Associated Engineering | GLOBAL PERSPECTIVE. LOCAL FOCUS.

REPORT

City of Vernon

Hesperia Landfill
Operations and Closure Plan

JULY 2024

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1 INTRODUCTION

The City of Vernon (the City) owns and operates Hesperia Landfill (the Site) as a disposal facility for construction fill material generated from City-managed projects. The site is authorized under Operational Certificate (OC) PR-15288, issued in 1998 by the BC Ministry of Environment, Land, and Parks (now BC Ministry of Environment and Climate Change Strategy [ENV]) under the provisions of the *Waste Management Act*, RSBC 1996, c. 482, and in accordance with the approved Solid Waste Management Plan for the Regional District of North Okanagan. Under the OC, the City is authorized to discharge up to 15,200 m^3 of demolition and construction wastes, comprising inert materials such as clean fill and concrete, each year.[1]

The OC sets out the requirements that must be adhered to for the Site. One of the requirements is to prepare an **Operations and Closure Plan** to guide operations for the site and outline the ultimate plan for site closure. In 2023, the City retained Associated Environmental Consultants Inc. (Associated) to prepare an updated Operations and Closure Plan (this document), as several conditions have changed since the last Operations and Closure Plan was prepared in 2016 (Golder 2016).

1.1 Regulatory Framework

The City must adhere to the requirements of the OC, which was issued on January 21, 1998, superseding the prior permit (PR-6591) originally issued in 1983. The conditions in the OC must be adhered to, with the exception of Section 2.8, which states that "*the distance between the discharged municipal solid waste and the nearest surface water is to be a minimum of 100 m.*" In 2019, ENV provided an amendment letter to allow for the current location for the existing ephemeral watercourse on the west side of the Site (ENV 2019).

The OC also requires that the City operate the Site in 'substantial accordance' with the authorized Operational and Closure Plan (OC Section 2.4.6); however, if there are any inconsistencies between the two, the OC takes precedence (OC Section 2.4.7). The OC is provided in **Appendix A**.

The BC Landfill Criteria for Municipal Solid Waste ('the Criteria'; MOE 2016) are also applicable to the Site. The Criteria provide guidance on landfill siting, expansion, operation, and closure and reflect ENV's expectations regarding landfill operations. The Criteria apply to sites that receive 'municipal solid waste', defined by the *Environmental Management Act*, SBC 2023, c. 53, as 'refuse that originates from residential, commercial, institutional, demolition, land clearing, or construction sources'. The Criteria are written for sites that receive a wide range of materials. Some of these, such as residential and commercial waste, are not applicable to the Hesperia Landfill, which receives only clean fill material. This is addressed throughout the Operations and Closure Plan.

1.2 Purpose and Content

The purpose of this Operations and Closure Plan is provide an updated closure plan for the Site, and to provide guidance to operating staff and management personnel to operate the facility in a safe, practical, and reasonable manner while maintaining compliance with the OC requirements. This plan also includes recommended procedures and "best practices" for site operations, management, and closure.

[1] The OC states that the maximum rate is 6,000 tonnes (or 15,200 m^3) per year, which equates to a density of 0.395 tonnes/m^3. The actual waste density is estimated at closer to 1.3 tonnes/m^3. Furthermore, there is no weigh scale at the site. The City tracks and reports the estimated volume of material deposited (in m^3) only; this approach was discussed with ENV in 2017 (ENV 2017).

The structure of this document generally aligns with the Criteria requirements for an operations and closure plan, first describing the physical setting (Section 2), previous groundwater and surface water impact assessments (Section 3), and existing site operations (Section 4). This is followed by the operating and closure plan (Section 5), environmental management and monitoring plan (Section 6), and cost estimate and financial plan (Section 7).

1.3 Site History

The Site was originally permitted in 1983 (MOE 1983). That permit allowed for the discharge of up to 15,200 m^3/year of "inert material such as wood and concrete, but specifically excluding putrescible materials, domestic refuse, plastics, rubber, and other chemical or toxic waste" (MOE 1983). In 1998, the permit was superseded by the current OC, but the type of material and the maximum disposal rate did not change. However, following a fire at the site in June 1999 (SHA 2000), the City began reducing the placement of wood at the Site. Since 2004, wood waste has been formally banned from the Site by the City.

The following provides a summary of significant work completed at the Site since 2016 (the date of the previous Operations and Closure Plan). Further information can be found in the annual operations and monitoring reports, which are submitted to the ENV each year.

- In 2016, an Operations and Closure Plan was prepared and submitted to ENV (Golder 2016); superseding the original Operations and Closure Plan that was prepared in 2000.
- In 2017, the City implemented an annual groundwater and surface water monitoring program (Associated 2018a, 2019a, 2020a, 2021, 2022a, 2023).
- In 2018, a geotechnical and seismic assessment (Fletcher 2018) and a landfill gas generation assessment (Associated 2019b) were prepared and submitted to ENV. An issue with the property line was also identified and ENV was notified (Associated 2018b). Specifically, an updated legal survey completed in 2018 indicated that approximately 440 m^2 of fill material had encroached onto adjacent Crown land property to the east of the Site. At the time, the City held a lease for that land from the Province for reclaimed water use.
- In 2019, following direction from ENV and discussions with the Province, the City applied for a new lease to the Province to accommodate the current encroachment, a future fill area, and a 50-m setback to the nearest property line. In 2022, the long-term lease for the Crown Land property was approved by the Province.
- In 2021, the City completed a diversion of the onsite ephemeral watercourse, as approved by the Province via Water Licence #501526. An unnamed ephemeral watercourse historically flowed adjacent to the east portion of the Site. It was present prior to the approval of the Site in 1983, but the OC states surface water flow should not occur with 100 m. As part of a larger drainage improvement project and to reduce contact of onsite material with the stream, the watercourse was re-routed to the western side of the site following approvals by the Province (via a Water Licence under the *Water Sustainability Act*, SBC 2014, c. 15,) and the ENV (ENV 2019).

2 PHYSICAL SETTING

2.1 Location and Topography

The Site is located north of Bench Row Road in Vernon, BC, on the southern portion of a large property that is owned by the City (PID 010-994-394[2]; **Appendix B**, Figure B-1). It is situated on the south side of the Priest Valley and is elevated above the valley bottom. The southern valley wall has a slope of approximately 15% toward the north and is incised by several north-trending ravines; the Site is situated at the upper elevations of one of these ravines. The elevation of the Site ranges from approximately 410 m above mean sea level (mamsl) to 485 mamsl.

The topographic map, site plan, and site layout plans are in the figures and drawings in **Appendix B**.

2.2 Surrounding Land Use

The surrounding land use consists of mostly City-owned lands that are used for agricultural purposes and are irrigated with reclaimed water (**Appendix B**, Figure B-1). The properties to the south, southwest, and southeast are owned by the City, and leased to the Vernon Seed Orchard for tree farming. The property to the east is Crown Land that is used for hay production and cattle grazing, and for which the City holds a long-term lease for the Hesperia expansion. The properties to the north and northeast include a commercial storage centre (Elephant Storage Centre) and residential properties. The property to the northwest is undeveloped and is also owned by the City.

2.3 Climate

The climate in Vernon is characterized by warm, dry summers and mild winters. The closest Environment Canada climate station with available climate normals is the Vernon Bella Vista Station (Climate ID: 1128553). The station is about 3 km northeast of the Site at an elevation of 427 m (Environment Canada 2023). Based on 1981-2010 climate normals[3], the average daily temperature ranges from -2.1°C in December to 20.5°C in July (Environment Canada 2023). Mean annual precipitation is 428.1 mm, with 90.0 mm (water equivalent) falling as snow and 337.1 mm as rain. The highest amount of rainfall occurs in November (48.1 mm) and June (47.4 mm). These precipitation volumes are expected to vary with climate change.

Climate normal data for 1991-2010 were obtained from ClimateNA (v7.40) for the Site (50.2359, -119.3213; elevation of 410 m), along with future climate projections (Mahony et al., 2021; Wang et al., 2016). ClimateNA provides projections from 13 General Circulation Models of the Coupled Model Intercomparison Project (CMIP6) under different emission scenarios called “Shared Socioeconomic Pathways” (SSPs). For this analysis, future projections were generated using SSP5-8.5, which is a “fossil fuel-rich development” scenario with very high GHG emissions (IPCC 2021; Lee et al., 2021).

Projected mean annual temperatures, mean annual precipitation, annual precipitation as snow, annual Hargreaves reference evaporation, seasonal precipitation, and seasonal precipitation as snow were extracted for the future climate normal periods of 2011–2040, 2041–2070, and 2071–2100, hereafter referred to as the 2005, 2025, 2055, and 2085 climate periods, respectively, and the 1991–2020 climate normal (Table 2-1). Mean annual and seasonal precipitation includes precipitation as rain and snow.

[2] Lot A Plan 2591 Township 9 District Lot 62 Osoyoos Division Yale District Section 19&20, Except Plan 18975 19925 KAP85838, & DL 63 AND 64, Lot B, Plan 2591, District Lot 64, Osoyoos Division of Yale Land District, Except Plan 3985, Management Unit 9A

[3] 1981-2010 was the most recently climate normal dataset available from Environment Canada at the time of preparing this report.

Compared to the 1981-2020 normals, mean annual precipitation is expected to increase in all future scenarios while mean annual precipitation as snow is expected to decrease, i.e., future scenarios will see precipitation falling as more rainfall and less snowfall (Table 2-1). Additionally, mean annual temperature and mean annual evaporation are expected to increase (Table 2-1). On a seasonal basis, future precipitation is expected to increase in winter, spring, and autumn and decrease in summer. Overall, there is a higher potential for runoff in the future, particularly during rainfall on frozen ground, as the rain is unable to permeate the soil.

Table 2-1 Annual Climate Normals and Future Projections (SSP5-8.5) for Select Variables

Period	Mean Annual Precipitation (mm)	Mean Annual Precipitation as Snow (mm)	Mean Annual Temperature	Mean Annual Hargreaves Reference Evaporation (mm)
1981-2010 Normal	405	55	8.7	734
2011-2040	410	54	10	804
2041-2070	424	32	11.9	868
2071-2100	439	16	14.1	943

2.4 Hydrology

The nearest surface water body is an unnamed ephemeral watercourse that flows south to north adjacent to the Site. The watercourse originates on the sloped agricultural land on the south side of Bench Row Road and flows through a culvert across Bench Row Road. Historically, the flow was directed beneath Vernon Seed Orchard, then daylighted at the south end of the Site and flowed along the eastern edge of the Site, coming into contact with some site material. In 2021, the City completed a long-term project that involved diverting the watercourse around the western side of the Site to reduce contact with fill material. The works were approved via a Water Licence (issued by the Ministry of Forests) and by the ENV (via the OC amendment [ENV 2019]).[4]

The watercourse now flows through an open constructed channel that runs parallel to the Site access road (on the west side of the Site) for an estimated 630 m, before being directed into a 600 mm culvert that directs the flow around the waste material and ultimately discharges it into the original channel location, which continues north to a downstream stormwater pond (**Appendix B**, Figure B-1)[5]. From there, the watercourse then drains to a ditch on Okanagan Avenue before crossing the roadway through a culvert and draining into a wetland. The wetland drains to an existing stormwater pipe before draining into Vernon Creek at Okanagan Landing Road.

2.5 Geology

Associated (2022a) provides a detailed summary of the geological and hydrogeological characteristics of the Site based on drilling programs completed in 2017 and 2018, local and regional geological assessments (e.g., Fulton et al. 1965, Nasmith 1962, Okulitch 2013, Wittneben 1986), and publicly available well logs. Surficial geology in the vicinity of the Site is a result of several glacial/interglacial periods and therefore comprises gravel, sand, silt, clay, and till (i.e., typically gravel and sand within a firm silty clay matrix). The surficial sediments are <0-14 m thick south of the Site and thicken towards the valley bottom where surficial sediments are greater than 75 m thick, with no publicly available records confirming bedrock depth (ENV 2023). Along the hillside, surficial sediments are typically glacio-lacustrine in origin

[4] The water licence 20012084 was issued by the Ministry of Forests in September 2019. The City also received an amendment to the OC from ENV to allow for a reduced setback between the Site and the relocated watercourse (ENV 2019).
[5] Constructed by the City in 2018 to prevent periodic flooding of downstream residences.

(i.e., clay and silt with some sand and gravel) overlying pre-Fraser glaciation deposits (>25,000 years ago; Nasmith 1962). Further north where topography is flatter, lithology is a mix of the glacio-lacustrine deposits on the slope and the fluvial/alluvial deposits (i.e., sand and gravel) in the valley bottom (Fulton et al. 1965). Soils around the Site range from clay loam (i.e., low infiltration capacity) to sandy loam (i.e., moderate infiltration capacity) at surface (Wittneben 1986). Bedrock is defined as the Harper Ranch Group and comprises variable sedimentary and volcanic rocks (Okulitch 2013). Table 2-2 provides a summary of the lithology in the vicinity of the Site separated into four distinct units.

Table 2-2 Simplified Lithology

Unit	Description	Approximate Elevation
Unit A	Post-Fraser Glaciation (<10,000 ya) fluvial/alluvial sand and gravel in valley bottom	Known to be present at 350 mamsl in valley bottom only
Unit B	Fraser Glaciation (25,000–10,000 ya) glacio-lacustrine silts and clay	Known to be present at 510 mamsl and 350 mamsl in valley bottom and on valley sides; unknown thickness
Unit C	Pre-Fraser Glaciation (>25,000 ya) deposits – sand, silt, gravel, and till; located below Unit A on the hillside and beside/below Unit B in the valley bottom	Unknown elevation and thickness
Unit D	Bedrock (360–209 ma) – Harper Ranch Group (siltstone, sandstone, argillite, conglomerate, breccia, phyllite, quartz, limestone); lesser volcanics (tuff, andesite)	Approximately 512 mamsl near Bench Row Road; not observed in valley bottom below 260 mamsl

Notes: ma – mega-annum (million years ago); mamsl – metres above mean sea level; ya – years ago

2.6 Hydrogeology

There are no provincially mapped aquifers below the Site. Borehole logs from previous drilling north/northwest of the Site (Fletcher Paine 2015) indicate variable lithology to a depth of approximately 10 m, and sand and gravel units with variable clay and till layers throughout. Some of the boreholes intersected water above the clay and till layers, indicating the presence of perched aquifers along the hillside. Any deep aquifer(s) along the hillside would be below layers of clay and/or till and are less likely to be influenced by potential contaminants from the Site.

The BC Water Resources Atlas (ENV 2023) indicates the presence of three provincially mapped aquifers in the Priest Valley (Table 2-3).

Table 2-3 Mapped Aquifers Near the Site

	Aquifer 346	Aquifer 347	Aquifer 1227
Aquifer name	South Vernon Unconfined Aquifer	South Vernon Confined Aquifer	Okanagan Landing Deep Confined Aquifer
Lithology	Likely alluvium or stream terrace deposits (Unit A)	Sands and gravels from alluvium or stream terrace deposits (Unit C)	Sand and gravel dominated, but can be silty (Unit C); contact with bedrock
Groundwater recharge	Assumed to be from precipitation, leakage from creeks/alluvial fans, and mountain block recharge	Predominantly from leakage through overlying confining unit from Aquifer 346; also mountain block recharge and leakage from sediments along the valley margins	Predominantly expected to derive from mountain block recharge via seepage from fractures and faults below the valley
Size (km^2)	14.7	6.8	3.8
Number of registered wells correlated to the aquifer	105	113	6
Median well depth (m)	13.7	38.1	112.8
Number of registered flowing artesian wells	17 (16% of wells)	47 (42% of wells)	2 (33% of wells)

Source: ENV 2023

The conceptual model of groundwater flow in the vicinity of the Site is complex. Data obtained to date through the drilling of three monitoring wells around the Site have indicated that there are one or more shallow perched aquifers in the vicinity of the Site, but they are thin and form seasonally in response to precipitation events or due to snowmelt in the spring. Two of the three wells are consistently dry (Associated 2022a), despite being drilled to depths of approximately 20 m. Beneath the perched aquifer(s) are thick successions of glacial and pre-glacial sediments of variable textures, including gravel, sand, silt, and clay till deposits. Deeper aquifers may exist in the vicinity of the Site beneath the pre-glacial sediments (>90 m), but these aquifers are capped by layers of lesser permeability (e.g., clay and silt), making migration of potential contaminants from the Site into deeper aquifers unlikely.

Based on the available information, the areas around and upslope of the Site act as the groundwater recharge area. Precipitation and melting snow predominantly run off the slopes, giving way to the largely incised north–south trending gullies along the hillside. The small amount of water that infiltrates the ground percolates down, perches on layers of less permeability (e.g., clay and till), and moves via gravity toward the valley bottom aquifer(s). Some groundwater in the recharge area likely enters a more regional flow regime and, due to the high elevation of the recharge zone, presents itself as flowing artesian wells in the valley bottom.

The lithology observed during previous drilling programs (2017 and 2018) indicates significant variability of sediments among the boreholes, which makes it difficult to determine which lithological units are connected and which ones are isolated; however, given the other information gained as part of the hydrogeological study, the units are likely not all

interconnected (Associated 2022a). The water chemistry throughout the region is variable, which reinforces the presence of various aquifer systems and limited hydraulic connections between aquifer systems throughout the subsurface. This characteristic also makes it difficult to assess background groundwater quality, as the perched aquifer system upgradient of the Site is not the same as the aquifers downgradient of the Site. Background water quality is assessed using domestic wells that are outside the area of any assumed Site influence and regional background concentrations developed by ENV; however, these wells are in different aquifers and may be affected by different land uses.

2.7 Wildlife

The nearest fish bearing stream is Vernon Creek, approximately 380 m downstream of the constructed stormwater pond. Existing culverts, ditches, and flow volumes prevent fish from travelling between Vernon Creek and the Site.

Wildlife species of conservation concern with potential to occur at the Site based on habitat suitability and known presence in the general area are provided in Table 2-4.

Table 2-4 Wildlife Species at Risk with Potential to Occur Near the Site

Common Name	Scientific Name	BC Listing[1]	SARA Listing[2]	Potential to Occur on Site
Great Basin spadefoot toad	*Spea intermontana*	Blue	1 - Threatened	High
Great Basin gophersnake	*Pituophis catenifer deserticola*	Blue	1 – Threatened	Moderate
Northern rubber boa	*Charina bottae*	Not listed	1 – Special concern	Moderate
American badger	*Taxidea taxus jeffersonii*	Red	1 – Special concern	Moderate
Western harvest mouse	*Reithrodontomys megalotis*	Blue	1 – Special concern	Moderate
Grasshopper sparrow	*Ammodramus savannarum*	Red	Not listed	Moderate
Swainson's hawk	*Buteo swainsoni*	Red	Not listed	Moderate
Immaculate green hairstreak	*Callophrys affinis*	Blue	Not listed	Moderate

Source: British Columbia Conservation Data Centre (CDC) 2023.
[1]**BC Status:** Red listed: indigenous species or subspecies (taxa) considered *Extirpated*, *Endangered*, or *Threatened* in BC.; Blue listed: indigenous taxa considered vulnerable in BC.
[2]Status under ***Species at Risk Act* (SARA):** federally designated species listed as Extirpated, Endangered, Threatened, or of Special Concern are listed as Schedule 1. Once listed as Schedule 1, measures to protect and recover listed species are implemented.

The Site is within mapped critical habitat for Great Basin spadefoot (*Spea intermontana*), American badger (*Taxidea taxus jeffersonii*), western rattlesnake (*Crotalus oreganus*), and Great Basin gophersnake (*Pituophis catenifer deserticola*; DataBC 2023). Rodent burrows observed at the Site provide refugia for amphibians and reptiles. Habitat adjacent to the Site provides suitable forage, living, and growing for Great Basin gophersnakes. There is low potential for western

rattlesnake to occur on the Site based on known extents of the population in region. Badger may occupy habitats near the project and may excavate dens in the deep friable soils along the north-south oriented gully, north of the Site. Badger dens are conspicuous features on the landscape and are easily identified by informed observers. Great Basin spadefoot breed in shallow ponds and ephemeral water, and spadefoot breeding has been reported in several wetlands in the valley bottom. The federal Recovery Strategy (Government of Canada 2017) indicates that spadefoot are unlikely to travel distances greater than 500 m of terrestrial habitat from breeding sites, and there are presently no known breeding sites within 500 m of the Hesperia site;[6] however, they have the potential to occur at the Site.

Recommended measures to protect wildlife during Site operations are in Section 6.6.

2.8 Vegetation

The Site is located within the Okanagan Very Dry Hot Interior Douglas-fir (IDFxh1) biogeoclimatic zone. The IDFxh1 zone occupies much of the lower elevations in the Okanagan Valley and is characterized by a warm, dry climatic regime, with long growing seasons and less extreme low temperatures in winter (Lloyd et al. 1990).

A search of the Conservation Data Centre mapping (DataBC 2023) resulted in a single ecological community, the Red-listed Trembling Aspen / Common Snowberry / Kentucky Bluegrass (*Populus tremuloides / Symphoricarpos albus / Poa pratensis*), that may occur near the Site. Although this community has the potential to occur, it has not been observed at the Site. Limited riparian vegetation adjacent to the ravine comprises of black hawthorn (*Crataegus douglasii*) and the non-native Siberian elm (*Ulmus pumila*). Weeds, including scotch thistle (*Onopordum acanthium*) and burdock (*Arctium lappa*) were also observed at the Site. The area outside of the ravine is primarily agronomic grasses.

[6] The ephemeral watercourse flows only rarely, and the stormwater pond downstream of the Site does not generally contain standing water.

3 GROUNDWATER AND SURFACE WATER IMPACT ASSESSMENT AND MONITORING

Previous iterations of the Operations and Closure Plan had concluded that groundwater monitoring wells were not warranted, given the type of waste deposited, relatively dry climate, and restricted access to the Site (Golder 2016; SHA 2000). Following a request by ENV to implement a groundwater monitoring program at the Site, the City initiated a groundwater and surface water impact assessment in 2017. Since that time, the potential for groundwater impacts has been assessed through the following:

- Drilling of six monitoring wells (three near the Site and three down-gradient between the Site and nearest downgradient drinking water well);
- An in-depth desktop study of available borehole log data and groundwater levels and development of cross-sections;
- Annual groundwater quality monitoring from a series monitoring wells and domestic water supply wells; and
- Interpretation of the results by Qualified Professionals.

Groundwater and surface water reports have been submitted to ENV annually since 2017. This section provides a brief summary of the findings to date. For further details and methodology, refer to Associated (2019a).

3.1 Groundwater

As outlined in Section 2.6, the hydrostratigraphy of the area surrounding the Site results in a complex groundwater flow regime. There are aquifers down-gradient of the Site (Section 2.6; Table 2-3) that are used for domestic and irrigation water supply and they are within 1 km of the Site. Within 150 m of the Site, three monitoring wells were installed in 2018 to better understand up-gradient groundwater chemistry, but these wells are not within the same aquifer(s) as those located further down-gradient. Furthermore, monitoring of groundwater chemistry down-gradient from the Site started in 2017, 34 years after the Site began operating; thus, no baseline data are available.

Potential risks to the private domestic and irrigation wells are considered the primary focus of the groundwater monitoring program. Each year, groundwater samples are collected from the six monitoring wells (if water is present) and four domestic wells along Okanagan Avenue, and results are compared to applicable guidelines and standards for the protection of drinking water, aquatic life, and irrigation water. Results to date have not indicated any direct impacts from the Site, but the program has only been in place since 2017. Given the complex hydrogeological nature of the area and the fact that wells are used for domestic purposes, the potential for groundwater impacts need to be assessed annually by a Qualified Professional.

3.2 Surface Water

Impacts to surface water are also assessed annually as part of the groundwater and surface water monitoring program described above. Samples are collected from the unnamed watercourse during the standard monitoring program when water is flowing, but this occurs rarely (i.e., it is typically dry). Results from previous monitoring programs are provided in Associated 2020a, 2021, 2022a, and 2023. The watercourse from which samples were collected ultimately drains to an existing ditch on Okanagan Avenue before crossing the roadway through a culvert and draining into a wetland, which ultimately discharges into Vernon Creek at Okanagan Landing Road. The wetland upstream of Vernon Creek may provide some buffering (settling) capacity and reduce the suspended sediment load.

Given the minimal flow observed to date in the watercourse, and the fact that it no longer comes into contact with site material, impacts to surface water are not anticipated; however, surface water monitoring will continue. Overall protection of surface water quality downstream of the Site is expected to be achieved by mitigating onsite erosion and sediment transport into the watercourse; this is addressed further in Section 6.2.

3.3 Future Monitoring

As per the OC and the Criteria, a groundwater and surface water monitoring program will occur annually throughout the life of the Site and post-closure (for a minimum of 25 years, as per the OC). The methods, results, frequency, parameters, and locations will be reviewed annually by a Qualified Professional and adjusted if necessary. Results and any recommended changes to the monitoring program will be presented to the ENV each year in the Annual Operations and Monitoring Report.

4 EXISTING SITE OPERATIONS

Historically, the Site has operated as a gully landfill that is filled with end-dumping[7], starting from the south towards the downslope north end.

