

WOOD WASTE LANDFILLS GUIDELINE
FOR THE CODE OF PRACTICE FOR INDUSTRIAL
NON-HAZARDOUS WASTE LANDFILLS
INCIDENTAL TO THE WOOD PROCESSING
INDUSTRY



Ministry of
Environment

Ministry of Environment
Victoria, B.C.

September 2011

Table of Contents

1.	Purpose of the Guideline	1
2.	the Code of Practice	1
3.	Key Provisions of the Code	2
4.	Applicable Landfills	3
5.	Acceptable and Unacceptable Wastes	4
5.1	The “3Rs” of Waste Management – Reduce, Reuse, Recycle.....	5
6.	REGISTRATION	6
6.1	Overview.....	6
6.2	How to Register.....	6
6.3	Registration Requirements	7
6.4	Registration Guidance.....	8
7.	Siting Requirements.....	10
8.	Plans and Reports	12
8.1	General Discussion.....	12
8.2	Conceptual Closure Plan	13
8.3	Waste Characterization Report.....	15
8.4	Design Plan.....	16
8.5	Operational Plan	19
8.6	Final Closure Plan and Report.....	29
8.7	Annual Report.....	30
9.	Financial Security.....	31
10.	Records.....	32
11.	Fees	32
12.	Assuring Compliance	33
13.	References:	34
	Appendix A – Registration Form	36
	Appendix B – Minimum requirements	37
	Appendix C – The B.C. Aquifer Classification System.....	38
	Appendix D – Code of Practice REGISTRATION Checklist.....	39

1. PURPOSE OF THE GUIDELINE

This guideline has been developed for use by companies and individuals who work in the wood processing industry and who intend to operate landfills for the disposal of “industrial non-hazardous wastes incidental to the wood processing industry” (“wood waste landfills”). The guideline will also help consultants, the public and other interested parties understand the regulatory requirements associated with wood waste landfills. The primary purpose of this document is to provide guidance in the application of the Code of Practice for Industrial Non-Hazardous Waste Landfills Incidental to the Wood Processing Industry (“the code”), the *Environmental Management Act* and the *Waste Discharge Regulation*.

This is not an exhaustive guide and, where applicable, references to more detailed information are provided. In all cases, review the actual legislation and regulations for exact wording. This information is provided to the user entirely at his or her own risk. The ministry will not be liable for any claims, damages or losses of any kind arising out of the use of, or reliance upon, this information.

If you have questions about the code or the guideline, check the ministry’s [industrial non-hazardous waste landfills](#) website, or contact one of the ministry’s [regional offices](#).

2. THE CODE OF PRACTICE

The [Code of Practice for Industrial Non-Hazardous Waste Landfills Incidental to the Wood Processing Industry](#) (the code) is administered by the Ministry of Environment (“the ministry”). The code addresses industrial non-hazardous waste landfills for the wood processing industry under provisions of the *Environmental Management Act* (EMA) and the [Waste Discharge Regulation](#) (WDR).

The code (or “Minister’s regulation”) is a legally binding and enforceable set of rules that must be followed. It establishes province-wide standards for the discharge of wood waste to industrial non-hazardous waste landfill sites. The code applies to the **discharge of non-hazardous wood waste that originates from the primary and secondary wood processing industry** as defined in [Schedule 2 of the Waste Discharge Regulation](#).

The wood processing industry includes establishments engaged in log sorting operations and/or manufacturing lumber, wood or millwork products (including dimensional lumber, shingles and shakes, prefabricated buildings and furniture). Although landfills associated with these establishments do not generally pose high threats to the environment there are a number of environmental risks – including contamination of ground and/or surface water and spontaneous combustion – that may be realized if appropriate environmental management practices are not followed.

The ministry’s objectives for the code are to:

- Provide clear effective guidance to industries developing non-hazardous wood waste landfills
- Provide protection of groundwater and surface water resources near wood waste landfill sites
- Protect human health and environmental resources
- Promote waste reduction, reuse and recycling opportunities
- Rely on Qualified Professionals (QPs) to apply best practices and to sign off on landfill design plans, operational plans, final closure plans and reports and waste characterization reports

3. KEY PROVISIONS OF THE CODE

All new wood waste landfills, as well as existing wood waste landfills currently authorized by permit that require a significant amendment, are required to comply with all relevant provisions of the EMA, the WDR and the code.

The code contains provisions and directions the owner operator or agent of all landfills to

- Register** their facility

Prepare

- A **conceptual closure plan**
- An **annual report**
- A **final closure plan and report**

Pay

- Any required **Annual Waste Fee**

This guideline specifies the requirements and form of **financial security** that must be provided for all landfills.

In addition, all large landfills are required to prepare a **waste characterization report**, a **design plan** and an **operation plan**.

The Ministry of Environment (MOE) also requires that the operator of the landfill will assume long term liability and will bear the responsibility if any environmental problem occurs in future. The ministry also encourages operators to seek beneficial alternatives to landfilling.

4. APPLICABLE LANDFILLS

The code applies to the **discharge of non-hazardous wood waste that originates from the primary and secondary wood processing industry** as defined in Schedule 2 of the Waste Discharge Regulation. This includes log sorting and/or processing operations, the manufacturing of dimensional lumber, shingles and shakes, prefabricated buildings and furniture.

The code *does not* apply to:

- **Commercial landfills** that accept waste for a tipping fee
- **Pulp mills**

An owner/operator/discharger who conducts a wood processing industry and who operates or proposes to operate a landfill solely for the disposal of solid waste incidental to wood processing operations is obliged to register and operate under provisions of the code. An applicable landfill may include solid waste incidental to the wood processing operations of that organization, as well as other organizations who conduct primary or secondary wood processing.

Owners of existing permitted landfills may continue operating under **current permits**. An owner may choose, at any time, to cancel a permit and register the landfill under the code. However once the landfill is registered under the code, they will not be able to revert back to a permit. Also, the ministry is not able to issue an amendment to an existing permit if it involves a significant amendment like an increase of greater than 10% of the authorized quantity of this discharge, or a change that in the opinion of the director will have a greater impact on the environment than the current operation as per the EMA section 14(4) and section 1 of the Public Notification Regulation. In this case the owners will be required to relinquish their permit and register under the code.

The code has established a threshold between **large and small landfills**. A large landfill facility has a total capacity or designed capacity of more than 5,000 cubic metres of waste or receives more than 500 cubic metres of waste per year. Because there is potential for a greater impact to the environment, a large landfill facility is required to prepare a waste characterization report, a design plan, an operational plan and meet additional siting requirements.

A **Qualified Professional (QP)** is defined in the code as an individual who is registered in a professional organization in B.C. and is acting under that organizations code of ethics and is subject to disciplinary action by that organization, and through suitable education, accreditation and knowledge provide advice in his or her area of expertise. A Qualified Professional is required to prepare the waste characterization report, design plan, operation plan, a final closure plan and calculate financial security. It is recommended that the Qualified Professional prepare all reports including the conceptual closure plan being submitted to the ministry. All landfill reports developed or submitted by QPs should meet the minimum site plan requirements outlined in Appendix B of this guide.

The Qualified Professional can be a consultant hired by the company or they can be employed by the company.

5. ACCEPTABLE AND UNACCEPTABLE WASTES

The code allows the following wastes that originated from the wood processing industry to be disposed of under the code:

- **Wood waste** – that has not been treated with glue, paint or preservative, wood waste less than 1 m in length, dirty wood that cannot be recycled, screened, recovered, incinerated, or used for energy production
- **Dredgings** – are wood residue, sand, gravel and rock that is gathered by dredging in water below the high water mark
- **Sand, gravel and rocks**
- **Ash** – produced by burning of wood waste, except ash from wood that has been immersed in marine waters
- **Inert waste** – which includes cured concrete, asphaltic material (except roofing material and road grindings), brick and masonry (used for structural or construction purposes), ceramic material, glass (except glass derived from electronic waste), stainless steel and aluminum, or any material that if discharged to a landfill cannot reasonably be expected to undergo a physical, chemical or biological change and is approved by a director
- **Inert cover material** – includes soil, gravel, rock or any material that if discharged to a landfill cannot reasonably be expected to undergo a physical, chemical or biological change and is approved by a director
- **Office or shop waste** – (does not include liquid waste, putrescible waste, electronic waste, a product regulated under the Recycling Regulation, or a hazardous waste) office or shop refuse may also be discharged, but only if the total volume from that site does not exceed 1% of the expected annual capacity (volume) of the landfill
- **Other solid wastes approved by a director**

Wastes not on the list will need to be disposed of in a hazardous waste landfill, or a municipal landfill. The operator will need to contact the hazardous waste or municipal landfill operator to determine if they will accept the waste.

Examples of wastes that are *unacceptable* for disposal in a landfill operated under this code include:

- Metal (cables, vehicle hulks and drums), antifreeze, batteries, herbicides and pesticides
- Hydrocarbon contaminated soil (> 3% oil content)
- Paints, plastics & synthetics, petroleum oils and lubricants
- Oil contaminated sludges and sorbents (> 3% oil content)
- Solvents, tires, waste oil/waste oil filters, other hazardous wastes
- Sewage sludges from septic tank pumpout
- Dead animals
- Liquids
- Hazardous wastes as defined under Part 1 of the Hazardous Waste Regulation
- Recyclable products under product categories defined in the [Recycling Regulation](#)

5.1 The “3Rs” of Waste Management – Reduce, Reuse, Recycle

An efficient and effective waste management program can best be achieved when an integrated approach is taken to waste management. Consistent with current trends, the design and operation of landfills should reflect the “3Rs” of waste management (reduce, reuse, recycle). Wood waste can be diverted from landfill and used in a number of applications. Within the broad lumber market, strong niches have been established for recycled wood products in recent years. Demand for the recycled wood products has been stimulated through sustainable development and green building initiatives.

Common uses of the recovered wood include:

- Reuse
- Remilling or remanufacturing
- Fiber products – such as pulp and paper, panel board, composite products, loose fiber products, pressed fuel products, shakes and shingles
- Direct end use applications – such as mulch and landscaping, soil amendments, compost bulking agent, interim road bed construction, “hog fuel”, animal bedding, biofilter media
- Biomass energy application

The ministry encourages landfill owners and operators to consider all possible opportunities to reduce, reuse, recycle or in other ways minimize the amount of waste disposed in the landfill to increase the landfill life.

