2009 VANCOUVER LANDFILL ANNUAL REPORT

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Introduction

This annual report covers the period from January to December 2009 for the Vancouver Landfill, and has been prepared in accordance with the Landfill's Operational Certificate MR-01611. Issued by the Ministry of Environment on March 8, 2001, the Operational Certificate authorizes the discharge of municipal solid waste and specifies environmental protection requirements for the Landfill.

The purpose of this report is to meet the Operational Certificate reporting requirements in Section 3.5.2 by providing the following information:

- updates to the design and operating plan;
- revised closure/post closure costs;
- planned improvements;
- records for waste, recyclable material and compost quantities;
- a review of recycling and composting programs;
- a review of environmental monitoring data with interpretation;
- details on environmental protection programs, including leachate and landfill gas collection systems;
- operating problems and corrective actions taken; and
- a summary of the public complaint and resolution log.

Updates to the Design and Operations Plan

Completed by Sperling Hansen Associates, the *Design & Operations Plan* (Plan) was submitted to the Ministry of Environment in January 2000. The Plan directs day-to-day operations of the Landfill to achieve a final elevation of 39 meters, and includes a description of the detailed fill plan that is comprised of nine distinct phases, as shown in Figure 1. The Plan also contains summaries of the total amount of materials to be deposited in the Landfill; a cash-flow analysis for the planned operational life; a contingency plan should the Landfill be closed before reaching design capacity; and information on leachate and landfill gas management, environmental controls and monitoring, and landfill closure and associated costs.

A full update to the Design and Operations Plan is planned for 2011/2012.

Closure and Post Closure Costs

The Landfill's Operational Certificate requires the City to maintain a reserve sufficient to fund closure, post-closure and environmental contingencies related to the Landfill. The Solid Waste Capital Reserve (SWCR) was established to address these costs. In 2001, Council set the minimum balance of the SWCR at $30,000,000 and directed that the requirements for the SWCR be reviewed every five years. The closing balance of the SWCR was $67,700,000 at the end of 2009. Every year, closure and post-closure costs are reviewed and updated with current available information.

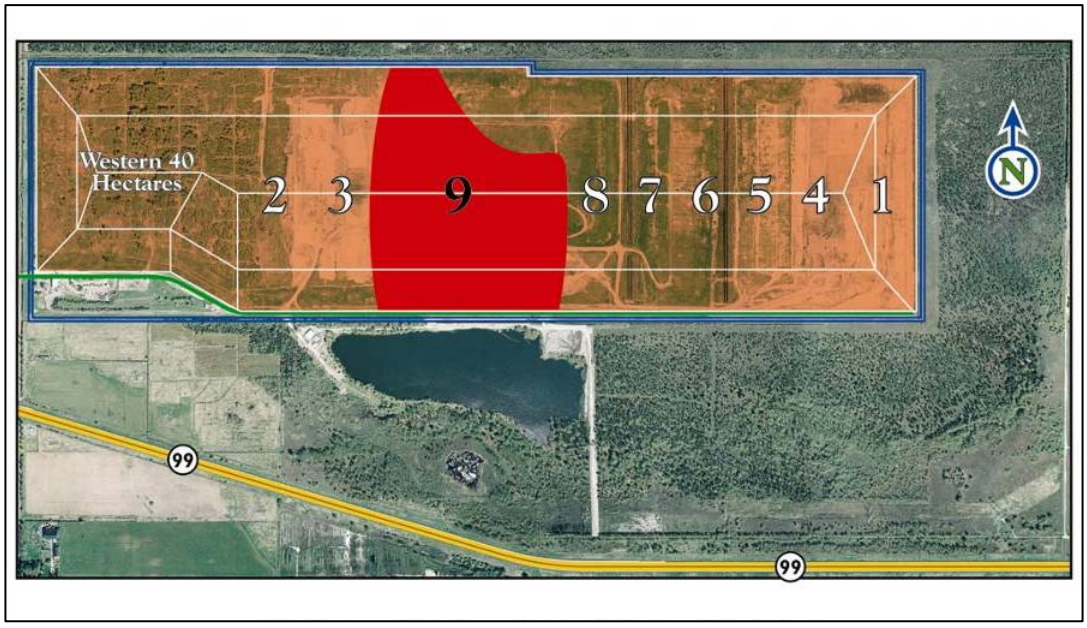


Figure 1: Fill Plan for Vancouver Landfill

Planned Improvements

In 2005, Vancouver City Council approved funding for a number of projects, including Phase 1 Closure, Pump Station Controls Upgrade and Hydrogeological Review. Details on these projects can be viewed at www.vancouver.ca/ctyclerk/cclerk/20050616/documents/cs5.pdf.

2009 Project Update: Phase 1 Closure and Landfill Gas Control System Upgrades

- Contract awarded to TYAM Construction for the construction and landfill gas upgrades in February 2009.
- TYAM mobilized to the site in March and installed the following components of the Phase 1 Closure System during the remainder of the year:
    - *Leachate/Gas Collection Layer* to collect leachate generated below the geomembrane cover and convey it to the Landfill collection and treatment system.
    - *Landfill Gas Extraction Wells* to protect the integrity of the geomembrane by capturing gas.
    - *Geomembrane Layer with Geotextile Cushions* to keep the above rainwater clean and trap landfill gas below.
    - *Drainage Layer* to direct clean water to the water collection system.
    - *Geotextile Separation Layer* to prevent the drainage layer from clogging.
    - *Subsoil Layer* to protect the geomembrane from damage due to root penetration.
    - *Topsoil Layer* to provide a growth medium for the overlying vegetation layer.
- Construction expected to be completed in the fall of 2010. The total cost of the project is estimated at $15 million.

2009 Project Update: Pump Station Controls Upgrade

In 2008, Stantec Consulting Ltd. (Stantec) reviewed the structural, mechanical and electrical components of the leachate pump station and recommended a number of improvements. In addition to a new control system, these improvements included increased standby generator capacity, variable frequency drives for the two larger pumps, modifications to the valves and piping and a new prefabricated building. Stantec completed the detailed design for the upgrade in July 2009. Subsequently the City procured a new dedicated 800 kW generator. The general construction portion of the project is expected to be complete in the fall of 2010.

2009 Project Update: Hydrogeological Review Follow Up Studies

The Landfill's Operational Certificate requires the City to complete a hydrogeological review every five years to determine if the operation of the Landfill is impacting ground and surface water systems in the vicinity of the Landfill. In 2008, Sperling Hansen Associates ('Sperling Hansen') completed the latest hydrogeological review which included two major recommendations for further investigation:

- Implement a drilling program in Phase 1 to verify water table elevations and determine if leachate is perched or mounding.
- Perform an analysis of leachate storage requirements to evaluate available capacity to store some leachate on site during extreme precipitation events.

In 2009, Sperling Hansen Associates completed two follow up studies to address these recommendations, which established the following:

- Water levels measured in Phase 1 are due to perched water conditions created by areas of low hydraulic conductivity (dense garbage & cover soil that hinder the flow of leachate by gravity).
- There is sufficient leachate storage capacity on site to accommodate the flash runoff conditions that occur during extreme precipitation events. New culverts will be installed in 2010 to ensure the maximum storage capacity can be realized.

Waste Quantities

As part of the City of Vancouver's Solid Waste Management System, the City owns and operates a municipal solid waste landfill located in the municipality of Delta. In addition to Vancouver and Delta, the Vancouver Landfill serves the communities of Richmond, White Rock, the University Endowment Lands and portions of Surrey under the terms of the 1985 Regional Solid Waste Management Plan and the 1989 Tripartite Agreement. In 2009, the total population served by the Landfill was approximately 1,025,000 or 44% of Metro Vancouver.

