Making a difference...together

Hartland Landfill Environmental Program

2014–2015 Annual Report

Parks & Environmental Services | Environmental Protection

Prepared By
GeoEnvironmental Programs

Capital Regional District
625 Fisgard Street, Victoria, BC V8W 2S6
T: 250-360-3000 F: 250-360-3079
www.crd.bc.ca

October 2015

HARTLAND LANDFILL ENVIRONMENTAL PROGRAM
2014–2015 ANNUAL REPORT

EXECUTIVE SUMMARY

The Hartland landfill provides solid waste disposal services for the Capital Regional District (CRD). The operation of a landfill can result in environmental effects and health and safety issues; specifically, effects to surface water and groundwater, and the production of landfill leachate and landfill gas.

Measures are in place at Hartland landfill to reduce and control releases to groundwater, surface water, leachate and air. An environmental monitoring, assessment and management program assesses the effectiveness of the control measures and identifies potential impacts. In addition, a permitting program regulates the receipt of controlled wastes which require special handling due to operational requirements, potential health and safety risk to workers or adverse effects to the environment.

This annual report presents a summary of the key findings and recommendations for the following Hartland Environmental Program components and reporting periods:

- Landfill gas monitoring (January to December 2014)
- Groundwater, surface water and leachate monitoring (April 2014 to March 2015)
- Controlled waste permitting (January to December 2014)

LANDFILL GAS

Decomposition of refuse creates landfill gas which, if not controlled, escapes to the atmosphere. Landfill gas management is dictated by a variety of BC regulations, design guidelines, criteria, Hartland-specific management plans, and WorkSafeBC. As required, Hartland landfill has implemented a system to assess and control fugitive landfill gas emissions. The objective of these controls is ultimately to reduce emissions, ensure staff health and safety, and comply with regulations. Landfill gas collection and/or management program at Hartland includes gas generation modelling, gas collection infrastructure installation and maintenance, and operation of a landfill gas beneficial use facility. Additionally, the landfill gas program monitors the effectiveness of the collection infrastructure through a variety of monitoring programs.

Landfill gas generated in the landfill is drawn under vacuum to the gas plant where it is directed to a generator and/or to a flare. The gas is then conditioned (cleaned) and methane and oxygen content is measured. Excess gas is fed back to a candlestick flare, while the groundflare is only used during extended generator downtime.

The landfill gas collection system is designed to reach 75% collection efficiency as per the Landfill Gas Management Facilities Design Guidelines (the Guidelines). The CRD is in the process of implementing the plan. In 2014, landfill gas collection efficiency was approximately 56% and modelled methane generation was 1,671 standard cubic feet per minute (scfm) and of that an average of 943 scfm (at 50% methane) was captured through the gas plant. While overall collection efficiency decreased slightly in 2014, current data and projections indicate that landfill gas management plan implementation is likely to achieve the recommended collection efficiency of 75% by the end of 2016.

In order to monitor the effectiveness of the landfill gas collection infrastructure, Hartland landfill has implemented a four component monitoring program. In 2014, the monitoring program confirmed that landfill gas was maintained within the landfill and results were within specified criteria or regulatory limits.

GROUNDWATER, SURFACE WATER AND LEACHATE

The decomposition of solid waste, along with rain and groundwater draining through the landfill, produces leachate. Engineered controls are in place at Hartland landfill to collect and contain leachate to reduce or eliminate potential effects to groundwater and surface water quality. Since 1990, the leachate has been captured and contained on site prior to discharge by pipeline to the sanitary sewer. To verify that effects

are mitigated, and resources protected, groundwater and surface water is monitored at the Hartland landfill and specific off-site locations. In addition, leachate, generated by the percolation of precipitation through the garbage, is also monitored for flow and quality.

This monitoring program evaluates groundwater, surface water and leachate quality to assess the effectiveness of the leachate management facilities and assess regulatory compliance. Based on monitoring conducted between April 1, 2014 and March 31, 2015, the program continues to provide data needed to assess the effectiveness of the leachate containment and collection system and regulatory compliance, and provides information needed to guide management and operational decisions. The key findings of the groundwater, surface water and leachate monitoring program are summarized below.

Groundwater

Groundwater quality and flow data indicate that landfill leachate is effectively contained and controlled on site, and statistical analysis of water quality trends, at key locations north and south of the landfill, indicates that groundwater quality is stable or gradually improving. Boundary compliance monitoring stations are primarily clustered along the property boundary and some are located closer to the filling area to monitor potential pathways for leachate movement in groundwater. Groundwater quality met the BC Contaminated Sites Regulation (CSR) standards in all boundary compliance locations. Groundwater quality at the landfill has generally improved over time largely due to effective leachate control measures (purge well systems).

Previous impacts in the Hartland north pad area have been reduced and overall concentrations are stable or decreasing. Improvements in groundwater quality at wells near the Hartland north pad are attributed to the cover system installed in January 2012.

Twelve privately-owned domestic wells were monitored during the reporting period. No leachate impacts were identified in the wells sampled.

Surface Water

A total of five surface water monitoring stations have been identified as boundary compliance monitoring stations and are sampled to assess compliance with the landfill operating certificate. These stations are concentrated north and south of the landfill where creeks flow from the landfill property to off-site locations. The surface water monitoring program provides an effective measure of compliance with water quality guidelines and important information to guide management and operational decisions. Data collected between April 2014 and March 2015 indicated that property boundary stations and the majority of on-site and off-site stations met water quality guidelines with only occasional exceedences for iron, nitrate, total suspended solids, conductivity ammonia, and/or sulphate. These concentrations are considered related to seasonal impacts (rain events or dry low-flow conditions) or were anomalous. Some concentration trends (both increasing and/or decreasing) were identified which are generally correlated with mild aggregate runoff impacts, dilute leachate, or road salt.

The surface water quality data collected in 2014/15 revealed that nearby surface water bodies, Tod Creek, Durrance Lake, Durrance Creek and Killarney Lake are not impacted by leachate.