The [Recycling Regulation](#) lists all products that are required to be recycled.

If the wood wastes cannot be reused or taken offsite for recycling, the next viable diversion option is reduction. Grinding is the most common method of reduction. Wood tub grinders may be used to reduce wood wastes into smaller particles. The longer-sized wood chips from the tub grinder can be used as a biomass fuel or as bulking agent to balance high nitrogen load in composting operations. The smaller sized-material can be composted or used as mulch.

The code does not authorize the burning of wood waste. Approval for burning of wood waste is required by other legislation. Please contact your Ministry of Environment Regional Office and/or municipality for information on approvals for burning of the wood waste.

There may also be opportunity to provide some or all of the waste as fire wood for comfort heat systems (an acceptable use under the EMA) in an adjacent logging camp or to nearby residential wood heating systems.

Material that is pressure treated, chemically treated, or creosote contaminated cannot be composted. Such wood contains chemicals that inhibit plant growth or are toxic to the environment. Instead, the material should be sent to a landfill authorized to take this material.

6. REGISTRATION

6.1 Overview

The Waste Discharge Regulation of the *Environmental Management Act* requires prescribed industries, trades, businesses, operations and activities to obtain an authorization to discharge waste into the environment. Wood waste landfills are a “prescribed activity” in the Waste Discharge Regulation; therefore require an “authorization” to discharge a waste into the environment.

Wood waste landfills that formerly required a permit for authorization are now required under the code to **register** with the ministry and to meet the requirements of the code.

Section 6(4) of the *Environmental Management Act* stating that “the discharge must not cause pollution” remains applicable to wood waste landfills regulated under the code.

The following wood waste landfills **must** register under the code:

- a) **All new wood processing industry landfills** – Wood Processing Industry Primary and Secondary as defined in Schedule 2 of the Waste Discharge Regulation;
- b) **All wood industry wood waste landfills undergoing a significant expansion** – a significant expansion is any increase of more than 10% in the authorized quantity of the discharged waste. The EMA section 14(4) describes requirements for amending a permit; The Public Notification Regulation defines what a significant expansion is.

Also, the following wood waste landfills **may** register under the code:

- c) **Any existing wood industry wood waste landfills with a permit** – operators with a current permit have the option of remaining under terms of their permit or registering the landfill under the code – once the company has registered they cannot revert to a permit (i.e., the permit is extinguished).¹

6.2 How to Register

Any person that wishes to operate a landfill under the code must register their facility with the ministry.

The [registration form](#) can be downloaded in pdf format from the ministry’s [Industrial Non-hazardous Waste Landfills Code of Practice](#) web site, or mailed on request from any of the ministry’s [regional offices](#).

The registration form **must be signed and submitted by an identified responsible person** – i.e., a (senior) manager of the owner or operator of the facility or Qualified Professional hired by the company associated with the landfill.

¹ For an existing permitted landfill that requires registration under the code, the permit remains in force until the registration becomes effective (which is normally 45 days following submission of registration). A waste characterization report and design and operation plans will not be required to be prepared when registering such a landfill under the code. Similar plans and reports however, would have been prepared for the permit and should be in keeping with current standards, guidelines and requirements.

The completed form, along with the Registration Fee and the Annual Waste Fee, may be submitted to the ministry by mail, courier or fax to the “**Ministry of Environment, Environmental Management Branch**”:

Mail: P.O. Box 9377 Stn Prov Govt Victoria, B.C. V8W 9M1

Fax: (250) 356-0299

Courier: 3rd Floor, 2975 Jutland Road, Victoria, B.C. V8T 5J9

Note that the registration form cannot be submitted by email.

Following receipt of the registration form, the ministry may request additional information or changes to the registration. Any changes requested by the ministry must be made before the facility can be registered.

Under provisions of the Waste Discharge Regulation registration becomes effective 45 days after the completed registration and fee are delivered to the ministry if no requests for information are made by the ministry within that 45 day time period. Should the ministry make any requests for additional information following initial receipt of the registration and fee, the registration does not become effective until 45 days after the last requested information is submitted.

6.3 Registration Requirements

Registration requirements are from the Waste Discharge Regulation (section 4(2)) and the code (section 3, 4, and 5).

The [registration form](#) that must be completed and submitted to the MOE needs to include the following information:

All landfills:

- “Generic information in section 4(2) of the Waste Discharge Regulation”
- The **source and composition of the solid waste** discharged or proposed to be discharged at the landfill (i.e., a waste characterization report)
- The **total capacity or designed total capacity** of the landfill
- The **maximum volume of solid waste discharged** or to be discharged annually (cubic meters per year) at the landfill²
- Identification of the location where the **landfill records** will be maintained
- A **legal property description and survey** including the area of waste discharge, buffer area, Crown Lands and Forestry Leases. The survey should be conducted by GPS with minimum 5 m accuracy in areas where established legal survey control is at least 1 km away. In areas where legal survey control is available a legal survey shall be completed
- A **written confirmation of local government notification** at least 30 days prior to submission of the registration (intended to allow local government sufficient time to review an application and ensure that the zoning is correct, or make any desired changes to zoning)

² The code requires the landfill operator to determine the maximum volume of solid waste in cubic metres per year discharged or to be discharged to the landfill as part of the registration process. The ministry requires the facility to determine the amount of waste deposited into the landfill by volume trucked.

- Confirmation that a **conceptual closure plan** in compliance with the code has been prepared (note: phased landfill development and progressive closure is encouraged)
- A completed payment form with payment of appropriate fees – a cheque payable to the Minister of Finance for \$100 for the **annual base fee plus a fee based on the annual maximum discharge rate to the landfill** (in cubic metres). The fee is calculated based on the current Contaminant Fee for Refuse (\$0.74/tonne), as outlined in Schedule 3 of the Waste Discharge Regulation. The fee will change from time to time as the Permit Fee Regulation (B.C. Reg 299/92) is amended. For additional information on fees, see section 11 of this guideline document.
- Financial Security is in place (see section 9 of this guideline document) to the satisfaction of the Director. This guideline specifies the amount and form of **financial security** that must be provided for all landfills.

“Large” landfills (a landfill that has a total capacity of more than 5,000 m³ or will receive more than 500 m³ of waste per year) are also required to submit:

- Confirmation* that the waste characterization report has been prepared
- Confirmation* that the design plan has been prepared
- Confirmation* that the operational plan has been prepared

* Note that confirmation is not required if the large landfill facility has a valid permit issued prior to enactment and proclamation of the code.

6.4 Registration Guidance

Consultation

A person, who intends to register under section 4 of the Waste Discharge Regulation for the purposes of an exemption in relation to the introduction of waste to the environment, must notify the appropriate local government at least 30 days before the date on which the registration is provided to the Director. This is done by mailing or delivering a copy of the application to the clerk of the municipality and the secretary of the regional district where the landfill will be located.

If significant expansion of an existing landfill is being proposed, the person applying for the registration must notify the **appropriate local government**. The code defines appropriate local government as the local government for the area within which the landfill or the expanded portion of the landfill will be located. The code requires that, notification be done at least 30 days before the effective date of registration.

In order to minimize the concerns of nearby **property owners and communities**, it is prudent to make it known to these parties in advance that a landfill registration will be occurring in an area. Notification to these parties should include some background information on the proposed landfill.

For **small landfills**, it may be sufficient to notify neighbours of when and where the landfill will be built – either personally or by letter.

Where a **large landfill** is contemplated, appropriate public engagement is suggested. For example, one or several open houses and/or formal meetings should be held to inform, identify interests and concerns, answer questions, and if appropriate address concerns that have been identified.

Inadequate consideration of neighbours and other stakeholders in the early stages of a landfill appli-

cation planning process may result in significant delays throughout or following the registration process.

Companies or individuals intending to submit a registration who are unsure about the requirements of the Code should arrange a pre-registration meeting with MOE.

The code does not require formal notification of other government agencies other than local government but it is highly recommended. However, formal approvals, notification, referrals and/or consultation with appropriate government agencies may be required under other federal or provincial legislation. Compliance with this code does not relieve the owner/operator/discharger of obligations under other legislation. It is the registrant's responsibility to ensure that all relevant regulatory obligations are met.

It may be suggested that the registration be referred to some or all of the following organizations and agencies:

- Federal government (Environment Canada, DFO and Coast Guard);
- Local First Nations
- Ministry of Health
- Ministry of Energy and Mines
- Ministry of Forests Lands and Natural Resource Operations
- Ministry of Agriculture
- Ministry of Transportation and Infrastructure
- Ministry of Environment –Ecosystems Protection and Sustainability Branch

It is also strongly recommended that municipalities/villages and local governments of the site, as well as adjacent property owners, be notified concurrently.

Consultation with First Nations

It is in a registrant's best interests to ensure there are no potential issues with a landfill site relative to First Nation rights and title prior to initiating modification of the site. Local First Nations making claims on an area can be determined by searching the map links provided on the Ministry of Aboriginal Relations and Reconciliation "[First Nation by Region](#)" website. Further guidance on consultation with potentially affected First Nations may be provided by contacting representatives within the Ministry of Aboriginal Relation and Reconciliation at their [Contacts](#) website.

Sale or Transfer of Company Owning or Operating a Landfill

When a landfill that is registered under the code is sold to another party, the company is required under section 4(5) of the Waste Discharge Regulation to provide a director with written notice within 30 days of a change in information provided in a person's registration. The new owner is required to reregister the landfill facility and meet the siting requirements when the landfill was originally registered. The new owner would not be able to operate until they receive written notice from the director that the registration is effective, or 45 days after the person delivers the registration and fee.

The code states that the siting requirements apply at the time of registration and does not differentiate between registering a new landfill or an existing landfill. The intention of the code is that when

a new owner takes over a landfill, the new owner will only be required to meet requirements applicable to the time that the landfill was first registered or permitted. If, for example, a person has drilled a water supply well within the 300 m of the landfill subsequent to the initial registration of the landfill, any new owner of the landfill would not be required to move the landfill or obtain a substitution to maintain the status of the registration.

