
Mr. Fequet,

An outcome of the March 23rd, 2015 technical session was several information requests (detailed in the March 26th, 2015 letter from the WLWB). Six of these information requests were directed towards the GNWT (IR#1; IR#2; IR#3; IR5; IR6; IR8). I can only speak to IR#3, i.e., provide Information on any standards and/or guidelines that exist for landfill leachate testing in the NWT and/or Canada.

To that end, I’ve attempted to provide a summary of leachate testing information obtained from B.C., Alberta, Ontario, and (to a limited extent) Canada as a whole. Please note that the summary only includes information I felt was pertinent to the information request. I’d like to take the liberty to note that the information quoted should be interpreted with caution, as the landfills discussed for other provinces typically include waste streams not included in the list of materials approved for landfiling at Diavik (such as hazardous waste & contaminated soils). That difference should factor into any future discussion/decision of which (if any) conditions the revised Water License should contain (i.e., I caution interested parties to consider that fact when considering the possible need for landfill leachate conditions in the new Water License.

CANADA:

I’m told that federal guidelines with regards to landfill leachate are “in the works”. But there is currently nothing on paper at this time. I’m also told that a workshop was apparently held recently with regards to landfills in the north (but inspectors were not privy to this meeting & I can’t provide any information).

The following general statements (from an Environment Canada fact sheet) do provide some general context with regards to landfills/leachate from a federal perspective:

- “It is now accepted that all landfills will eventually release leachate to the surrounding environment”.
- Traditionally, solid waste landfills are monitored for nutrients, heavy metals, major ions and volatile organic compounds (VOCs).

It should be recognized that the aforementioned statements were about landfills predominantly composed of (1) domestic waste, (2) building debris, (3) industrial waste, (4) contaminated soils and (5) hazardous waste. At least 2 of those sources are not deposited into the Diavik Landfill (#4 and #5), and a significant portion of the domestic waste (#3) at Diavik is removed from the waste stream through the current recycling/repurposing program.
ONTARIO  (Based on info from “Landfill Standards: A guideline on the regulatory and approval requirements for new or expanding landfilling sites (2012); pgs. 78, 79, 96):

- Regulation 232/98 requires that a leachate monitoring program be carried out at the landfilling site.
- Section 26 of the Regulation requires: “the owner and the operator of a landfilling site shall ensure that a program is carried out for monitoring leachate quality and quantity”.
- The program for monitoring leachate quality and quantity should typically involve information described in Table 20.
- Table 20 in turn notes (amongst other things):
  - (a): Representative samples of leachate taken from within the waste or from the leachate collection system should be (i) taken annually and analyzed for parameters listed in column 1 of schedule 5.
  - (e): The results and an assessment of the results of the leachate monitoring should be included in an annual report.
- (e): The parameters and frequency for monitoring may be amended where the owner prepares a report showing alternative provisions are appropriate based on conditions such as geographic location, climatic conditions and the type of waste to be deposited.

- Column 1 of schedule 5 includes a comprehensive list for groundwater and leachate with the following parameters:

  Inorganics  (Alkalinity, Ammonia, Arsenic, Barium, Boron, Cadmium, Calcium, Chloride, Chromium, Conductivity, Copper, Iron, Lean, Magnesium, Manganese, Mercury, Nitrate, Nitrite, Total Kjeldahl Nitrogen, pH, Total Phosphorus, Potassium, Sodium, Suspended Solids (Leachate Only), TDS, Sulphate, Zinc).

  Volatile Organics  Benzene, 1,4 Dichlorobenzene, Dichlormethane, Toluene, Vinyl Chloride.

  Other Organics  BOD₅ (leachate only), Chemical Oxygen Demand, Dissolved Organic Carbon, Phenol.

  Field Parameters  pH, Conductivity.

ALBERTA  (Info. From “Standards for Landfills in Alberta, 2010, v. 1.0“)

- (a) The Leachate Monitoring Program shall include, at a minimum:
- (i) A detailed program for leachate collection system sample collection and analysis, that includes (a) a program to measure the depth of leachate head in the cells; (b) retrieval of representative samples at a frequency as described in Table 5.4.
- (b) The Leachate Monitoring Program shall be implemented during the active landfill life, final landfill closure, and post-closure for the landfill.

Table 5.4. Landfill Leachate Sampling and Analysis.

- pH, TDS, TSS (annually, at each leachate manhole and sump and, if applicable, each leachate pond).
- Ammonia (total), Total Kjeldahl Nitrogen, Chloride, Sodium, Sulphate, COD.
- Metals.
- BTEX, F1, F2, Phenols.
Landfills must not be operated in a manner such that ground or surface water quality existing or potential future water supply aquifers or surface waters decreases beyond that allowed by the Approved Working Criteria for Water Quality...at or beyond the landfill property boundary.

- If anticipated leachate quantity and quality, based on incoming waste characteristics, indicate that leachate discharge will not cause excursions from the established criteria, consideration may be given for not installing a leachate collection/treatment system.

- In the event that leachate discharge from the landfill results in excursions to the established criteria, the leachate shall be managed to control the impact. ...the method of treatment shall be...in accordance with the Ministry of Environments’ current policy on control technology.

- Exemptions based on economic considerations will be contemplated for existing landfills (only). The intent of these criteria is to set Sanitary Landfill standards as the goal for all MSW landfills.

I trust that the above summarizes the information requested in IR#3. I look forward to the opportunity to discuss landfill leachate monitoring & possible associated monitoring conditions for the new Water License. To help facilitate such discussions, I’ve attached pdf copies of the documents I made reference to (as always, feel free to disseminate those to any interested parties).

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Landfill Criteria
For Municipal Solid Waste

Author:

This document is available online at:
http://www.env.gov.bc.ca/epd/mun-waste/

Province of British Columbia

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These criteria were last reviewed in 1994.
1. Definitions

"200 Year Floodplain" means land where the chance of a flood occurring in any given year is at least one in two hundred.

"access road" means a road that leads from a public road to a waste disposal site.

"active life" means the period of operation beginning with the initial receipt of municipal solid waste and ending at completion of closure activities.

"action plan" means a document describing an organized, planned, technically coordinated and financially feasible course of action to be followed in identifying nonconforming landfills and to upgrade the landfill(s) to meet these criteria or to justify exemptions.

"aerobic" means in the presence of oxygen.

"approved" means authorized in writing or specified in writing with or without conditions or requirements, by the Minister of Environment, his designate, or a Manager.

"aquifer" includes any soil or rock formation that has sufficient porosity and water yielding ability to permit the extraction or injection of water at reasonably useful rates.

"biomedical waste" means a substance that is defined as biomedical waste in the Environmental Management Act.

"black water" means toilet waste

"buffer zone" means land used to separate a facility from other land.

"cell" means a compartment within a landfill isolated from other compartments by appropriate cover material and of such size so as to be considered manageable in the context of total volume and the day-to-day operating concerns including garbage placement and compaction, stability of working surfaces and slopes and the operation of landfill equipment.
"composting" is the aerobic biological decomposition of organic municipal solid waste under controlled circumstances to a condition sufficiently stable for nuisance-free storage and for safe use in land application.

"contingency plan" means a document describing an organized, planned, technically coordinated and financially feasible course of action to be followed in case of emergency or other special conditions, including, but not limited to, equipment breakdowns, fires, odours, vectors, explosions, spills, accidents, receipt or release of hazardous or toxic materials or substances, contamination of ground water, surface water or the air attributable to a solid waste management facility and other incidents that could threaten human health or safety or impair the usefulness of the environment.

"cover material" means soil or other material approved for use in sealing cells in landfills.

"daily cover" means a compacted layer of at least 0.15 metre of soil or functionally equivalent depth of other cover material that is placed on all exposed solid waste at the end of each day that municipal solid waste is discharged at the landfill.

"design volume" means the maximum volume of solid waste, including cover material, to be discharged at the solid waste management facility during its active life.

"designated flood" means a flood, which may occur in any given year, of such magnitude as to equal a flood having a 200 year recurrence interval, based on a frequency analysis of unregulated historic flood records or by regional analysis where there is inadequate stream flow data available. Where the flow of a large watercourse is controlled by a major dam, the designated flood shall be set on a site-specific basis.

"disposal" means the introduction of waste into the environment for the purpose of final burial, destruction or placement for future recovery.

"fault" means a geological fracture or zone of fractures in any material along which strata on one side have been displaced with respect to that on the other side.

"final cover" means a layer consisting of soil and, in some cases, other natural or synthetic materials that is placed on any surface of a landfill where no additional solid waste will be deposited and serves to restrict the infiltration of precipitation, to support vegetation, to control landfill gas, to restrict access by wildlife, and to promote surface drainage.
"floodplain" means a lowland area, whether dyked, floodproofed or not, which, by reasons of land elevation, is susceptible to flooding from an adjoining watercourse, ocean, lake or other body of water and for administration purposes is taken to be that area submerged by the designated flood plus freeboard.

"floodway" means the channel of the watercourse and those portions of the floodplains which are reasonably required to discharge the flood flow of a designated flood. A minimum required floodway shall be equal to the width of the channel within the natural boundary plus a minimum setback of thirty metres from the natural boundary on each side of the channel or channels unless otherwise approved.

"freeboard" means a vertical distance added to the designated flood level and is used to establish the flood construction level.

"free liquid" means any quantity of a liquid which is separated from a solid when subjected to the Free Liquid Test Procedure described in Part 3 of Schedule 4 of the Hazardous Waste Regulation.

"groundwater" means water below the ground surface in a zone of saturation.

"hazardous waste" means "hazardous waste" as defined in the Hazardous Waste Regulation.

"infiltration" is the entry into the soil or solid waste of water at the soil or solid waste surface.

"intermediate cover" means a compacted layer of at least 0.30 metre of soil or functionally equivalent depth of other cover material placed where no additional solid waste has been deposited or will be deposited within a period of 30 days.

"lateral expansion" means a horizontal expansion of the footprint of the area of landfilling beyond that which is currently authorized for waste discharge by an approved permit or operational certificate. The footprint area must not be greater than the area within the property boundaries less the areas set aside for other land uses such as buffer zones, access roads, recyclable storage areas and any other areas designated for uses other than waste discharge.

"leachate" means any liquid and suspended materials which it contains, which has percolated through or drained from a municipal solid waste disposal facility.
"liner" means a continuous layer of synthetic material or natural clay or earth materials, placed beneath and at the sides of a landfill and intended to restrict the downward or lateral escape of waste or leachate or in some cases to restrict the upward movement of ground water into the landfill.

"lower explosive limit" means the minimum percent concentration (by volume) of a substance in air that will explode or produce a flash of fire when an ignition source is present, measured at 25 degrees Celsius and atmospheric pressure.

"manager" means the "manager" as defined in the Environmental Management Act.

"municipal solid waste" means "municipal solid waste" as defined in the Environmental Management Act.

"natural boundary" means the visible high watermark of any lake, river, stream or other body of water where the presence and action of the water are so common and usual and so long continued in all ordinary years as to mark upon the soil of the bed of the lake, river, stream or other body of water a character distinct from that of the banks thereof, in respect to vegetation, as well as in respect to the nature of the soil itself (Land Act, Section 1). In addition, the natural boundary includes the best estimate of the edge of dormant or old side channels and marsh areas.

"open burning" means the combustion of any material or solid waste in the absence of containment and control of the combustion reaction with respect to residence time, temperature and mixing.

"person" includes an individual, a corporation, partnership or party, and the personal or other legal representatives of a person to whom the context can apply according to law.

"public nuisance" refers to an activity or action or result of such activity or action, which in the opinion of the Manager:

(a) interferes with the reasonable use and enjoyment of property surrounding the landfill;

(b) is a source of irritation to the public; or

(c) is annoying, unpleasant or obnoxious to the public.
"putrescible" refers to organic matter which has the potential to decompose with the formation of malodorous byproducts.

"recovery" means reclaiming of recyclable components and/or energy from the post-collection solid waste stream by various methods including incineration, pyrolysis, distillation, gasification or biological conversion (including composting) and includes the collection and subsequent management of methane gas generated in the landfill.

"recyclable material" means "recyclable material" as defined in the Environmental Management Act.

"recycling" means the collection, transportation and processing of products separated from the municipal solid waste stream which are no longer useful in their present form and the use (including composting) of their material content in the manufacture and sale of new products. Recycling refers to source-separated wastes only, when used in the context of the 3 Rs (Reduce, Reuse, and Recycle).

"reduction" means decreasing the volume, weight, and/or toxicity of discarded material and includes activities which result in greater ease or efficiency of reuse of a product or recycling of materials.

"regional district" means a jurisdiction created under Section 767 of the Municipal Act.

"remediation" means actions taken to remove, eliminate, limit, correct, counteract or mitigate the negative effects on human health or the environment of a release or threatened release of one or more contaminants into the environment.

"reuse" means the repeated use of a product in the same form but not necessarily for the same purpose.

"salvaging" means the removal of material from a solid waste facility under the control of the facility owner or operator.

"scavenging" means the uncontrolled removal of material from a solid waste facility.

"seismic impact zone" means an area with a ten percent or greater probability that the maximum horizontal acceleration in lithified earth material, expressed as a percentage of the earth's gravitational pull, will exceed 0.10 g in 250 years.
"septage" means the pumped contents of a septic tank

"sewage" means effluent from a municipal sewerage system.

"solid waste facility" refers to a facility designed, constructed and operated for the collection, processing, transferring or disposal of the solid waste stream or components thereof, including but not limited to, transfer stations, material recycling facilities, composting facilities and disposal facilities.

"Solid waste stream" means the aggregate of all solid waste components, and also the process through which they move from point of generation to ultimate disposal.

"surface water" means lakes, bays, sounds, ponds, impounding reservoirs, perennial or ephemeral streams and springs, rivers, creeks, estuaries, marshes, inlets, canals, the Pacific Ocean within the territorial limits of British Columbia, and all other perennial or ephemeral bodies of water, natural or artificial, inland or coastal, fresh or salt, public or private, but excludes groundwater or leachate collection channels or works.

"unstable area" means a location that is susceptible to natural or human-induced events or forces capable of impairing the integrity of some or all of the landfill structural components responsible for preventing releases from a landfill. Unstable areas can include poor foundation conditions, areas susceptible to mass movement, and Karst terrains.

"vector" means a carrier that is capable of transmitting a pathogen from one organism to another and includes, but is not limited to, flies and other insects, rodents and birds.

"vertical expansion" means an expansion of the vertical profile of waste deposited in a landfill or an increase in the number of lifts in a landfill beyond that which is currently authorized by an approved permit or operational certificate. The concept of vertical expansion is not applicable to those landfills for which no explicit limit on vertical height is provided in the permit or operational certificate.

"white goods" means stoves, refrigerators, freezers, washers, dryers, hot water heaters and dishwashers

"waste management plan" means "waste management plan" as defined in the Environmental Management Act.
2. Applicability

2.1 New Landfills and Lateral Expansions

These criteria are effective from the date of issuance and apply to all new landfills and both lateral and vertical expansions of existing landfills subsequently designed and constructed for the disposal of municipal solid waste (MSW).

2.2 Existing Landfills

During the preparation of a waste management plan, each regional district is to identify those MSW landfills, including privately owned and operated sites, that do not conform to these criteria. The Waste Management Plan is to include an action plan to upgrade nonconforming landfill(s) to meet these criteria or to justify exemptions. Where a Waste Management Plan is already in place, the holder of the plan is to identify nonconforming landfills and submit a corrective action plan to the Manager on or before December 31, 1995.

3. Landfill Classifications

For the purposes of these criteria, the following classifications of MSW disposal facilities are established:

- Sanitary Landfills
- Modified Sanitary Landfills
- Selected Waste Landfills

Separate criteria for Modified Sanitary and Selected Waste Landfills have not been established but rather exemptions from Sanitary Landfill criteria may be approved by the Manager, based on site specific environmental and public health considerations. Exemptions based on economic considerations will be contemplated only for existing landfills. The intent of these criteria is to set Sanitary Landfills as the goal for all MSW landfills while recognizing that, for some types of waste and in some areas of the province, there is a need for Modified Sanitary and Selected Waste Landfills.

3.1 Sanitary Landfills

Sanitary Landfills are defined as disposal facilities which are normally, but not necessarily, located in areas serving populations of 5,000 or more people and which may accept all types of municipal solid
wastes. Sanitary landfills are normally required to comply with all the criteria for landfill siting, design, operation and closure.

### 3.2 Modified Sanitary Landfills

Modified Sanitary Landfills are defined as disposal facilities which may accept all types of municipal solid wastes. These facilities are normally but not necessarily located in areas serving populations of fewer than 5,000 people where a regional or cooperative waste disposal system with neighbouring communities may not be practical or feasible.

Based on environmental considerations and economic constraints the Manager may exempt these facilities from some of the criteria except those specified in Sections 4, 5, 6.1, 6.2, 6.3, 6.5, 6.7, 7.1, 7.4, 7.7, 7.8, 7.9, 7.11 through 7.17, 8.1, 8.3, 8.4, and 8.6, all of which are considered mandatory (mandatory sections are designated by an "M" following the section heading). However, at the discretion of the Manager, the siting and operating criteria for these landfills can be made more stringent to reduce impacts on the environment. Modified Sanitary Landfills will normally not be considered acceptable for remote industrial, recreational, exploration and construction camps. MSW from these facilities should be incinerated in properly designed and permitted, auxiliary fuel fired refuse incinerators.

### 3.3 Selected Waste Landfills

Selected Waste Landfills are defined as disposal facilities which accept selected types of refuse, not including putrescibles. Wastes received at these landfills may include: demolition, land clearing and construction (DLC) debris; solid industrial wastes (excluding all hazardous wastes) such as foundry sands; and, where recycling options are not available or feasible and only with the approval of the Manager, bulky wastes such as large appliances ("white goods") and derelict motor vehicles. Generally, these Selected Waste Landfills will only receive a few types of waste which should each be discharged to discrete areas of the site.

Based on the waste type, leachate generation potential, location, environmental considerations and economic constraints, the Manager may exempt these landfill facilities from some of the criteria except those specified in Sections 4, 5, 6.1, 6.2, 6.3, 6.5, 6.7, 7.1, 7.4, 7.7, 7.8, 7.9, 7.11 through 7.17, 8.1, 8.3, 8.4, and 8.6, all of which are considered mandatory (mandatory sections are designated by an "M" following the section heading). Any person seeking to establish a Selected Waste Landfill must demonstrate, to the satisfaction of the Manager, the value of keeping these wastes separate from the main waste stream.
4. Performance Criteria (M)

Consistent with current trends, the design and operation of landfills should reflect the 3Rs of waste management, namely reduce, reuse and recycle. This translates to a philosophy that stresses preventing, or at least minimizing, the production of leachate and landfill gas. Initiatives to reduce the quantity of waste directed to landfills by 50% by the year 2000 will certainly result in an overall reduction in the loading of organics and other leachate/landfill gas-producing materials. For new landfills, and to a lesser extent existing landfills, design features and operating conditions can be specified that would deter the production of both leachate and landfill gas. These could include means to prevent the introduction of water to the garbage by the use of a moveable cover or structure over the working area until soil or other permanent cover material can be spread.

In recognition of the transition period that will be experienced in proceeding from the past and present to the future, the following sections address the issues of leachate and landfill gas from an environmental protection perspective.

4.1 Ground and Surface Water Quality Impairment (M)

Landfills must not be operated in a manner such that ground or surface water quality in existing or potential future water supply aquifers or surface waters decreases beyond that allowed by the Approved and Working Criteria for Water Quality prepared by the Water Management Division of the Ministry of Environment, or other appropriate criteria, at or beyond the landfill property boundary. 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. The appropriate water quality criteria for each site will be specified by the Manager after reviewing existing and potential future uses of the ground and surface water resources.

For new landfills, the potential for leachate generation and the estimated leachate impact must be assessed during the design stage of the landfill. If anticipated leachate quantity and quality, based on local conditions of precipitation and net water balance combined with incoming waste characteristics, indicate that leachate discharge will not cause excursions from the established criteria, consideration may be given for not installing a leachate collection/treatment system. If the assessment indicates that leachate could result in an excursion from the established criteria, provision for leachate management in the form of control of quality and quantity or collection/treatment is mandatory. In the event that leachate collection/treatment is indicated, the method of treatment shall be satisfactory to the Manager in accordance with the Ministry’s policy on Best Available Control Technology (BACT).
For existing landfills, in the event that leachate discharge from the landfill results in excursions to the established criteria, the leachate shall be managed to control the impact. In the event that leachate collection/treatment is indicated, the method of treatment shall be satisfactory to the Manager in accordance with the Ministry’s current policy on control technology.

### 4.2 Landfill Gas Management and Odour Nuisance (M)

As indicated in Section 6 addressing design criteria, 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. The generic grouping of gases referred to as "non-methane organic compounds" (NMOCs) has been selected as a surrogate or indicator for the purposes of assessment and subsequent management of landfill gas. This group contains many toxic and/or reactive organic gases that are normally a component of landfill gas generated in sanitary landfills. For those landfills which by virtue of their nature would not be expected to produce NMOCs in any great quantity, assessment and management of landfill gas by methane emissions directly may be appropriate. An example of this scenario would be a selected waste landfill accepting wood waste and no mixed garbage. For those landfills which by virtue of their nature would not be expected to produce landfill gas in any great quantity, management of gas may not be necessary. An assessment of the need for passive landfill gas venting will, however, still be necessary.

Notwithstanding the results of this assessment, at no time should combustible gas concentrations exceed the lower explosive limit in soils at the property boundary or 25% of the lower explosive limit in any on-site or off-site structure or facility. With regard to the construction of any on-site building and structure or the installation of services (water, sewer, electrical, etc.), due consideration must be given to the potential gas hazard.

Landfills must not be operated in a manner such that gas emissions create a public odour nuisance, or that federal, provincial or local air quality criteria are exceeded.

### 4.3 Public Health, Safety and Nuisance (M)

A landfill must not be operated in a manner such that a significant threat to public health or safety or a public nuisance is created with respect to: unauthorized access, roads, traffic, noise, dust, litter, vectors or wildlife attraction.
5. Siting Criteria (M)

Landfill siting requires a detailed site location investigation which addresses all the issues outlined below and on Schedule 1, Table 1 which includes water contamination, air pollution, wildlife conflicts, as well as transportation, social and economic factors. The information provided in Table 1 is intended solely as guidance for proponents in their siting activities. Concerns associated with each of the broad categories of impact are presented along with the impacted receptor and exposure pathway. The landfill design, operation and closure requirements discussed in Sections 6, 7 and 8 provide additional constraints to the siting process.

5.1 Property Boundary (M)

The buffer zone between the discharged MSW and the property boundary should be at least 50 metres of which the 15 metres closest to the property boundary must be reserved for natural or landscaped screening (berms or vegetative screens). Depending on adjacent land use and environmental factors, buffer zones of less than 50 metres but not less than 15 metres may be approved by the Manager.

5.2 Other Facilities (M)

The distance between the discharged MSW and the nearest residence, water supply well, water supply intake, hotel, restaurant, food processing facility, school, church or public park is to be a minimum of 300 metres. Greater or lesser separation distances may be approved where justified. For those landfills designed to collect and recover methane gas generated, the issue of potential on-site or off-site users of the energy should be addressed in siting the landfill, consistent with the preceding regarding public places.

5.3 Airports (M)

The distance between an airport utilized by commercial aircraft and a landfill containing food wastes which may attract birds is to be a minimum of 8.0 kilometres, unless bird control measures acceptable to Transport Canada and approved by the Manager are instituted or the potential for birds causing hazard to aircraft is minimal.

5.4 Surface Water (M)

The distance between the discharged MSW and the nearest surface water is to be a minimum of 100 metres. Greater or lesser separation distances may be approved by the Manager where justified by hydrogeological investigations or by provision of surface water diversion works to reroute the watercourse of concern.
5.5 Floodplain (M)

Landfills proposed for locations within the 200 year floodplain and the associated floodway are not to be sited without adequate protection to prevent washouts. Designs for flood protection will be referred by the Manager to the Water Management Branch of the Water Management Division of the Ministry of Environment for comment. The Manager retains the final authority for approval.

5.6 Unstable Areas (M)

Landfills are not to be located within 100 metres of an unstable area.

5.7 Other Excluded Areas (M)

Landfills are not to be located within the boundaries of those areas listed in Section 3(e) of the Hazardous Waste Regulation.

6. Design Criteria

The following clauses have been written to give guidance in designing MSW landfills. It is important to note the operational and closure provisions outlined in Sections 7 and 8.

6.1 Landfill Design Approach (M)

Landfills are to be designed to minimize environmental impact and risk and to ensure compliance with the Performance Criteria. In order to do this, the design must be based on a sound knowledge of the environmental setting including climate, surface and subsurface drainage, geology, groundwater, ecology as well as economic and social factors and must be carried out by qualified professionals.

The design criteria listed below identify two types of landfills: "natural control landfills" which utilize the attributes of the site's natural setting (e.g. low permeability soils) to control emissions such as leachate or landfill gas and "engineered landfills" which use engineered systems (e.g. leachate and gas collection systems) to compensate for inadequacies in the natural abilities of the site to restrict off-site environmental impacts.

Some landfills will not fall into these precise types but will contain components of each. The design criteria listed below are not necessarily the best achievable technology for every landfill site and merely following the criteria does not absolve the designers from taking full responsibility and liability for their design.
6.1.1 Natural Control Landfills

The following criteria apply to "natural control" landfills which do not rely on leachate containment/collection/disposal systems:

The bottom-most solid waste cell is to be 1.2 metres above the seasonal high water table. Greater or lesser separation depths may be approved based on soil permeability and the leachate renovation capability of the soil.

There is to be at least a 2 metres thick layer of low permeability soil with a hydraulic conductivity of 1 x 10^-6 cm/s or less (i.e. silt or clay), below each of the bottom-most waste cells. Lesser thicknesses or no layer of low permeability soil may be approved based on the potential for leachate generation and the unsaturated depth, permeability and leachate renovation capability of the existing soil.

6.1.2 Engineered Landfills

The following criteria apply to "engineered" landfills which have leachate containment/collection/disposal systems:

The minimum liner specification for leachate containment systems is a 1 metre thick, compacted soil liner with a hydraulic conductivity of 1 x 10^-7 cm/s or less. Minimum bottom slopes of the liner are to be 2 percent on controlling slopes and 0.5 percent on the remaining slopes. Natural, in-situ, low permeability soils, geomembranes, or composite liners (consisting of a geomembrane and a soil layer) which provide the same level of leachate containment are acceptable equivalents. Liners with higher hydraulic conductivities may be approved depending on the leachate generation potential and the unsaturated depth, permeability and leachate renovation capability of the existing soil.

Minimum specifications for leachate collection systems are a 0.3 metre thick sand drainage layer having a hydraulic conductivity of 1 x 10^-2 cm/s or greater. Synthetic drainage nets which provide an equivalent hydraulic conductivity are an acceptable alternative.

If there is any concern for the precipitation of leachate constituents causing a plugging problem, the leachate collection system is to be designed to prevent such precipitation from occurring. The drainage layer is to be designed with appropriate grades and collection piping so that the leachate hydraulic head on the liner does not exceed 0.3 metre at any time.
6.2 Water (M)

The disposal of municipal solid waste into water is unacceptable. Surface water diversion to restrict
storm water runoff from contacting the wastes is required.

6.3 Final Cover (M)

Final cover for landfill sites is to consist of a minimum of 1 metre of low permeability (<1 x 10 - 5
cm/s) compacted soil plus a minimum of 0.15 metre of topsoil with approved vegetation established.
The depth of the topsoil layer should be related to the type of vegetation proposed (i.e. rooting
depth). Soils of higher permeability may be approved based on leachate generation potential at the
landfill site. Final cover is to be constructed with slopes between 4% and 33% with appropriate run-
on/run-off drainage controls and erosion controls. An assessment of the need for gas collection and
recovery systems shall be made so that, in the event such systems are required, cover can be
appropriately designed and constructed. Final cover is to be installed within 90 days of landfill closure
or on any areas of the landfill which will not receive any more refuse within the next year. Completed
portions of the landfill are to progressively receive final cover during the active life of the landfill.

Additional layers of natural materials including earth and aggregate and/or synthetic materials may be
necessary for inclusion in the final cover design due to site specific conditions and the presence of
management systems for leachate and landfill gas.

6.4 Gas Venting or Recovery and Management Systems

Landfill gas recovery and management systems are not required for landfills of a total capacity not
exceeding 100,000 tonnes. For landfills exceeding this total capacity, an assessment of the potential
emissions of non-methane organic compounds (NMOCs), the surrogate group of gaseous compounds
associated with landfill gas, shall be carried out according to the procedure appended to this document
as Schedule 2. If the assessment indicates that the emission of NMOCs exceeds or is expected to
exceed 150 tonnes/year, the installation and operation of landfill gas recovery and management
systems are mandatory. Where a gas recovery and management system is installed, direct venting to
the air of gases collected must be avoided; rather, subsequent utilization for energy recovery is
recommended. Combustion, even by incineration or flaring, should be encouraged over direct venting
to the atmosphere to reduce odours and greenhouse gas emissions. At no time should combustible
gas concentrations be allowed that exceed or are predicted to exceed the lower explosive limit in soils
at the property boundary or 25% of the lower explosive limit at or in on-site or off-site structures.
Minimum recommended spacing for gas vents is two per hectare.
In the event that gas recovery and management systems are not required according to the procedure presented in Schedule 2, an assessment of the need for passive gas venting should be carried out.

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

6.6 Fencing and Access
Fencing is required around the perimeter of the landfill. The type and extent of fencing will depend on the existing natural vegetation and topographic features and is to be approved by the Manager. All access points are to have locking gates.

6.7 Design by Qualified Persons (M)
All landfills are to be designed by persons qualified in landfill site selection, design and operation. At the discretion of the Manager, and for all sanitary landfills serving populations of 10,000 persons or greater, these landfill designs must also include both an assessment of risk from seismic activity if the site is not located on bedrock, solid glacial till or clay and an assessment of risk from fault activity.

7. Operational Criteria

7.1 Prohibited Wastes (M)
The CO-disposal of the following wastes with the rest of the MSW is prohibited unless specifically approved by the manager:

- Hazardous Wastes other than those specifically authorized in the Hazardous Waste Regulation
- Bulk liquids and semisolid sludges which contain free liquid;
- Liquid or semisolid wastes including septage, black water, sewage treatment sludge, etc.;
- Automobiles, white goods, other large metallic objects and tires (except in the case of Selected Waste Landfills approved by the Manager where recycling options are not available or feasible);
- Biomedical waste as defined in the document "Guidelines for the Management of Biomedical Waste in Canada" (CCME, February 1992); and
- Dead animals and slaughter house, fish hatchery and farming wastes or cannery wastes and byproducts.
Burial of these wastes in dedicated locations (i.e. avoiding co-disposal) at a landfill site may be approved only if there is no other viable alternative such as treatment/disposal, recycling, reprocessing or composting. Viability of alternatives is to be determined by the Manager. For those cases in which the dedicated disposal of otherwise prohibited wastes is approved, the specific on-site location of the disposal shall be recorded to allow ready access to the waste should corrective or further action pertaining to the management of these wastes be required by the Ministry at some time in the future.

7.2 Landfilling Method

The method of landfilling (e.g. trench, area, ramp) will be determined by factors including the physical site characteristics and the owner's ability to achieve compliance with these criteria.

7.3 Designated Areas

All landfill sites should be provided with and maintain, within the confines of the site or at other more appropriate locations, areas for the separation, handling and storage of recyclable, compostable or reusable materials such as bulky metallic objects and white goods, tires, batteries, and, where applicable, source separated materials such as yard wastes, glass, metal, plastic, paper, concrete, cardboard and drywall.

When a separated recyclable material is a hazardous waste it is to be stored and managed in accordance with the Hazardous Waste Regulation.

7.4 Signs (M)

All landfill sites are to have a sign posted at each entrance with the following current information:

- Site name
- Owner and operator
- Contact phone number and address for owner and operator
- Phone number in case of emergency (such as fire)
- Hours of operation (if applicable)
- Materials/wastes accepted for landfill and recycling
- Materials/wastes banned
- Tipping fees (if applicable)
Additional signs which clearly indicate the directions to the active tipping face, public disposal area, recycling and waste separation areas, etc. should also be displayed.

7.5 Supervision
All Sanitary Landfills are to have full-time, trained operators on-site during operating hours. The gates are to be locked to prevent unauthorized access during non-operating hours. Properly designed and maintained public waste disposal and/or recyclable material bins situated outside the main gate may be provided for after hours use.

7.6 Waste Measurement
The quantity of all wastes received at landfills which service a population of 5,000 or more or which receive more than 5,000 tonnes/year of waste should be measured by a method approved by the Manager. For municipal landfills serving a population greater than 10,000 or more or which receive greater than 10,000 tonnes/year and for all private landfills, weigh scales are recommended.

The federal government requires that weigh scales used to assess charges related to the weight of a commodity be accurate and sensitive to the range of weights being measured. A weigh scale accurate for measuring typical commercial waste vehicles and/or containers (loaded weight as well as tare weight) may not be accurate for measuring waste loads brought to the landfill in smaller vehicles such as pickup trucks and private automobiles. If fees are being contemplated for small loads, the accuracy of the scales for measuring these smaller weights should be confirmed with the federal department of Consumer and Corporate Affairs-Weights and Measures. Alternatively, charges for these loads could be based on typical load sizes according to type of vehicle rather than on a direct measure of weight.

7.7 Scavenging (M)
Scavenging of waste is to be prevented. The salvaging of wastes should be encouraged by providing areas and facilities for separation of recyclable or reusable materials.

7.8 Dust Control (M)
Dust created within the landfill property is to be controlled, using methods and materials acceptable to the Manager, such that it does not cause a public nuisance.

7.9 Waste Compaction and Covering (M)
Wastes are to be spread in thin layers (0.6 m or less) on the working face and compacted. Normally, 3-5 passes of the compacting equipment over the wastes are sufficient to achieve an appropriate density. The working face area should be minimized as much as possible. Cover material is to be
applied at all Sanitary Landfills at the end of each day of operation. Where a Sanitary Landfill operates continuously 24 hours per day, 0.15 m of cover material is to be applied at a frequency approved by the Manager. Under specific circumstances, such as during bear season, the Manager may specify more stringent cover requirements.

When intermediate cover is required, it is to be applied immediately after the last day of operation on areas of the landfill where disposal will not occur for a period exceeding a further 30 days.

The frequency of covering for Modified Sanitary and Selected Waste Landfills shall be specified by the Manager based on public health, environmental and economic factors. Proponents may be required to justify requests for less frequent than daily covering at these types of landfill sites.

7.10 Extreme Weather Conditions

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.

7.11 Litter Control (M)

Litter is to be controlled by compacting the waste, minimizing the working face area, applying cover at appropriate frequencies, providing litter control fences and instituting a regular litter pickup and general good housekeeping program or any other measures required by the Manager.

