# VANCOUVER LANDFILL

## 2010 Annual Report

CITY OF VANCOUVER

Transfer & Landfill Operations Branch
City of Vancouver Engineering Services

# 2010 VANCOUVER LANDFILL ANNUAL REPORT

## TABLE OF CONTENTS

## LIST OF TABLES



## LIST OF FIGURES



## APPENDICES

## Introduction

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.

This annual report covers the period from January to December 2010 for the Vancouver Landfill, and has been prepared in accordance with the Landfill's Operational Certificate MR-01611 and the *Landfill Gas Management Regulation*.

Issued by the Ministry of Environment on March 8, 2001, the Operational Certificate authorizes the discharge of municipal solid waste and specifies the 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.

This report also meets the reporting requirements in Section 14.1 of the *Landfill Gas Management Regulation* by providing the following information:

- records for municipal solid waste quantity, sources, and composition
- description of organics diversion program(s)
- maintenance and shutdown records for the LFG management facilities
- quantity and composition of LFG collected, flared and beneficially used

## 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.

In 2009/2010, Sperling Hansen Associates completed a detailed design/fill plan for Phase 3. Elements of the plan include gas collection, leachate collection and surface water diversion works. In addition, the design specifies dividing the phase into western and eastern sections, thereby allowing one half to be filled to completion and closed prior to the second half. The advantages offered by early closure include an increase in landfill gas capture and reduction in leachate generation.

In 2010, filling occurred simultaneously in Phases 2 and 3 because of the relatively narrow widths of Phases 2 and Phase 3 west. Phase 2 will be filled to completion in 2011. Based on the 2010 Aerial Mapping Report, it is anticipated that Phase 3 West will be filled to completion in 2014, and Phase 3 East in 2020.

A full update to the Design and Operations Plan (D&O Plan) was planned for 2011/2012, however this timeline may be shifted depending on the outcome of the draft Solid Waste Management Plan (SWMP) and timing required to perform a detailed review. The role of the Landfill as outlined in the SWMP will be used to update the D&O Plan accordingly.

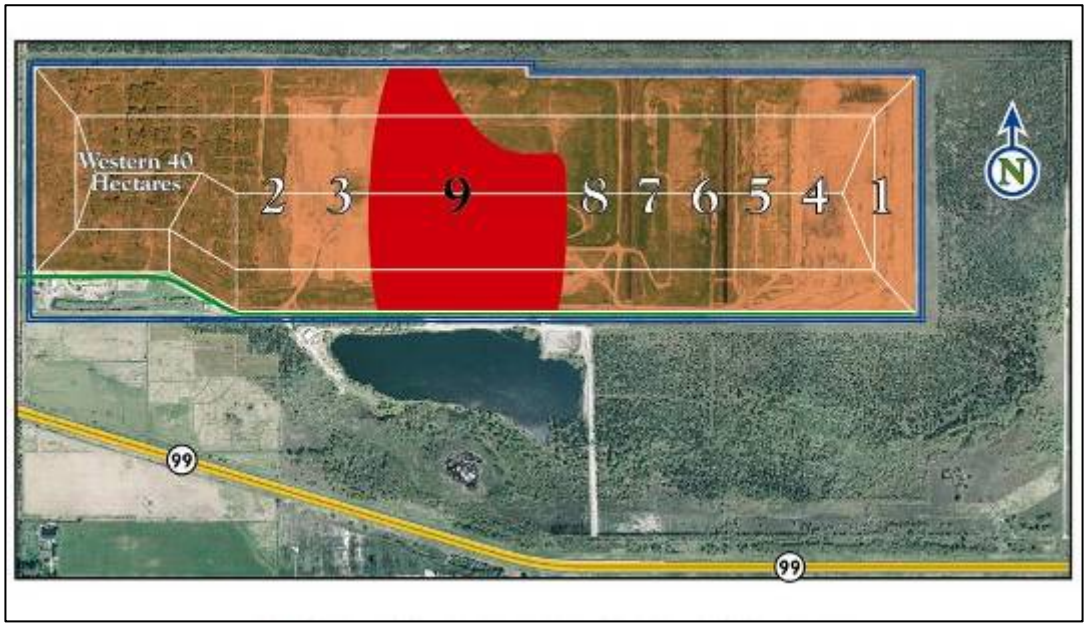



**Figure 1: Fill Plan for Vancouver Landfill**

## 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 $68,900,000 at the end of 2010.

Every year, future closure and post-closure costs are reviewed and updated with current available information. At the end of 2010, the estimated Net Present Value (NPV) of Landfill

closure & post-closure activities was $141,430,640. This estimate is based on a number of assumptions related to closure strategies & technologies, waste diversion rates, closure dates.

As per the 1989 Tripartite Agreement, the Greater Vancouver Sewerage & Drainage District (GVSDD) will cover the fraction of closure and post closure costs equivalent to the fraction of regional waste disposed of at the Vancouver Landfill. The City of Vancouver will cover the remainder of the costs, which are attributed to the fraction of waste disposed of from the City of Vancouver and Corporation of Delta. Up until the end of 2010, 23% of the total waste disposed of at the Vancouver Landfill is regional waste, with the remaining 77% originating from Vancouver and Delta.

The closure costs for Phase 1 totaled $12,275,400, of which $2,774,200 was recovered from Metro Vancouver.

## Planned Improvements

The two major capital projects underway at the Landfill in 2010 were the Phase 1 Closure and Pump Station Controls Upgrade Projects. Details on project approvals through Vancouver City Council can be viewed at www.vancouver.ca/ctyclerk/cclerk/20050616/documents/cs5.pdf.

*2010 Project Update: Phase 1 Closure and Landfill Gas Control System Upgrades*

Phase 1 of the Landfill was filled to completion in 2008 and Closure System installation began in 2009. The Phase 1 Closure System includes the following components, also depicted in Figure 2:

- *Topsoil Layer* to provide a growth medium for the overlying vegetation layer.
- *Subsoil Layer* to protect the geomembrane from damage due to root penetration.
- *Geotextile Separation Layer* to prevent the drainage layer from clogging.
- *Drainage Layer* to direct clean water to the water collection system.
- *Geomembrane Layer with Geotextile Cushion*s to keep the above rainwater clean and trap landfill gas below
- *Leachate/Gas Collection Layer* to collect leachate generated below the geomembrane cover
- *Water Collection and Discharge System* to convey water to the treatment system

The new landfill gas extraction wells in Phase 1 were fully functional as of January 2010, and the remainder of the closure project completed in the fall of 2010. Additional details on the upgrades to the collection system at Phase 1 and at the Flare Station are included in the Landfill Gas Management System section of this report, starting on page 14.

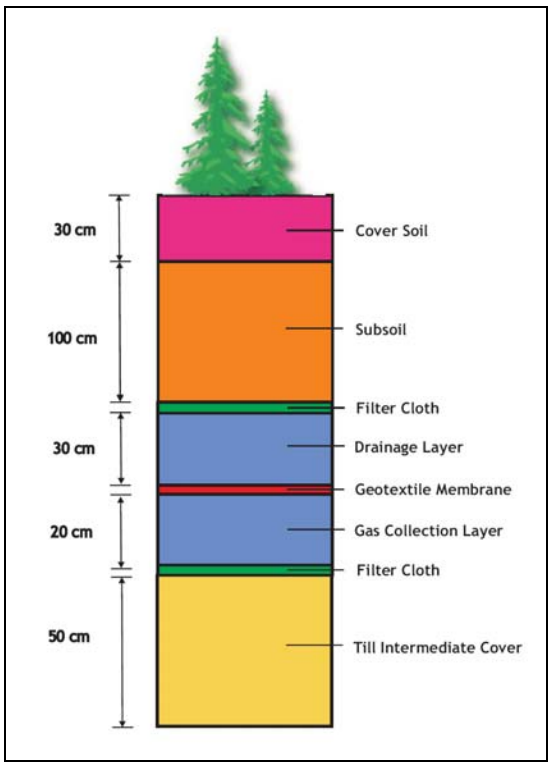



**Figure 2: Phase 1 Closure System**

*2010 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 upgrades to improve operational flexibility, efficiency and reliability. In addition to a new control system, the 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.

