrous oxide) (DCC, 2009).

For all mobile sources, either a fuel-based or distance-based methodology can be applied to calculate CO_2 emissions. In the fuel-based approach, which is used in the assessment of emissions from kerbside collection vehicles, fuel consumption is multiplied by the CO_2 emission factor for the fuel type, i.e. diesel oil. A fuel (diesel) combustion emission factor of 2,698.14 kg CO_2-e per cubic metre was used in this assessment (DCC, 2009).

Table 6: Fuel combustion emission factors – fuels used for transport energy purposes (DCC, 2009)

Fuel combusted	Energy content factor (GJ/kL)	Emission factor (kg CO_2-e/GJ) (relevant oxidation factors incorporated)		
		CO_2	CH_4	N_2O
Diesel oil	38.6	69.2	0.2	0.5

In the distance-based method, which was used in estimating the emissions from haulage of waste from the transfer station to the landfill, emissions can be calculated by using the yearly distance travelled, fuel consumption and fuel type to calculate emissions (Greenhouse Gas Protocol Initiative, 2010). In this assessment, a fuel consumption of 30 litres per 100 kilometres was used (VTT, 2005). The trucks have a capacity of 30 cubic metres and the waste was assumed to be well-compacted in the truck. The trucks are travelling 27 kilometres one way

[4] NGER Draft Technical Guidelines 2009, Chapter 5.

from the transfer station in Rockdale to Lucas Heights landfill. The emissions calculations also include the emissions associated with empty trucks' return trips from Lucas Heights to Rockdale.

3.3.4 GHG emissions – composting process

Composting can result in direct (process-related) emissions of methane (CH_4), nitrous oxide (N_2O), ammonia (NH_3), as well as carbon dioxide (CO_2). CH_4 and N_2O are the main GHG emissions associated with composting, if biogenic CO_2 is not accounted for (see discussion above). Both CH_4 and N_2O are particularly potent GHGs, and are currently considered by the IPCC to have global warming potentials (GWP) 25 and 298 times that of CO_2, respectively (when a time horizon of 100 years is considered) (see Table 7 and also Footnote 1 regarding the Australian Government's use of a lower GWP of 21).

Table 7: Global warming potential (GWP) for a given time horizon (Forster et al 2007)

Greenhouse gas	GWP 20-yr (kg CO_2-e)	GWP (IPCC 2007) 100-yr (kg CO_2-e)	GWP 500-yr (kg CO_2-e)
Carbon dioxide CO_2	1	1	1
Methane CH_4	72	25[1]	7.6
Nitrous oxide N_2O	289	298	153

Only limited empirical data is available for measured GHG emissions from home composting (for example, Wheeler and Parfitt 2002; Amlinger et al 2008). A number of studies have assumed that home composting produces only biogenic CO_2 through aerobic degradation processes, or that any methane generated in the centre of a compost pile would be converted to CO_2 by methane-oxidising bacteria in the outer, aerobic layers of the pile (e.g. Knipe 2007). Given that most home composting occurs in semi-enclosed bins (i.e. 0.8 m^2 boxes with non-airtight lids), and are not turned or aerated on a daily basis, it is highly likely that pockets of anaerobic digestion occur in the system, generating quantities of CH_4 and N_2O, which are not completely neutralised by aerobic bacteria. The evaluation in the present report relies on recently published results based on scientifically measured emissions of CH_4 and N_2O from typical home compost bins, which appear to provide the most representative values for GHG emissions (Amlinger et al 2008).

The Amlinger et al study (2008) indicated that the level of total GHG emissions depends on a number of factors, including: ratio of food waste to garden waste (effectively the C:N ratio); ambient temperature; and degree of management (i.e. turning bin contents to aerate). Generally, higher levels of food waste and less aeration result in higher GHG emissions. However, CH_4 emissions were found to be highest at temperatures above 40-50°C whereas N_2O only occurs at temperatures below 45°C. In the Amlinger et al study, which took place in Austria, this equated to a seasonal variation with higher relative CH_4 emissions in European summer, and higher relative N_2O emissions in European winter. The study concluded a 'reliable range' of emissions from composting processes of 0.02 to 0.065 tonne CO_2-e per tonne of fresh organic waste (Amlinger et al 2008).

Given the much warmer seasonal temperatures in NSW compared to Austria (therefore potentially much less formation of nitrous oxide), and the much greater GWP of N_2O compared to methane, we believe that a value of 0.02 tonne CO_2-e per tonne of fresh organic waste is valid for home composting in Sydney. However, we have provided the full range of GHG emissions to account for extremely poorly managed compost systems (i.e. 0.065 tonne CO_2-e per tonne of fresh organic waste) where no bulking material or garden waste is added to the food waste, and the bin is not turned to aerate.

It should be noted that emissions estimates are provided for backyard compost bins only. Worm composting may generate different levels GHG emissions, but no data is available to evaluate this impact.

3.4 Ecologically Sustainable Development Indicators

Indicators are simplified measures that best represent key elements of a complex system. A guiding principle of ecologically sustainable development (ESD) is that the conservation of ecological integrity should be a fundamental consideration in decision-making. Therefore, the ESD indicators should be selected to provide information on how an activity is performing in achieving the goals and objectives of ESD, namely economic and social progress within the framework of a healthy, functioning ecosystem. In the current evaluation, four indicators have been selected to provide a qualitative measure of the relative performance of the current waste management system and home composting in terms of ESD. The focus of the ESD indicators is on direct and indirect flow-on effects of the systems on desired environmental and social outcomes

In consultation with the food waste reduction officer, four ESD indicators were selected for qualitative evaluation. The selected ESD indicators and the approach taken to their qualitative assessment are presented in Table 8. The performance of systems/activities is rated as poor, uncertain (i.e. not measurable), good, and excellent.

Table 8: Selected ESD indicators and assessment approach

ESD indicator	Description	Measure of system/activity performance
ESD1	Avoidance of food waste, which is key point of interest and focus for the home composting project, and also part of DECCW's recently launched food avoidance programme	The system promotes and/or enables avoidance of food waste
ESD2	Increased interest in gardening, growing fruit and vegetables and food sustainability (i.e. reduced food miles)	The system encourages gardening activities, local production of food, and reduction of food miles
ESD3	Positive contribution to social capital through community strengthening and involvement in Council environmental/sustainable initiatives	The system helps to strengthen local community and stimulates interest and involvement in Councils' environmental/sustainable initiatives
ESD4	Enhanced source-separation, improved household resource recovery and waste management	The system encourages improved household management of resources and promotes positive behaviour change vis-à-vis waste

Using the participants' responses to questionnaires, anecdotal evidence provided by the food waste reduction officer, and information from the literature, the performance of the current waste management system, the home composting project, and an extension of home composting across the LGA were assessed. Evidently, there is a degree of subjectivity in the evaluation.

3.5 Evaluation and analysis of Home Compost Project

At the time of the current evaluation (April 2010), the project has been running for 8 months with a total of 575 participants. It should be noted that initial participation occurred gradually over the first month – in other words, there was not a 100% up-take of composting in August or in November 2009. The evaluation of the project is based on the following data provided by the food waste reduction officer:

- Results of weight-based waste audits conducted by EC Sustainable on the residual waste bins of participating households both immediately prior to the start of the project, and in February 2010 (i.e. after 6-7 months of participation by Group 1 participants, and 2-3 months of participation by Group 2).
- Results of monthly surveys for August, September, and October 2009 and November, December 2009 and January 2010, completed by Group 1 participants to indicate the quantity of food waste they were composting (based on the number of 7.5 kitchen 'tidies' emptied into compost bins each month).
- Results of monthly surveys for December 2009, January and February 2010, completed by Group 2 participants to indicate the quantity of food waste they were composting (based on the number of 7.5 kitchen 'tidies' emptied into compost bins each month).
- Results of two questionnaires sent to participants to gather ancillary information relating to flow-on effects of the project, involvement in sustainable activities, environmental awareness, etc.
- Project cost data.

GHG emissions were estimated using the methods described above. A qualitative assessment of ESD indicators relied on questionnaire responses and examples found in the literature (as referenced in the results section).

