Compost Facility Requirements Guideline: How to Comply With Part 5 of the Organic Matter Recycling Regulation

March 2004

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FORWARD

The Organic Matter Recycling Regulation (OMRR) enacted on February 5, 2002, applies in British Columbia to the construction and operation of composting facilities, and the production, distribution, storage, sale and use or land application of biosolids and compost.

Compost facility operators, qualified professionals, local government and ministry staff have requested guidance with respect to the Compost Facility Requirements detailed in Part 5 of the OMRR.

This guideline was developed to assist dischargers in complying with Part 5 of the OMRR which may require dischargers to have a qualified professional conduct, prepare and/or submit: Environmental Impact Studies (under section 23(2)&(3)), Odour and Leachate Management Plans, Operating and Closure Plans, and Specifications (under section 24) and Environmental Impact Assessments (under section 26 (4)). Dischargers, qualified professionals and ministry staff should view this guideline as a resource containing information that should be addressed within the above mentioned studies, plans and assessments. This guideline emphasizes proactive strategies that should be considered during the construction and operation of composting facilities.

This guideline is the result of collaborative work among compost facility operators, professionals, industry representatives and regulators. The guideline reflects current knowledge around composting best management practices and is to be considered a starting point from which to build upon as accepted practices and technologies advance. The guideline is not an exhaustive manual, but wherever possible it contains references to more detailed sources of information.

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OMRR GLOSSARY

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BACKGROUND

Legislation and regulations governing British Columbia waste management, which includes composting and composting facilities, are managed under the British Columbia Waste Management Act (1986). To govern the construction and operation of composting facilities, and the production, distribution, storage, sale, and use or land application of biosolids and compost, the Ministry of Water, Land and Air Protection (MWLAP) established the Organic Matter Recycling Regulation (OMRR). This regulation was promulgated on February 5, 2002.

The Compost Facility Requirements Guideline: How to Comply With Part 5 of the Organic Matter Recycling Regulation, hereby referred to as "Guideline", is intended as a companion document to the OMRR. The intent of this Guideline is to assist waste generators, the general public, qualified professionals ("QP"s), compost producers and/or facility owners ("dischargers" under the definitions in the OMRR) and Ministry staff in understanding and/or complying with the conditions established in Part 5 - Composting Facility Requirements of the OMRR.

Part 5 is separated into four divisions: Division 1 - Requirements for Composting Facilities, Division 2 - Construction and Operation of Composting Facilities, Division 3 - Leachate Management for Composting Facilities, and Division 4 - Capacity of Composting Facilities. This guideline is made up of nine sections; each section covers material pertaining to Part 5 of the OMRR. Cross-referencing of these nine sections to the four Divisions in the OMRR is provided. In addition, a Glossary of the OMRR terminology is provided at the back of this document.

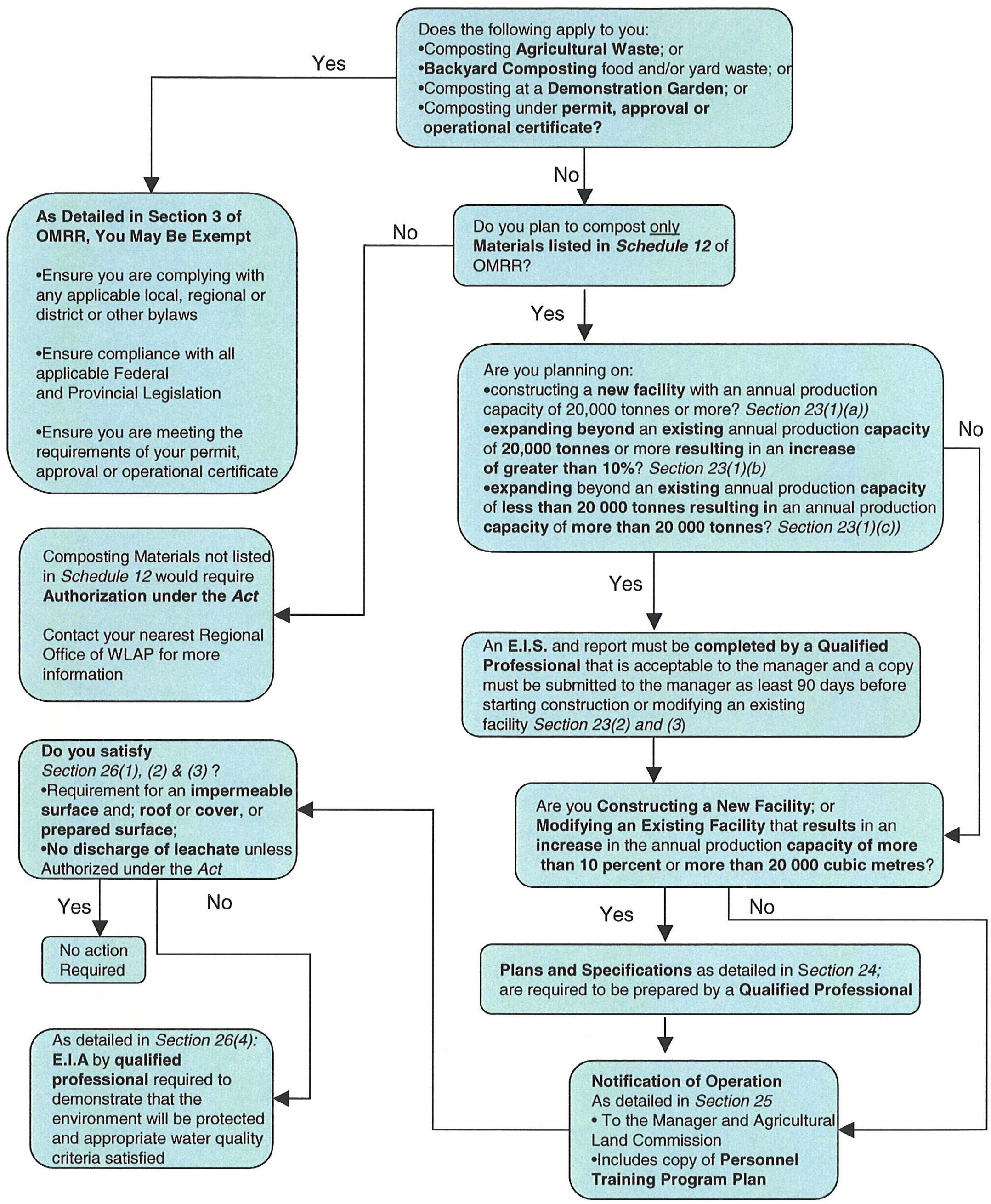
The reader should note that this Guideline is only a guidance document. It should be used to help make decisions about what features and tasks are necessary when planning, designing and operating a composting facility. It is the responsibility of the compost facility owner or operator (or "discharger" as per the OMRR) or their designated qualified professional (QP) to consult with the various government agencies and to take all necessary actions in order to comply with the applicable legislation and regulations. If there are any differences between this Guideline and the OMRR, or any omissions in this document, then the OMRR, under authority of the British Columbia Waste Management Act and Health Act, applies.

It should be noted that this document pertains to those composting materials listed in Schedule 12 of the OMRR. Neither this document, nor the OMRR, apply to the composting of Agricultural wastes, e.g. farm animal manures, mushroom medium, and agricultural vegetation waste, on farms. This falls under the Agricultural Waste Control Regulation [BC Reg 131/92].

This document is not intended to be a "How to Manual" regarding composting. There are a number of documents available that do this. Several of these are referenced in this Guideline, either directly, through internet hotlinks and/or listing in the Resources section of the Guideline. It is expected that the discharger or their QP will make themselves familiar with this material.

A flow chart that will lead you through Part 5 of the OMRR is presented on the next page.

OMRR Part 5 Flowchart: Answer the questions and follow the arrows



ENVIRONMENTAL IMPACT STUDIES

SECTION 2

2.1 INTRODUCTION TO ENVIRONMENTAL IMPACT STUDIES

Under Part 5, Division 1 – Requirements for Composting Facilities, an environmental impact study (EIS) must be conducted and a report prepared if the composting facility is, for any reason (see below), going to produce more than 20,000 tonnes of product per year. Facilities that do not meet the criteria of Division 1 (23) (1) should consider being proactive and address EIS issues regardless. For those that do, the exact Division 1 EIS requirement criteria in the OMRR is as follows:

Division 1 (23) (1) (a) constructed with an existing or proposed annual production capacity of 20 000 tonnes or more,
(b) expanded beyond an existing annual production capacity of 20 000 tonnes or more resulting in an increase in production capacity of more than 10 percent, or
(c) expanded beyond an existing annual production capacity of less than 20 000 tonnes resulting in an annual production capacity of more than 20 000 tonnes.

According to the Canadian Environmental Assessment Agency (CEAA), an EIS is a document prepared by the discharger (i.e. person(s) wanting to build or operate a composting facility), or their designate, outlining the effects of the project (in this case a composting facility) will have on the environment. Basically, an EIS details the nature and scale of the composting facility, how this project will impact the physical, chemical and biological environment and its inhabitants, and the measures that can be taken to reduce, alleviate, and monitor these impacts.

Dischargers are advised to be familiar with the requirements of the OMRR. Under Part 5, Division 1, Section 23 (3) of the OMRR, an EIS must be completed and submitted to the Ministry of Water, Land and Air Protection Manager (“Manager”) at least 90 days before beginning construction of a new composting facility or the modification of an existing composting facility.

Division 1 (23) (3) A copy of the environmental impact study report required by subsection (2) must be submitted to the manager at least 90 days before commencement of construction of a new composting facility or the modification of an existing composting facility.

An EIS is required to be conducted by a qualified professional, as defined by the OMRR, with expertise and experience in conducting environmental impact studies and assessments. For larger or more environmentally sensitive projects, and depending on the scope of work for the EIS, a team of qualified professionals may be required.

The purpose of this section is to provide guidance to the qualified professional (QP) for developing an appropriate scope of work for an EIS that will satisfy the requirements of the OMRR. It is not intended to be a comprehensive document detailing exactly what an EIS must contain. This remains the responsibility of the discharger or their designated QP.

For the qualifying compost facilities (more than 20,000 tonnes/year production or expanded as detailed in Division 1(23) (1)), the intent of the EIS is to determine whether the operation of the facility and the production of compost will substantially alter or impair the usefulness of the environment or adversely affect human or ecological health in the area. On this basis, the EIS must, in general, do the following:

- Establish pre-facility operation conditions in the receiving environment using existing data and/or by conducting adequate sampling of water, air, sediment and biota;
- Establish, before and after construction and/or operations commence, receiving environment monitoring locations, and sampling parameters and frequencies;
- Assess existing and potential uses of the receiving air shed, surface waters or groundwaters, by humans, plants and animals, including reference to blue and red species lists;
- Determine whether receiving water and air quality guidelines are and will be met, and under what conditions;
- Carry out analyses, as appropriate to the nature of the discharge and the receiving environment, to determine if the proposed composting facility will adversely affect human health or the environment; and
- Provide recommendations to ensure that the proposed composting facility not impact human health and the receiving environment, or to recommend against the proposed composting facility.

The completed EIS should establish the extent to which the proposed construction or modification and operation of the composting facility will affect human health and/or the environment. If the effect is unacceptable, the proposed facility should be modified to ensure that no adverse effects will occur, or the proposal for the composting facility should be withdrawn. This guideline has been structured to identify and explain the requirements in the regulation for an EIS.

Prior to commencing an EIS, the qualified professional should make themselves aware of the requirements of the various agencies that may be involved. These agencies include, but are not limited to, MWLAP, Environment Canada, Department of Fisheries and Oceans, Ministry of Agriculture, Food and Fisheries, the Local Health Authority, Municipality, Regional District, First Nations, etc. It is important to note that if the discharger is proposing to compost materials in Schedule 12 of the OMRR within Agricultural Land Reserve (ALR) lands, the legislative requirements of the Provincial Agricultural Land Commission (PALC) must also be met, in addition to those of the OMRR. The discharger or their designated QP must contact PALC to determine what these requirements are. In all cases, should meetings with any of these agencies be required either prior to or during the EIS process, it is the responsibility of the discharger or their QP to arrange these meetings.

In general, the OMRR, this Guideline, and/or any particular concerns or questions raised by other legislation, should be adhered to when conducting the EIS. As well, justification should be provided to the MWALP Manager for any deviations. Dischargers should be aware that under Division 1 (23) (5) of the OMRR enables the Manager to impose additional requirements, including specific requirements to be addressed by an environmental impact study:

Division 1 (23) (5) The manager may request additional information with respect to the environmental impact study that he or she considers necessary for the protection of human health and the environment, and may specify particular concerns or questions that the impact study must address.

2.2 GENERAL EIS REQUIREMENTS

Siting, construction and operation of a composting facility should always take into consideration the potential for environmental impacts. Division 1 (23) (2) of the OMRR outlines the general requirements of an EIS, should the facility be large enough (greater than 20,000 tonnes per year production), as follows:

Division 1 (23) (2) A discharger must ensure that no organic matter is collected at, and no compost is distributed from, a composting facility unless a qualified professional conducts and completes an environmental impact study and produces an environmental impact study report acceptable to the manager which includes, but is not limited to,
(a) design of the composting facilities including buildings, works and other appurtenances,
(b) odour and leachate collection and treatment systems, and
(c) site preparation for the composting facilities, buffer zones and plans to minimize the impact on adjacent lands.

Concerns that typically need to be addressed in an EIS include but are not necessarily limited to the following:

1. Potential for impacts on flora and fauna including terrestrial and aquatic habitats both during the construction of the facility and the subsequent operation of the composting facility. Of particular concern would be the presence of “Red” (species that are threatened) and “Blue” (species that are sensitive or vulnerable to human activity or habitat encroachment) category species, as defined by the current “species at risk” legislation, and the potential impacts from site development. This would include potential problems related to:

    - Any activities during sensitive periods of plant or animal (including birds, fish and other wildlife) lifecycles.
    - Land clearing, site grading and hard surfacing operations including location of roads, buildings, ditches or drainage, pipelines, excavations and related issues such as slope stability.
    - Runoff and sediment control during construction.
    - Truck traffic during construction and facility operation.
    - Noise during construction and facility operation.
    - Impacts on surface and ground water quality due to uncontrolled runoff and/or leachate production.
    - Runoff/leachate control and/or treatment during operation.

2. Potential for impacts on local residents during facility construction and operation and potential mitigative measures including:

- Dust potential and appropriate control mechanisms.
- Noise potential and appropriate control mechanisms.
- Odour potential and appropriate control mechanisms (Note: In many cases, development of an odour model for the facility will assist in the assessment of the odour control needs).
- Leachate potential and appropriate control mechanisms.
- Impacts on ground and/or surface water drinking water supplies.
- First Nation's Land Claims and/or entitlements.
- Vectors such as birds, rats, flies, insects, rodents and other animals.

3. Potential for impacts on air quality:

   - Greenhouse gas emissions.
   - Particulates from material handling.
   - Dust from roads and during construction.
   - Hazardous air contaminants.

4. Potential impacts on archaeological values, including First Nations interests which include archaeological values, land claims, etc., as well as any evidence of early settlements by non-First Nations peoples. Dischargers may refer to the Provincial Policy on First Nations Consultations available on the Internet at: http://srmwww.gov.bc.ca/clrg/alrb/cabinet/ConsultationPolicyFN.pdf.

An example listing of the detailed contents of an EIS is presented in Appendix A.

2.3 LAND USE ISSUES

On the topic of land use, the OMRR applies to the recycling of organic matter listed in Schedule 12 of the OMRR. Where the facility is located on Agricultural Land Reserve (ALR) lands the situation can be complicated. Where the OMRR-related activities occur on an ALR, the legislation of the Provincial Agricultural Land Commission (Commission) applies. The land use regulation of the Commission, also applies to composting facilities as they to any other land use in the ALR.

The ALR, Use, Subdivision and Procedure Regulation (ALRUSP) [B.C. Reg. 171/2002] makes direct reference to the OMRR. Where a composting facility meets certain requirements, including compliance with the OMRR, the production of 'Class A

Compost', and all the compost product is used on the property, the composting is an activity designated as a 'farm use'. As such, the activity, although it may be regulated by by-laws, may not be prohibited by local government.

Should not all the compost be used on the property, the composting would not be recognized as a 'farm use'. However, by using at least 50% of the compost on the property, it would be a permitted activity, unless prohibited by local government by-law. Should the composting activity not be in compliance with the ALRUSP, as a 'farm use' or permitted other use, meaning at least 50% of the produced compost is used on the property, the activity would be considered a non-farm use and not be permitted in the ALR without an approval from the Commission. More information regarding the Agricultural Land Commission and its legislation, policies and application process can be obtained from their website available at http://www.alc.gov.bc.ca.

In addition, the ALRUSP requires notification be provided to the CEO of the Commission where the construction of composting facilities require the removal of soil or placement of fill and where the facility site is in excess of 2% of the parcel size. This enables the CEO of the Commission to limit the impact resulting from the soil removal or placement of fill on the property. In addition to the above, the OMRR requires notification of operation be given to the Commission under Division 2, Section 25 (1) (b).

This agricultural bias or requirement applies fully to the construction and operational requirements of composting facilities and needs to be understood by the discharger, the qualified professional, as well as other regulating bodies. The OMRR applies on all land in B.C. Therefore, it is recommended that local government bylaws and bylaws under solid waste management plans are consulted.

Once again, the above are recommendations on the issues and concerns that may need to be addressed in a standard EIS for a compost facility. It is the responsibility of the hired qualified professional to determine exactly what is to be examined, detailed and included in the EIS for a given composting facility.

2.4 COMPLETION OF THE EIS

Where a proposed new or expanded composting facility will produce more than 20,000 tonnes of product per year or is expanded as detailed in Division 1 (23) (1), an EIS must be completed. Once the EIS is completed, under Division 1 (23) (3), it must be submitted in a form acceptable to the MWLAP Regional Pollution Prevention Manager (the Manager) at least 90 days before commencement of construction of a new facility or modification of an existing facility. The discharger must keep a copy of the completed EIS for the Manager to inspect at any time.

Division 1 (23) (4) The discharger must retain a copy of the completed environmental impact study report for inspection by the manager at any time.

If the form or content of the EIS is unacceptable to the Manager, they have the authority to ask the discharger for additional information with respect to the EIS if he or she feels it is necessary for the protection of human health and the environment. The discharger and/or discharger's hired qualified professional may be obliged to answer the Manager's questions and/or address any areas of concern and then resubmit the EIS.

Division 1 (23) (5) The manager may request additional information with respect to the environmental impact study that he or she considers necessary for the protection of human health and the environment, and may specify particular concerns or questions that the impact study must address.

It is highly recommended to review the *Environmental Impact Study Guideline – A Companion to the Municipal Sewage Regulation* for guidance. It is available at http://wlapwww.gov.bc.ca/epd/epdpa/mpp/ms_guidelines.htm or http://wlapwww.gov.bc.ca/epd/epdpa/mpp/EIS_Guideline_Dec2000.pdf .

Important note: Contact with a MWLAP Regional Pollution Prevention Manager (Manager), other government agencies, and third parties throughout the EIS process is recommended to ensure the composting facility design, construction, and operation all are in compliance with the appropriate regulatory standards. There may be additional municipal, provincial or federal regulations that may apply to compost facilities depending on the location of the facility and construction plans. Each region in British Columbia has a solid waste management plan, which may be impacted and may or may not require amendment. Each city/town will have local zoning bylaws, which list the kinds of activities/development that are allowed in specific areas. Therefore, it is best to take some time to thoroughly investigate and discuss all legal matters at the beginning of the planning and/or the EIS processes.

The following sources may be contacted for additional information:

Ministry of Water, Land and Air Protection (MWLAP)
Environmental Management Branch
Tel: 250-387-3205
Fax: 250-356-5496

Website: http://www.gov.bc.ca/wlap/cont/

Mailing Address:
Box 9342 Stn Prov Govt
Victoria, BC V8W 9M1

Delivery Address:
3 – 2975 Jutland Road
Victoria, BC V8T 5J9

Provincial Agricultural Land Commission
133-4940 Canada Way
Burnaby, BC V5G 4K6
Tel: 604 660-7000
Fax: 604 660-7033
Website: http://www.alc.gov.bc.ca/contacts/contacts.htm

Resource Management Branch
Ministry of Agriculture, Food & Fisheries
1767 Angus Campbell Road
Abbotsford, BC V3G 2M3
Tel: (604) 556-3100
Fax: (604) 556-3099

British Columbia Waste Management Act
Website: http://www.qp.gov.bc.ca/statreg/stat/W/96482_01.htm

Environmental Impact Study Guideline – A Companion to the Municipal Sewage Regulation
Website: http://wlapwww.gov.bc.ca/epd/epdpa/mpp/EIS_Guideline_Dec2000.pdf

BC Ministry of Agriculture, Food and Fisheries
Website: http://www.gov.bc.ca/bvprd/bc/channel.do?action=ministry&channelID=-8377&navId=NAV_ID_province

DIVISION 2 - CONSTRUCTION AND OPERATION OF COMPOSTING FACILITIES

Under Part 5, Division 2 of the OMRR, a composting facility discharger (owner/operator) must have a qualified professional, as defined by the OMRR, prepare plans and specifications for the construction and operation of a new composting facility (regardless of capacity) or a modification of an existing facility (with some exceptions).

Division 2 (24) *(1) A discharger must have a qualified professional prepare plans and specifications for*
(a) the construction and operation of a new composting facility, or
(b) any modification of an existing composting facility that results in an increase in the annual production capacity of more than 10 percent or [to] more than 20 000 cubic metres.
[Note: "to" has been added here. We believe it was on oversight in the OMRR].
[Note: It is recognized that in other areas of the OMRR, 20,000 refers to tonnes. In all cases, the values refer to finished product. To clarify the situation between tonnes and cubic metres, the Act may be amended at some point in the future to rationalize these differences]

The primary intent of this requirement is to ensure that the facility is constructed in an appropriate and safe manner and that it will withstand the conditions under which it will be required to operate. This requires considering several issues including, but not limited to:

- wind loading
- snow loads
- seismic loading
- static loading from the materials used to construct the facility as well as fixed composting equipment and materials being stored in the facility
- dynamic loading from mobile composting equipment, e.g. front-end loaders with buckets full of moist compost materials
- corrosion due to drainage from feedstock materials
- corrosion due to moisture from the composting process
- corrosion due to any off-gassing of composting materials
- fire protection and suppression, as appropriate
- ventilation to protect the buildings from corrosion due to excess moisture and personnel from gas, odours or microbial spore build-ups.

Appropriate local, BC and National building (structural, electrical, heating and ventilation, plumbing, etc.) codes should be met. Suitable materials, e.g. concrete, stainless steel, galvanized steel, appropriate plastics, etc. should be considered, evaluated and selected. Workers Compensation Board worker health and safety requirements, e.g. lighting, heating, ventilation, confined space entry, safety railings, safety shut-offs and lock-outs, etc. should be considered, evaluated and complied with, as required. Building permits should be applied for and approved prior to construction, as appropriate for that area.

The composting facility design should also be capable of being operated efficiently and safely while reflecting and being compatible with the intended composting operations. When developing the layout of the compost facility, the QP should discuss the planned operations with the owner or operator and consider all aspects of the proposed composting operation prior to beginning the facility layout. This will permit the QP to understand how the various components of the facility will work together as a whole. Material flows and equipment movements should be studied and the distances between areas and activities selected accordingly so that the facility can be operated as smoothly, efficiently and safely as possible without conflicts between machines and machines, machines and equipment, machines and buildings, and machines and personnel. In addition, the facility layout should reflect the need to keep the public away from all composting activity areas for both safety and aesthetic reasons.

The plans and specifications for the proposed composting facility or facility expansion must include, but are not limited to, all of the following:

Division 2 (24) (2) The plans and specifications required by subsection (1) must include, but are not limited to, all of the following:
(a) all works to be constructed on the site;
(b) design capacity of the composting facility;
(c) a leachate management plan which stipulates how leachate generated from any and all stages of the composting process will be minimized, managed, treated or disposed;
(d) an odour management plan which stipulates how air contaminants from the composting facility will be discharged in a manner that does not cause pollution;
(e) an operating and closure plan for the composting facility.

