Supporting Document 2

Conceptual Design Report

Eastern Ontario Waste Handling Facility Future Development Environmental Assessment

GFL Environmental Inc.

Moose Creek, Ontario

May 26, 2023

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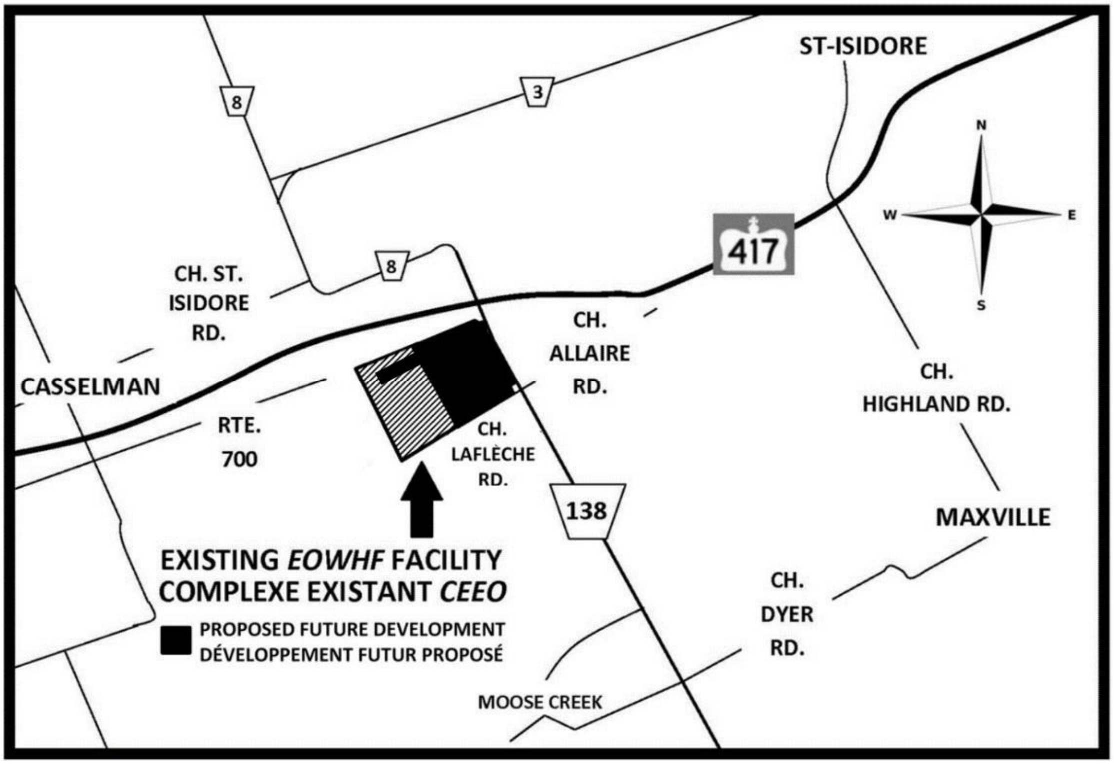
1. Introduction

1.1 Background

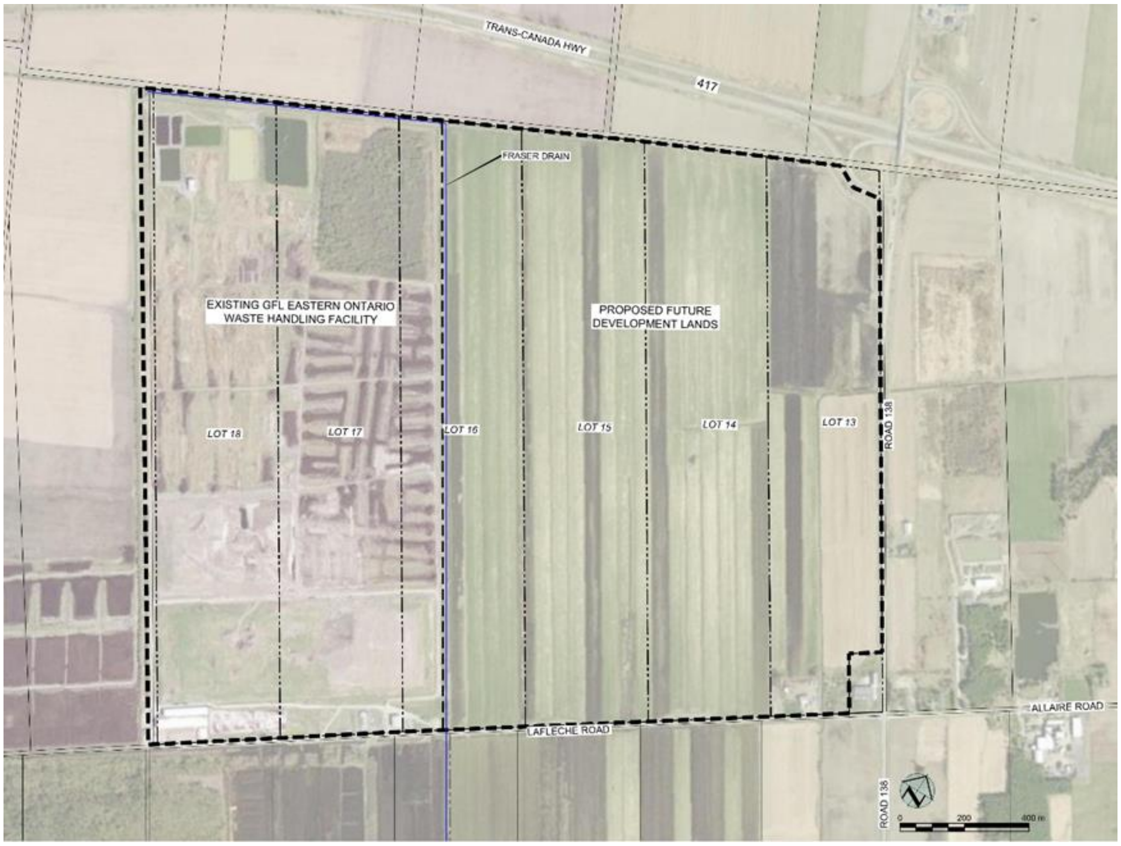
GFL Environmental Inc. (GFL) is undertaking an Environmental Assessment (EA) for the future development of its Eastern Ontario Waste Handling Facility (EOWHF). The purpose of the proposed undertaking is to provide approximately 15.1 million cubic metres (m^3) of additional landfill disposal capacity at the existing EOWHF over a 20-year planning period, with operations anticipated to begin in 2025 and closure anticipated in 2045. The EOWHF is located within the Township of North Stormont, approximately 5 kilometres north-northwest of the village of Moose Creek, Ontario, and 5 kilometres east of the village of Casselman, Ontario (**Figure 1-1**).