3.6 Modelling to determine potential benefits of home composting for each council

Based on the result of the evaluation and analysis of the Home Compost Project, a model has been generated showing the potential impact that an extension of home composting across the LGA could have on residual waste management for each Council, in terms of cost, climate, and ESD indicators. It must be noted that this modelling provides a snapshot of potential benefits given current waste management services, and costs, rather than detailed future projections. Two scenarios were examined across the three Councils:

- Where 20% of the LGA participate in home composting
- Where 40% of the LGA participate in home composting

Note that the Councils do not know what proportion of the population currently home composts – 20% and 40% were selected as reasonable values, providing a range of feasible participation rates.

The food waste reduction officer provided cost estimates for extending a home composting programme across 20% and 40% of each LGA, assuming a gradual, four-year implementation process. Cost savings were calculated based on present day residual waste collection and disposal costs (for example, future landfill levy increases, gate fees to alternative waste treatment facilities, fuel surcharges on transport costs, etc have not been taken into consideration).

The climate impact has been estimated from anticipated organic waste diversion rates, based on diversion rates achieved in the current home composting project. GHG emissions are calculated using the methods described above.

The evaluation of ESD indicators is largely an extension of the effects identified for the home composting project.

4 Results

4.1 Assessment of current residual waste management systems

The following sections provide an assessment of the current residual waste management systems employed by the Councils in terms of climate impact (GHG), costs, and performance against selected ESD indicators.

4.1.1 Greenhouse gas emissions assessment

The climate impact of the current residual waste system is estimated based on direct GHG emissions, including emissions from waste collection/transport vehicles and emissions from waste disposed to landfill. Indirect emissions, such as those associated with material or energy use, have not been assessed. The existing dry recyclables system is not considered in the present assessment. GHG emissions from the treatment of separately collected food and garden wastes in Woollahra Council are also not included in the analysis (this calculation was outside the scope of the present study).

Landfill emissions

Using the FOD model described above, methane emissions from landfill were estimated over the full degradation cycle of residual waste material disposed in 2008/09. As described under methodology, above, waste deposited today will degrade gradually over a period of several years, depending on the specific materials. The waste deposited in 2008/09 is therefore responsible for emissions accumulated over several years into the future. Methane emissions generated by one year's residual waste disposed to landfill today, over the full degradation cycle of the waste material, from each Council (and a total for the 3 Councils) are presented in Figure 2. The emissions are expressed as tonnes of carbon dioxide equivalents (t CO_2-e), using a global warming factor of 21 for methane, as previously explained. The full degradation cycle of one year's residual waste disposed to landfill is approximately 125 years – after 125 years, based on the modelled estimates, methane emissions from organic waste material disposed in the landfill are negligible.

Results are also presented as tonnes CO_2-e per household in Figure 3. Although Randwick Council produces more residual waste (larger population) and therefore generates more landfill emissions than the other Councils, Woollahra has the higher landfill emissions per household. The slightly higher landfill emissions per household in Woollahra are due to a higher content of paper and cardboard in the MSW stream, i.e. 15% compared to 9% in Randwick and 10% in Waverley. In the first order decay methane emissions model, the higher proportion degradable organic carbon in paper and cardboard produce more methane over a longer period of time than the majority of the other solid waste material types.

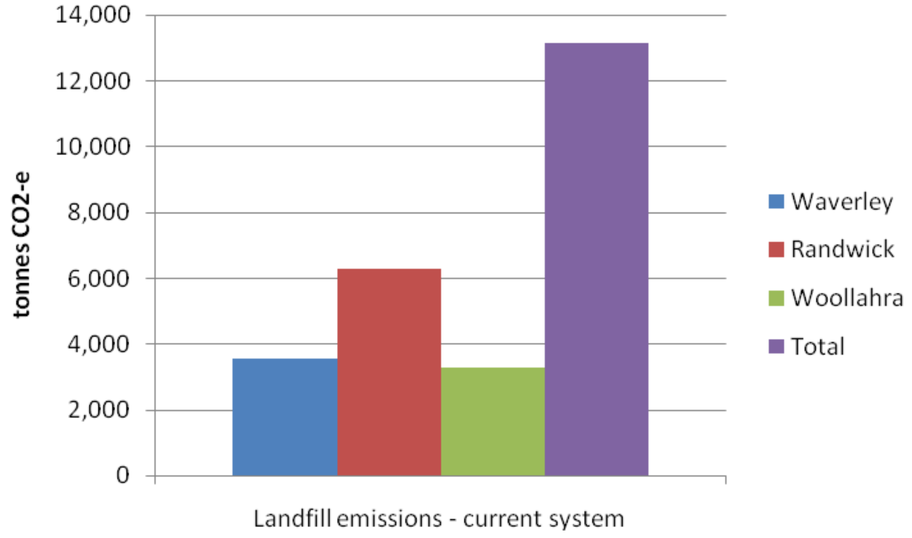

Figure 2: Landfill methane emissions (tonnes CO_2-e) of waste deposited today over the full degradation cycle of residual waste material

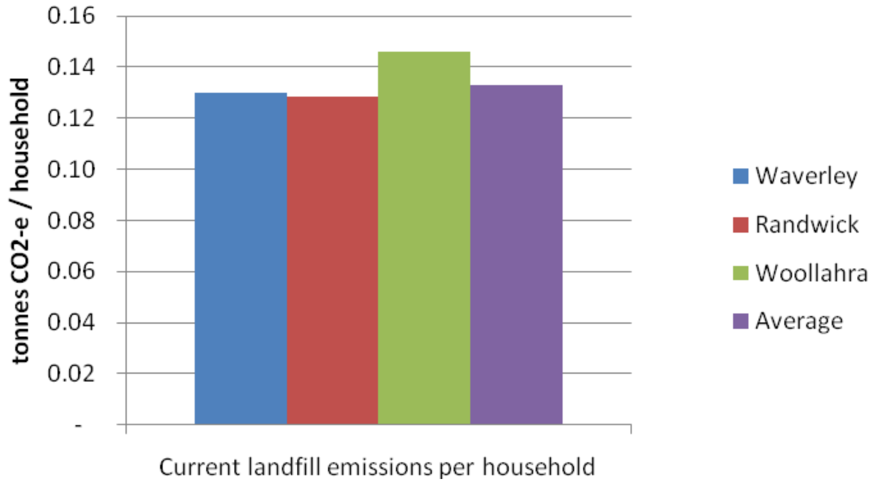

Figure 3: Landfill methane emissions (tonnes CO_2-e per household) of waste deposited today over the full degradation cycle of residual waste material

Collection/Transport emissions

Using the collection/transport emissions methodology described above, CO_2-e emissions from waste collection and transport were estimated from yearly consumption of fuel for waste collection vehicles in 2008/09. The results are presented in Table 9.

Table 9: Transport emissions (tonnes CO_2-e per year)

Activity	Greenhouse gas emissions (tonnes CO_2-e / year)		
	Waverley	**Randwick**	**Woollahra**
Emissions from collection/transport per year	672	1,358	660
Emissions from collection/transport per household per year	0.02	0.03	0.03

Total greenhouse gas emissions

The total greenhouse gas emissions associated with the current waste management system are presented in Figure 4 and Figure 5 show the proportional contributions of landfill and collection/transport emissions.