Section 4 of this Guideline reviews site and environmental considerations, which may be of assistance to the QP when developing the plans and specifications mentioned above.

To assist in the preparation of a leachate management plan, and an odour management plan, individual sections on odour control (refer to Section 5) and leachate management (refer to Section 6) have been provided in this guidance document. Examples of a leachate management plan, an odour management plan and an operating and closure plan are provided in the Appendices to this document.

Once the plans and specifications for the composting facility are complete, the qualified professional (QP) must affix his or her professional seal or signature, or both, to the plans and specifications.

Division 2 (24) (3) The discharger must ensure that (a) the qualified professional (i) affixes his or her professional seal or signature, or both, to the plans and specifications for the composting facility.

After the facility has been constructed, the qualified professional (QP) must certify that the composting facility has been constructed in substantial accordance with the original or approved modifications of the plans and specifications by providing a certified signed statement indicating such.

Division 2 (24) (3) (a) The qualified professional (ii) makes a signed statement certifying that the composting facility has been constructed in accordance with the plans and specifications.

The operator(s) of the facility should note that Part 5 of the OMRR requires that a copy of the plans and specifications be kept at the composting facility for inspection purposes at all times. The plans and specifications may also have to be submitted to the manager upon request.

Division 2 (24) (3) (b) a copy of the plans and specifications for the composting facility are kept at the composting facility at all times, and are available to the manager upon request,
(c) the plans and specifications are submitted to the manager upon request.

Facility operators must ensure that the composting facility is managed in compliance with the plans and specifications that were developed prior to the construction and operation:

Division 2 (24) (d) the discharger must ensure (that) the composting facility is operated in compliance with the plans and specifications required by subsection (1) (i.e. Division 2 (24) (1)).

In the interest of protecting human health and the environment, the manager has the authority to ask the discharger (compost owner/operator) for more information, or raise concerns or questions regarding facility plans and specifications.

Division 2 (24) (4) The manager may request additional information with respect to the plans and specifications that he or she considers necessary for the protection of human health and the environment, and may specify particular concerns or questions that the plans and specifications must address.

Notice of operation

At least 90 days before operation, the discharger must inform, in writing, the MWLAP Manager and, if the composting facility is in an agriculture or forest land reserve, the Provincial Land Reserve Commission. This notification document must indicate the composting facility address, design capacity, type of feedstocks received, intended distribution of compost, name of a contact person, and a copy of a personnel training program plan that addresses the specific training required to operate the facility in accordance with the OMRR. An example personnel training plan is provided in Appendix B to this guideline.

Division 2 (25) *(1) The discharger must, at least 90 days before beginning the operation of a composting facility, give notice in writing to*
(a) the manager, and
(b) the (Provincial) Land Reserve Commission if the composting facility is in an agricultural land reserve or forest reserve land.
(2) The notification required by subsection (1) must include
(a) the composting facility location and design capacity, name of a contact person, type of waste received, and intended distribution of compost, and
(b) a copy of a personnel training program plan that addresses the specific training needed to operate the composting facility in compliance with this regulation.

It should be noted that the requirement for submission of an Environmental Impact Study (EIS) (if the facility is large enough or expanding as detailed in Division 1 (23) (1) to require such a study), 90 days before the commencement of construction of a new facility or the modification of an existing composting facility, in Division 1 (23) (3), can run in parallel (be concurrent) with the requirements for notification of operations discussed above.

SITE AND ENVIRONMENTAL CONSIDERATIONS

Consideration of the current and planned development near the site and the local environmental conditions is critical to establishing a successful composting facility. It must be recognized that, if not properly managed, a composting facility can easily produce strong odours that can adversely affect its neighbours, as well as a strong leachate that can impact local groundwater and/or streams. Historically, odours and economics have been the primary basis for the closure of composting facilities. Leachate control is also very important to successful composting operations. For example, data collected at several composting facilities in Washington State found that, depending on the feedstock materials, runoff from composting facilities can be significantly higher in most common pollutants than many raw municipal wastewaters. These factors should be in the forefront during the planning and design of any composting facility.

Selecting a composting site is a very important decision that will affect the overall long-term success of the facility. Such a decision should be made only after careful consideration and review of the regulations, composting operations and requirements in terms of buildings and processes. The site selection process should take into account a site that meets land area requirements, which are based on the following:

- The composting method and the equipment selected - a “holistic” (or “big picture”) approach should be used for the compost facility design strategy. Selection of the composting method should be based on a complete review of regulatory constraints, site conditions, feedstocks, and the market for finished compost. Unfortunately, too many dischargers (compost facility owners/operators) have selected the process first (frequently inappropriately, based on their experience and familiarity, rather than on sound design principles) and then they struggle to make it work at the site. It is the QP’s role to assist the discharger in avoiding this situation and developing a successful facility that runs efficiently and safely while producing an appropriate final product without creating odour or leachate impacts.

- Topography – will affect site drainage, facility visibility and, potentially, the movement of odours offsite.

- Proximity to residences, commercial establishments, institutions such as schools or hospitals, areas of worship, water wells, and water bodies – these are the points that the proposed new or expanded facility will potentially impact sensitive individuals due to noise, odour, dust, spores, etc. The discharger and their QP need to know about where and who the potential points of impact will be and plan accordingly to avoid these impacts. This is where an EIS can be advantageous even if the facility is technically small enough not to need one.

- Buffer areas for odour, noise, and pollution control – buffer areas (open fields, treed spaces, etc) are one means by which environmental (noise, odour and leachate) impacts can be avoided or mitigated.

- Vectors – including flies, rats, mice, larger animals, other insects, etc. that have the potential to carry and transport diseases, depending on the feedstock materials, e.g. yard waste has a low risk but food wastes would have a high risk of vector attraction problems.

- Fires – Since composting facilities can and have caused fires and forest or bush fires can burn down composting facilities, maintaining a substantial buffer distance to trees can be prudent.

- Weather conditions including rainfall patterns and prevailing winds – will affect leachate generation and odour movement.

- Vehicular traffic and traffic patterns – access to the composting facility should be easy and should be over appropriately wide, paved roads through non-residential areas. Difficult access, down primarily residential, narrow and/or unpaved roads will lead to vehicle conflicts and noise and exhaust fume issues.

- Travel distance to and from site where raw material is generated, and distance travelled to get finished product to market – these should be minimized as much as possible so that the facility operation is as efficient and profitable as possible.

- Space requirements for storing raw materials, curing, storing finished compost, odour and leachate control measures (i.e. space for biofilters, retention ponds, etc.) must be included during the conceptual facility design phase.

- Local zoning requirements – Some municipalities may choose to not permit composting facilities. Others may restrict composting facilities to areas zoned for industrial facilities, away from residential and commercially-zoned areas.

Timely planning and review of local, provincial, and federal laws prior to developing the site development plans is strongly recommended.

When selecting a site, the importance of public participation must be stressed. Concerns raised may include odour, traffic, noise, litter, water pollution, and health issues. It will be beneficial to have an open line of communication with surrounding property owners and members of the general public about the proposed facility. It is often favourable to select a site that is not visible to neighbours, yet easily accessible with the minimum amount of travel distance from the source material to the site. Site access over non-crowded, non-residential, hard surface roads, whenever possible, is recommended.

4.1 BUFFER ZONE DISTANCES

While nothing can replace good facility designs that control and treat odours and leachate and minimize noise, the impacts from a composting facility can be further minimized by providing buffer zones from the composting site and nearby neighbours and/or points of potential impact. These buffer zone distances help to minimize potential environmental conflicts between non-compatible land uses, to minimize odour and noise related problems, and to ensure the integrity of surface and groundwater systems. The buffer zone may include the use of vegetation, shrubs or trees, as well as a berm (often of soil and/or finished compost) to serve as a visual barrier, help control vehicular access, and reduce noise levels off-site. Consideration should also be given to future development, which may encroach on the buffer zone established at the time of construction.

The following table outlines some example buffer zone distances. However, buffer zone distances will vary for different situations. The Manager may request additional buffer information under Division 2 (24) (4). Modifications to the plans and/or specifications typically will be based on the type of material to be composted, the composting site, operational procedures, the proximity to housing or businesses, etc.

Table 4.1
Suggested Minimum Composting Facility Buffer Zone Distances

Distance from the composting site to:	Suggested minimum buffer zone distance (metres)*
Property line	15-30
Residential area	400 to 1000
Hospitals	800 to 2000
Tourist Areas	400 to 1000
Farm	100
Commercial or industrial area	100 to 300
Private well or other potable water source	150
Wetlands, ponds, lakes, streams, etc.	150-300
Subsurface drainage pipe or drainage ditch discharging to a natural water course	30
Water table (seasonal high)	0.6-1.5
Bedrock	0.6-1.5

*Consult local and provincial government regulations for actual separation distance requirements, if available and applicable.

4.2 WETLANDS AND FLOOD PLAINS

Siting a composting facility in or near wetlands or wetland buffer areas will very likely not be acceptable due to the higher potential for environmental impacts. As a result, these areas are strongly not recommended. Several sections of the Federal Fisheries Act and Waste Management Act may apply to compost site development and operation due to the potential for negative environmental impacts. It is highly recommended that these and other applicable acts are consulted. The Federal Fisheries Act is available on the Internet at: http://laws.justice.gc.ca/en/F-14/59482.html. The Waste Management Act is available on the Internet at: http://www.qp.gov.bc.ca/statreg/stat/W/96482_01.htm.

Composting operations should not be located in areas subject to flooding and where the seasonal high groundwater table is less than 1 metre from the soil surface. A high water table is undesirable because it may lead to flooding of the site and increases the chance of uncontrolled leachate contaminating groundwater. During periods of flooding, composting windrows or curing piles may impede water flow, and leachate might wash into the stream. Flooding of the windrows may also lead to extensive anaerobic conditions and resultant problems of odour and a lower decomposition rate. Flooding of the site could pose serious operational difficulties, including problems with equipment access and operation.

Based on the above, it is highly recommended that regional flood plain maps are referred to prior to siting a composting facility. Floodplain maps show the location of the normal channel of a watercourse, surrounding features or developments, ground elevation contours, flood levels and floodplain limits (the estimated elevation and horizontal extent of the high water marks of a 200-year flood). The 200-year flood is one that occurs, on average once every 200 years. Flood plain maps may be viewed at the offices of the Regional Water Managers. BC Environment Regional Water Managers can provide information on local flood hazards. Additionally, most local authorities will have copies of map sheets within their jurisdiction available for viewing. For information on local bylaws regulating construction in flood-prone areas, contact your local government.

Regional flood plain maps can be viewed using the following Government of British Columbia, Ministry of Sustainable Resource Management website:

http://srmwww.gov.bc.ca/rib/wat/fpm/index.htm

If required, flood plain maps may be ordered by fax, phone or mail at the number and address listed below:

Crown Publications Inc.
521 Fort Street
Victoria BC V8W 1E7
Telephone: (250) 386-4636
Fax: (250) 386-0221
website: http://www.crownpub.bc.ca

4.3 SITE DRAINAGE

There are three main aspects of site drainage: run-on control, runoff control and leachate management. Run-on is the clean water from rainfall or snow melt that runs on to the site from adjacent higher land. Runoff is the clean, uncontaminated water from rainfall or snow melt that is generated on the composting site. Leachate is a contaminated water that results when rainfall or snowmelt from any source (run-on, runoff and direct atmospheric contact) comes into contact with composting feed stocks, materials being composted and/or curing compost to the extent that the water becomes contaminated and is of sufficient quantity to drain away from the materials in which it came in contact.

Run-on control should be accomplished by using a combination of ditches and/or berms to divert run-on around or away from the composting facility. Clean runoff, which has never come to contact with any composting-related materials, can be allowed to percolate into the site soils if these soils are permeable. If the soils are relatively impermeable, then clean runoff should be diverted to a runoff sedimentation pond prior to discharge to the off-site environment, e.g. a natural wetland or a surface water.

Areas that will generate leachate, i.e. areas in which rainfall or snowmelt will come into contact with compostable materials, the composting process and/or pre- and post-composting processing, should be hard-surfaced with drains to control leachate. Covering these areas can be a cost-effective way to minimize leachate generation and, subsequent, leachate treatment requirements.

Division 3 (26) (2) The receiving, storage, processing and curing areas of a composting facility must comply with all of the following: [NOTE: "all"]
(a) be located on asphalt, concrete or another similar impermeable surface that is capable of withstanding wear and tear from normal operations that will prevent the release of leachate into the environment;
(b) have a roof or cover, or a prepared surface designed to prevent :
- *(i) the surface collection of water around the base of organic matter and compost and*
- *(ii) runoff water from entering the receiving, storage, processing and curing areas*

(c) have a leachate collection system designed, constructed, maintained and operated to reuse leachate, or to remove leachate, from the receiving, storage, processing, and curing areas.

“Impermeable surface” typically refers to a surface that has a permeability rating of less than 1 x 10^{-7} cm per second, and has been designed and approved by a qualified professional to ensure that there is no onsite discharge of leachate to the environment. Typical materials that can be used as impervious surfaces include compacted clay (with a crushed limestone travelling surface), asphalt, reinforced concrete and roller-compacted concrete.

The Division 3 (26) (2) (b) clause above can be interpreted to mean if there is no cover provided, then a “prepared surface” such as an impermeable surface with edge berms or curbs can also be used to fulfill the requirements of sub-clauses (i) and (ii). In any case, under 26 (2) (c) above, there typically must be a leachate collection system.

As will be discussed in Section 6, Leachate Management, under Division 3 (26) (4), it may be possible to avoid the impermeable surface, roof, cover, prepared surface and leachate collection if a qualified professional can use an environmental impact assessment (EIA) to demonstrate that alternative leachate management processes will adequately protect the environment.

Steep slopes are unsatisfactory because of problems with erosion, vehicular access, and equipment operation. A gentle slope, however, is desirable to prevent ponding of runoff and leachate. The compost site should have a land slope of 1% (minimum) or 2 to 4% (recommended). Greater site slopes may work but will increase the amount of surface runoff and soil erosion. The grade should be designed in such a way that the liquid leachate from compost can flow freely to a centre point for collection and restricted reuse or treatment and disposal. Initial site preparation usually requires grading, and yearly maintenance should include re-grading of non-hard surfaces, where necessary. Site grading allows the land to handle surface runoff (clean stormwater or snow melt) without contributing to soil erosion. Re-grading is not applicable for paved or concrete areas, which are required under Division 3 (26) (2) for areas where compostable materials are handled. Durability of improved surfaces is very important. Front-end loaders and excavator buckets can easily destroy a concrete or asphalt surface if care is not taken in design and operation.

4.4 SITE UTILITIES

Siting of a compost facility should consider access to several types of infrastructure utilities including:

- electrical service,
- phone service,
- domestic sewage treatment, and
- water lines.

Electricity may be required for operating equipment such as blowers for aerated piles, conveyors, augers, mixers, screening equipment, grinders, odour control fans, etc. A composting facility also needs a source for water supply, even though it usually is unnecessary to add water to most incoming material. However, water may be needed during hot, dry periods and will be needed for dust control, fire protection, washing equipment, and on-site shower and toilet facilities. Water can be taken from a municipal piped-source, or by pumping from a nearby lake, stream, or well. The source for water primarily depends on water rights, access, and volume.

As part of a water conservation and reuse program, collected and separated clean runoff can be used effectively by applying to active compost. Collected leachate can also be reused as long as caution is taken to ensure recycled leachate is not used where recontamination with pathogens or indicator organisms can occur.

4.5 FIRE PROTECTION

Facility siting should take into account fire protection when composting dry materials such as leaves. Fires have been an issue and have occurred occasionally at composting facilities in BC. Normally, compost burns poorly, since the interior of the pile is moist. However, vandals may be able to ignite the dry surface, e.g. of a windrow, or the compost pile may catch on fire “spontaneously”.

Extremely dry materials do not bring about spontaneous combustion of the compost piles. Spontaneous combustion typically occurs when piles are within the 20 to 45 percent moisture range and further activated by microbial activity, which raises the temperature of the materials enough to allow chemical processes to come to the flash point. Keeping materials either drier or moister than this moisture range as well as evenly moist should alleviate fears of spontaneous combustion. Feedstock stockpiles and oversize material (“overs”) from the screening process are of more concern for fire, than the actual compost windrows, which are usually well managed.

Operators and QP’s should be familiar with the article in the January 2000 BioCycle Magazine, “*Fires At Composting Facilities: Causes And Conditions*” by R. Rynk at the following website:
http://www.jgpress.com/BCArticles/2000/01004.html

A composting facility fire protection plan could include, but not necessarily be limited to the following:

- Having a readily available, pressurized water supply, complete with standpipes, hose bibs, and, in some cases, either a sprinkler system or hydrants for connection to pumper trucks.
- A road design that permits easy access by fire-fighting equipment.
- Providing aisles between windrows as a firebreak and for access.
- Providing buffer distances between potentially combustible materials.
- Access to earth moving equipment, e.g. a tracked excavator, in the event a deep subsurface fire occurs and needs to be isolated or dug out.
- Having a readily available stockpile of soil to smother fires (as an alternative to using water).

An example fire safety plan, and other helpful information on fire protection and legislation, is available at the office of the Fire Commissioner website:
http://www.mcaws.gov.bc.ca/firecom/fsp/index.htm.

4.6 VEHICULAR ACCESS

Access roads should be planned to accommodate all types of vehicles that will be entering and leaving the site. This will include, but not necessarily be limited to, the following:

- Having separate routes for large commercial vehicles and smaller domestic vehicles.
- Providing sufficient area for vehicles to back out without interfering with composting equipment.

- Providing enough area for machinery to turn around, especially equipment such as front-end loaders, compost turners, and delivery trucks.

Because of the heavy truck traffic, a limited road network (possibly paved) within the site may be desirable to improve all-weather access. A circular traffic flow pattern may be advantageous at heavily used sites. The purpose of the on-site roads is to help prevent trucks from getting stuck during muddy conditions. An extensive on-site road network is typically not required. Safety precautions usual to any operation involving heavy machinery should be exercised. Road layout should be designed with safety in mind.

The general public are not normally aware of equipment movements. Therefore, where possible, separate public areas from active machinery areas, and restrict public access in active composting areas. It is highly recommended to use appropriate signage to direct vehicles on site, and in some instances, having personnel available to direct traffic, heavy machinery, etc.

Vehicular access to the site must be controlled to prevent illegal dumping. A gate across the entrance road is a minimum precaution. In some cases the entire perimeter may have to be fenced, but usually pre-existing features such as streams, trees, and embankments will provide partial security. Berms consisting of soil and finished compost can often serve in place of a fence at other points. Vandalism may be of concern, especially if equipment is to be left on site unattended overnight or over weekends. Storage within a locked chain link fenced area is minimum. Equipment buildings are strongly recommended.

4.7 WEIGH SCALES

It is highly recommended to install and use weigh scales at the composting site. Weigh scales help to keep track of feedstock materials entering the site, finished product exiting the site, and levying and collection of fees.

ODOURS

SECTION 5

Odour is perhaps the most common problem associated with composting. Failure to sufficiently address the odour issue has led to unpleasant relationships with neighbours and, sometimes, closure of the facilities. Although a well-constructed and well-operated compost system will not be odour-free, it should not produce offensive odours. Some odour control techniques—such as good housekeeping and eliminating sources of odour like wet feedstocks and/or stagnant water—cost very little and can be extremely effective in preventing odour production. Sound management practices, careful site selection, and communication with your neighbours may be the best and least expensive prevention for odour complaints. If prevention measures fail to solve disputes over compost odours, technology-based approaches to odour control may be necessary. However, technological measures can be expensive and their effectiveness can vary widely. Current odour control methods include preventing the production, release, and transport of odours, as well as altering or reducing them through some form of control and treatment. Odour control can also help to minimize the release of bio-aerosols that may contain pathogenic microorganisms.

Odours can be broadcast through air as a gas, or they can be adsorbed onto and transported by dust particles. Odours will tend to linger in the area on humid, windless days and will dissipate on dry, warm, windy days. Frequency, intensity, duration, and offensiveness are the main factors affecting the acceptability of composting odours. Any combination of frequent, intense, long-lasting, or offensive odours probably will be unacceptable to the facility neighbours. Neighbours may tolerate frequent or intense odours that do not linger in the air or are not offensive, although sensitivity to odours varies from one person to the next. They will not tolerate persistent odours that linger. A helpful facility design and operating strategy would be to identify target off site odour conditions that would not cause odour problems for neighbours. The target could be as simple as a maximum expected odour level at the property boundary or a more sophisticated approach that establishes a matrix of acceptable offensiveness, frequency, duration, and intensity.

5.1 ODOROUS COMPOUNDS

Odorous compounds come in a wide variety of forms, as demonstrated in the Compost Odour Wheel found in Appendix C. They range from the earthy, moldy, musty to the rancid/putrid to fishy to sulphury to fruity, depending on the materials being composted and the type of composting facility being used and the operation of that facility.

Odorous compounds of some type are continuously being generated and discharged from an active composting process. The offensiveness of the compounds being released depends on the environment being experienced by the organisms performing the composting. Generally, in a more aerobic environment, more of the odorous compounds will tend to be less offensive and in lower concentrations.

High temperatures have also been observed at times to result in the generation and release of more odorous gases. Higher temperatures typically only cause odours if there is not enough oxygen in the process. However, if you don't have the right microorganisms to complete oxidation, some metabolic processes end with odorous compounds even if oxygen is present.

Odours from the compost system typically arise if process conditions (mix composition, moisture content, aeration conditions, temperature, etc.) are not optimal. These odours include a wide range of compounds, of which the most notorious are the following:

- Reduced sulphur compounds (e.g. hydrogen sulphide (rotten egg smell), dimethyl sulphide (rotten cabbage smell), dimethyl disulfide (strong rotting cabbage smell), methanethiol (pungent sulphide smell), and carbon disulphide (rotting pumpkin)), and mercaptans (strong garlic or skunky).

- Volatile fatty acids (e.g. acetic acid (vinegar smell), propionic acid (rancid, pungent smell), butyric acid (rancid smell)).

- Ammonia and nitrogen-containing compounds (e.g. ammonia (sharp pungent smell), amines (pungent, fishy smell)).

Ammonia is the most common odour that can be formed anaerobically as well as aerobically, and is usually more noticeable on the composting site rather than off-site. This is due in part because it is lighter than air and rapidly rises up into the atmosphere. Warm temperatures enhance anaerobic decay and odour production so problems are more likely to occur in the summer when more people are also outdoors. After waiting all winter to enjoy a barbeque on the back deck, no one will want to be driven indoors to avoid odours from a nearby composting facility. If the facility's neighbours are impacted, the facility operator and the regulatory agencies, the local news media, etc. will soon know about the problem. This puts the facility operator in a difficult position because it is much better to prevent odours proactively than having to play "catch up" after an odour problem has already occurred. Typically, more effort and expense is required to remedy a problem that has occurred than it would have taken to prevent the problem in the first place.