Additional Guidance

The Waste Discharge Regulation section 4(2)(k) and (l) allows the ministry to request additional information related to the code. This includes documents requested as part of the registration process, the registration form or anything related to the ongoing operation of the landfill to ensure there is no impact on the environment. Requesting of additional information related to the registration form and process could delay the registering of the landfill, and the ability to discharge waste into the landfill.

Registration does not authorize entry upon, crossing over, or use for any purpose of private or Crown lands or works, unless and except as authorized by the owner of such lands or works. The responsibility for obtaining such authority rests with the registrant. Registration is issued pursuant to the provisions of the *Environmental Management Act* to ensure compliance with section 120(3) of that statute, which makes it an offence to discharge waste, from a prescribed industry or activity, without proper authorization. It is also the responsibility of the registrant to ensure that all activities conducted under this authorization (i.e., the registration) are carried out with regard to the rights of third parties, and comply with other applicable legislation that may be in force.

7. SITING REQUIREMENTS

All landfills must meet the siting requirements of the code with large landfills having additional requirements. Siting requirements are the minimum standards that the operators of the landfills must meet to dispose of waste into the landfill.

The code (section 6) requires the following siting requirements at registration for all landfills:

- (a) **Must be located:**
 - (i) within a property so that there are at least 100 m between the property line and the boundary of the landfill,
 - (ii) so that there are at least 1.2 m between the seasonally high water table beneath the landfill and each of the bottommost cells of the landfill, *and*
 - (iii) so that there are at least 2 m of low permeability soil with a hydraulic conductivity of 1×10^{-6} cm/s or less below each of the bottommost cells of the landfill,
- (b) **Must not be located within:**
 - (i) 100 m of any land that is subject to slope failure,
 - (ii) 5 vertical metres of high tide line,
 - (iii) 100 m of any surface water,
 - (iv) 300 m of a water supply well, *or*
 - (v) 100 m of an existing residence,
- (c) **Must not be located within 300 m of the boundaries of:**
 - (i) a national, Provincial, regional or municipal park,
 - (ii) a conservancy as defined in the *Park Act*,
 - (iii) a wildlife management area designated under section 4 of the *Wildlife Act*,

- (iv) a critical wildlife area or wildlife sanctuary designated under section 5 of the *Wildlife Act*,
 - (v) any land acquired and administered under the *Wildlife Act*,
 - (vi) an ecological reserve designated under the *Ecological Reserve Act*,
 - (vii) a bird sanctuary designated under the regulations pursuant to the *Migratory Birds Convention Act (Canada)*, **or**
 - (viii) a wildlife area designated under the *Canada Wildlife Act (Canada)*.
- (3) At registration, a natural control landfill must not be located on land above an aquifer that is classified as a level IA or IIA aquifer by an aquifer classification system approved by a director.
- (4) The operator of a landfill must not increase the area of the landfill if the increase would contravene subsection (2) (b) or (c) or (3).

Large landfills must meet the following additional requirements:

- (1) In addition to meeting the requirements of section 6, at registration, a large landfill must not be located:
- (a) in a 200 year floodplain, **or**
 - (b) within 1,000 m of a holocene fault as defined in the Hazardous Waste Regulation. The Hazardous Waste Regulation defines a holocene fault as a fault which is active or has been active or has had displacement during the last 11,000 years.
- (2) The operator of a landfill must not increase the area of the large landfill if the increase would contravene subsection (1). Therefore the landfill cannot encroach on a 200 year floodplain or holocene fault throughout the life of the landfill.

If a company cannot meet the siting requirements or any other requirement of the code, the company can request a substitution under section 8 of the [Waste Discharge Regulation](#) and the company must follow the process outlined in that section. The company applying for the substitution must demonstrate that any substituted requirement meets the intent of the code.

If a company fails to meet the siting requirement, they are out of compliance and are subject to fines or imprisonment. Please refer to section 12 of the guideline for additional information.

8. PLANS AND REPORTS

8.1 General Discussion

The code requires operators of large landfills to develop a waste characterization report, design plan and an operational plan. Although these reports and plans are not required of small landfills, the ministry encourages all wood waste landfill operators design and plan landfill(s) to this level of rigour.

The ministry recommends that operators of small landfills – as well as large landfills – hire or use a **Qualified Professional (QP)** to develop plans and reports for their facility. A QP should use code requirements (siting requirements) and industry best management plans to develop the design plan and operational plan to reduce the risk to the environment, human health and future liabilities.

The code requires that the following documentation be prepared by a QP:

- **A waste characterization report**
- **A design plan**
- **An operational plan**
- **Final closure plan**

To support consistent consideration and protection of human health and the environment, the operator should apply the following general requirements to all landfills operating under this code:

1. Large landfills must be located and constructed in accordance with the **design plan** – the design plan must be prepared by a QP.
2. The large landfill owner/operator/discharger must ensure that the landfill is operated in accordance with the **operations plan** – the operations plan must be prepared by a QP.
3. The landfill or part of a landfill must be closed in accordance with the **final closure plan**. Phased landfill development and progressive closure is encouraged. The discharger must provide three months written notice to the Director prior to the intended closure of each phase or phases of a landfill cell or cells of a landfill. The conceptual closure plan must be made available to the Director or an officer at the time of registration. This is a conceptual level plan that makes predictions based on what is known at the design stage before any material is placed in the ground. It is recognized that as the operation of the landfill proceeds the closure needs may change. Thus the need for a final closure plan to be prepared prior to the actual closure.
4. A **survey of the landfill site** including the areas for waste disposal and the landfill buffer zones must be provided as part of the design plan. Minimum requirements for site plans, design plans, operating plans and closure plans are provided in Appendix B.

While preparing a design, operating and closure plan, the owner/operator/discharger should consult with the QP to determine the extent of the need to notify government agencies (e.g., MOE, DFO, Regional Districts, Agricultural Land Commission) and conduct public information and/or consultation.

The disposal of wood waste to a landfill can be problematic for a number of reasons including leachate generation, fire hazard and odours. The bulky mass of the wood waste makes it difficult to compact and a high carbon to nitrogen ratio of the wood means decomposition is slow, even in the

most amenable conditions. Once the material starts to decompose, large void spaces can result in landfill subsidence. Waste wood can contribute to gas generation in landfill and has the potential to produce toxic leachate. Also under certain conditions wood waste can ignite spontaneously (combustion) as a result of heat buildup from aerobic decomposition.

8.2 Conceptual Closure Plan

All landfills require a conceptual closure plan as an element of the registration. The plan does not have to be an elaborate and complex document. If requested by a director or an officer, the conceptual closure plan must be submitted to the ministry within 7 business days of the request. The ministry sees the conceptual closure plan as documentation that the company has properly thought through the design of the landfill before it is built. It also anticipates the life of the landfill (the length of time that the landfill will be in operation).

The conceptual closure plan must:

- a) specify the final design elevations of the landfill,
- b) specify the maximum volume and area of the landfill at the time of closure,
- c) include the design of the final slope of the landfill and identify:
 - i. the vegetation cover, and
 - ii. the inert cover material proposed for the landfill,
- d) identify the measures to be taken to prevent, or minimize the risk of, any of the following occurring after the closure of the landfill facility:
 - i. an escape of leachate or waste from the landfill;
 - ii. erosion of the landfill cover;
 - iii. fire at the landfill facility;
 - iv. water running onto the landfill facility,
- e) identify maximum periods following the final discharge of waste before the implementation of the plan is initiated, and
- f) include a site plan.

The site plan is a sketch describing existing and future activities and improvements to the property. This sketch does not need to be to scale as it is meant to give a general overview of the proposed developments. Recent aerial photography of the site may also be helpful.

The **site plan** should indicate:

- Property boundaries
- All surface water features, please include their name(s)
- Roads
- Position of buildings (structures, storage facilities)
- Water supply (if any) (well, reservoir, underground pipes, etc.)
- The location of the landfill with distances to all property boundaries and surface water features

- The location of any diversion or collection ditches
- The location of any surface or ground water monitoring sites
- Any distinct topographic features such as steep slopes or gullies
- Any fuel or hazardous product storage facilities
- Adjacent properties
- Environmentally sensitive areas
- North arrow

The conceptual **closure plan** should:

- Identify how the closure is appropriate for the discharged waste, site characteristics, proposed land use and climate
- Include an estimation of final landfill topography
- Identify management methods for drainage restoration; soil replacement; final cover and slopes; erosion control; re-vegetation and conditioning of the site; and monitoring
- Include plans for operation of any environmental control systems, and monitoring of erosion and settlement for a minimum post-closure period of 10 years
- Include a plan for operation of any required pollution abatement engineering works such as leachate collection and treatment systems, for maximum post-closure period of 25 years
- Describe the post closure surface and ground water quality monitoring program, if required
- Provide plans to restrict access to the closed landfill

The conceptual **closure plan** should also specify final cover requirements for the landfill including how the final cover design:

- Is appropriate for the waste in the landfill and site characteristics (including but not limited to climate)
- Minimizes infiltration if the landfill does not have a liner and leachate collection and treatment system (or equivalent in situ ground water protection)
- Ensures that water runs off the landfill and erosion is minimized over the short and long term
- Supports re-vegetation

Leachate production should be minimized by constructing landfills in phases and adopting a progressive closure strategy.

8.3 Waste Characterization Report

Section 5(1) of the code requires the owner/operator/discharger to prepare a waste characterization study before discharging waste to large landfills operated under the code. The waste characterization report is a key element of the landfill design and must be prepared by a Qualified Professional.

The waste characterization report supports efficient design and operation of the landfill – and helps landfill operators in anticipating and avoiding potential problems associated with the character of the landfill waste material.