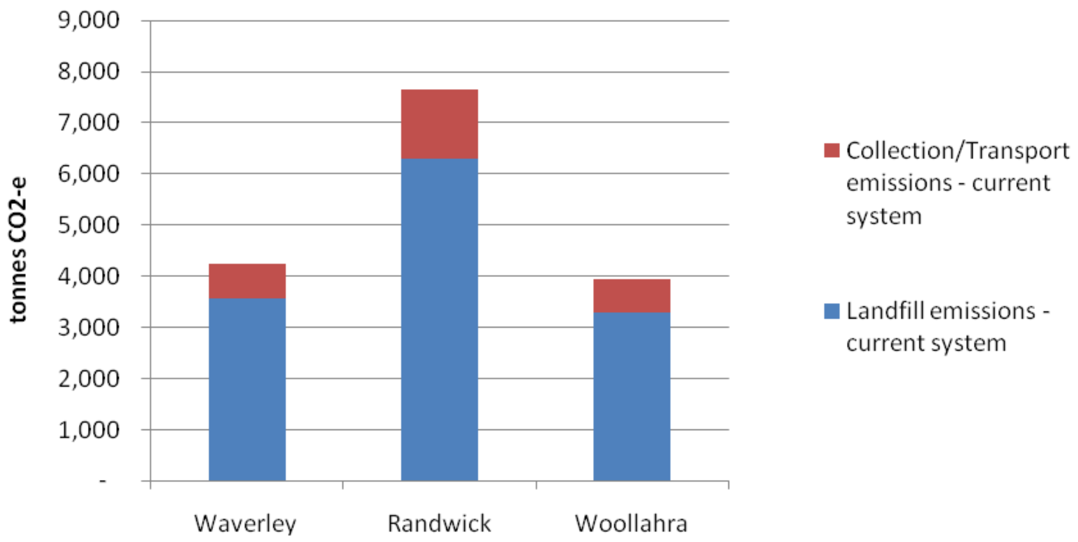

Figure 4: Total greenhouse gas emissions (tonnes CO_2-e)

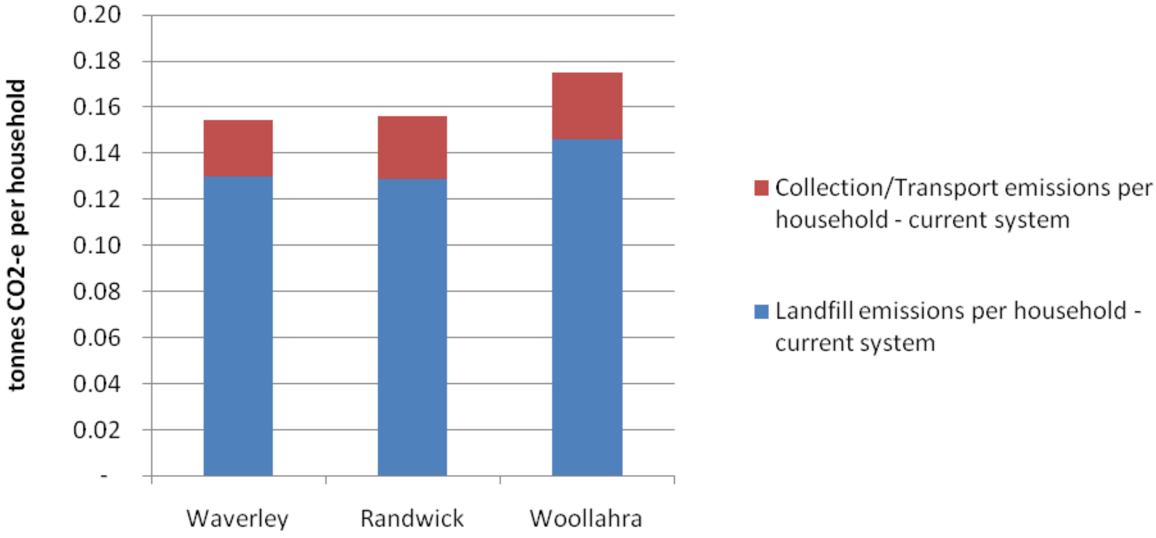

Figure 5: **Greenhouse gas emissions per household (tonnes CO2-e per household)**

4.1.2 Cost assessment

Annual collection and disposal costs of the current waste management systems across the LGA were provided by the three Councils, as presented in Table 10 and Figure 6. Randwick Council comprises significantly more households than either Waverley or Woollahra, hence the higher collection and subsequent total costs for this Council. Data is also presented as a cost per household, presented in Figure 7.

Table 10: **Cost per year of the current waste management systems**

	Cost of current waste management system ($ / year)			
Activity	**Waverley**	**Randwick**	**Woollahra**	**All councils**
Collection cost per year	$2,475,898	$2,396,495	$2,905,416	$7,777,808
Disposal cost per year	$1,780,366	$3,230,549	$1,482,367	$6,493,282
Total cost per year	$4,256,263	$5,627,044	$4,387,782	$14,271,090

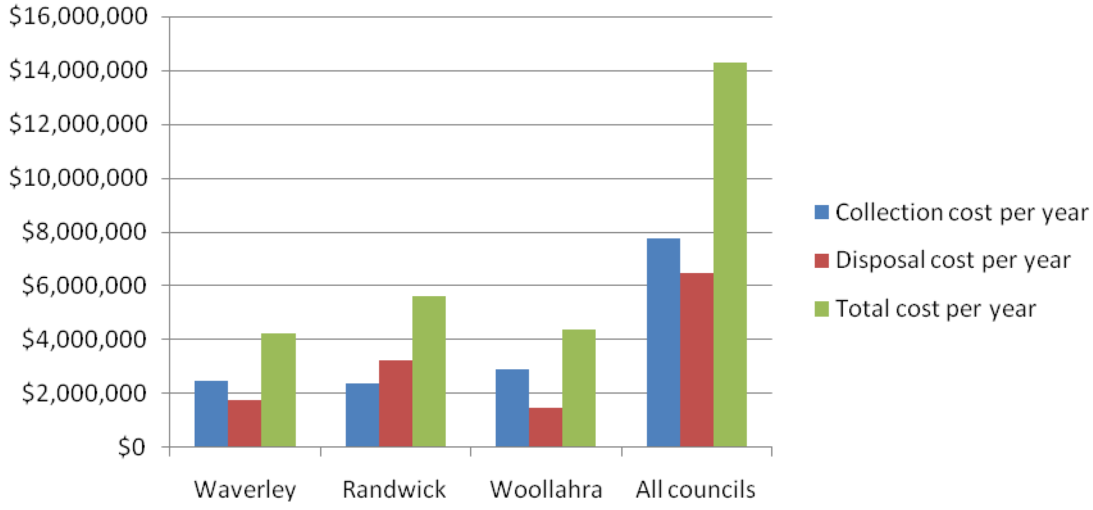

Figure 6: Cost per year of the current waste management systems

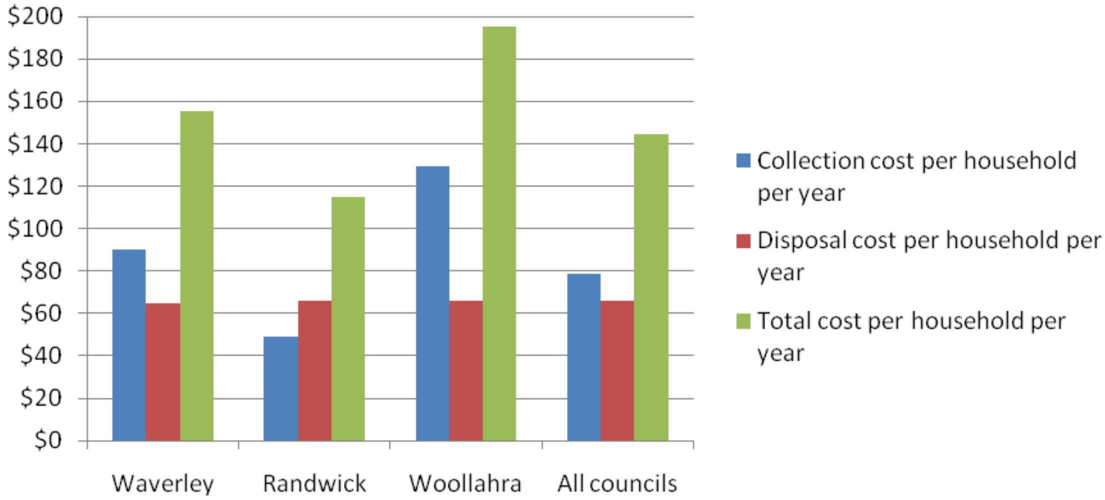

Figure 7: Cost per household per year of the current waste management systems

4.1.3 Assessment of Ecologically Sustainable Development indicators

The current waste management systems operated by the Councils represents a 'base case' scenario, and as such they are difficult to measure in terms of ESD performance. Typically, indicators are measured against a baseline level of performance, and the current waste management system is the baseline. However several observations can be made:

ESD1: The current waste management system does not promote avoidance of food waste. The current system does not offer an incentive (i.e. service or alternative infrastructure) to either reduce or separate food waste. In addition, the provision of weekly mixed refuse collection does not provide an incentive to reduce food waste – this has been indirectly demonstrated through a series of collection trials in the UK (WRAP 2008). Therefore the current system can be considered to perform poorly with respect to ESD1.

