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SERVICES AND SOLUTIONS FOR A LIVABLE REGION

ON-SITE ORGANICS MANAGEMENT OPTIONS REVIEW

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EXECUTIVE SUMMARY

Metro Vancouver retained Tetra Tech EBA Inc. (Tetra Tech EBA) to conduct a review of on-site organics management options for food service and food retail sector establishments. In preparation of Metro Vancouver's plans to implement an organics disposal ban in 2015, the intent of the study is to: 1) to provide an underlying analysis that will guide the commercial food services/retail sectors in choosing appropriate storage, pre-treatment, and automated processing options to divert organics from disposal in an efficient, cost-effective manner; and 2) to build on previous organics management research and pilots such that knowledge and industry experience is compounded for ease of use by the food services/retail sectors.

The study entailed a review and evaluation of over 15 on-site organic management methods that were summarized into the following four options: (1) storage; (2) pre-treatment; (3) aerobic composting; or (4) anaerobic digestion. Stakeholders from the restaurant and food retail sector vetted this information to further determine applicability of the various options and find ways to overcome barriers as the technical and economic viability of each technology was evaluated. Options summaries were then finalized, analyzed using an 'apples to apples' comparison, and sample scenarios built to provide a useful tool for the commercial sector to use when evaluating on-site organics management options.

The on-site organics management review process consisted of two main components: 1) organics management options review; and 2) scenario development for comparative analysis. Part 1 consisted of the review of systems that are capable of processing organics on-site within the following four categories and corresponding sub-categories, referred to as "options" and sub-options, respectively, as shown in the table below. The interface of options with hauling and service requirements was also reviewed.

Table 1: On-site Management Options

#	Option	Sub-Option
1	Storage	Conventional
		Specialized
2	Pre-Treatment	Dewatering
		Dehydration
3	Aerobic In-Vessel	Small (approximately 10 tonnes per year)
		Medium (approximately 100 tonnes per year)
		Large (approximately 1,000 tonnes per year)
4	Anaerobic In-Vessel	Medium (approximately 500 tonnes per year)
		Large (approximately 1,000 tonnes per year)

The most common way to manage organics is temporary **storage** prior to hauling off-site for processing at a commercial facility. Common decision factors for organics collection include frequency of pick-up as based on generation, size and type of containers, odour concerns, and available space for organic bins. Fees are set by haulers who offer the collection service based on the desired service level and incorporate tipping fee costs charged by the processing facilities, on-site bin options, and frequency of collection.

Pre-treatment, in the context of this study, refers to mechanical or thermal treatment to reduce the mass and volume of the organics stream. This method can be used in conjunction with an in-vessel processing system or as a standalone system requiring conventional hauling. The two main sub-options within the pre-treatment category are dewatering and dehydration.

Aerobic Composting is the microbial degradation of organic materials in the presence of oxygen. An **aerobic in-vessel** system is an engineered system in which favourable composting conditions are induced in order to accelerate the degradation process and contain it within a manageable area. Aerobic in-vessel composting systems come in a variety of sizes and technologies, produce usable soil amendment, and generally require additional curing. Aerobic in-vessel systems considered in this study are automated.

Anaerobic Digestion is a process in which organic material is degraded in the absence of oxygen. The by-products of anaerobic digestion are biogas, which can be used as an energy source; a liquid component which can be used as fertilizer and a solid component which, depending on process parameters, can be used as soil-amendment or may require further treatment to create finished compost.

In order for a given food service/retail establishment to determine which option would be most beneficial for their specific circumstances, the following questions are recommended to serve as a basis for decision making:

- How much organic material do I produce?
- What type of organic material do I produce?
- How much space do I have?
- How much labour is required?
- What sort of corporate sustainability benefits can I expect?
- How close to compost will I get?
- How much will it cost?

To assist in evaluating the organic management options available the following summary chart was developed to provide an overview of all options and how they compare to one another:

Table 2: Comparative Analysis

Icon	○	◔	◑	◕	●
Score	Mediocre	Fair	Good	Better	Best

Option	Weekly Capacity	Capital Cost	Annual Maintenance Cost	Footprint	Materials Accepted	Time commitment	Corporate Sustainability Benefit	Odour control	Output Material	Maintenance	Capital	Process Time	Installation Requirements	Capacity	Electricity Requirements
Conventional Storage	Depends on hauling	Up to $1,000	Minimal	◕	●	●	○	○	○	●	●	●	●	◑	●
Specialized Storage	Depends on hauling	$4,000-6,000	Minimal	◕	●	●	○	◔	○	●	●	●	●	◑	●
Dewatering	Up to 400,000 kg/week	$25,000	$250	●	◑	◕	◔	◔	◔	◕	◑	●	◑	●	◔
Dehydration	Up to 14,000 kg/week	$27,000-50,000	$200	●	◕	◕	◑	◑	◑	◕	◑	◕	◑	◕	○
Small Aerobic In-Vessel	150 -3,500 kg/week	$18,000	$400	◕	◑	◑	◕	◑	◕	◑	◕	◑	◕	◔	◑
Medium Aerobic In-Vessel	700 -8,000 kg/week	$30,000+	$600	◑	◑	◑	◕	●	●	◑	◑	◔	◑	◑	◑
Large Aerobic In-Vessel	2,000-18,000 kg/week	$450,000	$500	◔	◕	○	◕	◕	◕	◑	◔	○	◔	●	◑
Medium Anaerobic In-Vessel	5000 - 20,000 kg/week	$240,000+	$14,000	◑	○	◔	●	◑	◕	○	◔	○	◔	◕	●
Large Anaerobic In-Vessel	20,000 kg/week	$825,000+	$10,000	○	◔	○	●	◕	◕	○	○	○	○	●	●

Note to the Reader

The options presented within the report represent a small cross section of the many technologies and potential usage scenarios that are possible. To develop an accurate organic management option for a given establishment, it is recommended to contact a technology supplier to answer questions with more details related to the site-specific implementation of the management option. It is also recommended, if possible, to obtain a non-biased review of a technology from a current user or view the system in operation.

Only options that result in the recovery of energy or useful materials (e.g., compost) were evaluated; technologies that result only in sewer discharge are considered disposal technologies which are inconsistent with best management practices for waste management and were excluded from the evaluation.

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ACRONYMS & ABBREVIATIONS

Acronyms/Abbreviations	Definition
Ft^2	Square Feet
kg	Kilograms
kWh	Kilowatt Hours
L	Litres
m	Metres
m^2	Square Metres (area)
m^3	Cubic Metres (volume)
Organics or Organic Material	Compostable organics (food scraps, food-soiled paper, yard and garden debris)
T	Tonne
wk	Week
yd	Yard
yd^3	Cubic Yard (industry standard uses 'yard' when referencing container volume)
yr	Year

LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of the Greater Vancouver Regional District (Metro Vancouver) and their agents. Tetra Tech EBA Inc. (Tetra Tech EBA) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Metro Vancouver, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in Tetra Tech EBA's Services Agreement. Tetra Tech EBA's General Conditions are provided in Appendix A of this report.

1.0 INTRODUCTION

The study entailed a review and evaluation of over 15 on-site organic management technologies that were summarized into the following four types of options: (1) storage; (2) pre-treatment; (3) aerobic composting; or (4) anaerobic digestion. This information was vetted by stakeholders from the restaurant and food retail sector to determine applicability of various options and find ways to overcome barriers as the technical and economic viability of each technology was evaluated. Option summaries were then finalized, analyzed using an 'apples to apples' comparison, and sample scenarios were built to provide a useful tool for the commercial sector to use when evaluating on-site organics management options.

The technologies reviewed in this report focus on the third level (recycle/compost) of the pollution prevention hierarchy, highlight automated systems that are considered 'turn-key' (easy to use and applicable in a variety of scenarios), and consider manufacturer input and practitioner feedback. Options for organics management were compared across a range of variables, including cost per tonne processed (or collected), across a range of sizes (10, 100, and 1,000 tonnes per year capacity). The report was designed to provide food service, food retail, and other commercial businesses with relevant options and scenarios to use when evaluating their own organics diversion on-site management options.

1.1 Drivers and Intent

Globally, as city populations grow, so does waste generation and the cost of waste disposal, especially if new waste diversion and prevention programs are not implemented. Cities are looking to composting initiatives as a means to divert compostable organics (herein referred to as organics or organic material) away from disposal, in a manner that is cost effective, sustainable, and responsible. Increasingly, on-site pre-treatment, composting and anaerobic digestion systems are viewed as a viable solution for processing of organics across residential and commercial business sectors. Metro Vancouver estimates that industrial, commercial, and institutional sectors dispose of more than 150,000 tonnes of organics in the region's waste stream every year. In Metro Vancouver, on-site organics management solutions present an opportunity to encourage a diversified processing infrastructure to complement the region's large-scale facilities, reduce frequency of pick-up and collection costs, and minimize travel distances. They also provide opportunities for businesses to engage with their staff in initiatives that increase their waste diversion, and make high quality soil amendment available for urban agriculture.

In preparation for the organics disposal ban to be implemented in Metro Vancouver in 2015, the intent of this study is twofold: 1) to provide an underlying analysis that will guide the commercial food services/retail sectors in choosing appropriate storage, pre-treatment, and automated processing options to divert organics from disposal in an efficient, cost-effective manner; and 2) to build on previous organics management research and pilots such that knowledge and industry experience is compounded for ease of use by the food services/retail sectors. Technologies reviewed for the purposes of this study were chosen based on those used in other countries including the UK, New Zealand, and Korea, with a focus on those that have become established in North America.

1.2 Using This Report

Section 2.0, Options for Organics Management Practices, outlines the four options, which are further broken down into sub-options. Important operational parameters, as well as pros, cons, and key considerations are listed to provide a basic understanding of each option. The interface of options with hauling and service requirements was reviewed in Section 2.6.

Section 3.0, Scenario Development, provides a framework to evaluate which options are most suitable for a given establishment. Key decision making criteria are posed in the form of questions in Section 3.1, and options are compared based on specific variables. An overall comparison key of all options is shown in Section 3.2. Two scenario examples are provided in Section 3.3.

See Appendix B for more information on project background and research methodology.

The technologies reviewed to establish parameters for each option are listed in Appendix C along with links to these company websites where more detailed specifications and company contact information can be found.

2.0 OPTIONS FOR ORGANICS MANAGEMENT PRACTICES

For an organics stream, there are a number of on-site processes that can take place prior to hauling or processing. These can range from simply storing the organic material, to composting, curing, and potentially using the end product on site. The options considered within this study—in addition to traditional hauling to an off-site organics management facility—are storage, pre-treatment, in-vessel aerobic composting, and anaerobic digestion. These options, as well as associated processes, are summarized in the figure below:

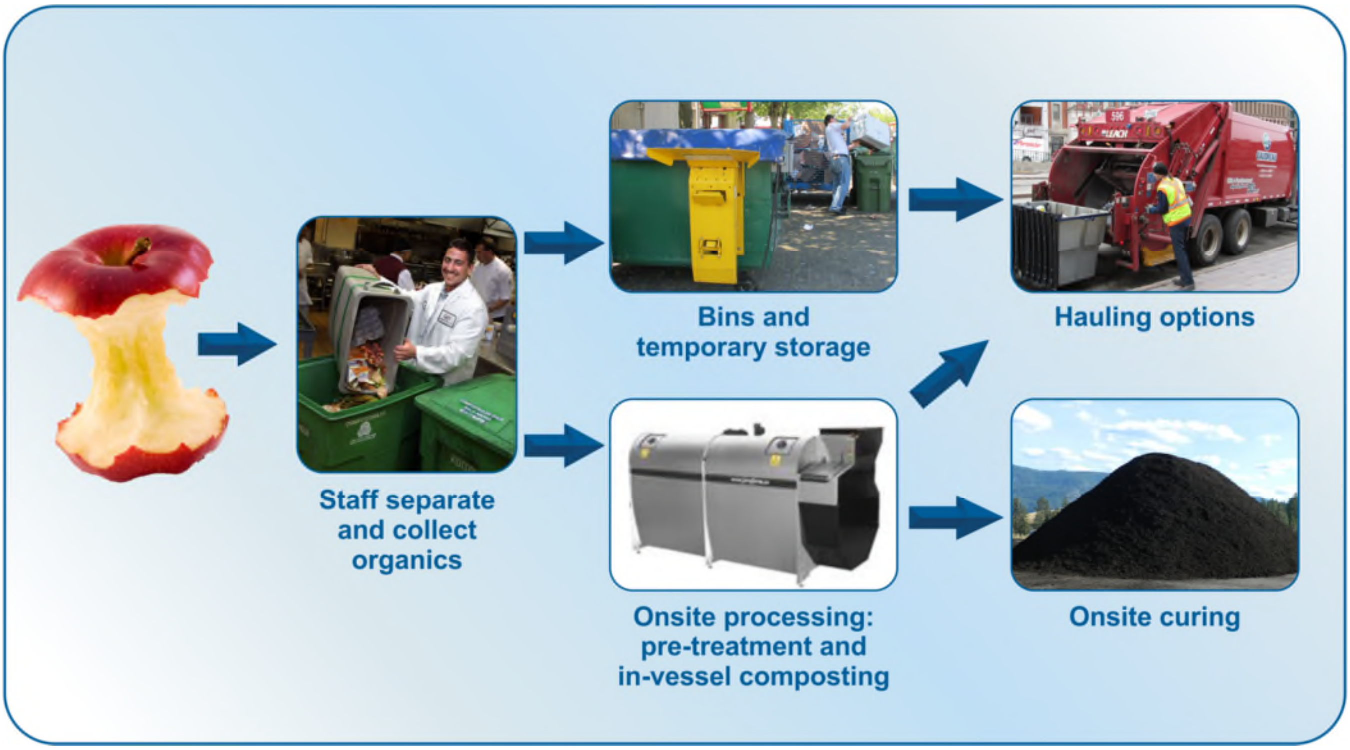


Figure 1: Organics Management Flow Diagram

For a given establishment, many factors need to be considered to evaluate which options are feasible; however, within each option there are a range of technologies available to suit site-specific needs. Important variables to consider before selection include:

- Siting and installation requirements, including the space required for the unit and any hook-ups, such as drainage, or foundational requirements, such as a concrete pad.
- Economics, including capital cost of the technology, and any ongoing operation and maintenance costs.
- Labour requirements, including staff time required to operate and maintain the system.
- Capacity, including the quantity and quality of materials that can be accepted by the system. It should be noted that certain materials such as compostable plastics cannot be accepted at all facilities and control of feedstock composition is necessary in some cases to maintain consistent operation.
- Detractors, such as odour, vectors, or noise that may result from improper system management.