In 2009, garbage was disposed of in Phases 2 and 3. The annual totals for 2008 and 2009 waste, cover, and road construction materials received at the Vancouver Landfill are provided in Table 1. The historical quantities of municipal solid waste, cover soil, demolition material, and road materials are shown in Figure 2.

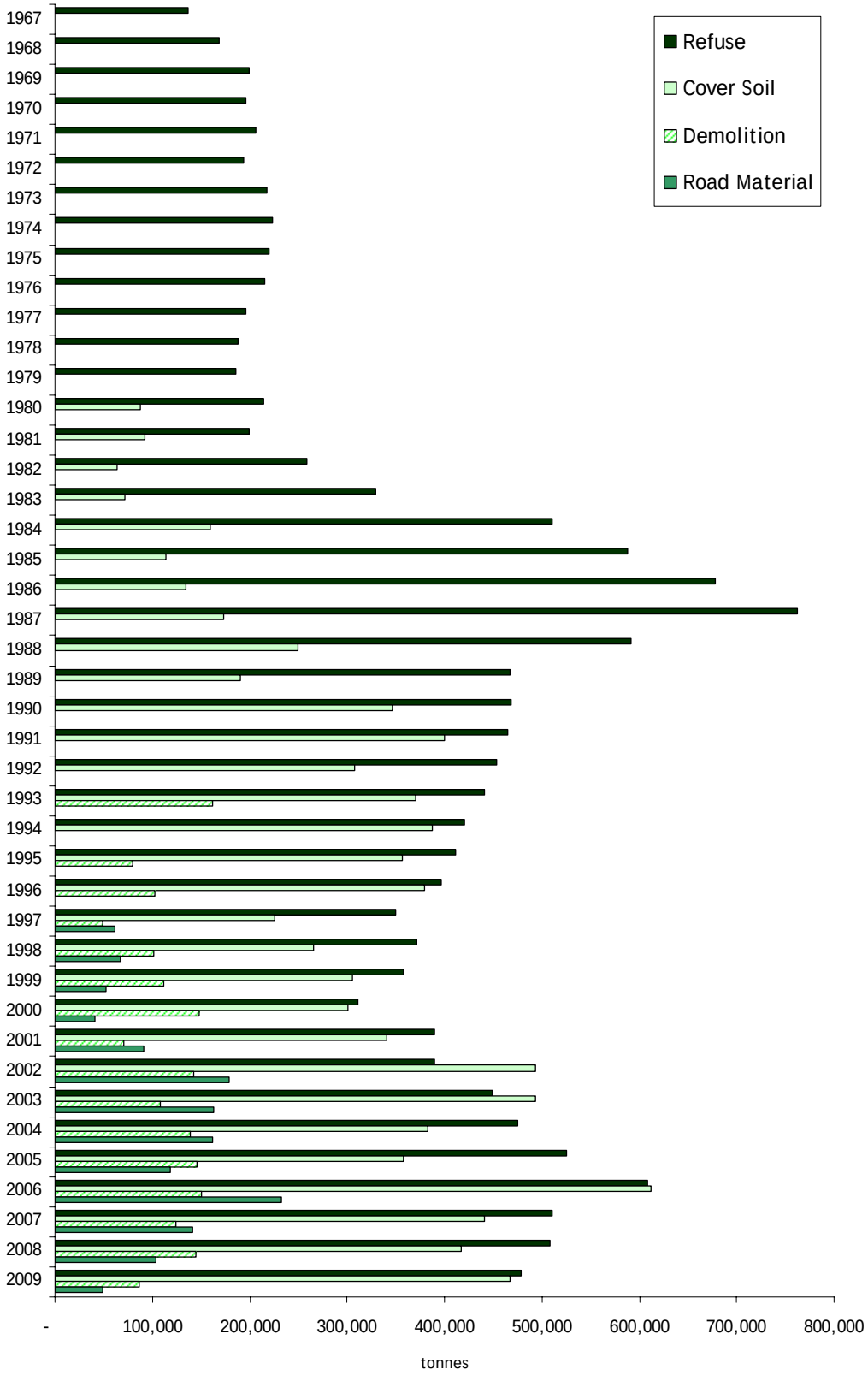


Figure 2: Vancouver Landfill Historical Waste Quantities

Waste Disposal

Waste disposed of at the Vancouver Landfill is either hauled directly to the Landfill or transferred through the Vancouver South Transfer Station (VSTS). In 2009, a total of 478,427 tonnes of municipal solid waste was disposed of at the Landfill. Of this, 211,015 tonnes was transferred through the VSTS and 163,958 tonnes was transferred from Metro Vancouver's system via the Coquitlam, North Shore and Surrey Transfer Stations. Table A1 in Appendix A provides a breakdown of material type, origin and disposal location for 2009. Table A3 shows the breakdown by month of refuse, yard trimmings, demolition material, cover material, road materials, and bottom ash for 2009.

Table 1: Vancouver Landfill Material Quantities

Material	**2009 Quantity** (tonnes)	**2008 Quantity** (tonnes)
Waste Discharge		
Municipal Solid Waste	478,427	508,207
Demolition Material	86,760	145,042
Cover Material		
Cover Soil*	467,124	416,721
Cover Sand*	3,064	5,337
Bottom Ash*	45,388	47,259
Road Construction Materials		
Crushed concrete*	3,262	9,589
Purchased concrete*	84,666	54,266
Demolition hog*	52,048	56,396
Foundry slag	2,692	3,138
Foundry sand	2,501	4,314
Total	1,225,932	1,250,269

* Note: Cover & road construction materials are used beneficially and are not included in waste discharge quantities.

Comparatively, in 2008 a total of 508,207 tonnes of municipal solid waste was disposed of at the Landfill. Table A2 provides a breakdown of material type, origin and disposal location for 2008.

A total of 6,532 tonnes of waste water treatment plant (WWTP) residuals were disposed of at the Landfill in 2009, including 2,601 tonnes of grit from Annacis Island, Lions Gate, Lulu Island and Iona WWTPs. Grit is primarily composed of materials that are denser than water and may include sand, pebbles, cinders, coffee grounds, seeds, cigarette filters and organic matter. Before grit was accepted at the Landfill, testing was conducted to confirm that it is not a Hazardous Waste under the *Environmental Management Act* and to ensure that it is acceptable for disposal at the Landfill. To minimize nuisance impacts, containers are tarped, drained and sealed at the WWTP to eliminate leakage during transportation to the Landfill.

In 2005, the Landfill began accepting sludge and scum screenings from Annacis Island WWTP on a trial basis. The goal of the trial was to identify any health, safety, environmental or nuisance impacts resulting from disposal. In October 2008 the MOE authorized the disposal of

sludge and scum screenings at the VLF, and in 2009 a total of 3,802 tonnes of these materials were accepted.

In November 2009, the Landfill began accepting drinking water treatment plant (WTP) residuals on a trial basis for the same purposes as noted above. The residuals are from the Seymour Capilano WTP and consist of silts, clays and other materials removed from the reservoirs. Approximately 151 tonnes of WTP residuals were accepted at the Landfill in 2009.

Demolition material is mainly wood waste and specified to be a minimum of 80% wood. Gypsum, asbestos, putrescible material and Hazardous Wastes are prohibited. Since 1993, demolition material has been recorded separately from excavation material because it has been accepted for a fee. In 2009, a total of 86,760 tonnes of demolition material was accepted and used to regrade the Western 40 Hectares in accordance with the approved closure plan.

Cover Material

Cover soil is primarily excavation material generated by City sewer, water and street construction activities. The landfill received a total of 467,124 tonnes of cover soil in 2009, and used the material as daily and intermediate cover on active landfill cells.

