Hartland Landfill Operating & Environmental Monitoring 2019/2020 Report

Operational Certificate 12659

Capital Regional District | Parks & Environmental Services, Environmental Protection

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HARTLAND LANDFILL
OPERATING & ENVIRONMENTAL MONITORING
2019/2020 REPORT

EXECUTIVE SUMMARY

Hartland Landfill is owned and operated by the Capital Regional District (CRD) and is the only sanitary landfill in the capital region. The multi-purpose facility provides recycling, household hazardous waste collection, a salvage area, yard and garden waste collection and processing, controlled waste disposal and landfill services to commercial and residential customers.

The facility operates under an approved Solid Waste Management Plan and Operational Certificate #12659 issued by the BC Ministry of Environment and Climate Change Strategy and is authorized to deposit waste asbestos. The CRD is required to report annually on the operating and environmental monitoring under the Hartland Operational Certificate. The required operating information includes waste tonnages, landfill lifespan, closure funding, operational and construction-related activities.

The CRD is also required to report the results of monitoring programs and activities. Hartland Landfill employs a number of engineering controls to ensure leachate and landfill gas are contained and/or controlled on site. An environmental monitoring program is in place to assess the effectiveness of these controls and to confirm regulatory compliance. Monitoring data is reported either for the year (January to December) or between April 1, 2019 and March 31, 2020, depending on the program.

The 2019/2020 environmental monitoring program confirms that regulatory requirements were met and effective measures are in place to mitigate environmental impacts and to contain leachate prior to discharge to the sanitary sewer. In 2019, the landfill gas collection met regulatory requirements and reported a collection efficiency of 65.5%.

In 2019, the Hartland Landfill received a total of 163,359 tonnes of waste at the active landfilling location and a total of 3,804 tonnes at the asbestos location. The estimated remaining capacity is 7,000,356 cubic metres (m^3). The estimated landfill capacity will be reached in 31 years (i.e., 2051), assuming current rates of waste deposit.

Hartland Landfill has an annual capital budget of approximately $4 million and supports many capital projects focused on environmental protection and control. In 2019, the Landfill Master Filling Plan was completed to assess and optimize remaining landfill airspace capacity and review the Hartland 2100 design concept. Other operations and capital projects that occurred in 2019 include:

- Landfill Master Filling Plan (Detailed Phase 2 Filling Plan and Hartland 2100 design concept)
- Landfill operations, mechanical services, security and vector control contracts
- BC Landfill Criteria conformance assessment
- Fire protection/water system upgrades
- Demolition and renovation waste management
- Gas and leachate collection infrastructure
- New aggregate management area development (Hartland North)
- Environmental monitoring network upgrades
- Voluntary wood waste diversion program
- Annual invasive plant species control
- Litter control

HARTLAND LANDFILL
OPERATING & ENVIRONMENTAL MONITORING
2019/2020 REPORT

Table of Contents

TABLES

APPENDICES

HARTLAND LANDFILL
OPERATING & ENVIRONMENTAL MONITORING
2019/2020 REPORT

1.0 INTRODUCTION

Hartland Landfill is owned and operated by the Capital Regional District (CRD) and is located about 14 km northwest of Victoria. It is the only sanitary landfill in the capital region, serving a population of 418,511 people. The operation is a multi-purpose facility providing recycling, household hazardous waste collection, a salvage area, yard and garden waste collection and processing, controlled waste disposal, and landfill services to commercial and residential customers.

This report represents the consolidation of three historically separate documents (Hartland Operations Annual Report, Hartland Environmental Programs Annual Report, and Landfill Gas Annual Report). The data herein is required to meet CRD operating standards, and provincial regulatory requirements per Section 3.2 of the Operational Certificate. As required by the Operational Certificate, this report includes:

- waste tonnages
- remaining landfill lifespan
- post closure funding
- 2019 operations activities
- 2019 construction contract related activities
- 2019/2020 environmental monitoring program results[1]
- 2019 annual landfill gas report

2.0 SITE OVERVIEW

Hartland Landfill is located in the Tod Creek watershed, in the bedrock highlands of the Gowlland Range, northwest of Victoria. The terrain is moderately rugged with relief of up to 446 m in the area. Undeveloped CRD property (about 320 ha in total) lies to the west and south of the landfill site. Mount Work Regional Park also lies to the west. Willis Point Road borders the site to the north, and beyond that is a Department of National Defence rifle range. Private residential properties are located to the east and southeast of the landfill.

The landfill is situated in a north-south trending bedrock saddle with Mount Work to the west and an unnamed bedrock ridge to the east. The crest of the landfill forms a drainage divide between the Heal Creek drainage basin to the north and the Killarney Creek drainage basin to the south.

Filling with waste started at the site in the 1950s under private ownership. The site continued to be owned and operated privately until 1975 when the CRD purchased the property. Hartland Landfill is the primary solid waste disposal site for all areas of the capital region. Landfilling operations and equipment maintenance is conducted by private companies under contract and direction of CRD staff.

The Hartland Landfill site is divided into two distinct areas referred to as Phase 1 and Phase 2. Initially, waste was deposited in Phase 1, which reached capacity in 1996 and was capped in 1997. Phase 2 is currently receiving waste. Filling of Phase 2, Cell 1 was completed in 2004. Subsequently, the filling of Phase 2, Cell 2 was completed in 2016 and its interim closure is in progress. Phase 2, Cell 3 was prepared in the summer of 2016 and became active in September 2016.