4.1 Site Access

The Site is only used by the City or their authorized contractors working on City-projects, and access is restricted by a private road and locked gate. The frequency with which waste is received is dependant on City construction projects, and therefore, most waste is received during construction season (April to October) with very minimal waste received in the winter.

There is no scale at the Site. The average capacity and load of the City trucks is used to generate a tipping fee to be applied per load, which is then charged to individual projects.

4.2 Waste Acceptance and Cover Material

The OC allows for the disposal of "demolition and construction wastes that are comprised of inert material such as wood and concrete, but specifically excluding putrescible materials, domestic refuse, plastics, rubber, and other chemical or toxic waste." The type of material deposited at the Site is primarily fill material (i.e., sands, silts, and gravels from the Vernon area) from City construction projects, as well as some concrete. Although the OC allows for the disposal of wood waste, it has been voluntarily banned by the City since approximately 2004.

Cover material: Section 2.20 of the OC states that 'intermediate cover' consisting of 'at least 0.3 m of soil or other cover material' is to be placed within 30 days. As the type of material that is deposited constitutes cover, compliance with this section of the OC is inferred.

Natural control landfill: There is no liner at the Site, nor was one required when the Site was originally permitted. The OC instead requires that the bottommost waste cell be at least 1.2 m above the seasonal high water table (OC Section 2.9.1), and that there be at least 2 m of low permeability soil (i.e., silt or clay; hydraulic conductivity of 1 x 10^{-6} cm/s or less) below the waste cells (OC Section 2.9.2). It also notes that a lesser thickness or no layer of low permeability soil may be authorized based on leachate generation (OC Section 2.9.2).

There are no monitoring wells drilled within the Site boundary, but three were drilled near to the Site and indicated silt and clay to at least 20 m and no laterally extensive aquifer(s), only small perched systems with seasonal fluctuations. Overburden may be as thick as 90 m in this area (Section 2.5) and no groundwater table is evident. Furthermore, the Site has minimal leachate generation potential due to the type of fill material accepted at the facility and the relatively dry climate in the Okanagan. The primary sources of leachate are from water infiltrating through waste material and from organic matter generating leachate as it decomposes. Since the accepted material is inert[8] fill material, there is low potential for leachate generation.

4.3 Site Roles and Responsibilities

There are no full-time staff at the Site as it is not used daily. There is also no equipment stored at the Site; all equipment is brought to the Site as needed. Key Site roles and responsibilities are outlined below.

[7] The practice of dumping waste materials at the edge or end of a landfill.
[8] Waste materials that are not chemically reactive, flammable, or biologically active and do not decompose over time.

Director of Operations: The Director of Operations is responsible for overseeing the Site and ensuring operations meet the OC requirements. The Director of Operations' general duties are:

1. **Prepare annual budgets**
   - Manage the reserve funds for the final closure requirements.
   - Set tipping fees.
2. **Maintain operating records and administrative reports**
   - Oversee the completion of annual reports to confirm compliance with OC requirements.
   - Plan any required corrective work for non-compliance items.
   - Ensure the operating records are kept and stored correctly.

Site Manager (Manager of Roads, Drainage, and Airport): The Site Manager is responsible for day-to-day operations, and reports to the Director of Operations. The Site Manager's general duties are:

1. **Plan landfill filling activities**
   - Coordinate when City projects will bring waste to the Site.
   - Coordinate the Operators to be on-site when required.
   - Coordinate on-site equipment when required.
2. **Regulatory compliance**
   - Maintain the operations within regulatory and OC approval conditions.
   - Take immediate corrective action for minor issues of non-compliance.
   - Recommend corrective action to the Director of Operations for major items of non-compliance.
3. **Administrative duties**
   - Supervise operating personnel.
   - Maintain daily operating records.
   - Prepare annual report.

Operators: The Operators are the City's equipment operators. They report to the Site Manager and are responsible for the spread and compaction of waste at the Site. The general duties for the Operators are:

1. **Equipment operation**
   - Push the waste to the lower plateau from where the trucks have placed the waste through end-dumping.
   - Spread and compact the waste on the working face.[9]
   - Excavate and stockpile cover soil.
   - Place and compact cover soil.
2. **Site operation**
   - Ensure City trucks are disposing to unloading area.
   - Visually inspect wastes, looking for prohibited wastes.
   - Inform users of safety practices.
3. **Site maintenance**
   - Minor maintenance of roads, drainage ditches, and erosion and sediment control measures.
   - Maintain stockpile area.
   - Control dust.
4. **Administrative duties**
   - Fill out operating logs.

[9] The active area where the waste is end-dumped from the dump trucks, and then spread and compacted with equipment.

5 OPERATING AND CLOSURE PLAN

Section 5.1 describes the operating and filling plan to maintain the Site to the OC standards and to achieve final closure as outlined in Section 5.2. Site health and safety and contingency planning are addressed in **Appendix C** (Site Safety Information) and **Appendix D** (Emergency Response and Contingency Plan).

5.1 Filling Plan

The Site is operated as a single cell that is currently most developed at the upper portion (i.e., the south end). The concept for the fill placement is to build upwards (north to south) from the toe (i.e., northern extent) of the Site until the desired elevation is achieved for each phase. The volume of material to achieve correct elevation aligns with closure planning, as described in Section 5.2 and presented in the drawings located in **Appendix B**.

5.1.1 Placement of Waste

The Site has historically been filled by end-dumping. Trucks drive along the existing access road until they reach the active face where the waste is unloaded. At the active face, a grader spreads the waste back to the wall of the ravine. The side slope of the active face of the Site is graded to a maximum of 3H:1V.

As the Site develops further, waste material will be placed starting at the toe of the Site and spread to reach the horizontal fill extent (ravine bank) in layers, until the elevation matches the surrounding land. Side slopes will constructed at a maximum of 3H:1V with top slopes at a minimum of 25:1V. Access roads will be developed to allow haul trucks to dump near the active face. To fill the northern portion of the landfill, it is anticipated that dozers will be required to push materials from the upper plateau to the lower areas, as the grade will be too steep for haul trucks to reach this area (i.e., greater than 8% slope).

The south end (highest elevation) is already partially developed (cleared and levelled), and will be used as a temporary material stockpile location.

5.1.2 Access, Security, and Signage

Only City personnel and their authorized contractors will have access to the Site; this will continue to be managed via the private road and locked gate at the main entrance on Bench Row Road. All existing perimeter fencing that restricts access will be maintained by the City.

As required by the OC, existing signage will be maintained at the Site entrance. Signage details the site name, owner and operator, contact phone number and emergency number, accepted material, and prohibited material.

5.1.3 Waste Control and Waste Handling Guide

The OC outlines acceptable waste as demolition and construction wastes that are compromised of inert material such as wood and concrete. However, concrete cannot be placed in the Crown Land long-term approved lease area, which is regulated by the Agricultural Land Commission (i.e., the eastern portion of the landfill shown in **Appendix B**). Per the OC, the placement of the following waste at the Site is prohibited (OC Section 1.1.2):

- Putrescible materials;
- Domestic refuse;
- Plastics;

- Rubber;
- Chemical or toxic wastes;
- Special wastes other than those specifically authorized in the *Special Waste Regulation*;
- Bulk liquids and semisolid sludges that contain free liquid;
- Automobiles, white goods, other large metallic objects, and tires;
- Biomedical waste; and
- Dead animals and slaughterhouse wastes, fish hatchery and farming wastes, or cannery wastes and by-products.

For waste handling at the site, Table 5-1 outlines general guidance to handling typical waste that may be found in the construction and demolition material that is accepted at the Site. This guide is only intended for reference as some circumstances may dictate specific handling requirements and procedures. The Site has a designated area for storage or recyclable or reusable materials, if encountered in the waste.

Table 5-1 Waste Handling Guide

Type of Waste	Handling Procedures
Fill material (soil and gravel, small rocks)	• Dispose mixed inert loads as per fill plan. • Screen and remove any prohibited material. • Separate soil that has hydrocarbon staining or smell. Stockpile for appropriate further analysis, remediation, or disposal. • Stockpile any clay or heavy clay soil (if free of debris) separately to use as clay cover or, if using for topsoil, for blending with sandy, loam, and/or silty soil. • Stockpile organic topsoil (i.e., darker soil, humus present) separately for use during closure.
Concrete	• Where practical, divert concrete to storage area for recycling or send to the regional landfill. • Ensure concrete does not get deposited within the Crown Land long-term approved lease boundary.
Metal (contained within fill material)	• Screen out where possible; collect in waste bill on site; send to regional landfill.
Glass (contained within fill material)	• Screen out where possible; collect in waste bill on site; send to regional landfill.
Asphalt (contained within fill material)	• Screen out where possible; stockpile on site; send offsite for proper disposal.
Asbestos (insulation, coated pipes) *Not accepted	• Screen and remove any incidental pipe material. Note that airborne particles post a health risk to employees and contractors; refer to WorkSafe BC handbook “Safe Work Practices Handling Asbestos”.
Major vegetation (trees, stumps, etc.) *Not accepted	• Do not accept wood waste; divert it to the local landfill for composting. • Exception: If primarily clean soils with few roots and other debris, it may be suitable as cover material.

5.1.4 Stockpiling

Topsoil that is removed during Site expansion is stored and stockpiled in designated areas for reuse during closure. All stockpiles will be surrounded by berms to keep the materials contained and prevent erosion. They will be seeded with a quick germinating grass mix to reduce erosion.

5.1.5 Working Face Procedures

Working Face

The working face is the active area where the waste is end-dumped from trucks, and then spread and compacted with equipment. For efficient operation of the compaction equipment, the working face slope will vary between 20% (5H:1V) and 33% (3H:1V) depending on its location within the landfill. There should only be one active working face at any one time.

Compaction Procedures

Compaction of waste is completed by Operators using heavy equipment that is brought to Site. The purpose of waste compaction is to:

- Maximize waste density to reduce its volume and optimize airspace;
- Increase overall potential revenue by maximizing site capacity;
- Reduce potential for wind-blown litter and dust;
- Provide a solid base on which vehicles can travel; and
- Minimize settlement upon reclamation of the Site.

To maximize density the compaction process will be as follows:

- Spread waste on the working face in successive layers 0.6 m thick or less;
- Crush and incorporate bulky items onto the working face; and
- Compact each layer by traveling over the working face so that the compactor wheels cover the entire surface (typically takes four passes).

The Site Manager will visually monitor compaction procedures. The Operators will visually inspect the working face at the end of each day of operation to ensure the working face has an even surface.

Cover Application and Procedure

The waste material received at Site is primarily soil fill material and is the same as what would generally be used as a daily or intermediate cover. Therefore, daily or intermediate cover is not warranted.

Waste material at the Site should have hydraulic permeability testing completed and documented annually. If the waste material meets the final cover hydraulic conductivity permeability requirements of $1x10^{-5}$ cm/s or less, the barrier layer may not be required in all areas the time of closure (Section 2.11 of the OC).

5.1.6 End-of-Day Closure

Once waste receival is complete for the day, the Operator will secure the Site conducting the following “end-of-day closure” procedure:

- Check for remaining trucks or personnel on the site;
- Conduct a final check of the working face to ensure the area is secure; and
- Lock the Main Entrance Gate.

5.1.7 Nuisance Controls

To remain compliant with nuisance bylaws related to litter, dust, noise, and odour control, the Site must operate to prevent nuisance complaints from neighbouring receptors. The potential for issue and solutions are described in the following sub-sections.

Litter

There is limited potential for litter at the Site due to the type of material that is deposited and restricted access. Operators will monitor trucks entering the Site to ensure their loads are secure and that waste material is not coming

off the trucks. The Operators are also responsible for checking and removing any litter from the Site. Bins are provided onsite for collection and disposal of litter.

Illegal dumping of waste is very unlikely at the Site, given the restricted access. However, in the event that any loads are illegally unloaded, the waste load will be inspected for any identifying wastes (i.e., addressed envelopes, utility bills, etc.), the RCMP will be contacted, and the material will be cleaned up immediately.

Dust

Dust on the Site may be generated by traffic on access roads, unloading of powdery or fine-grained wastes, and soil being blown from stockpiles or soil cover. Dust may be controlled by the following:

- Reduce vehicle speed limits on the access roads;
- Apply water or dust suppressant on gravel road surfaces as needed in hot, dry weather;
- Require the waste generator/hauler to moisten the waste prior to delivery to the Site;
- Compact waste and keep the size of the active face to a minimum; and
- Maintain soil stockpiles to prevent blowing soil by seeding with quick germinating grasses on stockpiles where soils may not be utilized for more than a year.

Noise

The City has not received any noise complaints to date. To reduce the potential for noise impacts from the neighbouring residences in the future, primary vehicle access to the Site will continue from the south off Bench Row Road, where the main entrance gate is. Heavy equipment onsite will only be used between 7 am and 5 pm, except in emergency circumstances, in alignment with City bylaws.

Noise caused by operating equipment and vehicles may affect employee hearing, and therefore, employees are encouraged to wear protective ear wear when working on or around equipment.

Odour

Due to the inert nature of the waste received at the Site, there is low potential for odour concerns, and therefore specific odour controls are not necessary.

5.1.8 Inspections

Daily Visual Inspections

On days that waste is received, the Operators will visually inspect or monitor the waste being placed as well as the general site conditions. Items that will be inspected include:

- Type of materials being placed: ensure no prohibited materials are present.
- Placement of concrete: ensure concrete is not placed in the Crown Land long-term approved lease area (**Appendix B**).
- Access road condition: ensure no material is spilled on the road and that dust is managed.
- Safety: look for and report any safety concerns with the Site or equipment.

Any concerns with the items listed above will be reported to the Site Manager and Director of Operations.

Quarterly Inspections

Quarterly inspections are a more formal and thorough investigation of the site conditions. They are intended to recognize any concerns that may be overlooked during the daily inspections. The quarterly inspections will be completed by the Site Manager and will include the inspection of the following for any concerns or deficiencies:

- Access road: inspect the entire length of the access road, along with driving areas within the Site.
- Final cover: inspect any areas that have been progressively closed for signs of ponding water, cracks, or breaches (infiltration).
- Site security: inspect the perimeter fencing and ensure all the required signage is still present and legible.
- Erosion and sediment control: inspect the Site surface and any temporary erosion controls, and the watercourse for risk of sedimentation from adjacent areas.
- Invasive vegetation: note any invasive vegetation seen onsite and species to help determine priority and method for control.
- Compliance with the OC: review the conditions of the OC and look for any signs of non-compliance.

Records of inspections will be kept for review by ENV, if requested.

5.1.9 Topographic Surveys

As required by the OC, topographic surveys must be updated every two years.

5.1.10 Reports

Daily Record Log

On days that is waste received at the Site, record the following:

- Number of loads;
- Day of disposal; and
- Comments or concerns resulting from daily inspections.

The Site Manager will always have access to the most recent daily record log and any concerns from the daily inspections will be immediately brought to the Site Manager's attention.

Annual Reports

The City is required to prepare an Annual Operations and Monitoring Report for the Hesperia Landfill and submit it to the ENV within 60 days of the end of the calendar year (Section 3.4 of the OC). The OC specifies the minimum information that must be included within the report:

- Total volume of waste discharged into the Site for the year;
- Authorized design volume;
- Remaining site life and capacity;
- Service population and waste discharge rate trends;
- Operational plan for the next 12 months;
- Any operational and maintenance expenditures from the past year;
- Any changes from authorized reports, plans and specifications; and
- Review of conceptual closure plan and estimated closure costs.

The report will also include the Annual Groundwater and Surface Water Monitoring Report.

5.2 Closure Plan

The closure plan is designed to support cattle grazing as the land use. Specifically, the cultivation and irrigation of forage crops. This process involves staged filling (per the filling plan, Section 5.1), topsoil placement, and grading the Site in phases to match the elevation and slope of the surrounding land, as described throughout this section.

During closure, several key points should be considered to achieve the desired condition:

- The watercourse will remain in its current location and will continue to divert surface water around the Site.
- The most recent landfill gas assessment (Associated 2024a) indicated minimal potential for gas generation from the inert construction waste. Therefore, a gas collection and recovery system is not expected to be required at the time of closure.
- Prior to final cover material sourcing or placement, it is recommended the City undertake annual permeability testing of the waste material. If the results show the waste material meets the required permeability of $1x10^{-5}$ cm/s or less, then it may be possible to use the material as the barrier layer (Section 5.2.4).

Design drawings showing the proposed final elevations, fill extent, buffer zones, and setback lines for the Site are located in **Appendix B.**

5.2.1 Setbacks and Future Site Boundaries

The proposed future site boundaries at closure are shown in **Appendix B,** and were identified as follows:

- The northern boundary is based on the location of the Fortis Gas Line. By not extending past this location, the OC requirement to maintain a minimum of 300 m from the nearest residence or water intake is met.
- The eastern boundary will maintain a 50 m setback from the Crown Land long-term approved lease boundary.
- The western and southern boundaries are based on the existing road and orchard property; no further expansion east and south from the existing footprint are anticipated.

These proposed boundaries satisfy the OC requirements, but the Criteria specify greater distances in some cases. Most notably, the Criteria state that the footprint should not be within 500 m of a sensitive land use, which would include private residences. The Site footprint is currently approximately 500 m from the nearest residence, and the future expansion will put the Site approximately 350 m from that residence. Section 5.1.7 addresses the recommended nuisance controls to reduce the likelihood of impacts to neighbouring properties.

5.2.2 Geotechnical and Seismic Assessment of the Site and Waste Material

A geotechnical and seismic assessment for the Site was completed by Fletcher Paine Associates Ltd. (Fletcher Paine) in 2018 and submitted to ENV (Fletcher Paine 2018). The report, which can be found in **Appendix E**, identified that the undisturbed in-situ foundation soils have adequate bearing capacity to support Site operations and are anticipated to have negligible differential settlement. Differential settlement would primarily impact a liner and leachate collection system, which is not present at the Site (Fletcher Paine 2018). Fletcher Paine (2018) identified that the Site is suitable for landfill development.

The bearing capacity of the Site was not determined, as significant effort is required to determine a comprehensive bearing capacity given the non-homogenous nature of the material. Furthermore, bearing capacity was not considered

a critical factor as the waste is not expected to have a building or structure built on top of it (Fletcher 2018). The waste is expected to have significant differential settlement, but it will vary across the Site depending on the waste types (Fletcher Paine 2018).

Fletcher Paine (2018) specified that there are no seismic design requirements for landfills, so they followed the seismic design requirements for residential areas because of the residential subdivision downslope of the Site. Fletcher Paine (2018) identified that the Site would follow Site Class D requirements as per the 2012 BC Building Code. The Criteria state that landfills must not be located within 100 m of a geologic fault; the Site is approximately 1.9 km away from the closest identified geologic fault and therefore meets this criteria.

A slope stability analysis was conducted for seismic and static conditions, based on the following assumptions (Fletcher Paine 2018):

- The slope stability analysis used an alignment that runs along the bottom of the natural ravine as it was assumed to have the thickest waste levels.
- Historic topographic mapping and test hole soil logs from nearby locations were used to assess the pre-development and natural site conditions.
- The City provided the 2016 contour mapping for the existing waste levels.
- An earthquake ground design motion was based on a seismic event of 1 in 2,500 years which is 0.134 (g) for this Site.[10]
- Conservative engineering properties were used due to the non-homogenous nature of the landfill waste.

The results of the stability analysis are summarized in Figure 5-1 (taken from Fletcher Paine 2018). The table shows the factor of safety for each scenario.

Figure 5-1 Slope Stability Analysis Results from 2018 Geotechnical Report (Fletcher Paine 2018)

D = Horizontal distance behind the crest of the active face (m)
H = The active face vertical height (m)

Load Condition	Location of stability analysis for factor of safety			
	D = 0.25H	D = 0.5H	D = 0.75H	D = 1.0H
Static	0.8	1	1.2	1.3
Seismic 1/2500 yr	0.6	0.8	0.9	1

There is a slope stability concern near the active face of the Site. The report recommends, for safety reasons, that dump trucks do not go within a horizontal distance of D=0.75xH; that distance increases to D=1.5xH when there are wet conditions. Despite this, the report noted it is still possible that there will be a landslide event; however, it is expected that most of the landslide material will end up within 50 m of the toe of the current extent (Fletcher Paine 2018).

[10] The value was selected as there are no provincial regulations for earthquake ground design motions for landfills, so the design requirement guidelines for residential areas were used because of the residential area downslope of the landfill (Fletcher Paine 2018).

Fletcher Paine (2018) recommended installing a subsurface drainage system for any subsequent landfill filling onto existing undisturbed in situ soils; this recommendation has been incorporated into the design for the expansion of the Site (**Appendix B**). Fletcher Paine (2018) provided the following recommendations:

- Topsoil should be removed to expose the undisturbed, in situ native soils.
- A subsurface drainage system should be installed at the base of the gully. Some options include:
  - A 200mm diameter perforated PVC pipe completely surrounded by a 200mm thick layer of 25mm diameter drain rock, completely enclosed in non-woven geotextile.
  - A layer of pea gravel (10mm diameter drain rock) at least 0.3m thick and 1.5m wide.
  - A layer of 25mm diameter drain rock completely enclosed in a non-woven geotextile at least 0.3m thick and 1.5m wide.

It is recommended that as the landfill is further developed the ongoing slope stability be reviewed periodically by a geotechnical engineer.

5.2.3 Slope Requirements

The closure plan is based on the following:

- Maximum side slopes of 3H:1V were used for material placed to provide stable slopes and allow for future placement of cap material.
- Minimum slopes of 25H:1V at the top plateau are to maintain drainage.
- Maximum elevation of 489.50 m.

5.2.4 Final Cover

Final cover will consist of a barrier layer (1 m) and topsoil (at least 0.15 m), as required by the OC:

The **barrier layer** will be placed over the graded waste and compacted to a thickness of 1 m. The barrier layer soils will consist of a low permeability soil (clay content of > 30%) that, when compacted, will achieve an in situ permeability of less than 1.0×10^{-5} cm/s.

The **topsoil layer** will consist of previously stripped and stockpiled topsoil from the Site blended with Ogogrow (Class A Compost from the Vernon Compost Facility) and will be placed over the subsoil at a thickness of 0.15 m. Blending ratios for the compost and topsoil will be determined by a Qualified Professional prior to topsoil placement to make sure it is appropriate to support forage establishment.

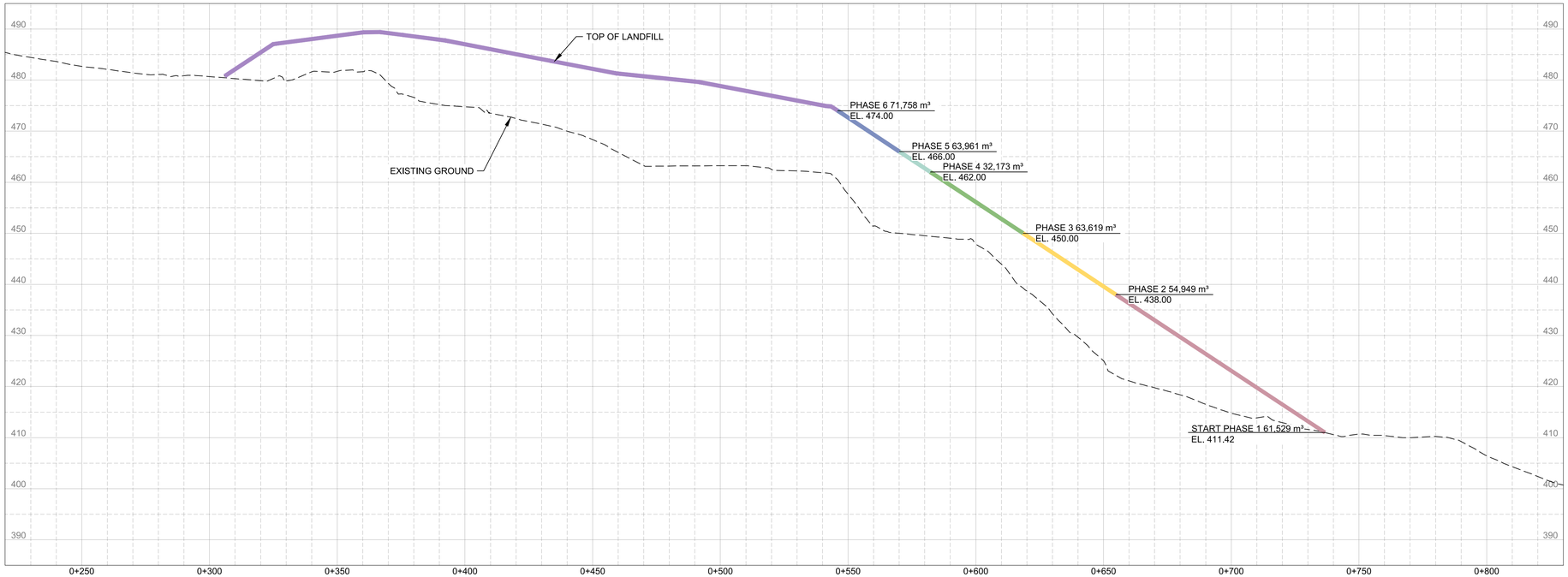
5.2.5 Re-Vegetation

In following a phased approach to closure, the portions of the Site where final cover has been placed will be promptly revegetated by seeding with an agronomic species forage mix. The mix will be a blend typical of forage production in the region that is quick to establish and drought tolerant, and will be applied at a rate of ≥75 kg/hectare. By using Ogogrow in the fabricated topsoil mix, nutrient availability should be sufficient so that fertilizer is not required. The rooting of the established grasses will minimize surface water infiltration to the top 15 to 30 cm depth and protect the final cover from erosion. The seeded areas will be irrigated for the first growing season to support grass establishment and, as required, to increase forage production during end land use (grazing).