5.2 ODOUR SOURCE CONTROL STRATEGY

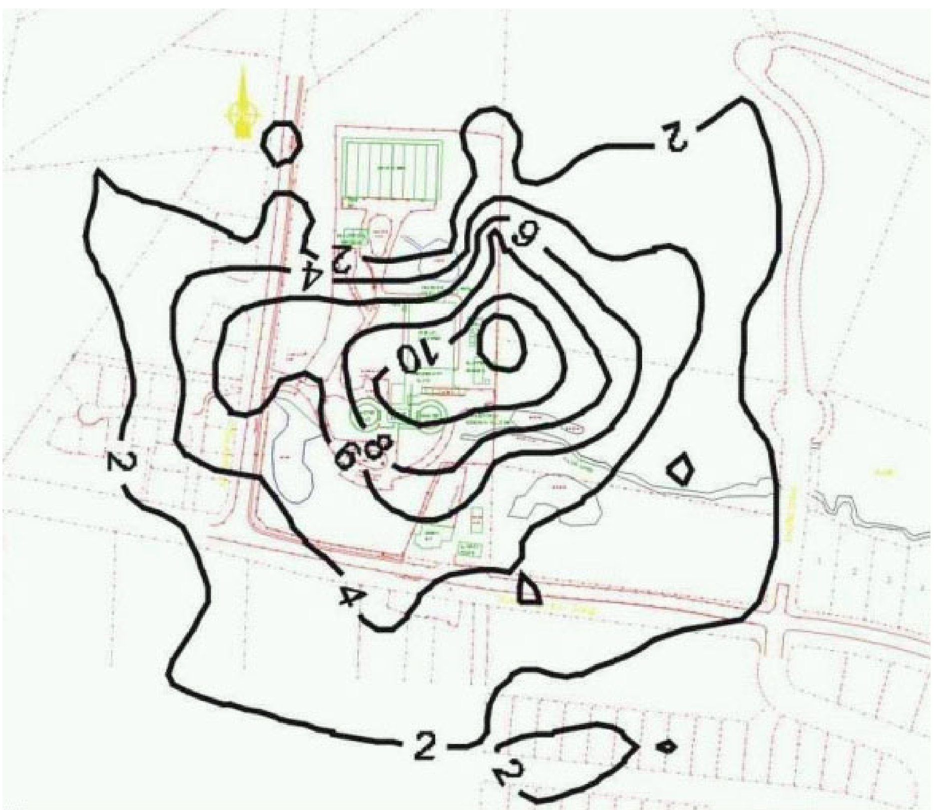
Every composting facility operator should know and understand the sources of odour at their facility. This would include the types of odours, conditions which lead to odour release, practices that reduce odour potential and the potential for impact to neighbouring land uses.

A variety of tools are available for identifying potential odour problems and assisting with developing effective solutions:

- Experience at similar facilities – Most composting facilities have experienced odour problems. The exchange of verified technical information on emissions before and after process modifications is valuable in identifying and selecting process / facility odour control adjustments. Casually observed odour control results that are not backed by supportive technical data should not be used as the sole basis for justifying corrective actions.

- Measurement of generated odours or odorous compounds – The emission of odours from each facility source can be measured by laboratory analysis together with field measurement of air volumes. The laboratory analysis can include either chemical analysis for specific compounds or the measurement of total odours using an odour panel. [NOTE: An odour panel is a group of trained individuals who are subjected to highly diluted samples of the odour to be tested. The operator of the odour panel feeds the diluted samples into an olfactometer (a three sample port device), one by one, members of the odour panel try to detect the first occurrence of the odour. If no one detects the odour, the dilution factor is decreased until, finally, at least 50% of the panel have detected the odour. The current dilution ratio is then used to calculate a dilution to threshold (D/T) or "odour number". The higher the D/T; the stronger and/or more detectable the odour. Odour panels are used because they are more consistent and have no personal bias or sensitivity to any particular odours or odour generation situations than the local impacted members of the public.]

An Odour Panel testing an odour with a dynamic Olfactometer



The Results of an Odour Model Showing Isopleths of Dilutions to Threshold Numbers

- Specific compound analysis is useful when a known compound or compounds are the primary sources of odour. With composting, the odour panel analysis is normally more useful because of the complex mix of compounds that contribute to odours. The emission of odour can be calculated if the odorant concentration and air volume are known. The rate of emission is a critical factor in determining the potential for off site odour impacts from a compost facility source.

- Odour modeling – Odour modeling uses the odour emissions from all sources, historical weather data and local topography to estimate the off site odour levels that would be experienced over a historical period of 3 to 5 years. This information provides a technical basis for the need to make process modification in order to prevent odour problems. This could include odour treatment technologies such as biofilters and/or odour dilution techniques like discharge stacks or agricultural air mixing fans. Once a facility model has been established, it can be used to evaluate alternative improvements with minimal cost. The model can also be used as a tool for evaluating the off site impacts over time that would be expected based on source monitoring results. The USEPA Support Center for Regulatory Air Models provides assistance and offers recommendations on commonly used models on their website at: http://www.epa.gov/scram001

- Source monitoring – Measurement of odours at off site receptors (neighbours) or the facility property line is extremely difficult due to the timing and the fleeting character of off site odour events. Early morning and late evening are common times for the occurrence of odour impacts. Composting facility staff are frequently not available at these times so the opportunity to measure the odour level is missed. On the other hand, the odours emitted from the compost facility sources are relatively consistent. There is variability, but it is far less than the variability at any point of site and can be statistically determined as a historical database is developed for each source. Source monitoring provides the needed input for a model analysis, which will provide the long-term impact of the measured odour emissions. In addition, source monitoring can also relate odour generation to specific site activities such as turning of piles or windrows, and accepting certain types of materials.

5.3 KEY FACTORS RELATED TO ODOUR

Understanding the factors leading to odorous conditions, including the interactions of feedstock degradability, particle size, porosity, moisture, and oxygen transport, will provide additional insights into odour prevention. While the emphasis should always be on prevention, odour treatment will likely be required, particularly in sensitive neighbourhoods. Composting can be affected by many factors, but the four key factors that can be controlled more easily to promote aerobic conditions and reduce odours are:

1. Feedstock Degradability
2. Aeration (Particle/pile size)
3. Temperature
4. Moisture content

5.3.1 Feedstock Degradability

Preventing excessive odours requires consistent management of the composting process, starting with prompt and detailed attention to incoming ingredients. Understanding the amount and type of food available to the degrading organisms in each feedstock is important operational information. Grass, food waste and undigested wastewater solids have high levels of readily degradable compounds. The microbial population quickly attacks and degrades these compounds. If oxygen is present, these materials will be degraded using aerobic metabolic pathways. If air is limited or absent, then fermentation metabolic pathways will be used. From an odour control perspective, it is much preferred to direct the composting process to aerobic degradation. Although there is always a mix of aerobic respiration and anoxic or anaerobic fermentation taking place in any composting mass, the greater the percentage of aerobic degradation, the less the potential for undesirable odour emission.

Nutrient balance is determined primarily by the carbon to nitrogen ratio (C:N ratio) in the compost mix. Therefore, wet nitrogen-rich materials should be mixed with a porous carbon-rich bulking amendment, such as sawdust, woodchips, straw and/or shredded or ground paper (used as animal bedding) in order to retain the nutrient value in the compost product. [Note: This is fairly specific to biosolids and food waste composting – normally C:N is not a factor for yard debris and solid waste composting and bulking materials are not added. An exception can be in the spring and early summer when grass clippings can represent a major nitrogen source.] In all cases, it is important to note that insufficient N can retard microbial activity. More details about carbon to nitrogen ratios are available in various composting manuals including the "On Farm Composting Handbook" by R. Rynk and "The Art and Science of Composting – A resource for farmers and compost producers" by Leslie Cooperbrand, University of Wisconsin-Madison. At the time of writing this guideline, this document was available free at:

http://www.wisc.edu/cias/pubs/artofcompost.pdf

Too much available feedstock food energy can cause accelerated microbial growth, which will rapidly use up the available oxygen, resulting in anaerobic conditions, and thereby, odours. In addition, high levels of feedstock energy can cause the composting piles to become too hot, killing the aerobic microorganisms and resulting in anaerobic conditions (odours).

The presence of excess nitrogen in a composting mass will frequently lead to the release of large quantities of ammonia gas. At large composting facilities this release may impact the quality of ground and/or surface waters. The excess nitrogen can also be released as ammonia gas, which has a pungent smell and may contribute to an array of environmental problems such as smog, acid rain, and greenhouse gas.

5.3.2 Aeration

Once these mixed feedstocks and bulking agents are incorporated into the composting system, subsequent odour problems are usually the result of anaerobic (low to no oxygen) conditions. Efforts should be made to compost aerobically. Aerobic composting refers to decomposition by microorganisms that require oxygen. The compost pile or windrow must be aerated or turned as required during the active stages of the composting process to promote oxygen transfer which leads to aerobic conditions.

Aeration is important to allow proper airflow, and make oxygen available to the microorganisms. This also helps to maintain the moisture and the temperature in the compost mix at the appropriate levels. Aeration uses moisture to maintain temperatures (through evaporation). Aeration also helps remove moisture so the material is dry enough for efficient screening. Moisture can affect aeration efficiency if there is too much and it reduces porosity and/or oxygen transfer.

Aeration depends on the size and shape of the particles in the compost mix. Larger particle sizes and loosely packed material makes a compost pile highly porous, which increases airflow and reduces the accumulation of moisture. Small particles will be more compacted, making the flow of air more difficult.

Odours can also be biologically oxidized after they have formed, and this is important for most composting systems. Odorous anaerobic products, produced in the low oxygen center of a pile, usually pass through an aerobic zone on the way out. Microorganisms will then degrade the odours aerobically. This process probably occurs on both a macro scale (the pile as a whole) and a micro scale (within individual particles or clumps), essentially providing in-situ biofiltration. When turning an anaerobic compost pile, this advantage is lost, which is why frequent turning is not the best way to deal with an odour problem, and instead often makes the problem worse. In a windrow system, it is far better to address the fundamentals of porosity and pile size to ensure adequate passive aeration (diffusion and convection) throughout the compost pile.

5.3.2.1 Forced Aeration Systems

Forced aeration composting systems provide a way to mechanically introduce oxygen, and are common at facilities that compost materials such as biosolids (sewage sludge) with a high potential to generate odours. These systems require relatively uniform pile shapes and porosity to reduce the potential for air to short-circuit along the path of least resistance.

Forced aeration composting systems include aerated static piles. Aerated static piles use a blower and connected perforated pipes located below the pile to push air into the compost. Forced aeration systems are also utilized by some composting facilities to increase airflow between turnings.

Uniformly sizing windrows facilitates oxygen diffusion and natural air convection. This practice is helpful whether using standard windrows or forced aeration windrow systems. Placing an aerobic biofilter layer over static aerated piles is a technique used to reduce the release of odours. In biofiltration, the water film surrounding the organic matter actively absorbs odorous compounds. The aerobic organisms in the biofilter layer will help by metabolizing the compounds responsible for odours produced by any anaerobic organisms.

A biofilter layer can be used for turned windrows; however, due to frequent turning, the operator would have to incorporate the biofilter layer every time the windrow is turned, or scrape it off before turning (and then replace it after turning). This is typically impractical for windrow operations, leaving turning to maintain aerobic conditions the method of choice for windrow odour control.

The biofilter layer must be at least 150 mm thick, and consist of shredded yard waste, authorized bulking agents, or cured compost. A blended mix of three parts amendments and one part finished (mature) compost works well for a biofilter.

5.3.2.2 Passive Aeration Systems

In passively aerated systems, which depend on diffusion and natural convection, sufficient porosity is essential to reduce the resistance to oxygen movement. The compost pile or windrow dimensions must also be appropriate for both the mix of ingredients and stage in the composting process, so that the oxygen diffusing into the pile is not entirely consumed before it reaches the centre. As a result, passive systems must be designed and managed very carefully in order to avoid odour problems. Passive aeration is only applicable when composting yard waste alone (OMRR Schedule 1, Section 5).

5.3.3 Temperature

The compost temperature needs to be measured daily (at least for the first four weeks) during composting. The optimum compost temperature to promote microbial growth ranges from 40°C to 60°C. The heat generated is the result of the decomposition of organic matter by microorganisms. These high temperatures are important because the rate of decomposition occurs at its maximum, and weed seeds and most microbes of pathogenic significance cannot survive. However, at temperatures higher than 65 to 70°C, most microorganism activity is retarded and the degradation process slows dramatically. Therefore, composting proceeds at a much slower rate at excessively high temperatures.

While not specifically part of Part 5 of the OMRR, there are time and temperature requirements that need to be considered as part of the composting operations and, therefore, the potential generation of odours. These time and temperature considerations are found in Schedule 1 - Pathogen Reduction Processes and Schedule 2 – Vector Attraction Reduction of the OMRR. For example, to produce Class A compost, the requirements include:

- Not less than 55°C for at least 15 days with not less than five turnings for windrow composting.
- Not less than 55°C maintained throughout the compost pile for at least three days for static aerated pile composting.
- Not less than 55°C maintained for at least three days during an enclosed vessel composting process.

Details regarding the various types of temperature probes, both manual and electronic, and their use, are available in the various composting handbooks and guides that are referenced in Section 10 of this Guideline.

5.3.4 Moisture Content

Excessive moisture in a composting mass reduces porosity and increases compaction, thereby limiting the movement of air into the mass. This results in increased anaerobic activity and the associated release of odorous anaerobic degradation by-products such as reduced sulphur compounds. Strong, musty odours coming from compost may be a sign that the mix is too moist. Adding more “dry” bulking agent in the initial mix can prevent this type of odour problem. Ideally, moisture content in the composting mix should be 45-60% range (wet basis). This provides the microorganisms with the moisture they need to survive, while, at the same time does not impede the movement of air through the composting windrows.

If the compost material is too dry, biological activity will be slow because the microorganisms need moisture to flourish. However, at high moisture conditions, liquids fill the porous spaces (free air pockets) in the compost piles, thus preventing the flow of air. Under these conditions, oxygen required for aerobic decomposition is very limited and rapidly depleted, resulting in anaerobic decomposition. However, even at normally acceptable moisture contents, anaerobic conditions are likely if compaction or small particle sizes lead to inadequate free space for air flow (porosity). Left uncorrected, compost that is too wet may go anaerobic, producing a foul sulphurous odour that is hard to ignore. If this occurs in indoor bioreactors or static aerated piles, they may have to be taken down and aerated or mixed thoroughly, adding additional absorbent material such as wood chips or sawdust as required. In an outdoor compost pile, turning the pile may be sufficient to correct the anaerobic condition, although initially this may make the odour even more pronounced, at least temporarily.

The moisture content of compost can be measured by (1) weighing an empty container, (2) weighing the container with the moist compost sample in it, (3) drying the sample in an oven at 105°C for six to eight 8 hours, (4) cooling the sample in a desiccator (drying chamber), (5) weighing the container with the dried sample in it, (6) subtracting the container weight (1) from both the wet (2) and dry (5) weights to obtain the sample weights. Calculate the moisture content of the sample using the following equation:

$$\text{Moisture Content} = \frac{\text{(Weight of Wet Sample – Weight of Dry Sample)}}{\text{(Weight of Wet Sample)}} \times 100$$

The “squeeze test” can be used in the field to get an indication of the wetness of the compost. The “squeeze test” can be conducted by taking a hand full of compost and squeezing it tightly. At approximately 60% moisture content, the material should feel damp to the touch, and when it is tightly squeezed in the hand, one or two drops of liquid will be released.

Refer also to the OMRR Schedule 2 – Vector Attraction Reduction, which has moisture requirements.

5.3.5 Compost maturity tests

Composting maturity tests can also be used as a guideline to the remaining odour generation potential in a compost pile or curing pile. These tests can be as simple as measuring the germination success of radish seeds planted in the compost to testing methods such as the “Solvita” maturity test. More information about this latter test is available at:

http://www.woodsend.org/aaa/solvita.html

The US Composting Council has an industry standard for compost maturity called the “Seal of Testing Assurance”, where approved labs test chemical, physical, and biological properties. It is anticipated that there will be similar Canadian programs offered in the future.

The requirements relating to compost maturity including C:N ratio, pathogen limits, etc. are outlined in Schedules 1 through 6.

5.3.6 Odour Summary

Whenever possible, use practices that aim to prevent odours from reaching and impacting the facility’s neighbours. When planning the compost facility, provide a large distance between the compost piles and neighbouring properties and consider the prevailing winds in the area when choosing a site for a composting facility. Try to locate a new facility downwind and as far from residential areas as possible. Refer to local government bylaws respecting nuisance and odour.

Composting raw materials as soon as possible can minimize odours. Select a good mix of raw materials to use in the compost mix and avoid overly wet mixes. Strong smelling materials can be mixed with bulking agents to get a more porous mixture. Try to avoid storing raw materials, however, if you must store materials then make sure to keep them dry.

Regularly monitor compost temperatures. Noticeable ammonia and amine losses and resulting odours are primarily a result of low C: N ratio. Control ammonia by increasing the amount of carbon used in the mix and by maintaining pH levels below 8. Generally, compost material should have a pH at or slightly below neutral (pH = 7) for best odour control. Where odours do not present a problem, a pH of 8 or 9 is acceptable.

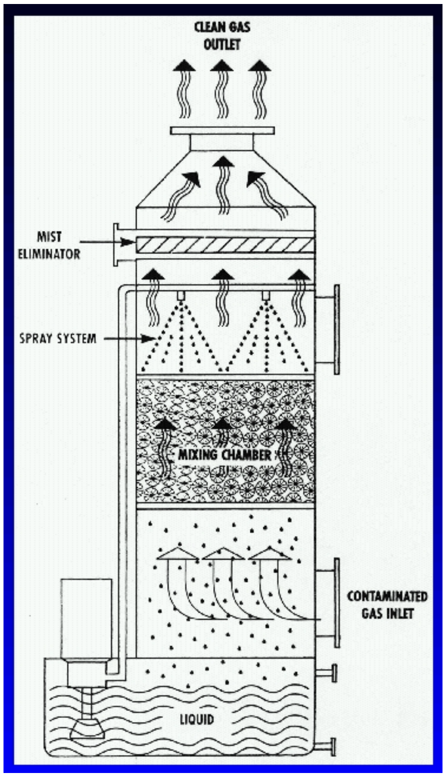
For windrow systems, keep the piles aerobic by having a regular schedule for mixing and turning. Try to mix, turn and move the compost pile during conditions or a period of time that is least bothersome to neighbours such as windy conditions and early mornings, avoiding weekends, and hot, still days. Minimize dusty conditions, which tend to carry odours offsite. Spraying water on dirt or gravel roads can reduce dust. Visual buffers such trees and shrubs around composting areas may help reduce odorous air streams and also the number of complaints (if you can see where the odour is coming from, the people are more likely to complain about it than if they don’t know where the odour is coming from.)

5.4 RECOMMENDED ODOUR MANAGEMENT PROCEDURE

The most complete technical evaluation currently available to define the potential for off site odours is to develop a computer-based odour model specific to the proposed (or existing) composting site. Odour emissions for each on-site source would need to be measured or estimated based on information from other facilities. This approach provides a solid basis for designing a facility to limit off site odour problems and a mechanism for re-evaluating the odour potential based on routine monitoring or to evaluate the veracity of odour complaints. This approach is suggested for all composting facilities, but is not required. The need for this approach will depend on specific site conditions as determined in the environmental impact study. However, this approach will be required in situations where the neighbouring population indicates that the composting facility is creating nuisance conditions.

The facility owner/operator (the “discharger’) or their qualified professional should be aware of the various technologies for odour control including:

- Biofilters
- Wet-chemical scrubbers



Wet Chemical Scrubber Schematic and Installation Photo

An In-ground Biofilter at a Compost Facility

- Thermal catalytic destruction
- Ultra violet irradiation (a new, emerging, technology)
- Chemical odour suppression or counteractants

The QP should also provide the discharger with a monitoring program that includes regular inspection and repair of duct work that carries the foul air stream to the odour control devices.

It is highly recommended for the discharger to document odour complaints in a record book. In addition, a discharger may want to be proactive and distribute generic copies of an odour incident report to neighbours. This would allow neighbours the opportunity to document the date, time, location, weather conditions, and odour characteristics on the incident report and then mail/fax the report back to the composting facility.

An example Composting Facility Odour Management Plan, complete with a compost “odour wheel” and an example odour incident report, is provided in Appendix C to these guidelines. It is highly recommended to check with the local government regarding nuisance and odour bylaws.

DIVISION 3 - LEACHATE MANAGEMENT FOR COMPOSTING FACILITIES

SECTION 6

6.1 INTRODUCTION

Leachate has been defined as "the liquid that results when water comes in contact with a solid and extracts material, either dissolved or suspended, from the solid" (Rynk, 1992). On a composting facility site, this typically refers to "liquid that has percolated through and drained from feedstock or compost and has extracted dissolved or suspended materials" (Alberta Environmental Protection). The British Columbia Organic Matter Recycling Regulation (OMRR, 2002) defines leachate as:

(a) effluent originating from organic matter being received, processed, composted, cured or stored at a composting facility,

(b) effluent originating from managed organic matter being stored or applied to land, or

(c) precipitation, stormwater, equipment wash water or other wash water which has come into contact with, or mixed with, organic matter or managed organic matter being received, processed, composted, cured or stored.

In this way, leachate differs from clean precipitation or even runoff water that may accumulate on the composting site because leachate will contain any combination of nutrients, organic matter, soluble chemicals and, potentially, pathogens. Leachate is generated any time water comes into contact with and drains away from feedstock piles, compost mix piles, the active composting material, materials being screened, materials being cured and materials that have been cured, but have not yet been certified as "Class A" compost.

For example, Table 6-1 contains typical expectations of leachate quality for yard waste composting facilities. Typical concentration ranges (in mg/L unless noted) for compost pad runoff, i.e. leachate, are compared to the State of Oregon General Permit Storm Water Benchmark values and to the typical characteristics of raw sewage:

Table 6-1

Comparison of Yard Debris Composting Leachate with Regulation And Other Wastewater Sources

	Yard Debris Facilities[1]	Oregon Storm Water Benchmark[2]	Typical Raw Sewage[3]
Biochemical Oxygen Demand (BOD)	390-3,200		110-400
Total Suspended Solids (TSS)	2,000-20,000	130	100-350
Total Kjeldahl Nitrogen (TKN)	85-2,600		20-85
Ammonia	23-1,600		12-50
Potassium (K)	170-4,500		
Total Phosphorus (P)	10-170		4-15
Total Copper	0.07-0.8	0.1	
Total Lead		0.4	
Total Zinc	0.1-1.5	0.6	
Fecal Coliform (FC) MPN/100ml	$110\text{-}4.9\text{x}10^{6}$ [(5)]	406 (*E. coli*)[4]	$10^4\text{-}10^5$

.1 Evaluation of Compost Facility Run off for Beneficial Reuse -- Phase 2 (CM-98-1), or Evaluation of Compost; Facility Run off for Beneficial Reuse -- Phase 1 (CM-97-4), Clean Washington Center.

.2 Storm Water General Permit 1200-Z (7/22/97). Oregon State DEQ indicates possible future changes for compost facilities.

.3 Metcalf and Eddy, 3rd Ed., Wastewater Engineering – Treatment, Disposal and Reuse

.4 Only for landfills accepting biosolids and wastewater treatment facilities.

.5 This value is real and was confirmed by one of the Guideline authors (Larry Sasser)

In general, the OMRR requires that leachate be proactively managed through provision of impervious surfaces, covers, curbing and a collection system, as given in Division 3 (26) (2):

Division 3 (26) (2) The receiving, storage, processing and curing areas of a composting facility must comply with all of the following: [NOTE: “all”]

(a) be located on asphalt, concrete or another similar impermeable surface that is capable of withstanding the wear and tear from normal operations and will prevent the release of leachate into the environment;
(b) have a roof or cover, or a prepared surface designed to prevent :
(i) the surface collection of water around the base of organic matter and compost and
(ii) runoff water from entering the receiving, storage, processing and curing areas
(c) have a leachate collection system designed, constructed, maintained and operated to reuse leachate, or to remove leachate, from the receiving, storage, processing, and curing areas.

The Division 3 (26) (2) (b) clause above can be interpreted to mean if there is no cover provided, then a "prepared surface" such as an impermeable surface with edge berms or curbs can also be used to fulfill the requirements of sub-clauses (i) and (ii). In any, case under 26(2)(c) above, there typically must be a leachate collection system.

Division 3 (26) (3) of the OMRR states "Leachate that is not collected and reused in the composting process must not be discharged into the environment unless authorized by this Act."

Division 3 (26) (3) Leachate that is not collected and reused in the composting process must not be discharged into the environment unless authorized under the Act. [the Waste Management Act or its successor].

In actual fact, MWLAP would prefer that composting facilities be designed and operated so that there is no discharge of leachate. For this reason, under Division 3 (26) (4) of the OMRR, it may be possible to avoid the impermeable surface, roof, cover, prepared surface and/or leachate collection and treatment, IF a qualified professional (QP) can use an environmental impact assessment (EIA) to demonstrate that alternative leachate management processes will adequately protect the environment. This can involve site specific leachate management solutions, meeting applicable water quality guidelines (for drinking water and surface waters) at the property boundary and monitoring the nearest receptors (monitoring wells at the property boundary; the closest surface water, etc.)