Leachate Quality

Leachate is regulated under CRD Regional Source Control Program (RSCP) waste discharge permit, which authorizes discharge to sanitary sewer. The average leachate flow over the reporting period was comparable to long-term average flow rates of 11.48 L/s. Leachate discharges remained in compliance with the waste discharge permit with the exception of total sulphide in two samples. Leachate mitigation measures were implemented in 2014 to mitigate elevated sulphide concentrations. Overall, Hartland landfill leachate continues to report low contaminant levels compared to typical municipal waste landfills.

CONTROLLED WASTE

The controlled waste area of the landfill is a designated area that accepts a range of waste requiring special handling due to specific health and safety, operational or environmental concerns. Discharges of controlled waste are regulated through a permit system administered by Environmental Protection staff to provide control over the wastes discharged, protect worker health and safety, meet operational requirements and minimize additional contaminant loading to leachate and landfill gas.

RECOMMENDATIONS

The environmental monitoring programs at Hartland landfill provide a valuable foundation to evaluate the effectiveness of the control measures, assess potential impacts of Hartland landfill and support landfill management and operations by providing information to staff, managers and committees. The following recommendations are made regarding the programs:

- Overall the monitoring programs conducted at Harland Landfill (landfill gas, groundwater, surface water, domestic wells, and leachate) should be sustained to meet regulatory requirements and to inform management and operational decisions. Monitoring programs should be optimized through a continuous improvement program that evaluates data, sampling techniques and quality. As required to meet regulations, the annual monitoring program results should continue to be reviewed and interpreted by qualified professionals experienced in assessing the impacts of landfill leachate at large municipal landfills similar to Hartland landfill.

Landfill Gas Monitoring Program

- Continue routine monitoring program (quarterly perimeter probes, quarterly building foundation probes, bi-annual ambient grid and hot spot monitoring) in support of regulatory compliance. Conduct gas speciation in 2015 to enable tracking of gas composition changes. Conduct well field balancing monthly, to optimize gas collection, and as required.

Groundwater, Surface Water and Leachate Monitoring Program

- Operation of the north and south purge well systems, including optimization and maintenance activities, should continue in order to provide effective leachate control and containment. Water levels and the extent of the drawdown cone should continue to be validated routinely. Consideration should be given to increasing pumping capacity in the north purge well system.

- Aggregate stockpiles managed within the leachate containment area or infiltration should be mitigated (e.g., via cover systems) to protect downgradient surface water quality. Water quality downgradient of aggregate stockpile areas should continue to be closely monitored to assess the effects of these activities on water quality and the effectiveness of cover systems.

- Leachate flow and chemistry should continue to be monitored to inform landfill management and operational decisions and to comply with the RSCP permit. Leachate treatment should be implemented on an as-needed basis to periodic sulphide concentration spikes and monitoring should be conducted to demonstrate the effectiveness of the leachate treatment. Additionally, aeration system in the lower lagoon should continue to be operated as a cost effective way to limit sulphide formation during storage of leachate.

Controlled Waste Program

- Continue site inspections and audits to verify acceptability of wastes and to confirm that only permitted wastes are discharged as the program ensures adequate level of health and safety and environmental protection is maintained at the landfill.

HARTLAND LANDFILL ENVIRONMENTAL PROGRAM
2014–2015 ANNUAL REPORT

TABLE OF CONTENTS

List of Tables

List of Figures

List of Appendices

HARTLAND LANDFILL ENVIRONMENTAL PROGRAM
2014–2015 ANNUAL REPORT

1.0 INTRODUCTION

The Hartland landfill provides solid waste disposal services for the Capital Regional District (CRD). The landfill is a multi-purpose facility providing collection services for recyclable materials, household hazardous waste, items covered by product stewardship, and disposal of municipal solid waste and controlled waste. The landfill is operated in accordance with an Operational Certificate issued under the provisions of the *Environmental Management Act* by the BC Ministry of Environment (MOE).

The operation of a landfill can result in a number of environmental effects and health and safety issues. These include effects to groundwater and surface water quality and the production of landfill gas and leachate.

At Hartland landfill, control measures are in place to reduce and control effects to groundwater, surface water, leachate and air. The Hartland Landfill Environmental Program provides a comprehensive monitoring, assessment and management program to meet the Operational Certificate and regulatory requirements by:

- assessing the impact of the Hartland landfill
- evaluating the effectiveness of the control measures
- managing the acceptance of nuisance wastes and wastes that require special handling

The monitoring and assessment results are used to aid in the management of the landfill by providing information to CRD staff, managers and committees for decision making. This report presents a summary of data collected for the following Hartland Environmental Program components, and reporting periods:

- Landfill gas monitoring (January to December 2014)
- Groundwater, surface water and leachate monitoring (April 2014 to March 2015)
- Controlled waste permitting (January to December 2013)

The reporting period for groundwater, surface water and leachate monitoring components differ from the others to facilitate evaluation of trends through the complete wet winter period which is key to understanding the hydrogeological response in the system.

This report summarizes key findings and recommendations from the consultants' evaluation of data collected for the groundwater, surface water and leachate monitoring and a staff review of the landfill gas monitoring and controlled waste program. The report titles are as follows:

- *Hartland Landfill Groundwater, Surface Water and Leachate Monitoring Program Annual Report (April 2014 to March 2015)*, by AECOM Canada Ltd., dated October 2015

- *Hartland Landfill – Landfill Gas Monitoring Annual Report 2014,* by Capital Regional District, dated October 2015.

Complete copies of these two technical reports are attached as Appendix A and Appendix B, respectively.

2.0 BACKGROUND

The CRD took over operation of the Hartland landfill site in 1985. Prior to that, the landfill was owned and operated privately. The landfill currently occupies approximately 36 hectares with an estimated 6,500,000 tonnes of municipal solid waste in place at the end of 2013. When the landfill reaches the planned final filling elevations it will occupy approximately 46 hectares with a volume of approximately 12,000,000 tonnes of municipal solid waste. The annual disposal rate varies, but it is currently around 120,000 tonnes of residential, commercial and industrial waste. A landfill capacity study was commenced in 2015 to support lifespan planning for the landfill.

