Hartland Landfill Operating & Environmental Monitoring 2023/2024 Report

Operational Certificate 12659

Capital Regional District | Parks, Recreation & Environmental Services, Environmental Protection

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HARTLAND LANDFILL
OPERATING & ENVIRONMENTAL MONITORING
2023/2024 REPORT

EXECUTIVE SUMMARY

Hartland Landfill is owned and operated by the Capital Regional District (CRD) and is the only 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 in accordance with an approved Solid Waste Management Plan and Operational Certificate #12659 issued by the BC Ministry of Environment and Climate Change Strategy (ENV) and is authorized to deposit waste asbestos. The CRD is required to submit an annual operations report that details waste tonnages, landfill lifespan, closure funding, and operational and construction-related activities for the period of January 1 to December 31, 2023.

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 for the period between April 1, 2023 and March 31, 2024, in accordance with the Operational Certificate.

The groundwater quality results from 2023/2024 indicate that landfill leachate was contained and controlled within the landfill property. The 2023/2024 environmental monitoring program indicated off-site nitrate impacts in surface water and groundwater related to aggregate quarrying and stockpiling at Hartland Landfill. Surface water quality data indicated that nearby surface water bodies, including Tod Creek, Durrance Lake, and Killarney Lake are not impacted by landfill leachate; whereas aggregate impacts are inferred on Durrance Creek. CRD staff have completed an aggregate management review and are actively planning and implementing measures such as hydraulic control, prioritizing stockpile depletion, and expanding the monitoring network to further assess and mitigate nitrate impacts in the northern portion of the site.

The landfill gas collection efficiency for 2023 was 64% with the ENV model and 74% with the UBCi model, and monthly well field balancing is ongoing to optimize gas collection. In 2023, the Hartland Landfill received 208,647 tonnes of waste which included 184,566 tonnes of general refuse (including biosolids mixed with sand), 21,124 tonnes of controlled waste and 2,957 tonnes of asbestos. Additionally, 5,100 tonnes of ground wood waste were beneficially reused for cover material (e.g. side and controlled waste cover).

The detailed Phase 2 cell design and filling plan optimization resulted in an estimated remaining capacity of 7,135,047 m^3 compared to that reported at the end of 2022 (6,533,036 m^3). The estimated landfill capacity will be reached in approximately 30 years (approximately 2050), assuming current rates of waste disposal. A second update to the Hartland Design, Operations and Closure Plan (DOCP) was updated and submitted to ENV in April 2023. The DOCP update included updated air space and lifespan projections as well as a conformance review under the 2016 Landfill Criteria for Municipal Solid Waste for the Phase 3 (Hartland 2100) landfill expansion. It also included a minor amendment for the use of shredded construction and demolition waste as an alternative daily cover. The CRD's 2022 Solid Waste Management Plan amendment was approved by ENV in July 2023.

Hartland Landfill has a normal annual capital budget of approximately $2.5 million. Construction of Cells 4, 5 and 6 in 2023-2025 will increase the average annual capital budget to approximately $20 million to ensure the cells are ready for filling. This budget supports many capital projects focused on efficient landfill operation, health and safety, waste diversion infrastructure, and environmental protection. Operations and capital projects that occurred in 2023 include:

- Ongoing landfill operations, mechanical services, security and vector control contracts
- Fire protection/water system upgrades
- Residential renovation waste management

- Education and outreach campaigns
- Installation of new engineering controls to address diminished surface water quality in the north end
- Ongoing aggregate management area development
- Gas and leachate collection infrastructure installation
- Air space/aggregate production to prepare for Cell 4 liner construction was completed in September 2023
- Design of Cell 4 liner system and award of construction contract
- Preliminary design and procurement of a new Material Diversion Transfer Station
- Continued pilot for shredding of Construction and Demolition (C&D) waste
- Design Operations and Closure Plan update
- Hartland North Scale construction
- Annual invasive plant species control
- Litter control
- Wood Waste Diversion Program
- Yard and Garden Diversion Program
- Construction of the Biogas Upgrading Facility began
- Aggregate Management Plan project initiated
- Ongoing review of the environmental monitoring network

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1.0 INTRODUCTION

Hartland Landfill (Hartland) 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 approximately 450,000 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 documents (Hartland Landfill Operations Annual Report, Hartland Landfill Environmental Programs Annual Report, and Landfill Gas Monitoring 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
- 2023 operations activities
- 2023 construction contract-related activities
- 2023/2024 environmental monitoring program results[1]
- 2023 annual landfill gas monitoring report summary

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 Defense 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. Cell 4 construction is currently underway with planned filling to start in late 2024 or Q1 2025.

