Organic Waste Recycling Pre-Feasibility Assessment

Indian Ocean Territories – Christmas Island and Cocos (Keeling) Islands

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1. Introduction

1.1 Background

The Indian Ocean Territories (IOT) are comprised of Christmas Island (CI) and the Cocos (Keeling) Islands (CKI), located around 2,600 kilometres (km) and 2,900 km respectively from Perth. Both have their own shire council, being the Shire of Christmas Island (SoCI) and Shire of Cocos (Keeling) Islands (SoCKI).

Despite being administered by the Australian Government's Department of Infrastructure, Transport, Regional Development and Communications and the Arts (DITRDCA), the IOT receive many public services from the Government of Western Australia (WA). Laws of WA are also applied to the IOT, except where the Australian Government has determined otherwise.

DITRDCA are seeking to improve waste management practices and performance in the IOT to deliver waste services that benefit the local economy, the community and the environment. Historically, funding constraints and challenges specific to the local environment have restricted the implementation of traditional waste management options within the IOT, which are commonly used on the Australian mainland. As such, there is a gap between current waste management performance in the IOT and both national and state targets.

A Waste and Resource Recovery Strategy (the Strategy) for the IOT was developed to provide consistency with broader Australian Government waste management objectives and align local aspirations. As part of Strategy development, GHD prepared a *General Waste Management Report*[1] to investigate various processing technologies that may be suitable for implementation within the IOT. The findings from that report recommended further assessment of the viability of organic waste processing as a key priority.

1.2 Purpose of this report

The purpose of this report is to explore the feasibility of organic waste processing technologies for long term implementation on CI and CKI.

1.3 Scope of work

The following scope of work was undertaken to prepare this report:

- Reassessment of organic waste volumes estimated in the *General Waste Management Report.*
- Detailed assessment of available technology options that could potentially be viable in the IOT context.
- Review of potential funding sources, revenue sources, regulatory requirements and potential markets for recycled organic products.
- Multi Criteria Analysis (MCA) assessment of the potential processing options to develop a short list.
- Cost estimations for the shortlisted processing options.
- Development of recommendations including suitable organic processing options to pursue.

This report is subject to, and must be read in conjunction with, the limitations and disclaimers described in Section 1.4

1.4 Limitations

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[1] GHD 2022, '*General Waste Management Report'*, DITRDCA.

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2. Why organics?

2.1 Defining organics

Food organic (FO) and garden organic (GO) wastes can encompass a broad range of materials. For this project, FOGO is defined as domestic and commercial food wastes, garden organics and uncontaminated timber. This includes items such as meat, chicken, bread, eggshells, coffee grounds, dairy products, grass clippings, etc. It does not include engineered or preservative treated timbers that may contain contaminants that are unsuitable as inputs to an organic waste recycling process that will generate soil amendment products.

Fibre-based materials (e.g. paper and cardboard) and compostable packaging are not included within this definition as these materials are not currently widely encouraged and accepted and organics recycling facilities in Australia. This is mainly due to limitations in collection arrangements, difficulties distinguishing between compostable and non-compostable items, and the associated risk of contamination in recycled organic products.

Another organic waste streams that could be considered for organics processing include biosolids - the dewatered organic sludge resulting from treatment of sewage in wastewater treatment facilities. Biosolids are nutrient rich and can often be a beneficial input to organics processing.

2.2 Why organics?

In Australia, organic waste material management has been identified as a key priority due to the large volumes generated from households and businesses, providing opportunities to increase resource recovery and reduce greenhouse gas emissions. The Australian Government, in partnership with state and territory governments, have set a target to halve the amount of organic waste sent to landfill for disposal by 2030[2].

Organic waste is the largest component (by mass) in the IOT's mixed residual waste stream.[3] Processing and recycling this material on-island could provide a number economic and environmental opportunities, including:

- Production of recycled organic products such as soil conditioner for beneficial use around the islands (e.g., in topsoil for landscaping and community gardens, or as mulch for erosion control)
- Job creation through operation of processing facilities
- Reduction in material requiring disposal to landfill and/or incineration, thereby reducing greenhouse gas emissions
- Community pride
- Local fruit and vegetable cultivation, reducing costs of importing some fresh produce
- Increased resource recovery rates, and
- Reduction in diesel consumption and greenhouse gas emissions from avoided incineration through reduced need for supplementary fuel required for emissions control during residual waste incineration. Diesel costs for incineration energy supplementation exceeded $100,000 per annum for SoCKI when the previously installed incineration system was operating.

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[2] DCCEEW 2019, '*National Waste Policy Action Plan 2019'*, available from:
https://www.dcceew.gov.au/sites/default/files/documents/national-waste-policy-action-plan-2019.pdf
[3] GHD 2022, '*General Waste Management Report',* DITRDCA.

3. Regulatory setting

3.1 Policy and strategy

Federal and state governments have released several policy and strategy documents to facilitate growth in organic waste recycling. The National Waste Policy is a framework for action to achieve sustainable waste management by industry, government, and communities out to 2030. Recovery and recycling of organic material in the IOT addresses several principles set out in the policy.

The National Waste Policy Action Plan provides targets and specific actions to implement the 2018 policy through investments and national efforts. The action plan specifies 7 targets that overall are intended to make Australia more responsible for its own waste. Organics processing with the IOT directly relates to and could make a worthwhile contribution towards achieving the following targets:

– Target 3: 80% average resource recovery rate from all waste streams by 2030
– Target 6: Halve the amount of organic waste sent to landfill by 2030.

WA's Waste Avoidance and Resource Recovery Strategy 2030 and Action Plan outlines key targets and strategies to achieve Federal objectives and support the WA Government's vision to become a sustainable, low-waste, circular economy. The WA strategy supports the implementation of organic waste collection and processing infrastructure within WA.

3.2 Regulation and guidelines

3.2.1 Better practice organics recycling 2022[4]

The WA Department of Water and Environmental Regulation (DWER) guideline: Better Practice Organics Recycling (the guideline) defines 'better practice' for organics recycling facilities in relation to the Waste Avoidance and Resource Recovery Strategy 2030. The guideline also provides guidance on environmental performance objectives and identifies benchmark controls for the planning, design and operation of organics recycling facilities.

3.2.2 Environmental Protection Regulations 1987

Under the WA *Environmental Protection Regulations 1987,* DWER requires works approval and licensing for new waste infrastructure above annual tonnage thresholds. The following prescribed premises categories are applicable to the IOT:

– Category 67A: Composting, manufacturing and soil blending – the licensing threshold is currently 1000 tonnes per annum (tpa).
– Category 61A: Solid waste facilities receiving and storing composting feedstocks or composting premises operating below the production and design capacity for Category 67A.

It is likely that Category 61A would be relevant to potential organics processing infrastructure in the IOT. However, some of the minimum requirements in Category 67A will likely also apply. There are additional site requirements for organics processing infrastructure set out in the guideline which may constrain the identification, approval and development of suitable sites in the IOT. For example, one criterion is that organics recycling facilities should be at least 500 m from the high-water mark. This would likely be difficult to achieve alignment with in the IOT.

[4]WA Government 2023, '*Guideline: Better practice organics recycling'*, available from:
https://www.wa.gov.au/government/publications/guideline-better-practice-organics-recycling

It is recommended that the Shires and DITRDCA engage with DWER and the WA Department of Health to understand whether there is scope for flexibility around regulatory policy expectations for the IOT if organics processing is implemented. In particular, a focus on encouraging reuse and recycling of material and promoting circularity in waste management should be preferred over the default waste management pathways available in the IOT.

3.3 Funding, education and support opportunities

A number of state (WA) and federal programs and funding initiatives have been rolled out to support the uptake of organics processing. Table 3.1 provides an overview of programs and funding sources that may be available to support the implementation of organics processing in the IOT. It is noted that the Waste Authority provides funding for projects undertaken in WA, however the IOT has not been previously eligible for this funding. The WA Waste Authority has agreed to assess the eligibility of projects put forward in the IOT, to allow the Australian Government to provide funding as if the IOT were part of the operations of WA.[5]

Table 3.1 Funding, education and support opportunities

Name	Description
Federal government	
National Soil Strategy - Food Waste for Healthy Soils Fund[6]	The Food Waste for Healthy Soils Fund is a $67 million fund to support the diversion of household and commercial FOGO from landfill to soil via the expansion of existing organics processing infrastructure and capacity, and supporting elements to ensure the quality, consistency and safety of recycled organics products for use on agricultural soils. Funding is provided in the form of grants.
Australian Recycling Investment Fund[7]	The $100 million Australian Recycling Investment Fund draws on existing Clean Energy Finance Corporation finance. The fund was established to support projects that reduce waste and increase recycling in Australia. Projects related to organic waste processing may be eligible for funding. For example, the Sacyr Group received funding for a organics processing facility in Melbourne.
State government	
Better Bins Plus: Go FOGO[8] (Waste Authority)	The $20 million Better Bins Plus: Go FOGO program is an initiative established by the WA Government. The program supports local governments to provide better practice three-bin kerbside collection systems with a separate FOGO service.
WasteSorted Schools[9] (Waste Authority)	The WasteSorted Schools program provides support (including funding, programs and resources) to schools across WA to promote responsible waste management behaviours.
WasteSorted[10] (Waste Authority)	WasteSorted is a brand and communication toolkit developed to help WA local governments and regional councils communicate the importance of separating and sorting waste.
WasteSorted Grants Program 2022-23[11] (Waste Authority)	This is a state government initiative to help existing organics handling and processing facilities align to the Better Practice Organics Recycling Guideline. The program has a total of $1,000,000 available for projects to be funded in 2022-23.
State Natural Resource Management (NRM) Program[12]	This program provides funding for natural resource management projects, including waste management initiatives. Organic waste processing projects may be eligible for funding.

[5] As per comms., Waste Authority 2022.
[6] DCCEEW 2023, '*Food Waste for Healthy Soils Fund*', available from: **https://www.dcceew.gov.au/environment/protection/waste/food-waste/food-waste-for-healthy-soils-fund**
[7] CEFC 2023, '*Australian Recycling investment Fund*'
[8] Waste Authority, 2023, '*Better Bins Plus: Go FOGO*', available from: **https://www.wasteauthority.wa.gov.au/programs/view/better-bins**
[9] Waste Authority, 2023, '*WasteSorted Schools'*, available from: **WasteSorted Schools | Waste Authority WA**
[10] Waste Authority, 2023, '*Be a GREAT Sort and do better than the bin'*, available from: **Be a GREAT Sort | WasteSorted**
[11] Waste Authority, 2023, '*WasteSorted Grants – Organics Infrastructure Program*'
[12] WA Government 2023, '*NRM Program*', available from: **https://www.wa.gov.au/organisation/department-of-primary-industries-and-regional-development/state-natural-resource-management-program**

4. Current state

A review of historical population data suggests that the population of residents within CI and CKI is likely to continue to decrease. However, transient populations will continue to increase. Population and tourism data is provided in Appendix A. Further details of the demographic and waste management information relevant to this project has been provided in Table 9.2 in Appendix A.

4.1 Current population - Christmas Island

CI has a total area of approximately 135 km^2, with a breadth of up to 14 km and a length of 19 km between the furthest point. The island has five settlements; Flying Fish Cove, Settlement, Silver City, Poon Saan and Drumsite, with a total resident population of approximately 1,700 people. However, the population on CI fluctuates due to the migrant detention centre administrated by the Commonwealth, which has a capacity of 3,000 people, as well as other temporary visitors (i.e. tourists, fly-in fly-out workers).

4.2 Current population - Cocos (Keeling) Islands

The CKI territory consists of two atolls made up of 27 coral islands, with a total area of approximately 14 km^2. Of the 27 islands, only West Island and Home Island are inhabited. Between these islands, the total resident population is approximately 600 people. The population on the islands also sees fluctuations due to temporary visitors, especially associated with Commonwealth infrastructure projects.

4.3 Organic waste volumes

Organic waste is not currently collected separately, recovered or recycled at the waste transfer stations. As such, there currently a lack of accurate data available on waste composition and volumes produced in the IOT. Estimated volumes of organic waste generation per capita per week on each island have been derived and are included in Table 4.1. These estimates have been based on the following assumptions:

- CKI: SoCKI waste data from facilities on Home Island and West Island (2021).[13]
- CI: Waste audit data from Raum International Pty Ltd (2011).
- CI: Waste calculations 2020/2021 from CI landfill.[14]
- CI / CKI: WaterCorp for biosolids produced.[15]

Table 4.1 Organic data - generation rate per capita per week

	FO (kg)	GO (kg)
CKI – West Island*	2.79	1.20
CKI – Home Island*	7.33	3.14
Christmas Island**	7.56	69.19
Average organic generation rates	**2.5**	**1.06**

Notes: *Data provided by SoCKI did not include a breakdown of residential and commercial entities. As such, it is expected that the FO and GO rates may be higher than the average organic generation rates identified.
**Data provided by CI only included residential organic waste and does not include commercial organic waste generation data.

[13] This data was provided by SoCKI. SoCKI have noted that there are significant constraints to the accuracy of this data as the transfer stations are unmanned and do not currently have a data collection process in place. SoCKI also noted that waste is often burned by residents and not disposed at the SoCKI facilities.
[14] Provided by SOCI.
[15] As per comms., WaterCcorp 2022

The waste data provided by the Shires indicates that organic material generation per capita is higher than the average generation rate estimated for Australia.[16] To account for this anomaly and the uncertainty in organic waste generation potential, minimum and maximum volumes of FO and GO material were estimated for each island.

The current and forecasted estimated volumes for FO and GO from commercial and residential sources is presented in Figure 4.1 to Figure 4.3. More details on derivation of this data have been included in Appendix B.