Division 3 (26) (4) Despite subsections (2) and (3), an impermeable surface, roof, cover, prepared surface or leachate collection system is not necessary if a qualified professional can demonstrate through an environmental impact assessment that the environment will be protected and appropriate water quality criteria satisfied through the use of alternative leachate management processes.

Considering the potential pollutant load indicated in Table 6-1, all composting facilities should be designed to prevent leachate discharges. These objectives lead to a focus on prevention of leachate generation, recycling and reuse of any leachate that is generated, and a significant treatment effort for any that cannot be reused. In most cases, this will mean minimizing contact between rainwater and snowmelt and composting feedstocks, materials under active composting, compost that is curing, and compost that is finished curing, but is not yet certified as “Class A”. It will also mean preventing run-on from entering the site and making sure that uncontaminated runoff from precipitation falling on non-compost-related site areas is effectively separated and controlled. However, this does not necessarily mean that “clean” runoff will not need some treatment prior to discharge from the composting site.

The following sections discuss both leachate control and treatment and stormwater runoff control and treatment.

6.2 LEACHATE CONTROL AND TREATMENT

Based on the above, for the purposes of this Guideline, leachate is defined as water, either from rainfall, snowmelt or intentional addition, which has come into contact with organic materials within the composting facility. This will include the raw composting feedstock materials and their attendant storage areas, materials within any compost mixing areas, materials in the active composting process, materials in the compost curing area, and materials in the compost screening, storage and/or bagging areas. Since the leachate that is produced by such water-material contact can be very strong in terms of biochemical oxygen demand, chemical oxygen demand, resin fatty acids (from woody materials), ammonia-nitrogen, and fecal contamination (depending on the feedstock), it is important that leachate be minimized and that which is produced, is reused as much as possible so that the amount and cost of treatment can be minimized or eliminated.

Leachate control and treatment should be founded on the principals of reduction and reuse, leaving leachate treatment as the option of last resort. These principles include the following:

.1 **Prevent leachate production** – The facility should be designed to separate rainfall and snowmelt from stored feedstock, mixed compost, composting areas, curing compost, and final product through the diversion of clean runoff away from and/or appropriate covering of areas where composting materials (feedstock, mixed compost, curing compost and final product) are located. A proper mix of compost feedstocks, including not using materials that are too wet or adding too much water to the compost mix, should be used. A properly designed compost mix will not generate leachate on its own. If it does generate leachate, it is too wet and the mix and/or mixing procedures need to be revised.

.2 **Reuse leachate that cannot be prevented** - Collection and control of any compost leachate that does occur through the use of hard surfaces, curbing, drains and pipes for the composting feedstock storage areas, the composting mixing area, the composting area, the compost curing area, and the compost screening area. Storage of collected leachate can be reused in obtaining proper moisture content in the initial compost mix. Reuse of leachate during the composting process (e.g. in an open windrow process), should only be done in advance of beginning to measure the time and temperature requirements, e.g. 5 days at greater than 55°C.

.3 **Treat any excess leachate** - This is the method of last resort. Any leachate that has been generated but cannot be reused in the composting process should be treated to a standard that does not unduly impact the natural or man-made environment. This will mean considering leachate as wastewater, and treating it to a standard that, when released, does not cause any impact on the environment. The qualified professional (QP) could look outside the OMRR to the 1999 BC Municipal Sewage Regulations (MSR) requirements for some guidance:

http://wlapwww.gov.bc.ca/epd/epdpa/mpp/msrhome.html

However, using the MSR criteria would not absolve the QP of the need to show that there will be no impairment of the environment due to any leachate release, either treated or untreated as part of an EIA under Section 26 (4) of the OMRR.

Leachate treatment must ensure that the release of leachate does not cause a problem in the receiving environment. The main parameters of concern may include:

- Biochemical oxygen demand
- Chemical oxygen demand
- Ammonia
- Resin fatty acids
- Fecal coliforms

The above listed parameters of concern are site specific to the leachate and receiving environment associated with the composting facility in question. Additional contaminants such as phosphorus and toxicity may also be of concern.

In any case, if treated leachate is discharged, it should not impact the environment. Typically, this may mean that the QP will have to model the discharge and its impact on groundwater and/or surface waters both at the facility property line and at the nearest conceivable receptors, e.g. the nearest drinking water well or the nearest surface water. It will be the responsibility of the QP team to demonstrate and sign-off on the lack of negative impacts.

6.2.1 Compost Facility Water Management as a Leachate Control Strategy

The design of a compost facility should include water management as an integral design feature. Stormwater runoff management should not be considered independently of the moisture needs for the composting process and the ability of the process to evaporate excess moisture. Rainfall can be viewed as an asset or a detriment for compost operations. Despite the common perception that rainfall is an enemy of compost facility operators, if properly managed, rainfall can be turned into a valuable asset. A compost facility design needs to have a water budget, using the highest rainfall in 25 years. Information about rainfalls can be obtained from Environment Canada at websites such as:

http://www.climate.weatheroffice.ec.gc.ca/climate_normals/index_e.html

Rain falls relatively uniformly over a composting facility and takes the path of least resistance, eventually ending up evaporating, absorbed into materials placed on the ground, in a stream, the soil, groundwater or the ocean. The arrangement of the composting facility determines where each drop of water will go and how much absorbed and eroded organic material it will carry with it.

Rainfall or snowmelt that does not come into contact with organic matter on the composting site can be managed as clean runoff. Rainfall or snow melt that does come into contact with organic matter will have to be managed as leachate. A primary management practice therefore, must include consideration of the configuration of the composting process.

The following basic scientific facts are provided as the basis for developing and evaluating BMP's for managing stormwater that falls on composting facilities:

1. Water is essential for composting.
    a. Too much impedes the composting process by retarding the heating process and reducing the movement of air into the composting matrix.
    b. Too little impedes the composting process by hindering the activity of the microorganisms.
2. Water is a powerful solvent for organic compounds. Water in contact with products of degradation (carbohydrates and proteins) will quickly solubilize these compounds and carry them away as leachate.
3. Water is a powerful and active eroding force. Organic particulates, colloids, fats and oils will be eroded and transported by flowing water.
4. The power of water is demonstrated by a survey of compost facility runoff quality by the Clean Washington Center (http://www.cwc.org). The survey found that runoff from compost facilities (primarily green waste) had concentration of critical pollution parameters that were one to several orders of magnitude greater than raw sewage. (See Table 6-1). For perspective, the quality data together with typical runoff estimates indicates that 25 mm of rain on a 1.2 ha yard debris-composting facility

could produce about 310 m^3 of runoff with the organic loading equivalent to one day's sewage from a population of 1,500 people.

5. Together with wheel loaders, organic debris on ground surface produces pulverized organics perfectly prepared for dissolution and erosion by water.
6. Composting organics contain energy capable of evaporating water.
7. Composting can be viewed as an evaporative or "swamp" cooler. Heat generated by microbial degradation of the feedstock may overheat the piles and stop composting. Water in the mix evaporates, thereby cooling the pile and maintaining temperatures in an optimum range for microbial activity. The rate of evaporation is location specific.
8. Initial heating phase is critical for water management. If excess or insufficient water in the initial mix prevents the rapid degradation that heats the pile to thermophilic temperatures, the composting process will be greatly impeded.
9. Compost facility water management must consider the unique ability of the composting process to absorb and evaporate water. Consider these example runoff situations for common composting process components and these sample calculations:
   a. Bare ground averages about zero kg of degradable organic matter per square metre. This provides no energy for evaporation of water. Twenty-five millimetres (25 mm) of rain on bare ground at a composting facility produces about 245,000 litres of runoff per hectare. If this runoff is in contact with pulverized organic debris it may be polluted.
   b. A windrow composting operation with 1.2 m deep and 2.4 m wide piles and 1.5 m aisles, averages about 44 kg of degradable organic matter per square metre. This provides about 600 MJoules of evaporation energy per square metre, which if properly managed has the potential to evaporate 250 mm of water per square metre. Twenty-five millimetres (25 mm) of rain on the active composting area at this facility produces about 96,000 litres per hectare of polluted runoff.
   c. A windrow composting operation with 3 m deep and 7.6 m wide piles and 1.5 m aisles averages about 195 kg of degradable organic matter per square metre. This provides about 2840 MJoule of evaporation energy per square metre, which has the

potential to evaporate 1125 mm of water per square metre. Twenty-five millimetres (25 mm) of rain on the active composting area at this facility produces about 37,000 litres per hectare of polluted runoff.

d. An extended aerated static pile (no aisles) composting operation with 3 m deep piles averages about 3340 kg of degradable organic matter per square foot. This provides about 4900 MJoules of evaporation energy per square metre, which has the potential to evaporate about 2000 mm of water per square metre over a 21 to 28 day composting period. Twenty-five millimetres (25 mm) of rain in 24 hours on the active composting area at this facility should be fully absorbed and evaporated by the composting mass and, therefore, should not produce runoff.

6.3 STRATEGIES TO MINIMIZE COMPOST LEACHATE TREATMENT REQUIREMENTS

Water quality protection can be accomplished at most composting facilities by proper attention to siting, ingredient mixtures, and composting process management. Composting facilities vary in size, materials processed, and site characteristics, and these factors will affect the leachate management design process. Excess water, in addition to increasing the odour potential via anaerobic decomposition, will increase the runoff and leachate potential of a composting pile during rainfall events.

Selecting the right site to locate a composting facility is essential to many aspects of a well-managed composting operation. From an environmental management point of view, the essential issues are soil type, slope, and the nature of the buffer between the site and surface or groundwater resources.

A buffer between the site and surface or groundwater resources is the first line of defence against water pollution. Deep soils, well above the seasonally high water table, can filter solid particles and decrease nitrate migration. A recommended minimum 1 metre vertical buffer would be advantageous because some parts of the province do not have deep soils. Typical horizontal setbacks from the facility to a groundwater well and a surface water body are suggested to be a minimum 30 metres and 15 metres, respectively. The QP should check what is applicable in the specific case in question.

Site design issues may have an impact on water quality. Design issues include the selection of an impermeable working surface, exclusion of run-on to the site by surface diversions, possible drainage of wet areas, and the possible provision of roofs over some or all of the composting area to divert precipitation and keep compost or waste materials dry. In all but fully roofed sites, there will be surface runoff, which may need to be managed. Leachate is often caused by poor site drainage, i.e. when clean runoff is allowed to come into contact with organic composting-related materials. Therefore, the site design process should consider the slope of the site, surface drainage to divert water away from the site, and runoff management. Locate the site on moderately to well-drained soil. Site slope should be a minimum of 1%, but ideally 2 to 4%. Greater slopes generate more runoff and cause soil erosion.

Composting process design can influence leachate generation. For example, for windrows, once the raw materials are mixed and formed into a compost windrow, windrow management becomes an important factor. Windrows should run up and down, rather than across slopes to allow leachate and runoff to move between piles, rather than through them.

Composting pile shape can have a considerable influence on the amount of precipitation retained in a pile, with a flat or concave top retaining water and a convex or peaked shape shedding water, particularly in periods of heavy rain. These effects are most pronounced when the composting process is just starting or after a period of dry weather. In the early phases of composting, a peaked windrow shape can act like a thatched roof or haystack, effectively shedding water. Part of this effect is due to the large initial particle size, and part is due to waxes and oils on the surfaces of particles. Both of these initial effects will diminish over time as the material decomposes. During dry weather, the outer surface of evenly stabilized organic material can become somewhat hydrophobic, limiting absorption and encouraging runoff.

To minimize compost leaching, the moisture content in windrows and piles should be maintained below the maximum recommended moisture content of 65%.

Under the definitions in the OMRR, water that percolates through certified stabilized Class A compost cannot be classified as leachate. However, management of this runoff should still be addressed to comply with the requirements of the Waste Management Act. The QP may choose to use this knowledge in the development of the site and the requirements for covers, etc.

6.3.1 Collection and Reuse of Leachate

As discussed above, the primary strategy to handle compost facility leachate is to minimize generation as much as possible. However, if there is leachate generation, the leachate must be collected and either reused or treated. The following sections discuss leachate collection and reuse.

6.3.1.1 Collection

A variety of methods can be used to collect leachate from a composting site. Division 3, (26) (2) (c) of the OMRR states that leachate collection systems must be "designed, constructed, maintained, and operated to reuse leachate, or to remove leachate, from the receiving, storage, processing and curing areas." In high precipitation areas, where an open compost system is used, a structure of lined gutters can be installed to move leachate to a holding pond. In low precipitation areas, orienting the windrows or piles can maximize drainage away from the site and into a leachate collection pond at the bottom of the slope. Facility planners should note that the described systems will collect both the leachate from the facility and also, the precipitation that falls on-site. Therefore, the leachate collection system should account for both during planning and design phase.

The leachate produced in a closed system (in-vessel, channel, or container) can be collected using options built into the system. This leachate can be stored in a holding tank to be later treated or used for some other purpose, such as providing moisture to a dry compost mixture.

6.3.1.2 Leachate Reuse

Leachate can be a significant source of soluble plant nutrients and organic matter, and therefore, may be valuable in a variety of applications. However, the content of soluble or suspended material in the leachate at a specific composting site is completely dependent on the composition of the feedstocks being processed. In open systems, which pool all on-site water including runoff from raw feedstocks, this may be of particular concern. Besides plant nutrients, leachate can potentially contain trace elements, salts, pesticide residue, and pathogens. For this reason, it is very important that operators, who are planning to manage their leachate in any way other than disposing of it, should have the leachate tested so that they are aware of what it contains. Protection of ground and surface water is critical.

Collected leachate can be recirculated back to the composting process to provide additional moisture for optimum composting conditions. However, raw leachate may contain significant pathogen concentrations, depending on the feedstocks being processed. As a result, it is important that the recycled leachate is only added into the composting material before the start of the compliance period for any time and temperature requirements for pathogen reduction.

6.3.2 Leachate Treatment and Disposal

As discussed above, the need for leachate treatment should be avoided by minimizing the generation of leachate in the first case and through maximizing leachate reuse (in the composting process) as much as possible in the second case. However, if there is still leachate to be disposed of, it must be treated or managed such that its discharge does not cause any negative environmental impacts. While Division 3 (26) (3) requires authorization under the Waste Management Act, e.g. a permit or approval or operational certificate, under Division 3 (26) (4), the OMRR will allow a qualified professional to use an Environmental Impact Assessment (EIA) to demonstrate that the environment will be protected and appropriate water quality criteria satisfied through the use of "alternative leachate management processes". Despite this alternative, there still may be the need for leachate treatment. As result, the following is provided as some guidance to the QP.

6.3.2.1 Parameters of Concern

Leachate treatment must ensure that the release of leachate does not cause a problem in the receiving environment. Parameters of concern are site specific to the leachate and receiving environment. These parameters may include:

- Biochemical oxygen demand
- Chemical oxygen demand
- Ammonia
- Resin fatty acids
- Fecal coliforms
- Pesticide residuals
- Phosphorus
- Toxicity

Biochemical oxygen demand (BOD) is a measure of the strength of the degradable organics in the leachate. A high BOD leachate that is released to receiving water has a higher risk of causing an impact due to oxygen depletion in the stream (river, creek, lake, ocean) than one with a low BOD (either naturally or after treatment).

Chemical oxygen demand (COD) is a measure of all the materials (both organic and inorganic) that can be oxidized by heat and acid. As such, it can include organic materials that are normally not very biodegradable and, as a result, the BOD/COD ratio can be used as a guide as to the biodegradability of the leachate. For example, a leachate with a high BOD/COD ratio, e.g. 0.7, is very amenable to biodegradation and if the BOD is high, then the untreated leachate represents a significant threat to the receiving water. In contrast if the BOD/COD ratio is low, e.g. 0.1, then biological degradation and/or treatment is going to be difficult and the untreated leachate represents much less of an immediate threat to the receiving water. BOD/COD ratios can, therefore, be used to help determine the most appropriate treatment processes that should be used to treat the leachate.

Ammonia as the un-ionized dissolved ammonia gas, NH_3, is toxic to fish. The degree of toxicity is a function of pH and temperature with toxicity increasing significantly with higher pH's, but only marginally with higher temperatures. Ammonia in leachate from a composting facility would likely be the result of an improper Carbon: Nitrogen ratio in the mix, i.e.

too much fresh green waste (e.g. grass clippings in the summer). As a result, the first defence against high ammonia leachates would be proper mix design and implementation. If that does not prevent ammonia in the leachate, it is likely that aerobic biological treatment of the leachate and, specifically, nitrification will be required. If nitrification is required, then there are issues with having sufficient alkalinity in the leachate and then supplying sufficient aeration to complete biological conversion of ammonia to nitrate. Since anoxic denitrification of nitrate to nitrogen helps to recover some alkalinity and oxygen consumed in nitrification, nitrification and denitrification are often paired. Since this obviously further complicates the treatment process, it is best to minimize ammonia in the leachate.

Resin fatty acids are one of the contaminants that result from water leaching through wood waste piles. In the case of a composting facility, this would include both ground yard waste as well as wood chips that are either the main materials to be composted or the main bulking agent for other compostables, e.g. wastewater treatment sludges. In any event, the composition of the wood-derived leachate changes depending upon which tree species it is derived from, but generally it is made up of water-soluble tannins, lignins, fatty acids and wood resin acids from terpenes, which are acutely toxic to fish. These leachates often have a noticeable black or brown colour and may have a strong petroleum like smell (from the terpenes). If they are discharged untreated to surface waters, there is typically a formation of white foam, which identifies changes in local water chemistry, primarily due to the wood resins. Other compounds, such as terpenes, create oily iridescent slicks in slow moving waters where wood waste leachate is present. Since these leachates can be very toxic, e.g. a 1.4% volume/volume 96 hour Lethal Concentration – 50% mortality (96 hr LC_{50}), minimization and treatment is very important. Treatment can include both physical-chemical treatment, e.g. flocculation/sedimentation/ filtration to remove particulates and biological treatment to remove dissolved organics. Constructed wetlands have been shown to provide both types of treatment and substantially reduce the impact on the receiving environment. Standards for toxicity of treated leachate should be based on passing the 96 hr LC_{50} test at 100% concentration in order to not contravene the Federal Fisheries Act.

Fecal coliforms are an indication of the potential pathogen content of the wastewater effluent. Fecal coliforms are associated with composting of either manures or wastewater treatment plant sludges. Standards for fecal coliforms in the discharge of treated composting leachate should likely be the same as those for treated municipal wastewaters under the 1999 BC MSR. (NOTE: This is not an OMRR requirement, and is left to the judgement of the qualified professional).

6.3.2.2 Leachate Treatment and Disposal

If leachate generation and reuse cannot be used to eliminate excess leachate, it may be necessary to treat the leachate in order to protect the environment when the excess leachate is released. This is particularly true if the discharge is to fish bearing waters. The selection of leachate treatment is not prescribed in the OMRR and is left to the judgement of the qualified professional involved.

Leachate treatment will be a function of the strength and characteristics of the leachate. The objectives of leachate treatment should be to have no impact on the environment and, therefore, the QP may look to the quality requirements of the 1999 BC Municipal Sewage Regulations (MSR) as a guideline. The MSR is available at:
http://www.qp.gov.bc.ca/statreg.reg/W/WasteMgmt/129_99.htm
Other resources that may be consulted are the Federal Fisheries Act available at: http://laws.justice.gc.ca/en/F-14/59482.html and the BC Approved Water Quality Guidelines (Criteria) is available at:
http://wlapwww.gov.bc.ca/wat/wq/BCguidelines/approved.html
This could mean equivalent to either secondary or advanced treatment effluent quality, depending on the point of discharge to the environment, i.e. stream, river, ocean, ground disposal, evaporation/percolation beds, etc. For weaker leachates, constructed wetlands may be able to produce the required effluent quality. For stronger leachates, physical/chemical and/or biological treatment may be required prior to disposal. Depending on the situation, either package-type mechanical treatment or pond-type biological treatment processes can be used.

Mechanical/biological treatment would include suspended growth, activated sludge-type systems and fixed-film, rotating biological contactor or trickling filter-type systems. Some form of sedimentation and/or filtration prior to effluent discharge would then follow these. In addition, leachate treatment lagoons can be designed for aerobic or facultative leachate treatment. To be effective, lagoons must be designed to contain the leachate from major storm events, with an adequate residence time for microbial stabilization. Details of pond design vary with climate, runoff characteristics, and pond effluent requirements.

In all biological treatment cases, microorganisms continue the decomposition process started in the compost pile, but in an aqueous system. As the organic material stabilizes, the BOD levels will drop. Pathogen levels should also be expected to drop, although the rate will be dependant on seasonal temperature variations and will be slow during colder winter months.

Composting facility owners and operators (“dischargers”) can use a range of treated effluent disposal methods such as disposal through a local wastewater treatment system (provided the pre-treated leachate meets the local Sewer Use Bylaw requirements and a permit to discharge to the sewer system can be obtained), release through an engineered wetland designed to treat or polish the leachate effluent, and release through other engineered natural purification systems, including grassy swales and filter fields. In some cases, rapid infiltration basins could be used for disposal of treated leachate. Only in rare cases, and only under a permit or some other form of approval, will the discharge be to an actual receiving surface water body. Again, this is left to the judgement of the qualified professional (QP) and his/her ability to show, with an EIA, under Division 3 (26) (4) of the OMRR that the environment is not being harmed.

6.3.3 Example Leachate Management Plan

Appendix D contains an example Leachate Management Plan that deals with separation of clean and contaminated waters, reuse of leachate and treatment of the residual leachate that cannot be reused.

6.4 STORMWATER RUNOFF CONTROL AND TREATMENT

As discussed above, the primary strategy for leachate management is to minimize leachate generation by keeping stormwater run-on and runoff and precipitation away from the compostable organics as much as possible. This implies that, depending on the climate and soil conditions at the site, significant quantities of “clean”, uncontaminated, stormwater runoff from rainfall and snowmelt (that never comes into contact with organic matter) will be generated. While this runoff should be low in organic content and typically should not require biological treatment, it will likely contain some inorganic contaminants including sediments. As a result, in order to prevent environmental impacts on the local ground and surface waters due to erosion and/or other types of sediment transport, it may be necessary to control and/or treat “clean” stormwater runoff from a composting facility.

Stormwater runoff management is likely to take the form of:

- Locating the facility in drier rather than wetter microclimates, where possible, so as to minimize the creation of runoff (as well as leachate).
- Run-on control (minimizing the impact from rainwater or snow melt that flows onto the composting facility) through the use of berms and/or ditches to divert run-on around the composting facility, decreasing the amount of stormwater runoff that needs to be controlled and/or treated.
- Berming and/or curbing to direct rainfall and snowmelt away from all organic materials (this also applies to leachate management).
- Directing rainfall and snowmelt from building roofs away from organic materials and, potentially, into some form of on-site clean water storage for use on the site, e.g. fire and/or dust control or in the composting and/or odour control processes, or for obtaining the correct mix moisture content and/or maintaining the correct moisture content in an odour control biofilter.

Simple technologies such as soil treatment, filter strips, recirculation, or sediment traps can be implemented to help distribute collected runoff. These straightforward, low-cost treatment strategies have proven effective.

The simplest runoff management strategy is the installation of a vegetative filter strip. Vegetative filter strips trap particles in dense surface vegetation. Grasses are commonly used, and must be planted in a carefully graded surface over which runoff can be directed in a thin even layer. Vegetative filter strips slow the motion of runoff water so that many particles can settle out of the water, while others are physically filtered and adsorbed onto plants. Suspended particles flowing slowly through the grass attach to plants and settle to the soil surface, leading to a significant reduction in suspended solids levels.

Clean runoff can also be stored and added to the compost (but only if there is insufficient leachate available for addition), or alternately used to irrigate cropland or pasture areas on the site or on nearby properties. The moisture can thus serve a useful purpose, either by supplying needed moisture to the compost process or by providing water to crops. Reuse of runoff would involve pumping the clean runoff water into the compost windrows, where the water would be evaporated through the composting process. This last option is recommended for use during dry summer or early fall weather, when water often needs to be added to the compost. This option would not be feasible if the moisture content of the compost was already high. However, a runoff reuse system requires both a pumping and distribution system and adequate storage capacity for prolonged wet periods. Runoff storage typically requires the construction of a storage tank or an open pond. However, while an open pond also provides some settling of sediments, it also receives rainfall and, therefore, may result in even more water for treatment, reuse and/or disposal.