7.12 Vectors (M)

Vectors are to be controlled by the application of cover material at a specified frequency or by other control measures as required and approved by the Manager.

7.13 Wildlife (M)

Landfills are to be operated so as to minimize the attraction of wildlife such as bears and birds by applying cover at required frequencies and instituting a good housekeeping program. Further control measures, such as bear control fences and bird control devices, may be specified by the Manager.

7.14 Open Burning (M)

Open burning of typical domestic garbage, sawdust and bark at landfills is prohibited. Open burning of other combustibles is generally discouraged. Controlled burning of other wood residues such as stumps, brush and untreated wood may be allowed when approved by the Manager, subject to the following minimum provisions:
• The reuse or recycling of the wood residues is not feasible;
• The landfill services a population of 10,000 or less or receives less than 10,000 tonnes/year of waste and is a minimum of 2 km from the nearest permanently occupied residence, school, hospital or airport;
• A separate area is provided for the burning away from the fill area, complete with any fire breaks (to prevent the spread of fire to the rest of the landfill or the adjacent forest or other surrounding land use) as deemed appropriate and necessary by the Ministry of Forests or the local fire department;
• Authorization to burn in the form of a burning permit is obtained from the Ministry of Forests or any appropriate municipal authority such as the local fire department as well as authorization under the Environmental Management Act for the burn (unless an exempted burn) is obtained from the Ministry of Environment; (Note: Environmental Management Act approval may be in the form of a specific burning permit or a landfill permit or operating certificate;
• Adequate fire fighting equipment is available on-site as outlined in the issued burning permit or as required by all authorising agencies;
• Brush and wood is seasoned for at least one season and is free of rocks, soil, etc.;
• Brush and wood is stacked in a series of separate piles to facilitate fire control to the satisfaction of the Ministry of Forests or the local fire department, to enhance a hot burn for the minimization of smoke and to prevent spread to other nearby areas;
• Atmospheric conditions are suitable so that there is no threat to public health and safety and no nuisance or hazard is caused by smoke or odour; the Venting Index (VI) may be an appropriate tool for evaluating the local conditions to make the "burn/no burn" decision;
• The duration of any burning is less than 24 hours; and
• Full time supervision is provided until the burning activity is complete (i.e. until there is no smoke and until no danger of fire exists).

7.15 Monitoring (M)
A monitoring program must be submitted to and approved by the Manager addressing, as a minimum, ground and surface water, landfill gas and ambient air quality as set out pursuant to these criteria in monitoring guidelines being prepared by the Ministry. Monitoring of other environmental media such as vegetation and soils should be assessed and a program developed as the site-specific situation warrants.
7.16 Record Keeping (M)

The owner and/or operator of a landfill shall record and maintain the following information both on-site and at the legal address of the owner/operator:

- copy of the permit(s) for the site or the certificate(s) of operation;
- inspection records for inspections conducted by staff and regulatory agencies;
- training procedures;
- contingency plan and notification procedures;
- closure and post-closure care plans;
- monitoring results for gas, leachate, surface and ground water;
- volumes of gas extracted/recovered from the site (where gas collection and management are carried out);
- volumes of leachate collected from the site (where leachate collection and management are carried out);
- interpretations of monitoring results;
- financial assurance documentation if financial assurance is required; and
- copies of all annual reports.

7.17 Annual Report (M)

An annual Operations and Monitoring Report is to be submitted to the Manager in a timely fashion as specified by the Manager. These reports are to contain at least the following information:

- Total volume and/or tonnage of waste discharged into the landfill for the year;
- Approved design volume;
- Remaining site life and capacity;
- Operational plan for next 12 months;
- Operation and maintenance expenditures;
- Leachate, water quality and landfill gas monitoring data and interpretation;
- Amounts of leachate collected, treated and disposed;
- Any changes from approved reports, plans and specifications;
- An up to date contingency plan, noting any amendments made to the plan during the year;
- Amount of landfill gas collected and its disposition; and
- Review of the closure plan and associated estimated costs.
8. Closure and Post-closure Criteria

8.1 Closure Plans (M)

A closure plan for existing landfills is to be submitted to and approved by the Manager by December 31, 1995. Submission of a closure plan will be a requirement for permitting any new landfill site. A closure plan for sanitary landfills will specify at least the following:

- Anticipated total waste volumes and tonnage, and life of the landfill (i.e. closure date);
- A topographic plan showing the final elevation contours of the landfill and surface water diversion and drainage controls;
- Design of the final cover including the thickness and permeability of barrier layers and drainage layers, and information on topsoil, vegetative cover and erosion prevention controls;
- Procedures for notifying the public about the closure and about alternative waste disposal facilities;
- Rodent and nuisance wildlife control procedures;
- Proposed end use of the property after closure;
- A plan for monitoring groundwater, surface water and landfill gas, erosion and settlement for a minimum post-closure period of 25 years;
- A plan and accompanying design for the collection, storage and treatment/use of landfill gas for a minimum of 25 years;
- A plan for operation of any required pollution abatement engineering works such as leachate collection and treatment systems, for a minimum post-closure period of 25 years; and
- An estimated cost, updated annually, to carry out closure and post-closure activities for a minimum period of 25 years.

The minimum contents of a closure plan may be revised as appropriate by the Manager for Modified Sanitary or Selected Waste Landfills.

8.2 Financial Security

A person that owns an existing or proposed new landfill site is to provide for the future financial security of the operations at and beyond closure by establishing a Closure Fund in a form acceptable to the Manager, such as upfront security or a fund financed on a charge per tonne of waste disposed basis. Such a fund would be analogous to the provincial Waste Management Trust Fund which the
Minister may establish under Section 136 of the *Environmental Management Act*. The ultimate amount of the financial security will meet or exceed the currently estimated closure and post-closure costs as outlined in the closure plan plus a reasonable contingency for any remediation which may be required. For municipally owned landfills, the financial security can be built up over time according to a schedule approved by the Manager.

**8.3 Legal Survey (M)**

All landfills sited on titled land must register a covenant that the property was used for the purpose of waste disposal as a charge against the title to the property as provided for under Section 215.1 of the Land Title Act.

**8.4 Buildings and Structures (M)**

The construction of buildings and other structures on landfills containing putrescible wastes is not recommended for a minimum period of 25 years after closure due to concerns about combustible gas and excessive settlement. Such activity will only be considered and/or authorized after an investigation and report by qualified persons. The report is to be submitted for approval to the Manager prior to initiating construction activities.

**8.5 Operation of Gas Recovery and Management System**

Where landfill gas recovery and management is required, operation of the system should be considered an integral part of overall landfill management. The system should be planned for from the early design stage of the landfill and arrangements made for its operation for a minimum 25 year life after closure.

**8.6 Operation of Other Control Systems (M)**

Operation of other environmental control systems for leachate and run-off as well as monitoring of leachate, groundwater and surface water must be continued during the entire post-closure period unless the early suspension of such operations or monitoring is approved by the Manager.
### Schedule 1 — Table 1: Siting Concerns

<table>
<thead>
<tr>
<th>Composite</th>
<th>Concerns</th>
<th>At Risk</th>
<th>Pathway</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td>Water Contamination</td>
<td>1 wells</td>
<td>humans (health)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 creeks, rivers, lakes, etc.</td>
<td>humans (health)</td>
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<td>aquatic life</td>
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<td></td>
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<td>plant life</td>
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<td></td>
<td></td>
<td>animal life</td>
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<tr>
<td><strong>B</strong></td>
<td>Site Air Contamination</td>
<td>1 odour</td>
<td>humans (aesth.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 chemical</td>
<td>humans (health)</td>
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<td></td>
<td></td>
<td>3 physical (methane gas)</td>
<td>plants</td>
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<td></td>
<td></td>
<td>4 noise</td>
<td>humans (explosion)</td>
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<td></td>
<td></td>
<td>5 dust</td>
<td>plants</td>
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<tr>
<td></td>
<td></td>
<td>6 smoke</td>
<td>humans (aesth.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7 greenhouse gases</td>
<td>humans (global climate)</td>
</tr>
<tr>
<td><strong>C</strong></td>
<td>Wildlife Conflicts</td>
<td>1 birds</td>
<td>humans (plane traffic, nuisance)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 animals</td>
<td>humans (human / bear conflict)</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>bears (destroyed as a nuisance)</td>
</tr>
<tr>
<td><strong>D</strong></td>
<td>Transportation</td>
<td>1 accidents</td>
<td>humans (health)</td>
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<tr>
<td></td>
<td></td>
<td>2 noise</td>
<td>humans (aesth.)</td>
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<tr>
<td></td>
<td></td>
<td>3 dust</td>
<td>Humans (aesth.)</td>
</tr>
<tr>
<td><strong>E</strong></td>
<td>Social</td>
<td>1 site aesthetics</td>
<td>adjacent land owners</td>
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<td></td>
<td></td>
<td>2 compatible land use</td>
<td>adjacent land owners</td>
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<tr>
<td><strong>F</strong></td>
<td>Economic</td>
<td>1 waste transport and transfer</td>
<td>taxpayers</td>
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<tr>
<td></td>
<td></td>
<td>2 capital cost</td>
<td>taxpayers</td>
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<td></td>
<td>3 operating cost</td>
<td>taxpayers</td>
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</tbody>
</table>
Schedule 2: Procedure for Estimating the Potential Emission of Non-methane Organic Compounds (NMOCs) from Municipal Solid Waste Landfills

Introduction

The approach adopted in these criteria for the management of landfill gas emissions from municipal solid waste landfills is virtually identical to that developed and currently under review by the United States Environmental Protection Agency (USEPA). The EPA proposal would add subpart WWW to 40 CFR part 60 for the control of new sources and would propose emission guidelines and compliance schedules for existing sources under subpart C.

These criteria require municipal waste landfills emitting greater than 150 tonnes/year of non-methane organic compounds (NMOCs) to design and install gas collection systems and then combust the captured landfill gases. Energy recovery is optional. Landfills less than 100,000 tonnes total capacity would be exempt from control requirements. Landfills with design capacities greater than or equal to 100,000 tonnes would install collection and control equipment if their calculated NMOC emissions are greater than 150 tonnes/year. These larger landfills are required to calculate and report their NMOC emission rate periodically until closure or until the need for a collection and control system is indicated. Actual site-specific measurements of the calculation parameters may replace default values assumed in the estimation procedure. Alternatively, actual site-specific measurements of landfill gas generated may be used to estimate total emissions for the purpose of comparison to the 150 tonnes/year of NMOCs action level.

Calculation of Estimated NMOC Emission Rate

The estimated annual emission rate of NMOCs from municipal solid waste landfills is calculated according to the following equation:

\[ M \text{ [NMOC]} = 2LoR(1-e^{-kt})(C \text{ [NMOC]})(3.595\times10^{-9}) \quad (1) \]
where:

\[ M \text{ [NMOC]} = \text{mass emission rate of NMOC, tonnes/year} \]

\[ Lo = \text{refuse methane generation potential, m}^3/\text{tonne of refuse} \]

\[ R = \text{average annual refuse acceptance rate, tonne/year} \]

\[ k = \text{landfill gas/methane generation rate constant, year}^{-1} \]

\[ t = \text{age of landfill, years} \]

\[ C \text{ [NMOC]} = \text{concentration of NMOC in landfill gas, ppmv as Hexane} \]

\[ 3.595 \times 10^{-9} = \text{conversion factor} \]

For those landfills for which the actual year-to-year acceptance rate is known, the estimated annual emission rate of NMOCs from municipal solid waste landfills is calculated according to the following equation:

\[ QT = \sum_{i=1}^{n} 2kLoMi(e^{-kti})(C \text{ [NMOC]})(3.595 \times 10^{-9}) \]

where:

\[ QT = \text{total NMOC emission rate from the landfill, tonnes/year} \]

\[ k = \text{landfill gas generation constant, year}^{-1} \]

\[ Lo = \text{methane generation potential, m}^3/\text{tonne of refuse} \]

\[ Mi = \text{mass of refuse in the } i \text{th section, tonnes} \]

\[ ti = \text{age of the } i \text{th section, years} \]

\[ C \text{ [NMOC]} = \text{concentration of NMOC in landfill gas, ppmv as hexane} \]
In the absence of site-specific data, the default values to be used for $k$, $L_0$, and NMOC concentration are as follows:

$$k = 0.02 \text{ year}^{-1}$$

$$L_0 = 230 \text{ m}^3/\text{tonne of refuse}$$

$$C_{\text{NMOC}} = 8,000 \text{ ppmv as hexane}$$

Sample calculations of annual emission rate of NMOCs have been carried out according to Equation (1) above for a range of annual refuse acceptance rates and ages of landfill. The results, depicting the annual NMOC emission rate as a function of both annual acceptance rate and landfill age, are presented in Figures 1 and 2.

![Figure 1: Annual Emission of NMOCs as a Function of Annual Refuse Charging Rate & Landfill Age (t) in Years](image-url)
Figure 2: Annual Emission of NMOCs as a Function of Annual Refuse Charging Rate & Landfill Age (t) in Years

Emission of NMOCs (tonnes/year)

Refuse Charging Rate (tonnes/year)

l=30 y

l= 1 y

0 20000 40000 60000 80000 100000 120000 140000 160000 180000 200000

0 200 400 600 800 1000 1200
STANDARDS FOR LANDFILLS IN ALBERTA

February 2010

Government of Alberta
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FOREWORD

Alberta Environment is updating its waste management regulatory requirements. It is anticipated that the new regulatory requirements will be in place for all landfills by 2011. The *Standards for Landfills in Alberta (Standards)* is one initiative in upgrading waste management regulatory requirements. The *Standards* were developed by a group of people with extensive knowledge of landfill technology from Alberta Environment and the industry. Alberta Environment acknowledges, with gratitude, the guidance and direction provided by the participants in developing this document. The members willingly participated in the process by volunteering their expertise, attend meetings and review documents.

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APPLICATION OF THE STANDARDS FOR LANDFILLS

The Alberta Standards for Landfills (Standards) outline the minimum requirements for development, operation, monitoring, closure and post-closure of Class I, Class II, and Class III landfills. The Standards are intended to provide public assurance regarding the protection of groundwater and surface water, and the appropriate management of nuisances associated with landfill development.

The Standards apply to disposal activities at new landfills, new cells at existing landfills, and lateral expansions at existing landfills. The Standards will also apply to existing registered landfills that are required to apply for an Approval due to an increase in annual waste disposal tonnage. A transition plan will be developed in consultation with landfill approval and registration holders for existing landfills operating under an Approval or Registration.

The Standards are intended to be a continuous improvement document. A review of the Standards will be conducted a minimum of every 5 years by a multi-stakeholder technical committee comprised of representatives from industry and government. The next scheduled review will be in 2015. Written requests for improvements to the Standards may be directed to:

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DEFINITIONS

All definitions as stated in the *Environmental Protection and Enhancement Act* and associated regulations shall apply to these *Standards*.

In these *Standards*,

(a) “Act” means the *Environmental Protection and Enhancement Act, R.S.A 2000, c E-12*, as amended;

(b) “action leakage rate” means the amount of leakage that would occur through the primary liner, based on two holes per hectare, each with a diameter of 2 mm;

(c) “active landfill area” means the portion of the landfill that has received or is receiving waste for disposal, where final cover has not been placed, and includes areas that are being used for interim management of waste prior to disposition;

(d) “active landfill life” means the period of operation during which waste is received for disposal at the landfill, beginning with the initial receipt of waste and ending with the start of final landfill closure activities;

(e) “adjacent” means lands that are contiguous to the landfill or would be contiguous if not for a river, stream, railway, road, or utility right of way;

(f) “APEGGA” means the Association of Professional Engineers, Geologists and Geophysicists of Alberta;

(g) “aquifer” means an aquifer as defined in the *Water Act*;

(h) “background” means the natural concentration of a substance in a particular groundwater zone in the absence of any input from anthropogenic activities or sources;

(i) “background level monitoring” means a sampling and analysis program that establishes water quality representative of pre-development conditions;

(j) “bulk liquid” means a liquid transported in a vehicle tank or body that is not contained in barrels or other such containers;

(k) “certified operator” means a person who holds a valid Certificate recognized by the Director;

(l) “clay liner” means a liner meeting the specifications in section 3.5(c);

(m) “clayey deposit” means an unconsolidated geological unit that is capable of achieving a hydraulic conductivity of $1 \times 10^{-8}$ metres per second;

(n) “compliance boundary” means locations where measurements of groundwater quality for regulatory purposes are taken to assess a landfill’s performance;

(o) “composite liner” means a liner meeting the specifications in section 3.5(d);
“construction quality assurance” means an integrated system of management activities involving planning, implementation, documentation, assessment, reporting and quality improvement to identify the level to which the construction is in compliance with the specifications;

“construction quality control” means the overall system of technical activities that measures the attributes and performance of construction to verify that the construction meets the specifications;

“coulee” means a dry or intermittent stream valley or wash, especially a long steep-walled gorge representing a Pleistocene overflow channel that carried melt water from an ice sheet;

“day” means any period of 24 consecutive hours unless otherwise specified;

“detection level monitoring” means a monitoring program that is undertaken during the active landfill life, final landfill closure and post-closure for the purpose of detecting the migration of a contaminant constituent to the surrounding environment;

“equivalent hydraulic conductivity” means and is obtained from the following calculation:

\[ K = \frac{d}{\sum \left( \frac{d_i}{K_i} \right)} \]

where:

- \( K \) = equivalent hydraulic conductivity
- \( d \) = thickness of natural geologic material between the bottom of a landfill and the top of an exceptional underlying aquifer
- \( d_i \) = thickness of each distinctly different geologic layer within the thickness of \( d \)
- \( K_i \) = the hydraulic conductivity of geologic layer \( d_i \)
- \( \Sigma \) = means the summation of all \( \frac{d_i}{K_i} \) values for the distinctly different geologic layers

“exceptional underlying aquifer” means a hydrostratigraphic unit with a transmissivity of greater than \( 2.5 \times 10^{-3} \) m\(^2\)/sec yielding water with a total dissolved solids (TDS) concentration not exceeding 4000 mg/L;

“final cover” means a designed system, natural or man made, that is placed on the surface of a landfill or landfill cell that has reached its maximum designed waste elevation to control transmission of moisture and gas, and conforms to the end use plan;

“final landfill closure” means the period of time when waste is no longer placed in the defined portion of a landfill and activities are undertaken to complete the final cover system and decommission components and facilities that are no longer required, and includes the construction of any additional components or monitoring systems that are necessary for post-closure;

“fractured non-porous bedrock” means fractured bedrock with a primary porosity of less than 5 percent as measured by a helium porosimeter;
(z) “geologic materials” for the purpose of these Standards means one or more geologic formations;

(aa) “geomembrane” means a sheet of manufactured synthetic material designed to control migration of liquid and gas;

(bb) “geosynthetic clay liner (GCL)” means a liner that is made of a thin layer of bentonite either bonded to a geomembrane or fixed between two sheets of geotextile;

(cc) "grab sample" means an individual sample collected in less than 30 minutes and which is representative of the substance sampled;

(dd) “groundwater” means groundwater as defined in the Water Act;

(ee) “groundwater quality control limit” means a concentration of a key indicator parameter above which there is a risk that groundwater quality is impacted by landfill activity;

(ff) “gully” means a small channel with steep sides caused by erosion and cut by concentrated but intermittent flow of water usually during and immediately following heavy rains or after ice or snow melt;

(gg) “hydraulic conductivity” means the ease with which water can be transported through a material;

(hh) “hydrogeologist” means a person who is registered with APEGGA with a specialization in hydrogeology;

(ii) “hydrogeology” means the study of the relationship between water and geology with particular emphasis on the movement and chemistry of water;

(jj) “hydrostratigraphic unit” means the geological formation, or part of a geological formation, or a group of geological formations, in which the hydraulic properties are similar and allow for grouping into aquifers or aquitards;

(kk) “inert waste” means a solid waste that, when disposed of in a landfill or re-used, is not reasonably expected to undergo physical, chemical or biological changes to such an extent as to produce substances that may cause an adverse effect and includes without limitation, demolition debris, concrete, asphalt, glass, ceramic materials, scrap metal and dry timber or wood that has not been chemically treated;

(ll) “industrial solid waste” means solid waste resulting from or incidental to any process of industry;

(mm) "ISO 17025" means the international standard, developed and published by International Organization for Standardization (ISO), specifying management and technical requirements for laboratories;
"key operating personnel" mean all staff that are in responsible charge of daily operations of a landfill;

"landfill cell" means a designed or designated area of a landfill comprised of an excavation or earthen structure in which waste is enclosed;

"landfill gas" means a mixture of gases generated by the microbial decomposition of and chemical reactions between wastes in a landfill;

"laterally expanding landfill" means a landfill that is being expanded beyond the previously approved waste footprint;

"leachate" means a liquid that has been in contact with waste in the landfill cell and has undergone chemical or physical changes;

"leachate collection system" means a system that gathers leachate so that it may be removed from a landfill;

"leachate pond" means a pond that is designed for temporary storage of leachate;

"liner" means a continuous layer placed beneath and at the sides of a landfill cell that is compatible with the waste and restricts the migration of leachate, or landfill gas or both;

"lower explosive limit (LEL)" means the lowest percentage, by volume, of an explosive vapour or gas that must be present in air to ignite;

"maximum acceptable leachate head" means the maximum depth of leachate above the primary liner, not including the sumps or leachate pipe trenches;

"monitoring system" means all equipment used for sampling, analyzing or recording data in respect of any parameter;

"monitoring well" means a well drilled at a site to measure groundwater levels and collect groundwater samples for the purpose of physical, chemical, or biological analysis to determine the concentration of groundwater constituents;

"municipal solid waste" means solid waste resulting from or incidental to municipal, community, commercial, institutional and recreational activities, and includes garbage, rubbish, ashes, street cleanings, abandoned automobiles, and all other solid wastes except hazardous waste, industrial solid waste, oilfield waste and biomedical wastes;

"post-closure" means the period of time after completion of the final landfill closure;

"primary liner" means the uppermost liner;

"primary porosity" means the pore space in the rock matrix excluding pore space created by processes such as dissolution or fracturing;
“prohibited waste” means a waste that may not be accepted for disposal at a landfill because of the classification of the landfill as defined in the Waste Control Regulation, as amended, or that is otherwise prohibited by the Province of Alberta;

“ravine” means a small stream channel, narrow, steep-sided, and commonly V-shaped in cross-section, and larger than a gully;

“recycle” means to do anything that results in providing a use for a thing that otherwise would be disposed of or dealt with as waste, including collecting, transporting, handling, storing, sorting, separating and processing the thing, but does not include the application of waste to land or the use of a thermal destruction process;

“response level monitoring” means a monitoring program that is undertaken following detection of contaminant constituents above specified limits or performance standards and is continued until corrective measures have mitigated the contaminant constituents to below the specified limits or meets performance standards;

“run-off” means any rainwater or melt water that drains as surface flow from the active landfill area, excluding leachate;

“run-on” means any rainwater or melt water that may drain as surface flow onto the active landfill area;

“secondary leachate collection system” means a system that gathers liquids between a primary liner and a secondary liner system;

“secondary liner” means the lowermost liner of a double liner system;

“site specific conditions” means all conditions related to the landfill site that may influence its design or operation including climate and quantity and nature of the waste received or proposed to be received at the landfill;

“siting” means the process of identifying, investigating, evaluating and selecting locations for solid waste management and disposal facilities;

“soil” means mineral or organic earthen materials that can, have, or are being altered by weathering, biological processes or human activity;

“structural components” means liners, leachate collection systems, final cover systems, run-on and run-off systems and any other landfill components that are necessary for the protection of human health and the environment;

“subsoil” means the layer of soil directly below the topsoil, to a maximum depth of 1.2 metres below the topsoil surface, that consists of the B and C horizons as defined in The System of Soil Classification for Canada, Agriculture and Agri-Food Canada, 1998, Publication 1643, 3rd Edition, as amended or replaced from time to time;
(qqq) “topsoil” means the uppermost layers of soil that consist of the L, F, H, O, and A horizons as defined in *The System of Soil Classification for Canada*, Agriculture and Agri-Food Canada, 1998, *Publication 1643, 3rd Edition*, as amended or replaced from time to time;

(rrr) “unstable area” means land which may be subject to differential settling due to soil conditions, geologic and geomorphic features or man-made features;

(sss) “uppermost formation” means a continuous water-saturated geological stratum or strata, including but not limited to sand lenses and aquifers, that is projected to be the most probable pathway or pathways for lateral transport of leachate;

(ttt) “waste footprint” means the areas within a landfill where waste has been disposed of and is proposed to be disposed of, but does not include those areas used for purposes other than disposal such as surface water storage, recycling facilities, buffer zones and buildings; and

(uuu) “year” means calendar year, unless otherwise specified.
SECTION 1: REGULATORY DISCLOSURE PROCESS FOR A NEW OR LATERALLY EXPANDING LANDFILL

1.1 Disclosure Plan

(a) Prior to submitting an application for a landfill approval or registration, the person responsible for a proposed new or laterally expanding landfill shall submit a written Disclosure Plan to the Director.

(b) The Disclosure Plan shall include, at a minimum, all of the following:
   (i) the proposed process for public consultation;
   (ii) a proposed process for responding to concerns identified during the public consultation process; and
   (iii) the proposed process for technical investigation of the site.

(c) The person responsible for a proposed new or laterally expanding landfill shall implement the Disclosure Plan as authorized in writing by the Director.

1.2 Application Submission

(a) In addition to any information required by the Director under the Approvals and Registration Procedure Regulation (AR 113/93), an application for approval or registration of a new or laterally expanding landfill shall be submitted to the Director prior to commencing construction of the landfill.

(b) The application for a new or laterally expanding landfill shall contain at a minimum, all the following documents:
   (i) documentation that demonstrates conformance with the Disclosure Plan;
   (ii) detailed Technical Investigation Program Report as per section 2.4;
   (iii) financial security or environmental reserve fund documentation for closure and post-closure activities;
   (iv) Landfill Design Plan and Specifications as per section 3.1;
   (v) Operations Plan as per section 4.3; and
   (vi) Landfill Monitoring Plan as per section 5.1.
SECTION 2: LANDFILL DEVELOPMENT AND SITING

2.1 Natural Environment Separation

(a) The person responsible for a new landfill shall comply with setbacks as provided in Table 2.1.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Distance from waste footprint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land subject to slope failure</td>
<td>100 meters</td>
</tr>
<tr>
<td>A natural area that permanently contains water such as a lake, river or creek.</td>
<td>300 meters, unless otherwise authorized in writing by the Director</td>
</tr>
<tr>
<td>A man-made surface feature that permanently contains water such as an irrigation canal, drainage ditch, but not a road-side ditch, or dugout.</td>
<td>300 meters, unless otherwise authorized in writing by the Director</td>
</tr>
</tbody>
</table>

(b) The person responsible for a laterally expanding landfill shall comply with setbacks as provided in Table 2.1 unless:
   (i) the landfill existed prior to September 1st, 1996; or
   (ii) the Director accepts evidence in writing from the person responsible that surface water and groundwater will not be impacted.

(c) A new landfill or the new waste footprint of a laterally expanding landfill shall not be situated at a location where there exists one or more of the following conditions:
   (i) the area is situated within a ravine, coulee or gully;
   (ii) there is less than 30 metres of geologic materials with an equivalent hydraulic conductivity greater than $1 \times 10^{-8}$ metres/second between the bottom of the liner, or where no liner is required, immediately beneath where waste will be deposited, excluding sumps or leachate pipe trenches, and an exceptional underlying aquifer; or
   (iii) the geologic materials within 10 metres below the bottom of the liner, excluding sumps or leachate pipe trenches, include fractured non-porous bedrock or karst features.
(d) A new landfill, or the new waste footprint of a laterally expanding landfill, shall only be situated at a location where:
   (i) there is a 5 metre thick layer of a clayey deposit having an equivalent hydraulic conductivity less than $1 \times 10^{-8}$ metres per second immediately beneath the lowest part of the liner, or where no liner is required, immediately beneath where waste will be deposited, excluding sumps or leachate pipe trenches; and
   (ii) the geologic materials immediately beneath the clayey deposit required in 2.1(d)(i) or 2.1(d)(ii) consist of at least 3 metres of material providing equivalent or better protection to the requirements in 2.1(d)(i).

(e) The clayey deposit in 2.1(d) may include one or more layers of a material with a hydraulic conductivity greater than $1 \times 10^{-6}$ metres per second provided that:
   (i) the accumulated thickness of the layers are less than 0.5 metres; and
   (ii) any such layers do not extend beyond the compliance boundary.

(f) The thickness of the clayey deposit required in 2.1(d) may be attained by reconstruction of compacted earthen materials to an equivalent hydraulic conductivity less than $1 \times 10^{-8}$ metres per second.

(g) Sections 2.1(c) to 2.1(d) do not apply to the new waste footprint of a laterally expanding landfill if the Director accepts written evidence from the person responsible that the groundwater quality will not exceed groundwater performance standards as per section 5.3 at the compliance boundary.

(h) Section 2.1(g) only applies to landfills which were in existence prior to January 1, 2010.

2.2 Requirements for a Technical Investigation Program

(a) Prior to the design of a new or laterally expanding landfill, the person responsible shall complete a Technical Investigation Program specific to the landfill site and its surrounding area.

(b) The person responsible shall ensure that the components of the Technical Investigation Program are prepared by APEGGA registered professionals with expertise in the subject area.

(c) The Technical Investigation Program shall include characterization of the geologic, hydrologic, hydrogeologic and geotechnical settings expressed on regional and local scales.

(d) The Technical Investigation Program shall identify the geologic, hydrologic, hydrogeologic and geotechnical characteristics of the site including, at a minimum, all of the following:
   (i) the groundwater and surface water regimes associated with the new or laterally expanding landfill;
   (ii) the potential contaminant flow paths from the landfill into the receiving environment;
(iii) for a laterally expanding landfill, the potential impacts on groundwater and surface water regimes relative to the existing landfill;
(iv) characterization of the variability, depth, and engineering properties of onsite soils; and
(v) a site stability assessment.

(e) The boreholes completed for the Technical Investigation Program shall be distributed at:
(i) an evenly distributed spacing of not more than 200 metres; or
(ii) a minimum of five evenly distributed locations for landfills with a waste footprint smaller than 5 hectares.

(f) The minimum depth of the hydrogeologic characterization component of the Technical Investigation Program shall be deeper than 30 metres below the proposed base of the new or laterally expanding landfill.

(g) The Director may require additional boreholes for hydrogeologic characterization required in 2.2(e) and 2.2(f) to adequately delineate geologic formations.

(h) A topographic survey shall be conducted for the area of the new or laterally expanding landfill as part of the Technical Investigation Program.

2.3 Groundwater Monitoring Wells

(a) The drilling, construction, maintenance and reclamation of boreholes and monitoring wells for the purposes of conducting the Technical Investigation Program shall be done in accordance with all applicable requirements described in Part 7 of the Water (Ministerial) Regulation (AR 205/98), as amended.

2.4 Detailed Technical Investigation Program Report

(a) The person responsible for a new or laterally expanding landfill shall ensure that APEGGA registered professionals with expertise in the subject area prepares components of the Detailed Technical Investigation Program Report.

(b) The Detailed Technical Investigation Program Report shall include, at a minimum, all of the following information:
(i) a description of the topography, surface drainage patterns, geology, hydrogeology, existing and surrounding land use within 800 metres of the proposed site;
(ii) a drawing showing the proposed site in relation to:
   a. adjacent development and infrastructure;
   b. natural and constructed physical features such as streams, rivers, water bodies, canals and drainage controls;
   c. domestic, municipal and other licensed water well locations within 5 km of the proposed site; and
   d. municipal wellhead protection zones;
(iii) a detailed site plan showing:
   a. surface topography; and
   b. locations and surface elevations of all boreholes and monitoring wells;
Scottish International Fæderation for the Abolition of Nuclear Weapons (SIFANAW)
SECTION 3: DESIGN AND CONSTRUCTION

3.1 Landfill Design Plan and Specifications

(a) The person responsible shall ensure that APEGGA registered professionals with expertise in the subject area prepares the Landfill Design Plan and Specifications for a new or laterally expanding landfill.

(b) The Landfill Design Plan and Specifications for a new or laterally expanding landfill shall include, at a minimum, all of the following information:

(i) an engineering design report that provides:
   a. a description of the type and quantity of waste that is anticipated to be accepted at the landfill;
   b. a description of the design intent and a summary of the components included in the design to achieve the design intent;
   c. an evaluation of the potential for leachate generation and leachate composition based on site specific conditions;
   d. an evaluation of the potential for landfill gas generation and gas composition based on the type of waste accepted, climate, the landfill design, or other site specific conditions;
   e. a description of monitoring systems;
   f. a preliminary landfill closure plan that includes at a minimum:
      i a staging plan for closure of the landfill or portions of the landfill;
      ii a plan to manage surface water infiltration or moisture additions according to the design intent of the landfill cells;
      iii a proposed design for the final landfill cover system;
      iv general information of the final elevation and slopes;
      v a re-vegetation plan of completed areas of the landfill; and
      vi a description of the potential end-use of the landfill after final landfill closure; and

(ii) engineering design maps and plans that provide:
   a. topographic maps showing the overall proposed site development and setbacks;
   b. a site plan that shows the proposed landfill footprint and the location of the compliance boundary;
   c. a minimum 30 metre separation between the waste footprint and the landfill property line;
   d. cross-sections showing the proposed surface elevations, base elevations and grades for the landfill development;
   e. drawings for structural components of the landfill including, but not limited to, liner systems and leachate collection and removal systems;
   f. a run-on control system to prevent flow onto the active landfill area for events up to at least the peak discharge from a 1 in 25 year – 24 hour duration rainfall event;
   g. a run-off control system for the active landfill area to collect and control at least the run-off water volume resulting from a 1 in 25 year – 24 hour duration rainfall event; and
   h. a groundwater monitoring system as per the minimum requirements in section 5.6.
(c) If a new or laterally expanding landfill accepts segregated material for the purpose of waste minimization, sorting, recovery, processing, or storage then the Landfill Design Plan and Specifications shall include specific areas to be used for these activities.

(d) Any deviations to the Landfill Design Plan and Specifications must be authorized in writing by the Director prior to implementation.

3.2 Design of a Class II Landfill

(a) In addition to the requirements in section 3.1, the Landfill Design Plan and Specifications for the construction of a new or laterally expanding Class II Landfill shall include, at a minimum, all of the following:

(i) a liner; and

(ii) a leachate collection system capable of maintaining the maximum acceptable leachate head.

3.3 Design of a Class III Landfill

(a) In addition to the requirements as described in section 3.1, the Landfill Design Plan and Specifications for construction of a new or laterally expanding Class III landfill shall provide for the containment of inert wastes.

