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NEWFOUNDLAND AND LABRADOR

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GUIDANCE DOCUMENT

Title: **Environmental Standards for Municipal Solid Waste Compost Facilities**

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Environmental Standards for Municipal Solid Waste Compost Facilities
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See also Appendices (posted as separate documents on the Departmental website)

1.0 PURPOSE:

To define the Environmental Standards for Municipal Solid Waste Compost Facilities to be followed in site selection, design, construction, operation and decommissioning of a Municipal Solid Waste Compost Facility to minimize nuisance and provide a high level of environmental protection.

This document is also intended to serve as a guide when applying for a Certificate of Approval to construct and operate a Municipal Solid Waste Compost Facility.

2.0 BACKGROUND:

The organic component of municipal solid waste represents at least 30% of the total waste stream, that can be diverted to a managed composting process for the production of a beneficial soil amendment. Composting organic waste significantly reduces the volume of waste that would normally be disposed to landfill, the quantity of landfill leachate and greenhouse gas production that would result. The compost produced can be used as a soil amendment, for horticultural purposes, erosion control, landscaping, and landfill cover where necessary.

This document will address the standards specific to the municipal solid waste composting facility: the siting, location, design, construction, processing, operation and decommissioning. The General Environmental Standards for MSW Management facilities/systems apply to all facilities handling municipal solid waste, including composting facilities.

Definitions for technical terms used throughout this document may be found in the separate Appendix D Definitions for Waste Management Strategy Environmental Standards Guidance Documents.

3.0 APPLICATION OF ENVIRONMENTAL STANDARDS:

These Standards apply to all municipal solid waste composting facilities processing greater than 1000 metric tonnes of organics per year. Composting facilities may use in-vessel, windrow, or static (passive or aerated) pile technology for aerobic composting of organic material. However, due to the wet and windy climatic conditions typical to Newfoundland and Labrador, in-vessel or covered facilities are recommended for composting MSW and/or comparable institutional, commercial or industrial waste streams. Additional terms and conditions may apply for the co-composting of septic sludges or other biosolids. The terms and conditions for the operation of a specific composting facility would be set out in a Certificate of Approval from the Department.

Compost facilities handling more than 2500 tonnes per year of organic material from municipal sources shall be in-vessel systems for the initial phases of composting. However, in most cases compost curing would be completed using an open windrow system where space permits. Open windrow and static pile composting methods are typically used for composting leaf, brush and yard waste. These latter methods are not always suited to the municipal solid waste stream, but may be used in combination with other in-vessel technology.

All composting facilities are to be appropriately managed to minimize adverse environmental impact. The Department shall be consulted whenever composting of large seasonal quantities of organic waste and compostable special waste (refer to Definitions) is proposed. Environmental

requirements will be determined on a site specific basis depending upon the feedstock characteristics and operational constraints.

These standards apply to Municipal Solid Waste including:

- source separated organics collection
- the wet part of wet/dry collection systems
- other feedstocks and bulking agents added to MSW organic waste
- co-composting of MSW with biosolids from various sources

These Standards do not apply to:

- generally accepted agricultural practices and backyard composting;
- composting facilities that accept only leaf, brush and yard waste;
- composting of organic material only from non-municipal sources (e.g. fish waste); and,
- composting of biosolids primarily.

The terms and conditions for the operation of all composting facilities are site specific and and may vary from these standards depending upon the proposed feedstock, technology and location, scale, processing and end-use marketing proposed. Compost product quality requirements are based on proposed end use.

4.0 LEGISLATION AND APPROVALS

4.1 Legislative Authority

The legislative authority for establishment, development and operation of a Waste Management System is provided through (but is not limited to) the *Environmental Protection Act,* Parts IV, V, X and XI; and the *Municipalities Act,* Part XIII.1.

Any proposed municipal solid waste compost facility may be subject to registration in accordance with Part X of the *Environment Protection Act* and as detailed in the *Environmental Assessment Regulations*.

A list of applicable legislation is provided in the General Standards for Waste Management Facilities (March, 2010).

The Canadian Council of Ministers of the Environment (CCME) Guidelines Compost Quality (latest version) apply to compost produced at all facilities unless other compost product criteria are approved in writing by the Department.

The Federal *Fertilizers Act* (enforced by the Canadian Food Inspection Agency) applies to compost products that are bagged, labeled and marketed as soil amendment.

4.2 Certificate of Approval Process

A Certificate of Approval to Construct and Operate a Composting Facility must be requested from the Department at least six months in advance of the proposed construction date, either during or once the Environmental Assessment Process has been completed. Approval for a compost facility that is constructed as part of a Regional Waste Management Facility would likely be issued as part of the Certificate of Approval for the Regional Facility, but terms and

conditions specific to the composting facility/process would be included.

In brief: The information required by the Department for the issuance of a Certificate of Approval for a composting facility/operation would be prepared by a suitably qualified professional and address the following:

- ✓ the proposed site location and preparation;
- ✓ facility design and space requirements e.g. for curing and maturing of compost
- ✓ the technology/combination selected (windrow, passive/aerated static pile or in-vessel system)
- ✓ feedstock sources/bulking agents, procurement schedule, storage and handling
- ✓ equipment needed for collection, pre-processing, processing and post-processing
- ✓ proposed compost quality, sampling, analyses and quality control/assurance
- ✓ control of leachate, odour control (use of biofilters) and air quality;
- ✓ 'housekeeping' and control of vectors, rodents, litter etc.
- ✓ permitting and regulatory requirements
- ✓ personnel and training requirements
- ✓ end use of the compost product and marketing/distribution

The design and specifications for all buildings and system components shall be described in sufficient detail to allow for technical evaluation to determine compliance with the existing standards for environmental protection.

A quality control/quality assurance program is required for all aspects and phases of a MSW management facility/system.

Compost facilities that are privately owned or operated and are located on separate sites from the Regional Waste Management Facility must provide a letter from the local municipal unit stating that the compost facility and site meets zoning, planning restrictions and such other by-laws as may exist.

The Department may issue a Certificate of Approval for facilities for a specified operating period upon which time the proponent may apply to renew the Approval.

4.3 Approval for other Composting Activities

Approval from the Department is required if composting of feedstocks other than or in addition to MSW is to be undertaken at the facility in question.

4.4 Public Notification

Composting facilities located at Regional Waste Management Facilities would normally be considered as part of the larger system with respect to requirements for environmental assessment. Regional composting facilities located on sites that are separate from the Regional Facility may be subject to separate registration as part of the Environmental Assessment Process. Privately owned composting facilities, operating in association with a regional waste management system or municipality may also be subject to separate registration as part of the Environmental Assessment Process. Consultation with the Department's Environmental Assessment Division is recommended.

The Environmental Assessment Process includes provisions for public notification of the proposed undertaking. If environmental assessment registration is not required, public notification for proposed composting facilities shall consist of posting of a public notice in a local newspaper once per week for three consecutive weeks; or serving notice by registered mail to the occupiers of property situated within 1.6 kilometres of the proposed site. The notice shall be provided to the Department for approval before posting or distribution. A municipal plan amendment notice may serve as the public notice of intent to establish a MSW Composting facility.

4.5 Financial Assurance and Environmental Impairment Liability Insurance

The Department requires that privately owned, commercially operated municipal solid waste composting facilities post financial security when requested by the Department under Section 84(1) of the *Environmental Protection Act*. Financial assurance, with the exception of pilot projects, may be required for compost facilities that are owned/operated in association with Regional Waste Management Facilities. Financial assurance and insurance requirements are also outlined in the General Environmental Standards for MSW Management (GD-PPD-063).