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 via the centrate return line (shared with the CRD's Residual Treatment Facility) to the McLoughlin Point Wastewater Treatment Plant. Leachate discharge to

[1] Note, operational and landfill gas data/information is presented in a calendar year (January to December), but environmental monitoring data is presented from April 2023 to March 2024 (so it encompasses a full wet season).

sewer is authorized by CRD Regional Source Control Program (RSCP) Waste Discharge Authorization 1978692 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 current Hartland monitoring program is required under the Amended Operational Certificate #12659 issued by the BC Ministry of Environment and Climate Change Strategy (ENV) and last amended on January 21, 2013.

The Residuals Treatment Facility resides in the northwest corner of the Hartland Landfill property. The facility anaerobically digests residual solids from the CRD's McLoughlin Point Wastewater Treatment Plant and produces Class A biosolids for beneficial reuse, in accordance with the CRD's Liquid Waste Management Plan. Operation and annual reporting for the facility is completed under Operational Certificate #109471 issued by 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, 2022 (received approval from ENV on July 13, 2023).
- 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.
- RSCP Waste Discharge Authorization 1978692, last amended on December 20, 2022, and subject to the CRD Sewer Use Bylaw (Bylaw No. 2922).
- Landfill gas is regulated by the BC *Landfill Gas Management Regulation* and various provincial guidelines and criteria. Hartland continues to operate under an approved Landfill Gas Management Plan.

4.0 WASTE VOLUMES AND AIR SPACE CONSUMPTION

In 2023, the Hartland Landfill received 208,647 tonnes of waste which included 184,566 tonnes of general refuse (including biosolids mixed with sand), 21,124 tonnes of controlled waste and 2,957 tonnes of asbestos. Air space consumption also considers wood waste beneficially used as cover (e.g. side cover or controlled waste cover). In 2023, 5,100 tonnes of wood waste was beneficially reused for side and controlled waste cover.

Air space consumption is calculated separately for waste received at the active face and asbestos areas as they have different disposal locations and waste-to-cover ratios. The following section reports annual landfill air space and waste tonnage statistics. The CRD conducts monthly volumetric surveys for all wastes in order to document changes in air space volume and support quality control, design conformance assessments, and assist in ongoing landfill optimization assessments.

4.1 Compaction Data

Localized compaction data is obtained routinely at Hartland Landfill to support the landfill operations and to verify target compaction rates. An average compaction density of 0.85 tonnes/m^3 is targeted during landfilling operations. No in-situ compaction tests were conducted in 2023. The CRD has a compaction monitoring system installed in the compactor and bulldozer. This system monitors the deflection of the compactor wheels through the garbage in real-time and provides visual assistance to ensure the operator conducts sufficient passes across each waste lift to achieve the targeted density.

4.2 Air Space Utilization – Consumption and General Refuse Tonnage

The annual air space consumed at the active landfilling location from waste and daily cover, tonnage of waste landfilled, and associated Air Space Utilization Factor is shown below in Table 1. The waste air space utilization is calculated using all refuse and shredded wood.

Table 1 General Refuse Air Space Utilization

2023 Waste Air Space/Density Calculations	Quantity
Air space consumed by landfilling waste (m^3) (includes waste and cover)	307,289
Tonnage of waste landfilled (tonnes) (scale data)	210,789[1]
Air Space Utilization Factor (tonnes/m^3)[2]	0.69

[1] Includes 184,566 tonnes of general refuse, 21,124 tonnes of controlled waste and 5,100 tonnes of wood waste
[2] Air Space Utilization Factor = Total tonnes disposed divided by the volume of air space consumed, including waste and cover

In 2023, it was not possible to accurately track the amount of cover material used for landfilling. Therefore, an Air Space Utilization Factor will be used as a key performance indicator.