3.4 Design of a Leachate Pond

(a) The Design Plan and Specifications for the construction of a leachate pond shall include, at a minimum, all of the following:

(i) a primary geomembrane liner;

(ii) a secondary geomembrane liner; and

(iii) a secondary leachate collection system.

(b) The liner system in 3.4(a) shall be constructed over a prepared clay sub-grade suitable to protect the integrity of the liner system.

3.5 Construction

(a) The person responsible shall construct a new or laterally expanding landfill or landfill cell in accordance with the Landfill Design Plan and Specifications authorized in an Approval or Registration.

(b) Detailed Construction Plans and Specifications, prepared in accordance with the Landfill Design Plan and Specifications, shall be submitted to the Director prior to each major stage of construction, including but not restricted to cell construction and closure.
(c) If the new landfill, laterally expanding landfill or landfill cell is to be constructed with a clay liner, the clay liner shall be constructed by compacting earthen material:

(i) that has a hydraulic conductivity of less than $1 \times 10^{-9}$ metres/second to a thickness of not less than 1 metre, measured perpendicular to the slope, or

(ii) that has a hydraulic conductivity greater than $1 \times 10^{-9}$ metres/second to a thickness greater than 1 metre that will achieve an equivalent advective performance to 3.5(c)(i).

(d) If the new landfill, laterally expanding landfill or landfill cell is to be constructed with a composite liner, the composite liner shall be constructed with a geomembrane placed directly on the surface of:

(i) a liner that is comprised of earthen material with a hydraulic conductivity of less than $1 \times 10^{-9}$ metres/second compacted to a thickness of not less than 0.6 metres, measured perpendicular to the slope, or

(ii) a liner that is comprised of earthen materials with a hydraulic conductivity greater than $1 \times 10^{-9}$ metres/second compacted to a thickness greater than 0.6 metres that will achieve an equivalent advective performance to 3.5(d)(i), or

(iii) a liner that is comprised of a geosynthetic clay liner and earthen material compacted to a thickness of not less than 0.6 metres, measured perpendicular to the slope, that will achieve a combined equivalent advective performance to 3.5(d)(i).

3.6 Construction Quality Assurance and Control

(a) Prior to the construction of a new landfill, laterally expanding landfill or landfill cell, the person responsible shall submit to the Director a Construction Quality Assurance Plan and a Construction Quality Control Plan.

(b) The person responsible shall construct a new landfill, new landfill cell, laterally expanding landfill or landfill cell according to the Construction Quality Assurance Plan and the Construction Quality Control Plan as authorized in writing by the Director.

(c) Any deviations to the Construction Quality Assurance or Construction Quality Control Plan or the Detailed Construction Plans and Specifications, must be authorized in writing by the Director prior to implementation.

(d) Section 3.6 (c) does not apply to deviations where:

(i) the deviation results in a minor adjustment to the Detailed Construction Plan and Specifications to suit field conditions encountered; and

(ii) the deviation will not result in a change in the design performance of the landfill or landfill cell.

(e) Prior to commencing operation of a new or laterally expanding landfill or landfill cell, the person responsible shall submit a report detailing the Construction Quality Assurance Results to the Director confirming that the landfill has been constructed according to the Construction Quality Assurance Plan, Construction Quality Control Plan, and the Landfill Design Plan and Specifications.
(f) If the construction of the new or laterally expanding landfill or landfill cell has not been carried out according to some or all of the Construction Quality Assurance Plan, the Construction Quality Control Plan or the Landfill Design Plans and Specifications, the person responsible shall provide a report to the Director that explains the deviation(s) and includes a description of any potential impacts that may result from the deviation(s).
SECTION 4: LANDFILL OPERATION

4.1 Operator Certification

(a) The person responsible for a landfill shall ensure that during active landfill life and until final landfill closure all key operating personnel hold a valid basic landfill operator certificate after 18 months of employment at the facility.

(b) To qualify for basic certification, the operator must:
   (i) be at least 18 years of age; and
   (ii) have one year of full time operational experience at a landfill which is current to within the last 3 years from the date of application.

(c) The following landfill operator certificates are recognized by the Director:
   (i) Alberta Environment Certificate of Qualification issued under the Municipal Waste Facility Operator Certification Guideline; and

(d) The person responsible for the facility shall ensure that the facility has operators with the required certification endorsements as per the Alberta Landfill and Composting Facility Operator Certification Guidelines, published by Alberta Environment.

(e) The person responsible for the landfill shall notify the Director in writing of the names of all the key operating personnel, the required facility endorsements, and any change in any of the key operating personnel or facility endorsements within 30 days of the change.

4.2 Topsoil and Subsoil Salvaging and Storage

(a) During the construction and operation of a landfill, the person responsible shall separately recover and stockpile all topsoil and subsoil such that all topsoil and subsoil stockpiles:
   (i) shall be constructed in a manner that allows for maximum recovery of the topsoil and subsoil;
   (ii) shall be contoured, stabilized and seeded to protect against soil loss by erosion; and
   (iii) shall only be used for reclamation at the landfill site.

4.3 Operations Plan

(a) The person responsible for a landfill shall
   (i) develop;
   (ii) maintain; and
   (iii) implement

an Operations Plan that is consistent with the Landfill Design Plan and Specifications and these Standards.
(b) The Operations Plan shall include, at a minimum, all of the following information:
   (i) waste acceptance policies and procedures as per section 4.4;
   (ii) policies and procedures for wastes requiring special handing, if accepted;
   (iii) operating procedures for nuisance management as per section 4.5;
   (iv) a Wildlife Management Plan as per section 4.6;
   (v) procedures for covering the waste including a description of proposed materials and the frequency of cover applications;
   (vi) a plan for the protection of liners;
   (vii) an emergency response plan;
   (viii) a site safety plan;
   (ix) a plan for the detection and management of subsurface landfill gas, if applicable;
   (x) a plan for the management of leachate including its collection, removal, treatment and disposal;
   (xi) a plan for leachate pond management, if applicable;
   (xii) a plan for the management of surface water run-off and run-on control systems;
   (xiii) the Landfill Monitoring Plan in accordance with section 5.1; and
   (xiv) a plan for other operations where they are included at the landfill site such as the storage, processing, recycling or composting of segregated waste or feedstocks.

4.4 Waste Acceptance Policies and Procedures

(a) The waste acceptance policies and procedures in the Operations Plan shall be consistent with the requirements as described in the Waste Control Regulation (AR 192/96), as amended, or as specified in writing by the Director.

(b) The waste acceptance policies and procedures shall include a program to detect a prohibited waste so that it is prevented from being disposed of in a landfill cell.

4.5 Nuisance Management

(a) The person responsible for a landfill shall take all necessary measures to control nuisances such as litter, fires, disease vectors, odours and dust, including but not limited to:
   (i) erecting artificial barriers, utilizing natural barriers, or other effective measures to control access to the site;
   (ii) covering solid waste that is disposed in the landfill with soil or other cover material at a frequency specified in the Operations Plan;
   (iii) maintaining areas for storage, processing or recycling of segregated waste in a clean and orderly manner;
   (iv) establishing and maintaining litter controls to minimize the escape of waste from the landfill site;
   (v) retrieval of litter that accumulates on the landfill site; and
   (vi) retrieval of litter that is washed, blown, or transported onto adjacent properties, provided the consent of the owner of the adjacent property is first obtained.
4.6 Wildlife Management

(a) The person responsible for a landfill shall restrict wildlife from the landfill in accordance with both of the following:

(i) *Waste Management Facilities and Wildlife*, Alberta Sustainable Resource Development, as amended; and

(ii) *The Landfill Guidelines*, Alberta Environment, as amended.

(b) Where wildlife problems are not resolved, the person responsible must develop a wildlife management plan acceptable to local Fish and Wildlife officials.

4.7 Controlled Burning

(a) No person shall conduct opening burning or permit open burning at a landfill unless:

(i) the open burning is conducted in accordance with the *Substance Release Regulation (AR 124/93)*; and

(ii) the open burning is done in an area that is:

a. constructed with a fire break consisting of barren mineral soil;

b. located so that is separated from disposal operations, storage compounds and buildings; and

c. supervised at the time of burning.

(b) At least 7 days prior to the date of the burning, the person responsible for the landfill shall notify all of the following:

(i) the local authorities;

(ii) all adjacent property owners; and

(iii) the local fire department.

informing them of the proposed burning and the date on which the proposed burning is to take place.

4.8 Liquid Waste Restriction

(a) No liquid waste shall be disposed in a Class III landfill cell.

(b) No oilfield waste that is liquid shall be disposed in any landfill cell.

(c) No hazardous waste that is liquid shall be disposed in any landfill cell.

(d) A containerized liquid, that is waste, greater than 5 litres shall not be disposed in any landfill cell.

(e) A bulk liquid, that is waste, greater than 5 litres shall not be disposed in a Class II landfill unless the landfill cell is designed with a liner and leachate collection system and acceptable liquid addition limits are as described in the Landfill Design and Specifications Plan authorized in writing by the Director.

(f) Section 4.8(e) includes wastewater sewage from a community that is not served by a wastewater treatment plant.
4.9 Signage

(a) The person responsible shall erect and maintain signs at the landfill entrance providing, at a minimum, all of the following information:
   (i) the name of the approval or registration holder;
   (ii) the landfill class;
   (iii) any waste restrictions; and
   (iv) the telephone numbers for:
       a. the person responsible;
       b. the local fire department; and
       c. Alberta Environment (1-800-222-6514).

4.10 Leachate Management

(a) Section 4.10 applies to all landfills with leachate collection systems.

(b) During active landfill life, final landfill closure and post-closure the maximum acceptable leachate head in landfill cells constructed after July 1, 2009 shall not exceed 300 mm.

(c) During active landfill life, final landfill closure and post-closure the maximum acceptable leachate head for landfill cells constructed prior to July 1, 2009 shall not exceed the maximum acceptable leachate head as authorized in writing by the Director.

(d) The person responsible for a landfill shall remove leachate from the cell at a frequency that maintains the level of leachate at or below the maximum acceptable leachate head.

(e) Notwithstanding the requirements in 4.10(b), 4.10(c) and 4.10(d), upon detection of any exceedances of the maximum acceptable leachate head, the person responsible shall reduce the leachate head level to below the maximum acceptable leachate head level within a maximum of 14 calendar days subsequent to the detection.

(f) Landfills or landfill cells that have been approved by the Director to include an alternative design for liner and leachate collection systems shall manage leachate as authorized in writing by the Director.
SECTION 5: MONITORING, ANALYSIS AND CORRECTIVE ACTION

5.1 Landfill Monitoring Plan

(a) The person responsible for a landfill shall
(i) develop;
(ii) maintain; and
(iii) implement

a Landfill Monitoring Plan.

(b) The Landfill Monitoring Plan shall include, at a minimum, all of the following:
(i) a Groundwater Monitoring Program; and
(ii) a Surface Water Monitoring Program.

(c) In addition to the requirements in section 5.1(b) the person responsible for a
landfill that is designed and constructed with a leachate collection system shall
develop a Leachate Monitoring Program as part of the Landfill Monitoring Plan.

(d) In addition to the requirements in section 5.1(b), the person responsible for a
landfill that accepts organic waste that is reasonably expected to undergo
microbial decomposition shall develop a Subsurface Landfill Gas Monitoring
Program as part of the Landfill Monitoring Plan.

(e) The person responsible shall ensure that APEGGA registered professionals with
expertise in the subject area prepares the Landfill Monitoring Plan.

(f) If the Director finds the Landfill Monitoring Plan to be deficient, the person
responsible shall correct all deficiencies as outlined by the Director in writing.

(g) The person responsible shall implement the Landfill Monitoring Plan as
authorized in writing by the Director.

(h) The person responsible shall implement the Landfill Monitoring Plan from the
beginning of the active landfill life until the end of post-closure, unless otherwise
authorized in writing by the Director.

5.2 Groundwater Monitoring Program

(a) The person responsible for a landfill shall develop the Groundwater Monitoring
Program to include, at a minimum, all of the following:
(i) background groundwater quality for each monitoring well;
   a. existing landfills or landfill cells may establish background levels
      after the start of landfill operations by:
      i. using historical data; or
      ii. obtaining groundwater samples from monitoring wells
          established in nearby areas not affected by landfill activity;
(ii) establish groundwater quality control limits for each naturally occurring
     parameter;
(iii) a detailed program for groundwater sample collection frequency and analysis, that includes, at a minimum, all of the following:
   a. retrieval of representative samples from the groundwater monitoring system at a frequency set out in Table 5.1, or as otherwise authorized in writing by the Director; and
   b. laboratory analysis of the samples for parameters as described in Table 5.2; and

(iv) a Groundwater Contingency Plan

(b) The Groundwater Monitoring Program for a Class II landfill that receives wastes other than municipal solid wastes shall include additional parameters than those specified in Table 5.2 as specified in writing by the Director and based on site-specific conditions.

(c) Response level monitoring parameters and frequency shall be as authorized in writing by the Director.

(d) The groundwater monitoring data shall be presented using control charts and interpreted by a professional registered with APEGGA, or other professional authorized in writing by the Director, to determine any groundwater quality impacts as a result of the landfill operations.

<table>
<thead>
<tr>
<th>Table 5.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency for Groundwater Sampling and Analysis</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Landfill</th>
<th>Background Monitoring</th>
<th>Detection Level</th>
</tr>
</thead>
</table>
| Class II and III Landfills with liner and leachate collection systems | • Twice\(^1\) per year for the first four (4) years of operations.  
  • Once per year every 3\(^{rd}\) year after background levels have been established. | Twice per year\(^2\) |
| Class II and III Landfills without liner and leachate collection systems | • Twice per year for the first four (4) years of operations.  
  • Once per year after background levels have been established. | Once per year |

\(^1\) The two sampling events should be considerate of seasonal variations.

\(^2\) The frequency is reduced to 1 time per year during the year when the background parameters are done.
Table 5.2
Groundwater Parameters for Background Level and Detection Level Monitoring Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Background</th>
<th>Detection level</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General and Inorganic Parameters</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH, Total Dissolved Solids, Alkalinity, Ammonia, Total Kjeldahl Nitrogen, Electrical Conductivity, Hardness (CaCO3)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Major Ions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chloride, Calcium, Magnesium, Sodium, Potassium, Sulphate, Nitrate-N, Nitrite - N</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Dissolved Metals</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Copper, Iron, Lead, Lithium, Manganese, Molybdenum, Mercury, Nickel, Phosphorus, Silicon, Silver, Strontium, Thallium, Tin, Vanadium, Uranium, and Zinc</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Iron and Manganese</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Other Organics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dissolved Organic Carbon (DOC)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Volatile Organic Compounds</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benzene, Toluene, Ethylbenzene, Xylene, F1, F2, Phenols</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Methylene Chloride, Vinyl Chloride, Trichloroethylene (TCE), Tetrachlorethylene (PCE).</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

5.3 Groundwater Performance Standards

(a) Throughout the active landfill life, final landfill closure, and post-closure of the landfill, the groundwater quality within the compliance boundary shall meet the all of the following groundwater performance standards:

(i) groundwater quality of one or more parameters shall not display an increasing trend;
(ii) groundwater parameters shall not exceed the corresponding groundwater quality control limit; and
(iii) any parameters not naturally present in groundwater is not detected in three consecutive sampling events.

5.4 Implementation of Groundwater Contingency Plan

(a) The person responsible shall immediately notify the Director and shall implement the Groundwater Contingency Plan developed in accordance with section 5.2(a)(iv), if at any time until the end of post-closure the groundwater fails to meet the groundwater performance standards within the compliance boundary.

3 Parameters not naturally present in groundwater
5.5 Compliance Boundary

(a) The person responsible shall establish the compliance boundary at locations that are:
   (i) at least 20 metres inside the property boundary of the landfill; and
   (ii) at least 10 metres, but not more than 60 metres from the waste footprint.

5.6 Groundwater Monitoring Wells

(a) The person responsible for a new or laterally expanding landfill shall construct groundwater monitoring wells that are:
   (i) no more than 200 metres from the nearest groundwater monitoring well as measured along the compliance boundary;
   (ii) at locations that provide an accurate representation of upgradient and downgradient groundwater quality.

(b) The person responsible shall ensure that each groundwater monitoring location along the compliance boundary includes at least one well designed to allow for the collection of groundwater samples from the uppermost formation.

(c) All groundwater monitoring wells shall be protected from damage and shall be locked, except when being sampled, unless otherwise authorized in writing by the Director.

(d) If a groundwater sample cannot be collected because the monitoring well is damaged or is no longer capable of producing a representative sample:
   (i) the groundwater monitoring well shall be cleaned, repaired or replaced; and
   (ii) a representative groundwater sample shall be collected prior to the next scheduled sampling date unless otherwise authorized in writing by the Director.

5.7 Surface Water Monitoring Program

(a) The Surface Water Monitoring Program shall include, at a minimum, all of the following:
   (i) a detailed program for surface water sample collection and analysis, that includes, at a minimum, all of the following:
      a. retrieval of representative samples from the run-off control system at a frequency as described in Table 5.3, or as otherwise authorized in writing by the Director;
      b. laboratory analysis of the samples for parameters as described in Table 5.3;
      c. surface water quality of the receiving water body; and
      d. upstream and downstream surface water quality of any run-off water receiving stream, if applicable.
   (ii) identification of potential sources of contamination, spills and leaks at the landfill;
   (iii) release procedures for run-off that meets release limits in Table 5.3;
   (iv) management of run-off that exceeds the release limits in Table 5.3; and
(v) a Surface Water Contingency Plan for response and assessment in the event that:
   a. the run-off containment is contaminated from spills or leaks;
   b. there is an accidental release to the surrounding watershed; or
   c. there is an unauthorized release to the surrounding watershed.

(b) Releases from the run-off control system shall comply with the limits for the parameters specified in Table 5.3.

c) Notwithstanding 5.7(b), the person responsible may use alternate run-off control system release limits, if the Director accepts written justification for the use of the proposed run-off control system release limits.

d) The Surface Water Monitoring Program for a Class II landfill that receives wastes other than municipal solid wastes shall include additional parameters additional to those specified in Table 5.3, as specified in writing by the Director and based on site-specific conditions.

e) The person responsible shall not release any substances from the run-off control system to the surrounding watershed, except in accordance with the Surface Water Monitoring Program, as approved in writing by the Director.

(f) The surface water monitoring data shall be interpreted by a professional registered with APEGGA, or other professional authorized in writing by the Director, to determine any surface water quality impacts as a result of the landfill operation.

Table 5.3
Surface Water Monitoring and Release Limits

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Frequency</th>
<th>Sample Type</th>
<th>Sample Location</th>
<th>Release Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>a) prior to each release; and b) during any unanticipated release from the runoff control system</td>
<td>Representative grab sample</td>
<td>Each runoff Control System Pond from which a release: (a) is to occur, or (b) is occurring</td>
<td>6.0 – 9.5 pH units</td>
</tr>
<tr>
<td>Total Dissolved Solids</td>
<td></td>
<td></td>
<td></td>
<td>2500 units</td>
</tr>
<tr>
<td>Total Suspended Solids</td>
<td></td>
<td></td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Ammonia (Total)</td>
<td></td>
<td></td>
<td></td>
<td>5.0</td>
</tr>
<tr>
<td>Chloride</td>
<td></td>
<td></td>
<td></td>
<td>250</td>
</tr>
<tr>
<td>Sodium</td>
<td></td>
<td></td>
<td></td>
<td>200</td>
</tr>
<tr>
<td>Sulphate</td>
<td></td>
<td></td>
<td></td>
<td>500</td>
</tr>
<tr>
<td>Chemical Oxygen Demand</td>
<td></td>
<td></td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>Oil and Grease</td>
<td></td>
<td></td>
<td></td>
<td>No visible sheen</td>
</tr>
<tr>
<td>Volume</td>
<td>When released</td>
<td>When released</td>
<td>Discharge Point</td>
<td>When released</td>
</tr>
</tbody>
</table>
5.8 Implementation of the Surface Water Contingency Plan

(a) If at any time until the end of post-closure, there are accidental or unauthorized releases from the run-off control system to the receiving watershed, the person responsible shall immediately notify the Director and shall implement the Surface Water Contingency Plan developed in accordance with section 5.7(a)(v).

5.9 Leachate Monitoring Program

(a) The Leachate Monitoring Program shall include, at a minimum, all of the following:

(i) a detailed program for leachate collection system sample collection and analysis, that includes, at a minimum, all of the following:
   a. a program to measure the depth of leachate head in the cells;
   b. retrieval of representative samples at a frequency as described in Table 5.4, or as otherwise authorized in writing by the Director; and
   c. laboratory analysis of the leachate samples for parameters as described in Table 5.4;

(ii) if applicable, a detailed program for leachate pond sample collection and analysis, that includes, at a minimum, all of the following:
   a. retrieval of representative samples at a frequency as described in Table 5.4, or as otherwise authorized in writing by the Director; and
   b. laboratory analysis of the leachate pond content for parameters as described in Table 5.4;

(iii) an Action Leakage Rate shall be developed for the sump(s) associated with the leachate pond leak detection system, as applicable, as per the Action Leakage Rate Guideline published by Alberta Environment.

(iv) a Leak Detection Response Action Plan shall be developed, in accordance with section 6.2 of the Action Leakage Rate Guideline, for response and action if the Action Leakage Rate is exceeded.

(b) The Leachate Monitoring Program shall be implemented during the active landfill life, final landfill closure and post-closure for the landfill.


Table 5.4
Landfill Leachate Sampling and Analysis

<table>
<thead>
<tr>
<th>Monitoring Activity</th>
<th>Minimum Frequency</th>
<th>Method</th>
<th>Sampling Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leachate level monitoring in cells</td>
<td>April to October - weekly</td>
<td>Measurement</td>
<td>At each leachate manhole and sump</td>
</tr>
<tr>
<td></td>
<td>November to March - Monthly</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume of leachate removed from cells</td>
<td>As removed</td>
<td>Measurement</td>
<td>At each leachate manhole and sump</td>
</tr>
<tr>
<td>Volume of leak detection liquid removed from the secondary leachate collection system</td>
<td>Monthly or as removed</td>
<td>Measurement or calculated</td>
<td>At secondary leachate collection system sump(s)</td>
</tr>
<tr>
<td>Leachate parameters:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH, Total Dissolved Solids, Total Suspended Solids</td>
<td>Annually (a) grab sample</td>
<td>(a) at each leachate manhole and sump; and (b) at the leachate pond, if applicable</td>
<td></td>
</tr>
<tr>
<td>Ammonia (total), Total Kjeldahl Nitrogen, Chloride, Sodium, Sulphate, COD.</td>
<td>(b) representative grab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BTEX, F1, F2, Phenols</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.10 Implementation of the Leak Detection Response Action Plan

(a) Throughout the active landfill life, closure, and post-closure of the landfill, the total flow per month at the leachate pond leak detection system shall not be greater than the Action Leakage Rate, or as otherwise authorized in writing by the Director.

(b) If at any time until the end of post-closure, the total flow per month at the leachate pond leak detection system is greater than the Action Leakage Rate, then the person responsible shall immediately notify the Director and shall implement the Leak Detection Response Action Plan developed in accordance with section 5.9(a)(iv).
5.11 Subsurface Landfill Gas Monitoring Program

(a) The Subsurface Landfill Gas Monitoring Program shall include, at a minimum, the all of the following:
   (i) a description of the subsurface landfill gas monitoring sites and their locations;
   (ii) the methods to be used for measurement and detection of the lateral migration of subsurface landfill gas;
   (iii) the frequency for measurement of subsurface landfill gas; and
   (iv) a Subsurface Landfill Gas Contingency Plan for the mitigation of subsurface landfill gas migration.

(b) The subsurface landfill gas monitoring data shall be interpreted by a professional registered with APEGGA, or other professional authorized in writing by the Director, to determine the potential impacts from the subsurface migration of landfill gas.

5.12 Implementation of the Subsurface Landfill Gas Contingency Plan

(a) Throughout the active landfill life, final landfill closure, and post-closure the subsurface landfill gas shall not exceed the landfill gas explosive limits as described in Table 5.5.

(b) If at any time until the end of the post-closure, the explosive gas limits as described in Table 5.5 are exceeded, the person responsible shall immediately notify the Director and shall implement the Subsurface Landfill Gas Contingency Plan developed in accordance with section 5.11(a)(iv).

<table>
<thead>
<tr>
<th>Sampling Location</th>
<th>Explosive Gas Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>In the subsurface at the property boundary</td>
<td>50% LEL</td>
</tr>
<tr>
<td>In an on-site building or enclosed structure or in the area immediately outside the foundation of the building or structure</td>
<td>20% LEL</td>
</tr>
<tr>
<td>In an off-site building or enclosed structure or in the area immediately outside the foundation of the building or structure</td>
<td>1% LEL</td>
</tr>
</tbody>
</table>
5.13 Methods for Water, Leachate and Solid Waste Analysis

(a) With respect to any sample required to be taken, the person responsible shall ensure that:

(i) collection;
(ii) preservation;
(iii) storage;
(iv) handling; and
(v) analysis;

shall be conducted in accordance with the following, or as otherwise specified in writing by the Director:

(vi) For air monitoring:
   a. The Methods Manual for Chemical Analysis of Atmospheric Pollutants, Alberta Environment, as amended; and
   b. The Air Monitoring Directive, Alberta Environment, as amended;

(vii) For surface water, leachate and groundwater monitoring:
   a. the Standard Methods for the Examination of Water and Wastewater, American Public Health Association, American Water Works Association and the Water Environmental Federation, as amended; and

(viii) For whole effluent toxicity tests:
   b. the Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to Daphnia Magna, Environment Canada, Environmental Protection Series, I/RM/14, July 1990, as amended;
   c. the Biological Test Method: Growth Inhibition Test Using the Freshwater Alga Selenastrum capricornutum, Environment Canada, Environmental Protection Series, November 1992, as amended;
   d. the Biological Test Method: Test of Reproduction and Survival Using the Cladoceran Ceriodaphnia dubia, Environment Canada, Environmental Protection Series 1/RM/21, February 1992, as amended;
   e. the Biological Test Method: Test of Larval Growth and Survival Using Fathead Minnows, Environment Canada, Environmental Protection Series 1/RM/22, February 1992, as amended; and
   f. the Biological Test Method: Toxicity Test Using Luminescent Bacteria (Photobacterium phosphoreum), Environment Canada, Environmental Protection Series, 1/RM/24, November 1992, as amended.
(ix) For soil samples:
   b. The Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, USEPA, SW-846; September 1986, as amended;
   c. The Soil Quality Criteria Relative to Disturbance and Reclamation, Alberta Agriculture, March 1987, as amended;
   d. the Guidance Manual on Sampling, Analysis and Data Management for Contaminated Sites – Volume I: Main Report, CCME EPC-NCS62E, 1993, as amended; and

(x) For waste analysis
   a. the Test Methods for Evaluation of Solid Waste, Physical/Chemical Methods, USEPA, SW-846, September 1986, as amended;
   c. the Standard Methods for the Examination of Water and Wastewater, American Public Health Association, American Water Works Association, and the Water Environment Federation, as amended;
   d. the Interim Compilation of Test Methods and Methods of Dangerous Goods Regulations, Environment Canada, as amended; or
   e. the Toxicity Characteristic Leaching Procedure (TCLP), USEPA Regulation 40 CFR261, Appendix II, Method No. 1311, as amended.

(b) The person responsible shall analyze all samples that are required to be obtained by this approval in a laboratory accredited pursuant to ISO 17025, as amended, for the specific parameter(s) to be analyzed, unless otherwise authorized in writing by the Director.
SECTION 6: FINAL LANDFILL CLOSURE AND POST-CLOSURE

6.1 Detailed Final Landfill Closure Plan

(a) The person responsible for a landfill shall submit a Detailed Final Landfill Closure Plan and notify the Director in writing of the intent to close the landfill at least 180 calendar days prior to implementing final landfill closure.

(b) The Detailed Final Landfill Closure Plan shall include, at a minimum, all of the following:
   (i) a schedule for completion of the final landfill closure;
   (ii) a plan for design and completion of final cover;
   (iii) a design plan for erosion control;
   (iv) a design plan for restoration of surface water drainage;
   (v) design plans for changes to the groundwater and landfill gas monitoring systems, including, but not limited to the addition or reclamation of monitoring wells;
   (vi) design plans for changes to the leachate collection and landfill gas control systems, including but not limited to the addition or deletion of components of those systems;
   (vii) a schedule for decommissioning and removal of buildings, storage areas, processing areas or any other operations or facilities that are on the landfill property that will no longer be required; and
   (viii) a Post-Closure Plan.

(c) The design plan of the final cover shall include as a minimum, all of the following:
   (i) a drawing that shows the proposed geometry of the final cover, which shall have a slope at a minimum of 5 percent and a maximum of 30 percent;
   (ii) a final cover system consisting of three layers constructed in the following order from bottom to top:
      a. 0.60 metres barrier layer with a maximum hydraulic conductivity of $1 \times 10^{-7}$ metres per second;
      b. subsoil; and
      c. 0.20 metres of topsoil.
   (iii) subsoil depth in 6.1(c)(ii)b. shall be:
      a. 0.35 metres for pasture or recreational uses; or
      b. 0.80 metres for cultivated land use or forestry;
   (iv) vegetation establishment as per the intended land use;
   (v) alternative final cover systems may be authorized by the Director.

(d) The person responsible shall ensure that APEGGA registered professionals with expertise in the subject area prepares components of the Detailed Final Landfill Closure Plan.

(e) If the Director finds the Detailed Final Landfill Closure Plan to be deficient, the person responsible shall correct the deficiencies as outlined by the Director in writing prior to completion of the final landfill closure.
(f) The person responsible shall complete the final landfill closure in accordance with the Detailed Final Landfill Closure Plan as authorized in writing by the Director.

6.2 Post-Closure Plan

(a) The Post-Closure Plan shall include, at a minimum, all of the following:

   (i) a plan for maintaining the integrity of the final cover;
   (ii) a plan for remediation of areas affected by subsidence and differential settlement;
   (iii) a plan for maintaining surface water drainage systems; and
   (iv) a plan for maintaining and operating the following components where they are part of the landfill design:
       a. groundwater monitoring systems;
       b. leachate collection and removal systems; and
       c. landfill gas control systems.

(b) If the Director finds the Post-Closure Plan to be deficient, the person responsible shall correct the deficiencies as specified in writing by the Director within 120 calendar days of the date of the deficiency letter.

6.3 Post-Closure

(a) Post-Closure shall be a minimum period of 25 years following the final landfill closure.

(b) Post-Closure will begin 30 days following submission of the Final Landfill Closure Report, unless otherwise authorized in writing by the Director.

(c) In addition to 6.3(a), Post-Closure shall continue until the following circumstances occur:

   (i) groundwater quality performance standards for each parameter are met within the compliance boundary;
   (ii) subsurface landfill gas concentrations are below explosive limits as described in Table 5.5 at subsurface gas monitoring locations;
   (iii) the leachate constituents are:
       a. below the upper groundwater quality control limits established for each parameter; and
       b. parameters not naturally present in groundwater is not detected in three consecutive sampling events; and
   (iv) the accumulated volume of leachate is equal to or less than the previous years accumulated volume of leachate for five consecutive years.

(d) During Post-Closure, the person responsible, at a minimum, shall:

   (i) protect and maintain the integrity of the final cover and surface water drainage systems;
   (ii) make repairs to the cover system as necessary to correct the effects of settling, subsidence, erosion, leachate break-out or other such events within one year of discovery of any problem; and
   (iii) protect, maintain, operate and monitor the following components where they are part of the landfill design:
a. groundwater monitoring system;
b. leachate collection system; and
c. landfill gas control system.

(e) During Post-Closure, the person responsible shall inspect the final cover a minimum of two times per year.
SECTION 7: RECORD KEEPING AND REPORTING

7.1 Reporting of Contraventions

(a) In addition to any other reporting required pursuant to the Act or the regulations, any person carrying out a landfill operation shall immediately report any contravention of these Standards to:
   (i) the person responsible; and
   (ii) the Director:
       a. by telephone at (780) 422-4505; or
       b. by any other method authorized in writing by the Director.

(b) In addition to any other reporting required pursuant to the Act or the regulations, where a contravention is reported under section 7.1(a), the person responsible shall provide a report to the Director:
   (i) in writing; or
   (ii) by any other method authorized in writing by the Director within 7 calendar days of the reporting of the contravention, or within any other time period specified in writing by the Director.

(c) The report required in section 7.1(b) shall contain, at a minimum, all of the following:
   (i) a description of the contravention;
   (ii) the date of the contravention;
   (iii) an explanation as to why the contravention occurred;
   (iv) the legal land description of the location of the contravention;
   (v) the name of the registered owner or owners of the parcel of land on which the contravention occurred;
   (vi) a summary of all preventative measures and actions that were taken prior to the contravention;
   (vii) a summary of all measures and actions that were taken to mitigate any effects of the contravention;
   (viii) the measures that will be taken to address any remaining potential effects related to the contravention;
   (ix) the Approval number or Registration number provided by the Director for the landfill site, and the name of the person who held the Approval or Registration number at the time when the contravention occurred;
   (x) the names, addresses, telephone numbers and responsibilities of all persons operating the site at the time that the contravention occurred;
   (xi) the names, addresses and telephone numbers of all persons who had charge, management or control of the site at the time that the contravention occurred;
   (xii) a summary of proposed measures that will prevent future contraventions including a schedule of implementation for those measures;
   (xiii) any information that was maintained or recorded under these Standards, as a result of the contravention; and
   (xiv) any other information required by the Director in writing.
7.2 Report Requested by the Director or Representative of the Director

(a) The person responsible shall provide within 7 calendar days, or any other time period specified in writing by the Director, any records, reports, documents, or data required to be created by these Standards to the Director, or a representative of the Director, upon request.

7.3 Operating Record

(a) The person responsible for a landfill shall establish and maintain an Operating Record for a landfill until the end of Post-Closure.

(b) The person responsible shall provide the Operating Record to the Director upon a request in writing.

(c) The Operating Record shall contain, at a minimum, all of the following information:
   (i) the Approval or Registration number;
   (ii) as-built records for the landfill showing the location and development of excavations, fill areas, final grades and structural components;
   (iii) annual topographic survey records and plans showing the areas where waste has been disposed in the previous year of operation;
   (iv) the most recent version of the design and operating plan for the landfill;
   (v) records of handing of any wastes accepted at the landfill including the amounts accepted and the disposal locations within the landfill;
   (vi) all Annual Reports for the landfill as described in section 7.5;
   (vii) nuisance records;
   (viii) the Final Landfill Closure Report as described in section 7.6; and
   (ix) all Post-Closure Annual Reports for the landfill as described in section 7.7.

7.4 Tonnage Records

(a) The person responsible shall submit annual tonnage records through Alberta Environment’s online Waste Measurement System for wastes accepted by March 31 of the year following the year in which the waste was accepted.