5.0 ENVIRONMENTAL STANDARDS

5.1 Site Selection

Table 1 provides the recommended separation distances for MSW composting facilities. Separation distances are necessary in order to minimize potential environmental conflicts between non-compatible land uses and the facility. It is advised to exceed these recommendations wherever possible to minimize the possibility of public complaints and environmental issues. The Department may vary requirements depending on the type of material to be recovered, operational procedures, environmental sensitivity and other site-specific conditions.

Table 1: Recommended separation distances for MSW Composting Facilities

Land Use	Sites shall not be sited in environmentally sensitive areas (parks, nature reserves, areas where there may be endangered species of plants or animals, wildlife migration corridors, wetlands, etc). MSW composting sites shall be established in accordance with municipal zoning requirements.
Access Roads	Access roads shall be accessible year round by the weight and type of vehicles anticipated.

Flood Plain	The site shall not be located within a 100 year flood plain or in any area which has greater than 1% chance of flooding in any year. Flood risk mapping shall be consulted if available.			
Watersheds	A MSW composting site shall not be located in a protected water supply area or a protected well field.			
Hydrogeology	Areas where there is a reasonable depth of native soils and no useful groundwater resources are preferred.			
Separation Distances from MSW Compost Facility Property Boundary	**Feature**	**Recommended Separation Distances (m)**		
		In-Vessel	**Windrow/ Static Pile**	**Windrow/Static Pile** Includes >1000 tonnes food waste in total feedstock /year **OR** > 10000 tonnes annually of total feedstock
	Active Composting Area (the 15 m closest to the property boundary must be always reserved for natural or landscaped screening)	100	100	150
	Residential, Institutional, Commercial and Industrial Properties (Examples: public schools, hospitals, churches, public parks and playgrounds)	1600	1600	To be determined on a site specific basis
	Right-of Way of a Public Road	100	100	100
	The High Water Mark of any Water Course, River, Stream, Water Body, Lake, Pond, Marsh, Bog, Swamp, Tidal Flat, or Similar Area	150	150	150
	Drinking Water Supply (Well or Surface Water)	300	300	300
Unstable Area	Composting facilities are not to be located within 100 metres of an unstable area.			
Airports	Landfill sites shall be located a minimum of 8 km from airports that are used by commercial aircraft. This distance may be reduced if bird control measures, that are approved by both Transport Canada and the Department, are implemented, or if the potential for birds causing hazard to aircraft is minimal. - This separation distance also applies to any outside activities associated with a composting facility.			
Fire Break	Distance to be approved in consultation with the Fire Commissioner's Office.			

5.2 Site Investigation

Site investigations are undertaken to provide environmental baseline on regional and local hydrogeology, groundwater and surface water quality/conditions for the proposed site. A summary of site characteristics as it relates to potential transport of contaminants in the environment is required prior to any approval for construction. The factors addressed include: soil and bedrock composition, the hydraulic conductivity, depth to groundwater, direction of groundwater flow, and use of the aquifer for drinking water supplies. Discussion of surface water resources where relevant will include: the location of on-site and off-site surface water bodies and the use of surface water for drinking water and other purposes. The presence of wetlands, floodplains and sensitive environmental features shall also addressed.

Further detail on the content of a site investigation is contained in Section 5.2 of the General Environmental Standards for Municipal Solid Waste Management Facilities and the separate Appendix C.

A qualified professional would provide an evaluation of the hydrogeologic, groundwater and surface water investigations to assess the suitability of the site for MSW composting. The information obtained would serve to recommend appropriate technology and optimize facility design. The site suitability, and the proposed technology/facility for the volume and type of material to be composted will be taken into consideration before an approval may be issued by the Department. Based on the results of site investigations and recommendations of the qualified professional, a comprehensive Environmental Monitoring Program would be developed in consultation with the Department. The monitoring program would be specific to potential environmental impacts of the facility, but would be integrated into the monitoring program for a Regional site where several waste management facilities are located in proximity.

5.3 MSW Composting Site/Facility Location and Facility Design – Information required

Site location

- ✓ an accurate description of the proposed location
- ✓ aerial photos;
- ✓ a legal survey;
- ✓ plans showing all property boundaries, buildings, roads, utility corridors, contours, drainage channels, water bodies, rights of way, easements, forested areas and adjacent land uses;
- ✓ GPS coordinates/GIS system mapping of facility features in a compatible and manageable format and resolution
- ✓ site compatibility with other land uses, and any environmental sensitivity of the area must be commented and addressed.

Facility location

- ✓ A surveyed plot plan, showing the location of all on-site facilities and infrastructure.
- ✓ A description of the required infrastructure design specifications, access requirements and support services to handle the anticipated waste volume to be received/processed/ stored/disposed over the life of the facility.
- ✓ Information on the amount of material to be processed, the proximity of the facility to collection routes and markets and the availability of transportation.

Preferred locations are nearby existing waste disposal sites.

Facility Design

Municipal Solid Waste Composting Facilities shall be sited, designed and constructed to ensure environmental protection, facilitate site operation, decommissioning and future use of the site (i.e. post-decommissioning).

The layout shall consider surface area requirements for material reception, removal of non-compostable material, pre-processing and storage of feedstock, and bulking agents, curing post processing and storage of the compost product. The requirements for material containment, biofilters and other forms of odour control, ventilation and air quality control shall be addressed at the design phase. The site plan shall indicate roadways, direction for traffic flow, parking areas and buffer zones. Where required (determined by facility size, tonnage processed, and record keeping requirements), there shall be sufficient area for weigh scales for incoming materials, and for earth moving equipment.

The facility design shall accommodate population growth in the area served and/or program expansion.

The full design of a composting facility shall be shown on plans certified by a Professional Engineer and described in written form as per the general environmental standards for MSW management facilities, to allow evaluation and determination of compliance.

6.0 Construction

The Compost Facility is required to meet the generally accepted environmental standards for construction, including an approved design, quality control/assurance protocol and environmentally sound construction practices.

Prior to opening the composting facility, the owner and/or operator shall provide documentation to the Department, in the form of a Certificate of Completion, that the site has been constructed as per the approved design, that all facilities and systems are in place and functional, and the site is ready to receive compostable materials/approved feedstocks.

Prior to opening the compost facility all permits, approvals and authorizations shall have been obtained, all regulatory requirements shall be met; and, environmental controls shall be in place.

7.0 Quality Control/Assurance

7.1 Quality Control/Assurance

A description of the quality control/assurance program to be carried out on all aspects of the waste management facility/system integral to environmentally sound design and performance is required. This requirement includes both construction and operations phases of the facility.

7.2 Compost Product Quality Control/Assurance

MSW feedstock is highly heterogenous, varying within and among batches, seasonally and

regionally. Rigorous quality control is required to produce a consistent compost product. An optimal facility-specific sampling regime will need to be developed to address variability and determine the validity of analytical results within a statistically acceptable range of confidence. Development of a comprehensive sampling regime producing valid and reliable results will take a period of time, and continuous improvement. More intensive sampling will be required until this is achieved, at which point a routine sampling program may be implemented. A Qualified Professional shall be involved in the design and optimization of the sampling regime. The Department requires all analyses be conducted by a certified laboratory as per the policy document PD:PP2001-01: Use of Accredited and Certified Laboratories (separate document posted to Departmental website).