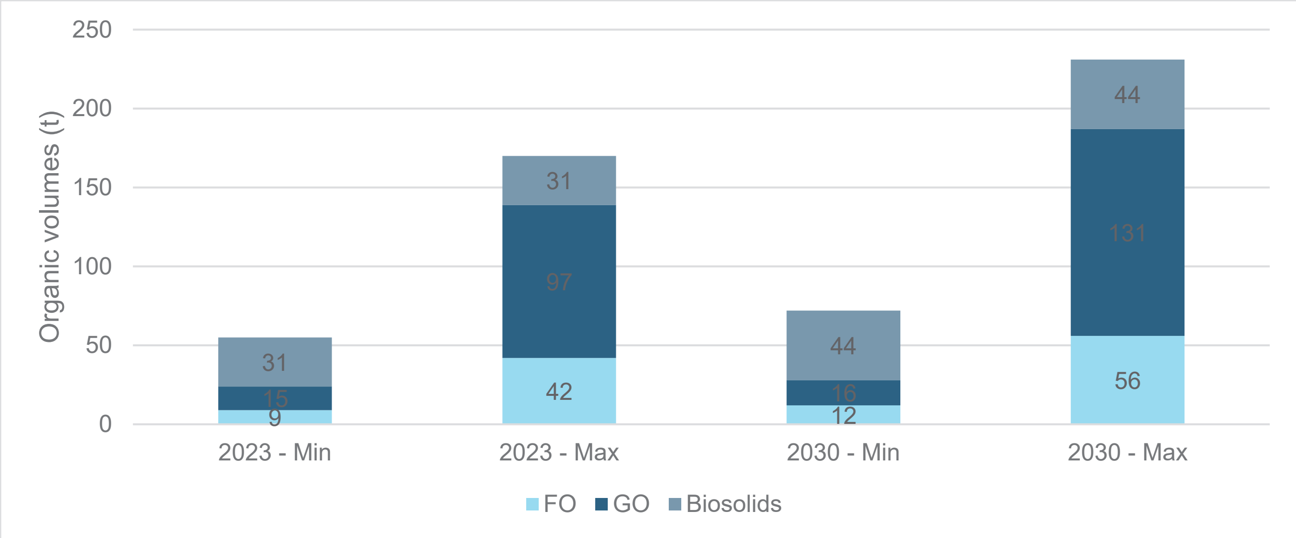


Figure 4.1 Organics volumes (annual) – West Island

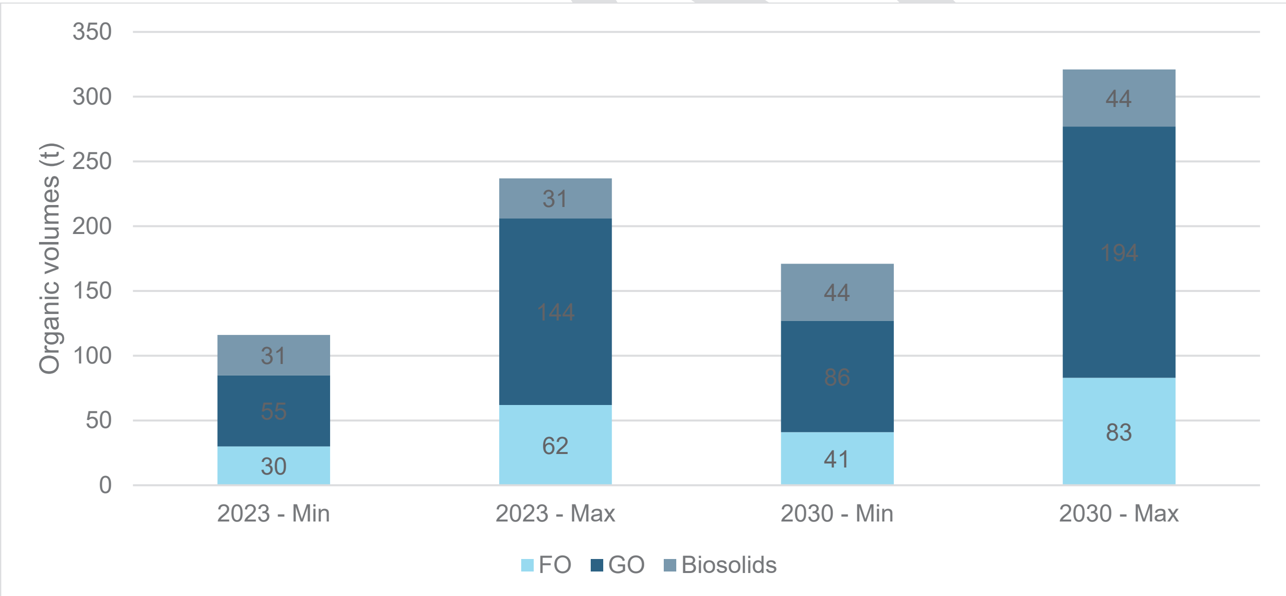
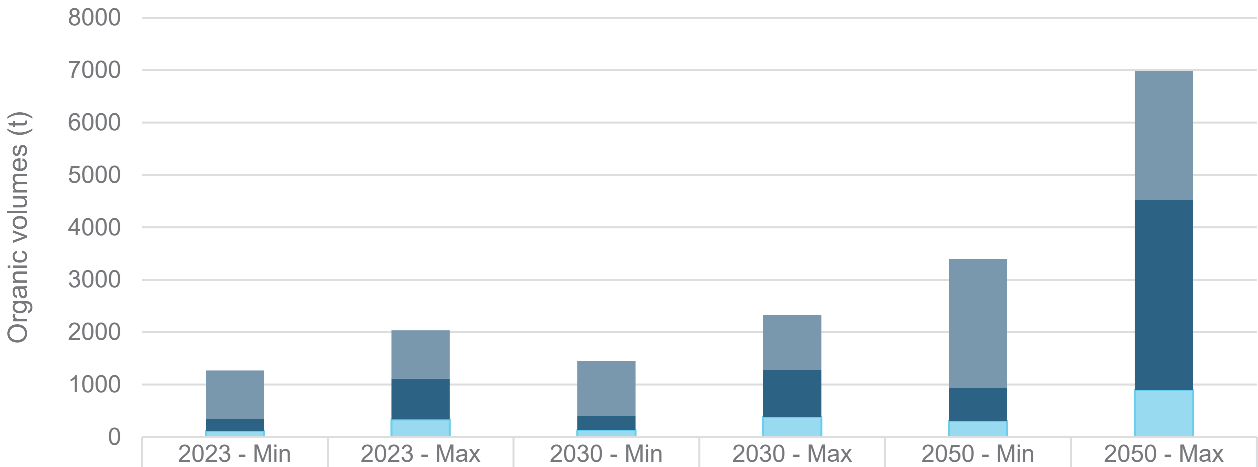


Figure 4.2 Organics volumes (annual) – Home Island

[16] Rawtec 2018, *'Analysis of Food and Garden Bin Audit Data'*, retrieved March 2023, avaliable from: **https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/managewaste/nsw-fogo-analysis.pdf?la=en&hash=F2F341DB7CF6C517801CD04DBBCFA389C03DF82A**



	2023 - Min	2023 - Max	2030 - Min	2030 - Max	2050 - Min	2050 - Max
Biosolids	919	919	1,052	1,052	2,459	2,459
GO	236	781	269	894	632	3,632
FO	113	335	130	383	303	895

Figure 4.3 Organics volumes (annual) – Christmas Island

For FO, the minimum volume for kerbside collection is based upon the average rate expected to be produced per week per capita. For commercial entities, FO volumes have been calculated based upon the number of businesses that are likely to produce a high quantity of FO material (shown in Table 9.2 in Appendix A).[17]

There is a degree of uncertainty in the self-haul volumes of GO, and there are frequent one-off storm events that will give rise to seasonal organic waste volume peaks. Therefore, to estimate the minimum amount of material generated, the GO self haul rates provided by CI have been used. However, the GO quantity produced by residents has been adjusted based upon the average organic waste generation rate provided in Table 4.1.

Available organic feedstock has also been calculated for a potential population of 5,000 people on CI as this is the maximum number of people that would be expected to reside on-island at any time (due to known water and infrastructure constraints).

> ***It is recommended that volumetric waste audits of residential and commercial premises be undertaken to better understand the waste volume and composition on the islands. This is a common practice on islands around Australia due to the absence of weighbridges and appropriate infrastructure to measure and accurately track waste generation rates and composition.***

4.3.1 Feedstock availability

The volumes of material (feedstock) described in Section 4.3 represent the estimated total volumes of organic waste generated in the IOT. The availability of feedstock for a potential organics processing facility will be largely dependent on the collection system implemented, contamination rates, 'non-core' organics captured (i.e. compostable packaging) and any processing infrastructure established.

To account for the potential limitations in availability of feedstock, a capture rate of 90% recovery for GO and 50% recovery for FO has been assumed based upon industry understanding of recovery rates elsewhere in Australia. The estimated volumes of organic material available for processing are outlined in Table 4.2 below.

Biosolids has not been included as a feedstock due to constraints around the use of end-products from this material stream. Refer to Section 5 for further details. For the assessment of various organics processing infrastructure (refer Section 7), the maximum estimated 2030 tonnages have been applied.

[17] Commercial entities have been assumed to generate approximately 46.6 kg per week of FO. This assumption is based upon GHD's industry experience and available published references.

Table 4.2 Realistic available feedstock

Feedstock	Expected capture rate (%)	Annual tonnes 2023		Annual tonnes 2030		Annual tonnes 2050*	
		Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
CKI - West Island							
FO total	50	4	21	6	28		
GO total	90	14	87	14	118		
FOGO total		**18**	**108**	**20**	**146**		
CKI – Home Island							
FO total	50	15	31	20	42		
GO total	90	49	129	77	175		
FOGO total		65	**160**	**98**	**217**		
CI							
FO total	50	57	167	65	192	152	448
GO total	90	213	702	242	804	569	3,269
FOGO total		**269**	**870**	**307**	**996**	**721**	**3,717**

Note: *Available organic feedstock has been calculated for a potential peak population of 5,000 people on CI as this is the maximum number of people that would be expected on-island at any time (due to known water and infrastructure constraints).

5. Case studies

To understand best practice FO and GO collection and management options, a number of island and remote region case studies were reviewed and summarised in Table 5.1 below.

Table 5.1 Case studies

Location	Summary of case studies	Organic system
Lord Howe Island	Lord Howe Island (LHI) is a small island located 570 km east of the mid-north coast of New South Wales (NSW). With a resident population of less than 400 people but more than 15,000 visitors a year, tourism is the basis for the local economy. LHI has no landfill capacity and as such all waste that is not able to be reused or composted is shipped to the mainland. LHI have an **in-vessel composting system (HotRot)** to manage organic waste.[18] LHI does not have a garbage collection service, so residents are responsible for delivery and sorting of waste to the WMF. The composter used by LHI is a vertical unit with three chambers that process biosolids, grease trap, paper and FOGO. Previously, cardboard and paper were shredded (using a machine acquired just this year) and used in the system. They initially manually removed items from the cardboard and paper that could not be processed (i.e. plastic tapes, glossy boxes and wax boxes) and stockpiled the large volume of shredded paper and cardboard before processing. However, in 2023 they will be excluding this material from the feedstock due to contamination. Due to the range of input material fed into the machine, there is not enough time for the compost to become mature enough for reuse. To address this, LHIB are currently investigating the potential for a secondary processing unit after the HotRot system. This secondary process is expected to be **aerated static piles**. LHIB are also developing a business case for **anerobic digestion** which could potentially power 120 houses on island. Based upon discussions with LHI Board (LHIB) they currently reuse the organic output material (compost) on site due recent problems with pesticides in the compost restricting the sale of the material. Previously the LHIB have sold the material onsite, however this required significant laboratory analysis costs (approximately $100,000).	In-vessel composting Aerated static piles Anaerobic digestion
Kangaroo Island	Kangaroo Island is 4,400 km^{2}. and has a permanent population of 4,890, with more than 150,000 tourists visiting annually.[19] . The island has a tourism and agricultural economic base. Kangaroo Island has three different collection bins, being[20]: – Yellow-lid bin (fortnightly collection) – recycling (240 L). – Green bin (weekly collection) – FOGO (240 L). – Red/blue bin (fortnightly collection) – General waste to landfill (140 L). All FOGO waste is composted using a **HotRot in-vessel composting system**.	In-vessel composting
Norfolk Island	Norfolk Island is located 1500 km off the coast of Australia. It has a resident population of approximately 1,800. The island's economic base is founded on international tourism and can accommodates approximately 940 visitors at any one time and has a total annual visitation of around 25,000 per year. Waste Management is coordinated at the island's waste management centre by external contractors. There is currently no waste collection service on the island and residents and commercial entities are responsible for transporting sorted waste to the waste management centre. At the centre, waste is deposited into separate chutes depending on the type of waste being deposited.[21] To manage organic waste, a **HotRot system** was installed in 2022. The system manages both FO and GO (including butchers' waste) that is disposed of at the centre and manually screened. Discussions with Norfolk Island Council suggest that it is a reliable system, however there have been some issues reported with large butchers' waste materials. The system runs seven days a week, 24 hours a day in a sealed	In-vessel composting

[18] Lord Howe Island Board 2022, '*Waste management and recycling*'. Available from: **https://www.lhib.nsw.gov.au/waste-management-recycling**
[19] Australian Bureau of Statistics 2016, '*2021 Census population data – Kangaroo Island*'. Available from: **https://abs.gov.au/census/find-census-data/quickstats/2021/LGA42750**
[20] Fleurieu Regional Waste Authority 2022, '*Kerbside Collection*', available from: **https://fleurieuregionalwasteauthority.com.au/kerbside-collections/commercial-food-waste-collection/**
[21] Norfolk Island 2022, '*Waste management*', available from: **http://www.norfolkisland.gov.nf/services/waste-management**

Location	Summary of case studies	Organic system
	vessel that minimises odour. It is a no leachate system and the only odour generated is from the moving floor feeder. The compost produced is sold back to the community or used by the council.[22] Norfolk Island, although within the Queensland jurisdiction, are their own environmental regulator and undertake their own due diligence. As such, the compost material can be sold to residents without testing. The Norfolk Island Council have noted there is some degree of plastic contamination in the compost, from contamination in the FO waste stream. The council are seeking to undertake testing in the future to ensure that the compost material is safe. Material is self hauled to the processing facility and there is generally plastic contamination in the FO. The material is manually screened and this is managed by a contractor. ***It may be worth considering rationalisation of some waste collection service/s in the IOT and incentivising self-haul, particularly for GO waste. This is a common practice on islands and may reduce contamination risks and organic waste collection costs.***	
Maui, Hawaii	The island of Maui has a population of approximately 150,000 people. It is the second-largest of the islands of the state of Hawaii. A **dehydration system (Gore)** was set up in Maui Hawaii in 2021 to process up to 700 t / annum of organic waste.[23] This was a small above ground system with low infrastructure requirements and is powered by solar power. The output product is a quality compost that is used for agricultural purposes. There have been minimal contamination issues within the compost as the feedstock is spread flat on the ground and contamination is manually removed.	Covered aerated static pile
Atacama Desert Mine - Chile	The Atacama Desert Mine is located in Escondida in Chile's Atacama Desert. It is a copper-gold-silver mine. At the Atacama Desert Mine in Chile the operators of the mine, in conjunction with their catering provider, sought technology that could process their food organic (FO) waste safely on site, while also minimising their environmental impact.[24] A **WasteMaster 1000 system (dehydration)** was commissioned and began converting the mine's organic waste in June 2020. This is a simple system that requires minimal training. The system does not require microbes, bacteria, or water in the treatment process. The output from this system is reused on site.	Dehydration
Samoa (Vaitele)	Samoa is a Polynesian island country consisting of two main islands (Savai'i and Upolu). It has a population of more than 200,000 people. The Vaitele community (7,972 people) in Samoa has a biogas reactor system from **BioEnceptionz** that has been designed to treat the community's sewage and some household organic food and garden waste.[25] The implementation of this reactor highlighted the need for adequate time to be factored in for consultation and training, with ongoing support available to participants to troubleshoot issues over time. Samoa has continued to invest in bio-digestion, with a second biogas system established in Sa'asa'ai community in 2021. As the BioEnceptionz system at Vaitele is primarily by a need for sanitation, and treatment of sewage in the IOT is provided by the Water Corporation, it is not considered directly applicable to the IOT. It is highlighted that the Bahamas also has a functioning AD facility to manage septic waste. The system is capable of processing approximately 2 m^3 of biosolids per week. The facility also processes and biodegrades glycerol, which is collected as a by-product from the biodiesel production process.[26]	Anaerobic digestion

[22] LGAQ 2022, '*Dealing with rubbish on Norfolk Island is not trash-talk*', available from: **https://www.lgaq.asn.au/news/article/1296/dealing-with-rubbish-on-norfolk-island-is-not-trash-talk**
[23] As per comms., Gore 2023.
[24] Green Eco Technologies 2023, 'Atacama Desert Mine', available from: **https://www.greenecotec.com/successstories/atacama-desert-mine**
[25] European Union 2021, '*Waste to Energy Research Report*', available from: **https://pacwasteplus.org/wp-content/uploads/2021/12/Waste-to-Energy-Research-Report-_Formatted_Final.pdf**

6. End products

A high-level market sounding exercise was undertaken to understand the potential market opportunities and challenges for recycled organic products in the IOT. It is noted that community consultation has not been undertaken as part of this study into the for potential implementation of organics processing technologies.

It is recommended that community engagement and consultation is undertaken prior to the implementation of an organics processing facility.

6.1 Recycled organic products

Organics processing can convert FO and GO into a range of recycled organic products including mulch, compost, soil amendment / conditioner acting as a slow release fertiliser, and in the case of anaerobic digestion, the production of biogas. The current market for recycled organic products in Australia (including FOGO-derived products and blends) is largely dominated by the urban amenity sector (~52%), for uses in residential and commercial landscaping, retail nursery and public works (i.e. road embankments).[27]

Australia currently has stringent standards applied to the sale of end-products from organics processing facilities. These standards may impact the ability to cost-effectively produce saleable material, however the output may still be able to be used on the islands (subject to approval by DWER and WA Department of Health).

For selling and reusing any of the output material, compliance with the Australian standard AS4454:2012: Composts, soil conditioners and mulches is likely to be required.[28] Approval may also need to be sought from the WA Department of Health and regular testing of the output material would be required as per the applicable environmental licence of the organics processing facility. However, it is likely that routine laboratory testing of composted products would not be practicable for the IOT due to the associated costs and travel times for samples.[29]

For example, LHIB which are under the jurisdiction of NSW has recently paid approximately $100,000 for sampling of 4.5 m^3 of compost material (including PFAS sampling) to reuse on island (refer to **case study in Section 5**). Norfolk Island also reuse their recycled organic material. However, although Norfolk Island now falls within the jurisdiction of the Queensland government (since 2021) for health and education services, the council is effectively their own environmental regulator. As such, the island is not obliged to adhere to stringent Australian standards. However, in 2023, Norfolk Island council will begin to test the output compost material as part of their own due diligence (refer to **case study in Section 5**).

If the output material is not tested, it could still potentially be reused on site at Waste Transfer Stations (WTS) and landfill for landscaping and commercial site rehabilitation, subject to appropriate controls.

It is recommended that if organics processing is implemented in the IOT, the Shires should continue engagement with WA regulators to identify a pathway and protocols for recycled organic product use around the islands. Organics recycling contributes to a more circular approach to waste management and consistent with working towards state and national targets.

Organics processing in the IOT does need to produce a net revenue stream to be considered cost effective, as the diversion of organic material from landfill or incineration will likely decrease overall expenditure on waste management, and reduce capacity requirements for residual waste disposal.

[27] DCCEEW 2021, '*AORA Australian Organics Recycling Industry Capacity Assessment'*.
[28] Noting that these guidelines do not have any compliance level for per- and polyfluoroalkyl substances (PFAS). However, would likely be assessed if this was identified as a significant risk to groundwater resources in the IOT.
[29] As per comms., LHIB, March 2023.

6.2 Drying of organic waste

Rather than the implementation of organics processing infrastructure to produce recycled organic products, an alternative pathway to lower cost disposal of organic waste is reducing moisture content such that combustion in an incinerator is more cost effective. As both CI and CKI are looking to procure incinerators in the future, this could complement the approach to optimising waste management on the islands.

Noting that there is no advantage for landfilling of dried organic waste since leachate and landfill gas would still be generated (which is relevant to CI where landfilling continues), treatment options could include bio-drying as a precursor to incineration of dried organic waste, particularly garden organics, blended with residual waste, to reduce the need for supplementary fuel (e.g. diesel) when combusting residual waste.

6.3 Biosolids management

Application to land as a soil amendment in agricultural regions is the most common use of biosolids in Australia. Although similar applications may be theoretically possible in the IOT, any use would need to comply with the WA Guidelines for Biosolids Management to ensure that potential impacts on human health and the environment are addressed and risks appropriately managed.[30] These guidelines include contaminant acceptance concentration thresholds, as well as contaminant limited and nutrient limited application rates, monitoring (soil testing before and after application) and reapplication restrictions.