Starting in 2002, sand was no longer generated through on-site dredging. As a result, offsite cover sand was purchased. A total of 3,064 tonnes of sand were purchased in 2009 compared to 5,337 tonnes in 2008. Additionally since 2002, bottom ash has been accepted for use as a sand substitute for intermediate cover. A total of 45,388 tonnes of bottom ash was used in 2009. Lastly, a reusable tarp is employed for daily cover. Using bottom ash and a reusable tarp reduces the amount of sand required for cover.

Road Construction Materials

Road construction materials include purchased and recycled concrete, demolition (demo) hog, foundry slag and foundry sand. Demo hog is ground construction wood waste received at a nominal fee. In July 2003 and May 2004, the City began receiving foundry slag and foundry sand, respectively to reduce the amount of concrete needed for road building. Before these materials were approved to be accepted at the Landfill, testing was conducted to show that foundry slag and sand are not Hazardous Wastes under the *Environmental Management Act*.

Waste Reduction & Recycling Initiatives

Residential Drop-Off Area

The on-site transfer station, known as the Residential Drop-Off area (RDO), offers a recycling area for scrap metal, white goods, corrugated cardboard, mixed paper, newspaper, lead acid batteries, used oil, used oil filters, tires and propane tanks. Recycled quantities are provided in Table 2. The total amount of material recycled in 2009, excluding the materials measured in litres and units, was 4,325 tonnes, compared to 4,988 tonnes in 2008.

Access to the RDO is free of charge to residents if loads contain only recyclable materials. Gypsum, putrescible material and Household Hazardous Wastes are prohibited from disposal in the Landfill, and are collected in the RDO area for collection by contracted professionals.

Asbestos is also collected in the RDO area and must be double bagged. Bags are buried at the active face and their locations recorded with a GPS device.

Disposal Bans

To reduce the amount of material being landfilled that could instead be recycled, the City of Vancouver (in alignment with Metro Vancouver) implemented additional disposal bans in January 2008. Appendix 3 contains a complete list of materials that are prohibited from disposal or accepted for recycling at the Vancouver Landfill. For the most up to date list, please see the website at http://www.vancouver.ca/landfill.

Table 2: Vancouver Landfill Recycling Quantities

Item	Quantity		
	2009	2008	
Cardboard (OCC)	191	210	tonnes
Gypsum	1,737	2,600	tonnes
Lead Acid Batteries	45	45	tonnes
Mixed Paper (MPP) & Newspaper (ONP)	130	130	tonnes
Product Care Items (Paint, Aerosol, Solvent)	3	3	tonnes
Plastics	1	20	tonnes
Propane Tanks	866	860	units
Refrigerators, Freezers & Air Conditioners	2,464	2,190	units
Scrap Metal	2,143	1,870	tonnes
Tires	75	100	tonnes
Waste Antifreeze	1,025	1,230	litres
Waste Oil	16,780	11,329	litres
Waste Oil Filters	10	14	drums
Total	**4,325**	**4,988**	**tonnes**

Yard Trimmings Collection and Composting

In December 1992, Vancouver City Council approved the construction and operation of a yard and garden trimmings composting facility for an initial capital cost of $2,500,000. The facility has been operating since 1995 and includes the following; a 4.8 hectare hard surfaced footprint, an electric linear feed grinder, two front-end loaders, an excavator, and two trommel screens.

Starting in 2000, residential yard trimmings have been collected biweekly by City crews and in 2009 made up approximately 49% of trimmings processed. In total, the composting facility processed approximately 47,586 tonnes of yard trimmings in 2008, compared to 52,105 tonnes in 2009.

A total of 37,250 cubic meters of finished compost was produced and distributed in 2009, compared to 34,076 in 2008. Of this, 35,087 cubic metres were sold and 2,163 cubic metres

were donated to school groups, community gardens, City of Vancouver residents during the Keep Vancouver Spectacular (KVS) event in May 2009, and Delta residents.

Financial information for the composting facility is included in Table 3.

Table 3: Composting Facility Financial Analysis

Item	2009 Expenditure	2008 Expenditure
Operating and Equipment Capital Recovery Costs	$2,065,002	$2,334,900
Net Compost Sales Revenues	$(251,782)	$(137,800)
Compost Facility Costs	$1,813,220	$2,197,100
Transfer Costs from VSTS	$633,423	$601,300
Yard and Garden Trimmings Composting Fees	$(1,148,438)	$(885,800)
Vancouver Residential Yard Trimmings	$(1,150,108)	$(1,318,400)
Vancouver Street Leaves Collection	$(108,528)	$(206,900)
Delta Subsidy from SWCR and Delta Municipal Paid	$(59,185)	$(3,300)
Net Cost	$(19,616)	$384,000

The cost for compost production in 2009 was $38.10 per tonne of yard and garden trimmings processed, based on the compost facility costs. This represents a decrease from the 2008 cost of $44.54 per tonne processed.

Compost quality is compared to standards set out in the Ministry of Environment's Organic Matter Recycling Regulation. In 2009, the compost met the standards for unrestricted distribution for all parameters listed in the regulation. A summary of the compost quality and the standards for unrestricted use is provided in Table 4.

Table 4: Compost Quality

Parameter	2009 Mean Value mg/kg unless stated	BC Standard mg/kg unless stated
Arsenic	< 10	13
Cadmium	0.6	3
Chromium	18.7	100
Cobalt	4.2	34
Copper	61.6	400
Lead	51.3	150
Mercury	0.1	2
Molybdenum	< 4	5
Nickel	13.6	62
Selenium	< 2	2
Zinc	182.3	500
Foreign Matter	0.1%	1%

UBC Yard Trimmings & Compost Agricultural Use Studies

For many years, the City of Vancouver has worked with the University of British Columbia (UBC) Agroecology Soil Science Group to investigate the use of yard trimmings compost for local agricultural purposes. The goal of the research has been to demonstrate the benefits of using compost combined with other materials, such as poultry manure, in both conventional and organic agriculture on local farms in Delta. A new aspect of the program began in 2008, to investigate the use of compost and ground yard trimmings as a soil amendment and mulch for blueberry farming.

The program has provided significant benefits to both the City of Vancouver and Delta farmers through improved agricultural practices and a better understanding of the role of the Landfill in the community. Participation in the project supports Vancouver's sustainability objectives as well as Vancouver's food strategy by encouraging local growing of conventional and organic produce.

Environmental Protection Programs

Leachate Management

Leachate, which is defined as the product of water percolating through refuse, is collected in a double ditch system around the perimeter of the Landfill as shown in Figure 3. The inner ditch collects leachate, while the outer ditch collects clean water that runs off adjacent land. The leachate is transported from the pump station located in the southwest corner of the Landfill through a force main to Annacis Island Wastewater Treatment Plant. The 2009 unit cost for conveyance of leachate was $0.15 per m^3 plus an additional surcharge of $0.70 per m^3 for biochemical oxygen demand (BOD) and total suspended solids (TSS).