Figure 1-1. Location of the EOWHF



The existing EOWHF is located on the western half of Lot 16 and Lots 17 and 18, Concession 10, Township of North Stormont, within the United Counties of Stormont, Dundas and Glengarry, near the intersection of Highway 417 and Highway 138. The municipal street address for the facility is 17125 Laflèche Road, Moose Creek, Ontario. The lands being considered for the future development include a small portion of Lot 17 north of and adjacent to the existing landfill, and the eastern half of Lot 16, Lots 14 and 15, and the majority of Lot 13 of Concession 10 which are to the east of the existing landfill. The future development lands are shown on **Figure 1-2**.

Figure 1-2. Proposed Future Development Lands



GFL has undertaken and received approval for the EA Terms of Reference (ToR) for the proposed future development of the EOWHF[1]. The following two alternative methods for the future development were identified in the ToR:

- Alternative Method 1: The development of four stages oriented east-west, similar to the existing stages at the EOWHF landfill, and one stage in the northeast corner of the existing EOWHF. It is noted that the ToR references three east-west stages; however, this alternative method was refined to four stages through the conceptual design process.
- Alternative Method 2: The development of three stages oriented north-south, perpendicular to the existing stages at the EOWHF landfill, and one stage in the northeast corner of the existing EOWHF.

The conceptual designs for the two alternative methods each provide 15.1 million m³ of landfill disposal capacity and differ primarily in their geometry and footprint. The disposal capacity for both alternatives will be consumed at a rate of approximately 755,000 m³ per year over the 20-year planning period. Approximately 755,000 m³ of landfill capacity corresponds to 755,000 tonnes (t) of received waste.

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[1] HDR Corporation. 2020. Terms of Reference, Eastern Ontario Waste Handling Facility Future Development Environmental Assessment, GFL Environmental Inc., Moose Creek, Ontario. September 11, 2020.

The same design concepts have been applied to both alternative methods including base liner, leachate and landfill gas collection, stormwater management system, and final cover. The conceptual designs were developed according to Ontario Regulation 232/98 (O. Reg. 232/98) and are consistent with the Ministry of Environment, Conservation and Parks (MECP) landfill standards[2]. The proposed designs are site-specific designs that meet or exceed the requirements of O. Reg. 232/98.

1.2 Objectives

This Conceptual Design Report presents the conceptual design and operations for the two future development alternative methods identified in the ToR. Its purpose is to provide details to enable each environmental discipline to assess the potential environmental effects of the two alternative methods and to form the basis of their comparison. The aspects of the design and operations of the future development include:

- geometry of the landfill envelopes (e.g., location, orientation, volume);
- key design features of the landfill;
- buffer zones around the waste footprint;
- sequence of landfill development and construction activities;
- leachate generation, management, and treatment;
- landfill gas generation, management, and treatment;
- stormwater management;
- ancillary facilities;
- traffic management; and
- landfill operations.

A discussion is also provided for the effects of climate change on the project and the effects of the project on climate change.

Upon selection of a preferred alternative method for the future development, and completion of the EA, GFL will proceed to develop the detailed design for the selective alternative method. It is understood that the concepts presented in this report will be refined during detailed design.

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[2] MECP. 2012. Landfill Standards: A Guideline on the Regulatory and Approval Requirements for New or Expanding Landfilling Sites. January, 2012.

2. Conceptual Design of Alternative Method 1

2.1 Overview

Alternative Method 1 consists of implementing the future development through five stages: one stage adjacent to and north of the existing landfill (Stage 5[3]); and four stages oriented east-west within the future development lands (Stages 6 through 9). Stages 6 through 8 will be identical in size, while Stages 5 and 9 will be smaller. Stage 9 is located north of Stage 8 and to the east of the stormwater pond. The layout for Alternative Method 1 is shown on **Figure 2-1**. The design of these stages will be consistent with the existing landfill design including:

- Base excavation into native soils (e.g., into natural low permeability barrier).
- Construction of perimeter berms around each stage utilizing either existing low-permeability soils, or compacted soils overlain by a geosynthetic clay liner (GCL) keyed into native soils at the inside toe of the berm.
- Leachate collection system (LCS) consisting of granular layers and a piping network with collected leachate conveyed to leachate aeration ponds located in the southeast portion of the existing landfill and then to a leachate treatment plant located north of the existing landfill. The capacity of the leachate treatment plant will be expanded to accept leachate generated from the existing landfill as well as from the future development.
- Final contours reflecting a 4H to 1V slope at the perimeter of the stage transitioning to an approximately 3% slope on the top of the stage.
- Low permeability final cover consisting of a soil/geomembrane composite.
- Landfill gas (LFG) collection system consisting of vertical extraction wells and lateral and header piping within the waste. Collected LFG will be conveyed to the existing LFG plant located south of Stage 1 and which includes internal combustion reciprocating engines which generate electricity as well as enclosed LFG flares. LFG condensate will be re-introduced into the waste or conveyed to the leachate treatment plant.
- Stormwater management system consisting of conveyance ditches around the perimeter of each stage and a retention pond located northwest portion of Stage 8. The existing pond located northeast of Stage 5 will be modified to attenuate peak flows if required.