In the absence of an existing agricultural farming industry in the IOT, land application of biosolids is not currently considered financially viable for the IOT. The amount of biosolids produced in the IOT is also relatively small. Additionally, anecdotal evidence suggests that there are also cultural concerns with the reuse of biosolids in the IOT.

6.4 Use of recycled organic products in the IOT

Organics processing in the IOT does need to produce a net revenue stream to be considered cost effective, as the diversion of organic material from landfill or incineration will likely decrease overall expenditure on waste management, and reduce capacity requirements for residual waste disposal.

[30] Department of Environment and Conservation 2012, '*WA guidelines for biosolids management*', available from: **https://www.health.wa.gov.au/~/media/Files/Corporate/general-documents/water/Wastewater/WAGuidelines_for_biosolids_management_2012.pdf**

7. Organic processing technologies

A number of organics processing technologies were reviewed to understand their potential to cost-effectively process organic waste within the IOT. The technologies considered are summarised in Table 7.1.

Table 7.1 Organic waste management technology options

Technology	Summary
Small scale anaerobic digestion (AD)	AD is an anaerobic process whereby organic material is converted into combustible biogas and digestate that can either be used directly as an organic fertiliser or further treated via aerobic composting to produce a stabilised soil conditioner.
Covered aerated static pile (CASP)	CASP composting is an aerobic process using covered piles of organic material to assist with the efficient decomposition of organic material and creation of compost.
Covered / open windrow	Windrow composting is a form of aerobic composting and involves decomposition of organic waste through the presence of moisture, natural heat and air moving through the organic piles, referred to as windrows.
Covered inoculated static pile (CISP)	CISP is a variation of standard windrow composting uses a biological inoculant (a formulation containing microbes) to accelerate the composting process. Semi-permeable covers are placed over the windrows.
In-vessel composting (IVC).	IVC are fully enclosed systems where organic material is converted into compost with the presence of oxygen and (often) the addition of carbon-based bulking agents.
Dehydration	Dehydration is a moisture-deprived composting process that can convert FO at high temperatures into a dry, odourless, compost-like output which can be used as a soil amendment.
Biodrying	Biodrying is a form of moisture-deprived composting that takes advantage of biological heat generation and reduces the moisture content of larger quantities of organic waste with less capital and energy intensive processing than electro-mechanical systems (i.e. dehydration).
Black soldier fly larvae	Black soldier fly larvae compost organic material through digesting FO. The output product is a soil amendment.

7.1 Small-scale anaerobic digesters

7.1.1 Technology overview

AD converts readily biodegradable organic material in the absence of oxygen into biogas, which can be used as fuel, and digestate (solid and liquid residue) that can either be used directly as an organic fertiliser or further treated via aerobic composting to produce a stabilised soil conditioner. The biogas principally contains methane and carbon dioxide and can be utilised to produce heat, electricity, renewable natural gas or compressed natural gas.[31] There are two main types of AD processes, being:

– **Wet AD**: Low solids (wet) AD is primarily for FO and other readily degradable liquid organic wastes. Liquid digestate produced by this process can be used as an input to composting, directly as liquid fertiliser, or further processed to produce a dried pelletised fertiliser, soil conditioner or blended product.[32] Wet AD is often operated in the mesophilic temperature range (between 35°C and 38°C), and pathogen destruction in digestate is therefore not assured without a subsequent pasteurisation (heat treatment) step.

– **Dry AD**: High solids (dry) AD is a treatment option for FO combined with GO. Dry AD generates solid digestate that can be composted and subsequently used as compost, or sold directly as a pasteurised soil conditioner if the AD system operates in the thermophilic temperature range (between 55°C and 58°C) to eliminate pathogens. There are currently no dry AD facilities commercially processing organic waste in Australia, however the technology is common and well established in Europe and is being increasingly deployed in North America.[32]

[31] Sustainability Victoria. 2018. *R'RE007 Guide to Biological Recovery of Organics',* available from: **(sustainability.vic.gov.au)**

[32] NQROC 2021, '*NQROC Organics Management Roadmap'*.

Engagement with suppliers of small scale AD units, including BioBowser and Earthlee, suggests that the smallest unit requires a minimum throughput of 100 tonnes (t) of FO as feedstock per year. This would therefore only be suitable for CI organic waste volumes, subject to suitable management of feedstock contamination.

7.1.2 Current feasibility

Table 7.2 assesses the feasibility of AD for implementation in the IOT.

Table 7.2 Feasibility of small-scale AD

Factor	Description
Benefits	– Internationally proven technology for energy and biogas generation. – Has the greatest GHG emission reduction among the considered technology options. – Creates both biogas and digestate as outputs. – There are policy drivers emerging to support AD. – Some systems available in modular containers.
Constraints	– Small-scale AD is not yet well established as a reliable technology option in Australia, particularly for remote locations. – Needs a higher quantity of FO than available on CKI and therefore only scale appropriate for CI. – AD systems are more technically challenging to maintain and operate then the other options considered, which is a key consideration in the IOT. – The mass of digestate produced from an AD system is typically around 90% of the mass of organic waste entering the process. – Digestate is used in many parts of the world as an organic fertiliser. However, land application of digestate requires appropriate risk management to avoid potential adverse impacts associated with over-application or accumulation of nutrients and trace contaminants and the potential spreading of weed seeds and pathogens. Raw digestate is also highly odorous. – The technologies and systems available for small scale AD require some technical management of inherent safety implications of dealing with flammable gas and the efficient operation and maintenance of mechanical, electrical and process control systems. – No Australian certification standard currently available for digestate. – AD systems can be susceptible to shock loading and ‘digester failure’ if not appropriately managed, leading to processing continuity disruption. – The WA government’s *Guideline: Better practice organics recycling* provides defines digestate from AD as liquid waste and this creates uncertainty as to acceptable cost-effective pathways for digestate management and use.
Feasibility	Not suitable in current IOT context.

7.2 Covered / open windrow

7.2.1 Technology overview

Windrow composting is a form of aerobic composting involving microbial decomposition of organic waste through the presence of moisture, natural heat (over 65°C) and air moving through organic piles, with long piles referred to as windrows. The process requires semi-frequent turning of the piles or windrows, usually at least fortnightly after pasteurisation. This is necessary to aerate the piles, build porosity, release trapped gas and heat, and ultimately speed up the composting process. Depending on the size of the system, sprinklers or a mobile water tanker are used to maintain moisture levels in the composting mass.

Windrow composting is one of the simplest methods of organic processing with limited infrastructure requirements. This is the most widely utilised composting system in Australia. Piles can be covered or uncovered, however uncovered (open) windrow composting is susceptible to moisture variance during periods of high evaporation (requiring more moisture addition), or periods of high rainfall (which can lead to waterlogging, odour and leachate management issues).

Organic material is pre-shredded and placed in piles or windrows and naturally occurring microbes progressively break down organic material, producing heat, carbon dioxide and water vapour, and releasing nutrients. It is a relatively slow process – typically between 8-16 weeks, however the output product is a pasteurised and mature compost. The process is generally more suited to a higher proportion of GO than FO.

7.2.2 Current feasibility

Table 7.3 assesses the feasibility of covered / open windrow for implementation in the IOT. Details of some potential equipment and technology providers are presented in Appendix C.

Table 7.3 Feasibility of covered / open windrow

Factor	Description
Benefits	– Simple system. – The CAPEX for covered / open windrow is variable. However, typically it is expected that a covered / open windrow system has a lower upfront cost than other processing methods. – Scalable and suitable for smaller applications. – Proven and widely adopted system in Australia. – Likely that the system can be operated by existing staff. – Greenhouse gas saving and leachate avoidance by diverting biodegradable material from landfill.
Constraints	– There are fewer process controls than other organic processing systems. – Odour and vectors may be a problem compared to IVC, CASP and dehydration, particularly, if not covered. – Leachate management needs to be considered. – Limited offsite support and remote monitoring is not included. – Needs daily monitoring for optimum oxygen and moisture levels. – Longer processing time; 8-16 weeks per batch. – More prone to exposure to natural elements (if not covered). – Potential odour and vector issues resulting in community complaints. – Medium CAPEX and OPEX compared to other options (refer to Section 8). – Slow process when compared to some other organics processing technologies. Therefore, requires more land than an accelerated, covered or enclosed process.
Feasibility	Suitable in current IOT context.

7.3 CASP

7.3.1 Technology overview

Covered aerated static pile composting is similar to windrow composting, however CASP composting involves active aeration of covered piles or windrows (long piles) to improve composting process efficiency and accommodate higher risk feedstocks (including food waste). Shredded organic material is placed in piles on a mobile aerated floor (MAF) or a fixed aerated floor (FAF) where air is sucked or blown through the compost pile to encourage microbial activity. Semi-permeable covers are placed over the pile. Air sucked through compost piles is passed through a biofilter to absorb and degrade odorous compounds. Once the initial significant biological processes are completed, air can be blown through the composting mass directly to atmosphere without creating significant odour risks.

Temperature is controlled by the rate of air movement through the pile. Turning is not required as air is pushed or drawn through the composting mass. The system is generally modular, and it is therefore easy to add capacity to the system if needed. The modular system allows economies to be realised even at low annual volumes. FAF systems use aeration pipes that are installed in or underneath the composting pad or floor. These systems are more expensive to install but allow for mixing or turning of the composting mass without the risk of damaging the pipework. Often, below-floor systems provide more efficient air delivery, which translates to reduced electrical consumption by aeration fans or solar panels. Output is a pasteurised, mature soil amendment product.

7.3.2 Current feasibility

Table 7.4 assesses the feasibility of CASP for implementation in the IOT. Details of some potential technology providers are presented in Appendix C.

Table 7.4 Feasibility of CASP

Factor	Description
Benefits	– Well-developed and publicly accepted technology in Australia and remote areas including islands (**refer to case study in Section 5**). – Low risk as technology is simple and proven in Australia and can also be fully enclosed. – System quoted is essentially self-contained which minimises environmental risks (i.e. odour and vectors). – System is easy to operate and maintain. – Scalable and suitable for smaller (and able to scale to larger) applications. – Use of solar panels to power the fan units can reduce energy costs and greenhouse gas emissions. – Could readily contribute towards achieving Federal and State targets. – System can readily produce mature compost and pasteurised mulch meeting Australian Standard 4454 without additional processing system, other than screening. – Likely that the system can be operated by existing IOT waste management staff. – Has the lowest OPEX costs for CKI and one of the lowest for CI (refer to Section 8). – Limited servicing requirements. Offsite support and remote monitoring are included. – Minimal water required depending on moisture content of the inputs. High FO mixtures generally have enough moisture whereas a high GO batch may require water addition. – Greenhouse gas saving and leachate avoidance by diverting biodegradable material from landfill.
Constraints	– Although this is a covered process it is not fully enclosed. – Without adequate monitoring, pile settling may lead to anaerobic activity (increasing odour) and systems can dry out quickly. – Slow process when compared to some other organic processing technologies. Therefore, requires more land than an accelerated enclosed process. – Needs daily monitoring for maintaining optimum oxygen and moisture levels. – Leachate management needs to be considered. – Pipes can become blocked or damaged and may require cleaning and/or replacement. – Has the highest CAPEX for CKI and second highest CAPEX for CI. However, typically CASP is known to be a low cost system. The Gore system quoted reduces risks to the environment to the highest degree (i.e. bunded, solar powered etc); as such, costs could be reduced if a simpler system is installed (refer to Section 8).
Feasibility	Suitable in current IOT context.

7.4 CISP

7.4.1 Technology overview

A covered inoculated static pile (CISP) system is a variation of standard windrow composting and uses a biological inoculant (a formulation containing select beneficial microbes) to accelerate the composting process. Semi-permeable covers are placed over the windrows to mitigate vector attraction and retain moisture. The feedstock for these processes can be of a low ratio of FO which is suitable for FOGO. Products produced include topsoil conditioners and humus soil. Labour and operating costs are reduced under this system as no pre-shredding is required and turning is typically only undertaken once during the composting cycle (compared to daily or weekly with a traditional windrow system). It generally takes between 8-16 weeks for composting and maturation.

This is one of the simplest methods and is currently used at several Australian facilities, and also widely used internationally.[33] As with CASP systems, GORE® Cover, and also Convaero by Eggersmann, can supply CISP systems.

7.4.2 Current feasibility

Table 7.5 assesses the feasibility of CISP for implementation in the IOT.

Table 7.5 Feasibility of CISP

Factor	Description
Benefits	– Proven to produce high quality end products. – Case studies of successful implementation in Australia. – Relatively low CAPEX and OPEX cost compared to alternatives. – Greenhouse gas saving and leachate avoidance by diverting biodegradable material from landfill.
Constraints	– Although this is a covered process it is not enclosed. – Slowest process to produce the end product and therefore requires a large site. – Covers may need removing and reinstalling during batch cycle (2 operators) when turning is required (once per cycle). – Pile may need turning with wheel loader (covers removed). – Covers also need replacing periodically as they wear/tear. – Windrows have a heightened risk associated with air quality, landscape and visual amenity if not managed correctly. – Procuring regular supply of proprietary microbial inoculant to maintain accelerated composting may be an issue in the IOT due to potential for shipping delays. However, inoculation with finished compost from a previous batch can reduce cost and simplify processing, noting that process duration may be extended as a result.
Feasibility	Not suitable in current IOT context (unless not using proprietary inoculant).

7.5 In-vessel aerobic composting

7.5.1 Technology overview

In-vessel composting (IVC) processes are fully enclosed systems where organic material is converted into compost in the presence of oxygen and (often) the addition of carbon-based bulking agent such as wood chips.[32] Feedstock can be continuously fed into one end of a plug flow (continuous) system and the controlled aerated composting process is initiated, or once a vessel or tunnel has been filled in a batch system. Temperatures within the unit can readily exceed 55°C during the pasteurisation phase of the process, which enables reduction of odour emissions and management of weed seeds and pathogens in the feedstock.

In-vessel processes are generally suitable for more odorous waste streams that include food and biosolid waste and are often modular systems that provide flexibility and allow for increased capacity with addition of more modules. The in-vessel composting is a relatively slow process with high initial cost (relative to non-enclosed composting processes), but its lower environmental impacts from leachate, odour and dust make it one of most widely used composting technologies throughout Australia and on islands. The composting processes generally produces a stable and quality-controlled compost.[32]

Compost produced can be removed from the system after the completion of a processing cycle and can be used as composted soil conditioner.[34] Smaller-scale in-vessel composting processes can accommodate smaller overall quantities of organic waste and systems such as HotRot have been successfully used across Australia and islands, including Lord Howe Island and Norfolk Island (**refer to Section 5**).[35]

[33] CISP 2023, '*Methodology and case studies*', available from: **https://harvestquest.com/press/**
[34] Sustainability Victoria 2019, '*Guide to Biological Recovery of Organics*', available from: **https://assets.sustainability.vic.gov.au/susvic/Guide-Waste-Biological-Recovery-of-Organics.pdf**
[35] As per comms., LHIB 2023.

7.5.2 Current feasibility

Table 7.6 assesses the feasibility of IVC for implementation in the IOT. Details of some potential technology providers are presented in Appendix C.

Table 7.6 Feasibility of IVC

Factor	Description
Benefits	– No laydown is required for organic material. Bin lifter used or automatic moving floor. – Well-developed and publicly accepted technology in Australia and remote areas including islands (**refer to case study in Section 5**). – Easy to use and operate. – Contained leachate systems. – Fully enclosed system to prevent odour and vermin. – The option will contribute to federal and state targets. – Likely that the system can be operated by existing staff.
Constraints	– Generally powered off electricity. May need solar panels. – Shredding will be required prior to input of bulky organic material. – System will likely require additional processing infrastructure for mature compost. – Medium to high CAPEX and OPEX compared to other options (refer to Section 8).
Feasibility	Suitable in current IOT context.

7.6 Dehydration

7.6.1 Technology overview

Dehydration is a process that can convert FO at high temperatures into a dry, odourless, compost-like output which can be used as a soil amendment. This output can be stored for a period and mixed with soil at a ratio of 10:1 to apply in parks and gardens.

Power supply is required to provide the desired temperature (40-84°C) to enable extraction of moisture and stabilisation of output. Steam generated during the process is condensed and can be used for grey water applications or discharged to sewer as it has a lower biological oxygen demand (BOD) and total suspended solids (TSS) content compared with typical digestate liquids from wet anaerobic digestion processes. At the end of a processing cycle, 80% to 90% volume reduction can be achieved.

Dehydrators do not require addition of water, wood chips or microbes during the process. Dehydrators have been commonly used to process FO at residential apartments, shopping centres and commercial food outlets, and remote locations such as mine sites and offshore islands; both internationally and throughout Australia.[32]

7.6.2 Current feasibility

Table 7.2 assesses the feasibility of dehydration for implementation in the IOT. Details of potential technology providers are presented in Appendix C.

Table 7.7 Feasibility of dehydration

Factor	Description
Benefits	– Furthermore, it is likely for the dehydration systems that solar panels will be required which will increase these costs further. – Simple system. – Proven technology in remote areas. – There is generally no pre-shredding required, and batch loading once a cycle. – Processing cycles are short (10 – 24 hours). – Manual loading required for some processing infrastructure.