ESD2: The current waste management system does not appear to affect on gardening or make any connection with food sustainability. There is no component of the current system that promotes gardening activities, local food production, or use of local food sources. However, there is also no evidence that the current system actively discourages these activities.

ESD3: The current waste management system is unlikely to contribute to community strengthening: it does not promote neighbour interactions, and does not provide focal points for positive community initiatives. Current systems do not appear to stimulate interest in the Councils' various sustainable activities and programmes.

ESD4: The current waste management system encourages source-separation by providing a dry recyclables bin. If the base-case is considered to be a standard 2-bin system (residuals and dry recyclables) for metropolitan Sydney, then the three Councils' existing residual waste system does not represent enhanced source-separation or an improvement in household waste management behaviour, but rather, it represents business as usual. Educational material (pamphlets, stickers on bins, etc) may encourage residents to recycle and reduce residual waste.

The ESD assessment is summarised in Table 11.

Table 11: Qualitative assessment of ESDs

ESD indicator	System performance
ESD1: Food waste avoidance	Poor
ESD2: Gardening and local food production	Uncertain
ESD3: Social capital	Poor
ESD4: Enhanced household waste management	Uncertain

4.2 Evaluation of Home Composting project

Comparison of audit data to survey data

EC Sustainable conducted residual waste bin audits of 60 participating households prior to the home compost project and six months after project commencement. EC Sustainable used a standard weight-based methodology, as prescribed by DECCW for municipal waste audits (EC Sustainable 2010). Only SUDs were audited, and the results indicated an average food waste diversion of approximately 2.3 kg food waste per household per week. This value is relatively consistent with previous studies conducted in Australia, which showed an average 2.2 kg of food and garden organics per household per week (DEC NSW 2007). As public awareness and experience with source-separation of organic waste increases, the level of diversion would be expected to increase. Also, the DEC NSW (2007) report referred to combined food and garden waste, whereas the EC Sustainable audit recorded food waste only.

As part of the home composting project, participating households were asked to complete monthly reports for six months on the number of 7.5 L kitchen tidies emptied into their compost bins. 242 participants in Group 1 and 223 participants in Group 2 provided information. August results for Group 1 were disregarded due to participants joining the project at various times throughout the month – it was not a representative month. The results indicate an average diversion of approximately 3.75 kg food waste/hh/week (4.55 kg/hh/week for SUDs and 2.95 kg/hh/week for MUDs). 26 of the participating households completed a ‘food waste diary’ as part of PhD student Natalie Jean Baptiste’s project *People & Food Waste - The practice of everyday life*, where they weighed their food waste before disposing of it in the compost bin. An average of 5.1 kg of food waste was diverted per household per week into the compost bins. Evidently, there is considerable difference between the audit and the ‘food waste diary’ diversion estimates and survey diversion estimates.

The differences between the audit data and survey results may be due to the fact that the survey average was calculated assuming full kitchen tidies (7.5 L) and a food waste density of 0.416 kg/L. It is possible that kitchen tidies were not consistently full at the time of emptying, which could lead to an overestimation of the volume of material diverted. In addition, a food waste density of 0.416 kg/L was provided by EC Sustainable, and appears to correspond to the density of food waste as found in residual waste bins/bags. Food waste in residual bins/bags is subjected to compaction from the other contents of the bin/bag, and often over several days (before collection). Food waste in a kitchen tidy will be less compacted; therefore the density may be significantly less than 0.416 kg/L. Again, this would lead to overestimation of food waste diversion. Given the level of education and on-going support provided to the home composting project participants, it is possible that diversion rates are higher than average. Based on existing data, it is not possible to determine whether the actual diversion value is more accurately represented by the EC audit results (2.3 kg) than by the survey results. It should be noted that, according to EC Sustainable, the audit sample size was low, i.e. 60 households. The food waste reduction officer was advised that more samples should be included in order to better represent the average food waste diversion in the programme. Furthermore, the audit was only a one-off ‘snapshot’ of 60 households and may not give a good representation of the diversion achieved in the whole project. As requested by the food waste reduction officer, the survey results have been used in the current evaluation.

4.2.1 Reduction in food waste

For the purposes of the current report, unused / still packaged and meal leftovers have been defined as avoidable food waste whereas preparatory and meat scraps are considered to be unavoidable food waste. The reduction in food waste across these categories has been calculated based on the results of the EC Sustainable waste audit (see Table 12). Although the majority of the analyses presented in the current report are based on survey data, as discussed above, the surveys did not provide sufficient detail to assess the reduction in each food waste category. Hence, the EC Sustainable figures have been used here. According to the audit, preparatory food waste has decreased by 64%, discarded meal leftovers decreased by 42%, and meat (i.e. bones) has decreased by 40% after 6 months of project participation. The amount of avoidable food waste has decreased by 33% as shown in Table 13. The detailed results from the pre and mid audit are included in Appendix A. Given that the survey results suggest a higher total kg per household reduction in food waste than the EC Sustainable audit results (see discussion above), it is likely that the kg reductions in each food waste category are also greater than those shown in Table 12. However, the percentage reductions may still be representative – more detailed surveys would need to be conducted to confirm.

Table 12: Reduction of different categories of food waste in the residual waste bin between Audit 1 and Audit 2 (an increase of food waste is indicated by a negative number)

	Weight (kg)	Weight (kg) per household	Percentage (%) reduction[5]
Preparatory	61.53	1.03	64%
Meal leftovers	78.48	1.31	42%
Unused / still packaged	-8.79	-0.15	-35%
Meat (bones)	6.74	0.11	40%

Table 13: Reduction of avoidable and unavoidable food waste in the residual waste bin between Audit 1 and Audit 2

	Weight (kg)	Weight (kg) per household	Percentage (%) reduction[6]
Avoidable food waste	69.69	1.16	33%
Unavoidable food waste	68.28	1.14	61%
All food waste	137.97	2.30	43%

[5] Calculations are based on weight per household, which is normalised.

[6] Calculations are based on weight per household, which is normalised.

4.2.2 Greenhouse gas emissions assessment

Emissions benefits and impacts associated with the home composting trial

Figure 8 and Table 14 below present GHG emissions and savings estimated for the home composting project, in which 575 households participate for one year at current levels of food waste diversion (i.e. the project has not yet completed its 12-month duration; therefore, estimates based on data collected to date have been projected for a 12-month period). Negative values (columns projecting below the axis) depict GHG savings associated with avoided collection/transport and avoided landfill emissions. Positive values depict GHG emissions – these due to direct process emissions from the compost bins. A poorly managed (purple bar) and well managed (green bar) compost process is shown for comparison (see discussion above).

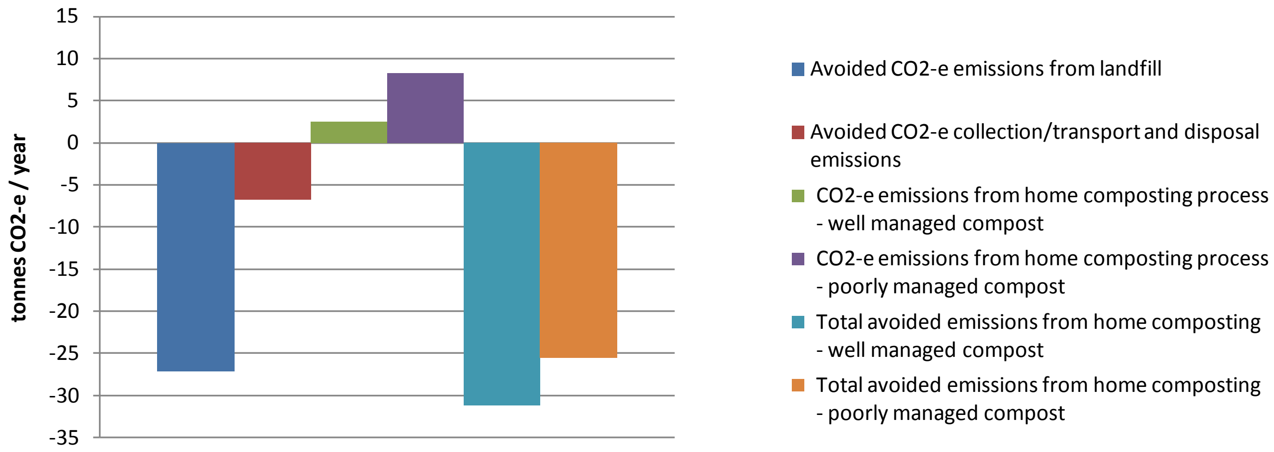

Figure 8: Greenhouse gas savings associated with the 1-year home composting project