Work completed on the Pump Station Controls Upgrade Project in 2010 included the following:

- Dedicated 800 kW generator installed in February
- General contractor hired in April
- New controls building and system installed and fully operational within the footprint of the old building through the use of a nearby temporary control system

The Pump Station Controls Upgrade Project will conclude in the spring of 2011. The estimated project cost is $1,200,000, of which one third is covered by the Federal Government under the Infrastructure Stimulus Fund.

*2010 Project Update: New Landfill Waterline*

In late 2009, flow testing was conducted at several water hydrants at the Landfill along the existing water supply line that runs from the site entrance to the Composting Facility. The water is used for filling the Landfill water truck for dust suppression, and on rare occurrences

for fire fighting. It was recognized that the system had limited capacity for providing water at high pressure to the east side of the site, which would be the most efficient and effective way to fight a fire should one occur in that area.

The City is currently installing a new waterline along the south perimeter of the site, which will provide a flow of at least 3,800 litres per minute across the entire site. The detailed design for the project was completed by Wedler Engineering in late 2010. Construction by Sandpiper Contracting Ltd is scheduled for completion in the spring of 2011.

Total project cost is estimated at $1,000,000 of which one third is covered by the Federal Government under the Infrastructure Stimulus Fund.

*2011 – 2015: Upcoming Capital Projects*

The planned improvements for the Landfill in the next five years include the following:

- Installation of a Landfill Gas Ring Header along the northern boundary of the Landfill to increase system redundancies
- Upgrades to Weighscales and Residential Drop Off Area to improve traffic flows and capacity at the site entrance

## Waste Quantities

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 2010, the total population served by the Landfill was approximately 1,044,000 or 44% of Metro Vancouver.

In 2010, garbage was disposed of in Phases 2 and 3 West. The annual totals for 2009 and 2010 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 3.

The composition of the municipal solid waste generated in the region is measured at regular intervals in waste composition studies commissioned by Metro Vancouver. Reports for the studies conducted in 2004, 2007 and 2009 are available through Metro Vancouver's website: http://www.metrovancouver.org/services/solidwaste/planning/Pages/Reports.aspx

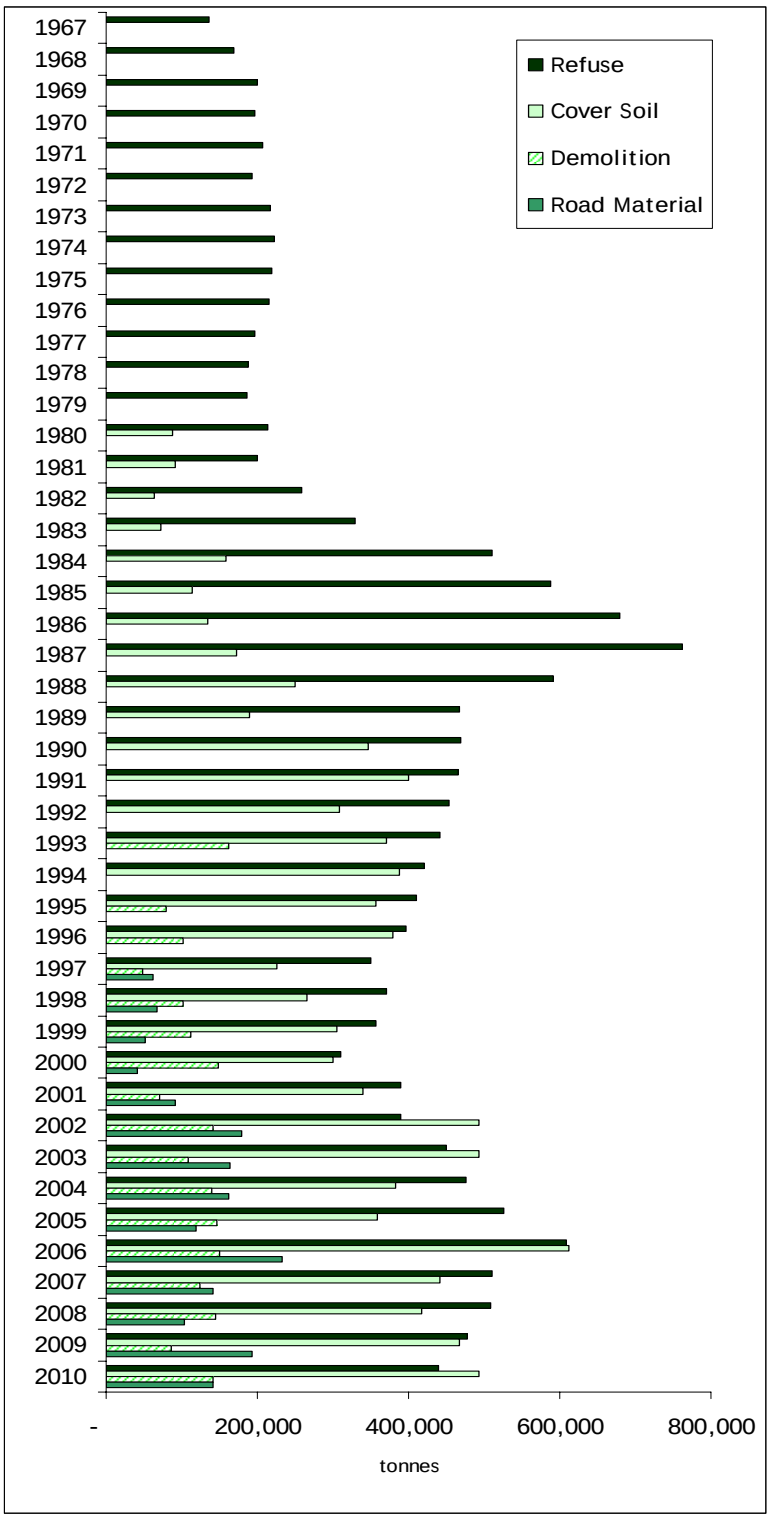



**Figure 3: Vancouver Landfill Historical Waste Quantities**

*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) or one of Metro Vancouver's Transfer Stations. In 2010, a total of 439,575 tonnes of municipal solid waste were disposed of at the Landfill. Of this, 201,950 tonnes were transferred through the VSTS and 138,475 tonnes were transferred from the Coquitlam, North Shore and Surrey Transfer Stations. Table A1 in Appendix 1 provides a breakdown of material type, origin and disposal location for 2010. Table A3 shows the breakdown by month of refuse, yard trimmings, demolition material, cover material, road materials, and bottom ash for 2010.

**Table 1: Vancouver Landfill Material Quantities**

| Material | 2010 Quantity (tonnes) | 2009 Quantity (tonnes) |
|---|---|---|
| Waste Discharge | | |
| Municipal Solid Waste | 439,575 | 478,427 |
| Demolition Material | 140,733 | 86,760 |
| Cover Material | | |
| Cover Soil* | 492,862 | 467,124 |
| Cover Sand* | 1,763 | 3,064 |
| Bottom Ash* | 46,353 | 45,388 |
| Road Construction Materials | | |
| Demolition hog* | 47,505 | 52,048 |
| Crushed concrete* | 5,244 | 3,262 |
| Purchased concrete & rock* | 35,115 | 84,666 |
| Foundry slag | 2,540 | 2,692 |
| Foundry sand | 3,505 | 2,501 |
| Total | 1,215,195 | 1,225,932 |

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

Comparatively, in 2009 a total of 478,427 tonnes of municipal solid waste were disposed of at the Landfill. Table A2 provides a breakdown of material type, origin and disposal location for 2009.

A total of 6,545 tonnes of waste water treatment plant (WWTP) residuals were disposed of at the Landfill in 2010, including 2,790 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 2010 a total of 3,755 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, and under a temporary authorization from the Ministry of Environment until the end of 2011. The residuals are from the Seymour Capilano WTP and consist of silts, clays and other materials removed from the reservoirs. Approximately 6,065 tonnes of WTP residuals were accepted at the Landfill in 2010.

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 2010, a total of 140,734 tonnes of demolition material was accepted and used to re-grade the Western 40 Hectares in accordance with the approved closure plan.

