Consent Guide for Composting Operations in New Zealand

Waste Management Institute of New Zealand

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Developing a sustainable NZ together

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1 Introduction

1.1 Background

Compost New Zealand, a sector group of the Waste Management Institute of New Zealand (WasteMINZ) is developing a series of resources for composting and other organic waste processing facilities. These cover best practice composting and processing, the marketing of product and consideration of the regulatory requirements relevant to composting operations.

Commercial-scale composting operations generally require approval to operate from regional councils, and in some cases, territorial authorities (city or district councils).

A brief review of a range of consents for composting operations in 2007 indicated that there is wide variation in the consent conditions imposed and the level of detail required for consent applications. Participants at a WasteMINZ workshop for council staff and compost operators in mid-2007 agreed that a guide to assist with the consenting process would be useful. This document has been prepared in response to that mandate with funding from WasteMINZ, the Ministry for the Environment, and composting operators around New Zealand.

1.2 Purpose of this Guide

The Guide provides an overview of the key features of commercial composting operations in the context of the resource consent process, to assist with the development and implementation of appropriate and effective resource consent conditions for composting facilities. It does not eliminate the need for the detailed development of site-specific consent conditions. While examples of consent conditions are provided, these are not intended to be copied *verbatim*, or adopted without consideration of their applicability on a case-by-case basis.

Additional information sources on the science underlying commercial composting, practical issues for composting operations and the resource consent process are listed in Appendix A (Information Sources), which provides a selection of useful websites on composting and the resource consent process.

1.3 The regulatory environment for composting and organic waste processing

All activities that have the potential to adversely affect the environment are regulated by the Resource Management Act 1991 (RMA). Specific controls are set out in district and regional plans and vary between districts and regions. Regional plans, prepared by regional councils, generally address discharges to the environment such as odour, leachate and dust. District plans, prepared by city or district councils, focus on managing the use of land. In most cases, an organic waste processing facility will require one or more resource consents to operate, either from the relevant regional council and district or city council, or both. Consents will cover the activities to be undertaken on the processing site, but not the use of the end product. Regional councils usually address those aspects of the operation that are likely to result in discharges to air (odour and dust) and water (leachate and stormwater). City or district councils may wish to control noise, visual impacts and the potential for attracting vermin.

The use of compost is likely to be covered under the relevant regional plan as a Permitted

Activity, specifying acceptable levels of contaminants and application rates. Permitted Activities are not generally monitored by regional councils but contravening conditions associated with a Permitted Activity rule may result in prosecution or a fine.

Other legislation relevant to organic waste processing facilities includes:

- The Health and Safety in Employment Act 1992, which seeks to ensure the health and safety of site staff and the public. For composting operations, specific health and safety issues relate to the presence of pathogens in raw feedstock (animal and human), which can cause disease in humans, for example legionella or salmonella.
- The Health Act 1956, which addresses the impacts of the operation on the health of staff and the general public, for example due to the generation of aerosols or the use of compost end product. An offensive trades licence is generally required for composting animal carcasses, parts of animals and for general refuse collection and disposal.

Although not mandatory, New Zealand Standard 4454:2005 - Composts, Soil Conditioners and Mulches (hereafter referred to as NZS 4454) sets the standard for compost, soil conditioners and mulches in New Zealand. It specifies physical, chemical and biological requirements for these products and related products that have been derived from compostable organic materials.

The Standard also provides a benchmark for users of compost products. It offers composting operators the means to carry out safe, hygienic, efficient, and environmentally responsible operations. Some Permitted Activity rules in regional plans refer to NZS 4454.

The use of feedstock that represents a disease risk is specifically excluded from NZS 4454:

Products containing at risk animal mortalities due to notifiable diseases under either the Health Act 1956 or MAF 153 Series of Standards issued by the Biosecurity Authority of the Ministry Of Agriculture and Forestry Response Programme for Exotic Diseases of Animals (and its amendments) are excluded from this Standard. Disposal of such animals shall be done under the guidance of Ministry of Agriculture and Forestry or the Ministry of Health, as appropriate.

Consent authorities are also likely to exclude the composting of feedstock of this type unless specific controls are in place.

1.4 The benefits of composting

New Zealand's solid waste stream consists of approximately 26% recyclable organic material. There is considerable potential to reduce the burden on landfills by using the organic material beneficially, for example through composting. Compost can complement the use of artificial fertilisers and enhance productivity. The use of compost, soil conditioners and mulches also helps to improve soil properties. Moreover, organic waste in landfills produces leachate and breaks down anaerobically into methane, which is 20 times more potent as a greenhouse gas than CO^2.

A 60% reduction in the landfilling of garden waste would reduce total landfill volumes by as much as 800,000 tonnes and save around $40 million in disposal costs per year (New Zealand Waste Strategy, 2002). To achieve this outcome, the New Zealand Waste Strategy has set a goal of diverting over 95% of commercial organic wastes from landfill to beneficial use by 2010.

1.5 Structure of this Guide

Following this introduction, Section 2 outlines the resource consent process and provides information on consent application requirements. It is primarily intended for consent applicants and is particularly useful for those with little or no experience of the consent process.

Section 3 provides an overview of the composting process and different composting technologies. The primary target audience for this section are consent staff at regional and city or district councils, to assist those with little or no knowledge of commercial-scale composting operations.

Section 4 summarises the key impacts of a composting operation and addresses the issues that should be covered by resource consent conditions and in site management plans. The appendices provide additional information, including example consent conditions.

2 The Consent Process

2.1 Consent requirements

The first step consists of identifying what types of consents – if any - are required for the proposed operation, which means careful consideration of the relevant rules in both the applicable regional and district plans. The former address discharges to air, land or water, while district plans focus on land use issues and may include controls intended to reduce the adverse effects on public health due to vermin, traffic and noise, among other considerations. The district plan determines where specific activities such composting operations may locate.

Under the RMA, there are five types of resource consents - land use consents, subdivision consents, coastal permits, water permits and discharge permits. A composting operation is likely to require a land use consent from the city or district council, and a discharge consent (to air, land and/or water) from the regional council. A water permit, also issued by the regional council, may be necessary if surface or groundwater is to be extracted.

Activities described in regional and district plans are classified as permitted, controlled, restricted discretionary, discretionary, non-complying and prohibited. There is also provision for restricted coastal activities. Composting and other organic waste processing activities are likely to be classified as controlled, restricted discretionary or discretionary. If the activity is controlled or restricted discretionary, a consent is required and the plan will state the matters over which the council has reserved its control or discretion. Only these matters need to be addressed in the consent application and assessment of environmental effects. Information requirements may differ between composting operations that use green waste only and those intending to compost a wider range of materials.

A discretionary activity also requires a resource consent before it can be carried out, but the consent authority can exercise full discretion as to whether or not to grant the consent, and with respect to the conditions it will impose. These conditions will be developed based on material provided by the applicant and the council's understanding of the actual and potential effects of the proposed activity. A comprehensive assessment of the potential effects and clear explanation of how these effects will be avoided or managed will assist the councils in assessing an application.

2.2 The application process

The RMA Guide website ***www.rmaguide.org.nz*** provides detailed information about a variety of processes under the Resource Management Act, including the consent process. Prior to lodging an application it is always advisable to meet with resource consent officer(s) at both regional and city or district councils to discuss the application. This will help to identify the specific requirements for information the councils(s) may have, obtain information about the potential length and nature of the application process and the projected costs and fees.

