AUCKLAND REGIONAL OPTIONS FOR FOOD WASTE COMPOSTING

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Background

In July 2003 URS New Zealand Limited (URS) was commissioned by the Manukau, North Shore and Auckland City Council members of the Organic Waste Working Group (OWWG) to conduct a study on options for composting of domestic food waste, in the Auckland Region. This comprehensive study was divided into two parts that considered the following issues:

Part 1: Regional Options for Food Waste Composting (URS, February 2004a)

- food waste quantities;
- existing composting operations;
- requirements for food waste composting facilities;
- an overview of composting systems;
- processing requirements;
- proprietary composting systems;
- indicative facility costings;
- facility operations and management issues;
- resource consent issues;
- product quality.

Part 2: Marketing Issues (URS, June 2004)

- benefits of compost use;
- current and potential uses of compost;
- existing land uses in the Auckland region;
- end markets for compost products and market risks;
- market development;
- facility management risks;
- food waste collection systems and costs.

A third report "Preliminary Cost Estimates for Food Waste Composting Facilities" was also produced. (URS, February 2004b) This confidential report developed capital and operating costs for food waste composting facilities with varying capacities and using a variety of composting technologies.

Scope of this Paper

This paper summarises the technical considerations associated with the establishment of one, or a number of, food waste composting facilities in the Auckland region. Facility requirements are considered from the point of delivery at the facility through to the removal of product offsite (either for sale or further product refinement). Suitable composting systems are outlined along with requirements for materials storage and handling, pre-processing of wastes, and post-processing. Collection and end market issues are addressed in a paper prepared on behalf of the OWWG by Stuart Gane of Manukau City Council. (Gane, 2004) This paper considers the findings from the Part 1 and 2 reports from a Council perspective, and within the wider regional context of reducing organic wastes disposed of to landfill.

Facility Capacity Requirements

Based on council waste analysis surveys and the North Shore City food waste collection trials, it is estimated that between three and five kilograms of food waste per household per week could be available for kerbside collection. Lower and upper participation rates of 40 and 80 percent, respectively, were applied to this quantity range, resulting in facility design capacities of 6,000, 12,000 and 18,000 tonnes per year of food waste. This range of facility sizes would allow for food waste composting facilities for either individual councils or shared facilities. The facility sizes adopted were considered to provide a reasonable basis for the development of indicative costs and to consider economies of scale. Facilities to process domestic food waste of greater than 18,000 tonnes per year are not considered likely to be required within a five to ten year timeframe.

Overview of Facility Components

Conceptual, generic facilities, with no specific location were used to develop cost estimates for proprietary technologies (both in-vessel and enclosed composting systems). Figures 1 and 2 show generic facility layouts developed for in-vessel and enclosed composting systems.

It was assumed that the site would be within the Auckland Region urban limits (therefore requiring stringent odour control) and, in all likelihood, would be incorporated into a transfer station or similar facility. In addition, it was assumed that facility operating parameters and resource consent requirements would be in accordance with applicable New Zealand, and overseas, standards and/or best practice guidelines, as well as existing resource consent conditions applied to existing composting facilities within the Auckland region.

There are a number of processing, handling and operational requirements common to food waste composting facilities, regardless of the type of composting system employed. These requirements include materials storage and handling, pre-processing, processing and secondary treatment phases. They may involve costly ancillary equipment and/or have significant impacts on facility operations.