*Cover Material*

Cover soil is primarily excavation material generated by sewer, water and street construction activities in the City of Vancouver and Corporation of Delta. The landfill received a total of 492,862 tonnes of cover soil in 2010, 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 1,763 tonnes of sand were purchased in 2010 compared to 3,064 tonnes in 2009. Additionally since 2002, bottom ash has been accepted for use as a sand substitute for intermediate cover. A total of 46,353 tonnes of bottom ash was used in 2010. 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 gypsum, scrap metal, white goods, corrugated cardboard, mixed paper, newspaper, lead acid batteries, used oil, used oil filters, tires and propane tanks. Starting in the summer of 2010, the RDO began acting as a collection site for two new industry led stewardship programs; Switch the Stat – for the collection of mercury containing thermostats, and

Call2Recycle – for the collection of household batteries (single use and rechargeable) and cellular phones. Recycled quantities are provided in Table 2. The total amount of material recycled in 2010, excluding the materials measured in litres and units, was 4,905 tonnes, compared to 4,325 tonnes in 2010.

Gypsum and Household Hazardous Wastes (HHW) are prohibited from disposal in the Landfill. Gypsum is accepted at a charge to cover the costs for transportation and recycling. Batteries and used oil related items (oil, filters and containers) are the only HHW items accepted at the RDO. However, other types of HHW such as paint, pesticides, antifreeze, and flammables, are periodically abandoned or recovered by staff from the waste stream. These items are sorted into a temporary storage facility in the RDO area for collection by contracted professionals. Asbestos is also collected in the RDO area and must be double bagged for disposal. Bags are buried in a designated location close to the active face and their locations recorded with a GPS device for reference for future filling and construction activities (i.e. landfill gas wells).

**Table 2: 2010 Vancouver Landfill Recycling Quantities**

| Item | Quantity | | |
|---|---|---|---|
| | 2010 | 2009 | |
| Cardboard (OCC) | 986 | 191 | tonnes |
| Gypsum | 1,806 | 1,737 | tonnes |
| Household Batteries & Cell Phones | 205 | - | tonnes |
| Lead Acid Batteries | 30.4 | 45 | tonnes |
| Mixed Paper (MPP) & Newspaper (ONP) | 81.02 | 130 | tonnes |
| Product Care Items (Paint, Aerosol, Solvent) | 5.4 | 3 | tonnes |
| Plastics | 0.38 | 1 | tonnes |
| Propane Tanks | 886 | 866 | units |
| Refrigerators, Freezers & Air Conditioners | 2,142 | 2,464 | units |
| Scrap Metal | 1,924 | 2,143 | tonnes |
| Thermostats | - | - | tonnes |
| Tires | 72.2 | 75 | tonnes |
| Waste Antifreeze | 1640 | 1,025 | litres |
| Waste Oil | 13,640 | 16,780 | litres |
| Waste Oil Filters | 11 | 10 | drums |
| **Total** | 4,905 | **4,325** | **tonnes** |

Starting in 2011, mattresses will be received at a per-piece disposal fee and segregated for recycling.

*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. The bans included all items accepted under provincial Programs Stewardship programs and curbside collection programs.

Appendix 2 contains a complete list of materials that are accepted for recycling at the Vancouver Landfill, as well as prohibited from disposal as garbage. For the most up to date list, please see the Landfill website at www.vancouver.ca/landfill.

*Yard Trimmings Collection and Composting*

The Composting Facility at the Landfill has been operating since 1995 to process the yard and garden trimmings dropped off at the Vancouver South Transfer Station & Vancouver Landfill. In 2000, City crews began collecting residential yard and garden trimmings at the curbside for composting at the Landfill. The Facility includes a 4.8 hectare hard surfaced footprint, electric linear feed grinder, two front-end loaders, an excavator, and one trommel screen.

The open windrow composting method is utilized to process the trimmings into finished compost over a period of 6 or more months. Material is received on a daily basis from drop off at the Transfer Station & Landfill. It is ground up and placed in windrows (piles) that are turned once per month using front end loaders, to maintain optimal oxygen and temperature levels through the piles. After 5 or more turns, the material is screened and stockpiled for curing and subsequent sale or donation.

In 2009, a total of 52,205 tonnes were accepted for composting; the highest annual tonnage received to date. The total yard and garden trimmings tonnage for 2010 dropped to 31,247 tonnes due to the implementation of the Food Scraps Recycling Program in the City. Starting on April 22, 2010, residents were allowed to include uncooked fruit and vegetable waste, coffee grinds, tea bags and egg shells in their yard trimmings carts to divert them from the Landfill. The curbside material has since been going to a private composting facility because the Landfill is not yet permitted nor set up with the required technology & environmental controls to compost food waste.

Despite the drop in the incoming feedstock in 2010, a total of 38,480 cubic meters of finished compost was distributed in 2010, the highest volume distributed to date. Having such a high feedstock tonnage in 2009 allowed for this. Of the compost distributed, 35,890 cubic metres were sold, while 2,590 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.

The cost for compost production in 2010 was $48.69 per tonne of yard and garden trimmings processed, based on the compost facility costs. This represents a increase from the 2009 cost of $38.10 per tonne processed, due to the significant reduction in feedstock. Staffing and equipment levels were reduced later in the year and where feasible to maintain a competitive processing cost.

Compost quality is compared to standards set out in the Ministry of Environment's Organic Matter Recycling Regulation. In 2010, 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 3.

**Table 3: 2010 Compost Quality**

| Parameter | 2010 Mean Value mg/kg unless stated | BC Standard mg/kg unless stated |
|---|---|---|
| Arsenic | <10 | 13 |
| Cadmium | 0.6 | 3 |
| Chromium | 19 | 100 |
| Cobalt | 4 | 34 |
| Copper | 57 | 400 |
| Lead | 49 | 150 |
| Mercury | 0.1 | 2 |
| Molybdenum | <4 | 5 |
| Nickel | 13 | 62 |
| Selenium | <2 | 2 |
| Zinc | 164 | 500 |
| Foreign Matter | 0.10 | 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. The grant funding provided for these projects expired at the end of 2010 and was not renewed due to the required reduction in spending associated with the Composting Facility.

## 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 4. The inner ditch collects leachate, while the outer ditch collects clean water that runs off adjacent land. The leachate drains to the pump station located in the southwest corner of the Landfill, from which it is pumped through force mains to the Annacis Island Wastewater Treatment Plant (WWTP) under Waste Discharge Permit SC-100168-FSA.

The annual fees associated with leachate disposal include a conveyance fee paid to Delta for the use of the sewer system, and an industrial discharge fee made up of capacity and usage components for the treatment of the leachate at the WWTP. The capacity and usage charges account for biological oxygen demand (BOD), total suspended solids (TSS) and flow. In 2010, the rate for conveyance was $0.71/m3, while the rates for treatment included usage charges of $0.324/kg BOD, $0.432/kg TSS and $0.152/m3, and capacity charges of $25.082/kg BOD/day, $26.865 /kg TSS/day and $10.884/$m^3$/day.

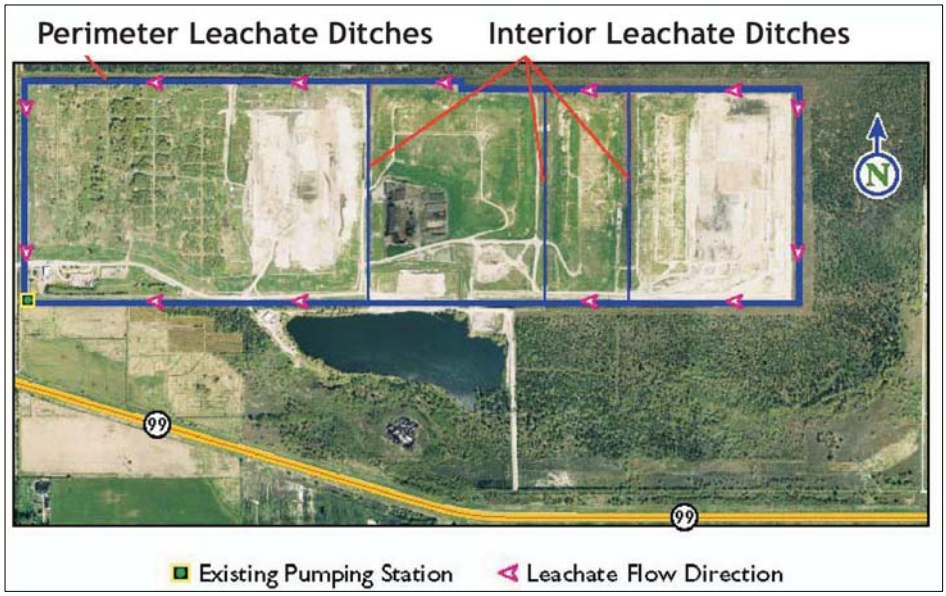



**Figure 4: Leachate Collection System**

Monthly leachate flow and precipitation data are provided in Table 4. A total of 2,185,798 m3 of leachate was pumped to Annacis Island in 2010. The total leachate discharge represents 80% of the total precipitation volume. The remaining volume is lost from the landfill surface through evapouration.