Table 2 summarizes the recommended practices to assess compost product quality. Further detailed information respecting the development of a sampling program for MSW compost is provided in Appendix 1 of this guidance document.

Table 2 Recommended Sampling and Laboratory Practices to Assess Trace Element Concentration of MSW Compost Products

- Obtain multiple composite samples from randomly selected locations within a pile or windrow.
- Use plastic containers for sampling and storage to avoid contamination; use field blanks ("samples" without the substance being analyzed) to test for such contamination during sample storage, transport, and processing.
- Analyze replicate subsamples of each composite sample, being careful to mix samples thoroughly and reduce particle size as needed.
- Use National Institute of Standards and Technology (NIST) or comparable standard reference materials to determine the accuracy and precision of the digest/analysis technique.
- Add a known concentration of the element of interest to compost digest solutions to check for potential matrix interferences.
- Carry reagent blanks throughout the digest and analysis protocols.
- Report metal concentrations of the compost on a dry weight basis.
- Report the ash content of samples.
- Report all quality assurance data along with sample data so that data quality can be independently evaluated.

Note: Additional care must be taken with some metals such as selenium and mercury that may volatilize during processing and for organic compounds that may volatilize or undergo chemical transformation prior to analysis.

7.3 Finished Product Testing and Compost Classification

The finished compost is to be tested for quality on a regular basis, at least every 1000 tonnes of production or every three months, and prior to marketing any product. All compost will be classified in accordance with the latest version of the CCME Guidelines for Compost Quality. Compost must meet all criteria as established for foreign matter, maturity, pathogens and trace elements.

The testing requirements and compost classifications are outlined in the Canadian Council of Ministers of the Environment (CCME) Guidelines for Compost Quality and the Federal Fertilizers Act, administered by the Canadian Food Inspection Agency. Testing of compost shall

be done in accordance with the minimum testing procedures in Section 4 of the CCME Guidelines for Compost Quality.

The classification of the compost, will be subject to CCME criteria limits for determining appropriate end use of the finished product. Compost which is tested and classified as a hazardous or special waste shall be handled and treated in accordance with the requirements of the Department.

8.0 Reception of materials

8.1 Receiving, Inspection and Monitoring

All vehicles delivering material to the site shall be screened to ensure that they are carrying acceptable materials, and weighed where required to determine material quantities for accounting purposes. Vehicles shall be refused access to the site and the facility if known to contain unacceptable, hazardous or suspected hazardous material.

A trained operator shall oversee the unloading of organic material and bulking agents delivered to the receiving area and identify any unacceptable materials. Unacceptable materials shall be immediately segregated and removed from the site as per the operations manual and applicable contingency plan.

Unless there are outstanding circumstances, compostables shall be processed on the day of delivery. Limited storage of bulking agents (materials or feedstocks added to increase the porosity or improve the carbon-nitrogen balance of the compost) may be approved, consistent with availability and rate of utilization. Procedures for receiving, inspecting and documenting sources, quantities and types of compostable material, and directing vehicles to the appropriate area of the site shall be outlined in the facility operations manual (refer to Section 10.0).

8.2 Hazardous or Suspected Hazardous Material

Suspected hazardous material shall be kept in a designated holding area to facilitate storage, handling, removal and disposal according to regulations.

Details of non-compliant material brought to the facility shall be recorded including: date received; type, quantity, source and owner of the material; name of transport company, contact information and transport vehicle identification.

8.3 Acceptable Material

The composting facility may be authorized to accept several different types of feedstocks depending upon the technology and process management regime at the facility. Acceptable materials will be outlined in the facility Certificate of Approval to operate and may include: MSW wet stream, leaf and yard waste, source separated organics, biosolid sludge, compatible industrial waste and pre-processed construction and demolition debris, and paper and cardboard in small amounts as a carbon source.

The owner/operator shall provide details of the origin, types and quantity of feedstock material to be handled at the facility, from various municipal sources.

Any changes or modification shall be approved by the Department.

Any residual products associated with the operation shall be disposed of in a manner acceptable to the Department.

9.0 Facility Operations – Design Considerations

9.1 Facility Sizing and Process Flow

The facility size and selected technology(ies), including the dimensions of the site and anticipated lifespan shall be described. It may be useful to provide a mass balance diagram showing inputs to and outputs from the composting process, showing facility capacity for feedstock and bulking agents, final compost product volume and residual material.

The facility design and sizing shall provide for installation and maintenance of ventilation systems and biofilters, and upgrading of equipment for process management.

Buildings and access shall be appropriately sized and designed to accommodate throughput, and anticipated traffic.

At least 3 months storage capacity for post-processing of compost is recommended. The curing area required would be about ¼ of the composting area. The curing area may be located at another site.

9.2 Environmental Control Systems

Design features are required to maintain acceptable air quality, to minimize dust and odour generation, to reduce noise levels and control nuisance such as rodents, flies and litter.

Environmental design controls may include the following:

- prevention of water pooling at the site (ensure proper drainage);
- installation and maintenance of ventilation equipment and odour controls; including fans and negative air pressure inside the building;
- provision for water mist for dust suppression; and
- a sprinkler system in case of fire (where recommended by the Fire Commissioner's office or local Fire Department)

Complementary operational controls would include:

- regular maintenance of the site, systems and equipment;
- good housekeeping practices;
- provision of training and personal protective equipment for employees;
- provision for air quality monitoring and analysis; and
- Effective contingency plans.

9.3 Access Requirements

Compost facilities shall be designed to accommodate the type and volume of vehicle traffic anticipated such as heavy equipment, trucks and public vehicles used to deliver material and/or complete work on the site. Access roads shall be maintained (surfaced and drained) to prevent rutting and excessive erosion. The site shall have controlled site entry and exit points to control the types of material received at the site and vehicle movement. The facility shall be secured using fencing and gates that prevent pedestrian and vehicular traffic from entering the facility

property during non-operating hours.

9.4 Receiving Areas

Details of material receiving and storage, including infrastructure (buildings/containers) such as weigh scales, roadway and parking areas and any facilities for temporary on-site storage shall be clearly described. Consideration shall be given to designing a facility which minimizes long wait times for vehicles delivering material to the site.

Weigh scales are to be approved and functioning pursuant to Weights and Measures Canada Standards for the purpose of weighing the waste as it is delivered to the site. Regional Waste Management Facilities and large Transfer Stations would normally have weigh scales in place near the site entrance.

9.4.1 In-Vessel Systems:

- The receiving/tipping and material storage areas shall be within an enclosed building and the tipping floor shall be made of an impermeable, sealed concrete, asphalt or other material as approved by the Department.

- The floors shall be designed to prevent subsurface soil and potential groundwater contamination and to contain and collect runoff, leachate or drainage of liquids. The floor shall be of sufficient thickness and strength to withstand the wear of the hauling/transport vehicles, other heavy equipment and the accumulated materials.

- The impermeable surface shall be curbed to prevent run off of leachate and graded sufficiently to direct leachate for recirculation or collection. Collected leachate shall be stored in a structure approved as part of the facility design, and treated prior to discharge.

- The receiving area and tipping floor shall be appropriately sized to accommodate at least 2 days of incoming organic waste, without restricting truck or equipment movement.

- The facility shall be designed to minimize the length of time that the doors are open when trucks deliver material.

- The floors of the receiving and tipping areas shall be inspected regularly and repaired as needed, consistent with good housekeeping practices.