Table 14: Greenhouse gas savings associated with the 1-year home composting project

Activity	Greenhouse gas emissions (tonnes CO_2-e / year)
Avoided CO_2-e landfill emissions	-27
Avoided CO_2-e landfill emissions per household	-0.05
Avoided CO_2-e collection/transport emissions	-6.7
Avoided CO_2-e collection/transport emissions per household	-0.01
CO_2-e emissions from the home composting process – well managed compost	2.5
CO_2-e emissions from the home composting process – poorly managed compost	8.3

4.2.3 Assessment of Ecologically Sustainable Development indicators

Questionnaire responses and anecdotal evidence provided by the food waste reduction officer enable an assessment of the home composting project against the selected ESD indicators, as follows:

ESD1: The home composting project encourages avoidance of food waste in households. Initial results, based on an audit of 60 households participating in the programme for six months, show a reduction of 33%of the avoidable food waste discarded in residual waste bins, and a 61% decrease in the unavoidable food waste discarded. This indicates a significant change in behaviour and food waste habits amongst project participants. Indeed, 62 – 81% of respondents to a 6-month project survey feel they have reduced their weekly food waste as a result of the project. Around 23% of project participants believe that they do not waste food and that the project will therefore not impact on food waste avoidance in their household.

The reasons underlying food wastage are complex – a major research project to investigate food waste, commissioned by the Waste and Resources Action Programme (WRAP), UK, found that most households had a poor understanding of how much food they were wasting and what types of food were being thrown away (i.e. raw materials versus prepared/cooked food). Through the home composting project, households gain hands-on experience of the quantity and types of food being wasted, and its impact on their residual waste.

A sub-group of the participating households completed a ‘food waste diary’ in which they recorded the food waste they diverted. The participants weighed the food waste and recorded the composition. In addition to gaining hands-on experience through the home composting programme, these households gained a greater understanding of how much food they were wasting and what types of food were being thrown away, which may have a further positive effect on reducing food waste.

ESD2: 52% of respondents to a 6-month project survey believe they are spending more time doing garden related activities as a result of their involvement in the home compost project. It can be assumed that at least a portion of these people are growing vegetables as part of their gardening activities, which would marginally increase local food production and reduce ‘food-miles’. Increased interest in gardening may also lead to increased awareness of local food producers and suppliers. Having appreciated their own fresh produce, participants may seek local suppliers for additional produce items, for instance at local farmers’ markets.

ESD3: The home composting project is strengthening community, with 74% of survey respondents saying that they are talking about composting to neighbours, friends or family. A number of project participants (approximately 35% of respondents) wish to assist in increasing local awareness of composting by becoming compost ‘teachers’. More involvement in garden activities also tends to lead to more interaction with neighbours: people working outside in gardens, even on balcony gardens, are more accessible to their neighbours. Communal composting bins located in MUDs provide neighbours with the opportunity to meet and converse spontaneously while emptying bins.

36% of respondents to the 6-month project survey had undertaken to learn more about Council’s sustainability activities as a result of their involvement in the project. The food waste reduction officer reported considerable positive feedback from the community on Council’s environmental initiatives during a compost programme soiree held in December 2009.

ESD4: Based on pre-project and mid (6-month) audit results, the home compost project has significantly enhanced household source separation of food waste, with an almost 10% reduction in the quantity of food waste disposed in residual waste bins of participating households. The audit results suggest that there has been a change in other recycling activity, with a 26% decrease in the amount of recoverable paper, card, and containers found in residual bins after 6 months of project participation.

The ESD assessment is summarised in Table 15

Table 15: Qualitative assessment of ESD indicators

ESD indicator	System performance
ESD1: Food waste avoidance	Excellent
ESD2: Gardening and local food production	Excellent
ESD3: Social capital	Excellent
ESD4: Enhanced household waste management	Excellent

4.3 Modelling of potential benefits of expansion of Home Composting

4.3.1 Greenhouse gas emissions assessment

Figure 9 and Figure 10 below compare the landfill and transport GHG emissions of the current waste management system with those of a home composting programme extended to 20% and 40% of the LGA. The reduced quantity of food waste disposed to landfill and the reduced emissions associated with collection and transport of a home composting programme extended to 20% of the LGA, will result in approximately a 7% decrease of total emissions associated with waste management. A system with a home composting programme extended to 40% of the LGA will reduce the overall emissions by 13%.

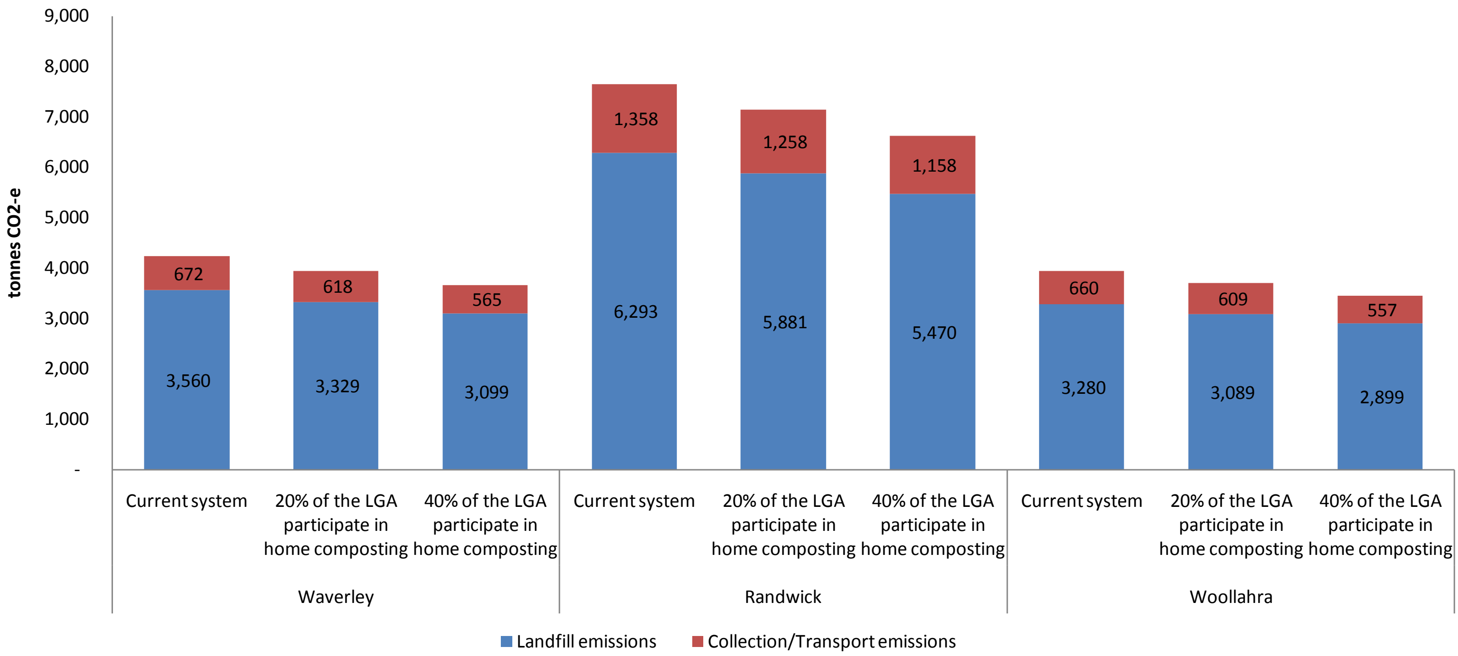

Figure 9 : Landfill CO_2-e emissions for the current system, 20% of the LGA participate in home composting and 40% of the LGA participate in home composting