5.2.6 Progressive Closure Plan

The Site will be progressively closed and reclaimed as it is filled. The Site will be closed in phases with each phase being approximately 60,000 m^3 of material, including cover, which is estimated to be 4 to 6 years for annual waste disposal of 15,000 m^3 to 10,000 m^3 (described further in Section 5.2.7). Once the Site has been filled to appropriate elevation and graded to a slope that will support the cultivation of forage grass, as described above, it can be closed. A final cover is to be placed within 90 days of the closure of a phase.

Figure 5-2 illustrates the final cover phases on a cross-section that runs north to south through the proposed Site. The surface of each phase will have final cover placed once waste has reached maximum elevation. The remaining portion of the Site will be covered at the time of the closure.



1 C-102 SECTION H: 1:1000 V: 1:2000

NOTE:
TOTAL AIRSPACE BETWEEN TOP OF LANDFILL AND EXISTING GROUND IS 360,000 m³.
REMAINING CAPACITY FOR FILL MATERIAL IS 311,300 m³.

PRELIMINARY/
FOR DISCUSSION
NOT FOR CONSTRUCTION

REV	DATE	DESIGN	DRAWN	DESCRIPTION
A	2024APR19	S. NICOLL	E. KELSEY	ISSUED FOR OPERATIONS PLAN UPDATE

CITY OF VERNON

HESPERIA LANDFILL DESIGN
OPERATIONS AND CLOSURE
PLAN UPDATE
20228344-00

SCALE: AS SHOWN

CIVIL
SECTION AND DETAILS

DRAWING	REVISION	SHEET
Figure 5-2		

5.2.7 Lifespan Analysis

The remaining airspace[11] of the Site is approximately 347,900 m^3 as of January 2023[12], of which up to 47,500 m^3 is allocated for cover material. It is possible that at least part of the final cover barrier layer may be composed of the inert fill waste material; however, the lifespan analysis presented here conservatively assumes that no waste material will be used for the final cover. Therefore, there is an estimated 300,400 m^3 of remaining capacity at the Site as of January 2023.

Using the maximum permitted disposal rate of 15,200 m^3 per year, the estimated lifespan is 20 years (i.e., closure in 2043). However, a disposal rate of 10,000 m^3 per year is more representative of the City's current usage and future plan (as discussed with the City). Using this average rate, the estimated lifespan is 30 years (i.e., closure in 2053).

Tables 5-2 and 5-3 summarize the Site lifespan assuming the maximum allowable discharge (15,200 m^3/year) and average discharge (10,000 m^3/year), respectively.

Table 5-2 Lifespan for Maximum Allowable Discharge (15,200 m^3/year)

Year	Starting Airspace (m^3)	Waste Received[1] (m^3)	Remaining Airspace (m^3)
2023	300,400	1,210	299,190
2028	299,190	76,000	223,190
2033	223,190	76,000	147,190
2038	147,190	76,000	71,190
2042	71,190	60,800	10,390

[1] Reflects the actual volume discharged in 2023, as per the City's annual operations and monitoring report (Associated 2024b), and assumes the maximum allowable annual discharge rate of 15,200 m^3/year thereafter.

Table 5-3 Lifespan for Average Annual Discharge (10,000 m^3/year)

Year	Starting Airspace (m^3)	Waste Received[1] (m^3)	Remaining Airspace (m^3)
2023	300,400	1,210	299,200
2028	299,190	50,000	249,200
2033	249,190	50,000	199,200
2038	199,190	50,000	149,200
2043	149,190	50,000	99,200
2048	99,190	50,000	49,200
2052	49,190	40,000	9,200

[1] Reflects the actual volume discharged in 2023, as per the City's annual operations and monitoring report (Associated 2024b), and assumes an average annual discharge rate of 10,000 m^3/year thereafter.

[11] Airspace is the volume of space within a landfill site that can be used for waste material.
[12] The most recent topographic survey was completed in January 2023.

The earliest year for closure of the Site is 2043 if the maximum allowable placement of waste occurs every year. However, this plan anticipates closure in 2053, based on the more representative annual waste filling of 10,000 m^3 per year, as confirmed by the City.

5.3 Post Closure

The proposed use of the Site after closure will be cattle grazing on agronomic forage grasses.

The Site will have a 25 year post-closure monitoring period, as required by the OC. In addition to groundwater and surface water monitoring (Section 3.3), the Site will be inspected annually for the following:

- Defects within ditches and culverts;
- Debris build up in ditches and culverts;
- Areas of ponding water or depressions;
- Erosion of cover;
- Vegetation stress and confirmation of establishment;
- Signs of burrowing animals; and
- Condition of perimeter fencing and gates.

Any required maintenance will be promptly executed to meet the requirements outlined in the OC.

6 ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

6.1 Leachate Management and Groundwater Protection

Leachate is generated from water percolating through the waste material within the Site. The amount of leachate generated is therefore directly related to the amount of water that is allowed to enter the Site, and will be minimized by:

- Diligent management of surface water to prevent run-on water, as described in Section 6.2[13].
- Fill open excavations or depressions with a grader.
- Prohibit the disposal of liquid or wet waste at the Site.
- Undertake progressive closure and re-vegetation throughout the history of the Site.

The Site is defined by the OC as a natural control landfill (OC Section 2.9) and there is no liner or leachate collection system in place; nor was one recommended in previous iterations of the Operations and Closure Plans (SHA 2000, Golder 2016). The Site is considered to have a low leachate generation potential due to dry nature of the area and type of material that is deposited (fill material, no organics). Based on this and what is known about the hydrogeological characteristics at the Site (Sections 2.4 to 2.6 and 3.1), leachate management measures are not warranted. However, a groundwater monitoring program should occur annually throughout the life of the Site and post-closure (minimum 25 years) to continue to monitor for any signs of groundwater impacts.

6.2 Surface Water Management Plan

During Operational Phase

The onsite management of surface water will include directing water away from the Site wherever possible. This will be achieved by:

- Intercepting run-off and surface water flow above the Site (i.e., from the ephemeral watercourse) and directing around the west side of the Site to minimize contact with Site material.
- Designing and maintaining side slopes to shed the water away from the active face.
- Managing and monitoring irrigation of the surrounding properties to ensure no irrigation of the Site.

If the above recommendations are followed, run-on water (i.e., water that flows onto the Site) should be limited to direct precipitation and snow accumulation. This water will either be absorbed into the inert fill waste or percolate into the ground (which will be monitored as per Section 3). Additional erosion management measures to control sediment transport from the Site during the filling phase will include the following general techniques:

- Keep soil stockpiles away from natural water flow paths (and preferably >30 m from the nearest watercourse or flowing water channel) and surround with berms, straw bales, or silt fence as needed.
- Restrict vehicle and equipment movement in areas that may cause stockpile slumping and soil or sediment transport off site.
- Install sediment control structures, such as silt fences, as needed to protect areas that have been progressively closed from transporting sediment off site. These fences must be located on the downslope side of the working face. The lower edge of the fence fabric should be buried on the upslope side of the fence. At the

[13] Run-on water is that flows onto the Site from sources such precipitation, nearby streams, or stormwater runoff.

ends of each panel of fence section, the sections should be coupled together by overlapping one full panel each and rolling the two together to ensure full integration. These silt fences will:
    - Protect the final cover of closed areas until vegetation establishes;
    - Reduce fine sediment from being transported offsite and downstream; and
    - Prevent large sediment from leaving the working face.
- Inspect erosion structures on a regular basis and after major rainfalls to ensure continued effectiveness, to identify where replacement or maintenance is required, and to identify where trapped sediments need to be removed. Where erosion control structures need maintenance or repair, these works must be undertaken as soon as practicable.
- Remove any soil/fill material that is unintentionally deposited on Bench Road from trucks accessing the Site. Monitor the success of this measure to avoid transporting soil off site.

Post Closure Surface Water Management

After Site closure, including placement of final cover, all previously mentioned surface water controls will remain. The Site will be sloped to promote water drainage off and away from the waste material.

The Site will be vegetated to reduce run-on water from percolating into the fill material, and inspected for depressions that would cause water to pond, as part of post-closure maintenance procedures (Section 5.3).

6.3 Landfill Gas Management

The *Landfill Gas Management Regulation*, BC Reg. 391/2008, requires that the owner of any landfill that has more than 100,000 tonnes of municipal solid waste in place or receives more than 10,000 tonnes of waste in a calendar year retain a Qualified Professional to complete an Initial Landfill Gas (LFG) Assessment to estimate annual methane production. This also aligns with Section 2.6 of the OC, which states that an assessment of the emissions of non-methane organic compounds is required for landfills exceeding a total capacity of 100,000 tonnes. Landfill gas is defined under the *Landfill Gas Management Regulation* as “a mixture of gases generated by the decomposition of municipal solid waste”. Landfill gas is typically composed of approximately 50% methane and 50% carbon dioxide, with small amounts of non-methane organic compounds (EPA 2018) and the generation rate is dependent upon the type of material present (MOE 2009).

The LFG Generation Assessment Procedure provides guidance for estimating LFG production using the LFG Generation Estimate Tool (available in Microsoft Excel) to model methane emissions based on the Scholl Canyon first order decay model (MOE 2009). This information is used in the model to estimate the annual methane production based on the methane generation rate (k), as determined by the waste characterization, climate data, and water addition factor. If the results indicate that > 1000 tonnes of methane were produced in the preceding calendar year, a LFG Management Facilities Design Plan must be prepared and submitted to MOE the year following the assessment. If the results indicate that < 1000 tonnes of methane or more than 160 tonnes of non-methane organic compounds were produced, the estimates should be revisited every 5 years.

As per the regulations, the LFG Assessment was last updated for the Site as of 2023 (Associated 2024a). The results indicated that the estimated annual methane production is substantially less than the threshold of 1,000 tonnes per year for all case scenarios, due to the lack of organic material deposited at the Site since wood waste stopped being accepted in 2004. Methane gas is primarily produced from organic materials, and therefore, methane generation is expected to be minimal.

As per MOE (2009), a supplementary LFG Generation Assessment should be prepared every 5 years and submitted to the ENV with the annual report for that year; however, the results are not anticipated to change and no landfill gas management needs are expected for the Site.

6.4 Vegetation Removal

The area surrounding the Site is comprised of dry agronomic grassland with sparse trees and shrubs adjacent to the existing daylighted section of the stream. Clearing will be limited to grasses and weeds and any areas disturbed will be seeded with certified weed-free grass mix.

No riparian trees or shrubs are anticipated to be removed during filling. If any are identified, a Qualified Professional should be consulted prior to removal. Mitigative measures will include replanting with appropriate native vegetation at a 3:1 ratio. Furthermore, if vegetation removal or disturbance occurs within the migratory or breeding bird window, between April 15 and August 15 (ECCC 2018), a Qualified Professional will be required to conduct a bird nest survey prior to disturbance. If breeding birds are detected and may be affected by the work (as determined by the Qualified Professional), a species-appropriate no-disturbance buffer will be established to protect the nesting birds. Additional surveys to verify if American badger or snakes may be affected by the clearing may also be required (Section 6.6).

6.5 Weed Management

There is risk the existing weed species within the Site may spread to neighbouring properties and that new weed species are introduced to the Site during fill operations. To manage the introduction and spread of weeds during fill operations, City will monitor the Site and use mechanical methods to eliminate established weeds. As weeds start to grow, they will be cut or buried prior to setting seed.

During progressive reclamation, all imported topsoil will be certified weed-free and disturbed soils will be seeded with a combination of quick germinating grasses and legumes and native drought tolerant species. The success of revegetation will be monitored, and re-seeding, irrigation, and spot spraying for weeds will occur as necessary to ensure adequate coverage with desired species.

6.6 Wildlife

6.6.1 Potential Effects

The potential for environmental effects from operations on wildlife include:

- Temporary and permanent disturbance of living and growing habitat or overwintering habitat of wildlife species;
- Temporary sensory (e.g., noise, vibration, or light) disturbance to wildlife species during fill operations; or
- Accidental mortality or injury of wildlife.

6.6.2 Wildlife Management and Monitoring

Great Basin spadefoot and Great Basin gophersnake are known to burrow year-round in loose, friable soils or rodent burrows, such as those found near the Site. American badger may excavate dens in similar habitats and will use dens intermittently throughout the year for resting, security, or natal habitat. The following management and monitoring measures will help mitigate impacts on wildlife:

- Educate all personnel employed at the Site on how to detect for spadefoot, gophersnake, and badger, and in the case of badgers, include how to identify an active or recently excavated den. This may be done via direct communication with Site employees and posters erected on site for contractors.
- Prior to expanding into an undisturbed area, retain a Qualified Professional (QEP)[14] to identify the need for wildlife surveys for spadefoot, gophersnake, and badger to determine potential impacts of expansion on these species. Should evidence of use by any of these species be noted, a species specific management plan will be developed by the QEP.
- Temporarily cease operations immediately if spadefoot, gophersnake, or badger are observed during operations, if there is potential to kill or injure an individual.
- Report observation of spadefoot, gophersnake, and badger to the Site Manager, who will contact a QEP for advice on next steps. Resume operations in alternate locations, where possible, while decisions are being made to avoid further disturbance to sensitive wildlife species.
- Resume operations in the area where the species was detected if the operator is confident that the individual has abandoned the site.

6.6.3 Reporting

Site Operators should implement and maintain a wildlife observation log that includes the following mandatory entries:

- Name of the observer;
- Date of the observation;
- Species detected (including confidence rating in the identification);
- Type of observation (sign, auditory, visual); and
- Behaviour of the species during the observation (e.g., alert, fleeing, no response).

If mortality events exceed one individual per year, the wildlife monitoring plan should be reviewed by a Qualified Professional to determine if there are opportunities to improve practices and avoid future mortalities.

[14] In this context, a Qualified Professional is a person in good standing with a professional organization that is appropriate for the type of work being completed. A Registered Professional Biologist (R.P.Bio.) in good standing with the College of Applied Biologists or similar would meet this description if they are skilled in the identification and ecology of the wildlife species that have potential to occur in the North Okanagan.

7 COST ESTIMATE AND FINANCIAL PLAN

Section 3.6 of the OC requires a schedule of reserve funds or security to be collected each year until closure to cover estimated costs of operations, closure, post-closure, and a contingency for remediation.

The recommended plan is to progressively close and then construct the final cap as the Site develops. As per the OC and described in Section 5.2.4, final cover must consist of a 1 m thick barrier layer (low permeability material that, when compacted, will achieve an in situ permeability of less than 1.0×10^{-5} cm/s) and at least 0.15 m of topsoil. It is possible that material brought to site can be used for the barrier layer if it meets the permeability requirements; however, for the purposes of developing the cost estimate, two options for the barrier layer were considered: compacted clay (referred to as CCL) or geocomposite clay (referred to as GCL). Table 7-1 summarizes the key advantages and disadvantages of each.

Table 7-1 Barrier Layer Option Comparison

Liner Option	Advantages	Disadvantages
Geocomposite Clay Liner (GCL)[1]	• Thin layer (approximately 6mm) that leaves more airspace for waste. • Puncture resistant. • Installed by general contractor. • Fast installation, no mechanical seaming. • Robust and can self-heal small punctures. • Sufficient mass to prevent uplift of liner during windy conditions.	• Relatively expensive. • Heavy product, transportation costs and handling. • Potential long wait times for delivery. • Need to confirm Ministry acceptance; however, use of GCL is relatively standard practice.
Compacted Clay Liner (CCL)	• Puncture resistant. • Natural material. • If an acceptable clay borrow source is near the site, no or low material cost and only placement costs. • There is the potential that the received material could meet the required permeability which would be a project cost saving.	• Must be at least 1 m thick as per OC requirements. • Requires material testing to confirm acceptable clay material. • Testing would be required to determine if the received material meets the permeability requirements

[1] Geocomposite clay liners consist of two layers of geotextile with bentonite clay in between.

Table 7-2 outlines the progressive closure phase, the area that will be capped with final cover, and the estimated cost in 2023 dollars for the two cover options, based on an annual disposal rate of 10,000 m^3. The Class 3 (25% contingency) cost breakdown for the progressive closure costs is in **Appendix F** (Tables F-1 and F-2).

Table 7-2 Progressive Closure Phase Costs

Progressive Closure Phase	Anticipated Date of Closure	Surface Area to be Capped with Final Cover (m^2)	Closure Cost in 2023 Dollars with Compacted Clay Barrier Layer	Closure Cost in 2023 dollars with Geocomposite Clay Barrier Layer
1	2029	5244	$ 310,000	$ 414,000
2	2034	4479	$ 269,000	$ 360,000
3	2039	7190	$ 429,000	$ 567,000
4	2043	3289	$ 205,000	$ 262,000
5	2049	7888	$ 466,000	$ 616,000
6	2053	15622	$ 923,000	$ 1,221,000

The estimated progressive closure phase costs (Table 7-2, Appendix F) are based on the following assumptions:

- The topsoil will be comprised of a combination of soil and compost. There is no anticipated cost to the City for the Ogogrow compost material, but the City will have to pay for hauling.
- A 3% per year rate of inflation was used to account for future cost increases.
- Material and construction cost are based on recently received tenders from similar projects that AE has been involved with.
- The phased closure costs include a 25% contingency.

Currently, a tipping fee of $400.00 per truck load (approximately $33.33/$m^3$ [assuming 12 m^3 per load]) is charged to the City project that is disposing of waste at the Site. In discussion with the City, the estimated operational cost to dispose of 10,000 m^3 of waste is $83,000 or $8.33/$m^3$ (I. Adkins, personal communication, 2023). This cost does not account for the future cost of closure. Appendix F (Table F-3 and F-4) provides the detailed cash flow estimates, based on the progressive closure costs in Table 7-2 and assuming average operational costs remain the same (i.e., $8.33/$m^3$) with the exception of a 3% annual increase to account for inflation. Additional assumptions include the following:

- The City's current reserve fund is $541,475.
- Accumulated funds accrue interest at 3.34% per year as per the current Bank of Canada 10 year bond yields.
- The future closure and 25-year post closure costs are to be paid out of accumulated funds, and long term borrowing will not be required. The annual cost assumed to complete post closure requirements is estimated to be $40,000 (in 2023 dollars).

To account for future costs for closure, tipping fees should change as follows:

- For Option 1, closing the Site using a CCL barrier layer, the recommended tipping fee in 2023 is $17.96/$m^3$ which includes an operating cost of $8.33/$m^3$ and a reserve amount of approximately $9.63/$m^3$.
- For Option 2, using the GCL as the barrier layer, the recommended tipping fee in 2023 is $20.70/$m^3$ which includes an operating cost of $8.33/$m^3$ and a reserve amount of approximately $12.37/$m^3$.
- For both options, the tipping fee should increase by 3% each year that the Site is in operation.

For planning and budgeting purposes the City should include the following reviews annually:

- Review the operational cost of the facility vs. the current tipping fee; and
- Review the accumulated reserve vs. the future projected costs.

At least every 5 years, the City should re-evaluate the closure and post closure cost estimate and the accumulated reserve and adjust the tipping as required.

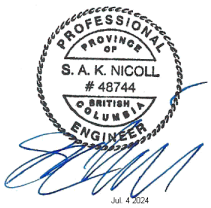
CLOSURE

This report was prepared for the City of Vernon to provide the Operations and Closure Plan for the Hesperia Landfill.

The services provided by Associated Engineering (B.C.) Ltd. in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,

Associated Engineering (B.C.) Ltd.
Engineers & Geoscientists BC Permit Number 1000163



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APPENDIX A - OPERATIONAL CERTIFICATE

BRITISH COLUMBIA

January 21, 1998

File: 76750-40/PR-15288

INIT.	DATE	SIGNED

REGISTERED MAIL

Corporation of the City of Vernon
3400 - 30th Street
Vernon BC V1T 5E6

Dear Mr. Eric Jackson:

Enclosed is Operational Certificate PR-15288 issued under the provisions of the *Waste Management Act*. This Operational Certificate supercedes Permit PR-6591 which is hereby cancelled in accordance with Section 18(12) of the *Waste Management Act*. Your attention is respectfully directed to the terms and conditions outlined in the Operational Certificate. An annual fee will be determined according to the *Waste Management Permit Fees Regulation*.

This Operational Certificate does not authorize entry upon, crossing over, or use for any purpose of private or Crown lands or works, unless and except as authorized by the owner of such lands or works. The responsibility for obtaining such authority shall rest with the holder of the Operational Certificate. This Operational Certificate is issued pursuant to the provisions of the *Waste Management Act*, which makes it an offence to discharge waste without proper authorization. It is also the responsibility of the holder of the Operational Certificate to ensure that all activities conducted under this authorization are carried out with regard to the rights of third parties, and comply with other applicable legislation that may be in force.

This Operational Certificate may be appealed by persons who consider themselves aggrieved by this decision in accordance with Part 7 of the *Waste Management Act*. Written notice of intent to appeal must be received by the Regional Waste Manager within thirty (30) days.

Administration of this Operational Certificate will be carried out by staff from our Regional Office located at Suite 201, 3547 Skaha Lake Road, Penticton, B.C., V2A 7K2. Plans, data and reports pertinent to the Operational Certificate are to be submitted to the Regional Waste Manager at this address.

Yours truly,

T.R. Forty, P.Eng.
Assistant Regional Waste Manager
Pollution Prevention
Southern Interior Region

Enclosure

cc: Regional District of North Okanagan, Attention: Mr. Barry Gagnon

Ministry of Environment, Lands and Parks
Environment and Lands
Telephone: (250) 490-8200
Facsimile: (250) 492-1314
Mailing Address & Location:
Suite 201-3547 Skaha Lake Rd.
Penticton, B.C.
V2A 7K2

POLLUTION
PREVENTION

BRITISH COLUMBIA

Suite 201
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MINISTRY OF ENVIRONMENT,
LANDS AND PARKS

OPERATIONAL CERTIFICATE
PR 15288

Under the provisions of the Waste Management Act and in accordance with the Approved Regional District of North Okanagan Solid Waste Management Plan,

Corporation of the City of Vernon

3400-30th Street

Vernon, British Columbia

V1T 5E6

is authorized to manage recyclable materials and to discharge inert demolition and construction waste to the ground at the Hesperia landfill facility located approximately 2 km southwest of Vernon, British Columbia, subject to the conditions listed below. Contravention of any of these conditions is a violation of the ***Waste Management Act*** and may result in prosecution.

1. AUTHORIZED DISCHARGES

1.1. The discharge of refuse to which this Sub-Section is applicable is shown on the attached Site Plan A. The Environmental Monitoring System (EMS) reference number for this discharge is E212378.

1.1.1. The maximum rate at which refuse may be discharged to the landfill is 6000 tonnes (or 15,200 m^3) per year.

1.1.2. The type of refuse which may be discharged is demolition and construction wastes that are comprised of inert material such as wood and concrete, but specifically excluding putrescible materials, domestic refuse, plastics, rubber and other chemical or toxic wastes.

1.1.3. The works authorized are a selected waste landfill and related appurtenances.

T.R. Forty, P.Eng.
Assistant Regional Waste Manager

1.1.4. The location from which the discharge originates is generally Vernon and surrounding area.

1.1.5. The location of the approximate area of discharge is part of Lot 64, Township 9, Osoyoos Division of Yale District, as shown on Site Plan A.

2. GENERAL REQUIREMENTS

2.1. Maintenance of Works and Emergency Procedures

The holder of the Operational Certificate shall inspect the landfill, any related pollution control works and designated areas for managing recyclable or reusable materials regularly and maintain them in good working order. In the event of an emergency or condition beyond the control of the holder of the Operational Certificate which prevents continuing operation of the authorized method of pollution control, the holder of the Operational Certificate shall immediately notify the Regional Waste Manager and take appropriate remedial action.

2.2. Process Modifications

The holder of the Operational Certificate shall notify the Regional Waste Manager prior to implementing changes to any process that may affect the quality and/or quantity of the discharge.

2.3. Plans - New Works

Plans and specifications of any new works related to this facility shall be submitted to the Regional Waste Manager and his consent obtained before construction commences. The works shall be constructed in accordance with such plans. Review of the submitted plans and specifications is for the purpose of administration of the Operational Certificate and only implies that the works specified therein meet the appropriate guidelines, criteria or standards.

2.4. Operational and Closure Plan

2.4.1. An ***Operational and Closure Plan***, prepared by a suitably qualified professional shall be submitted for authorization by the Regional Waste Manager, on or before December 31, 1999. The Regional Waste Manager will provide comments and/or authorization upon completion of the review.