4.3 Asbestos Air Space Utilization – Consumption and Asbestos Tonnage

The annual air space 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 Air Space Utilization

2023 Asbestos Air space/Density Calculations	Quantity
Air space consumed by asbestos (m^3) (includes asbestos and cover)	14,635
Tonnage of asbestos (tonnes)	2,957
Asbestos Air Space Utilization Factor (tonnes/m^3)[1]	0.20

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

4.4 Uncertainties

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

4.5 Design Conformance

Hartland Landfill is currently in Phase 2 of development and is being constructed in a series of cells with each cell divided into a series of lifts that are progressively filled with waste. In 2023, filling within Phase 2, Cell 3 of Hartland Landfill was ongoing, as per the Hartland Design, Operations and Closure Plan (DOCP) and Master Filling Plan for the site.

5.0 REMAINING SITE LIFE

In 2021 the use of LIDAR (Light Detection of Ranging) technology was replaced with photogrammetry technology. Each month a drone is used to take top-down, overlapping photos of the landfill. The photos are run though photogrammetry software which produces a three-dimensional point cloud. The point clouds are used to create three-dimensional surfaces that allow for the filling volume calculations to be conducted monthly and assist with landfill lifespan estimates. The remaining landfill life is calculated by dividing the remaining capacity by the previous three-year average yearly landfilling volume.

In 2022 the Hartland DOCP was updated, and a detailed assessment of air space was completed. Evaluation of site capacity and landfill lifespan was carried out and the concept of extending the life of the landfill to 2100 was also presented (Phase 3). The remaining capacity of the Phase 2 landfill is summarized in Table 3. It is estimated that Hartland's current capacity will be reached by the year 2050. Additional capacity, as part of the Phase 3 (Hartland 2100) expansion concept is also presented.

Table 3 Summary of Landfill Capacity from the Hartland Landfill DOCP, 2022

Phase/Cell	Gross Cell Capacity m^3	Linear Area m^2	Linear Volume m^3	Net Cell Capacity m^3
Phase 2 (Cells 3-6)	7,484,122	141,772	191,392	7,292,730
Phase 3 (Proposed expansion area)	8,062,484	---	---	8,062,484
Total All Phases	**15,546,606**	**141,772**	**191,392**	**15,355,214**

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 2023, the closure/post-closure fund was $13,670,125.

7.0 2023 COMPLETED STUDIES AND PROJECTS

The annual Hartland capital and operations budget supports many capital projects and studies focused on environmental protection and meeting Solid Waste Management Plan (SWMP) commitments. The following is a summary of work completed in 2023.

- **Landfill operations, mechanical services, security and vector control:** Throughout 2023, 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:** Enhancements to the fire protection system were installed in 2023 to allow the Saanich Fire Department to attach standard fire hoses to the system to assist with firefighting.
- **Residential renovation waste management:** The Reno Safe Waste Wise program continued into 2023. This screening process for renovation wastes is in place to improve health and safety at the public bins area.
- **Outreach campaigns:** Outreach campaigns were planned and implemented in 2023 including issuance of 20 Rethink Waste Grants, support to 10 local non-profit reuse organizations, resumption of in-person school and educational tours, circulating six issues of the Rethink Waste Newsletter and continuing the Local Government Waste Reduction Working Group.
- **Air space/aggregate production:** In 2023, approximately 183,646 m^3 of rock was extracted to produce more air space. The aggregate storage area in the northwest and northeast corners of Hartland will continue to be used as a long-term aggregate production and storage area.
- **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.
- **Design of Cell 4:** Procurement of Cell 4 construction services was initiated and awarded in Q4 2023.
- **Design Operations and Closure Plan (DOCP):** An update to the Hartland DOCP was submitted to ENV in 2023, at the ministry's request, to supplement information regarding Phase 3 presented in the SWMP. It included updates to filling plan, remaining lifespan, Cells 4-6 design, the use of shredded C&D as alternative daily cover, as well as the Phase 3 landfill expansion concept (Hartland 2100) and Siting Criteria Review under the BC Landfill Criteria for Municipal Solid Waste.

- **Shredding of Construction and Demolition (C&D) Waste Pilot:** Ongoing waste shredding trials were conducted to understand the benefits shredders may have on landfilling operations and performance.