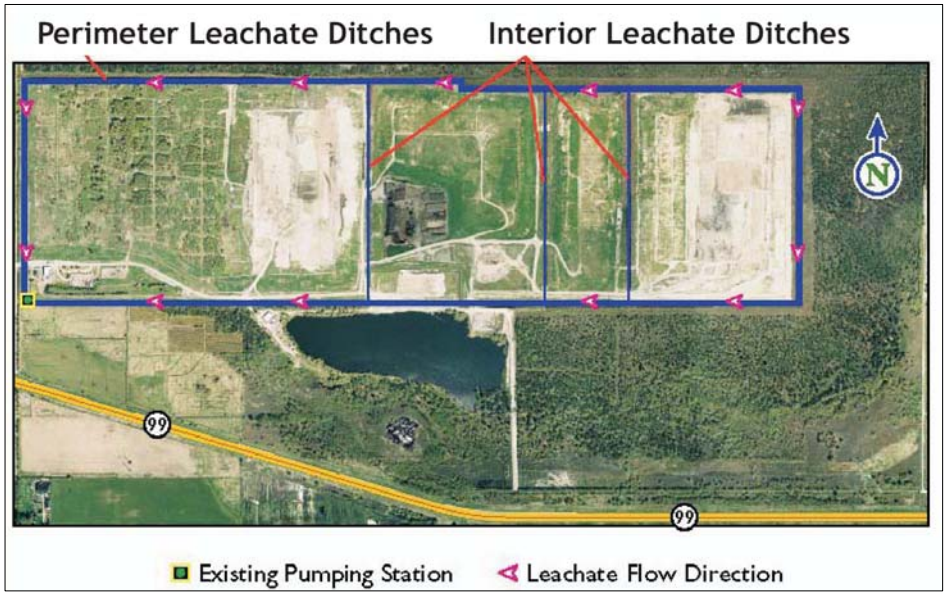


Figure 3: Leachate Collection System

Monthly leachate flow and precipitation data are provided in Table 5. A total of 1,943,564 m^3 of leachate was pumped to Annacis Island in 2009, with approximately 25% of the annual total discharged during January and 21% during November. The total leachate discharge represents 81% of the total precipitation volume. In the 2008 Hydrogeological Review, Sperling Hansen Associates estimated that approximately 35% of the total precipitation evaporates from the Landfill surface.

Table 5: 2009 Leachate Flow Volumes and Precipitation

Month	Leachate Flow (m^3)	Precipitation[1] (mm)	Precipitation Volume (m^3)	Ratio of Leachate Flow to Precipitation Volume
January	478,712	129	291,150	164%
February	144,145	57	127,800	113%
March	155,011	105	235,350	66%
April	157,453	78	174,600	90%
May	97,298	72	161,550	60%
June	50,659	11	24,300	208%
July	41,659	20	45,000	93%
August	38,324	27	59,850	64%
September	34,215	66	147,600	23%
October	89,773	147	330,750	27%
November	416,089	282	634,500	66%
December	240,226	77	174,150	138%
Total	1,943,564	1,070	2,406,600	81%

[1] Recorded Vancouver International Airport

Leachate from the Vancouver Landfill is considered dilute compared to leachate at other municipal solid waste landfills because of the high precipitation received on the site. The application of daily and intermediate cover serves to lower the infiltration of precipitation, reducing its contact time with garbage.

The geomembrane system utilized for progressive closure includes an impermeable membrane and surface water collection system that will keep the precipitation that falls on the area clean and minimize leachate generation. Initially, the surface runoff will be diverted to the leachate ditch to allow for water quality testing. When the water quality has stabilized and meets the applicable discharge criteria, the Landfill will apply for permission to divert the water to the drainage ditch. Phase 1 closure is scheduled to be completed in mid 2010.

Water Quality Review

In 2009, 15 deep groundwater wells, 13 shallow groundwater wells, and 10 surface water locations were grab sampled quarterly at the monitoring well locations shown in Appendix 4. Additionally, 24-hour composite samples representing the leachate pumped to Annacis Island Wastewater Treatment Plant were taken monthly. The samples were analyzed for up to 40 different parameters, which are listed in Appendix 2.

Consultants hired by the City have completed annual water quality reviews at the Landfill each year since 1999. The most recent review analyzed the 2009 water quality monitoring program and the executive summary of the report is provided in Appendix 6.

Landfill Gas Management System

The City of Vancouver has operated an active landfill gas collection and flare system since 1991. The system was initially installed to control odour and had the added benefit of reducing greenhouse gas emissions. In December 2002, the City entered into a 20-year agreement with Maxim Power ('Maxim') for landfill gas utilization and the following year Maxim commissioned a gas conditioning facility at the Landfill. Currently, a small portion of the gas is directed to the Landfill Administration buildings where it is used to provide space heat as well as to heat water.

The 2009 highlights related to the landfill gas management system 2009 are attributed primarily to the Phase 1 Closure Project, which included the following:

- Main Landfill Gas Header extended 525 metres around the north side of Phase 1
- Geomembrane liner installed over an area of 143,000 m^3 in Phase 1 to increase the landfill gas collection efficiency and decrease GHG emissions
- 23 new vertical gas wells installed in Phase 1 and commissioned in January 2010, which will help protect the liner by preventing gas build up
- Upgrades to the landfill gas control system began, which will include the supply & installation of new blowers, flares, control software and hardware

An overview of the landfill gas management system is shown in Figure 4.

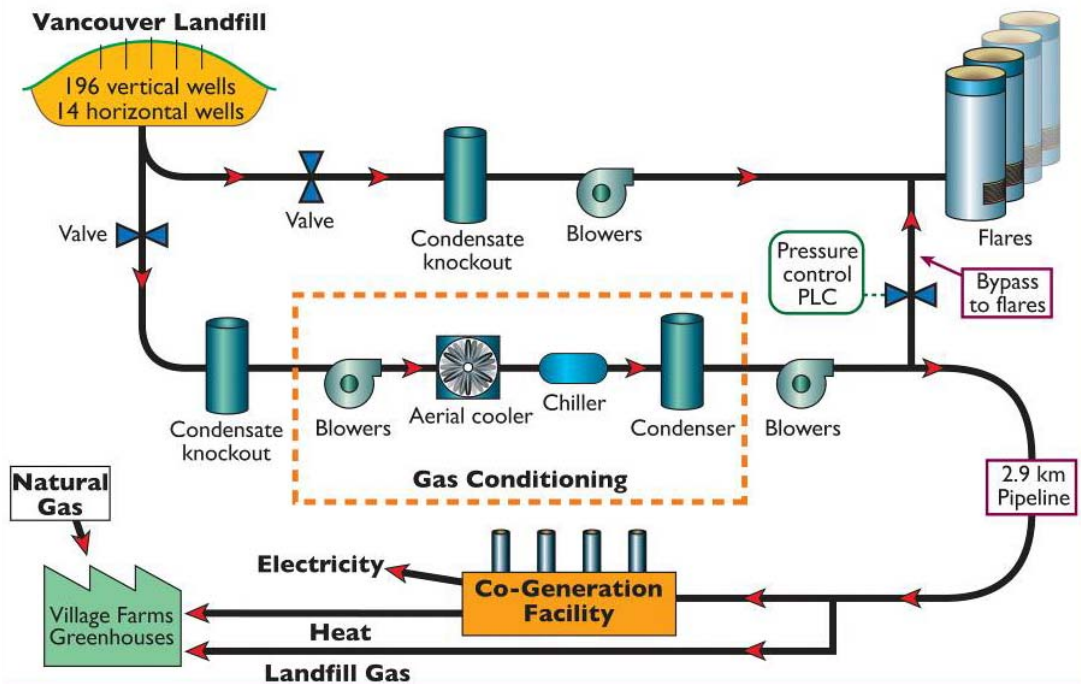


Figure 4: Vancouver Landfill Gas Collection & Beneficial Use System

Approximately 33,931,000 m^3 of LFG was collected in 2009, of which 66% was directed to beneficial use, and the remaining portion was flared. The average 2009 recovery rate corresponds to approximately 2275 scfm.

In 2009, the City began investigations into utilizing LFG as an alternate fuel for its tractor-trailer fleet. This work is continuing in 2010.

Landfill Gas Migration & Emission Monitoring Program

In October 2000, the City retained an independent consultant to implement the Landfill Gas Migration and Emission Monitoring Program. Since June 2001, ambient air has been routinely monitored in confined spaces, on-site buildings, at the flare station and at property boundary monitoring stations.

Sampling at all locations is conducted using portable gas analyzers. The flare station and confined spaces are tested for combustible gases, oxygen and hydrogen sulphide. On-site buildings are also tested for carbon dioxide. Property boundary stations are tested for total organic carbon and hydrogen sulphide.

