APPENDIX C
Environmental Baseline and Monitoring

TYPICAL SURFACE AND GROUNDWATER MONITORING PROGRAM

(*Directly from: Nova Scotia Department of the Environment Municipal Solid Waste Landfill Guidelines*, Government of Nova Scotia, Department of the Environment, October 1997)

1.0 Hydrogeologic Assessment

Prior to the establishment or expansion of a site, a report shall be prepared by the owner containing plans, specifications, and description of the hydrogeologic conditions of the site, adjacent and nearby properties, and the regional area in which the site is located, including at a minimum, the following:

1.1 a general description of the regional geologic and hydrogeologic conditions occurring with 5 km of the site, identifying any unstable soils or bedrock, the location and nature of any boundaries to groundwater movement, and characterizing the significance of ground water resources;

1.2 a description of local hydrogeologic conditions occurring at the site, and adjacent and other properties within 500 m of the site, indicating how local conditions relate to regional conditions;

1.3 a detailed hydrogeologic investigation of the site which establishes soil, rock, and groundwater conditions;

1.4 an interpretation of the results of the detailed hydrogeologic investigation of the site, including plans, specifications and descriptions;

1.5 an assessment of the suitability of the site for water disposal purposes considering the regional, local and site specific hydrogeologic conditions, the design of the site, and the contingency plans for the control of leachate and landfill gas.

2.0 Surface Water Assessment

Prior to the establishment or expansion of a site, a report shall be prepared by the owner containing plans, specifications, and descriptions of the surface water conditions of the site, adjacent and nearby properties, and the regional area in which the site is located, including, at a minimum, the following:

2.1 a general description of the surface water features occurring within 5 km of the site that is based on the contributing/receiving drainage area, catchment, subwatershed or watershed that is sufficiently large to assess the range and extent of potential effects. This description will include, but not be limited to, flood plains, natural watercourses, drainage paths and boundaries, streamflows, surface water quality, and the sources of water supply;

2.2 a description of the local surface water features occurring at the site, and adjacent and other properties within 500 m of the site, and the description shall include how local feature relate to regional features;

2.3 a detailed surface water investigation of the site to assess water quality, quantity, and habitat conditions of the surface water features identified on site;

2.4 an interpretation of the results of the detailed surface water investigation of the site, including plans, specifications and descriptions;

2.5 an assessment of the suitability of the site for waste disposal purposes considering the regional, local and site specific surface water conditions, the design of the site, and the contingency plan for the control of leachate.

3.0 Surface Water Quality Monitoring

A regular program of surface water monitoring shall include: a program for measuring surface water quality upstream of the site; a program for detection and measurement of leachate contaminants in the surface water; and a suitably designed QC/QA program.

The surface water monitoring program shall include a combination of visual inspection for leachate seeps from the landfill / waste management facility, along with surface water sampling.

3.1 A Typical Surface Water Monitoring program

A program for monitoring surface water quality, quantity, and biological features shall be carried out by the owner/operator and shall include, at a minimum, the following:

1) representative samples of surface water being discharged from the site and of any waterbody, including upstream control locations, which may be affected by leachate, stormwater runoff, or sediment from the site, obtained semi-annually and analyzed for the parameters listed in column 3 of Table 1, and for other parameters of concern identified in the surface water assessment;

2) representative samples obtained quarterly and analyzed for the parameters listed in column 4 of Table 1; and

3) annual monitoring of biological features to assess the composition and any changes to the benthic community present in any waterbody, located downstream of storm water discharges, that may be affected by leachate, stormwater runoff, or sediment from the site.

The results and assessment of the results of the surface water monitoring shall be provided to the Department in an annual report, and where the assessment indicates an increase in contaminant concentrations exceeding the natural variability exhibited by baseline and operation monitoring date, the Department shall be notified immediately. The parameters to be monitored may be amended where the owner/operator prepares a report showing alternative parameters should be monitored, based on the type of waste to be deposited at the site.

4.0 Assessment of Groundwater Resources and Groundwater Monitoring

Prior to the establishment or expansion of a site, a report shall be prepared by the owner containing a detailed description of the groundwater resources associated with the site, and implications for adjacent and nearby properties.

Monitoring wells shall be installed to a depth which will span the anticipated high and low water table levels and be appropriately sized to allow proper well development, purging and sampling. Monitoring wells will also be used for the measurement of water levels, the determination of horizontal and vertical gradients and the determination of flow directions and groundwater velocities.

The groundwater monitoring program will include:

- a program for baseline groundwater chemistry;
- a program for detection of leachate in the groundwater;
- a program to measure the extent and magnitude of leachate contamination, should it occur;
- measuring groundwater levels and general hydrogeological conditions on the site; and
- a suitably designed QC/QA program.

The groundwater monitoring program, designed by a suitably Qualified Professional, is to be site-specific and shall include an appropriate number and configuration of monitoring wells around the perimeter of the site, both up and down gradient, to allow accurate evaluation of the impact of the operation and assessment of any migration pathway.

The groundwater monitoring system should consist of the following:

- groundwater monitoring wells installed hydraulically above and below the gradient direction of the

landfill / waste management facility;

- monitoring wells sufficiently close to the active disposal area to allow early detection of contamination and implementation of mitigation measures;
- specifications for well drilling methods, casing, screens, filter packs, annular space seals, ground surface seals, grout, caps, development and purging which are to be provided; and
- monitoring wells to be retained throughout the lifespan of the facility.