7.5 Annual Report

(a) For each year of the active landfill life, the person responsible shall prepare an Annual Report for the landfill covering the calendar year reported on.

(b) The person responsible shall submit the Annual Report to the Director by March 31 of the year following the year on which the report is based.

(c) The Annual Report shall contain, at a minimum, all of the following information:
   (i) a report from Alberta Environment’s online Waste Measurement System including the types and quantities of wastes disposed at the landfill;
   (ii) the deposition location of wastes requiring special handling;
(iii) all of the following environmental monitoring records and their interpretations:
   a. groundwater monitoring;
   b. leachate monitoring, if applicable;
   c. landfill gas monitoring, if applicable;
   d. records on the quality and quantity of leachate removed from each landfill cell for treatment or disposal;
   e. records on the quality and quantity of leachate removed from each leachate pond for treatment or disposal, if applicable; and
   f. records on the quality and quantity of impounded surface water released to the environment;

(iv) a statement of compliance

(v) a site development plan showing the status of landfill operations at the end of the operating year, including but not limited to:
   a. contour mapping;
   b. the location of active and inactive disposal areas;
   c. areas where a final cover has been placed; and
   d. the location of cells constructed;

(vi) any remedial action taken;

(vii) any complaints received and the action or actions taken as a result of a complaint; and

(viii) adjustments to financial security or the environmental reserve fund necessary for final landfill closure and post-closure activities.

7.6 Final Landfill Closure Report

(a) The person responsible shall ensure that APEGGA registered professionals with expertise in the subject area prepares components of the Final Landfill Closure Report.

(b) The person responsible shall submit a copy of the Final Landfill Closure Report to the Director within 60 calendar days of completion of the final landfill closure.

(c) The person responsible shall file a copy of the Final Landfill Closure Report in the operating record for the landfill within 60 calendar days of completion of the Final Landfill Closure Report.

(d) The Final Landfill Closure Report shall include, at a minimum, all of the following:
   (i) the date of completion of the final landfill closure;
   (ii) a statement including supporting evidence that the Final Landfill Closure has been completed in accordance with the Final Landfill Closure Plan;
   (iii) a description of any deviations to the Final Landfill Closure Plan and the reasons for the deviations;
   (iv) a description of the final cover system and the installation methods and procedures used;
   (v) an estimate of the total quantity of waste placed on the site over the active landfill life; and
   (vi) a description of how all of the following elements have been, or will be dealt with:
      a. the final use of the closed areas;
      b. drainage restoration;
c. soil replacement;
d. final cover slopes;
e. erosion control;
f. re-vegetation and conditioning of the site; and
g. subsidence and differential settlement remediation.

7.7 Post-Closure Annual Report

(a) During each year of post-closure, the person responsible shall prepare a Post-Closure Annual Report for the landfill covering the calendar year reported on.

(b) The person responsible shall place the Post-Closure Annual Report in the Operating Record by March 31 of the year following the year on which the report is based.

(c) During the Post-Closure the person responsible shall compile all of the following information, unless otherwise authorized in writing by the Director:

(i) the annual groundwater monitoring report;
(ii) the annual surface water monitoring report;
(iii) a report on the operation of the leachate collection and removal systems, if required in section 5.1(c);
(iv) the leachate monitoring report if required in section 5.1(c);
(v) the annual landfill gas monitoring report if required in section 5.1(d);
(vi) a report on the operation of the landfill gas control systems, if required in section 5.1(d);
(vii) a record of any maintenance and repairs carried out; and
(viii) a report of any remedial or corrective action taken.

7.8 End of Post-Closure Report

(a) The person responsible for the landfill shall notify the Director of the end of the Post-Closure by submitting an End of Post-Closure Report within 60 days following the end of post-closure.

(b) The End of Post-Closure Report shall include, at a minimum, all of the following:

(i) a summary of Post-Closure activities;
(ii) a summary of Post-Closure monitoring data; and
(iii) supporting evidence that the requirements as described in 6.3(c) have been achieved.
APPENDIX A:

**Document Submission Checklist**

**Disclosure Process**

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<thead>
<tr>
<th>Document</th>
<th>Timing of Submission</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written Disclosure Plan</td>
<td>Prior to application submission.</td>
<td>1.1(a)</td>
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</table>

**Landfill Application (prior to construction)**

<table>
<thead>
<tr>
<th>Document</th>
<th>Timing of Submission</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landfill Application Form</td>
<td>Upon submission of application and completion of Disclosure Plan</td>
<td>Approvals and Registrations Procedure Regulation</td>
</tr>
<tr>
<td>Report that the Disclosure Process was carried out as planned.</td>
<td>Upon submission of application and completion of Disclosure Plan</td>
<td>1.2(b)</td>
</tr>
<tr>
<td>Detailed Technical Investigation Program Report</td>
<td>Upon submission of application and completion of Technical Investigation Program</td>
<td>1.2(b)</td>
</tr>
<tr>
<td>Landfill Design Plan and Specifications</td>
<td>Upon submission of application</td>
<td>1.2(b)</td>
</tr>
<tr>
<td>Operations Plan</td>
<td>Upon submission of application</td>
<td>1.2(b)</td>
</tr>
<tr>
<td>Financial Security or environmental reserve fund</td>
<td>Upon submission of application</td>
<td>1.2(b)</td>
</tr>
<tr>
<td>Landfill Monitoring Plan</td>
<td>Upon submission of application</td>
<td>1.2(b)</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Document</th>
<th>Timing of Submission</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detailed construction plans and specifications</td>
<td>Prior to each major stage of construction (e.g. new cells and final landfill closure)</td>
<td>3.5(b)</td>
</tr>
<tr>
<td>Construction QA Plan and Construction QC Plan</td>
<td>Prior to construction of a new or laterally expanding landfill</td>
<td>3.6(a)</td>
</tr>
<tr>
<td>Deviations in Construction QA Plan and Construction QC Plan</td>
<td>These must be authorized prior to implementation.</td>
<td>3.6(c)</td>
</tr>
<tr>
<td>Construction Quality Assurance Results</td>
<td>Prior to operations and each major stage after construction</td>
<td>3.6(e)</td>
</tr>
<tr>
<td>Report that details any environmental impacts that may result from deviations to the construction QA Plan, construction QC plan, and Landfill Design and Specifications Plan.</td>
<td>Prior to operations and each major stage after construction</td>
<td>3.6(f)</td>
</tr>
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## Operations

<table>
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<th>Timing of Submission</th>
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</tr>
</thead>
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<tr>
<td>Certified Operators</td>
<td>Within 30 days of any change</td>
<td>4.1(e)</td>
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<tr>
<td>Contraventions</td>
<td>7 calendar days after the reporting of the contravention to the Director</td>
<td>7.1(b)</td>
</tr>
<tr>
<td>Online Tonnage Reports</td>
<td>On or before March 31</td>
<td>7.4(a)</td>
</tr>
<tr>
<td>Annual Reports</td>
<td>On or before March 31</td>
<td>7.5(b)</td>
</tr>
</tbody>
</table>

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<table>
<thead>
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<th>Document</th>
<th>Timing of Submission</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detailed Final Landfill Closure Plan</td>
<td>180 days prior to implementation</td>
<td>6.1(a)</td>
</tr>
<tr>
<td>Post-Closure Plan</td>
<td>To be submitted as part of the Detailed Final Landfill Closure Plan</td>
<td>6.1(b)</td>
</tr>
<tr>
<td>Final Landfill Closure Report</td>
<td>Within 60 days upon completion of Final Landfill Closure Plan</td>
<td>7.6(b)</td>
</tr>
<tr>
<td>End of Post-Closure Report</td>
<td>Within 60 days of End of Post-Closure date.</td>
<td>7.8(a)</td>
</tr>
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LANDFILL STANDARDS:
A GUIDELINE ON THE REGULATORY AND APPROVAL REQUIREMENTS FOR NEW OR EXPANDING LANDFILLING SITES

Last Revision Date:
January 2012

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PREFACE

This Guideline describes the regulatory and approval requirements for the design, operation, closure and post-closure care of new or expanding municipal (i.e. non-hazardous) waste landfilling sites. The new regulatory requirements are contained in Ontario Regulation 232/98 made under the Environmental Protection Act. The new regulation takes effect on August 1, 1998. The Guideline is intended to help landfill owners, consultants, the public and other interested parties understand the new requirements. The Guideline includes a description of the new regulatory requirements along with supporting approval guidelines for use when obtaining an Environmental Compliance Approval under the Environmental Protection Act.

The regulatory requirements are given in this Guideline for the convenience of the reader only. A copy of Regulation 232/98 should be obtained and used in conjunction with the Guideline.
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1.0 INTRODUCTION

An efficient and effective waste management program can best be achieved when an integrated approach is taken in the delivery of waste management services. Although the Ministry of the Environment continues to emphasize the 3Rs (Reduce, Reuse and Recycle), landfilling remains a necessary component of waste management -- whether to manage 3Rs residuals or to dispose of wastes which are not amenable to reuse or recycling. To ensure Ontario landfills are state-of-the-art and fully protective of the environment, comprehensive new landfill standards have been established by the Ministry.

Ontario Regulation 232/98 made under Part V of the *Environmental Protection Act* takes effect on August 1, 1998 and contains detailed requirements for the design, operation, closure and post-closure care of municipal (i.e. non-hazardous) waste landfilling sites. The new requirements apply to new or expanding landfilling sites where the total waste disposal volume of the site is greater than 40,000 cubic metres. The requirements do not apply to small sites (i.e. sites smaller than -- or equal to -- 40,000 cubic metres) or to existing sites which are not being expanded. For small and existing sites, the existing requirements under the Act and Regulation 347 remain in effect.

This Guideline has been prepared to help landfill owners, consultants, the public and other interested parties understand the new standards. For each standard, the Guideline gives the regulatory requirements and provides approval guidelines containing further information or details on issues to be addressed in complying with the regulation and obtaining an Environmental Compliance Approval.

Chapter 2 of the Guideline briefly describes the legislative framework within which the landfill standards operate and provides a summary of the new standards. The new standards are described in detail in the remaining chapters, as follows:

- **Chapter 3** - Application and Ownership
- **Chapter 4** - Design
- **Chapter 5** - Financial Assurance
- **Chapter 6** - Operations

Users of this Guideline should note that the regulatory requirements have been included here for convenience only. A copy of Regulation 232/98 should be obtained and used in conjunction with the Guideline.
2.0 LEGISLATION AND APPROVALS

2.1 Environmental Protection Act
In Ontario, landfilling sites and other waste management activities are subject to Part V of the Environmental Protection Act and the regulations made under the Act. The basic legislative framework for waste management is defined in Part V and the regulatory requirements for the design and operation of waste disposal sites are included in Regulation 347. For new or expanding landfilling sites, these regulatory requirements are superseded by Regulation 232/98.

Section 27 of the Act requires that an Environmental Compliance Approval be obtained from the Ministry of the Environment for the establishment, operation, alteration or enlargement of a landfilling site. To obtain approval for a new or expanding landfilling site, a detailed assessment of the site as required by Regulation 232/98 must be carried out to identify any potential effects on the environment and to show how these potential effects can be satisfactorily addressed. The basis for this assessment and the requirements for site design and operation are given in Regulation 232/98. The Environmental Compliance Approval process takes the landfill standards and refines them as necessary to reflect the particular setting and conditions at each landfill. The resulting Environmental Compliance Approval will define how large the site is to be, the types of waste to be accepted, and any necessary conditions for design and operation. The approval will also describe how the site is to be closed and the measures to be taken following closure to ensure the site is properly maintained and monitored for the long term protection of the environment.

2.2 Regulation 347
Regulation 347 is the general waste management regulation under Part V of the Environmental Protection Act. Regulation 347 provides definitions of waste management terms, defines different classes of waste, and provides standards for the design and operation of landfilling sites (other than new or expanding landfilling sites now covered by Regulation 232/98) and other waste management facilities. For existing and small municipal waste landfilling sites (i.e. sites less than -- or equal to -- 40,000 cubic metres), the existing requirements given in Section 11 of Regulation 347 remain in effect. Additional or more detailed requirements for waste sites and systems are addressed as appropriate through the Environmental Compliance Approval process. Regulation 347 also defines when waste is considered hazardous or non-hazardous. Hazardous waste is defined by listing some specific wastes as being hazardous, and by identifying certain hazardous waste characteristics and tests. Non-hazardous waste is called “municipal” waste in Regulation 347. The new landfill standards in Regulation 232/98 only apply to sites accepting “municipal” waste.

2.3 Other Acts and Approvals
The focus of this Guideline is on the regulatory and approval requirements under Part V of the Environmental Protection Act. Landfilling sites, however, may also be subject to approval under the Environmental Assessment Act. Many landfill proposals, particularly larger sites may require approval under the Environmental Assessment Act. Under the Environmental Assessment Act, a broader view of the environment is taken and issues beyond the effects on the natural environment must be addressed. For a municipally owned landfilling site, Regulation 334 pursuant to the Environmental Assessment Act (EAA) identifies when a proposal is subject to EAA approval. For private sector landfills,
proposals are made subject to EAA requirements by being individually designated through regulation. Typically, sites larger than 40,000 cubic metres are designated, however, this may not always be the case. Once a landfill is subject to EAA approval, the decision to hold a public hearing and give approval for the undertaking rests with the Ministry. Regulation 101/07 under the Environmental Assessment Act also needs to be considered. This regulation defines what waste projects are subject to the EAA process.

2.4 Summary of the New Landfill Standards
The new landfill standards contained in Regulation 232/98 include requirements for design, operation, closure, post-closure care and financial assurance. The standards apply to all new or expanding municipal (i.e. non-hazardous) waste landfills sites larger than 40,000 cubic metres. The new standards are effective on August 1, 1998 and cover issues such as:
- design specifications for groundwater protection including a site specific design option and two generic design options,
- mandatory air emissions control for sites larger than 3 million cubic metres,
- the assessment of groundwater and surface water conditions;
- design requirements for buffer areas, final cover design, surface water and landfill gas control, and the preparation of a site design report,
- operation and monitoring requirements for site preparation, groundwater and surface water monitoring, daily cover, record keeping and reporting,
- requirements for a leachate contingency plan,
- site closure and post-closure care provisions; and
- financial assurance requirements for private sector landfills.

The regulatory requirements concerning which sites the new standards apply to, the effective date of the Regulation, and the requirements for site ownership are described in Sections 3.1 and 3.2 of this Guideline. Definitions for certain terms used in the Regulation are included at the end of the Guideline.
The new standards are described in detail in Chapters 4.0 to 6.0 of this Guideline. For each of the standards, the Guideline describes the new regulatory requirements as given in Regulation 232/98 and provides additional information in the form of approval guidelines on the types of issues and details to be addressed through the Environmental Compliance Approval process. The approval guidelines in the Guideline complement the regulatory requirements and indicate the Ministry’s expectations with respect to these matters. The use of approval guidelines allows the site specific aspects of landfill design and operation to be tailored to the conditions of the particular site.
3.0 APPLICATION AND OWNERSHIP

3.1 Application
The new landfill standards apply to new or expanding landfilling sites accepting municipal (i.e. non-hazardous) waste. The standards apply whether the site is owned by a municipality or a private landfill operator. The new standards do not apply to small landfills or to existing sites which are not being expanded. For purposes of the standards, a small landfill is considered to be a site with a total waste disposal volume of 40,000 cubic metres or less. For small or existing landfills, the existing requirements under Regulation 347 and the Environmental Protection Act (the Act) remain in effect. Once a site has received approval under the new standards, the site continues thereafter to be governed by these standards.

The new standards take effect on August 1, 1998. The standards do not apply to an application under Part 2.1 of the Act received by the Director prior to this date unless the landfill owner gives written notice asking that they apply. This notice must be provided prior to the issuance of the Environmental Compliance Approval or January 1, 1999, whichever comes first.

The regulatory requirements defining which landfilling sites are affected by the new standards and when the standards take effect are given in Sections 2 and 33 of Regulation 232/98, and are as follows:

Application

2. (1) This Regulation applies to the following landfilling sites:

   1. Every landfilling site that comes into existence on or after August 1, 1998 and that is intended at the time it comes into existence to have a total waste disposal volume of more than 40,000 cubic metres and to accept only municipal waste for disposal.

   2. Every landfilling site for which an alteration, enlargement or extension is proposed on or after August 1, 1998 that involves an increase in the site’s total waste disposal volume, if the site is intended after the alteration, enlargement or extension to have a total waste disposal volume of more than 40,000 cubic metres and to accept only municipal waste for disposal.

   (2) Subsection (1) does not apply with respect to a landfilling site in respect of which an application for a Certificate of Approval has been received by the Director under Part V of the Act before August 1, 1998, unless the operator or owner of the landfilling site gives written notice to the Director that the operator or owner wants this Regulation to apply.

   (3) The notice under subsection (2) must be given before the earlier of the following dates:

       1. The date the Environmental Compliance Approval or provisional approval is issued.


   (4) The standards, procedures and requirements set out in this Regulation do not apply to the extent that terms and conditions set out in a Environmental Compliance Approval.
3.2 Ownership
The party responsible for the landfilling site as discussed in Regulation 232/98 must have sufficient control of the site to ensure any necessary monitoring, maintenance, environmental control or remedial activities can be carried out to protect the environment. As a result, the applicant or holder of the Environmental Compliance Approval as required by Regulation 232/98 must own the entire site, including the waste fill area and the buffer area, unless the site is located on Crown land. In other cases, however, where additional land adjacent to a site is needed for the attenuation of contaminants (i.e. leachate or landfill gas), a Contaminant Attenuation Zone may be acceptable. To establish a Contaminant Attenuation Zone, the landfill owner must acquire property rights to use the adjacent land for purposes including contaminant attenuation, monitoring and remediation as required by Regulation 232/98. These rights must be held for the contaminating life span of the site. The regulatory requirements concerning ownership of landfilling sites and Contaminant Attenuation Zones are given in Sections 3, 4 and 5 of Regulation 232/98 and are as follows:

Landfilling Site

3. The holder of an Environmental Compliance Approval for a landfilling site must own the entire site in fee simple, unless the site is on Crown land.

Contaminant Attenuation Zone

4. (1) If a contaminant attenuation zone is necessary for proper operation of a landfilling site, the holder of an Environmental Compliance Approval for the landfilling site must own property rights respecting the contaminant attenuation zone, unless,

(a) the contaminant attenuation zone is on Crown land and the Crown has agreed in writing to the use of the land for that purpose; or
(b) the contaminant attenuation zone is on a public road and the road authority has agreed in writing to the use of the land for that purpose.

(2) The holder of the Environmental Compliance Approval must continue to own the property rights for all of the contaminating life span of the site.

(3) The ownership of the property rights must include the right to,
(a) discharge contaminants from the landfilling site into the contaminant attenuation zone;
(b) enter into the contaminant attenuation zone and onto the surface above the contaminant attenuation zone for purposes of testing, monitoring, intercepting contaminants and carrying out remedial work;
(c) install, operate and maintain works, for the purposes mentioned in clause (b), in or above the contaminant attenuation zone, including on the surface above the contaminant attenuation zone; and
(d) prevent the owner of the land in which the contaminant attenuation zone is located from paving, erecting a structure or making any use of land above or in the vicinity of the contaminant attenuation zone that would interfere with the functioning of the contaminant attenuation zone or with the exercise of any of the rights mentioned in this subsection.

Changes

5. The holder of an Environmental Compliance Approval or the applicant for an Environmental Compliance Approval for a landfilling site shall notify the Director in writing within 30 days after any change in his, her or its identity or status or any change in ownership of the site or ownership of property rights in the contaminant attenuation zone.

Contaminant Attenuation Zones are also discussed in Section 4.2 of this Guideline.
4.0 DESIGN

4.1 Design Specifications

Regulation 232/98 was created to ensure that New or Expanding Landfilling Sites are:
- Are designed for groundwater and surface water protection;
- Minimize impacts to the environment from site operations; and
- To facilitate site closure and post-closure care.

To accomplish these goals, Regulation 232/98 requires that a report be prepared containing plans and specifications on the design of the site. The design report must address matters such as:
- the proposed site boundaries, buffer area, waste fill area and contours, surface water control works, on-site roads and structures, and final cover design,
- the design of any liner and leachate collection system or landfill gas control works needed for the site,
- monitoring facilities for groundwater, leachate and surface water,
- a contingency plan for leachate control, and
- site closure and post-closure care requirements.

The regulatory requirements for preparing a landfill design report and the issues to be addressed are described in Subsection 4.1.1 of this Guideline.

In addition to the regulatory requirements described in Subsection 4.1.1, there are a number of other separate landfill standards dealing with specific aspects of landfill design as required by Regulation 232/98 which must be addressed. These other standards provide additional details on issues such as groundwater protection, surface water control, and subsurface migration of landfill gas. Where reference is made in these other standards to the preparation of a written report, the written report can be combined, as appropriate, with the design report described in Subsection 4.1.1. These other standards are dealt with in Sections 4.2 to 4.14 of this Guideline.

4.1.1 Regulatory Requirements

Regulation 232/98 requires that a design report be prepared for a landfilling site. This requirement is given in Section 6 of the Regulation and is as follows:

Design Specifications
6. (1) A person shall not establish a new landfilling site or increase the total waste disposal volume of an existing landfilling site unless a written report has been prepared in accordance with this section.

(2) The report must describe the design of the landfilling site and must contain,
(a) a legal survey of the site;
(b) an up to date plan and description of the site and the area within 500 metres of the site that covers,
(i) all property and property boundaries,
(ii) all buildings, roads and utility corridors,
(iii) land contours, surface water drainage, water bodies, rights-of-way and other easements,
(iv) forested areas,
(v) land uses and land use designations, and
(vi) property conditions not otherwise covered in subclauses (i) to (v);

(c) detailed plans, specifications and descriptions for the design of the site, including,

(i) a plan and description of the waste fill area, base contours for waste disposal, base contours for any leachate collection system, top contours for waste disposal and top contours with final cover;

(ii) the total waste disposal volume;

(iii) a materials balance between the sources of soils, on or off the site, and the uses of soils on the site;

(iv) a hydrogeological assessment of the suitability of the site for the landfilling of municipal waste that considers the geologic and hydrogeologic conditions of the site, the design of the site and the monitoring and contingency plans;

(v) a geotechnical assessment of the suitability of the site for the landfilling of municipal waste that considers bearing capacity, differential settlement and slope stability during construction, operation and after closure, and that addresses the potential effects on any liner or leachate collection system;

(vi) a description of the expected quality and quantity of leachate,

(vii) detailed plans, specifications and descriptions of any liner system necessary to control leachate, including construction and quality assurance and quality control procedures for the liner materials and liner system installation,

(viii) detailed plans, specifications and descriptions of any leachate collection, treatment and disposal system necessary to control leachate, including construction and quality assurance and quality control procedures for the system components and system installation,

(ix) an assessment of the potential for subsurface migration of landfill gas at the site and of any control system necessary for monitoring or controlling the migration,

(x) detailed plans, specifications and descriptions of any system necessary for controlling landfill gas by venting it or by collecting and burning or using it, including construction and quality assurance and quality control procedures for the system components and system installation,

(xi) an assessment of the potential impacts on surface water features that may be caused by the site or operations at the site,

(xii) detailed plans, specifications and descriptions of the system for collecting, directing and discharging surface water, including details of any sediment control or other features and including construction, quality assurance and quality control procedures for the system components and system installation,

(xiii) detailed plans, specifications and descriptions of monitoring facilities for leachate, ground water, surface water and, where appropriate, landfill gas,
(xiv) an assessment of potential noise impacts due to operations at the site and to local trucking related to operations at the site, including an evaluation of any proposed noise control measures,

(xv) an assessment of potential visual impacts on nearby properties due to the site and site operations,

(xvi) detailed plans, specifications and descriptions of the buffer area and ancillary facilities, including any screening, landscaping, fencing, weigh scales, buildings, structures, access roads, internal roads, holding areas for cover material, holding areas for rejected waste or materials for recycling, and other holding areas,

(xvii) detailed plans, specifications and descriptions of the contaminant attenuation zone, if one is necessary,

(xviii) an estimate of the contaminating life span of the site with respect to contaminants involved in the subsurface migration of landfill gas and an estimate of the service life of any engineered facilities associated with the subsurface migration of landfill gas,

(xix) an estimate of the contaminating life span of the site with respect to contaminants in leachate, unless a new landfilling site is being established and the design for ground water protection features of the site meets the criteria set out in subsection 10 (4) or (5),

(xx) an estimate of the service life of every engineered facility associated with leachate, which may be specified as the service life provided for in Schedule 1, 2, 3 or 4 if the engineered facility meets the relevant conditions set out in that Schedule,

(xxi) details of any facilities intended to control or change the contaminating life span of the landfilling site,

(xxii) contingency plans that can be implemented to control and dispose of leachate produced in a quantity greater than expected or with a quality worse than expected, including specifications and descriptions in sufficient detail to demonstrate the feasibility of the plans,

(xxiii) contingency plans that can be implemented to control and dispose of landfill gas migrating in the subsurface in a quantity greater than expected or with a quality worse than expected, including specifications and descriptions in sufficient detail to demonstrate the feasibility of the plans,

(xxiv) a description of the source, nature and quality of daily cover, including, with respect to material not normally used for daily cover, a discussion of its benefits and limitations, a description of quality assurance and quality control procedures for daily cover and a description of application rates and application procedures for daily cover, including the frequency and timing of application of daily cover if other than at the end of each working day,

(xxv) a description of the nature, quality and quantity of final cover, including construction details and quality assurance and
quality control procedures for the materials to be used and their installation,

(xxvi) a site closure plan, including details of the proposed end use of the site, the appearance of the site after closure, revegetation, landscaping, the construction of new facilities, and the removal of existing facilities to facilitate closure, post-closure care and site end use, and

(xxvii) a summary of the main characteristics of the landfilling site, including the maximum daily quantity of waste that will be accepted for disposal, the estimated annual average quantity of waste that will be accepted for disposal, the area of the landfilling site, the area of the waste fill area, the total waste disposal volume, the estimated waste disposal capacity in tonnes, any subcategories of municipal waste that are not expected to be received or that will not be accepted for disposal, and the estimated date of site closure.

4.1.2 Approval Guidelines
As described in Subsection 4.1.1 above, Regulation 232/98 requires the preparation of a landfill design report and identifies the issues which are to be addressed. All the design features are typically discussed and shown in this report to show the features readily confirm that the design will be acceptable and its construction will be practical. Final, detailed construction plans and specifications would normally be dealt with through conditions of approval and not be required prior to the issuance of an Environmental Compliance Approval.
More detailed provisions dealing with specific aspects of landfill design are described separately in Sections 4.2 to 4.14 of this Guideline.

4.2 Buffer Area
The buffer area is the green belt or zone located on the site between the waste fill area and the site boundaries. The buffer area allows for contaminant attenuation and provides space around the perimeter of the waste area in which various monitoring, maintenance and environmental control activities can take place. The regulatory requirements for the minimum size of the buffer area are described in Subsection 4.2.1 of this Guideline. Additional information on the buffer area is included in the approval guidelines given in Subsection 4.2.2.

4.2.1 Regulatory Requirements
Regulation 232/98 sets a minimum requirement for the size of the buffer area at a landfilling site. This requirement is given in Section 7 of the Regulation and is as follows:

Buffer Area
7. (1) The owner and the operator of a landfilling site shall ensure that the waste fill area is completely surrounded by buffer area in accordance with this section.
(2) The buffer area shall be at least 100 metres wide at every point.
(3) Subsection (2) does not apply to a buffer area if the buffer area is at least 30 metres wide at every point and a written report confirms that,
(a) the buffer area provides adequate space for vehicle entry, exit, turning, access to all areas of the site and parking;
(b) the buffer area provides adequate space on the surface of the site for all anticipated structures, equipment and activities; and
(c) the buffer area is sufficient to ensure that potential effects of the landfilling operation do not have any unacceptable impact outside the site.

(4) For the purpose of clause (3) (c), potential effects include surface runoff, litter, vectors, vermin, leachate, subsurface migration of landfill gas and aesthetic effects.

4.2.2 Approval Guidelines
A buffer area provides space around the perimeter of the waste area in which contaminant attenuation may occur, and various monitoring, maintenance and environmental control activities can take place. The buffer area may contain a site access road, site services and buildings, groundwater monitoring wells, landscaping and visual screening. The regulatory requirements described in Subsection 4.2.1 specify a 100 metre wide buffer area, but allow this to be reduced to not less than 30 metres if shown to be appropriate based on a site specific assessment. A minimum 30 metre buffer area has been established to ensure there is sufficient site access for site monitoring, maintenance and remedial measures. As discussed in Section 3.2 of this Guideline, unless the site is located on Crown land, the landfill owner as required by Regulation 232/98 must own the entire landfilling site including the waste fill area and the buffer area. In some cases, however, additional land adjacent to the on-site buffer area may be needed for leachate or landfill gas attenuation. This off-site land is defined as a Contaminant Attenuation Zone and the landfill owner as required by regulation 232/98 must acquire the rights to use this land for purposes such as contaminant attenuation, monitoring and remediation. Ownership of these rights would have to be registered on title for the property containing the Contaminant Attenuation Zone. Contaminant Attenuation Zones are dealt with in Section 3.2 of this Guideline.

4.3 Hydrogeological Assessment
An assessment of the hydrogeologic setting of a landfilling site is necessary to properly design the site, and to ensure the site can be effectively monitored and an acceptable contingency plan can be developed. Regulation 232/98 includes a basic requirement that the geologic and hydrogeologic conditions of the landfilling site be assessed. The regulatory requirement is included in Subsection 4.3.1 of this Guideline. A more detailed description of the type of information typically included in the assessment, the kinds of analyses which are typically undertaken, and the issues typically addressed is included in the approval guidelines given in Subsection 4.3.2. The approval guidelines address both the regional area in which the site is located, and the detailed study of site conditions. For the detailed site study, the assessment deals with matters such as those detailed in Table 1.
Table 1: Hydrogeological Assessment Requirements

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>i.</td>
<td>the drilling of boreholes and obtaining samples to characterize soil or bedrock conditions at the site.</td>
</tr>
<tr>
<td>ii.</td>
<td>the measurement of groundwater levels and pressures to define groundwater flow characteristics.</td>
</tr>
<tr>
<td>iii.</td>
<td>the collection of groundwater samples to assess groundwater quality.</td>
</tr>
<tr>
<td>iv.</td>
<td>the interpretation of collected data including the preparation of site and piezometric contour plans, the determination of groundwater flow paths and contaminant attenuation capabilities, and the identification of any unstable soils or geologic conditions.</td>
</tr>
<tr>
<td>v.</td>
<td>an assessment of the suitability of the site for landfilling with respect to the design, monitoring and contingency plan requirements.</td>
</tr>
</tbody>
</table>

A hydrogeological assessment is required for all landfilling sites including sites which are to be designed in accordance with the generic designs (refer to Section 4.5 of this Guideline) specified in the Regulation. Although the generic designs are fully protective of groundwater quality, a hydrogeological assessment is needed to ensure that the conditions for use of the generic designs are present, and to ensure that effective groundwater monitoring and leachate contingency plans can be developed for the site. A good understanding of the geologic and hydrogeologic conditions of a site is also needed for site construction purposes.

4.3.1 Regulatory Requirements

Regulation 232/98 requires that the geologic and hydrogeologic conditions of a landfilling site be assessed. This requirement is given in Section 8 of the Regulation and is as follows:

**Hydrogeological Assessment**

8. (1) A person shall not establish a new landfilling site or increase the total waste disposal volume of an existing landfilling site unless a written report on the geologic and hydrogeologic conditions of the site and groundwater protection for the site has been prepared in accordance with this section.

(2) The report must contain,

- (a) plans, specifications and descriptions of the geologic and hydrogeologic conditions of the site and the area in which the site is located; and
- (b) an assessment of the suitability of the site for the landfilling of municipal waste, taking into account,
(i) the design of the site, including existing features and features that will be implemented to control the expected production of leachate and the expected subsurface migration of landfill gas,
(ii) regional and site specific geologic and hydrogeologic conditions,
(iii) the ability to identify future impacts on the ground water by monitoring,
(iv) the feasibility of contingency plans that can be implemented to control leachate produced in a quantity greater than expected or with a quality worse than expected, and
(v) the feasibility of contingency plans that can be implemented to control landfill gas migrating in the subsurface in a quantity greater than expected or with a quality worse than expected.

4.3.2 Approval Guidelines

The objectives of a hydrogeological assessment are to: determine the physical, hydraulic and chemical properties of the surficial materials (and bedrock where appropriate); define groundwater flow characteristics and potential contaminant plume migration pathways; determine the structural integrity of the subgrade to support the landfill (including its construction) and any overlying facilities; determine the availability and suitability of the soil for cover and liner uses; establish a groundwater monitoring network; and determine the feasibility of the contingency plans for contaminant control.

The following guidelines provide a more detailed description of the information and analytical needs, and the types of issues which are typically addressed in the assessment.