2.4.2. The ***Operational and Closure Plan*** shall include the following:

- Anticipated total waste volumes and tonnage, and life of the landfill (ie: closure date);

T.R. Forty, P.Eng.
Assistant Regional Waste Manager

- A topographic plan showing the final elevation contours of the landfill and surface water diversion and drainage controls;
- Design of the final cover including the thickness and permeability of barrier layers and drainage layers, and information on topsoil, vegetative cover and erosion prevention controls;
- Procedures for notifying the public about the closure and about alternative waste disposal facilities;
- Rodent and nuisance wildlife control procedures;
- Proposed end use of the property after closure;
- A plan and implementation schedule for monitoring groundwater, surface water and landfill gas, erosion and settlement for a minimum post-closure period of 25 years;
- A plan and accompanying design and implementation schedule for the collection, storage and treatment/use of landfill gas for a minimum of 25 years;
- A plan and implementation schedule for operation of any required pollution abatement engineering works such as leachate collection and treatment systems, for a minimum post-closure period of 25 years;
- A schedule of reserve funds or security to be collected each year until closure; to cover estimated costs of closure, post-closure and a contingency for remediation;
- A screening plan, ie: vegetative or berm, if required;
- A perimeter fencing assessment/design;
- Litter and odour control measures;
- Contingency plan & notification procedures in the event of an emergency;
- Training procedures for operators; and
- Any other site specific concerns as identified by the Regional Waste Manager.

2.4.3. The minimum contents of an ***Operational and Closure Plan*** may be revised as appropriate by the Regional Waste Manager for a selected waste landfill.

2.4.4. Terms of reference for the ***Operational and Closure Plan*** are subject to authorization by the Regional Waste Manager.

2.4.5. The Regional Waste Manager may request revisions to the ***Operational and Closure Plan***. Terms of reference for the revisions to the ***Operational and Closure Plan*** are subject to authorization by the Regional Waste Manager.

2.4.6. Operation of this landfill is to be in substantial accordance with the authorized ***Operational and Closure Plan***.

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Assistant Regional Waste Manager

2.4.7. If there should be an inconsistency between this Operational Certificate and the authorized *Operational and Closure Plan*, the Operational Certificate shall take precedence.

2.5. Ground and Surface Water Quality Impairment

2.5.1. Landfills must be operated in a manner such that ground or surface water quality does not decrease beyond that allowed by the *Approved and Working Criteria for Water Quality* dated 1995 prepared by the Water Quality Branch of the Ministry of Environment, Lands and Parks at or beyond the landfill property boundary.

2.5.2. If excursions result to the specified water quality criteria, the Regional Waste Manager may require that leachate management control measures or works be undertaken. Terms of reference for any leachate management study and/or design work is subject to the authorization of the Regional Waste Manager.

2.6. Landfill Gas Management

An assessment of the emissions of non-methane organic compounds (NMOCs) is required for landfills exceeding a total capacity of 100,000 tonnes. If NMOCs are determined to exceed 150 tonnes/year, landfill gas recovery and management systems will be required to be designed, installed and operational within 3 years. If NMOCs are projected to be less than 150 tonnes/year for the operating life of the landfill, an assessment for the need of passive gas venting will be required. Terms of reference for any landfill gas study or design is subject to the authorization of the Regional Waste Manager.

2.7. Property Boundary

The buffer zone between any municipal solid waste discharged and the property boundary is to be at least 50 metres of which the 15 metres closest to the property boundary must be reserved for natural or landscaped screening (berms or vegetative screens). Depending on adjacent land use and environmental factors, buffer zones of less than 50 metres but not less than 15 metres may be authorized by the Regional Waste Manager.

2.8. Setbacks

The distance between the discharged municipal solid waste and the nearest residence, water supply intake, hotel, restaurant, food processing facility, school, church or public park is to be a minimum of 300 metres. The distance between the discharged municipal solid waste and the nearest surface water is to be a minimum of 100m Greater or lesser separation distances may be authorized by the Regional Waste Manager where justified. For those landfills designed to collect and recover methane

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Assistant Regional Waste Manager

gas generated, the issue of potential on-site or off-site users of the energy should be addressed in siting the landfill, consistent with the preceding regarding public places.

2.9. Natural Control Landfill

2.9.1. The bottommost solid waste cell is to be at least 1.2 metres above the seasonal high water table. Greater or lesser separation depths may be authorized based on soil permeability and the leachate renovation capability of the soil.

2.9.2. There is to be at least a 2 metres thick layer of low permeability soil with a hydraulic conductivity of 1×10^{-6} cm/s or less (i.e. silt or clay), below each of the bottommost waste cells. Lesser thicknesses or no layer of low permeability soil may be authorized based on the potential for leachate generation and the unsaturated depth, permeability and leachate renovation capability of the existing soil.

2.10. Water

The disposal of municipal solid waste into water is unacceptable. Surface water diversion to restrict storm water runoff from contacting the wastes is required.

2.11. Final Cover

Final cover for landfill sites is to consist of a minimum of 1 metre of low permeability ($<1 \times 10^{-5}$ cm/s) compacted soil plus a minimum of 0.15 metre of topsoil with authorized vegetation established. The depth of the topsoil layer should be related to the type of vegetation proposed (ie rooting depth). Soils of higher permeability may be authorized based on leachate generation potential at the landfill site. Final cover is to be constructed with slopes between 4% and 33% with appropriate run-on/run-off drainage controls and erosion controls. An assessment of the need for gas collection and recovery systems shall be made so that, in the event such systems are required, cover can be appropriately designed and constructed. Final cover is to be installed within 90 days of landfill closure or on any areas of the landfill which will not receive any more refuse within the next 12 months. Completed portions of the landfill are to progressively receive final cover during the active life of the landfill.

Additional layers of natural materials including earth and aggregate and/or synthetic materials may be necessary for inclusion in the final cover design due to site specific conditions and the presence of management systems for leachate and landfill gas.

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2.12. Access Road

An appropriately constructed and maintained access road to, and a road system within the landfill site capable of supporting all vehicles hauling waste, are required during the operating life of the landfill.

2.13. Fencing and Access

Existing fencing is to be maintained. The type and extent of additional fencing will depend on the existing natural vegetation and topographic features and is to be authorized by the Regional Waste Manager.

2.14. Design by Qualified Persons

All landfills are to be designed by persons qualified in landfill site selection, design and operation. All plans, specifications, and reports are to be sealed by a professional engineer or geoscientist licensed to practice in the province of British Columbia.

2.15. Prohibited Wastes

The co-disposal of the following wastes with the rest of the municipal solid waste is prohibited unless specifically authorized by the Regional Waste Manager:

- Special Wastes other than those specifically authorized in the ***Special Waste Regulation***
- Bulk liquids and semisolid sludges which contain free liquid;
- Liquid or semisolid wastes including septage, black water, sewage treatment sludge, etc.;
- Automobiles, white goods, other large metallic objects and tires;
- Biomedical waste as defined in the document ***Guidelines for the Management of Biomedical Waste in Canada*** (CCME, February 1992); and
- Dead animals and slaughter house, fish hatchery and farming wastes or cannery wastes and byproducts.

Burial of these wastes in dedicated locations (i.e. avoiding co-disposal) at a landfill site may be authorized by the Regional Waste Manager only if there is no other viable alternative such as treatment/disposal, recycling, reprocessing or composting. The viability of alternatives is to be determined by the Regional Waste Manager based on submission of cost data by the holder of the Operational Certificate. For those cases in which the dedicated disposal of otherwise prohibited wastes is authorized, the specific on-site location of the disposal shall be recorded to allow ready access to the

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waste should corrective or further action pertaining to the management of these wastes be required by the Ministry at some time in the future.

2.16. Designated Areas

Maintain areas for the separation, handling and storage of recyclable or reusable materials where applicable.

When a separated recyclable material is a special waste it is to be stored and managed in accordance with the *Special Waste Regulation*.

2.17. Signs

A sign is to be posted at each entrance of the landfill with the following current information:

- Site name
- Owner and operator
- Contact phone number and address for owner and operator
- Phone number in case of emergency (such as fire)
- Hours of operation (if applicable)
- Materials/wastes accepted for landfill and recycling
- Materials/wastes banned
- Tipping fees (if applicable)

Additional signs which clearly indicate the directions to the active tipping face, public disposal area, recycling waste separation areas and potential bear hazards (if applicable), etc. should also be displayed.

2.18. **Scavenging**

Scavenging of waste is to be prevented. The salvaging of wastes should be encouraged by providing areas and facilities for separation of recyclable or reusable materials.

2.19. **Dust Control**

Dust created within the landfill property is to be controlled, using methods and materials acceptable to the Regional Waste Manager, such that it does not cause a public nuisance.

2.20. **Waste Compaction and Covering**

2.20.1. Wastes are to be spread in thin layers (0.6 m or less) on the working face And compacted. The working face area should be minimized as much as possible. A compacted layer of cover material of at least 0.15 metre of soil or functionally equivalent depth of other cover material, as authorized by the Regional Waste Manager, is to be placed on all exposed solid waste at a

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frequency of once per week. Under specific circumstances, such as during bear season, the Regional Waste Manager may specify more stringent cover requirements. During periods of extreme weather conditions, such as those that cause the ground to freeze, an exemption to the normal cover requirements may be authorized at a frequency authorized by the Regional Waste Manager.

2.20.2. An intermediate cover consisting of a compacted layer of at least 0.30 metre of soil or functionally equivalent depth of other cover material is to be placed where no additional solid waste has been deposited or will be deposited within a period of 30 days.

2.21. Litter Control

Litter is to be controlled by compacting the waste, minimizing the working face area, applying cover, providing litter control fences and instituting a regular litter pickup and general good housekeeping program or any other measures required by the Regional Waste Manager.

2.22. Vectors

Vectors are to be controlled by the application of cover material at a specified frequency or by other control measures as required and authorized by the Regional Waste Manager.

2.23. Wildlife

The landfill is to be operated so as to minimize the attraction of wildlife such as bears and birds by applying cover at required frequencies and instituting a good housekeeping program. Further control measures, such as bear control fences, and bird control devices, may be specified by the Regional Waste Manager.

2.24. Fire Protection

Adequate fire fighting equipment is to be available to extinguish surface or underground fires. Recyclables and reusable materials are to be stored in such a manner to not constitute a fire hazard.

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3. MONITORING AND REPORTING REQUIREMENTS

3.1. Municipal Solid Waste Measurement

Topographical surveys are to be conducted every two years to determine filling rates and remaining capacity.

3.2. Sampling and Analytical Requirements

3.2.1. The sampling and monitoring requirements specified above shall be carried out in accordance with the appropriate procedures listed in the table below. Alternative test methods may be used provided that the alternative test methods are authorized by the Regional Waste Manager prior to performing the actual source testing. Test methods for parameters not listed below require the consent of the Regional Waste Manager.

DISCHARGES TO AIR, AMBIENT AIR:		
Parameter	**Source Testing Procedure**	**Analytical Procedure**
Particulate Matter Rate of Discharge (flow rate) Gaseous emissions	Stationary Emission Testing Code - contained in British Columbia Field Sampling Manual for Continuous Monitoring plus the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples, 1996 Permittee Edition	A Laboratory Manual for the Chemical Analysis of Ambient Air, Emissions, Precipitation, Soil and Vegetation, 3rd edition, April, 1983, 253 pp.
LIQUID EFFLUENTS, SURFACE WATER, GROUND WATER, SOILS, SEDIMENTS, VEGETATIVE MATTER:		
Parameter	**Source Testing Procedure**	**Analytical Procedure**
Metals Nutrients Organics Toxicity	British Columbia Field Sampling Manual for Continuous Monitoring plus the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples, 1996 Permittee Edition	British Columbia Environmental Laboratory Manual for the Analysis of Water, Wastewater, Sediment and Biological Materials, March, 1994, Permittee Edition

The above manuals are available from Queen's Printer Publications Centre, P.O. Box 9452, Stn. Prov. Govt, Victoria, BC, V8W 9V7 (1-800-663-6105 or (250) 387-4609). The above manuals are also available for inspection at all Pollution Prevention offices.

3.2.2. Proper care should be taken in sampling, storing and transporting the samples to adequately control temperature and avoid contamination and breakage.

3.2.3. Maintain the groundwater monitoring wells including provisions to ensure protection from damage due to vehicles or vandalism.

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3.2.4. Groundwater monitoring wells are to be covered with lockable caps, fitted with locks all keyed alike, and a key is to be provided to the Regional Waste Manager.

3.2.5. Three well bore volumes are to be pumped from each monitoring well prior to sample collection.

3.3. Changes to Sampling and Monitoring Program

On the basis of findings during routine inspections and any other information related to the effect of the discharge on the receiving environment, the Regional Waste Manager may allow reductions or require additional sampling and monitoring of the discharge and receiving environment.

3.4. Annual Report

An annual operations and monitoring report is to be submitted to the Regional Waste Manager within 60 days of the end of the calendar year. The first annual report is due on March 1, 1998. These reports are to contain at least the following information:

- Total volume and/or weight of waste discharged into the landfill for the year;
- Service population and waste discharge rate for the year (in tonnes per capita per year) and a trend analysis with a comparison to the 1990 baseline waste discharge rate of 1.10 tonnes per capita per year ;
- Authorized design volume;
- Remaining site life and capacity (this may include estimates utilizing interpolation between topographic surveys,etc. as required);
- Operational plan for next 12 months;
- Operation and maintenance expenditures;
- Any changes from authorized reports, plans and specifications (if applicable);
- any changes to the contingency plan (if applicable);
- Review of the closure plan and associated estimated costs, and
- Any other data relevant to this Operational Certificate.

3.5. Format of Submission

Monitoring and/or reporting information shall be submitted in an electronic and/or printed format which is suitable for review by the public and/or other government agencies and is satisfactory to the Regional Waste Manager.

3.6. Financial Security

It is recommended that a future financial security for the operations at and beyond closure by establishing a Closure Fund in a form acceptable to the Regional Waste Manager, such as upfront security or a fund financed on a charge per tonne of waste disposed basis. Such a fund would be analogous to the provincial Waste Management Trust Fund which the Minister may establish under Section 53 of the

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Waste Management Act. The ultimate amount of the financial security should meet or exceed the currently estimated closure and post-closure costs as outlined in the closure plan plus a reasonable contingency for any remediation which may be required. For municipally owned landfills, the financial security can be built up over time according to a schedule authorized by the Regional Waste Manager.

3.7. Declaration of Landfill

Landfills sited on titled land must register a covenant that the property was used for the purpose of waste disposal as a charge against the title to the property as provided for under Section 215.1 of the ***Land Title Act***. Landfills located on crown land are to have a "notation on file" registered that the property was used for the purpose of waste disposal.

3.8. Buildings and Structures

The construction of buildings and other structures on landfills containing putrescible wastes is not recommended for a minimum period of 25 years after closure due to concerns about combustible gas and excessive settlement. Such activity will only be considered and /or authorized after an investigation and report by qualified persons. The report is to be submitted for authorization to the Regional Waste Manager prior to initiating construction activities.

3.9. Operation of Other Control Systems

Operation of other environmental control systems for leachate and run-off as well as monitoring of leachate, groundwater and surface water must be continued during the entire post-closure period unless the early suspension of such operations or monitoring is authorized by the Regional Waste Manager.

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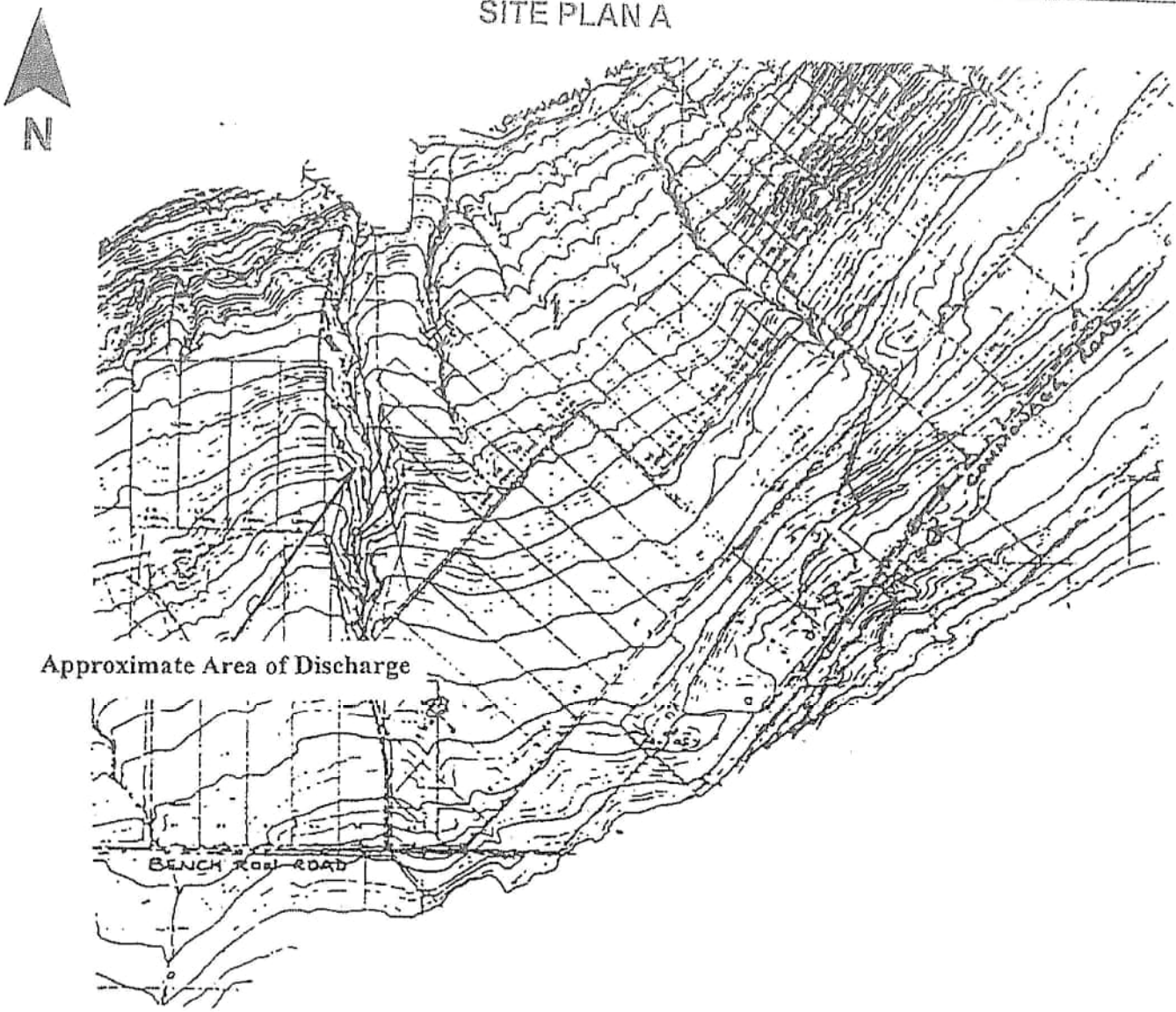
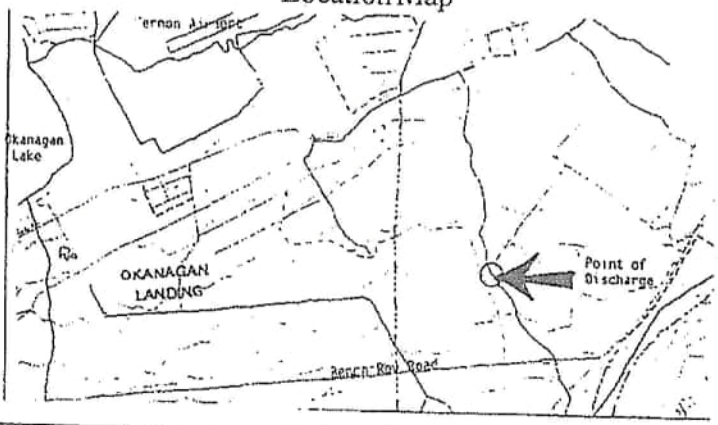
SITE PLAN A



The location of the approximate area of discharge is part of Lot 64, Township 9, Osoyoos Division of Yale District.

Location Map



Scale: NTS

Permit No. PR 15288

Date: January 21, 1998

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Assistant Regional Waste Manager

APPENDIX B - FIGURES AND DRAWINGS

F:\MAPPING\PROJECTS\2022\2022-8344_HESPERIA\HESPERIALANDFILL.APRX

Associated Engineering

- Property Line
- Gas Line ROW
- Stormwater Pond

Watercourse Path

- Culvert
- Open channel

AE PROJECT NO.	2022-8344.000
SCALE	1:6,500
COORD. SYSTEM	NAD 1983 UTM ZONE 11N
DATE	2023-09-29
REV	00
DRAWN BY	BDJ
CHECKED BY	NP