The Year 8 Landfill Gas Migration and Emission Annual Report, issued in January 2010, provides details on measured gas levels. The Year 8 boundary perimeter test results were consistent with the historical pattern of generally low TOC readings, and had an average of less than 10 ppm. No test locations had reading exceeding the 50 ppm guideline.

The perimeter test locations along the Western edge of the property were relocated approximately 10 metres to the West, to accommodate construction of the Western portion of the new perimeter road.

The 20% of the lower explosive limit (LEL) guideline was exceeded in six of the seventeen confined spaces a total of six times; in the four pump station chambers and two the compost manholes. Depleted oxygen levels were detected in three of the confined spaces; the two compost manholes and the oil-water separator. Historically, the pump station chambers, compost manholes, and oil-water separator have had some of the highest %LEL and lowest O_2 concentrations on the property. The City is aware of these conditions, and Confined Spaces Standard Operating Procedures are strictly followed when access is required.

There were no %LEL or depleted O_2 exceedances at the flare station or in any of the on-site buildings. In addition, there were no measurable H_2S readings in either the on-site buildings or along the perimeter buffer during the year.

California Polytechnic State University Project

Cal Poly (formerly Lawrence Technological University) started a project in 2003 to investigate the impact of climate on refuse degradation. This project involved installing instrumentation in gas wells at four landfills in different climatic regions of North America. Vancouver Landfill is the 'wet climate', while landfills in Alaska, New Mexico, and Michigan represent cold, arid and control climates, respectively. Field research involves monitoring temperatures and gas concentrations over the long term, potentially for up to 20 years. Data collection continued on a limited basis due to changes in Branch staffing levels. The instrumentation arrays were abandoned in Cell F of Phase 1, and relocated in Cell A due to the closure project and construction activities.

Operational Information

Nuisance Waste

In 1999, a database was created to track nuisance waste accepted at the Landfill. Nuisance waste is defined as material that requires special consideration, documentation, handling or disposal (such as direct burial). These materials typically originate from small businesses or light industry and are not classified as Hazardous Waste under the Ministry of Environment's *Hazardous Waste Regulation*. The waste generator completes a Waste Assessment Form and submits it for review and approval by City staff. Waste Assessment Forms are entered into the database from which summary reports can be generated. Table 6 lists the types of nuisance wastes and quantities received at the Landfill in 2009.

Table 6: 2009 Vancouver Landfill Nuisance Waste Quantities

Material	2009 Quantity (tonnes)
Plant material	12
Food	1,263
Fish Plant Waste	1,085
Organic Waste with Packaging	182
Fish Nets	169
Tires	9
Other[2]	438
Total	3,176

Bird Control

Birds, particularly gulls, are a nuisance at landfill sites. In large numbers, they create a negative image of landfills and scatter litter onto surrounding areas. Birds are also a potential aviation hazard. In 1994, a trial program was initiated using an austringer (a trainer with a hawk) to control gulls at the Vancouver Landfill.

A formal program using birds of prey started in July 2001. The presence of predatory birds near the active face discourages gulls and other birds from approaching the waste. Several Harris hawks, Goshawks, and Peregrine Falcons are utilized in the program allowing multiple birds to fly on a given day, and additional birds to provide relief for those that are flying or molting. In addition, bangers, crackers and a recording of a distressed gull are used as part of the Bird Control Program.

Household Hazardous Waste

Household hazardous wastes (HHW), such as paints and pesticides, are prohibited from disposal at the Vancouver Landfill. However, residents periodically abandon or discard HHW in loads of refuse.

In 1993, a storage facility was set up at the Vancouver Landfill for abandoned HHW. The facility was upgraded in 1999 to provide a larger covered drop-off area and improved security. The facility consists of a fenced area where HHW waste is placed into 45-gallon drums, tub skids or a fireproof storage cabinet. A HHW contractor regularly removes and safely disposes of the waste.

In 2009, the total cost of processing HHW was approximately $24,500 compared to $33,900 in 2008. This cost does not include City staff time for segregating and packing the materials.

[2] Other category includes barnacles, counterfeit products, tallow & sand, etc.

Public Complaint and Resolution Log

In 2009, Landfill staff received 18 complaints, compared to 6 in 2008. The Public Complaint and Resolution Log for 2009 is provided in Appendix 5.

The majority of complaints were related to rate increases, wait times, and recyclable material limits:

- Tipping fees & minimum charges increased on July 1st in line with the regional rate increase. Customers were advised by handouts, signage & on the Landfill website.
- The purpose of the Landfill Weighscale & Residential Drop-Off Upgrade Project is to decrease wait times and improve the efficiency of the front end of the operation. This project is on hold pending the outcome of the Solid Waste Management Planning process.
- Material limits are in place to ensure the Residential Drop Off area can accommodate numerous loads of residential quantities. Commercial loads are directed to the recyclers.

Appendix 1: Annual Waste Quantities

Table A1: 2009 Vancouver Landfill Disposal Summary

	VSTS MSW	VLF MSW	Total MSW	Demo	Cover Sand	Cover Soil	Road Construction Materials					Bottom Ash
							demo hog	concrete	purchased	foundry slag	foundry sand	
	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)					(tonnes)
Vancouver Residential Collection	71,564	4,288	75,852	-	-	-	-	-	-	-	-	-
Vancouver Other	89,077	8,577	97,654	38,492	-	400,505	26,662	936	51,898	-	-	
Delta Public Works	-	5,786	5,786	-	-	-	-	-	-	-	-	-
Delta Residential Drop-Off	59	13,456	13,515	-	-	-	-	-	-	-	-	-
Delta Commercial	550	14,066	14,615	3,456	-	37,020	-	2,069	-	-	-	-
Delta Residential Contractor	-	17,057	17,057	-	-	-	-	-	-	-	-	-
Richmond	46,054	11,809	57,863	20,437	3,049	28,181	-	-	8,955	-	-	-
UEL	3,331	155	3,486	340	-	-	-	-	-	-	-	-
Surrey	26	12,175	12,201	9,915	15	565	363	-	23,813	-	-	-
White Rock	2	6,514	6,516	683	-	-	-	-	-	-	-	-
Coquitlam Resource Recovery	-	57,945	57,945	-	-	-	-	-	-	-	-	-
North Shore Transfer Station	-	105,053	105,053	-	-	-	-	-	-	-	-	-
Surrey Transfer Station Transfer	-	959	959	-	-	-	-	-	-	-	-	-
Sewage Treatment Plant Residuals	-	6,532	6,532	-	-	-	-	-	-	-	-	-
Other	352	3,039	3,391	13,437	-	852	25,022	258	-	2,692	2,501	45,388
Totals	211,015	267,411	478,427	86,760	3,064	467,124	52,048	3,262	84,666	2,692	2,501	45,388
Total Material to Vancouver Landfill:			1,225,932	tonnes								