Every resource consent application must include an assessment of environmental effects. The detail required for this assessment will depend on the scale and significance of the proposal. As a general rule, the quality and relevance of the information provided to the council(s) will significantly influence the application process, and should therefore be of a high standard. Key matters to include are an overview of the surrounding environment, potential impacts of the operation (noise, odour, traffic, discharges to air, land and water), emergency and contingency planning, and proposed monitoring procedures. Councils will also look for evidence of discussions with 'affected parties'. In addition to neighbouring

properties this is likely to include public health agencies. Preparing an application for composting operations should involve people with a detailed understanding of the composting process and consenting procedures.

If the application is for a controlled activity, or if the consent authority is satisfied that the proposal will only have minor adverse effects, it will be processed as 'non-notified' provided the written consent of all adversely affected persons has been obtained. The council(s) will advise who the affected persons are likely to be and provide their contact details.

While it is not a requirement of the RMA, it is advisable to prepare sufficient information for any affected parties to understand and consider the activity, and to involve them at an early stage. Addressing potential concerns as early as possible is likely to avoid delays later on, and may save costs. Being proactive in this way may also assist the applicant should the consent be appealed and thus become subject to consideration by the Environment Court.

The applicant may also propose consent conditions, which may assist both the applicant and the consent authority in identifying issues and ways to address them. Examples of consent conditions are provided in Appendix C.

2.3 Monitoring

Once resource consent has been granted, the issuing authority (regional, city or district council) is obliged to monitor its implementation. Hence, there is likely to be a monitoring charge in addition to some form of annual administration charge. There may also be an obligation on the consent holder to provide regular monitoring reports and/or data. Any monitoring requirements should be integrated into the site management plan (Section 4).

The consent holder can seek to change or cancel the conditions attached to a resource consent at a later stage. The consent authority will advise the steps necessary to initiate a consent review.

3 The Composting Process

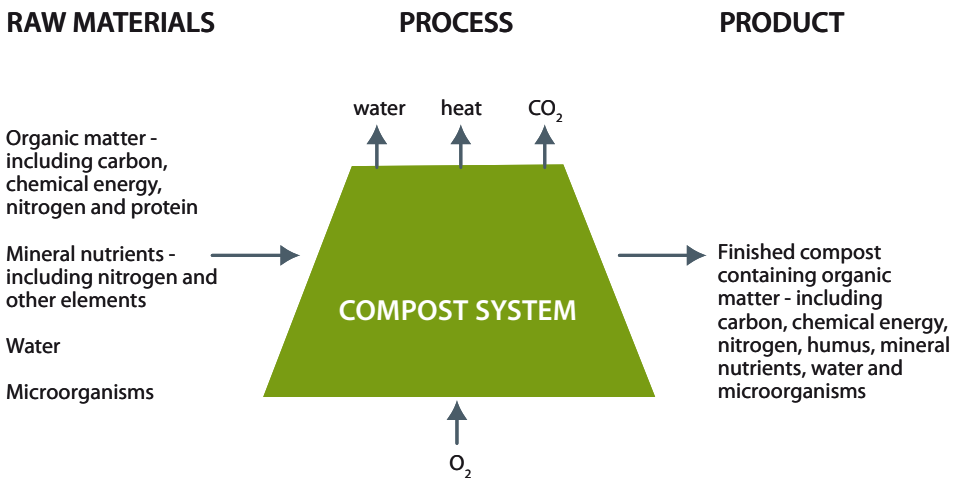
3.1 Introduction

In the context of waste management, the term aerobic composting is applied to the controlled biological decomposition (through the activity of naturally occurring micro-organisms) of 'source separated' organic material derived from animal and vegetative residues. The initial and most basic goal of composting is transformative - turning waste into stabilised, value-added product. In the context of creating a safe product consistent with NZS 4454, composting should also achieve pasteurisation of the raw materials, as described in the following excerpt form the Standard:

A methodology whereby organic materials are microbiologically transformed under thermophilic aerobic conditions to achieve time-temperature requirements for pasteurisation, stability and maturity to achieve the parameters in Table 3.1.

Figure 1 provides an overview of the composting process. In brief, organic matter along with water and oxygen provide a food/energy source for micro-organisms. Most of the organic matter is converted to compost, with water, heat and CO^2 released as a result of the microbial action.

Figure 1: Process diagram for composting systems



Source: Compost New Zealand (2007): Introduction to Composting Science and Management for Industry Training

Composting systems are often described in terms of a complete process from the reception of raw material through to the handling of the end product. However, all systems involve the following steps:

1. Feedstock preparation.
2. Initial mixing.
3. Active composting.
4. Maturing.

There is a range of composting technologies available. All of these involve the above steps and focus on creating appropriate conditions for Stage 3 (Active Composting). Some technologies are discussed briefly in Section 3.5. Further detail is available in Appendix K of NZS 4454.

3.2 Feedstock preparation

Feedstock is the material that will serve as the main ingredient in the compost. The ideal compost feedstock is a clean, homogeneous organic material. Since few waste streams produce such material, it is usually necessary to separate the incoming mixture into compostable, recyclable, and disposable fractions. From a compost production perspective, effective separation is important in order to reduce or eliminate:

- visible non-compostable materials in the finished compost such as plastic and glass, and
- chemical contaminants such as household hazardous waste.

Materials such as aluminium, ferrous metal and other locally valuable recyclables should be removed prior to the composting process. This not only produces cleaner compost, but may be an additional source of income. The actual separation processes chosen will vary with each individual facility.

In addition to feedstock preparation, other pre-processing may include:

- diversion of material not to be shredded, such as grass clippings, leaves and weeds;
- conditioning of high moisture content material such as manure, food processing waste and kitchen waste[1].

Any given feedstock in its raw state is unlikely to possess all the necessary characteristics for successful decomposition. Because of this, effective composting relies upon understanding the nature of the various input feedstock and then appropriately preparing, amending, bulking (if necessary) and combining these into a mixture that has the required characteristics. In general, the focus is on achieving an appropriate moisture content, particle size (to allow the circulation of air) and carbon to nitrogen ratio (C:N ratio).

The need to blend the different components means that raw materials may have to be stockpiled prior to mixing. Examples include green waste, bark or sawdust (bulking agent) and potentially more putrescible wastes such as manure and food wastes. In some cases, oversized screenings from the end product may be used as a bulking agent.

Covering of stockpiles to avoid dust and windblown litter may be important. Putrescible wastes may need to be stored in an enclosed area to exclude scavengers or be aerated to minimise odour.

Shredding is necessary for woody branches and large materials that cannot be composted effectively without size reduction. This may only comprise 5% of green waste. The primary purpose of shredding is to increase the bulk density of feedstock materials (garden or other green waste) while increasing free air space to levels that promote optimum thermophyllic composting conditions (rapid microbial activity, appropriate temperature build-up and retention of moisture content). Shredding increases the surface area of the raw materials, thereby exposing more of them to microbes.

Ideally, shredding should be undertaken regularly with the objective of keeping the reception area clear, promoting hygiene and preventing odour, and ensuring that pre-processed material is blended into an aerobic composting process as soon as possible (some resource consents stipulate that blending/mixing must occur within 24 to 48 hours of feedstock being received on the site).