A natural barrier layer protects the groundwater beneath the Landfill and surrounding Bog from leachate contamination. The 2008 Hydrogeological Review completed by Sperling Hansen Associates established that the effectiveness of the compressed peat and silty clay layers beneath the Landfill provide the equivalent of twice the level of barrier protection required by the Ministry of Environment's *Landfill Criteria for Municipal Solid Waste.*

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.

**Table 4: 2010 Leachate Flow Volumes and Precipitation**

| Month | Leachate Flow | Precipitation[1] | Precipitation Volume | Ratio of Leachate Flow to Precipitation Volume |
|---|---|---|---|---|
| | ($m^3$) | (mm) | ($m^3$) | |
| January | 359,022 | 182.8 | 411,300 | 87% |
| February | 189,992 | 102.2 | 229,950 | 83% |
| March | 197,578 | 108.2 | 243,450 | 81% |
| April | 131,288 | 88.0 | 198,000 | 66% |
| May | 75,916 | 54.2 | 121,950 | 62% |
| June | 65,051 | 48.6 | 109,350 | 59% |
| July * | 36,324 | 0.6 | 1,350 | 2691% |
| August | 34,301 | 69.6 | 156,600 | 22% |
| September | 173,667 | 166.4 | 374,400 | 46% |
| October | 162,677 | 76.3 | 171,675 | 95% |
| November | 262,257 | 142.8 | 321,300 | 82% |
| December * | 497,725 | 167.4 | 376,650 | 132% |
| Total | 2,185,798 | 1,207 | 2,715,975 | 80% |

* Note: the high ratios of leachate flow to precipitation volume reported in July and December 2010 are due to the release of stored water, which occurs when the landfill becomes saturated.

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 the water quality to stabilize, and for water quality testing and flow measurement. The surface water collection system also includes water diversion bridges that pass over the leachate ditch and can allow for the diversion of the surface water above the cover to the outer drainage ditch. The Design and Operations Plan suggests that diversion be considered when the water quality has stabilized and meets the applicable discharge criteria, and permission for discharge is granted from the Ministry of Environment. It is recognized that other options may need to be considered in addition to direct discharge to the outer ditch to reduce leachate volumes requiring conveyance and treatment, while minimizing impacts beyond the Landfill property.

*Water Quality Monitoring Program & Annual Review*

The Landfill's Water Quality Monitoring Program includes leachate, surface water and groundwater monitoring locations in and outside of the leachate collection system for collecting water samples to ensure there is no migration of leachate into the surrounding environment. The groundwater wells consist of shallow wells in the peat aquifer that range in depth between 2.5 – 4 m deep, as well as deep wells in the sand aquifer that range in depth between 6 – 9 m deep.

In 2010, 10 surface water locations, 16 shallow groundwater wells, and 18 deep groundwater wells were grab-sampled quarterly at the monitoring well locations shown in Appendix 3. This

[1] Recorded Vancouver International Airport

includes two shallow wells and three deep wells that were installed in 2010 and sampled in the last two quarterly events only. 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.

The installation of five new groundwater wells in 2010 was based on the conclusions & recommendations of previous annual reviews of the Water Quality Monitoring Program. The new well details are as follows:

- Shallow & deep groundwater wells 120 and 121, respectively, are located in the northeast corner of the property. These wells were installed to serve as background wells to ultimately replace background wells 1 and 60, pending approval from the Ministry of Environment (to be requested after additional sampling of the new wells).
- Shallow & deep groundwater wells 123 and 124, respectively, are located in the berm between the ditches and approximately 50m east of monitoring well 23 at the pump station. They will provide water quality data hydraulically cross-gradient to well 23.
- Deep groundwater well numbered 122 is located approximately 50m southwest of well 23, which is immediately downgradient of the pump station and well 23.

Consultants hired by the City have completed annual reviews of the Water Quality Monitoring Program at the Landfill each year since 1999. The executive summary from the *2010 Water Quality Monitoring Program Review* prepared by SNC-Lavalin Environmental Inc is included in Appendix 6. The recommendations from the review include the following:

1. Continue to review staff gauge data on an on-going basis.
2. Investigate the applicability of the numerical standards for the protection of drinking water in *Technical Guidance Document 6* of the *Contaminated Site Regulation* as brought into effect on February 1, 2011, as part of the 2011 Water Quality Monitoring Program Review.
3. Request that the analytical laboratory lower the detection limits for all reported total and dissolved metals concentrations in surface water, leachate and groundwater.
4. Request that the analytical laboratory lower the detection limits for the analysis of sulphate and chloride in surface water and groundwater for the 2011 water quality monitoring program.
5. Continue sampling for non-chlorinated phenols in 2011.
6. Review the analytical parameters required by the Operational Certificate and Waste Discharge Permit to ensure that there are no unnecessary parameters being collected and analyzed.
7. Re-survey shallow and deep monitoring wells 1 and 60, respectively. Decommission these wells before the land on the eastern side of the property is transferred over to the Corporation of Delta.
8. Consider decommissioning deep monitoring well 23 and drilling a replacement well in the vicinity of this location.

*Landfill Gas Management System*

The City of Vancouver has operated an active landfill gas (LFG) 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. In 2009, the City began investigations into utilizing LFG as an alternate fuel for its tractor-trailer fleet. This work continued in 2010.

The 2010 highlights related to the landfill gas management system included the following:

- The 23 new vertical wells, 1 horizontal well and new horizontal collection network in Phase 1 were commissioned in January.
- 3 condensate tanks, 3 blowers, 2 flares, and an electrical controls building were installed as part of the Flare Station Landfill Gas Control Systems Upgrade. This equipment will allow the City to increase gas collection and flaring capacities with the upcoming phase closures.
- Measures to improve intermediate cover and control erosion were undertaken on areas of Phase 2 and the Western 40 hectares to reduce the potential for air intrusion into the Landfill. Air intrusion is a concern because it can reduce the production of landfill gas and increase the potential for fire. Specific erosion control works will be incorporated into the designs for future phases.

An overview of the landfill gas management system is shown in Figure 5.

Approximately 40,789,225 $m^3$ of LFG was collected in 2010, which represents an increase in collection from 2009 of over 20%, and is in line with gas collected annually from 2006 - 2008. Of the gas collected, 69% was directed to beneficial use, and the remaining portion was flared. The average 2010 recovery rate corresponds to approximately 2,741 scfm of LFG.

The composition of the landfill gas collected is measured at the flare station / gas conditioning facility by a gas analyser, and the average composition logged in daily reports. In 2010, the average daily concentration of methane in the landfill gas ranged from 45.8% to 55.6%, with an average of 51.7% for the year.