The landfill encompasses two operational areas. Phase 1 is the older, closed area of the landfill that was operational from the 1950s to 1997, and filling in the active Phase 2 area began in spring 1997.

Phase 1 is unlined and covered with a combination geo-membrane/clay cap. Phase 2 is the current active portion of the landfill. Phase 2 was constructed within a former lake basin (now referred to as the Phase 2 basin). It is partially lined and relies on a “hydraulic trap concept” for leachate containment. Completed portions around the western perimeter of Phase 2 have been closed with an interim cover comprised of a 500-mm layer of clay, without geo-membrane. As landfill development progresses, final closure of areas will be completed. Development of the Hartland landfill is guided conceptually by the Cell Development Plan from the *Hartland Landfill Phase 2 Long Term Leachate Management Plan* – Sperling Hansen Associates (June 2007).

3.0 LANDFILL GAS

Decomposition of refuse creates landfill gas; the composition and amount of gas generated varies based on factors such as amount, type and age of waste as well as environmental conditions, such as moisture content. Peak gas generation occurs during the first one to three years after disposal. Initially, decomposition of waste is an aerobic process and produces mainly carbon dioxide. As oxygen is depleted the decomposition occurs under anaerobic conditions.

Landfill gas is primarily made up of methane and carbon dioxide with small amounts of water vapour, oxygen, nitrogen and trace gases. These constituents pose health and safety concerns related to asphyxiation, carcinogenicity and/or flammability. In addition, methane is a greenhouse gas (GHG), with 21-25 times the warming potential of carbon dioxide and emissions are regulated by various federal and provincial regulations.

The management and regulation of the landfill gas system is dictated by the following documents:

- Landfill Gas Management Regulation: Regulates the operation and maintenance of the landfill gas plant and collection system.
- Landfill Gas Management Plan: Specific to Hartland, and a requirement under the regulation, the plan specifies how the collection infrastructure will be installed and operated.
- BC Landfill Gas Management Facilities Design Guidelines: Sets out targets for collection efficiency, utilization and reporting.
- BC Landfill Criteria and WorkSafeBC Regulations: Dictates acceptable subsurface and ambient landfill gas concentrations in infrastructure, throughout the site and in soils at the site boundary.

In accordance with these regulations, Hartland landfill has implemented a system to assess and control fugitive landfill gas emissions. The objective of these controls is ultimately to reduce emissions, ensure staff health and safety, and comply with regulations. The following programs are in place to achieve this:

- A Landfill gas generation model.
- A collection and utilization system incorporating gas extraction wells, collection piping, flares and a landfill gas utilization facility (1.6 MW generator).
- A landfill gas monitoring program.

A summary of recommendations relating to landfill gas management and monitoring is provided in Section 6.

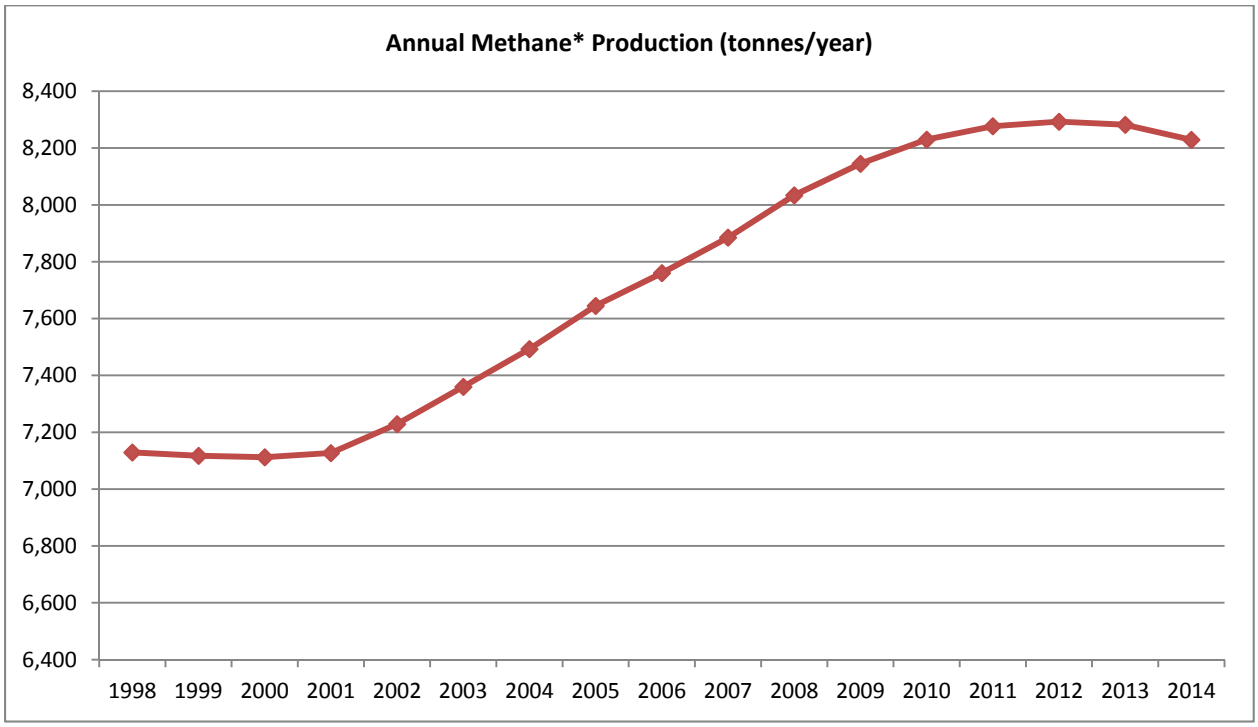
3.1 Landfill Gas Management Plan and Gas Generation Model

The Landfill Gas Management Regulation (LGMR) requires landfills that generate greater than 1,000 tonnes per year of methane to develop landfill gas management plans (LGMP). The Hartland LGMP was submitted to the MOE in April 2012 and had an implementation date of December 2016. In accordance with the Guidelines, the Hartland LGMP design strives to achieve 75% collection efficiency following complete implementation.