1 *Conditioning usually involves lowering the moisture content of these materials through drying, mechanical dewatering (in the case of biosolids) or addition of a bulking agent such as sawdust.*

3.3 Initial mixing

The focus of initial mixing is to achieve rapid, biological decomposition and stabilisation of the organic materials. This requires conditions that allow for the development of thermophilic temperatures as a result of biologically produced heat, which in turn should produce a final product sufficiently stable for storage and application to land without adverse environmental effects. The commonly quoted optimum parameters for aerobic decomposition (which may vary according to feedstock and processing technology) are:

- C:N ratio 25-30 to 1;
- moisture content 50-60%;
- oxygen concentrations at least 12-14% (and never less than 5%);
- average wet bulk density 200-300 kg/m^3 (this increases to 500-700 kg/m^3 during the composting process);
- pH 6.5-8;
- temperature 45-65°C for optimum thermophilic microbial action, including a period of 3 to 4 days at greater than 55°C for pasteurisation[2].

Combining different feedstock is a common strategy to manage the particle size and moisture content of the composting mass. For example, shredded green waste, sawdust or bark may be added to high-moisture content putrescible wastes to improve particle size and moisture content.

For windrow systems, periodic turning during processing can address initial mixing difficulties, but many in-vessel systems require the initial mixing to be correct to ensure a quality end product.

3.4 Active composting

The decomposition process in a compost pile or in-vessel system (either stationary or agitated) can be broken down into two phases:

- The high-rate initial phase, which is characterised by thermophilic temperatures, high odour potential, high oxygen (O_2) uptake, rapid biological volatile solids (BVS) reduction rates and pasteurisation.
- The secondary low-rate phase, which is characterised by reduced O_2 uptake rates, lowering temperatures and reduced odour production potential as the product reaches a stable condition.

During the active composting period, the temperature will fall if oxygen becomes scarce due to decreasing microbial activity. Conversely, if oxygen is available and microbial activity is intense, the temperature can rise above 70°C. At this point, many micro-organisms begin to die or become dormant, and BVS reduction rates decrease. Temperature is a good indicator of the overall health and success of the decomposition pasteurisation process, and should therefore be monitored throughout the process.

To ensure pasteurisation, the temperature of the whole compost mass must exceed 55°C for a minimum of three days. This can be achieved by turning and extending the composting period, for example through holding the compost at a temperature of more than 55°C for 15 days with a minimum of five turnings, or by insulating the outer zones.

Aeration must be optimised to keep the composting material fully aerobic (thereby avoiding offensive odours) but not dry it out. Increased aeration may be used to cool the compost if it is deemed too hot, but this has the disadvantage of removing large amounts

2 *NZS 4454 stipulates at least 3 days at 55°C for pasteurisation.*

of water. Depending on the technology, temperature, aeration and water content must be managed to maximise aerobic microbial activity. If the material dries out too much, the addition of water and physical mixing may be necessary.

Offensive odours are generally related to anaerobic decomposition of material in the composting pile. This in itself is not an issue if it occurs in the middle of the pile, as the remainder of the composting material acts as an effective bio-filter that removes odours before they are discharged to the surrounding atmosphere. However, odour may be generated when turning the composting mass, or if the oxygen levels become so low that the majority of the composting mass becomes anaerobic.

In the context of windrow composting, turning is used to control moisture, temperature and oxygen and its frequency is determined by monitoring these parameters.

During the active composting stage, potential environmental effects include the generation of leachate, odour and dust depending on the system used and the degree of control maintained.

3.5 Compost maturing

Once active composting has run its course, it will be necessary to allow the compost to mature. For windrow and static pile systems, some maturing will occur at the end of the active stage while the material is still in the pile. For in-vessel systems the initial active phase occurs quickly and the maturing stage is critical in producing a stable and fully composted product.

The composting process gradually slows as it reaches an advanced state and this is reflected in a decline in temperature. However, microbial activity does not cease, but goes through a natural succession in the course of maturing the product. The material must be kept aerobic and hydrated to allow maturation to progress. Maturity criteria can be quantitatively defined in terms of:

- specific oxygen consumption rate (mg O_2/kg volatile solids per hour);
- an absence of phototoxic compounds;
- a reduction of BVS;
- a return to near ambient temperatures.

Maturing compost still requires turning and wetting to keep it aerobic, sustain continued microbial activity and suppress dust. Control of the potential for pathogen regrowth or contamination from feedstock is also required during this period. Run-off (leachate and stormwater) must be managed to avoid adverse effects associated with high nutrient loads and pathogens (if pasteurisation has been inadequate) in the water leaving the composting site.

3.6 Composting technologies

A range of composting systems are available for processing a wide variety of organic materials. They differ in the methods employed for temperature, oxygen and moisture control, but for all of them operator performance is crucial for achieving effective composting, managing and minimising adverse effects, and creating a quality product.

Common approaches to composting include:

- Static Aerated Windrow - air blowers force air through a pile or windrow via dedicated pipework or sunken covered troughs.
- Windrow Composting - the organic waste is placed in linear heaps, allowing the aerobic

decomposition of the organic matter. Mechanical turning ensures that the material is subjected to periodic increases in aeration and that all parts of the composting materials are exposed to the decomposition process. Windrow composting normally takes place outdoors, but may also occur in buildings or under cover.

- In-vessel Composting – the composting process is carried out within an enclosed system where moisture content, temperature and oxygen levels can be regulated. The key advantage is that operating parameters can be optimised to reduce environmental impacts. In-vessel composting can provide the greatest degree of odour and dust control, as odours generated in the vessel are scrubbed prior to release to the atmosphere.
- In-vessel composting encompasses a wide range of systems. Examples include covered windrows (for example the Gore Cover System), tunnel/bunker systems and agitated systems (such as Rotocom and Hot Rot).

High technology in-vessel composting systems are now used to process materials that have traditionally been difficult to manage in outdoor windrow systems. Other key drivers for technological advancement are the controls for odour, leachate and pathogen removal as well as the adoption of quality assurance standards such as NZS 4454.

Good site design and layout is essential for all technologies and sites, but in particular those that involve a composting mass that is exposed to the elements. Particular attention should be given to simplifying materials handling, and management of run-off (leachate and stormwater) to ensure that any liquids from active composting areas are collected and treated. Many sites reuse run-off for dust control and/or maintaining the appropriate water content in the composting mass.

4 Key Issues for composting operations

4.1 Introduction

This section provides an overview of issues common to all organic waste processing facilities, taking into account that their relative importance will vary according to location, feedstock and processing technology. Matters that require particular attention include:

- controlling feedstock quality;
- dust generated by storage and processing areas;
- odour associated with feedstock storage and the composting process;
- run-off (leachate and stormwater) from storage and processing areas;
- controls that may be imposed in a land use consent;
- final product quality, including maturity and contamination levels.

Action taken to manage issues in one area will often show benefits in another as well. For example, ensuring that a compost pile is operating aerobically and with an appropriate C:N ratio will ensure a high quality, stable product as well as reducing the potential for unpleasant odour.

Regional and city or district councils vary in the level of control they exercise over organic waste processing facilities. This section provides an overview of the issues of most concern, and outlines the matters that may be covered in a resource consent.