- Corporate sustainability benefit, including value to the business, employees, and customers.
- Input requirements, including limitations to the size and type of feedstock and additions required such as bulking agent.
- The potential for usage of the end product, including capacity for the composted product to cure and any landscaped areas to which an end product could be applied.

The following sub-sections provide an overview of each option, including the pros and cons and key considerations for each. The technologies reviewed to establish parameters for each option are listed in Appendix C along with links to these company websites where more detailed specifications and company contact information can be found.

2.1 Option 1: Storage

Figure 2: Example Storage Units

Technologies: BioBin (left), Toter (centre), and Organics FEL Container (right)

The most common way to manage organics is to store them temporarily in order to have them hauled off-site for processing at a commercial facility. This option allows a business to set up an organics collection program that is similar to other recycling programs where staff members are required to sort material into the proper bins, and the contents of these bins are hauled away for processing and recycling. Common decision factors for organics collection include frequency of pick-up as based on generation, size and type of containers, odour and sanitary concerns, and available space for organic bins. Fees are set by haulers who offer the collection service based on the desired service level and incorporate tipping fee costs charged by the processing facilities, on-site bin options, and frequency of collection.

The type of container chosen is primarily a function of the volume of organics produced and hauling frequency; however, some options can be tailored to organics to minimize common issues such as odours and pests, space constraints, and access. Storage containers reviewed in this study range from the most basic totes and cubic yard (yd^3; herein referred to as 'yard') containers, to organics-specific options which may include odour control technology, underground storage or some degree of compaction.

2.1.1 Conventional Storage – Totes and Yard Containers

Generally conventional storage containers will be provided by the organics hauler if a multi-year hauling contract or service agreement is signed, and the costs of the container are built into the hauling contract.

Compactors can accommodate up to 15 cubic metres (m^3) of organics; however, weight is generally the limiting factor and not volume. Degradation will occur to some extent within these containers; therefore odour can be present and is best mitigated through regular maintenance and proper lid closure.

Standard Yard Container
(Image from www.burnaby.ca/Assets/dumpster.jpg)

The following table provides an overview of basic parameters of interest for conventional storage technologies reviewed:

Table 3: Conventional Storage Summary

Conventional Storage			
Size	Small (Totes)	Medium (Yard Containers)	Large (Compactors)
Capacity	Up to 0.36 m³	Up to 6 m³	Up to 10 m³
Example Businesses*	Small restaurant	Medium to large restaurant	Grocery Store
Capital Cost (per container)	Up to $115	Up to $1,200	Up to $40,000
Annual Maintenance Cost	Minimal		
Daily Labour Requirements	Minimal (Bin Cleaning)		
Footprint (per container)	Approx. 0.25 m² to 0.5 m²	Approx. 3 m²	Approx. 19 m²
Inputs	Food and food scraps, food-soiled paper, waxed cardboard, and green waste		
Outputs	Food and food scraps, food-soiled paper, waxed cardboard, and green waste		
*	Example businesses based on twice weekly hauling		
Traditional Hauling Costs			
Bin Rental Per Month	$2 to $5	$25 to $50	$200 to $500
Cost Per Service for Hauling	$7 to $15 per bin each service	$15 to $50 per bin service	$50 to $200 per service
Off-Site Processing/ Tipping Fees	$50 to $80 per tonne		

- **Pros** – The obvious benefit of this option is convenience. Haulers will provide the necessary bins or totes to handle the organics stream in return for a signed hauling contract or service agreement that has been negotiated. Most establishments are already familiar with this storage option, and the price of the equipment at the smaller range is generally less than $1,200 with minimal maintenance required other than washing bins down regularly. Staff labour requirements are minimal, and no re-training is necessary in order to operate. Additional installation requirements are generally not needed to store the containers.
- **Cons** – The drawbacks of remaining with the conventional storage system generally result in the requirement for more frequent pick-up by haulers, leading to increased hauling costs. Contracts will often define a set frequency of collection that may not optimize the amount of hauling that is necessary. There is no mass reduction, and odour and vector issues are a possibility. Frequent bin cleaning would be required, and if not provided by the hauler, cleaning infrastructure would be required. There is no corporate sustainability benefit or added educational value to employees, as organics are treated the same as recycling and garbage in this case.
- **Key considerations** for establishments wishing to continue with conventional storage options are:
  - Are my hauling costs and organics generation low enough that I don't need to look at other options?
  - Is my pick-up schedule sufficient to minimize odour and vector problems?
  - Is convenience a top priority?

2.1.2 Specialized Storage

Several specialized storage options are available, allowing users to increase the volume of organics stored on-site while minimizing common issues such as odour and pests. Options include split-compartment bins, underground storage, adaptations of regular yard containers to be more suitable for organics (e.g., adaption of bins with biofilters to control odours), or technology with some degree of compaction occurring within the storage process. These types of systems range from sizes of 0.3 m³ up to 5 m³. Plastic construction, sealing lids, and specialized openings for loading provide solutions to common storage problems. Table 4 provides the basic parameters for specialized storage technologies reviewed:

Molok Underground Storage Containers
(Image from www.molkna.com)

Table 4: Specialized Storage Summary

Specialized Storage	
Capacity	Up to 5 m³
Applicable Business Examples	Restaurants, grocery retail
Capital Cost	Up to $6,000
Annual Maintenance Cost	Same as status quo (garbage storage and hauling)
Daily Labour Requirements	Same as status quo (garbage storage and hauling)
Footprint	Up to approx. 3 m²
Inputs	Food and food scraps, food-soiled paper, waxed cardboard, and yard debris
Outputs	Food and food scraps, food-soiled paper, waxed cardboard, and yard debris

- **Pros** – The increased storage capacity designed to minimize the aboveground footprint along with organic storage-specific features of these options make them an attractive option in comparison to conventional storage options. They are also relatively inexpensive compared to pre-treatment and in-vessel composting, and minimal ongoing maintenance is required. Staff time is also minimal and would be comparable to current staff time spent on waste management.
- **Cons** – The downside to this option is that organics hauling will still be necessary on a consistent schedule, although pick-ups could be optimized and/or minimized. Some specialized storage options will require more on-site space, and require a level of planning to determine what size and storage capacity would best optimize hauling frequency. For establishments looking for high corporate sustainability benefit, this option is better than conventional storage, but not as involving as pre-treatment and composting. Specialized trucks and equipment are needed to empty underground containers. Typically the underground containers are purchased and installed from the same company that will provide the collection service. Currently there is one company in the region that can install and service underground containers.
- **Key considerations** for establishments interested in specialized storage options are:
  - By how much could I reduce my costs by reducing pick-up frequency?
  - How much space is available?
  - What type of storage is preferable for my establishment (underground vs. aboveground)?

2.2 Hauling and Service

Generally a hauling contract or servicing agreement would be signed with a hauling company to empty organics containers on a set schedule. A contract would usually determine the frequency of service, and the cost for each service, with a specific cost for emptying a set number of bins. Therefore, it is advantageous to ensure that the frequency of collection is at a rate such that all the bins are typically full on each collection day.

One of the main advantages of specialized systems and technologies reviewed in this section is the decrease in the hauling frequency that can be achieved from the increase in storage capacity, ability to control odours with biofilters and specialized sealing lids, or pre-treatment of organics to reduce the quantity and control odours.

1. **Traditional Hauling**

- This service level is the same as standard garbage collection where the hauler will arrive, tip the contents from the bins and return the bins to their location. It would be up to each establishment to rinse bins that are unclean, or place cardboard in the bottom of the empty bins to minimize residue becoming stuck in bins after emptying.

2. **Typical Additional Services**

- For totes, bin liners made of certified compostable plastics are one option to keep containers clean, and generally they are supplied by the hauler and included in the cost of the bin service. However it is important to consult the hauler and the regional facility that is accepting the material as not all locations will accept compostable plastics, or will only accept specific bags that meet their standards.
- Totes and yard containers can be rinsed or exchanged by collection staff; these services can be added into the service agreement.
- Establishments can also opt to hire a separate business to clean their bins outside of the collection contract.

3. **Premium Services**

- Specialized premium service companies provide an array of waste management services, including customized options where the hauler can collect totes from inside the building, provide clean totes during each collection, or clean collection containers on request.
- Options exist where as little as one kitchen container of organics can be collected from inside a business, emptied, cleaned and returned through a "valet service" that will require no help from cleaning staff or property management team.

4. **Specialized Equipment Services**

- A combination of equipment service and hauling contract exist for the specialized technologies. Companies exist that will service the unit each day including emptying the unit, adding in new organic material that was generated since the unit was last serviced, and performing any other maintenance that is required.

5. **Other Value Added Services**

- Companies can also provide services such as waste audits to determine the quantity of materials that could be diverted from the existing waste stream, and to determine optimal bin placement and signage within an establishment to improve diversion practices. Audits can be useful for optimizing bin sizes and reducing hauling costs. Monthly waste diversion reports quantify the amount of organics and recycling that an establishment is diverting from the waste stream and can allow a company to monitor the performance of their waste management program.

6. **Solutions for Small Establishments**

- Bin-sharing with adjacent establishments, or units in the same building. In this case, an audit prior to service would be recommended to determine cost sharing. It could also be an option to coordinate this type of effort through a Business Improvement Association.

On-site organics management can provide a number of benefits compared to traditional hauling: a decrease in hauling frequency can be achieved from an increase in onsite storage capacity; odours can be controlled with biofilters and specialized sealing lids; or the quantity of material that needs to be hauled off-site can be reduced and odours mitigated using pre-treatment and on-site treatment of organics. Table 5 provides general comments on strengths and weaknesses of the options reviewed here and in subsequent sections of this report, along with their impacts to the level of hauling service required.

Table 5: On-site Organics Management and Effects on Hauling

Option	How Option Affects Hauling	Strengths	Weaknesses	Hauling Frequency	Amount Hauled Offsite	Hauling Cost
Conventional Storage	▪ Generally frequent hauling preferred to minimize odours and material stored on-site ▪ Bin liner and/or cleaning recommended ▪ Small generators have options for premium services	▪ Readily available with adjustable collection options and service levels offered	▪ Required frequency of service and quantity produced dictates cost ▪ Must ensure bin size is optimized to the frequency of collection that is desired.	High	High	High
Specialized Storage	▪ Hauling frequency can decrease as storage options can control odours and allow for larger storage capacities on-site	▪ Increases the capacity that can be stored on-site while mitigating issues such as odour ▪ Decreases frequency of hauling which can reduce costs.	▪ Requires increased space, planning and investment upfront ▪ Limited number of suppliers in the region for some bin types	Medium	High	Medium
Pre-Treatment	▪ Hauling frequency can decrease, and amount hauled is decreased	▪ Reduced volume, potential	▪ Additional time to load/unload the unit	Medium	Medium/ Low	Medium

Option	How Option Affects Hauling	Strengths	Weaknesses	Hauling Frequency	Amount Hauled Offsite	Hauling Cost
	▪ Specialized service is available to empty and/or load material into the unit at the desired frequency	odour mitigation				
Aerobic In-Vessel	▪ Hauling frequency can decrease, and amount hauled is decrease ▪ Specialized service is available to empty and/or load material into the unit at the desired frequency	▪ Reduced volume, potential odour mitigation	▪ Additional time to load/unload the unit	Medium/ Low	Low	Low
Anaerobic In-Vessel	▪ Hauling frequency can decrease, and amount hauled is decreased ▪ Specialized service is available to empty and/or load material into the unit at the desired frequency	▪ Reduced volume, potential odour mitigation	▪ Additional time to load/unload the unit	Low	Low	Low

2.3 Option 2: Pre-Treatment

Figure 3: Example Pre-Treatment Units
Technologies: Gaia Dehydrator (Left and Center), IMC Waste Station (Right)

Pre-treatment, in the context of this study, refers to mechanical or heat treatment to reduce the mass and volume of the organics stream. This can be used in conjunction with an anaerobic in-vessel system or as a stand-alone system requiring storage and conventional hauling. The two main sub-options within the pre-treatment category are dewatering and dehydration.

2.3.1 Dewatering

Dewatering involves the grinding of organic material into fine particles and removal of excess water. The technologies reviewed accomplish this through mechanical expulsion of excess liquid from the organic material. The liquid goes down the drain, while the solids, reduced in volume by 70% to 80%, are directed to a container and removed by the user. The output, while not suitable to be used as a soil amendment, can be fed into an in-vessel or other composting system, or hauled off-site to a large scale composting facility.

IMC Waste Station
(Image from imco.co.uk)

Capacity for dewatering systems can be as high as 700 kilograms (kg) per hour with no minimum. There are no requirements for timing of feedstock input; organics can be deposited into the system as it is produced and is processed within minutes. This type of technology works best for food scraps with higher water content, such as raw produce and so is better suited for back-of-house generated food scraps and not plate scrapings.

The following table provides an overview of basic parameters of interest for dewatering technologies reviewed:

Table 6: Dewatering Summary

Dewatering	
Capacity	Up to 400,000 kg per week*
Applicable Business Examples	Restaurant or group of restaurants, food court, cafeteria, or grocery store
Capital Cost	$25,000
Annual Maintenance Cost	$250
Daily Labour Requirements	Less than 30 minutes
Footprint	Less than 1 m^2
Inputs	Raw food scraps, electricity, and water
Outputs	Dewatered, partially degraded food scraps

*Based on an 8-hour day and 7-hour working week.