Appendix 1: Annual Waste Quantities

Table A2: 2008 Vancouver Landfill Disposal Summary

	VSTS MSW	VLF MSW	Total MSW	Demo	Cover Sand	Cover Soil	Road Construction Materials					Bottom Ash
							demo hog	concrete	purchased	foundry slag	foundry sand	
	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)					(tonnes)
Vancouver Residential Collection	62,131	20	62,152	-	-	-	-	-	-	-	-	-
Vancouver Other	103,041	10,150	113,191	68,645	36	362,433	26,625	6,888	29,820	-	-	-
Delta Public Works	-	5,653	5,653	-	-	54,288	-	-	-	-	-	-
Delta Residential Drop-Off	18	13,660	13,678	46	-	-	-	-	-	-	-	-
Delta Commercial	525	16,911	17,436	6,078	-	-	-	-	505	-	-	-
Delta Residential Contractor	-	17,484	17,484	-	-	-	-	-	-	-	-	-
Richmond	50,073	13,825	63,898	24,798	4,154	-	-	-	5,953	-	-	-
UEL	3,440	103	3,543	99	-	-	-	6	-	-	-	-
Surrey	44	10,495	10,539	18,302	1,147	-	-	-	13,488	-	-	-
White Rock	1	7,277	7,278	1,477	-	-	-	-	-	-	-	-
Coquitlam Resource Recovery	-	68,549	68,549	-	-	-	-	-	-	-	-	-
North Shore Transfer Station	-	114,822	114,822	-	-	-	-	-	-	-	-	-
Surrey Transfer Station	-	2,281	2,281	-	-	-	-	-	-	-	-	-
Sewage Treatment Plant Residuals	-	3,318	3,318	-	-	-	-	-	-	-	-	-
Other	257	4,127	4,384	25,597	-	-	29,772	2,695	4,500	3,138	4,314	47,259
Totals	219,530	288,676	508,206	145,042	5,337	416,721	56,396	9,589	54,266	3,138	4,314	47,259
Total Material to Vancouver Landfill:			1,250,269	tonnes								

Appendix 1: Annual Waste Quantities

Table A3: 2009 Vancouver Landfill Disposal Summary by Month

Month	MSW			Yard Trimmings			Demolition Material	Cover Material	Road Material	Bottom Ash
	VSTS	VLF	Total	VSTS	VLF	Total				
	tonnes	tonnes		(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)	(tonnes)
January	17,461	26,487	43,948	1,299	347	1,647	4,555	29,068	15,842	3,523
February	15,029	16,571	31,600	2,069	480	2,549	7,243	67,484	14,452	3,388
March	15,611	22,916	38,528	2,528	583	3,111	5,814	48,057	12,024	3,204
April	17,032	29,273	46,305	3,766	848	4,614	7,445	48,377	15,934	4,165
May	17,372	29,131	46,503	4,626	842	5,468	7,706	42,141	21,426	4,135
June	18,651	27,112	45,763	4,374	788	5,162	6,654	41,397	13,111	4,271
July	18,918	23,826	42,744	3,255	692	3,948	7,837	36,919	9,394	4,434
August	18,492	20,651	39,143	2,785	663	3,448	7,025	31,863	8,791	4,293
September	18,464	21,826	40,290	3,192	705	3,897	9,040	33,098	5,122	3,477
October	18,629	20,190	38,819	3,888	1,469	5,358	8,783	37,534	10,695	3,308
November	18,421	17,019	35,440	5,467	3,460	8,928	7,001	29,258	10,630	4,097
December	16,934	12,409	29,343	2,960	1,016	3,976	7,658	21,927	7,749	3,093
Total	211,015	267,411	478,427	40,212	11,893	52,105	86,760	467,124	145,170	45,388

Appendix 2: 2009 Vancouver Landfill Water Quality Monitoring Program Parameters

Surface Water

alkalinity as $CaCO_3$	copper, total	phenols
aluminium, total	dissolved oxygen*	potassium, total & dissolved
ammonia	hardness as $CaCO_3$	sodium, total & dissolved
arsenic, total	iron, total & dissolved	specific conductivity
cadmium, total	lead, total	sulphate
calcium, total & dissolved	magnesium, total & dissolved	temperature*
chloride	manganese, total & dissolved	zinc, total
chromium, total	nickel, total	TSS
cobalt, total	pH*	TOC
turbidity	true colour	

Groundwater

alkalinity as CaCO3	cobalt, dissolved	pH*
aluminium, dissolved	copper, dissolved	phenols
ammonia	hardness as $CaCO_3$	potassium, dissolved
arsenic, dissolved	iron, dissolved	sodium, dissolved
cadmium, dissolved	lead, dissolved	specific conductivity
calcium, dissolved	magnesium, dissolved	sulphate
chloride	manganese, dissolved	temperature*
chromium, dissolved	nickel, dissolved	zinc, dissolved

Leachate Grab Samples

alkalinity as $CaCO_3$	cyanide	potassium, total & dissolved
aluminium, total	dissolved oxygen*	sodium, total & dissolved
ammonia	hardness as $CaCO_3$	specific conductivity
cadmium, total	iron, total & dissolved	sulphate
calcium, total & dissolved	lead, total	sulphide, total & dissolved
chloride	magnesium, total & dissolved	temperature*
chromium, total	manganese, total & dissolved	toxicity
cobalt, total	pH*	volatile organic compounds
copper, total	phenols, total**	zinc, total

Leachate Composite Samples

aluminium, total	copper, total	nickel, total
cadmium, total	iron, total	pH
chemical oxygen demand	lead, total	total suspended solids
chromium, total	manganese, total	zinc, total
cobalt, total	molybdenum, total	

* Field Data

** Total of 2,3,4,5 and 2,3,4,6 tetrachlorophenols and pentachlorophenols

Appendix 3: Vancouver Landfill Prohibited Waste List

The following wastes are **prohibited from garbage disposal** at the Vancouver Landfill:

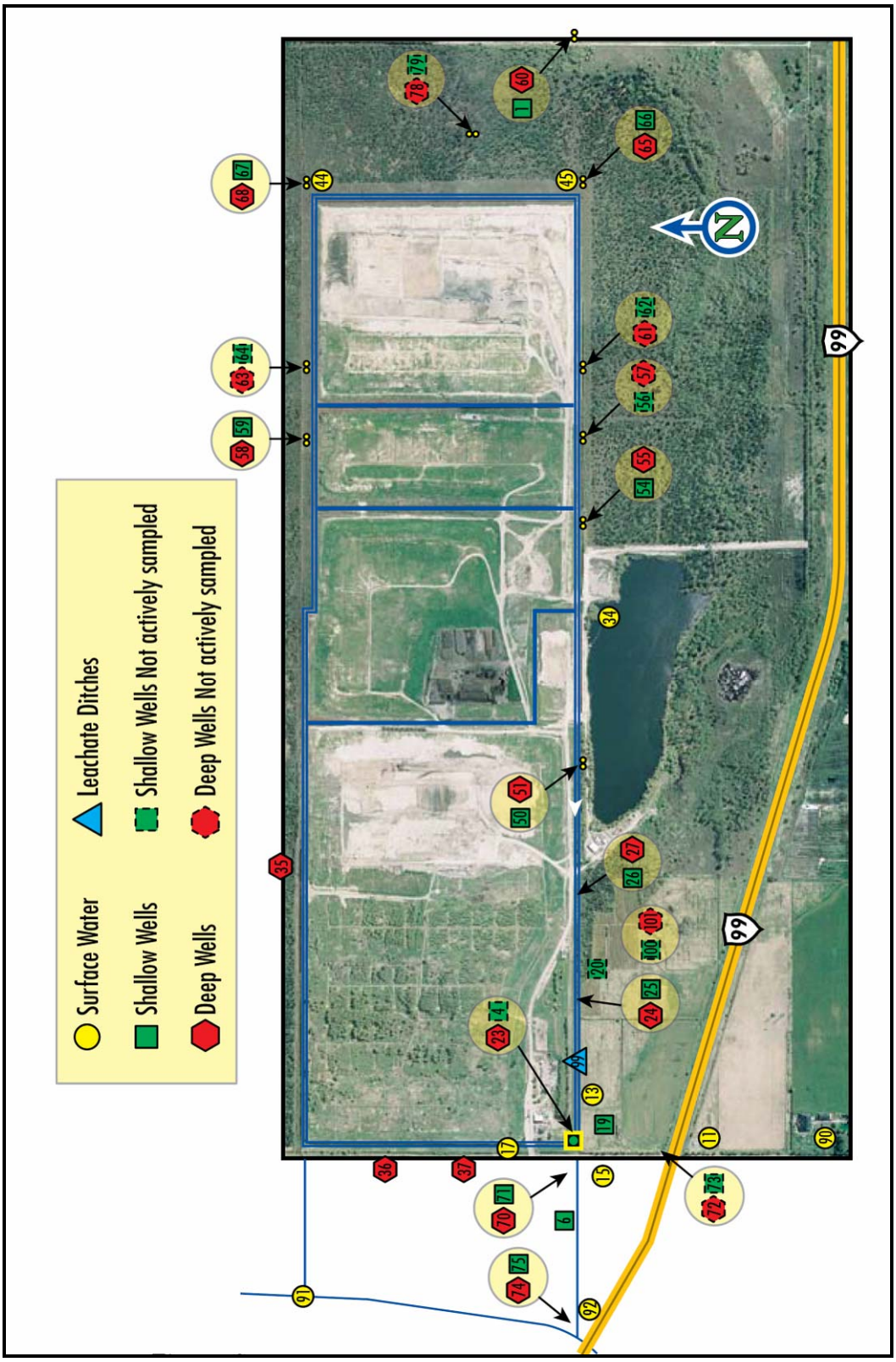
- Hazardous wastes (i.e. pathogenic and radioactive materials)
- Hazardous wastes as defined by the *Hazardous Waste Regulation* of the *Environmental Management Act*
- Biomedical waste, including sharps
- Paints, solvents, and flammable liquids, gasoline and pesticides
- Liquid wastes and sludges
- Explosive substances
- Chemicals or other materials which may create hazardous working conditions
- Inflammable materials
- Materials hot enough to start combustion
- Automobile bodies
- Boat hulls longer than 30 ft, and/or containing any metals or oils (fibreglass and wood parts are accepted for disposal only)
- Dead animals and animal parts including bones, feathers, skin, hair, nails and teeth (excluding processed meat)
- All forms of excrement
- Barrels, drums and other large liquid containers, whether full or empty
- Lumber, timber, logs, etc., longer than 3.6m (12ft)
- Solid objects larger in cross section than 3500 cm^2 ($3.8ft^2$) if longer than 2.5m (8ft)
- Fabricated objects wider or thicker than 1.2m (4ft) and longer than 2.5m (8ft).
- Soil with contaminant levels exceeding Urban Park standards defined by the *Contaminated Sites Regulation* of the *Environmental Management Act*
- Coated or uncoated wire or cable in excess of 1% by weight of any load
- Commercial loads of dry cell batteries
- Materials accepted for recycling (see list above)
- Blue box recyclables
- Beverage containers (all except milk)
- Medications/pharmaceuticals
- Asbestos and materials containing asbestos that are not double-bagged
- Desktop computers, computer monitors, notebook computers, desktop printers and fax machines, and televisions

Note: A 50% surcharge may be assessed on **garbage loads** containing:

- 5% or more by volume of one of a combination of clean old corrugated cardboard, newsprint, office paper, gypsum, yard & green waste, beverage containers, and blue box recyclables, OR
- any of lead acid batteries, medications/pharmaceuticals, paint, solvents, flammable liquids, gasoline, pesticides, vehicle tires, oil, oil filters, empty oil containers, electronic waste (tvs, computers, printers).

The City of Vancouver reserves the right not to accept any waste material. If any prohibited material is disposed at the Landfill without prior written approval by the City Engineer or an authorized representative, the material shall be removed immediately by the offending party. Violations may result in the hauler being banned from disposing at City waste facilities.

Appendix 4: Water Quality Monitoring Location Plan



Appendix 5: 2009 Public Complaint and Resolution Log

	Date	Complaint	Resolution
1	7-May-09	Recycle Limits	Advised that limit of 15 L oil per day is due to storage capacity, and provided list of alternative disposal locations.
2	19-May-09	Wait Time	Explained reason for delays: weighscale upgrades (software and hardware), Phase 1 construction, paving of bypass, etc.
3	29-Jun-09	Wait Time	Advised looking at options to better traffic flow once onsite.
4	8-Jul-09	Placards for Non Friable asbestos	Carrier agreed to hang placards for non friable asbestos.
5	10-Jul-09	Weighmaster too slow	Investigation showed there was a computer issue at the time.
6	19-Jul-09	Odour Complaint	Explained Phase 1 closure and upgrades to be completed. Encouraged to phone with any future odour compaints.
7	21-Jul-09	Rate Increase	Refund requested & granted.
8	30-Jul-09	Drywall Fee	Advised rates are the same across the region and are for cost recovery.
9	11-Aug-09	Rude Staff	Inappropriate comment made by weighscale staff. Apology made to customer.
10	12-Aug-09	Electronic Ban	Customer concerned that electronics are being dumped into dumpsters. Disposal Ban inspection process explained to customer.
11	18-Aug-09	Rates	Complaint about 'Peak Period' rates. Explained regional rates structure & that rates were advertised and are posted.
12	2-Sep-09	Wait Time	3rd complaint. See item #1
13	14-Sep-09	Rates	Complaint about 'Peak Period' rates. Explained regional rates structure & that rates were advertised and are posted.
14	14-Oct-09	Drywall Fee	Received conflicting info on drywall rate. Customer was allowed to dump & was advised that rate is posted.
15	15-Oct-09	KVS Charges	Advised that charges can only be waived if driver has proof of residency in Vancouver.
16	3-Dec-09	Weighmaster	Customer took offence to being questioned by Weighscale staff. Superintendent followed up with customer and notified Weighscale staff.
17	4-Dec-09	Rates	Complaint about 'Peak Period' rates. Explained regional rates structure & that rates were advertised and are posted.

	Date	Complaint	Resolution
18	7-May-09	Recycle Limits	Advised that limit of 15 L oil per day due to storage capacity, and provided list of alternative disposal locations.

Appendix 6: 2009 Water Quality Monitoring Report Executive Summary

A review was carried out by SNC-Lavalin Environment, Division of SNC-Lavalin Inc. (SLE) of 2009 water quality monitoring data on behalf of the City of Vancouver (the 'City'), for the City's Vancouver Landfill site (the 'Site'), located in Delta, B.C. The annual review is a requirement under the terms of the Operational Certificate (OC) for the landfill

The monitoring data collected by the City at the landfill site includes leachate flows and leachate quality, surface water elevations in the perimeter ditches, surface water quality, groundwater levels in shallow and deep aquifers, and groundwater quality in both shallow and deep aquifers. The nature and scope of the monitoring program to be carried out at the landfill site are specified within the OC and Waste Discharge Permit (WDP), the latter of which provides authorization for the City to discharge leachate from the landfill into the GVSDD sewage treatment system. The existing WDP (SC-1121) was amended by Metro Vancouver in January 2008 in response to a new sewer use Bylaw No. 299. The new WDP contains relatively minor changes with respect to sample collection methodology and provides discharge limits for several new parameters.

In compliance with the terms of the OC, SLE carried out an assessment of all 2009 landfill site water quality monitoring data, to evaluate the ongoing leachate collection and containment system efficiency, and prepare a report on the findings.

The 2009 Landfill site water quality monitoring program carried out by the City meets or exceeds the requirements set out in the OC and the WDP with respect to the number, type and locations of stations monitored, sampling frequency, water quality parameters and detection limits with the exception of two surface water stations located in the perimeter ditch system that were not sampled during dry ditch conditions.

Leachate Flow & Quality

Climatologically, 2009 was characterized by a very wet January with a significant rain-on-snow event, a very warm, dry summer and high precipitation in the month of November. There was a total of 1,943,564 m^3 of leachate discharged from the Site during 2009, with approximately 25% of the annual total discharged during January and 21% during November. Overall, this was the sixth highest annual leachate discharge over the last fifteen years while total precipitation corresponded to the fourth driest year over this period.