4.2 Feedstock

The feedstock used greatly influences the potential environmental and health impacts of an organic waste processing operation. For example, processing woody or fibrous waste produces little odour and moisture, whereas processing food, meat, fish, and fatty or oily sludges has a higher potential for odour and leachate generation. Table 1 has been adapted from a publication of the New South Wales Department of Environment and Climate Change (2004), and illustrates the degree of impact likely to be associated with different materials.

Table 1: Categorisation of Organic Waste Material

Potential Environmental Impact	Type of feedstock	Examples
Low	Garden and landscaping supplies	Leaves, plants, loppings, branches, tree trunks and stumps
	Untreated timber	Sawdust, shavings, timber off-cuts, crates, pallets, wood packaging
	Natural organic fibrous products	Peat, seed hulls/husks straw, bagasse and other natural organic fibrous products
	Processed fibrous products	Paper, cardboard, paper-processing sludge

Potential Environmental Impact	Type of feedstock	Examples
Medium	Natural or processed vegetable organics	▸ vegetables, fruits, seeds, and processing sludges and wastes; ▸ winery, brewery and distillery wastes; ▸ other food organics not listed in the 'High Impact' category
High	Meat, fish and fatty foods	Carcasses and parts of carcasses, blood, bone, fish, and fatty food or processing wastes
	Fatty and oily sludges and organics of animal or vegetable origin	Dewatered grease traps and fatty and/or oily sludges of animal and vegetable origin
	Grass	Grass clippings
	Biosolids and manures	Sewage biosolids, animal manure and mixtures of manure and biodegradable animal bedding
	Mixed residual wastes containing putrescible organics	Wastes containing putrescible organics, including household domestic waste that is set aside for kerbside collection or delivered by the householder directly to the processing facility, and waste from commerce and industry

There are a variety of approaches to ensure that feedstock acceptance and handling does not result in adverse effects on the environment. Some regional councils rely on general 'no adverse effect' conditions, while others specify types of feedstock that can be accepted, and/or how feedstock should be handled. Maintaining a continuous record of feedstock used provides information for troubleshooting should any odour issues arise, as well as enabling compliance with the labelling requirements of NZS 4454.

4.2.1 Issues addressed in consent conditions

Consent conditions relating to feedstock are likely to focus on the potential and actual effects of the feedstock with respect to discharges to air, land or water and the use of land. They aim to minimise and manage odour, capture and treat leachate and stormwater, and exclude vermin.

A consent may specify:

- limits on the quantity of feedstock stored on site;
- specifications regarding the types of feedstock that may be used;
- excluded feedstock;
- limits on time that feedstock can be stored prior to processing;
- requirements to record feedstock type and quantity;
- stormwater management requirements in the feedstock acceptance and storage area;
- site layout and design where this impacts on stormwater management and groundwater protection;
- vermin prevention (land use consent).

4.2.2 Issues for the site management plan

In addition to addressing of the concerns of consent authorities and ensuring that consent conditions are complied with, the management plan should also ensure that feedstock selection and handling supports the production of good quality compost. If the composting operation aims to produce compost in accordance with NZS 4454, details of any feedstock utilised must be recorded. The Standard also specifies acceptable levels of physical, chemical and microbiological contamination, and effective control of feedstock will assist the compost operator with avoiding unacceptable contamination of the end product.

The management plan should specify:

- acceptable materials (reflecting any requirements specified in the resource consent);
- location and maximum residence time for stockpiles;
- feedstock preparation methods;
- recording of incoming materials;
- the mix of feedstock for each batch.

4.3 Dust

Dust is generated by the movement of materials onto and around the site, and the storage, grinding, mixing, screening and transport of feedstock and products. Activities that involve movement of materials may need to be suspended on very windy days. Dust generation may also be an indication of insufficient moisture content in the composting mass.

4.3.1 Issues addressed in consent conditions

Consent conditions may require that composting site operators:

- develop a management plan with provisions relating to the control of dust from the site;
- use dust suppression equipment such as sprinklers, water carts and/or wheel washing;
- consider the impacts of aerosols or run-off if contaminated water is used for dust suppression;
- take into account weather conditions when turning windrows or handling stockpiles;
- ensure that finished stockpiles are covered or stored in an enclosed area;
- enclose finished product storage bay(s) during filling operations;
- limit traffic speed on site.

4.3.2 Issues for the site management plan

The management plan should outline standard procedures for a range of activities that may result in excessive dust. Mitigation measures may include using water or other dust suppressants, working in enclosed areas or limiting certain activities to calm weather conditions.

The management plan should specify which activities should take place in enclosed areas, as well as procedures for:

- handling raw materials to minimise dust;
- turning windrows (if applicable) to avoid excessive dust;

- handling product stockpiles;
- dealing with general dust generation on the composting site, for example dust generated by traffic on unpaved roads.

4.4 Odour

The composting process generates significant quantities of gas. Under aerobic conditions, most of this is carbon dioxide, and under anaerobic conditions the majority is methane, along with significant amounts of hydrogen sulphide, organic sulphides and/or volatile fatty acids.

Open-air compost facilities therefore have the potential to produce a significant amount of odour if they are not operated correctly. The causes of odour generation may include:

- oxygen levels of less than 5% during the initial 21 days of active composting, promoting volatile organic compound formation;
- low porosity in the compost pile, inhibiting air circulation;
- high moisture levels in the compost pile, eliminating adequate free airspace;
- a low carbon to nitrogen ratio (C:N), promoting ammonia volatilisation[3];
- high pH in the compost pile, which also promotes ammonia volatilisation.

Odour problems associated with composting and similar processing facilities for organic materials can generally be managed through careful process control and treatment and/or containment of odorous materials, for example through bio-filters associated with in-vessel or enclosed composting systems. Odour control systems need to be appropriately operated and maintained.

Careful management of feedstock will often have a beneficial impact on controlling odour from composting operations. For example, ensuring that feedstock is processed quickly and introduced into the composting process will prevent odour generation from the feedstock itself. To assist with processing feedstock as soon as possible, bulking agent should be stockpiled so that it is available for the quick processing of feedstock when it arrives on site.

4.4.1 Issues addressed in consent conditions

Consent conditions relating to odour may specify a standard to be met and/or activities to be undertaken. Actions to minimise the potential for odour are likely to also have a positive impact on end product quality. Appendix K of NZS 4454 is relevant, as are the temperature and time criteria required by NZS 4454 to achieve effective pasteurisation of the raw materials:

a) *During the composting process, the temperature of all of the compost is maintained as follows:*
   i. *In-vessel: ≥ 55°C for ≥ 3 days;*
   ii. *Windrow: ≥ 55°C for ≥ 15 days with a minimum of five turnings during this period for specified products*
   iii. *Garden organics or green wastes: ≥ 55°C for ≥ 3 days with a minimum of three turnings;*

A consent may specify or require the following:

- a management plan with provisions relating to the control of odour from the site;

3 *There will always be variations in the C:N ratio. Some processing technology handles low C:N ratio better than others. Depending on the feedstock, this may be a key factor in technology selection.*

- that there is to be no offensive odour at the boundary;
- how raw materials and product stockpiles are to be handled;
- processing technology and/or operational detail, for example turning of windrows;
- process conditions such as temperature and oxygen levels;
- temperature and time criteria to be met for pasteurisation;
- acceptable or unacceptable feedstock materials.