The CRD tracks collection efficiency and emissions using a BC MOE model that is updated annually with waste quantity and composition data which correlate with landfill gas quantities. In 2014, Hartland landfill received 128,045 tonnes of waste, which includes 119,306 tonnes of refuse and 8,739 tonnes of controlled waste. The 2014 composition data reflects organics reduction due to mandatory diversion instituted in 2015.

Figure 1 shows the estimated annual methane production for Hartland landfill. The years selected for the table coincide with the activation of the gas collection system in 1998. According to the model, gas production has peaked, potentially as a result of the kitchen scraps diversion program, as well as declining annual refuse quantities.

Figure 1 Annual Hartland Landfill Gas Generation



Note:
* From MOE model

3.2 Landfill Gas Collection

The landfill gas collection system consists of a series of vertical and horizontal wells. The current LGMP specifies the installation of horizontal wells for every 4 m lift of refuse to maximize gas collection. The first of these wells was installed in 1998 and system expansion since then has resulted in over 74 vertical and 51 horizontal-style (trench, leachate and horizontal) extraction wells (Table 1). In 2014, five wells accounted for over 30% the total landfill gas collected.

Landfill gas collection wells are connected to a blower system which pulls landfill gas into the gas plant for destruction or utilization. Each well is equipped with a control valve to regulate gas flow. Individual wells are monitored and adjusted routinely to optimize methane collection and flow to the gas utilization facility. A variety of factors can impact gas generation and frequent well adjustments are critical to maintain optimal gas generation and efficient collection. Well field monitoring also helps to identify non-producing wells that can be removed from the monitoring and collection network.

Table 1 Summary of Gas Collection Wells in 2014

Type of Gas Well	# of New Wells Added in 2014	# of Wells Decommissioned	# of Wells in Operation 2014
Vertical Gas Wells	1 (reactivated)	0	74
Horizontal Gas Wells	10	2	34
Leachate Horizontal Gas Wells	4	3	12
Leachate Gas Trench	0	0	5
Total	**15**	**50**	**125**

3.3 Landfill Gas Utilization

The gas utilization system consists of a 1.6MW generator, a candlestick flare and a groundflare. Excess gas that is not used by the generator for production of electricity is directed to the candlestick flare. The groundflare is used only during extended generator down time such as during power failures or periods of extended maintenance.

From 2004 to 2013, Maxim Power Corp. (MAXIM), under a contract with the CRD, operated the generator to utilize landfill gas. In September of 2013, the CRD purchased the utilization facility and now operates all aspects of the landfill gas collection system.

Flow meters at the gas plant continuously measure the total volume of gas collected and report the information to the CRD SCADA system. Data is compiled to determine collection and utilization rates. It is also compared to the generation model to estimate the collection efficiency of the system.

Table 2 shows the five-year annual gas collection in standard cubic feet per minute (scfm) and indicates the volumes of gas sent to each destruction device. The amount of gas collected has increased significantly over the last two years with implementation of the LGMP in 2012. The generator consumed an average of 4,492 scfm in 2014, or 50.8% of the total gas collected. The remaining gas was sent through the candlestick flare or groundflare.

Table 2 Landfill Gas Flows to Destruction Devices (2010 to 2014)

Annual Average	Year				
	2010	2011	2012	2013	2014
Gas Collected (scfm)*	546	581	829	987	953
Gas Burned by Generator (scfm)*	428	359	439	488	492
Gas Burned by Candlestick Flare (scfm)*	81	131	302.9	477	427
Gas Burned by Groundflare (scfm)*	37	91	87.1	28.53	42

Notes:
*Normalized to 50% methane.

Table 3 shows the quantities of gas generated and captured, the collection efficiency, and the estimated greenhouse gas emissions.

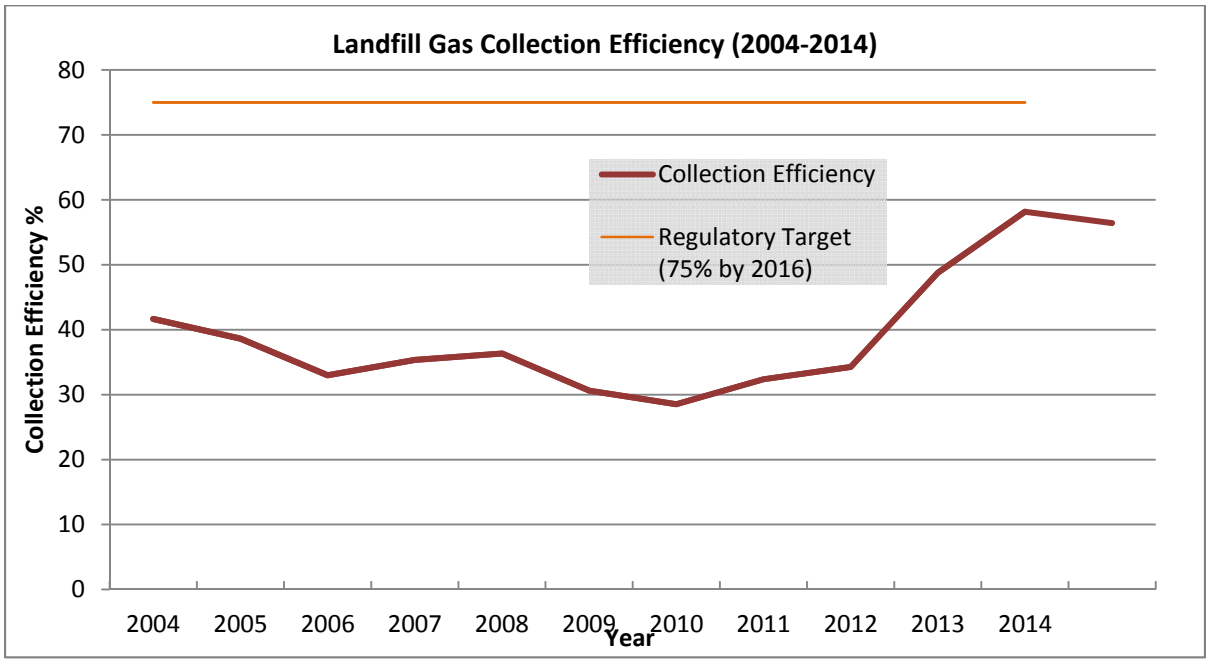
Table 3 Landfill Gas Generation, Collection, Collection Efficiency and Greenhouse Gas Emissions (GHG) 1998 to 2014