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[3] The current EOWHF comprises Stages 1 through 4.

Figure 2-1. Alternative Method 1

ISSUE	DATE	DESCRIPTION
I	2022-08-25	ISSUED FOR CDR
H	2022-06-02	ISSUED FOR REVIEW
G	2022-05-13	ISSUED FOR REVIEW
F	2022-03-04	ISSUED FOR REVIEW
E	2021-11-17	ISSUED FOR REVIEW
D	2021-08-09	ISSUED FOR REVIEW
C	2021-06-29	ISSUED FOR REVIEW
B	2021-06-15	ISSUED FOR REVIEW
A	2021-03-24	DRAFT FOR DISCUSSION

DESIGN	AJC
DRAWN	AJC
CHECKED	MS
APPROVED	LF
PROJECT NUMBER	10287067

Other key design features include:

- Visual screening to be constructed along the north and east perimeters and a portion of the south perimeter consisting of earthen berms and/or vegetation plantings.
- New road entrance from Laflèche Road, including new scale facility with three 26 m long scales.
- Soil storage pad adjacent to the new scale facility and to the north of Stage 9.
- Internal road network permitting access to the new stages.

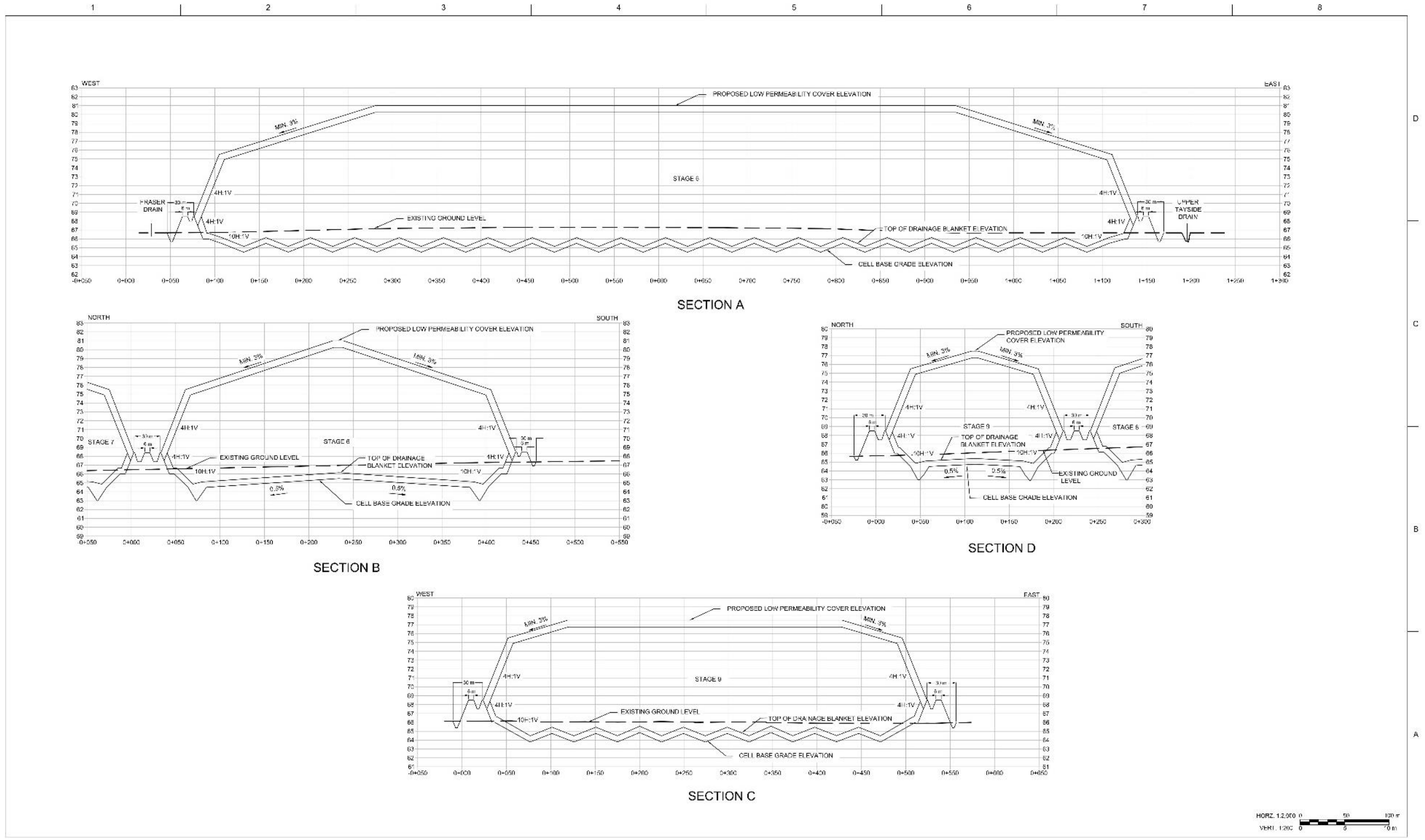
2.2 Landfill Design and Geometry

The geometry of Alternative Method 1 is shown in plan view on **Figure 2-1** and in cross-section on **Figure 2-2** and **Figure 2-3**. This alternative method consists of five stages with 34 cells as shown in **Table 2-1**. The areas and volumes of the Stages and Cells shown in **Table 2-1** are approximate and will be confirmed through detailed design. However, the total landfill volume of Alternative Method 1 will remain at 15,100,000 m^3.