4.4.2 Issues for the site management plan

The management plan should provide standard procedures for the range of activities that may generate odour from the composting operation.

The management plan should address:

- measures to identify, store and incorporate various feedstock;
- processing procedures (windrow turning, compost 'recipes', mixing procedures and monitoring;
- contingency measures;
- complaints procedures;
- procedures for dealing with a wide range of adverse weather conditions.

4.5 Leachate and stormwater

Leachate from composting facilities has the potential to pollute groundwater and surface water. It can be high in nutrients, therefore making it a favourable host media for bacteria and other micro-organisms which generate a high biological oxygen demand (BOD). Leachate can also be acidic, especially when generated under anaerobic conditions. Under aerobic conditions, alkaline leachate can be formed from organic materials with low carbon/high nitrogen ratios such as food and animal matter.

In addition to the leachate produced by the water contents of organic waste materials, stormwater can infiltrate the composting mass and dilute the existing leachate. Most commercial-scale composting operations require active stormwater management to minimise the impacts of sediment-laden and leachate-contaminated stormwater.

Treatment and discharge of leachate must take into account the potential for pathogens. In some cases, a consent condition may specify limits for *Escherichia coli* (*E. coli*), which will be determined by the nature of the receiving environment.

4.5.1 Issues addressed in consent conditions

Consent conditions may specify:

- separation of 'contaminated' and 'clean' stormwater on the processing site;
- monitoring required for stormwater and leachate collected on site[4];
- treatment of stormwater and leachate from the site;
- monitoring of groundwater and/or nearby surface water bodies;
- handling of specific feedstock likely to contribute to leachate form the site.

4.5.2 Issues for the site management plan

The management plan should provide standard procedures for the management of clean and contaminated water. Mitigation measures may include specifications

4 *Parameters to be monitored may include BOD_5, TSS, E. coli, ammonia, etc.*

for the reuse of water as a dust suppressant, stormwater or leachate treatment, identification of low permeability areas, bunding of various parts of the processing site or covering parts of the site to prevent stormwater ingress.

The management plan should specify:

- the design and layout of water management systems on the site;
- measures to prevent feedstock contaminating stormwater;
- processes for preventing stormwater coming into contact with composting materials;
- methods for the capture and treatment and/or reuse of contaminated stormwater and leachate;
- contingency measures;
- complaints procedures;
- monitoring of stormwater and/or leachate quality and quantity.

4.6 Land use issues

Land use matters are addressed in consents issued by district or city councils. Issues of concern may include noise, traffic movements, vermin management and amenity values. Some of the issues specific to composting operations are covered by both regional and district planning requirements.

As previously noted, good practice and housekeeping in composting operations will have flow-on effects on other management issues; for example, reducing the potential for attracting rats or birds will also ensure that odour generation is minimised.

4.6.1 Issues addressed in consent conditions

Land use consent conditions may specify:

- hours of operation;
- permitted heavy vehicle movements;
- processing procedures and/or technology;
- the contents and requirements for the site management plan;
- monitoring requirements;
- control measures for site access such as fencing.

4.7 Site management plan

Good site and operational management is essential for achieving a consistently high level of environmental performance as well as an end product of high quality. Many consent authorities require the development of a site management plan through consent conditions, but regardless of the regulatory requirements a plan outlining key activities and procedures on site is important.

Consent conditions relating to the preparation and implementation of a site management plan can vary in detail. Some conditions may outline the parameters to be covered in the management plan in some detail, while others simply require the preparation of a plan. A generic table of contents for a management plan is provided in Appendix B.

4.7.1 Issues addressed in consent conditions

The level of detail required in a site management plan depends on the location and scale of the operation, the nature of the feedstock accepted, and - to some

degree - on the level of detail specified in the consent conditions. In some cases, the consent may be prescriptive with respect to the technology used, operational procedures and parameters, and monitoring.

Even where the consent is less prescriptive, the management plan generally becomes the principal tool for ensuring compliance with consent conditions, and is therefore the key operational document for the composting facility.

A consent may specify:

- matters to be covered in a site management plan (for example complaints procedures, monitoring requirements, standard operating procedures);
- the procedure for the approval and review of the management plan;
- timing of initial submission and periodic review of the management plan.

4.8 Product quality

As noted in Section 1.3, consents for composting operations are unlikely to include conditions relating to product quality, although the use of compost is likely to be covered by permitted activity rules in regional plans. NZS 4454 also specifies physical, chemical and microbiological standards for compost.

To ensure that each compost batch meets quality specifications, the facility operator should have quality assurance procedures in place, as well as workplace practices suited to the local situation. Such procedures may include feedstock controls, monitoring operating conditions, and testing of the end product. The extent of sampling and testing will depend on the expected contaminants or pathogens in the feedstock and the anticipated end use of the product. According to NZS 4454, "microbial testing will apply to high risk sources such as animal manures, parts of animals or animal mortalities, kitchen/food residuals, meat processing residuals, and fish/shellfish". Compost operations with little risk of contamination – such as those processing only green waste – may be able to adopt a minimal testing frequency.

If the end use of the product is categorised as a permitted activity, the criteria in Table 3.1 of NZS 4454 apply. However, if the end product and/or end use do not comply with permitted activity conditions, a consent for the disposal of the compost may be required.

4.8.1 Issues for the site management plan

While unlikely to be explicitly required by resource consents for a composting facility, it may be appropriate to address product quality in the site management plan.

The management plan could specify:

- the physical, chemical and microbiological parameters the finished product is expected to meet;
- the product testing regime to ensure product quality;
- standard processing procedures;
- parameters that affect product quality and that need to be monitored;
- contingency measures for situations where the product does not meet quality criteria;
- recall procedures for product that has left the site but does not meet quality criteria;
- labelling requirements to ensure that the product is labelled in accordance with NZS 4454.

APPENDIX A: INFORMATION SOURCES

1.1 The resource consent process

The RMA Guide.

http://www.rmaguide.org.nz

An Everyday Guide to the Resource Management Act Series.

http://www.mfe.govt.nz/publications/rma/everyday/index.html

1.2 The composting process

Compost New Zealand (2007): A Tool Kit for NZS 4454: 2005.
Available from the Waste Management Institute of New Zealand

http://www.wasteminz.org.nz

Department of Environment and Climate Change New South Wales (2004): Environmental Guidelines, Composting And Related Organics Processing Facilities.

http://www.environment.nsw.gov.au/waste/envguidlns/contents.htm

EPA Victoria (1996): Environmental Guidelines for Composting And Other Organic Recycling Facilities.

http://epanote2.epa.vic.gov.au/EPA/publications.nsf/PubDocsLU/508?OpenDocument

NZS 4454:2005 - Composts, Soil Conditions and Mulches. Standards New Zealand.

http://www.standards.govt.nz

The Composting Association (UK) (2005): The Composting Industry Code of Practice.

http://www.compost.org.uk/component/option,com_docman/task,cat_view/gid,115/Itemid,231/

Ministry of Health (1995): Guidelines for the Control of Legionellosis. (Currently under review).

Ministry for the Environment (2003): Good Practice Guide for Assessing and Managing Odour.

http://www.mfe.govt.nz/publications/air/odour-guidelines-jun03/index.html

The reader should be aware that due to the rapidly changing nature of the information base on the internet, information relating to specific websites may not always be accurate.