- **Pros** – The main benefit of this type of system is the rapid volume reduction and the ability to continually process materials. Labour requirements are also minimal, and consist primarily of loading and unloading the system and potentially cleaning, although some models are self-cleaning. Dewaterers are also generally quite compact with an approximately a 1 square metre (m^2) footprint, and thus could be easily installed within a small food service/retail establishment provided electrical and drainage connections are available. The bin in which the output material is expelled fits within the footprint of the machinery and therefore does not require any additional space.

- **Cons** – One of the main drawbacks is the high water usage required. Not only is water extracted from the system, a large amount (from 4 litres per minute upward) of water is used as a carrier to transport material throughout the system. This water, as well as excess water removed from the organics, then enters the sanitary system, which may trigger a regulatory compliance issue depending on the quantity and quality of the effluent being discharged. Electricity use is also relatively high at approximately 100 kWh per week, roughly $1 per day at BC Hydro's current rates. Storage vessels and space will also be required to temporarily store the dewatered material prior to hauling to a commercial processing facility.

- **Key considerations** for establishments interested in a dewatering system are:
  - Do I produce an organics stream that is primarily food with a higher water content (minimal fibres), without bones?
  - Do I produce a sufficient volume of organics such that volume reduction will significantly reduce my costs?
  - Do I have the capability to hook the equipment up to sanitary?
  - How important is the public relation/educational value of the equipment to my company?

2.3.2 Dehydration

Dehydration consists of grinding and heating a batch of organic material to a temperature sufficiently high to evaporate water within the material. That water is then re-condensed and removed from the system as a high-purity distillate suitable for drainage. The process takes place with constant agitation in an aerobic environment and is similar to the first stage of traditional composting. The output is a soil-like sterile biomass that has been reduced in volume and mass from the original feedstock by up to 90%. For every 100 kg of organics entered into the system, approximately 10 kg to 20 kg will be removed as a solid biomass, and the remaining 80 kg to 90 kg will enter the sanitary sewer system as distilled water or will become water vapour.

Gaia Dehydrator
(Image from www.gairecycle.com)

Dehydration systems operate either as a batch process, meaning the feedstock is loaded all at once and then a cycle is started, or as continuous flow. Cycle time for batch models is approximately 6 to 8 hours, regardless of size, meaning a typical food service/retail establishment could run 1 cycle per day. There is a wide range of sizes for this technology with the highest capacities being approximately 1,000 kg per cycle (batch) or 1,500 kg per day (continuous flow). All types of organics are acceptable, including fibres; however, for the batch process, higher fibre concentrations result in a longer cycle time. For continuous flow options, up to 70% fibre is acceptable with operational adjustments. The smaller and more inexpensive options may have limitations with respect to harder food items such as pits and bones. The upper end of the spectrum can even accept compostable plastics; however, it depends on the desired end use of the output. A benefit of continuous flow versus batch is that organics can be continually loaded without having to wait for a new cycle to start, cutting down on storage space and timing errors.

The following table provides an overview of basic parameters of interest for dehydration technologies reviewed:

Table 7: Dehydration Summary

Dehydration	
Capacity	Up to 14,000 kg per week
Applicable Business Examples	Restaurants, Food Courts
Capital Cost	$27,000 to 50,000
Annual Maintenance Cost	$200
Daily Labour Requirements	Less than 30 minutes
Footprint	From 0.2 m^2 to 8 m^2
Inputs	Food and food scraps and electricity
Outputs	Sterile biomass

- **Pros** – A dehydration system also reduces volume by 70-80% and is a relatively inexpensive way to process organic materials, however, the end product, while sterile, is not suitable to be used as a soil amendment and would still require further processing. The capacity, while not as high as that of a dewatering system, is still relatively high and the 6 to 8 hour batch system could be run in such a way that two cycles could be run per typical work day. The system is also relatively small and could fit in a restaurant's kitchen. Operationally, this type of system is very simple: after loading, the user can essentially "set and forget", returning at the end of the cycle to remove the biomass produced. Systems can be designed to run off gas or steam rather than solely electricity.

- **Cons** – For some establishments, the batch system could be seen as a drawback, as interim storage would be necessary while the system is operating. A potential solution could be the use of two systems – one in use while the other is being loaded, however this is not an option for all prospective users. The majority of the output for the batch system ends up in the sanitary system; although it is distilled water, some may find this an undesirable aspect and it may trigger additional regulatory requirements. For the continuous flow options, water vapour is produced and must be ventilated. The remainder of the output will need to be treated further to produce a usable composted product or hauled off-site. Electricity usage is also relatively high due to the energy input required for evaporation – for a facility treating 1 tonne per week usage may be as high as 700 kWh per week.

- **Key considerations** for establishments interested in a dehydration system are:
  - Do I produce a sufficient volume of organics such that volume reduction will significantly reduce my costs?
  - Am I willing to increase my energy consumption by up to 700 kWh per week?
  - Do I have the capability to hook the equipment up to sanitary?
  - If a batch process is used, do I have interim storage for organics to be used while a cycle is running?

2.4 Option 3: Aerobic In-Vessel

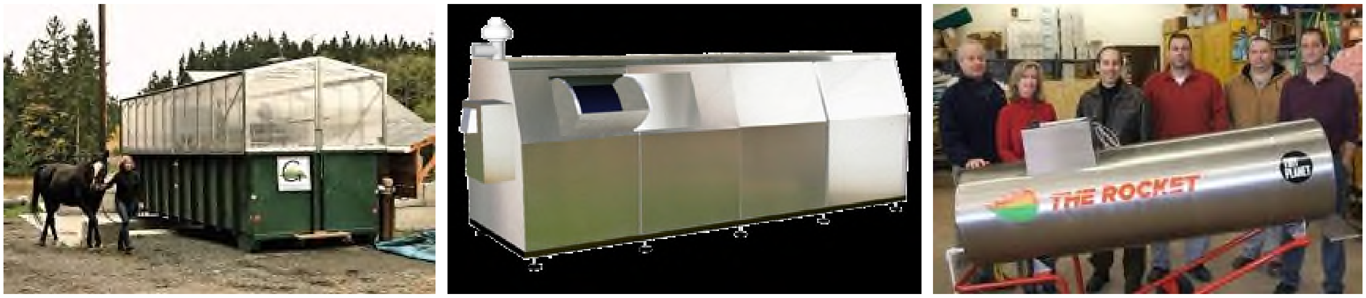


Figure 4: Example Aerobic In Vessel Units
Technologies: Earth Flow (left), Citypod (center), and The Rocket (right)

Aerobic composting is the microbial degradation of organic materials in the presence of oxygen. An aerobic in-vessel system is an engineered system in which favourable composting conditions are induced in order to accelerate the degradation process and contain it within a manageable area. Although the technology is relatively new, it is expanding rapidly and many options are already in use, including several within Metro Vancouver. Aerobic in-vessel composting systems come in a variety of sizes and technologies, and produces usable soil amendment, potentially requiring additional curing. In the context of this study, three size ranges were considered: small (approximately 10 tonnes per year), medium (approximately 100 tonnes per year), and large (approximately 1,000 tonnes per year). Several technologies were reviewed within each size range. Generally, as the size of the system increases, so does the complexity, cost, and operational commitment required. All systems considered in this study are automated.

One notable requirement of aerobic in-vessels systems is the addition of a bulking agent. To achieve an output that can be considered as compost, a certain ratio of Carbon to Nitrogen is required. Organics are rich in nitrogen, so a source of carbon generally needs to be added to the system to achieve the proper balance. Generally, wood chips, sawdust, or wood pellets are used, however, in some cases paper or cardboard can be used as a bulking agent. Bulking agents also serve to control moisture content. The ratio and recommended bulking agent depends on the specific technology used.

Aerobic in-vessel options can be used in tandem with pre-treatment for even greater volume reduction and control of process parameters through supply of consistent feedstock. However, due to the low moisture content from the pre-treatment options, it may be necessary to add moisture in order to optimize the degradation process.

2.4.1 Small Aerobic In-Vessel Systems

Few options exist for small automated aerobic in-vessel systems – at the 10 tonne/year range, most composting technology available requires some sort of manual process, such as turning a crank to rotate the compost material. However, some options do exist and are distributed in Canada. These systems consist of a small stainless steel vessel in which compost material is artificially brought up to temperature to kill any pathogens and accelerate the composting process. The output of a small aerobic in-vessel system would require additional curing of up to 30 days in order to be used as a soil amendment. Depending on the feedstock, a 50% reduction in volume is possible, not including bulking agent.

The following table provides an overview of basic parameters of interest for small aerobic in-vessel technologies reviewed:

Table 8: Small Aerobic In-Vessel Systems Summary

Small Aerobic In-Vessel Systems	
Capacity	150 to 3,500 kg per week
Applicable Business Examples	Small Restaurant
Capital Cost	$18,000
Annual Maintenance Cost	$400
Daily Labour Requirements	Less than 30 minutes
Footprint	2 m²
Inputs	Food and food scraps, bulking agent, and electricity
Outputs	Compost (requires curing)

- **Pros –** Small aerobic in-vessel systems can process up to 150 kg per week; however, larger systems are available of a similar type to process up to 3,500 kg per week. The process takes approximately two to three weeks to produce an output material. All types of food scraps can be composted, as well as small amounts of compostable paper (up to 10%) and yard and garden debris (up to 20%). Wood chips are recommended as a bulking agent at a 1:1 ratio, and can potentially be re-used if screened from the compost. This type of system is simple, and provides a high corporate sustainability benefit. Organics are managed on-site, and, provided there is space for curing to occur, can be converted into a usable soil amendment product.
- **Cons** – The up-front purchase cost of a small in-vessel system is less than that of the pre-treatment options discussed; however, maintenance and labour requirements are higher. In order to avoid odour and vector issues, regular cleaning is required, and in order to keep the process running smoothly, daily temperature and moisture checks are recommended. The system also produces leachate and requires periodic draining and generally requires access to a sanitary sewer and a water supply for cleaning. Installation requirements are also slightly higher than that of pre-treatment systems, as the smallest system is approximately 2.4 m long by 0.7 m wide by 1.3 m high and requires a level non-porous surface and shelter for installation. Staff would require some sort of training in order to operate this type of system.
- **Key considerations** for establishments interested in a small aerobic in-vessel system are:
  - Do I produce less than 3,500 kg per week of organics?
  - Do I have space (approximately 2 m²) for a system of this size?
  - Do I have additional space for on-site curing (another 2 m²) or will I need to have the end product hauled elsewhere?
  - Do I have a secure source of bulking agent, along with space to store it on-site?
  - Do I have a use for the end product on my site?
  - Do I have staff that would be interested and willing enough to help keep the system operating well?

2.4.2 Medium Aerobic In-Vessel Systems

Most food service establishments would likely fall into the medium range for anaerobic in-vessel systems, which treat from approximately 50 to 300 tonnes per year. Within this range of capacities, there are many different options to choose from; some range from relatively low-tech systems consisting of an auger moving through a contained pile of compost, to fully sealed and automated vessels producing ready-to-use soil amendment with no need for additional curing. Volume reduction (not including bulking agent) ranges from 50% to 75%.

These systems can accept all types of food scraps, but some are more tolerant than others to bones. Generally fibres should be kept to less than 10% by volume; however some systems can accept cross-cut cardboard as an alternative to typical bulking agents. Most systems come in a variety of size ranges, starting from approximately 36.4 tonnes per year (700 kg per week) on the low end to approximately 200 tonnes per year (8,000 kg per week) on the higher end. The process can take anywhere from two to six weeks depending on the desired output, and most options operate as a continuous flow system.

Jora JK5100
(Image from www.joracanada.ca)

The following table provides an overview of basic parameters of interest for medium aerobic in-vessel technologies reviewed:

Table 9: Medium Aerobic In-Vessel Systems Summary

Medium Aerobic In-Vessel Systems	
Capacity	700 to 8,000 kg per week
Applicable Business Examples	Medium/large restaurant, campus, institution
Capital Cost	$30,000+
Annual Maintenance Cost	$600+
Daily Labour Requirements	One hour
Footprint	From 3 m² to 96 m²
Inputs	Food and food scraps, bulking agent, and electricity
Outputs	From compost (requiring curing) to usable soil amendment

- **Pros** – These types of systems provide a great corporate sustainability benefit for those establishments that have the space and labour requirements for them. Systems start at around $30,000; only slightly more expensive than some pre-treatment options, however, with increasing size and automation, prices can reach the $100,000 range. Another benefit is the potential to produce ready-to-use compost with no need for additional curing, which helps to minimize the overall spatial footprint of the system. Most options also include some sort of odour mitigation, ranging from biofilters to odour-removing products such as sprays.
- **Cons** – Generally, these options require more space than previous options discussed and may have additional installation requirements such as a concrete slab, ventilation to outdoors if inside, or shelter if outside. Operation and maintenance costs are also higher than more simple options, starting at about $600/year; however, most companies provide installation and staff training as part of the purchase price. Electricity requirements are lower than pre-treatment in most cases, ranging from approximately 1 kWh per day to about

10 kWh per day for the larger systems. Total staff time required for operation and maintenance is about an hour per day, on average, depending on the complexity of the system.

- **Key considerations** for establishments interested in a medium aerobic in-vessel system are:
  - Do I produce between 700 and 8,000 kg per week of organics?
  - Do I have an appropriate location for this system, including sufficient space (3 m² for the smallest system, 96 m² for the largest) and potentially a concrete pad (for outdoor systems) or ability to vent outside (for indoor systems)?
  - Do I want a ready-to-use soil amendment product?
  - Do I have a use for the end product on my site?
  - Do I have staff that would be interested and willing enough to help keep the system operating well?
  - Are my staff members able to allocate an hour per day toward running the system?

2.4.3 Large Aerobic In-Vessel Systems

Large aerobic in-vessel systems provide an organics management solution for establishments producing high volumes of organics. The system analyzed in this study consists of a stainless steel hull containing tine bearing shafts which move organics through the system. Air is injected periodically and compost is automatically discharged at the opposite end from the inlet. Depending on retention time within the system, ready-to-use soil amendment can be produced. Retention times vary from 10 to 25 days, and the output is reduced in mass and volume by approximately 80%. Leachate is not produced in this type of system.