- **Use of shredded C&D as alternative daily cover:** The use of shredded C&D as an alternative daily cover continued in 2023. Use of shredded C&D reduces overall demand and use of virgin aggregate and conserves air space.

- **Aggregate management:** Construction and operation of the aggregate storage areas located in the northwest and northeast corner of the landfill property continued in 2023, with depletion of the northeast stockpile being prioritized.

- **Hartland North Scale:** Final finishes and occupancy permits for the new scale building were secured in 2023.

- **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 litter fences were prioritized throughout the year.

- **Wood Waste Diversion Program:** The voluntary wood waste diversion program continued through 2023. All accumulated wood waste is ground and shipped off-site for beneficial use as an alternative fuel.

- **Yard and Garden (Y&G) Diversion Program:** Diversion of Y&G materials continued in 2023. Y&G is sent off-site to be beneficially used at an external composting facility.

- **Biosolids landfilled at Hartland Landfill:** This includes 2,233 tonnes of biosolids that were mixed volumetrically 1:1 with overburden or sand.

- **Biogas Upgrading Facility (BUF):** Design and construction of a biogas upgrading facility continued in 2023 with commissioning planned for Q4 2024. The facility will feed renewable natural gas into the Fortis BC network. The existing gas-to-energy facility (generator) was formally decommissioned on December 31, 2023 to enable construction of the BUF. Landfill gas (LFG) is currently treated via enclosed flare.

- **Engineered water quality controls/mitigation:** Staff and consultants worked throughout 2023 to implement surface water and groundwater controls to mitigate water quality impacts related to quarrying and aggregate production, and landfilling. A detailed aggregate management plan is almost complete and will address site-wide management practices.

- **Aggregate Management Plan:** The development of an aggregate management and storage plan continued in 2023 and is expected to be complete in 2024. The project will include actions such as run-off mitigation and strategies such as hydraulic control, prioritizing stockpile reduction, and expanding the monitoring network for all aggregate stockpiles on-site in efforts to improve on site water quality.

- **Environmental monitoring network review:** A partial review of the groundwater, surface water and leachate monitoring network at Hartland was completed in 2023. In accordance with consultant recommendations, some changes to the monitoring network were completed.

8.0 2024 PLANNED STUDIES AND PROJECTS

- **Engineered water quality controls/mitigation:** Staff and consultants will design and install additional controls in 2024 to mitigate water quality impacts related to quarrying and aggregate production. Controls include a catchment ditch below an aggregate stockpile and collector pipes to convey impacted stormwater to the leachate system and the installation of additional groundwater monitoring wells. In addition, a detailed aggregate management plan will be finalized to address site-wide management practices.

- **Outreach campaigns:** Public outreach campaigns will continue into 2024.

- **Gas and leachate collection infrastructure:** Combined landfill gas and leachate collectors continue to be installed as landfilling progresses. Installation of a new LFG header to increase collection coverage in Phase 3, Cell 2 is planned for 2024.

- **Landfill gas capture optimization:** Pilot projects for automated well head tuning devices and continuous methane surface emission monitoring devices are set to begin in 2024, aiming to improve gas collection efficiency and reduce emissions.

- **Construction of Cell 4** is scheduled to be completed in 2024.

- **Procurement of Cell 5A construction** services will be completed in summer 2024. Construction will begin in Q4 2024.

- **Biogas Upgrading Facility (BUF):** Construction and commissioning of the BUF began in Q4 2023. More detail is available in the Hartland Landfill Gas Monitoring 2023 Annual Report.

- **Material Diversion Transfer Facility:** A Design/Build/Operate Tender will be awarded in 2024 for an on-site transfer station to divert wood and asphalt shingles from the landfill. This facility will receive and transport wood waste (clean and dirty) and asphalt roofing off-site for recycling/beneficial reuse. Collection of this material will be consistent with upcoming disposal bans in 2024.

- **A Biosolids Mixing Pad** will be completed in 2024 to allow for blending of biosolids prior to transport off-site.

- **Kitchen Scraps Transfer Station relocation to the north:** Construction of the kitchen scraps transfer depot will be complete by Q4 2024. Once complete, the south kitchen scraps transfer station will be closed.

- **Automation of the North Scale system:** will be completed in 2024 along with various traffic flow and security upgrades to facilitate commercial access.