Sediment traps operate by settling dense particles out of the runoff. Particles settle by gravity during passage through a basin of slowly moving water. This approach can be particularly effective for removing phosphorous associated with sediment. This will help limit sediment movement off the site, and can be a useful adjunct to either a vegetative filter strip or a treatment pond, enhancing the effectiveness of each.

More information regarding effective stormwater management can be obtained from the Ministry of Water, Land and Air Protection website at:
http://wlapwww.gov.bc.ca/epd/epdpa/mpp/stormwater/stormwater.html

CAPACITY OF COMPOSTING FACILITIES

SECTION 7

On the topic of facility capacity, Part 5, Division 4, Section 27 of the OMRR specifies:

Division 4 (27) *The amount of organic matter in a composting facility must not at any time exceed the total design capacity of the facility.*

Facility design requires enough land to facilitate and operate areas for feedstock unloading, feedstock preparation, active composting, curing, screening and refining, and storing and packaging. It is highly recommended to separate public areas (if applicable) from active working areas. The public is not familiar with equipment operations and movement and as a result, may be harmed.

7.1 FEEDSTOCK UNLOADING AREA AND FEEDSTOCK PREPARATION AREA

The feedstock unloading area should be located on a paved surface, away from the main traffic flow pattern. For efficient material handling, the feedstock unloading area should be located close to the feedstock preparation area. The feedstock preparation area may need additional area to include conveyor belts, grinders, front-end loaders, bulking agents, and other amendments, which may be in place.

7.2 ACTIVE COMPOSTING AREA

The active composting area will depend on the method of composting used. The area required for composting depends on the amount of waste to be received, the amount of bulking agents required and the composting process that is to be used. Generally, for a windrow process, one cubic metre of raw composting material will require about 0.8 square metres of land area. Other composting processes such as extended aerated static pile and in-channel or bin-type composting will require less area. The plan should also allocate room for actual compost piles/windrows and also the operation of any equipment used on site.

7.3 COMPOST CURING

Depending on compost methodology, the area for compost curing is sometimes included in the active compost area. According to Division 3 (26) (1) “curing area” means an area where organic matter which has undergone the rapid initial stage of composting is further matured into a humus-like material. This could be in the open, under cover or in-vessel as long as the requirements for leachate management and odour control are met.

Separate curing areas are used on composting sites using aeration systems. To prevent contamination, it is recommended to keep curing compost away from incoming feedstocks. To prevent cross-contamination, equipment such as front-end loaders used to handle feedstock should be steam-cleaned before handling curing compost.

7.4 SCREENING AND REFINING

Under the OMRR, Schedule 4, Item 2(a) retail grade product should have less than 1% by weight foreign matter. As a result, the compost-finishing step requires screening and refining to remove oversized material such as bulking agents, stones, metal, etc. Therefore, the site layout needs to provide area for screens, machinery, and storage of screened off residues (stones, metal, etc.). Under Part 5, Division 4, Section 29 of the OMRR, the composting facility must include capacity for residuals, i.e. waste contaminants or foreign matter, that need to be disposed of off-site, which must not exceed 15 cubic metres in total at any one time. Residuals management must also consider prevention of vector attraction and disposal. Disposal of residuals is typically to a permitted landfill.

Division 4 (29)
(a) Residuals from the composting process must
(i) be stored so as to prevent vector attraction, and
(ii) be disposed of on a regular basis in accordance with the Act.
(b) Residuals that are stored at a composting facility must not at any time exceed 15 cubic metres in total.

7.5 STORING AND PACKAGING

After screening, it is important to have a place to store the finished compost until it can be used. If the compost is available for sale, additional area may be required for packaging and storing. Regarding stored compost, Part 5, Division 4, Section 28, states:

Division 4 (28) *At least half of the compost stored at a composting facility must be removed annually from the facility beginning in the third year after facility start-up.*

Under Division 3, Section 26(2)(a), roofs or covers are required as part of a leachate minimization plan in order to comply with the requirements of the OMRR. Buildings may be useful for storing equipment, finished compost, or office space, if required. If buildings are used to store raw materials, the composting process and/or the finished compost, they should be well ventilated and able to withstand high moistures. If the final product is a Class A compost, the drainage is, by the OMRR standards, not leachate. However, runoff from Class A compost is still subject to the requirements of the Waste Management Act, including the prohibition on causing pollution. This may have some impact on the storage building requirements.

In addition, a landscaping plan, including plantings of trees and shrubs is strongly recommended to enhance the appearance of the facility and to block the view of day-to-day composting operations.

GENERAL COMPOSTING BEST MANAGEMENT PRACTICES

SECTION 8

This section is intended to provide some guidance regarding best management practices (BMPs) for the actual composting process. It is not intended as a complete composting manual and, as such, does not necessarily deal with all aspects of composting or all types of composting to the same level of detail. The information provided in this section of the Guideline is only a very small portion of the information that is available and which should be considered before designing, constructing or operating a composting facility. Section 10 of this Guideline lists some of the more extensive composting resources.

8.1 OVERVIEW OF MATERIALS FOR COMPOSTING

Most organic materials can be composted eventually, given sufficient time and suitable composting conditions. Some of these materials will be more difficult to compost than others. Materials high in cellulose or lignin content will take longer than those with low contents. Materials high in protein will tend to cause more potential problems with odours due to sulphur compounds and/or amines. Moister materials will tend to have more potential for odour problems (because of porosity issues) than drier materials.

Schedule 12 of the OMRR contains a list of materials that are potentially suitable for composting. Table 8.1 contains a review of these materials and their roles, and potential issues in a composting operation.

The information in Table 8.1 has been provided because composting is a thermophilic process – i.e. “thermo”, as in heat, as in energy. The whole process is about biological energy management. To understand energy management it is necessary to understand the energy potential and characteristics of the feedstocks. Lack of understanding of energy has led to many compost facility failures due to moisture, odour and economic issues. It is all interrelated. Energy determines how much aeration and moisture is needed to maintain pile temperatures. Lack of energy causes difficulty in maintaining temperatures.

Table 8.1
Review of the OMRR Schedule 12 Composting Materials

Raw Material	Bulking Material Suitability	Porosity	Odour Potential	Energy Release	Moisture Content
animal bedding	potential	possible	moderate	moderate	variable
biosolids	no	no	moderate	moderate	moderate
brewery/ winery waste	no	no	high	high	high
domestic septic tank sludge	no	no	high	moderate	high
fish waste	no	no	high	high	high
food waste	no	no	high	high	high
hatchery waste	no	no	high	high	high
manure	no	no	high	high	variable
milk waste	no	no	high	high	high
plant matter	no	variable	high	high	high
poultry carcases	no	no	high	high	moderate to high
wood residuals	yes	yes	low	low	moderate
whey	no	no	high	high	high
yard waste - woody fraction	yes	yes	low	moderate	moderate
yard waste - grass fraction	no	no	high	high	high

Note: These classifications are general and based on experience. There are always exceptions for site-specific conditions.

8.2 TYPICALLY SUCCESSFUL INITIAL CARBON-TO-NITROGEN RATIOS

Nutrient balance is determined primarily by the carbon to nitrogen ratio (C:N ratio) in the compost mix. Although typical C:N ratios can range from 20:1 to 40:1, an efficient composting process needs the composting materials to be characterized by an approximate C:N ratio of 25 to 30:1 (25 to 30 parts carbon to 1 part nitrogen). If woodchips are used as a bulking agent, a C:N ratio of 35 to 40:1 may be used because of the low availability of carbon. Going above 40:1 increases the likelihood that the mix will not heat up.

A listing of common feedstocks and their moisture, C:N and bulk density characteristics is presented in Table 2. pg. 3 of The Art and Science of Composting – A resource for farmers and compost producers, by Leslie Cooperbrand, University of Wisconsin-Madison available at:

http://www.wisc.edu/cias/pubs/artofcompost.pdf

Mixing wet nitrogen-rich material with coarse, dry bulking agents provides an extra carbon source to increase the C:N ratio. It also increases porosity, enhances air circulation, and reduces moisture in the incoming material. As a result, wet nitrogen-rich materials such as biosolids (sewage sludge) or food waste should be mixed with a porous carbon-rich bulking amendment, such as sawdust, woodchips, straw and/or shredded or ground paper in order to retain some fertilizer value in the compost product.

Normally C: N is not a factor for yard debris and solid waste composting and bulking materials are not added. However, during some times of the year, nitrogen from grass clippings can be a problem. Normally carbon feedstocks will not necessarily be in the composting pile on the same day as they are received. Carbon supplies may be erratic and the feedstock may be on site for some time before mixing with the available nitrogen source. In contrast, high nitrogen grass clippings should be composted as soon as possible.

In any event, a qualified professional or trained composting technologist should be consulted regarding the best C: N mix design for each specific case.

8.3 TYPICALLY SUCCESSFUL MOISTURE CONTENTS

Moisture content in the composting mix should be in the 45-65% range and, in most cases, 50% to 60% is the most successful range. This provides the microorganisms with the moisture they need to survive, while, at the same time does not impede the movement of air through the composting mixture. Excessive moisture in a composting mixture reduces porosity and increases compaction thereby limiting the movement of air into the mass. This results in increased anaerobic activity and the associated release of odorous anaerobic degradation by-products such as reduced sulphur compounds. Strong, musty odours coming from compost may be a sign that the mix is too moist. Adding more “dry” bulking agent in the initial mix can prevent this type of odour problem.

In any event, a qualified professional or trained composting technologist should be consulted regarding the best moisture content mix design for each specific case.

8.4 TYPICALLY SUCCESSFUL COMPOSTING PROCESSES

There are many types of composting processes available. These include:

- Passive composting (essentially just a piling technique, no mechanical turning or aeration).
- Turned windrows or piles (with mechanical turning of some form).
- Passively aerated windrows (no turning, but aeration through convection and open-ended perforated pipes).
- Open aerated static piles (no turning, but spaces between the piles, with forced air aeration (either negative or positive aeration)).
- Aerated static piles with fabric covers (such as GORE^{tm}) to control moisture and odours (a relatively new process in 2004).
- Extended aerated static piles (no turning, no spaces between the piles, with forced air aeration (either negative or positive aeration)).
- Aerated turned extended bed (similar to extended aerated static piles but with additional periodic mechanical turning of the piles).
- In-vessel systems (totally enclosed systems with forced air aeration) including ECS, Stinnes-Enerco and Wright.
- Rectangular agitated beds (similar to turned windrows except the compost material is in concrete channels, mechanical turning, may also have forced air aeration through the channel floor).

The control of all composting processes is based on several parameters including:

- The initial carbon to nitrogen ratio (C: N).
- The initial moisture content and maintenance of moisture content.
- Provision of oxygen to the process.
- Control of temperature.
- Maintenance of porosity (which, in turn, helps with the control of oxygen, temperature and moisture content).

Table 8.2 compares the available composting processes and their respective control parameters.

In general, more passive the composting process, the longer it takes to complete the active composting period. Conversely, the more mechanical intervention that is applied, including turning and/or forced air aeration, the shorter the active composting process. If odour control is required, it is easier to facilitate in closed systems than in open systems (but mix design, moisture content and aeration are still the first means of preventing odours from occurring in the first place).

8.5 TYPICALLY SUCCESSFUL EQUIPMENT

This section provides some insights into the effectiveness of typical mixing, aeration and screening equipment.

8.5.1 Mixing

Selection of equipment for mixing of composting feedstock materials is a function of the materials and the available budget. The key factor is the better the mixing, the more homogeneous the mix will be and the more consistent the results will be. As a result, selecting mixing equipment is definitely a “you get what you pay for” exercise.

The least-cost mixing device is a rubber-tired front-end loader or tracked excavator. In this case, the procedure would be to first lay a bed of woody amendments and/or bulking agents down on an impervious (concrete or asphalt) pad, likely, but not necessarily, in an uncovered location. The materials to be composted would be laid on top of this pad and the front-end loader or tracked excavator operator would begin “folding” these materials together. Cascading the

Table 8.2
Comparison of Common Composting Processes and Their Respective Control Parameters

COMPOSTING METHOD	***PASSIVE COMPOSTING***	***TURNED WINDROWS OR PILES***	***PASSIVELY AERATED WINDROW***	***AERATED STATIC PILE***	***EXTENDED AERATED STATIC PILE***	***AERATED TURNED EXTENDED BED***	***IN-VESSEL COMPOSTING***	***RECTANGULAR AGITATED BEDS***
Process Management	Passive	Active	Active	Active	Active	Active	Active	Active
Nutrient Balance[1]	Unmanaged	Initial C:N ratio is set	Initial C:N ratio is set	Initial C:N ratio is set	Initial C:N ratio is set	Initial C:N ratio is set	Initial C:N ratio is set	Initial C:N ratio is set
Oxygen[2]	Infrequent turning	Turned mechanically (on a regular basis)	Air supplied through perforated pipes (with their ends left open to the atmosphere) located below each windrow.	No turning occurs. A blower is attached to perforated pipes located under the pile to actively supply air to the pile (positive /or negative aeration)	No turning occurs. A blower is attached to perforated pipes located under the pile to actively supply air to the pile (positive /or negative aeration)	Infrequent to no turning. Some form of forced aeration (positive and negative) is supplied through the bottom.	Infrequent to no turning of the bin. Some form of forced aeration (positive and negative) is supplied through the bottom of the bin.	Compost is turned using a turning machine Compost is aerated using blowers.
Temperature[3]	Unmanaged	Controlled by turning	Unmanaged	Controlled by blowers	Controlled by blowers	Controlled by blowers	Controlled by blowers	Controlled by blowers
Moisture[4]	Unmanaged	Addition feedstock dependent	Addition feedstock dependent	Addition feedstock dependent	Addition feedstock dependent	Addition feedstock dependent	Addition feedstock dependent	Addition feedstock dependent
Porosity[5]	Undisturbed	Turned	Undisturbed	Undisturbed	Undisturbed	Turned	Turned	Turned
Typical Active Composting Time Required[6]	12 to 24 months	2 months	2 to 3 months	1 to 2 months	1 to 2 months	3 to 4 weeks	3 to 4 weeks	3 to 4 weeks
Typical Curing Time Required[6]	-	1 to 2 months	1 to 2 months	1 to 2 months	1 to 2 months	1 to 2 months	1 to 2 months	1 to 2 months

1 C:N ratio ranges from 20:1 to 40:1. Preferably, C:N ratio ranges from 25:1 to 30:1.
2 Oxygen concentration is recommended to be greater than 5%.
3 Optimum compost temperature between 40 to 60 °C.
4 Moisture content ranges from 40 to 65%. Preferably, moisture content ranges from 50 to 60%.
5 Particle size diameter generally ranges from 3 to 13 mm and bulk density typically ranges from 530 to 650 kg/m^3.
6 Depends on materials; can be longer (or shorter) depending on the situation

materials out of the bucket onto the mixing pile will help to homogenize the mixture. However, this will also help to release odours from some compost feedstocks, e.g. sewage sludge or animal manure. This type of mixing operation is not recommended for animal morts.

The next level up in cost and effectiveness is a mechanical mixing bucket on a front-end loader or tracked excavator. These mix buckets are made by a number of vendors and typically involve some type of hydraulic drive system that moves a mechanical mixing device, e.g. flails or an auger, within this special purpose bucket. These buckets have limited capacity and throughput but can result in a much better mixed product than with a normal front-end loader and bucket.

Compost windrow turners can also be used as mixers in non-windrow situations. In this case the materials to be mixed would first be laid out, in layers, on an impervious (concrete or asphalt pad). The windrow turner would then make several passes over these materials, improving the homogeneity of the mixture with each pass until, after two or three passes, the improvements are very marginal. At that point, a front-end loader would be used to remove the mixture from the pad and place it in the composting process. [NOTE: Windrow turners are high energy devices and can throw heavy debris long distances. Appropriate safety protocols are required.]

The most costly, but also most effective means of mixing is a mechanical “mix box”. These mix boxes typically contain several (typically four) counter-rotating horizontal augers or two vertical augers. Such mix boxes can be set up on trailers as portable units or on a permanent concrete pad. In the latter case, the mix box can be equipped with load sensing-pressure transducers. When these transducers are connected to the proper electronic interface, they can be used to accurately control the composition of the mix, e.g. each of the components of the mix can be weighed within a few percent of the theoretical mix design requirements, and when the mix box is full, the mixing can proceed automatically on a preset mix-time basis. In addition, a tub grinder could be utilized if some of the feed stock needs to be reduced in size. Also a trommel screen would work in some cases.

Care must be taken not to over mix the composting feedstocks. Over mixing leads to bulking and the formation of clumps. Typical mix time is often only approximately 5 to 7 minutes.

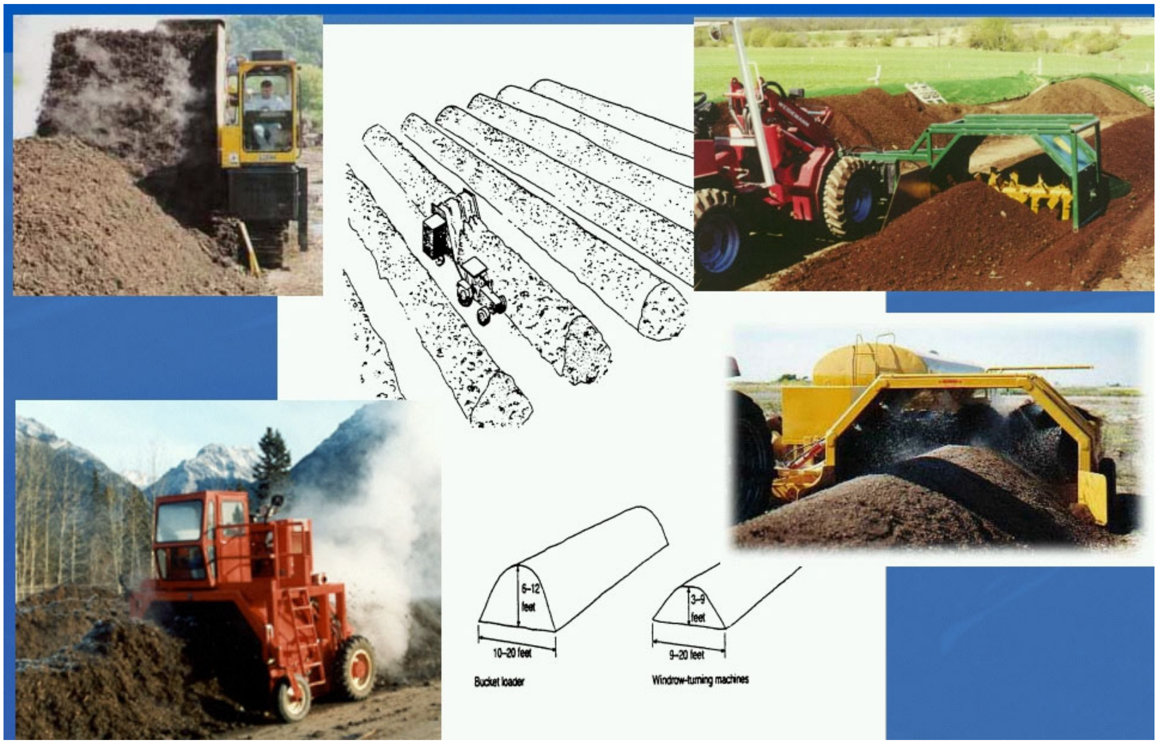
8.5.2 Aeration Equipment

Front End Loaders: The least cost, and likely least effective, aeration equipment would be a front-end loader in a windrow composting application. Such front-end loaders have been and are being used relatively effectively in windrow composting of relatively innocuous materials such as yard and leaf waste composting. The usual trade-off is the front-end loader is not as effective or productive as a purpose-built windrow turner but the facility will likely already have one and, therefore, does not have to invest additional capital in the operation. An excavator could serve the same purpose.

Purpose-built Windrow Turners: These come in a variety of designs including straddle-type and face-type as well as towed and self-propelled. The straddle-types go completely over the windrow and are either towed or driven down the pile with their rotary drum-type mixers operating very similarly to a garden roto-tiller. The size of the windrow is therefore related to the width and height of the “straddle”. Rising face-type elevating turners are more like conveyors. They lift the material from the bottom of the pile and up and over the back of the elevating cleated rubber conveyor. Elevating turners are often used to turn a windrow in two passes: once down one side and once down the other side. In some designs, the material is side-cast to form a new pile or windrow.

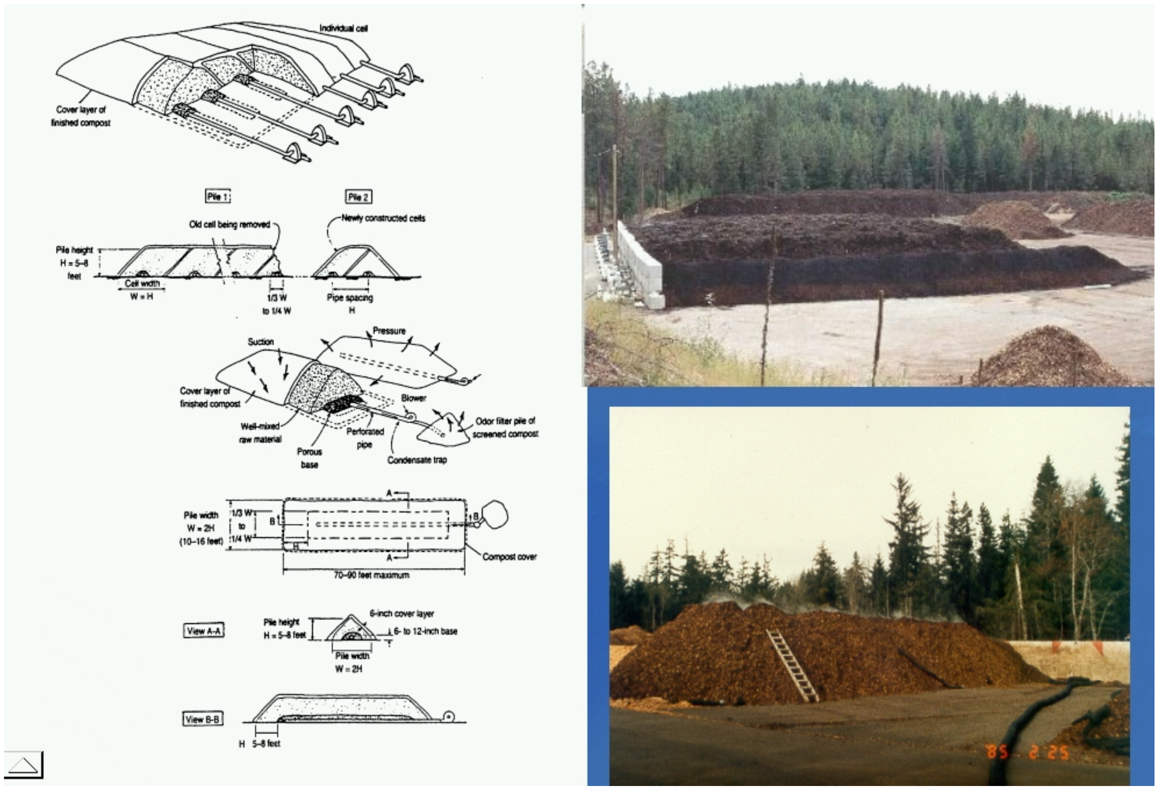
Aerated Static Piles (ASP) are similar to windrows but they are not turned. Instead the aeration is supplied from beneath the piles. In many cases, the aeration is based on perforated pipe, e.g. Big-O or perforated PVC, embedded in a layer of clean wood chips. In some cases, special permanent aeration floors with aeration grates or spigots embedded in concrete or asphalt are used. However, this is relatively rare for traditional aerated static piles.