APPENDIX B: OUTLINE OF A COMPOSTING OPERATION SITE MANAGEMENT PLAN

1 Introduction

- Purpose and objectives
- Overview of consents for the site (these should be included in the appendix, accompanied by the assessment of environmental effects)
- Risk Assessment – overview of potential hazards
- Definitions

2 Description of Operation

- Site owner and operator
- Management structure
- Staff management – responsibilities and duties, induction and training
- Contractual arrangements
- Customer service and quality management procedures
- Site layout and activities undertaken (relevant drawings, including a drainage plan, should be included in the appendix)
- Surrounding land uses
- Processing technology
- Description of material flows

3 Health and Safety

- Hazard identification
- Hazard Control Measures
- Staff responsibilities
- Emergency management plan, including training procedures
- Evacuation procedures
- Accident and incident reporting and investigation
- Training

4 Environmental Management

- Odour Control Measures
  - for incoming materials
  - during composting
- Dust Control Measures
  - vehicle movements
  - shredding
  - composting/maturing
  - screening
  - product storage
- Leachate Management
- Stormwater Management
- Pathogen Control Measures
  - feedstock
  - leachate and stormwater
  - compost
- Vermin Control

5 Standard Operating Procedures

- Incoming materials reception and storage
  - materials inspection procedures
  - batch recording
  - equipment
- Shredding and materials preparation
  - wetting
  - mixture analysis and recording
  - equipment
- Composting and processing - process description and operating instructions
- Screening
- Complaint Procedures
  - register, including description of weather conditions and action taken
- Contingency planning
  - equipment failure
  - staffing issues
- Quality Control
  - testing procedures (physical, chemical and microbiological parameters)
- Product storage and sale
  - batch identification and tracking
  - labelling

6 Monitoring

- Parameters
- Frequency
- Monitoring locations
- Reporting procedures

7 Review

- Auditing
- Scope and timing of site management plan review

Appendices

- Resource consents and Assessment of Environmental Effects
- Site layout and drawings
- Complaints register

APPENDIX C: EXAMPLE CONSENT CONDITIONS

1 Feedstock

Open windrow, rural:

*"The total amount of raw materials (excluding bark and sawdust) received on the site shall not exceed **x** m^3 in any 7 day period."*

"Materials accepted for composting shall be limited to the following (excluding standard bulking agents);

a) Grape skins and seeds (marc)

b) Olive processing solids

c) Chicken litter/manure

d) Horse manure

e) Horticultural waste"

Open windrow, urban, in close proximity to adjoining commercial and recreational properties:

*"Green waste accepted for composting shall be shredded and placed into windrows within **xx** hrs of acceptance at [the composting site]."*

"The consent holder shall keep and maintain the following information.

f) The date, time and volume of any material (except for standard bulking agents) brought onto the site;

g) The type of material and its source.

Copies of these records shall be made available to the Council at any time as may reasonably be requested."

2 Dust

Open windrow, rural:

"There shall be no airborne or deposited dust beyond the boundary of the consent holder's premises, that is, in the opinion of an enforcement officer of the Consent Authority, determined to be noxious, objectionable or offensive."

Open windrow, urban:

"That dust emissions from all handling operations, including screening, turning, loading and unloading operations, shall be kept to a practicable minimum through the use of water sprays or fogs, or other means of dust control to the satisfaction of the Manager, to ensure that dust emissions are minimised. Dust suppression equipment shall be maintained in good condition and no part of the process shall be operated without dust suppression equipment being fully operational and functioning correctly."

"That any finished product bay, including those after the secondary screen, shall be enclosed during filling operations to ensure that dust is kept to a practicable minimum."

"That the coarse mulch and additives stockpiles shall be dampened to ensure that dust emissions are minimised."

3 Odour

Open windrow, rural:

"In the event of regular odours from the composting operation, which in the opinion of [The Regional Council] are objectionable and/or offensive, beyond the boundary of the property, and where mitigation measures undertaken by the consent holder have failed to remedy the odour problem, the consent holder shall at the written direction of the Council, undertake appropriate mitigation measures which may include (but not be restricted to) the following: a reduction in the total weekly quantity of raw materials brought onto site; a reduction in the quantity of specific wastes brought on site at any time; an increase in the time spent in turned windrows; the use of zeolite fines as covering material."

Open Windrow, semi rural:

"That windrows shall only be turned at times which are least likely to cause offence to neighbours. Consideration shall be given to the wind speed and direction and irregular activities in the area such as recreational events."[5]

"There shall be no objectionable or offensive odour resulting from the consent holder's activities to the extent that, in the opinion of an enforcement officer of the Consent Authority, causes an adverse effect at or beyond the boundary of the consent holder's premises."

"During the composting treatment, the temperature of all the compost shall be maintained at greater than 55°C for a minimum of three continuous days. At the same time or after that, the compost shall be aerobically treated for 14 days or longer, during which time the temperature must always be over 40°C and the average temperature must be higher than 45°C."

"An odour shall be deemed to be offensive or objectionable if:

- *a. It is held to be so in the opinion of an enforcement officer of the Regional Council, having regard to the duration, frequency, intensity and nature of the odour; and/or*
- *b. An officer of the Regional Council observes that an odour is noticeable, and either it lasts longer than ten (10) minutes continuously, or it occurs frequently during a single period of more than one (1) hour <time periods adjusted as deemed appropriate>; and/or*
- *c. No less than three individuals from at least two different properties, each declare in writing that an objectionable or offensive odour was detected beyond the boundary of the site, provided the Council is satisfied that the declarations are not vexatious and that the objectionable or offensive odour was emitted from the site at the frequency and duration specified in (b). Each declaration shall be signed and dated and include:*
  - *i. the individuals' names and addresses;*
  - *ii. the date and time the objectionable or offensive odour was detected;*
  - *iii. details of the duration, frequency, intensity and nature of the odour that cause it to be considered offensive or objectionable;*
  - *iv. the location of the individual when it was detected; and*
  - *v. the prevailing weather conditions during the event.*

Open Windrow, urban

"All windrows on the impervious area shall be turned frequently to ensure the composting within the windrows remains aerobic."

"That the composting process shall be controlled to ensure an aerobic condition is maintained

5 *This assumes the worst case scenario, ie windrows not operating effectively and generating odour.*

throughout the windrows to ensure that offensive odours are not produced. Without prejudice to the generality of this condition, the windrows shall be maintained within the following limits:

a. *Maximum windrow pile temperature of **x**°C.*
b. *Windrow moisture content between **x**% and y% (on a wet basis).*
c. *Minimum oxygen level of **x**%."*

4 Leachate and stormwater

Open windrow, rural:

"All raw materials and compost (other than standard bulking agents) shall be stored on surfaces with a permeability of not more than 1 x 10-7 m/s." [6]

Open windrow, semi-rural:

"The consent holder shall ensure that within 60 days of commencement of this consent, 'upstream' and 'downstream' groundwater sampling bores are established."[7]

Open windrow, urban:

"All stormwater and leachate from the concrete and clay pads shall be collected in lined pond(s) with a minimum capacity of 1,000 m3." [8]

5 Site management plan

Open windrow, semi-rural:

"The consent holder shall log all complaints received. The log shall include:

a. *the date and time of the complaint;*
b. *the nature of the complaint;*
c. *the name, telephone number, and address of the complainant;*
d. *weather information (an estimate of wind speed and direction);*
e. *details of key operating parameters at the time of the complaint; and*
f. *the remedial action taken to prevent further incidents.*

Complaints shall be reported to the Council within 24 hours of receipt and the log of complaints shall be made available to the Council on request."