9.4.2 Muncipal solid waste (MSW) and/ or source separated organics (SSO) composting operations that are not in-vessel must be placed on liners (2 ft. thick of compacted soil) to achieve a permeability of no greater than 1×10^{-7} cm/s; or on a concrete or asphalt pad. 15-20 ft. aisles would normally be required between windrows if using a front end loader for turning and a covered structure or roof is recommended to reduce evaporation and prevent saturation.

9.5 Buildings

The building shall be sized to accommodate an adequate material residency time (typically 40 –

60 days) to complete the primary and secondary (curing) composting and achieve a level of product maturity suitable for outdoor stabilization (curing areas shall be underlain by an impermeable pad).

9.5.1 Corrosion Protection

Proper attention shall be given to corrosion protection, particularly in air handling systems, building structural components and various components of the building and infrastructure such as bolts, hanger brackets and electrical panels.

9.5.2 Water Supply

The proponent shall ensure that an adequate supply of clean water is available for the composting process at the proposed composting site. The proponent shall specify the source of water and volume required annually.

9.5.3 Ventilation

Adequate ventilation is very important to reduce and control adverse impact due to dust, odour, and excess moisture. Ventilation shall be provided for the composting area, organic feedstock storage areas and any other areas on site that contain readily putrescible materials. Negative pressure shall be maintained inside the buildings (when the doors are closed) to prevent the escape of odours.

9.5.4 Biofilters

Biofilters consist of a filtration media such as finished compost, soil or sand densely populated with microorganisms, through which the gases from the composting process are distributed via a perforated piping system. The biofilter medium acts as the nutrient supply for the microorganisms which adsorb and absorb odourous gases such as carbon, nitrogen, and sulfur to form non-odourous compounds. A highly porous, reactive medium with significant buffering capacity and uniform air distribution is needed. The plot plan for in-vessel composting facilities shall include provision for adequate sized biofilter(s) for the proposed tonnage/throughput.

9.5.5 Air scrubbers

Air scrubbers operate to remove odourous compounds via a scrubbant solution that is atomized in fine droplets into a contact chamber; the chemical mist then falls to the bottom of the chamber and is drained off. Consideration of infrastructure requirements to accommodate this air quality treatment option.

9.6 Pre-Processing Requirements

Pre-processing includes the receipt and storage of material and preparation of feedstock for composting. This may include mechanically opening garbage bags to remove wastes, movement of compostables over conveyer belts to various areas for manual sorting, inspection and grinding or shredding with heavy machinery. Equipment such as trommels and magnets may be used to separate uncompostable materials (e.g. plastics and metals) at the pre-processing stage to improve the quality of the end product. A description of the pre-processing requirements, specialized equipment, manpower and space required shall be provided. Details of collection, storage and disposal of residual wastes (bags, plastics, fragments etc.) resulting from pre-

processing are also required.

9.7 Active Composting Area

Surface area requirements for active composting are directly related to the technology option selected. Consideration must be given to appropriate management and monitoring of the process, while allowing for worker comfort and safety, and safe equipment operation and management.

9.8 Storage and Curing Space Requirements

Designated areas are required for storage of bulking materials, processing and curing materials and for storage of the finished compost product. The size and location of storage areas must not inhibit the flow of traffic or safe operation of equipment. Outside storage of materials should be as brief as possible and done in a way that minimizes contamination (e.g. separate storage from other materials that could cause contamination and protected from accumulation of dirt and mud). Materials in storage for extended periods of time (greater than one month) should be stored inside.

The area required for compost curing in open windrows required would be about ¼ of the area required for composting process. The curing area may be located at another site.

9.9 Post-Processing

Proponents shall describe the post-processing operations and any specialised equipment and space required. Post-processing of the cured compost usually involves one or two stages of screening to remove inert materials. An intermediate grinding of the compost may be required to reduce particle size depending on specific end use of the product. Additional mixing may be necessary to produce a saleable product. At least 3 months storage capacity for post-processing of compost is also recommended. Post-processing of composted material shall be undertaken in a fashion which minimizes the potential for windblown litter and dust.

9.10 Environmental / Nuisance Control

The facility design shall consider requirements for nuisance control of disease vectors such as insects, rodents, animals and birds.

Roads shall be surfaced and maintained to avoid dust problems. Suitable dust and noise control measures and systems shall be included in the design and operation of the site.

10.0 Operations Plans

10.1 Operations and Maintenance Manual

An operations and maintenance manual shall be developed that will be kept on site and be readily available for use by staff and regulators. The manual shall be prepared by the owner and/or operator and approved by the Department. It shall include the general operations, policies, procedures, monitoring requirements, maintenance and legal requirements of the facility. The facility shall operate in compliance with the provisions of the Certificate of Approval and this manual.

See Section 10.0 of the General Environmental Standards for MSW Management Facilities for further details on the expected content of an Operations and Maintenance Manual/Plan.

Given the nature of composting operations, odour management is essential to the acceptance and longevity of the facility within a community or region.

10.1.1 Operations management for Odour Control

< Manage the delivery, mixing and turning of feedstock to minimize odour potential.
< Monitor, manage and optimize the composting process to maintain aerobic conditions.
< Maintain a biofilter of adequate size.
< Maintain negative air pressure for in-vessel systems.
< Install air scrubbers if necessary and practical.
< Prohibit standing water on site.
< Track, appropriately respond to and learn from complaints.

10.2 Environmental Health and Safety Contingency Plan

The owner/operator shall have up-to-date contingency plans in place to effectively handle all reasonably foreseeable emergencies which could result in disruption of facility operations and/or environmental damage. The plan shall describe appropriate mitigation measures required to prevent damage to the waste management facility and the environment.

Bound copies of the contingency plan(s) shall be kept at the facility(ies) with the Operations Manual. Employees shall be familiar with the contingency plan(s) and participate in regular practice response exercises.

The attendant on site shall be equipped with an effective and quick means of communication for personal safety and to contact first responders (facility owner/operator, fire, police, and medical) in the event of an emergency.

An appropriate fire safety program shall be in place. The program shall be developed in consultation with the local fire department and with the Fire Commissioner's Office as required. Fire safety plans, including the comments of the local fire department as to the adequacy of the fire safety program, are to be provided. The Department of Natural Resources shall also be advised in areas where there is a forest fire risk.

Given the risk of fire associated with composting facilities, the details on site access for the anticipated vehicles and traffic should be reviewed by the Fire Commissioner's office to ensure adequate egress in the event of an emergency.

The owner and/or operator shall review the contingency plan annually and revise it as required.

11.0 Records and Reporting Requirements

The General Environmental Standards for MSW Management Facilities describes the variety of records and reporting requirements associated with the construction and operation of a facility. Documentation for a Regional Waste Management Facility should be in a standard format to facilitate reporting. The use of electronic records and reporting in a compatible format shall be considered as a means to reduce excessive use of paper. However, retaining limited hardcopies of annual reports, financial transactions, correspondence, and contingency plan implementation is recommended.

Operations management reports on daily activities at a Compost Facility would include the following information:

- identification of generators and transporters of the compost feedstock;
- the origin and quantity of the materials received (mass);
- the quantity of feedstock/bulking agents stored and processed;
- the type and amount of residual waste sent for disposal and the disposal method;
- compost process monitoring and management, sampling and analyses data
- the amount and end use of compost produced/distributed or sold;
- a description of any complaints received; and
- any incident requiring contingency plan implementation.