Table 2-1. Stage Areas and Volumes Alternative Method 1

Stage/Cell	Area (m^2)	Volume (m^3)
Stage 5 (CELLS 1 and 2)	102,948	755,000
Stage 6 (CELLS 1 and 2)	92,400	898,172
Stage 6 (CELLS 3 and 4)	80,065	899,764
Stage 6 (CELLS 5 and 6)	80,065	899,764
Stage 6 (CELLS 7 and 8)	80,065	899,764
Stage 6 (CELLS 9 and 10)	92,381	898,172
Stage 7 (CELLS 1 and 2)	92,400	898,172
Stage 7 (CELLS 3 and 4)	80,065	899,764
Stage 7 (CELLS 5 and 6)	80,065	899,764
Stage 7 (CELLS 7 and 8)	80,065	899,764
Stage 7 (CELLS 9 and 10)	92,381	898,172
Stage 8 (CELLS 1 and 2)	92,400	898,172
Stage 8 (CELLS 3 and 4)	80,065	899,764
Stage 8 (CELLS 5 and 6)	80,065	899,764
Stage 8 (CELLS 7 and 8)	80,065	899,764
Stage 8 (CELLS 9 and 10)	92,381	898,172
Stage 9 (CELLS 1 and 2)	100,020	858,095
TOTAL	**1,477,896**	**15,100,000**

Figure 2-2. Alternative Method 1 Cross-Sections



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Canada

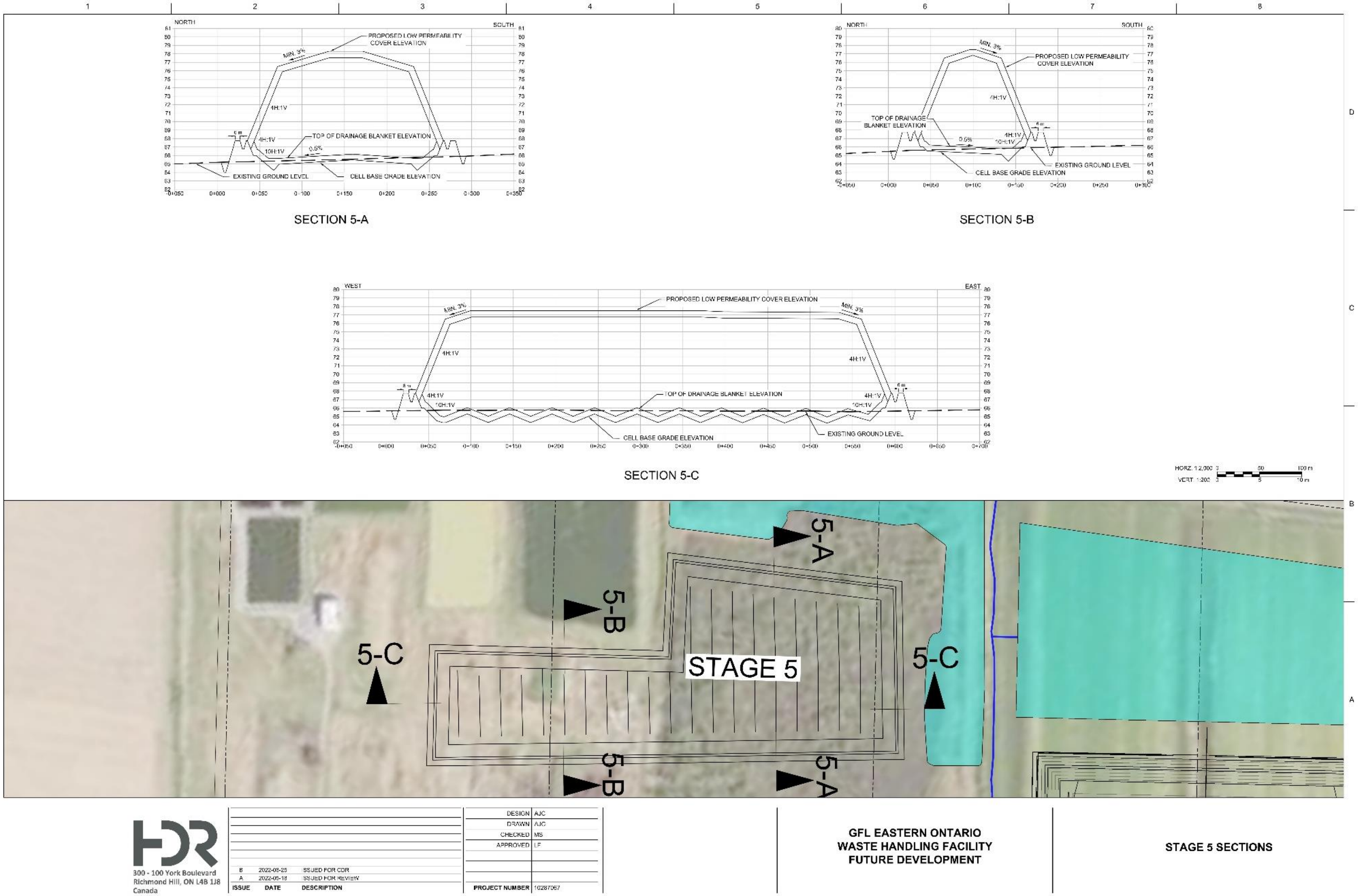
ISSUE	DATE	DESCRIPTION
B	2022-08-25	ISSUED FOR CDR
A	2022-03-04	ISSUED FOR REVIEW

	AJC
DESIGN	AJC
DRAWN	MS
CHECKED	LF
APPROVED	
PROJECT NUMBER	10287067

**GFL EASTERN ONTARIO
WASTE HANDLING FACILITY
FUTURE DEVELOPMENT**

**ALTERNATIVE METHOD 1
SECTIONS**

Figure 2-3. Cross-Sections for Stage 5



As shown on **Figure 2-1**, the maximum elevation of the top of final cover will range as follows:

- Stage 5: 78.5 metres above sea level (masl).
- Stages 6 through 8: 81.0 masl.
- Stage 9: 77.5 masl.