1 Note, some data is presented in a calendar year (January to December), but for technical reasons environmental monitoring data is presented from April 2019 to March 2020.

Leachate and surface runoff from the active landfill areas are directed to two leachate lagoons at the north end of the landfill. The leachate is then transported by a pipeline through the northwest trunk sewer system and ultimately to the Macaulay Point deep ocean outfall. Leachate discharge to sewer is authorized by CRD Regional Source Control Program Waste Discharge Permit SC97.001 and is subject to the CRD Sewer Use Bylaw (Bylaw No. 2922).

The CRD initiated a surface water and groundwater monitoring program for the landfill in 1983. Annual monitoring reports have been prepared and issued by consultants since 1988. The present Hartland monitoring program is required under the Amended Operational Certificate #12659 issued by the ministry and last amended January 21, 2013.

A Residuals Treatment Facility is under construction to the northwest corner of the Hartland Landfill property. The facility is part of the CRD's Wastewater Treatment Project, which is being completed in order to comply with provincial and federal wastewater requirements by the end of 2020. The project is funded by the Government of Canada, the Government of British Columbia and the CRD. Operations and annual report for the facility is completed under Operational Certificate #109471 issued by the BC Ministry of Environment and Climate Change Strategy.

3.0 REGULATORY SETTING

The Hartland Landfill operates in accordance with an approved solid waste management plan and an Operational Certificate. The following lists key regulatory approvals for Hartland Landfill:

- Solid Waste Management Plan (last revised in 1995), currently undergoing a revision.
- Amended Operational Certificate (#12659) approved by the ministry, last amended on January 21, 2013.
- Authorization to Dispose of Hazardous Waste Asbestos at the Hartland Landfill, approved by the ministry on July 23, 2012.
- Regional Source Control Program Waste Discharge Permit SC97.001, last amended on April 4, 2016, and subject to the CRD Sewer Use Bylaw (Bylaw No. 2922).
- Landfill gas is regulated by the Landfill Gas Management Regulation and various provincial guidelines and criteria. In April 2012, the CRD submitted the Hartland Landfill Gas Management Plan, in accordance with the Landfill Gas Regulation requirements.

3.1 BC Landfill Criteria Revised

In June 2016, the provincial Landfill Criteria for Municipal Solid Waste, Second Edition, June 2016 (Landfill Criteria) was released. The Landfill Criteria reflect the ministry's expectations regarding the standards for municipal landfills in BC and provide guidance to landfill owners, operators and consultants on environmentally sound landfilling practices and procedures. Although the Landfill Criteria is not a regulatory document itself, it is legally enforceable at Hartland Landfill, because it is incorporated into the Hartland Operational Certificate. The Landfill Criteria is prescriptive in nature and has many new requirements; however, modified practices and exceptions are allowable, if supported by technical justification and formally approved. Several requirements do not apply to existing landfills until vertical or horizontal expansion is proposed.

Many aspects of Hartland's design and operation are already compliant; however, a preliminary review identified some conformance requirements for Hartland under the status quo (i.e., no expansion). Non-conformance issues at Hartland are generally technical assessments (e.g., hydrologic model), administrative reporting updates (e.g., design, operations and closure plan update upgrade) or capital improvements (e.g., landfill fire management). Many of these initiatives are already in the planning stages and have been included in the Hartland capital plan.

The Landfill Criteria requires submission of a conformance review and related upgrading plan during the next solid waste management plan review or within five years of issuance of the Landfill Criteria, (i.e., June 2021). The Hartland Landfill conformance review has been completed in draft and will be submitted in 2021. Hartland Landfill is also operated under a solid waste management plan. The original plan was approved by the ministry in 1989 and has been revised via two revisions and several amendments. The third plan revision is currently in progress.

4.0 WASTE VOLUMES AND AIR SPACE CONSUMPTION

In 2019, the Hartland Landfill received a total of 163,359 tonnes of waste at the active landfilling location and a total of 3,804 tonnes at the asbestos location. The active landfilling location receives general refuse and controlled waste (excluding asbestos). The following section reports annual landfill air space and waste tonnage statistics.

4.1 Compaction Data

Localized compaction data is obtained routinely at Hartland Landfill to support the landfill operations and to verify target compaction rates. Four different compaction tests were completed throughout 2019 at random locations throughout Hartland's recently landfilled areas. An average compaction result of 0.90 tonnes/m^3 was confirmed after testing, and the target compaction density (0.85 tonnes/m^3) was achieved.

4.2 Landfill Utilization – Airspace Consumption and Waste Tonnage

CRD's Facilities Management & Engineering Service Division conducts monthly volumetric surveys at the following two locations: active landfilling (general refuse) and active asbestos (asbestos). Volumetric surveys document changes in airspace volume and support quality control, design conformance assessments, and assist in ongoing landfill optimization assessments.

The annual airspace consumed at the active landfilling location from waste and daily cover, tonnage of waste landfilled, and associated landfill utilization factor is shown below in Table 1:

Table 1 Waste Airspace Utilization

2019 Waste Airspace/Density Calculations	Quantity
Airspace consumed by landfilling waste (m^3) (includes waste and cover)	241,248
Tonnage of waste landfilled (tonnes) (scale data)	163,359
Landfill Utilization Factor (m^3/m^3) [1]	0.68

[1] Landfill Utilization Factor = Total tonnes disposed divided by the volume of airspace consumed, including waste and cover.