The hydrogeological assessment of a landfilling site typically includes a discussion on the information identified in Table 2:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>A general description of the geologic and hydrogeologic conditions of the (regional) area in which the site is located. This description should include a description of the stratigraphy, groundwater quantity and quality, groundwater movement, and should characterize the significance of groundwater resources and the use made of these resources.</td>
</tr>
</tbody>
</table>
| b. | A detailed description of the geologic and hydrogeologic conditions occurring at the site based on a detailed investigation of the site which establishes soil, rock and groundwater conditions, including:  
  (i) the drilling of boreholes hydraulically upgradient and hydraulically downgradient of the potential waste fill area and in other locations, including areas adjacent to the site where necessary, to a depth and in a manner sufficient to:  
    - provide soil samples of a number and type to adequately characterize the thickness and nature of soil units underlying the site;  
    - provide soil samples of a number and type for laboratory analysis of physical and/or chemical properties;  
    - permit, as necessary, the geological and/or geophysical logging of boreholes; |
- permit installation, as necessary, of groundwater monitoring facilities;
- permit other tests of soil and/or borehole properties, as necessary; and
- permit testing of bedrock properties, as necessary;

(ii) the use of drilling, coring, drive-points, test pitting, trenching and/or other means of soil excavation/sample extraction to obtain representative samples of soil and/or rock for the testing of soil and/or rock properties and chemistry/quality;

(iii) the installation in boreholes of groundwater monitoring facilities in a manner appropriate for the collection of groundwater samples or the measurement of groundwater levels or hydraulic pressures representative of the hydrostratigraphic units at the site;

(iv) the development and purging of groundwater monitoring facilities, as necessary, in a manner and over a period of time sufficient to ensure that water level/hydraulic pressure data collected in the groundwater monitor and/or groundwater samples collected from the groundwater monitor are representative of hydrogeologic conditions at the site;

(v) the collection, in a manner which ensures data are representative of a sufficient number of measurements of groundwater level/hydraulic pressure in groundwater monitoring facilities to confirm, as necessary:
- that the groundwater monitor is functioning properly; and
- attainment of static water level;

and to establish, as necessary,

- differences in water level/hydraulic pressure both laterally and vertically at the site;

(vi) the collection of groundwater samples from groundwater monitoring facilities in a manner that ensures these samples are in a sufficient number and over a sufficient period of time to establish the potential seasonal and/or spatial/depth variability of groundwater chemistry/quality;

(vii) the analysis of groundwater samples from groundwater monitoring facilities for the parameters listed in Schedule 5, column 1, unless alternative parameters are considered more appropriate; and

(viii) the use of pumping tests, slug tests and other procedures, as necessary, to measure the in-situ permeability of geologic materials at the site;

c. An interpretation of the results of the detailed investigation of the site, including the following plans, specifications and descriptions under existing conditions, during site construction and operation, and following site closure:
(i) a contour plan of the ground surface, showing surface watercourses and bodies of surface water, if any;

(ii) a contour plan of the water table, showing expected directions of groundwater movement;

(iii) piezometric contour plans for each aquifer, showing expected directions of groundwater movement;

(iv) a description of any aquifers and their interconnection, with generalized estimates of groundwater flow;

(iv) a description of the background quality of the groundwater, and the existing and potential uses of the groundwater;

(v) site plans and cross sections of the hydrogeologic conditions;

(vi) the identification of any unstable soils or unstable bedrock;

(vii) a description of the flow velocity and volumetric flow rate in the aquifers;

(ix) a water balance analysis considering precipitation, surface water drainage, infiltration, groundwater flow, exfiltration and evapotranspiration; and

(x) the potential flow paths and contaminant attenuation capabilities in the event leachate leaves the waste fill area in planned or unplanned quantities.

d. An assessment of the suitability of the site for waste disposal purposes considering the regional and site specific geologic and hydrogeologic conditions, the design of the site, the monitoring of potential groundwater impacts, and the contingency plans for the control of leachate and landfill gas.

4.4 Surface Water Assessment

The assessment of the surface water conditions on and in the vicinity of a landfilling site, and of any surface water features which are to receive a discharge from the site is an important part in determining the suitability, design and monitoring requirements for the site. As described in Subsection 4.4.1 below, Regulation 232/98 includes a basic requirement that a surface water assessment be carried out. Further details on the type of information typically obtained and the analyses to be performed are included as approval guidelines in Subsection 4.4.2. The approval guidelines address matters such as:

- a description of the area (watershed) in which the site is located and the surface water features nearby the site,
- a detailed investigation and description of the surface water conditions on the site and any surface water features receiving a direct discharge from the landfilling site,
- a water quality assessment program, based on an extensive list of monitoring parameters, and
an assessment of the suitability of the site for landfilling.

4.4.1 Regulatory Requirements
Regulation 232/98 requires that the surface water conditions at and in the vicinity of a landfilling site be assessed. This requirement is given in Section 9 of the Regulation and is as follows:

Surface Water Assessment
9. (1) A person shall not establish a new landfilling site or increase the total waste disposal volume of an existing landfilling site unless a written report on the surface water conditions of the site and surface water protection for the site has been prepared in accordance with this section.

(2) The report must contain,

(a) plans, specifications and descriptions of the surface water features on the site, the surface water features that will receive a direct discharge from the site and the surface water features of the area in which the site is located; and

(b) an assessment of the suitability of the site for the landfilling of municipal waste, taking into account,

(i) the design of the site, including existing features and features that will be implemented to control the expected production of leachate, the flow of surface water, and erosion and sedimentation resulting from the flow of surface water,

(ii) the surface water features on the site, the surface water features that will receive a direct discharge from the site and the surface water features of the area in which the site is located,

(iii) the ability to identify future impacts on the surface water features by monitoring, and

(iv) the feasibility of contingency plans that can be implemented to control surface water impacts resulting from the production of leachate in a quantity greater than expected or with a quality worse than expected.

4.4.2 Approval Guidelines
The objectives of the surface water assessment are to: define existing surface water conditions on and in the vicinity of the site; determine the potential effects of surface water coming onto the site; determine the potential effects of runoff discharging from the site; and establish a surface water monitoring network. The following guidelines provide further details on the information and analytical needs, and the types of issues which are typically addressed in the assessment.

The surface water assessment for a landfilling site typically includes a discussion on the information in identified in Table 3:
Table 3: Surface Water Assessment

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>A general description of the surface water features of the area (watershed) in which the site is located.</td>
</tr>
<tr>
<td>b.</td>
<td>A description of the surface water features occurring within 500 m of the waste fill area of the site. This description should be based on contributing and receiving drainage, catchment, subwatershed or watershed areas that are sufficiently large to allow an assessment of the range and extent of potential effects. The description should include a description of surface water features such as flood plains, natural watercourses and water bodies, municipal drains, drainage paths and boundaries.</td>
</tr>
</tbody>
</table>
| c.       | A detailed surface water investigation to assess water quality, quantity and habitat conditions of the surface water features identified on the site, any surface water features flowing through the site, and any surface water features that are to receive a surface water discharge from the site, including:  
   (i) a surface water quantity program to assess current streamflow conditions, including low flow characteristics and stream-aquifer interaction, that includes periodic measurements of streamflow;  
   (ii) a surface water quality program to assess current surface water quality to establish seasonal variations over a period of one year, with surface water samples obtained:  
      - once for any compounds known to be commonly in industrial or agricultural use in the proposed site’s watershed to assess whether any of these should be included in the surface water monitoring program;  
      - semi-annually and analyzed for the parameters listed in Schedule 5, column 3; and  
      - on six other occasions analyzed for the parameters listed in Schedule 5, column 4; and  
      - unless alternative parameters and frequencies are considered more appropriate.  
   (iii) a benthic community inventory where considered appropriate based on factors such as the location, sensitivity or use of the surface water feature. |
| d.       | An interpretation of the results of the detailed surface water investigation of the site, any surface water features flowing through the site, and any surface water features that are to receive a direct discharge from the site, including:  
   (i) plans showing all existing surface water features;  
   (ii) a description of current surface water quality, and the existing and proposed surface water uses, including:  
      - a summary of sampling results;  
      - a review of data available from other sources, including the Ministry’s provincial surface water quality monitoring network for any stations upstream or downstream of the site;  
   (iii) a detailed hydrologic assessment of the surface water features, including: |
- changes to the frequency, magnitude and duration of streamflow at key locations entering, passing through and discharging from the site;
- changes to surface water flood levels within watercourses entering, passing through and discharging from the site that have an upstream drainage area greater than 125 ha;
- changes to average annual water budgets, including evapotranspiration, infiltration, surface runoff and groundwater recharge/discharge volumes expressed over the site area and the contributing drainage area; and
- changes to temperature and average annual sediment loading to receiving watercourses at key locations discharging from the site.

(iv) the potential leachate flow paths and location of any intersection with surface water features within 500 m of the waste fill area.

e. An assessment of the suitability of the site for waste disposal purposes considering the area in which the site is located, on-site and receiving surface water features, the design of the site, and the contingency plan for the control of leachate.

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**4.5 Design Criteria for Groundwater Protection**

Groundwater protection is fundamental to good landfill design. Groundwater is often the primary source of rural and urban water supply, and may be a significant contributor to streamflow. Preventing groundwater contamination is particularly important because of the difficulty and cost of restoration. Once contaminated, it may take many years to cleanup groundwater.

Regulation 232/98 includes two approaches for designing a landfill to protect groundwater quality. The first approach, called site specific design, allows the proponent to design the landfill to suit the local environmental setting provided the Ministry's Reasonable Use limits for groundwater protection are met at the property boundary. The second approach allows the proponent to select one of two generic designs which have been specified in the standards. The generic designs have been developed such that they will meet Reasonable Use limits within a broad range of hydrogeologic settings, as defined for their use.

**Reasonable Use Guideline**

To protect groundwater resources, landfills must be designed to meet stringent contaminant limits in accordance with the Ministry's Reasonable Use Guideline (1994) as described in Section 10 of Regulation 232/98. The Reasonable Use Guideline establishes limits for the allowable concentrations of contaminants based on background groundwater quality and the reasonable use of groundwater on adjacent property. The limits are set such that there would not be any significant effect on the use of the groundwater on the adjacent property.

As the reasonable use of groundwater is commonly drinking water, the Reasonable Use limits are typically set on this basis. As a result, the quality of groundwater may not be degraded by an amount in excess of:
- 50% of the difference between background and the Ontario Drinking Water Objectives for non-health related parameters (e.g. chloride), or
- 25% of the difference between background and the Ontario Drinking Water Objectives for health related parameters (e.g. lead).

In cases where the reasonable use of groundwater is other than drinking water, for example where background groundwater quality is poor, the Reasonable Use Guideline allows alternative concentration limits to be set. These alternative limits would be determined on a case-by-case basis.

The Reasonable Use Guideline has been incorporated in Regulation 232/98. The Reasonable Use requirements have been included directly as performance specifications for the site specific design approach, and have been incorporated in the development of the two generic designs.

**Site Specific Design**

The site specific design approach included in the Regulation gives the site owner flexibility to design the landfilling site to suit the local environmental setting, provided the Reasonable Use limits for groundwater protection are met. This is a performance based standard with the acceptability of a design judged on its ability to meet the Reasonable Use limits at the property boundary. The Regulation specifically sets out how these limits are determined, on the basis that groundwater is used for drinking purposes, but allows for the setting of other limits in other circumstances. Under this approach, a proponent may design a natural attenuation site, or an engineered site which incorporates a liner and leachate collection system. To obtain approval for the design, sufficient information on the site setting and the performance of the design as required in Regulation 232/98 must be presented to show that the Reasonable Use limits will be met.

To assist with site specific design, the Regulation also includes design criteria such as:
- identification of the chemical parameters to be used in design,
- waste and leachate characteristics for the identified parameters,
- decay constants (i.e. half-lives) for the organic parameters, and
- the service lives which can be used in design for certain liner and leachate collection systems.

These design criteria may be used in the design of a municipal waste landfilling site. A site which has been properly designed using these criteria will fully protect groundwater quality. Use of these criteria, however, is not mandatory and a proponent may use alternative design criteria where they can be shown to be appropriate. For example, alternative criteria may be more appropriate for the landfilling of a particular industrial waste, or for a site located in a geographic area where more representative leachate data is available. Design criteria have been included in the landfill standards as tools to help in landfill design. The criteria are not intended to prevent proponents from obtaining and using other, more representative criteria if they wish.

**Generic Design Options**

The Regulation includes two generic design options which incorporate specific liner and leachate collection system designs. To ensure the generic designs can be used within a broad range of hydrogeologic settings, the designs have been developed such that the Reasonable Use limits for groundwater protection will be met without reliance on contaminant attenuation in the landfill buffer area. In a hydrogeologic setting where
there is significant natural groundwater protection, the level of engineering in the generic designs may not be necessary and the site specific design approach could be followed. Similarly, a site specific design could be undertaken where it can be shown that the design criteria for the proposed site (e.g. the expected leachate characteristics) are different from those given in the Regulation. The advantage of using the generic designs is the added certainty they bring to the approval process.

The two generic design options differ with respect to their level of engineering and the quantity of waste which they can accommodate. The double composite liner design (i.e. Generic Design Option II) allows a greater quantity of waste to be deposited at a particular site, but the level of engineering is greater. Where less complex engineering is desired and the site area is large enough to accept the total quantity of waste to be deposited, a proponent may wish to use the single composite liner design (i.e. Generic Design Option I). The choice between the two designs will depend on the particular circumstances of the proposal.

A schematic view of a landfill incorporating the generic design approach is shown in Figure 1. The components of the two generic designs are shown in Figures 2 and 3, and are as follows:

a. **Generic Design Option I - Single Liner**

This generic design (shown in Figure 2) consists of the following components:
- a single composite liner consisting of a 1.5 millimetre (60 mil) thick high density polyethylene (HDPE) geomembrane liner, over a 0.75 metre thick compacted clayey liner;
- a natural, or constructed, 3 metre thick attenuation layer below the single composite liner; and
- a leachate collection system above the composite liner,
- provided the infiltration rate through the landfill cover is greater than or equal to 0.15 metres per year, and the maximum waste loading is no greater than the amount shown in Table 5 for the background chloride concentration for the site.

b. **Generic Design Option II - Double Liner**

This generic design (shown in Figure 3) consists of the following components:
- two composite liners with:
  - a primary (upper) liner consisting of a 1.5 millimetre (60 mil) thick high density polyethylene (HDPE) geomembrane liner over a 0.75 metre thick compacted clayey liner; and
  - a secondary (lower) liner consisting of a 2 millimetre (80 mil) thick high density polyethylene (HDPE) geomembrane liner over a 0.75 metre thick compacted clayey liner.
- a natural, or constructed, 1 metre thick attenuation layer below the lower composite liner; and
- two leachate collection systems with the first located above the upper composite liner, and the second located between the upper and lower composite liners,

provided the infiltration rate through the landfill cover is greater than or equal to 0.15 metres per year, and the maximum waste loading is no greater than the amount shown in Table 5 for the background chloride concentration for the site.

The generic designs have been developed using contaminant transport modelling to assess performance of the liner and leachate collection systems relative to meeting the Ministry's Reasonable Use limits. Input parameters (design criteria such as waste and leachate characteristics) used in the computer modelling were the same as those included in the Regulation and referred to above under Site Specific Design.
4.5.1 Regulatory Requirements
Regulation 232/98 includes two approaches to landfill design, either of which may be used for groundwater protection. The site specific design approach allows the owner to design the landfill to suit the local environmental setting provided the Ministry’s Reasonable Use limits are met. The generic design approach allows the owner to use one of two generic designs specified in the standards. The site specific and generic design approaches are given in Section 10 of the Regulation and are as follows:

**Ground Water Protection**

10. (1) A person shall not establish a new landfilling site or increase the total waste disposal volume of an existing landfilling site unless a written report describing the design for the ground water protection features of the site has been prepared in accordance with this section.

(2) The design for the ground water protection features of the site must,
(a) if a new landfilling site is being established, meet the criteria set out in subsection (3), (4) or (5); or
(b) if the total waste disposal volume of an existing landfilling site is being increased, meet the criteria set out in subsection (3).

[Site Specific Design]

(3) The design for the ground water protection features of a landfilling site complies with subsection (2) if it meets the following criteria:
1. The objective of the design must be that the site will not cause the concentration of any contaminant listed in Column 1 of Table 4 to exceed the maximum allowable concentration for the contaminant in the ground water at any point on any adjacent property.

2. For the purpose of paragraph 1, the maximum allowable concentration for a contaminant shall be determined in accordance with the following formula:

\[ C_m = C_b + X(C_r - C_b) \]

where,
- \( C_m \) is the maximum allowable concentration for the contaminant,
- \( C_b \) is the background concentration of the contaminant in the ground water of the receptor aquifer,
- \( C_r \) is the health related drinking water objective for the contaminant or the aesthetic drinking water objective for the contaminant, whichever is applicable, as set out in column 5 or 6 of Table 4, and
- \( X \) is,
  (a) 0.25, if \( C_r \) is a health related drinking water objective, or
  (b) 0.50, if \( C_r \) is an aesthetic drinking water objective.

3. The initial source concentration, mass as a proportion of total (wet) mass and half-life in leachate set out in Columns 2, 3 and 4 of Table 4 must be used for the purposes of evaluating the design with respect to the objective set out in paragraph 1.
4. The design must consider both advective and diffusive contaminant transport and must include examination of the effect of the failure of any engineered facilities when their service lives are reached.

5. A service life set out in Schedule 1, 2, 3 or 4 for an engineered facility may be used for the purpose of evaluating the design with respect to the objective set out in paragraph 1 if the relevant conditions set out in that Schedule are met.

6. Despite paragraphs 1, 2 and 3, if it is appropriate because of the nature of the waste or because the reasonable use of the ground water on the adjacent property is other than for drinking water, the Director may,

i. for the purposes of evaluating the design with respect to the objective set out in paragraph 1,

A. require or permit the use of values specified by the Director for Cr and X in the formula set out in paragraph 2, instead of the values set out in that paragraph, and

B. require or permit the use of an initial source concentration, mass as a proportion of total (wet) mass or half-life in leachate specified by the Director instead of the initial source concentration, mass as a proportion of total (wet) mass or half-life in leachate set out in Column 2, 3 or 4 of Table 4, or

ii. require or permit the objective of the design to be based in whole or in part on contaminants other than those listed in Column 1 of Table 4 and, for the purpose of evaluating the design with respect to that objective,

A. require or permit the use of values specified by the Director with respect to each of the other contaminants for Cr and X in the formula set out in paragraph 2, and

B. require or permit the use of an initial source concentration, mass as a proportion of total (wet) mass or half-life in leachate specified by the Director with respect to each of the other contaminants.

[Generic Design Option I - Single Liner]

(4) The design for the ground water protection features of a new landfilling site that is being established complies with clause (2) (a) if it meets the following criteria:

1. The maximum waste loading for any given background concentration of chloride in the ground water of the receptor aquifer must not be
more than the value set out for that concentration in Column 1 of Table 5.

2. The infiltration rate through the final cover of the landfilling site must be greater than or equal to 0.15 metres per year.

3. There must be, at the base of the waste fill zone, a natural or engineered layer of soil in which attenuation of contaminants from the wastes in the site may take place and that meets the following conditions:
   i. The layer must be at least three metres thick.
   ii. The layer must consist of material that is relatively homogeneous.
   iii. The layer must have a hydraulic conductivity less than or equal to $1 \times 10^{-7}$ metres per second.

4. The waste fill zone must have a ground water protection system above the attenuation layer referred to in paragraph 3 and below the waste consisting of, from bottom to top,
   i. a primary liner consisting of,
      A. a clayey liner at least 0.75 metres thick that meets the conditions set out in Schedule 4 for an unlimited service life, has a hydraulic conductivity of not more than $1 \times 10^{-9}$ metres per second, and has an organic carbon content of at least 0.1 per cent, and
      B. a high density polyethylene (HDPE) geomembrane liner at least 1.5 millimetres thick that meets the conditions set out in Schedule 3 for a 150 year service life, and
   ii. a primary leachate collection system that meets the conditions set out in Schedule 1 for a 100 year service life.

[Generic Design Option II - Double Liner]

(5) The design for the ground water protection features of a new landfilling site that is being established complies with clause (2) (a) if it meets the following criteria:

1. The maximum waste loading for any given background concentration of chloride in the ground water of the receptor aquifer must not be more than the value set out for that concentration in Column 2 of Table 5.

2. The infiltration rate through the final cover of the landfilling site must be greater than or equal to 0.15 metres per year.

3. There must be, at the base of the waste fill zone, a natural or engineered layer of soil in which attenuation of contaminants from the wastes in the site may take place and that meets the following conditions:
i. The layer must be at least one metre thick.
ii. The layer must consist of material that is relatively homogeneous.
iii. The layer must have a hydraulic conductivity less than or equal to $1 \times 10^{-7}$ metres per second.

4. The waste fill zone must have a ground water protection system above the attenuation layer referred to in paragraph 3 and below the waste consisting of, from bottom to top,

i. a secondary liner consisting of,

A. a clayey liner at least 0.75 metres thick that meets the conditions set out in Schedule 4 for an unlimited service life, has a hydraulic conductivity of not more than $1 \times 10^{-9}$ metres per second, and has an organic carbon content of at least 0.1 per cent, and

B. a high density polyethylene (HDPE) geomembrane liner at least 2.0 millimetres thick that meets the conditions set out in Schedule 3 for a 350 year service life,

ii. a secondary leachate collection system that meets the conditions set out in Schedule 2 for a 1000 year service life,

iii. a primary liner consisting of,

A. a clayey liner at least 0.75 metres thick that meets the conditions set out in Schedule 4 for an unlimited service life, has a hydraulic conductivity of not more than $1 \times 10^{-9}$ metres per second, and has an organic carbon content of at least 0.1 per cent, and

B. high density polyethylene (HDPE) geomembrane liner at least 1.5 millimetres thick that meets the conditions set out in Schedule 3 for a 150 year service life, and

iv. a primary leachate collection system that meets the conditions set out in Schedule 1 for a 60 year service life.

[Background Concentration]

(6) For the purpose of this section, the background concentration of a contaminant in the ground water of the receptor aquifer is the median value for that contaminant based on all ground water samples taken from the receptor aquifer in accordance with the following rules:

1. At least five samples must be taken.
2. The samples must be taken at or near the site boundary where the potential impact is being examined.
3. The samples must not be taken from locations known to be or likely to be contaminated by human activity.
TABLE 4: Leachate Characteristics (Regulation Section 10)

<table>
<thead>
<tr>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
<th>Column 4</th>
<th>Column 5</th>
<th>Column 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contaminant</td>
<td>Initial Source Concentration (mg/L)</td>
<td>Mass as a Proportion of Total (wet) Mass of Waste (mg/kg)</td>
<td>Half-Life in Leachate (years)</td>
<td>Health Related Drinking Water Objective (mg/L)</td>
<td>Aesthetic Drinking Water Objective (mg/L)</td>
</tr>
<tr>
<td>1. Benzene</td>
<td>0.02</td>
<td>0.014</td>
<td>25</td>
<td>0.005</td>
<td>n/a</td>
</tr>
<tr>
<td>2. Cadmium</td>
<td>0.05</td>
<td>0.035</td>
<td>n/a</td>
<td>0.005</td>
<td>n/a</td>
</tr>
<tr>
<td>3. Chloride$^1$</td>
<td>150,000 t/ha increasing to 250,000 t/ha</td>
<td>1,500</td>
<td>1,800</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>4. Lead</td>
<td>0.6</td>
<td>0.42</td>
<td>n/a</td>
<td>0.01</td>
<td>n/a</td>
</tr>
<tr>
<td>5. 1,4 Dichloro-benzene</td>
<td>0.01</td>
<td>0.007</td>
<td>50</td>
<td>n/a</td>
<td>0.001</td>
</tr>
<tr>
<td>6. Dichloro-methane</td>
<td>3.3</td>
<td>2.3</td>
<td>10</td>
<td>0.05</td>
<td>n/a</td>
</tr>
<tr>
<td>7. Toluene</td>
<td>1</td>
<td>0.7</td>
<td>15</td>
<td>n/a</td>
<td>0.024</td>
</tr>
<tr>
<td>8. Vinyl Chloride</td>
<td>0.055</td>
<td>0.039</td>
<td>25</td>
<td>0.002</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Notes:
1. The initial source concentration of chloride is taken to vary linearly between 1,500 and 2,500 milligrams per litre with maximum waste loading between 150,000 and 250,000 tonnes per hectare.
2. Half-lives may be used in considering a decrease in source concentration with time and for estimating the contaminating life span.
<table>
<thead>
<tr>
<th>Background Chloride Concentration (mg/L)</th>
<th>Maximum Waste Loading (m³/ha)</th>
<th>Column 1</th>
<th>Column 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Single Liner Design Option (Subsection 10(4))</td>
<td>Double Liner Design Option (Subsection 10(5))</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>98,500</td>
<td>287,000</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>100,500</td>
<td>295,500</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>102,500</td>
<td>299,500</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>104,000</td>
<td>303,000</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>106,000</td>
<td>307,000</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>107,500</td>
<td>310,500</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>109,000</td>
<td>314,000</td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>110,500</td>
<td>317,500</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>112,000</td>
<td>321,500</td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>113,500</td>
<td>325,000</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>115,000</td>
<td>328,500</td>
<td></td>
</tr>
<tr>
<td>110</td>
<td>117,000</td>
<td>332,000</td>
<td></td>
</tr>
<tr>
<td>120</td>
<td>118,500</td>
<td>335,500</td>
<td></td>
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<tr>
<td>130</td>
<td>120,000</td>
<td>339,000</td>
<td></td>
</tr>
<tr>
<td>140</td>
<td>121,500</td>
<td>343,000</td>
<td></td>
</tr>
<tr>
<td>150</td>
<td>123,500</td>
<td>346,500</td>
<td></td>
</tr>
<tr>
<td>160</td>
<td>125,000</td>
<td>350,000</td>
<td></td>
</tr>
<tr>
<td>170</td>
<td>126,500</td>
<td>353,500</td>
<td></td>
</tr>
<tr>
<td>180</td>
<td>128,000</td>
<td>357,000</td>
<td></td>
</tr>
<tr>
<td>190</td>
<td>129,500</td>
<td>360,500</td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>131,000</td>
<td>363,500</td>
<td></td>
</tr>
<tr>
<td>210</td>
<td>132,500</td>
<td>366,500</td>
<td></td>
</tr>
<tr>
<td>220</td>
<td>134,500</td>
<td>370,000</td>
<td></td>
</tr>
<tr>
<td>230</td>
<td>136,000</td>
<td>373,000</td>
<td></td>
</tr>
<tr>
<td>240</td>
<td>137,500</td>
<td>376,000</td>
<td></td>
</tr>
<tr>
<td>250 or more</td>
<td>139,000</td>
<td>380,000</td>
<td></td>
</tr>
</tbody>
</table>

Note: If the Background Chloride Concentration falls between two values in Table 5, the appropriate limiting value shall be interpolated from the values in Column 1 or 2, whichever applies. These values are considered to vary linearly with the values for chloride.
4.5.2 Approval Guidelines
The regulatory requirements for groundwater protection are described above in Subsection 4.5.1. Both the site specific and generic design approaches incorporate the Ministry’s Reasonable Use limits and will ensure groundwater is protected. The Reasonable Use limits have been included directly into the specifications for the site specific design approach and were used in the development of the two generic designs. Regardless of which design approach is followed, a hydrogeological assessment (refer to Section 4.3 of this Guideline) is required by Regulation 232/98. In site specific design, a hydrogeological assessment is needed to determine what type of design is appropriate -- whether the site is to be a natural attenuation site, or an engineered site which incorporates a liner and leachate collection system. For the generic designs, although the designs will protect groundwater quality, a hydrogeologic assessment is still necessary to ensure that the conditions for use of the designs are met (i.e. attenuation layer and background chloride concentration). In both the site specific and generic design cases, a good understanding of the geologic and hydrogeologic setting is needed to ensure that effective groundwater monitoring and leachate contingency plans can be developed, and for site construction purposes.
Where a generic design is to be used, an owner must show how the generic design features (as discussed in Section 6 of Regulation 232/98) are to be incorporated in the design of the particular landfill (i.e. given the varying site sizes, depths, base side slopes, etc.). For example, the single composite generic design incorporates a primary leachate collection system which has a 100 year design service life. This collection system is expected to require replacement by some alternative system, such as a perimeter leachate collection system, to control leachate mounding and prevent leachate breakout at surface. For the double composite generic design, which incorporates a 60 year primary collection system, similar provisions would have to be made. Considerations such as these typically are addressed in the design report required for the site (refer to Section 4.1 of this Guideline).
For planning post-closure care activities for a site utilizing the single or double composite generic design, the contaminating life span for leachate impact on groundwater (based on the minimum infiltration rate of 0.15 metres per year) is 160 years and 360 years, respectively. By this time, the geomembrane(s) are assumed to have failed and the discharge rate through the compacted clayey liner(s) at the base of the site equals the infiltration rate (i.e. 0.15 metres per year) through the final top cover. The landfill can then be allowed to discharge passively into the groundwater environment.

4.6 Groundwater Protection System
As described in Section 4.1 of this Guideline, Regulation 232/98 requires that a design report be prepared for the site. The design report is to contain plans and specifications on the design of any liner or leachate collection system to be used for groundwater protection. A detailed description of the type of information to be provided on the liner and leachate collection system design is included in the approval guidelines given in Subsection 4.6.2 below. The information to be provided as required by Regulation 232/98 covers issues such as the site foundation, bottom liners (i.e. compacted clay, geomembrane, or geosynthetic clay liners), leachate collection systems, and construction quality control and assurance procedures.
4.6.1 Regulatory Requirements
The regulatory requirement to prepare plans and specifications for the groundwater protection system is included in the Design Specifications requirements in Section 6 of Regulation 232/98 as described in Section 4.1 of this Guideline.

4.6.2 Approval Guidelines
Information on the groundwater protection system as required by Section 10 of Regulation 232/98 must be included in the design report required for a landfilling site (refer to Section 4.1 of this Guideline). The following guidelines provide a detailed description of the information which is typically discussed in the reports.
Irrespective of whether the groundwater protection system is designed in accordance with the site specific design approach or using one of the two generic designs (refer to Section 4.5 of this Guideline), where a liner or leachate collection system is to be constructed at a site, Regulation 232/98 requires the report on the design specifications for the site to include a discussion on the following plans, specifications and descriptions:

a. Foundation and Clayey Liner Design

For the site foundation, and any clayey liner which is to be constructed at the site, the report typically discusses the information detailed in Table 6a:

Table 6a: Foundation and Clayey Liner Design

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>i.</td>
<td>A description of the foundation design and materials of construction, including a discussion of the capability of the foundation to support any expected static and dynamic loadings.</td>
</tr>
<tr>
<td>ii.</td>
<td>Data showing fluctuations in the depth of the water table and the seasonal high and low watertable in relation to the foundation or liner system.</td>
</tr>
<tr>
<td>iii.</td>
<td>Sufficient data to evaluate the engineering properties of the foundation and, if proposed, the clayey liner materials. This should include data relating to the Atterberg limits, organic carbon content, grain size distribution, mineralogy, strength, hydraulic conductivity, compressibility and, when appropriate, compaction curves. The report should also clearly indicate other parameters used by the designer (e.g., diffusion coefficients, partitioning coefficients [Koc], effective porosity, any other parameter used in the design or analysis) and provide data and/or references supporting the choice of these parameters.</td>
</tr>
<tr>
<td>iv.</td>
<td>To address the issue of clay/leachate compatibility, data showing that there will be no significant increase in hydraulic conductivity or reference given to tests that have been conducted on soil that is mineralogically similar using a leachate similar to that anticipated for the site.</td>
</tr>
<tr>
<td>v.</td>
<td>Engineering analyses, based on the data gathered through subsurface exploration and laboratory testing programs, that provide:</td>
</tr>
</tbody>
</table>
estimates of the total and differential settlement, including immediate settlement and primary and secondary consolidation, with particular attention paid to any maintenance holes;

- estimates of the bearing capacity and stability of the foundation which demonstrate that the allowable bearing capacity will not be exceeded, with particular attention paid to any maintenance holes;

- estimates of the potential for bottom heave or blow-out due to hydrostatic or gas pressures;

- evidence that the foundation is capable of providing adequate support for operating and construction equipment;

- evidence that the side slopes of the landfill will be stable at all times during and following construction (this includes the side slopes to the base of the landfill as well as the cover) allowing for all possible failure mechanisms (including the potential for sliding within or between any layers in any liner, leachate collection system and gas collection system).

vi. A description of construction and installation procedures. If a compacted clayey liner is proposed, include details regarding the control of compaction water content, lift thickness, equipment to be used, scarification between lifts, limits on clod size, removal of stones, and procedures to avoid desiccation of the clayey liner. Liner test sections should be constructed to develop and confirm construction procedures.

vii. A description of the inspection, monitoring, sampling and testing methods and frequencies to be employed to assure that the foundation and, where present, liner(s) meet the design requirements.

viii A description of any soil additives that are proposed, the concentrations to be added and the methods that will be used to mix and spread the material.

b. Geomembrane Liner

If a geomembrane liner is proposed, the information in Table 6b is also typically discussed in the report:

Table 6b: Geomembrane Liner

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>i.</td>
<td>A description of the proposed geomembrane (type, thickness, texture, etc.).</td>
</tr>
<tr>
<td>ii.</td>
<td>The design requirements and technical specifications for the geomembrane (e.g. thickness, density, melt index, carbon black dispersion, tensile properties, tear</td>
</tr>
<tr>
<td></td>
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<tr>
<td>---</td>
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</tr>
<tr>
<td>iii.</td>
<td>Requirements for delivery, storage, installation and sampling of the geomembrane.</td>
</tr>
<tr>
<td>iv.</td>
<td>Calculations of the physical stress, including those due to:</td>
</tr>
<tr>
<td></td>
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<td></td>
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<tr>
<td>v.</td>
<td>A statement on the chemical compatibility of the liner, (other than a high density polyethylene (HDPE) liner) and the leachate, and cite the basis for the statement.</td>
</tr>
<tr>
<td>vi.</td>
<td>A description of how the short-term stresses such as equipment traffic during installation and thermal effects during construction and operation will be taken into account. The liner must be able to withstand the stresses resulting from application of the protection layer placed between the liner and the leachate collection system.</td>
</tr>
<tr>
<td>vii.</td>
<td>A demonstration that there will be adequate friction between the components of the liner system so that slippage and sloughing does not occur on the slopes of the facility. Specifically, using design equations, evaluate:</td>
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<td></td>
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<tr>
<td>viii.</td>
<td>Installation specifications, including details regarding:</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Constraints;</td>
<td>Procedures to be adopted to prevent desiccation of the underlying compacted clayey liner during and subsequent to the placement of the geomembrane.</td>
</tr>
<tr>
<td>------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| ix. Inspection activities, including both non-destructive and destructive quality control field testing of sheets and seams during installation of the geomembrane. | Describe how the following will be taken into account:  
  - ambient temperature at which seams are made;  
  - relative humidity;  
  - control of panel uplift by wind;  
  - wrinkles;  
  - effects of cloud cover and direct sunlight on geomembrane temperature;  
  - water content of the subsurface beneath the geomembrane;  
  - supporting surface on which the seam is bonded;  
  - skill of the seaming crew;  
  - quality and consistency of the chemical or welding material;  
  - proper preparation of the liner surfaces to be joined; and  
  - the cleanliness of the seam interface (e.g., amount of airborne dust). |
| x. A specification for liner strength and the calculations defining the minimum strength requirement considering: |  
  - internal and external pressure gradients;  
  - stresses resulting from settlement, compression or uplift;  
  - climatic conditions;  
  - installation stresses; and  
  - operating stresses. |
| xi. A specification for the geomembrane protection layer that will be placed between the geomembrane and the leachate collection system, including the method of placement. |
If a geosynthetic clay liner (GCL) is proposed for a site specific design, the information in Table 6c is typically discussed in the report:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>i.</td>
<td>A description of the proposed GCL including sufficient data to evaluate the engineering properties of the GCL. This should include data relating to Atterberg limits, organic carbon content, mineralogy, shear strength, hydraulic conductivity and hydrated thickness under field stress conditions (based on tests with a permeant with a chemical composition similar to the expected landfill leachate). The hydraulic conductivity tests supporting the design hydraulic conductivity must have been conducted on samples hydrated to simulate expected field hydration and permeated with a sufficient number of pore volumes of permeant such that either (a) the concentration of the parameter in the effluent chemistry exceeded 90% of that in the influent, or (b) it exceeds the number of pore volumes that could reasonably pass through the GCL during the contaminating life span of the landfill (whichever is less). The report should also clearly indicate other parameters used by the designer (e.g., diffusion coefficients, partitioning coefficients [Koc], effective porosity, any other parameter used in the design or analysis) and provide relevant data and/or references (i.e., for similar conditions) supporting the choice of these parameters.</td>
</tr>
</tbody>
</table>
| ii.      | A description of construction and installation procedures. Identify how the GCL will be hydrated in the field and provide installation specifications including details regarding:  

- visual inspection of the suitability of the subgrade;  
- methods of protecting the GCL during shipping, storage and handling; and  
- deployment of the GCL at the construction site (include a panel layout plan), seam preparation, seaming methods. Indicate how opening of seams (due to movement as overlaying layers are placed) will be avoided. |
| iii.     | A description of the inspection, sampling and testing methods and frequencies to be employed to assure that the GCL meets the design requirements. |
| iv.      | Demonstrate that there will be adequate shear strength both within the GCL and between the GCL and other components of the liner system so that slippage and sloughing does not occur on the slopes of the facility. |

d. Leachate Collection System

If a primary or secondary leachate collection system is proposed, the information in Table 6d is typically discussed in the report:
Table 6d: Leachate Collection System

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>i.</td>
<td>A description of the proposed leachate collection system, including estimated leachate flows, drainage layer design, any pipe network and the leachate removal system.</td>
</tr>
</tbody>
</table>
| ii.      | Design specifications, calculations and descriptions of design and operational measures that demonstrate that the leachate collection system either meets the requirements of Schedules 1 and 2 or will provide the service life and leachate head control assumed in the assessment of groundwater impact for a site specific design by addressing:  
  - the gradation (nominal diameter, uniformity coefficient, silt content), drainage path length, thickness normal to leachate drainage, surface grades of the landfill base, leachate compatibility, biological/chemical clogging potential and hydraulic conductivity of the granular drainage materials;  
  - the long-term transmissivity under final loads, biological/chemical clogging potential and leachate compatibility of any geosynthetic drainage layers;  
  - the geotextile or graded granular filter/seperator between the waste and the drainage medium; and  
  - the material, internal diameter, wall thickness, perforation size and location and spacing, flow capacity, structural capacity (wall crushing, pipe deflection, critical buckling pressure), access for cleaning, and the inspection and cleaning schedule of any collection pipes; y addressing. |
| iii.     | A demonstration that the side slopes of the leachate collection system will be stable. Specifically, using design equations, evaluate:  
  - the stability of the granular drainage materials on the underlying soil or geomembrane;  
  - the stability between the components of any geosynthetic drainage layer (geotextiles, geonets) and between the geosynthetic drainage layer and the underlying soil or geomembrane;  
  - the ability of any geosynthetic drainage layer to support its own weight on the side slopes;  
  - the ability of any geosynthetic drainage layer to withstand down-drag during and after waste placement;  
  - the suitability of the anchorage configuration for the geosynthetic drainage layer; and  
  - the stability of any filter/seperator layer above the geosynthetic drainage layer. |
| iv.      | Installation specifications, including details regarding:  
  - equipment used in granular drainage layer placement;  
  - methods to control granular drainage layer thickness;  
  - bedding depth for any collection pipes;  
  - method of joining collection pipes;  
  - method of placement and seaming, if any, of geosynthetic drainage layers; and  
  - method of placement of any filter/seperator layer above the drainage layer. |
e. Construction Quality Control and Assurance

The report typically includes a discussion on the quality assurance plan that addresses both construction material quality control (CQC) and construction quality assurance (CQA), as they pertain to (as applicable) the information discussed in table 6e below.