The chemical composition of wood waste leachate varies with wood type, wood component, leaching time, water flow rate and water chemistry. Wood waste leachate can be generally characterized as dark, acidic, and very high organic strength. As biological activity has little effect on the quality of leachate released from wood waste landfills, contaminant concentrations are almost entirely controlled by the solubility of wood waste extract (Atwater, 1980). Wood waste leachate can adversely impact on water due to the presence of oxygen demanding substances, toxic compounds and nutrients present in the leachate. The high organic matter content of wood waste leachate exerts a significant biological and chemical oxygen demand in the water due to bacterial and fungal decomposition. This results in low dissolved oxygen levels which can result in fish mortalities. Wood waste leachate contains various toxic compounds such as troplones and resin acids which can be acutely toxic to aquatic life including fish. Nutrients present in wood waste leachate can result in more chronic problems such as increased algal or heterotrophic growth which can smother aquatic habitat as well as contribute to low dissolved oxygen which can kill fish (MOE, 1998).

Wood waste leachate can also contaminate groundwater. Wood waste leachate contains high concentrations of natural organic compounds and can mobilize metals such as iron and manganese from soils. The groundwater impacted by the wood waste leachate is generally brownish in colour, has an unpleasant odour, an offensive taste and can cause staining of plumbing fixtures and laundry.

The discharge of wood waste leachate may result in an increase in acidity in the receiving waters, depending on the volume and concentration of the leachate and the available dilution. The pH of leachate significantly influences its toxicity (Haygreen and Bowyer, 1989). In most cases, the toxicity of wood leachate declines as pH rises toward neutrality. The toxic actions of low pH may or may not be reversible, depending on the extent of damage that has occurred. In addition, the toxic actions of low pH will likely make the fish more susceptible to the effects of other toxicants, diseases and hypoxic conditions. High concentrations of metals such as iron from native soils can smother the bottoms of streams and lakes forming a pavement like area (OMOE, 2004)

The **waste characterization report** for a large landfill facility must be prepared by a Qualified Professional and must:

- a) Identify the types of solid waste to be discharged to the landfill
- b) Specify the estimated volume of each type of waste that will be discharged annually
- c) Specify the physical properties and the chemical properties of each type of waste
- d) Indicate whether there is any possibility of landfill gas being generated at the landfill facility
- e) Include an analysis of total concentrations and leachable concentrations of substances referred to in item (g) in representative waste samples

- f) Identify opportunities for the reduction, reuse or recycling of the types of solid wastes identified under item (a)
- g) Identify, based on the information provided under item (a) to (c), any substances in each type of waste that may adversely affect the environment or human health

The **waste characterization report** should include:

- a) Physical properties and chemical properties of each type of waste typically including its density, moisture content, particle size, compressibility, strength and other applicable properties, pH, corrosivity, reactivity, volatility, leachability and flammability
- b) Analysis of total concentrations and leachable concentrations of the potential contaminants of concern in representative waste samples
- c) Identification of opportunities for the reduction, reuse, or recycling of waste, or energy recovery from waste
- d) Potential for landfill gas generation

Most of the information required above may be available from standard industry testing and may not need to be obtained on a site specific basis. If information is presented that is not derived from local data then adequate references are required in order to verify the information.

8.4 Design Plan

Landfills are to be designed to minimize environmental impact, risk to human health, and long term liabilities. The design should ensure compliance with the performance criteria as well as minimal or no environmental impact in the future. The code requires that large landfills must be located and constructed in accordance with the design plan. The ministry recommends that small landfills develop a design plan for their facility.

The design plan must be prepared by a QP and meet all requirements in section 19 of the code including siting requirements listed in section 6 and 7 of the code.

Design Features – The buffer zone between the discharged waste and the landfill property boundary must be a minimum of 100 m. Fifteen metres closest to the property boundary should be reserved for natural or landscaped screening (berms or vegetative screens). The 35 m closest to the landfill should be used for firebreak, access roads, leachate management and monitoring works as required. Natural control landfills generally require larger buffer zones than engineered landfills. A minimum natural attenuation buffer of 200 m should be provided in the down gradient direction for small landfills (<5,000 m³), while large landfills (>5,000 m³) should provide at least 300 m down gradient buffer. The buffer also provides an area to retro fit supplemental leachate treatment and collection works in the eventuality that initial leachate mitigation works fail.

Design elements should be selected based on the type of landfill selected. Natural control landfills utilize the attributes of the site's natural setting such as low permeability soils to control leachate and landfill gas emission.

As required by the code, a design plan must include an assessment of the climatic, geological and hydrogeological conditions at the landfill. The code also requires an assessment of the site specific conditions, including proximity to any sensitive area or activity that may be adversely affected by the landfill.

Depending on local hydrogeologic conditions, climatic conditions and land use landfills can be designed as natural control landfills or engineered landfills. Natural control landfills rely on climatic and geologic conditions to renovate leachate in the subsurface (“natural attenuation”) sufficiently to comply with appropriate groundwater quality standards at the property boundary or the appropriate surface water quality criteria where leachate discharges to surface water. (Appropriate standards are drinking water if ground water is being used for drinking water, etc.) A QP must consider waste type, waste volume, leachate quality, landfill siting, buffer zones and other factors when designing a natural control landfill. Landfills designed as “natural control” sites that do not require engineered leachate collection/treatment systems will require an in-depth understanding of the hydrogeological setting, leachate pathways and potential receptors in the vicinity of the site to ensure that the site is indeed suitable for a natural control site. Enhanced protection of the natural control landfills may include diversion ditching, enhanced capping systems, and or a leachate treatment system such as an engineered wetland.

Landfills located in environmentally sensitive areas and very large landfills may require an engineered design. Engineered landfills require liners and a leachate collection and treatment systems in order to comply with the groundwater and surface water performance criteria.

Landfills can also be designed with a combination of engineered and natural control features to protect human health and the environment.

Selection of the appropriate level of environmental protection at a landfill site should be assessed based on the precipitation rating. The bullet list below provides a broad categorization of the leachate generation potential relative to the average annual precipitation received at the site.

Annual precipitation and leachate generation potential:

- <400 mm/year precipitation = Low leachate generation potential (dry)
- 400 to 1,000 mm/year precipitation = Moderate leachate generation potential (moderate)
- >1,000mm/year precipitation = High leachate generation potential (wet)

The water surplus should be calculated using an appropriate model, such as the Hydrologic Evaluation of Landfill Performance (HELP) model. The chosen model should accept weather, soil, and design data and use solution techniques that account for the effects of surface storage, snowmelt, frozen soil, runoff, infiltration, evapotranspiration, vegetative growth, soil moisture storage, lateral subsurface drainage, leachate recirculation, unsaturated vertical drainage, and leakage through the soil, geomembrane, or composite liners to calculate the water balance for a site.

Small landfills proposed for locations within the 200 year floodplain and associated floodway are required to be adequately protected from flooding and washouts and possible related impacts i.e. increased leachate generation potential. Landfills should not be located in gullies or depressions that act as points of water collection during rainfall events or the wet season.

Long-term property usage must be considered prior to siting a new landfill (e.g., future residential or commercial development). Consultation with local municipalities and regional districts with regard to the official community plan is recommended.

Engineered landfills, which use engineered systems to control leachate and gas, are selected when there are inadequacies in the natural abilities of the site to restrict off-site environmental impacts. In addition to the siting requirements, engineered landfills typically include the following criteria:

- 1 m thick compacted soil liner with hydraulic conductivity of 10^{-7} cm/s or less
- Geomembrane or Geosynthetic Clay Liner (GCL) providing the same level of leachate containment
- Bottom slope of the liner (2% on the controlling slope and 0.5 % on the remaining slope)
- Minimum 0.3 m thick drainage layer with material having hydraulic conductivity of 1×10^{-2} cm/s or greater
- The grades of the drainage layer and collection piping are to be designed appropriately so that leachate hydraulic head on the liner does not exceed 0.3 m at any time

A landfill under this code can also be designed as a combination of engineered and natural control.

Run On and Run Off Control – The best management practices for diverting any water entering into the landfill site (run on) are to intercept the run on by diversion ditches. For effective run off control, it is always recommended that leachate production be minimized by keeping clean water clean. This can be achieved by diverting clean run-off, by minimizing percolation through the top surface of the landfill and by enhancing run-off from the landfill. It is also necessary to prevent erosion of the operational interim and final cover systems, to prevent ponding of surface water on the cover system, to control flooding of active landfill areas, to manage suspended sediments, and to control surface water.

In order to properly control run on, surface water diversion works should be designed to handle the 1 in 100 year storm/flood events to minimize long term liabilities associated with erosion. Global warming and subsequent climate change are expected to increase the intensity and duration of winter storm events and summer droughts. Consideration of these phenomena in any design work is necessary. Increase in flows due to climate change should be accounted in the flow estimation. Adequate measures should be taken for erosion protection as recommended by the design QP of record.

For proper management of the surface water (clean or partially contaminated water coming in contact with waste) and flowing off the landfill surface (run off) the surface water conveyance systems should be designed to withstand the 1 in 200 year storm/flood event. Adequate erosion control measures should be provided and a sedimentation pond should be provided for a 24 hour retention time. Surface water discharges must meet the section 21(1)(e) of the code.

Slopes – In designing slopes of the landfill operated under this code the following criteria should be maintained:

- The maximum height or thickness of waste should not exceed 15 m
- Landfill side slopes should be optimally constructed with slopes of 25% (4H:1V) or less with a maximum slope of 33% (3H:1V) if designed by a QP
- If slopes are to be constructed on top of steeper existing slopes, then the toe of the new slope shall be set back from the existing slope crest such that a 3H:1V slope is maintained
- Benches with a minimum width of 5 m should be established on all landfill slopes higher than 15 m (vertical)

- If installed, benches should be established at a road grade between 5% and 20%. Drainage ditches should be installed on the inside shoulder of each bench
- The bench surface should be sloped in to promote runoff to collect in the ditch
- Minimum slopes on top of landfills is 4% after allowing for long term settlement of waste
- Gentle slopes are recommended on the landfill crest as they reduce the potential for long term erosion and maintenance costs
- Borrow Pit slopes need to be approved by the Ministry of Energy and Mines to ensure long term stability and successful re-vegetation
- A static slope stability analysis should be performed. Static Stability of slopes should exceed a Factor of Safety of 1.5 under expected worse case water level conditions
- A seismic stability analysis should also be done. Seismic stability should be greater than 1.0 with a design earthquake
- Newmark analysis, a limit equilibrium approach to provide an estimate of the displacement of a landslide block subjected to seismic motion, should yield less than 150 mm of displacement

Access Road – An appropriately constructed and maintained access road to the landfill and a road system within the landfill site capable of supporting all vehicles hauling waste are required during the operating life of the landfill.