In 2019, it was not possible to track the amount of cover soil used for landfilling. Therefore, a landfill utilization factor will be used as a key performance indicator.

4.3 Asbestos Area Utilization – Airspace Consumption and Asbestos Tonnage

The annual airspace consumed at the asbestos location from asbestos and daily cover, tonnage of asbestos deposited, and associated asbestos utilization factor is shown below in Table 2:

Table 2 Asbestos Airspace Utilization

2019 Asbestos Airspace/Density Calculations	Quantity
Airspace consumed by asbestos (m^3) (includes asbestos and cover)	16,733
Tonnage of asbestos (tonnes)	3,804
Asbestos Utilization Factor (m^3/m^3) [1]	0.23

[1] Asbestos Utilization Factor = Total tonnes disposed divided by the volume of airspace consumed, including asbestos and cover.

4.4 Uncertainties

The waste deposited at Hartland Landfill is constantly compressing and settling. Settlement and airspace is assessed by monthly topographic surveys; however, this introduces uncertainty into the tracking data. The settlement factor has not been factored into the airspace utilization data above, as reporting monthly landfill tracking data is assumed to be more accurate when calculating a landfill utilization factor.

4.5 Design Conformance

Hartland Landfill is currently in Phase 2 of construction. The landfill phase is designed to be constructed in a series of cells. Each cell is divided into a series of lifts, which are progressively filled with waste. In 2019, Cell 3 – 159 m and 163 m lift filling were completed, and Cell 3 – 167 m lift started. Filling within Phase 2, Cell 3 of Hartland Landfill was completed as designed.

5.0 REMAINING SITE LIFE

As of 2019, LIDAR (Light Detection of Ranging) surveys are used for annual landfilling surveys at Hartland. The annual survey was completed in the summer of 2019 and the data was used to define the surface elevations within the landfill site. Each year, the annual survey is completed and compared to the final surface elevations associated with the Master Filling Plan. In 2019, a revised Master Filling Plan was prepared by Sperling Hansen Associates. Comparing the updated final landfill surface to the 2019 LIDAR landfill surface, it is estimated that the remaining landfill capacity is 7,000,356 m^3.

With a remaining capacity of 7,000,356 m^3, it is estimated that Hartland's capacity will be reached by the year 2051, giving a remaining landfill life of 31 years. The remaining landfill life is calculated by dividing the remaining capacity by the previous three-year average yearly landfilling volume.

The Landfill Master Filling Plan was completed in 2019 to assess and optimize remaining landfill airspace capacity and develop future expansion plans for Phase 3 and Phase 4 to take the landfill life to year 2100 (i.e., Vision 2100).

6.0 CLOSURE AND POST-CLOSURE FUND

A requirement of the Operational Certificate is a closure and post-closure liability fund to meet or exceed the estimated closure and post-closure costs with a reasonable contingency. At the end of 2019, the closure/post-closure fund was $10,658,111.

7.0 2019 COMPLETED STUDIES AND PROJECTS

The annual Hartland capital and operations budget supports many capital projects and studies focused on environmental protection and control. The following is a brief summary of work completed in 2019.

- **Hartland Landfill Master Filling Plan (Detailed Phase 2 Filling Plan and Hartland 2100 design concept):** In 2019, the CRD started an update to the previous 2007 landfill master filling plan to support the long-term vision and engineering design of the landfill. It details filling plans and phasing, road access, controlled waste relocation strategy, controlled stormwater relocation strategy, quarry development and lining strategy, progressive closure plans, gas system management plans, and others, relating to the development of the landfill.

- **Landfill operations, mechanical services, security and vector control:** Throughout 2019, contract management continued for mechanical services, on-site security, seasonal bird control, bin haul, stewardship, household hazardous waste, recycling and ozone depleting substance removal.

- **Fire protection system:** As a result of a 2015 active face fire, fire protection resources (including water availability) were evaluated in coordination with the local municipality and emergency service providers. Ongoing in-house planning, options analysis, and design continued into 2019 for site fire suppression system improvements.

- **Residential renovation waste management pilot:** In 2019, Hartland continued the Reno Safe Waste Wise program. This screening process for renovation wastes is in place to improve health and safety at the public bins area.

- **Outreach campaigns – Household Hazardous Waste and Love Food Hate Waste:** Two outreach campaigns were planned and implemented in 2019 regarding food waste reduction awareness and the risks of household hazardous wastes disposal, which is the main cause of landfill fires.

- **New aggregate management area development**: Development and use of a new aggregate management area located in the northern corner of the landfill property was completed in the spring of 2019.

- **Gas and leachate collection infrastructure:** Landfill gas infrastructure was installed per the Hartland Landfill Gas Management Plan. Wellheads, valves, condensation traps, monitoring points and piping are installed and commissioned to convey landfill gas to the gas plant and leachate to the storage lagoons. In 2019, nine new wells in Phase 2, Cell 2 and Cell 3 were activated.

- **Air space/aggregate production:** The new aggregate storage area in the northwest corner of Hartland will continue to be used as a long-term aggregate production and storage area. Future airspace production contracts within Toutle Valley were designed during 2019.