- **Access Roads:** Construction of the new north commercial access road to the future Cell 4 and kitchen scraps transfer depot will be completed in 2024.

- **Asphalt Paving:** Select access roads in the north end of the property will be paved in 2024.

- **Wood Waste Diversion Pilot Program:** The voluntary wood waste diversion program is expected to continue until the new Material Diversion Transfer Facility is operational.

9.0 2023/2024 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 in 2023/2024[2], the program continues to provide data needed to:

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

A brief summary of key findings of the landfill gas, groundwater, surface water and leachate monitoring program are presented here. For a detailed discussion of results, recommendations and actions please reference the following reports:

- Hartland Landfill Groundwater, Surface Water, Leachate Monitoring Program Annual Report (April 2023 to March 2024), AECOM Canada Ltd. (AECOM) – Appendix I
- Hartland Landfill – Landfill Gas Monitoring 2023 Report, Parks, Recreation & Environmental Services, Environmental Protection, CRD, November 2024 – 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 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 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.

9.1.1 Groundwater Flow

Groundwater flow throughout the landfill followed previously established patterns. 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.

[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’).

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 groundwater levels are monitored in Phase 2 to ensure that the hydraulic trap is maintained. The 2023/2024 data indicate that the hydraulic trap functioned effectively throughout the year. 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, 2023 and March 31, 2024.

Of the 97 groundwater wells monitored at Hartland, 36 groundwater monitoring wells are considered boundary compliance locations, listed below:

South of the Landfill (10)
- 04-3-1, 04-4-1
- 71-1-1, 71-2-1, 71-3-1
- 72-1-1, 72-3-1
- 73-1-1, 73-2-1, 73-3-1

East of the Landfill (6)
- 17-1-1, 17-1-2, 17-1-3
- 18-1-1, 18-2-1, 18-2-2

North of the Landfill (15)
- 20-1-1, 20-1-2
- 21-1-1, 21-1-2, 21-2-1
- 28-1-0
- 29-1-1, 29-1-2
- 30-1-1, 30-1-2
- 31-1-1, 31-1-2
- 39-1-1, 39-2-1
- 53-1-1

North of the Hartland North Pad (5)
- 41-1-1
- 42-1-1
- 55-1-1
- 56-1-1
- 57-1-1

Groundwater quality at all landfill boundary compliance locations was less than the applicable BC CSR standards except for nitrate at GW-31-1-1 and GW-31-1-2; and boron at GW-20-1-2 where elevated boron concentrations have persisted for several years. Further results of the 2023/2024 groundwater quality monitoring program are presented by area in the following sections.

9.1.2.1 North of Phase 1 and Phase 2

Groundwater quality in boundary compliance locations north of the landfill met the applicable BC CSR groundwater standards except for nitrate at GW-31-1-1, GW-31-1-2 and GW-39-1-1; and boron at GW-20-1-2. Compliance groundwater quality is summarized in Table 4.

Groundwater quality in proximity to the Phase 2 basin confirms the hydraulic trap leachate collection system is effectively containing leachate north of Phase 2. Groundwater quality 100 m north of Phase 2 continued to show low concentrations of leachate indicator parameters, indicating groundwater quality is not affected by landfill leachate. Operation of the Phase 1 North Purge Well System continued to mitigate leachate impacts north of the landfill.

Table 4 Compliance Groundwater Quality – North of Phase 1 and Phase 2 (2023/2024)

Well	Exceedances	# of Exceedances	Comments
20-1-1	none	-	
20-1-2	Boron	-	
21-1-1	none	-	
21-1-2	none	-	
21-2-1	none	-	
28-1-0	none	-	
29-1-1	none	-	
29-1-2	none	-	
30-1-1	none	-	
30-1-2	none	-	
31-1-1	Nitrate	2	Nitrate exceedances are associated with aggregate production and stockpiling at Hartland. The nitrate originates from leaching of ammonium nitrate / fuel oil (ANFO) residue left on the aggregate after blasting.
31-1-2	Nitrate	3	
39-1-1	Nitrate	1	
39-2-1	none	-	
53-1-1	none	-	

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.

Groundwater quality in boundary compliance locations south of the landfill continued to show no evidence of landfill leachate impacts and met the applicable BC CSR groundwater standards, summarized below in Table 5.