4.1 A Typical Groundwater Monitoring Program

A program for monitoring groundwater quality and quantity shall be carried out by the owner and shall include, at a minimum, the following:

1) representative samples from groundwater monitoring facilities within the site obtained annually and be analyzed for the parameters listed in column 1 of Table 1; and obtained quarterly and analyzed for the parameters listed in column 2 of Table 1; and
2) where requested by property owners or occupants, representative samples of groundwater obtained from domestic wells located within 500 m of the site at a frequency of 1 sample per well per year and analyzed for the parameters listed in column 2 of Table 1;

The results of analyses of water samplse collected shall be immediately provided to the Department and the owner or occupant of the property with the domestic well from which the sample was obtained.

The results of analyses of all water samples collected in the groundwater monitoring program, together with an assessment of these results shall be provided to the Department in an annual report, and where the assessment indicates a significant increase in contaminant concentrations, the Department shall be notified immediately

The parameters to be monitored may be amended where the owner/operator prepares a report showing alternative parameters should be monitored, based on the type of waste to be deposited at the sites.

5.0 Evaluation Criteria

Surface water and groundwater monitoring results shall be compared to the appropriate Canadian Council Ministers of the Environment (CCME) Water Quality Guidelines applied on a site specific basis depending on the surface water and groundwater use in the area.

Discharge water must also comply with the *Environmental Control Water and Sewage Regulations*, 2003.

The person conducting the groundwater monitoring program must be a suitably Qualified Professional.

The Department of Environment and Conservation Policy PD:PP2001-0.1: *Use of Accredited and Certified Laboratories* applies. (separate document)

Table 1 provides a list of criteria limits for parameters normally analysed in surface and groundwater sampling programs.

1. Prior to discharge to the environment, where possible, all contaminated wastewater shall be within acceptable limits as per the latest edition of the ***Canadian Environmental Quality Guidelines (CEQG).*** For those parameters regulated in the ***Environmental Control Water and Sewage Regulations, 2003*** the limits established in these regulations shall apply.

TABLE 1

Groundwater, Leachate and Surface Water Monitoring Parameters*

* (Parameter limits to be specified in the Certificate of Approval)

Parameter				
Parameter Group	**Column 1**	**Column 2**	**Column 3**	**Column 4**
	Comprehensive List for Groundwater and Leachate	**Indicator List for Groundwater and Leachate**	**Comprehensive List for Surface Water**	**Indicator List for Surface Water**
Inorganics				
	Alkalinity	Alkalinity	Alkalinity	Alkalinity
	Ammonia	Ammonia	Ammonia	Ammonia
	Arsenic		Arsenic	
	Barium		Barium	
	Boron		Boron	
	Cadmium	Cadmium	Cadmium	
	Calcium	Calcium	Calcium	Calcium
	Chloride	Chloride	Chloride	Chloride
	Chromium		Chromium	
	Conductivity	Conductivity	Conductivity	Conductivity
	Copper		Copper	
	Iron	Iron	Iron	
	Lead	Lead	Lead	
	Magnesium	Magnesium		
	Manganese			
	Mercury	Mercury	Mercury	Mercury
	Nitrate	Nitrate	Nitrate	Nitrate
	Nitrite	Nitrite	Nitrite	Nitrite
	Total Kjeldahl Nitrogen		Total Kjeldahl Nitrogen	Total Kjeldahl Nitrogen
	pH	pH	pH	pH
	Total Phosphorus	Total Phosphorus	Total Phosphorus	Total Phosphorus
	Potassium	Potassium		
	Sodium	Sodium		
	Suspended Solids	Suspended Solids	Suspended Solids	Suspended Solids
	Total Dissolved Solids	Total Dissolved Solids	Total Dissolved Solids	Total Dissolved Solids
Parameter				

Parameter Group	Column 1 Comprehensive List for Groundwater and Leachate	Column 2 Indicator List for Groundwater and Leachate	Column 3 Comprehensive List for Surface Water	Column 4 Indicator List for Surface Water
	Sulphate	Sulphate	Sulphate	Sulphate
	Zinc		Zinc	
Volatile Organics				
	Benzene	Benzene		
	1.4 Dichlorobenzene	1.4 Dichlorobenzene		
	Dichlorobenzene	Dichlorobenzene	Dichlorobenzene	Dichlorobenzene
	Toluene	Toluene	Toluene	
	Vinyl Chloride	Vinyl Chloride		
Other Organics				
	Biochemical Oxygen Demand (BOD5)	Biochemical Oxygen Demand (BOD_5)	Biochemical Oxygen Demand (BOD_5)	Biochemical Oxygen Demand (BOD_5)
	Chemical Oxygen Demand	Chemical Oxygen Demand	Chemical Oxygen Demand	Chemical Oxygen Demand
	Dissolved Organic Carbon	Dissolved Organic Carbon	Total Organic Carbon	
	Phenol	Phenol	Phenol	Phenol
Field Parameters				
			Temperature	Temperature
	pH	pH	pH	pH
	Conductivity	Conductivity	Conductivity	Conductivity
			Dissolved Oxygen	Dissolved Oxygen
			Flow	Flow