Factor	Description
	– Remote monitoring available, however may not work in the IOT context. – Contained leachate and processing system. – Likely that the system can be operated by existing staff. – Enclosed unit so lower risk of odour and vectors. – Dehydration is on average the least expensive food organic processing system (CAPEX and OPEX) for both CKI and CI.
Constraints	– Suited to a higher throughput of FO. – Not suitable for GO, noting that IOT have a higher volume of GO than FO feedstock. – As this system is unable to process GO, when examining the CAPEX and OPEX per tonne, dehydration is not the most cost-effective option (refer to Section 8). – Solar panels need to be considered to run this unit continuously. This has not considered in costs provided in Section 8. – A building would be required. – Only suitable for relatively homogenous FO mixes with acceptable moisture, bulk density and porosity characteristics. – If reused on island products will need to be blended with soil (1:10) for use.
Feasibility	Suitable in current IOT context (for FO only).

7.7 Biodrying

7.7.1 Technology overview

An alternate approach to dehydration is biodrying, a form of moisture-deprived composting that takes advantage of biological heat generation and reduces the moisture content of larger quantities of (particularly garden) organic waste with less capital and energy intensive processing than electro-mechanical systems. Examples of this processing technology include the Convaero composting and biodrying system offered by Eggersmann Recycling Technology. The system is an adaptation of covered windrow, ASP composting. According to Eggersmann, for the purpose of composting, waste is reliably sanitized and stabilized after a short process time. For the purpose of biological drying, standard water content in the output waste (after drying) is 20% or less depending on requirement. The system can treat municipal waste (sorted or screened), green waste, organic waste, sewage sludge or digestate.

During processing, pile temperature rises to 60 - 70 °C, pasteurising the organic fraction and evaporating moisture in the waste. After 2 to 4 weeks, the moisture content of the waste is lower, and the material is essentially odourless and largely stabilised. It is understood that this relatively low cost technology has been successfully implemented in tropical climate locations.

7.7.2 Current feasibility

Table 7.8 assesses the feasibility of biodrying for implementation in the IOT.

Table 7.8 Feasibility of biodrying

Factor	Description
Benefits	– Low CAPEX/OPEX – Can experiment with different feedstocks and a lower ratio of FO. – Dried product more suited to incineration than undried GO or FOGO. – Less supplementary fuel required for incineration of dried organic waste.
Constraints	– Although this is a covered process it is not enclosed. – Larger footprint. – Biodrying is generally not a suitable option for very small quantities of FOGO, as generated in the IOT. – The material would need to be turned frequently and progressively with biodrying.

Factor	Description
	– Slow process takes some weeks to produce the dried product and therefore it requires a large site.
Feasibility	Not suitable in current IOT context.

7.8 Protein farming (black soldier fly larvae)

7.8.1 Technology overview

Goterra use black soldier fly larvae for food waste bioconversion. FO with an allowance of no more than 25% of GO, is digested by the fly larvae. The products produced include insect protein that can be used in animal feed and aquaculture, and frass (insect manure) which can be used as a soil conditioner. It can be applied to land or further composted [36] GO is not degraded or pasteurised in the process however.

The process takes place in modular, autonomous shipping container units with dimensions of 13 m long, 2.5 m wide and 2.5 m high, which can be located outdoors on a hardstand area.

One container can process approximate 1,500 tpa or 5 t/day of FO. The units require servicing every 12 days which involves the removal of mature larvae and the introduction of new larvae. There is no capital cost as the units are only leased from Goterra due to the frequent servicing requirement. Goterra processes and on-sells the end product, therefore potential revenue to the IOT is not possible (noting also that export and sale of product from the IOT is unlikely to generate net revenue for Goterra). Contamination (i.e., non-digestible material) is removed during processing and treated as general waste, making for a high-quality end product, however, any GO will likely form part of the residual general waste component as it is not consumed by the insects.

7.8.2 Current feasibility

Table 7.9 assesses the feasibility of black larvae for implementation in the IOT.

Table 7.9 Feasibility of black soldier fly larvae

Factor	Description
Benefits	– High value end products (noting however that there is likely no market in the IOT). – Small footprint. – Low risk as contractor operates the facility. – The black soldier fly larvae can eat compostable packaging but do not eat contamination (or GO) and physical contaminants will therefore not contaminate the end product. – Successfully proven processing technology. An example of this system being implemented is in Barangaroo in the International Towers Sydney, and the Albury Waste Management Centre. – There is no capital cost as the units are only leased from Goterra due to the frequent servicing requirement.
Constraints	– Goterra processes and on-sells the end product, therefore potential revenue / providing end products to residents and commercial entities is not possible. It is unlikely that the product would generate net revenue given high shipping costs and isolation of the IOT. – Supports only FO processing. If applied to FOGO, it would require a high FO:GO ratio which is not suited to the feedstock on the islands, and would not pasteurise or reduce the volume of GO. – Less decarbonisation than other processes that can process FOGO. – OPEX cost is high as it require servicing every 12 days which involves the removal of mature larvae and the introduction of new larvae. – Still commercialising – not yet considered commercially mature technology in a remote site context.
Feasibility	Not suitable in current IOT context.

[36] Goterra 2023, '*Black larvae*', available from: **https://goterra.com.au/**

7.9 Summary

Based upon the technology options considered in Section 7, the following technologies have been considered potentially suitable for implementation in the IOT context and will be further assessed through a cost comparison and MCA:

– Covered / open windrow.
– CASP.
– IVC.
– Dehydration.

8. Cost comparison

Based upon the processing options assessed in Section 7, cost estimates have been calculated and displayed in Figure 8.1 and Figure 8.2. These costs are based upon a number of assumptions. Complete costings cannot be fully realised until detailed quotes are provided, and this was beyond the scope of the current study. The assumptions are based upon information provided by equipment and technology providers and system vendors and when information was missing, GHD's industry understanding and published reference information was used to address gaps.

Cost details, assumptions and further information on the technology providers assessed are provided in Appendix D. Note that these costs do not include contingency, depreciation and cost of preparation / shredding garden organic waste and screening of products if required and not already been included by the technology provider. In addition to this, community education will need to be accounted for. The cost estimates are based on the waste data currently available. These costs may be adjusted once more accurate waste data has been captured by the Shires. These costs do not take into account the sale of material on island which would contribute to offsetting ongoing operating costs. Ideally, the recycled organic products should be able to be given away for free to residents, or sold to businesses on the islands to create a circular economy.

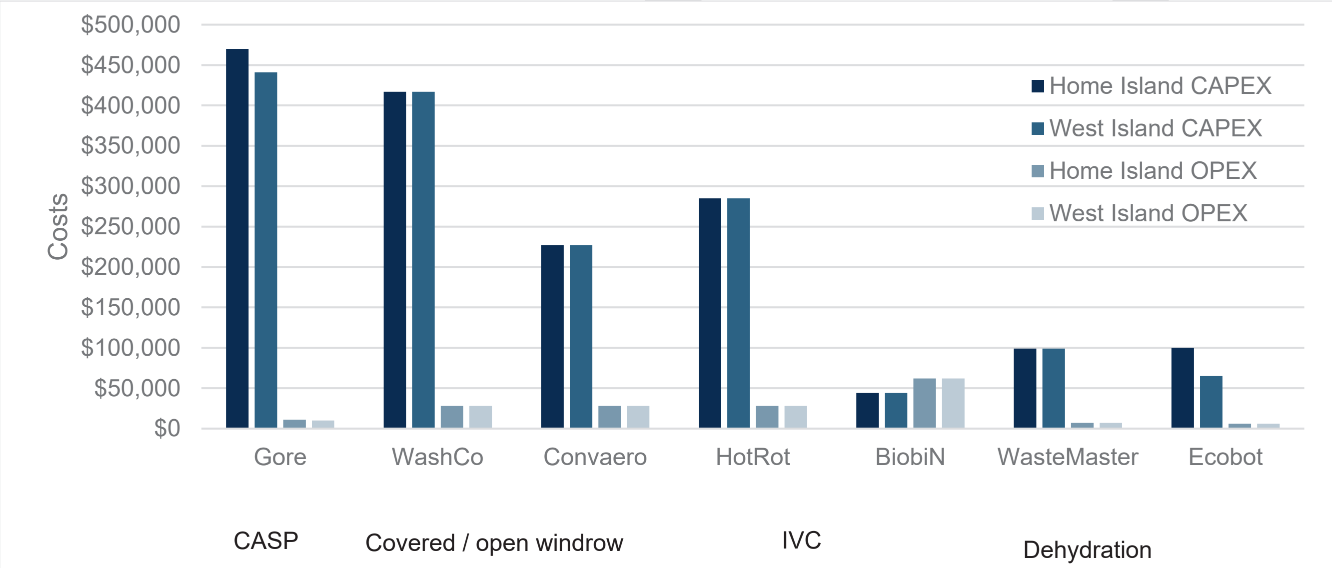


Figure 8.1 Cost estimates (CKI)

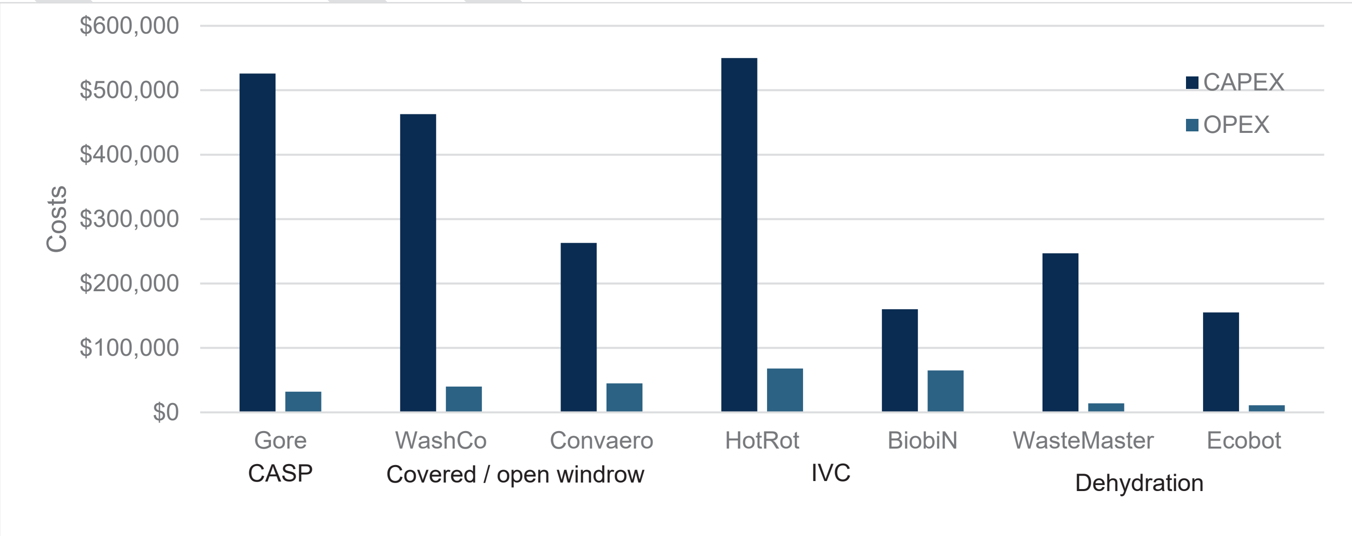


Figure 8.2 Cost estimates (CI)

9. Multi criteria analysis

9.1 Criteria

To understand the potential of each technology within the IOT context, a MCA was undertaken to assess the performance of each option against six (6) key factors. Each factor was assigned a weighting to represent the importance of each factor in considering the feasibility of the technologies. An overview of the categories, weightings and evaluation criteria is provided in Table 9.1 below. Further detail is provided in Appendix E.

Table 9.1 Summary of MCA categories and criteria

Categories	Weightings	Summary of evaluation criteria
Technical maturity and practicality	**20%**	– Consideration of overall feasibility and practicality of organics processing option. – Technical maturity of this option in remote areas, Australia and globally. Can the equipment required be purchased and commissioned in remote areas, from other states or overseas
Operational requirement	**20%**	– Is the operation labour intensive and does it require skilled staff to operate? Is it easy to find local staff? – Can the system readily handle an increase or decrease in waste quantities over time? – Does equipment require regular servicing and is it easy to train local staff or engage a contractor to maintain facilities or fix / replace faulty equipment?
Environmental and strategic drivers	**15%**	– Does the option pose a negative impact upon environmental values (e.g. greenhouse gas emissions, waste to landfill)? – Does the option align with regional, national, and international waste strategy? – Is there an existing or foreseen conflict to legislation requirements?
Risk, health and safety	**10%**	– Does the option provide the communities with a safer environment by reducing exposure to pollution, pests and disease? – Does the option and associated technology pose a safety risk to users?
Socioeconomic considerations	**15%**	– Will the proposed options provide job opportunities to the IOT? – Is it practical and will it be well-received by the communities? – Will it provide extra benefits for the IOT such as improved satisfaction of visitors/tourists?
Financial feasibility	**25%**	– Consideration of investment cost vs operational costs and potential cost savings (high level consideration of whole of life cycle costs). – Ancillary infrastructure requirements e.g. road upgrades, additional trucks, etc.

It should be noted that the nature of the assessment, and particularly the adoption of the evaluation criteria for each aspect, inherently leads to a certain level of subjectivity. It is therefore recognised that by changing the weighting applied to each category, or altering the evaluation criteria, significant changes in the overall scoring would be possible.

9.2 Preferred processing technology

The MCA above found that a CASP system is the preferred scenario as it has the highest total weighted score of 77. This is followed by IVC, open / closed windrow and finally dehydration (refer Figure 9.1). Refer to results in Appendix F

The following key observations are made:

– All shortlisted systems can be potentially feasible in the IOT context. However, consideration needs to be given to regulations that will be enforced, uses for the recycled organic product and community acceptance.

– CASP is the highest rated technology as it is a simple solution. CASP has the lowest ongoing costs and therefore these systems have the lowest economic and social risk.

– CASP produces mature composts, however it is a relatively slow process compared to IVC and dehydration. If looking to reuse the output product on island, some IVC units would need additional processing infrastructure.

– IVC is the next preferred, as it is the most practiced option in an island context and is a contained solution. As such, it is perceived to pose a lower environmental risk, noting that maintenance could be challenging in the remote IOT context.

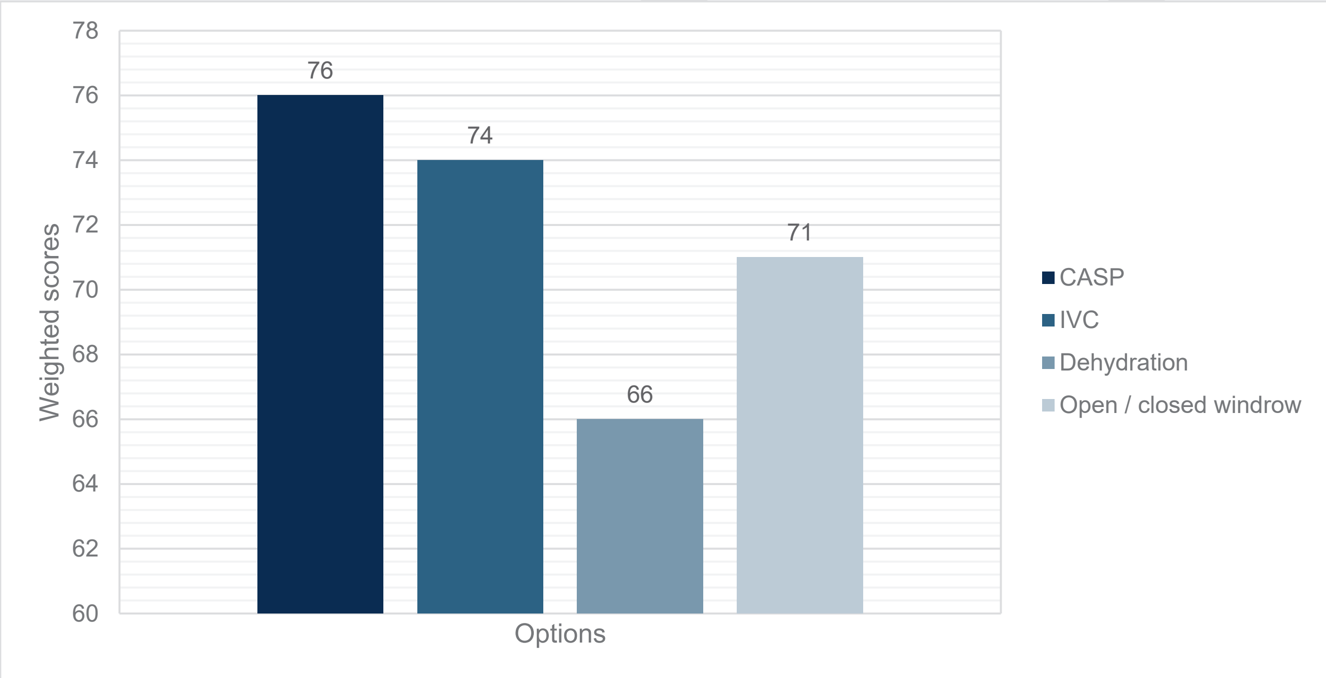


Figure 9.1 Preferred option

10. Conclusions and recommendations

This report was prepared to investigate the feasibility of organic waste processing and compare technologies for long-term implementation on CI and CKI. This investigation was initiated to support the Strategy that identified organics processing to be a key priority to be explored within the IOT.

Processing and recycling organic material on-island can provide a number economic and environmental opportunities. It also presents an opportunity to achieve higher resource recovery rates. A key benefit identified is that the implementation of organic processing infrastructure can reduce the operational costs and environmental impacts of managing residual waste.