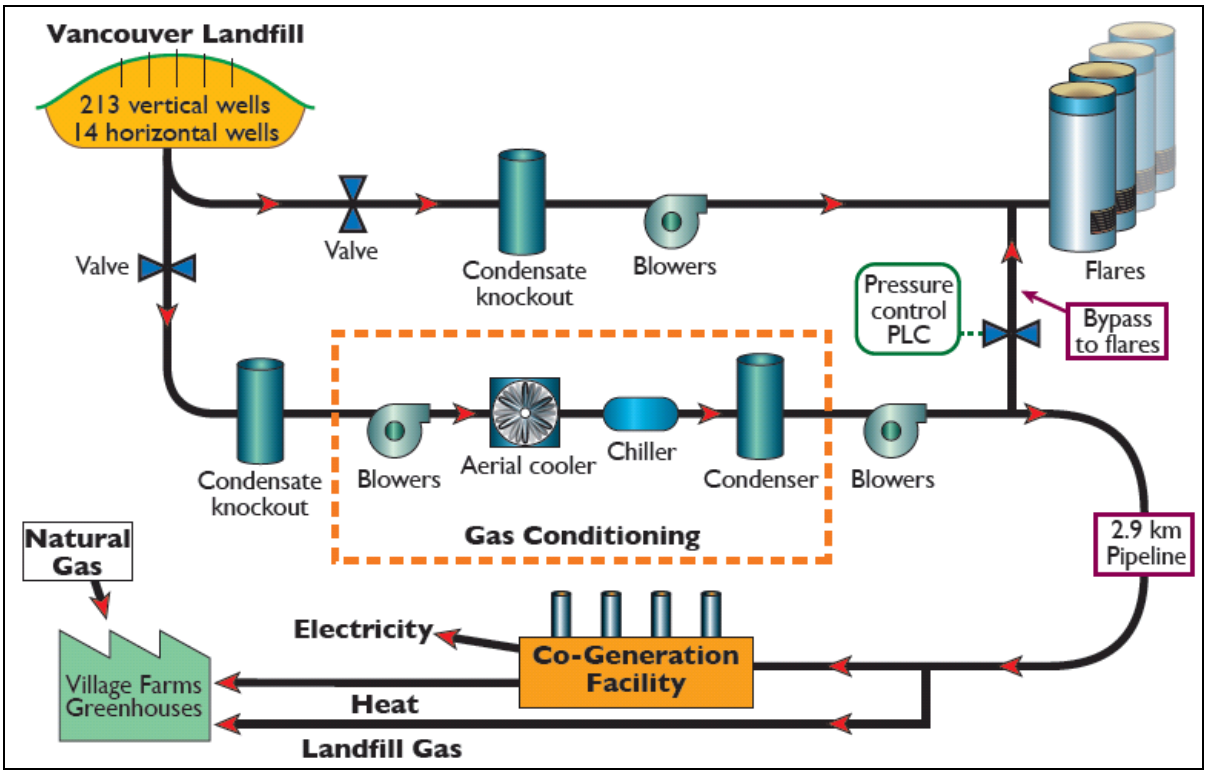



**Figure 5: Vancouver Landfill Gas Collection & Beneficial Use System**

In 2010, there were a total of 8 instances when the landfill gas collection station was inactive, either for maintenance purposes or due to a power outage. The system was operational 99.6% of the time. Table 5 provides a list of the date, time, duration and comments associated with each outage. In 2011, the City owned portion of the collection system will be connected to the backup generator at the landfill, so the collection system will continue to function and flare the gas during any power outages. Shutdowns will only occur on a planned basis when maintenance is required. All efforts are made during planned shut downs to minimize duration: through planning and coordination.

**Table 5: 2010 Gas Collection System Outages**

| | Date | Start | End | Duration (hours) | Comments |
|---|---|---|---|---|---|
| 1 | Jan 23, 2010 | 6:00 | 9:00 | 3 | Chiller faulted |
| 2 | Mar 26, 2010 | 8:45 | 13:30 | 4.75 | Shut down to clean knock out pot (KOP#3) |
| 3 | Apr 24, 2010 | 5:18 | 7:42 | 2.4 | Power Outage |
| 4 | Apr 29, 2010 | 7:00 | 18:12 | 11.2 | Shut down to install condensate trap (CT14A) |
| 5 | Jun 20, 2010 | 4:26 | 10:30 | 6.1 | Power Outage |
| 6 | Aug 7, 2010 | 7:56 | 9:16 | 1.3 | Power Outage |
| 7 | Aug 31, 2010 | 15:38 | 19:38 | 4 | Power Outage |
| 8 | Dec 6, 2010 | 8:45 | 12:00 | 3.25 | Power Outage |
| Total Outage Time | | | | 36 hours | |

*Landfill Gas Generation Assessment*

A Landfill Gas Generation Assessment Report was completed for the Vancouver Landfill in early 2011 by Conestoga-Rovers and Associates to fulfill the requirements of the Ministry of Environment's *Landfill Gas Management Regulation* (Regulation). A prescribed calculation methodology was used to establish whether methane generation exceeded the threshold of 1,000 tonnes in 2010. Exceeding the threshold triggers the requirement for the facility to prepare a LFG Management Facility Design Plan by January 1, 2012, and to implement the design works to establish a minimum collection efficiency of 75% by January 1, 2016.

Based on actual Vancouver Landfill waste quantities received up to 2009 and forecasted 2010 waste tonnages, Conestoga-Rovers & Associates estimated that the total methane generated at the Landfill in 2010 was approximately 25,847 tonnes. This equates to 5,297 scfm of LFG. In 2010, the City collected a total of 13,374 tonnes of LFG or an average of approximately 2,741 scfm of LFG. On this basis, the collection efficiency of the system in 2010 was approximately 52%. The collection efficiencies previously reported were based on modeling work conducted in 2007 and thus did not take into account the reduction in waste tonnage experienced between 2006 and 2010. Gas collection also increased in 2010 compared to 2009 as a result of the completion of Phase 1 Closure.

*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 (total of 106) are tested for total organic carbon (as methane; TOC) and hydrogen sulphide.

The results of the 2010 Landfill Gas Migration and Emission Monitoring Program are as follows:

- The perimeter test results were consistent with the historical pattern of generally low total organic carbon (TOC) readings, and had an average of less than 10 ppm. No test locations had readings exceeding the 50 ppm guideline for TOC, or any readings for hydrogen sulphide.
- Elevated combustible gas levels were measured in two of the seventeen confined spaces in October 2010; in one of the two compost manholes and in the oil water separator. The 20% lower explosive limit (LEL) guideline was not exceeded. Depleted oxygen levels were detected in three of the confined spaces; the two compost manholes and the oil-water separator, consistent with historical results. 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 oxygen exceedances at the flare station or in any of the on-site buildings. In addition, there were no measurable hydrogen sulphide readings in the on-site buildings 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. In 2009, the instrumentation arrays were abandoned in Cell F of Phase 1, and relocated in Cell A due to the closure project and construction activities. Data collection continued in 2010.

## 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 2010.

**Table 6: 2010 Vancouver Landfill Nuisance Waste Quantities**

| Material | 2010 Quantity (tonnes) |
|---|---|
| Fish Nets | 68 |
| Fish Processing Waste | 633 |
| Food Waste | 336 |
| Grain Shipping Waste | 693 |
| Greenhouse Mixed Waste | 99 |
| Tires | 23 |
| Other[2] | 84 |
| **Total** | 2,118 |

[2] Other category includes mattresses, ice paint, incinerator ash, wood siding, counterfeit products, foam and plastic waste.

*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 and screechers 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 2010, the total cost of processing HHW was approximately $47,430 compared to $24,500 in 2008. This cost does not include City staff time for segregating and packing the materials.

*Public Complaint and Resolution Log*

In 2010, Landfill staff received 22 complaints, compared to 18 in 2009. The Public Complaint and Resolution Log for 2010 is provided in Appendix 5.

The majority of complaints were related to a compost rate adjustment and wait times (line ups):

- In 2010, the compost rates at the scales were adjusted to account for the advertised rate of $\$10/m^3$ (by volume), which is measured at the scales by weight.
- There were periods in 2010 when the volume dirt coming to the Landfill was higher than usual due to the number of construction and municipal infrastructure projects underway in the City of Vancouver and Corporation of Delta. Limits were placed on the number of loads that could be received per day to try to minimize line-ups.

  Construction for the Landfill Weighscale & Residential Drop-Off Upgrade Project is planned for 2011/2012, which will decrease wait times and improve the efficiency of the front end of the operation.