An annual report shall be prepared by the owner/operator and submitted to the Department. The expected content of an annual report is outlined in the General Environmental Standards for MSW Management Facilities.

Environmental monitoring and reporting requirements are also outlined in the General Environmental Standards and shall be set out in the terms and conditions of the facility specific Certificate of Approval.

Regional Service Boards may opt to consolidate the reporting requirements for facilities they administer and submit one annual report and or environmental monitoring report(s) to the Department.

Records shall be kept on site for a minimum of two years. All records shall be available for inspection by the Department over the life of the facility.

11.1 Complaints

The owner and/or operator of the composting facility shall record all complaints when they are received and shall notify the department of complaints in accordance with operations and contingency plan protocol/procedures. Complaints shall be recorded in a log book and shall include the following information:

- description of complaint;
- date and time received;
- date and time of occurrence;
- name of complainant and contact information;
- name of employee receiving the complaint;
- atmospheric conditions at the time of the occurrence (including wind speed and direction, temperature, humidity, etc.);
- action taken by the owner and/or operator to address the complaint (telephone calls and correspondence);
- all correspondence regarding the complaint.

The Department shall be copied on all correspondence related to complaints received at the composting facility. Records of complaints shall be made available to the Department upon request.

12.0 Site Safety and Security

A more explicative, but non-exhaustive list of factors important to safe and secure operation of a waste management facility/site is provided in the General Environmental Standards for MSW Management Facilities.

In brief, controlled access, clear signage, and having a sufficient number of well trained personnel in place when the site/facility is open to the public are seen as the central components of safe operations. Adherence to the Operations and Maintenance Manual and Reporting Requirements will also ensure safe practices at the facility/site.

Working conditions shall always meet or exceed Occupational Health and Safety Guidelines/Standards, and sufficient good quality personal protective equipment shall be provided. Environmental Health and Safety Emergency Contingency Plans shall be well known and practiced by employees. Ongoing staff and public education will also serve to improve facility efficiency, and decrease overall risk.

12.1 Staffing and Training Requirements

Staff shall be trained in compost facility management and operations and hold certification through the Compost Council of Canada sponsored programs or other equivalent programs. At least one person shall be certified as a compost facility operator. Staff shall have appropriate training to address routine operations, complaints and emergency situations.

12.2 Composting Coordinator / Compost Facility Manager Duties and Responsibilities:

- ✓ Ensuring feedstock procurement on a timely basis.
- ✓ Monitoring feedstock composition and any contamination issues.
- ✓ Understanding of how the composting system works;
- ✓ Understanding the chemical, physical and biological aspects of the process and conditions required to meet regulatory guidelines and produce a quality product.

- ✓ Finding safe alternative feedstock sources when required to maintain optimal composting feedstock mix, including carbon souces (leaves, sawdust), nitrogen sources (grass clippings, expired produce, biosolids); and bulking agents (e.g. woodchips, possibly shredded cardboard).
- ✓ Oversee operations management, record keeping, analyses, and housekeeping.
- ✓ Be ready to deal with any system failures or emergency situations and implement contingency plans.
- ✓ Determine when compost is fully mature/cured and arrange for end use.

13.0 Environmental Monitoring

An appropriate environmental monitoring program shall be developed as part of the Certificate of Approval process for the facility/site. The requirements shall be based on an assessment of site investigations, including the hydrogeologic, groundwater and surface water investigation, and proposed facility operations. Where groundwater, surface water or leachate quality monitoring is required, the monitoring program shall be designed and conducted by a suitably Qualified Professional and approved by the Department prior to implementation.

The type and frequency of monitoring and reporting requirements shall be specified in the terms and conditions of a Certificate of Approval. The Department shall be informed immediately if the facility fails to operate in compliance with their approval to operate. The Department may develop or adjust the list of parameters and/or monitoring schedule on a site-specific basis.

The General Environmental Standards for MSW Facilities/Systems provide further information on possible monitoring requirements which may or may not apply to the Composting Facility.

All surface water (storm water runoff, or leachate) discharged from the site shall comply with the *Environmental Control Water and Sewage Regulations*, 2003. Additionally, liquid effluents shall not be acutely lethal as determined by the suite of biological test Methods developed by Environment Canada for this purpose. Further details on monitoring criteria will be provided in the Certificate of Approval and the monitoring program as developed by a Qualified Professional and approved by the Department. The Department of Environment and Conservation Policy PD:PP2001-01: *Use of Accredited and Certified Laboratories* applies to all sampling and analyses conducted with respect to environmental management of the compost facility.

13.1 Compost Process Management

A compost sampling and analyses program shall be designed by a suitably qualified professional and optimized over time using the information in Appendix 1 of this document as a starting point. Due to the heterogeneous nature of MSW, and limited experience in composting this waste type in the province,optimizing the process will be the primary challenge of the compost facility operator. Careful monitoring and record keeping is essential.

13.2 Leachate Management Program

A leachate management program, if required would include collection, recirculation, or storage, treatment and appropriate disposal of all leachate generated on a year round basis, and an approved quality controlled sampling program as developed by a suitably qualified professional.

13.3 Odour / Management Program

Operational protocols for odour management shall be in place and all staff shall be properly trained in operational issues associated with odour management. The facility design should

include a detailed plan for the owner and/or operator to progressively upgrade the management of the process, emissions capture and control and other systems, in order to manage odours if it is determined that a a higher level of odour control is required.

Odour generation controls include the following:

- maintain optimal pile porosity for aeration by turning, using bulking agents, mixing (homogenous particle size) and avoiding excessive pile height;
- maintain optimal pile moisture;
- maintain pH and nutrient balance (carbon/nitrogen ratio) to avoid production of ammonia, hydrogen sulphide and other gases;
- destroy fly larva by turning frequently for high temperature exposure;

The Department may require the proponent to submit results of air dispersion modelling to determine the likelihood of problem odours at the property boundary and near the facility. The potential for odour problems may be increased with the volume of feedstock composted. Problems have been reported for facilities composting more than 1000 tonnes of food waste or 10000 tonnes of the total feedstock annually.

The initial aim of air dispersion modeling is to provide baseline information for air quality at the proposed facility and at the property boundary and to identify parameters and limitations for future air quality testing.

Maintenance and monitoring procedures for bio-filters shall be in place and followed.

An odour management program shall be submitted to the Department prior to approval and shall include the following information:

- the sensitivities and location of facility users and occupants of adjacent and nearby properties;
- population density;
- planned development in the immediate area;
- climatic features such as prevailing wind direction and speed, annual rainfall, average seasonal temperatures, humidity and pressure conditions;
- description of the local air shed (the geographic area of potential impact from odours); and,
- geographic features of the proposed site.

If odour problems are identified, the Department may require the following be submitted:

- identification of the odour source, intensity, frequency, characteristics and associated meteorological conditions;
- development of criteria limits based on maximum allowable off-site odor;
- selection of suitable controls for each odor source;
- air dispersion modeling to determine the likelihood of problem odours at the property boundary and near the facility.

13.4 Environmental and Nuisance Control

A treed or bermed buffer zone between the property line and the active composting area is recommended. If problems regarding dust and noise are reported the Department may require

monitoring programs.

A litter control/monitoring program shall be implemented which includes regular litter collection on and around the entire site. Truck loads of waste transported to and from the site shall be covered by a tarpaulin, or a similar material, to prevent loss of waste at the site and during delivery. Proper housekeeping practices shall be in place to prevent litter and nuisance problems from the facility.