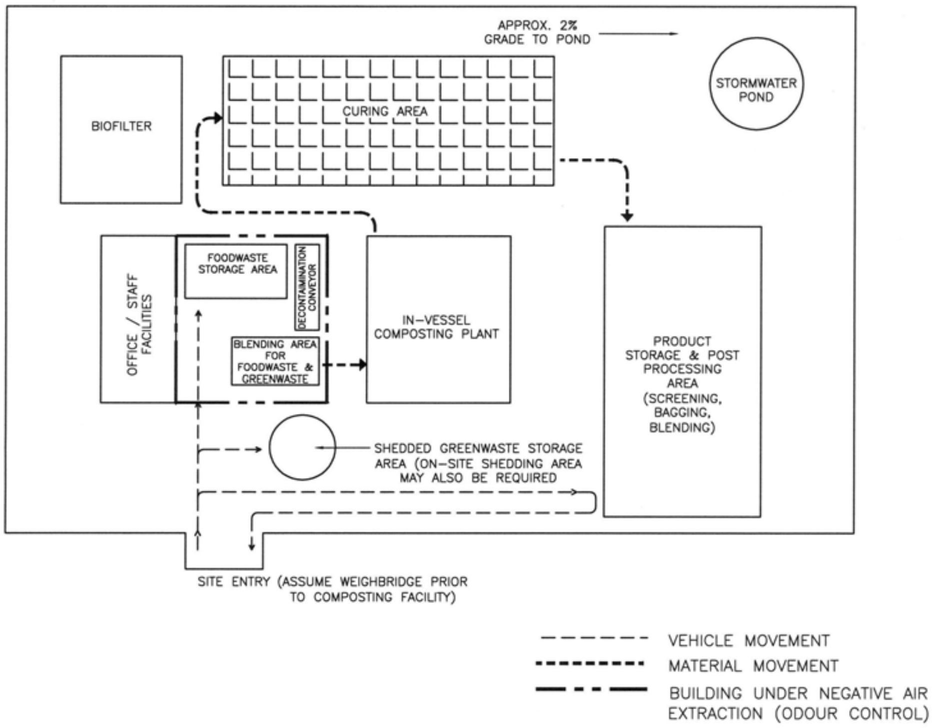

Figure 1: In-vessel Composting Facility Layout Schematic (not to scale)

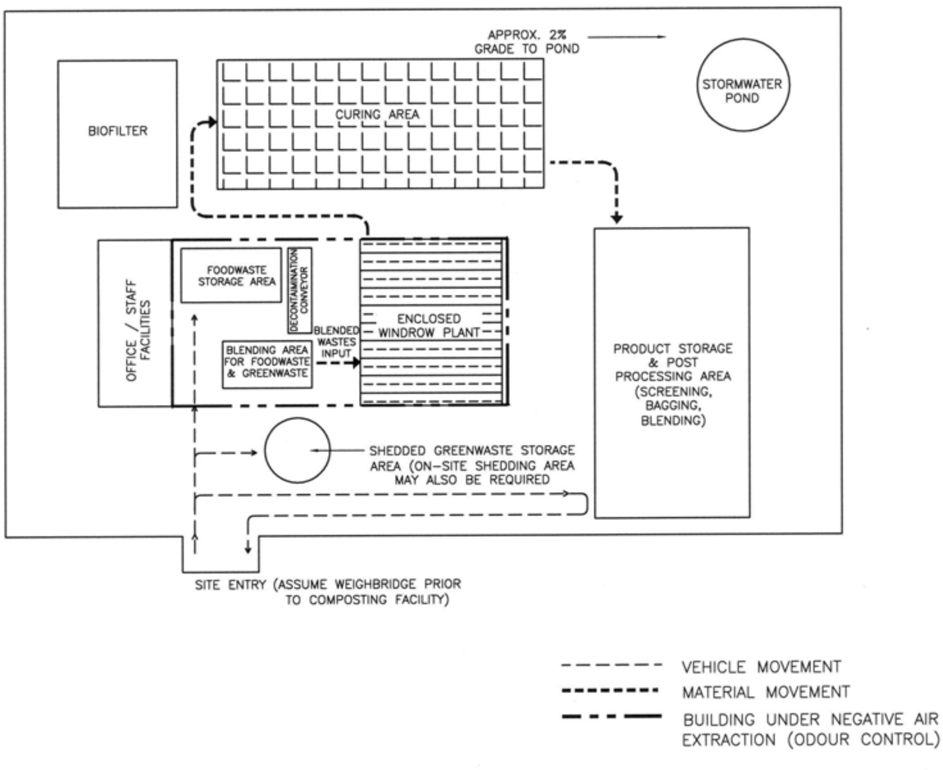

Figure 2: Enclosed Windrow Composting Facility Layout Schematic (not to scale)

Materials Storage and Handling Requirements

For both odour control and health and safety considerations, facility buildings where food wastes are to be accepted, stored or handled would require a negative pressure extraction system to remove odourous and potentially harmful gases. Material transfer throughout the process would most likely be by front-end loader (or similar) or purpose built conveyor systems. Conveyors may be in the form of belts, chain configurations, moving floors or augers.