Hot Rod Composter
(Image from www.mbendi.com)

Feedstock requirements are similar to those of smaller options: fibres should be kept to less than 10%, and overall contamination should not exceed 20% in order for the process to run smoothly. Large organics—such as bones or woody debris—should be shredded prior to inclusion. Most larger systems can be designed to meet a given capacity, but upwards of 1,000 tonnes per year, an in-vessel system may no longer be the most cost effective option.

The following table provides an overview of basic parameters of interest for large aerobic in-vessel technologies reviewed:

Table 10: Large Aerobic In-Vessel Systems Summary

Large Aerobic In-Vessel Systems	
Capacity	2,000 to 18,000 kg per week
Applicable Business Examples	Grocery store, large cafeteria, institution
Capital Cost	$450,000
Annual Maintenance Cost	$500/year
Daily Labour Requirements	3 hours
Footprint	From 30 to 320 m²
Inputs	Food and food scraps, electricity, and bulking agent
Outputs	Compost (may require curing)

- **Pros –** One distinguishing feature of larger in-vessel systems are a variety of add-on options that will generally be included in a given quote, including feed-hopper attachments, bin lifters, and shredders. Considering the capacity, these systems can fit in a relatively compact space, with a footprint of approximately 13 m long by 2 m wide by 2 m high. One notable feature of the larger options reviewed was an “odour free guarantee”. Depending on retention time within the system, ready-to-use soil amendment can be produced.

- **Cons –** A significant consideration for this size of system is the staff time requirements. Approximately three hours per day are needed for operation, which would most likely require a half-time operator. The purchase cost is also around $500,000, but subject to a lot of variation based on specific siting requirements. Another drawback for the systems reviewed within this study would be the necessity of having a specialized technician come to the site in case of any major problems, due to the complexity of the system. For establishments looking for a quick set-up, this would not be an ideal option, as the time from order to use is expected to be around four to five months. Although the footprint of the system is smaller, a concrete pad as well as water, power, and sewer connections is required.

- **Key considerations** for establishments interested in a large aerobic in-vessel system are:
  - Do I produce more than 5,000 kg per week of organics?
  - Are my hauling costs high enough to warrant an investment of this size?
  - Do I have an appropriate location for this system, including sufficient space (30 m² for the smallest system, 320 m² for the largest), a concrete pad, and ability to hook up to power, water, and sewer?
  - Am I able to wait the four to five months required before the product will be functional?
  - Am I able to hire a half-time operator?
  - Do I have a use for the end product on my site?
  - Do I have staff that would be interested and willing enough to help keep the system operating well?

2.5 Option 4: Anaerobic In-Vessel

Figure 5: Example Anaerobic In-Vessel Units
Technologies: SEAB Flexibuster (left) and Impact BioEnergy concept system (right)

Anaerobic digestion is a process in which organic material is degraded in the absence of oxygen. More typically associated with waste water treatment processes, smaller scale in-vessel anaerobic digesters are beginning to be developed as a way to not only manage an organics stream, but to generate energy in the process.

The by-products of anaerobic digestion are biogas, which can be used as an energy source, a liquid component which can be used as fertilizer, and a solid component which, depending on process parameters, can be used as soil-amendment or may require further treatment.

Anaerobic in-vessel systems can be used in conjunction with pre-treatment technologies to control moisture content of the feedstock. The solid output of an anaerobic in-vessel system can also be fed into an aerobic in-vessel system to create a usable soil amendment product.

Two scales of anaerobic digestion were reviewed in this study, in reference to the tonnages outlined in Section 3.0: medium and large.

2.5.1 Medium Anaerobic In-Vessel Systems

In the context of this study, medium anaerobic in-vessel systems refers to a containerized digester including a mixing/chopping unit, digestion tanks, a gas holder, and a heat and power unit. Organics are loaded into the mixing/chopping unit and are then pasteurized and digested in a series of three tanks. Liquids are retained in the system, while solids and gas are removed. Gas is stored in a separate holder and used in the heat and power unit which converts the gas to usable energy.

Any organics apart from wood, paper, and cardboard are accepted as these cannot be broken down by the bacteria used in the process. Capacity ranges from 200 to 1,000 tonnes per year. While biogas will be produced a week after start-up, the full digestion process takes upwards of three weeks.

SEAB Flexibuster
(Image from www.seabenergy.com)

The following table provides an overview of basic parameters of interest for medium anaerobic in-vessel technologies reviewed:

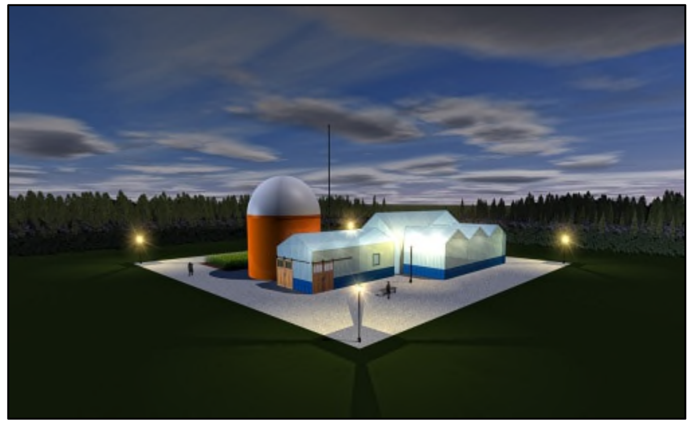
Table 11: Medium Anaerobic In-Vessel Systems Summary

Medium Anaerobic In-Vessel Systems	
Capacity	5,000 to 20,000 kg per week
Applicable Business Examples	Larger grocery store, food distribution centre, larger institution
Capital Cost	$240,000
Annual Maintenance Cost	$14,000
Daily Labour Requirements	Up to 2 hours
Footprint	From 7 m^2
Inputs	Food and food scraps, minimal electricity
Outputs	Sterile biomass, liquid fertilizer, electricity

- **Pros** – One of the greatest benefits of this system is the ability to generate power. Not only that, but the corporate sustainability benefits for a system is very high as compostable organics are converted not only into a saleable by-product, but into immediately usable energy. Smaller scale systems can be hooked up into an in-sink kitchen macerator for direct feeding into the system. The system is also monitored remotely so faults can be seen by the customer service team and hopefully corrected before causing a problem.
- **Cons** – The biggest drawback to a medium-scale anaerobic in-vessel system is cost, which is in the $200,000 to $300,000 range. Operation and maintenance costs are also high, at around $14,000 annually. However, with the option of selling the end product as liquid or pelletized fertilizer—or further processing digestate into compost—and generating power, there is opportunity to recoup costs. Space may also be a limiting variable for some establishments, as well as the presence of a continually operating generator system on a given premise. Compared to a similarly-sized aerobic option, the anaerobic option also takes considerable staff time – approximately two hours per day.
- **Key considerations** for establishments interested in a medium anaerobic in-vessel system are:
  - Do I produce more than 5,000 kg per week of compostable organics?
  - Is my compostable organics stream consistent enough to warrant an investment of this size?
  - Do I have an appropriate location for this system, including at least 7 m^2 of outdoor space?
  - Do I have the potential to use energy generated by the system?
  - Am I able to commit two hours of staff time per day?
  - Do I have a use for the end product on my site?

2.5.2 Large Anaerobic In-Vessel Systems

Large anaerobic in-vessel systems, although not considered large in comparison to industrial and wastewater anaerobic digesters, are capable of handling quantities upwards of 1,000 tonnes per year. The process in this case would involve grinding the feedstock into a pumpable uniform texture, which would then go into a digester, producing biogas (10% to15% of feedstock), liquid fertilizer (25% to 30%) and solid digestate (50% to 55%). These systems are generally designed to order and can therefore be customized depending on the needs of the establishment. The size of a 1,000 tonne/year system would be approximately 200 m^2.



Prototype Design of Impact BioEnergy System
(Image from www.impactbioenergy.com)

Acceptable feedstock for a large anaerobic in-vessel system includes all food scraps, but not wood, yard and garden debris, plastic, glass, or metal. The process, from feedstock to end product, would take between 40 and 50 days.

The following table provides an overview of basic parameters of interest for large anaerobic in-vessel technologies reviewed:

Table 12: Large Aerobic In-Vessel Systems Summary

Large Anaerobic In-Vessel Systems	
Capacity	20,000 kg per week+
Applicable Business Examples	Large grocery store, large institution, food distribution, large food processing
Capital Cost	$800,000+
Annual Maintenance Cost	$10,000+
Daily Labour Requirements	3 to 4 hours
Footprint	200 m^2+
Inputs	Food and food scraps, and minimal electricity
Outputs	Sterile biomass, liquid fertilizer, and electricity

- **Pros –** Among the benefits of a system this size would be the quantity of power generated. This type of system comes equipped with a net metering connection, which would provide the opportunity to sell power back to the grid. These systems can also be produced in the Pacific Northwest, allowing for easy consultation with designing engineers and technicians, if necessary. The option of a designed-to-order system would also likely be appealing to some establishments with unique restrictions.

- **Cons** – The major obstacle to a system this size is that, in order to be economical, at least 1,000 tonnes per year need to be produced. A significant capital investment (upwards of $800,000) as well as on-going maintenance (around $10,000) would also be needed. Time commitment is also high, requiring a half-time operator to keep the system operating smoothly. Size is also likely an issue for establishments with limited space.
- **Key considerations** for establishments interested in a large anaerobic in-vessel system are:
  - Do I produce more than 20,000 kg per week of organics?
  - Is my organics stream consistent enough to warrant an investment of this size?
  - Do I have enough space for this system, including at least 200 m² of outdoor space?
  - Do I have the potential to use energy generated by the system?
  - Am I able to provide a half-time operator for the system?
  - Do I have a use for the end product on my site?

2.6 Option Combinations

As outlined in the subsections above, some options can be combined in order to maximize specific factors, such as volume reduction. Pre-treatment can be used to reduce volume of the feedstock prior to storage or usage in an aerobic or anaerobic in-vessel system. Aerobic in-vessel systems can also be used following anaerobic digestion to further process the solid end product into a usable soil amendment.

3.0 SCENARIO DEVELOPMENT

3.1 Decision-Making Criteria

In order for a given food service/retail establishment to decide on which option or options would be most beneficial for their specific circumstance, the following questions are recommended to serve as a basis for decision making:

Question 1: How much organic material do I produce?

Question 2: What type of organic material do I produce?

Question 3: How much space do I have?

Question 4: How much labour is required?

Question 5: What sort of corporate sustainability benefits can I expect?

Question 6: How close will I get to producing compost?

Question 7: How much will it cost?

Each of the above criteria is discussed in the following subsections with a summary of the most suitable option(s) considering each criterion independently.

3.1.1 Question 1: How much organic material do I produce?

The first question that a food service/retail institution should be able to answer is how much organic material is generated. This will serve as a basis to decide which options may be suitable, and which technologies within that option could be feasible for a given organic stream. Assuming most establishments won't know the weight of organics produced on a weekly basis offhand; volume of disposed waste can serve as a basis for estimation. Using the number of bins, the frequency of pick-up, and the approximate level to which each bin is full, the total volume of organics produced on a weekly basis can be calculated. The table below outlines some common organic generation rates:

Table 13: Common Organics Generation Rates and Containers Filled per Week

Organics Generation Rate				Number of Organic Bins Filled per week Estimated for each Bin Size						Example
Size	t/yr	t/wk	kg/ day	120 L Tote	240 L Tote	360 L Tote	2 yd^3	6 yd^3	20 yd^3	
Small	10	0.19	27	4	2	1	<1	-	-	Fill less than one 120 L tote per day, for a total of three to five 120 L totes per week.
Medium	100	1.92	275	38	19	13	2	1	<1	Fill four to six 120 L totes per day, which is enough to fill two to three 2 yard bins per week.
Large	1,000	19.23	2,747	385	192	128	24	8	2	Fill fifty to sixty 120 L totes per day, which is enough to fill two to three compactors per week.

In terms of storage options, the mass and volume of organic material produced will help to serve as a guide for how many containers are needed and how frequent pick-up should be. For pre-treatment and in-vessel composting options, the following figure summarizes which types are available for a given weight of organics produced per week.