The subsurface soil conditions in the proposed landfill future development area consist of very soft to soft silty clay, underlain by very loose to very dense sand and gravel till, underlain by shale and limestone bedrock. The silty clay will undergo consolidation settlement as a result of loading from the waste. It is also classified as a sensitive clay and is subject to softening when exposed to excess moisture or disturbance. The upper 0.2 m to 2.0 m of the silty clay has a desiccated zone that withstands disturbance more than the underlying non-desiccated material.

The depth to bedrock is typically 15 m or greater throughout the future development area, with the exception of the southeast corner of the site where depth to bedrock is approximately 5 m. This shallow bedrock depth occurs close to the eastern limit of Stage 6 and further investigation of bedrock depth in this area is warranted during detailed design.

The proposed design is a natural containment landfill that utilizes the existing in situ low permeability silty clay as a hydraulic barrier layer with performance criteria equivalent to or exceeding a generic composite liner system. This will be overlain by an LCS, which consists of a leachate collection blanket of coarse stones (incorporating a leachate piping network) overlain by a protective layer of finer granular material acting as a filter, consistent with the design criteria set out in O. Reg. 232/98, Schedule 1.

The conceptual cell base grade elevations have been based on the interpreted contours for the bottom of the desiccated zone within the silty clay while also maintaining sufficient slope to facilitate leachate drainage to the LCS and reduce the head of leachate on the base of the cells. The depth of the conceptual base grade will vary between about 63.5 to 65.5 masl, which can be several metres below existing grade.

The base in each of Stages 6 through 9 will be excavated to form an east-west oriented central ridge with an approximately 0.6% slope away from the central ridge towards both the south and north perimeters of the stage. As well, the base will be excavated to form a series of smaller ridges and valleys such that a steeper slope (e.g., about 4%) will exist toward LCS piping within each valley.

The maximum width of the new stages (Stages 6 through 8) will be 400 m, which is consistent with the maximum stage width developed in the existing landfill. A compacted earthen berm with 4H to 1V slopes will be constructed around the perimeter of each stage utilizing either existing low-permeability soils, or compacted soils overlain by a geosynthetic clay liner (GCL) keyed into native soils at the inside toe of the berm. The berm will be approximately 33 m in width and constructed to an elevation of between 64.5 to 68.5 masl.

Slope stability analyses were carried out as part of conceptual design and the analyses are presented in **Appendix A**. The results indicate that the external landfill slopes will be stable under static and seismic conditions, and that the proposed internal slope geometry of 4 horizontal to 1 vertical is feasible provided that a stability berm is constructed along the inside base of the landfill stage to increase passive resistance to slope movement. A stability berm has been accounted for in the volumetric design of the landfill. The geometry and extent of the stability berms throughout the landfill future development area will be refined and confirmed during detailed design.

2.3 Buffer Zones

Alternative Method 1 will provide the following minimum buffer widths between the limits of waste placement and property boundaries:

- North limit Stage 5 to north property boundary: 158 m.
- North limit of Stage 9 to north property boundary: 145 m.
- East limit of Stages 7 through 9 to east property boundary: 242 m.
- South limit of Stage 6 to south property boundary: 100 m.

2.4 Site Development

2.4.1 Phasing and Schedule of Site Development

For the purposes of the EA, it was assumed that landfilling will commence in Stage 5 with filling progressing from east to west and, upon completion of Stage 5, filling would progress to each of Stages 6 through 9 moving from west to east within each stage. The planned landfilling sequence may be modified by GFL prior to or during implementation of the future development.

The landfill future development will be filled over a period of 20 years. GFL anticipates that, as the landfill is developed, a maximum of up to two cells will be active in any given year (e.g., landfilling will occur within an area of between 8 to 10 ha), and that similar area would be inactive (e.g., some waste placed, with a soil intermediate cover). The maximum combined area of active landfill and intermediate covered landfill in any given year will be up to approximately 17.4 ha, with the remaining site area closed with final cover after the waste fill reaches the final contours.

2.4.2 Construction Activities

Preparation of cells for landfilling will include the following activities:

- Construction of temporary ditching to limit stormwater entry into excavations and to allow for dry working conditions. Temporary ditches will drain into drainage features that will be constructed according to the stormwater management design.
- Excavation to the cell base grades. Excavation will be undertaken with methods to minimize disturbance and excess moisture on the silty clay including:
    - Sequencing of excavation to utilize the desiccated zone at the top of the clay layer as a construction platform and limiting construction traffic to the degree possible.

  - Use of smooth-edged buckets to minimize disturbance of the clay subgrade.
  - Sequencing of excavation so that construction traffic over the exposed clay subgrade surface is limited to the degree possible (e.g., where desiccated zone layer has been removed from the top of the silty clay).
  - Minimizing time that clay subgrades are left exposed (e.g., coordination of excavation to design depths with inspection and subsequent placement of the leachate drainage blanket following as soon as possible).
  - Use of dewatering methods to create and maintain dry working conditions (e.g., temporary sumps and pumps).
  - Construction of a temporary work platform where required when excavation has been advanced into the soft silty clay (e.g., following advancement of excavation to the required depth, placement of a woven geotextile on the clay surface followed by 300 to 600 mm of compacted granular).
- Construction of the LCS within the excavated landfill cell area.
- Construction of temporary separation berms at the LCS edge that will divert surface water away from the waste placement operations within the open landfill cell.
- Construction of berms around the perimeter of the stage.

Prior to commencement of landfilling in Stage 6 (e.g., the first landfill stage planned to be developed within the future development lands), the new site access will be constructed as shown on **Figure 2-1**.