Year	Estimated Annual[1] Methane Generated (scfm)[3]	Annual Gas[2] Capture (scfm)[3]	Estimated Collection Efficiency (%)	GHG Emissions (tonnes/year CO_2e)
1998	1,461	1,181	80.8	28,680
1999	1,458	937	64.2	53,432
2000	1,457	738	50.6	73,716
2001	1,461	565	38.7	91,768
2002	1,481	499	33.7	100,665
2003	1,508	628	41.6	90,205
2004	1,535	593	38.6	96,589
2005	1,567	517	33.0	107,571
2006	1,590	562	35.3	105,372
2007	1,616	587	36.3	105,431
2008	1,646	504	30.6	117,066
2009	1,669	476	28.5	122,262
2010	1,687	546	32.4	116,878
2011	1,696	581	34.2	114,282
2012	1,700	829	48.8	87,542
2013	1,697	987	58.2	70,779
2014	1,671	943	56.4	74,686

Notes:
[1]Generated using the MOE model
[2]Measured
[3]Standard cubic feet per minute - Normalized to 50% methane

Collection efficiency improved beginning in 2012 (Figure 2) due to the installation/connection of several horizontal wells in late 2011, as well as the connection of new wells associated with the Phase 2, Cell 1 closure. Further improvements in collection efficiency were observed in 2013 as a result of installation of six new horizontal collection wells in Phase 2. The 2014 landfill gas collection efficiency values are within expected variability.

Figure 2 Landfill Gas Collection Efficiency (2004–2014)



While overall collection efficiency has decreased slightly in 2014, current data and projections indicate that LGMP implementation is likely to achieve the recommended collection efficiency of 75% by the end of 2016.

3.4 Landfill Gas Monitoring Programs

In order to monitor the effectiveness of the landfill gas collection infrastructure, Hartland landfill has implemented a four component monitoring program.

1. **Collection and treatment system monitoring** to evaluate changes in gas quality over time, and evaluates data for gas collection and gas utilization to assess collection efficiency and total emissions from the landfill.
2. **Perimeter and building foundation probe monitoring** to assess the potential for subsurface landfill gas migration at the eastern landfill boundary and at on-site buildings for compliance with criteria, and for worker and public health and safety.
3. **Ambient grid and hot spot monitoring** to verify the effectiveness of cover and landfill gas collection systems and identify areas of concern where landfill gas is being released to the atmosphere for protection of worker and public health and safety.
4. **Landfill Gas Speciation** to assess the composition of gas with regard to volatile organic compounds, sulphur gases and typical landfill gases in order to calculate ambient dilution concentrations for health and safety and infrastructure integrity purposes.

Please refer to Table 4 for information on the monitoring programs. All monitoring was conducted in accordance with standard operating procedures and no exceedence of specified criteria or regulatory limits or guideline was observed in 2014.

3.5 Landfill Gas Compliance

The following results summary table (Table 4) outlines all landfill gas monitoring programs, compliance status, any actions taken to address non-compliance and recommendations.

Table 4 Landfill Gas Compliance 2014

Program	Compliance Location	Criteria	Findings	Actions	Recommendations
Perimeter Probe Monitoring	Probes GP-1A, 1B, 2A, 2B, 3A, 3B, 11A, 11B, 12A and 12B	Maximum 1.25% methane in subsurface soil (MOE Landfill Criteria for Municipal Solid Waste)	No exceedences. Low risk of sub-surface gas migration to adjacent properties.	None	Continue quarterly monitoring.
Building Foundation Probe Monitoring	Probes GP- 4A, 5A, 6A, 6B, 7A, 7B, 8A, 9A, 13A, 14A, 17A, 18A	Maximum 1.25% methane in any on-site facility (MOE Landfill Criteria for Municipal Solid Waste). Maximum 1% methane inside buildings (Landfill Gas Management Facility Design Guidelines).	No exceedences. Low risk of subsurface gas migration to adjacent building.	None	Continue quarterly monitoring.
Ambient Grid Monitoring	N/A	100 ppm THC (CRD internal guideline)	13 grid locations >100 ppm No cover system failures suspected in the closed area of Phase 1.	Investigated hot spots, mitigated were possible.	Continue biannual monitoring.
Hot Spot Monitoring	N/A	1,000 ppm THC (CRD internal guideline).	5 new hot spots >1,000 ppm, 4 hot spots removed. Currently 22 locations for hot spot investigation.	Added new locations of hot spots to the monitoring program.	Continue biannual monitoring. Investigate remediation measures.
Well Field Monitoring and Balancing	N/A	Monitor monthly. Oxygen <3% - gas optimization and reduction of fire potential	Monitoring completed monthly; oxygen did not exceed 3%.	Well field monitoring has been scheduled monthly for 2015.	Continue monthly monitoring at minimum.
Gas Speciation (2013)	N/A	N/A	Undiluted landfill gas exceeded WorkSafeBC criteria for methane, carbon dioxide, hydrogen sulfide, vinyl chloride and benzene; however, ambient concentrations are likely well below WorkSafeBC limits due to dilution with ambient air.	None	Conduct speciation of landfill gas in 2015.
Gas Collection	N/A	75% gas collection efficiency target by the end of 2016 as per LGMP.	Gas collection efficiency was estimated at 56.4%, based on the MOE gas generation model.	LGMP submitted to MOE.	Continue to implement the gas management plan.