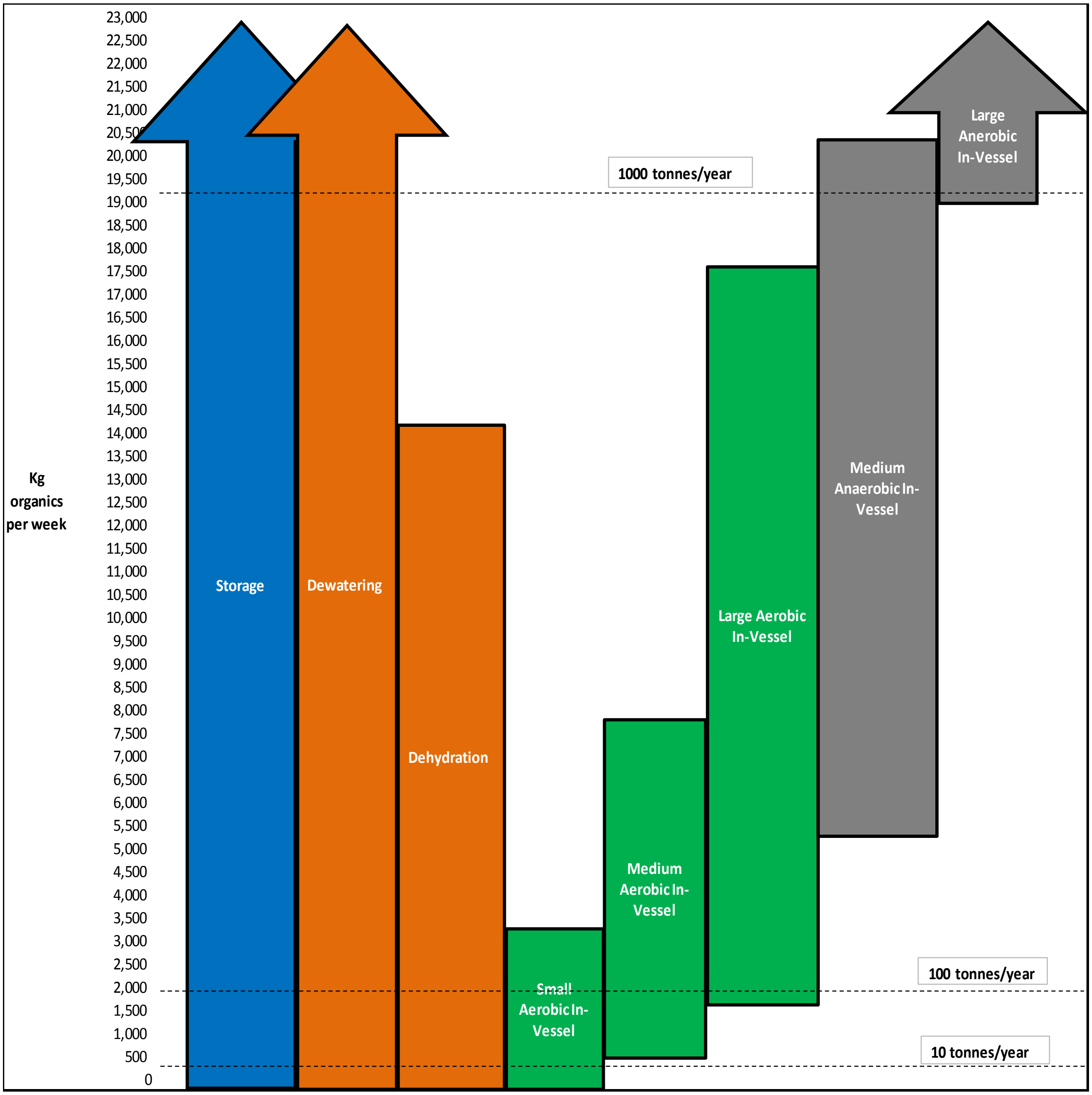


Figure 6: Options Based on Capacity

It can be seen from Figure 6 that dewatering is an option for all amounts of organics generation. For smaller generators, pre-treatment (dewatering or dehydration), small aerobic in-vessel or medium aerobic in-vessel options are most suitable. For larger producers, dewatering prior to use of large aerobic in-vessel or anaerobic in-vessel systems would help to increase total volume reduction.

3.1.2 Question 2: What type or organic material do I produce?

Not all technologies can accept all types of organics. Some materials may not break down in certain technologies, and some harder materials may cause jams or damage mechanical components. Generally, if an organics stream contains bones or carcasses, paper or cardboard, compostable plastics or yard and garden debris, the technology chosen may be limited. While these materials can be avoided by source separation, in some cases, the added convenience of being able to use various material types in one device may be a selling factor for some users.

Generally, anaerobic digestion systems, especially at the scale specified for this report, have more stringent input requirements than other options as the bacteria used in the process can only flourish with certain feedstock. Most technologies have a limit to the amount of fibres (paper and cardboard) that can be added to the system, and acceptability of compostable plastics and yard and garden debris may vary. The following table summarizes the options and whether or not they can accept certain items as feedstock.

Of all the options, storage is the only one that can accept any material type; however, restrictions on regional organics processing facilities may limit what can be part of the organics stream (for example, compostable plastics are not accepted at all facilities). Dehydration and large aerobic in-vessel systems are the next best options in terms of acceptability of materials. Medium anaerobic in-vessel systems are the least flexible in terms of feedstock.

Table 14: Feedstock Type Accepted

Option	Food Scraps	Bones and Carcasses	Paper and Cardboard	Compostable Plastic	Yard and Garden Debris
Storage	✓	✓	✓	✓	✓
Dewatering	✓	⚠ 1	⚠ 2	⚠ 3	✗
Dehydration	✓	✓	✓	✓	✗
Small Aerobic In-Vessel	✓	✓	⚠ 2	✓	⚠ 4
Medium Aerobic In-Vessel	✓	⚠ 5	⚠ 2	⚠ 5	✓
Large Aerobic In-Vessel	✓	✓	⚠ 2	✓	✓
Medium Anaerobic In-Vessel	✓	✓	✗	✗	✗
Large Anaerobic In-Vessel	✓	✓	✓	✗	✗

Notes:

1. May jam mechanical components of system.
2. Maximum 10% of feedstock.
3. Maximum 5% of feedstock must be shredded.
4. Maximum 20% of feedstock.
5. Acceptable, but may not degrade completely.

3.1.3 Question 3: How much space do I have?

For many food service establishments, space is a very important limiting factor. A small restaurant may not have room for an in-vessel system in their back alley and may be restricted to options that can fit within a kitchen or storage area. Alternatively, a food service area within a university may have the ability to install a mid-scale facility on campus property. All spaces are not created equal; some technologies, such as anaerobic digestion, will need to be sited outdoors, while others, such as pre-treatment, should be indoors. In all cases, extreme variation in temperature may impact the speed of the process.

Generally, the size of the system increases with capacity; however, certain types of systems tend to be larger than others. Pre-treatment options tend to be smallest, with aerobic in-vessel systems in the mid-range and anaerobic systems the largest. Storage size is a function of hauling frequency and therefore is difficult to quantify in this respect. The following table summarizes the space requirements for each option. The footprint shown is the minimum for a given option for the equipment only, and will tend to increase within the capacity range for that option. Additional storage space is required to store material inputs and outputs. The specific dimensions (i.e., length and width) of each option will vary depending on the specific technology chosen. Grid units indicate 0.25 m².

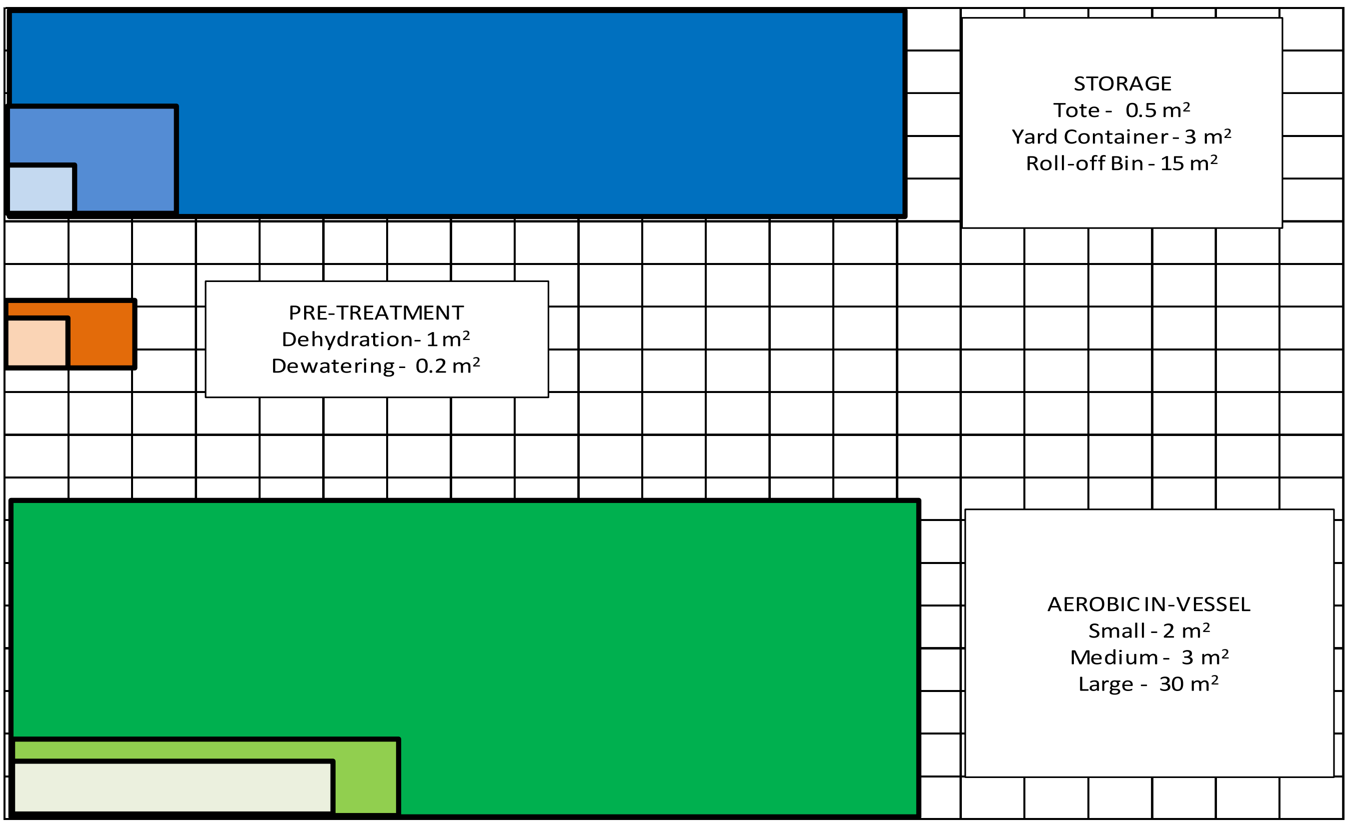


Figure 7: Relative Minimum Footprint for Options

Figure 7 demonstrates that dehydration technologies can be the most compact, while large anaerobic in-vessel systems require the most space. Aerobic in-vessel options tend to be much longer than they are wide, going by the horizontal cylinder configuration of several options. Anaerobic in-vessel systems were not shown on this figure due to the large space requirements for a large anaerobic in-vessel system (>200 m²). Medium anaerobic in-vessel systems have a much smaller footprint (approximately 7 m²). If space alone was the deciding factor, dehydration would be the option of choice.

3.1.4 Question 4: How much labour is required?

Labour requirements are an important consideration when determining what the total cost of an option will be, and whether an option will be feasible based on the staff situation at a given establishment. A higher labour requirement will not only increase the costs of operating the system, but will require that staff are appropriately trained and can put the necessary effort to keep the system running smoothly. For food service establishments with a high turnover, a time-consuming system may not make sense.

When determining how much time can be spent on a daily or weekly basis, there are three questions that should be answered: 1) How much time can my current staff spare from their daily activities? 2) How much extra can I afford to pay my staff for the extra time? 3) How competent do I expect my staff would be at running this system? Most technology providers will provide training as part of the initial capital cost, but depending on the complexity of the system, this may range from reading a manual to a two-day training course. If staff members are too busy to commit much extra time to the system, then more complex options may have to be ruled out.

Within the options available, storage is the least time consuming, as it would require very little extra time, if any, from current waste management practices. Pre-treatment is generally the next most time consuming, followed by aerobic composting. Anaerobic systems generally require more time based on the complexity of the systems. Some complex systems may have options available to cut down on time required, such as bin lifters for loading large systems, or in-sink macerators that feed directly to the in-vessel system.

The daily and per tonne labour requirements for each option are summarized in the Figure 8.

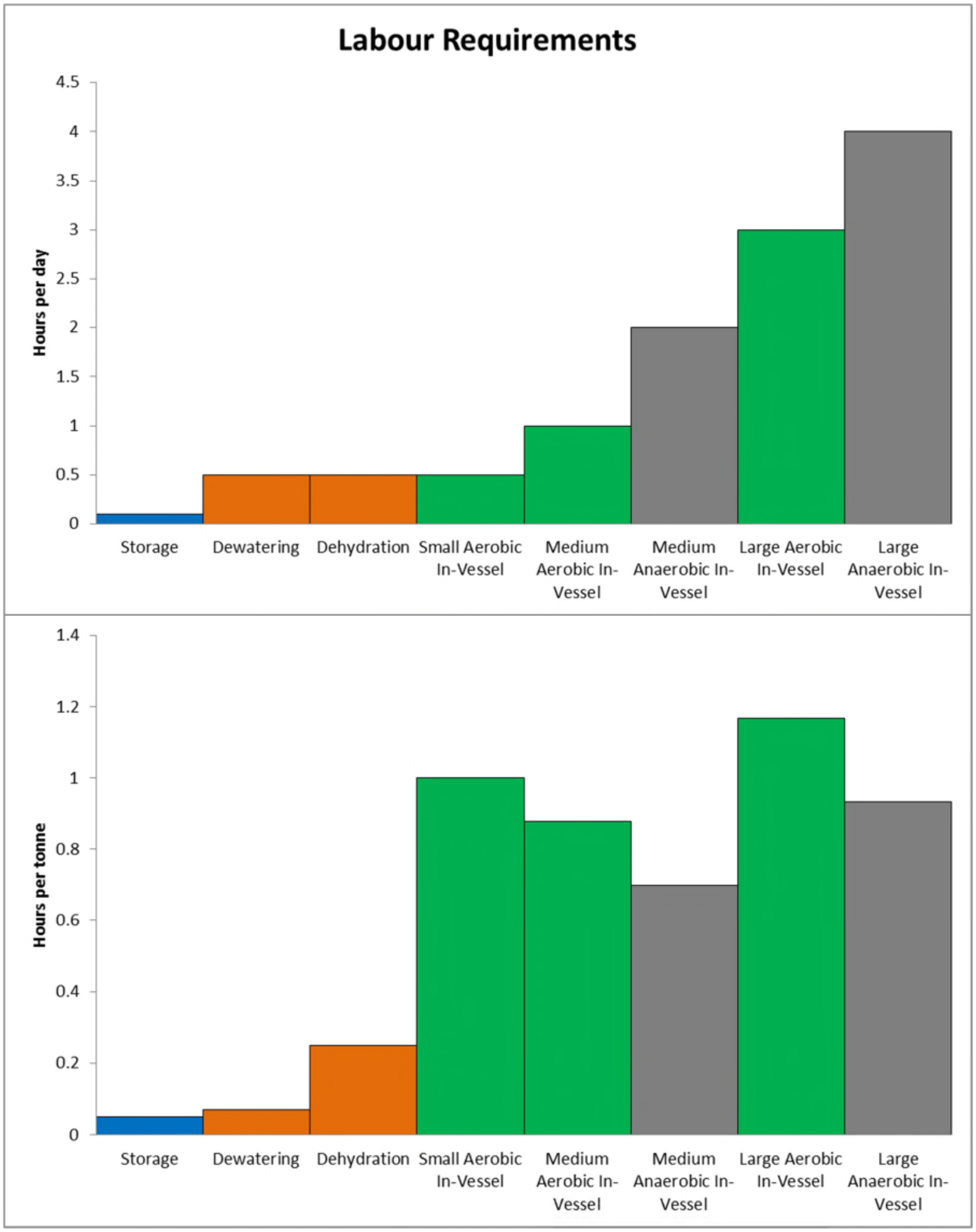


Figure 8: Operating Labour Requirements for Organics Management Options

As shown in Figure 8, Pre-treatment (dewatering and dehydration) has a similar time commitment required as for a small aerobic in-vessel system. The larger systems, aerobic and anaerobic, require the most time per day and would most likely require a half-time operator. If only considering labour, storage would be the least time consuming and therefore a preferable option.