Pre-processing Requirements

Pre-processing requirements include decontamination of food wastes and physical and chemical amendment of input materials (through either mechanical treatment or blending with other materials). By creating the correct form and blend of input materials, both the rate of composting and product quality are optimised. This is particularly important for large scale, urban facilities where the potential for complaints about odour and other nuisances are increased.

Decontamination of Food Wastes

Residential food waste can be expected to contain a range of contaminants, including metal, plastic, paper and glass, which could effect both the operation of equipment in a composting facility and final product quality. Experience at overseas food waste composting facilities indicates that a level of contamination of 2 to 20 % by weight can be expected[1]. At facilities within Germany and Nova Scotia, which have had kerbside collection of organic wastes in place for a number of years, average contamination levels are 5 % and 4 to 10 %[2] respectively. Contamination rates can be expected to be at the higher end of the range in the early stages of a kerbside collection programme. For the purpose of the study a contamination rate of 10 % was assumed.

Although there are a number of mechanical / automated systems for sorting waste fractions and removing contaminants, they are capital intensive and may still require manual checking and / or sorting in respect of the smaller sized contaminants. It was assumed that manual sorting, involving a conveyor picking line, would be the most effective decontamination method for an Auckland food waste composting facility.

Bulking Agent Addition

Regardless of the type of composting technology selected, a successful composting process is dependent upon establishing and maintaining optimum conditions for the survival and growth of microbial populations. The main properties considered for process optimisation were moisture content and the carbon to nitrogen ratio (C:N) of the waste input blend. These

[1] Personal comment from David Perkins of Living Earth Ltd., and Paul Brown of VCU Technology Ltd.
[2] Personal comment from David Perkins of Living Earth Ltd.

properties are typically amended through the addition of a suitable bulking agent to the food wastes.

Domestic food wastes are typically high in moisture and nitrogen. Therefore, the addition of a bulking agent to control moisture, increase porosity (as high moisture content will reduce porosity and airflow) and raise the carbon to nitrogen ratio of the input mix is desirable. Greenwaste is an effective, readily available material that will achieve all three of these objectives. The optimum moisture content for composting was taken as 60 % and the desired carbon to nitrogen (C: N) ratio as 30: 1. These optimum values for moisture content and C: N ratio are accepted parameters within the composting industry and verified by the general composting literature.

Mechanical Pre-treatment

Mechanical treatment of food wastes and bulking agent materials is also a means to optimise the composting process, as well as improving the appearance and consistency of the end product. Mechanical treatment may involve the shredding of bulking agents, macerating, or pulverising, of food wastes and blending of the two materials. These operations require various forms of ancillary equipment, all of which add cost and complexity to the operation of a composting facility.

Composting – Primary Processing Requirements

Primary processing refers to the initial high rate, high temperature phase of the composting process. The primary goal during this phase is the destruction of pathogens and weed seeds, meeting vector attraction reduction (VAR) requirements and stabilising odours so that the discharged material will not cause objectionable odours.

The proprietary composting technologies assessed in the study were:

- VCU® (vertical in-vessel composting system);
- HotRot® (horizontal in-vessel composting system);
- Rotocom® (horizontal in-vessel composting system);
- IPS® (enclosed, mechanical windrow/bay composting system)
- GICOM® (enclosed tunnel composting system);
- Vermitech® (enclosed vermicomposting system).

Table 1 provides a summary of the operating characteristics and advantages and limitations for each system, as evaluated for a 6, 000 – 18, 000 tonnes per annum Auckland food waste composting facility.

