Hartland Landfill Operating & Environmental Monitoring 2020/2021 Report

Operational Certificate 12659

Capital Regional District | Parks & Environmental Services, Environmental Protection

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HARTLAND LANDFILL
OPERATING & ENVIRONMENTAL MONITORING
2020/2021 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, 2020 and March 31, 2021, depending on the program.

The 2020/2021 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 2020, the landfill gas collection met regulatory requirements and reported a collection efficiency of 66.7%.

In 2020, the Hartland Landfill received 168,221 tonnes of waste at the active landfilling location and 3,093 tonnes at the asbestos location. The estimated remaining capacity within Phase 2 is 6,977,400 (m^3). The estimated landfill capacity will be reached in 30 years (i.e., 2050), assuming current rates of waste disposal. The Landfill Master Filling Plan was completed in 2020 to assess and optimize remaining landfill airspace capacity and to review landfill expansion options for an additional 50 years of landfill capacity (Vision 2100).

Hartland Landfill has an annual capital budget of approximately $4 million and supports many capital projects focused on environmental protection and control. Operations and capital projects that occurred in 2020 include:

- Landfill operations, mechanical services, security and vector control contracts
- Fire protection/water system upgrades
- Residential renovation waste management pilot
- Outreach campaigns
- New aggregate management area development
- Gas and leachate collection infrastructure
- Residual Treatment Facility support infrastructure
- North Access traffic studies
- Annual invasive plant species control
- Litter control
- Wood Waste Diversion Program

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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 425,503 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
- 2020 operations activities
- 2020 construction contract-related activities
- 2020/2021 environmental monitoring program results[1]
- 2020 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 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 environmental monitoring data is presented from April 2020 to March 2021 (so it encompasses a full wet season).

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 was built in the northwest corner of the Hartland Landfill property. The facility is part of the CRD's Wastewater Treatment Project, which was completed in order to comply with provincial and federal wastewater requirements by the end of 2020. The project was 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 (ENV).

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 (2021 revision submitted and awaiting ENV approval).
- Amended Operational Certificate (#12659) approved by ENV, last amended on January 21, 2013.
- Authorization to Dispose of Hazardous Waste Asbestos at the Hartland Landfill, approved by ENV on July 23, 2012.
- Regional Source Control Program Waste Discharge Permit SC97.001, last amended on June 12, 2021, 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. Hartland continues to operate under an approved Landfill Gas Management Plan.

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 ENV'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, administrative reporting updates (e.g., DOCP update – currently underway) or capital improvements (e.g., landfill fire management). Many of these initiatives are already complete, or in the planning stages and have been included in the Hartland capital plan.

The Hartland Landfill conformance review has been completed in draft and will be submitted at the end of 2021 along with an updated Design Operations Closure Plan (DOCP) and Upgrading Plan.

4.0 WASTE VOLUMES AND AIR SPACE CONSUMPTION

In 2020, the Hartland Landfill received a total of 168,221 tonnes of waste at the active landfilling location and a total of 3,093 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 2020 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

2020 Waste Airspace/Density Calculations	Quantity
Airspace consumed by landfilling waste (m^3) (includes waste and cover)	231,000
Tonnage of waste landfilled (tonnes) (scale data)	168,221
Airspace Utilization Factor (T/m^3) [1]	0.72

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

In 2020, it was not possible to accurately track the amount of cover material 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

2020 Asbestos Airspace/Density Calculations	Quantity
Airspace consumed by asbestos (m^3) (includes asbestos and cover)	16,733
Tonnage of asbestos (tonnes)	3,093
Asbestos Utilization Factor (T/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 an airspace utilization factor.

4.5 Design Conformance

Hartland Landfill is currently in Phase 2 of development. The landfill phase is designed to be constructed in a series of cells with each cell divided into a series of lifts that are progressively filled with waste. In 2020, filling within Phase 2, Cell 3 of Hartland Landfill was ongoing, as per the previously approved cell development plan for the site.

5.0 REMAINING SITE LIFE

LIDAR (Light Detection of Ranging) surveys are used for annual landfilling surveys at Hartland. The annual survey was completed in the summer of 2020 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.

With a remaining capacity of 6,977,400 (m^3), it is estimated that Hartland's capacity will be reached by the year 2050, giving a remaining landfill life of approximately 30 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 2020 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 2020, the closure/post-closure fund was $11,281,091.

7.0 2020 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 2020.