4.0 GROUNDWATER, SURFACE WATER AND LEACHATE MONITORING

Groundwater and surface water monitoring stations on the Hartland landfill property and specific off-site locations have been monitored since 1983. In addition to this, leachate, generated by the percolation of precipitation through the garbage, is also monitored for flow and quality. Since 1990, the leachate has been captured and contained on site prior to discharge by pipeline to the sanitary sewer. Monitoring data is collected to assess the potential for effect of landfill processes on groundwater and surface water resources. The annual monitoring program has three main components:

- Groundwater monitoring on site and at selected off-site domestic wells
- Surface water monitoring at on-site and off-site locations
- Leachate flow and leachate quality monitoring

Water quality is evaluated by comparing the data with the appropriate Provincial drinking water or freshwater aquatic life standards or guidelines and background concentrations typical of the area. Leachate flow volumes and leachate quality monitoring are used to confirm compliance with the CRD RSCP's waste discharge permit (#SC97.001) authorizing discharge to sanitary sewer.

A summary of recommendations relating to the monitoring programs are provided in Section 6.

4.1 Groundwater Monitoring Program

The purpose of the groundwater monitoring program is to assess impacts of landfill processes and operations on groundwater quality and to assess compliance with water quality standards at the property boundary.

Hartland landfill has an extensive network of groundwater wells to monitor conditions immediately adjacent to the Phase 1 and Phase 2 areas and at points adjacent to the landfill property boundary. Groundwater elevations are routinely monitored in approximately 120 well locations to understand the direction of groundwater flow within the landfill property. Groundwater quality is monitored at groundwater well locations to evaluate and identify changes in water chemistry that may be attributed to landfill processes and operations and, specifically, the effect of landfill leachate on groundwater resources. In addition, 12 privately-owned, domestic drinking water wells within a two-kilometre radius of Hartland landfill are monitored.

Groundwater quality parameters are assessed against BC Contaminated Site Regulation (BC CSR) numerical standards for the protection of drinking water and aquatic life in groundwater. This represents a change, as the data was previously compared against only the BC Water Quality Guidelines[1]. Water quality in 2013/2014 is generally similar to previous years, though when compared to the new standards site conditions have improved.

4.1.1 Results

The monitoring program provided an effective measure of compliance and important information to guide management and operational decisions. Of 131 wells at Hartland, 42 are boundary compliance monitoring stations. These boundary compliance wells are primarily clustered along the property boundary and some are located closer to the filling area to monitor potential pathways for leachate movement in groundwater. Groundwater quality data collected between April 2013 and March 2014 indicated that the majority of boundary stations were in compliance with BC CSR standards. The results of the 2014-2015 program were similar to those measured in 2013-2014 and showed improvement in several areas. The results of groundwater monitoring for each of the landfill boundary areas are presented in the following sections.

[1] BC Approved Water Quality Guidelines and the Compendium of Working Water Quality Guidelines

Phase 1

Groundwater flow was consistent with historic trends. Groundwater flow directions in the Phase 1 area were primarily to the north, and most of the northward flowing groundwater was captured by the leachate containment and collection system. At the south end of Phase 1, a groundwater divide corresponding with a bedrock high influences the groundwater flow. North of this divide, groundwater flows to the north. South of the divide, groundwater flows south and is intercepted by the leachate containment and collection system.

Elevated leachate levels (i.e., leachate mounding) continued to be present in Phase 1 areas of the landfill, as it has for many years; however, the water quality data south of Phase 1 confirms that leachate containment has successfully controlled leachate impacts. Water level monitoring in this area should continue to assess the effectiveness of leachate containment and identify any changes to magnitude or extent of leachate.

North of Phase 1

Groundwater quality in boundary compliance locations north of Phase 1 met the BC CSR drinking water and aquatic life groundwater standards. Groundwater quality in this area has improved over time or continues to remain stable based upon statistical analysis as summarized in Table 5 below. Improvements are considered related to the effective operation of the north purge well system.

Table 5 Groundwater Quality Compliance Summary North of the Landfill (2014–2015)

Well	Exceedences	Number of Exceedences	Trend
20-1-1	none	-	Stable
20-1-2	none	-	Decreasing conductivity and chloride
21-1-1	none	-	Stable
21-1-2	none	-	Decreasing ammonia
21-2-1	none	-	Stable
28-1-0	none	-	Decreasing ammonia, increasing conductivity
29-1-1	none	-	Decreasing sulphate
29-1-2	none	-	Decreasing conductivity and ammonia
30-1-1	none	-	Stable
30-1-2	none	-	Stable
31-1-1	none	-	Stable
31-1-2	none	-	Stable
39-1-1	none	-	Decreasing conductivity
39-2-1	none	-	Stable

Concentrations of groundwater quality in non-compliance wells north of Phase 1 were consistent with previous years. Leachate impacts continued in areas immediately adjacent to the landfill (e.g., 40-1-1). Impacted groundwater in this area is collected by the north purge well system. Continued operation of the purge well system will reinforce leachate collection and containment and to contribute to water quality improvements. Augmentation of the north purge well system is recommended to further reduce the persistent presence of these leachate indicator parameters in groundwater at this location.

Wells along Willis Point Road met the BC CSR standards but continued to show road salt related impacts.

South of Phase 1:

To the south of the Phase 1 groundwater divide, groundwater flows towards the south. A number of leachate containment measures have been installed in this area since the mid-1980s. The containment system in this area is composed of a grout curtain, a clay berm, a shallow toe-drain and five purge wells which, in combination, obstruct and intercept southward-flowing leachate. The leachate is then directed to the leachate collection system.

Water quality in the boundary compliance stations south of Phase 1 met the BC CSR standards. Although concentrations comply with the groundwater standards, leachate indicator parameter concentrations reported at some stations indicate the possibility of leachate migration towards the south, which is consistent with data from the last few years. Potential leachate migration is being addressed through continued optimization and maintenance of the south leachate purge well system.

As shown in Table 6 below, leachate indicator parameter trends indicate that concentrations are generally either stable or decreasing.