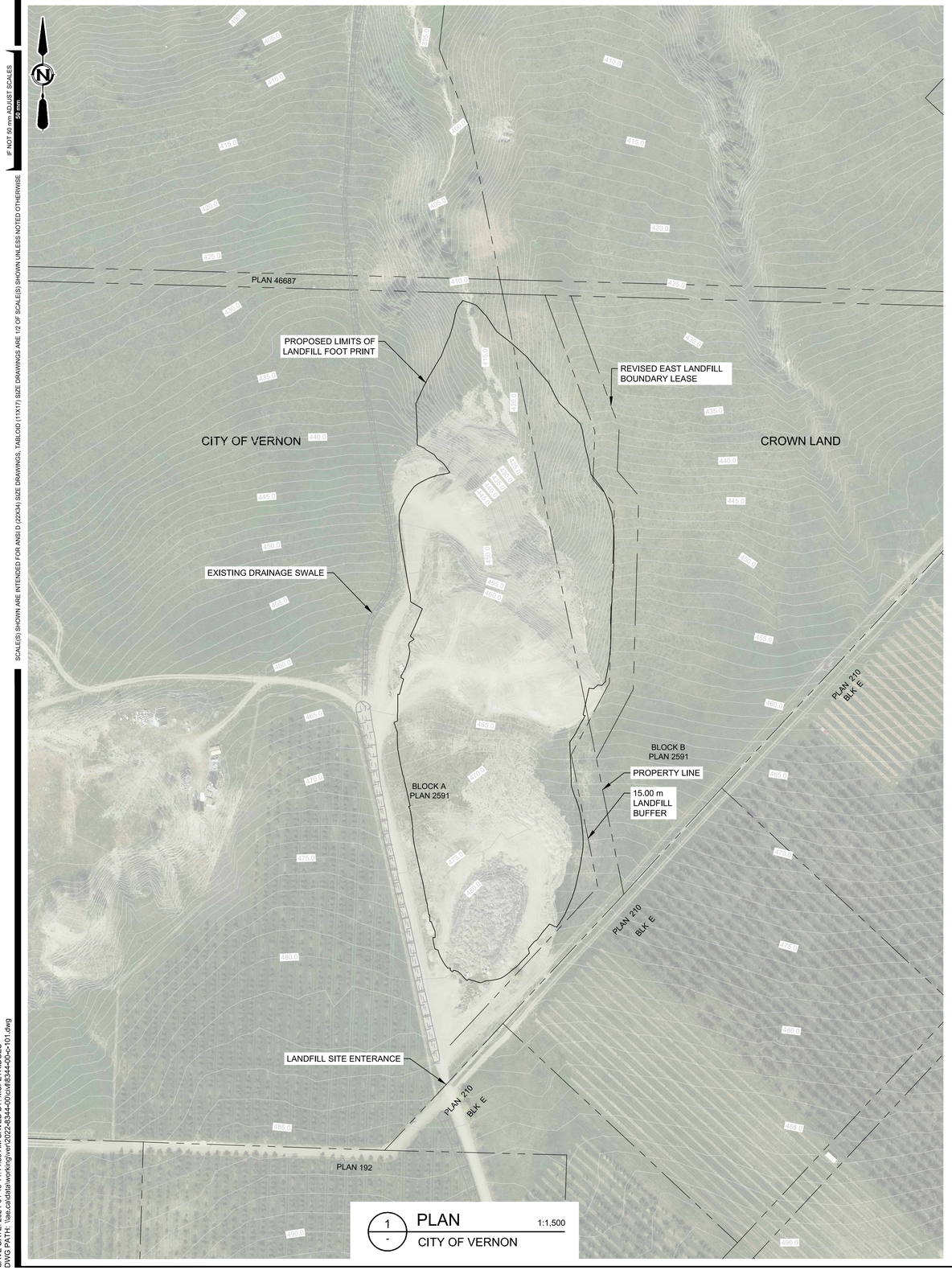
FIGURE B-1: HESPERIA LANDFILL SITE PLAN

CITY OF VERNON

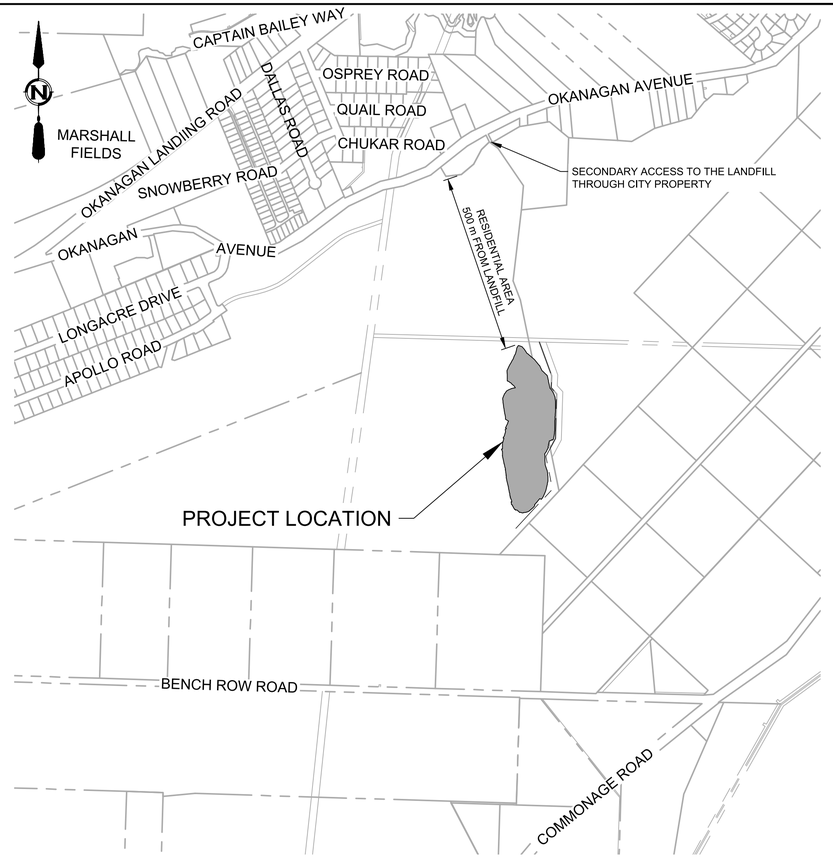
HESPERIA LANDFILL OPERATIONS AND CLOSURE PLAN

IF NOT 50 mm ADJUST SCALES
50 mm

SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE



1 - PLAN 1:1,500
CITY OF VERNON



2 - PLAN 1:10,000
CITY OF VERNON

GENERAL NOTES:
1. EXISTING CONTOUR INTERVALS ARE 1.00 m
2. THE ESTIMATED REMAINING CAPACITY OF THE SITE IS 311,300 m³

Associated Engineering

BEST MANAGED COMPANIES
Platinum member

PRELIMINARY/
FOR DISCUSSION
NOT FOR CONSTRUCTION

REV	DATE	DESIGN	DRAWN	DESCRIPTION
A	2024APR19	S. NICOLL	E. KELSEY	ISSUED FOR OPERATIONS PLAN UPDATE

CITY OF VERNON

HESPERIA LANDFILL DESIGN
OPERATIONS AND CLOSURE
PLAN UPDATE
20228344-00

SCALE: AS SHOWN

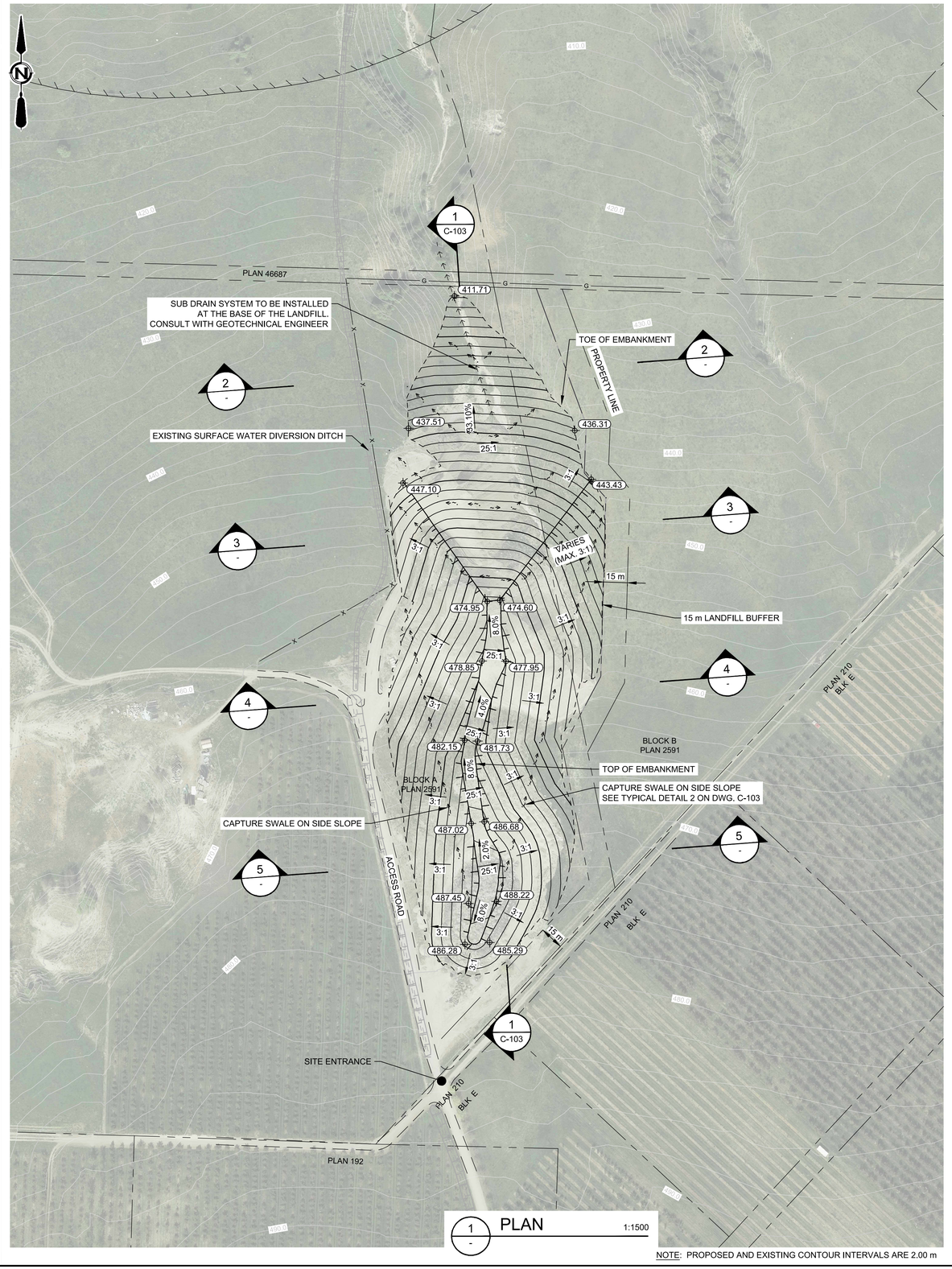
CIVIL
SITE PLAN AND LEGAL LOCATION PLAN

DRAWING	REVISION	SHEET
8344-00-C-101	A	3

PLOT DATE: 2024-07-02 8:54:05 AM
SAVE DATE: 2024-04-19 11:14:59 AM SAVED BY: MCFETRIDGES
DWG PATH: \\ae.ca\data\working\ver\2022-8344-00\civil\8344-00-c-101.dwg

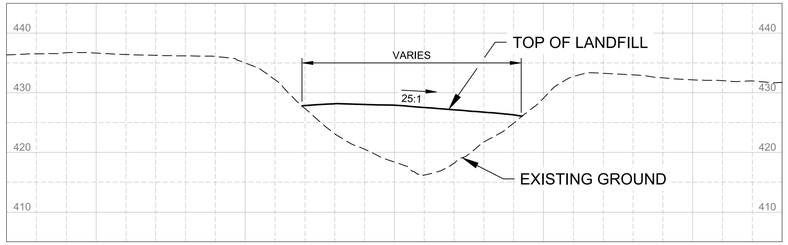
IF NOT 50 mm ADJUST SCALES
50 mm

SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE

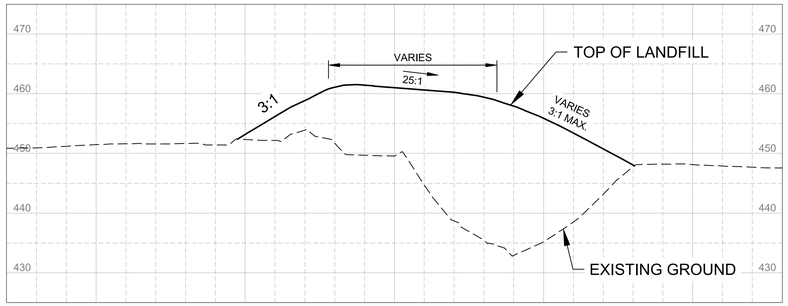


1 - PLAN 1:1500

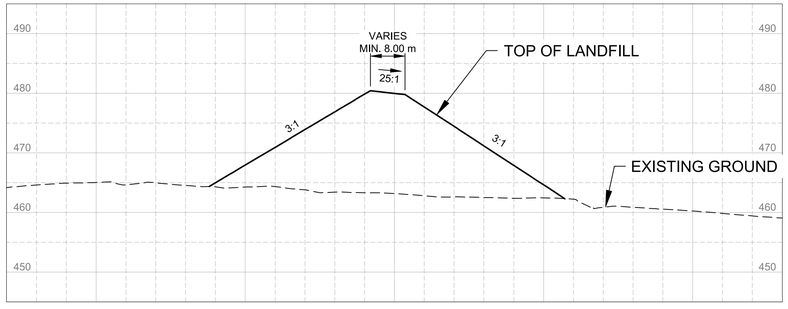
NOTE: PROPOSED AND EXISTING CONTOUR INTERVALS ARE 2.00 m



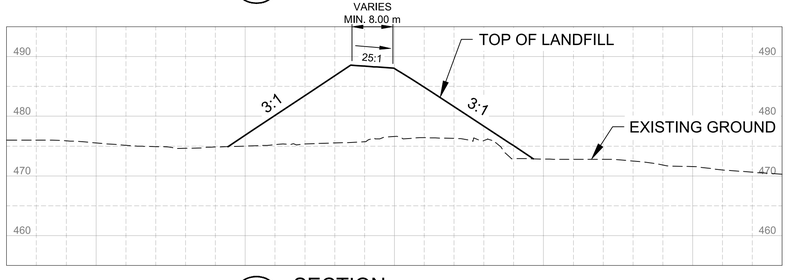
2 - SECTION H: 1:1000 V: 1:2000



3 - SECTION H: 1:1000 V: 1:2000



4 - SECTION H: 1:1000 V: 1:2000



5 - SECTION H: 1:1000 V: 1:2000

REFER TO DWG 8344-00-C-103 FOR SECTION E

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A	2024APR19	S. NICOLL	E. KELSEY	ISSUED FOR OPERATIONS PLAN UPDATE

CITY OF VERNON

HESPERIA LANDFILL DESIGN
OPERATIONS AND CLOSURE
PLAN UPDATE
20228344-00

SCALE: AS SHOWN

CIVIL
PLAN AND SECTIONS

DRAWING	REVISION	SHEET
8344-00-C-102	A	4

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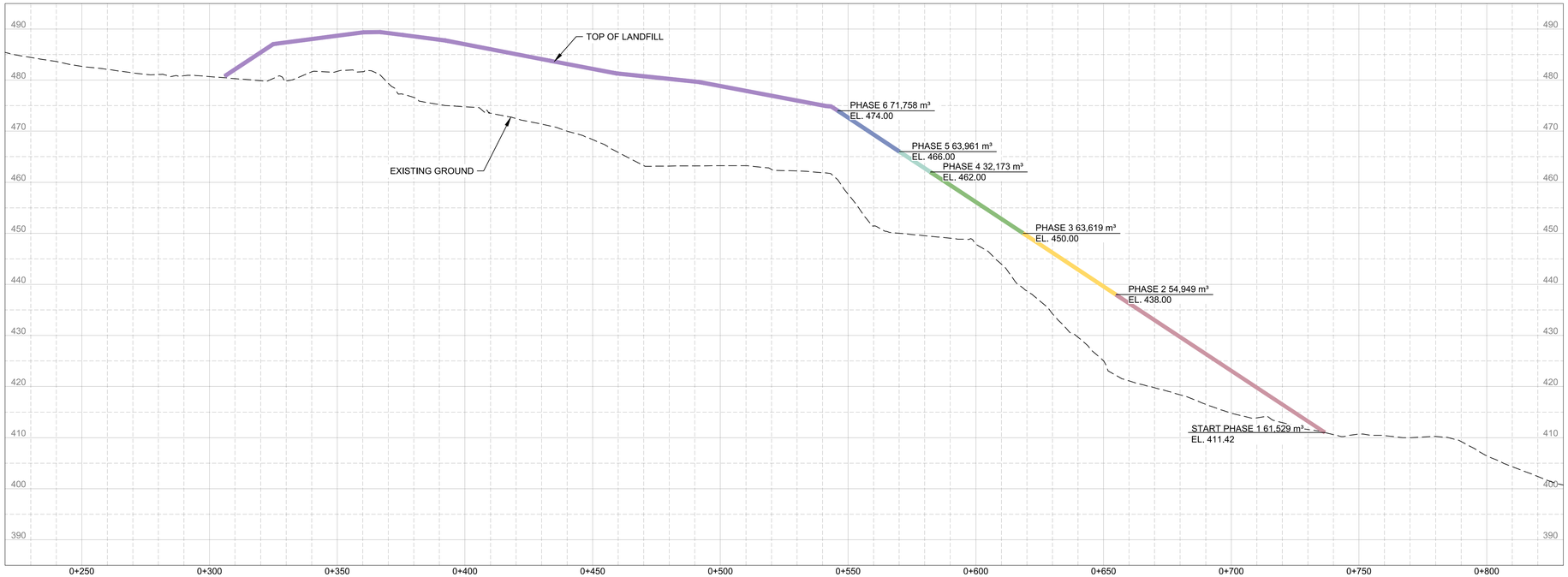
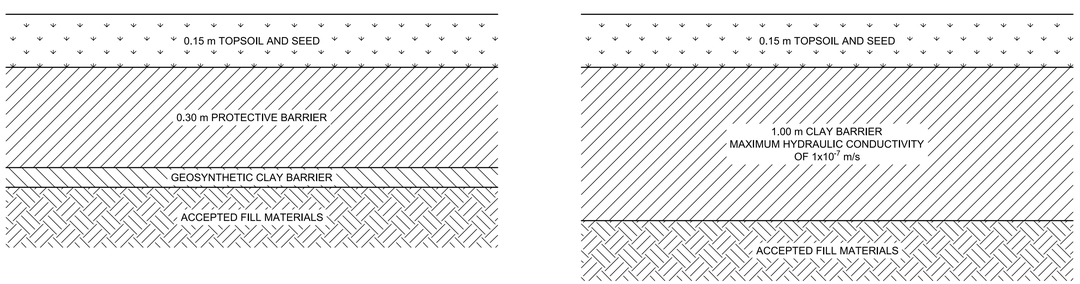


1 C-102 SECTION H: 1:1000 V: 1:2000

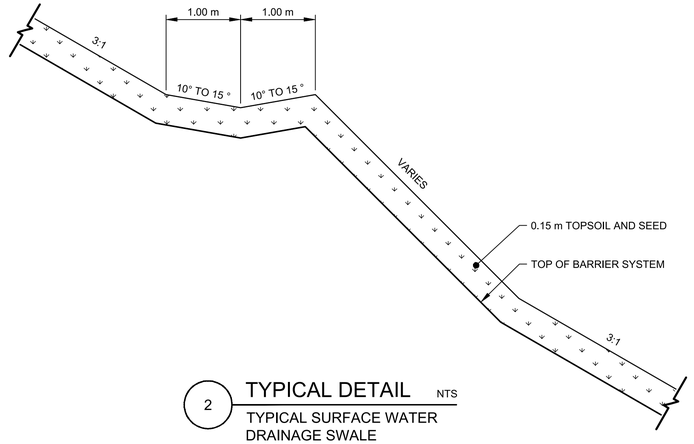
NOTE:
TOTAL AIRSPACE BETWEEN TOP OF LANDFILL AND EXISTING GROUND IS 360,000 m³.
REMAINING CAPACITY FOR FILL MATERIAL IS 311,300 m³.



USING GEOSYNTHETIC AS A CLAY BARRIER

USING CLAY AS A BARRIER LAYER

1 TYPICAL DETAIL NTS
LINER COVER SYSTEM



2 TYPICAL DETAIL NTS
TYPICAL SURFACE WATER
DRAINAGE SWALE

Associated Engineering

BEST MANAGED COMPANIES
Platinum member

PRELIMINARY/
FOR DISCUSSION
NOT FOR CONSTRUCTION

REV	DATE	DESIGN	DRAWN	DESCRIPTION
A	2024APR19	S. NICOLL	E. KELSEY	ISSUED FOR OPERATIONS PLAN UPDATE

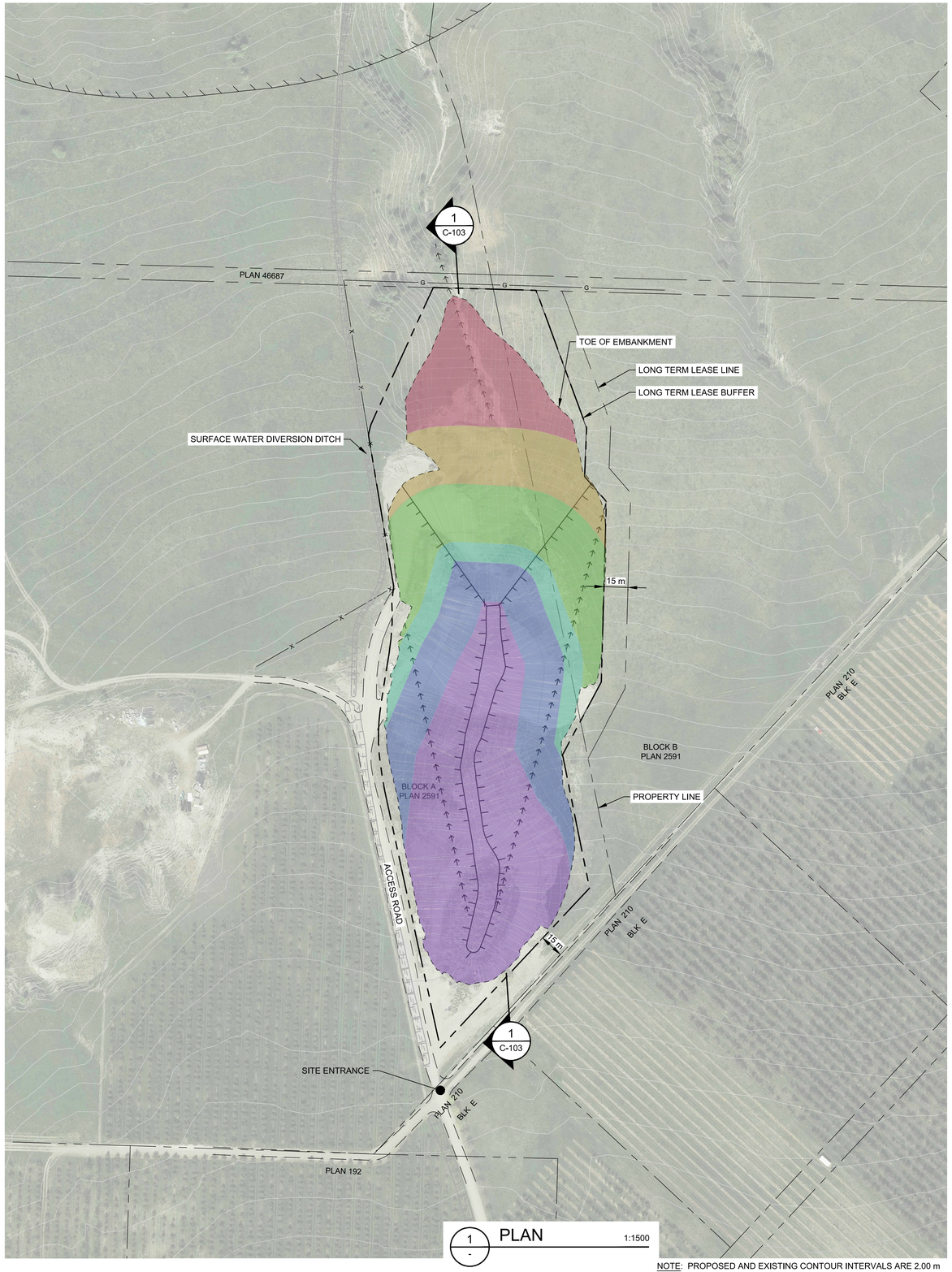
CITY OF VERNON

HESPERIA LANDFILL DESIGN
OPERATIONS AND CLOSURE
PLAN UPDATE
20228344-00

SCALE: AS SHOWN

CIVIL
SECTION AND DETAILS

DRAWING	REVISION	SHEET
8344-00-C-103	A	5



1 PLAN 1:1500

NOTE: PROPOSED AND EXISTING CONTOUR INTERVALS ARE 2.00 m

ELEVATION RANGE LEGEND					
CLOSURE PLAN		MIN.	MAX.	AREA	VOLUME
1		411.4 m	438.0 m	5240.75 m²	61,529 m³
2		438.0 m	450.0 m	4479.10 m²	54,949 m³
3		450.0 m	462.0 m	7197.76 m²	63,619 m³
4		462.0 m	466.0 m	3288.87 m²	32,173 m³
5		466.0 m	474.0 m	7888.63 m²	63,961 m³
6		474.0 m	489.5 m	15622.20 m²	71,758 m³

Associated Engineering

BEST MANAGED COMPANIES
Platinum member

PRELIMINARY/
FOR DISCUSSION
NOT FOR CONSTRUCTION

REV	DATE	DESIGN	DRAWN	DESCRIPTION
A	2024APR19	S. NICOLL	E. KELSEY	ISSUED FOR OPERATIONS PLAN UPDATE

CITY OF VERNON

HESPERIA LANDFILL DESIGN
OPERATIONS AND CLOSURE
PLAN UPDATE
20228344-00

SCALE: AS SHOWN

CIVIL
CONCEPTUAL PHASED CLOSURE PLAN

DRAWING	REVISION	SHEET
8344-00-C-104	A	6

APPENDIX C - GENERAL SITE SAFETY INFORMATION

Occupational Health and Safety

All operations and site activities will be in accordance with the Occupational Health and Safety Regulation. All site employees are to be familiar with the requirements set out in this Regulation.

Hazards

The potential emergencies that may be faced at the Hesperia Landfill are considerably less than a standard municipal landfill, as there is no public access, no buildings, and no reliance on power, and the type of material that is deposited is consistent clean fill. However, some key significant hazards that are present at the Hesperia site include the following:

- Heavy equipment use;
- Steep slopes and slope failure;
- Buried lines;
- Dust and exposure to site material;
- Unregulated access; and
- Wildfire.

General Site Safety

The safety of site operating personnel is of primary importance at all times. Site employees will not endanger themselves or others by their actions. All employees at the site are obligated to report unsafe practices and are empowered to notify other employees who are acting unsafe.

All accidents, injuries, or “near misses” will be reported to the Landfill Manager. The Landfill Manager will document and investigate the incident, and implement any necessary measures required to prevent a reoccurrence.

In the event of a serious mishap involving and injury, the Landfill Manager will notify WorkSafeBC and will cooperate with any investigations.

The Landfill Manager and one at least one of the Landfill Operators will have first aid training.

Employee Safety

The following work practices are to be followed by all employees at the landfill:

- Ensure equipment back-up alarms are operating.
- Wear safety footwear always.
- Wear gloves, goggles, and other protective clothing as appropriate for the tasks undertaken.
- Do not smoke.
- Do not enter any confined spaces.
- Visually inspect equipment prior to use by conducting a walk around inspection.
- Be aware of other workers, equipment, site customers, and vehicles when operating equipment.
- Move slowly over large items to avoid tipping equipment.
- Do not crush sealed containers, or containers with unknown contents.
- Do not scavenge materials.
- Clearly post emergency phone numbers.

APPENDIX D - EMERGENCY RESPONSE AND CONTINGENCY PLANS

Introduction

The key elements of an Emergency Response Plan are:

1. What is the nature and severity of the emergency?
2. What is to be done?
3. Who is responsible for each task?

This document provides the Emergency Response Plan for the Hesperia Landfill (the Site). The types of emergencies that may occur include:

- Accidents and medical emergencies.
- Environmental and operation contingencies.

The Emergency Response Plan for the Site is unique from standard municipal landfills as there is no public access and no designated personnel onsite daily.

Emergency Plan Updates

The emergency plan will be reviewed annually and following an emergency incident to ensure that:

- Emergency response procedures for the Site are effective and updated as necessary.
- Appropriate individuals are appointed to manage emergency situations.
- Regular safety and emergency meetings are held with landfill employees.

Emergency Organization

The key to success of the Emergency Response Plan is to assign a responsible person to take charge of an emergency. The Site Manager or Director of Operations has the primary responsibility to manage emergency situations at the landfill.

The Site Manager or Director of Operations will have complete commission for the duration of the emergency. In addition, there will be proper training of operating personnel, practice drills to test emergency response activities, and continual review and updates to the plan to ensure an efficient and effective response to emergencies.

Site Manager Responsibility

The Site Manager has the responsibility to:

- Declare an emergency.
- Review and update the emergency response procedures.
- Ensure that all emergency response procedures are appropriate.
- Respond to all emergencies and contact appropriate emergency response agencies.
- Establish control of the emergency prior to the arrival of appropriate emergency response agencies.
- Direct personnel and site visitors to a safe muster point.
- Liaise with the emergency response representatives upon their arrival.
- Correct any potential emergency or unsafe situations.
- Complete necessary documentation with respect to emergencies.