Extended aerated static piles (EASP) are similar to aerated static piles except that the piles are continuous, i.e. one week’s pile lies up against the previous week’s pile, etc. As such, the aeration systems are similar to those of aerated



Windrow Composting Schematic and Example Windrow Turners

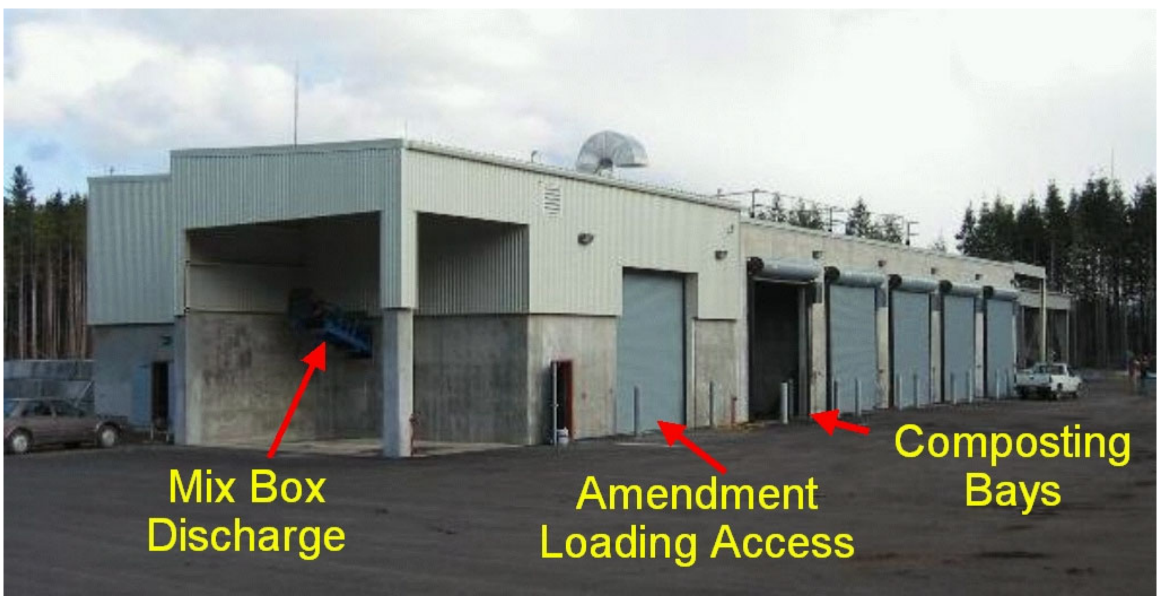
Windrow Composting Inside a Building (showing a self-propelled elevating turner)



Aerated Static Pile and Extended Aerated Static Pile Schematics and Photos

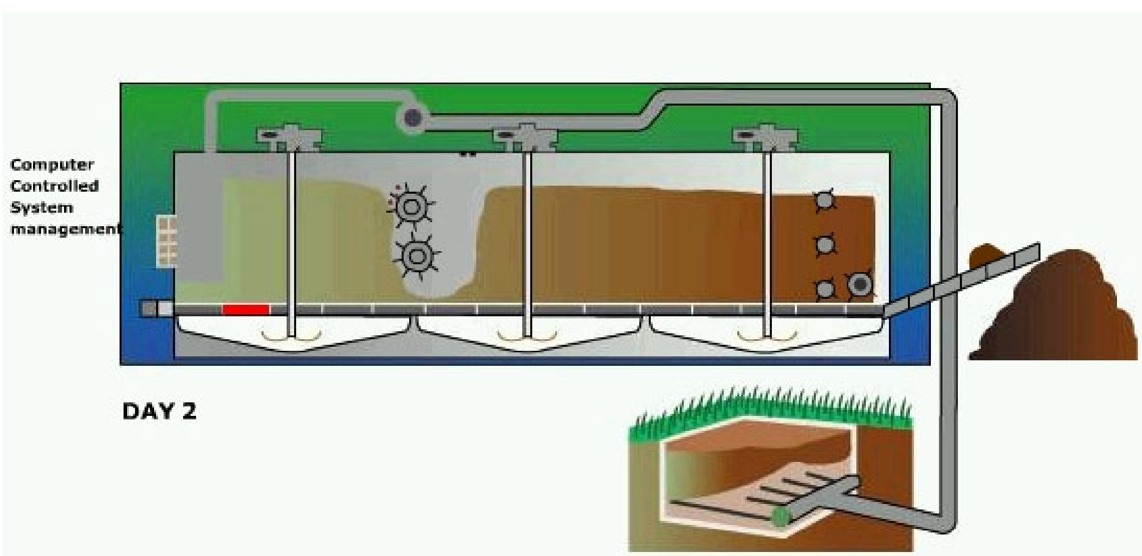
Building an Extended Aerated Static Pile Compost Pile at an Interior B.C. Facility

An Aerated Static Pile System with a Fabric Cover (Gore TM) for Moisture and Odour Control



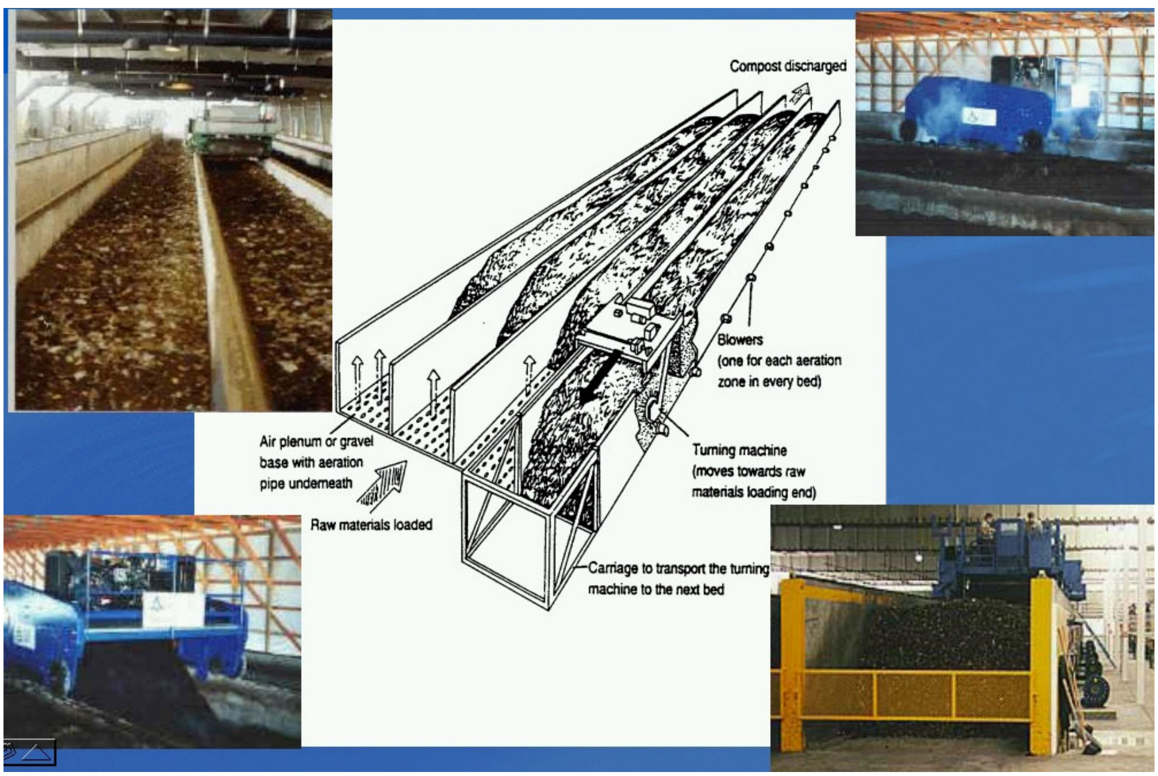
An Aerated Static Pile System Based on Covered, In-Floor Aeration, Sealed Bays

A Containerized In-vessel Composting Facility (courtesy of Engineered Compost Systems)



A Schematic of the Wright Environmental Moving-bed In-vessel Composting System

A Stinnes-Enerco In-vessel Composting Facility



A Schematic of a Rectangular Agitated Bed Compost System with Examples static pile. However, EASP's are more likely to have permanent aeration floor systems than ASP's.

Bin-type composting systems are much the same as extended aerated static piles except there is a wall between each week's pile. In this case, because bin-type systems are very often in permanent buildings, it is very common for bin-type systems to be equipped with permanent in-floor aeration systems.

Agitated bed or channel systems are, in some ways, similar to windrows in that the mixing and aeration is typically done with a straddle-type roto-tiller-like machine. The differences include the fact that the compost materials are in concrete channels rather than open windrows, and the compost turner runs on rails on the top of the channel walls, rather than on tracks or rubber tires like a windrow turner.

The aerated and turned extended bed system uses aeration and frequent turning to fully manage the environment in a composting mass. This approach uses an extended pile and an aerated floor similar to the EASP but includes periodic turning using a rising-face conveyor / sidecast-type turning machine. This process provides the benefits of aeration and turning to control temperature, moisture (added during turning), and porosity throughout the active composting period.

8.5.3 Screens

Screening is required to remove uncomposted materials from the compost. Depending on the feedstock, this would include contaminants such as rocks, stones, plastics, and metal objects as well as amendment-type materials such as large woody debris and woodchips. Screens are usually paired with multiple conveyors to help separate and sort these screened materials because there is some value in recycling some of the materials, e.g. the woody debris and wood chips.

The two most common types of successful composting screens are the internally fed rotary trommel screen and the externally fed "star" screen. While both screen types have their supporters and detractors, the trommel screen is most likely to be negatively affected by pre- or post-curing compost that is too wet. However,

Screening Finished Compost Under cover on a Paved Pad

An Aerated Curing System Under Cover on a Paved Pad newer trommel screen cleaning brush designs are helping to eliminate much of the clogging problems formerly experienced with wet compost. Star screens are good for wetter products; however, the disadvantage is that bulking agents (overs) can fall through the spaces between the “stars”. The “star” screens don’t remove plastic film very well and can be damaged by rocks (but so can trommel screens).

8.6 TYPICALLY SUCCESSFUL RE-MOISTENING STRATEGIES

The most effective method of re-moistening the composting material is to physically mix the water with the composting material. With windrows, the external material can be moistened with surface spray and then mixed in with one or more turning machine passes. In addition, the windrow compost turners can be equipped with a spray bar system to permit additional re-moistening during compost turning.

Injection and surface spraying of static piles may be helpful, but will likely cause uneven moisture, which may create process control difficulties. Moisture addition techniques that allow direct water addition to thin layers of material are the most effective. An example is running the material on a conveyor under a spray bar. Additional mixing of the material remoistened in this way will assure complete distribution of the moisture throughout the composting material. Aerated static pile systems with membrane covers don’t require re-moistening.

8.7 TYPICALLY SUCCESSFUL TEMPERATURE MONITORING AND CONTROL EQUIPMENT AND PROCEDURES

The OMRR is all about creating composting products that can be reused in some manner. One of the main criteria that govern this reuse is the pathogen content of the compost. This in turn, is governed by the time and temperature requirements for the specific compost classification, i.e. Class A or Class B compost. The owner or operator of a composting facility (or “discharger” under the OMRR) or their designated qualified professional (QP) should be fully aware of the time and temperature requirements of Part 3, Division 5, Section 12 for Class A compost and Part 3, Division 6, Section 14 for Class B compost as well as the contents of Schedules 1, 2, 3, and 4 of the OMRR.

There is a wide range of temperature monitoring and control equipment procedures that are available. At the very low end, there are long tube-type thermometer probes (similar to but longer than kitchen meat thermometers). These can be temporarily inserted into the compost pile or left in the compost pile during the composting process, and physically read. As such, this technique is likely only suitable for small-scale windrow or aerated static pile composting systems.

A slight improvement on this temperature measuring technique is the use of thermocouples mounted on aluminum rods. The read-outs from these systems can be done physically in small-scale operations or remotely in larger operations through wires and a System Control and Data Acquisition (SCADA)-type system to a central control facility. As a result, this is probably cheaper and more effective where multiple temperature readings are needed.

A more recent innovation is the development of wireless remote temperature sensors. These probes eliminate the troublesome hard wire connections of previous SCADA systems and can transmit up to approximately 200 m to a central monitoring system. According to one manufacturer, up to 64 such probes spread over 8 hectares can be monitored by their central monitoring system.

8.8 TYPICALLY SUCCESSFUL CURING PROCEDURES

Successful curing relies on an effective active composting process. The degree of attention and processing needed during curing is directly related to the degree of stability provided by the active composting phase. A well-stabilized material delivered to curing may only need time and no operator attention to provide a fully mature product. Material that is not fully stable may require aeration, turning and temperature monitoring in order to develop a stable product without undesirable odours. Another curing process is to turn piles to allow excess moisture to be driven off prior to screening.

Curing should meet the requirements of the OMRR including Schedule 2, Vector Attraction Reduction. Tests for stability should be used to determine whether curing is complete.

8.9 TYPICAL COMPOST FACILITY STAFFING LEVELS

Sufficient staff should be provided to safely process the quantities received in a timely manner. Feedstocks should be processed and placed in composting piles on the day received. Sufficient staff should be provided to monitor the composting process to assure that the facility is not creating undesirable off site impacts and to assure that all requirements are being satisfied. Staff should have training, either through on-the-job learning at this or another composting facility, or through training provided through a community college or composting association. For example, training courses are available through the Canada and US Composting Councils, Olds College in Alberta, Washington Organic Recycling Council, and the Solid Waste Association of North America. More information is provided on the next page.

8.10 SAFETY

Composting facilities can be dangerous operations if care and caution are not taken. There are both stationary and mobile equipment that can and have caused personnel injury and/or death. In addition, microoganisms involved in the composting process can cause health issues in sensitive individuals. As a result, the operation of all composting facilities needs to be done in a manner that is in complete compliance with Workers Compensation Board (WCB) requirements.

The Composting Council of Canada 16 Northumberland Street Toronto, Ontario M6H 1P7 Toll free: 1-877-571-4769 Tel: (416) 535-0240 ccc@compost.org	The Council hosts Operator's courses if there is sufficient interest. Contact the Council for more information and to register. In addition, the Council has a "Compost Facility Operating Guide" which is the basis of their training course. The guide is available for $200.
Washington Organic Recycling Council P.O. Box 2799 Longview, WA 98632 Tel: (360) 556-3926 training@compostwashington.org	The Council offers Operator training which consists of classroom training, hands on interactive sessions, field trips and a written examination. Contact the Council for more information and to register.
Olds College Centre for Innovation 4500 50 Street Olds, Alberta T4H 1R6 Toll free: 1-877-815-6224 Tel: (403) 507-7970 occi@admin.oldscollege.ab.ca	Olds College has three-day tutorials on Operator training. Contact the College for more information and to register.
Solid Waste Association of North America (SWANA) http://www.swana.org BC Chapter of SWANA http://www.ecowaste.com/swanabc	In partnership with the US, Composting Council's Professional Credentials Committee, SWANA offers a certification program for composting professionals, and several courses on compost operations online and at various locations each year. Course information is available on websites.

COMPOST OPERATING AND CLOSURE PLAN

SECTION 9

Compost operating and closure plans are required under Part 5, Division 2, Section 24(2) (e) of the OMRR. The operating plan is intended to describe the day-to-day facility operations and corrective actions should they be required.

9.1 OPERATING PLAN

It is recommended that a compost operating plan include (but is not limited to) the following elements:

1. Facility Design Criteria – Provide the capacities, function and sizing criteria for all systems provided for composting and support services.

2. On-site solid waste handling – Include the type and quantities of waste to be composted, how the incoming material will measured (volume and/or weight), how it will be handled from the time it is received to the time it is stored, a material flow diagram, the type of compost method used, the actual compost facility capacity, procedures for handling peak and low flow of materials, procedures for preventing cross-contamination of raw materials and finished compost, etc. Demonstrate that highly odorous feedstock materials, such as animal morts and fish offal, will be processed immediately and not stored on-site.

3. Type and frequency of inspections/monitoring that will take place and records to verify that the inspections/monitoring are occurring - Address how incoming feedstock will be inspected and how to differentiate between acceptable and non-acceptable feedstocks. Include procedures to deal with problem feedstock, procedures to identify and correct problem compost piles, procedures to monitor compost moisture and temperature (include frequency of monitoring), and any additional monitoring that will be conducted at the facility, as well as monitoring of groundwater and surface water if applicable. Include procedures to deal with equipment failures including contingency plans for turning and/or aeration equipment failures and odour control system failures.

4. Sampling and Analyses plans to show how the operation will comply with Schedule 5 of the OMRR.

5. Record keeping plans to show how the operation will comply with Schedule 6 of the OMRR.

6. Air quality control plan – The air quality control plan should describe procedures for preventing and mitigating problems related to dust, and equipment exhausts.

7. Wildlife management and control plan – Plan to detail the management and control of birds, rodents, vectors, bears, etc.

8. Equipment operation and safety procedures – Describe the type of equipment that will be used at the facility and Workers Compensation Board (WCB)-compliant safe equipment operating procedures. Include equipment maintenance procedures and a plan of action to handle equipment operational failures. If standby equipment is available, make reference to it in the procedures and indicate under what circumstances it will be used.

9. Employee training procedures – Describe how employees will be trained about the composting process and corresponding facility operations and procedures including operator health protection procedures. Training courses are available through the Canada and US Composting Councils, as well as through Olds College in Alberta as was discussed in Section 8.9.

10. Safety Plans – Safety plan should provide details regarding employee and visitor safety, including the use of safety equipment such as eye and ear protection and dust/mold respiration masks.

11. Emergency Plans – Emergency plans consist of, but are not limited to fire emergencies and environmental contamination emergencies. Provide emergency procedures, including emergency contact numbers.

12. Facility and equipment maintenance programs – This program is intended to keep the facility and equipment in top shape by having regularly scheduled maintenance for the facility and various pieces of equipment. Indicate how each piece of equipment will be maintained and how frequently maintenance will be conducted.

13. Record keeping – Record keeping is an important task that is required under Schedule 6 of the OMRR. Records will help track routine composting activities and assist in troubleshooting when problems such as odours occur. It is recommended to keep records indicating the type and amount of raw materials received at the facility, and various monitoring activities such as compost temperature and pH.

14. Marketing Plan Summary - expected markets and marketing methods (at least in a general manner)

15. Community Relations Plan – to demonstrate how problems will be dealt with.

In addition to the above, it should be noted that separate leachate/stormwater management and odour management plans must also be submitted as part of a total package of information for the Facility. Example Odour and Leachate Management Plans are attached in Appendices A and B.

9.2 CLOSURE PLAN

Part 5, Division 4, Section 30 of the OMRR states that a compost closure plan should address how all compost will be "applied or distributed in accordance with this regulation [OMRR]" before the composting facility closes. Division 4 also states "all unprocessed organic matter must be removed from the facility and dealt with in accordance with the Act [the Waste Management Act]."

Division 4 (30) *Before the closure of a composting facility,*
(a) all compost must be applied or distributed in accordance with this regulation, and
(b) all unprocessed organic matter must be removed from the facility and dealt with in accordance with the Act.

A compost facility closure plan is recommended to include the following:

1. Schedule and closure plan steps - A schedule and description of the steps necessary to close the composting facility.

2. Closure period – Indicate the length of time between receiving raw material and the completion of closure activities.

3. Waste removal procedures - After the facility has ceased operation, describe how all residuals, waste, leachate, etc. will be removed from the site and disposed of according to the Waste Management Act.

Division 4 (29) *(1) Residuals from the composting process must (b) be disposed of on a regular basis in accordance with the Act.*

4. Facility clean up procedures - Describe the procedures to be followed to conduct the final cleaning of any containers, equipment, machines, floors, etc. that have come in contact with the waste.

5. Site restoration procedures - Describe procedures and plans for composting site restoration.

6. Third party involvement - If a third party will be involved in the facility closure procedures, indicate how they will be involved and the cost amount required by the third party to perform the closure activities.

7. Requirements of other agencies must be taken into account. For example, if the facility is on an Agricultural Land Reserve (ALR) land, the facility closure plan should indicate how to get the land back to agriculture use.

RESOURCE LIST

SECTION 10

This section consists of sub-section 10.1 – Acts and Regulation and sub-section 10.2 – Guidelines, Handbooks and Internet Resources.

10.1 ACTS AND REGULATIONS

The following are some of the Acts and Regulations that the Composting Facility Owner/Operator (the "discharger') and/or their qualified professional (QP) should consult during the development of their compost facility development and operation plans:

1. Waste Management Act and Health Act - Organic Matter Recycling Regulation, Government of British Columbia, 2002.

   Available on the Internet at:
   http://www.qp.gov.bc.ca/statreg/reg/W/WasteMgmt/18_2002.htm

2. The Agricultural Land Reserve (ALR), Use, Subdivision and Procedure Regulation (ALRUSP) [B.C. Reg. 171/2002]

   Available on the Internet at:
   http://www.alc.gov.bc.ca/alr/alr_main.htm

3. The Drinking Water Protection Act
   This Act prohibits introducing, causing or allowing anything that will result or is likely to result in a drinking water health hazard in relation to a domestic water system.

   Available on the Internet at:
   http://www.qp.gov.bc.ca/statreg/stat/D/01009_01.htm

4. The Health Act
   This Act has conditions under the Sanitary Regulations:
   *Section 9: prohibits accumulation or discharge of wastes that endanger the public health;
   *Section 42: provides separation distances from wells to be at least 30.5 m from any probable source of contamination (probable source of contamination could include compost materials and leachate);
   *Section 43: prohibits the contamination of any domestic water supply.

Available on the Internet at:
http://www.qp.gov.bc.ca/statreg/stat/H/96179_01.htm

5. The Mushroom Composting Pollution Prevention Regulation
Applies to a farm that is producing media that will be sold off-farm. It regulates air and water discharges by requiring an implemented pollution prevention plan. The specifications for the plan are identified in the Regulation.

   Available on the Internet at:
   http://www.qp.gov.bc.ca/statreg/reg/W/WasteMgmt/413_98.htm

6. The Federal Fisheries Act
This Act has two sections of importance to compost management:
*Section 36(3): prohibits the deposit of deleterious substances into watercourses (deleterious substances could include compost materials and leachate);
*Section 38(4): requires reporting infractions of Section 36.

   Available on the Internet at:
   http://laws.justice.gc.ca/en/F-14/59482.html

7. The Species at Risk Act
This Act has sections that protect listed species, their residence and critical habitat. It applies to federal lands, internal waters (i.e., all watercourses), territorial sea of Canada, and the air space above them. Until ordered by the federal government, it does not apply to private or provincial Crown lands.

   Available on the Internet at:
   http://www.speciesatrisk.gc.ca/legislation/default_e.cfm

8. Agricultural Land Commission Homepage

   Available on the Internet at:
   http://www.alc.gov.bc.ca

9. Office of the Fire Commissioner Homepage

   Available on the Internet at:
   http://www.mcaws.gov.bc.ca/firecom/fsp/index.htm

10. Stormwater Planning: A Guidebook for British Columbia

    Available on the Internet at:
    http://wlapwww.gov.bc.ca/epd/epdpa/mpp/stormwater/stormwater.htm

10.2 GUIDELINES, HANDBOOKS AND INTERNET RESOURCES

1. "The Science of Composting", E. Epstein, Technomic Publ. Co., Inc., Lancaster, Pennsylvania. 1997

2. The Citizen's Guide - Canadian Environmental Assessment Process, Canadian Environmental Assessment Agency, 1994.

   Available on the Internet at:
   http://www.acee.gc.ca/

3. "Site Selection for Composting", Composting Fact Sheet, British Columbia Ministry of Agriculture, Food and Fisheries, 1996.

   Available on the Internet at:
   http://www.agf.gov.bc.ca/resmgmt/publist/300series/382500-6.pdf

4. "Managing Agricultural Composting Systems", Composting Fact Sheet, British Columbia Ministry of Agriculture, Food and Fisheries, 1996.

   Available on the Internet at:
   http://www.agf.gov.bc.ca/resmgmt/publist/300series/382500-7.pdf

5. On-Farm Composting Handbook, Robert Rynk, 1992.

   Available by contacting:
   Northeast Regional Agricultural Engineering Service, 152 Riley-Robb Hall, Cooperative Extension, Ithaca, NY 14853-5701
   Or libraries at ISBN 0-935817-19-0

6. The Art and Science of Composting – A resource for farmers and compost producers , Leslie Cooperbrand, University of Wisconsin-Madison

   http://www.wisc.edu/cias/pubs/artofcompost.pdf

7. Compost Facility Resource Handbook - Guidance for Washington State, Washington State Department of Ecology, 1998.

   Available by contacting:

Department of Ecology Publications, P.O. Box 47600 Olympia, WA 98504-7600, Telephone: (360) 407-7472.