- **Monitoring Network Upgrades:** In 2019, the groundwater monitoring well network was upgraded with additional wells along the north ridge. New automated water level monitoring devices were procured and deployed.

- **Residual Treatment Facility:** In support of the wastewater treatment plant project, Hartland Landfill has completed several projects, including construction of Residual Way (a new roadway connecting the facility and the landfill), planning and design of new scales at north entrance.

- **Annual invasive plant species control:** Invasive species control continued with removal of some species and spraying of others with herbicide.

- **Litter control:** Ongoing litter cleanup and installation of littler fences prioritized throughout the year.

- **Wood Waste Diversion Program:** The voluntary wood waste diversion program continued through 2019. All accumulated wood waste is ground for beneficial use as landfill cover material.

8.0 2020 PLANNED STUDIES AND PROJECTS

- **Annual invasive plant species control:** Invasive species control will continue with removal of some species and spraying of others with herbicide.
- **Landfill operations, mechanical services, security and vector control:** Ongoing management of CRD contractors, including security, bird control, operations and kitchen scraps management will continue.
- **Fire protection system:** Following earlier design, additional fire protection resources (portable trailered system) continued to be planned for in 2020.
- **Outreach campaigns – Household Hazardous Waste and Love Food Hate Waste:** Public service campaigns will continue into 2020.

- **Gas and leachate collection infrastructure:** Combined landfill gas and leachate collectors will continue to be installed, as landfilling progresses. Wellheads, valves, condensation traps, monitoring points and piping are installed and commissioned to convey landfill gas to the gas plant and leachate to the storage lagoons. Horizontal gas and leachate collectors will be installed and activated in the Phase 2, Cell 3.
- **Landfill gas plant generator:** A backup generator is planned to be installed 2020.
- **Interim landfill cover design – Phase 2, Cell 2 (North Face):** Interim cover design was completed in 2019 for Phase 2, Cell 2 North face, as required in the Landfill Criteria for Municipal Solid Waste, to reduce leachate generation and improve landfill gas capture. Hartland interim closures include a gravel layer overlain by a synthetic tarpaulin cover.
- **Monitoring network upgrades:** Ongoing upgrades to the environmental monitoring network will continue through 2020. Planned work includes the installation of automated monitoring devices to enable the tracking of water levels, where appropriate.
- **Residual Treatment Facility:** Construction of the facility, associated with the region's new wastewater treatment plant, will continue through 2020. CRD staff will coordinate construction to support ongoing Hartland needs and environmental controls, including the tie in of the leachate conveyance system into the new facility centrate return line and install new scales at the Hartland Landfill north entrance.
- **Biosolids growing medium bench-scale trials:** Planning for laboratory bench scale tests of Class A biosolids generated from the Residual Treatment Facility and various feedstocks materials. The purposes of testing is to develop mixing ratios for the fabrication of regulatory-approved biosolids growing medium.

9.0 2019/2020 ENVIRONMENTAL MONITORING

CRD staff monitor landfill gas, groundwater, surface water and leachate quality to ensure the effectiveness of management activities, and confirm regulatory compliance. Environmental data reported herein is compared to the most current and applicable provincial standards.

Based on monitoring conducted 2019/2020[2], the program continues to provide data needed to:

- meet Operational Certificate requirements
- identify potential impacts of landfill operations, if any
- evaluate the effectiveness of control measures, and plan for mitigation (if required)

The key findings of the landfill gas, groundwater, surface water and leachate monitoring program presented here are referenced from the following:

- Hartland Landfill Groundwater, Surface Water, Leachate Monitoring Program Annual Report (April 2019 to March 2020), AECOM Canada Ltd. (AECOM) – Appendix I
- Hartland Landfill – Landfill Gas Monitoring, Annual Report, 2019, Parks & Environmental Services, Environmental Protection, CRD, September 2019 – Appendix II

9.1 Environmental Monitoring Program

Engineered controls at Hartland Landfill collect and contain leachate to control contaminant migration and, therefore, reduce or eliminate potential impacts to groundwater and surface water quality. Since 1990, the leachate has been captured and contained on site and discharged via pipeline to the sanitary sewer.

2 Monitoring periods vary such that the landfill gas "year" is January to December, but the groundwater, surface water and leachate "year" is April to March.

Groundwater and surface water monitoring stations on the Hartland Landfill property and specific off-site locations have been monitored since 1983. Monitoring is mandated through the landfill Operational Certificate and is conducted on a quarterly basis to assess the potential for landfill processes to impact groundwater and surface water resources. Additionally, leachate, generated by the infiltration of precipitation through the municipal waste, is monitored for flow characteristics, quantity and quality. The annual monitoring program has four main components, as listed below:

1. groundwater monitoring at on-site and off-site locations
2. private domestic well monitoring off site
3. surface water monitoring at on-site and off-site locations
4. leachate quality and flow monitoring

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 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.

9.1.1 Groundwater Flow

Groundwater flow throughout the landfill was consistent with historical trends. Flow directions in the Phase 1 area were primarily to the north, and this component of flow is captured by the northern leachate containment system. At the south end of Phase 1, a groundwater divide exists where groundwater flows towards the north (into the landfill) and south (away from the landfill). The southerly component of flow is intercepted by the south leachate containment system.