Landfill development will be transitioned from cell to cell in the following order:

- Construction of the next landfill cell according to the activities listed above.
- Construction and installation of the LCS piping and granular drainage blanket in the new cell. This will include connection of leachate collection and header piping between the current and new cell, and removal of portions of the temporary berms between the cells to facilitate LCS piping connections.
- Removal of the remaining interior berms to recover airspace.

Once two cells have reached the limits of their final waste contours, and their respective landfill LFG collection system has been installed, the final cover will be constructed. Final cover will be placed at the earliest possibility to minimize fugitive LFG emissions and minimize infiltration of precipitation, which in turn will reduce leachate generation.

2.5 Leachate Management

2.5.1 Leachate Generation

A leachate generation assessment was undertaken in order to evaluate leachate production at varying stages of development throughout the life of the future development. The evaluation was carried out using the Hydrologic Evaluation of Landfill Performance Model (HELP, Version 4.0). The HELP model is a quasi-two-dimensional computer program used to estimate water balances within a landfill. The primary purpose of the analysis is to evaluate the leachate generation of the site in order to ensure leachate treatment capacity is not exceeded. A summary of the leachate generation assessment is provided herein, and detailed results are provided in **Appendix B**.

Leachate generation was estimated on a per hectare basis for four different conditions that will exist during the life of the future development, as follows:

- Open cell conditions (i.e., all precipitation is considered leachate), representing leachate generation at the construction of a new cell and initial placement of waste (3,956.3 m^3/ha).
- Intermediate cover over 5 m of waste, representing leachate generation in an area where there is approximately 5 m of waste in place covered by 30 cm of intermediate soil cover (2,146.6 m^3/ha).
- Intermediate cover over 10 m of waste, representing leachate generation in an area where there is approximately 10 m of waste in place covered by 30 cm of intermediate soil cover (2,146.7 m^3/ha).
- Final cover conditions, representing leachate generation in an area where waste has been placed to final waste grades and the composite soil/geomembrane final cover has been constructed (419.5 m^3/ha).

The future development will occur over a 20-year period and GFL proposes that operations in the future development area will be similar to Stage 4 at the existing landfill. This reflects that, in a given year:

- four cells (approximately 17.4 ha) would be active.
- two of the four active cells would be in an open cell condition (e.g., active landfilling).
- two of the four cells will be in an intermediate cover condition; however, GFL has indicated that stormwater runoff is not released from the intermediate covered cells. As such, these cells were assumed to be equivalent to the open cell condition for the purpose of estimating leachate generation.
- The remainder of developed area under final cover conditions.

On this basis, the maximum leachate generation for Alternative Method 1 is estimated to occur in approximately Year 19 when 17.4 ha are active (entire area modelled as an open cell condition), and 130.4 ha is in a final covered condition, corresponding to between 131,000 m^3 and 141,000 m^3 of leachate.

The potential effect that climate change may have on leachate generation has been considered in Section 4. Projections of potential precipitation and temperature changes for different parts of Ontario are presented in a 2015 report prepared by the Ontario Ministry of Natural Resources and Forestry[4]. Projections are provided under various emission scenarios (termed 'representative concentration pathways' or RCPs). Under the highest scenario presented (RCP 8.5), average annual precipitation in the Ottawa River Basin could increase by 56 mm/yr over the period from 2011 to 2040, with a maximum

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[4] McDermid, J., S. Fera and A. Hogg. 2015. Climate change projections for Ontario: An updated synthesis for policymakers and planners. Ontario Ministry of Natural Resources and Forestry, Science and Research Branch, Peterborough, Ontario. Climate Change Research Report CCRR-44.

projected increase of 128 mm/yr over the same period. This range represents an increase of approximately 6% to 14% over the annual average precipitation used in the HELP model. A conservative assumption is that maximum leachate generation could increase by the same amount to a range of 131,000 m³/yr to 141,000 m³/yr.

2.5.2 Leachate Treatment

Leachate collected in the future development landfill LCS will be conveyed via a newly constructed forcemain to the existing leachate aeration ponds located in the southern portion of the existing landfill and subsequently to the on-site treatment plant and managed as per current practices. The leachate treatment plant includes two holding/pre-treatment ponds, three suspended media biological reactors (SMBRs), a coagulation/flocculation tank, a dissolved air flotation device, and a tertiary filtration system. Currently the plant is permitted to treat 200,000 m³ of leachate per year and in 2021 approximately 175,285 m³ of leachate was treated. Upon full closure of the existing landfill, it is estimated that the existing landfill will generate approximately 130,000 m³ to 145,000 m³ of leachate per year. The maximum leachate generation annually is estimated to be 286,000 m³, and declining in subsequent years after closure. This maximum leachate generation will occur in a single year during Year 19 of the future development (i.e., the leachate generation volume will be less for every other year of operation).

Planned upgrades are anticipated to increase the capacity of the leachate treatment plant to 304,000 m³/year so the projected volume of leachate from the future development can be managed. Based on leachate generation projections and planned upgrades to the leachate treatment plant, it is anticipated that the upgraded plant will have the capacity to treat all leachate from the existing landfill and the future development.

Condition 36.3 of ECA No. A420018 includes an approved contingency for leachate management at the existing landfill comprising the removal of leachate for treatment at an off-site wastewater treatment facility. This contingency will be maintained for the future development.

2.6 Landfill Gas Management

2.6.1 Landfill Gas Generation

An assessment was undertaken to evaluate LFG production at varying stages of the future development. The analysis was based on the EPA LandGEM model (version 3.02) which is built upon a first-order decay rate equation that requires inputs including total waste mass, the type and composition of waste placed in the landfill, and moisture in the waste. The primary purpose of the evaluation is to ensure that LFG treatment capacity is not exceeded. A summary of the LFG generation assessment is provided in the following sections and details are provided in **Appendix C**.