## Appendix 1: Annual Waste Quantities

### Table A1: 2010 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 | |
| | *tonne* | *tonne* | *tonne* | *tonne* | *tonne* | *tonne* | | | *tonne* | | | *tonne* |
| Vancouver Residential Collection | 62,564 | 327 | 62,981 | - | - | - | - | - | - | - | - | - |
| Vancouver Other | 96,399 | 9,057 | 105,456 | 53,082 | 266 | 343,311 | 18,476 | 909 | 25,246 | - | - | - |
| Delta Public Works | - | 6,056 | 6,056 | - | - | - | - | - | - | - | - | - |
| Delta Residential Drop-Off | 56 | 13,013 | 13,069 | - | - | - | - | - | - | - | - | - |
| Delta Commercial | 408 | 12,515 | 12,924 | 7,564 | - | 75,820 | - | 589 | - | - | - | - |
| Delta Residential Contractor | 38 | 17,067 | 17,106 | - | - | - | - | - | - | - | - | - |
| Richmond | 38,243 | 12,102 | 50,345 | 34,698 | 1,496 | 5,683 | - | 491 | 2,198 | - | - | - |
| UEL | 3,332 | 82 | 3,415 | 215 | - | 41,565 | - | 632 | - | - | - | - |
| Surrey | 95 | 10,393 | 10,488 | 18,860 | - | 26,483 | - | 79 | 7,671 | - | - | - |
| White Rock | 8 | 4,335 | 4,343 | 2,262 | - | - | 104 | - | - | - | - | - |
| Coquitlam Resource Recovery | - | 60,209 | 60,209 | - | - | - | - | - | - | - | - | - |
| North Shore Transfer Station | - | 77,584 | 77,584 | - | - | - | - | - | - | - | - | - |
| Surrey Transfer Station Transfer | - | 683 | 683 | - | - | - | - | - | - | - | - | - |
| Water Treatment Plant Residuals | - | 6,065 | 6,065 | - | - | - | - | - | - | - | - | - |
| Sewage Treatment Plant Residuals | - | 6,545 | 6,545 | - | - | - | - | - | - | - | - | - |
| Other | 807 | 1,592 | 2,399 | 24,052 | | - | 28,925 | 2,545 | | 2,540 | 3,505 | |
| Totals | 201,950 | 237,625 | 439,575 | 140,733 | 1,763 | 492,862 | 47,505 | 5,244 | 35,115 | 2,540 | 3,505 | 46,353 |

Total Material to Vancouver Landfill: 1,215,195 tonnes

## Appendix 1: Annual Waste Quantities

### Table A2: 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 | |
| | *tonne* | *tonne* | *tonne* | *tonne* | *tonne* | *tonne* | | | *tonne* | | | *tonne* |
| Vancouver Residential Collection | 64,430 | - | 64,430 | - | - | - | - | - | - | - | - | - |
| Vancouver Other | 96,211 | 12,865 | 109,076 | 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 | 267,412 | 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: 1,225,933 tonnes

## Appendix 1: Annual Waste Quantities

### Table A3: 2010 Vancouver Landfill Disposal Summary by Month

| Month | MSW | | | Yard Trimmings | | | Demolition Material | Cover Material | Road Material | Bottom Ash |
|---|---|---|---|---|---|---|---|---|---|---|
| | VSTS | VLF | Total | VSTS | VLF | Total | | | | |
| | *tonne* | *tonne* | *tonne* | *tonne* | *tonne* | *tonne* | *tonne* | *tonne* | *tonne* | *tonne* |
| January | 17,231 | 18,254 | 35,486 | 1,829 | 388 | 2,217 | 7,463 | 22,454 | 8,932 | 4,244 |
| February | 16,906 | 13,824 | 30,730 | 1,550 | 505 | 2,055 | 9,703 | 19,595 | 9,497 | 3,919 |
| March | 17,955 | 21,915 | 39,869 | 2,688 | 801 | 3,489 | 11,790 | 42,090 | 5,400 | 4,088 |
| April | 16,707 | 29,328 | 46,035 | 2,789 | 957 | 3,746 | 10,354 | 57,052 | 6,736 | 3,250 |
| May | 16,733 | 26,872 | 43,604 | 1,351 | 1,008 | 2,359 | 11,793 | 39,313 | 9,153 | 4,334 |
| June | 16,917 | 27,769 | 44,686 | 1,494 | 863 | 2,357 | 14,103 | 38,722 | 7,492 | 4,273 |
| July | 17,632 | 26,601 | 44,233 | 1,289 | 591 | 1,880 | 15,082 | 37,293 | 6,000 | 4,129 |
| August | 17,253 | 19,382 | 36,634 | 1,125 | 407 | 1,532 | 13,471 | 66,269 | 6,526 | 3,971 |
| September | 17,409 | 15,995 | 33,404 | 1,278 | 438 | 1,716 | 14,232 | 55,024 | 7,294 | 3,505 |
| October | 16,203 | 19,219 | 35,422 | 1,562 | 687 | 2,249 | 10,081 | 52,724 | 8,245 | 3,027 |
| November | 15,505 | 9,804 | 25,309 | 1,836 | 2,339 | 4,175 | 12,087 | 40,072 | 7,608 | 3,572 |
| December | 15,500 | 8,662 | 24,162 | 1,439 | 2,289 | 3,728 | 10,574 | 24,016 | 11,027 | 4,040 |
| Total | 201,950 | 237,625 | 439,575 | 20,229 | 11,274 | 31,502 | 140,734 | 494,624 | 93,910 | 46,353 |

## Appendix 2: Vancouver Landfill Recyclable Materials and Prohibited Wastes List

### RECYCLABLE MATERIALS AND PROHIBITED WASTES

**Residential quantities** of the following materials are accepted free of charge for **recycling** at the Vancouver Landfill:

- ✓ Used oil filters (maximum 3)
- ✓ Used oil (maximum 15 litres)
- ✓ Used oil containers
- ✓ Lead acid car batteries
- ✓ Empty propane cylinders
- ✓ White goods (large appliances)
- ✓ Metal
- ✓ Corrugated cardboard (OCC)
- ✓ Recyclable old newspapers (ONP) and office papers (OP); telephone books, computer paper, white and coloured bond and letterhead
- ✓ Rigid plastic containers (any color) marked #1 (PET), #2 (HDPE), #4 (LDPE) and/or #5 (PP)
- ✓ Tires (passenger or light truck with or without rims)
- ✓ Gypsum drywall (max. 1 pick up truck load, charges apply)

Note: As of Nov. 1, 2008, mattresses are not accepted for recycling. They can be brought to the Landfill for disposal at the garbage tipping fee. Loads of 5 or more mattresses will be subject to a **burial charge** of $200.