The current context of the IOT and jurisdictional requirements associated with organic processing create a number of barriers that need to be overcome to successfully implement organics processing. These barriers are summarised below:

– Site regulations – There are currently strict site establishment and management requirements for the implementation of organics processing infrastructure which may be inhibiting for the IOT. Particularly, regulations / guidelines associated with sensitive receptors, and groundwater protection.
– Recycled organic product use – For reuse of organic material there are generally stringent testing requirements. In the current context of the IOT, frequent testing requirements would be challenging due to holding time constraints, strict guidelines and funding constraints. If no testing is undertaken, revenue generation potential would be limited and outputs may need to be used for rehabilitation purposes only, noting this would still need to be approved by DWER, or incinerated, noting that in this circumstance, a CASP process could be operated as a biodrying process.
– Community support – Community support is integral for the implementation of waste management technology. Particularly, if an organic collection service is implemented.

It is emphasised that organics processing in the IOT does need to produce a revenue source or even break-even cost, given that overall cost savings and environmental benefits would still be key drivers. Reducing the amount of material requiring disposal as residual waste decreases the overall residual waste management cost and infrastructure maintenance requirements to SoCKI, SoCI and DITRDCA.

The volumes of organic waste generated in the IOT are generally considered small, in the context of the technologies available and their relative processing capacities. However, the overall benefits associated with removing organic waste from the general waste stream via appropriately implemented processing arrangements are potentially quite significant. A number of organic processing technologies and providers were evaluated to assess the feasibility of organics processing in the IOT. The technologies assessed included: small-scale anaerobic digestors, CASP, open / covered windrow, CISP, IVC, dehydration and biodrying.

Based upon this assessment it was considered that organic processing can be feasible in the IOT context. The following technologies considered to be potentially feasible for implementation in the IOT were further assessed through an MCA:

– CASP.
– Open / covered windrow.
– IVC.
– Dehydration.
– Biodrying.

Based upon technical maturity and practicality, operational requirement, financial feasibility, health, safety and sustainability, and socioeconomic considerations, the preferred option was identified to be CASP, followed by IVC due to the lower risks posed to the environment, well-developed and publicly accepted technology and the technology’s simplicity. However, all systems assessed through the MCA may be potentially feasible in the IOT context.

10.1 Recommendations

The following list summarises the recommendations from this assessment to support DITRDCA in successfully establishing organics processing solutions within the IOT.

- Engage with DWER and WA Department of Health to understand requirements for reuse of recycled organic products and site establishment requirements that would need to be satisfied for an organic waste processing facility within the IOT context, particularly in light of current arrangements and a do-nothing scenario.
- Undertake consultation to gauge community interest in the potential implementation of organics collection and processing. It is also important to understand community perspectives and appetite for recycled organic products and their use on the islands. As the project progresses, engagement with the community and other stakeholders will be needed during planning and post-implementation for successful service delivery.
- Undertake further, detailed assessment of potential organics collection options. This could include consideration of separate FO and GO collection, FOGO or GO-only collection. A waste collection trial and associated composition audit could provide detailed data on contamination rates, uptake, community feedback and volumes of municipal organic waste produced in the IOT.
- Alternatively, waste audits could be undertaken of existing residential and commercial waste streams via a bin audit to better understand the waste volume and composition on the islands. This is a common practice on islands around Australia due to the absence of weighbridges and appropriate infrastructure to track waste generation rates and composition.
- It is acknowledged that an organics collection service will be costly to implement. For CKI, due to the smaller population and limited distances involved, it may be worth considering the rationalisation of existing waste collection services and implementation of self-haul to convenient drop-off locations. This is a common practice on islands and would reduce waste collection costs and risks associated with contamination management.
- Following a detailed waste stream audit, next steps could include undertaking a detailed feasibility assessment and preparing a business case to select the most suitable organics collection and processing service. This assessment should include market sounding and detailed financial modelling to inform investment decision making, as well as analysis of collection trial data and community engagement to understand participation rates.

Appendices

Appendix A

Current state

Permanent residents

Population data from the Australian Census was reviewed for both CI and CKI and there has been a steady though modest population decline on both Islands and as such it is expected that the permanent residential population will decrease. This is shown in Figure 10.1.

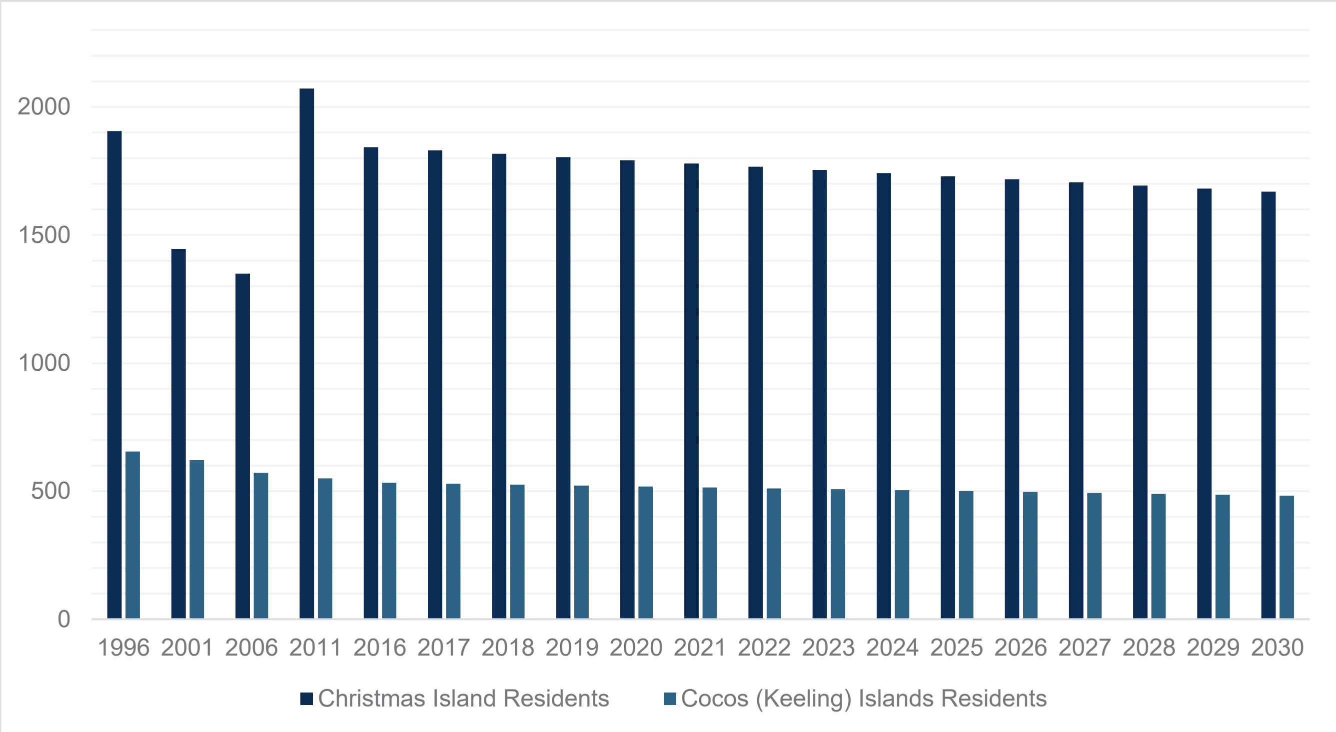


Figure 10.1 Historical and projected residential population in the IOT

Temporary population

Transient groups such as fly-in fly-out (FIFO) workers and visitors (including tourists) exert a strain on existing infrastructure and assets within the IOT. This is relevant for both CI and CKI due to Department of Defence and Commonwealth infrastructure projects, uncertainty surrounding the ongoing operational status and numbers of detainees and associated staffing required at the CI detention centre, as well as uncertainty around the long-term future of phosphate mining operations.

When comparing tourism numbers between 2016 and 2021, there was a large increase in tourism numbers in both CI and CKI at the end of 2020 and throughout 2021. This is attributed to the increased number of mainland Australian visitors due to international and interstate travel restrictions associated with COVID-19.

Figure 10.2 and Figure 10.3 show the trend in tourism between 2016 and 2021 for CI and CKI respectively. As stated previously, tourist numbers increased significantly relative to historical data. However, it is also noted that between 2016 and 2021, the numbers visiting for business have noticeably fluctuated. This fluctuation, in combination with increased tourist numbers, exerts a strain on existing infrastructure and assets within the IOT.

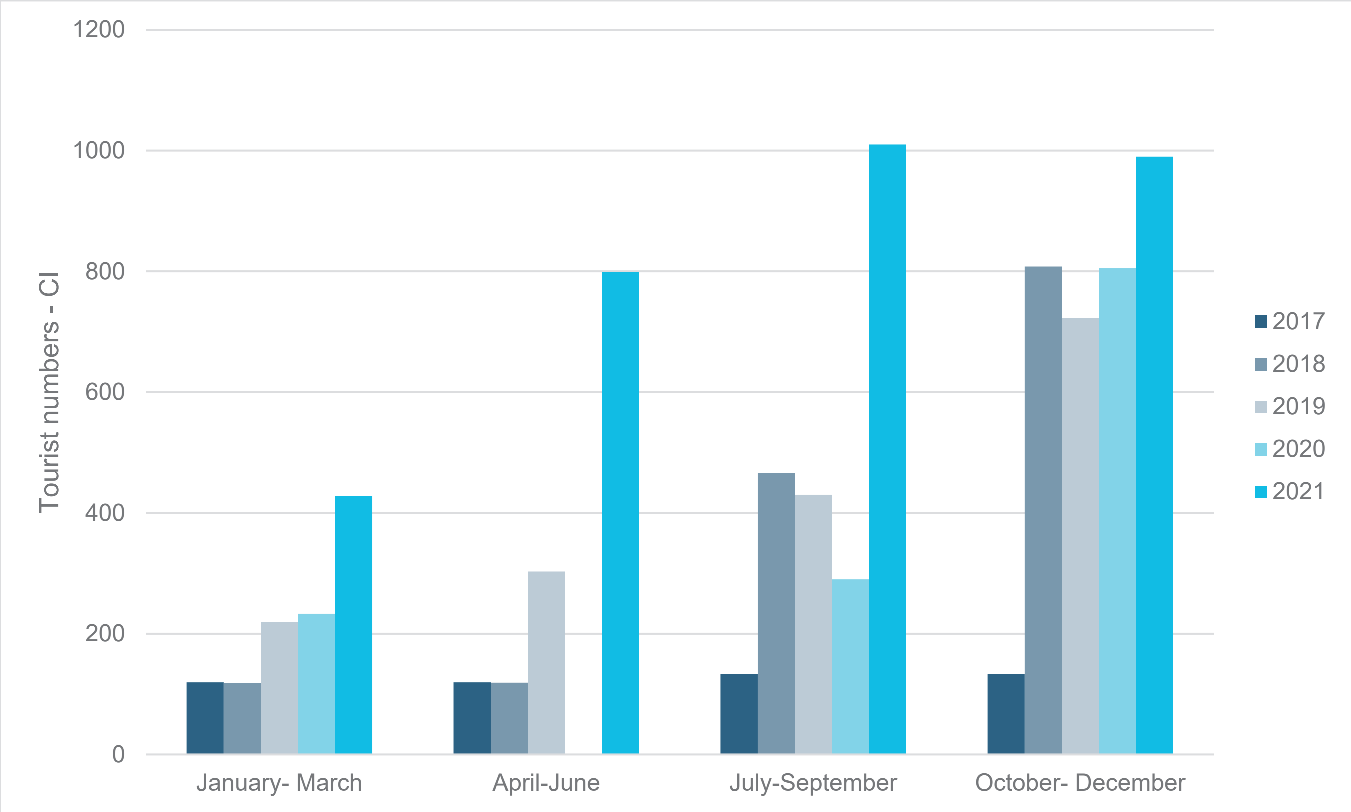


Figure 10.2 CI: Tourist numbers 2016 - 2021

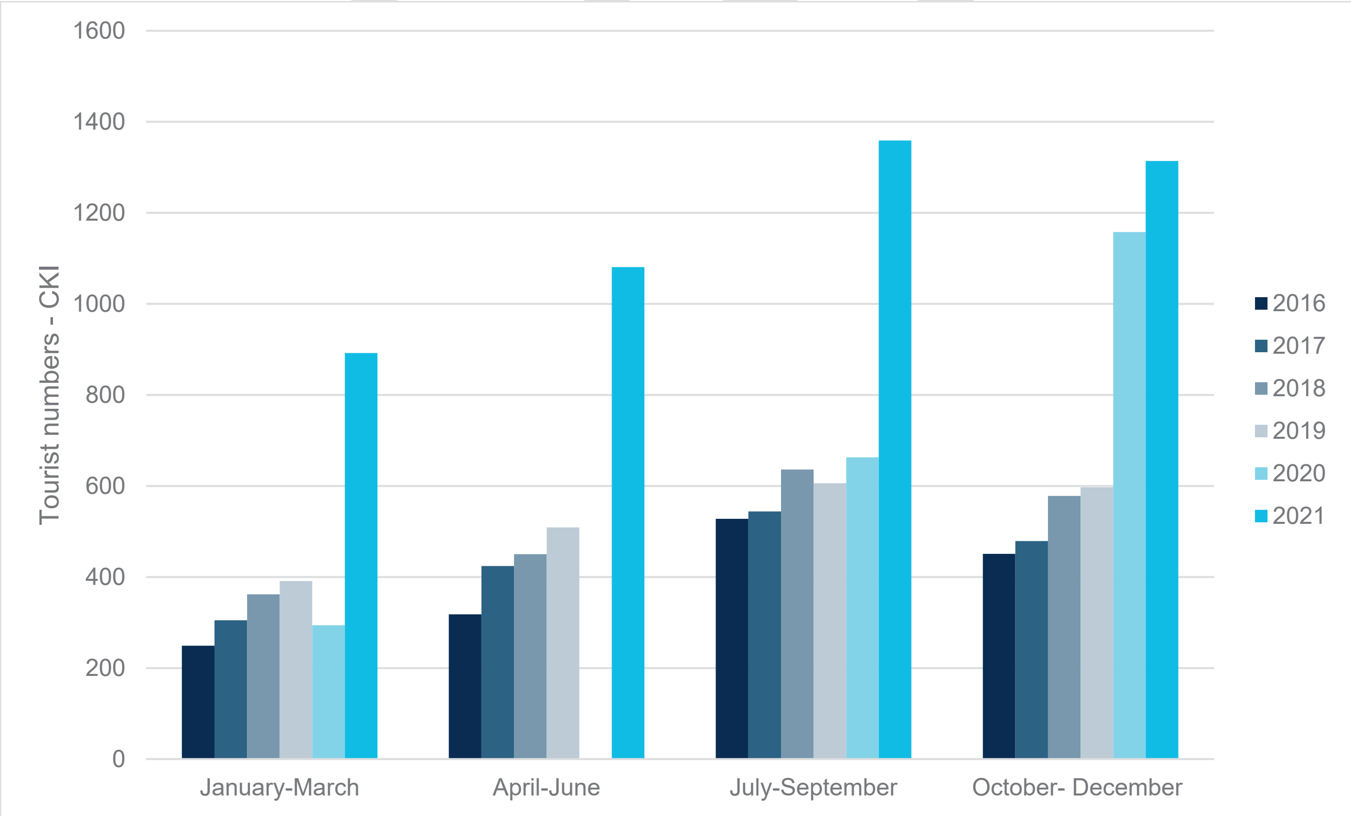


Figure 10.3 CKI: Tourist numbers 2016 - 2021

Projected growth

Figure 10.4 displays the projected annual population, inclusive of residents, tourists and others visiting friends/relatives and businesses. Given the limited flight frequency (e.g. twice weekly service from Perth), GHD has assumed that temporary groups stay on the islands for five (5) days, and based upon this, GHD has calculated how many permanent residents the additional visitors would be equivalent to. It is considered that this a conservative approach to population growth estimation for the islands. It is also noted that visitor numbers are currently restricted by accommodation capacity, with only around 140 accommodation beds per night currently available at CKI, and approximately 120 accommodation beds per night available at CI.