Table 5 Compliance Groundwater Quality – South of the Landfill (2023/2024)

Well	Exceedances	# of Exceedances
04-3-1	none	-
04-4-1	none	-
71-1-1	none	-
71-2-1	none	-
71-3-1	none	-
72-1-1	none	-
72-3-1	none	-
73-1-1	none	-
73-2-1	none	-
73-3-1	none	-

9.1.2.3 East of Phase 1

All boundary compliance locations met the applicable BC CSR standards, summarized in Table 6.

Table 6 Compliance Groundwater Quality – East of the Landfill (2023/2024)

Well	Exceedances	# of Exceedances
17-1-1	none	-
17-1-2	none	-
17-1-3	none	-
18-1-1	none	-
18-2-1	none	-
18-2-2	none	-

9.1.2.4 Hartland North Pad

Groundwater quality met BC CSR standards at all boundary compliance locations north of the Hartland North Pad and Residuals Treatment Facility, summarized in Table 7.

Table 7 Compliance Groundwater Quality – Hartland North Pad (2023/2024)

Well	Exceedances	# of Exceedances
41-1-1	none	-
42-1-1	none	-
55-1-1	none	-
56-1-1	none	-
57-1-1	none	-

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. Seventeen domestic wells were sampled in 2023 within a two-kilometre radius of the landfill.

Analytical results were compared to the BC *Source Drinking Water Guidelines* (updated 2020) and *Guidelines for Canadian Drinking Water Quality* (updated 2022).

9.1.3.1 Results

The domestic groundwater quality data was consistent with historical results, meeting all applicable federal and provincial drinking water quality guidelines other than two manganese and iron Aesthetic Objective exceedances, and one total manganese exceedance in an untreated sample. Overall, the results indicate that off-site domestic water wells continue to remain unimpacted by landfill leachate.

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 Tod Inlet. Surface water quality is monitored to assess impacts of various landfill activities, such as road construction, blasting, and aggregate stockpiling, as well as their impact on the downstream environment.

The program consists of approximately 31 monitoring locations, five of which are considered boundary compliance locations, listed below. These locations are concentrated along the southern and northern

property boundaries and monitored to assess compliance with the landfill operating permit. Water Quality data is compared to BC *Approved and Working Water Quality Short Term Acute Guidelines* (BC WQG-STA) for Freshwater Aquatic Life:

South of the Landfill

- SW-S-04

North of Phases 1 and 2

- SW-N-05
- SW-N-16

North of the Hartland North Pad

- SW-N-41S1
- SW-N-42S1

9.1.4.1 Results

Surface water quality data collected in 2023/2024 confirmed that nearby surface water bodies, including Tod Creek, Durrance Lake and Killarney Lake are not impacted by landfill leachate or aggregate runoff. Elevated nitrate concentrations observed at SW-N-14, indicates that Durrance Creek water quality may be impacted by aggregate runoff.

There were two exceedances of the BC WQG-STA at boundary compliance station SW-N-05, summarized in Table 8. Since November 2021, this station has exhibited elevated and non-compliant nutrient concentrations determined to be related to aggregate management activities and the Northwest Aggregate stockpile. Remedial strategies and options for managing impacts from aggregate blasting and stockpiles have been implemented, with additional strategies ongoing as outlined in the upcoming Aggregate Management Plan.

Other surface water monitoring locations within the landfill footprint showed signs of water quality degradation related to aggregate runoff. Use of dust suppressants may have contributed to the water quality impacts. Aggregate runoff impacts to surface water quality at and around the landfill have persisted for several years. The water quality impacts were most prevalent in November and December 2023, following major precipitation events.

In addition to the aggregate runoff impacts, elevated chloride concentrations were observed at several monitoring points in the south area of the landfill. Staff are investigating if the source of chloride is associated with the de-icing products used on site.

Ultimately, in 2023/2024, surface water quality at SW-N-05 was not compliant with the Landfill Operational Certificate. Table 8 summarizes BC WQG-STA exceedances observed at Hartland in 2023/2024.