Fencing and Access – Landfills operated under this code should be designed to restrict access by unauthorized persons. Fencing, natural vegetation, topographic features and gates on access roads and signs are recommended to prevent unauthorized access. The remoteness of the landfill location will also determine the appropriate requirements for restricting access. Fencing should be installed around the perimeter of the landfill in populated areas. The type and extent will depend on the existing natural vegetation.

8.5 Operational Plan

An **operational plan** addresses the day to day operation of the landfill. Even though only large landfills require an operational plan, small landfills should develop an operational plan to ensure employees know what is required of them. The code identifies the procedures that are required to be addressed in an operational plan (listed below), with the Qualified Professional who prepares the plan responsible for identifying specific measures and actions under each of the plan elements. The landfill must be operated in accordance with the operational plan for the landfill facility.

The code requires the operational plan be prepared by a Qualified Professional and include a description of the following procedures:

- a) Covering waste with inert cover material
- b) Monitoring ground water
- c) Monitoring and managing surface water
- d) Monitoring and managing leachate

- e) Controlling dust, litter and disease vectors at the large landfill facility
- f) Controlling access to the large landfill by wildlife
- g) Accepting and diverting waste
- h) Responding to emergencies
- i) Monitoring and managing landfill gas, including by means of intercepting, venting, recovering or flaring
- j) Detecting and preventing the discharge of hazardous waste and other prohibited wastes
- k) Any additional actions that the Qualified Professional who prepares the plan considers necessary to meet the requirements of this code

Assuring Ground and Surface Water Quality

The Director approves the following documents in support of provisions in the code:

- [British Columbia Environmental Laboratory Manual – For the Analysis of Water, Wastewater, Sediment, Biological Materials and Discrete Ambient Air Samples 2007 Edition](#) – Section 22(3).
- [British Columbia Field Sampling Manual for Continuous Monitoring and the Collection of Air, Air-emission, Water, Wastewater, Soil, Sediment and Biological Samples, 2003 Edition](#) – Section 22(2).
- [An Aquifer Classification System for Groundwater Management in British Columbia](#) – Section 6(3).
- [British Columbia Approved Water Quality Guidelines, 2006 Edition](#) – Section 21(1)(e)(i).

A landfill under this code should be operated and maintained so that surface water that enters the landfill site (i.e., run-on) does not contact the discharged waste, infiltration into the landfill site of water from precipitation is minimized, and any water that comes into contact with the discharged waste does not cause pollution to ground or surface water.

The landfill must be operated and maintained in a manner so that the landfill is in compliance with the performance criteria for groundwater and surface water. A natural control landfill must not be constructed on ground located above an aquifer identified by the Province as IA or IIA aquifer. Perimeter ditching should be constructed around the landfill perimeter to intercept and divert run-on and to collect clean run-off from the final cover system. Typically a setback of 4 m to 5 m is required for the ditch to ensure adequate room to construct the final cover.

Leachate breakouts can develop in coastal landfills before final closure due to leachate mounding. A Qualified Professional should assess any leachate breakouts or discharges that occur to determine if immediate mitigation is warranted. Possible mitigation measures include:

- Direct leachate to a natural settling pond for aeration followed by discharge to the environment after treatment, preferably through a wetland
- Discharge to natural or engineered wetland
- Improve landfill cover and cover sequence to reduce infiltration (progressive closure)
- Provide complete operational intermediate cover of waste prior to periods of heavy rainfall (coastal fall and winter seasons) or extended periods of landfill inactivity.

- Collection and discharge to an on-site waste water treatment plant
- Collection and discharge to a sanitary sewer system after receiving authorization
- Leachate breakouts on landfill side slopes that are caused by perched water tables should be managed by excavating into the slope through the low permeability intermediate cover layer responsible for the perched water table and allowing/providing/facilitating drainage into lower layers within the landfill

Wood waste landfills must be properly capped to prevent leachate generation.

Landfills operated under the code must not cause groundwater quality to exceed the Generic Numerical Water Standards outlined in the Contaminated Sites Regulation (CSR) (Schedules 6 and 10) for the applicable, site-specific, existing land use, or for the land use having a reasonable probability of being used (i.e., one or more of aquatic life, irrigation, livestock, drinking water) at the landfill site. These standards apply at the monitoring locations identified in the Operational Plan.

The water standards are the level at which the contaminants from the landfill do not pollute ground water and surface water. Monitoring should determine if contaminant levels are rising and the operator should take action to correct it. The landfill should be designed to keep clean areas clean.

The aquatic life water use standards apply to all ground water located within 500 metres of a surface water body containing aquatic life. Investigations must demonstrate that ground water containing substances at concentrations greater than the applicable aquatic life water use standards does not have the potential to migrate to within 500 metres of a surface water body used by aquatic life. Aquatic life water use does not apply when a site exists within 500 metres of a surface water body containing aquatic life and it is shown using methods described in CSR Technical Guidance 8, that ground water at the site flows to another surface water body located greater than 500 metres from the source.

The drinking water standards apply where the ground water or surface water at or near the sites is currently used for drinking water. For site investigation purposes, nearby drinking water wells or surface water intakes are those present within a radial distance of 500 metres from the outer extent of the ground water contamination source. If an aquifer is present below the site and is determined to have a hydraulic conductivity greater than 1×10^{-6} m/s then it must be shown that the aquifer yield is less than 1.3 L/min to exclude future drinking water use. (Technical Guidance #6 on Contaminated Sites – July 2010).

For additional information on how to determine the appropriate water use please refer to the Technical Guidance #6 on Contaminated Sites.

Section 21(1) of the code requires that the landfill facility be operated and maintained so that surface water does not come into contact with the waste, infiltration is minimized and the discharged waste does not cause pollution of groundwater and surface water. Infiltration is the amount of water that percolates after evapo-transpiration takes place and has potential to generate leachate. Minimization of the infiltration will reduce the potential for leachate generation and subsequent groundwater pollution. The groundwater at the monitoring locations identified in the operational plan for the landfill does not contain any substance with a concentration greater than the Generic Numerical Water Standard for the applicable water uses, or the local background concentration of that substance in the groundwater, if that concentration is higher than the standard.

As per section 21(2) of the code, the Director may specify other numerical water quality (standards/objectives) that the operator of the landfill must meet if the concentration of a substance in the groundwater exceeds the local background concentration. The Director will decide, on the basis of the existing information, which water uses and water quality standards apply at a site. This allows the Director to make changes when he/she sees a problem developing.

The code requires that the surface water entering the landfill site does not come into the contact with any discharged waste and the discharged waste also does not cause pollution of surface water. Landfills operated under the code must not cause surface water quality at the monitoring locations, identified in the operational plan for the landfill, to exceed the [British Columbia Approved Water Quality Guidelines 2006 Edition](#) or the local background concentration approved by a Director.

Landfills operated under the code should not cause surface water quality impairment in the perennial streams, lakes or rivers, such that water quality exceed the B.C. Approved and Working Water Quality Guidelines (Criteria), or other appropriate criteria. Criteria from other jurisdictions should be used only for those contaminants which have not been dealt with in the Approved and Working Criteria by the Water Quality Branch of the ministry.

Landfill Gas Management – The landfill must be designed, operated and closed in a manner that would cause minimal risk of explosive or toxic gas emission that could create risk to human health and the environment. An assessment of the potential for emission of landfill gas is required to determine the need for the collection and subsequent management of methane and other gases generated in the landfill. Landfill gases can be created when certain wastes, particularly cellulose and lignin are broken down by methanogenic bacteria. Although these materials break down at a shorter rate than organics found in municipal solid waste; nevertheless, significant quantities of methane can be produced from wood waste landfills. Wood waste landfills have been identified as a source of methane emissions (Environment Canada, 2008). An assessment by a Qualified Professional is necessary to determine whether landfill gas poses a risk (e.g., offsite migration) and whether gas control is necessary. The evaluation should be conducted in the context of the new landfill gas regulation.

Under section 20(2)(i) of the code, the operational plan must include a description of the procedures for monitoring and managing of landfill gas, including intercepting, venting, recovering or flaring. For those landfills which will not be expected to produce landfill gas in significant quantity, active management of gas may not be necessary. An assessment of the need for passive landfill gas venting may still be necessary. Landfills under this code should be operated in a manner such that at no time should methane concentrations exceed the lower explosive limit (LEL), the lowest percent by volume of methane gas in the air that will allow an explosion, in soils at the property boundary or 25% of the LEL for methane in any on-site buildings and structures (SWANA, 1997; MOE Landfill Criteria, 1993).

Odour Nuisance – Landfills operated under this code must not be operated in a manner where gas emissions from the landfill creates a public odour or nuisance, or that federal, provincial or local air quality criteria are exceeded.

A landfill under this code must be designed and operated to control dust, odour, litter, disease vectors. The operational plan should include the following effective measures:

- Dust produced in the operation of the landfill or produced by the traffic or works at the site must not cause a nuisance or hazard to people or the environment
- Discharged waste is contained within the landfill and the escape of waste beyond the property boundary is prevented
- Odour arising from the operation of the facility must be properly controlled and must not cause nuisance or hazard to people or the environment outside the boundary of the facility

Unauthorized access of the public should also be controlled. The code does not impose any regulation on the noise level.

Visual Impacts – Although there is no specific requirement for the aesthetic aspects of the landfill site and its operation, it is recommended that the landfill be operated in a manner that does not result in any negative impact on the neighbours and people passing by the landfill. This can be done by maintaining adequate setbacks and vegetated buffers between the landfill and publicly traveled roads.

Landfill Construction – Landfills operated under the code should be constructed in phases that accommodate progressive closure. Each phase should be less than 2 hectares with a maximum landfill height of 15 m. Landfills should be constructed in layers, each layer being less than 3m thick, then covered with intermediate cover. Layers should be sloped at 2 to 5% in areas with a wet or moderate precipitation rating.