A program to control insects, rodents, animals, birds and other vectors shall be in place during the lifespan of the facility. The control program shall be approved by the Department.

14.0 Decommissioning Plan

The owner/operator shall submit a preliminary decommissioning plan to the Department when applying for a Certificate of Approval. Factors to be considered include site cleanup, repair and rehabilitation, and removal or securing of infrastructure, equipment and access. Controls/contingencies for nuisance including wind-blown debris, litter, rodents, other vectors and illegal dumping may also be required. A detailed decommissioning plan shall be submitted prior to the closure of the site.

The design of the compost facility shall take into consideration the requirements of proper closure and decommissioning, and future use of the facility/site. The plan must be updated whenever significant changes are made and submitted to the Department for approval.

The General Environmental Standards for MSW Management Facilities provide further information on required notifications and the expected content of a decommissioning plan. Decommissioning requirements include informing site users and regulators, and installing signage. A decommissioning report and final inspection by the Department is required. Post-decommissioning monitoring, maintenance and reporting shall also be required depending on the final condition of the site upon closure and the proposed future use.

Prior to the closure and decommissioning of the MSW compost facility, the owner and/or operator shall make arrangements to remove all unprocessed waste material and finished compost to an acceptable alternate facility or end use.

Upon termination of operations, the site must be rehabilitated to the satisfaction of the Department. Termination is defined as out of use, by the owner and/or operator, for any consecutive 12 month period or when the owner and/or operator indicates there will be no further activity at the site.

REFERENCES

- *Nova Scotia Department of Environment and Labour Compost Facility Guidelines,* Nova Scotia Department of Environment and Labour.

- *Solid Waste Management Regulations (Section 102 of the Environment Act),* Government of Nova Scotia.
- *Recycling and Composting of Municipal Waste (Ontario Regulation 104/94 of the Environment Act)*, Government of Ontario.
- *Newfoundland and Labrador Waste Management Strategy*, Government of Newfoundland and Labrador, Department of the Environment, April 2002.
- *Waste Disposal for Small Communities*, Government of Alberta, Department of the Environment, 1989.
- *Guidelines for Site Selection, Operation and Approval of Composting Facilities in New Brunswick,* Municipal Services Section of the New Brunswick Department of the Environment, February 2000.
- *Siting and Operating a Compost Facility,* New Brunswick Department of the Environment and Local Government.
- *Waste Management Act - Production and Use of Compost Regulation,* Government of British Columbia, January 1994.
- *Code of Practice for Compost Facilities,* Alberta Environmental Protection.
- *Waste Control Regulation of the Environmental Protection and Enhancement Act (AR 192/96),* Government of Alberta.
- Activities Designation Regulation of the Environmental Protection Enhancement Act (AR211/96), Government of Alberta.
- *Compost Facility Resource Handbook: Guidance for Washington State* ,#97-502. November 1998.
- *Municipal Decision Maker's Guide to Solid Waste Management, Chapter 7 - Composting*, United States Environmental Protection Agency, Second Edition August 1995.
- Canadian Council of Ministers of the Environment (CCME), *Guidelines for Compost Quality, 2005*, PN 1340. ISBN 1-896997-60-0.

Appendix 1 – Environmental Standards for MSW Compost Facilities - Compost Quality

The CCME Compost Quality Guidelines (2005) have been developed to ensure that compost produced in Canada is safe for the environment and human health. These guidelines, backed by regulations, define the acceptable criteria limits for composition, pathogens, contaminants and stability in finished compost with respect to application rates and potential end use.

The Department of Environment and Conservation Policy PD:PP2001-01: *Use of Accredited and Certified Laboratories* (separate document) applies for all legislated environmental monitoring requirements.

The information below has been adapted from original document "Municipal Solid Waste Composting: Key Aspects of Compost Quality, P.B. Woodbury and V.T. Breslin. Copyright ©1996 is held by Cornell University, Ithaca, NY 14853-5601. :

Sample collection and analyses: Compost facility managers must develop an appropriate testing program to ensure quality control and regulatory compliance. Laboratories that analyze for contaminants shall also have an established quality assurance program for their chemical analyses and provide recognized certification to this effect.

Accurate and precise analyses depend on the development of an optimal, quality controlled compost sampling program, proper sample handling, chemical analysis, and data reduction and reporting. The quality of information generated at each step is entirely dependent on that of the previous steps. Clearly, if inappropriate samples are collected, even highly accurate chemical analyses will not produce useful information about compost quality. If sampling and testing methods are not adequately recorded or reported, assuring the quality of the information generated, and thus, the quality of the compost produced, is impossible.

Since sample collection, handling, storage, and shipping are generally conducted by facility personnel, a quality assurance program that addresses these steps must be developed by each facility.

Defining data collection objectives: To accurately assess quality and control costs, data collection objectives must be defined precisely. Regulators are concerned with compliance aspects including compost nutrient content and availability, compost maturity (stability), soluble salts, toxicity to plants, organic contaminants, trace metals, and foreign matter such as glass and plastic film. Compost users may be concerned about the physical characteristics such as water-holding capacity critical for certain applications of compost; as well as contaminants and foreign matter affecting the function and appearance of MSW compost.

Facility managers need data to establish sampling plans and achieve quality control. Their objectives will include optimizing the composting process to produce high quality compost at the lowest possible cost and to meet product standards. Generating the data needed to set standards or to establish a quality control program may require more intensive sampling than will be required for routine screening.

Compost sampling is often the limiting step in assuring compost quality.

Ensuring proper sample collection: Because of the great variety of materials in MSW feedstocks, the distribution of contaminants within the composts can be highly variable. Understanding this variability within and among compost batches is essential for establishing appropriate sampling methods and determining the required number of samples to predict whether the given batch of compost will meet the required standard.

Random sampling, ensuring an adequate number of samples, determining the frequency and timing of sampling, and sub-sampling -- are crucial to answer questions about composition and variability, and to ensure valid test results.

"Random sampling" means that every location in the batch has an equal chance of being sampled. Multiple samples must be collected from *randomly selected* locations within the batch. "Representative samples" are not an adequate substitute for random sampling. Without random sampling, no assessment of the bulk material is statistically valid, no matter how carefully the subsequent chemical analysis is performed.

Measuring the variability in concentration of contaminants is particularly critical when the levels are near regulatory thresholds. The number of samples needed depends on the accuracy required, the heterogeneity of the feedstock, and the degree of mixing during processing. Each facility should determine the number of samples required as part of its quality assurance plan to achieve the desired level of confidence (95%).

It is important that the sampling program be designed specific to the particular facility.

Frequency of sampling: In addition to variability *within* a batch of compost, one must also expect variability *among* batches of compost. Feedstocks may vary considerably throughout the year, resulting in changes in contaminant levels. Testing the variation of potential contaminants over time is necessary to assess the variation present at any one time, and to design an optimal, reliable sampling regime.

Timing of sampling: Decisions must also be made about *when* during the composting process the compost is to be tested. As the organic matter in the compost continues to decompose over time, the concentration of other components such as trace metals will increase on a dry weight basis.

Alternatively, the data may be presented on an ash basis, which is a proportion of the weight of the non-organic component. Since this component will not decompose, this approach permits contaminant measurements to be made at any time in the process.

Sub-sampling: Because of the variability within compost samples, analytical laboratories must pay special attention to sub-sampling. As with the original sample collection, multiple sub-samples must be collected from randomly-selected locations. Whenever samples are taken from a larger batch for analysis, homogenization (e.g. mixing, grinding) is critical and verification of the effectiveness of such homogenization by sub-sampling is needed.