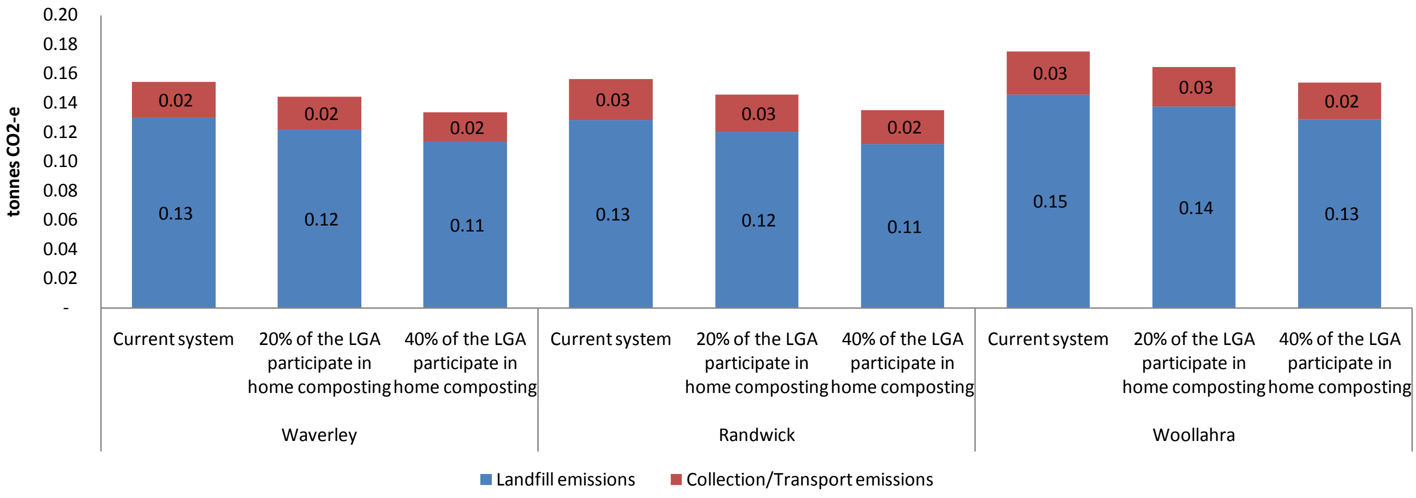

Figure 10 : Landfill CO2-e emissions per household for the current waste management system, 20% of the LGA participate in home composting and 40% of the LGA participate in home composting

Fuel usage

The reduction in food waste in the residual waste bins, which would result if home composting were expanded to 20% or 40% of the households in the LGAs, would theoretically result in less waste collection and haulage truck movements and associated emissions. In reality, there will only be a marginal decrease in vehicle impacts as the trucks will still have to collect and transport the remaining residual waste from the same number of households – the small per household reduction in food waste would be unlikely to result in a decrease in truck pass rates, numbers, or routes. However, in order to estimate a theoretical decrease in transport and collection emissions (see Figure 11), it has been assumed that the reduction in food waste results in a proportional decrease in the number of waste collection and haulage vehicle movements, and hence a decrease in fuel usage and emissions.

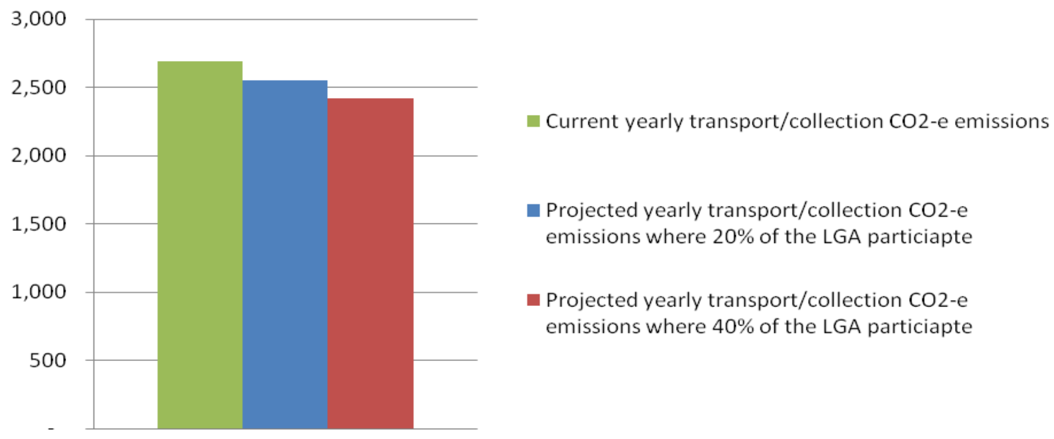

Figure 11 : Projected yearly transport/collection CO_2-e emissions

4.3.2 Cost assessment

Annual collection and disposal costs of the current waste management system across the LGAs were compared to the operational costs of expanding the home composting programme to 20% and 40% of each LGA (see Figure 12 and Figure 13). Expanding the home composting project would result in reduced collection and landfill disposal costs. It should be noted that the cost assessment did not examine the impact of reduced waste quantities on numbers of collection vehicles, for reasons described in the previous section. Furthermore, future landfill levy increases and gate fees to alternative waste treatment facilities have not been taken into consideration. The ongoing operational costs for implementing home composting in 20% and 40% of each LGA do not include the initial costs of bins and other equipment in order to make a comparison with the cost of the current waste management system which excludes the costs of bins and equipment.

The modelling indicates that the reduced collection and landfill disposal costs of a home composting programme extended to 20% of each LGA, will result in approximately a 6% decrease of the operational waste management costs. A system with a home composting programme extended to 40% of the LGA will reduce the overall costs by 15%.

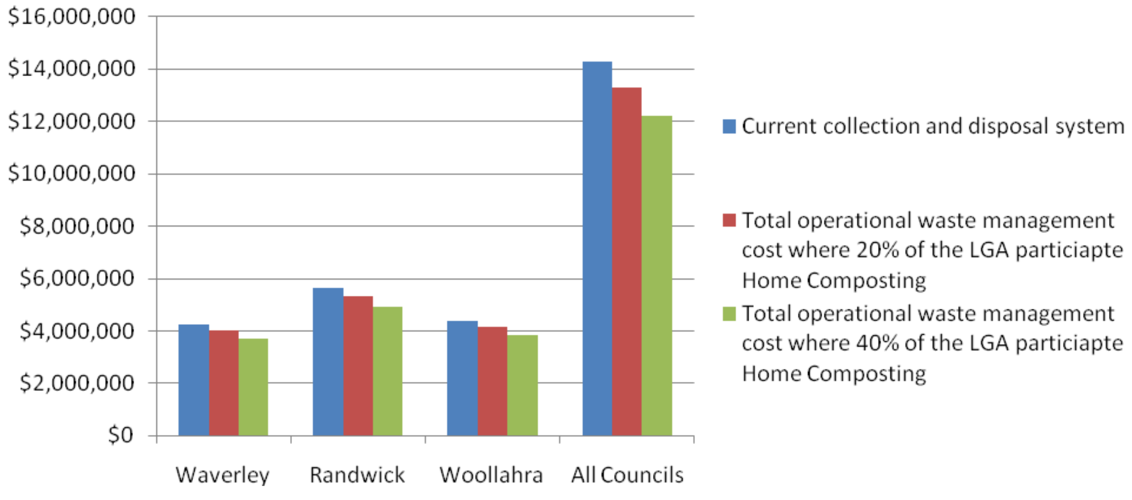

Figure 12: Operational waste management costs

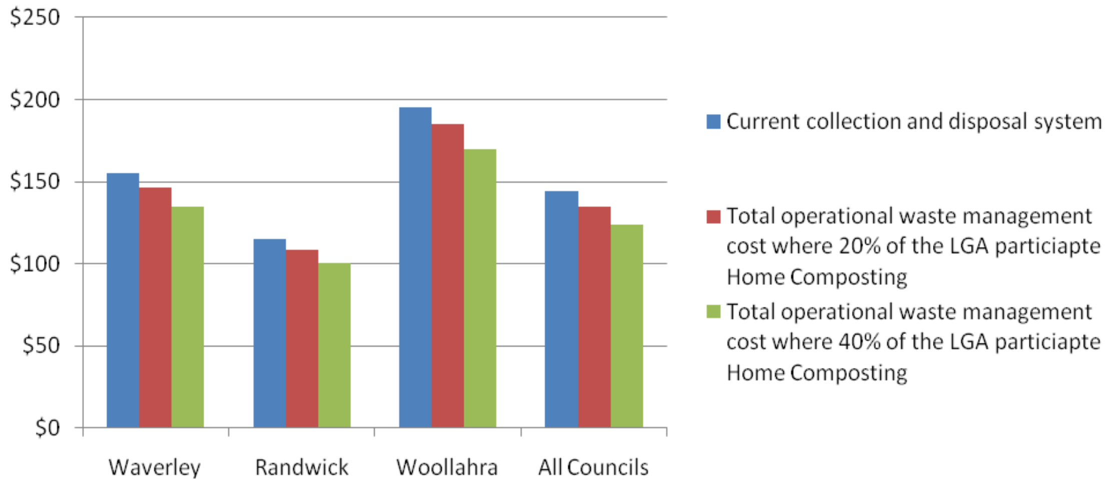

Figure 13: Operational waste management costs per household

If expansion of home composting is implemented gradually over four years, i.e. a proportion of the households are introduced to the programme per year, the collection and disposal costs for residual waste presented in Table 16 and Table 17 could be saved by the Councils. The assessment of the saved costs included the initial costs of bins and other equipment for the home composting programme.