The monitoring program was carried out in accordance with all requirements of the OC and WDP with respect to sampling frequency and parameters analyzed. There were no exceedances of the WDP standards for any of the parameters analyzed during 2009 with the exception of total sulphide in one sample which marginally exceeded the discharge standard of 1.0 mg/L at a sample concentration of 1.31 mg/L. There is no evidence of increasing sulphide concentrations in the leachate and the single sample exceedance observed in 2009 was one of only four exceedances recorded for monthly samples over the period 1995 to 2009. It is recommended that leachate samples are analyzed for phenolic compounds using the GC/MS method in 2010 to assist in interpreting whether the source of these compounds detected in shallow and deep groundwater is due to leachate or a natural source associated with decay of organic matter in the bog vegetation.

Ditch Gradients

Inward hydraulic gradients were maintained between the outer perimeter drainage ditch and inner leachate collection ditch approximately 95% of the time during 2009, consistent with results for 2006 and 2007, but marginally lower than the 97% containment efficiency recorded for 2008. A short-term (approximately two day) gradient reversal occurred during early January 2009 when high rainfall occurred onto a melting snowpack and runoff rates temporarily exceeded leachate pumping capacity. The lowest containment efficiency (79%) in 2009 was recorded on the south landfill perimeter ditch at SG2 compared to 85% in 2008 and 98% over the preceeding five years. This was due to a weir placed in the leachate ditch in 2007 to measure leachate flows for use in closure design of Phase I of the Site that impounded leachate in the ditch and caused a reversal in gradient. Inward gradients were maintained at SG2 for the remainder of 2009 following removal of the weir in October.

Consistent with previous results, ditch gradients were undetermined during the dry summer period when dry ditch conditions prevailed, particularly in the eastern part of the Site where flow in the perimeter ditches derives from seepage from off-Site.

Groundwater Flow and Gradients

Groundwater flow directions and gradients are consistent with previous results, with the lateral flow direction in both the shallow peat and deep sand aquifers from the northeast towards the south and southwest. The majority of the operational area of the Site, including the upgradient northeast sector, is a groundwater recharge area characterized by downward hydraulic gradients from the peat into the sand aquifer. The southwest area of the Site is a groundwater discharge zone with upward flow from the sand aquifer to the water table.

Surface Water Quality

Consistent with previous findings, based on assessment of the 2009 surface water quality monitoring data, there is no indication that leachate is negatively affecting the surface water receiving environment at the Site.

Water quality in the surface drainage system ranges from an acidic (pH less than 4) water with low mineral content typical of bog-type drainage in the northeast sections of the perimeter ditch system to a neutral pH mineralized water to the south and west of the Site. Surface water outside the Site is influenced by brackish water from drainage ditches and Crescent Slough, where floodgates on the Fraser River estuary are managed to allow tidewater to back up into the slough for irrigation use. In addition to ingress of brackish water, a major highway construction project (South Fraser Perimeter Road) was underway in 2009 involving extensive placement of dredge sand as preload fill along the west margin of the Site.

Elevated concentrations of a number of metals were detected in the 2009 water quality monitoring program, particularly in the fourth quarter sampling results when preload construction activities were occurring. Spatial analysis of the concentrations indicate

concentrations of metals decrease from tidewater in Crescent Slough and Boundary Bay towards the Site indicating an off-site source such as ingress of brackish water or runoff from preload construction activities. Exceptions included dissolved aluminum and lead concentrations which are elevated in the perimeter ditch system where pH is low favouring enhanced solubility of these metals.

In addition to the metals noted above, concentrations of pH and several physical parameters and anions did not meet the applicable BCAWQG[3] and BCWWQG[4] criteria during 2009. Low pH values relative to the BCAWQG freshwater aquatic life (AW) guideline noted in surface water stations hydraulically upgradient of the Site are attributable to the acidic waters associated with natural Burns Bog drainage. Other physical parameters and anions that exceeded the criteria included EC, chloride and sulphate. Brackish waters are associated with elevated concentrations of EC, chloride and sulphate. The highest concentrations of these parameters were measured in the third quarter during the irrigation season when floodgates are managed on the Fraser River to allow water from the Fraser River estuary to flood into Crescent Slough. Based on the timing of the elevated sample concentrations, and spatial analysis of concentration patterns, the elevated concentrations of EC, chloride and sulphate appear to be related to influx of brackish water and not leachate derived from the Site.

Shallow Groundwater Quality

The transitional geologic environment across the Site from natural peat bog to cohesive mineral soils results in a corresponding gradational background shallow ground water chemistry, on which any impacts of Site operations are superimposed. The natural water quality changes from an acidic, mineral-poor bog water in the northeast sector of the Site to a more pH-neutral, minerotrophic water in the southwest corner of the Site.

Increasing concentrations in some leachate indicator parameters (primarily chloride and EC) and detections of phenolic compounds (p-cresol) were noted in several shallow groundwater monitoring stations, primarily at locations to the south and southwest of the Site. Possible causes of these trends southwest of the Landfill include previous leakage from the Ladner Trunk forcemain and brackish water from Crescent Slough. However, the historic short-term reversals in ditch gradients along the southern and western Site boundaries may also be a cause of the noted increasing trends in some leachate parameters and the phenolics detections. Water quality data collected from shallow wells along the southern landfill boundary during 2010 should be examined to determine if removal of the weir in the leachate ditch during 2009 will result in changes to the increasing leachate indicator trends observed at these locations and consideration should also be given to sampling from additional shallow wells south of the perimeter ditch system to confirm that the concentration trends observed are localized. Analysis of leachate samples for phenolic compounds by the GC/MS method is also recommended to assist in discriminating the source of detections of these compounds in both shallow and deep groundwater which may be due to decay of naturally occurring organic

[3] Water, Air and Climate Change Branch, MoE, *British Columbia Approved Water Quality Guidelines (Criteria)*, 2006 Edition (BCAWQG).
[4] Water, Air and Climate Change Branch, MoE, *A Compendium of Working Water Quality Guidelines for British Columbia* (BCWWQG), 1998 Edition, updated August 2006.

matter or leachate.

Deep Groundwater Quality

The deep aquifer background water chemistry can be described as a calcium-magnesium bicarbonate groundwater of relatively neutral pH, with a major ion chemistry and EC concentrations similar to those observed in the shallow aquifer. However, the deep aquifer is also characterized by high iron and manganese concentrations due to the strongly reducing conditions in the confined sand aquifer. EC levels typically increase from approximately 200 uS/cm in the northeast corner of the Site to approximately 500 uS/cm in the southwest corner of the Site.

The only station that appears to be affected by leachate is Station 23, where concentrations of indicator parameters have been noted to be gradually increasing since 1997. This may be due to short-circuiting of leachate from the pumping station wet well and or adjacent leachate ditch. Increasing trends in leachate indicator concentrations have been observed at several other deep aquifer groundwater monitoring stations, but the concentration increases over time are very slight, and for only a limited number of parameters. Consideration should be given to sampling of an additional well or wells in the vicinity of Station 23, but removed from potential influences of the wetwell and leachate ditch, to confirm the anomalous water quality results detected at this location.

Phenolic compounds (p-cresol) were also detected at three deep aquifer monitoring locations, both upgradient and downgradient of the Site, and thus may have a natural cause, such as the microbial degradation of vegetation.

Quality Assurance/Quality Control

The environmental monitoring program carried out for the landfill site in 2009 adhered to specified QA/QC requirements. Data Quality Objectives (DQOs) set out in the Quality Control manual were met in 2009. Overall, based on QA/QC results, leachate, groundwater and surface water analytical data can be considered reliable for the purposes outlined in the OC.