Also available on the Internet at:
http://www.wa.gov/ecology/swfa/swhome.html

8. B.C. Agricultural Composting Handbook. 1996. British Columbia Ministry of Agriculture, Food and Fisheries.

   Available by contacting:
   Ministry of Agriculture, Food and Fisheries, (604) 556-3100, Order No. 382.500.

9. On-Farm Composting, A Review of the Literature, Government of Alberta, Agriculture, Food and Rural Development, 2002.

   Available on the Internet at:
   http://www.agric.gov.ab.ca/sustain/compost/standards.html

10. Conservation Practice Standard, Composting Facility, Code 317, Natural Resources Conservation Service, 1990.

    Available on the Internet at:
    http://h2o.enr.state.nc.us/nps/317.pdf

11. Washington State University Compost Connection Homepage

    Available on the Internet at:
    http://csanr.wsu.edu/programs/compost/

12. Cornell University Composting Homepage

    Available on the Internet at:
    http://compost.css.cornell.edu/Composting_homepage.html

13. Clean Washington Center Homepage

    Available on the Internet at:
    http://www.cwc.org/

14. “The Green Lane”, Environment Canada Homepage

    Available on the Internet at:
    http://www.ec.gc.ca/envhome.html

15. “Practice Introduction”, USDA, Natural Resources Conservation Service – Practice Codes, 2002.

    Available on the Internet at:
    http://www.nrcs.usda.gov/programs/Env_Assess/EQIP/AppB_AFO.pdf

16. “Code of Practice For Compost Facilities”, Alberta Environmental Protection

    Available on the Internet at:
    http://www.qp.gov.ab.ca/document_print.cfm

17. “Wastes – Composting”, U.S. Environmental Protection Agency Homepage

    Available on the Internet at:
    http://www.epa.gov/epaoswer/non-hw/compost/index.htm

18. The Composting Council of Canada Homepage

    Available on the Internet at:
    http://www.compost.org/

19. “On-Farm Composting – A Review of Literature”, Alberta Agriculture, Food and Rural Development Homepage

    Available on the Internet at:
    http://www.agric.gov.ab.ca/sustain/compost/standards/html

20. Canadian Environmental Assessment Agency Homepage

    Available on the Internet at:
    http://www.acee.gc.ca/

21. U.S. Composting Council Homepage

    Available on the Internet at:
    http://www.compostingcouncil.org/index.cfm

22. The Recycled Organics Unit Composting Information

    Available on the Internet at:

    http://www.recycledorganics.com/processing/composting/composting.htm

OMRR GLOSSARY

Act: Waste Management Act

Active Composting: Compost feedstock that is in the process of being rapidly decomposed and is unstable.

Aerated Static Pile: A method of composting that involves mechanically moving air through the compost pile, either through suction or blowing air through the pile. Little or no pile agitation or turning is performed.

Buffer Zone: The area between the active composting area and the property boundary. Separation distance.

Bulking Agent: Carbonaceous material (i.e. wood chips or sawdust) added to feedstock to improve the structure and porosity of the compost mix.

Capacity: The amount of finished compost that can be produced at the facility.

Carbon-to-Nitrogen Ratio (C:N ratio): The ratio of the weight of organic carbon (C) to that of total nitrogen (N) in an organic material.

Compost: Product which is (a) a stabilized earthy matter having the properties and structure of humus, (b) beneficial to plant growth when used as a soil amendment, (c) produced by composting, and (d) only derived from organic matter.

Composting: The controlled biological oxidation and decomposition of organic matter in accordance with the time and temperature requirements specified in Schedule 1. Compost includes vegetable, yard, and wood wastes, which are not hazardous wastes.

Composting Facility: A facility that processes organic matter to produce compost.

Curing: The last stage of the composting process that occurs after most of the readily metabolized material has been decomposed and stabilized. Turning and/or forced aeration is no longer necessary.

Decomposition: The breakdown of organic matter by microorganisms and invertebrates.

Discharger: Any of the following responsible persons: (a) an owner of a composting facility; (b) an owner of a facility that produces managed organic matter for land application; (c) a registered owner of the land where managed organic matter is applied.

Environmental Impact Assessment (EIA): This is a targeted study to demonstrate how well planned pollution control mitigative measures will protect the environment from impact. In the context of the OMRR (Division 3 (26) 4), if conditions are suitable, a qualified professional (QP) can use an EIA to demonstrate that alternative leachate management processes, other than impermeable surfaces or covers and leachate treatment facilities, can be used to protect the environment, e.g. surface and groundwater quality.

Environmental Impact Study (EIS): This is a comprehensive study and inventory of the natural environment around the site and its surroundings that is conducted before the facility is built or expanded. Under the OMRR (Division 3 (26) 1), an EIS is only needed when the facility capacity will be 20,000 tonnes/year of product after construction or expansion.

Fecal Coliforms: Bacteria that are aerobic or facultative anaerobic, gram-negative, non-spore forming, rod shaped, capable of fermenting lactose and producing acid and gas within 24 hours at 44.5°C.

Feedstocks: Biologically decomposable organic materials used for the production of compost (i.e. food wastes, plant matter, yard waste).

Forced Aeration: Using blowers to move air through the composting material in a compost pile or vessel.

Impermeable: Not permitting water or another fluid to pass through. Typically this is taken to mean the hydraulic conductivity is less than 1×10^{-7} cm/s.

In-Vessel Composting: A method of composting where the composted materials are completely encapsulated during the composting process.

Leachate: Any of the following: (a) effluent originating from organic matter being received, processed, composted, cured or stored at a composting facility, (b) effluent originating from managed organic matter being stored or applied to land, or (c) precipitation, stormwater, equipment wash water or other water which has come into contact with, or mixed with, organic matter or managed organic matter being received, processed, composted, cured or stored.

Manager: A Ministry of Water, Land and Air Protection (MWLAP) Regional Pollution Prevention Manager.

Moisture Content: The fraction of a substance made up of water. Moisture content equals the weight of the water portion, divided by the total weight of the substance.

Odour: The property or quality of a thing that stimulates or is perceived by the sense of smell.

Organic Matter: Those materials set out in Schedule 12 of the OMRR that are suitable for composting.

Passive Aeration: Naturally occurring air movement through compost windrows and piles such as wind, diffusion, and convection which supplies air. No mechanical devices are used.

Pathogen: An organism capable of causing disease in humans, animals or plants.

pH: A measure of the concentration of hydrogen ions in a solution, expressed as the negative logarithm of the hydrogen ion concentration. The pH scale ranges from 0 to 14, where pH 7 is neutral. A pH greater than 7 is basic, meaning fewer hydrogen ions are present. A pH less than 7 is acidic, meaning more hydrogen ions are present.

Porosity: The pore space (area) around individual compost particles. Porosity is calculated as the volume of the pores divided by the total volume.

Qualified Professional: A person who (a) is registered in British Columbia with his or her appropriate professional association, acts under that professional association's code of ethics, and is subject to disciplinary action by that professional association, and (b) through suitable education, experience, accreditation and knowledge, may be reasonably relied on to provide advice within his or her area of expertise as it relates to this regulation.

Screening: Sifting of compost through a screen to remove large particles and improve consistency and quality of the end product.

Setback: A set distance separating a particular area of activity and a neighbouring boundary such as, the distance between the compost pad and the property line.

Siting: To situate or locate on a site.

Static Pile: A method of composting that does not involve turning the pile or the use of mechanical devices for the purpose of introducing oxygen into the pile.

Stormwater: Rainfall and snow melt runoff.

Turning: A composting action that mixes and agitates material in a windrow, pile or vessel to increase porosity, and later will enhance passive aeration of the compost.

Windrow: Elongated, relatively narrow, and low pile with a large exposed surface area ideal for passive aeration and drying.

APPENDIX A

EXAMPLE LISTING OF DETAILED CONTENTS OF AN EIS

Under the OMRR Part 5, Division 1 (23) 1, an environmental impact study (EIS) is required if the composting facility is going to have a capacity more than 20,000 tonnes per year of product. The general requirements of an EIS were discussed in Section 2 of the Guideline. The EIS would be conducted by a Qualified Professional (QP) or a team of QP's.

The content of the EIS would be based on site specific needs, the local conditions, the size of the composting facility, and the type of composting process to be utilized. However, it is suggested that a typical compost facility EIS document should include, but not necessarily be limited to, sections that cover the following:

1. Baseline conditions, which would include the following:

   - The planning/design timeframe in which the implementation of various aspects of the project will take place.
   - Pre-construction and operation conditions using existing data and/or by conducting adequate sampling of water, sediment, biota, etc.
   - Physical site characteristics including contour maps.
   - Vegetation (field study, air photos).
   - Location of existing surface and ground water sources.
   - Sensitive ecosystems (use Sensitive Ecosystem Inventory maps from MWLAP).
   - Rare and endangered species, plants, and plant communities on the site (use lists provided by Conservation Data Center – "Red" category (species that are threatened), "Blue" category (species that are sensitive or vulnerable to human activity or habitat encroachment).
   - Wildlife that use or traverse the site (field visits using Resource Inventory Committee standards).
   - Fisheries resources (field study to collect information on fish habitat, populations, species, water channel characteristics, barriers to fish passage, location and description of bridges, culverts, etc., vegetation, threatened, rare and endangered species, potential salmonoid spawning and rearing habitat).
   - Rainfall and runoff.
   - Prevailing winds.
   - Land use of proposed site and surrounding areas.

- Topography including contour mapping.
- Aboriginal rights inventory. Note: Dischargers and/or their agents should be aware of the Provincial policy on First Nations consultations available on the Internet at: http://srmwww.gov.bc.ca/clrg/alrb/cabinet/ConsultationPolicyFN.pdf

2. Identification of issues such as:

- The optimum location for the facility in terms of minimizing environmental impacts and protecting human health and safety.
- Site preparation for the composting facilities, roads, implementation of buffer zones and set back requirements from streams, lakes, wetlands, and wells, and plans to minimize the impact on adjacent lands.
- Impact on quality of surface and ground water and mitigation measures.
- Design of the composting facilities including buildings, works and other appurtenances.
- Site work, including location of roads, buildings, ditches or drainage, pipelines, excavations, berms and related issues such as slope stability.
- Preliminary assessment of potential impacts.
- Nuisances such as noise from construction, operation, additional traffic.
- Odour collection, treatment and monitoring systems, which includes determining seasonal wind and atmospheric conditions, dilutions to threshold (D/T) at the fence line, etc. Odour modeling can be conducted. Information about commonly used odour models and guidance is available by accessing the USEPA Support Center for Regulatory Air Models website at: http://www.epa.gov/scram001
- Leachate minimization, control, collection, treatment and monitoring systems.
- Social impacts.
- Archaeological impact which includes: determining if site is registered as an archaeological site, and determining if site is First Nations land or under active claim. Archaeological impacts are only a small subset of aboriginal interests. Dischargers are responsible for carrying out any consultation with First Nations in accordance with "Provincial Policy for Consultation with First Nations", dated October 2002, available on the Internet at: http://srmwww.gov.bc.ca/clrg/alrb/cabinet/ConsultationPolicyFN.pdf

- Visual impact of the facility on surrounding properties.
- Mitigation measures which include terrestrial resources, aquatic resources, archaeological and heritage resources, air quality, odour, noise, leachate, land resources, public visibility, and First Nation's land claims.

3. Interactions with development regulations, which include:

- Federal environmental regulations such as the Fisheries Act.
- The Federal Fertilizers Act which regulates the sale of compost as a fertilizer.
- The Canadian Council of Ministers of the Environment (CCME) compost guidelines.
- Provincial regulations such as the British Columbia Environmental Assessment Act, Water Act, Waste Management Act, Fish Protection Act, Wildlife Act, and the Agricultural Land Reserve Act.
- Municipal regulations such as the Official Community Plan, Zoning Bylaws, allowable uses.
- Municipal and/or Regional District Solid Waste Management Plans and bylaws.

4. Constraints and opportunities, which include:

- Terrestrial resources (vegetation, animals, birds, insects, etc.)
- Aquatic resources (fish, invertebrates, molluscs, etc.)
- Air quality
- Noise
- Odour
- Land use

5. Other items which the Qualified Professional deems appropriate for the given situation.

AN EXAMPLE COMPOSTING PERSONNEL TRAINING PLAN

APPENDIX B

As per other documentation, the Big Ocean Composting Company Inc. (BOCCI) intends to operate a combined windrow and extended aerated static pile (EASP) compost facility. BOCCI will have a master composter on staff; however, all personnel will be given classroom training prior to startup. The proposed training program will allow our personnel to be fully functional as compost professionals so that our facility can comply with:

- Part 3, Divisions 5 and 6 of the OMRR regarding Class A and B compost quality and the relationships between time, temperature and pathogen kill.
- Schedule 5 of the OMRR – Sampling and Analyses
- Schedule 6 of the OMRR – Record Keeping
- All other pertinent sections of the OMRR

In addition to understanding how to operate, monitor and manage a composting process, they will also be trained in safety aspects of the compost operation, including machinery, dust, fungi, microorganisms, etc.

The training program will include the following:

1. Basic information on composting
   a. The biological process; microorganisms, bacteria, fungi, dust, etc.
   b. Objectives of composting
      i. Pathogen destruction
      ii. Product quality production

2. Principals of aerobic composting
   a. Materials balance
   b. Feedstock characteristics
      i. Moisture/total solids
      ii. Particle size
      iii. Bulk density
      iv. Volatile solids
   c. Bulking agent functions
      i. Moisture control
      ii. Porosity and aeration

- iii. Pile structure
- iv. Adjustment of the carbon/nitrogen balance

d. Aeration basics
- i. Oxygen demand
- ii. Aeration as a means of temperature control

3. Basic Design Aspects

a. Mixing
- i. Controlling solids and moisture
- ii. Importance of achieving homogeneity
- iii. Effectiveness of mixing equipment
- iv. Odour control

b. Windrow Composting
- i. Constructing windrows
  1. Height
  2. Shape
- ii. Turning frequency
- iii. Turning equipment
- iv. Odour control

c. Aerated Pile Composting
- i. Extended vs. discrete piles vs. bin-type systems
- ii. Aeration aspects for aerated static pile and related systems
  1. Negative vs. positive aeration – advantages and disadvantages
  2. Continuous vs. intermittent aeration
- iii. Aeration system
  1. Piping
  2. Blowers
  3. Cycling aeration/timers
- iv. Base and cover aspects
- v. Stacking material
- vi. Moisture control
- vii. Odour control

d. Pile and/or windrow tear down

e. Compost screening

f. Curing

g. Product storage

4. Monitoring
    a. Labelling piles and/or windrows
    b. Temperature collection and recording; creation of spreadsheet trendline graphs
    c. Moisture analysis
    d. Oxygen analysis
    e. Monitoring data sheets and trendline graphs
    f. Analysis for regulatory compliance
        i. Sampling
        ii. Testing

5. Odour control
    a. Biofiltration
        i. Design of biofilters
        ii. Maintaining the biofilter
            1. Moisture control
            2. Pressure drop
            3. Determining when to replace biofilter media
    b. Process management

6. Record Keeping
    a. Maintaining records
        i. Type of records; importance of trendline graphs
        ii. Daily monitoring data sheets
        iii. Keeping track of quantities of material
    b. Records of regulatory review

7. Troubleshooting
    a. Odour issues
    b. Pathogen destruction problems – time and temperature maintenance
    c. Cross-contamination prevention
    d. Equipment

8. Safety aspects
    a. Machinery
    b. Dust and fungus
    c. Microorganisms

9. Product marketing and distribution
    a. Quality control
    b. Product testing
    c. Record keeping
    d. Marketing analysis; bulk versus bagged sales

In addition to the above, BOCCI intends to have mini-refresher courses twice per year and a major refresher course every two years. Alternatively, BOCCI reserves the right to send new staff to accredited composting courses in B.C., Washington State, Oregon State or Alberta, as the need and/or opportunity arises.

AN EXAMPLE ODOUR MANAGEMENT PLAN

APPENDIX C

General

The purpose of this plan is to outline the procedures that we, the XYZ Composting Co. Ltd., will take to minimize odours generated by our proposed composting facility located at 12345 East Country Lane, Somewhereville, BC. The intent of this plan is to control odours to the point where our facility does not cause any significant or long lasting impacts to our neighbours. We have had a consultant develop a computer odour model of our proposed facility. This model has allowed us to anticipate where the odours will travel and at what strength, for a number of different atmospheric conditions. We have used this information to prioritize odour control within our facility. On this basis, we plan to minimize and control odours that may be generated at our facility through control of our feedstocks and control of our composting, curing, screening and final compost handling operations.

Control of Feedstocks

We will endeavour to use feedstocks that are compatible with our composting operations. We will endeavour to not use feedstocks that are too wet for the desired mix characteristics, nor will we maintain stockpiles of dry feedstocks larger than one-week worth of processing at any one time. Odorous feedstock materials such a sewage sludges and/or animal morts will be processed on a daily basis and no unprocessed stockpiles of these materials will be allowed to accumulate. If we encounter problems with processing these materials, we will temporarily cease to import them to the composting facility until the processing problem is resolved. If, during emergency situations, we cannot process odorous feedstocks that have already been brought to the facility and off-loaded, we will cover these materials with clean wood chips or sawdust and either tarp the resulting pile or apply a topical odour suppression/masking chemical. In other situations, we may simply cut back on compost production and acceptance of feedstocks until the odour issues are resolved.

Control of the Composting Processes

We fully understand that composting odours are primarily related to not maintaining proper aerobic conditions throughout the composting piles, windrows and/or channels. On this basis, our primary means of controlling odours during the composting processes that we will operate will be to maintain aerobic composting conditions. This will include turning our windrow piles on a regular basis, running our aeration blowers constantly (albeit at variable speeds depending on temperature control requirements) for the aerated static piles, and regularly mechanically-turning our composting materials in our agitated bed system. We may also chose to run the aerated static piles in a negative aeration mode and discharge the collected air through an odour control biofilter or wet chemical scrubber (if the monitoring shows that the biofilter can not remove particularly nasty chemicals such as dimethyl disulphide).

Turning of the windrows will be done using a properly-sized windrow turner equipped with a dust suppression hood over the compost turning mechanism as well as a spray bar, nozzles, water tank and pressure pump system to further suppress dust and odours by using a water mist. Furthermore, turning will be planned, as much as possible, in accordance with wind direction, air temperature and time of day so as to minimize the possibility of odours impacting those people living and working adjacent to our site. In the event, that this strategy is shown to be insufficient to prevent odour impacts, we will install a chemical odour control misting system around the perimeter of the windrow composting area and then use this system on an “as required” basis.

Our outdoor aerated static pile process will be equipped with fans and aeration header dampers such that we will be able to aerate the piles with both positive and negative aeration. When we are using positive aeration (air is blown in from the bottom of the pile), we will maintain a minimum of 200 mm thick layer of finished mature compost cover on the piles with the intent that this finished compost layer will act as a biofilter and eliminate odours. When we are using negative aeration (with air drawn into the composting piles), we will exhaust the air drawn out of the compost piles through an odour control scrubber system. At this point, our intention is this scrubber system will be comprised of a series of biofilters with a minimum of 45 seconds empty bed retention time filled with a 3 part woodchip: 1 part finished compost mixture about a perforated pipe/round river rock plenum. If the biofilters are unable to sufficiently remove certain persistent chemicals, e.g. dimethyl disulphide, that may be encountered, we will make steps to improve this situation including, but not necessarily limited to, a wet chemical scrubber or other appropriate technologies, as required. Another option will be to scale back production.

Our agitated bed system, which will be used to compost food wastes and animal morts with ground yard waste, will be located within a building. As such, we will be supplying fresh air into the building and drawing moisture- and odour-laden air from the building.

This exhaust air will be routed through biofilters similar to but larger than those described above. Alternative technologies will be employed, as required, to eliminate odours not removed by the biofilter system.

In all cases, the active composting processes will be maintained for a sufficient period of time such that the material will not release significant quantities of noxious odours during the short period when the composted materials are moved to the curing area.

Control of Odours During Curing

Curing of all our composted mixes will be done outdoors, on paved pads, under roof cover. As with the main composting process, we will endeavour to maintain aerobic conditions in the curing piles and, thereby, minimize generation of noxious odours. We will use a combination of front-end loaders, windrow turners and/or aerated floor systems to maintain aerobic conditions during curing. The odours that are generated during the curing process are anticipated to be “earthy” or “musty” in character and very unlikely to cause off-site impacts.

Control of Odours During Screening and Final Processing

Some odours will be released during the screening process. These odours are likely to be “earthy” or “musty” in character and very unlikely to cause off-site impacts. However, will endeavour to minimize odour impacts by suppressing any dust generation and movement during the screening process. This will be achieved through careful attention to wind conditions and the use of a high-pressure water misting system to knock down the dust, as required.

Screened compost will be stored under cover and is not expected to be a source of odours. Some screened compost may be bagged for retail sales. Such bagging operations will occur within a building with normal heating, ventilation and air conditioning (HVAC) considerations. No special odour control is anticipated.

Monitoring

Periodic monitoring of odours around the pertinent areas of site will be done using a Draeger tube-type portable odour monitoring device. Parameters of concern will include hydrogen sulphide, total reduced sulphur compounds and total amines and ammonia.

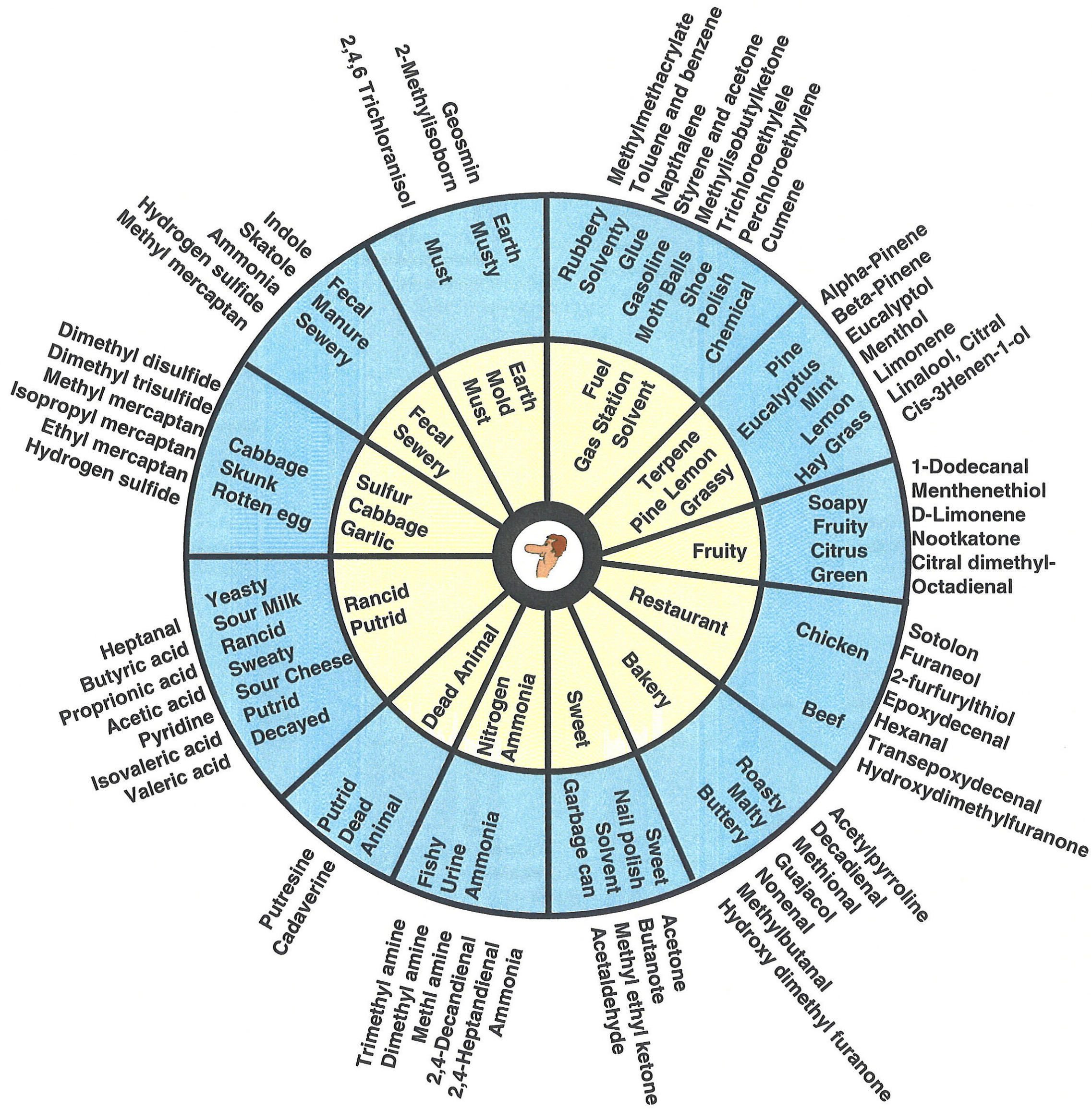
This will be conducted on a weekly basis during the warmer drier months of the year and monthly during the cooler wetter months of the year. Data will be recorded and correlated to any odour complaints that may be received. Adjustments to the operations will be made accordingly in order to mitigate the odour production and maximize the odour control.