Table 8 Compliance Surface Water Quality (2023/2024)

Location	Exceedances of BC Water Quality – Short-Term Acute Guidelines	# of Samples with Exceedances	Comments
SW-N-05	Nitrate, Total iron	2	Nitrate exceedances are associated with aggregate production and stockpiling at Hartland. The nitrate originates from leaching of ammonium nitrate / fuel oil (ANFO) residue left on the aggregate after blasting. Iron associated with high total suspended solids (TSS).
SW-N-16	none	-	
SW-S-04	none	-	

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 DOCP and its supporting documents.

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 RSCP Waste Discharge Authorization 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 Authorization 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 530,735 m^3, which is approximately 1.9% higher than the previous year's volume of 520,740 m^3, likely due to the approximately 21% higher volume of precipitation in 2023/2024 compared to 2022/2023. Leachate generation rates typically vary with annual precipitation and landfill filling/construction-related activities (e.g., interim cover installation, final closures, etc.).

In 2023/2024, the leachate quality observed in the Hartland Valve Chamber met the requirements of the Waste Discharge Authorization. Overall, average annual leachate concentrations in 2023/2024 were comparable with those measured in 2022/2023.

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 regulated by a variety of BC regulations (including the BC *Landfill Gas Management Regulation*), design guidelines, BC Landfill 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 a 75% collection efficiency in four years. Landfill gas is managed in accordance with a site-specific Landfill Gas Management Plan required by the BC *Landfill Gas Management Regulation*.

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 BC *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 2023, Hartland Landfill generated 8,418 tonnes/year 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 the annual calculation of collection efficiency and greenhouse gas emissions.

9.2.2 Gas Collection and Utilization

In 2023, the gas collection system consisted of 58 vertical wells and 94 horizontal wells, as well as one leachate horizontal gas well. In 2023, the construction of Cell 4 in Phase 2 was initiated, resulting in delayed connection of 33 collection wells already installed in the upper lifts of Cell 3. These wells will be connected to a collection system at both ends (north and south) but south connections require the extension of a main gas header on top of Cell 3, which is scheduled for construction in the third and fourth quarters (Q3/Q4) of 2024. The final north connection will not be completed until Cell 4 construction and subsequent LFG collection design is completed (2025). Gas collection is expected to decline in 2024 until the wells are connected. Gas collected by the well field averaged 5,408 tonnes/year for the year. The well field was balanced monthly in 2023, as recommended by the BC *Landfill Gas Management Facilities Design Guidelines*.

Total fugitive greenhouse gas emissions generated from the landfill for 2023 are estimated at 83,888 tonnes CO_2. Though not required under the regulation, alternative gas modeling using the UBCi model, shows CO_2e emissions (52,780 tonnes CO_2e) to be substantially less than the ENV model.

In 2020, landfill gas emissions were measured across the site and a methane mass balance was completed. Data was compared to three landfill gas generation models (including the required ENV model) and collection efficiency was calculated. Gas generation results from the UBCi model correlate closely with the methane mass balance and result in a higher collection efficiency. The UBCi model was used along with the ENV model in 2023.

In 2023, collection efficiency using both the ENV model and UBCi model was calculated at 64% and 74% respectively. Gas collection varies as a result of refuse age, well installation/operation, and well balancing activity.

Overall, the following observations can be made regarding gas production and collection at Hartland:

- Phase 1 gas production is depleting. Waste in this area of the landfill has been in place for more than 30 years and a decline in gas production is expected.
- There is decreased gas production in some high producing wells in Phase 2, which is expected due to age of refuse and advanced methanogenic processes.
- Activation of gas wells in Cell 3 required sufficient refuse in place to prevent oxygen intrusion. Wells in Cell 3 are now producing sufficient gas. More wells will be brought online in 2024.

The design and construction of Cells 4, 5 and 6 will require updating of the Landfill Gas Management Plan. This will be completed in 2024.

9.2.3 Gas Monitoring and Compliance Summary

Numerous monitoring programs are in place to evaluate the performance of the landfill gas system. Table 9 summarizes the results of these monitoring programs, compliance status, remedial actions, if any, and recommendations.

Table 9 Landfill Gas Compliance Summary 2023

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, 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)	11 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)	No new hotspots (Z-points) >1,000 ppm were identified. Currently 23 locations for hotspot 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 Collection	N/A	75% gas collection efficiency target by the end of 2016, as per *Landfill Gas Management Plan*	Site specific model (UBCi) estimated collection efficiency at 74%. ENV model estimated collection efficiency at 64%	*Landfill Gas Management Plan* submitted to ENV	Continue to implement the gas management plan and optimize methane and nitrogen, oxygen levels in the well field.