Table 1: Summary of Advantages and Limitations of Proprietary Technologies

<table>
<tr><th></th><th>Advantages</th><th>Limitations</th></tr>
<tr><td>VCU</td><td colspan="2">Vertical, in-vessel plug flow, static system with material discharged by turning rollers at the base, and movement of the pile down through the chamber via gravity.
Aeration relies on convective air currents created by temperature difference between top and base of pile (typically 70+ at top down to 40°C at base), aided by a small fan.
Range of conveyor options for feed and discharge systems.</td></tr>
<tr><td></td><td>• Relatively small footprint.
• Flexible facility capacity.
• Modularity in respect of maintenance
• Odour control using feedstock to ‘self-biofilter’.
• No moving parts for turning composting material.
• NZ based manufacturer and supplier.</td><td>• High capital costs.
• Sensitive to overly wet or poorly mixed feedstocks.
• Complex feed systems for larger facilities.
• Limited access to material within the chamber.
• Limited sites for temperature measurement.
• No air injection through mass and limited cooling mechanism.</td></tr>
<tr><td>HotRot</td><td colspan="2">Horizontal in-vessel tumbling solids bed system (cylindrical).
Fixed cylinder with a central shaft and attached paddles. Shaft rotates and paddles transfer material from the inlet to the outlet, while tumbling material to mix and aerate.
Aeration aided by a fan, tumbling action of shaft and blades and head space above pile.
Range of conveyor options for feed and discharge systems.</td></tr>
<tr><td></td><td>• Flexible facility capacity.
• Modularity in respect of maintenance.
• Proven pathogen destruction.
• Chamber inclined in opposite direction to material movement, preventing risk of reinfecting treated material with pathogens from wastes.
• Access hatches along cylinder length to remove material if required.
• Good material blending and aeration.
• Sampling and monitoring of material possible.
• NZ based manufacturer and supplier.</td><td>• High capital costs.
• Complex feed systems for larger facilities.
• Biofilter (or other odour treatment device) required to control odour.
• Moving parts require servicing and maintenance.
• Designed to be fed over 24 hours.</td></tr>
<tr><td>Rotocom</td><td colspan="2">Horizontal in-vessel tumbling solids bed system (cylindrical).
Cylinder rotates around a fixed central shaft with paddles attached to direct material from the inlet to the outlet and to aid in mixing and aeration.
Aeration aided by a fan, tumbling action of vessel and head space above pile.
Range of conveyor options for feed and discharge systems.</td></tr>
<tr><td></td><td>• Flexible facility capacity.
• Modularity in respect of maintenance.
• Proven pathogen destruction.
• Good material blending and aeration.
• Sampling and monitoring of material possible.
• NZ based manufacturer and supplier.</td><td>• High capital costs.
• Sensitive to overly wet or poorly mixed feedstocks (to a lesser extent than static systems but potentially ‘balling’ of wet material could occur).
• Complex feed systems for larger facilities.
• Biofilter (or other odour treatment device) required to control odour.
• Moving parts require servicing and maintenance.</td></tr>
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	Advantages	Limitations
IPS	Enclosed windrow agitated bed system. Concrete bays with tracks along top for automated agitator. Agitator moves down the bays, turning material and transferring it from the inlet to the outlet. Air injection along length of bays, with injection rate set from temperature monitoring. Front-end loader, or similar, used to load and unload bays (one at either end to prevent cross-contamination).	
	• Relatively low capital cost. • Good control of temperature and aeration. • Proven pathogen destruction. • Can access material along entire process length, allowing removal of material if problems develop. • Sampling and monitoring of material possible.	• May not be economic for smaller waste quantities. • Relatively large area required compared to other in-vessel systems. • Less flexible for expansion. • Hot, damp and corrosive atmosphere within building. • Moving parts (agitator) require servicing and maintenance. • Biofilter (or other odour treatment device) required to control odour.
GICOM	Horizontal in-vessel static solids bed tunnel system, batch fed. Tunnels are filled and sealed for a programmed retention time, with a climate control programme operating the aeration and air extraction systems Front-end loader, or similar, used to load and unload tunnels (one at either end to prevent cross-contamination)	
	• Proven pathogen destruction. • Pre-assembled units to reduce installation time. • Good control of temperature and aeration. • Batch system enables processing material to be fully contained throughout the retention period. • No moving parts for turning composting material.	• Relatively large area required due to horizontal nature of containers. • Need to extract air and pass through a biofilter to control odour (potentially high capital and operational costs). • Bulk feed system not very flexible for variable feedstock quantities. • Increased storage time of putrescible wastes.
Vermitech	In-vessel vermicomposting system. Primarily used to process sludges, although have been used for food wastes in Canada. Wastes are fed to the surface of the bed on a daily basis using specialised feed equipment (no further details of specialised feed, or harvest, equipment provided by manufacturer).	
	• Suitable for small scale institutional and educational applications. • Produces high value products. • Significant quantities of bulking agent not required.	• Requires large land area. • Worms are sensitive to feedstocks, contaminants and temperature. • Long time to re-establish a full-scale process if worms die off. • Does not meet guideline requirements in respect of pathogen control, as temperatures required for pathogen destruction would also kill worms. Therefore some form of pre-composting likely to be required. • More suitable to small scale systems and homogeneous feedstocks.