In the Phase 2 area, west of Phase 1, groundwater flow is directed inward toward the base of the former Heal Lake. Because the groundwater flow is directed inward toward the basin, it is considered a hydraulic trap. In the basin, the leachate is then conveyed into the leachate lagoons. Leachate and water levels are monitored in Phase 2 to ensure that the hydraulic trap is maintained. The 2019/2020 data indicate that the hydraulic trap functioned effectively throughout the year. The water quality data confirm that leachate containment system successfully controls leachate impacts. Water level and quality monitoring should continue to confirm ongoing effectiveness of leachate containment and identify any changes in the extent or magnitude of leachate impacts.

9.1.2 Groundwater Quality Results

Groundwater quality is compared against BC Contaminated Sites Regulation (CSR) numerical standards for the protection of drinking water and aquatic life. To account for seasonal variations, groundwater quality is reported between April 1, 2019 and March 31, 2020.

Of the 135 wells at Hartland, 34 groundwater monitoring wells are considered boundary compliance locations. These include locations 4, 18, 20, 21, 28, 29, 30, 31, 39, 41, 42, 53, 55, 56, 57, 71, 72 and 73. Groundwater quality at all landfill boundary compliance locations was less than the applicable BC CSR standards. The results of the 2019/2020 program were similar to those measured in recent years and showed improvement in several areas. The results of groundwater monitoring for each of the landfill areas are presented in the following sections.

9.1.2.1 North of the Landfill

Groundwater quality in boundary compliance locations north of the landfill met the applicable BC CSR groundwater standards. Groundwater quality in this area is stable or improving, as shown in Table 3. Improvements are attributed to the effective operation of the north purge well system.

Table 3 Compliance Groundwater Quality – North of the Landfill (2019/2020)

Well	Exceedances	# of Exceedances	Five-year Trend
20-1-1	none	-	Decreasing conductivity, sulphate, ammonia/Increasing nitrate
20-1-2	none	-	Decreasing conductivity, sulphate
21-1-1	none	-	Stable
21-1-2	none	-	Decreasing conductivity, sulphate
21-2-1	none	-	Decreasing conductivity, sulphate
28-1-0	none	-	Decreasing conductivity/Increasing nitrate
29-1-1	none	-	Decreasing conductivity/Increasing chloride, nitrate
29-1-2	none	-	Decreasing conductivity/Increasing sulphate
30-1-1	none	-	Decreasing conductivity, chloride
30-1-2	none	-	Stable
31-1-1	none	-	Decreasing conductivity
31-1-2	none	-	Increasing nitrate
39-1-1	none	-	Decreasing conductivity, chloride/Increasing sulphate
39-2-1	none	-	Decreasing conductivity
53-1-1	none	-	Decreasing conductivity, chloride, sulphate

Concentrations of groundwater quality in other Phase 1 wells (i.e., not compliance locations) were consistent with previous years, with leachate impacts present in areas within or immediately adjacent to the landfill (e.g., 58-1-0). Wells along Willis Point Road met the BC CSR standards, but continued to show road salt-related impacts.

Impacted groundwater in this area is collected by the north purge well system. Additional pumping capacity, installed in 2015 (P9), has had a positive impact on groundwater quality in this area. Performance of the north purge well system is routinely assessed through drawdown testing.

Continued operation of the north purge well system will reinforce leachate collection and containment. Continued improvements to the north purge well system are recommended to further reduce low level leachate impacts at the leachate lagoons.

9.1.2.2 South of Phase 1

Groundwater flows south in the furthest south portions of Phase 1. A number of leachate containment measures have been installed in this area since the mid-1980s, including a grout curtain, a clay berm, a shallow toe drain and five purge wells. In combination, these engineered improvements obstruct and intercept southward-flowing leachate, which is then directed to the leachate collection system.

Water quality in the boundary compliance stations south of Phase 1 met the BC CSR standards. Consistent with the previous reporting periods, leachate indicator parameter concentrations indicate some leachate influence in this area; however, five-year concentration trends are improving. In late 2018, the CRD reinstalled a key purge well to improve pumping capacity and decrease maintenance.

As shown in Table 4, trends indicate that concentrations of leachate indicator parameters are generally stable or decreasing.

Table 4 Compliance Groundwater Quality – South of the Landfill (2019/2020)

Well	Exceedances	# of Exceedances	Five-year Trend
04-3-1	none	-	Decreasing conductivity
04-4-1	none	-	Decreasing chloride
07-1-0	none	-	Decreasing ammonia/Increasing chloride
71-1-1	none	-	Decreasing conductivity, sulphate
71-2-1	none	-	Decreasing ammonia/Increasing chloride, sulphate
71-3-1	none	-	Increasing ammonia, chloride, sulphate
72-1-1	none	-	Decreasing conductivity
72-3-1	none	-	Decreasing ammonia, conductivity, chloride
73-1-1	none	-	Decreasing conductivity, chloride, sulphate
73-2-1	none	-	Decreasing conductivity
73-3-1	none	-	Decreasing conductivity/Increasing nitrate

9.1.2.3 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 5). Water level and quality data confirm that leachate is effectively contained on site in this area. Groundwater in this area naturally flows east to west (inward towards the landfill), preventing off-site leachate migration to the east. This area should continue to be monitored.