"The permit holder shall prepare an Operation and Maintenance Manual for the site to the satisfaction of [the Council].

The manual shall be forwarded to [the Council] within three months of the date of commencement of this permit.

The manual shall include:

- *methods that will ensure that the conditions of this consent are met at all times;*
- *maintenance of the stormwater treatment system, including the* separator, to ensure it is operational; and
- *anything else considered relevant.*

The manual shall be reviewed and updated annually to the satisfaction of [the Council]."

6 *This only provides value where retained run-off or leachate is collected for treatment.*

7 *It would be expected that the monitoring system is established prior to commencing the activity.*

8 *This should be linked to catchment size and storage required i.e. 1-3 months, 5% Annual Estimated Precipitation, etc.*

Open windrow, urban:

"That the Consent Holder shall maintain an Air Quality Management Plan, which accurately records all management, operational and monitoring procedures, methodologies and contingency plans necessary to comply with the conditions of this consent. The Consent Holder shall submit the Air Quality Management Plan to the Manager for review by [Date]. All subsequent changes shall be submitted to the Manager for review prior to becoming operational. The Manager will advise the Consent Holder in writing if any aspects of the Air Quality Management Plan are considered to be inconsistent with the provisions of this consent."

"Within three months of the date of issue of this consent, the consent holder shall prepare and submit to the Consent Authority a Management Plan for the composting operation. The composting operation shall be managed in accordance with this plan, and a copy shall be held onsite by the operator at all times. The plan shall include, but not be limited to, the following:

- *a detailed description of the compost operation, including hours of operation, acceptable wastes, unacceptable wastes, site access and security; and*
- *a description of activities that may generate odours or dust, and measures in place to avoid, remedy or mitigate those discharges; and*
- *a description of how the leachate and stormwater collection system will operate, including when and how this collected leachate will be pumped onsite back over the windrows and/or off site for disposal to land; and*
- *the means of receiving, recording in writing, and dealing with any complaints as detailed in condition **xx**; and*
- *a list of site management structure and responsibilities; and*
- *a list of after hours contact details in case of any emergency or problems; and*
- *contingency plans in the event of system malfunctions or breakdowns.*

The Management Plan shall be reviewed annually, and updated as required, and the outcome of the review and any update, shall be provided in writing to the Consent Authority by 1 July each year. At all times, the consent holder shall ensure that the Consent Authority has a copy of the most recent version of the Management Plan."[9]

6 Land use

Open Windrow, urban:

"The site shall be operated in a manner designed to avoid the needless attraction of birds or vermin and control programmes and inspections shall be carried out on a regular basis".

9 *Depending on the role of the management plan, it would be preferable for the plan to be approved prior to the activity commencing.*

APPENDIX D: EXAMPLE SITE MANAGEMENT PLAN PROVISIONS

1 Feedstock

Open windrow, rural:

a. Composting Feedstock

Acceptable materials are:

Garden and Landscape Material

Trees, branches, grass, leaves, tree trunks and stumps (up to 400 mm in diametre), and weeds. Depending on the equipment used, highly fibrous plant material may have to be excluded. Examples are flax, cabbage tree, toi-toi, tussock and palm leaves as well as bamboo.

Other Organic Fibrous Material

Un-treated Sawdust, timber off cuts, crates, pallets wood packing, bark, shavings, straw and animal (cow, deer, pig, hen and horse) manure. Note: all this material is to be untreated. All material should be shredded and metal fixtures/fittings removed.

All other materials are unacceptable"

In-vessel, urban:

a. Feedstock Preparation

The Operations Manager will determine the appropriate mix of shredded green waste and putrescible materials for each batch. Feedstock preparation will be recorded on the batch information sheet including the quantity/source of all materials, time of preparation and batch number."

2 Dust

Open windrow, semi rural:

a. Dust Control

The effect on neighbouring properties of particulate matter generated from this site is also expected to negligible. Compost turning and screening will not be undertaken when the wind is blowing toward our nearest neighbours or when winds exceed approximately 15 km/hr. This will minimize the generation of dust and any possible detrimental health effects for our staff (albeit remotely). Workers will turn compost in loaders with enclosed and air conditioned cabs also assisting to minimise dust.

Careful monitoring of the windrow after heavy rain will be necessary to ensure that the windrow remains in an aerobic state. Water will be used to 'dampen down' dust and to assist in the composting process. The use of water to ensure that the rows are kept to optimum water content will also ensure that particulate matter is kept to a minimum."

3 Odour

Open windrow, rural:

"From our existing compost operation it has been observed that the compost really emits odours when being disturbed, i.e. turned moved or when the feedstock is taken from the stockpile and formed into a windrow. The only time odour is likely to be a potential nuisance is

when the feedstock is being shifted or when the compost windrow is turned or screened. Never the less, we will not do any odour generating activity when the wind is blowing directly toward our neighbours.

To avoid the risk of 'bad' compost that had gone anaerobic, the windrow pile will be formed into a trapezoidal shape approximately eight to ten metres across at the base, not more than three meters high, and three meters across the top. Ensuring that these dimensions are adhered to will enable adequate inflow of air to the core of the pile and minimise the chance of the compost becoming anaerobic and producing foul odours.

With these basic operational measures adopted in the routine management of the site, it is not expected that there will be any odour nuisance effects from the site."

4 Leachate and stormwater

Open windrow, urban:

a. Surface Water Controls

The processing area will be constructed with a bund around it so that storm water does not enter the processing area. This will avoid the possibility of the any unnecessary generation of leachate.

DEFINITIONS

Actinomycetes	A group of microorganisms, intermediate between bacteria and true fungi, that usually produce a characteristic branched mycelium. The organisms are responsible for the earthy smell of compost.
Aerated Static Pile (ASP)	Forced aeration method of composting in which a free standing pile is aerated by a blower moving air through perforated pipes located beneath the pile.
Aerobic	In the presence of, or requiring oxygen.
Anaerobic	In the absence of oxygen, or not requiring oxygen. Composting systems subject to anaerobic conditions often produce odorous compounds and other metabolites that are partly responsible for the temporary phytotoxic properties of compost. Anaerobic conditions are important for anaerobic digestion systems.
Ammonia (NH3)	A gaseous compound comprised of nitrogen and hydrogen. Ammonia, which has a (sharp) pungent odour, is commonly formed from organic nitrogen compounds during composting.
Bacteria	A group of microorganisms having singlecelled or non-cellular bodies. Bacteria usually appear as spheroid, rod-like, or curved entities but occasionally appear as sheets, chains, or branched filaments. Bacteria mostly break down organic materials in composting systems. It is bacteria that generate the heat associated with thermophilic composting systems. Bacteria have different temperature optima and are grouped accordingly: psychrophiles (<20°C); mesophiles (20-45°C), and thermophiles (>45°C).
Biosolids	Organic solids or semi-solids produced by municipal sewage treatment processes. Solids become biosolids when they come out of an anaerobic digester or other treatment process and can be benefi cially used. Until such solids are suitable for benefi cial use they are defi ned as waste-water solids. The solids content in biosolids should be equal to or greater than 0.5% weight by volume (w/v). Biosolids are commonly cocomposted with garden organics and/or residual wood and timber to produce range of recycled organics products.
Bund	A containment wall to prevent the loss of liquids from a specified area.
Bulking Agent	An ingredient in a mixture of composting raw materials included to improve the structure and porosity of the mix. Bulking agents are usually rigid and dry and often have large particles (for example, straw or wood chips). The terms “bulking agent” and “amendment” are often used interchangeably.
Cellulose	A long chain of tightly bound sugar molecules that constitutes the chief part of the cell walls of plants.
Carbon to Nitrogen (C:N) Ratio	The ratio of the weight of organic carbon (C) to that of total nitrogen (N) in an organic material.