The method of landfilling should be determined by factors including the physical site characteristics and the owner's ability to achieve compliance with these criteria. The strip method of filling is recommended, rather than end dumping because end dumping is inefficient to cover and has the potential to allow air into the landfilled waste. Excess air can enhance chemical and biological action that can lead to spontaneous combustion and landfill fires. Generally, each phase is broken down into a series of lifts, and each lift into a number of sequential strips. Waste is placed using either the push-up or push-down method of cell construction. The push-up method is the preferable method but the push-down method can be used where the phase geometry dictates its necessity.

The strip method, which is an organized and systematic approach to landfill construction, is recommended for filling. This method of filling results in very efficient operations. In this method the landfill is developed as a series of horizontal layers. Each layer should consist of a series of linear strips. Each strip should be further subdivided into a series of abutting waste cells. The cells themselves represent the smallest building blocks of the landfill. In the systematic filling strategy, each waste cell should be fully encapsulated by wall of soil cover on all six sides. Cell volume should not exceed 1,000 m³ at large landfills (with total capacity of 5,000 m³) and 500 m³ at small landfills (<5,000 m³ total capacity).

Separated Materials – Burial of some wastes in dedicated locations is needed to allow easy and ready access to them if corrective or further action be required to manage these wastes by the Ministry at any time. Section 9 of the code requires that the following materials be separated from other solid wastes and discharged at an identified location (segregated area of the landfill):

- Stainless steel and aluminum
- Any inert waste that the Director specifies to be separated from the main stream of waste

Ashes deposited in a landfill and wood waste should be segregated and disposed of in separate cells. The ashes must be at ambient temperature when placed in the separate cell. Ashes from open burns should be left to cool down for a minimum cool-off period of 30 days before they are dug up and placed in the landfill cell. Operators must confirm that ashes are cold to the touch throughout the pile and receive cover at least once every two months to minimize ash from blowing around.

Designated Areas – It is recommended to set aside a stockpiling area of sufficient size for accumulation of recyclables. The code does not regulate the storage of recyclable waste therefore the operator is required to follow the regulations that apply to their recyclables. The overriding requirement of Environmental Management Act (EMA) 6(4) – “a person must not allow the introduction of a waste into the environment in such a manner as to cause Pollution” also applies in this context.

For site security purposes, the gates are to be locked to prevent unauthorized access during non-operating hours.

Scavenging of wood waste is to be prevented for fire control. Salvaging of wood for heating fuel should be encouraged by providing areas and facilities for separation of suitable wood. Resource recovery should be encouraged at designated areas.

Dust Control – Dust created within the landfill property is to be controlled using methods and materials, such that it does not cause public nuisance. It is expected that dust mitigation will be required at the landfill, especially during construction operations to expand the landfill. Dust control techniques, such as watering down road surfaces, applying dust suppression chemicals, posting and enforcing reasonable on-site speed limits, and vegetation programs, can be used as required. When watering road surfaces, application of water should be kept light to avoid slippery or erosive conditions and to minimize the production of leachate. If necessary, dust palliatives, which have the ability to reduce dust by absorbing moisture, may be used to control dust within the active landfill area. The commonly used dust palliatives include magnesium chloride, calcium chloride or other similar hydrating chemicals. The method should comply with the design and operation plan.

Although it is beyond the scope of these guidelines, it is recommended that the noise level be controlled as regulated by the Regional District or the Municipality.

Waste Compaction and Covering – Wastes are to be spread in thin layers (0.6 m or less) on the working face and compacted. The compaction equipment needs to make a number of passes to achieve an appropriate density (typically 3-5 passes). Voids within the waste should be minimized by keeping large (>1 meter) pieces of wood out of the landfill and through proper compaction. Placement of large logs should be minimized.

Inert cover material should be used as operational cover for covering wastes in landfill cells. Intermediate cover is typically defined as a compacted layer of at least 0.3 m of soil or functionally equivalent depth of other cover materials placed in areas of the landfill where no additional wastes

have been or will be deposited within a period of 30 days. The landfill design QP must determine whether there is a need for daily or weekly operational cover and the appropriate frequencies (cell size). For example, if the waste does not have wind transport, odour, wildlife attractant, fire or leachate issues then daily or weekly cover may not be required. In most cases, intermediate cover placed every 90 days for erosion control, protection from water infiltration, visual aesthetics, fire, or leachate control or other purposes may be adequate. Intermediate cover may not be required if the composition of waste deposited is greater than 50% inert, i.e. rock, gravel, soil or ash combined with wood waste. Other conditions that may impact cover frequency can include seasonal variation in rainfall, freezing conditions that make access to cover material difficult or impossible, or if a landfill is to be dormant for a period. Uncovered active face area should not exceed 500 m². By reducing the active face, the operator can reduce the amount of financial security held by the Ministry.

Less frequent application of cover material may be justified by the Director based on public health, environmental and economic factors. During periods of extreme weather conditions, such as those that cause the ground to freeze, an exemption to the normal cover requirements may be approved. Dust, litter and fire risk is to be controlled by either or all of the following methods:

- Compacting the waste
- Minimizing the working face area
- Applying cover at appropriate frequencies

Inert intermediate cover shall be placed on all completed cells. Intermediate cover shall be at least 0.3 m thick. The landfill operator is encouraged to cover completed surfaces of each cell as they reach design height.

Final cover is required for all landfills and must be approved by a Director. Final cover must cover all wastes, reduce water infiltration and provide a suitable soil growing medium to allow re-vegetation or other acceptable use of the site. Landfill slopes should promote runoff but not be so steep that erosion and/or slope instability become problems. Progressive closure of completed portions of the landfill is recommended. The final cover systems for a landfill should include at least 1m of compacted low permeability soil (hydraulic conductivity, k of 1×10^{-6} cm/s or less), at least 0.15m of topsoil with vegetation and slopes between 4% and 33%. Less stringent final cover requirements need to be justified with valid scientific and engineering data and signed off by the Qualified Professional.

Emergency Procedures – Emergency in a landfill operated under this code includes:

- Any fire at the landfill site
- Any unplanned escape of leachate or another substance from the landfill site
- Any subsidence or other sign of instability of the landfill site
- Any other occurrence at the landfill site posing a risk to public health and safety

If there is an emergency or condition beyond the control of the owner/operator/discharger, which prevents him/her from meeting the requirements of this code, the person must notify the Director within two business days of the emergency or condition (or knowledge thereof), and take appropriate remedial action specified by the Director. To protect the environment, the Director may reduce or suspend the operation of the landfill until approved methods of pollution control have been restored. The Director may also specify additional emergency reporting requirements, as well as re-

quiring that the responsible person provide a written report of any or all emergency events and subsequent actions on the part of the responsible person.

Monitoring – A monitoring program must be submitted as part of the operation plan that should address groundwater and surface water, landfill gas (and ambient water quality). The procedures for monitoring groundwater and surface water under this code must provide for an assessment of the risk to groundwater and surface water quality from the landfill, and the detection of changes in groundwater and surface water quality caused by the landfill site.

Groundwater monitoring – Groundwater monitoring at landfills is meant to detect unacceptable groundwater contamination resulting from landfill operations. The monitoring program developed by a QP should specify the number and locations of monitoring locations for the monitoring network necessary to monitor groundwater based on the following information:

- The volume and characteristics of the waste to be discharged at the landfill facility
- The location and capacity of the landfill facility
- Adjacent land uses and surface water receptors
- The hydrogeology of the area where the landfill site is located, including unconfined aquifers underlying the landfill site
- The direction, the horizontal and vertical gradient and the velocity of the groundwater flow
- Potential contaminants of concern
- Waste characterization report
- Sensitive areas

Groundwater sampling frequency should be based on the rate of contaminant movement. Groundwater velocities are usually much less than those of surface waters, and therefore sampling intervals may be longer. Monitoring parameters and frequency of sampling are usually site specific. Quarterly monitoring of water levels in all monitoring wells should be conducted to determine seasonal variations in groundwater flow and quality for the first five years of landfill operations. If conditions are stable then the frequencies of monitoring can be reduced to annual or two times per year at the discretion of the Director. Water levels should be monitored on at least the same frequency as the regular chemical monitoring. The seasonal variation should be considered in designing the monitoring program. The low water levels may result in potentially higher concentration, while high water tables may result in lower concentrations.

In order to effectively detect and evaluate potential or existing groundwater contamination at a landfill, there are three principal locations for groundwater monitoring (MOE, 1996):

- At least one well upgradient from the landfill to establish background water quality, and to establish water level elevations and hydraulic gradients for determining groundwater flow into, or below, the landfill. Although one upgradient well is the minimum, it is recommended that two upgradient wells be installed to give some idea of background water quality variability.
- A well immediately adjacent to the downgradient edge of the filled area, with screen intercepting the water table to enable sampling of undiluted leachate for chemical constituents at the contaminant source and to measure fluid levels for determining leachate position in relation to the refuse.
- A line of three wells situated downgradient from the landfill and perpendicular to groundwater flow in the horizontal plane to detect and determine the extent and concentrations of any leachate plumes; to assess groundwater levels, flow directions, and flow rates; and to assess leachate impacts on receptors (e.g. supply wells and receiving waters). The initial sentinel wells should be located within 25 m of the landfill toe to provide early detection of groundwater impairment.
- Monitoring parameters should include potential contaminants of concern identified in the waste characterization report and pH, dissolved oxygen, resin acids, redox potential and electrical conductivity in the field, and iron, manganese, BOD and nitrogen in the laboratory.
- Additional monitoring parameters may be added at the discretion of the Director if leachate impact is indicated.

Networks of monitoring wells are often developed in phases, with data reviewed at the end of each phase to determine if the hydraulics of the site are being adequately defined. A groundwater monitoring well network should consist of a sufficient number of wells, installed at appropriate locations and varying depths, to yield samples that represent the quality of both ambient groundwater and leachate which has passed under or through the disposal area of the landfill (Environmental Protection Agency (EPA), 1993).