- **Landfill operations, mechanical services, security and vector control:** Throughout 2020, contract management continued for mechanical services, on-site security, seasonal bird control, bin haul, stewardship, household hazardous waste, recycling and ozone-depleting substance removal.
- **Landfill gas plant back-up generator**: A backup generator was installed in 2020.
- Numerous fencing and site safety improvements completed.
- **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, a section of new water main installation (for firefighting) and the procurement of a new fire suppression pump were conducted in 2020.
- **Residential renovation waste management pilot:** In 2020, 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:** Four outreach campaigns were planned and implemented in 2020 regarding end markets for recyclable materials, illegal dumping prevention, household hazardous waste disposal and holiday season waste reduction.
- **New aggregate management area development:** Additional development of new aggregate storage areas located in the northeast corner of the landfill property was completed in 2020.

- **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.
- **Air space/aggregate production:** In 2020, approximately 200,000 m^3 of rock was extracted to produce more air space. 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 multi-year airspace production contracts were planned for 2021.
- **Residual Treatment Facility:** In support of the wastewater treatment plant project, Hartland Landfill has completed several projects, including construction of an internal road way connecting the Residuals Treatment Facility to Hartland landfill, and installation of new scales at north entrance
- Multiple traffic studies were completed in relation to the augmenting the landfill site entrance and utilizing an alternative access road.
- **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 2020. All accumulated wood waste is ground for beneficial use as landfill cover material.
- Environmental Audit of the new aggregate storage area completed in 2020.

8.0 2021 PLANNED STUDIES AND PROJECTS

- **Fire protection system:** Following earlier design and installation, additional fire protection resources continued to be planned for in 2020.
- **Outreach campaigns:** Public service campaigns will continue into 2021.
- **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.
- **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:** Commissioning of the facility, associated with the region's new wastewater treatment plant, will continue through 2021. CRD staff will continue to support ongoing Hartland needs and environmental controls, including the operation of new scales at the Hartland Landfill north entrance. A new larger water reservoir was constructed at the landfill as part of the wastewater treatment project; it is maintained and operated by the District of Saanich.
- **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. A biosolids growing medium blending trial is scheduled for 2021.
- Planning for relocation of Kitchen Scraps transfer site underway.
- Design and tender for clearing of aggregate storage are planned for 2021.
- Updates to the Design Operations and Closure Plan is planned for 2021

- A Solid Waste Management Plan Amendment is ongoing with submission to ENV planned for 2021.
- Procurement planning and technical studies for new the Renewable Natural Gas facility are underway.
- A new communication network using fibre optic lines to connect the south and north end of the site is being planned.
- Planning for recovery of excess biogas from the Residuals Treatment Facility project with integration into the Renewable Natural Gas upgrading facility is underway.

9.0 2020/2021 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 2020/2021[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 2020 to March 2021), AECOM Canada Ltd. (AECOM) – Appendix I
- Hartland Landfill – Landfill Gas Monitoring 2020 Report, Parks & Environmental Services, Environmental Protection, CRD, October 2021 – 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.

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- and off-site locations
2. private domestic well monitoring off site
3. surface water monitoring at on- 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.

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 (to enable review of a full ‘wet season’).

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 2020/2021 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, 2020 and March 31, 2021.

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 2020/2021 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 (2020/2021)

Well	Exceedances	# of Exceedances	Five-year Trend
20-1-1	none	-	Decreasing conductivity, chloride, ammonia
20-1-2	none	-	Decreasing conductivity, ammonia
21-1-1	none	-	Decreasing conductivity
21-1-2	none	-	Decreasing conductivity
21-2-1	none	-	Decreasing conductivity
28-1-0	none	-	Decreasing conductivity, increasing nitrate
29-1-1	none	-	Decreasing conductivity, increasing chloride, sulphate
29-1-2	none	-	Increasing sulphate, nitrate
30-1-1	none	-	Decreasing conductivity, chloride
30-1-2	none	-	Stable
31-1-1	none	-	Could not be determined
31-1-2	none	-	Could not be determined
39-1-1	none	-	Decreasing conductivity, chloride, increasing sulphate
39-2-1	none	-	Decreasing conductivity
53-1-1	none	-	Decreasing conductivity

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 has been assessed in previous years 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 (2020/2021)

Well	Exceedances	# of Exceedances	Five-year Trend
04-3-1	none	-	Decreasing conductivity, ammonia
04-4-1	none	-	Increasing chloride
07-1-0	none	-	Increasing ammonia
71-1-1	none	-	Decreasing conductivity, increasing sulphate
71-2-1	none	-	Decreasing conductivity, increasing sulphate, chloride
71-3-1	none	-	Increasing sulphate, chloride
72-1-1	none	-	Decreasing conductivity
72-3-1	none	-	Decreasing conductivity, chloride
73-1-1	none	-	Decreasing conductivity, chloride, increasing 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 (2020-2021)

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

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 to Willis Point Road is the site of the Residuals Treatment Facility, which was completed and in late 2020 (see Section 3.0).