Table 16: Costs saved over 4 years of implementing home composting, 20% of the LGA participate in home composting

Scenario	Cost of home composting[7]	Cost of collection and disposal of remaining residual waste	Cost of current waste management system	Costs saved
First year of implementation	$616,821	$14,001,700	$14,271,090	- $347,431
Second year of implementation	$616,821	$13,732,310	$14,271,090	- $78,042
Third year of implementation	$616,821	$13,462,921	$14,271,090	$191,348
Fourth year of implementation	$616,821	$13,193,531	$14,271,090	$460,737
Total	**$2,467,284**	**$54,390,462**	**$57,084,360**	**$226,612**

The cost assessment is indicative only and not intended as a rigorous financial analysis.

[7] Including the initial cost of bins and other equipment

Table 17: Costs saved over 4 years of implementing home composting, 40% of the LGA participate in home composting

Scenario	Cost of home composting	Cost of collection and disposal of remaining residual waste	Cost of current waste management system	Costs saved
First year of implementation	$1,135,642	$13,732,310	$14,271,090	- $596,862
Second year of implementation	$1,135,642	$13,193,531	$14,271,090	- $58,083
Third year of implementation	$1,135,642	$12,654,752	$14,271,090	$480,696
Fourth year of implementation	$1,135,642	$12,115,973	$14,271,090	$1,019,475
Total	**$4,542,568**	**$51,696,566**	**$57,084,360**	**$845,225**

The collection and disposal costs for residual waste that could be saved by the Councils if expansion of home composting is implemented gradually over four years are $226,612 (at a 20% participation rate) to $845,225 (at a 40% participation rate) as presented in Table 16 and Table 17. The first and second year incur a cost as the cost of collection and disposal of the remaining residual waste when only a relatively small proportion of the households participate in home composting combined with the cost of implementing home compositing is higher than the cost of the current waste management system. In year three and four, when a higher proportion of households participate in home composting, the quantities of residual waste are considerable reduced, which results in a saving (i.e. much lower disposal costs). The costs saved over 4 years of implementing home composting for each Council are provided in Appendix B.

Table 18: Costs saved per year for each Council after the four-year home composting implementation period

Council	Annual saving at 20% participation rate	Annual saving at 40% participation rate
Waverley	$302,256	$637,179
Randwick	$376,055	$784,766
Woollahra	$301,247	$635,162
Total	**$979,558**	**$2,057,117**

After a four-year period to establish the composting programme, assuming annual 'maintenance costs' for the home composting programme of $98,000 per annum (across the three LGAs) an estimated annual saving of $979,558 (at a 20% participation rate) to $2,057,117 (at a 40% participation rate) could be achieved through diversion of food waste from the current residual waste management system. Table 18 shows the annual cost savings that could be achieved for each Council after the four-year home composting implementation period.

Calculations indicate that expansion of a home composting programme across 20% or 40% of the combined council areas would create both cost and CO_2-e savings. If a home composting programme is extended across 20% of the three LGAs, an estimated $593 would be saved per tonne of CO_2-e. If the programme were extended across 40% of the three LGAs, an estimated $641 would be saved per tonne of CO_2-e. There is a cost associated with each tonne of CO2-e saved through implementation of a home composting programme. The implementation cost per tonne of CO_2-e saved appears to be in the order of $554 to $601 as shown in Figure 14. However the avoided landfill and transportation costs are $1195 per tonne of CO_2-e saved through diverting food waste. The result is a significant net saving as shown by the green bars in Figure 14.

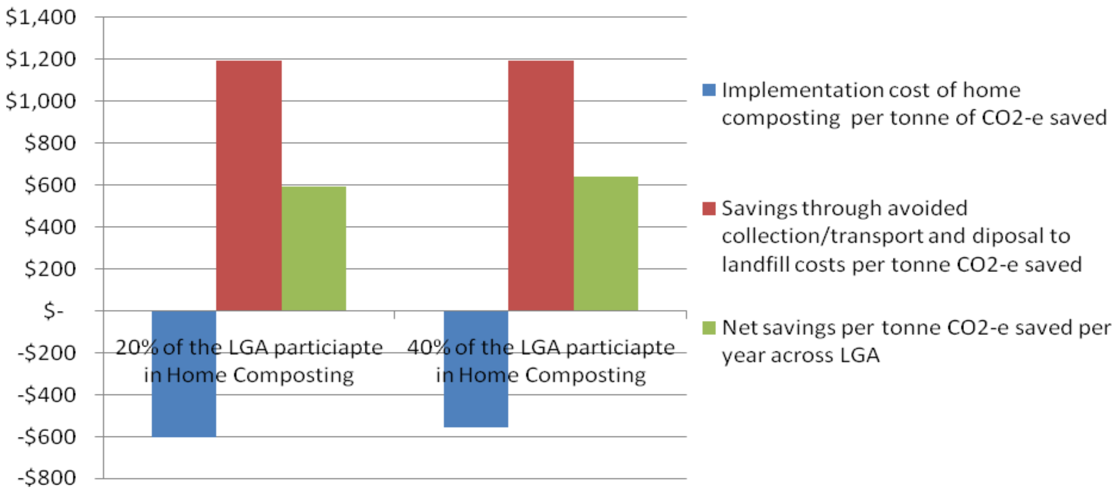

Figure 14: Cost savings per tonne of CO_2-e saved

4.3.3 Assessment of Ecologically Sustainable Development indicators

An expansion of home composting across 20% or 40% of the Councils' households should result in a proportional improvement of the various qualitative aspects identified under the ESD indicators assessed for the home composting project (see Table 15). Given that the assessment of the home composting trial suggests excellent outcomes across each of the four ESD indicators, it follows that expansion of home composting across the LGA's would also result in excellent ESD outcomes. However, it is likely that participants in a wider home composting programme would receive less personalised attention than participants in the trial project. In particular, this may result in a lessened impact on ESD4 – less follow-up through questionnaires, surveys, and contact with the food waste reduction officer may reduce ongoing participation and long-term enthusiasm for home composting. In contrast, wider community involvement in home composting may generate alternative support networks and on-going momentum.

The community education and communication programme that accompanies an expansion of home composting across the LGA will be crucial for ensuring continued involvement and momentum. Long-term commitment to public education on 'urban agriculture' and home composting is possible, and has been successfully demonstrated by local authorities overseas. For example, home composting is strongly promoted in Vancouver, Canada, through the Vancouver Compost Demonstration Garden, established in 1982, and run by not-for-profit group City Farmer. The purpose of the demonstration garden is to give novice gardeners hands-on experience in gardening techniques, specifically composting. The garden runs workshops for community groups and individuals in various composting methods (City Farmer 2010). A gardening and composting hotline is also run from the garden, which provides free advice to Vancouver residents on all aspects of urban agriculture.

The ESD assessment is summarised in Table 19. See Section 4.2.3 ESD assessment for home composting project for detailed analysis.

Table 19: Qualitative assessment of ESD indicators

ESD indicator	System performance
ESD1: Food waste avoidance	Excellent
ESD2: Gardening and local food production	Excellent
ESD3: Social capital	Excellent
ESD4: Enhanced household waste management	Excellent

5 Conclusion

Following the documented evaluation of the current residential waste management practices, the existing home composting project and the benefits of the expansion of the home composting programme across the three Councils outlined above, the following conclusions can be made.