Surface water monitoring – Surface water monitoring at landfills is intended to detect unacceptable surface water contamination resulting from landfill operations. Surface monitoring locations should include:

- Upstream (Background) – to establish background water quality / bottom fauna conditions and flow
- Immediately Downstream (Pathway, Receptor) – to determine leachate impacts on water quality and bottom fauna at and immediately downstream of the landfill
- Downstream Recovery (Receptor) – located further downstream to document the extent of the mixing zone and distance required for the surface water to assimilate leachate and for water quality to recover to background levels.

Surface water monitoring frequencies should initially be higher than groundwater sampling frequencies in order to account for the greater variability in flow until a drainage is characterized. However, in most cases the sampling frequency will depend on the goals/objectives of the monitoring pro-

gram. For example, the assessment of annual trends would require monthly to more frequent sampling whereas, the assessment of a specific event (e.g. low flow period) would require that sampling be conducted only during its occurrence. Measurements of surface water flow should be taken whenever surface water samples or bottom fauna are collected. Surface water monitoring may need to consider potential impact from groundwater affected by landfill leachate.

Surface water should be monitored for pH, redox potential, specific conductance, temperature and dissolved oxygen concentration. This range of parameters is usually sufficient to give an indication of any changes in inorganic water quality. Samples should always be collected on the same day as field measurements and during constant flow conditions.

Sampling – Appropriate sampling protocols for surface and ground water should be followed to ensure that representative samples are collected. Analytical parameters should include both field and laboratory tests. Surface water and groundwater flow measurements should also be taken to facilitate interpretation of water quality results.

The Director requires that all sampling and flow measurements shall be carried out in accordance with the procedures described in the latest version of “[British Columbia Field Sampling Manual for Continuous Monitoring plus the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples](#)”.

The Director requires that all analyses of the required parameters are to be carried out in accordance with procedures described in the latest version of “British Columbia Environmental Laboratory Manual for the Analysis of Water, Wastewater, Sediment, Biological Materials and Discrete Ambient Air Samples 2007 Edition”, or by suitable alternative procedures as authorized by the Director.

Copies of the above manuals may be purchased from Queen’s Printer Publications Centre, P.O. Box 9452, Stn. Prov. Gov’t. Victoria, British Columbia, V8W 9V7, 1-800-663-6105 or 250-387-6409 or via fax at 250-387-1120. The manuals are also available for inspection at all Regional offices.

Fire – Landfills must be operated in a manner that reduces the risk of fire. This may include the installation and maintenance of firebreaks, intermediate cover, compaction, waste segregation and other fire prevention features required by the landfill design. Hot wastes such as ashes must not be co-disposed with combustible material such as wood wastes. Conditions in the landfill should be maintained to minimize any potential for spontaneous combustion of combustible wastes, such as avoiding landfilling of metals with wood wastes and providing adequate operational cover. Quarterly inspection for signs of fire (steam, smoke, high temperatures, Carbon Monoxide (CO) measurements) is recommended.

Signs should be posted at each entrance to the landfill with the following wording:

- “WOOD DEBRIS LANDFILL – NO SMOKING OR OPEN FLAME”

All metal, including cables and straps should be kept out of the landfills or held in a separate area, because metals may act as a catalyst that initiates spontaneous combustion.

Where landfills are adjacent to stands of timber, a minimum 10 m wide firebreak free of vegetation should be maintained. Staff should be trained and the operational plan should outline how fires will be extinguished.

An unauthorized fire in or adjacent to discharged waste must be extinguished immediately upon detection. Fire extinguishing equipment should be maintained and be available to landfill operational staff. In the event of a landfill fire only staff adequately trained in landfill fire prevention and fire-fighting techniques should be utilized. If a fire cannot be extinguished within seven days of detection, a fire control expert should be retained to provide guidance of extinguishing it. The portion of the landfill where the fire has occurred may have to be excavated to extinguish the fire if required by the fire control expert.

After the fire has been extinguished the portion of the landfill where the fire has occurred must be reconstructed or closed in such a manner that similar occurrences are prevented. The B.C. Forest Service and local fire departments may have additional requirements.

8.6 Final Closure Plan and Report

The **final closure plan and report** is an extension of the **conceptual closure plan** and when properly designed and executed will reduce the risk to the environment.

All landfills are required to have a Qualified Professional prepare a final closure plan for the landfill facility. Before closure of the landfill, the conceptual closure plan must be reviewed by a QP and amended to reflect any changes that have taken place during the operation of the landfill facility or site specific conditions. This may include recommendations for any changes that the QP may deem necessary such as barrier layer selection, surface water management, leachate management and additional monitoring.

At least three months prior to the intended closure of the landfill, the owner/operator/discharger must provide written notice to the Director in the region where the landfill facility is located, of the intended closure and provide a copy of the final closure plan for the landfill. It is recommended that the landfill operator close the landfill facility in phases. Under the Contaminated Sites Regulations, the operator of the landfill facility is required to submit a Site Profile to Land Remediation Section of the Ministry of Environment before the landfill is closed.

The final closure plan cannot be implemented until it has been approved by the Director. If the Director has not notified the operator within 45 days after the final closure plan has been submitted to the Director, the operator can initiate closure of the landfill facility.

The **final closure plan** must include the following information:

- The final design elevation of the landfill
- The area of the landfill
- The measures to be taken to prevent, or minimize the risk of:
 - Leachate or waste escaping from the landfill
 - Erosion of the landfill cover
 - Fire occurring in the closed landfill or its cover
 - Water running onto the closed landfill
- Maximum periods following the final discharge of waste before the implementation of the closure plan is initiated
- A description of the final cover of the landfill

- An estimate of the total volume of solid waste discharged to the landfill
- A survey of the location of the landfill, prepared by a land surveyor admitted as a land surveyor under the *Land Surveyors Act*
- A description of how the operator of the landfill facility has managed:
 - Drainage restoration
 - Soil replacement
 - The slope of the final cover
 - Erosion control
 - Re-vegetation and conditioning of the site
- A description of how the operator of the landfill facility will monitor the site of the landfill facility

Post Closure Monitoring – At the end of the operational life of the landfill, a post closure monitoring program as outlined in the final closure report will be implemented. All monitoring data collected up to that point will form an essential part of the detail needed to demonstrate closure conditions. The length of time for post closure monitoring will depend on the results of the ground water and surface water monitoring. If the contaminant levels have been rising throughout the life of the landfill, then the Director will require you to monitor for a longer period.

Within 3 months after the closure of the landfill facility, the operator must close the landfill facility in accordance with the final closure plan, prepare a final closure report and notify the Director in writing.

8.7 Annual Report

An annual report provides a summary of how the landfill facility has been operated and the results and interpretation of the monitoring that is required for each calendar year the facility is operating. The annual report does not need to be submitted to the ministry, but must be made available to the ministry within 7 business days.

The annual report must contain:

- The types and volumes of each waste type discharged to the landfill during the calendar year
- The locations where any wastes requiring special handling under the code are discharged within the landfill
- Any other information requested by a director

Large landfills will require the following additional information:

- Groundwater and surface water monitoring data and remedial actions taken
- Gas monitoring data and remedial actions taken
- Leachate monitoring data and remedial actions taken
- Interpretation of all the data and associated trends

The annual report should contain site inspection reports that include photos and site observations.

9. FINANCIAL SECURITY

The Director approves the following financial security requirements in support of the provision in the code that financial security can be required by the Director for registering all landfill facilities to ensure there are sufficient funds to close and monitor the landfill. Financial security must be site specific and calculated by a Qualified Professional.

This section outlines the ministry's expectations for the owner or operator of the landfill facility to provide financial security in the amount and form and subject to conditions that may be specified by the Director under applicable legislation.

A Qualified Professional will be required to calculate the financial security based on risk to the environment (escape of leachate, erosion, covering landfill, post closure monitoring, etc.) Financial security will be required for the life of the landfill and for 5 years after closure. The director can require financial security to be retained for longer than 5 years after closure if the director sees a problem developing (monitoring wells showing an increase in contamination rather than a decrease) while reviewing the final closure report.

The landfill operator will be required to recalculate the amount of financial security every 5 years for the operational life of the landfill. The landfill operator can voluntarily recalculate the financial security once per calendar year.

The director can require the landfill operator to change the amount or type of financial security to ensure sufficient funds are available.

When the amount of financial security is recalculated by a Qualified Professional, the landfill operator must notify the regional office in writing. Included in the notification to the regional office is information to justify changing the amount financial security based on risk to the environment. The regional office has 30 days from the day they receive the notice to respond to the landfill operator if the regional office believes the amount of financial security is insufficient. If the regional office does not respond within 30 days then the recalculated financial security is approved.

If the landfill operator does not maintain financial security as required then the landfill operator would be considered in non-compliance. The Ministry can order the repair or complete the necessary work to lessen the impact on the environment by issuing an order under the EMA (pollution or prevention order). The company would then be allowed to go through an appeal process.

The regional office can use any portion of the financial security if conditions in the design and operating plans are not followed and there is a risk to the environment, the landfill operator has not complied with an order, the landfill operator is declaring bankruptcy, or the financial security is being cancelled by the guarantor. The landfill operator would be required to replenish the amount of financial security that was used.

Financial security can be converted to cash under an assortment of situations, including: party defaulting, potential of financial security to lapse, company dissolution, onsite and offsite regulated party and third party property damage/pollution, receivership, bankruptcy, exceeding the amount of waste permitted.

Types of financial security that are acceptable include:

- a) Irrevocable letters of credit, issued by a Schedule I or Schedule II Canadian Financial Institution or a Canadian Credit Union, with a termination date beyond the required term of security and containing a promise to pay the minister a specified sum on written demand;
- b) Surety bonds, issued by a surety licensed under the *Insurance Act*;

The following types of financial security are acceptable, but not preferred. It should be noted that the Ministry will not pay interest on these deposits:

- Irrevocable trusts including: internal trusts, external trusts and qualified environmental trusts
 - Irrevocable trusts are subject to Legal Services Branch conducting a search in the *Personal Property Security Act* registry to confirm that the security posted for Internal/External Irrevocable Trusts and Qualified Environmental Trusts has not been previously pledged and is currently free and clear of any encumbrances and liens prior to acceptance.