The Site Manager will report emergency or contingency situations to the Director of Operations. The Director of Operations will contact appropriate agencies to report incidents related to environmental or health and safety as they relate to the emergency or contingency activities.

Evacuation Procedures and Muster Points

If an evacuation of the area must occur when workers are on site, designated muster point(s) will be identified for the emergency according to the nature and the location of the emergency and a safe exit route. A muster point must not be used when it is unsafe or if downwind of a fire. The muster points for the Hesperia Landfill are as follows:

1. Primary: Main Entrance Access Gate at Bench Row Road; or
2. An alternate area designated by the Landfill Manager or Landfill Operator.

The Site Manager (or Operator if the Site Manager is not onsite) will ensure everyone onsite is notified of the need to evacuate and then:

- Meet at the muster point to ensure all site employees have been evacuated.
- Wait for appropriate emergency response personnel.
- As required, establish perimeter security, conduct searches, or other actions that may be warranted by specific circumstances.

It is imperative that all employees remain at the muster point until the Site Manager or designated Operator gives permission to return to the respective areas or to leave the site. Upon termination of the emergency, an "All Clear" will be indicated to allow employees to return to their work areas. Under NO circumstances will an employee return to the work area prior to receiving permission from the Site Manager.

ACCIDENTS AND MEDICAL EMERGENCIES

All injuries are be considered important and will be reported as a safety incident to the Site Manager. First Aid will be applied that is appropriate to the nature of the injury, and in the event the injury requires medical assistance, the individual will be either taken to a medical emergency centre, or an ambulance service contacted. A medical doctor will be consulted for all injuries that may result in infections as a result of working with waste materials. This includes injuries such as cuts and scrapes, and skin punctures with sharp items.

Medical Injuries

Minor Medical Injuries

Prevention:

- Safety Plan and Procedures.
- Employee Safety Training and Awareness.
- First Aid Training.

Response Plan:

Action	Time Frame	Who?
Apply appropriate First Aid	Immediately	First Aider
Recommend injured person consult a physician	Immediately	First Aider
Take injured person to a medical emergency centre or contact an ambulance service if deemed appropriate	Immediately	First Aider
Review cause of the injury and prepare appropriate mitigative measures	Within 1 month	Site Manager Site Employees Occupational Health and Safety

Serious Medical Injury

Prevention:

- Safety Plan and Procedures.
- Employee Safety Training and Awareness.
- First Aid Training.

Response Plan:

Action	Time Frame	Who?
Assess site conditions for personal safety and safety of others, and take appropriate actions to secure unsafe areas	Immediately	Site Manager First Aiders Site Employees
Attend to the injured person and apply First Aid	Immediately when safe to do so	First Aider
Contact 911	**Immediately**	First Aider Site Employees
Stay with the injured person until medical assistance arrives	Duration of medical emergency	First Aider
Investigate to determine the cause of the injury and prepare appropriate mitigative measures	Immediately following the incident	Site Manager Director of Operations

Vehicle or Equipment Accidents

All vehicle accidents will be reported and an investigation as to the cause will be carried out. Following the investigation, appropriate mitigative measure should be determined an implemented to avoid future accidents.

Vehicle or Equipment Accidents		
Prevention:		
• Safety Plan and Procedures. • Employee Safety Training and Awareness. • Traffic Control Signs. • Vehicle spotting during heavy traffic situations.		
Response Plan		
Action	**Time Frame**	**Who?**
Report the accident to the Site Manager	Immediately	All employees
If damage is minor, have the vehicle driver report the accident to the RCMP	Immediately	Site Manager Operators
If the damage is significant, call the RCMP	Immediately	Site Manager Operators
If an injury is involved, call 911, and implement medical response actions	Immediately	Site Manager Operators
Secure the area for a follow-up investigation	Immediately	Site Manager Operators
Investigate the cause of the accident and prepare appropriate mitigative measures	Within 1 month of the accident	Site Manager RCMP Occupational Health and Safety

ENVIRONMENTAL AND OPERATIONAL CONTINGENCIES

Environmental and operational contingencies may vary in degree of their nature and seriousness, and therefore actual situations will dictate the appropriate actions and responses that should be undertaken. Generally, the Emergency Response and Contingency Plan includes the following steps:

1. Secure and contain the problem.
2. Verify and validate the problem.
3. Investigate the cause and potential risk.
4. Assess appropriate corrective actions.
5. Implement the corrective action.
6. Review operation procedures and preventative measures.

The following sections address key environmental or operational hazards that may occur at the Site.

Prohibited Waste Discovered at the Landfill

Prohibited Waste Discovered at the Landfill

Prevention:

- Waste Acceptance Policies and Procedures.
- Employee Training and Awareness.

Response Plan:

Action	Time Frame	Who?
Isolate waste and cease operations in the area of the waste	Immediate	Operators
Construct containment around perimeter of the waste if necessary	Immediate	Operators
Determine source of waste, and if possible the waste hauler and generator	1 week	Site Manager
If identified, contact the hauler and waste generator to review options	1 to 2 weeks	Site Manager Director of Operations
Review waste acceptance procedures and practices, and implement mitigative measures	1 month	Operators

Extreme Weather

Extreme Weather

Prevention

- Monitor weather forecasts.
- Employee safety and response training and awareness.
- Maintain on and off-site communications systems.
- Do not receive waste to the landfill during extreme weather.

Response Plan

The Site Manager and/or Director of Operations is responsible for closing the facility in severe weather conditions that may affect the health and safety of the staff. As the Site primarily receives inert construction waste, in the event of extreme weather, it is unlikely there will be active construction and the Site will remain closed.

Excess Stormwater Flow into the Active Operating Area

Excess Stormwater Flow into the Active Operating Area
Prevention

- Continued inspection and maintenance of surface water management system.
- Surface water diversion ditches and berms around working face.
- Application of cover soils.
- Maintain minimal working face.
- Employee training and awareness.

Response Plan		
Action	**Time Frame**	**Who?**
Cease operations in active area	Immediate	Operators
Construct perimeter berms to prevent run-on	Immediate	Operators
Review cause and identify corrective measures	Within 2 weeks	Operators
Implement corrective measures	Within 2 weeks	Site Manager Director of Operations

Extreme Dust Emissions

Extreme Dust Emissions
Prevention

- Control speed limits on on-site gravel roads.
- Road maintenance; limit the amount of road maintenance done during dry conditions.
- Seed soil stockpiles.
- Cover inbound loads.
- Use special handling procedures for waste loads prone to emission of dust.
- Employee training and awareness.

Response Plan		
Action	**Time Frame**	**Who?**
Apply water to road surfaces as necessary	1 Day	Operators
Pre-wet waste load	Prior to delivery when pre-arranged	City staff Contractors
Cover dusty wastes with other waste or soil	Immediately upon unloading	Operators

Accidental Release (Spills)

Accidental Release (Spills)		
Prevention:		
• Ensure that all machines carry suitable spill kits that are appropriate for containing the greatest volume of spill possible given the type of machinery or equipment. • Ensure that all equipment operators are familiar with the available spill kits and are aware of the spill prevention measures. • Ensure that all equipment, machinery, and tools are in good working order and are free of oil, grease, and other contaminants. • Inspect equipment daily for any leaks or excess oil or grease before use. • Clean up any leaks immediately and report them to a Qualified Professional and the Site Manager. • Ensure Operators are familiar with the provincial Spill Reporting Requirements.		
Response Plan:		
Action	**Time Frame**	**Who?**
Any person who discovers a spill incident must immediately conduct an initial assessment to determine the magnitude of the problem and whether they can remedy the situation or if they will require additional help. Actions to be taken are as follows: 1) **Ensure Safety** • Ensure personal, public, and environmental safety. • Wear appropriate protective gear. • Determine the product spilled before clean-up. • Warn people in the vicinity. • Ensure no ignition sources are present if the spill is flammable. 2) **Stop the Flow** • Act quickly to reduce the risk to the environment. • Close valves, shut off pumps, or plug leaks. • Stop the flow at its source. 3) **Secure the Area** • Limit access to the area. • Prevent unauthorized entry onto the site. 4) **Contain the Spill** • Prevent the spill from entering any drainage structures. • Use spill absorbent material to contain the spill. • Minimize environmental contamination. 5) **Notify/Report Spill to Site Manager**	Immediately	Operators Contractors
Notify the BC Ministry of Environment and Climate Change Strategy if required (additional info below).	Immediately	Site Manager Operators

Spill Reporting Requirements

The *Spill Reporting Regulation*[15] outlines the reporting requirements for spills in BC. Operators should be familiar with the spill reporting requirements, as they may change over time. Spills are reportable if:

1. The volume spilled (or likely to be spilled) is greater than the minimum quantities outlined in the *Spill Reporting Regulation*, or
2. The spill enters or is likely to enter a body of water (such as the ephemeral watercourse onsite, regardless of whether water is flowing in it at the time).

If a spill is reportable, contact the Province **immediately** at their 24-hour emergency contact number (**1-800-663-3456**).

Incident reports will be prepared that contain the following information:

- Date and time of the incident and persons involved;
- Type of incident (non-conformance and/or spill);
- Quantity of spilled material and ecosystem affected;
- Corrective action taken (stop work and mitigation measures);
- Duration and extent of incident;
- People contacted and communications record; and
- Follow up actions that were taken.

Follow-up

Depending on the nature and quantity of the spill, additional reporting may be required by the Province (e.g., Update to Minister Report, End of Spill Report).

Regardless of any provincial reporting requirements, the Landfill Manager will conduct an investigation into the cause of any spills onsite, and identify and implement mitigative measures to prevent similar incidents in the future.

[15] Spill Reporting Regulation BC Reg. 187/2017. December 5, 2017 (last updated). Victoria, BC. https://www.bclaws.gov.bc.ca/civix/document/id/crbc/crbc/187_2017

Wildfire

The Site is considered to have a low on-site fire risk (compared to standard municipal landfills) because waste primarily consists of inert fill material from construction projects, and the City has banned all flammable or wood material from being placed since 2004. As a result, the primary risk of fire relates to grass fires on the surrounding lands. Fires may be caused by hot loads unloaded at the working face, intentional ignition, vehicle and engine use near flammable grasses, smoking (i.e., discarded cigarette butts), flammable debris on hot parts of the landfill equipment, and natural causes (lightening).

Onsite measures to prevent fires include:

- Employee training and awareness.
- Prohibit smoking at the Site.
- Operate vehicles and equipment within the existing access roads and active site. Avoid dry grass and shrubs
- Maintain operating equipment.

While fire is unlikely to originate in the Site, there is a potential for fire to spread into the Site from a grass fire on the surrounding fields. In the event a grass fire occurs, the **City's Fire Response Plan** should be followed.

Other Contingency Plans

The Landfill Criteria requires that the Contingency Plan address the potential for failure or non-compliance scenarios of the leachate, surface water, and landfill gas management facilities.

Groundwater or Surface Water Quality Impacts

A Groundwater and Surface Water Monitoring program will occur annually at the Site. A Qualified Professional will oversee the program, review the results, and provide recommendations regarding the testing locations, parameters, and frequency throughout the life of the Site. The assessment of impacts to groundwater or surface water should follow the recommendations of the Qualified Professional and a general trigger and response approach. Generally, this means the following:

- If results do not exceed an applicable guideline and/or if concentrations are similar upstream/upgradient and downstream/downgradient, actions include ongoing, normal monitoring (low-risk).
- If results exceed a water quality guideline at a downgradient site (i.e., a trigger), the response will depend on the level of risk (medium or high), which depends on the exceeding parameter and on the duration and magnitude of that exceedance. Examples of responses and/or additional investigations that can be implemented include the following:
  - Medium-risk (e.g., minor in magnitude or infrequent exceedances):
    - Assess the issue again following the next sampling round to determine if the exceedance persists.
    - Investigate the potential causes (e.g., operational malfunctions or process upsets, weather, improper field and laboratory procedures, review of surface water management policies, QA/QC).
    - Adjust sampling frequency to focus on critical times of the year or the time period when exceedances are occurring, and/or conduct additional water quality sampling.
  - High-risk (e.g., large in magnitude or frequent exceedances):
    - Investigate the potential causes, as above.
    - Conduct confirmatory re-sampling if a cause cannot be found.
    - Notify ENV, along with proposed investigative or remedial actions.
    - Expand field investigations to evaluate the magnitude, frequency, duration, and spatial extent of the above-guideline event.

- Conduct field investigations into potential adverse effects, such ecological or human health risk assessment.

The monitoring program includes collecting water quality samples directly from domestic water supply wells that are downgradient of the Site. Following each sampling event, the results from these samples should be compared to applicable drinking water guidelines. If exceedances of drinking water guidelines are identified, the owners of the wells should be notified, regardless of the potential cause (i.e., even if the exceedance is considered 'background' and unrelated to the Site, well owners should be notified for due diligence purposes).

Nuisance Impacts to Nearby Residences

If the City receives complaints from the nearby residences, the complaints should be investigated to determine the source or cause that generated the nuisance activity, and mitigative measures should be implemented. This may include changes to operations (e.g. to mitigate dust, noise, etc.).

Landfill Gas Management

As described in Section 6.3, landfill gas management facilities are not considered necessary for the Site due to the nature of the material that is deposited. Contingency measures include:

- Review and update landfill gas generation assessments every 5 years and submit to the ENV with the annual report for that year (as required by the regulations).
- Review the need for landfill gas management facilities:
  - should the City wish to change waste acceptance policies (e.g., landfilling organic material), or for
  - future site use after closure (e.g., construction of any buildings on the Site, which is currently not planned).

APPENDIX E - GEOTECHNICAL AND SEISMIC ASSESSMENT

Fletcher Paine Associates Ltd.
Consulting Geotechnical and Materials Engineers
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File 6476

December 19, 2018

Associated Environmental Consultants Inc.
#200, 2800-29 Street
Vernon, BC
V1T 9P9

Attention: Nicole Penner, B.Sc.
Environmental Scientist

Dear Ms. Penner,

Preliminary Geotechnical Assessment and Report
Hesperia Landfill - Vernon, BC

1.0 INTRODUCTION

1.1 Authorization

The work reported upon in this document was authorized by Nicole Penner on behalf of Associated Environmental Consultants Inc. (The Client) in an email correspondence dated October 24, 2018.

1.2 Qualifications

Use of this report is subject to the Statement of Qualifications and General Conditions, which is attached. The reader's attention is specifically drawn to these conditions as it is considered essential that they be followed for the proper use and interpretation of this report.

1.3 Terms of Engagement

The terms under which our services are provided are attached.

1.4 Authorized Use of Report

This report has been prepared exclusively for the client listed above, for the use of others on their design team and for the relevant approving authorities.

2.0 SCOPE OF THE REPORT

The accepted scope of work was communicated to the client in an email correspondence dated July 24, 2018. In general, the contents of this report are intended to provide preliminary geotechnical engineering assessments related to the City of Vernon owned Hesperia Landfill accessed from Bench Row Road in Vernon, BC, and located in the south

east corner of the property with legal description Lot A, Plan 2591, Township 9, District Lot 62, ODYD, Section 19 & 20, as shown on the Site Location Plan, Figure 6476-1.

This report addresses relevant geotechnical items as outlined in Section 10.3.3 of the British Columbia Ministry of Environment publication entitled "Landfill Criteria For Municipal Solid Waste", dated June 2016. At the request of The Client representative, this report will not include post-closure geotechnical engineering assessments due to the lack of existing information necessary to determine the future extent of landfill operations. As discussed with The Client representatives, a subsurface test pit program through the existing landfill was not required for the intended purposes of this report, based on the available information.

This report addresses the following specific items:

a) Background information

b) Site description and geology

c) Site reconnaissance and meetings

d) Geotechnical assessments of:

i) Bearing capacity
ii) Differential settlement
iii) Seismic and fault activity
iv) Slope stability

e) Recommendations and conclusions

3.0 BACKGROUND INFORMATION

3.1 Available Documentation

The following documents, listed in chronological order, have been read in preparation of this report:

a) 1960 - "Map 1059A; Geology; Vernon; Kamloops, Osoyoos And Kootenay Districs; British Columbia". Drawing prepared by Geological Survey of Canada.

b) 1974 - "Map 1392A; Surficial Geology; Vernon; West of Sixth Meridian; British Columbia". Drawing prepared by Geological Survey of Canada.

c) 1979 - "Summerland - Salmon Arm Topography; 82L.024.1.4". Drawing prepared by Province of British Columbia Ministry of Environment.

d) 1981 - 2007 - Relevant airphotos taken by the Province of British Columbia.

e) June 29, 1983 - "Permit PR-6591". Document prepared for the Corporation of the City of Vernon by the British Columbia Ministry of Environment.

f) January 21, 1998 - "Operational Certification PR 15288". Document prepared for the Corporation of the City of Vernon by the British Columbia Ministry of Environment, Lands and Parks.

g) September 21, 2000 - "Hesperia Landfill Fire Monitoring and Closure Plan". Report prepared for the Corporation of the City of Vernon by Sperling Hansen Associates Inc.

h) September 2008 - "Phase I & II Environmental Site Assessment & Detailed Environmental Site Assessment: Hesperia Development Area, Vernon, B.C.". Report prepared for the Hesperia Development Corporation by Summit Environmental Consultants Ltd.

i) September 29, 2008 - "Preliminary Geotechnical Assessment, Hesperia Residential Development Area, Vernon, B.C.". Report prepared for the Hesperia Development Corporation by Fletcher Paine Associates Ltd.

j) November 19, 2009 - "Investigation into public complaint regarding disposal of material at Hesperia Landfill, Vernon, B.C.". Report prepared for the City of Vernon by Summit Environmental Consultants Ltd.

k) September 11, 2014 - "Hesperia Topo And Sections; Bench Row Road To Okanagan Avenue; City of Vernon (F.P.A.)". Drawings prepared for the Corporation of the City of Vernon by Shatzko Engineering Ltd.

l) September 12, 2014 - "Preliminary Designs Of Ditch And Sediment Trap; Hesperia Landfill, Vernon, BC (Draft)". Report prepared for the Corporation of the City of Vernon by Golder Associates Ltd.

m) October 22, 2014 - "Geotechnical Engineering Assessment; Okanagan Avenue Groundwater Discharge, Vernon, B.C.". Report prepared for the City of Vernon by Fletcher Paine Associates Ltd.

n) June 9, 2016 (draft dated April 20, 2011) - Operations and Closure Plan, Hesperia Landfill, Vernon, BC". Report prepared for the Corporation of the City of Vernon by Golder Associates Ltd.

o) September 28, 2017 - "Okanagan Avenue Drainage Upgrades". Drawings prepared for the City of Vernon by True Consulting Ltd.

p) November 30, 2018 - "Interim Filling Plan". Document prepared for the City of Vernon by Associated Environmental Consultants Inc.

3.2 Unavailable Historical Documentation

Historic documented landfill waste material filling rates and locations were not provided. The topographical surveys of the landfill used for the purposes of this report were made with Lidar technology between 2010 and 2016.

3.3 Background Information Review

The subject site was permitted to be a landfill in 1983, by the issuance of "Operational Certification PR-6591". There are no records of the preliminary landfill design drawings; however, based on discussion with the City of Vernon representatives, it is understood that there is no liner below the landfill and no leachate collection system.

In 1998, Operational Certificate PR-6591 was superseded by "Operational Certification PR-15288", which allowed the City of Vernon owned landfill to receive up to 6000 tonnes

(15 200 m^3) per year of demolition and construction wastes of inert material such as wood and concrete, but specifically excluding putrescible materials, domestic refuse, plastics, rubber and other chemical or toxic wastes.

In the September 21, 2000 "Hesperia Landfill Fire Monitoring and Closure Plan"issued report by Sperling Hansen Associates Inc, in 1999, it is noted that a fire, fuelled by wood debris, erupted at the subject site within the landfill waste. As a result, allowing flammable and biodegradable materials within the landfill waste has been greatly reduced, and finally discontinued in approximately 2004.

In the November 19, 2009 "Investigation into public complaint regarding disposal of material at Hesperia Landfill, Vernon, B.C." issued report by Summit Environmental Consultants Ltd, it is noted that the types of landfill waste materials being dumped at the Hesperia Landfill were confirmed to meet the requirements in the operational certificate.

In the September 12, 2014 "Preliminary Designs Of Ditch And Sediment Trap; Hesperia Landfill, Vernon, BC (Draft)" issued report by Golder Associates Ltd, it is noted that a sediment trap was designed for the south end of the landfill to help keep sedimentation originating from the landfill from entering the local storm water management system, downstream of the landfill. It is understood that the finalized sediment controlling structure was designed by True Consulting Ltd. in September 28, 2017, and ultimately constructed in 2018.

In the June 9, 2016 "Operations and Closure Plan, Hesperia Landfill, Vernon, BC" issued report by Golder Associates Ltd, it is noted that the updated Operating and Closure plan provided recommendations to allow for a projected landfill closure in approximately 2070.

In the November 30, 2018 "Interim Filling Plan" issued report by Associated Environmental Consultants Inc. recommendations related to the next three years of landfill operations were provided by the author of the report. This document also suggested that the northern extent of the landfill could be reduced by approximately one third, depending on the cost-benefit analysis of moving an existing high pressure natural gas main.

4.0 SITE DESCRIPTION AND GEOLOGY

4.1 Site Description

The landfill site is located in the southwest area of the City of Vernon, between Bench Row Road and Okanagan Avenue, as shown on the attached Figure 6476-1. The landfill site is considered to be a "natural controlled" landfill as material is placed within a natural gully with approximate side slope gradients of 2H:1V and elevation difference ranging between approximately 10 m and 25 m between the gully crest and toe.

With the exception of the gully and landfill materials, on site grades generally slope down towards the north at slope gradients ranging between approximately 5H:1V and 15H:1V.

Downstream of the landfill, the base of the gully sees intermittent runoff water. It is understood that the natural drainage paths in the area have been modified since the construction of the landfill, and should see additional modification with landfill associated filling and alterations to stormwater management upstream of the landfill.

The site is surrounded on its east, west and south sides by agricultural fields. A disturbed site west of the landfill was previously used as a gravel pit and a rapid infiltration site. Generally, single family residential lots exists on the north side of the site. Access for the landfill is available from a gated gravel road from Bench Row Road, near its intersection with Commonage Road.

4.2 Site Bedrock Geology

Available bedrock geology mapping indicates that the geology at the site consists of mainly limestone; minor argillite, quartzite, and andesite lava, breccia, and tuff from the Carboniferous and Permian eras.

4.3 Site Surficial Geology

Available surficial geology mapping indicates that the soils at the site are thin lacustrine deposits consisting of silt with minor clay and sand that were deposited prior to the last ice age advance. The lacustrine deposits are underlain by undifferentiated morainal deposits consisting of till with minor sands, gravel, and silt.

Although there was no field subsurface investigation performed for the purpose of this report, the documents read for the purpose of this report contained several subsurface investigations near the landfill site. The materials encountered during the field investigations noted in these documents were consistent with the above description.

5.0 SITE RECONNAISSANCE AND MEETINGS

5.1 Introductory Site Meeting

An introductory site visit was carried out on May 16, 2018 to meet with project stakeholders, confirm and finalize the geotechnical scope for the purposes of this report, and observe the existing site conditions. The parties present at the meeting included:

- Nicole Penner, B.Sc. and Tony Friesen, M.Sc., GIT of Associated Environmental Consultants Inc.
- James Rice of the City of Vernon
- Robert Scherz, P.Eng. and Terry Eddy, P.Eng. of Fletcher Paine Associates Ltd.

Based on the discussions from this site meeting, and subsequent correspondence, Fletcher Paine Associates Ltd. was instructed by the City of Vernon representatives to eliminate the post-closure geotechnical assessments from this report. The original geotechnical scope included a subsurface investigation and design for an earthen berm located at the proposed toe of the landfill material for slope stability purposes; however, it is understood that the proposed landfill toe location is not finalized, such that the post-closure geotechnical assessment has been deferred until the landfill toe location is confirmed.

5.2 Site Reconnaissance

A site reconnaissance visit was carried out at the Hesperia Landfill by Robert Scherz (Fletcher Paine Associates) on November 7, 2018. Nicole Penner (Associated

Environmental), James Rice and Chris Ovens (City of Vernon) were also on site during this site visit. The site reconnaissance visit was made for the purposes of making geotechnical observations of the landfill conditions and discussing current landfill practices with the City of Vernon personnel.

5.3 Current Landfill Use

Based on the information noted in previous sections of this report, the following is intended to summarize current landfill usage practices.

The site is an active landfill that generally receives construction waste from City of Vernon owned projects, primary consisting of a mixture of fine and coarse grained soils and aggregates with occasional concrete, organic matter and asphalt inclusions, although it is understood that the latter is generally screened out. These waste materials generally originate from local construction sites.

The materials are generally placed by end-dumping waste materials near the crest of the fill slope, which are then pushed over the edge as required with construction equipment that is not kept on site. At the time of the site reconnaissance, the active face ranged between approximately 4.0 m and 8.0 m in height, and had slope gradients ranging between approximately 1.5H:1V and 2.0H:1V. While on site, a dump truck drove to within 2.0 m of the crest of the fill slope and end dumped its load. There were several dump truck wheel ruts extending to within 2.0 m of the crest of the fill slope, ranging between approximately 0.2 m and 0.4 m deep, demonstrating that this is a typical practice.