Odour Complaint Procedures

It is our desire to not cause our neighbours any impacts due our composting operations. However, we realize that we may not always be able to totally control the conditions at the site and, therefore, there may be some odours generated from time to time. So that we can learn from our mistakes and better rectify the problem, we will be using the following odour complaint procedures:

- Odour complainants will be dealt with by our staff in a polite and courteous manner.
- The odour complaint will be recorded on the attached odour incident report form.
- Our staff will note the operating conditions at the plant.
- Our staff will visit the site of the odour impact, e.g. the complainant’s home, to determine the nature of the odour (using the compost “odour wheel” as a guide in discussions with the complainant).
- Staff will determine what the problem is and what actions can be taken to mitigate the odour situation.
- The appropriate actions will be taken.
- After sufficient time for the mitigating actions to have occurred, the situation at the site of the odour impact will be monitored and reported to the odour complainant.
- If necessary, further actions will be taken until the odour problem is solved.

Compost Odour Wheel



SWAPE
WWW.SWAPE.COM

For (1) Odor Analysis And Characterization, (2) Dispersion Modeling, (3) Odor Control, (4) Risk Assessment, (5) Community Outreach Or (6) Legal Testimony Please Contact:
Paul Rosenfeld Ph.D. at (310) 795-2335 or prosenfeld@swape.com

Odour Incident Report

In order to facilitate the review of odour incidents, **this odour incident report will become part of the public record** and **a copy of it, including your contact information and comments, will be provided to other parties** including other persons, agencies, governments and the source(s) of the odour.

During the odour incident, please call:
Composting facility contact information

Your Contact Information

Name ____

Address ____

City & Postal Code ____

Telephone ____

Odour Incident Start Date & Time ____________________________________

Odour Incident End Date & Time _____________________________________

Location Where You Smelled the Odour

Street Address ____

Other ____

Weather Conditions

Sunny ☐ Partly Cloudy ☐ Cloudy ☐ Foggy ☐ Raining ☐ Snowing ☐

Wind Strength

None ☐ Light ☐ Medium ☐ Strong ☐ Very Strong ☐

Wind Direction

from N ☐ from NE ☐ from E ☐ from SE ☐
from S ☐ from SW ☐ from W ☐ from NW ☐

Odour Intensity (Strength of the odour)

Not Perceptible ☐ Very Weak ☐ Weak ☐ Distinct ☐
Very Strong ☐ Extremely Strong ☐

Odour Tone (Degree to which the odour is pleasant or unpleasant)

Very Pleasant ☐ Mildly pleasant ☐ Neutral ☐ Mildly Unpleasant ☐
Very Unpleasant ☐

Odour Character (Describe what the odour smells like)

____
____
____
____

Source of Odour (Describe where the odour is coming from)

____
____
____
____

Effects of the Odour (Describe the effects of the odour on you and your lifestyle – please be specific)

____
____
____
____

APPENDIX D

AN EXAMPLE LEACHATE MANAGEMENT PLAN

General

The purpose of this plan is to outline the procedures that we, the XYZ Composting Co. Ltd., will take to minimize and manage leachate generated by our proposed composting facility located at 12345 East Country Lane, Somewhere Ville, B.C. The intent of this plan is to control leachate to the point where our facility does not cause any significant or long lasting impacts to the ground and surface waters around the facility.

We plan to minimize and control leachate that may be generated at our facility through control of stormwater run-on and runoff, control of our feedstocks and control of our composting, curing, screening and final compost processing operations.

Control of Stormwater Run-on and Runoff

We realize that one way to minimize leachate from our facility is to ensure that we minimize the amount of stormwater (rainfall and snow melt) that comes into contact with our composting feedstocks, the active composting processes and the curing and final storage areas. To this end, our site development plans include diversion of rainfall and run-on, capture of rainfall and snowmelt that comes into contact with the composting materials, reuse of leachate in the composting process (where possible) and treatment of any leachate that cannot be reused.

Run-on Control - Run-on to the site will be controlled by a combination of berms and ditches that will divert any overland flow of rainfall or snowmelt, from terrain above our site, away from and around the composting facility.

Prevention of Leachate Formation - Rainfall and snowmelt runoff will occur on the composting site. Our leachate management strategy is based on preventing clean runoff from coming into contact with compost feedstocks, active composting areas, compost curing areas, etc. To this end, we will endeavour to separate clean runoff from runoff that does come into contact with the compost materials through the judicious use of impervious surfaces, paving, curbs, culverts and/or swales. To prevent contact between rainfall and feedstocks, the receiving and pre- and post-processing areas will be provided with a structural cover (designed to meet the local seismic and snow load requirements). In addition, any equipment travel routes that are exposed to rainfall will be mechanically swept daily to minimize the organics that can be eroded and leached by rainfall runoff. The active and curing piles will be constructed to minimize exposed impervious surface and will be designed to absorb and utilize all rainfall that falls on their surfaces.

Leachate Capture – Any leachate that is generated will be collected from the paved, curbed, materials storage pads, and composting and curing areas and directed to a separate leachate storage tank. As needed, the captured leachate will be recirculated back to the composting process to provide additional moisture for optimum compost materials mixing and/or processing. The recycled leachate will be added into the composting material before the compliance period for any time and temperature requirements for pathogen reduction. Any leachate in excess of that which can be used in the process will be treated on site using the following described process or discharged to the local wastewater treatment facility via pipeline or truck hauling, as we deem to be economically achievable.

The on-site leachate treatment system consists of the following components: an inlet screen to remove gross solids that may be carried by the runoff, an aerated lagoon, a facultative/settling lagoon and a constructed wetland designed to reduce the organic strength of the leachate. The method of estimating leachate quantity and quality for use in designing the treatment system are provided in Appendix 1 (not shown here) These effluent limits are designed to provide compliance with the receiving water quality standards for Nearby Stream. We have had ABC Aquatic Biologists review our leachate treatment and discharge plans and they have indicated that the discharge will not cause impacts to Nearby Stream (EIA as required under Section 26 (4)).

Stormwater Management - Our site development plan shows how runoff from clean, non-compost-related, areas will be diverted to a sedimentation pond at the lower corner of the site. Clean runoff from the roof drains of the facility will be diverted to a storage tank for potential use in supplementing our site water supplies. Excess roof water will be diverted to the runoff sedimentation pond. The contents of the runoff sedimentation pond may be reused from time to time to supplement our groundwater supply for use in site-clean up and/or the composting process. All excess settled stormwater will be discharged downstream of the leachate treatment plant discharge in order to further dilute the treated leachate and thereby further limit any impacts from the discharge.

Control of Feedstocks

We will endeavour to use feedstocks that are compatible with our composting operations. We will not use feedstocks that are too wet for the desired mix characteristics, or to the point that they are free draining. Feedstock storage areas will be on curbed, paved, covered pads equipped with a drainage collection sump. Any resulting leachate that is collected will be conveyed to a separate centralized leachate storage tank.

Control of the Composting Processes

We fully understand that composting leachates are primarily related to having excessive moisture in the initial compost mix or allowing water from external sources (e.g. run-on, rainfall and snowmelt) to enter the composting materials during processing. To this end, some of our composting operations will be either covered or in a building.

Our leaf and yard debris windrow composting will remain in open air. Our bin-type static aerated pile composting process will be conducted outdoors but under structural fabric covers. Our food waste and chicken mort in-channel agitated bed composting process will occur in a building.

In all cases, the composting processes will include impermeable pads, curbs and drains so that any leachate that is generated during the composting process can be collected. Following collection, the leachate will be conveyed to the centralized leachate storage tank for subsequent reuse and/or treatment. Application of leachate into the composting process will only occur before the starting of the time/temperature compliance period. Following remoistening, the material will be maintained at pathogen reduction temperatures for the required time.

Control of Leachate from the Curing, Screening and Final Processing Areas

Curing of all our composted mixes will be done outdoors, on paved pads, under roof cover. These pads will be equipped with curbs and drains and the collected leachate will be conveyed to the centralized leachate storage tank. Similarly, screening of compost will occur on a covered pad equipped with curbs and drains and the collected leachate will be conveyed to the centralized leachate storage tank. The screened compost storage area will be a covered pad equipped with curbs and drains and the collected leachate will be conveyed to the centralized leachate storage tank.

Reuse and/or Treatment of the Collected Leachate

As part of our leachate control and management strategy, our first priority for dealing with the collected leachate is to reuse it during the composting operations, either in the initial mix preparation or during any mix re-wetting operations during the active composting process. Any excess leachate will be processed through a combination of aerobic biological treatment and secondary clarification that our qualified professional, A. Smart, P.Eng. has designed to meet the secondary treatment criteria BC Municipal Sewage Regulations (MSR). Disposal of this treated leachate will be through a combination of rapid infiltration basin and/or constructed wetland located within our property boundary. Our qualified professional, A. Smart, P.Eng. has studied this situation and has determined that, with this level of treatment and with this type of discharge, there will be no impacts to the ground or surface waters and that the appropriate drinking water and aquatic life water criteria will be met at the points of impact of site. (An EIA was conducted as required under Section 26 (4)).

Monitoring

In order to ensure that our facility and our proposed leachate management system do not cause any environmental problems, our qualified professional has developed a monitoring program that we will implement at the time of construction. Monitoring of the leachate control system will include monthly sampling of the following: contents of the leachate storage tank, the influent to the leachate treatment plant, the effluent of the leachate treatment plant, monitoring wells around the rapid infiltration basins, and the discharge end of the constructed wetland. Weekly records will be kept regarding the amount of leachate collected, the amount reused and the amount that is treated and disposed.

EXAMPLE: ENVIRONMENTAL IMPACT ASSESSMENT FOR THE BIG OCEAN COMPOSTING COMPANY INC. FACILITY

Introduction

The Big Ocean Composting Company Inc. (BOCCI) composting facility has been designed on the principles of the aerated static pile (ASP) process. This process was developed by the United States Department of Agriculture in 1975 (Epstein et al., 1976; Willson et al., 1980) and is currently being used in over 350 facilities in North America. The facility will be able to compost food waste, grocery wastes and yard trimmings into an OMRR Class A product. BOCCI also plans to compost biosolids to Class A standards in the future. Our expected product tonnage will be less than 18,000 tonnes per year, and therefore, we have not completed the Environmental Impact Study that is required under the OMRR Part 5 Division 2 (23) 1 for facilities producing greater than 20,000 tonnes per year. Nevertheless, we will be addressing the control and mitigation of odours, noise and leachate that may result from the operation of our new facility.

The BOCCI facility was designed to address the following environmental concerns:

- Destruction of pathogens in waste through maintenance of high temperatures. Temperatures must exceed 55°C for a minimum of three consecutive days (OMRR, Schedule 1, Section 4 (b)).
- Control of vectors through destruction of putrescible organic materials (Epstein, 1997).
- Control of odours (Williams, 1993).
- Control of noise.
- Avoidance of leachate generation and, therefore, treatment and discharge.
- Production of a stable and mature Class A compost product, suitable for use in agriculture and horticulture applications.
- Prevention of impacts on ground and surface waters.

This facility has been designed to meet all of these concerns.

Facility Design and Operations

The facility design is shown in Figure 1 [NOTE: THE SITE PLAN WOULD BE ATTACHED]. It consists of the following elements:

- A grinding and feedstock delivery area, located to the east of the facility. These areas are under roofed cover, on paved and curbed pads to minimize and control the generation of leachate. The grinder is also housed within concrete lock block walls to assist with the control and mitigation of noise from the grinding operations.
- The ASP composting area. This area consists of two concrete walls in a "T" formation. Blowers will be located on the back of the wall and aeration pipes will be fed through holes in the wall to form the aeration system. The "T" forms two sections, an A and B. Each section is designed to handle five weeks of material for composting. The fans are housed in acoustic enclosures to minimize off-site noise impacts.
- The odour control biofilter, located north of the composting area.
- A screen, located to the northwest of the composting area.
- A compost berm, which will surround the facility on the three lower sides to collect and prevent any runoff from leaving the facility.

The basic composting facility operations consists of the following elements:

- Pre-processing
  - Grinding of waste materials
  - Mixing with amendments, as needed

- Composting using the aerated static pile (ASP) process:
  - An aeration plenum capable of providing either positive or negative aeration. A bed over the aeration system consisting of an absorbent material such as coarse screen over-sized material or "overs", designed to distribute the aeration airflow evenly, as well as to absorb any free water or leachate that may be produced.

  - A mixture of waste material and amendments that will be piled over the aeration plenum to a height not more than 3 m at 1.5:1 side slopes.

  - A layer of stable compost over the entire ASP pile. This layer serves two purposes. The layer will act as an insulating layer so as to ensure that temperatures exceed 55°C throughout the mass of material. This layer will also act as a “mini” biofilter and thus scrub odourous volatiles emitted during composting.

- The aeration system will be connected to a blower system. The system will be capable of being operated either in a negative mode with odourous gases going to a biofilter or in positive mode, with the air being filtered through the mini biofilter cover. Many facilities operate either in positive, negative or a combination of aeration modes.

- Post-processing
  - Screening – The “overs” will be used as bed material over the aeration plenum and the fines or compost will be cured.
  - Curing – Curing will be done by windrowing; alternatively curing may be done using positive aeration, similar to the active composting area.

Environmental Impact Assessment

The potential environmental impact sources from our proposed facility include:

- Odours
- Noise
- Leachate
- Runoff

We realize that under the OMRR (Division 3 (26) 4), the only item that must be addressed in this EIA is leachate management. However, we believe that odour, noise and runoff control are part of the overall impacts that this facility could cause unless mitigative actions are taken. As a result, we would like to demonstrate that we have addressed all of these concerns, including leachate control and management.

These potential impacts are addressed as follows:

Odour Control

Although we did not conduct an EIS, we are fully aware that odours are a main cause of complaints from neighbours of composting facilities, and that odours have caused several composting facilities to be closed. As a result, since we want to have a successful operation and we want to provide a positive service to our community, we intend to minimize the generation of odours and, therefore, minimize the potential for impacts due to odours.

The most important thing that we did for odour control was selecting a site for the facility that is well away from current or future residential areas. Our closest anticipated neighbours will be in an expansion of a local industrial park that is likely to generate some odours on its own. Nevertheless, we will be taking proactive steps to prevent and/or control odours from our facility.

The materials that we will initially process include food waste, grocery wastes and yard trimmings. BOCCI also plans to compost biosolids at some point in the future. We are fully aware that these materials have the potential to create odours as they decompose. On this basis, with the exception of clean woody yard waste, all composting materials brought to the site to be processed will normally be processed the same day as delivery. Exceptions may run to second day processing at worst. In case of processing problems, our contingency plan is to cease accepting wastes and covering of already accepted putrescible wastes with a thick layer of sawdust and/or wood chips. In the worst case, these materials would be taken offsite, at our expense, and landfilled until the problem is correct.

Once the materials are processed and mixed, odours will be managed through temperature control in the piles and through the use of odour control biofilters. Adjusting the blower on-off cycle will control temperatures in the piles and help to minimize the generation of odours. This adjustment will be made through either a timer or PLC software connected to the blower.

Initially, the piles will be operated under positive aeration and odour emissions will be controlled by using a layer of stable finished compost that acts as a mini biofilter. United States Department of Agriculture (Willson et at., 1980) indicated that a blanket of finished compost over the compost piles is effective in controlling surface emissions.

A large biofilter will be provided to treat the exhaust air when the composting process is operated under negative aeration. This biofilter will have a surface area of 353 m^3 (3,800 sf). [EXAMPLE ONLY – ACTUAL AIRFLOW, ETC. WOULD VARY]. The flow rate through the biofilter is designed for 141.58 L/min (5 scf/sf). The empty bed retention time (EBRT) through the biofilter will be 60 seconds which is at the high end of the normally accepted EBRT of 45 to 60 seconds.

The sequence of operations is planned as follows:

.1 Positive aeration with an approximate 45 cm stable compost cover on the piles.
.2 In the event that additional odour control is needed, the blowers will be operated using suction (negative) aeration for 14 days followed by positive aeration.
.3 If further odour control is advisable, the piles will be operated under negative aeration and the biofilters used for the entire active composting period.

Noise Control

Noise control is important because, as with odours, noise from composting can cause an impact on its neighbours. To this end, we will control the noise generated by our composting operations by the following actions:

- Selecting a site for the facility that is well away from current or future residential areas. Our closest anticipated neighbours will be in an expansion of a local industrial park which is likely to generate some noise on its own.

- Limiting the hours of operation to 8:00 AM to 4:00 PM in order to minimize noise from truck and equipment traffic and the operation of the grinder, mixer, screens.

- Enclosing noisy equipment such as the grinder and mixer within buildings or lock block enclosures to help absorb and mitigate the noise generated by operating these processes.

- Enclosing the composting fans in acoustic enclosures to minimize noise generation.

Leachate Control and Management

Although we did not conduct an Environmental Impact Study (EIS), we are fully aware that compost facility leachate is the prime concern of MWLAP regarding preventing environmental impacts. We have worked with our qualified professionals, i.e. our compost facility design specialist, a hydrogeologist, and terrestrial and aquatic biologist to develop a plan for leachate control and management that both minimizes the generation of leachate and the potential for impacts from any leachate that is generated.

One of the first and most important things we did to prevent leachate impacts was the selection of our proposed facility site. We have selected a site that has the following characteristics:

- It is on high ground so that concerns about flooding and/or run-on are minimized.
- It is a gently sloping site that will allow us to drain and collect the clean runoff and leachate with out the need for pumps.
- The site is in a local microclimate that has less rainfall than other sites only 5 km away (there are native Arbutus trees in the treed buffer around the site – this is a sign that there is less rainfall than other sites without Arbutus trees).
- Soils are relatively impermeable to minimize percolation into the groundwater. We will augment these soils with impermeable pads, as required.
- The nearest surface water is a small creek located 1000 m to the east of the site boundary.
- Groundwater is approximately 30 m down and the soils beneath the site are relatively fine grained. The site was once considered for use as a natural attenuation landfill site but was rejected because the area was too small.
- The site is well away from residential areas which, we understand, are on piped water. Our closest anticipated neighbours will be in an expansion of a local industrial park. We anticipate that this industrial park will also be on piped water.
- The site size is large enough for use to create leachate storage and disposal facilities within our fenceline.

In order to minimize leachate generation, our qualified professional, A. Smart, P.Eng. has selected the aerated static pile process. Furthermore, Ms. Smart has designed the compost mix so that the piles have capacity to absorb rainfall and snowmelt without generating leachate. Unpublished data during studies by United States Department of Agriculture (Epstein, 2002) showed that no leachate was generated even when 23 cm of precipitation occurred in a 24-hour period.

Leachate control will be accomplished in several ways:

- Feedstock materials will be stored on paved curbed pads under cover and, therefore, leachate will be minimized.

- Grinding and mixing will occur under cover to minimize the uncontrolled intrusion of water into the process.

- The piles will be formed on sloped paved pads with curbing and a collection sump to minimize the excursion of leachate either off-site or into the groundwater beneath the site.

- The bed of screened "overs", between 30 and 45 cm, on top of the aeration pipes is designed to absorb and retain any leachate or drainage from the ASP piles.

- In developing the compost mix requirements, our QP has conducted a water balance model and determined that if the mix going into the piles is at a moisture content of 60 percent or less, there will be no free water that could be drained through the pile. This is an important operating procedure. Free water would block the pore space within the matrix and prevent proper aerobic conditions. Positive aeration will further reduce the moisture content within the pile over time and thus reduce any potential for liquid generation.

- Rainfall falling on the piles will tend to be shed by the piles. Any liquid that does penetrate into the piles will be temporarily absorbed and then evaporated by the aeration process.

- Drainage from the piles, should there be any, will be directed across the paved curbed pad to a collection sump. From there, the generated leachate will be pumped to a leachate holding tank for reuse in the creation of the initial mix.

- Although the water balance that the QP has performed for us indicates that there should never by any excess leachate, we have provided a contingency plan. This plan it premised on the idea that any leachate not reused in the creation of the mix and is in excess of the capacity of the leachate holding tank will be pumped to a small lined earthen pond where the leachate will be subjected to passive facultative treatment. The overflow from this pond will then flow through a subsurface flow constructed wetland and then a rapid infiltration basin, all located within our property line.

Our QP hydrogeologist and biologists have completed modelling of the groundwater regime and the influence of a leachate released in this manner. They have assured us that, at the property boundary, the water quality will still make Canadian and BC Drinking Water Quality guidelines. Furthermore, if there was a release to surface waters, they have stated that the B.C. aquatic water quality criteria will also be met. (Reference: http://wlapwww.gov.bc.ca/wat/wq/BCguidelines/appproved.html)

On the basis of the above, we believe that the will be no impacts from leachate from our composting facility. Furthermore, since there will normally be no discharge from the facility and any discharge that does occur will be on our property and the water quality at the fenceline will not be impaired, we will not be applying for discharge authorization under the Waste Management Act.

Runoff Control

Runoff is clean rainfall or snowmelt that has never come into contact with organic materials and, therefore, is not leachate. While runoff will not cause an impact, we have included it in our EIA to show that we will be minimizing leachate by maximizing runoff control.

Runoff will be controlled by the compacted compost berm located along three sides of the facility. This berm covers the eastern, southern and western sections of the facility in the direction of the slope as shown in Figure 1 [NOTE: SITE PLAN WOULD BE INCLUDED]. Any water not absorbed will be conveyed from the composting site to the paved area across the roadway. This water will be conveyed through the drain located at the southeast area of the pavement to a retention pond.

A collection system at the southeast corner of the composting area, will be installed and the runoff conveyed across the roadway to the paved area. From this paved area, it will enter a drain and be piped to the retention pond to permit settling of sediments prior to discharge via an infiltration ditch located along the lowest edge of the site.

Product Characteristics

This facility is designed to produce a Class A product as specified in Division 5 of the OMRR.

References

Epstein, E., Willson, G.B., Burge, W.D., Mullen, D.C., and Enkiri, N.K. 1976. A forced aeration system for composting wastewater sludge. J. Water Pollut. Control Fed. 48:688-694.

Epstein, E. 1997. The Science of Composting, Technomic Publ. Co., Inc., Lancaster, Pennsylvania.

Epstein, E. 2002, Personal Communication.

USEPA. 1999. Control of Pathogens and Vector Attraction in Sewage Sludge, Rep. No. EPA/625/R-92-013. U.S. Environmental Protection Agency, Office of Research and Development, National Risk Management Research Laboratory, Center for Environmental Research Information, Cincinnati, OH.

Williams, T.O. 1993. Biofiltration for the control of odorous emissions from composting facilities. Third Annual Meeting Composting Council of Canada. E&A Environmental Consultants, Inc., Montreal, Canada.

Willson, G.B., Parr, J.F., Epstein, E., March, P.B., Chaney, R.L., Colacicco, D., Burge, W.D., Sikora, L.J., Tester, C.F., and Hornick, S. 1980. Manual for composting sewage sludge by the Beltsville aerated-pile method, Rep. No. EPA-600/8-80-022. USEPA Office of Res. and Dev., Cincinnati, Ohio.