Coarse mulch	Any pasteurised or composted organic product that is suitable for placing on soil surfaces. Coarse mulch has less than 20% by mass of material that has passed through a 20mm sieve.
Compost	Organic matter that has undergone controlled aerobic composting to achieve pasteurisation, stability and maturity. Compost has at least 95% by mass of material that has passed a 20mm sieve
Curing	Final stage of composting in which stabilisation of the compost continues but the rate of decomposition has slowed to a point where turning or forced aeration is no longer necessary. Curing generally occurs at lower, mesophilic temperatures. See stability.
Enzymes	Any of numerous complex proteins produced by living cells to catalyse specifi c biochemical reactions.
Feedstock	Organic materials used for composting or related biological treatment systems. Different feedstocks have different nutrient concentrations, moisture, structure and contamination levels (physical, chemical and biological).
Food Organics	Food Organics includes organics generated by any one of the following activities: the manufacturing, preparation or consumption of food (including beverages); the processing of meat, poultry or fi sh, and the manufacturing of edible grocery products. Such materials may be derived from domestic or commercial and industrial sources. The defi nition does not include grease trap waste. Food organics is one of the primary components of the compostable organics stream.
Forced Aeration	Means of supplying air to a composting pile or vessel which relies on blowers to move air through the composting materials.
Fungi	Singular - fungus. A group of simple microorganisms that lack a photosynthetic pigment. The individual cells have a nucleus surrounded by a membrane, and they may be linked together in long fi laments called hyphae. The individual hyphae can grow together to form a visible body. See also bacteria.
Garden Organics	Any garden derived organic (plant) materials generated by domestic, C&D and C&I sources. Garden Organics is defi ned by its component materials including: putrescible garden organics (grass clippings); non-woody garden organics; woody garden organics; trees and limbs, and stumps and rootballs. Garden organics is one of the primary components of the compostable organics stream.
In-vessel	System of composting involving the use of an enclosed chamber or vessel in which (in most cases) the composting process is controlled by regulating the rate of mechanical aeration. Aeration assists in heat removal, temperature control and oxygenation of the mass. Aeration is provided to the chamber by a blower fan which can work in a positive (blowing) and/or negative (sucking) mode. Rate of aeration can be controlled with temperature, oxygen or carbon dioxide feedback signals.

Lignin	A substance that, together with cellulose, forms the woody cell walls of plants and the cementing material between them. Lignin is resistant to decomposition.
Maturation	Final stage of composting where temperatures remain steady below 45°C, and the compost becomes safe to use with plants due to the absence of toxins.
Manure	The fecal and urinary excretion of livestock and poultry. Sometimes referred to as livestock waste. This material may also contain bedding, spilled feed, water or soil.
Mesophilic	A temperature range of 20-45°C. Mesophilic microorganisms grow well at these temperatures and are also important for decomposition during the cool-down or maturation stage of composting. Most pathogenic microorganisms grow in this temperature range, and are thus destroyed under high temperature (thermophilic) conditions during composting.
Moisture Content	The fraction or percentage of a substrate comprised of water. Moisture content equals the weight of the water portion divided by the total weight (water plus dry matter portion).
Mulch	Any pasteurised or composted organic product that is suitable for placing on soil surfaces. Mulch has at least 20% by mass of material that has passed through a 20mm sieve.
Mushroom compost	The residue from beds of composted organic materials that have supported a crop of mushrooms.
Organic matter	Chemical substances of animal or vegetable origin consisting of hydrocarbons and their derivatives.
Passively Aerated Windrow	A composting method in which windrows are constructed over a series of perforated plastic pipes, which serve as air ducts for passive aeration. Windrows are not turned.
Pasteurisation	The process whereby organic materials are treated to kill plant and animal pathogens and weed propagules.
Pathogen	Microorganisms capable of producing disease or infection in plants or animals. Pathogens can be killed by heat produced during thermophilic composting
pH	A measure of the concentration of hydrogen ions in a solution. pH is expressed as a negative exponent. Material that has a pH of 8 has ten times fewer hydrogen ions than a material with a pH of 7. The lower the pH, the more hydrogen ions are present, and the more acidic the material is. The higher the pH, the fewer hydrogen ions present, and the more basic it is. A pH of 7 is considered neutral.
Phytotoxic	Toxic to plants. Partially decomposed organic materials or immature composts are often phytotoxic, but this usually decreases with time. Such products may be phytotoxic due to a number of factors, including: low nutrient content; high oxygen consumption; presence of fatty acid or alcohol metabolites formed by microorganisms under anaerobic conditions; or due to excessive concentrations of salts, heavy metals and other organic compounds.

Process Control	Stringent and documented monitoring of all critical control points in a composting operation so as to minimise defects and make products which can be guaranteed to customers.
Source Separation	Separation of recyclable materials from other waste at the point and time the waste is generated (ie. at its source). This includes separation of recyclable material into its component categories (e.g. paper, glass, aluminium), and may include further separation within each category (e.g. paper into computer paper, offi ce whites and newsprint).
Soil conditioner	Any composted or pasteurised organic product, including vermicast, manure and mushroom substrate that is suitable for adding to soils. This term also includes 'soil amendment', 'soil additive', 'soil improver'. Soil conditioner has at least 95% by mass of material that has passed through a 20mm sieve.
Thermophilic	Temperatures above 45°C. Used to describe a stage of composting in which high temperatures are sustained resulting in high rates of decomposition and pasteurisation of the organic material. Heat tolerant microorganisms survive well in these conditions.
Turning	A composting operation which mixes and agitates material in a windrow pile or vessel. Its main aeration effect is to increase the porosity of the windrow to enhance passive aeration. It can be accomplished with front-end loaders or specially designed turning machines.
Vermiculture	The use of compost worms to process and stabilise organic residues.
Windrow (with or without aeration)	System of composting involving the aeration of horizontally extended piles formed by a frontend loader or windrow turner. Extended piles are generally 1.5 to 3 m in height, and length is limited by the size of the composting pad. Aeration can be achieved by mechanical turning and/or the delivery of air from the base of the windrow (see aerated static pile).

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Getting to grips with Waste Minimisation?

Participate in our sector and technical working group programme.

- Safety @ WasteMINZ
- Contaminated Land Management Sector Group
- Landfill and Residual Waste Sector Group
- Resource Efficiency
- Liquid and Hazardous Waste Sector Group
- Compost NZ
- Behaviour Change
- Resource Recovery
  - Construction and demolition
  - E-waste
  - Tyre Collectors and Recyclers
- Medical Waste

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