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

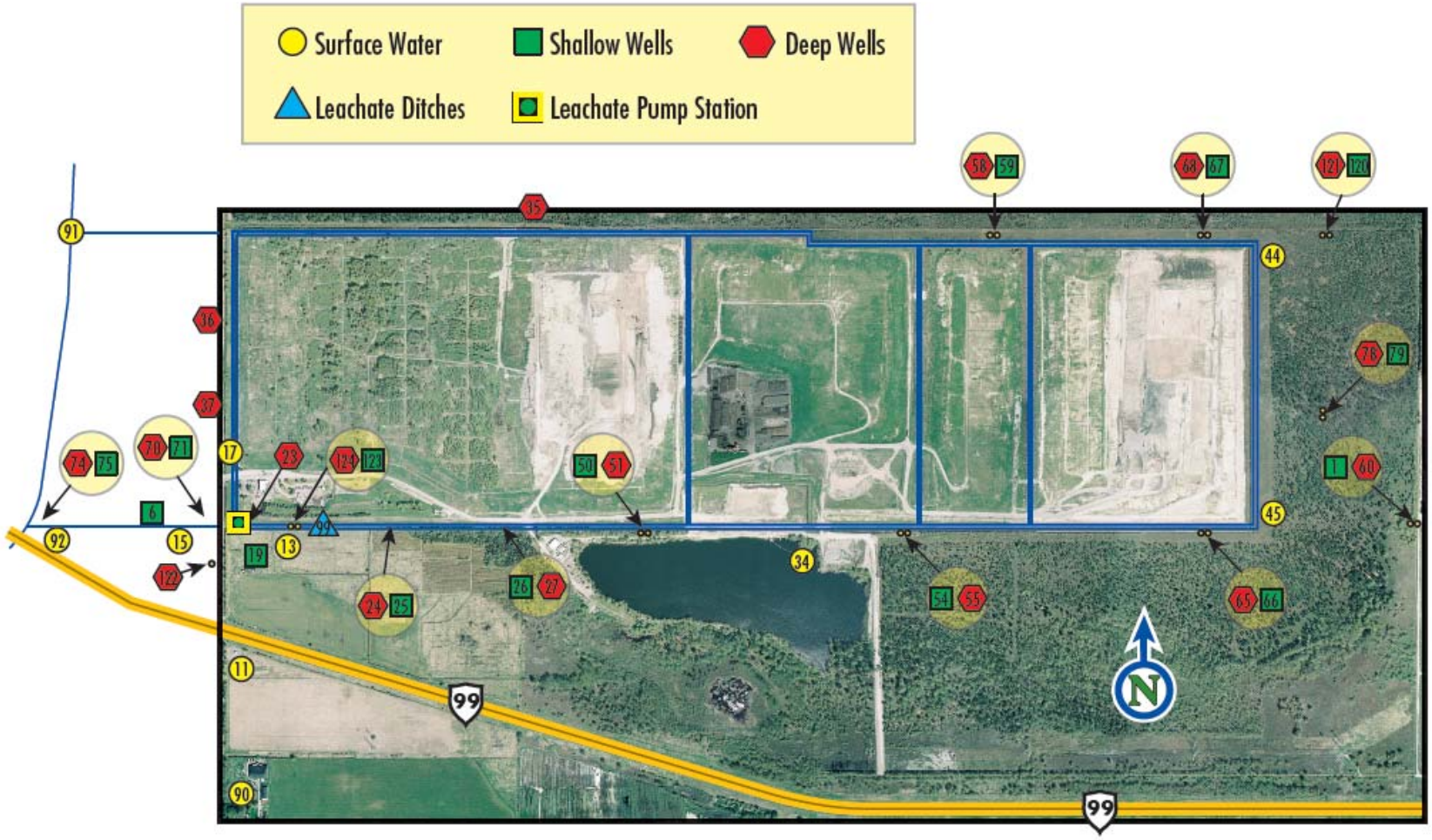
- × Hazardous wastes (i.e. pathogenic and radioactive materials)
- × Hazardous wastes as defined by the *Hazardous Waste Regulation* of the *Environmental Management Act*
- × Biomedical waste, including sharps
- × Paints, solvents, and flammable liquids, gasoline and pesticides
- × Liquid wastes and 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 $cm^2$ (3.8$ft^2$) 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 3: Water Quality Monitoring Location Plan**



## Appendix 4: 2010 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 5: 2010 Public Complaint and Resolution Log

| | Date | Complaint | Resolution |
|---|---|---|---|
| 1 | Jan 11 | Rates - Drywall Line-up | Confirmed website rate error, refunded customer.<br>Updated website rate.<br>Advised of unexpected challenges encountered with scale software, which caused delays. |
| 2 | Jan 20 | Rates - Garbage | Confirmed website error. Corrected website. Refunded customer. |
| 3 | Feb 9 | Over charge | Checked ticket to determine whether peak rates applied. Adjusted ticket this time only, and suggested coming outside of peak hours next time. |
| 4 | Feb 15 | Rates - Compost | Explained rate structure and conversion from volume to weight at the scales. Added note on website to provide additional messaging on how rates are calculated. |
| 5 | Feb 17 | Odour | Assessed wind direction and wind speed, and whether LFG system was operating normally. Advised Metro Vancouver Air Quality Inspector accordingly, by phone. |
| 6 | Mar 2 | Rude staff | Addressed complaint with staff and discussed appropriate responses for future use. |
| 7 | Mar 4 | Odour | Assessed wind direction and wind speed, and whether LFG system was operating normally. Advised Metro Vancouver Air Quality Inspector accordingly, by email. |
| 8 | Mar 19 | Odour | Assessed wind direction and wind speed, and whether LFG system was operating normally. Advised Metro Vancouver Air Quality Inspector accordingly, by email. |
| 9 | Mar 20 | Misinformation at scales | Checked website for accuracy and updated staff with correct rate information. |
| 10 | Mar 22 | Rates - Compost | Explained rate structure and conversion from volume to weight at the scales. Charges are determined by weight for consistency. |
| 11 | Mar 24 | Over charge | Checked ticket to determine whether peak rates applied. Adjusted ticket this time only, and suggested coming outside of peak hours next time. |
| 12 | Apr 12 | Line-up | Staff reminded to call for assistance when needed. |
| 13 | Apr 13 | Payment Policy | Customer advised that payment is required for each transaction according to payment policy for those customers not on account, as oppose to running a daily tab. Reviewed compost website to ensure payment policy is clear. |
| 14 | Apr 29 | Rates - Compost | Explained rate structure and conversion from volume to weight at the scales. Charges are determined by weight for consistency. |
| 15 | May 3 | Misinformation at scales | Updated material type on ticket and provided partial refund accordingly. |
| 16 | May 12 | Line-up | Explained that line-ups do occur during free disposal month for Vancouver, flaggers are hired during peak times, and upgrades to the site entrance are planned. |
| 17 | May 17 | Rude staff | Superintendent spoke to Contracted Staff to discuss the issue, then phoned customer for resolve. |
| 18 | May 18 | Line-up | Explained that line-ups do occur during free disposal month for Vancouver, flaggers are hired during peak times, and upgrades to the site entrance are planned. |
| 19 | May 21 | Rates - Compost | Advised that rates haven't gone up, and explained rate structure. |
| 20 | May 31 | Line-up | Explained that line-ups do occur during free disposal month for Vancouver, flaggers are hired during peak times, and upgrades to the site entrance are planned. |

| | Date | Complaint | Resolution |
|---|---|---|---|
| 21 | Oct 21 | Material not accepted | Customer advised that limits for Gypsum Drywall are clearly stated on Landfill website, and are necessary to ensure that customers with residential quantities can be accommodated. |
| 22 | Dec 31 | Compost Rate Increase for 2011 | Explained reasoning behind compost rate increase from $\$6/m^3$ to $\$10/m^3$. |

## Appendix 6: 2010 Water Quality Monitoring Program Review Executive Summary

A review was carried out by SNC-Lavalin Environment, Division of SNC-Lavalin Inc. (SLE) of the 2010 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, BC. 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 Greater Vancouver Sewerage and Drainage District's (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 criteria for several new parameters.

In compliance with the terms of the OC, SLE carried out an assessment of all 2010 landfill site water quality monitoring data, to evaluate the ongoing leachate collection and containment system efficiency, and prepare a report on the findings.

The 2010 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. In 2010, one leachate, 11 surface water, 16 shallow groundwater and 18 deep groundwater monitoring stations were sampled. This includes five groundwater monitoring wells that were installed in 2010 as a result of recommendations made in the 2009 Water Quality Monitoring Report (SLE, 2010).

### Leachate

Climatologically, 2010 was characterized by a very warm, dry July and August with overall average annual precipitation. There was a total of 2,185,798 $m^3$ of leachate discharged from the Site during 2010, with approximately 22% of the annual total discharged during December.

Overall, this was the highest annual leachate discharge over the last fifteen years while total precipitation corresponded to approximately the median year over this period. The relatively high discharge of leachate in 2010 is likely related to the installation of an impermeable cover on Phase 1 as part of the closure activities conducted in 2009. Runoff from above the cover is routed directly to the inner leachate ditch through the surface water diversion system and the rate of runoff from the Phase 1 cover system is expected to be greater from the soil cover present over the remainder of the landfill.

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 authorized discharge criteria for any of the leachate parameters analyzed during 2010. No spikes in sulphide concentration above the 1 mg/L criteria were measured in 2010 as have been observed periodically in previous years. Leachate electrical conductivity (EC) values were lower than in previous years and did not show a continuation of the increasing trend observed in recent years. This also may reflect dilution by runoff from the Phase 1 area.

Trace concentrations of several volatile organic carbon (VOC) parameters, including benzene, ethylbenzene, toluene, xylenes, styrene, and chlorobenzenes, and 1,2 dichloroethane were noted in leachate samples; however, concentrations of benzene and total BETX, the only two parameters for which WDP standards are specified, were present in the leachate at concentrations well below the applicable WDP standards.