Current waste management system

- The current combined landfill emissions for all councils exceed 13,000 tonnes of CO_2-e.
- Randwick Council produces more residual waste (larger population) and therefore generates more landfill emissions than the other Councils
- Woollahra has the higher landfill emissions per household, which might be due to a higher content of paper and cardboard and garden organics in the MSW stream.
- Randwick Council comprises significantly more households than either Waverley or Woollahra, and has subsequent higher collection costs.
- Results from the quantitative assessment of ESDs:

ESD indicator	System performance
ESD1: Food waste avoidance	Poor
ESD2: Gardening and local food production	Uncertain
ESD3: Social capital	Poor
ESD4: Enhanced household waste management	Uncertain

Home composting project

- The home composting project, extrapolated over one year, avoids 34 tonnes of CO_2-e emissions associated with transport/collection and disposal of food waste to landfill.
- Results from the quantitative assessment of ESDs:

ESD indicator	System performance
ESD1: Food waste avoidance	Excellent
ESD2: Gardening and local food production	Excellent
ESD3: Social capital	Excellent
ESD4: Enhanced household waste management	Excellent

Expansion of Home Composting

- The reduced quantity of food waste disposed to landfill and the reduced emissions associated with collection and transport of a home composting programme extended to 20% of the LGAs, will result in approximately a 7% decrease of total emissions associated with waste management.
- A system with a home composting programme extended to 40% of the LGAs will reduce the overall emissions by 13% compared to the current waste management system.
- The reduced collection and landfill disposal costs of a home composting programme extended to 20% of each LGA, will result in approximately a 6% decrease of the operational costs compared to the current waste management system.

- A system with a home composting programme extended to 40% of each LGA will reduce the overall costs by 15% compared to the current waste management system..
- If a home composting programme is extended across 20% of the three LGAs, an estimated $593 would be saved per tonne of CO_2-e. If the programme were extended across 40% of the three LGAs, an estimated $641 would be saved per tonne of CO_2-e.
- After a four-year period to establish the composting programme, assuming annual 'maintenance costs' for the home composting programme of $98,000 per annum (across the three LGAs) an estimated annual saving of $979,559 (at a 20% participation rate) to $2,057,117 (at a 40% participation rate) could be achieved through diversion of food waste from the current residual waste management system.
- Results from the quantitative assessment of ESDs:

ESD indicator	System performance
ESD1: Food waste avoidance	Excellent
ESD2: Gardening and local food production	Excellent
ESD3: Social capital	Excellent
ESD4: Enhanced household waste management	Excellent

The estimated reduced greenhouse gas emissions of 7%-13% associated with a home composting programme extension to 20% and 40% of the LGA would be significant. The programme also encourages food waste avoidance and enhanced overall household waste management. Extension of the programme would also have a significant financial impact on councils' waste management systems, namely an estimated 6-15% reduction of the operational waste management costs. Finally, the programme promotes participation and interest in gardening and local food production which will contribute positively to food sustainability (i.e. reduced food miles), and furthermore strengthens community and builds social capital.

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Appendix A

Survey and audit results

	note- these figures from survey data- dependent on numbers filling out survey	based on3- 5 months (only 50%started at first	based on 3 months (only 50% started)
Survey and audit results			
Food waste composted (kg/household/year)		240.00	211.00
		%change (decrease) for 60 households	combined for both groups
Total Food waste kg		57	
Total avoidable food waste kg		20	
Total garden waste kg		72	
Co-mingled containers left in bin		62	
Food waste kg/ household		57	
Total avoidable food waste kg/household		67	
Garden waste/household kg		72	
Co-mingled recycling/household		62	
% Food waste		9.93	
% avoidable food waste in bin		2.7	
% Garden waste		0.06	
% Co-mingled recycling		1.1	
Survey results for ESD indicators			
Respondents who believe they have reduced their food waste		81%	62%
Respondents already not wasting food therefore believe no change in food waste		18%	29%
People wanting to become compost "teachers"		33%	44%
People who talk about composting to neighbours, friends or family		N/A	74%
People who think compost is good/great want to continue (others unsure need help)		92%	93%
People spending more time doing garden related activities		N/A	52%
Learnt more about councils sustainability activities		N/A	36%

Audit 1 - Pre Home Composting Trial

	Weight (kg)	Weight (kg) per household	Proportion (%) of whole waste stream
Preparatory	95.52	1.592	12.9%
Meal leftovers	187.03	3.117	25.2%
Unused / still packaged	25.16	0.419	3.4%
Meat (bones)	16.74	0.279	2.3%

Audit 2 - Mid Home Composting Trial

	Weight (kg)	Weight (kg) per household	Proportion (%) of whole waste stream
Preparatory	33.99	0.567	6.2%
Meal leftovers	108.55	1.809	19.7%
Unused / still packaged	33.95	0.566	6.2%
Meat (bones)	9.99	0.167	1.8%

Appendix B

Costs saved over 4 years of implementing home composting per Council

Waverley

20% of the LGA participate in home composting

Scenario	Cost of home composting	Cost of collection and disposal of remaining residual waste	Cost of current waste management system	Costs saved
First year of implementation	$176,459	$4,172,533	$4,256,263	-$92,728
Second year of implementation	$176,459	$4,088,802	$4,256,263	-$8,998
Third year of implementation	$176,459	$4,005,071	$4,256,263	$74,733
Fourth year of implementation	$176,459	$3,921,341	$4,256,263	$158,464
Total	**$705,836**	**$16,187,747**	**$17,025,054**	**$131,471**

40% of the LGA participate in home composting

Scenario	Cost of home composting	Cost of collection and disposal of remaining residual waste	Cost of current waste management system	Costs saved
First year of implementation	$320,251	$4,088,802	$4,256,263	-$152,790
Second year of implementation	$320,251	$3,921,341	$4,256,263	$14,672
Third year of implementation	$320,251	$3,753,879	$4,256,263	$182,133
Fourth year of implementation	$320,251	$3,586,418	$4,256,263	$349,594
Total	**$1,281,005**	**$15,350,440**	**$17,025,054**	**$393,609**

Randwick

20% of the LGA participate in home composting

Scenario	Cost of home composting	Cost of collection and disposal of remaining residual waste	Cost of current waste management system	Costs saved
First year of implementation	$289,696	$5,524,864	$5,627,044	-$187,516
Second year of implementation	$289,696	$5,422,683	$5,627,044	-$85,336
Third year of implementation	$289,696	$5,320,503	$5,627,044	$16,845
Fourth year of implementation	$289,696	$5,218,323	$5,627,044	$119,025
Total	**$1,158,785**	**$21,486,373**	**$22,508,176**	**-$136,981**

40% of the LGA participate in home composting

Scenario	Cost of home composting	Cost of collection and disposal of remaining residual waste	Cost of current waste management system	Costs saved
First year of implementation	$546,726	$5,422,683	$5,627,044	-$342,365
Second year of implementation	$546,726	$5,218,323	$5,627,044	-$138,004
Third year of implementation	$546,726	$5,013,962	$5,627,044	$66,356
Fourth year of implementation	$546,726	$4,809,601	$5,627,044	$270,717
Total	**$2,186,903**	**$20,464,570**	**$22,508,176**	**-$143,296**

Woollahra

20% of the LGA participate in home composting

Scenario	Cost of home composting	Cost of collection and disposal of remaining residual waste	Cost of current waste management system	Costs saved
First year of implementation	$150,666	$4,304,304	$4,387,782	-$67,187
Second year of implementation	$150,666	$4,220,825	$4,387,782	$16,291
Third year of implementation	$150,666	$4,137,346	$4,387,782	$99,770
Fourth year of implementation	$150,666	$4,053,868	$4,387,782	$183,248
Total	**$602,663**	**$16,716,343**	**$17,551,128**	**$232,123**

40% of the LGA participate in home composting

Scenario	Cost of home composting	Cost of collection and disposal of remaining residual waste	Cost of current waste management system	Costs saved
First year of implementation	$268,665	$4,220,825	$4,387,782	-$101,708
Second year of implementation	$268,665	$4,053,868	$4,387,782	$65,249
Third year of implementation	$268,665	$3,886,911	$4,387,782	$232,207
Fourth year of implementation	$268,665	$3,719,954	$4,387,782	$399,164
Total	**$1,074,659**	**$15,881,558**	**$17,551,128**	**$594,912**