3.1.5 Question 5: What sort of corporate sustainability benefits can I expect?

Corporate sustainability benefits are more important to some establishments than others, but can be the deciding factor between systems that may be more expensive. Many on-site processing options demonstrate a commitment to waste reduction, resource management, sustainability and the environment in general. For companies with strong environmental core values, many of these options help demonstrate that they are taking action toward bettering their environmental footprint. This may also be a benefit to environmentally conscious staff that may prefer to work at a location that is actively doing something to increase their waste diversion.

Corporate sustainability benefits are difficult to quantify, but generally, the more usable the end product and the less that needs to be hauled to a licensed organics processing facility, the higher the corporate sustainability benefit. Storage would have the least value in this case, while anaerobic digestion, producing usable energy as well as fertilizer, would have a very high value. In many cases, this value is subjective, but for most, the closer the end product is to usable soil amendment, the higher the corporate sustainability benefit.

The following table describes what corporate sustainability benefits can be gained from each option:

Table 15: Corporate Sustainability Benefits

Option	Volume Reduction	Greenhouse Gas Reduction	Closing the Loop	Minimal Ecological Footprint	Staff Participation
	Amount of organic material hauled is substantially reduced.	Reduce Greenhouse gas emissions (by reduced hauling) by using this option.	After curing, end product can be used as soil amendment.	The system produces more electricity than it uses.	The technology contributes to staff education and sense of environmental contribution.
Storage		✓			
Pre-Treatment	✓	✓			
Aerobic In-Vessel	✓	✓	✓		✓
Anaerobic In-Vessel	✓	✓		✓	✓

If considering only corporate sustainability value, aerobic or anaerobic in-vessel systems would be the recommended choice.

3.1.6 Question 6: How close will I get to producing compost?

Depending on potential markets or on-site uses for the end product, certain outputs may be desired by different establishments. For an establishment that has space either on-site or nearby to use soil amendment for landscaping or gardens, a ready-to-use soil amendment would be highly desirable. For an establishment that would have difficulty finding a market for soil amendment, it may not be as useful, and volume reduction through pre-treatment may be the most suitable option. Similarly, for an establishment with high energy usage, it may make good financial sense to generate energy as an output, whereas for a smaller establishment, there may be little use for the amount of energy generated by an anaerobic digestion system.

Output of on-site organics management options ranges from raw food scraps to soil amendment, generally with increased process time. Other outputs may be liquid fertilizer and energy in the case of anaerobic digestion. Pre-treatment options tend to generate a product somewhere in the middle and can be classified as a “sterile biomass”. Some places may accept this sterile biomass to be used as compost after further processing. It should be noted that producing a saleable product may trigger additional regulatory requirements, such as testing under the BC Organic Matter Recycling Regulation and licensing.

The following figure demonstrates the scale of outputs for each option:

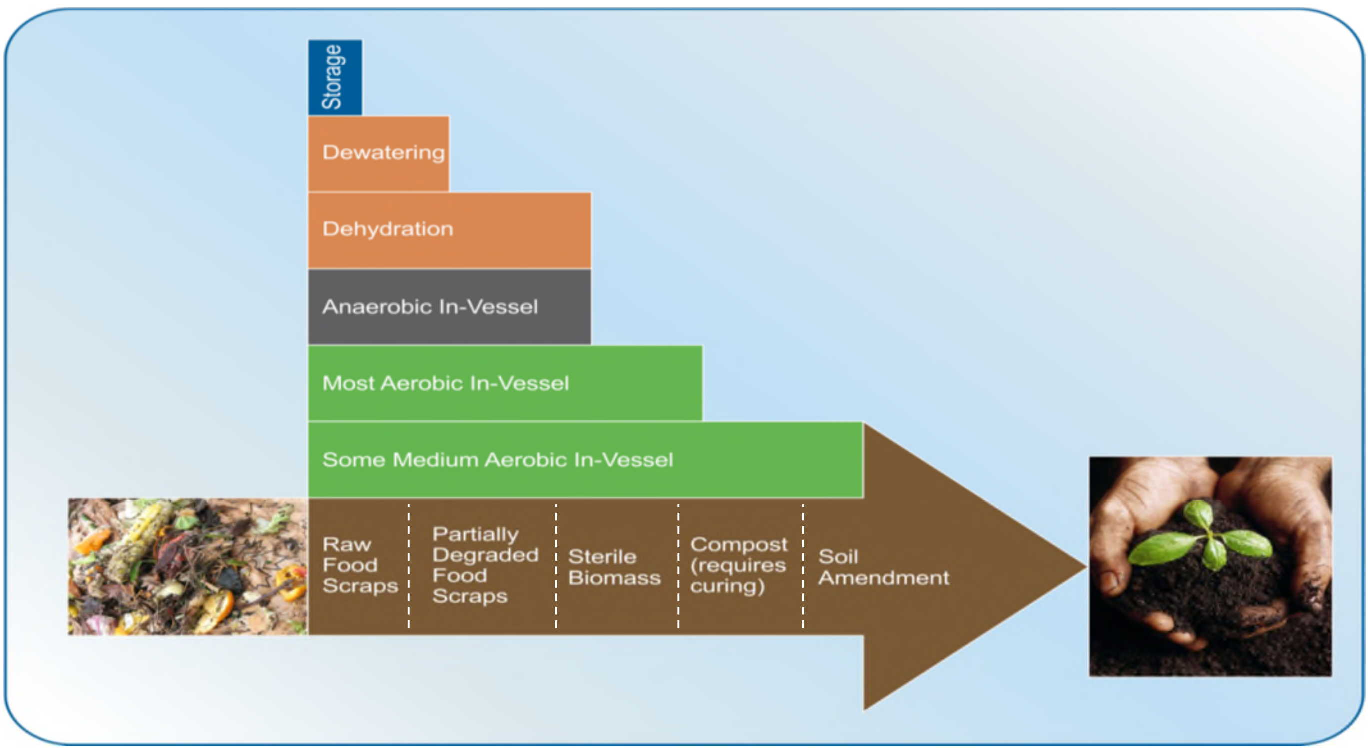


Figure 9: Outputs

As shown in Figure 9, the output can be different within the same option. For example, some medium aerobic in-vessel systems have the capability of producing soil amendment. If considering only the most ready-to-use output in terms of land application, medium anaerobic in-vessel systems would be the preferred option.

3.1.7 Question 7: How much will it cost?

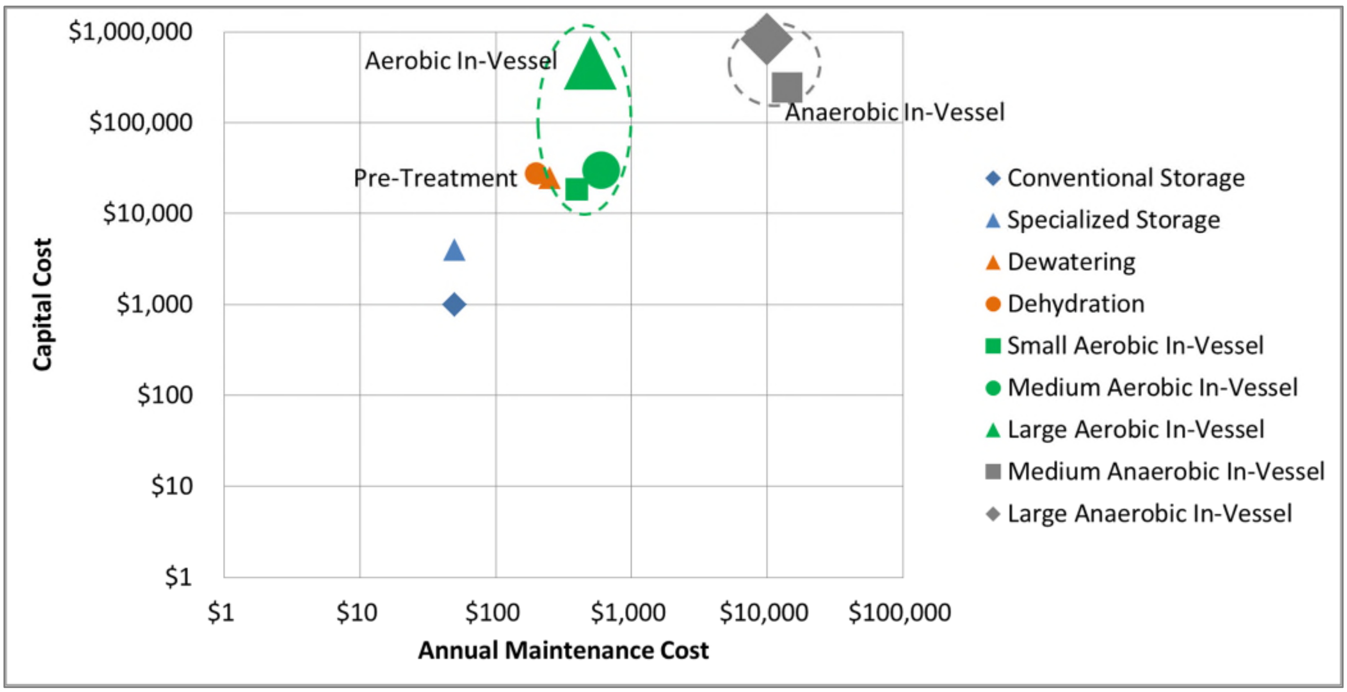
Once the basic parameters of what is suitable for a given establishment have been decided, the next logical step is to determine what available options available would be most economical. Although correlated, the initial capital investment and annual maintenance cost are both very important factors in deciding what can be afforded. Other costs, such as electricity or water depending on requirements for each model, will vary and should be discussed with the manufacturer or distributor.

Although costs vary widely depending on site-specific conditions, Tetra Tech has obtained high-level estimates of capital and annual maintenance fees in order to give potential technology users some planning level parameters. However, installation costs will vary widely depending on what already exists at an establishment. For example, some technologies require concrete pads or foundations which may or may not already exist. Others require outdoor shelter, plumbing hook-ups, or ventilation depending on where they are sited**.**

The numbers within this report should not be treated as the actual cost, but used as a comparative starting point.

When reviewing the four options (and omitting cost of hauling), on-site storage is generally the cheapest option. Pre-treatment and small and medium aerobic in-vessel systems are in a similar price range. The most expensive options are medium anaerobic systems and larger-scale in-vessel systems. Costs range from approximately $1,000 to $1,000,000 dollars, and maintenance ranges from minimal to over $10,000 per year, depending on the system complexity. The following figure shows capital and annual maintenance costs for all options on a logarithmic scale:

Figure 10: Option Costs (Total)



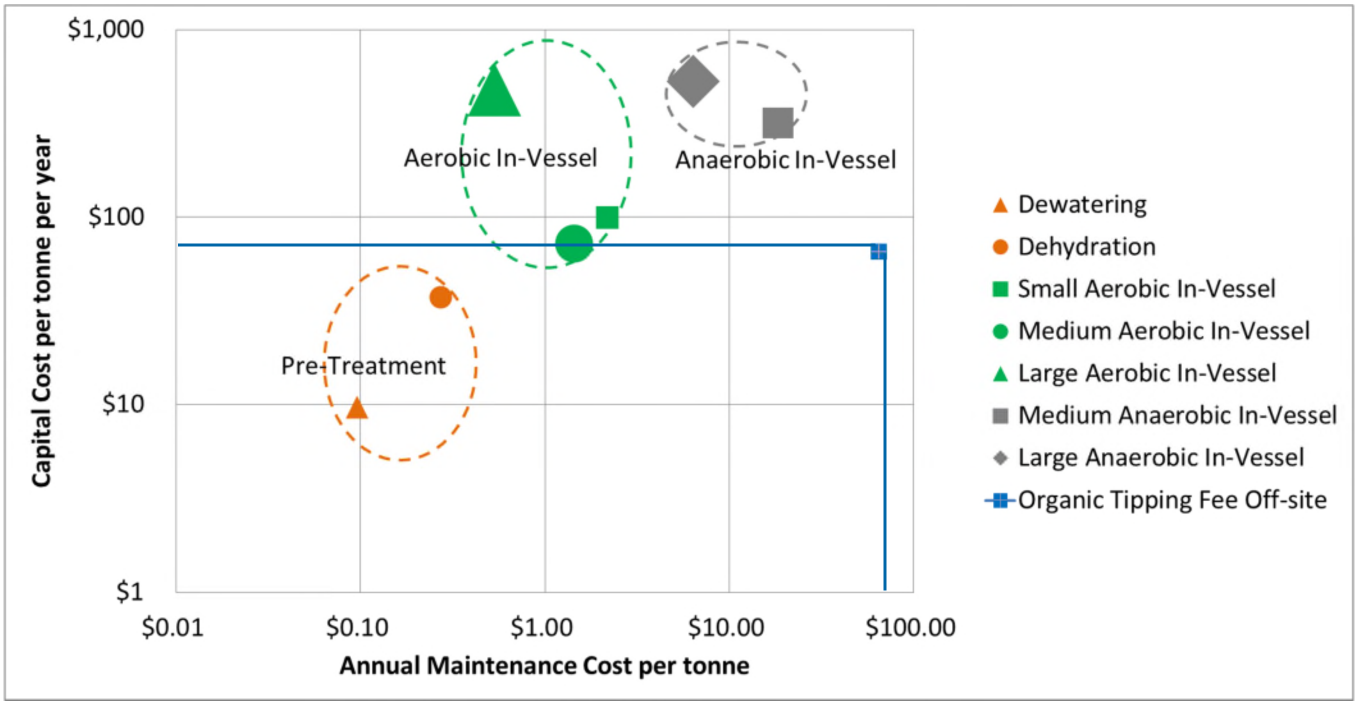


Figure 11: Option Costs (Per Tonne)

The costs shown in Figure 10 and Figure 11 are the estimated minimums for a given option; however, as noted previously, they are only estimates. If considering cost alone, independent of hauling, conventional storage is the most economical option. However, it was not considered in the “per tonne” figure as the cost per tonne is highly dependent on frequency of hauling and number of containers.