Waste Data

Annual waste placement used for the model was the approved maximum receipt of 755,000 tonnes per year starting in 2026 (first full year of receipt of 755,000 tonnes) and remaining constant through the end of 2045 (final year of operation). Composition of the waste is assumed to be similar to the average waste composition being handled at the existing landfill[5] with the following composition by weight: 2.7% construction and demolition (C&D); 48.1% institutional, commercial, and light industrial (ICI); 28.7% municipal solid waste (MSW); 0% specified risk material (SRM); and 20.5% cover soils.

Based on the large number of waste generators that utilize the landfill and waste sources, the composition of waste received at the landfill can be highly variable and is not homogeneous. As noted, the landfill's waste is received from a wide range of sources and generators across Eastern Ontario. As a result, more detailed waste composition data reflective of the EOWHF is not available. The province's proposed ban on landfilling of organics by 2030 has the potential to change waste composition in the future.

Since cover soils will not degrade and contribute to LFG generation, a disposal rate of 600,225 t/yr was used to determine the annual degradable waste placement for input into the LandGEM model.

Methane Generation

The Methane Generation Rate, k, determines the rate of methane generation for a unit mass of waste in the landfill and is highly dependent upon moisture in the waste mass. Per EPA's LandGEM model guidelines, arid landfills are sites located in areas that receive an average of less than 635 mm (25 inches) of rainfall per year. A review of the climate normals data from the Cornwall, Ontario station[6] indicates that the actual rainfall values are significantly higher at approximately 1,011 mm (39.8 inches) per year. Therefore, a k value of 0.05 $year^{-1}$ was chosen for the model, which represents the US Clean Air Act (CAA) Conventional default value.

The potential Methane Generation Capacity, L_o, depends on the type and composition of waste placed in the landfill and the higher the cellulose content of the waste, the higher the value of L_o. The default L_o values used by LandGEM are generally representative of MSW, but site-specific data can be used when available. Based on historical knowledge of the waste composition received at the EOWHF the EPA Inventory Conventional L_o value of 100 cubic metres per tonne (m^3/t) was considered representative and used for the model. The province's proposed ban on landfilling of organics by 2030 has the potential to change waste composition and reduce methane generation in the future.

LFG Model Results

LFG generation from the future development is expected to peak one year after closure in 2046 at approximately 8,680 cubic metres per hour (m^3/hr), or 5,110 cubic feet per

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[5] Tetra Tech. Conceptual Design Report, GFL Environmental Inc. Eastern Ontario Waste Handling Facility Landfill Expansion Environmental Assessment, Table 5. October 25, 2017.

[6] Government of Canada. 2022. Canadian Climate Normals 1981-2010 Station Data – Cornwall. Available at : https://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?stnID=4255&autofwd=1.

minute (cfm). LFG generation is expected to decline approximately 5% per year after closure reaching a value of approximately 1,750 m³/hr (1,030 cfm) in 2078.

LFG production from the existing site is estimated to peak one year after its closure in 2027 at 9,000 m³/hr (5,300 cfm) and then decline, as LFG generation from the future development area begins to increase. The combined generation from the existing site and the future development would peak one year after closure of the future development in 2046 at 14,300 m³/hr (8,400 cfm).

2.6.2 Landfill Gas Collection and Treatment

LFG generated in the future development area will be collected with a system of vertical extraction wells, a network of buried gas conveyance piping, and a condensate drop-out location system similar to the existing landfill. Collected LFG will be conveyed to the existing Landfill Gas to Energy (LFGTE) plant located in the southeast portion of the existing landfill, near the entrance to the existing site.

It has been assumed that the LFG collection system for the future development would achieve a 75% collection efficiency which is considered typical for municipal landfills. The final cover design for the landfill expansion will incorporate a geomembrane which is expected to enhance LFG collection as it will limit fugitive emissions through the cover. It will also reduce the infiltration of precipitation into the waste thereby slowing down the waste decomposition and LFG generation process. Overall, the LFG collection system should then operate with increased efficiency, possibly up to 95%, resulting in greater LFG capture and reduced fugitive emissions.

Historical LFG generation estimates and actual LFG collection data for the existing EOWHF landfill suggests an average collection efficiency in the order of 84% over the past four years; however, by utilizing the 75% collection efficiency assumption, the assessment of effects is expected to be the worst case for air emissions when the landfill is operating. As such the potential LFG recovery is expected to peak one year after closure in 2046 at approximately 6,510 m³/hr (3,830 cfm). Potential LFG recovery is expected to decline approximately 5% per year after closure reaching a value of approximately 1,315 m³/hr (775 cfm) in 2078.

The LFGTE plant has a total combustion capacity of 15,040 m³/hr (8,850 cfm) consisting of four reciprocating engines which generate electricity and have a combined capacity of 2,300 m³/hr (1,350 cfm @ 50% CH_4), and three enclosed flares with a combined capacity of 12,750 m³/hr (7,500 cfm).

LFG production from the existing site is estimated to peak one year after its closure in 2027 at 9,000 m³/hr (5,300 cfm) and then decline, as LFG generation from the future development area begins to increase (as discussed in Section 2.6.1 above). The combined generation from the existing site and the future development would peak one year after closure of the future development in 2046 at 14,300 m³/hr (8,400 cfm). A collection efficiency range of 75% to 95% corresponds to collection and management of between approximately 6,300 to 8,000 cfm of LFG.

The current combustion capacity of the LFGTE plant exceeds the future peak LFG generation; however, it is noted that the four reciprocating engines are being operated under a Feed-in-Tariff (FIT) contract valid until February 20, 2033. If contractually obligated electricity production is not required, then the continued operation of the reciprocating engines is unlikely.

GFL is considering the potential to divert LFG to a renewable natural gas (RNG) facility in the future. An RNG facility would be able to utilize all of the LFG generated, not just a portion as is the case with the LFGTE facility. All LFG will be flared in the event that the LFGTE facility is no longer operating and an RNG facility not developed. Operational techniques include utilizing full flare capacity as well as reducing vacuum on the well field to ensure uniform removal of LFG from the landfill during a shutdown.