It is understood that, historically, some landslip events have occurred within the landfill waste materials, generally within the northmost extents of the landfill, where steeper gradients are encountered.

In discussion with the City of Vernon representatives, periodic grading of the landfill occurs to help prevent stormwater from "ponding" above the fill. However, some ponding was noted during the site reconnaissance.

Landfill inspections are made on a monthly basis by City of Vernon personnel, in accordance with current operational procedures.

6.0 GEOTECHNICAL ASSESSMENT

6.1 Landfill Regulations

The work reported on in this document is intended to address the pertinent geotechnical aspects of the Hesperia Landfill by referring to the following documents:

i) "Landfill Criteria For Municipal Solid Waste, Second Edition"; British Columbia Ministry of Environment (2016). This document is intended to provide general guidelines relevant to landfilling practices and procedures throughout the entire life cycle of landfills in British Columbia.

ii) "Operational Certification PR 15288". British Columbia Ministry of Environment, Lands and Parks (1998) . This document is intended to provide certification for the Hesperial Landfill to be used as a landfill, given certain criteria.

Hesperia Landfill is currently in use, and has been since 1983. This landfill does not have a base liner or leachate collection system. Furthermore, the post closure plan for this landfill is not finalized.

For the above reasons, the following items, listed in section 10.3.3 of the "Landfill Criteria For Municipal Solid Waste, Second Edition", are excluded from this report:

a) Comments related to bearing capacity, differential settlement, slope stability during original site construction and post-closure

b) Any effects on the landfill base liner and leachate collection system

6.2 Bearing Capacity

6.2.1 In Situ Foundation Soils

Based on the known stratigraphy and ground preparation methods, the in situ undisturbed foundation soils below the Hesperia Landfill should provide an adequate bearing capacity for the existing landfill conditions. However, it is expected that negligible settlement will occur to the undisturbed in situ soils, which is addressed in the following section.

6.2.2 Landfill Waste Materials

No bearing capacity can be provided for the surface of the landfill waste material as this fill was placed in an uncontrolled fashion and is non-homogeneous in nature. In the event that the owner considers building or placing a structure at the landfill site, the services of a geotechnical engineer should be retained in order to provide recommendations related to the foundation soils preparation and foundation types. However, it should be noted that costs related to foundation soil preparation for such a structure would likely be cost prohibitive.

6.3 Differential Settlement

6.3.1 In Situ Foundation Soils

The Landfill Criteria For Municipal Waste document states that "The landfill base soils shall not be subject to consolidation that could result in differential settlement under the applied waste and cover soil loading." It is assumed that the main purpose for this statement is to confirm that any base liner or leachate collection system below the landfill will remain in a functioning state and not potentially be subjected to distress as a result of significant overall or differential settlement. As the Hesperia Landfill does not contain either of these landfill structures, the site should have no issues with any differential settlement and any settlement that does occur should happen during the operation phase of the landfill.

6.3.2 Landfill Waste Materials

The landfill waste materials should be expected to undergo settlement during the operation phase of the landfill. Furthermore, the uncontrolled, non-homogeneous fill will experience differential settlement, depending on the fill types and thickness. In addition to the above, any organic or wood waste materials previously placed in the landfill will undergo decomposition, which will result in further differential and overall settlement.

The amount of expected differential settlement for the landfill waste at this landfill cannot be determined given the non-homogeneous nature of the fill thickness, types and placement

method. Once the post-closure conceptual design is finalized, the landfill cover design should consider significant differential settlement.

6.4 Seismic And Fault Activity

6.4.1 Earthquake Ground Design Motions

Earthquake ground design motions are typically predicted using probability of annual exceedance, based on information related to historic earthquake in the subject area. Peak ground acceleration magnitudes are often used to define earthquake ground design motions.

Currently, there are no provincial regulations for earthquake ground design motions or probability of annual exceedance as a part of landfill design in British Columbia. However, due to the residential subdivisions down slope of the landfill, it is expected that the landfill should at least adhere to the seismic design requirement guidelines for residential areas, in accordance with the BC Building Code.

For the above noted reason, the probability of annual exceedance for a seismic event used in this report is 1 in 2500 years, which has a site specific earthquake ground design motion of 0.134(g).

6.4.2 Site Classification for Seismic Response

On the basis of the information gathered, the undisturbed, in situ soils at the landfill site can be described as "Site Class D" for seismic site response and design purposes, in accordance with the 2012 British Columbia Building Code.

6.4.3 Geologic Fault Activity

On the basis of the information gathered, the nearest identified geologic fault to the Hesperia Landfill site is approximately 1.9 km away, towards the north-east. As noted on the "Landfill Criteria for Municipal Waste" document, the landfill footprint should not be located within 100 m of a recent geologic fault.

6.5 Seismic / Static Slope Stability

6.5.1 Assumptions

It is assumed that the bottom of the gully will have the thickest landfill waste levels. Therefore, the slope stability analyses performed for the purposes of this report use an alignment that runs along the gully bottom, as shown on the Landfill Profile Schematic, Figure 6476-2. The pre-development and natural site conditions are taken from available historic topographic mapping and test hole soil logs from nearby locations. Existing landfill waste levels are taken from contour mapping from 2016, provided by the City of Vernon.

Due to the non homogeneous nature of the landfill waste materials, conservative engineering properties were used in the slope stability analyses performed for the purposes of this report. It should be noted that the Operational Certificate allows for 6000 tonnes, or 15 200 m^3 of material. This is equivalent to having a material with a unit weight of approximately 3.9 kN/m^3, which is lighter than the unit weight of the landfill waste material actually being dumped at this site. This discrepancy could be as a result of the banning of wood, flammable, and biodegradable materials from being dumped at the site.

6.5.2 Stability Analyses

The slope stability analyses used for the purposes of this report are broken into the following site locations and loading scenarios:

a) Active face - the site location where active dumping of unconsolidated waste materials are being placed.

b) Dry/damp waste material conditions - typical waste material conditions placed in dry environmental conditions.

c) Static load conditions - typical load conditions without dynamic loading.

d) Seismic load conditions - load conditions during seismic events. Note that the seismic slope stability analyses made for the purposes of this report used the value identified in Section 6.4.1 of this report.

The following table provides a summary of stability analysis factor of safety results for the various site locations and loading scenarios. It should be noted that symbols are used in the table, and in Section 7.1 of this report, to describe the following:

D = Horizontal distance behind the crest of the active face (m)
H = The active face vertical height (m)

Load Condition	Location of stability analysis for factor of safety			
	D = 0.25H	D = 0.5H	D = 0.75H	D = 1.0H
Static	0.8	1	1.2	1.3
Seismic 1/2500 yr	0.6	0.8	0.9	1

For comparison purposes only, the Canadian Dam Association guidelines recommend a long term slope stability minimum Factor of Safety of 1.5 for static conditions, and 1.0 for seismic conditions.

7.0 RECOMMENDATIONS AND CONCLUSIONS

7.1 Landfill Waste Placement

The slope stability analysis results summarized in Section 6.5.2 of this report indicate that there is a slope stability concern near the active face, given the current landfill waste placement practices. This was confirmed on site by the observance of tension cracks and as discussed with City of Vernon personnel.

Current landfill usage procedures may be permitted to continue; however, for worker safety reasons, it is recommended that dump trucks do not come, nor dump, within a horizontal distance D=0.75H. As saturated soil conditions would worsen soil parameters, this distance should be widened to a horizontal distance D=1.5H during, or within 72 hours after, any major precipitation or spring snowmelt events. Dump truck drivers should also be trained

to look for tension cracks near the active face surface, and the correct protocol in the event that tension cracks are encountered (for example, notify the correct City of Vernon personnel).

It should be noted that the above recommendations are not intended to prevent ongoing slope stability issues with the existing landfill waste materials, rather they are intended to minimize the acceleration of any slope movement. The owner should be made aware that continuing with current landfill usage practices may result in landslip events, where landfill waste materials can end up near the gully base. It is expected that the bulk of any landslip material will end up within 50 m of the toe of the current landfill extent; however, depending on gully bottom conditions, water has the potential to take fine materials further downstream. Given the current landfill conditions, there should be no risk to public safety with respect to the residential subdivisions downslope of the landfill.

7.2 Landfill Site Preparation

Any subsequent landfill waste filling onto existing undisturbed, in situ soils should adhere to the following recommendations:

i) Topsoil should be removed to expose the undisturbed, in situ native soils.

ii) A subsurface drainage system should be installed at the base of the gully. Some options for the subsurface drainage system include:

- a 200 mm diameter perforated PVC pipe completely surrounded by a 200 mm thick layer of 25 mm diameter drain rock, completely enclosed in non-woven geotextile

- a layer of peagravel (10 mm diameter drain rock) at least 0.3 m thick and 1.5 m wide

- a layer of 25 mm diameter drainrock completely enclosed in a non-woven geotextile at least 0.3 m thick and 1.5 m wide

The purposes for the above recommendations are to help reduce potential porewater pressures within the fill and increase slope stability of the newly filled area of the landfill.

It is understood that there is a plan to divert water upstream of the landfill such that the gully bottom will not act as a natural drainage path. However, there is always a potential for water to get into a natural drainage path and allowing for better drainage once the landfill waste materials are placed will increase overall bearing capacity and slope stability.

7.3 Post Closure Geotechnical and Seismic Assessment

Once the preferred conceptual post closure plan for the landfill is available, the geotechnical engineer can provide geotechnical and seismic assessments related to its bearing capacity, differential settlement and slope stability. The assessment of these items may include some field subsurface exploration test holes for the design of any required landfill waste retaining system.

7.4 Conclusions

It is concluded that, from a geotechnical point of view, the Hesperia Landfill site is suitable for use as a landfill provided the recommendations made in this report are followed.

We trust that the contents of this report are appropriate for your immediate needs. If you should have any questions please call our office at your convenience.

Yours truly,
Fletcher Paine Associates Ltd.

Robert M. Scherz, P.Eng.
Geotechnical Engineer

Ryan C. Stearns, P.Eng.
Review Engineer

STATEMENT OF QUALIFICATIONS AND GENERAL CONDITIONS

1. Standard of Care

This report has been prepared in accordance with generally accepted geotechnical engineering practices in this area. No other warranty, expressed or implied, is made.

2. Basis of the Report

This report has been prepared for the specific site, design objective, development and purpose that was described to Fletcher Paine Associates Ltd. (FPA) by the client and summarized in this letter. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the report are only valid to the extent that there has been no material alteration to or variation from any of the said descriptions provided to FPA, unless FPA was specifically requested by the Client to review and revise the report in light of such alteration or variation.

3. Uses of the Report

The information and opinions expressed in this report are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THIS REPORT OR ANY PORTION THEREOF WITHOUT FPA's EXPRESS WRITTEN CONSENT. FPA WILL CONSENT TO ANY REASONABLE REQUEST BY THE CLIENT TO APPROVE THE USE OF THIS REPORT BY OTHER PARTIES AS APPROVED USERS. The ownership and copyright of this report remain the property of FPA, who authorizes only the Client and Approved Users to make copies of the report, and only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell or otherwise make available the report or any portion thereof, or any copy of the report or portion thereof, to any other party without the express written permission of FPA.

4. Complete Report

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to FPA by the Client, communications between FPA and the Client, and to any other reports prepared by FPA for the Client relative to the specific site described in the report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS, AND OPINIONS EXPRESSED IN THE REPORT, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. FPA CANNOT BE RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

5. Interpretation of the Report

a) Nature and Exactness of Soil Description: Classification and identification of soils, rocks, and geologic units have been based upon commonly accepted methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from these systems have been used they are specifically mentioned. Classification and identification of the type and condition of soils, rocks and geologic units are judgmental in nature. Accordingly, FPA cannot warrant or guarantee the exactness of the descriptions of in situ ground conditions set forth in the Report.

b) Logs of Test Holes, Pits, Trenches, etc.: The test hole logs are a record of information obtained from field observations and laboratory testing of selected samples as well as an interpretation of the likely subsurface stratigraphy at the test holes sites. In some instances normal sampling procedures do not recover a complete or any sample. Soil, rock or geologic zones have been interpreted from the available data. The change from one zone to another, indicated on the logs as a distinct line, may be transitional. The same limitations apply to test pit and other logs.

c) Stratigraphic and Geologic Sections: The stratigraphic and geologic sections indicated on drawings contained in this report are interpreted from logs of test holes, test pits or other available information. Stratigraphy is inferred only at the locations of the test holes or pits to the extent indicated by items 5. a) and b) above. The actual geology and stratigraphy, particularly between these locations, may vary considerably from that shown on the drawings. Since natural variations in geologic conditions are inherent and a function of the historic site environment, FPA does not represent or warrant that the conditions illustrated are exact and the user of the report should recognize that variations may exist.

d) Groundwater Conditions: Groundwater conditions shown on logs of test holes and test pits, and/or given within the text of this report, record the observed conditions at the time of their measurement. Groundwater conditions may vary between test hole and test pit locations and can be affected by annual, seasonal, and special meteorological conditions, or by tidal conditions for sites near the seas. Groundwater conditions can also be altered by construction activity. These types of variation need to be considered in design and construction.

e) Changes of Exposed Ground: Many geologic materials deteriorate rapidly upon exposure to climatic elements. Deterioration may be caused by precipitation, sunshine and/or the action of frost. Therefore, site conditions may vary

considerably from the time of the making of the tests performed for preparation of the report and the time of actual construction.

f) Influence of Construction Activity: Construction activities can alter and damage the in situ ground conditions. The influence of all anticipated construction activities on the geologic environment should be considered in formulating and implementing the final design and construction techniques.

Wherever changes in the site occur after the preparation of the report or conditions are observed which indicate results clearly incompatible with the test results on which the report is based, the client and any other users of this report should notify FPA as soon as possible so that FPA will be able to provide necessary revisions to its report prior to any commencement of or alteration in design and construction.

6. Observations during Construction

Observations of geologic conditions should be carried out during the site preparation, excavation and construction to verify the conditions predicted by the report. Such observations should be communicated to FPA to allow for confirmation and/or alteration of the geotechnical recommendations or design guidelines presented in the report.

Whenever changes in the site occur after the preparation of the report or conditions are observed which indicate results clearly incompatible with the test results on which the report is based, then the client should notify FPA as soon as possible so that FPA will be able to provide necessary revisions to its report prior to any commencement of or alteration in design and construction.

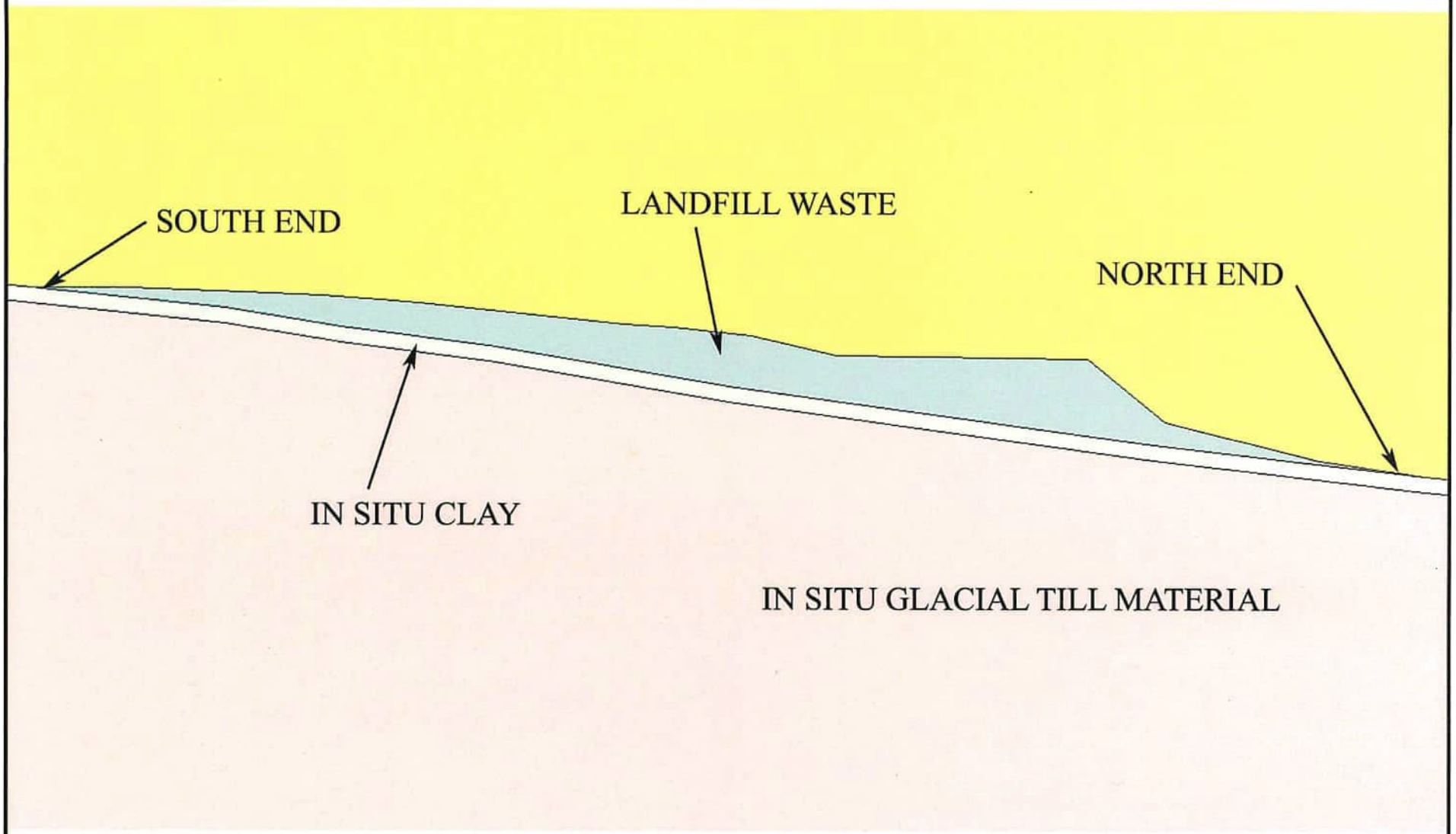
7. Samples

FPA normally disposes of all unused soil and rock samples after 90 days of completing the testing program for which the samples were obtained. Further storage or transfer of samples can be made at the owner's expense upon written request.

Site Location Plan

Figure: 6476-1

Date: 28-Nov-2018 | Scale: nts



Landfill Profile Schematic

Figure: 6376-2

Date: 28-Nov-2018 | Scale: nts

TERMS OF ENGAGEMENT

1. General

Fletcher Paine Associates Ltd. (FPA) shall render its services to the Client for this project with that degree of care, skill and diligence normally provided in the performance of services for projects of a similar nature to that contemplated.

In rendering services to the Client, FPA may, at its discretion and at any stage, engage subconsultants to FPA to carry out its duties and responsibilities as set forth.

2. Compensation

Charges for the services rendered will be made in accordance with our Schedule of Fees in effect at the time the work is performed. All charges will be made in, and will be payable in, Canadian Dollars. Invoices will be due and payable on receipt without holdback. A monthly service charge will be applicable to invoices remaining unpaid after 30 days.

3. Notices

FPA will designate a project manager who shall be responsible for the project. The Client shall designate an authorized representative to act with respect to the project.

4. Termination

Either party may terminate this engagement with cause upon seven (7) days notice in writing. The Client shall forthwith pay for all services performed, including all expenses and other charges payable that are associated with obligations incurred by FPA for this project.

5. Environment and Pollution

The FPA field investigation, laboratory testing and engineering recommendations are not intended to address or evaluate pollution of soil or pollution of groundwater. When practical, FPA will cooperate with the Client's environmental consultant during the field work phase of the investigation.

6. Professional Responsibility

FPA will provide the standards of care, skill and diligence normally provided by a Professional Engineer in the performance of engineering services as contemplated for this project.

7. Limitations of Liability

FPA shall not be responsible for:

a) The failure of a Contractor to perform work in accordance with the relevant contract documents for the Project;

b) The design of, or defects in, equipment provided by or on behalf of the Client by others, for incorporation into the Project;

c) Any damage to subsurface structures or utilities; resulting from subsurface investigations for the Project;

d) Any cross-contamination of ground or groundwater resulting from subsurface investigations for the Project;

e) Any costs incurred for stopping the flow of artesian water from test holes in the event that such conditions are encountered during any field investigation for the Project;

f) Any decisions made by the Client in relation to the Project that are inconsistent with, or contrary to, the advice provided by FPA;

g) Any consequential loss, injury, or damages suffered by the Client, including but not limited to loss of use, loss of earnings, or business interruption;

h) The distribution of any document or report prepared for the Client by or on behalf of FPA for the Project without express authorization by FPA.

Notwithstanding anything to the contrary, the aggregate liability of FPA, including liability for professional negligence and fundamental breach of contract, shall be limited to the amount of Professional Liability insurance carried by FPA.

The Client's failure to accept the professional recommendations and advice of FPA with respect to the geotechnical conditions at the Project shall relieve FPA of and from any and all legal liability, whether in contract or in tort, to the Client for all manner of loss and damage accruing to the Client, including consequential loss and damage, which may arise out of the FPA services.

8. Personal Liability

The Client agrees that FPA's principals and employees have no personal liability to the Client in respect of a claim whether in contract, tort, and/or any other cause of action in law, and expressly agrees that it will bring no proceedings and take no action in any court of law against any of FPA's principals or employees in their personal capacities.

9. Third Party Liability

This report was prepared by FPA for the Client and the material presented in it reflects the opinions and judgements of FPA as based upon the information available at the time of its preparation. Any use(s) made of this report by a third party is/are the sole responsibility of such third parties. FPA will not accept any responsibility for damages suffered by any third party as a result of decisions made or actions taken that are ostensibly based upon this report. Any use or reliance upon this report by a third party must be authorized in writing by FPA

10. Documents

All of the Documents prepared by FPA in connection with the Project are instruments of service for the execution of the Work. FPA retains the property and copyright in those Documents, whether the Project is executed or not. These Documents may not be used on any other project without prior written agreement and remuneration.

11. Field Services

Where applicable, the field services recommended are the minimum necessary to ascertain that the Contractor's work is being carried out in general conformity with the intent of our recommendations. Any reduction from the level of services recommended will result in FPA providing qualified opinions regarding the adequacy of the work.

12. Confirmation of Professional Liability Insurance

As required by the Association of Professional Engineers and Geoscientists of British Columbia, it is required that our firm advise whether or not Professional Liability Insurance is held. It is also required that a space for you to acknowledge this information is provided. Accordingly, this notice serves to advise you that FPA carries professional liability insurance. If you wish to acknowledge receipt of this information please sign and return a copy of this form.