3.2 Comparative Analysis

The summary chart at the end of this section provides an overview of all options and how they compare to one another. The options are ranked relative to one another and based on the following criteria:

- **Footprint** – A higher score was given to options that took up less space overall.
- **Materials Accepted** – A higher score was given to options that can accept a wider range of materials.
- **Time Commitment** – A higher score was given to options that require less labour to operate.
- **Corporate Sustainability Benefit –** Low scores indicate that the perceived corporate sustainability value of a given option is relatively low. High scores indicate an environmentally conscious option that could boost positive corporate image and improve educational opportunities.
- **Odour Control** – A low score indicates odour may still be an issue if proper process control is not implemented. A high score indicates advanced odour control technology as part of a given option.
- **Output Material** – A low score indicates that the output material is still generally raw food scraps. An intermediate score indicates some level of decomposition. A high score indicates ready-to-cure compost material or soil amendment.
- **Maintenance Cost** – A higher score was given to options with lower maintenance costs.
- **Capital Cost** – A higher score was given to options with lower capital costs.
- **Process Time** – A high score indicates more or less instant processing of organics. A low score indicates that process time may take upwards of several weeks.
- **Installation Requirements** – A high score indicates that no additional infrastructure is required for installation. A medium score may mean minimal infrastructure is required, such as a hook-up to drainage, ventilation or shelter. A low score indicates installation may require more expensive infrastructure such as concrete pads.
- **Capacity** – A higher score was given to options that could handle more organics on a weekly basis.

  Electricity Usage – A high score indicates no electricity usage for a given option. A low score indicates very high electricity usage.

To assist in evaluating the organic management options available the following summary chart was developed to provide an overview of all options and how they compare to one another:

Table 16: Comparative Analysis

Option	Weekly Capacity	Capital Cost	Annual Maintenance Cost	Footprint	Materials Accepted	Time commitment	Corporate Sustainability Benefit	Odour control	Output Material	Maintenance	Capital	Process Time	Installation Requirements	Capacity	Electricity Requirements
Conventional Storage	Depends on hauling	Up to $1,000	Minimal	◕	●	●	○	○	○	●	●	●	●	◑	●
Specialized Storage	Depends on hauling	$4,000-6,000	Minimal	◕	●	●	○	◔	○	●	●	●	●	◑	●
Dewatering	Up to 400,000 kg/week	$25,000	$250	●	◑	◕	◔	◔	◔	◕	◑	●	◑	●	◔
Dehydration	Up to 14,000 kg/week	$27,000-50,000	$200	●	◕	◕	◑	◑	◑	◕	◑	◕	◑	◕	○
Small Aerobic In-Vessel	150 -3,500 kg/week	$18,000	$400	◕	◑	◑	◕	◑	◕	◑	◕	◑	◕	◔	◑
Medium Aerobic In-Vessel	700 -8,000 kg/week	$30,000+	$600	◑	◑	◑	◕	●	●	◑	◑	◔	◑	◑	◑
Large Aerobic In-Vessel	2,000-18,000 kg/week	$450,000	$500	◔	◕	○	◕	◕	◕	◑	◔	○	◔	●	◑
Medium Anaerobic In-Vessel	5000 - 20,000 kg/week	$240,000+	$14,000	◑	○	◔	●	◑	◕	○	◔	○	◔	◕	●
Large Anaerobic In-Vessel	20,000 kg/week	$825,000+	$10,000	○	◔	○	●	◕	◕	○	○	○	○	●	●

Icon	○	◔	◑	◕	●
Score	Mediocre	Fair	Good	Better	Best

3.3 Scenario Examples

The following section outlines possible situations and uses the decision making criteria to choose one of the options presented in this review. The intent of this section is to demonstrate to potential on-site organics management technology users the options that may work in a situation similar to their setup to reduce hauling frequency and related costs. The scenarios examined are not exhaustive but should provide a framework which can be followed to come to a decision. The scenarios examined are as follows:

3.3.1 Scenario 1: A Small Restaurant in Downtown Vancouver

A hypothetical small restaurant in Vancouver occupies the ground floor of a multi-story building in the downtown core. The restaurant serves about 25 customers per hour and has eight staff: two servers, one busser, one bartender, two cooks and a dishwasher. They operate seven days a week with the busiest period being the work-week lunch hour.

- **Question 1**: How much organic material do I produce?

  For one week, the restaurant staff separates their organic material and places in a separate bin of known volume to estimate how much is produced. Each day they fill two small 120 L totes that weight 50 kg each. By the end of the week, they calculate that the restaurant generates about 700 kg per week of organics, which amounts to approximately 36 tonnes in a year. Based solely on weight, the only options that could be considered are storage, pre-treatment, and small or medium aerobic digestion.

- **Question 2:** How much space do I have?

  Due to their downtown location, space for on-site organics management equipment is very limited. The alley behind the restaurant is already tightly occupied, and only limited space is available within the kitchen. Additionally there are office spaces and condos nearby so odour must be kept to a minimum at all times. An aerobic in-vessel option would probably not be suitable primarily due to space limitations.

- **Question 3:** How much time am I willing to put into the process?

  With only eight staff working at one time, and with a busy lunch hour rush, the staff tends to be busy either prepping for the lunch rush, or cleaning up and preparing for the next day. Less than an hour of staff time would be available to operate the equipment purchased.

- **Question 4:** What sort of corporate sustainability benefit am I looking for?

  The owner of the restaurant prides herself on being environmentally conscious and would like to choose an option that would help to reduce her restaurant's environmental impact. She does not want to simply store and haul away organics produced, and does not want to choose an option that will involve any organics going down the drain.

- **Question 5:** What do I want in terms of output?

  Although the restaurant owner would like to produce a usable soil amendment from food scraps, it isn't feasible at present given the restaurant's location, as there are no gardens or on-site uses for an end product. A system that produces fewer odours is desirable to keep both staff and residents happy.

- **Question 6:** How much of an investment am I willing to make?

  The restaurant currently is serviced twice a week by a hauler who empties approximately seven totes during each service. Since there are many other locations in the area that also have organics bins, the owner has a contract and pays $100 for hauling per week. If hauling costs are reduced, the restaurant is willing to invest an amount that would be paid off after 3 years of operation.

  Given the amount of organic material produced and the space restrictions, storage and pre-treatment are really the only feasible options for this restaurant and the material will have to be hauled off-site for processing. Given the small space requirements and the fact that the owner would like to choose a more environmentally conscious option, pre-treatment is most likely the best option as there is the ability to reduce collection to one a week or twice a month with the appropriate storage and pre-treatment or the organics. Between dewatering and dehydration, dehydration would most likely be the preferred option in this case from an odour standpoint, and produces a sterile, odourless biomass.

  If a dehydration technology was chosen, the mass of material hauled would decrease by up to 75%. This could allow the frequency of hauling to be reduced by approximately 75%, which would result in $75 per week in savings or $3,900 per year. If the restaurant is willing to invest an amount that would be paid off after three years of operation, they could afford a system costing up to $11,700. This is not enough money to pay back an investment in a dehydration unit in three years, as these units typically cost $27,000. An option that could make dehydration technology affordable for this business within a three year payback period would be to partner with one or two other similarly-sized nearby restaurants and install a dehydrator in an area that can be shared. Dehydration units have a capacity of up to 1,500 kg per day, and if the dehydrator is shared, the capacity of the unit could be fully utilized allowing for economical operation of the unit and overall cost savings after the initial investment is paid off. Given space limitations of each business, this shared option may be preferred. This option will also require some additional staff time to operate and regular maintenance. See Section 2.2.2 Dehydration for further specifications.

  For example, this scenario could work in a context where businesses already have a shared property management group, business association, or hauler who can help to facilitate the ongoing partnerships and operations.

  Another option could be to use a larger 2 or 3 m^3 container instead of a number of smaller totes, and then the hauling cost could be decreased by up to $30 per week or up to $1,560 per year. However it may be necessary to purchase or invest in a specialized storage bin to control odours. Specialized bins can cost $3,000 depending on what features are required.

3.3.2 Scenario 2: A Medium Grocery Store in a Neighbourhood Setting

A hypothetical grocery store in a Metro Vancouver neighbourhood occupies a lot measuring 65 m by 40 m with approximately 50% of the area as an open parking area, and 50% of the area as the grocery store (1,300 m^2 or 14,000 ft^2). It is a full service grocery store with a large produce section, meat counter, deli, floral shop, and prepared food options. The store has approximately 13 staff during each shift: up to 6 cash registers, 2 meat and deli, 2 produce departments, 2 grocery aisles, 1 floral shop, and various management staff. They operate seven days a week, and are open from 8 a.m. to 10 p.m.

- **Question 1:** How much organic material do I produce?

  For one week, the grocery staff separates their organic material and places in a separate bin of known volume to estimate how much is produced. The grocery store also donates any usable food to a food runners program. Each day they fill six 120 L totes that weigh 50 kg each. By the end of the week, they calculate that the store generates about 2,100 kg per week of organics. This would be a total of 109 tonnes in a year. Based solely on weight, the only options that could be considered are storage, pre-treatment, and small or medium aerobic digestion. Additionally the staff notes that items such as meat and bones and waxed cardboard are produced at a fairly consistent rate and make up approximately 5% to 10% of the organics quantity.

- **Question 2:** How much space do I have?

  Due to their location, space for on-site organics management equipment is available but it would require use of a parking stall, or re-alignment and better space management of the materials stored in the alleyway beside the current disposal containers. There are houses adjacent to the grocery store, so odour must be kept to a minimum at all times.

- **Question 3:** How much time am I willing to put into the process?

  With 13 staff working at one time and additional nighttime staff to clean the store and re-stock shelves it will be possible to re-distribute workloads and ensure the maintenance technician for the store is trained in whatever system is deemed optimal. Less than an hour of staff time per day would be available to operate the equipment purchased.

- **Question 4:** What sort of corporate sustainability benefit am I looking for?

  The grocery store prides itself of sourcing local food from regional farms and being environmentally conscious. Additionally it would like to sell a compost product or show how it is being managed to its optimal potential. The store does not want to simply store and haul away organics produced, and does not want to choose an option that will involve any organics going down the drain.

- **Question 5:** What do I want in terms of output?

  Although the grocery store would like to produce a usable soil amendment from food scraps, there are no gardens or on-site uses for an end product at the given location. Something that produces fewer odours is desirable in order to keep both staff and residents happy.

- **Question 6**: How much of an investment am I willing to make?

  The grocery store currently is serviced three times per week by a hauler who empties a 3-yard bin each service. The owner has a contract and pays $600 for hauling per week. If hauling costs are reduced, the grocery store is willing to invest an amount that would be paid off after three to five years of operation. The store owner also understands that garbage tipping fees in the region may increase by up to 45% over the next five years.

  Given the amount of organic material produced and the space restrictions, storage and pre-treatment are the primary feasible options for this grocery store and the material will have to be hauled off-site for processing. Given the small space requirements and the fact that the owner would like to choose a more environmentally conscious option, pre-treatment is most likely the best option as collection frequency could be reduced to once a week or twice a month when paired with the appropriate storage solution. Between the pre-treatment options of dewatering and dehydration, dewatering would most likely be the preferred option in this case given the need to continually process material throughout the day.

  If a medium aerobic in-vessel system was chosen, the mass of material hauled would decrease by over 50%, representing savings of approximately $250 per week, or $13,000 per year. The capital cost for a medium in-vessel system that has some automation for ease of use is approximately $45,000. Additionally, there are costs for maintenance, bulking agents, and staff time to use the equipment. Since there is no use for the soil amendment on-site and the material would need to be shipped to a composting facility for packaging, certification, and re-sale, the store owner decides this option would not be in the best interests of the grocery store and not worth the extra staff effort and training. See Section 2.3 Aerobic In-Vessel for further specifications.

  If dewatering technology was chosen, the mass of material hauled would decrease by up to 75%. This could allow the frequency of garbage hauling to be reduced by at least 50% and would account to $250 per week in savings or $13,000 per year. If the grocery store is willing to invest an amount that would be paid off after two years of operation, they could afford a system of up to $26,000, which is within the dehydration price range. However, this option will also require some additional staff time to operate and regular maintenance, along with additional cost of around $50 per week to haul away the dewatered organic material. See Section 2.2.1 Dewatering for further specifications.

4.0 CLOSURE

The options and scenarios presented within the report represent a small cross-section of the many technologies and potential usage scenarios that are possible. While this report can be used as a starting point for investigating options, in order to develop a more accurate scenario for a given establishment, it is recommended that the technology supplier is contacted to answer questions in more detail and with a more site-specific focus. It is also recommended, if possible, to obtain an unbiased review of a technology from a current practitioner or view the system in operation. A list of technologies is presented in Appendix C.

We trust this report meets your present requirements. Should you have any questions or comments, please contact the undersigned.

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APPENDIX A
TETRA TECH EBA'S GENERAL CONDITIONS

GENERAL CONDITIONS

GEOENVIRONMENTAL REPORT

This report incorporates and is subject to these "General Conditions".