Table 5 Compliance Groundwater Quality – East of the Landfill (2019-2020)

Well	Exceedances	# of Exceedances	Five-year Trend
17-1-1	none	-	Decreasing ammonia, conductivity
17-1-2	none	-	Decreasing conductivity, sulphate
17-1-3	none	-	Stable
18-1-1	none	-	Decreasing conductivity, chloride, sulphate
18-2-1	none	-	Decreasing conductivity, chloride/Increasing sulphate
18-2-2	none	-	Decreasing conductivity, chloride

9.1.2.4 Hartland North Pad

Groundwater quality met BC CSR standards at all boundary compliance locations north of the Hartland North pad.

Groundwater quality has improved in the vicinity of the Hartland North pad, shown in Table 6. Previous impacts from former composting activities have reduced and impacts from aggregate stockpiling on the Hartland North pad have stabilized or are decreasing. As of winter 2017/2018, aggregate is no longer stored in this location.

Two separate areas in Hartland North area are being developed for new uses. The area closest to the landfill will be used for aggregate storage and the area adjacent o Willis Point Road is the site of the Residuals Treatment Facility, which is under construction (see Section 3.0).

Continued monitoring is warranted in this area, to confirm continued water quality improvements and to document environmental quality during and after construction activities.

Table 6 Compliance Groundwater Quality – Hartland North Pad (2019-2020)

Well	Exceedances	# of Exceedances	Five-year Trend
41-1-1	none	-	Decreasing conductivity, sulphate/Increasing chloride
42-1-1	none	-	Decreasing conductivity
55-1-1	none	-	Decreasing conductivity/Increasing chloride
56-1-1	none	-	Decreasing conductivity, sulphate/Increasing chloride
57-1-1	none	-	Decreasing conductivity

9.1.3 Domestic Well Monitoring Program

Since the 1980s, the CRD has performed routine sampling and analysis of domestic wells in the vicinity of the landfill that are used as the primary source of drinking water. In 2019, water quality data was collected from 18 domestic wells located within a 4 km radius of the landfill between July and August 2019. The sampling program included single samples and two replicate samples, which were analyzed for general water quality parameters and total metals. During this reporting period, five domestic locations located northwest of the landfill near the end of Willis Point Road were sampled at the request of residents, and only submitted for selected parameters (sodium, chloride, ammonia, conductivity and pH).

Laboratory analytical results were compared to the BC Approved Water Quality Guidelines (2015 edition), where available, and Guidelines for Canadian Drinking Water Quality (updated 2014), where they were more stringent.

9.1.3.1 Results

Overall, the 2019 domestic well water quality met the applicable guidelines. Well 53 had an exceedance of the aesthetic objective for iron. Similar to previous years, Wells 37 and 38 had an exceedance of the aesthetic objective for manganese. Manganese and iron concentrations in excess of drinking water guidelines occur occasionally throughout the area and are not related to Hartland Landfill. As well, the manganese and iron guidelines are aesthetic objectives and are not human health objectives. The domestic well results are consistent with background conditions and indicate that landfill leachate is not affecting any of the domestic wells sampled. Well 37 also had a marginal exceedance of the lead objective, which has occurred at this well before and is attributed to the filtration system.

9.1.4 Surface Water Monitoring Program

Hartland Landfill is located within the Tod Creek watershed. Drainage south of the landfill is directed toward Killarney and Prospect lakes, 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 it is not adversely affected by landfill operations.

The monitoring program includes approximately 23 sites within the landfill, at the property boundary and within each of the major off-site drainages. Five of these stations are considered 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. Water quality results are compared to the BC Approved and Working Water Quality Guidelines (BC WQG) for Freshwater Aquatic Life.

9.1.4.1 Results

Surface water quality data collected in 2019/2020 confirmed that nearby surface water bodies, Tod Creek, Durrance Lake, Durrance Creek and Killarney Lake are not impacted by leachate and have not been for many years.

Table 7 summarizes surface water samples collected in this monitoring period. The results typically met the BC WQG-MAC[3] and/or BC WQG 30-day average values. Occasional exceedances for select parameters were reported at four of the compliance locations. Elevated concentrations are not considered to be caused by leachate, but are related to any or all of the following:

- seasonal impacts – heavy rain events or low-flow (dry) conditions can lead to increased TSS and total metals
- adjacent construction activities – blasting for air space, road building and construction at Hartland north can lead to increased nitrate, TSS and total metals
- field filter contamination – staff determined that supplied field filters were contaminated and likely led to the dissolved metals exceedances observed.

Stable or improving trends were reported for three of five compliance locations. The CRD has addressed, field filter issues, as well as sample variation during low flow conditions. These efforts are expected to improve surface water quality results.

Table 7 Surface Water Quality Compliance Summary (2019/2020)

Location	Exceedances of BC Water Quality Guidelines				Trend
	Maximum Allowable Concentration	# of Exceedances	30-day Average	# of Exceedances	
SW-N-05	None	0	Nitrate	4	Increasing nitrate, sulphate
SW-N-16	pH, TSS, dissolved copper, dissolved iron, total iron	3	Nitrate, TSS, dissolved copper	5	Stable
SW-N-41s1	None	0	TSS	2	Stable
SW-N-42s1	None	0	None	0	Increasing sulphate
SW-S-04	None	0	pH, TSS, total copper, total zinc	3	Decreasing chloride

9.1.5 Leachate Management and Monitoring Program

Leachate is produced from the percolation of precipitation and groundwater through the decomposing refuse in the landfill. At Hartland Landfill, leachate is managed through landfill design, input monitoring, contaminant treatment, if required, and routine monitoring.