APPENDIX F - DETAILED COST BREAKDOWN

Table F-1 Cost Breakdown - Compacted Clay Liner Option

				Phase 1		Phase 2		Phase 3		Phase 4		Phase 5		Phase 6	
Item	Description	Unit	Unit Cost	Quantity	Estimate	Quantity	Estimate	Quantity	Estimate	Quantity	Estimate	Quantity	Estimate	Quantity	Estimate
PART A – GENERAL REQUIREMENTS															
1.1	Mobilization and Demobilization	L.S.		1	$20,000	1	$20,000	1	$30,000	1	$20,000	1	$30,000	1	$60,000
	TOTAL PART A - GENERAL REQUIREMENTS				**$20,000**		**$20,000**		**$30,000**		**$20,000**		**$30,000**		**$60,000**
PART B – LANDFILL CLOSURE SITE WORK															
2.1	Topsoil Stripping and Haul to Stockpile (Existing Ground)	m^2	12	5,244	$62,928	4,479	$53,748	7,190	$86,280	3,289	$39,468	7,888	$94,656	15,622	$187,464
2.2	Compact and Grade Final Compacted Clay Cover (1.0 m)	m^3	15	5,244	$78,660	4,479	$67,185	7,190	$107,850	3,289	$49,335	7,888	$118,320	15,622	$234,330
2.3	Hauling of Compost	m^3	15	787	$11,823	672	$10,098	1,079	$16,210	493	$7,415	1,183	$17,783	2,343	$35,220
2.4	Mix/ Place and Grade Topsoil (Composite) (Cover Landfill Cap)	m^3	20	787	$15,732	672	$13,437	1,079	$21,570	493	$9,867	1,183	$23,664	2,343	$46,866
2.5	Hydro Seeding	m^2	5	5,244	$26,220	4,479	$22,395	7,190	$35,950	3,289	$16,445	7,888	$39,440	15,622	$78,110
2.6	Supply and Place Protective Sand Layer (Provisional)	m^3	0	3,146	$0	2,687	$0	4,314	$0	1,973	$0	4,733	$0	9,373	$0
2.7	Supply and Install GCL Liner (Provisional)	m^2	0	5,244	$0	4,479	$0	7,190	$0	3,289	$0	7,888	$0	15,622	$0
	TOTAL PART B - LANDFILL CLOSURE SITE WORK				**$195,363**		**$166,863**		**$267,860**		**$122,530**		**$293,863**		**$581,990**
PART C - CONTINGENCY ALLOWANCE* **															
3.1	Project Contingency Allowance 25%	CA			$53,900		$46,800		$74,500		$35,700		$81,000		$160,500
	TOTAL PART D (a) - CONTINGENCY ALLOWANCE				**$53,900**		**$46,800**		**$74,500**		**$35,700**		**$81,000**		**$160,500**
BID SUMMARY															
Part A - General Requirements					$20,000		$20,000		$30,000		$20,000		$30,000		$60,000
Part B - Landfill Closure Site Work					$195,363		$166,863		$267,860		$122,530		$293,863		$581,990
Part C - Contingency Allowance***					$53,900		$46,800		$74,500		$35,700		$81,000		$160,500
TOTAL CONSTRUCTION OPC AMOUNT					**$269,300**		**$233,700**		**$372,400**		**$178,300**		**$404,900**		**$802,500**
Engineering Services															
Engineering Fees					**$26,930**		**$23,370**		**$37,240**		**$17,830**		**$40,490**		**$80,250**
Material Testing					**$13,465**		**$11,685**		**$18,620**		**$8,915**		**$20,245**		**$40,125**
					$40,395		**$35,055**		**$55,860**		**$26,745**		**$60,735**		**$120,375**
Recommended Budget					**$309,695**		**$268,755**		**$428,260**		**$205,045**		**$465,635**		**$922,875**

Table F-2 Cost Breakdown - Geocomposite Clay Liner Option

				Phase 1		Phase 2		Phase 3		Phase 4		Phase 5		Phase 6	
Item	Description	Unit	Unit Cost	Quantity	Estimate	Quantity	Estimate	Quantity	Estimate	Quantity	Estimate	Quantity	Estimate	Quantity	Estimate
PART A – GENERAL REQUIREMENTS															
1.1	Mobilization and Demobilization	L.S.		1	$30,000	1	$30,000	1	$40,000	1	$20,000	1	$40,000	1	$80,000
	TOTAL PART A - GENERAL REQUIREMENTS				**$30,000**		**$30,000**		**$40,000**		**$20,000**		**$40,000**		**$80,000**
PART B – LANDFILL CLOSURE SITE WORK															
2.1	Topsoil Stripping and haul to Stockpile (Existing Ground)	m2	12	5,244	$62,928	4,479	$53,748	7,190	$86,280	3,289	$39,468	7,888	$94,656	15,622	$187,464
2.2	Compact and Grade Final Compacted Clay Cover (1.0 m)	m3	0	5,244	$0	4,479	$0	7,190	$0	3,289	$0	7,888	$0	15,622	$0
2.3	Hauling of Compost	m3	15	787	$11,823	672	$10,098	1,079	$16,210	493	$7,415	1,183	$17,783	2,343	$35,220
2.4	Mix/Place and Grade Topsoil (Composite) (Cover Landfill Cap)	m3	20	787	$15,732	672	$13,437	1,079	$21,570	493	$9,867	1,183	$23,664	2,343	$46,866
2.5	Hydro Seeding	m2	5	5,244	$26,220	4,479	$22,395	7,190	$35,950	3,289	$16,445	7,888	$39,440	15,622	$78,110
2.6	Supply and Place Protective Sand Layer (Provisional)	m3	20	3,146	$62,928	2,687	$53,748	4,314	$86,280	1,973	$39,468	4,733	$94,656	9,373	$187,464
2.7	Supply and Install GCL Liner (Provisional)	m2	15	5,244	$78,660	4,479	$67,185	7,190	$107,850	3,289	$49,335	7,888	$118,320	15,622	$234,330
	TOTAL PART B - LANDFILL CLOSURE SITE WORK				**$258,291**		**$220,611**		**$354,140**		**$161,998**		**$388,519**		**$769,454**
PART C - CONTINGENCY ALLOWANCE* **															
3.1	Project Contingency Allowance 25%	CA			$72,100		$62,700		$98,600		$45,500		$107,200		$212,400
	TOTAL PART D (a) - CONTINGENCY ALLOWANCE				**$72,100**		**$62,700**		**$98,600**		**$45,500**		**$107,200**		**$212,400**
BID SUMMARY															
Part A - General Requirements					$30,000		$30,000		$40,000		$20,000		$40,000		$80,000
Part B - Landfill Closure Site Work					$258,291		$220,611		$354,140		$161,998		$388,519		$769,454
Part C - Contingency Allowance***					$72,100		$62,700		$98,600		$45,500		$107,200		$212,400
TOTAL CONSTRUCTION OPC AMOUNT					**$360,400**		**$313,400**		**$492,800**		**$227,500**		**$535,800**		**$1,061,900**
Engineering Services															
Engineering Fees					**$36,040**		**$31,340**		**$49,280**		**$22,750**		**$53,580**		**$106,190**
Material Testing					**$18,020**		**$15,670**		**$24,640**		**$11,375**		**$26,790**		**$53,095**
					$54,060		**$47,010**		**$73,920**		**$34,125**		**$80,370**		**$159,285**
Recommended Budget					**$414,460**		**$360,410**		**$566,720**		**$261,625**		**$616,170**		**$1,221,185**

Table F-3
Future Cost Analysis - Option 1 Compacted Clay Liner

2024-04-26

				Funds Out			Funds In				
Year	Fill Volume (Increases 1% per year) m^3	Operational Cost per m^3 (Increases 3% per year)	Phased Closure and Post-Closure Costs (2023 dollars)	Operational Costs	Future Capital Cost (Closure + Operational Costs in Future year) [B]	Tipping Fee (Increases 3% per year) per m3	Funds from Tipping Fee	Interest	Total Funds + Interest [A]	Accumulated	Accumulative Cash Flow [Funds and Interest] -[B]
2023	1,210	$ 8.33		$ 10,083	$ 10,083	$ 17.96	$ 21,733	$ 726	$ 22,459		$ 553,851
2024	10,000	$ 8.58		$ 85,833	$ 85,833	$ 18.50	$ 185,002	$ 18,499	$ 225,960		$ 671,518
2025	10,000	$ 8.84		$ 88,408	$ 88,408	$ 19.06	$ 190,552	$ 22,429	$ 438,941		$ 796,091
2026	10,000	$ 9.11		$ 91,061	$ 91,061	$ 19.63	$ 196,269	$ 26,589	$ 661,799		$ 927,889
2027	10,000	$ 9.38		$ 93,792	$ 93,792	$ 20.22	$ 202,157	$ 30,991	$ 894,948		$ 1,067,245
2028	10,000	$ 9.66		$ 96,606	$ 96,606	$ 20.82	$ 208,222	$ 35,646	$ 1,138,815		$ 1,214,506
2029	10,000	$ 9.95	$ 309,695	$ 99,504	$ 469,296	$ 21.45	$ 214,468	$ 40,564	$ 1,393,848		$ 1,000,242
2030	10,000	$ 10.25		$ 102,489	$ 102,489	$ 22.09	$ 220,902	$ 33,408	$ 1,648,158		$ 1,152,063
2031	10,000	$ 10.56		$ 105,564	$ 105,564	$ 22.75	$ 227,529	$ 38,479	$ 1,914,167		$ 1,312,507
2032	10,000	$ 10.87		$ 108,731	$ 108,731	$ 23.44	$ 234,355	$ 43,838	$ 2,192,360		$ 1,481,969
2033	10,000	$ 11.20		$ 111,993	$ 111,993	$ 24.14	$ 241,386	$ 49,498	$ 2,483,243		$ 1,660,860
2034	10,000	$ 11.54	$ 268,755	$ 115,353	$ 487,373	$ 24.86	$ 248,627	$ 55,473	$ 2,787,343		$ 1,477,587
2035	10,000	$ 11.88		$ 118,813	$ 118,813	$ 25.61	$ 256,086	$ 49,351	$ 3,092,781		$ 1,664,212
2036	10,000	$ 12.24		$ 122,378	$ 122,378	$ 26.38	$ 263,769	$ 55,585	$ 3,412,135		$ 1,861,188
2037	10,000	$ 12.60		$ 126,049	$ 126,049	$ 27.17	$ 271,682	$ 62,164	$ 3,745,980		$ 2,068,984
2038	10,000	$ 12.98		$ 129,831	$ 129,831	$ 27.98	$ 279,832	$ 69,104	$ 4,094,917		$ 2,288,090
2039	10,000	$ 13.37	$ 428,260	$ 133,726	$ 820,957	$ 28.82	$ 288,227	$ 76,422	$ 4,459,566		$ 1,831,782
2040	10,000	$ 13.77		$ 137,737	$ 137,737	$ 29.69	$ 296,874	$ 61,182	$ 4,817,622		$ 2,052,101
2041	10,000	$ 14.19		$ 141,869	$ 141,869	$ 30.58	$ 305,780	$ 68,540	$ 5,191,943		$ 2,284,552
2042	10,000	$ 14.61		$ 146,126	$ 146,126	$ 31.50	$ 314,954	$ 76,304	$ 5,583,201		$ 2,529,684
2043	10,000	$ 15.05	$ 205,045	$ 150,509	$ 520,843	$ 32.44	$ 324,402	$ 84,491	$ 5,992,095		$ 2,417,735
2044	10,000	$ 15.50		$ 155,025	$ 155,025	$ 33.41	$ 334,135	$ 80,752	$ 6,406,981		$ 2,677,597
2045	10,000	$ 15.97		$ 159,675	$ 159,675	$ 34.42	$ 344,159	$ 89,432	$ 6,840,572		$ 2,951,512
2046	10,000	$ 16.45		$ 164,466	$ 164,466	$ 35.45	$ 354,483	$ 98,581	$ 7,293,636		$ 3,240,111
2047	10,000	$ 16.94		$ 169,400	$ 169,400	$ 36.51	$ 365,118	$ 108,220	$ 7,766,973		$ 3,544,049
2048	10,000	$ 17.45		$ 174,481	$ 174,481	$ 37.61	$ 376,071	$ 118,371	$ 8,261,416		$ 3,864,010
2049	10,000	$ 17.97	$ 465,635	$ 179,716	$ 1,183,900	$ 38.74	$ 387,354	$ 129,058	$ 8,777,827		$ 3,196,521
2050	10,000	$ 18.51		$ 185,107	$ 185,107	$ 39.90	$ 398,974	$ 106,764	$ 9,283,565		$ 3,517,151
2051	10,000	$ 19.07		$ 190,661	$ 190,661	$ 41.09	$ 410,943	$ 117,473	$ 9,811,981		$ 3,854,907
2052	10,000	$ 19.64		$ 196,380	$ 196,380	$ 42.33	$ 423,272	$ 128,754	$ 10,364,007		$ 4,210,552
2053	9,200	$ 20.23	$ 922,875	$ 186,090	$ 2,426,150	$ 43.60	$ 401,092	$ 140,632	$ 10,905,731		$ 2,326,127
2054		$ 20.83	$ 40,000	$ -	$ 100,003	$ 44.90	$ -	$ 77,693	$ 10,983,424		$ 2,303,816
2055		$ 21.46	$ 40,000	$ -	$ 103,003	$ 46.25	$ -	$ 76,947	$ 11,060,371		$ 2,277,760
2056		$ 22.10	$ 40,000	$ -	$ 106,093	$ 47.64	$ -	$ 76,077	$ 11,136,449		$ 2,247,744
2057		$ 22.77	$ 40,000	$ -	$ 109,276	$ 49.07	$ -	$ 75,075	$ 11,211,523		$ 2,213,542
2058		$ 23.45	$ 40,000	$ -	$ 112,554	$ 50.54	$ -	$ 73,932	$ 11,285,456		$ 2,174,920
2059		$ 24.15	$ 40,000	$ -	$ 115,931	$ 52.06	$ -	$ 72,642	$ 11,358,098		$ 2,131,631
2060		$ 24.88	$ 40,000	$ -	$ 119,409	$ 53.62	$ -	$ 71,196	$ 11,429,294		$ 2,083,419
2061		$ 25.62	$ 40,000	$ -	$ 122,991	$ 55.23	$ -	$ 69,586	$ 11,498,881		$ 2,030,014
2062		$ 26.39	$ 40,000	$ -	$ 126,681	$ 56.88	$ -	$ 67,802	$ 11,566,683		$ 1,971,135
2063		$ 27.18	$ 40,000	$ -	$ 130,482	$ 58.59	$ -	$ 65,836	$ 11,632,519		$ 1,906,489
2064		$ 28.00	$ 40,000	$ -	$ 134,396	$ 60.35	$ -	$ 63,677	$ 11,696,196		$ 1,835,770
2065		$ 28.84	$ 40,000	$ -	$ 138,428	$ 62.16	$ -	$ 61,315	$ 11,757,510		$ 1,758,657
2066		$ 29.70	$ 40,000	$ -	$ 142,581	$ 64.02	$ -	$ 58,739	$ 11,816,250		$ 1,674,816
2067		$ 30.60	$ 40,000	$ -	$ 146,858	$ 65.94	$ -	$ 55,939	$ 11,872,188		$ 1,583,896
2068		$ 31.51	$ 40,000	$ -	$ 151,264	$ 67.92	$ -	$ 52,902	$ 11,925,091		$ 1,485,535
2069		$ 32.46	$ 40,000	$ -	$ 155,802	$ 69.96	$ -	$ 49,617	$ 11,974,707		$ 1,379,350
2070		$ 33.43	$ 40,000	$ -	$ 160,476	$ 72.06	$ -	$ 46,070	$ 12,020,778		$ 1,264,944
2071		$ 34.44	$ 40,000	$ -	$ 165,290	$ 74.22	$ -	$ 42,249	$ 12,063,027		$ 1,141,903
2072		$ 35.47	$ 40,000	$ -	$ 170,249	$ 76.45	$ -	$ 38,140	$ 12,101,166		$ 1,009,794
2073		$ 36.53	$ 40,000	$ -	$ 175,356	$ 78.74	$ -	$ 33,727	$ 12,134,894		$ 868,165
2074		$ 37.63	$ 40,000	$ -	$ 180,617	$ 81.10	$ -	$ 28,997	$ 12,163,890		$ 716,545
2075		$ 38.76	$ 40,000	$ -	$ 186,035	$ 83.54	$ -	$ 23,933	$ 12,187,823		$ 554,442
2076		$ 39.92	$ 40,000	$ -	$ 191,616	$ 86.04	$ -	$ 18,518	$ 12,206,341		$ 381,344
2077		$ 41.12	$ 40,000	$ -	$ 197,365	$ 88.62	$ -	$ 12,737	$ 12,219,078		$ 196,716
2078		$ 42.35	$ 40,000	$ -	$ 203,286	$ 91.28	$ -	$ 6,570	$ 12,225,648		$ (0)

Future Cost Analysis:

First year in analysis =	2,023
Inflation rate =	3.00%
Interest rate =	3.34%

Landfill Inputs

2023 reserve funds	$ 541,475
Average fill volume (2017-2022) (m^3) =	6,875
Operational cost (from City) =	$ 125,000
For a fill volume of (m^3) =	15,000
Operational cost per m^3 =	$ 8.33

NOTE
*Environmental monitoring is included in Post-Closure
Canadian Bond Yield Rates 10yr Bond - 3.34% - Bank of Canada (https://www.bankofcanada.ca/rates/interest-rates/canadian-bonds/)

Table F-4
Future Cost Analysis - Option 2 Geocomposite Liner

				Funds Out			Funds In				
Year	Fill Volume (Increases 1% per year) m^3	Operational Cost per m^3 (Increases 3% per year)	Phased Closure and Post-Closure Costs (2023 dollars)	Operational Costs	Future Capital Cost (Closure + Operational Costs in Future year) [B]	Tipping Fee (Increases 3% per year) per m3	Funds from Tipping Fee	Interest	Total Funds + Interest [A]	Accumulated	Accumulative Cash Flow [Funds and Interest] -[B]
2023	1,210	$ 8.33		$ 10,083	$ 10,083	$ 20.70	$ 25,053	$ 837	$ 25,890		$ 557,281
2024	10,000	$ 8.58		$ 85,833	$ 85,833	$ 21.33	$ 213,260	$ 18,613	$ 257,763		$ 703,322
2025	10,000	$ 8.84		$ 88,408	$ 88,408	$ 21.97	$ 219,658	$ 23,491	$ 500,912		$ 858,062
2026	10,000	$ 9.11		$ 91,061	$ 91,061	$ 22.62	$ 226,248	$ 28,659	$ 755,820		$ 1,021,909
2027	10,000	$ 9.38		$ 93,792	$ 93,792	$ 23.30	$ 233,035	$ 34,132	$ 1,022,987		$ 1,195,284
2028	10,000	$ 9.66		$ 96,606	$ 96,606	$ 24.00	$ 240,026	$ 39,922	$ 1,302,935		$ 1,378,626
2029	10,000	$ 9.95	$ 414,460	$ 99,504	$ 594,391	$ 24.72	$ 247,227	$ 46,046	$ 1,596,209		$ 1,077,508
2030	10,000	$ 10.25		$ 102,489	$ 102,489	$ 25.46	$ 254,644	$ 35,989	$ 1,886,842		$ 1,265,652
2031	10,000	$ 10.56		$ 105,564	$ 105,564	$ 26.23	$ 262,283	$ 42,273	$ 2,191,398		$ 1,464,644
2032	10,000	$ 10.87		$ 108,731	$ 108,731	$ 27.02	$ 270,152	$ 48,919	$ 2,510,469		$ 1,674,983
2033	10,000	$ 11.20		$ 111,993	$ 111,993	$ 27.83	$ 278,256	$ 55,944	$ 2,844,669		$ 1,897,191
2034	10,000	$ 11.54	$ 360,410	$ 115,353	$ 614,245	$ 28.66	$ 286,604	$ 63,366	$ 3,194,640		$ 1,632,917
2035	10,000	$ 11.88		$ 118,813	$ 118,813	$ 29.52	$ 295,202	$ 54,539	$ 3,544,381		$ 1,863,845
2036	10,000	$ 12.24		$ 122,378	$ 122,378	$ 30.41	$ 304,058	$ 62,252	$ 3,910,692		$ 2,107,778
2037	10,000	$ 12.60		$ 126,049	$ 126,049	$ 31.32	$ 313,180	$ 70,400	$ 4,294,272		$ 2,365,309
2038	10,000	$ 12.98		$ 129,831	$ 129,831	$ 32.26	$ 322,575	$ 79,001	$ 4,695,849		$ 2,637,055
2039	10,000	$ 13.37	$ 566,720	$ 133,726	$ 1,043,145	$ 33.23	$ 332,253	$ 88,078	$ 5,116,179		$ 2,014,240
2040	10,000	$ 13.77		$ 137,737	$ 137,737	$ 34.22	$ 342,220	$ 67,276	$ 5,525,675		$ 2,285,999
2041	10,000	$ 14.19		$ 141,869	$ 141,869	$ 35.25	$ 352,487	$ 76,352	$ 5,954,514		$ 2,572,969
2042	10,000	$ 14.61		$ 146,126	$ 146,126	$ 36.31	$ 363,061	$ 85,937	$ 6,403,513		$ 2,875,842
2043	10,000	$ 15.05	$ 261,625	$ 150,509	$ 623,033	$ 37.40	$ 373,953	$ 96,053	$ 6,873,519		$ 2,722,815
2044	10,000	$ 15.50		$ 155,025	$ 155,025	$ 38.52	$ 385,172	$ 90,942	$ 7,349,633		$ 3,043,904
2045	10,000	$ 15.97		$ 159,675	$ 159,675	$ 39.67	$ 396,727	$ 101,666	$ 7,848,026		$ 3,382,623
2046	10,000	$ 16.45		$ 164,466	$ 164,466	$ 40.86	$ 408,629	$ 112,980	$ 8,369,635		$ 3,739,766
2047	10,000	$ 16.94		$ 169,400	$ 169,400	$ 42.09	$ 420,888	$ 124,908	$ 8,915,431		$ 4,116,162
2048	10,000	$ 17.45		$ 174,481	$ 174,481	$ 43.35	$ 433,514	$ 137,480	$ 9,486,425		$ 4,512,675
2049	10,000	$ 17.97	$ 616,170	$ 179,716	$ 1,508,543	$ 44.65	$ 446,520	$ 150,723	$ 10,083,668		$ 3,601,375
2050	10,000	$ 18.51		$ 185,107	$ 185,107	$ 45.99	$ 459,915	$ 120,286	$ 10,663,869		$ 3,996,469
2051	10,000	$ 19.07		$ 190,661	$ 190,661	$ 47.37	$ 473,713	$ 133,482	$ 11,271,064		$ 4,413,003
2052	10,000	$ 19.64		$ 196,380	$ 196,380	$ 48.79	$ 487,924	$ 147,394	$ 11,906,383		$ 4,851,941
2053	9,200	$ 20.23	$ 1,221,185	$ 186,090	$ 3,150,227	$ 50.26	$ 462,357	$ 162,055	$ 12,530,795		$ 2,326,127
2054		$ 20.83	$ 40,000	$ -	$ 100,003	$ 51.76	$ -	$ 77,693	$ 12,608,487		$ 2,303,816
2055		$ 21.46	$ 40,000	$ -	$ 103,003	$ 53.32	$ -	$ 76,947	$ 12,685,435		$ 2,277,760
2056		$ 22.10	$ 40,000	$ -	$ 106,093	$ 54.92	$ -	$ 76,077	$ 12,761,512		$ 2,247,744
2057		$ 22.77	$ 40,000	$ -	$ 109,276	$ 56.56	$ -	$ 75,075	$ 12,836,587		$ 2,213,542
2058		$ 23.45	$ 40,000	$ -	$ 112,554	$ 58.26	$ -	$ 73,932	$ 12,910,519		$ 2,174,920
2059		$ 24.15	$ 40,000	$ -	$ 115,931	$ 60.01	$ -	$ 72,642	$ 12,983,161		$ 2,131,631
2060		$ 24.88	$ 40,000	$ -	$ 119,409	$ 61.81	$ -	$ 71,196	$ 13,054,358		$ 2,083,419
2061		$ 25.62	$ 40,000	$ -	$ 122,991	$ 63.66	$ -	$ 69,586	$ 13,123,944		$ 2,030,014
2062		$ 26.39	$ 40,000	$ -	$ 126,681	$ 65.57	$ -	$ 67,802	$ 13,191,746		$ 1,971,135
2063		$ 27.18	$ 40,000	$ -	$ 130,482	$ 67.54	$ -	$ 65,836	$ 13,257,582		$ 1,906,489
2064		$ 28.00	$ 40,000	$ -	$ 134,396	$ 69.57	$ -	$ 63,677	$ 13,321,259		$ 1,835,770
2065		$ 28.84	$ 40,000	$ -	$ 138,428	$ 71.65	$ -	$ 61,315	$ 13,382,574		$ 1,758,657
2066		$ 29.70	$ 40,000	$ -	$ 142,581	$ 73.80	$ -	$ 58,739	$ 13,441,313		$ 1,674,816
2067		$ 30.60	$ 40,000	$ -	$ 146,858	$ 76.02	$ -	$ 55,939	$ 13,497,252		$ 1,583,896
2068		$ 31.51	$ 40,000	$ -	$ 151,264	$ 78.30	$ -	$ 52,902	$ 13,550,154		$ 1,485,535
2069		$ 32.46	$ 40,000	$ -	$ 155,802	$ 80.65	$ -	$ 49,617	$ 13,599,771		$ 1,379,350
2070		$ 33.43	$ 40,000	$ -	$ 160,476	$ 83.07	$ -	$ 46,070	$ 13,645,841		$ 1,264,944
2071		$ 34.44	$ 40,000	$ -	$ 165,290	$ 85.56	$ -	$ 42,249	$ 13,688,090		$ 1,141,903
2072		$ 35.47	$ 40,000	$ -	$ 170,249	$ 88.12	$ -	$ 38,140	$ 13,726,230		$ 1,009,794
2073		$ 36.53	$ 40,000	$ -	$ 175,356	$ 90.77	$ -	$ 33,727	$ 13,759,957		$ 868,165
2074		$ 37.63	$ 40,000	$ -	$ 180,617	$ 93.49	$ -	$ 28,997	$ 13,788,954		$ 716,545
2075		$ 38.76	$ 40,000	$ -	$ 186,035	$ 96.30	$ -	$ 23,933	$ 13,812,886		$ 554,442
2076		$ 39.92	$ 40,000	$ -	$ 191,616	$ 99.18	$ -	$ 18,518	$ 13,831,405		$ 381,344
2077		$ 41.12	$ 40,000	$ -	$ 197,365	$ 102.16	$ -	$ 12,737	$ 13,844,141		$ 196,716
2078		$ 42.35	$ 40,000	$ -	$ 203,286	$ 105.23	$ -	$ 6,570	$ 13,850,712		$ (0)

Future Cost Analysis:

First year in analysis =	2,023
Inflation rate =	3.00%
Interest rate =	3.34%

Landfill Inputs

2023 reserve funds	$	541,475
Average fill volume (2017-2022) (m^3) =		6,875
Operational cost (from City) =	$	125,000
For a fill volume of (m^3) =		15,000
Operational cost per m^3 =	$	8.33

NOTE
*Environmental Monitoring is included in Post-Closure
Canadian Bond Yield Rates 10yr Bond - 3.34% - Bank of Canada (https://www.bankofcanada.ca/rates/interest-rates/canadian-bonds/)