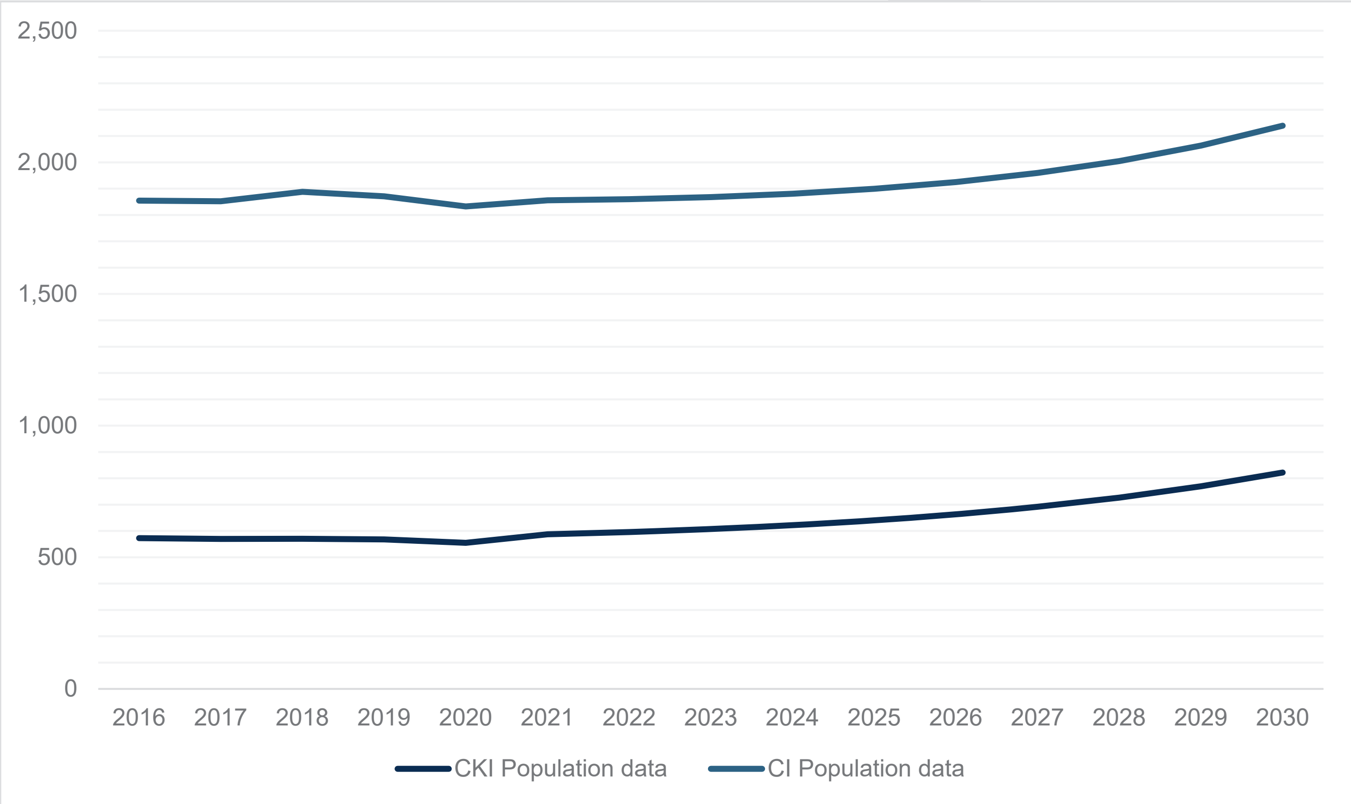


Figure 10.4 Projected population (permanent and temporary numbers) by year

Demographic and waste management information

Table 10.1 Demographic and waste management information

Data	Christmas Island	Cocos (Keeling) Islands
Predicted population (refer Figure 10.4)	1,868 people	Total: 607 people West Island: 116 Home Island: 451
Average household size	2.7 people	3.7 people
Collection service	Mixed residual waste collection from the settlements and townships twice a week. Mixed residual waste collection from the detention centre daily in two runs (including weekends). Mixed residual waste collection from public housing areas daily (excluding weekends).	Weekly household mixed waste collection. SoCKI are in the process of trialling twice weekly mixed waste collections due to increased demand and reduced opening hours at the transfer station.

Data	Christmas Island	Cocos (Keeling) Islands
Number of households / bins serviced	253 single household bins[37]: – Each residence has its own 240 litre (L)[38] Mobile Garbage Bin (MGB)* – There are a number of different coloured bins on the island without a designated purpose.[39] 129 multi residential bins: – Multi-unit households are provided with shared bins. 84 bins at commercial premises.	West Island[40]: Domestic putrescible waste bins: ~ 65 x 240 L MGB. – Commercial bins: ~ 20 x 240 L and 120 L MGB. – Glass and aluminium bins: ~ 40 240 L MGB (shared between two properties). – Public bins: 8 sets for the separate collection of waste, glass and aluminium (240 litre MGB). Home Island: – Domestic putrescible waste bins: ~ 100 x 240 L MBG. – Commercial bins: ~ 20 x 240 L and 120 L MBG. – Glass and aluminium bins: ~ 40 120 L MGB (per property).
Total number of businesses on the islands[41]	Approximately 130 licensed businesses. 11 licensed food venues. 22 accommodation venues. It is estimated that 10 tpa can be collected in average from each food licenced venue (this tonnage will go up and down depending on the size of the venue).	Approximately 80 licensed businesses. 8 licensed food venues. 20 accommodation venues. As well as a multitude of other commercial premises. It is estimated that 10 tpa can be collected in average from each food licenced venue (this tonnage will go up and down depending on the size of the venue).

Hidden Garden farm

Hidden Garden farm is located on previously mined, unproductive land on CI. Some community generated FO currently collected by SoCI is utilised to make liquid compost.[42] A small scale liquid composter is used to generate active Bio-Vital™ compost. The liquid compost product is used as a fertiliser. There is potential that recycled organic products produced from larger scaler organic processing of FO and GO could be utilised by Hidden Garden farm.

It is recommended that there should be consideration towards collaborating with Hidden Garden to scale up current operations.

[37] Environmental Solution Providers 2008, *'Christmas Island Waste Management Strategy Discussion Paper',* DITRDCA
[38] As per comms. SoCI, retrieved April 2022
[39] GHD 2000, '*Christmas Island Waste Management'*, Department of Transport and Regional Services.
[40] As per comms. Martin Faulkner, SoCKI Manager Infrastructure, retrieved 9 March 2022
[41] IOT 2023, '*Business Directory'*, available from: **https://iot-businesses.com.au/business_directory/**
[42] Hidden Garden Sustainable Farms 2022, '*Christmas Island'*, available from: **http://hiddengarden.com.au/christmas-island/**

Appendix B

Organic waste volumes

Table 10.2 and Table 10.3 shows the estimated volumes of FO, GO and biosolids generated on each island. Available organic feedstock has also been calculated for a potential population of 5,000 people on CI as this is the maximum number of people that would be expected on-island at any time (due to known water and infrastructure constraints). It is noted that the available feedstock provided below is only an estimation.

For FO, the minimum volume for kerbside collection is based upon the average rate expected to be produced per week per capita. For commercial entities, FO volumes have been calculated based upon the number of businesses that are likely to produce a high quantity of FO material (shown in Table 10.1 in Appendix A).[43]

It is difficult to ascertain how much GO material is generated via self-haul. Therefore, to estimate the minimum amount of material generated, the GO self-haul rates provided by CI have been used. However, the GO produced by residents have been adjusted based upon the organic generation average rate provided in Table 4.1.

Table 10.2 CKI available feedstock – organic waste, including population-based projections to 2030

CKI	2023		2030	
West Island	**Min**	**Max**	**Min**	**Max**
FO - kerbside	4		5	
FO - commercial	5		7	
FO - TOTAL	**9**	**42**	**12**	**56**
GO - kerbside	2		2	
GO - commercial	12		17	
GO - TOTAL	**15**	**97**	**16**	**131**
FOGO - TOTAL	**24**	**139**	**28**	**188**
BIOSOLIDS	**31**	**31**	**44**	**44**
Home Island	**Min**	**Max**	**Min**	**Max**
FO - kerbside	15		21	
FO - commercial	15		20	
FO - TOTAL	**30**	**62**	**41**	**83**
GO - kerbside	7		21	
GO - commercial	48		65	
GO - TOTAL	**55**	**144**	**86**	**194**
FOGO - TOTAL	**85**	**205**	**126**	**278**
BIOSOLIDS	**31**	**31**	**44**	**44**

Table 10.3 CI available feedstock – organic waste, including population-based projections to 2030

CI	2023		2030		2050	
Christmas Island	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
FO - kerbside	86	247	99	283	231	661
FO - commercial	27	87	31	100	72	234
FO - TOTAL	**113**	**335**	**130**	**383**	**303**	**895**
GO - kerbside	38	577	44	660	102	1,543
GO - commercial	198	204	225	234	530	2,089
GO - TOTAL	**236**	**781**	**269**	**894**	**632**	**3,632**
FOGO - TOTAL	**350**	**1,115**	**399**	**1,277**	**936**	**4,528**

[43] Commercial entities assumed to generate approximately 46.6 kg per week of FO (based upon GHD's industry experience).

CI	2023		2030		2050	
Biosolids	919	919	1,052	1,052	2,459	2,459

Appendix C

Technology providers

CASP

Gore ASP

Assessment criteria	Description
Technology provider	*GORE® Cover,* GORE® Further details are provided in Appendix D.
Description	Gore aerated static pile (ASP) uses compost piles and a woven textile fabric to cover the compost pile to protect the material from weather conditions, and retain moisture and heat inside the compost pile. [44] Many woven textile compost covers are also designed to contain odours and volatile organic compounds. Placement of a waterproof membrane cover keeps odorous compounds and moisture under cover. The system can be easily upscaled through the addition of piles attached to a single control system. The system can either have above ground or trenched piping which collects process water and diverts it to a holding tank. Due to the small scale of operations in the IOT, contaminants in the organic material can be manually picked in a flat area. Infrastructure required can be limited with no hardstand or bunding required. However, for a better safeguard against potential land contamination a hardstand area with bunding to divert groundwater has been examined for the IOT context. ASP is used for either the first stage (2 – 8 weeks) or intermediate stage between enclosed systems and open windrow maturation (additional 6 – 12 weeks).
Example photos	 
Feedstock accepted	FO:GO ratio is 1:1 weight or 3:1 carbon: nitrogen (food) volume ratio.
Batch size / loading requirements	Flexible. For the quoted system, the capacity range is as followed: CKI (West Island): 146 to 179 FOGO CKI (Home Island): 217 to 268 FOGO Christmas Island: 996 to 1062 FOGO
Retention time	Active composting: 21-28 days Maturation composting: 21-28 days Total: 42-56 days
CAPEX (per island)*	CKI (West Island): $441,000 CKI (Home Island): $470,000 Christmas Island: $526,000 Refer Section 8.
OPEX (annual)*	CKI (West Island): $9,000 CKI (Home Island): $11,000 Christmas Island: $31,000 Refer Section 8

Note: *These costs are based upon a number of assumptions. Complete costings cannot be fully realised until detailed quotes are provided. Costs have been based upon the 2030 maximum realistic feedstock quantity estimated in Section 4.3.

[44] GORE@Cover, industry budget quote for IOT, 2023.

Covered / open windrow

WashCo

Assessment criteria	Description
Technology provider	WashCo Further details are provided in Appendix D.
Description	WashCo located in Perth can provide the capital and ongoing support for open windrow systems on each island. This system will include hard stand area, concrete bunkers, windrow turners and screens. The ongoing running costs include labour, equipment maintenance and FOGO batch testing (if intending to reuse). It is noted that in 2019 WashCo examined the feasibility of organics processing on CKI which included undertaking a site visit. WashCo assessed organics processing to be feasible. However, the current jurisdiction requirements and site guidelines for organics processing delayed the project and will likely restrict this type of processing technology in the current context of the IOT. Particularly, as it is an open windrow system.
Example photos	No photo provided. Example photo below. 
Feedstock accepted	FOGO
Batch size / loading requirements	Flexible. Similar to CASP system, can be upscaled or downscaled through the addition of piles.
Retention time	8 – 16 weeks for composting and maturation.
CAPEX (per island)*	CKI (each island): $417,000 CI: $463,000 Refer Section 8.
OPEX (annual)*	CKI (each island): $27,000 CI: 40,000 Refer Section 8.

Note: *These costs are based upon a number of assumptions. Complete costings cannot be fully realised until detailed quotes are provided. Costs have been based upon the 2030 maximum realistic feedstock estimated in Section 4.3.

Convaero

Assessment criteria	Description
Technology provider	Convaero Further details are provided in Appendix D.
Description	Convaero can offer a covered windrow system and support the commissioning of the system. The primary equipment necessary includes a windrow turner, wheel loader, basic cover, hardstand as well as basic infrastructure (i.e. irrigation pipes, leachate tank). The system does not require connection to utilities and requires some earth moving infrastructure (e.g. loader, bobcat, etc) which run off diesel. The system 39equirees minimal training and has limited operational requirements. The most important operational requirement for the system to work effectively is moisture control. For better environmental controls Convaero offer a basic cover which can be manually placed over the piles during operation.
Example photos	No photo provided. Example photo below.

Assessment criteria	Description
	
Feedstock accepted	FOGO
Batch size / loading requirements	Flexible. Similar to CASP system can be upscaled or downscaled through the addition of piles.
Retention time	8 – 16 weeks for composting and maturation.
CAPEX (per island)*	CKI (each island): $227,000 CI: $263,000 Refer Section 8.
OPEX (annual)*	CKI (each island): $28,000 CI: $45,000 Refer Section 8.

Note: *These costs are based upon a number of assumptions. Complete costings cannot be fully realised until detailed quotes are provided. Costs have been based upon the 2030 maximum realistic feedstock estimated in Section 4.3.

IVC

HotRot

Assessment criteria	Description
Technology provider	*HotRot*, Global Composting solutions Further details are provided in Appendix D.
Description	HotRot manufactured by a New Zealand company is a continuous, flow-through in-vessel composter[45]. It incorporates a horizontal composting chamber that has a shaft running lengthwise through it. Arms attached to the shaft rotates slowly to ensure the composting process operates at high efficiency. HotRot is designed to process FO, GO, biosolids and animal waste. Feedstock can be loaded into the system by a bin lifter or an auto feeding unit after pre-processing, e.g., shredding. All HotRot units are fully enclosed and insulated meaning they do not need to be housed in a building, thus minimising capital and maintenance costs. Material is automatically discharged from the HotRot unit via a combination of shaft rotation and displacement down the unit, caused by waste additions at the opposite feed end of the unit. Material takes approximately 10-12 days to pass down the length of the vessel.
Example photos	
Feedstock accepted	FO, GO, FOGO

[45] HotRot 2023, *'HotRot – Source separated organics'*, available from: **https://www.globalcomposting.solutions/source-separated-organics**

Assessment criteria	Description
Feedstock output	Compost. Not fully matured.
Batch size / loading requirements	Hopper allows for unattended operation. Continual flow composting system.
Retention time	10 – 12 days Throughput typically requires 2-3 week storage for maturation.
CAPEX (per island)*	CKI (each island): $285,000 CI: $550,000 Refer Section 8.
OPEX (annual)*	CKI (each island): $28,000 CI: $46,000 Refer Section 8.

Note: *These costs are based upon a number of assumptions. Complete costings cannot be fully realised until detailed quotes are provided. Costs have been based upon the 2030 maximum realistic feedstock estimated in Section 4.3.

BiobiN

Assessment criteria	Description
Technology provider	*BioBin*, Peat's Soil Further details are provided in Appendix D.
Description	BiobiN is an on-site organic waste containment and processing system [46]. Organic waste is collected, and the composting process is initiated in the processing container. The moisture contained in FO is extracted and recycled through an attached biofilter then injected back into the container to keep the process going. Power (generators or solar panels) is required to regulate the temperature within the container to facilitate the degradation process. Leachate generated is required to be collected in tanks. There are different models available with a capacity ranging from 1,500 kg to 16,000 kg. This system has been used in Australia and internationally, providing organic waste options to farms, resorts and mine sites. A number of units can be used on rotation allowing the compost time to mature in the vessel. There are remote power options of either generator of solar PV units and these units have been effectively utilised in remote regions.
Example photos	
Feedstock accepted	FO, GO, FOGO. No ratio requirements.
Feedstock output	Compost. Not fully matured.
Batch size / loading requirements	Bin lifter used.
Retention time	1 – 2 weeks
CAPEX (per island)*	CKI (each island): $44,000 CI: $160,000 Refer Section 8.
OPEX (annual)*	CKI (each island): $62,000 CI: $65,000

[46] BiobiN 2022, '*BiobiN overview*', available from: **https://biobin.net/about-biobin/**

Assessment criteria	Description
	Refer Section 8.

Note: *These costs are based upon a number of assumptions. Complete costings cannot be fully realised until detailed quotes are provided. Costs have been based upon the 2030 maximum realistic feedstock estimated in Section 4.3.

Dehydration

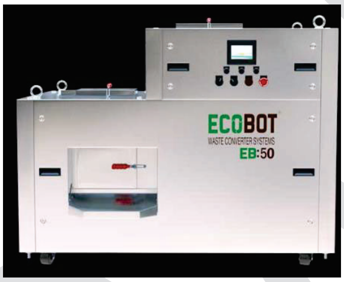
WasteMaster

Assessment criteria	Description
Technology provider	*WasteMaster*, GET Further details are provided in Appendix D.
Description	WasteMaster by Green Eco technologies (GET) is a dehydrator in which oxygen is supplied to accelerate the decomposition process and there is no requirement for additives[47]. The unit has less power demand compared to other dehydrators. FO is reduced by up to 80% by weight after 10 to 24 hours processing cycle, while the calorific and nutrient value of the feedstock remain consistent. The output is dry compost-like residual which can be used as a soil enhancer. GET provides two service options, including an outright plus a service/collection agreement and a fully managed agreement (equivalent to unit hire). The unit requires electricity supply and ventilation and can be easily used as a mobile unit. WasteMaster can be programmed in batch loading or continual loading modes.
Example photos	
Feedstock accepted	80% FO and up to 20% fresh grass clippings and soft vegetation. Potential for remainder of GO to be mulched (*separately)*.
Feedstock output	80% volume reduction. Soil amendment. If reused on island, products will need to be blended with soil (1:10) for use.
Batch size / loading requirements	Manually feed food waste. No minimum. Processing capacity between 0.25 to 1 t depending on machine.
Retention time	10 – 24 hours
CAPEX (per island)*	CKI (each island): $99,000 CI: $247,000 Refer Section 8.
OPEX (annual)*	CKI (each island): $7,000 CI: $14,000 Refer Section 8.
Footprint	Equipment: CKI (each island): 12 m^2 CI: 18 m^2 No laydown is required for organic material. Bin lifter used.