Continued monitoring is warranted in this area to monitor water quality near the Residuals Treatment Facility.

Table 6 Compliance Groundwater Quality – Hartland North Pad (2020-2021)

Well	Exceedances	# of Exceedances	Five-year Trend
41-1-1	none	-	Decreasing conductivity, sulphate, nitrate, increasing chloride
42-1-1	none	-	Decreasing conductivity
55-1-1	none	-	Decreasing conductivity, nitrate
56-1-1	none	-	Decreasing conductivity, sulphate
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 July 2020, water quality data was collected from 19 domestic wells located within a 4-km radius of the landfill. 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 Source Drinking Water Guidelines (updated 2020) and Guidelines for Canadian Drinking Water Quality (updated 2020).

9.1.3.1 Results

Overall, the 2020 domestic well water quality met the applicable guidelines. Well 7 had an exceedance of the aesthetic objective for iron. Wells 12 and 13 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.

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 2020/2021 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 total suspended solids (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

Stable or improving trends were reported for three of five compliance locations. CRD sampling staff will increase site maintenance (removing sediment accumulation, etc.) of the other two compliance stations to improve surface water quality results.

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

Table 7 Surface Water Quality Compliance Summary (2020/2021)

Location	Exceedances of BC Water Quality Guidelines				Trend
	Maximum Allowable Concentration	# Samples with Exceedances	30-day Average	# Samples with Exceedances	
SW-N-05	Dissolved copper	2	Nitrate, TSS, dissolved copper	3	Increasing conductivity, nitrate, sulphate
SW-N-16	pH, dissolved copper, total iron	3	Nitrate, TSS, dissolved copper	4	Stable
SW-N-41s1	Total iron, TSS	1	TSS	1	Stable
SW-N-42s1	TSS	1	TSS, dissolved copper	1	Increasing sulphate, conductivity
SW-S-04	Total iron, pH	2	TSS, dissolved copper, total zinc	3	Stable

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.

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 and are analyzed for 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 419,632 m^3, greater than the previous year's volume of 384,803 m^3. The average leachate flow over this reporting period was 13.3 L/s, greater than the previous reporting period's flow rate of 12.2 L/s. Leachate generation rates typically vary with annual precipitation and landfill construction-related activities (e.g., interim cover installation). Annual precipitation was higher, almost double, in this reporting period than in 2019/2020.

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 as required.

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 2020, Hartland Landfill generated 7,934 tonnes of methane, based on ENV'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 2020, the gas collection system consisted of 60 vertical wells, 84 horizontal wells, for a total of 144 wells. Nine non-productive wells were removed from the well field monitoring program and rendered inactive. Seven wells were connected to the system and 15 new horizontal wells were installed in completed lifts in Phase 2, Cell 3. The well field was balanced monthly in 2020, as recommended by the BC Landfill Gas Management Facilities Design Guidelines.

Total fugitive greenhouse gas emissions generated from the landfill for 2020 are estimated at 66,237 tonnes CO_2. This represents an overall decrease of 38% 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 2020, landfill gas collection efficiency was 66.7% (a slight increase from 2019), which is within estimated ranges, according to the Landfill Gas Management Plan, based on filling plan progression. A landfill gas quantification assessment were completed in 2020 to support increased gas collection and reduce fugitive emissions. Results of the quantification assessment indicate that modelled methane generation using the ENV model is higher than actual methane generation according to empirical data and mass balance calculations. Using the ENV model methane generation was 1,626 standard cubic feet per minute (scfm) and, of that, an average of 1,084 scfm was captured through the gas plant. The landfill gas quantification modelling and mass balance study reported lower gas generation (1,363 scfm) and consequently an increased collection efficiency of 81%. Additional efforts to understand and optimize landfill gas collection are ongoing, with a well field optimization project planned for 2021.

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 2020

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 (THC), as methane (CRD internal guideline)	18 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 29 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, carbon monoxide, hydrogen sulfide, vinyl chloride, and benzene; 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 66.7%, based on the ENV gas generation model. Collection efficiency using an alternative model (UBCi) and empirical data was estimated at 81%.	• *Landfill Gas Management Plan* submitted to ENV.	• Continue to implement the gas management plan. Conduct well field optimization study in 2021.

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 2020 was 66.7%. 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. 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 protect 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 Program waste discharge permit.
- Future landfill planning (Cell 4 development and beyond) 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.

9.4 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.

10.0 REPORT SIGNOFF

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