During the reporting period, leachate continued to be managed in accordance with the design, operations and closure plan and its supporting documents. Leachate quality was closely monitored during special projects, which included a routine lagoon drawdown test, to verify leachate control from the north purge well system.

9.1.5.1 Leachate Monitoring

A routine leachate monitoring program is conducted to:

- document leachate discharge volumes and flow rates to the sanitary sewer
- characterize the physical and chemical constituents in the leachate, and
- verify compliance with the CRD Regional Source Control Program waste discharge permit at the point of discharge.

3 BC WQG MAC are the maximum allowable concentration of a parameter that should not be exceeded at any time.

Automated monitoring of the volume of leachate discharged is maintained on the CRD SCADA (Supervisory Control and Data Acquisition) 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 waste discharge permit. Routine and annual leachate testing includes analysis of a variety of chemical parameters (e.g., nutrients, mineral oil and grease, organic compounds, metals and chlorinated compounds).

9.1.5.2 Results

The total volume of leachate discharged during this reporting period was 384,803 m^3, greater than the previous year's volume of 365,911 m^3. The average leachate flow over this reporting period was 12.2 L/s, greater than the previous reporting period's flow rate of 11.6 L/s. Leachate generation rates typically vary with annual precipitation and landfill construction-related activities (e.g., interim cover installation). Annual precipitation was higher in this reporting period than in 2018/2019.

Leachate quality at the point of discharge to the leachate pipeline complied with the applicable Regional Source Control Program waste discharge permit limits throughout the reporting period. Testing of emerging contaminants started in October 2017, with quarterly sampling of select parameters from April 2019 to March 2020. The applicability of emerging contaminant sampling will be assessed by a consultant later in 2020.

Hartland Landfill leachate continues to report low contaminant levels, compared to other typical municipal waste landfills.

9.2 Landfill Gas Monitoring Program

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. Landfill gas is primarily composed of methane and carbon dioxide with small amounts of water vapour, oxygen, nitrogen and trace gases. Trace gases include hydrogen sulphide, ammonia, nitrous oxide, volatile organic compounds and chlorofluorocarbons. 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 management is dictated by a variety of BC regulations (including the BC Landfill Gas Management Regulation), design guidelines, criteria, Hartland-specific management plans, and WorkSafeBC. The BC Landfill Gas Management Regulation requires landfills generating more than 1,000 tonnes per year of methane to develop landfill gas management plans that targets 75% collection efficiency in four years. A plan was completed for Hartland Landfill and submitted to the Province in April 2012, with an implementation target of the end of 2016.

Since the 1990s, 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 to comply with regulations. Since the implementation of the Landfill Gas Management Regulation in 2010, landfill gas collection and/or management program at Hartland now 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 ground flare is only used during extended generator downtime.

To assess the effectiveness of the landfill gas collection infrastructure, Hartland Landfill monitors landfill gas collection and utilization; perimeter and foundation probes, ambient air, and landfill gas speciation. In 2019, the monitoring program confirmed that landfill gas was contained within the landfill and results were within specified criteria or regulatory limits.

9.2.1 Gas Generation

In 2018, Hartland Landfill generated 7,915 tonnes of methane, based on the ministry's recommended gas generation model. As required, the Province's gas generation model is updated annually with waste quantity and composition data to enable annual calculation of collection efficiency and greenhouse gas emissions.

9.2.2 Gas Collection and Utilization

In 2018, the gas collection system consisted of 60 vertical wells, 78 horizontal wells, for a total of 146 wells. Four non-productive wells were removed from the well field monitoring program and rendered inactive. Nine wells were connected to the system (Phase 2, Cell 2) and seven new horizontal wells were installed in completed lifts in Phase 2, Cell 3. The well field was balanced at least monthly in 2019, as recommended by the BC Landfill Gas Management Facilities Design Guidelines.

Total fugitive greenhouse gas emissions generated from the landfill for 2019 are estimated at 68,451 tonnes CO_2. This represents an overall decrease of 35% since the implementation of the Landfill Gas Management Plan in 2012. It is expected that fugitive greenhouse gas emissions will continue to decline, due to improvements in gas extraction infrastructure.

In 2019, landfill gas collection efficiency was 65.5%, which is within estimated ranges according to the Landfill Gas Management Plan, based on filling plan progression. The slight decline in collection efficiency can be attributed to delays in filling progression, and immature gas and well activation challenges in Phase 2, Cell 3. A well optimization study and landfill gas quantification assessment is planned for 2020 to support increased gas collection and reduce fugitive emissions. Modelled methane generation was 1,622 standard cubic feet per minute (scfm) and, of that, an average of 1,062 scfm was captured through the gas plant.

The Landfill Master Filling Plan (Detailed Phase 2 Filling Plan), includes an overview of landfill gas management and future potential and is expected to prompt a future update of the Landfill Gas Management Plan.