Note: ppm = parts per million

10.0 RECOMMENDATIONS

Additional recommendations for 2023 are provided in the Hartland Environmental Monitoring and Landfill Gas Monitoring reports. A high-level summary of recommendations is summarized below.

- Air space utilization and compaction rates should continue to be regularly evaluated to accurately assess future air space/landfilling needs. Additional measures/procedures to increase compaction rates should be evaluated.
- Landfilling operations should be conducted in accordance with the most recent Hartland DOCP and approved SWMP.
- To support future landfill development planning a detailed hydrogeological evaluation should be completed to ensure that proposed works will not compromise the integrity of leachate containment, and that the existing monitoring network and monitoring program remain sufficient to mitigate future environmental impacts.
- To minimize the expected decline in gas collection throughout 2024, the construction of the Cell 3 gas header and its subsequent well connections should be completed promptly and without delay.
- Recommendations from the Aggregate Management Plan should be implemented to mitigate the environmental impacts from aggregate management and stockpiling at Hartland Landfill.
- Monitoring programs for groundwater, surface water, leachate and landfill gas should continue in order to evaluate effectiveness of environmental/engineering controls for the site and overall compliance with the landfill Operational Certificate. The program should be reviewed every five years to ensure it meets program objectives.
- Continue to evaluate landfill operations/activities to ensure compliance with the landfill Operational Certificate. Findings must be reported annually at minimum.

11.0 CONCLUSIONS

In 2023, Hartland Landfill received 213,748 tonnes of waste (including beneficially used material, blended biosolids, controlled waste and asbestos) and the total air space volume (waste and cover) consumed in 2023 was 307,289 m^3. At the current disposal rate, it is estimated that Hartland's current capacity will be reached in approximately 2050.

Site Operation

In 2023, Hartland focused on increasing air space by extracting 183,646 m^3 of rock in preparation for Cell 4 construction. Gas and leachate infrastructure was installed. Updates to the Design Operations and Closure Plan were submitted, including future Phase 3 expansion plans. The shredding trial for construction and demolition waste continued, with shredded material being used as alternative daily cover, conserving virgin aggregate and air space. Strategies for aggregate management and runoff mitigation prioritized the depletion of the northeast stockpile and initiation of an aggregate management plan.

In 2024, staff will focus on continuing to prevent or mitigate impacts related to aggregate management and storage. Measures will include hydraulic containment systems and expansion of the monitoring network to better evaluate impacts. Landfill gas projects are planned to optimize gas collection, and a new gas header design and installation in Cell 3 will enable connection of more than 30 wells. Construction of Cell 4 is expected to be complete and transition to disposal in the new cell is planned for late 2024. Thereafter, construction of Cell 5a will begin. Construction of the Biogas Upgrading Facility for Renewable Natural Gas (RNG) production is expected to continue with an expected commissioning date of December 2024.

Environmental Performance

Leachate and landfill gas are being managed in accordance with regulatory requirements and data are reported in Appendices I and II, respectively.

Groundwater quality data collected in 2023/2024 indicate that landfill leachate is being effectively contained and controlled on-site. In 2023, off-site groundwater impacts related to on-site aggregate quarrying and stockpiling activities were observed. It has been confirmed by the consultants that these levels pose no significant risk to human health, aquatic life or livestock. Currently, staff are actively implementing mitigation measures and engineering controls to address these impacts.

Surface water quality data collected in 2023/2024 indicated that nearby surface water bodies, including Tod Creek, Durrance Lake and Killarney Lake continue to be unimpacted by landfill leachate or aggregate runoff. However, elevated nitrate concentrations observed at one sampling location to the north, indicates that Durrance Creek water quality may be impacted by aggregate runoff.

Additional details can be found in Appendix I.

12.0 REPORT SIGNOFF

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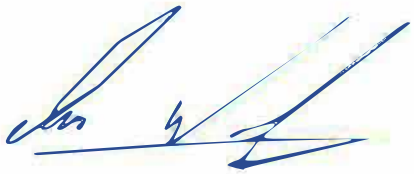

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