Table 6 Groundwater Quality Compliance Summary South of the Landfill (2014–2015)

Well	Exceedences	Number of Exceedences	Trend
04-2-1	none	-	Increasing chloride
04-3-1	none	-	Decreasing conductivity
04-4-1	none	-	Stable
07-1-0	none	-	Stable
71-1-1	none	-	Decreasing conductivity and sulphate
71-2-1	none	-	Decreasing conductivity
71-3-1	none	-	Decreasing conductivity
72-1-1	none	-	Increasing chloride
72-2-1	none	-	Increasing chloride; decreasing ammonia
72-3-1	none	-	Stable
73-1-1	none	-	Increasing chloride
73-2-1	none	-	Stable
73-3-1	none	-	Stable

East of Phase 1:

Similar to previous years, water quality east of Phase 1 met BC CSR standards for the reporting period (as shown in Table 7). Groundwater movement is directed from east to west, preventing off-site leachate migration to the east. The 2014-2015 data collected in wells east of Phase 1 confirmed that leachate is effectively contained on site in this area.

Table 7 Groundwater Quality Compliance Summary East of the Landfill (2014–2015)

Well	Exceedences	Number of Exceedences	Trend
18-1-1	none	-	Stable
18-2-1	none	-	Stable
18-2-2	none	-	Stable
54-1-1	none	-	Stable
54-2-1	none	-	Stable
54-3-1	none	-	Stable
76-1-1	none	-	Decreasing conductivity
76-2-1	none	-	Decreasing ammonia
76-3-1	none	-	Stable

Phase 2

In the Phase 2 area, immediately west of Phase 1, groundwater flow is directed inward toward the base of the former Heal Lake, where leachate is collected by an underdrain system and discharged to the leachate lagoons. This area of the leachate collection and containment system is known as the Phase 2 basin. Because the groundwater flow is directed inward toward the basin, it is considered a hydraulic trap. Leachate and water levels are monitored in Phase 2 to ensure that the hydraulic trap is maintained. The 2014-2015 data indicate that the hydraulic trap functioned effectively throughout the year.

Automated leachate level monitoring has traditionally been conducted within the refuse in Phase 2. Monitoring equipment failed during this reporting period but should be resumed within the next five years to ensure appropriate leachate and landfill operational activities.

North of Phase 2 and North of the Hartland North Pad:

North of Phase 2 and north of the Hartland north pad, groundwater quality met BC CSR standards at all boundary compliance locations north of Phase 2, including locations north of the Hartland north pad.

In the vicinity of the Hartland north pad, northwest of Phase 2, groundwater results indicate that over the past seven years, impacts from historical composting activities have been reduced and impacts from aggregate stockpiling on the Hartland north pad have stabilized or are decreasing. Improvements since 2012 are largely attributed to the cover system installed in January 2012. Continued monitoring is warranted to confirm ongoing improvements and efforts should be made to reduce infiltration by maintain temporary covers.

4.2 Domestic Well Testing

Water quality data collected in 2014 met applicable drinking water quality guidelines; except for the iron concentration in a single well (well 53). The result is consistent with historic results and is not leachate related. Iron is an aesthetic objective related to laundry and plumbing staining and is not related to health hazards. The results indicate that landfill leachate is not affecting any of the 12 domestic wells sampled and water quality was consistent with background conditions.

4.3 Surface Water Monitoring

Hartland landfill is located within the Tod Creek watershed. Drainage south of the landfill is directed toward Killarney Lake and Prospect Lake, discharging to Tod Creek. Drainage north of the landfill flows northeasterly within Heal Creek to Durrance Creek, discharging to Tod Creek, and ultimately, to Tod Inlet. Surface water is monitored to ensure that surface water quality is not being adversely affected by landfill operations.

The monitoring program includes sites within the landfill, at the property boundary and within each of the major off-site drainages. The program includes five surface water monitoring stations identified as boundary compliance monitoring stations. These stations are concentrated north and south of the landfill where creeks flow from the landfill property to off-site locations. In addition, Environmental Protection staff sample many surface water stations at upstream and downstream locations to assess potential environmental effects to surface water on the site and flowing from the site. Water quality results are compared to the BC Approved and Working Water Quality Guidelines (BC WQG) for Freshwater Aquatic Life to assess compliance with the landfill Operational Certificate. It is noted that the BC WQG guidelines for sulphate were revised in April 2013 to a less stringent guideline.

4.3.1 Results

The monitoring program provides an effective measure of compliance with water quality guidelines and important information to guide management and operational decisions. A review of the surface water quality data, collected between April 2014 and March 2015, indicated that property boundary stations and the majority of on-site and off-site stations met water quality guidelines. The surface water quality data

collected in 2014/15 revealed that nearby surface water bodies, Tod Creek, Durrance Lake, Durrance Creek and Killarney Lake are not impacted by leachate. Surface water in the vicinity of the landfill generally met the BC WQG-MAC and or BC WQG-30day average values with occasional exceedences for iron, nitrate, total suspended solids, conductivity ammonia, and/or sulphate. Elevated concentrations were largely related to seasonal impacts (rain events or dry low-flow conditions) or were anomalous. Some concentration trends (both increasing and/or decreasing) were identified which are generally correlated with mild impacts by runoff from aggregate, dilute leachate, or road salt.

4.4 Leachate Monitoring

Leachate is produced from the percolation of precipitation and groundwater through the decomposing refuse in the landfill. Closure of Phase 1 involved capping the landfill area to eliminate direct infiltration of precipitation and to minimize leachate generation. Phase 2 was designed to effectively capture leachate by using gravel as an intermediate cover, to enhance drainage within the landfill, and by construction of an underdrain system in the Phase 2 basin to collect leachate. The underdrain system discharges to one of two leachate lagoons constructed to contain the leachate on site prior to controlled discharge via pipeline to the Saanich sanitary sewer and, ultimately, to the Macaulay Point outfall.

A leachate monitoring program is conducted to:

- determine the volume of leachate discharged and flow rates to the sanitary sewer,
- characterize the physical and chemical constituents in the leachate, and
- verify compliance with the CRD RSCP waste discharge permit (#SC97.001) at the point of discharge.