9.2.3 Gas Monitoring and Compliance Summary

Numerous monitoring programs are in place to evaluate the performance of landfill gas system. Table 8 summarizes the results of these monitoring programs, compliance status, remedial actions, if any, and recommendations.

Table 8 Landfill Gas Compliance Summary 2019

Program	Compliance Location	Criteria	Findings	Mitigation/Actions	Recommendations
Perimeter Probe Monitoring	Probes GP-1A, 1B, 2A, 2B, 3A, 3B, 11A, 11B, 12A and 12B	• Methane must not exceed 5% in subsurface soils (BC Landfill Criteria for Municipal Solid Waste & BC Landfill Gas Management Facilities Design Guidelines)	• No exceedances • 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% methane in any on-site facility (BC Landfill Criteria for Municipal Solid Waste & BC Landfill Gas Management Facilities Design Guidelines)	• No exceedances • Low risk of subsurface gas migration to adjacent building	• None	• Continue quarterly monitoring
Ambient Grid Monitoring	N/A	• 100 ppm total hydrocarbon, as methane (CRD internal guideline)	• 10 grid locations >100 ppm • No cover system failures suspected in the closed area of Phase 1	• Investigated hot spots and mitigated where possible	• Continue annual monitoring
Hot Spot Monitoring	N/A	• 1,000 ppm THC (CRD internal guideline)	• Seven hot spots (z-points) >1,000 ppm • Currently 22 locations for hot spot investigation	• Added new locations of hot spots to the monitoring program	• Continue annual monitoring • Investigate mitigation options
Well Field Monitoring and Balancing	N/A	• Monitor monthly • Oxygen 2.5% - gas optimization and reduction of fire potential (BC Landfill Gas Management Facilities Design Guidelines)	• Monitoring completed monthly; oxygen did not exceed 2.5%	• None	• Continue monthly monitoring at minimum
Gas Speciation	N/A	• N/A	• Undiluted landfill gas exceeded WorkSafeBC criteria for carbon dioxide, hydrogen sulfide, vinyl chloride, toluene, benzene, ethylbenzene and n-hexane; however, ambient concentrations are likely well below WorkSafeBC limits, due to dilution with ambient air • Comprehensive sampling of gas identified increasing concentrations in oxygen and siloxanes	• None	• Continue speciation sampling in 2021 or sooner to support landfill gas utilization planning • Continue ambient monitoring program to confirm and implement health and safety protocols for hot spots
Gas Collection	N/A	• 75% gas collection efficiency target by the end of 2016, as per Landfill Gas Management Plan	• Gas collection efficiency was estimated at 65.5%, based on the ministry gas generation model and is within the estimated efficiency range specified in the Landfill Gas Management Plan, based on filling plan progression	• Landfill Gas Management Plan submitted to the ministry	• Continue to implement the gas management plan • Conduct well field optimization and landfill gas quantification studies in 2020

Notes: ppm = parts per million

9.3 Summary and Recommendations

The environmental monitoring program at Hartland Landfill provides 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 (landfill gas, groundwater, surface water, domestic wells and leachate) confirm that regulatory requirements are met.

- The continuous improvement program implemented at Hartland that evaluates data, sampling techniques and site quality should continue. The annual monitoring program must 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 programs should continue (i.e., perimeter probes, building foundation probes, ambient grid, hot spot monitoring and speciation) to measure and ensure regulatory compliance. Landfill gas collection efficiency for 2019 was 65.5%. Continued monthly well field balancing is necessary to optimize gas collection.
- The environmental monitoring program and data should be evaluated against the applicable standards, in accordance with the Landfill Criteria and the BC CSR, to continue meeting regulatory requirements, and to determine if monitoring program changes are warranted.
- Operation of the north and south purge well systems effectively control and contain leachate and should be continued, including planned optimization and maintenance activities. 2018 optimization efforts have had beneficial results. The extent of the drawdown cone of the north purge wells should continue to be verified routinely and additional optimization implemented, if warranted.
- Aggregate management and blasting activities should be conducted in accordance with previous recommendations, to maintain the integrity of leachate containment and to protection downgradient water quality. Specifically, blasting should be designed to mitigate impacts to bedrock flow regime and aggregate storage must be managed to mitigate impacts to water quantity and quality (i.e., both surface water and groundwater). Water quality downgradient of aggregate stockpile areas should continue to be closely monitored to confirm 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 Regional Source Control Permit waste discharge permit.
- Future landfill planning should include a detailed hydrogeological evaluation to ensure that proposed works will not compromise the integrity of leachate containment.
- The Hartland capital plan should continue to routinely include funds supporting monitoring infrastructure improvements.

10.0 CONCLUSIONS

The Hartland Landfill monitoring program assess the quality and quantity of landfill gas, leachate, groundwater and surface water. The program confirms that regulatory requirements are met and provide critical data that supports successful management of the landfill. Based upon the monitoring program, effective measures are in place to ensure environmental impacts are mitigated and leachate is effectively controlled and contained on site, prior to discharge to the sanitary sewer.

11.0 REPORT SIGNOFF

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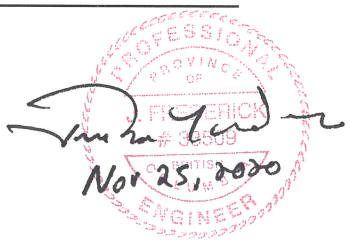

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