Composting – Secondary Processing Requirements

Secondary processing, or curing, refers to the slower, lower temperature phase of the composting process, where the primary goal is the creation of mature, stabile compost that, unlike immature compost, will not be toxic to plants upon application. Typically curing takes place in outdoor windrows that are regularly turned to mix and aerate the pile.

Product Refinement Requirements

The degree of product refinement is dependent upon the intended end use and markets. Requirements could range from as little as screening of the cured material through to screening, blending with other products (such as additional bulking agents, nutrients and trace elements) and bagging and labelling of the compost / garden mixes.

Monitoring Requirements

The extent of monitoring required at a food waste composting facility depends upon the capabilities of the composting system, market requirements (specific quality controls), site-specific resource consent conditions and operator requirements. Although not yet fully developed in New Zealand, future compost quality standards may include monitoring requirements for composting facilities. As a minimum, temperature, processing time and input/output quantities need to be monitored. A range of monitoring equipment is available, ranging from manual monitoring (e.g. hand-held temperature probes) through to automated monitoring systems with data logging and remote access capability.

Summary of Composting Facility Requirements

Issues important for the successful operation of a food waste composting facility include:

- minimising food waste contamination (influenced by collection method and education);
- ensuring a secure supply of a bulking agent to optimise waste input properties (typically greenwaste would be used);
- installing appropriate systems for odour containment, ventilation and treatment during acceptance, pre-processing and feeding of odorous materials into composting system;
- ensuring primary composting is carried out to a stage where materials are pathogen / weed free and can be cured without nuisances due to odour, vermin or vectors (time – temperature requirements).

The selection of equipment for a food waste composting facility will depend upon a range of factors, including:

- required facility capacity and site size / location;
- food waste collection system;

- food waste and bulking agent properties;
- end market requirements;
- facility ownership and operation arrangements;
- equipment costs (capital and operational).

Table 2 provides a summary of the potential process and equipment requirements for a food waste composting facility of the scale and location considered in the study.

Table 2: Process and Equipment Requirements for a Composting Facility

Process	Equipment required
Material Acceptance (storage and handling)	Hopper Conveyor or vehicle to load macerator - scale dependent, however most likely vehicle is a front-end loader Air extraction system (odour control)
Decontamination of food waste	Decontamination conveyor Air extraction system (odour control)
Pre-processing – food waste	Macerator Air extraction system (odour control)
Pre-processing – greenwaste	Shredder / chipper Conveyor or vehicle to load shredder / chipper – scale dependent Concrete pad (outdoors)
Blending – food and greenwastes	Blender bowl with a twin auger mixing system, or similar Conveyor or vehicle to load macerator - scale dependent, however most likely vehicle is a front-end loader Air extraction system (odour control)
Primary Composting	Refer to Table 1 for an overview of composting technologies available Air extraction system (odour control, not required for VCU)
Secondary Composting (curing)	Front-end loader, or similar, for turning of curing material
Product refinement (dependent upon end use)	Screen/s Bagging machine Blender for amendment of compost with other materials Loader to transport / load out product (separate to that that used for untreated wastes, to avoid recontamination of product with pathogens)
Monitoring	Temperature probes Facility inputs and outputs (quantity measurement)- eg. Weighbridge

Bibliography

Gane, S. (2004) “Issues and Risks to be Managed in Establishing Auckland Regional Food Waste Composting”. WasteMINZ Annual Conference Proceedings, November 2004.

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