Automated monitoring of the volume of leachate discharged is maintained on the CRD SCADA system and provides a basis for measuring flow rates to the sanitary sewer and leak detection. Monthly leachate samples are collected to verify compliance with the RSCP waste discharge permit. Monthly testing includes analysis of approximately 92 constituents, including nutrients, mineral oil and grease, organic compounds and metals. Additional monitoring is conducted quarterly including approximately 190 compounds.

In July 2014, the CRD was alerted to a minor leak along the leachate pipeline. In accordance with our emergency response plan, staff responded to the incident and notified the affected community and local agencies. The leak was repaired and environmental monitoring demonstrated that landfill leachate impacts were confined to the immediate area of the leak site and conditions had improved. Corrective actions were implemented and monitoring continued until leachate indicators had returned to background levels.

4.4.1 Results

The average leachate flow over the period April 2014 to March 2015 was 11.84 L/s, which is slightly more than the long-term average flow of 11.48 L/s. Because leachate generation rates are closely linked to rainfall, the average annual flow varies with total precipitation each year.

Leachate quality at the point of discharge to the leachate pipeline was in compliance with the RSCP waste discharge permit throughout the reporting period with the exception of total sulphides on two sampling events in April and May, 2014. To mitigate elevated sulphide concentrations, leachate was amended with nitrate and aerated during this reporting period. The effectiveness of aeration equipment in reducing sulphide concentration was evaluated in summer 2014 and based upon the results, continuous aeration has been employed throughout 2014/2015. Sulphide concentrations remained at very low levels following May 2014.

Hartland landfill leachate continues to report low contaminant levels compared to typical municipal waste landfills.

5.0 CONTROLLED WASTE PERMITTING

Controlled wastes require special handling as a result of health and safety, operational or environmental concerns associated with disposal of these waste. They are regulated under the CRD Hartland Landfill Tipping Fee and Regulation Bylaw (Bylaw 3881) and a permitting system administered by Environmental Protection Staff. The permitting program reduces the above risks and also provides a greater level of control over the materials being disposed of and aims to minimize additional contaminant loading in the landfill and leachate. The only exception to this program is asbestos which is managed by Hartland landfill staff under federal and provincial regulations. It is currently the only hazardous waste that Hartland is authorized to accept.

Controlled wastes are trenched away from the active area of the landfill and are covered frequently to minimize health and safety risks, nuisance odours and vector attraction (scavenging animals).

In 2014, Environmental Protection staff were responsible for responding to enquiries, obtaining adequate physical and chemical characterization of the waste from the generator, and issuing permits with specific limitations, as required. Each permit details the information about the generator, the characteristics of the waste, discharge requirements, and specific health and safety precautions required to protect landfill staff.

Recommendations relating to controlled waste permitting is provided in Section 6.

5.1 Results

During 2014, the permit system worked efficiently and provided landfill staff with the information needed to ensure adequate precautions were in place to receive the permitted wastes. As with previous years, sewage sludge and screenings comprise the largest portion of controlled wastes.

Table 8 Permits and Tonnage for Controlled Waste 2009 to 2014

Year	Permits Issued	Controlled Waste Received (tonnes)	Asbestos (tonnes)	Total Controlled Waste Received (tonnes)
2014	181	7,167	1,572	8,739
2013	178	6,497	1,711	8,208
2012	164	6,076	1,417	7,493
2011	150	6,753	1,012	7,765
2010	120	7,080	1,313	8,393
2009	147	7,359	572	7,931

Enquiries from the public and business operators are used as an initial screening to determine if the waste is considered to be a controlled waste. Generally, there are more enquiries than permits issued.

In 2014, Environmental Protection staff performed random site inspections and audits of permitted wastes. Where required, further waste characterization or analysis is requested. Staff also collects audit samples to confirm compliance with the permit issued and with applicable regulations. For each permit a record of quantity and number of discharges is kept and reviewed. No major violations or permit conditions were observed.

6.0 SUMMARY OF RECOMMENDATIONS

The environmental monitoring programs at Hartland landfill provide a valuable foundation to evaluate the effectiveness of the control measures, assess potential impacts of Hartland landfill and support landfill management and operations by providing information to staff, managers and committees.

- Overall the monitoring programs conducted at Harland Landfill (landfill gas, groundwater, surface water, domestic wells and leachate) should be sustained to meet regulatory requirements and to inform management and operational decisions. Monitoring programs should be optimized through a continuous improvement program that evaluates data, sampling techniques and quality. As required to meet regulations, the annual monitoring program results should continue to be reviewed and interpreted by qualified professionals experienced in assessing the impacts of landfill leachate at large municipal landfills similar to Hartland landfill.

6.1 Landfill Gas Monitoring Program

- Continue routine monitoring program (quarterly perimeter probes, quarterly building foundation probes, bi-annual ambient grid and hot spot monitoring) in support of regulatory compliance. Conduct gas speciation in 2015 to enable tracking of gas composition changes. Conduct well field balancing monthly to optimize gas collection and as required.

6.2 Groundwater, Surface Water and Leachate Monitoring Program

- Operation of the north and south purge well systems, including optimization and maintenance activities, should continue in order to provide effective leachate control and containment. Water levels and the extent of the drawdown cone should continue to be validated routinely. Consideration should be given to increasing pumping capacity in the north purge well system.
- Aggregate stockpiles managed within the leachate containment area or infiltration should be mitigated (e.g., via cover systems) to protect downgradient surface water quality. Water quality downgradient of aggregate stockpile areas should continue to be closely monitored to assess the effects of these activities on water quality and the effectiveness of cover systems.
- Leachate flow and chemistry should continue to be monitored to inform landfill management and operational decisions and to comply with the RSCP permit. Leachate treatment should be implemented on an as-needed basis to periodic sulphide concentration spikes and monitoring should be conducted to demonstrate the effectiveness of the leachate treatment. Additionally, aeration system in the lower lagoon should continue to be operated as a cost effective way to limit sulphide formation during storage of leachate.

6.3 Controlled Waste Program

- Continue site inspections and audits to verify acceptability of wastes and to confirm that only permitted wastes are discharged as the program ensures adequate level of health and safety and environmental protection is maintained at the landfill.