Table 6e: Construction Quality Control and Assurance

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Information</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>i.</td>
<td>the foundation</td>
<td></td>
</tr>
<tr>
<td>ii.</td>
<td>compacted clayey liners</td>
<td></td>
</tr>
<tr>
<td>iii.</td>
<td>geosynthetic clay liners</td>
<td></td>
</tr>
<tr>
<td>iv.</td>
<td>avoiding desiccation of the compacted clayey liner prior to placement of waste over each part of the liner system</td>
<td></td>
</tr>
<tr>
<td>v.</td>
<td>geomembrane liners</td>
<td></td>
</tr>
<tr>
<td>vi.</td>
<td>protection layers for geomembrane liners</td>
<td></td>
</tr>
<tr>
<td>vii.</td>
<td>leachate collection systems</td>
<td></td>
</tr>
<tr>
<td>viii.</td>
<td>filter/separator layers for leachate collection systems</td>
<td></td>
</tr>
</tbody>
</table>

This plan may include a discussion on the specification of the test methods to be adopted, the frequency of sampling, the use of blind samples, the acceptable range of data and the procedures to be adopted in the event that the data does not satisfy the specifications. A discussion on the rationale behind the plan is typically included in the report.

The CQC/CQA plan typically describes in detail the responsibilities of the construction quality control officer as they pertain to the information identified in Table 6f:

Table 6f: Quality Control Officer Responsibilities

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Information</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>i.</td>
<td>Communicating with the contractor.</td>
<td></td>
</tr>
<tr>
<td>ii.</td>
<td>Interpreting and clarifying project drawings and specifications with the designer, owner and contractor.</td>
<td></td>
</tr>
<tr>
<td>iii.</td>
<td>Recommending acceptance or rejection by the owner/operator of work completed by the construction contractor.</td>
<td></td>
</tr>
<tr>
<td>iv.</td>
<td>Submitting blind samples (e.g., duplicates) for analysis by the quality control laboratory and one or more independent laboratories.</td>
<td></td>
</tr>
<tr>
<td>v.</td>
<td>Notifying the owner/operator of construction quality problems not resolved on-site in a timely manner.</td>
<td></td>
</tr>
<tr>
<td>vi.</td>
<td>Observing the testing equipment, personnel and procedures used by the</td>
<td></td>
</tr>
</tbody>
</table>
construction contractor to check for detrimentally significant changes over time.

| vii   | Monitoring compliance with the procedures necessary to avoid desiccation of the compacted clayey liner prior to placement of waste over each part of the liner system. |
| viii. | Reviewing the quality control records, maintenance summary, and interpretation of test data for accuracy and appropriateness. |
| ix.   | Reporting to the owner/operator on monitoring results. |

### 4.7 Leachate Disposal
Where a site has been designed to collect leachate, the collected leachate must be managed and disposed of in an appropriate manner as required in Regulation 232/98. Typically, leachate disposal would involve discharge to an existing sewage works, either by discharge to a sewer or by hauling it to the sewage treatment plant, or would involve on-site treatment and discharge of the treated effluent to a surface water body. Pre-treatment of leachate may be necessary for discharge to an existing sewage works. As described in Subsection 4.7.1, Regulation 232/98 includes a basic requirement that a report be prepared on the management and disposal of any collected leachate. A more detailed description of the issues to be addressed and the type of information typically provided is included in the approval guidelines given in Subsection 4.7.2.

#### 4.7.1 Regulatory Requirements
Regulation 232/98 requires that a report be prepared describing the procedures for disposal of any leachate collected at a landfilling site. This requirement is given in Section 11 of the Regulation and is as follows:

**Leachate Disposal**

11. A person shall not establish a new landfilling site or increase the total waste disposal volume of an existing landfilling site unless a written report containing plans, specifications and descriptions for the management and disposal of any leachate collected at the site has been prepared.

#### 4.7.2 Approval Guidelines
Where a site has been designed to collect leachate, the leachate management and disposal plans for the site typically include discussions on the information listed in Table 7:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>The handling, treatment and discharge of leachate directly to a waterbody such that the plans, specifications and descriptions provide a level of detail sufficient to demonstrate the feasibility of obtaining approval under the <em>Ontario Water Resources Act</em>; or</td>
</tr>
</tbody>
</table>
b. the handling, treatment and discharge of leachate into an existing sanitary sewer, sewage works or system approved under the *Ontario Water Resources Act*, including:

(i) the location and owner of the sanitary sewer, if any, and the sewage works;
(ii) the transportation or piping of leachate to the sanitary sewer or sewage works;
(iii) the acceptance criteria for discharge to the sanitary sewer, if any, and the sewage works;
(iv) an assessment of the impact on the sanitary sewer, if any, the sewage works, the effluent discharge and sewage residue from the sewage works, and the receiving waterbody based on the expected quality and quantity of leachate to be discharged;
(v) any treatment required prior to acceptance of the leachate; and
(vi) the written agreement of the owner of the sanitary sewer, if any, and the sewage works for acceptance of the leachate.

### 4.8 Leachate Contingency Plans

A contingency plan is an organized set of procedures for identifying and reacting to an unexpected, but possible, occurrence. The development of a leachate contingency plan is particularly important in landfill design because of the potential for long term leachate impacts on groundwater and surface water. A leachate contingency plan includes the establishment of a predictive monitoring program, the setting of trigger levels for investigation and response activities, and the description of the contingency measures to be carried out. In developing the contingency plan, a sufficient level of detail as described in Regulation 232/98 must be provided to demonstrate its feasibility and practicality, particularly the ability to adequately monitor and predict potential impacts, and to implement effective remedial actions. For a leachate contingency plan, a good understanding of the hydrogeologic setting of the site is therefore a necessity.

As part of the contingency plan, trigger criteria for investigative activities as required by Section 12 of Regulation 232/98 should be established to identify contaminant increases above background, above any predicted impacts (considering temporal and spatial variations), and above the maximum allowable concentrations at property boundary (i.e. the Reasonable Use limits). Where there is a contaminant increase above a predicted concentration (or the maximum allowable concentration), the contingency plan should be reviewed and the necessary implementation procedures should be described as detailed in Regulation 232/98. Should continued monitoring and investigation indicate the Reasonable Use limits will be exceeded at the property boundary, the contingency measures would have to be implemented.

In the case of a landfilling site designed to protect groundwater in accordance with a generic design, the standard allows the landfill owner to delay establishing a full predictive monitoring program (i.e. contaminant attenuation modelling, setting predictive triggers, etc.) until such time as the monitoring devices located near the waste fill area indicate the site has had an impact on background groundwater concentrations. Once background concentrations have been impacted, contaminant modelling and a full predictive monitoring program would have to be established.

The regulatory requirement to develop a leachate contingency plan is included in Subsection 4.8.1 of this Guideline. The approval guidelines given in Subsection 4.8.2 identify the types of contingency measures and issues which should be considered when developing the plan.
4.8.1 Regulatory Requirements
Regulation 232/98 requires that a leachate contingency plan be developed for a landfilling site and identifies the issues to be addressed. These requirements are given in Sections 12 and 27 of the Regulation and are as follows:

**Leachate Contingency Plans**

12. (1) A person shall not establish a new landfilling site or increase the total waste disposal volume of an existing landfilling site unless a written report containing plans, specifications and descriptions for a leachate contingency plan for the site has been prepared in accordance with this section.

(2) The report must contain the following:

1. A description of the contingency measures, including the collection of leachate that would be carried out, if necessary, if a liner or leachate collection system fails or if leachate otherwise leaves the waste fill zone in a quantity greater than expected or with a quality worse than expected.

2. A statement of the maximum allowable concentrations for contaminants in the ground water at any point on any adjacent property and in any surface water feature on the site.

3. A description of the ground water monitoring stations to be used to identify potential increases in contaminant concentrations in the ground water beneath the site and predict potential increases at the property boundary and in any surface water feature on the site before any increases occur.

4. A discussion of the basis on which the monitoring stations referred to in paragraph 3 will be brought into service, indicating that stations near the waste fill area will be brought into service not later than the date that placement of the waste begins.

5. A description of the trigger criteria for initiating investigative activities into the cause of an increase in contaminant concentrations in ground water and in any surface water feature on the site, indicating that the criteria relate to the magnitude of the increase in contaminant concentrations or the magnitude of the rate of increase in contaminant concentrations.

**Leachate Contingencies**

27. (1) The owner and the operator of the landfilling site shall ensure that investigative activities are carried out with respect to the cause of an increase in contaminant concentrations if any of the trigger criteria described under paragraph 5 of subsection 12 (2), as they may have been modified under paragraph 2 of subsection (3) of this section, is exceeded for any single monitoring event.

(2) The owner and the operator of the landfilling site shall ensure that the steps described in subsection (3) are taken if the investigative activities required by subsection (1) indicate that,

(a) the potential exists for a liner or leachate collection system to fail or for leachate to otherwise leave the waste fill zone in a quantity greater than expected or with a quality worse than expected;
(b) the potential exists to exceed any maximum allowable contaminant concentration described under paragraph 2 of subsection 12 (2);
(c) an expected contaminant level predicted by studies and modelling previously carried out under paragraph 4 of subsection (3) has been exceeded; or
(d) the highest previous observation of the background concentration of a contaminant in the ground water of the receptor aquifer has been exceeded, if studies and modelling have not previously been carried out under paragraph 4 of subsection (3).

(3) The steps referred to in subsection (2) are the following:

1. Previously identified contingency measures must be reviewed and any necessary or desirable modifications made.
2. Previously identified trigger criteria must be reviewed and any necessary or desirable modifications made.
3. The monitoring programs for ground water, surface water and leachate must be reviewed and any necessary or desirable modifications made.
4. If they have not previously been carried out, studies and modelling that meet the following conditions must be carried out:
   i. The studies and modelling must provide predictions of expected contaminant concentrations at least annually for the contaminating life span of the site.
   ii. The studies and modelling must include predictions related to potential increases in contaminant concentrations in the ground water at the property boundary and in any surface water feature on the site, as well as at any ground water monitoring stations.
5. If studies and modelling described in paragraph 4 have previously been carried out, they must be reviewed and any necessary or desirable modifications made.
6. Implementation criteria for implementation of the contingency measures must be identified and the related activities and timing must be described.

(4) If the monitoring results, investigative activities and implementation criteria indicate the need to implement contingency measures, the owner and the operator of a landfilling site shall ensure that the following steps are taken:

1. The Director must be notified of the need to implement contingency measures.
2. Detailed plans, specifications and descriptions for the design, operation and maintenance of the contingency measures must be prepared.
3. The contingency measures must be implemented.
4.8.2 Approval Guidelines
Regulation 232/98 requires that a leachate contingency plan be prepared for a landfilling site. The plans and specifications for the leachate contingency plan typically include discussions on the assessment of the following contingency measures listed in Table 8:

Table 8: Leachate Contingencies

<table>
<thead>
<tr>
<th>Items No.</th>
<th>Contingency Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>The construction of purge wells or other system into the waste or within the buffer area to collect leachate or contaminated groundwater, such that the impact on adjacent properties will be in accordance with the Ministry's Reasonable Use Guideline (1994), or to control leachate mounding within the site. The handling, treatment and disposal of the collected leachate or groundwater should be described. Where purge wells are the method of leachate removal, the contingency plan should provide calculations of the number of wells likely to be required, the expected well spacing, the level of leachate mound control that can be realistically expected, and the potential impact on groundwater levels and uses. For leachate removal from within the waste, and in the absence of data, the hydraulic conductivity of the waste should be based on $k = 1 \times 10^{-6}$ m/s for waste depths of 10 m or less, $k = 1 \times 10^{-7}$ m/s for waste depths of 10 - 30 m, and $k = 1 \times 10^{-8}$ m/s for waste depths of 30 - 50 m. The landfill proponent should develop and support values for waste depths exceeding 50 m.</td>
</tr>
<tr>
<td>b.</td>
<td>The provision of an alternative water supply to adjacent and any other properties in the vicinity of the site that may be affected by the release of leachate into the groundwater in an amount in excess of the amount defined for the site in accordance with the Ministry's Reasonable Use Guideline (1994) or by the contingency plan (e.g. reduction in groundwater levels).</td>
</tr>
<tr>
<td>c.</td>
<td>Any other works or activities to protect human health and the environment that may be appropriate based on the design and hydrogeologic setting of the site.</td>
</tr>
</tbody>
</table>

4.9 Surface Water Control
Surface water control at a landfilling site is necessary to ensure drainage onto or leaving the site does not adversely affect site operations, on-site surface water or surface water in the vicinity of the site. As required by Section 13 of Regulation, where there is a potential for on-site surface drainage to become contaminated, measures should be taken to collect, test, and if necessary, treat the collected drainage. Regulation 232/98 requires that a landfilling site be designed to protect surface water and specifies performance standards which are to be met. The regulatory requirements are included in Subsection 4.9.1 of this Guideline. A more detailed description of the issues to be addressed and level of protection to be provided is included as approval guidelines in Subsection 4.9.2. The approval guidelines deal with matters such as:

- a site drainage plan showing existing natural conditions, and conditions during and following site operation,
- the conveyance and separation of off-site surface water, clean on-site runoff, and potentially contaminated on-site runoff,
- the design of any sedimentation ponds, and
the design of any temporary or permanent erosion control measures.

4.9.1 Regulatory Requirements
Regulation 232/98 requires that landfilling sites be designed to control surface water impacts and sets out the performance criteria for this control. These requirements are given in Section 13 of the Regulation and are as follows:

Surface Water Control
13. (1) A person shall not establish a new landfilling site or increase the total waste disposal volume of an existing landfilling site unless a written report containing plans, specifications and descriptions for the control, treatment and discharge of surface water at the site during construction, site operation and following closure has been prepared in accordance with this section.

(2) The plans, specifications and descriptions must ensure that:

(a) the concentration of any contaminant in surface water being discharged from the site to a waterbody is in accordance with Ministry of Environment and Energy Guideline B-1, Water Management, dated July 1994, and Ministry of Environment and Energy Procedure B-1-1, Water Management, dated July 1994, as they may be amended from time to time; and

(b) the background levels for dissolved oxygen, turbidity, and temperature, and the hydrologic cycle of any on-site, adjacent or receiving surface water features, are not adversely affected by the site.

4.9.2 Approval Guidelines
The objectives of the surface water control system for a landfilling site are to: divert or control surface water coming onto the site; control runoff discharging from the site; and control erosion, sedimentation and flooding. The following guidelines provide a more detailed description of the issue and the level of protection which are typically discussed in a surface water control report.

The design for surface water control and management at a landfilling site typically include the information listed in Table 9:

Table 9: Surface Water Control

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>A site drainage plan showing the drainage of surface water at the site before the site is established, during operation of the site, and following site closure.</td>
</tr>
<tr>
<td>b.</td>
<td>Plans, specifications and descriptions of the design features, control facilities and operational procedures to isolate, contain, convey, control and/or treat the surface water on and off site prior to its discharge to the receiving watercourse(s). The plans, specifications and descriptions should consider the following surface water flows:</td>
</tr>
<tr>
<td></td>
<td>(i) Clean Surface Water: off-site surface water flows that have been separated from landfilling site operations by means of diversions, berms,</td>
</tr>
</tbody>
</table>
**c.** The design and location of any surface water control facilities, such as berms, swales, ditches, control ponds or other facilities for the control of the quality and quantity of surface water from the site. The design should be in accordance with the following:

i. the design of surface water control facilities should be based on accepted methodologies, calculations and analytical tools including, where appropriate, hydrologic modelling (single event and/or continuous simulation), hydraulic modelling and water quality modelling using accepted computer models;

ii. the design of external diversion channels, ditches and conveyance structures should be sized to accommodate the peak flow generated from the higher of the 100-year design storm or the prevailing Regional Storm Event (e.g., Hurricane Hazel, Timmins or other historically observed maximum event);

iii. the design of all internal drainage ditches, storm sewers and conveyance structures should be sized to accommodate the peak flow generated from a 25-year design storm. In addition, a continuous overland flow route and/or ditch drainage system should be provided and sized to convey the peak flow generated from the higher of the 100-year design storm or the prevailing Regional Storm Event.

d. The design and location of any sedimentation ponds to remove sediment from any surface water control facilities constructed at the site. The design should be in accordance with the following:

(i) the design of any storm water management facilities for the purpose of surface water quality enhancement (i.e., settling of suspended sediment) of non-contaminated storm water should be designed to temporarily treat/store the runoff volume generated from a 4-hour, 25 mm storm event;

(ii) the design of any storm water management facilities for the purpose of surface water quantity control (i.e., peak flow reduction) of non-contaminated storm water should be designed to temporarily store the runoff volume generated from controlling all storm events up to the higher of the 24-hour, 100-year design storm or the prevailing Regional Storm event, at or below the existing condition (i.e., pre-landfill) peak
flows, such that there is no appreciable change in the potential for flooding and/or erosion in the watercourses receiving surface water discharges from the landfilling site.

e. The design and location of any temporary or permanent erosion and sediment control facilities or measures for the site, including for any surface water control, treatment and discharge facilities and for any areas in which construction/operation activities are taking place.

f. The design and location of any overflow control facilities for the site to safely convey storm water flows in excess of the specified design storm; and

g. a description of the operation, inspection and maintenance requirements for any surface water control, treatment and discharge facilities, including erosion and sediment control facilities.

4.10 Subsurface Migration of Landfill Gas

The natural biodegradation of organic waste in a landfilling site produces a gas that is emitted to the atmosphere through the landfill cover or after migrating for some distance in the soil below ground surface. The major constituents of landfill gas are methane (CH4) and carbon dioxide (CO2). Small amounts of other compounds such as hydrogen sulphide, mercaptans and non-methane organic compounds may also be present.

The methane component of landfill gas is of particular concern as it poses an explosion hazard if it becomes trapped in enclosed spaces at concentrations ranging from 5 to 15 percent by volume. Regulation 232/98 addresses this concern by requiring an assessment of the potential for subsurface migration and by setting concentration limits for methane. The concentration limits specified in the Regulation are:

- less than 2.5 percent methane gas in the subsurface at the property boundary,
- less than 1.0 percent methane in an on-site building, or its foundation, and
- less than 0.05 percent methane (i.e. not present) in a building, or its foundation, which is located off-site.

The regulatory requirements are described in Subsection 4.10.1 of this Guideline. Further details on the assessment, and if necessary, the monitoring and control of landfill gas migration are included as approval guidelines in Subsection 4.10.2.

4.10.1 Regulatory Requirements

Regulation 232/98 requires that the potential for landfill gas migration be assessed, and sets limits for control. The requirements are given in Section 14 of the Regulation and are as follows:

**Subsurface Migration of Landfill Gas**

14. (1) A person shall not establish a new landfilling site or increase the total waste disposal volume of an existing landfilling site unless a written report has been prepared in accordance with this section that contains the following:

1. An assessment of the potential for the migration of landfill gas in the subsurface.
2. Plans, specifications and descriptions for the monitoring, control, collection, use or discharge of landfill gas at the site if, on the basis of the assessment, any of these actions are necessary.

(2) The design of the site and any plans, specifications and descriptions for the control of landfill gas must ensure that the subsurface migration of landfill gas meets the following conditions:

1. The concentration of methane gas below the surface of the land at the boundary of the site must be less than 2.5 per cent by volume.

2. The concentration of methane gas must be less than 1.0 per cent by volume in any on-site building or enclosed structure, and in the area immediately outside the foundation or basement floor of the building or structure, if the building or structure is accessible to any person or contains electrical equipment or a potential source of ignition.

3. Paragraph 2 does not apply to a leachate collection, storage or treatment facility or a landfill gas collection or treatment facility for which specific health and safety measures and procedures are in place relating to the risk of asphyxiation and the risk of explosion.

4. The concentration of methane gas from the site must be less than 0.05 per cent by volume in any off-site building or enclosed structure, and in the area immediately outside the foundation or basement floor of the building or structure, if the building or structure is accessible to any person or contains electrical equipment or a potential source of ignition.

4.10.2 Approval Guidelines

The following guideline provides further details on the assessment of the subsurface migration of landfill gas and, if necessary, any measures for monitoring and control. The assessment and design of the landfilling site for landfill gas control typically includes a discussion on the information in Table 10:

Table 10: Landfill Gas

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>An assessment of the potential for landfill gas migration below land surface, including:</td>
</tr>
<tr>
<td></td>
<td>(i) background concentrations of methane gas and any existing potential sources of methane gas generation other than the waste;</td>
</tr>
<tr>
<td></td>
<td>(ii) the potential for generation of methane gas by the waste;</td>
</tr>
<tr>
<td></td>
<td>(iii) the potential for migration of landfill gas below land surface to adjacent or other off-site properties, or into buildings or enclosed structures located on-site or off-site; and</td>
</tr>
<tr>
<td></td>
<td>(iv) the potential for migration of landfill gas into and within any buried utility or service lines.</td>
</tr>
</tbody>
</table>
b. Monitoring of landfill gas migration is not normally required where the assessment shows that there is no significant potential for methane gas to migrate below land surface to adjacent or other off-site properties, or into buildings or enclosed structures located on-site or off-site, in concentrations in excess of those specified in Subsection (2) of the Regulation.

c. Where methane gas is expected to be generated at the site, the report should include the following for any buildings or enclosed structures which may be impacted by the methane gas:

(i) the provision of methane gas monitoring devices, with detection alarms, for any occupied building located on site and confined space entry protocols for other buildings or enclosed structures that are accessible by any person; and

(ii) a general description of the safety precautions to be taken for methane gas for any building or enclosed structure located on site which contains electrical equipment or any potential source of ignition.

d. Where monitoring of landfill gas migration is to be carried out, the report should include, at a minimum, the design of the monitoring devices, the monitoring locations, frequency and period of monitoring, and the parameters to be analyzed, including the concentration of methane gas and the gas pressure within the monitoring devices.

e. A contingency plan to control landfill gas migration below land surface to be implemented in the event methane gas migrates from the waste fill area at concentrations in excess of those specified in Subsection (2) of the Regulation including:

(i) a conceptual design of the control facilities;

(ii) an impact response plan describing the activities and timing of activities to be carried out in the event of an increase in methane gas concentrations within the buffer area, off site, or within buildings or enclosed structures which may be in excess of those specified in Subsection (2) of the Regulation; and

(iii) where the monitoring program indicates the contingency plan needs to be implemented, the owner must notify the Director of the need to implement the contingency plan, prepare detailed plans, specifications and descriptions for the design, operation and maintenance of the contingency plan, and implement the contingency plan.

### 4.11 Atmospheric Emissions of Landfill Gas

Landfill gas is produced by the natural biodegradation of organic waste in a landfill. In addition to the major constituents, methane (CH4) and carbon dioxide (CO2), small
amounts of other compounds such as hydrogen sulphide, mercaptans and non-methane organic compounds may also be present. These trace components may create nuisance odours and affect local air quality. Methane gas, and to a lesser extent carbon dioxide, are "greenhouse" gases which contribute to global warming. The methane component of landfill gas is also a potential source of energy.

Regulation 232/98 requires the mandatory collection of landfill gas for new or expanding sites with a total waste disposal capacity greater than 1.5 million cubic metres. This volume equates to approximately 2.5 million tonnes of waste. Although the precise quantities and nature of air emissions from each landfill varies somewhat, air emissions control for larger sites is considered good environmental practice.

For sites smaller than the mandatory trigger, air emissions control may be required in some cases. For example, factors such as waste type, site location near a populated area, and operational practices (such as enhanced infiltration to promote waste stabilization) may indicate that air emissions control is appropriate even though the site is smaller than 1.5 million cubic meters. On the other hand, there may be situations where air emissions control is not needed for a site larger than the 1.5 million cubic meters trigger and the Regulation allows a landfill owner to show if this is the case. For example, a landfill which receives primarily construction and demolition debris may not need air emissions control. In the case of woodwaste sites associated with the forest products industry, the mandatory requirement does not apply at all as these sites do not pose a significant concern with respect to the emission of trace compounds and are typically located in more remote areas.

The regulatory requirement for air emissions control is described in Subsection 4.11.1 of this Guideline. Further information on the types of issues to be addressed in the design of air emissions control works is included in the approval guidelines given in Subsection 4.11.2.

4.11.1 Regulatory Requirements

Regulation 232/98 requires mandatory air emissions control for landfilling sites larger than 3.0 million cubic metres. This requirement does not apply to landfills associated with forest products operations or to sites which do not have significant air emissions. The requirements for air emissions control are given in Section 15 of the Regulation and are as follows:

**Atmospheric Emissions of Landfill Gas**

15. **(1)** A person shall not establish a new landfilling site or increase the total waste disposal volume of an existing landfilling site unless a written report has been prepared respecting the design of facilities for the collection, and for the burning or use, of landfill gas generated by the site during site operation and following site closure.

**(2)** Subsection (1) applies only if a new landfilling site is being established with a total waste disposal volume of more than 1.5 million cubic metres or the total waste disposal volume of an existing landfilling site is being increased to more than 3.0 million cubic metres.

**(3)** Subsection (1) does not apply to a landfilling site if a written report is prepared showing that the nature and quantity of landfill gas generated at the site is not likely to be of significant concern to the Director, based on the following factors:

1. The characteristics of the site.
2. The type of waste to be deposited.
3. The rate at which waste is deposited at the site.

(3.1) Subsection (1) does not apply to a landfillsite if the only waste to be landfilled at the site is coal ash.

(4) Subsection (1) does not apply to a landfillsite associated with forest products operations, such as the operations of a lumber mill, sawmill, pulp mill or similar facility, if the waste to be deposited at the site is produced by the forest products operations and is predominantly solid, non-hazardous process waste, such as woodwaste, effluent treatment solids, hog fired boiler ash, recycling process rejects, lime mud, grits or dregs.

4.11.2 Approval Guidelines

The following guidelines describe the types of issues which are typically discussed in the design of air emissions control works:

When designing the air emissions control system for a landfillsite, a number of factors related to the overall site design and operation are considered. These factors may affect the type and layout of the gas collection system (e.g. horizontal trenches or vertical collection wells), the rate and quantity of gas generated, and the timing of system installation and operation. These factors typically include those listed in Table 11:

**Table 11: Factors Affecting Atmospheric and Landfill Gas**

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>i.</td>
<td>The presence of low permeability soil or a bottom liner system preventing lateral migration of landfill gas.</td>
</tr>
<tr>
<td>ii.</td>
<td>Leachate levels within the landfill.</td>
</tr>
<tr>
<td>iii.</td>
<td>Site configuration (e.g. landfill slopes, vertical configuration relative to surrounding ground surface, and landfill surface area relative to volume of waste.</td>
</tr>
<tr>
<td>iv.</td>
<td>Final cover characteristics and limitations (e.g. for groundwater protection and site end use) affecting moisture within the site and potential air intrusion.</td>
</tr>
<tr>
<td>v.</td>
<td>Phasing of landfilled and closure operations for each area of the site.</td>
</tr>
<tr>
<td>vi.</td>
<td>The type and procedures for daily or intermediate cover affecting hydraulic and landfill gas movement within the landfill.</td>
</tr>
<tr>
<td>vii.</td>
<td>Any activities to control or alter the moisture content within the landfill, such as leachate recirculation.</td>
</tr>
</tbody>
</table>

Taking these factors into consideration, the plans, specifications and descriptions for the design of the landfill gas collection and control system typically include a discussion on the information listed in Table 12:
### Table 12: Landfill Gas Collection System

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Information</th>
</tr>
</thead>
</table>
| a. | Plans, specifications and descriptions of the design of the landfill gas collection system, including:  
   (i) spatial design of the collection system including collector orientation (i.e. vertical wells or horizontal trenches), layout and spacing, depth(s) of placement within the landfill and radius of capture zone;  
   (ii) design of the collection pipes including size, material, perforations, granular bedding/envelope, and provisions for stress relief and settlement;  
   (iii) design of header and transmission pipes including size, material, slope, valving, access chambers, condensate control, seepage protection, protection from freezing, bedding and provisions for stress relief and settlement; and  
   (iv) condensate drainage, storage and disposal. |
| b. | Plans, specifications and descriptions of the design of the facilities for landfill gas burning, treatment or utilization, including:  
   (i) a description of the landfill gas extraction equipment (i.e. blower) and the design of any moisture removal and gas treatment system;  
   (ii) the design, performance characteristics and operational controls for any flare system including:  
      ▪ the type and design of the flare device;  
      ▪ design combustion temperature and residence time;  
      ▪ the destruction efficiency of volatile organic compounds;  
      ▪ operational control systems such as temperature and combustion air control, flame failure detection, automatic ignition system and flame arrester;  
   (iii) a description of any utilization system for collected landfill gas. |
| c. | Plans, specifications and descriptions of the operation, monitoring and maintenance procedures for the landfill gas system, including:  
   (i) phasing/timing of system installation, start up and operation -- particularly with respect to integration with overall landfill operation and maximizing landfill gas control;  
   (ii) inspection frequencies and maintenance/replacement procedures for system equipment;  
   (iii) monitoring of landfill gas flow rates and concentrations; and  
   (iv) contingency provisions in the event of unexpected component failures. |
In addition to obtaining a waste management approval for the landfill gas collection system under Part V of the *Environmental Protection Act*, approval for the discharge from the control works is also required.

### 4.12 Design Criteria for Engineered Facilities

Requirements for the design of various engineered facilities for a landfilling site are included in Regulation 232/98. These standards are described separately in Chapter 4.0 of this Guideline. An important design consideration for these facilities or works is that they be able to function effectively for as long as necessary to control contaminants or impacts. For a landfilling site, this means the engineered facilities must be durable enough or be capable of being repaired or replaced for the contaminating life of the site with respect to the contaminants or impacts of concern.

The concept of service life is not just an environmental issue or one limited to landfill design. It is a general concept or principle of all good engineering design. It has been included in the landfill standards as an approval guideline to emphasize its importance and complement the other landfill design standards.

#### 4.12.1 Regulatory Requirements

Design criteria for specific engineered facilities are included as separate requirements in Regulation 232/98 and are described separately in Chapter 4.0 of this Guideline. Service life is an important consideration in engineering design and has been included in the landfill standards as an approval guideline. There are no separate regulatory requirements for this standard in the Regulation.

#### 4.12.2 Approval Guidelines

Good engineering design requires that engineered facilities at a landfilling site be able to function effectively for as long as they are needed to control contaminants or impacts. Common engineered facilities include: liners, covers, berms, leachate collection systems, leachate treatment facilities, monitoring wells and equipment, landfill gas control equipment, and surface water control works.

An engineered facility which is to be constructed at a landfilling site for purposes of controlling leachate, groundwater, surface water or landfill gas should be designed such that:

(a) the service life of the engineered facility exceeds the period of time during which contaminants may be generated by the site and need to be controlled by the engineered facility to prevent an unacceptable impact; or

(b) the engineered facility can be replaced, or an alternative engineered facility can be constructed, as necessary to enable the combined service lives of the engineered facilities to exceed the period of time during which contaminants may be generated by the site and need to be controlled by the engineered facility to prevent an unacceptable impact.

For groundwater, an unacceptable impact is considered to be an increase in contaminant concentrations in excess of the maximum allowable concentrations defined in accordance with the Ministry’s Reasonable Use Guideline (refer to Section 4.5 of this Guideline).

For surface water, an unacceptable impact is considered to be an impact on a surface water feature in excess of the standards described in Section 4.9 of this Guideline.
For landfill gas migration below surface, an unacceptable impact is considered to be the migration of landfill gas at concentrations in excess of the allowable methane concentrations defined in Section 4.10 of this Guideline.