[47] Green Eco Technology 2022, '*Green eco tec*', available from: **https://www.greenecotec.com/**

Note: *These costs are based upon a number of assumptions. Complete costings cannot be fully realised until detailed quotes are provided.

Ecobot

Assessment criteria	Description
Technology provider	*ECOBOT*, BioBowser Further details are provided in Appendix D.
Description	Ecobot is another potentially suited dehydrator. Sawdust and microorganisms are added into the Foodie Bio Bowser at the beginning to enable the system to process FO.[48] Sawdust and microorganism are provided as a start-up kit by the supplier. The composter should be emptied by 25% each day, so microorganisms can remain in the system and reproduce. There is no need to add more microorganisms or sawdust if the system is used continuously without major breakdown. The system may require some pre-treatment of feedstock, for example a full cabbage will need to be shredded prior to placement in the unit. The system can accept chicken bones, eggshells, shellfish, but not large animal bones and oyster shells. The machine features two food waste inlets and a high-speed in-built shredder allows food waste fed without requirement for pre-treatment. Food waste will be converted into soil enhancer after a 24 hour cycle.
Example photos	
Feedstock accepted	FO – small amount of GO can be input into the system. Potential for remainder of GO to be mulched.
Feedstock output	80% volume reduction. Soil amendment. If reused on island products will need to be blended with soil (1:10) for use.
Batch size / loading requirements	360 L automatic bin hopper. No minimum. Processing capacity 6-8 t per bin unit.
Retention time	24 hour processing cycle
CAPEX (per island)*	CKI (West Island): $65,000 CKI (Home Island): $100,000 CI: $155,000 Refer Section 8.
OPEX (annual)*	CKI (each island): $6,000 CI: $11,000 Refer Section 8.
Footprint	Equipment: CKI (each island): 3.4 m^2 CI: 21 m^2 The unit will need to be housed in an enclosed shed 6 L x 2.5 W x 2.5 H.

Note: *These costs are based upon a number of assumptions. Complete costings cannot be fully realised until detailed quotes are provided.

[48] BioBowser 2022, '*Commercial composter*', available from: https://biobowserrenewabletechnologies.com.au/commercial-composter/

Appendix D

Cost details, assumptions and further information on the technology providers

Table D-1 Cost estimates – OPEX / CAPEX (CKI)

	Home Island		West Island	
	CAPEX	**OPEX**	**CAPEX**	**OPEX**
CASP				
Gore	$470,000	$11,000	$441,000	$10,000
Covered / open windrow				
WashCo	$417,000	$28,000	$417,000	$28,000
Convaero	$227,000	$28,000	$227,000	$28,000
IVC				
HotRot	$285,000	$28,000	$285,000	$28,000
BiobiN	$44,000	$62,000	$44,000	$62,000
Dehydration				
WasteMaster	$99,000	$7,000	$99,000	$7,000
Ecobot	$100,000	$6,000	$65,000	$6,000

Table D-2 Cost estimates – Cost per tonne (CKI)

	Home Island		West Island	
	CAPEX / t	**OPEX / t**	**CAPEX / t**	**OPEX / t**
CASP				
Gore	$2,200	$50	$3,000	$60
Covered / open windrow				
WashCo	$2,000	$130	$2,900	$190
Convaero	$1,000	$130	$800	$190
IVC				
HotRot	$1,300	$130	$1,900	$190
BiobiN	$200	290	$300	$430
Dehydration				
WasteMaster	$1,300	$90	$1,900	$130
Ecobot	$500	$70	$1,300	$110

Table D-3 Cost estimates – OPEX / CAPEX (CI)

	Christmas Island	
	CAPEX	**OPEX**
CASP		
Gore	$526,000	$32,000
Covered / open windrow		
WashCo	$463,000	$40,000
Convaero	$263,000	$45,000
IVC		
HotRot	$550,000	$68,000
BiobiN	$160,000	$65,000

	Christmas Island	
	CAPEX	**OPEX**
Dehydration		
WasteMaster	$247,000	$14,000
Ecobot	$155,000	$11,000

Table D-4 Cost estimates – Cost per tonne (CI)

	Christmas Island	
	CAPEX / t	**OPEX / t**
CASP		
Gore	$500	$30
Covered / open windrow		
WashCo	$500	$40
Convaero	$300	$50
IVC		
HotRot	$600	$70
BiobiN	$200	$70
Dehydration		
WasteMaster	$700	$40
Ecobot	$400	$30

Appendix D - Technology Overview Assumptions

Organic processing system	CASP	Open / covered windrow		IVC		Dehydration	
Provider	Gore	WashCo	Convaero	HotRot	BioBin	Wastemaster	ECOBOT Commercial Composter
Item	Gore	Open windrow	Covered windrow	Global Composting solutions	BioBin / Peat's Soil	Green Eco Technology	Bio Bowser
Feedstock accepted	FO, GO, FOGO	FO, GO, FOGO	FO, GO, FOGO	FO, GO, FOGO	FOGO	Primarily FO. Soft GO.	Primarily FO. Soft GO.
Capacity range (min to max) (tpa)	Flexible West Island: 146 to 179 FOGO Home Island: 217 to 268 FOGO Christmas Island: 996 to 1062 FOGO	Flexible	Flexible	Minimum 110 t per annum. Minimum 55 t of FO required.	6-8 t process capacity per unit	WM200 = 73 tpa WM400 = 140 tpa WM800 = 280 tpa	
Ratio	FO:GO ratio is 1:1 weight or 3:1 carbon: nitrogen (food) volume ratio	Variable. If biosolids included in system they should not exceed 10%	Variable	50:50 FOGO	All FOGO accepted. No ratio requirements	FO (80%) GO (20%)	FO (80%) GO (20%)
Land area (m2)	West Island: 160 m2 Home Island: 240 m2 Christmas Island: 450 m2	Cocos Islands: 200m2 Chrismas Island: 400 m2	Cocos Islands: 160-200m2 Chrismas Island: 400 m2	Unit 12.78 x 2/2 x 2.24 120m2	36m2 per unit	WM200 = 12m2 WM400 = 16m2 WM1000 = 18m2	BB250 and BB 500: The unit will need to be housed in an enclosed shed 6 m L x 2.5 m W x 2.5 m H.
Comments	System quoted: West Island: 2 SG Heap® System with 2 GORE® Cover Home Island: 2 SG Heap® System with 2 GORE® Cover Christmas Island: 4 SG Heap® System with 2 GORE® Cover	Required infrastructure: - Hard stand to mix and turn product - Concrete bunker 3 per island - Bobcat or loader or access to one - Tractor with PTO - Windrow turner - Screen	Simple system. Main components: windrow turner, whell loader, hose pipes, moving equipment.	System quoted HotRot 1206 unit. Does not required to be undercover. However, if odour an issue undercover area should be considered.	9m3 capacity unit. Electrics requires to be undercover.	Required to be under cover.	The shed will need 100mmm deep concrete pad.
CAPEX							
Processing infrastructure costs (approx)	West Island: $ 285,000.00 (USD) Home Island: $305,000.00 (USD) Christmas Island: $345,000.00 (USD)	$600,000 - $650,000 per island (CKI being lower end and CI being higher end). Without tractor between $400,000 - $450,000 per island.	Windrow turner: $150,000 Basic cover: $50,000 Basic infrastructure $10,000	$250,000 per unit	$30,000 per unit	WM200 = $85K WM400 = $130K WM1000 $230K	BB250 model cost $54,475 BB 500 model cost $ $72,785 BB 1000 model costs $ 128,920
Commissioning costs	Included in processing infrastructure cost - Commissioning, Start Up Services & Ongoing Technical Support	Included in above.	Included in above.	Includes installation. Does not include flights and accommodation. Assumed $8,000 incl. flights from New Zealand.	Included in training	$ 3,500	Nil.
Shipping costs (to Perth)	Does not include shipping. Assumed 20 ft shipping container required.	Does not include shipping. Assumed 20 ft shipping container required.	Does not include shipping. Assumed 20 ft shipping container required.	Does not include shipping. Assumed 20 ft shipping container required.	Shipping costs not provided to Perth. Assumed $4,000 for shipping to Perth and additional cost for shipping to islands.	$ 2,000	Above prices are delivery to Perth
Training costs	Included in processing infrastructure cost - Operating Training Module,	Budget for $10k per island. This will include initial training, and on going support and remote supervision.	Included in above. Only 1-2 hrs remote training required.	Includes training.	$2,500.00 per unit	$ 3,980	Average across all models.
Comments	Includes ancillary infrastructure i.e. container, solar, controllers and batteries.			Includes1 x1206 full stainless vessel, FU 2.5 hopper with lid, discharge auger, electrical and controls, bio- filter with fan and ducting, bin lifter for loading the hopper and installation excluding flights and accom.		Commissioning cost = $500 + travel costs (mainland) Training costs = $1,000 + travel costs	Extra BB1000 models can be added as time progresses and waste increases. Training will be provided and will contain WPHS training. There needs to be more discussion on deliveries, installations, commission, training and ongoing onsite servicing

Appendix D - Technology Overview Assumptions

Organic processing system	CASP	Open / covered windrow		IVC		Dehydration	
Provider	Gore	WashCo	Convaero	HotRot	BioBin	Wastemaster	ECOBOT Commercial Composter
Item	Gore	Open windrow	Covered windrow	Global Composting solutions	BioBin / Peat's Soil	Green Eco Technology	Bio Bowser
OPEX							
Electricity consumption (kwh year) / Diesel consumption (L)	Requires electricity which is powered with solar panels. Quote includes this. Solar panel unit is $85,000 USD for	Eah piece of equipment consumes 25-30L/hr. Assumed 2 hr consumption per week for CKI and 4 hrs for CI.	Similar to WashCo.	Single phased power. HotRot 1206: 20 kwh/t	Single phase power cord and connection (e.g. simple appliance electrical consumption) 1-4kw per day	WM400 uses on average 8kWh WM1000 uses on average 15kWh	BB250 model: 11.5kw BB 500 model cost 17kw BB 1000 model costs 31kw
Water consumption (t per day)	Minimal water is required depending on the moisture content of the input. High FO mixtures generally have enough moisture whereas a high GO batch may require a couple of litres of water added.	Minimal water required.	Minimal water required.	Minimal water required.	Minimal water required.	Minimal water required.	Minimal water required.
Service / maintenance cost (per annum)	Variable. Assumed $22/t cost as per industry knowledge as well as software fees per annum ($2,000 USD per annum). Remote monitoring. Annual servicing. Can be undertaken by site workers.	$1000 for 200 hrs. Assumed 8hr operation for 365 days.	$15,000 to $20,000 (contigency costs)	Variable. Assumed average service and maintenance cost across other technologies.	$50,000 per island	WM200 = $350 p/m, WM400 = $550 p/m and WM800 = $750p/m Remote monitoring using 4G. Island context will need to be considered further.	Servicing can be done by the local electrician at the owners expense . Assumed $200 p/m for BB250 and BB 500. Assumed $300p/m for BB1000
Comments	Costs do not need leachate collection pond and shredder.			There are grease nipples on each machine that need periodic greasing. The gearbox oil should also be replaced at least every 12 months. It is recommended that the tines and bearings be visually inspected annually. Hot Rot and its agents offer preventative maintenance and support contracts, however; maintenance can generally be performed by any competent operator.		Service cost will fluctuate. Costed for mainland. No additives, microbes or any additional inputs are required Fully automatic with the bin lifter included and we only require the operator to have a offload bin in position and empty each day in readiness for the offload after the days processing.	
Operational requirement							
Daily labour required (hours)	Assumed 2 hrs for CKI and 3 hrs for CI per week.	Assumed 2 hrs for CKI and 3 hrs for CI per week	Assumed 2 hrs for CKI and 3 hrs for CI per week	1 hr per day / per system	1 hr per day / per system	Assumed 1 hrs for CKI and 2 hrs for CI per week	Assumed 1 hrs for CKI and 2 hrs for CI per week
Skill level requirement for labour	Basic	Basic	Basic	Basic	Basic	Basic	Basic
Health and safety requirements	N/A	N/A	N/A	The feed system is enclosed, which prevents unauthorised entry into the system. The outlet is shrouded to prevent access. Emergency stops are located at convenient points on the Hot Rot machine, ancillary equipment and control panel.	N/A	None as WM is built/designed to the strict Australian OHS	
Output product							
Output product / additional processing required	Active composting: 21-28 days Maturation composting: 21-28 days Total: 42-56 days	8 – 16 weeks for composting and maturation	8 – 16 weeks for composting and maturation	Every 1.0 tonne = between 0.5 to 0.7 tonne of compost output.	Output will need to be blended with compost before applied on land	80% volume reduction	80% volume reduction

Appendix D - Other Assumptions

Assumptions	Cost	Unit	Source
Infrastructure			
Enclosed shed	1,700	per m^3	Assumed 25% loading on construction cost compared to mainland remote area
Hardstand	82.99	per m^2	Quantity surveyor
Staff			
Level 2 (HI)	$ 30.64	$/hr	SoCKI 2020-23 Waste to 21st Feb 23
Level 3 (HI)	$ 31.76	$/hr	SoCKI 2020-23 Waste to 21st Feb 23
Level 4 (HI)	$ 26.03	$/hr	SoCKI 2020-23 Waste to 21st Feb 23
Level 2 (WI)	$ 39.93	$/hr	SoCKI 2020-23 Waste to 21st Feb 23
Level 3 (WI)	$ 32.67	$/hr	SoCKI 2020-23 Waste to 21st Feb 23
Level 4(WI)	$ 26.22	$/hr	SoCKI 2020-23 Waste to 21st Feb 23
Level 5(WI)	$ 27.55	$/hr	SoCKI 2020-23 Waste to 21st Feb 23
Shipping			
Sea freight (FRE CKI)	$ 16,670.00	20 ft container	Zetner shipping + documentation fee and biosecurity.
Sea freight cost per cubic metre	$ 505.15	per cubic metre	Zetner shipping
Sea freight	$ 561.28	per m^2	Zetner shipping
Sea freight (FRE CI)	$ 12,960.00	20 ft container	Zetner shipping + documentation fee and biosecurity.
Sea freight cost per cubic metre	$ 392.73	per cubic metre	Zetner shipping
Sea freight	$ 436.36	per m^2	Zetner shipping
Diesel	3.3	L	SoCKI - West Island
Diesel	3.9	L	SoCKI - Home Island

Appendix D - Costs
(West Island)

CKI	CASP	Open windrow		IVC		Dehydration	
West Island	Gore	WASHCo	Convaero	HotRot	BioBin	Wastemaster	ECOBOT Commercial Composter
FO input	28	28	28	28	28	28	28
GO input	118	118	118	118	118	118	118
Biosolid input	#REF!	#REF!	118	44	44	#REF!	44
CAPEX							
Processing infrastructure	$ 423,933.80	$ 400,000.00	$ 210,000.00	$ 250,000.00	$ 30,000.00	$ 85,000	$ 54,475
Commissioning costs	Included	Included	Included	$ 8,000.00	Included in training	$ 3,500	$ 3,500
Construction costs i.e. land preparation	Included	$ 16,598.00	$ 13,278.40	$ 9,958.80	$ 2,987.64	Assumed storage in existing undercover area.	Assumed storage in existing undercover area.
Shipping costs (to Perth)	$ 16,670.00	$ 16,670.00	$ 16,670.00	$ 16,670.00	$ 8,546.36	$ 6,735	$ 2,806
Training costs	Included	Included	Included	Included	$ 2,500.00	$ 3,980	$ 3,980
Total CAPEX	**$ 440,603.80**	**$ 416,670.00**	**$ 226,670.00**	**$ 284,628.80**	**$ 44,034.00**	**$ 99,215.35**	**$ 64,761.40**
Cost per tonne (CAPEX)	**$ 3,017.83**	**$ 2,853.90**	**$ 776.27**	**$ 1,949.51**	**$ 301.60**	**$ 1,922.78**	**$ 1,255.07**
Comments	- This is the cost of a system that reduces risks to the environment to the highest degree. Costs can be reduced if more simple system is installed. - Cost includes solar panel.	- Assumed to have bobcat/loader and tractor. - Does not require a shredder.	- Above does not include shredder. - Does not include leachate collection system.	- 1 unit would be required. - Minimum 55 t of FO required per annum.	- 1 unit would be required to process approx. 3.2 t per week. - Assumed that there is an undercover space for the electrical equipment.	- WM200 system. - Not all GO could be processed due to ratio required. - Assumed that there is an undercover space for the equipment.	- BB250 model - Training and commissioning costs is average of other models. - Assumed that there is an undercover space for the equipment.
OPEX							
Electricity consumption (kwh year)	Runs off solar panels.	0	0	3796	912.5	2920	4197.5
Electricity cost	$ -	$ -	$ -	$ 1,328.60	$ 319.38	$ 1,022.00	$ 1,469.13
Diesel consumption (L)	0	2860	2860	0	0	0	0
Diesel cost	$ -	$ 9,438.00	$ 9,438.00	$ -	$ -	$ -	$ -
Service / maintenance cost (per annum)	$ 6,187.00	$ 14,600.00	$ 15,000.00	$ 15,397.83	$ 50,000.00	$ 4,200.00	$ 2,400.00
Labour requirements (hrs/annum)	104	104	104	365	365	52	52
Labour cost ($/year)	$ 3,191.55	$ 3,191.55	$ 3,191.55	$ 11,201.13	$ 11,201.13	$ 1,595.78	$ 1,595.78
Annual OPEX	**$9,483**	**$27,334**	**$ 27,733.55**	**$ 27,927.56**	**$ 62,113.63**	**$ 6,869.78**	**$ 5,516.90**
Cost per tonne (OPEX)	**$ 64.95**	**$ 187.22**	**$ 189.96**	**$ 191.28**	**$ 425.44**	**$ 133.14**	**$ 106.92**
Comments	N/A	N/A	N/A	N/A	Note: Solar panels may be required	Note: Solar panels may be required	N/A