1.0 USE OF REPORT AND OWNERSHIP

This report pertains to a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site or proposed development would necessitate a supplementary investigation and assessment.

This report and the assessments and recommendations contained in it are intended for the sole use of Tetra Tech EBA's client. Tetra Tech EBA does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than Tetra Tech EBA's Client unless otherwise authorized in writing by Tetra Tech EBA. Any unauthorized use of the report is at the sole risk of the user.

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Where Tetra Tech EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed Tetra Tech EBA's instruments of professional service), only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by Tetra Tech EBA shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of Tetra Tech EBA's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except Tetra Tech EBA. The Client warrants that Tetra Tech EBA's instruments of professional service will be used only and exactly as submitted by Tetra Tech EBA.

Electronic files submitted by Tetra Tech EBA have been prepared and submitted using specific software and hardware systems. Tetra Tech EBA makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

3.0 NOTIFICATION OF AUTHORITIES

In certain instances, the discovery of hazardous substances or conditions and materials may require that regulatory agencies and other persons be informed and the client agrees that notification to such bodies or persons as required may be done by Tetra Tech EBA in its reasonably exercised discretion.

4.0 INFORMATION PROVIDED TO TETRA TECH EBA BY OTHERS

During the performance of the work and the preparation of the report, Tetra Tech EBA may rely on information provided by persons other than the Client. While Tetra Tech EBA endeavours to verify the accuracy of such information when instructed to do so by the Client, Tetra Tech EBA accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

APPENDIX B
PROJECT BACKGROUND AND RESEARCH METHODOLOGY

1.0 BACKGROUND

Metro Vancouver retained Tetra Tech EBA Inc. (Tetra Tech EBA) to conduct the On-site Organics Management Options Review as per the methodology defined in the Request for Proposals sent on November 22, 2013.

1.1 Regional Policy and Infrastructure

In Metro Vancouver, the management of waste is governed by the Integrated Solid Waste and Resource Management Plan (The Plan). The Plan is guided by the waste hierarchy and specifies an increase in waste diversion from 55% to 70% in 2015. In order to achieve this target, a material disposal ban will be placed on compostable organics preventing their disposal in 2015. Metro Vancouver estimates that the industrial, commercial, and institutional (ICI) sectors alone dispose of more than 153,000 tonnes of compostable organics into the waste stream each year. In 2013, compostable organics represented approximately 36% of the ICI waste stream and up to 75% of the waste stream from food stores and full service restaurants (Tetra Tech EBA, February 2014). Currently, the food services/retail industry relies on the private sector for the collection of garbage and recycling, and is looking for a range of options for the management of compostable organics.

To date, the regional strategy to capture compostable organics has led to the development of large scale composting facilities and flow of organic material to such sites. As described in the Metro Vancouver Recycling Market Study, existing large-scale composting infrastructure includes Harvest Power located in Richmond and Enviro-Smart Organics in Delta (Tetra Tech EBA, May 2012). Capturing all of the region's compostable organics to be processed through large facilities, however, is not without its barriers. The Market Study, in addition to other reports and technology reviews, identifies on-site organics processing as an option to diversify regional processing infrastructure giving commercial food retail and food service establishments another option to manage their compostable organics.

1.2 On-Site Organics Technology Scan

Within the four categories, storage, pre-treatment, aerobic, and anaerobic in-vessel systems, more than 30 technology options were identified. All options identified are summarized in Appendix C, along with technical specifications of the options selected for further inquiry. For this research, on-site organic management options focused on turn-key automated systems that are currently available or in use in North America. On-site technologies that do not have a North American distributor, that are too new to marketplace or unproven (such as pneumatic storage), or that create a slurry that converts organics from solids to liquid for discharge to sewer without recovering materials or energy, were not included in the detailed analysis.

1.2.1 On-Site Storage and Collection

To date, on-site storage is the primary means of organics management at food service institutions. Totes or yard containers are commonly used as interim storage prior to collection by a hauling contractor that charges a per tip fee for pick-up. Storage vessels are generally lined or power washed to minimize odours and keep them in good working condition.

Some larger institutions may use larger and more specialized collection containers specifically designed for food scraps. Additions such as a biofilter, a specific port for loading, or heavy duty plastic construction helps to deal with some of the issues inherent with heavy, odorous material. Storage technologies are reviewed in more detail in Section 4.2.

1.2.2 Existing Regional On-Site Organics Management Systems

There are several examples of 'early adopters' in the region using on-site pre-processing and composting technologies as innovative solutions for organics management. Examples range from manual to automated systems in a variety of scenarios from multi-family dwellings to universities and restaurants.

In late 2011, Metro Vancouver conducted a technical study of seven on-site, small-scale composting systems operating both within and outside of the region. Technologies reviewed include automated, semi-automated, and manual systems. The purpose of the study was to determine the suitability of these systems for use in multi-family dwellings. Systems assessed had an annual processing capacity ranging from 1.3 to 130 tonnes (Garden Heart Productions, 2012). The study concluded, "given that the regional organics management infrastructure is not yet fully developed, on-site composting can serve as part of an integrated solution for diverting organics from the waste stream" (p. 6). To that end, several smaller pre-treatment and aerobic in-vessel systems have been trialed locally, including but not limited to Green Good, the Rocket, Jora, Earth Tub, and various vermicomposting (worm) systems.

While the region demonstrates a handful of early adopters undertaking on-site organics management, there are many other more automated solutions for on-site storage, pre-treatment, and management of organics. To that end, the technologies reviewed in this study include pre-processing options as well as fully automated systems which have been successfully demonstrated in the food services and other industries. Technologies that discharge an end product to the sewer system were not included in this study.

It should be noted that the technologies reviewed are all relatively new; as such, none have yet reached their expected product life span, and such a metric is not well known for all options. Most distributors, however, estimate a 10 to 20-year life span for the technologies reviewed.

1.3 Regulation and Licensing for On-Site Organics Management

Currently, solid waste and resource recovery systems fall under the regulatory requirements of municipal, provincial, and federal government in British Columbia (BC). Under the Greater Vancouver Sewerage and Drainage District (GVS&DD) Bylaw 181 (as amended by Bylaw 183), no person shall own or operate a solid waste or resource recovery facility without complying with a valid and subsisting license from Metro Vancouver. A license is not required when material is produced and managed on the same site from which it is generated. Other exclusions and exemptions in the Bylaw may apply. If there is a discharge to sewer or air, a license may be required under GVS&DD's sewer use bylaw (299) or air quality management bylaw (1082), respectively. Certain aspects of a given operation of any size may trigger all three levels of government regulation, bylaws, and operating requirements. While Metro Vancouver understands that this may present a challenge for some operations, it is beyond the scope of this report to guide businesses and institutions through these regulatory requirements. For more information, please refer to the bylaws mentioned here.

2.0 METHODOLOGY

The on-site organics management review process consisted of two main components: 1) organics management technology review; and 2) scenario development for comparative analysis. The review consisted of the evaluation of technologies that are capable of processing organics on site, using the following four categories and corresponding sub-categories, herein referred to as "options".

Table 1: On-Site Management Options

Option	Sub-Option
Storage	Conventional
	Specialized
Pre-Treatment	Dewatering
	Dehydration
Aerobic In-Vessel	Small (approximately 10 tonnes per year)
	Medium (approximately 100 tonnes per year)
	Large (approximately 1,000 tonnes per year)
Anaerobic In-Vessel	Medium (approximately 500 tonnes per year)
	Large (approximately 1,000 tonnes per year)

Within each category, various technologies were identified and selected based on their applicability to the study given the types of facilities and tonnages produced. For each technology selected, Tetra Tech interviewed manufacturers or distributors in order to obtain key metrics and operational considerations. Select practitioners for some technologies were also contacted in order to gain a better understanding of actual implementation situations and any resulting challenges. Other sources included small scale organic technology assessments completed by Tetra Tech, literature reviews, and technical specification sheets provided by distributors.

In order to provide an "Apples to Apples" comparison of the technology costs and requirements for a sustainable organics management system, Tetra Tech provided a decision analysis framework by which all options could be evaluated. This was done using a Consumer Report-style rating system (i.e., Harvey Ball comparison) to provide a rating for the following factors, as determined by stakeholder feedback:

- Footprint;
- Time Commitment;
- Corporate Sustainability Benefits;
- Odour Control;
- Output Material;
- Maintenance Cost;
- Capital (Implementation) Cost;
- Process Time;
- Installation Requirements;

- Capacity; and
- Electricity Usage.

Important considerations, such as cost per tonne of material, tonnes treated per square metre of space occupied, and throughput were used as key metrics by which to compare each option. This comparison was used to develop plausible scenarios for food service facilities describing how these options may be implemented into a functional and sustainable organics management strategy.

APPENDIX C
OPTIONS SUMMARY TABLE AND TECHNOLOGY OVERVIEW

Appendix C: On-site Organics Storing and Processing Options

Option	Overview	Sub-Option	Pros	Cons	Capacity	Footprint	Labour	Daily Time Requirement	Approximate Cost	Maintenance	PR and Education
STORAGE	Storage and hauling of organic material	Conventional Storage	Low tech, customary practice	Odour concerns, space	Up to 3,000 L	Up to approx. 3 m^2	No more than current practice.	Minimal	Up to $1,000	Minimal	No PR or educational value
		Specialized Storage	Adaptations to save on space, odour	Same end result as customary practice, only with less frequent pick up	Up to 5,000 L	Up to approx. 3 m^2			$4,000-$6,000		Novel way to store organics but no great educational value
PRE-TREATMENT	Mechanical or heat treatment to reduce volume	Dewatering	Rapid volume reduction	High water use	Up to 700 kg/hour	Less than 1 m^2	Loading, unloading and re-filling cleaning canister. Equipment is self-cleaning.	Less than 30 minutes	$25K	$250/year	Not great - volume reduction, but high consumption of water and energy
		Dehydration		High energy use, batch system	Up to 14,000 kg/week	From 0.2 to 8 m^2	Loading, unloading. Cleaning filter between cycles, keeping seal clean.	Less than 30 minutes	$27-50K	$200/year	Good, but high energy usage
AEROBIC INVESSEL	Composting in the presence of oxygen to produce soil amendment	Small	Material management at source, lower carbon footprint, PR and education value	Greater space, labour and time than other options	150 - 3,500 kg/week	2 m^2	Keep area clean to avoid vectors and odours. Daily temperature and moisture checks	Less than 30 minutes	$18K	$400/year+	Very good and can use material on-site (some systems may require curing)
		Medium			700 - 8,000 kg/week	From 3 to 96 m^2	May need to sharpen knives, replace odour control chemicals, replace augers teeth	One hour	$30K+	$600/year+	
		Large			2,000 - 18,000 kg/week	From 30 to 320 m^2	Half-time operator required	Three hours	$450K	$500/year	
ANAEROBIC DIGESTION	Degradation in the absence of oxygen to produce biogas (used to generate energy), liquid (used for fertilizer) and solid digestate (compostable).	Medium	Energy recovery through Biogas, PR and education value	Larger scale, generally more labour intensive	5,000 -20,000 kg/week	From 7 m^2	Load/unload	Up to two hours	$240K+	$14K/year+	Extremely good - zero waste if biogas captured and used for energy
		Large			20,000 kg/week+	200 m^2	Half-time operator required	Three to four hours	$825K+	$10K/year	

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Appendix C: On-site Organics Storing and Processing Technology Providers

Technology Name	Website	Included in Options Development
Tote	Various	Yes
Yard Container	Various	Yes
Vented Tote	http://www.rollinsmachinery.ca/WasteRecycling-Products_ep_83-1.html	Yes
BioBin	http://www.biobin.net/	Yes
Molok	http://www.molokna.com/	Yes
MASSerator	http://massenv.com/composting.php	Yes
GaiaRecycle	http://www.gaiarecycle.com/products.php?id=2	Yes
Green Good Composter	http://www.recyclingalternative.com/what-we-recycle/green-good-composters/	Yes
Rocket	http://massenv.com/composting.php	Yes
CITYPOD	http://www.vertal.ca/en/Citypod%20Composters.html	Yes
Hot Rot	http://www.hotrotsolutions.com/	Yes
Jora JK5100	http://www.joracanada.ca/en/index.php	Yes
EarthFlow Composter	http://compostingtechnology.com/	Yes
Impact BioEnergy	http://impactbioenergy.com/	Yes
SEAB Energy Flexibuster	http://seabenergy.com/products/mb400/	Yes
BW Organics Rotating Drum	http://tmaorganics.com/compostmodels.html	No
Big Hannah	http://www.bighanna.com/	No
Biovator	http://nioex.com/biovator/	No
Metro Taifun	http://www.metrotaifun.com/	No
Grind-to-energy	http://www.emerson.com/en-US/innovation-leadership/technology-solutions/featured-stories/Pages/Grind2Energy.aspx	No
IMCWastePro	http://www.imco.co.uk/food-waste-mgt/dewatering	No
GaiaRecycle	http://www.gaiarecycle.com/products.php?id=2	No
Hungry Giant	http://www.powerteninc.com/technology/hungry-giant/	No
EcoVim	http://www.ecovimusa.com/Solutions.html	No
EcoHero	http://greentail.ca/prod-ecohero.html	No
CV Composter	http://www.compostsystems.com/systems/cv-composter	No
Hungry Pig	http://www.hungrypig.net/benefits.htm	No
EVT In-Vessel Composter	http://www.ecovaluetech.com/products.html	No
Enviro Drum	http://www.dtenvironmental.com/Categories/Products/Enviro-Drum/	No
Jet Composter	http://www.jetcompost.com/	No
XACT Bioreactor	http://xactsystemscomposting.com/mobile-system/	No
Wright Invessel	http://www.wrightenvironmental.com/index_nonflash.html	No
Neter 30	http://www.edenproject.com/sites/default/files/neter.pdf	No
ORCA Green Machine	http://www.totallygreen.com/	No
Happy Together Garbage Drying Machine	None Available	No
Somat DH-100 Dehydrator	http://www.somatcompany.com/Products/Dehydrator-System/	No

ON-SITE ORGANICS MANAGEMENT OPTIONS REVIEW

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