4.13 Design Criteria for Noise

Noise sources associated with the operation of landfilling sites fall into three categories: construction equipment carrying out the landfilling operation, including on-site movement of waste trucks and vehicles; ancillary facilities such as waste receiving and recycling facilities; and off-site movement of waste trucks and vehicles. The landfill design report required by Regulation 232/98 (refer to Section 4.1 of this Guideline) must include an assessment of potential noise impacts and the need for control measures. Information on the design criteria to be used for the noise assessment is included in the approval guidelines given in Subsection 4.13.2.

4.13.1 Regulatory Requirements

The regulatory requirement to assess potential noise sources and the need for noise control measures is included in the standard on Design Specifications described in Section 4.1 of this Guideline. There is no separate regulatory requirement for this standard in Regulation 232/98.

4.13.2 Approval Guidelines

Information on noise considerations for landfilling sites is provided in the Ministry publication “Noise Guidelines for Landfill Sites”. The following is a summary of those guidelines:

Noise Guidelines for Landfill Sites

In landfill design, the potential noise effects from three components of the operation of the landfilling site should be considered: the landfilling operation itself (including construction equipment and on-site movement of waste trucks and other vehicles); ancillary facilities (such as waste reception and recycling); and off-site movement of waste trucks and other site vehicles.

a. Landfilling Operation - Sound Level Limits

The limits for sound levels due to the landfilling site operation at a Point of Reception are 45 dBA in any hour of the night, 7:00 p.m. - 7:00 a.m., and 55 dBA in any hour of the day, 7:00 a.m. - 7:00 p.m. These levels are expressed in terms of the One Hour Equivalent Sound Level (Leq).

Should the environment be dominated by noise sources from human activity, such as industry, commerce or road transportation, which produce sound in excess of the above limits, the higher sound levels may be used as the limit, provided noise abatement is not required for these other sources.

For impulsive sound, other than quasi-steady impulsive sound, from a pest control device employed to deter birds from the landfilling site, the applicable sound level limit at a Point of Reception expressed in terms of the Logarithmic Mean Impulse Sound Level (LLM) is 70 dBA.

For quasi-steady impulsive sound, but not including other impulsive sound from a pest control device employed to deter birds from the landfilling site, the applicable sound level limit at a Point of Reception expressed in terms of the One Hour Equivalent Sound Level (Leq) is 60 dBA.
b. Ancillary Facilities - Sound Level Limits

Facilities or equipment being used at the site, other than construction equipment or on-site vehicles, are considered to be stationary noise sources. The applicable sound level limits are those established for the assessment of stationary sources of sound given in the Ministry publications NPC-205 and NPC-232.

c. Off-Site Source Vehicles

For a landfilling site employing off-site source vehicles (i.e. vehicles hauling waste or cover material to the site) that constitute a predominant component of the background noise, an access route should be selected which will result in a minimum noise impact. The selection process should be based on a detailed quantitative assessment of noise impact on individual receptors and the number of affected receptors along the alternative routes.

4.14 Operation and Maintenance Procedures

Good operation and maintenance procedures at a landfilling site is a component of the overall design to ensure the environmental control and monitoring works continue to function as designed and for as long as they are needed. Good operational procedures are also important for minimizing potential nuisance impacts such as litter, noise, odour and dust.

Regulation 232/98 requires that the landfill owner prepare a report describing the operation and maintenance procedures to be followed at the site. The regulatory requirement is included in Subsection 4.14.1 of this Guideline and further details on the issues to be addressed are included as approval guidelines in Subsection 4.14.2. The guidelines identify operations matters typically discussed in the report:

- a waste control program to identify unacceptable wastes and ensure hazardous wastes are not accepted,
- site supervision and security,
- cover material type, source and stockpiling,
- operation and maintenance procedures for environmental control and monitoring facilities,
- procedures to control noise, odour and dust,
- any procedures, such as promoting infiltration, intended to shorten the contaminating life span of the site, and
- a complaint response plan to address any public concerns with site operations.

In addition to the requirement to prepare an operation and maintenance report, there are a number of other separate landfill standards dealing with specific aspects of landfill operations. These other standards deal with issues such as daily cover, groundwater and surface water monitoring, record keeping and reporting. These standards are described separately in Chapter 6.0 of this Guideline.

4.14.1 Regulatory Requirements

Regulation 232/98 requires that an operation and maintenance report be prepared for a landfilling site. This requirement is given in Section 16 of the Regulation and is as follows:
**Operation and Maintenance Procedures**

16. A person shall not establish a new landfilling site or increase the total waste disposal volume of an existing landfilling site unless a written report has been prepared containing plans, specifications and descriptions of the operation, maintenance, monitoring, closure and post-closure care of the site including matters related to record-keeping, reporting and financial assurance.

**4.14.2 Approval Guidelines**

Table 4.14.2 provides guidelines on additional information, details on the issues that are typically discussed in the operation and maintenance for a landfilling site:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Acceptable and unacceptable waste types, estimated annual quantities, maximum daily rate of fill, operating days per week and hours of operation.</td>
</tr>
<tr>
<td>b.</td>
<td>Signage posted at site entrance indicating hours and days of operation, acceptable and unacceptable wastes, operating authority, Ministry approval number, telephone number for emergencies and additional information.</td>
</tr>
<tr>
<td>c.</td>
<td>Site supervision and security.</td>
</tr>
<tr>
<td>d.</td>
<td>Procedures for acceptance of incoming waste, including identification of waste requiring special handling or unacceptable waste.</td>
</tr>
<tr>
<td>e.</td>
<td>Cover material to be used, sources of cover material, the procedures for acceptance of imported cover material, the procedures for the stockpiling of cover material prior to use, the location and maximum size of any stockpiles, and the minimum number of days supply of cover material to be maintained.</td>
</tr>
<tr>
<td>f.</td>
<td>Waste disposal equipment and procedures for waste handling, deposit, compaction and covering.</td>
</tr>
<tr>
<td>g.</td>
<td>Coordination and phasing of site development and operation.</td>
</tr>
<tr>
<td>h.</td>
<td>Procedures during site development for the protection of site vegetation that is to be preserved.</td>
</tr>
<tr>
<td>i.</td>
<td>Operation, inspection and maintenance of any control, treatment and disposal facilities for leachate, groundwater, surface water and landfill gas.</td>
</tr>
<tr>
<td></td>
<td>Description</td>
</tr>
<tr>
<td>---</td>
<td>-------------</td>
</tr>
<tr>
<td>j.</td>
<td>Operation, inspection and maintenance of any monitoring facilities for leachate, groundwater, surface water and landfill gas.</td>
</tr>
<tr>
<td>k.</td>
<td>Management, treatment and disposal procedures for any collected leachate, groundwater, surface water and landfill gas.</td>
</tr>
<tr>
<td>l.</td>
<td>Procedures to protect any liner system from damage during waste disposal operations.</td>
</tr>
<tr>
<td>m.</td>
<td>Procedures to protect any control facilities for leachate, groundwater, surface water and landfill gas from damage during waste disposal operations.</td>
</tr>
<tr>
<td>n.</td>
<td>Procedures to protect any monitoring facilities for leachate, groundwater, surface water and landfill gas from damage during waste disposal operations.</td>
</tr>
<tr>
<td>o.</td>
<td>Any procedures intended to alter or control the contaminating life span of the site.</td>
</tr>
<tr>
<td>p.</td>
<td>Procedures intended to maintain or extend the service life of any engineered facility.</td>
</tr>
<tr>
<td>q.</td>
<td>Procedures to minimize, including potential remedial measures for, noise, odour, dust, leachate seeps, vehicle mud tracking off-site, litter, birds, vectors and vermin.</td>
</tr>
<tr>
<td>r.</td>
<td>A response plan for fire and other emergencies.</td>
</tr>
<tr>
<td>s.</td>
<td>A complaint response plan describing actions to be taken in response to complaints from the public or others concerning site activities, including the actions to be taken to identify the activity causing the complaint and minimize future occurrences.</td>
</tr>
<tr>
<td>t.</td>
<td>Record keeping and reporting.</td>
</tr>
<tr>
<td>u.</td>
<td>A public communications plan.</td>
</tr>
<tr>
<td>v.</td>
<td>Trigger criteria and procedures to implement, operate and maintain the contingency plans for leachate and landfill gas in the event the primary design of the site is inadequate.</td>
</tr>
<tr>
<td>w.</td>
<td>Site closure procedures.</td>
</tr>
<tr>
<td>x.</td>
<td>Post-closure maintenance, monitoring and reporting; and</td>
</tr>
<tr>
<td>y.</td>
<td>Financial assurance provisions for a privately owned site.</td>
</tr>
</tbody>
</table>
5.0 FINANCIAL ASSURANCE

5.1 Financial Assurance - Contingency Plans

Financial assurance is required for the closure and post-closure costs for private sector landfilling sites (refer to Section 5.2 of this Guideline). An additional amount of financial assurance is required for these sites to ensure funds are available for contingencies such as the leachate and landfill gas contingency plans.

Contingency plans involve unexpected events, both with respect to if and when something may occur, as well as the nature and extent of the event. To simplify the financial assurance requirements for contingency plans, Regulation 232/98 specifies that the contingency amount be based on fifty (50) cents per tonne of waste deposited in the site. Also, since the 50 cents per tonne amount is based on 1997 dollars, the amount provided must be adjusted to account for inflation.

At the time of site closure, the total amount of financial assurance required for a site would be:

\[
\text{Financial Assurance} = \left[ \$0.50 \text{ per tonne} \right] \times \left[ \text{total tonnage capacity} \right]
\times \left[ \text{inflation adjustment from 1997 to date of site closure} \right]
\]

This amount would have to be adjusted annually thereafter to take into account inflation during the post-closure period.

The amount of contingency plan financial assurance required to be in place at the end of each operating year would be determined in a similar manner -- i.e. -- \( \left[ \$0.50/\text{tonne} \right] \times \left[ \text{total tonnage deposited to date} \right] \times \left[ \text{inflation adjustment from 1997 to date} \right] \).

While this approach to calculating financial assurance is consistent from site to site, it also recognizes that the amount of financial assurance should reflect the size of the landfill (i.e. a larger site generates a larger amount of financial assurance). The types of financial assurance that may be provided are identified in Part XII of the Environmental Protection Act and include a cash deposit, letter of credit, surety bond and other securities acceptable to the Ministry.

Financial assurance is not required for a site owned by a municipality.

As an alternative to establishing separate contingency plan financial assurance for each private sector landfill, the Regulation also includes a clause allowing the possibility of a single financial assurance plan to be established for a group of sites. The specific details of such a group plan would have to be acceptable to the Director.

The regulatory requirement to provide financial assurance for contingency plans is included in Subsection 5.1.1 of this Guideline. Additional information on financial assurance calculations is included in the approval guidelines given in Subsection 5.1.2.

5.1.1 Regulatory Requirements

Regulation 232/98 requires that contingency plan financial assurance be provided for private sector landfilling sites. This requirement is given in Section 17 of the Regulation and is as follows:

**Contingency Plans**

17. (1) The owner and the operator of a landfilling site shall ensure that financial assurance is provided for the contingency plans for the site, including the construction, operation, maintenance and replacement of works required by the contingency plans.
(2) The financial assurance shall be provided in the form of a cash deposit paid to the Director or in such other form, such as a bond, a letter of credit or negotiable securities, as is acceptable to the Director.

(3) Subject to subsection (4), the amount of the financial assurance shall be determined in accordance with the following formula:

\[ F = 0.50 \times W \times (I_2 / I_1) \]

where,

- \( F \) = the amount of the financial assurance,
- \( W \) = the number of tonnes of waste that have been deposited in the landfilling site at the time the amount of financial assurance is calculated,
- \( I_1 \) = the 1997 Annual Average Non-residential Building Construction Price Index for Toronto, determined with reference to the same base year as is applicable to \( I_2 \), as published by Statistics Canada under the authority of the Statistics Act (Canada),
- \( I_2 \) = the most recent Annual Average Non-residential Building Construction Price Index for Toronto available at the time the amount of the financial assurance is calculated, as published by Statistics Canada under the authority of the Statistics Act (Canada).

(4) The amount of financial assurance provided shall be updated annually or as otherwise required by the Director.

(5) The financial assurance shall remain in place until a written report is prepared that shows that the financial assurance is no longer required.

(6) The financial assurance may be used by the Director to pay for expenses related to any planned or unplanned closure of the site or to the post-closure care of the site, if the owner fails, on the request of the Director, to perform the work or cover the expenses.

(7) The owner and the operator of a landfilling site shall ensure that any amount of financial assurance used by the Director under subsection (6) is replaced within six months after it is used unless the Director directs otherwise.

(8) Subsection (1) does not apply to require site specific financial assurance if financial assurance for the contingency plans is provided by a group financial assurance plan acceptable to the Director.

(9) Subsection (1) does not apply in respect of a landfilling site owned by a municipality or the Crown.

(10) Subsection (1) does not apply to a landfilling site owned by a forest products company if the waste to be deposited at the site is produced by forest products operations, such as the operations of a lumber mill, sawmill, pulp mill or similar facility, and is predominantly solid, non-hazardous process waste, such as woodwaste, effluent treatment solids, hog fired boiler ash, recycling process rejects, lime mud, grits or dregs.
5.1.2 Approval Guidelines

5.2 Financial Assurance - Closure & Post-Closure Care
Financial assurance as stated in Section 18 of Regulation 232/98 is required for private sector landfilling sites to ensure that funds are available to close the landfill and to carry out all expected post-closure care activities. An additional amount of financial assurance is required for contingency plans (refer to Section 5.1 of this Guideline).

Site closure involves completing the final cover, landscaping and construction of site monitoring and control works. Post-closure care activities typically involve site inspection, monitoring and maintenance activities, and the construction or replacement of any monitoring or control works. The types of financial assurance which may be provided are identified in Part XII of the Environmental Protection Act and include a cash deposit, letter of credit, surety bond and other securities acceptable to the Ministry. Financial assurance is not required for a site owned by a municipality.

Regulation 232/98 requires that financial assurance be provided for closure and post-closure care of private sector landfilling sites. Where a site is being progressively closed during the operation of the site, financial assurance for site closure would not be necessary. The amount of financial assurance is determined on a case-by-case basis and must be sufficient to cover the contaminating life span of the site (e.g. the time period during which leachate collection is necessary to protect groundwater, or prevent mounding and surface discharge). Should the contaminating life span for a site be estimated at less than 25 years, however, the Regulation requires that a minimum 25 year period be used for post-closure care activities such as groundwater monitoring. The amount of financial assurance for a particular landfill typically depend on factors such as site design, type of waste, level of engineering and environmental setting. The amount of financial assurance as required by conditions in the Environmental Compliance Approval is reviewed periodically to ensure that it is sufficient to cover the estimated costs. The regulatory requirement for closure and post-closure care financial assurance is included in Subsection 5.2.1 of this Guideline. Additional guidance on financial assurance calculations is included in the approval guidelines given in Subsection 5.2.2.

5.2.1 Regulatory Requirements
Regulation 232/98 requires financial assurance for the closure and post-closure care of private sector landfilling sites. This requirement is given in Section 18 of the Regulation and is as follows:

**Closure and Post-Closure Care**

18. (1) The owner and the operator of a landfilling site shall ensure that financial assurance for the closure of the site and the post-closure care of the site is provided in accordance with this section.

(2) The financial assurance shall be provided in the form of a cash deposit paid to the Director or in such other form, such as a bond, a letter of credit or negotiable securities, as is acceptable to the Director.

(3) The amount of the financial assurance shall be the present value at the estimated date of closure, in dollars current at that date, of an amount sufficient to cover the estimated costs for,
(a) the planned closure of the largest area that will require final cover at any one time during the operation of the site, including the costs of final cover and landscaping;
(b) care and maintenance of the final cover and landscaping for the contaminating life span of the site; and
(c) all other expected post-closure care activities for the contaminating life span of the site, including monitoring, analysis and reporting, the design, construction, operation, maintenance and replacement of engineered facilities and the disposal of wastes from the facilities, but not including any additional activities in the contingency plans for the site.


(5) Clause (3) (a) does not apply if part of the site is closed at least every five years.

(6) If costs are estimated under subsection (3) for any matter related to leachate from the site, the contaminating life span of the site may not be estimated at less than 25 years from the date waste is last deposited at the site.

(7) The financial assurance may be provided in stages as long as the amount that has been provided is always greater than the minimum amount determined in accordance with the following formula:

\[ A = B \left( \frac{C}{D} \right) \]

where,

\[ A = \text{the minimum amount of financial assurance that must have been provided,} \]
\[ B = \text{the total amount of the financial assurance, as estimated under subsection (3),} \]
\[ C = \text{the amount of waste that has already been deposited at the site,} \]
\[ D = \text{the total amount of waste that will be deposited at the site.} \]

(8) The estimation of costs and the amount of financial assurance provided shall be updated annually or as otherwise required by the Director.

(9) The financial assurance shall remain in place until a written report is prepared that shows that the financial assurance is no longer required.

(10) The financial assurance may be used by the Director to pay for expenses related to any planned or unplanned closure of the site if the owner fails, on the request of the Director, to perform the work or cover the expenses.

(11) The owner and the operator of a landfilling site shall ensure that any amount of the financial assurance used by the Director under subsection (10) is replaced within six months after it is used unless the Director directs otherwise.
Subsection (1) does not apply in respect of a landfilling site owned by a municipality or the Crown.

5.2.2 Approval Guidelines
6.0 OPERATIONS

6.1 Site Preparation Report
A Site Preparation Report is prepared to confirm that site conditions are as expected, and the site has been prepared and constructed in accordance with the approved design. As described in Subsection 6.1.1 of this Guideline, Regulation 232/98 requires that a site preparation report be prepared. A description of the type of information which typically is discussed in the report is included in the approval guidelines given in Subsection 6.1.2.

6.1.1 Regulatory Requirements
Regulation 232/98 requires that a site preparation report be prepared for the landfilling site. This requirement is given in Section 19 of the Regulation and is as follows:

**Site Preparation Report**

19. A person shall not place any waste in a newly constructed base or base side slope area of a landfilling site until a written report has been prepared documenting all construction, quality assurance and quality control activities and confirming that the site conditions and details of the construction of the new area are in accordance with the design plans and specifications of the landfilling site.

6.1.2 Approval Guidelines
The Site Preparation Report documents that site conditions, construction activities and quality assurance/control procedures are in accordance with the design of the landfill and typically included discussion on the information described in Table 14:

<table>
<thead>
<tr>
<th>Table 14: Site Preparation Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item No.</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>a.</td>
</tr>
<tr>
<td>b.</td>
</tr>
<tr>
<td>c.</td>
</tr>
<tr>
<td>d.</td>
</tr>
</tbody>
</table>

6.2 Record Keeping
Daily records of landfill activities are needed to properly assess the effectiveness and efficiency of site design and operation, their effect or relationship to any nuisance and environmental impacts, and the occurrence of any public complaints or concerns. Thorough documentation of site activities is necessary for preparation of the annual operations report and will assist in planning future site activities.

Regulation 232/98 requires operational records to be kept by the landfill owner. The regulatory requirement is described in Subsection 6.2.1 of this Guideline. Further details
on the type of information typically kept are included in the approval guidelines given in Subsection 6.2.2.

6.2.1 Regulatory Requirements
Regulation 232/98 requires that daily records be kept of landfill operations. This requirement is given in Section 20 of the Regulation and is as follows:

**Record Keeping**

20. The owner and the operator of a landfilling site shall ensure that daily records of site operations are made during the operation of the site and that the records are retained for at least two years after they are made.

6.2.2 Approval Guidelines
Record keeping helps maintain high operational standards, and is needed for the annual operations report and to plan future site activities. Daily records typically are kept for each day waste is received at the site or when other significant activities take place. The daily records typically include information described in Table 15:

Table 15: Record Keeping

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>The type, date and time of arrival, hauler, and quantity (by weight where weigh scales are provided at the site, otherwise by estimated volume as received) of all waste and cover material received at the site.</td>
</tr>
<tr>
<td>b.</td>
<td>The area of the site in which waste disposal operations are taking place.</td>
</tr>
<tr>
<td>c.</td>
<td>Any complaints from the public received by the owner and a description of the action taken by the owner in response.</td>
</tr>
<tr>
<td>d.</td>
<td>A calculation of the total quantity (by weight where weigh scales are provided at the site, otherwise by estimated volume as received) of waste received at the site during each operating day and each operating week.</td>
</tr>
<tr>
<td>e.</td>
<td>The amount of any leachate removed, or treated and discharged from the site, for sites with leachate collection.</td>
</tr>
<tr>
<td>f.</td>
<td>Record of litter collection activities and the application of dust suppressants.</td>
</tr>
<tr>
<td>g.</td>
<td>A record of the inspections of any control, treatment, disposal or monitoring facilities.</td>
</tr>
<tr>
<td>h.</td>
<td>A description of any out-of-service period of any control, treatment, disposal or monitoring facilities, the reasons for the loss of service, and action taken to restore and maintain service.</td>
</tr>
</tbody>
</table>
6.3 Annual Operations Report
An annual operations report is typically required as a condition in the landfilling site’s Environmental Compliance Approval. The condition typically requires information that provides a discussion that describes the results of site monitoring, the status of site development and capacity usage, upcoming phases of site preparation and development, and any operational concerns. Based on the annual report, and the day-to-day review of site activities, any possible improvements to site design and operations typically are identified. For private sector landfilling sites, the annual report typically has a discussion on an update of the financial assurance required for the site and the amount in place.

Regulation 232/98 requires that an annual report on site operations be prepared. The regulatory requirement is described in Subsection 6.3.1 of this Guideline. The type of information which should be provided in the annual report is included in the approval guidelines given in Subsection 6.3.2.

6.3.1 Regulatory Requirements
Regulation 232/98 requires an annual operations report to be prepared for a landfilling site. This requirement is given in Section 21 of the Regulation and is as follows:

Annual Operations Report
21. The owner and the operator of a landfilling site shall ensure that,

(a) within three months after each anniversary of the date on which waste was first accepted at the site, an annual report is prepared respecting the operation of the landfilling site, including a summary of results from monitoring programs; and
(b) all of the reports are retained until at least two years after the site is closed.

6.3.2 Approval Guidelines
An annual report is an important tool used in reviewing site activities and for determining the effectiveness of site design. The annual operations report typically includes sections in the report that discusses information described in Table 16:

Table 16: Annual Operations Report

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>The results and an interpretive analysis of the results of all leachate, groundwater, surface water and landfill gas monitoring, including an assessment of the need to amend the monitoring programs.</td>
</tr>
<tr>
<td>b.</td>
<td>An assessment of the operation and performance of all engineered facilities, the need to amend the design or operation of the site, and the adequacy of and need to implement the contingency plans.</td>
</tr>
<tr>
<td>c.</td>
<td>Site plans showing the existing contours of the site; areas of landfilling operation during the reporting period; areas of intended operation during the next reporting period; areas of excavation during the reporting period; the progress of final cover, vegetative cover, and any intermediate cover application; previously existing site facilities; facilities installed during the reporting period; and site preparations and</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>d.</strong></td>
<td>Calculations of the volume of waste, daily and intermediate cover, and final cover deposited or placed at the site during the reporting period and a calculation of the total volume of site capacity used during the reporting period.</td>
</tr>
<tr>
<td><strong>e.</strong></td>
<td>A calculation of the remaining capacity of the site and an estimate of the remaining site life.</td>
</tr>
<tr>
<td><strong>f.</strong></td>
<td>A summary of the quantity of any leachate removed, or treated and discharged, from the site during each operating week, for sites with leachate collection.</td>
</tr>
<tr>
<td><strong>g.</strong></td>
<td>A summary of the weekly, maximum daily and total annual quantity (by weight where weigh scales are provided at the site, otherwise by estimated volume as received) of waste received at the site.</td>
</tr>
<tr>
<td><strong>h.</strong></td>
<td>A summary of any public complaints received by the owner and the responses made.</td>
</tr>
<tr>
<td><strong>i.</strong></td>
<td>A discussion of any operational problems encountered at the site and corrective action taken; and</td>
</tr>
<tr>
<td><strong>j.</strong></td>
<td>An update of the cost estimate for financial assurance and the amount which has been provided to the Director, in the case of a privately-owned site.</td>
</tr>
</tbody>
</table>

**6.4 Public Liaison Committee**

Those persons potentially affected by a landfill may need to be kept informed and be given the opportunity to provide input into activities taking place at the site. Ongoing dialogue with the public and local authorities is important in helping to maintain a commitment to high standards of operation and environmental protection at a site. Although not an express requirement of Regulation 232/98, the landfill owner may provide specific opportunities for public involvement, such as by offering to form a public liaison committee. An invitation to participate on the public liaison committee should be extended to nearby residents, residents along the local access road and to municipal representatives. Copies of reports such as the annual operations report may need to be made available to the committee. The specific details of the terms of reference for the committee should be determined on a case by case basis. Further information on establishing a public liaison committee is included in Subsection 6.4.2 of this Guideline.

**6.4.1 Regulatory Requirements**

The formation of a public liaison committee is an effective way to obtain public input into ongoing landfill operations and has been included in the standards as approval guidelines rather than as a regulatory requirement in Regulation 232/98.

**6.4.2 Approval Guidelines**

The landfill owner may be required through a condition in the site’s Environmental Compliance Approval to establish a forum for the exchange of information and public dialogue on activities carried out at the site. Open communication with the affected
public and local authorities is important in helping maintain high standards for site operation and environmental protection. Prior to the receipt of waste at a landfilling site, the owner may be required by a Condition in the site’s Environmental Compliance Approval to form a public liaison committee or should establish some other forum (such as regular public meetings) to obtain public input into site activities. Where a public liaison committee is to be formed, the committee may consider structuring and operating the committee in a manner which addresses information described in Table 17:

Table 17: Public Liaison Committee

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Notice of the possible formation of a public liaison committee should be provided to all property owners or occupants within 500 m of the site, property owners or occupants adjacent to the local access road to the site (other than a County Road or Provincial Highway), the local municipality and any upper tier municipality in which the site is located.</td>
</tr>
<tr>
<td>b.</td>
<td>The owner should offer to host regular meetings of the public liaison committee.</td>
</tr>
<tr>
<td>c.</td>
<td>Copies of the annual operations report, including site monitoring, should be provided to the public liaison committee.</td>
</tr>
<tr>
<td>d.</td>
<td>Where requested by the public liaison committee, copies of any applications pertaining to the site which have been submitted to the Director should be provided to the committee; and</td>
</tr>
<tr>
<td>e.</td>
<td>For an operating site, whenever there has not been a meeting of an existing public liaison committee within the previous twenty-four months, or a public liaison committee has not existed during that period, the owner should again offer to form a public liaison committee.</td>
</tr>
</tbody>
</table>

6.5 Burning

Regulation 232/98 prohibits the open burning of mixed municipal waste at a landfilling site. Open burning is unacceptable because of concerns with air emissions, smoke and other nuisance effects, and the potential fire hazard. The controlled burning of small quantities of clean wood and brush, however, may be permitted in some cases -- for example, at smaller more remote sites. The regulatory requirements on burning at landfilling sites are included in Subsection 6.5.1 of this Guideline. Additional guidance on the burning of clean woodwaste at landfilling sites is available from the Ministry, as indicated in Subsection 6.5.2

6.5.1 Regulatory Requirements

Regulation 232/98 prohibits open burning of mixed municipal waste landfilling sites. This requirement is given in Section 22 of the Regulation and is as follows:
Burning

22. (1) The owner and the operator of a landfilling site shall ensure that no municipal waste is burned at the site as part of the landfilling operation.

(2) Subsection (1) does not apply to clean wood and brush that is burned during daylight hours under controlled and supervised conditions in a segregated portion of the site.

6.5.2 Approval Guidelines
The burning of municipal waste at a landfilling site is prohibited except for the controlled burning of small quantities of clean wood and brush at some sites. Further information on burning at landfilling sites is provided in Ministry Guideline C-7 "Burning at Landfill Sites".

6.6 Scavenging
Scavenging is the uncontrolled removal of material from waste at a landfilling site and is prohibited in Regulation 232/98. Scavenging is not allowed due to safety concerns and the potential for damage to environmental control, monitoring and other works at the landfill.

The prohibition on scavenging is not intended to, and does not, prevent a landfill owner from setting up recycling areas at a landfilling site. The establishment of segregated recycling areas where potentially recyclable material is placed for subsequent pick-up is encouraged by the Ministry.

The regulatory requirement prohibiting scavenging is included in Subsection 6.6.1 of this Guideline. There are no approval guidelines for this standard.

6.6.1 Regulatory Requirements
Regulation 232/98 prohibits scavenging (i.e. the uncontrolled removal of material from waste) at a landfilling site. This requirement is given in Section 23 of the Regulation and is as follows:

Scavenging

23. The owner and the operator of a landfilling site shall ensure that there is no scavenging at the site.

6.6.2 Approval Guidelines
There are no approval guidelines for this standard.

6.7 Surface Water Monitoring
Surface water monitoring is necessary to demonstrate that a landfilling site is performing as designed and to identify any potential impacts on surface water features in the vicinity of the site. The surface water monitoring program typically addresses the discharges from on-site surface water control works and any potential impacts on receiving waters. Based on the results of the surface water assessment (described above in Section 4.4 of this Guideline), biological monitoring (i.e. benthic -- bottom dwelling -- organisms) of nearby surface water features may be considered appropriate in some cases.

Regulation 232/98 requires that a surface water monitoring program be carried out at a landfilling site. The regulatory requirement is included in Subsection 6.7.1 of this Guideline. A more detailed description of the type of information to be obtained and issues to be addressed is included in the approval guidelines given in Subsection 6.7.2. The approval guidelines deal with matters such as:
- semi-annual monitoring for a comprehensive list of inorganic and organic parameters including metals and volatile organics, and characteristics such as flow, temperature and dissolved oxygen content,
- monitoring on two other occasions per year for a reduced list of indicator parameters, and
- biological monitoring, where appropriate.

The monitoring results along with an assessment of the results and recommendations for future monitoring should be included in an annual site monitoring report.

6.7.1 Regulatory Requirements
Regulation 232/98 requires that a surface water monitoring program be carried out for a landfilling site. This requirement is given in Section 24 of the Regulation and is as follows:

Surface Water Monitoring
24. The owner and the operator of a landfilling site shall ensure that a program is carried out for monitoring the quality and quantity of the surface water features on the site and of the surface water features that receive a direct discharge from the site.

6.7.2 Approval Guidelines
The surface water monitoring program described below includes monitoring frequencies and a detailed list of monitoring parameters. The frequency and parameters for monitoring may be amended, however, where site specific conditions indicate this is appropriate. Monitoring locations and the specific details of the monitoring program will be affected by the location and nature of the surface water features, the type of waste to be deposited, and other design and operational factors.

The program for monitoring surface water quality and quantity typically involves the information described in Table 18:

Table 18: Surface Water Monitoring

<table>
<thead>
<tr>
<th>Task No.</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Representative samples of surface water being discharged from the site and of any receiving surface water features, including upstream control locations, should be: (i) obtained semi-annually in spring and fall and be analyzed for the parameters listed in column 3 of Schedule 5 and for other parameters of concern identified in the surface water assessment; and (ii) obtained on two other occasions per year and be analyzed for the parameters listed in column 4 of Schedule 5.</td>
</tr>
<tr>
<td>b.</td>
<td>Where appropriate based on the surface water assessment, monitoring to assess the composition and any changes to the benthic community present in any surface water features receiving a discharge from the site.</td>
</tr>
<tr>
<td>c.</td>
<td>The results and assessment of the results of the surface water monitoring should be included in an annual report.</td>
</tr>
<tr>
<td>d.</td>
<td>The results and assessment referred to in Subsection (c) should include: (i) an assessment of the sampling results relative to the predicted results and</td>
</tr>
</tbody>
</table>
expected impacts on surface water at the site and on any waterbody that may be affected by leachate or sediment from the site;

(ii) an assessment of the need to amend the frequency or location of sampling and analytical parameters; and

(iii) an assessment of the need to amend the design or operational procedures for the site, or to implement the leachate contingency plan.

e. The parameters and frequency for monitoring may be amended where the owner prepares a report showing alternative provisions are appropriate based on conditions such as geographic location, climatic conditions and the type of waste to be deposited at the site.

6.8 Groundwater Monitoring

Regular monitoring of groundwater is necessary to demonstrate that a landfilling site is performing as designed and the impacts on the environment are acceptable. Regular monitoring allows for the analysis of trends over time and ensures there is an early warning of potential problems.

Regulation 232/98 requires that a groundwater monitoring program be carried out at a landfilling site. The regulatory requirement is included in Subsection 6.8.1 of this Guideline. A more detailed description of the type of information to be obtained and issues to be addressed is included in the approval guidelines given in Subsection 6.8.2. The approval guidelines deal with matters such as:

- annual monitoring for a comprehensive list of inorganic and organic parameters including metals and volatile organics,
- monitoring on two other occasions per year for a reduced list of indicator parameters, and
- where requested by nearby property owners, annual monitoring of domestic wells.

The monitoring results along with an assessment of the results and recommendations for future monitoring should be included in an annual site monitoring report.

6.8.1 Regulatory Requirements

Regulation 232/98 requires that a groundwater monitoring program be carried out for a landfilling site. This requirement is given in Section 25 of the Regulation and is as follows:

**Ground Water Monitoring**

25. The owner and the operator of a landfilling site shall ensure that a program is carried out for monitoring ground water quality and quantity.

6.8.2 Approval Guidelines

The groundwater monitoring program described below includes monitoring frequencies and a detailed list of monitoring parameters. The frequency and parameters for monitoring may be amended, however, where site specific conditions indicate this is appropriate. Monitoring locations and the specific details of the monitoring program will be based on factors such as site size, hydrogeologic setting, the type of waste to be deposited and the design of the site.