Protocols for sample storage and transport: Samples must be stored and transported such that no materials are added or removed that alter the analytical result. Generally, samples should be collected in clean plastic containers, refrigerated but not frozen, kept in the dark, and analyzed within a few days of being sampled. Appropriate protocols for sample handling are dependent on the objectives and can be particularly stringent for analyses of volatile chemicals and micro-organisms.

Chain-of-custody: All samples should be permanently and unambiguously labelled, and a permanent record of all pertinent data be kept in a bound volume. The chain-of-custody for all samples should be specified, and it is useful to have one person supervise the entire process.

Selecting analytical methods: Since regulations are based on total metal content in the compost, complete extraction of the metal from the sample is essential if compost quality is to be assured. One way to measure extraction efficiency is to use certified reference standards. A "reference standard" is material in which the concentration of metals or other parameters are known, enabling laboratory analysts to validate the accuracy of their analytical methods.

Routine use of reference standards, along with appropriate spikes (known additions of the substance being analyzed) and blanks ("samples" without the substance being analyzed, used to test for contamination), can help validate analytical methods and avoid discrepancies.

Proper data record-keeping, statistical analysis, and reporting: The measurements used to validate results, protocols used in sampling and testing, and details of the statistical methods employed should be reported along with the primary data so that the strengths and weaknesses of the data can be determined independently by the reader.

Cost control: Compost facility operators must be aware that consistent production of high quality compost is critical to the success of all composting operations and that verification of compost quality will incur some unavoidable costs. However, the costs of sampling, analysis, and other aspects of a quality assurance program must be controlled. If the costs are prohibitive, the program will be difficult to implement.

Recap: The Key Steps in Development of a Quality Assurance Program

· Define Data Collection Objectives
· Develop a Quality Assurance Plan
· Ensure Proper Sample Collection
· Ensure Proper Sample Storage and Transport
· Select Appropriate Analytical Methods
· Record, Analyze, and Report Data

Although the following list is not comprehensive, it covers the most critical aspects of quality assurance for most metals

Recommended Sampling and Laboratory Practices to Assess the Trace Element Concentration of MSW Compost Products
✓ Obtain multiple composite samples from randomly selected locations within a pile or windrow. ✓ Use plastic containers for sampling and storage to avoid contamination; use field blanks ("samples" without the substance being analyzed) to test for such contamination during sample storage, transport, and processing. ✓ Analyze replicate subsamples of each composite sample, being careful to mix samples thoroughly and reduce particle size as needed. ✓ Use National Institute of Standards and Technology (NIST) or comparable standard reference materials to determine the accuracy and precision of the digest/analysis technique. ✓ Add a known concentration of the element of interest to compost digest solutions to check for potential matrix interferences. ✓ Carry reagent blanks throughout the digest and analysis protocols. ✓ Report metal concentrations of the compost on a dry weight basis. ✓ Report the ash content of samples. ✓ Report all quality assurance data along with sample data so that data quality can be independently evaluated. Note: Additional care must be taken with some metals such as selenium and mercury that may volatilize during processing and for organic compounds that may volatilize or undergo chemical transformation prior to analysis.

Useful Reference Materials for Developing Compost Quality Assurance Programs

American Chemical Society. In *Analytical Chemistry* 52:2242-2249. 1980. Guidelines for the acquisition and evaluation of environmental data.

Solid Waste Composting Council, 114 S. Pitt St., Alexandria, VA 22314. Guidelines for quality assurance, including proposed limits for compost stability, soluble salts, heavy metals and other parameters. In preparation.

U.S. Environmental Protection Agency. Office of Solid Waste and Emergency Response. *Test Methods for Evaluating Solid Waste.* Field Manual SW-846. 1986.

Woodbury, Peter B. and Vincent T. Breslin. In *Biomass and Bioenergy* (Vol. 3, Nos 3-4, pp. 213-225, 1992). *Assuring Compost Quality: Suggestions for Facility Managers, Regulators, and Researchers.*

References

See the fully referenced article in a special 1992 issue of *Biomass & Bioenergy* (Vol. 3, Nos 3-4, pp. 213-225, 1992), from which this fact sheet is extracted. A copy of that journal containing 11 articles on MSW composting can be obtained through the Composting Council, 114 S. Pitt St., Alexandria, VA 22314.

Appendix 2 – Environmental Standards for MSW Compost Facilities Composting Overview

Diversion of organic matter from landfill is essential to reducing total MSW volume which will save on transportation costs, and increase the useable life of the landfill. Viable options include grasscycling and/or yard waste composting; and composting or co-composting food waste with other organic feedstocks.

Backyard composting of organic waste is likely the more cost effective and practical option for very small populations (<200 residents) at low density. Vermi-composting (using select species of worms to break down organic matter), and community bin composting methods are also effective, low cost methods. Offering training and technical support is important to initiate and maintain participation. Curbing the use of chemical pesticides on yard waste destined for composting and banning landfill disposal of organic matter would be necessary.

For large scale municipal solid waste composting, extensive planning is required. The proposed feedstock and compost quality/end-use must be considered, to determine the best fit in terms of investment in composting technology, site location, and feedstock collection methods. Public support and participation are critical to a successful program.

The systems for municipal collection of compostable material in common use are: two-stream and three-stream. Two-stream (wet/dry) requires households to separate materials into 2 collection bins, one containing the wet - primarily compostable organic waste, and the second containing dry – primarily recyclable materials. The two-stream system requires less initial effort in separating waste material, and may have lower collection/transport costs associated. However, removal of contaminants and non-compostable materials at the composting facility is time-consuming, and can be costly.

A three-stream system involves separate collection of organics, recyclables and residual garbage. This option requires a higher level of public education and initial effort. Some contamination of the organics stream will occur e.g. from plastics, but overall feedstock and final compost product quality are better.

In all cases, household hazardous waste/hazardous material must always be collected separately to avoid adverse impact on the composting process, compost product quality and end use. Also municipal composting programs only work if residents participate, hence the requirement for public outreach and education.

The formal definition of composting is a managed process of bio-oxidation of a solid heterogenous organic substrate including a thermophilic phase. (Canadian Council of Ministers of the Environment, Compost Quality Guidelines, Revised Nov., 2005). For our purposes, composting is an aerobic (requires oxygen) biological process that transforms organic matter into a stable, non-toxic and beneficial soil amendment.

The environmental impacts most often associated with composting facilities include malodour, dust and airborne contaminants; noise due to vehicles and equipment; potential for contaminants and pathogens in leachate and run-off from stored feedstocks and compost piles; and nuisance due to vectors such as insects, rodents, or scavenging animals; and litter. Appropriate siting, design, technology, construction, operational management and decommissioning serve to minimize adverse impacts and are critical to the success of all composting facilities. Separation distances are necessary to minimize potential environmental conflicts between non-compatible land uses, and further reduce adverse impact to environmentally sensitive areas.

The General Environmental Standards for Municipal Solid Waste Management Facilities also apply to composting facilities.

The composting process

Aerobic composting involves microbial breakdown of organic matter, and the heat generated inactivates pathogens. The process is accelerated by removing the non-compostable and hazardous material, optimizing feedstock size (shredding, grinding) and composition (carbon, nitrogen and micronutrients), and optimizing conditions required for decomposition i.e. aeration, moisture content, turning/mixing for homogeneity, and maintaining/monitoring temperature.