Appendix D - Costs
(Home Island)

CKI	CASP	Open windrow		IVC		Dehydration	
West Island	Gore	WASHCo	Convaero	HotRot	BioBin	Wastemaster	ECOBOT Comercial Composter
FO input	42	42	42	42	42	42	42
GO input	175	175	175	175	175	175	175
CAPEX							
Processing infrastructure	$ 453,710.37	$ 400,000.00	$ 210,000.00	$ 250,000.00	$ 30,000.00	$ 85,000	$ 72,785
Commisioning costs	Included	Included	Included	$ 8,000.00	Included in training	$ 3,500	$ 3,500
Construction costs i.e. land preparation	Included	$ 16,598.00	$ 16,598.00	$ 9,958.80	$ 2,987.64	Assumed storage in existing undercover area.	Assumed storage in existing undercover area.
Shipping costs (to Perth)	$ 16,670.00	$ 16,670.00	$ 16,670.00	$ 16,670.00	$ 8,546.36	$ 6,735	$ 19,476
Training costs	Included	Included	Included	Included	$ 2,500.00	$ 3,980	$ 3,980
Total CAPEX	**$ 470,380.37**	**$ 416,670.00**	**$ 226,670.00**	**$ 284,628.80**	**$44,034**	**$99,215.35**	**$99,741.40**
Cost per tonne (CAPEX)	**$ 2,167.65**	**$ 1,920.14**	**$ 1,044.56**	**$ 1,311.65**	**$202.92**	**$1,288.51**	**$459.64**
Comments	- This is the cost of a system that reduces risks to the environment to the highest degree. Costs can be reduced if more simple system is installed. - Cost includes solar panel.	- Assumed to have bobcat/loader and tractor. - Does not require a shredder.	- Above does not include shredder. - Does not include leachate collection system.	- 1 unit would be required. - Minimum 55 t of FO required per annum.	- 1 unit would be required to process approx. 3.6 t per week. - Assumed that there is an undercover space for the electrical equipment.	- WM250 system. - Not all GO could be processed due to ratio required. - Assumed that there is an undercover space for the equipment.	- BB500 model - Assumed that there is an undercover space for the equipment.
OPEX							
Electricity consumption (kwh year)	Runs off solar panels.	0	0	2920	912.5	2920	4197.5
Electricity cost	$ -	$ -	$ -	$ 1,022.00	$ 319.38	$ 1,022.00	$ 1,469.13
Diesel consumption	0	2860	2860	0	0	0	0
Diesel cost	$ -	$ 9,438.00	$ 9,438.00	$ -	$ -	$ -	$ -
Service / maitenance cost (per annum)	$ 7,749.00	$ 14,600.00	$ 15,000.00	$ 16,087.25	$ 50,000.00	$ 4,200.00	$ 2,400.00
Labour requirements	104	104	104	365	365	52	52
Labour cost ($/year)	$ 3,191.55	$ 3,191.55	$ 3,191.55	$ 11,201.13	$ 11,201.13	$ 1,595.78	$ 1,595.78
Annual OPEX	**$ 11,044.55**	**$27,334**	**$ 27,733.55**	**$ 28,310.38**	**$ 62,113.63**	**$ 6,869.78**	**$ 5,516.90**
Cost per tonne (OPEX)	**$ 50.90**	**$ 125.96**	**$ 127.80**	**$ 130.46**	**$ 286.24**	**$ 89.22**	**$ 71.65**
Comments	N/A	N/A	N/A	N/A	Note: Solar panels may be required	Note: Solar panels may be required	N/A

Appendix D - Costs
(Christmas Island)

CI	CASP	Open windrow		IVC		Dehydration	
	Gore	WASHCo	Convaero	HotRot	BioBin	Wastemaster	ECOBOT Comercial Composter
FO input	192	192	192	192	192	192	192
GO input	804	804	804	804	804	804	804
CAPEX							
Processing infrastructure	$ 513,213.00	$ 450,000.00	$ 250,000.00	$ 500,000.00	$ 120,000.00	$ 230,000	$ 128,920
Commissioning costs	Included	Included	Included	$ 16,000.00	Included in training	$ 3,500	$ 3,500
Construction costs i.e. land preparation	Included	$ 16,598.00	$ 33,196.00	$ 19,917.60	$ 11,950.56	Assumed storage in existing undercover area.	Assumed storage in existing undercover area.
Shipping costs (to Perth)	$ 12,960.00	$ 12,960.00	$ 12,960.00	$ 12,960.00	$ 18,138.18	$ 9,069	$ 18,634
Training costs	Included	Included	Included	Included	$ 10,000.00	$ 3,980	$ 3,980
Total CAPEX	**$ 526,173.00**	**$ 462,960.00**	**$ 262,960.00**	**$ 548,877.60**	**$ 160,088.74**	**$ 246,549.09**	**$155,033.64**
Cost per tonne (CAPEX)	**$ 528.29**	**$ 464.82**	**$ 264.02**	**$ 551.08**	**$ 160.73**	**$ 698.84**	**$ 439.44**
Comments	- This is the cost of a system that reduces risks to the environment to the highest degree. Costs can be reduced if more simple system is installed. - Cost includes solar panel.	- Assumed to have bobcat/loader and tractor. - Does not require a shredder.	- Above does not include shredder. - Does not include leachate collection system.	- 4 units required	4 unit would be required to process approx. 25 t per week on rotation. Assumed that there is an undercover space for the electrical equipment.	- WM1000 system. - Not all GO could be processed due to ratio required. - Assumed that there is an undercover space for the equipment.	- BB1000 model - Assumed that there is an undercover space for the equipment.
OPEX							
Electricity consumption (kwh year)	Solar panels included in costs.	0	0	7592	3650	5475	11315
Electricity cost	$ -	$ -	$ -	$ 2,657.20	$ 1,277.50	$ 1,916.25	$ 3,960.25
Diesel consumption (L)	0	5720	5720	0	0	0	0
Diesel cost	$ -	$ 18,876.00	$ 18,876.00	$ -	$ -	$ -	$ -
Service / maintenance cost (per annum)	$ 24,887.00	$ 14,600.00	$ 20,000.00	$ 20,866.67	$ 50,000.00	$ 9,000.00	$ 3,600.00
Labour requirements (hrs/annum)	208	208	208	1460	1460	104	104
Labour cost ($/year)	$ 6,383.11	$ 6,383.11	$ 6,383.11	$ 44,804.52	$ 11,201.13	$ 3,191.55	$ 3,191.55
Annual OPEX	**$ 31,478.11**	**$40,067**	**$ 45,467.11**	**$ 68,328.39**	**$ 64,851.13**	**$ 14,211.80**	**$ 10,855.80**
Cost per tonne (OPEX)	**$ 31.60**	**$ 40.23**	**$ 45.65**	**$ 68.60**	**$ 65.11**	**$ 40.28**	**$ 30.77**
Comments	N/A	N/A	N/A	N/A	Note: Solar panels may be required	Note: Solar panels may be required	N/A

Appendix E

MCA criteria

Table E-1 MCA criteria

Criteria for MCA		Evaluation criteria
1	**Technical maturity and practicality**	5: Proven and mature technology, used in regional areas or remote communities, can be purchased in Australia. The option is practical and feasible. 4: Technology is in use in regional areas or remote communities, can be purchased in Australia. Relatively easy to implement option. 3: Technology has been used in regional areas or remote communities in Australia but needs to be purchased from overseas. The option is relatively practical and feasible. 2: Technology has been adapted and used abroad. Option is somewhat easy to implement. The option is somewhat impractical. 1: Unproven technology not yet used abroad nor in Australia. The option is difficult to implement.
	Consideration of overall feasibility and practicality of organic processing option.	
	Technical maturity of this option in remote areas, Australia and globally. Can the equipment required be purchased in remote areas, from other states or overseas?	
2	**Operational requirement**	5: Option is easy to operate (i.e. easy to recruit staff for the work, skilled staff not required, automatic feed of feedstock). Local contractors can undertake maintenance works. Equipment does not require regular servicing. Faulty equipment can be fixed or replaced locally. Able to handle large variations in waste input quantity with little additional expenditure. 4: Option is relatively easy to operate (i.e. relatively easy to recruit staff for the work, skilled staff not required, feedstock input can be automated or is easy to manually input). Local contractors can undertake maintenance works. Faulty equipment can be fixed or replaced locally. However, regular maintenance required. Able to handle moderate variations in waste input quantity with little additional expenditure. 3: Option is somewhat easy to operate (i.e. skilled staff required, fairly difficult to recruit staff, some difficulties in feeding the machine/bins). Local contractors can undertake maintenance job. Faulty equipment cannot be fixed or replaced locally. Regular maintenance required. Able to handle moderate variation in waste input quantity with moderate additional expenditure. 2: Option is somewhat easy to operate (i.e. skilled staff required, moderately difficult to recruit staff, labour intense handling of feedstock). Local contractors cannot undertake maintenance job. Faulty equipment cannot be fixed or replaced locally. Regular maintenance required. Able to handle moderate variation in waste input quantity with significant additional expenditure. 1: Technology is difficult to operate (i.e. skilled staff required, difficult to recruit staff, difficult to handle feedstock or very labour intense). Local contractors cannot undertake maintenance job. Faulty equipment cannot be fixed or replaced locally. Regular inspection and maintenance by skilled technician/s required. Unable to handle variation in waste input quantity.
	Is the operation labour intensive and does it require skilled staff to operate? Is it easy to find local staff?	
	Can the system readily handle an increase or decrease in waste quantities over time?	
	Does equipment require regular servicing and is it easy to train local staff or engage a contractor to maintain facilities or fix / replace faulty equipment?	
3	**Environmental and strategic drivers**	5: Option works towards strategic targets and aligns with existing policy / standards / certification. Reduction of greenhouse gas emission and reduced waste to landfill. 4: Option somewhat works towards strategic targets. Option aligns with existing policy / standards / certification. Reduced waste to landfill. 3: Option does not work towards strategic targets. Option aligns with existing policy / standards / certification. Reduced waste to landfill. 2: Option does not work towards strategic targets. Option somewhat aligns with existing policy / standards / certification. 1: Option does not work towards strategic targets. Option does not align with existing policy / standards / certification.
	Does the option pose a negative impact upon environmental values (e.g. greenhouse gas emissions, waste to landfill)?	
	Does the option align with regional, national, and international waste strategy?	
	Is there an existing or foreseen conflict to legislation requirements?	
4	**Risk, health and safety**	

Criteria for MCA		Evaluation criteria
	Does the option provide the communities with a safer environment by reducing exposure to pollution, pests and disease?	5: Clear environment/health outcomes improvement. There is a low risk to users/operators/community. 4: Clear environment/health outcomes. There is a medium risk to users/operators/community. 3: Partial environment/health outcomes. There is a medium risk to users/operators/community. 2: Minimal environment/health outcomes. There is a high risk to users/operators/community. 1: High environment, health and/or safety risk.
	Does the option and associated technology pose a safety risk to users?	
5	**Socioeconomic considerations**	5: Some local jobs created. High community acceptance. Some extra benefits for local communities such as improved satisfaction of visitors/ tourists. 4: Some local jobs created. High community acceptance. 3: Some local jobs created. Accepted by the community. 2: No local jobs created. Somewhat accepted by the community. 1: No local jobs created. Low community acceptance.
	Will the proposed options provide job opportunities to the IOT?	
	Is it practical and will it be well-received by the communities?	
	Will it provide extra benefits for the IOT such as improved satisfaction of visitors/tourists?	
6	**Financial feasibility**	5: Low cost. Some opportunities for revenue and/or potential cost savings. 4: Relatively low cost. Some opportunities for revenue and/or potential cost savings. 3: Moderate cost. Some opportunities for revenue and/or potential cost savings. 2: Relatively high cost. May be some opportunities for revenue and/or potential cost savings. 1: High cost. No opportunities for revenue and/or potential cost savings. Requires additional ancillary infrastructure to support option.
	Consideration of investment cost vs operational costs and potential cost savings (high level consideration of whole of life cycle costs)	
	Ancillary infrastructure requirements e.g. road upgrades, additional trucks, etc.	

Appendix F

MCA assessment

MCA criteria	CASP	IVC	Dehydration	Covered / open windrow
Technical maturity and practicality	Well-developed and publicly accepted technology in Australia and remote areas including islands (**refer to case study in Section 5**). Simple system, however, can be a slightly more onerous type of processing technology. Scalable and suitable for smaller or larger applications. Larger land space required.	Well-developed and publicly accepted technology in Australia and remote areas including islands (**refer to case study in Section 5**). Generally powered off electricity. May need solar panels.	Case studies of successful implementation in Australia. Simple system. Proven technology in remote areas. Suited to a higher throughput of FO. Noting that IOT have a higher GO feedstock. Generally powered off electricity will likely need solar panels.	Scalable and suitable for smaller applications (**refer to case study in Section 5**). Proven system. Well developed system in Australia.
Unweighted score	**4**	**3**	**3**	**5**
Operational requirement	Easy to use and operate. Needs daily monitoring for optimum oxygen and moisture levels. MAF system is flexible and can be moved and adapted to treat any volume of waste. Use of solar panel to power the unit will assist with reduction of energy usage and greenhouse gas emission. Leachate management will have to be considered.	Easy to use and operate. Produces ready compost (after 10-12 days in vessel). Continuous loading is required for some machines. Contained leachate systems. Use of solar panels will likely be required for three phased power system.	There is generally no pre-shredding required, and batch loading once a cycle. Some systems require. wood chips or microbes Processing cycles are short (10 – 24 hours). Manual loading required for some processing infrastructure. Remote monitoring available, however may not work in the IOT context. Use of solar panels will likely be required for three phased power system.	Simple once installed. Needs daily monitoring for optimum oxygen and moisture levels. Good process control (effective control of moisture and oxygen and less temperature variance). Longer processing time; 8-16 weeks per batch. Leachate management will have to be considered.
Unweighted score	4	4	4	4
Risk, health and safety	Pipes can become blocked**.** Lower risk as technology is proven in Australia and can also be fully enclosed. System quoted is essentially self-contained. Without adequate monitoring, pile settling may lead to anaerobic	Fully enclosed system to prevent odour and vermin. However, odour associated with continuous feeding of machine. Shredding will be required prior to input of bulky organic material. System will likely require additional processing infrastructure for mature compost.	Odour when loading machine. Only suitable for relatively homogenous FO mixes with acceptable moisture, bulk density and porosity characteristics. Primarily suite for FO then GO. Noting that IOT has a higher content of GO. Only non-bulky	Odour and vectors may be a problem compared to IVC, CASP and dehydration. Particularly, if not covered. More prone to exposure to natural elements (if not covered).

MCA criteria	CASP	IVC	Dehydration	Covered / open windrow
	activity (increasing odour) and systems can dry out quickly.		GO may be fed into processing infrastructure once mulched. If reused on island products will need to be blended with soil (1:10) for use. A building will be required.	
Unweighted score	4	4	3	3
Environmental and strategic drivers	The option will contribute to Federal and State targets. System can meet Australian standard for compost. System can be upscaled to be fully enclosed with leachate management and therefore minimising environmental impacts. Can produce mature composting without additional system.	The option will contribute to Federal and State targets. Lower environmental risk compared to other options as it is a largely contained system. Best option to secure funding as it is a well-practiced, simple. Limited leachate as water released as vapour.	This option does not support GO processing. Mature compost can only be produced after post maturation phase. Leachate generation needs to be considered.	Mature compost can only be produced after post maturation phase. More prone to natural elements if no cover. Greenhouse gas saving and leachate avoidance by diverting biodegradable material from landfill.
Unweighted score	5	5	3	4
Socioeconomic considerations	Likely that the system can be operated by existing staff. Enclosed unit so lower risk of odour and vectors. System can readily produce mature compost and pasteurised mulch meeting Australian Standard 4454 without additional processing system, other than screening.	Likely that the system can be operated by existing staff. Enclosed unit so lower risk of odour and vectors.	Likely that the system can be operated by existing staff. Enclosed unit so lower risk of odour and vectors.	Likely that the system can be operated by existing staff. Potential odour and vector issues resulting in community complaints.
Unweighted score	4	4	4	3
Financial feasibility	High CAPEX. Low OPEX. Refer to Section 8 for cost comparison.	Medium CAPEX and OPEX compared to other options. Refer to Section 8 for cost comparison.	Lowest CAPEX and OPEX compared to other options. Refer to Section 8 for cost comparison.	Medium CAPEX and OPEX compared to other options. Refer to Section 8 for cost comparison.
Unweighted score	3	3	4	3

MCA criteria	CASP	IVC	Dehydration	Covered / open windrow
Final unweighted score	22	23	20	21
Final weighted score	76	74	66	71

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