Analysis for nonchlorinated and chlorinated phenols in leachate using GC/MS returned non-detectable concentrations. This suggests that detection of these compounds in shallow and deep groundwater in monitoring wells located northeast of the landfill, along the southern perimeter and southwest of the landfill is probably due to a natural source associated with decay of organic matter in the bog vegetation versus associated with landfill leachate.

### Ditch Gradients

Inward hydraulic gradients were maintained between the outer perimeter drainage ditch and inner leachate collection ditch approximately 98% of the time during 2010, marginally higher than the 95% containment efficiency recorded for 2009. Ditch gradient reversals at SG1 occurred in November and December 2010 due to short term pump shut downs necessary for upgrades to the pump station controls, and briefly in August 2010 at SG2 as a result of low precipitation and seepage rates from Burns Bog.

Consistent with previous results, ditch gradients were undetermined during the dry summer period when dry ditch conditions prevailed in sections of the drainage ditches on the north, east and south perimeter of the Landfill. However, as described in the Hydrogeological Review completed by Sperling Hansen Associates (SHA) in 2008, the risk of leachate excursions as a result of gradient reversals in summer months is considered to be low as an inward gradient appears to be maintained by the water table when the ditches are dry, except possibly for short periods of time at the apex of drought conditions.

**Groundwater Gradients and Flow**

Groundwater gradients and flow directions in 2010 were 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**

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, placement of dredge sand as preload fill along the west margin of the Site as part of the South Fraser Perimeter Road project may also be influencing surface water quality off-site.

Surface water samples were collected quarterly by the City at 11 locations in the perimeter ditch system in 2010. Consistent with previous findings, the surface water quality monitoring data from 2010 indicates there was no indication that leachate is negatively affecting the surface water receiving environment at the Site.

Comparison to *BC Approved Water Quality Guidelines*[3] (BCAWQG) and *British Columbia Working Water Quality Guidelines*[4] (BCWWQG) aquatic life and irrigation water guidelines

[3] Water, Air and Climate Change Branch, MoE, *British Columbia Approved Water Quality Guidelines (Criteria)*, 2006 Edition (BCAWQG).

indicated exceedances for several physical parameters and anions in surface waters during 2010 including pH, EC, chloride, sulphate, and ammonia nitrogen. Low pH values relative to the BCAWQG 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. The elevated concentrations of electrical conductivity (EC), chloride, and sulphate were measured in surface water stations located in the southwest portion of the Site or further west and were associated with seasonal influx of brackish water and not leachate derived from the Site.

Elevated ammonia concentrations were also observed in surface water in both on-site (Station 13) and off-site (Stations 11 and 15) sampling stations located west-southwest of the Site. The presence of elevated ammonia in surface water corresponded with higher water levels in Crescent Slough and the perimeter ditches due to summer irrigation and is likely associated with off-site application of fertilizers and associated runoff from agricultural fields.

Elevated concentrations of a number of metals were detected in surface water during the 2010 water quality monitoring program. 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 and/or runoff from preload construction activities. Exceptions included dissolved aluminum and lead concentrations which are elevated in the perimeter ditch system. They can be attributed to low pH conditions, which favour enhanced solubility of these metals.

**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 groundwater 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.

Comparison of shallow groundwater sampled quarterly in 2010 from 16 monitoring wells to applicable *Contaminated Sites Regulation* (CSR) standards indicated exceedances of CSR Irrigation Water (IW) standards for dissolved iron and/or manganese in 12 monitoring wells

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

and marginal exceedances of applicable CSR IW standards for chloride in Station 75, ammonia in Station 25, and dissolved chromium in Station 50.

The elevated dissolved iron and manganese concentrations were measured in shallow groundwater wells located east of the Site, along the southern perimeter, and in the southwest corner of the Site. This was consistent with previous sampling results and the elevated iron and manganese can largely be attributed to either upwelling of iron-rich groundwater from the lower aquifer, an influx of brackish water from Crescent Slough, or other off-site source(s). Dissolved iron and manganese concentrations were low in upgradient, background wells located on the northeast side of the Site, including the new background well (Station 120).

The presence of elevated ammonia concentrations at Station 25 corresponds with increased concentrations of ammonia observed in 2010 surface water samples and is likely related to an off-site source (e.g. agricultural runoff associated with fertilizers) and is not considered to be Site-related.

The elevated concentration of chloride in Station 75 is likely a result of an off-site source. The source of chromium at Station 50 is not known; however, chromium was not detected above the CSR standard in any other well on the site, including the deep well at this location, and therefore its presence at Station 50 should be reconfirmed in 2011.

Increasing concentrations of leachate indicator parameters (primarily chloride and EC) over time were observed in several shallow groundwater monitoring stations, primarily at locations to the south and southwest of the Site. Possible causes of these trends include a previous Corporation of Delta Ladner Trunk forcemain break, seasonal influx of brackish water from Crescent Slough, and drainage ditches receiving agricultural runoff to the south of the landfill.

Increases in EC from upgradient shallow groundwater monitoring stations to those downgradient of the Site can be attributed, at least in part, to the corresponding increase in mineral content across the Site, as well as due to off-site sources such as salt water intrusion, upwelling of deep aquifer groundwater, and/or agricultural run-off. There is currently no indication of leachate migration from the Site in shallow groundwater, based on the EC data.

Detectable concentrations of non-chlorinated phenolic compounds (primarily p-cresol) were measured at Stations 1, 25, 50, 54 and 66, located in the southwest to south-central portion

of the Site. The concentrations of p-cresol and/or phenol exceeded the CSR AW standard of 0.01 mg/L in Stations 25 and 50. The absence of detectable concentrations of these compounds in leachate, and presence in upgradient deep wells suggests that the phenolic compounds in shallow groundwater are likely not associated with leachate from Site operations and are naturally occurring and associated with decay of bog vegetation.

**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.

Comparison of deep groundwater sampled quarterly in 2010 from a network of 18 monitoring wells to applicable CSR standards indicated exceedances of the CSR IW standards for dissolved iron and manganese in deep groundwater sampled from all 18 well locations. In addition, one well (Station 23) contained concentrations of chloride greater than the CSR IW standard and chromium was marginally greater than the CSR IW standard in four wells.

The only deep monitoring well that appears to be affected by leachate is Station 23. This is likely due to short-circuiting of leachate from the pumping station wet well and or adjacent leachate ditch. Statistical trend analysis indicates EC, chloride and sodium concentrations continue to increase at this location. Based on two new deep monitoring wells (Stations 122 and 124) drilled by SLE in this area in 2010, the lateral extent of elevated chloride in deep groundwater at Station 23 appears localized based on the presence of low chloride concentrations, less than the CSR IW standard, in monitoring wells located hydraulically cross-gradient (Stations 70 and 124), and downgradient (Station 122). Elevated EC observed at Station 122 located downgradient from Station 23 suggests that migration of leachate may be occurring; however, elevated EC at this location could also be a result of saline intrusion from Boundary Bay and/or the Fraser River estuary. Concentrations of EC and other leachate indicator parameters in Station 122 should be closely monitored in 2011 for any changes, which may suggest the presence of a localized leachate plume.

Concentrations of non-chlorinated phenol compounds p-cresol (4-methylphenol) and/or m-cresol (3-methylphenol) analyzed by the GC/MS method were detected in October and December 2010 in the newly installed monitoring well Stations 121 and 124 located on the northeast (upgradient) and southwest (downgradient) areas of the Site, respectively. The concentration of m-cresol measured in deep groundwater in Station 124 in October 2010 slightly exceeded the CSR AW standard for total non-chlorinated phenols of 0.01 mg/L. Non-chlorinated phenols were not detected in any of the remaining deep wells where phenolic compounds have been detected using GC/MS in previous years. The presence of non-chlorinated phenolic compounds in deep groundwater from monitoring wells located upgradient from the Site (Stations 78 [in 2009] and 121 [in 2010]) suggests they are likely naturally occurring and not site-related.

**Quality Assurance/Quality Control**

The environmental monitoring program carried out for the landfill site in 2010 appears to have adhered to specified QA/QC requirements. Data Quality Objectives (DQOs) set out in the Quality Control manual were met in 2010. Overall, based on QA/QC results, leachate, groundwater and surface water analytical data can be considered reliable for the purposes outlined in the OC.


# Transfer & Landfill Operations Branch
# 2010 Annual Report

March 2011