When the composting process is operated correctly, the organic material self heats to a temperature of 55°C or greater (thermophillic phase). When a temperature of 55°C is held for a minimum of 72 hours at the interior of the pile, pathogens and weed seeds are generally inactivated. The feedstock continues to decompose until nutrient sources and energy are depleted and the pile cools down. There is a succession of bacterial and fungal populations that rise and fall depending upon the physical aspects of the compost pile at any given time. Beneficial insects and other microorganisms are also involved in the composting process.

A final curing phase is required for all compost irrespective of the production technology. Compost may be cured or allowed to mature inside a building, but this phase commonly makes use of open (outdoor) windrows. Windrows are pyramidal rows of material created using heavy equipment. Maximum height to achieve aeration requirements is about 3 metres, and the required space between windrows is dictated by the equipment to be used. Windrow length is only limited by available space, however the orientation of the windrows may affect odour control during turning and control of surface water run on/off. Compost is mature when it no longer reheats above ambient temperature and does not consume oxygen. A finished compost product should not smell bad.

Aspects of the Composting Process:

Specifications for end uses will direct the level of effort to produce a suitable quality compost.

Pre-processing

a. Visual inspection and sorting to remove any non-compostables/non-organic materials may be manually conducted by facility workers on the site/floor/from a conveyer belt. There can be concerns for worker safety and equipment damage.
b. Separating involves manual removal of recyclables, or mechanical separation by magnetic or eddy current for recovery of metals; by air classification, wet separation and ballistic (inertial) separation, largely by weight; or by trommel screening.
c. Size reduction to achieve an effective compromise between efficiency and porosity, is accomplished by screening, shredding, the use of hammer mills, shear shredders and rotating drums.
d. Treating and mixing feedstocks is done to adjust C:N ratio, and to add moisture and bulking agents where required.

Active Composting Depending upon the facility and technology selected, the active composting period may take two to four weeks (for in-vessel, turned, aerated system) or three to six months or longer. This phase requires careful monitoring to effectively manage and optimize the biological breakdown of material and mitigate adverse environmental impacts. Often material is physically relocated (moved along) within a facility as the composting process advances.

Curing normally takes place once materials are adequately stable and may take several months and even up to a year. Fully cured compost is considered to be "finished" or "mature". Finished compost shall meet the criteria set out in guidelines, should not reheat above ambient; should not smell bad, and should have characteristics and a composition suitable for use as a soil amendment (C:N ratio of 20:1 is recommended).

Post-processing refers to the shredding, refining, screening, and bagging or blending for bulk distribution, or to meet selected end-use specifications. Compost is tested to ensure that it meets the CCME Compost Quality Guidelines in terms of stabilization, composition analyses, nutrient and pathogen levels.

Process summary

The composting process generally includes:

- Mixing of the feed stocks with the bulking agents
- Filling the composting vessels, or windrowing the compost and bulking agent
- Aeration or mixing of the composting material during the composting process
- Curing of the finished compost to allow for further stabilization of the material, and
- Screening of the compost prior to final use.

Optimal composting conditions	
Carbon-nitrogen ratio	30:1
Oxygen concentration	15% (no less than 5%)
Particle size	1 to 2 inches (some say 0.5 – 3 inches)
Moisture content	55 - 60% (couple of drops can be squeezed from a handful of material)
Temperature	45^{o} C - 59^{o} C
pH	5.5 – 9
Maximum windrow height and spacing	3-4 metres – may be limited by turner height
Maximum pile height (static/aerated)	3 metres, compaction may be a problem and there may be fire potential
Porosity	As needed to maintain aeration.
aeration/turning	As prescribed to maintain temperature and oxygen levels.
Macronutrients	carbon (C), nitrogen (N), potassium (K), phosphorus (P)
Micronutrients	Boron (B), calcium (Ca), chlorine (Cl), cobalt (Co), copper (Cu), iron (Fe), magnesium (Mg), manganese (Mn), molybdenum (Mb), selenium (Se), sodium (Na) and zinc (Zn).

Compost quality guidelines and standards are employed to ensure that compost is non-pathogenic, non-toxic and thermally stable so as to be safely and appropriately applied as a soil amendment. The guidelines typically referenced are the CCME Compost Quality Guidelines, as amended in 2005. The end use of any product that deviates from these guidelines would have to be separately reviewed and approved by the Department.

Composting Technology

There are three composting methods that may be considered for composting MSW at the community or regional scale.

1) "In-vessel" or "reactor" technology refers to composting within a fully enclosed system which allows for forced aeration and mechanical turning to speed up the composting process; odour containment and treatment using biofilters or air scrubbers; and leachate control/recirculation. In-vessel systems may consist of aerated channels or agitated beds (similar to windrows) contained within a building. There are also in-vessel modular containers and rotating drum systems whereby waste is fully contained and composted as it is pushed through the container/system. Material that is not satisfactorily composted is left for a longer time period or put back through the system again.

   The composting process requires (uses up) moisture so leachate would not normally be a concern.

   An in-vessel facility for composting MSW is a significant component of a waste

management system requiring substantial capital investment, and technical expertise for environmentally sound operation and management.

2) An aerated static (no turning) pile may be used for pre-processed MSW. Pre-processed (shredded) organic matter must be well mixed and piled on surfaces with an aeration system (fans/blowers pull or pump air through piping on continuous or intermittent basis) for injection of air into the composting material to control temperature and oxygenation of the pile.

   Covering the static pile is recommended to reduce litter and leachate due to exposure to the elements.

3) Open windrows are mechanically turned (usually with heavy equipment e.g. a windrow turner or front end loader) to promote decomposition and regulate temperature. This is a simple technology and a lower cost option compared to in-vessel systems. The method is not suited to composting MSW in Newfoundland and Labrador due to the prevalence of windy and wet weather. But it may be used for outside curing of fully composted material Open windrows are suited to composting of yard waste.

   Leachate may be a concern so various covering or shelter arrangements may be used for control of leachate, odour and other nuisance factors from open windrow composting.

All composting methods and technology involves management of the feedstock characteristics and composition (size, C:N ratio and porosity), managing the process (aeration, turning, moisture and temperature); odour control, and allowing the compost product to sufficiently mature. In most cases the final maturation phase is conducted in open windrows to achieve a usable soil amendment.

Costs to consider include:

- land/ space/location requirements
- the capital investment for the appropriate or preferred technology
- comparative costs to collect and transport MSW to landfill
- costs associated with waste collection and transportation to management facilities (may vary with the proposed number of waste streams)
- operational and lifetime system and equipment maintenance costs
- facility staffing and training of specialized staff
- public education and training
- revenue generated from compost sales and/or savings to the municipality by utilization of compost produced.

The economic and technical feasibility of a technology/system may vary regionally due to population, demographics; commercial, institutional and industrial contributions;

existing recycling programs or composting facilities; seasonal and climatic differences; financial commitment and the state of the economy.

A pilot study using simple technology may sometimes be used to gather information on participation levels, collection efficiency and feedstock contamination, and to test methods. Feedstock options might include source separated organics, mixed MSW and/ or yard waste.

The development of a privately owned/operated facility working on a long-term contract, with the municipality guaranteeing tipping fees and feedstock supply might also be considered where volumes and market conditions are attractive. The risks, benefits, track record of the proposed operator, and contractual guarantees would need to be evaluated.

The Composting Council of Canada (www.compost.org) is an excellent resource for technical and scientific information and training for facility operators.