The program for monitoring groundwater quality and quantity for a landfilling site typically includes the information described in Table 19:
Table 19: Ground Water Monitoring

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Information</th>
</tr>
</thead>
</table>
| a. | Representative samples of groundwater within the site should be:  
   (i) obtained annually from groundwater monitoring facilities and be analyzed for the parameters listed in column 1 of Schedule 5; and  
   (ii) obtained on two other occasions per year from groundwater monitoring facilities and be analyzed for the parameters listed in column 2 of Schedule 5. |
| b. | Water levels (prior to the removal of any water) from the groundwater monitoring facilities referred to in Subsection (a) should be measured and recorded during each monitoring event. |
| c. | Where requested by property owners or occupants, representative samples of groundwater should be obtained from domestic wells located within 500 m of the waste fill area of the site at a frequency of one sample per well per year and these groundwater samples should be analyzed for the parameters listed in column 2 of Schedule 5. |
| d. | The results of analysis of a water sample collected under Subsection (c) should be provided to the owner or occupant of the property with the domestic well from which the sample was obtained, within 90 days of obtaining the sample. |
| e. | The results of analysis of all water samples collected in the groundwater monitoring program, together with an assessment of these results should be included in an annual report. |
| f. | The results and assessment referred to in Subsection (e) should include:  
   (i) an assessment of the condition of groundwater monitoring facilities;  
   (ii) an assessment of background groundwater levels and chemistry in each of the principal hydrostratigraphic units identified in the hydrogeological assessment and sampled in the course of groundwater monitoring program;  
   (iii) an assessment of the sampling results relative to the predicted results and expected impacts on groundwater at the site and adjacent to the site;  
   (iv) an assessment of the need to amend the frequency or location of sampling and the analytical parameters; and  
   (v) an assessment of the need to amend the design or operational procedures for the site, or to implement the leachate contingency plan. |
| g. | The parameters and frequency for monitoring may be amended where the owner prepares a report showing alternative provisions are appropriate based on conditions such as geographic location, climatic conditions and the type of waste to be deposited at the site. |

6.9 Leachate Monitoring
Leachate monitoring complements the groundwater and surface water monitoring programs, and provides important information for landfill design and performance assessment. Initial leachate (source) concentrations are needed for purposes of landfill design while ongoing leachate monitoring is used to assess current and expected
impacts from the site. Where leachate is collected at a site, information on leachate quality and quantity is needed to develop appropriate leachate management and disposal procedures. Regulation 232/98 includes a basic requirement that leachate monitoring be carried out at a landfilling site. The regulatory requirement is included in Subsection 6.9.1 of this Guideline. A more detailed description of the type of information to be obtained, including a comprehensive list of monitoring parameters, is included in the approval guidelines given in Subsection 6.9.2. The leachate monitoring results and assessment is typically a requirement of a condition in the site's Environmental Compliance Approval as a component in the annual site monitoring report.

6.9.1 Regulatory Requirements
Regulation 232/98 requires that a leachate monitoring program be carried out at the landfilling site. This requirement is given in Section 26 of the Regulation and is as follows:

Leachate Monitoring
26. The owner and the operator of a landfilling site shall ensure that a program is carried out for monitoring leachate quality and quantity.

6.9.2 Approval Guidelines
The leachate monitoring program described below includes monitoring frequencies and a detailed list of monitoring parameters. The frequency and parameters for monitoring may be amended, however, where site specific conditions indicate this is appropriate. Monitoring locations and the specific details of the monitoring program will depend upon the extent of engineered leachate controls, the type of waste to be deposited, and other design and operational factors.

The program for monitoring leachate quality and quantity should typically involves the information described in Table 20:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Information</th>
</tr>
</thead>
</table>
| a.       | Representative samples of leachate taken from within the waste or from the primary and/or secondary leachate collection system should be:  
  (i) obtained annually and be analyzed for the parameters listed in column 1 of Schedule 5; and  
  (ii) obtained on two other occasions per year and be analyzed for the parameters listed in column 2 of Schedule 5. |
| b.       | Representative measurements taken on three occasions per year of the depth of leachate mounding in the deposited waste and any leachate collection system. |
| c.       | The results and an assessment of the results of the leachate monitoring should be included in an annual report. |
| d.       | The results and assessment referred to in Subsection (c) should include:  
  (i) an assessment of the results of the leachate quality analyses and determinations of the depth of leachate mounding relative to the predicted results;  
  (ii) an assessment of the need to amend the frequency or location of sampling and analytical parameters, and the frequency, location or procedures for |
determining the depth of leachate mounding; and
(iii) an assessment of the need to amend the design or operational procedures for the site, or to implement the leachate contingency plan.

| e. | The parameters and frequency for monitoring may be amended where the owner prepares a report showing alternative provisions are appropriate based on conditions such as geographic location, climatic conditions and the type of waste to be deposited at the site. |

**6.10 Daily Cover**

Daily cover is used to control potential nuisance effects such as insects, rodents, birds, litter and odour, to facilitate vehicle access on the site, and to ensure an acceptable site appearance is maintained. Typically, soil is used as daily cover; however, alternative materials such as foundry sand, wood chips and compost may be used provided they meet these performance objectives. Where low permeability cover soils are used for daily or intermediate cover, the owner may need to remove or scarify the soil before placement of additional wastes overtop to promote hydraulic connection throughout the landfill. In some cases, the nature of the waste to be deposited at the site, or the small size and remote location of the site may allow for less frequent covering. For example, in the case of woodwaste landfills associated with the forest products industry, daily cover is normally not required.

Regulation 232/98 includes a requirement that daily cover be used at landfilling sites, but allows for the use of alternative cover materials or procedures. The regulatory requirements are included in Subsection 6.10.1 of this Guideline. The approval guidelines in Subsection 6.10.2 provide additional information on stockpiling of cover material and the issues to be addressed when considering the use of alternative cover materials.

**6.10.1 Regulatory Requirements**

Regulation 232/98 includes requirements concerning the use of daily cover at landfilling sites. These requirements are given in Section 28 of the Regulation and are as follows:

**Daily Cover**

28. (1) The owner and the operator of a landfilling site shall ensure that all waste accepted for disposal at the site is disposed of in the waste fill zone and is covered at the end of each working day by daily cover in accordance with this section.

(2) The daily cover shall consist of soil, foundry sand, wood chips, compost or other material.

(3) When tested using the Toxicity Characteristic Leaching Procedure, the daily cover must not produce leachate containing any of the contaminants listed in Schedule 4 to Regulation 347 of the Revised Regulations of Ontario, 1990 (General — Waste Management) made under the Act at a concentration equal to or in excess of the concentration specified in that Schedule for the contaminant.

(4) Subsection (1) does not apply to a landfilling site associated with forest products operations, such as the operations of a lumber mill, sawmill, pulp mill or similar facility, if the waste to be deposited at the site is produced by
the forest products operations and is predominantly solid, non-hazardous process waste, such as woodwaste, effluent treatment solids, hog fired boiler ash, recycling process rejects, lime mud, grits or dregs.

6.10.2 Approval Guidelines
The following guidelines identify the types of issues which may need to be addressed when considering the use of alternative cover materials and provide additional information on the stockpiling of cover material.

As indicated in Section 4.14 of this Guideline, the operation and maintenance report for a landfilling site typically describes the material to be used for daily or intermediate cover, the procedures to be followed when using the material, and any stockpiling of the material. Where the material to be used for cover is something other than soil, foundry sand, woodchips or compost, the description of the covering activities typically includes providing the information described in Table 21:

Table 21: Daily Cover

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>A description of the material.</td>
</tr>
<tr>
<td>b.</td>
<td>The quantity to be applied at any one time and the procedures for its application.</td>
</tr>
<tr>
<td>c.</td>
<td>An assessment of the benefits and limitations of the cover material in controlling litter, odour, dust, vectors and vermin under the expected range of weather and operational conditions.</td>
</tr>
<tr>
<td>d.</td>
<td>The location and maximum quantity of material to be stockpiled on the site at any one time prior to its use as cover material, and</td>
</tr>
<tr>
<td>e.</td>
<td>An assessment of any measures necessary to control dust, surface water runoff and leachate from the stockpiling of the material.</td>
</tr>
</tbody>
</table>

Where the cover material is soil or foundry sand, and the quantity of soil or foundry sand accepted and stockpiled at the site for use as cover material exceeds the cover requirements for a 60 day period, and the concentration of contaminants in the soil or foundry sand exceeds the concentrations specified for industrial land (at-depth, potable) in the Ministry document 7382e: Soil, Groundwater and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, an assessment should be carried out of any measures necessary for the control of surface water runoff or leachate from the stockpile.

Low permeability daily or intermediate cover soil may hinder the downward flow of leachate to leachate collection systems or result in leachate breakouts at surface. Where factors such as the nature of the waste to be deposited at the site, or the size and location of the site indicate that covering on a daily basis may not be necessary, the alternative frequency and the basis for this frequency may need be described (refer to Section 4.1 of this Guideline -- Subsection 6(2)(c)(xxiv) of Regulation 232/98).
6.11 Final Cover

The proper closure of a landfilling site requires the application of a final cover which is aesthetically pleasing, controls infiltration, and is suitable for the end use planned for the site. The final cover should also be compatible with any gas control needs for the site. Typically, a simple soil and vegetative cover is used at landfilling sites; however, alternative covers can be considered. The specific characteristics of the final cover will depend on the particular proposal taking into consideration the type of waste and the design objectives for the cover.

A low permeability soil and vegetative cover is typically used for a natural attenuation landfill where a reduced rate of infiltration and leachate generation is normally desirable. For an engineered site with leachate collection, an increased rate of infiltration to promote waste stabilization would normally be desirable to reduce long term maintenance and monitoring requirements, and to reduce the contaminating life span of the site. The generic designs included in Regulation 232/98 (refer to Section 4.5 of this Guideline) in fact specify a minimum infiltration rate for this reason -- to help ensure the service life of the engineered facilities exceeds the contaminating life span.

Subsection 6.11.1 below describes the final cover requirements given in the Regulation. Information on the quality of soil which may be used in the final cover is included in the approval guidelines given in Subsection 6.11.2.

6.11.1 Regulatory Requirements

Regulation 232/98 sets out the performance factors to be addressed in the design of the final cover for a landfilling site. This requirement is given in Section 29 of the Regulation and is as follows:

**Final Cover**

29. (1) The owner and the operator of a landfilling site shall ensure that the following materials are applied to the waste fill zone as final cover, from bottom to top:

1. A minimum of 0.6 metres of cover material.
2. A minimum of 0.15 metres of topsoil or other material approved by the Director as able to sustain plant growth.
3. A vegetative cover consisting of vegetation that is suited to local conditions and that is capable with minimal care of providing vigorous, plentiful cover not later than its third growing season.

(2) The owner and the operator of a landfilling site shall ensure that the final cover is designed so that,

(a) the infiltration rate through the final cover is in accordance with the design for the site respecting ground water protection prepared under section 10;

(b) any existing or anticipated facilities for the control, collection, use or discharge of landfill gas are accommodated; and

(c) the requirements for the end use of the site, as described in the site design report prepared under section 6 and the closure report prepared under section 31, are met.

6.11.2 Approval Guidelines

Final cover through a condition within the site’s Environmental Compliance Approval may be required to be progressively applied to the site as the final waste contours are reached. This will improve the aesthetics of the site and reduce the extent of final closure measures which must be carried out at the end of waste disposal operations.
With respect to contaminant levels in the final cover, the concentrations of substances in the final cover should not exceed the concentrations (surface, non-potable) specified in the Ministry’s document 7382e: Soil, Groundwater and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act, as amended from time to time for the intended land use of the site upon closure.

6.12 Final Slopes
The final slopes of a landfilling site have an effect on the waste capacity of the site, the performance of the final cover (also refer to Section 6.11 of this Guideline) and site maintenance requirements. Steep slopes promote surface water runoff, but increase erosion potential. More gradual slopes reduce runoff and erosion, but increase infiltration and the potential for ponding of surface water. Each of these factors should be considered in the design of the site and choice of final contours.
Subsection 6.12.1 describes the regulatory requirements for final slope design given in Regulation 232/98. The regulatory requirements specify maximum and minimum slopes that experience has shown can be successfully used in Ontario. The standard, however, allows alternative limits to be used in site design where they can be shown to be appropriate for a particular proposal. Approval guidelines for final slopes are included in Subsection 6.12.2.

6.12.1 Regulatory Requirements
Regulation 232/98 sets limits on maximum and minimum final slopes, but allows alternative designs where appropriate. This requirement is given in Section 30 of the Regulation and is as follows:

**Final Slopes**
30. (1) The owner and the operator of a landfilling site shall ensure that the final slopes above grade within the waste fill zone at the time of site closure do not exceed one unit vertical to four units horizontal and are not less than one unit vertical to 20 units horizontal.

(2) Subsection (1) does not apply if a written report has been prepared that confirms that an alternative design for the final slopes is acceptable, having regard to the slope stability of the deposited waste and final cover, the potential for erosion of the final cover, the proposed end use of the site and the infiltration requirements for ground water protection.

6.12.2 Approval Guidelines
The final slopes for a landfill should not normally exceed one unit vertical to four units horizontal (1V:4H), or be less than one unit vertical to twenty units horizontal (1V:20H). The final slopes for a particular site, however, should be determined by considering erosion potential and long term maintenance requirements, and may need to be based on meeting the design criteria set out for final cover as described in Section 6.11 of this Guideline.

6.13 Closure Report
Once a landfilling site has reached capacity, final closure of the site must be completed in a manner that is aesthetically pleasing and ensures long term protection of the environment. Site closure activities involve the progressive closure of portions of the fill area as they reach final approved contours. While the closure of some sites, such as a small natural attenuation site, may only require completion of the final soil cover and
limited post-closure monitoring, other sites, such as a large, highly engineered site, likely require a number of constructed works to be completed, and significant ongoing monitoring and maintenance.

The post-closure care period for a landfill depends on the environmental setting, the level of engineering, the required service lives of any engineered works, and the type of waste and remaining contaminant concentrations. The post-closure period may extend from many decades to several hundreds of years. The contaminant concentrations throughout the post-closure period depend on the type of waste deposited in the site and the rate of waste stabilization. Waste stabilization is affected by site design, for example the final cover characteristics, and whether operational procedures such as enhanced infiltration (to promote waste stabilization) have been practiced. For an engineered site, promoting waste stabilization would normally be desirable. For a natural attenuation site, limiting infiltration and leachate production may be more appropriate.

Regulation 232/98 requires that a report be prepared describing site closure activities and post-closure care requirements. The report is to be prepared at least two years before the expected date of closure or by the time 90 percent of the site has been filled. The regulatory requirements are included in Subsection 6.13.1 of this Guideline. A description of the type of information which should be included in a closure report is given as approval guidelines in Subsection 6.13.2. The closure report is intended to update and provide more detail on the closure and post-closure activities described originally in the site design report. The report typically includes a discussion on the include information on:

- notification procedures concerning the upcoming closure of the site,
- completion and ongoing maintenance of the final cover and landscaping,
- the planned end use for the site,
- final construction of any environmental control or monitoring facilities,
- post-closure operation and maintenance requirements including those for any environmental control or monitoring facilities, and
- for private sector landfills, an update of the financial assurance provisions.

6.13.1 Regulatory Requirements

Regulation 232/98 requires that a report on closure and post-closure care be prepared prior to final site closure. This requirement is given in Section 31 of the Regulation and is as follows:

**Closure Report**

31. *The owner and the operator of a landfilling site shall ensure that a written report on activities for the closure of the site, activities for the post-closure care of the site and the proposed end use of the site is prepared not later than the date 90 per cent of the total waste disposal volume is reached or two years before the anticipated date of closure, whichever comes first.***

6.13.2 Approval Guidelines

A site closure report must be prepared before a landfill has reached capacity. The report typically includes a discussion that updates and provides further details on the closure and post-closure activities planned for the site. The report typically includes information described in Table 22:
Table 22: Closure Report

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>A plan showing site appearance after closure.</td>
</tr>
<tr>
<td>b.</td>
<td>A description of the proposed end use of the site.</td>
</tr>
</tbody>
</table>
| c.       | Descriptions of the procedures for closure of the site, including:  
  (i) advance notification of the public of the landfill closure;  
  (ii) posting of a sign at the site entrance indicating the landfill is closed and identifying any alternative waste disposal arrangements;  
  (iii) completion, inspection and maintenance of the final cover and landscaping;  
  (iv) site security;  
  (iv) removal of unnecessary structures, buildings and facilities; and  
  (vi) final construction of any control, treatment, disposal and monitoring facilities for leachate, groundwater, surface water and landfill gas. |
| d.       | Descriptions of the procedures for post-closure care of the site, including:  
  (i) operation, inspection and maintenance of the control, treatment, disposal and monitoring facilities for leachate, groundwater, surface water and landfill gas;  
  (ii) record keeping and reporting; and  
  (iii) complaint contact and response procedures. |
| e.       | An assessment of the adequacy of and need to implement the contingency plans for leachate and methane gas. |
| f.       | An updated estimate of the contaminating life span, based on the results of the monitoring to date; and |
| g.       | An update of the cost estimate for financial assurance and the amount which has been provided to the Director, in the case of a privately-owned site. |

6.14 Annual Post-Closure Care Report

To help ensure a landfilling site continues to perform as designed, an annual post-closure care report typically is be prepared summarizing the results of site monitoring and maintenance, and the operation of the environmental control works. Post-closure care will be required for as long as contaminants from the site pose a potential concern to the environment. The frequency and period of reporting may be reviewed and adjusted as necessary based on the results of previous post-closure inspection and monitoring.

Regulation 232/98 requires that an annual post-closure care report be prepared. The regulatory requirement is included in Subsection 6.14.1 of this Guideline. A description of the type of information to be included in the report is given in Subsection 6.14.2. These approval guidelines address issues such as:

- the results and assessment of all monitoring programs,
a discussion of any operational or maintenance problems with any environmental control facilities, and
for private sector landfills, an update of the financial assurance provisions.

6.14.1 Regulatory Requirements
Regulation 232/98 requires that an annual post-closure care report be prepared following closure of the site. This requirement is given in Section 32 of the Regulation and is as follows:

Annual Post-Closure Care Report
32. The owner and the operator of a landfilling site shall ensure that, within three months after each anniversary of the date on which waste was last placed on the site, an annual report is prepared respecting the post-closure care of the landfilling site, including a summary of results from monitoring programs.

6.14.2 Approval Guidelines
In a similar manner to the annual operations report discussed in Section 6.3 of this Guideline, an annual post-closure report is an important tool used in reviewing post-closure monitoring and maintenance activities, and for helping ensure the site continues to perform as designed. The annual post-closure care report typically includes discussion that include information described in Table 23:

Table 23: Post Closure Report

<table>
<thead>
<tr>
<th>Task No.</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>The results and an interpretive analysis of the results of all leachate, groundwater, surface water and landfill gas monitoring, including an assessment of the need to amend the monitoring programs.</td>
</tr>
<tr>
<td>b.</td>
<td>An assessment of the adequacy of and need to implement the contingency plans for leachate and methane gas.</td>
</tr>
<tr>
<td>c.</td>
<td>An assessment of the operation, maintenance and performance of, and a discussion of any corrective action taken concerning the final cover and any control, treatment, disposal and monitoring facilities for leachate, groundwater, surface water and landfill gas.</td>
</tr>
<tr>
<td>d.</td>
<td>A summary of the quantity of any leachate removed, or treated and discharged, from the site, for sites with leachate collection.</td>
</tr>
<tr>
<td>e.</td>
<td>An assessment of the need to continue the control, treatment, disposal or monitoring of leachate, groundwater, surface water or landfill gas.</td>
</tr>
<tr>
<td>f.</td>
<td>A summary of the public complaints received by the owner and the responses made.</td>
</tr>
<tr>
<td>g.</td>
<td>An updated estimate of the contaminating life span, based on the results of the monitoring to date.</td>
</tr>
<tr>
<td></td>
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<tr>
<td>---</td>
<td>-----------------------------------------------------------------</td>
</tr>
<tr>
<td>h.</td>
<td>An update of the cost estimate for financial assurance and the amount which has been provided to the Director, in the case of a privately-owned site; and</td>
</tr>
<tr>
<td>i.</td>
<td>An assessment of the need to amend the frequency and period covered by the post-closure care report.</td>
</tr>
</tbody>
</table>
SCHEDULE 1  
Service Lives -- Primary Leachate Collection Systems  
(Regulation Sections 6 and 10)  

100 Year Service Life

1. A landfilling site’s primary leachate collection system, consisting of perforated collection pipes bedded in a layer of stones with a separating layer above and below the stones, may be assumed to have a service life of 100 years, starting at the earlier of the mid-point of the site’s operating life and the tenth anniversary of the first deposit of waste in the waste fill zone, if the following conditions are met:

1. The pipes must be bedded in a continuous layer of stones that extends completely across the base of the waste fill zone and that has a minimum thickness of 0.3 metres on the base side slopes and a minimum thickness of 0.5 metres elsewhere. The stones must have a $D_{85}$ of not less than 37 millimetres, a $D_{10}$ of not less than 19 millimetres, a uniformity coefficient ($D_{60}/D_{10}$) of less than 2.0, and, when measured by weight, not more than 1.0 per cent of the stones may pass the US #200 sieve.

2. A suitable geotextile or graded granular separator must be installed between the stone layer and the overlying waste and between the stone layer and any underlying soil or liner.

3. The perforated leachate collection pipes must be made of high density polyethylene (HDPE), with a minimum internal diameter of 150 millimetres and with perforations not less than 12 millimetres in diameter located along and around the pipe so that,

   i. the hydraulic capacity of the perforations can readily accommodate the expected quantity of leachate,
   ii. leachate that enters the pipes can readily flow within the pipes,
   iii. blockage by sedimentation is minimized, and
   iv. the structural integrity of the pipes is maintained.

4. The perforated leachate collection pipes must be bedded in the stones so that there is at least 250 millimetres of stones above the pipes and at least 50 millimetres of stones below the pipes.

5. The perforated leachate collection pipes must be placed across the base of the waste fill zone, excluding the base side slopes, and spaced so that the drainage path before leachate can potentially intercept a collection pipe is not more than 50 metres in length.

6. The leachate collection pipes must have adequate structural integrity to withstand impacts from waste placement and other site operations and to withstand the weight of the waste, cover material and any structures that may be located over them.
7. Leachate collection pipes must be inspected at least annually for the first five years after placement of waste overtop of each pipe and then as often as future inspections indicate to be necessary.

8. Leachate collection pipes must be cleaned whenever an inspection indicates that cleaning is necessary.

9. Leachate must be removed from the collection system in order to avoid obstructions to leachate flows within the system.

10. The base of the waste fill zone must be contoured to provide minimum surface grades of 0.5 per cent toward the leachate collection pipes.

11. Sludge must not be deposited in the waste fill zone in a manner that would allow sludge to move into the leachate collection system and promote biological clogging.

75 Year Service Life

2. A landfilling site’s primary leachate collection system, consisting of perforated collection pipes bedded in a layer of stones with a separating layer above and below the stones, may be assumed to have a service life of 75 years, starting at the earlier of the mid-point of the site's operating life and the tenth anniversary of the first deposit of waste in the waste fill zone, if all of the conditions set out above for a 100 year service life are met with the following changes:
   1. The requirement that the layer of stones in which the pipes are bedded have a minimum thickness of 0.5 metres elsewhere than the base side slopes is changed to a requirement that the layer have a minimum thickness of 0.3 metres elsewhere than the base side slopes.
   2. The requirement that the perforated leachate collection pipes be bedded in the stones so that there is at least 250 millimetres of stones above the pipes and at least 50 millimetres of stones below the pipes must be met, but local thickening of the layer of stones is acceptable.
   3. The requirement that the perforated leachate collection pipes be spaced so that the drainage path before leachate can potentially intercept a collection pipe is not more than 50 metres in length is changed to a requirement that the pipes be spaced so that the drainage path before leachate can potentially intercept a collection pipe is not more than 25 metres in length.

60 Year Service Life

3. A landfilling site’s primary leachate collection system, consisting of perforated collection pipes bedded in a layer of stones with a separating layer above and below the stones, may be assumed to have a service life of 60 years, starting at the earlier of the mid-point of the site's operating life and the tenth anniversary of the first deposit of waste in the waste fill zone, if all of the conditions set out above for a 100 year service life are met with the following changes:

   1. The requirement that the layer of stones in which the pipes are bedded have a minimum thickness of 0.5 metres elsewhere than the base side slopes is changed to a requirement that the layer have a minimum thickness of 0.3 metres elsewhere than the base side slopes.
2. The requirement that the perforated leachate collection pipes be bedded in the stones so that there is at least 250 millimetres of stones above the pipes and at least 50 millimetres of stones below the pipes must be met, but local thickening of the layer of stones is acceptable.

4. In this Schedule,
   (a) \( D_{85} \) for stones in a stone layer is the stone diameter such that, when measured by weight, 85 per cent of the stones in the layer have a smaller diameter;
   (b) \( D_{60} \) for stones in a stone layer is the stone diameter such that, when measured by weight, 60 per cent of the stones in the layer have a smaller diameter; and
   (c) \( D_{10} \) for stones in a stone layer is the stone diameter such that, when measured by weight, 10 per cent of the stones in the layer have a smaller diameter.
1. A landfilling site’s secondary leachate collection system, consisting of perforated collection pipes bedded in a layer of stones with a separating layer above and below the stones, may be assumed to have a service life of 1000 years, starting at the earlier of the mid-point of the site’s operating life and the tenth anniversary of the first deposit of waste in the waste fill zone, if the following conditions are met:

1. The pipes must be bedded in a continuous layer of stones that extends completely across the base of the waste fill zone, including the base side slopes, and that has a minimum thickness of 0.3 metres. The stones must have a $D_{85}$ of not less than 37 millimetres, a $D_{10}$ of not less than 19 millimetres, a uniformity coefficient ($D_{60}/D_{10}$) of less than 2.0, and, when measured by weight, not more than 1.0 per cent of the stones may pass the US #200 sieve.

2. A suitable geotextile or graded granular separator must be installed between the stone layer and any underlying soil or liner and between the stone layer and any overlying material.

3. The perforated leachate collection pipes must be made of high density polyethylene (HDPE), with a minimum internal diameter of 150 millimetres and with perforations not less than 12 millimetres in diameter located along and around the pipe so that,
   
   i. the hydraulic capacity of the perforations can readily accommodate the expected quantity of leachate,
   ii. leachate that enters the pipes can readily flow within the pipes,
   iii. blockage by sedimentation is minimized, and
   iv. the structural integrity of the pipes is maintained.

4. The perforated leachate collection pipes must be bedded in the stones so that there is at least 250 millimetres of stones above the pipes and at least 50 millimetres of stones below the pipes. Local thickening of the layer of stones is acceptable.

5. The perforated leachate collection pipes must be placed across the base of the waste fill zone, excluding the base side slopes, and spaced so that the drainage path before leachate can potentially intercept a collection pipe is not more than 100 metres in length.

6. The leachate collection pipes must have adequate structural integrity to withstand impacts from waste placement and other site operations and to withstand the weight of the waste, cover material and any structures that may be located over them.

7. Leachate collection pipes must be inspected at least annually for the first five years after the initial production of leachate from the secondary leachate
collection system and then as often as future inspections indicate to be necessary.

8. **Leachate collection pipes must be cleaned whenever an inspection indicates that cleaning is necessary.**

9. **Leachate must be removed from the collection system in order to avoid obstructions to leachate flows within the system.**

10. **The base of the waste fill zone must be contoured to provide minimum surface grades of 0.5 per cent toward the leachate collection pipes.**

2. **In this Schedule,**
   (a) \( D_{85} \) for stones in a stone layer is the stone diameter such that, when measured by weight, 85 per cent of the stones in the layer have a smaller diameter;

   (b) \( D_{60} \) for stones in a stone layer is the stone diameter such that, when measured by weight, 60 per cent of the stones in the layer have a smaller diameter; and

   (c) \( D_{10} \) for stones in a stone layer is the stone diameter such that, when measured by weight, 10 per cent of the stones in the layer have a smaller diameter.
SCHEDULE 3
Service Lives -- Geomembrane Liners
(Regulation Sections 6 and 10)

Primary Liner -- 150 Year Service Life

1. The geomembrane used as part of a landfilling site's primary liner may be assumed to have a service life of 150 years, starting at the earlier of the mid-point of the site's operating life and the tenth anniversary of the first deposit of waste in the waste fill zone, if the following conditions are met:

   1. The geomembrane must be made of high density polyethylene (HDPE) and must have a thickness of at least 1.5 millimetres.

   2. The oxidative induction time of the geomembrane must exceed,
      i. 100 minutes, as determined by ASTM D3895-95 (American Society for Testing and Materials Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry), as it may be amended from time to time, or
      ii. 250 minutes, as determined by ASTM D5885-95 (American Society for Testing and Materials Standard Test Method for Oxidative-Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry), as it may be amended from time to time.

   3. The oxidative induction time of the geomembrane after oven aging at 85 degrees Celsius for 90 days, as described in ASTM D5721-95 (American Society for Testing and Materials Standard Practice for Air-Oven Aging of Polyolefin Geomembranes), as it may be amended from time to time, must exceed,
      i. 80 per cent of the value for the original geomembrane, as determined by ASTM D3895-95 (American Society for Testing and Materials Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry), as it may be amended from time to time, or
      ii. 80 per cent of the value for the original geomembrane, as determined by ASTM D5885-95 (American Society for Testing and Materials Standard Test Method for Oxidative-Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry), as it may be amended from time to time.

   4. The geomembrane must be installed in direct and uniform contact with a suitable foundation or clayey liner.

   5. The geomembrane must be protected against puncturing and load-induced damage at all times, including during installation.

   6. During installation, care must be taken to,
      i. remove wrinkles in the geomembrane,
      ii. minimize stress concentration,
      iii. ensure high quality seams,
      iv. minimize differential settlement,
v. minimize exposure to ultraviolet light,
vi. prevent damage due to sliding,
vii. prevent damage due to installation in cold conditions, and
viii. prevent damage due to rodents.

**Secondary Liner -- 350 Year Service Life**

2. The geomembrane used as part of a landfilling site's secondary liner may be assumed to have a service life of 350 years, starting at the earlier of the mid-point of the site's operating life and the tenth anniversary of the first deposit of waste in the waste fill zone, if all of the conditions set out above for a 150 year service life are met with the following change:

1. The requirement that the geomembrane have a thickness of at least 1.5 millimetres is changed to a requirement that the geomembrane have a thickness of at least 2.0 millimetres.
SCHEDULE 4
Service Lives -- Compacted Clayey Liners
(Regulation Sections 6 and 10)

Unlimited Service Life

1. A landfilling site’s compacted clayey liner may be assumed to have an unlimited service life if the following conditions are met:

   1. The liner must be,
      i. at least 0.75 metres thick and compacted in at least five lifts, or
      ii. at least 0.6 metres thick and compacted in at least four lifts, if the liner is not constructed over a leachate collection system and is not used in conjunction with a geomembrane as part of a composite liner.

   2. Each of the lifts in which the liner is compacted must be not more than 0.15 metres in compacted thickness.

   3. Appropriate mineralogical studies or other leachate compatibility studies must indicate that the clayey material is not likely to experience a significant increase in hydraulic conductivity due to interaction with leachate.

   4. During installation, care must be taken to,
      i. control soil properties and water content,
      ii. ensure the breakup of clods,
      iii. control lift thickness and compaction,
      iv. remove stones larger than 100 millimetres,
      v. prevent desiccation of the compacted clayey liner,
      vi. prevent damage to the compacted clayey liner due to freezing,
      vii. prevent damage to the compacted clayey liner from vehicular traffic,
      viii. prevent damage to the compacted clayey liner due to rodents, and
      ix. prevent damage to the compacted clayey liner due to differential settlement.

   5. The report of a suitably qualified geotechnical engineer must confirm that there is no evident cracking in the constructed liner or significant occurrence of clods, stones, branches or other material that could shorten the service life of the constructed liner or significantly increase the hydraulic conductivity.
## SCHEDULE 5
Groundwater, Leachate and Surface Water Monitoring Parameters

<table>
<thead>
<tr>
<th>Parameter Group</th>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
<th>Column 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehensive List for Groundwater and Leachate</td>
<td>Indicator List For Groundwater and Leachate</td>
<td>Comprehensive List for Surface Water</td>
<td>Indicator List for Surface Water</td>
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<td>Inorganics</td>
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<td>Suspended Solids (Leachate Only)</td>
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**Volatile Organics**

- Benzene
- 1,4 Dichlorobenzene
- Dichloromethane
- Toluene
- Vinyl Chloride

**Other Organics**

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<tr>
<th>Biochemical Oxygen Demand (BOD$_5$) (Leachate Only)</th>
<th>Biochemical Oxygen Demand (BOD$_5$) (Leachate Only)</th>
<th>Biochemical Oxygen Demand (BOD$_5$)</th>
<th>Biochemical Oxygen Demand (BOD$_5$)</th>
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**Field Parameters**

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<th>Conductivity</th>
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DEFINITIONS
The definitions of terms used in Regulation 232/98 are given in Section 1 of the Regulation and are as follows:

1. (1) In this Regulation,
"base side slope" means any portion of the base of the waste fill zone extending from ground surface downward at an angle steeper than one unit vertical to four units horizontal;
"buffer area" means that part of a landfilling site that is not waste fill area;

"contaminant attenuation zone" means a three-dimensional zone that,
   a. is located on land adjacent to a landfilling site,
   b. is in the subsurface or extends into the subsurface, and
   c. is used or is intended to be used for the attenuation of contaminants from the landfilling site to levels that will not have an unacceptable impact beyond the boundary of the zone;

"contaminating life span" means,
   (a) in respect of a landfilling site, the period of time during which the site will produce contaminants at concentrations that could have an unacceptable impact if they were to be discharged from the site, and
   (b) in respect of a landfilling site and a contaminant or group of contaminants, the period of time during which the site will produce the contaminant or a contaminant in the group at concentrations that could have an unacceptable impact if they were to be discharged from the site;

"engineered facility" means anything affixed to or made part of land that is intended to be a functional element or feature of a landfilling site for more than five years and that is created or put in place by human activity;

"maximum waste loading" means, for a landfilling site, the total waste disposal volume divided by the area of the waste fill area;

"primary leachate collection system" means the uppermost leachate collection system below the waste fill zone;

"primary liner" means the uppermost liner below the waste fill zone;
"secondary leachate collection system" means a leachate collection system located below the primary leachate collection system;

"secondary liner" means a liner located below the primary liner;

"service life" means the period of time during which a properly maintained engineered facility will function in accordance with the performance specifications for its design;

"total waste disposal volume" means, for a landfilling site, the maximum volume of waste, including the volume of any daily or intermediate cover, to be deposited at the site in the space extending from the base of the waste fill zone or the top of any engineered facilities located on the base of the site to the bottom of the final cover;
"unacceptable impact" means interference with existing or potential reasonable uses of,

(a) land,
(b) ground water in or under land, or
(c) surface water on land;

"waste fill area" means the area on the surface of the landfilling site beneath which or above which waste is disposed of by landfilling;

"waste fill zone" means the three-dimensional zone in which waste is disposed of by landfilling.

(2) The definitions in section 1 of Regulation 347 of the Revised Regulations of Ontario, 1990 also apply to this Regulation.

(3) For the purpose of better understanding the definition of "engineered facility" in subsection (1), the following things are examples of common engineered facilities, if they are intended to be functional elements or features of a landfilling site for more than five years:

1. Berms.
2. Drainage ditches.
3. Liners.
5. Pumps.
6. Facilities to detect, monitor, control, collect, redirect or treat leachate, surface water or ground water.
7. Facilities to detect, monitor, control, collect, redirect, treat, utilize or vent landfill gas.