The financial security must be made out to the Minister of Finance.

All or part of the financial security will be returned to the landfill operator when there is no longer a requirement for financial security or the Ministry of Environment has agreed to reduce the amount of financial security.

10. RECORDS

The operator of the landfill facility is required to maintain the records of the landfill operation at the location identified in the registration. The operator must maintain the following records:

- Registration number of the landfill
- A copy of the waste characterization study (large landfills only)
- A copy of the conceptual closure plan and final closure plan
- Copies of the design, and operating plans (large landfills only)
- Copies of all annual reports

The operator must retain the records for 10 years after the final closure of the landfill. The discharger must make all records available for inspection by an officer or the Director and must provide a copy on request within 7 business days.

11. FEES

Fees charged under the code to discharge a waste into the landfill is the same as was charged under a permit.

A cheque payable to the Minister of Finance for \$100 for the annual base fee plus a fee based on the annual maximum discharge rate to the landfill (in cubic metres). The fee is calculated based on the current Contaminant Fee for Refuse (\$0.74/tonne), as outlined in Schedule 3 of the Waste Discharge Regulation. The fee will change from time to time as the Permit Fee Regulation (B.C. Reg 299/92) is amended

If a company fails to pay their annual fee, they could be deregistered and not allowed to operate. If a company discharges waste into the landfill when they are deregistered they are in non-compliance and are subject to fines or imprisonment. Please refer to section 12 of the guideline (below) for additional information.

12. ASSURING COMPLIANCE

The Ministry assures compliance with the requirements of the Code through random audits and inspections. Review of submitted information and on-site inspections will be used to verify compliance with the requirements of the Code, the Waste Discharge Regulation, the *Environmental Management Act*, and with other applicable legislation.

Ministry staff have legal authority to enter onto the site, take samples and other specified actions as necessary to verify compliance with the Codes requirements. Operators will often be informed in advance of such inspections, but advance notice is not required.

When non-compliance is determined to be occurring, has occurred, or may occur, Ministry staff may respond in a variety of ways depending on the circumstances. Considerations for determining an appropriate response to non-compliance include the compliance history of the operator and the significance or impact (actual or potential) of the non-compliance on the environment or to human health and safety.

Alternative responses include:

- **Advisories or Warnings**
Advisories and warnings are normally used for non-compliance where there has not been a history of non-compliance and the harm to the environment or human health and safety is low. They form part of a permanent record of the operation's compliance history and inform choices if there are subsequent non-compliant occurrences.
- **Orders**
Orders may be used for more significant issues or where immediate action is required. Issuing an order creates, in itself, a new enforceable obligation on the operator. Failure to comply with an order is offence. Additionally, orders, and who they are issued to, are made public in the Ministry's [Quarterly Compliance and Enforcement Summary](#).
- **Violation Tickets**
For certain offences, the operator may receive a Violation Ticket. Violation Tickets are currently \$575. Tickets are also published for public information.
- **Prosecution**
For the more serious non-compliances, the Ministry may initiate prosecution through the Courts. If found guilty, the Court can impose maximum fines that range from \$200,000 to \$1,000,000. Detailed prosecution information is publicly available.

In selecting an appropriate response, the Ministry is guided by the compliance history of the operator, the seriousness of the issue, and Ministry standards for consistency and fairness. For additional information on how the Ministry responds to non-compliance, please refer to the Ministries [Compliance and Enforcement Policy and Procedure](#) guideline.

13. REFERENCES:

- Atwater, J.W. 1980. Fraser River Estuary Study, Water Quality: Impact of Landfills, Vancouver, B.C.
- Environment Canada, 2008. Canada's Greenhouse Gas Inventory 1990-2000, Greenhouse Gas Division Environment Canada, June 2002.
- Environmental Protection Agency. Solid Waste Disposal Facility criteria – Technical Manual. EPA 530-R-93-017 US EPA November 1993.
- Frankowski, K.A. 2000, The Treatment of Wood Leachate Using Constructed Wetlands, M.Sc. Thesis, The University of British Columbia.
- Gartner Lee Limited, 2007. Draft Guideline for Industrial Non-Hazardous Waste Landfill Code of Practice
- Haygreen, J.G. and Bowyer, J.L. 1989. Foresty Products and Wood Science: An Introduction, 2nd ed., Ames, Iowa State University Press, Iowa, USA.
- McBean, E.A. and G.J. Farquhar. An Examination of Temporal / Spatial Variations in Landfill Generated Methane Gas. Water, Air and Soil Pollution, 1980. pp 157-174.
- Ministry of Environment (MOE), 2002. Guide to Using the B.C. aquifer classification maps for the protection and management of groundwater
- Ministry of Environment (MOE), 1996. Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills, Environmental Protection Division.
- Ministry of Environment (MOE), 1998. Wood Waste Precautions.
- Ministry of Environment (MOE), 2001. Principles for preparing water quality objectives in British Columbia, Water Quality Branch, Environmental Protection Division.
- Ministry of Environment (MOE), 2007. British Columbia Environmental Laboratory Manual- For the Analysis of Water, Wastewater, Sediment, Biological Materials and Discrete Ambient Air Samples, Environmental Quality Branch, Environmental Protection Division.
- Mohsen, M.F.N., Gas Migration from Sanitary Landfills and Associated Problems Ph.D. Dissertation, Dept. of Civil Engineering, University of Waterloo, 1975.
- Moore, C.A. and Lynch, J.E., Design Criteria for Landfill Gas Migration Control Devices. Draft Report, Department of Civil Engineering, Ohio State University, September 1977.
- Ontario Ministry of Environment (OMOE), 2004. Wood Processing Waste and the Environment, Ontario.

Solid Waste Association of North America (SWANA). 1997. Landfill Gas Operation and Maintenance Manual of Operation. SR-430-23070.

Sperling Hansen Associates Inc., 2009. Draft Guideline for Industrial Non-Hazardous Waste Landfills Incidental to the Wood Processing Industry

Taylor, B.R., Goudey, J.S. and Carmichael, N.B., 1996. Toxicity of Aspen Wood Leachate to Aquatic Life: Laboratory Studies. Environmental Toxicology Chemistry, 15(2):150-159.

APPENDIX A – REGISTRATION FORM

The registration form can be obtained from the ministries web site

http://www.env.gov.bc.ca/epd/industrial/regs/codes/industrial_land/pdf/reg-form-wood-waste-landfill.pdf.

APPENDIX B – MINIMUM REQUIREMENTS

Minimum requirements for site plans submitted to the ministry for wood waste landfill registration, design plans, operating plans and closure plans.

Provide the following plans:

- One general location map 22 cm x 36 cm (8.5 “ x 11”)
- One surrounding land use plan 22 cm x 36 cm (8.5” x 11”)
- One ground plan 28 cm x 43 cm (11” x 17”) showing site facilities (current and former)

Containing, as appropriate, the following details:

- Scale bar in metres (plan scale of 1:5 000 or greater is preferred)
- North arrow
- Property boundaries, Landfill Site and buffer area boundaries
- Adjacent street names
- General indication of topographic relief and site drainage
- Description of surface cover (e.g., paved areas, building footprints, unpaved areas)
- Location of present and past potential sources of onsite contamination (e.g., equipment, above ground and underground storage tanks, spill sites, utilities, conduits)
- Legend identifying symbols used on plan
- Direction and distance to surface water (e.g., creeks, lakes) and sensitive areas
- Drinking water wells (on site and near off site)
- Adjacent business activities, residential areas, land uses
- Title block showing Qualified Professional’s name, site name, site address and date

In addition to the above information, show the following (on a separate plan if necessary):

- Locations of surface samples, boreholes, test pits, landfill gas sampling points, geophysical survey lines, etc.
- Boreholes, monitoring wells and test pit locations (if applicable)
- Estimated groundwater flow direction or measured groundwater direction and gradient
- Areas of waste deposition
- Groundwater/leachate contaminant plumes
- Leachate or gas management measures (e.g., engineered works)
- Location of waste, soil and water management areas (e.g., excavations, temporary storage areas, runoff control structures)
- Location of leachate management works (e.g., interception trenches, pumping wells)
- Predicted /modeled natural attenuation of groundwater capture zone(s)

APPENDIX C – THE BC AQUIFER CLASSIFICATION SYSTEM

See the ministry's Water Stewardship website "[An Aquifer Classification System for Ground Water Management in British Columbia](#)" for complete information.

Summary

A map-based aquifer classification system has been developed to support ground water management in the Province of British Columbia. The system classifies aquifers on the basis of their level of development and vulnerability to contamination and provides ranking values for aquifers using hydrogeologic and water use criteria. Application of the system leads to the development of an aquifer inventory. The classification system is being applied to selected areas in the Fraser River Basin. To date, a total of 153 aquifers have been identified and classified. Results include: 132 aquifers are used for drinking water, 9 aquifers are found to be heavily developed and highly vulnerable to contamination, and 13 aquifers have documented health-risk related quality concerns.

The aquifer classification system has two components:

1. A *classification* component to categorize aquifers based on their current level of development, (use) and vulnerability to contamination, and
2. A *ranking* component to indicate the relative importance of an aquifer.

APPENDIX D – CODE OF PRACTICE REGISTRATION CHECKLIST

The following checklist includes all the regulatory requirements set out in the Code of Practice for Non-hazardous Industrial Waste Landfills. Please make sure that your submission for registration includes all the required items.

- Completed registration form signed by the landfill owner/operator or agent
- The landfill meets all siting requirements
- Confirmation that a waste characterization report has been prepared by a Qualified Profession (QP) (Large Landfill only)
- Confirmation that a conceptual closure plan has been prepared
- Confirmation that a landfill design plan has been prepared by a QP (Large Landfill only)
- Confirmation that a landfill operating plan has been prepared by a QP (Large Landfill only)
- Confirmation that applicable local governments have been notified at least 30 days prior to registration
- Financial security has been provided or requirements are in place
- A cheque, money order or credit card payment for the \$100 Registration Fee and the Annual Waste Fee