The decision to develop an RNG facility versus continuing operation of the LFGTE engines is a business decision being considered by GFL. GHG emissions from either the operation of the reciprocating engines or an RNG facility will be effectively equal as the gas/methane will be combusted under both scenarios.

Based on the potential LFG collection efficiency of up to 95%, the LFG management system for the expansion will be designed to provide adequate capacity. GFL will continue to monitor the generation of LFG in future years to confirm that the LFG management infrastructure is sufficient. An additional flare may be added if required. Should additional flaring be needed, an ECA amendment application will be completed as required.

2.7 Stormwater Management

The EOWHF landfill future development lands are located in the Fraser Drain and Upper Tayside Drain subwatersheds, which ultimately drain into Moose Creek and Scotch River, respectively. The Fraser Drain flows along the west boundary, and the Upper Tayside Drain flows along a portion of the east boundary of the future development, respectively. Under existing conditions, shallow ditches in the future development lands direct runoff primarily into a perimeter ditch that runs along the northern boundary of the site and discharges into the Fraser Drain, where the Fraser Drain changes flow direction from north to west. The shallow ditches also direct a small portion of the runoff to the Upper Tayside Drain.

The future development area will increase the impervious surface area, peak flows, and volume of surface runoff. To prevent an increase in risk of flooding and negative impacts to water quality, a proposed conceptual stormwater management (SWM) design has been developed that will mitigate potential negative impacts to the existing surface water drainage system.

Relevant SWM criteria as identified by the MECP in O. Reg. 232/98 and its related guidance document (refer to Section 4.9.2 of MECP, 2012) include:

- Water quality enhancement features (e.g., sedimentation ponds) of non-contaminated stormwater should be designed to temporarily treat/store the runoff volume generated from a 4-hour, 25 mm storm event and will be sized to provide “Enhanced” (Level 1) protection (i.e., 80% long-term suspended solids removal) and meet the SWM design requirements of the MECP Stormwater Management Planning and Design Manual[7] .

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[7] MECP. 2003. Stormwater Management Planning and Design Manual. March 2003.

- Surface water quantity control (i.e., peak flow reduction) measures of non-contaminated stormwater to be designed to temporarily store the runoff volume generated from storm events up to the higher of the 24-hour, 100-year design storm or the prevailing Regional Storm event, and release at or below the existing condition peak flows, such that there is no appreciable change in the potential for flooding and/or erosion in the watercourses receiving surface water discharges.

The following design storms were used to assess the design of the SWM system:

- Environment Canada's rain gauge station: Ottawa CDA RCS Station (6105978).
- Quantity control design storms: SCS Type II 24-hour Storm for the 2-year, 5--year, 10-year, 25-year, 50-year, and 100-year return periods.

In order to satisfy quantity and quality requirements, the proposed SWM system includes a new wet pond in the northwest corner of the future development area and oversized drainage ditches around the east and west perimeter of the site as shown on **Figure 2-1**. The proposed wet pond will discharge into the Fraser Drain just upstream of where the Fraser Drain changes flow direction from north to west. Based on the available topographic information, the bottom elevation of the Fraser Drain is at approximately 63.7 masl, and the 100-year flow depth is approximately 1.5 m. All the runoff from the future development is proposed to be directed to the Fraser Drain, and accordingly will not generate negative water quality or quantity impacts to the Upper Tayside Drain.

For stormwater quality control, the wet ponds have been designed to provide an "Enhanced" protection level (i.e., 80% long-term TSS removal). Under proposed conditions, the site imperviousness is 70%, which corresponds to a volumetric water quality criterion of 225 m^3/ha including 40 m^3/ha for extended detention. An orifice plate will be provided in the outlet structure for extended detention.

For stormwater quantity control, the wet pond is designed to temporarily store the runoff volume generated by storm events up to the 24-hour, 100-year design storm and maintain peak flow discharge below existing levels. The actual pond location and footprint size, and the storage volume and conveyance capacity of the perimeter ditches will be confirmed during detailed design.

The proposed SWM system for Alternative Method 1 is shown on **Figure 2-1** and the estimated required storage volumes in the proposed facilities are summarized in **Table 2-2**.

Table 2-2. Estimated Required Stormwater Volumes for Alternative Method 1

Facility ID	Quality Control	Quantity Control	Required Volumes (m^3)		
			Permanent Pool[1]	Extended Detention[1]	Active Storage[2]
Wet Pond	80% Long-Term TSS removal	100-year storm	39,500	8,600	64,300
Perimeter Ditch	N/A	100-year storm	N/A	N/A	N/A

[1] As per MECP SWM Manual Table 3.2 for 'Enhanced' Protection.

[2] Based on a controlled peak release rate of 5.7 m^3/s, excluding permanent pool and extended detention storage.

2.8 Ancillary Facilities

The construction of Stages 6 through 9 will require the development of a new network of perimeter roads, entrance roadway, and weigh scale facility with three scale decks as shown on **Figure 2-1**. The road access will be at the southern limit of the future development lands, off of Laflèche Road. There will be a 12 m wide entrance prior to the scale and 12 m wide exit. Access to the cells will be through three 26 m x 4 m scales with 3 m long ramps. A 6 m roadway will be built around the perimeters of Stages 6 through 9, with two access bridges over the Fraser Drain to the existing EOWHF lands at the south of Stage 6 and north of Stage 8. The access bridges will be designed to allow the passage of landfill equipment as well as to convey infrastructure (e.g., leachate pipeline and gas mains) as required.

2.9 Site Traffic

There are no operational changes anticipated for the future development and it will operate consistent with current conditions with the same daily and annual tonnage limits. There is no proposed change to the effective catchment area for the facility, the origin-destination patterns of vehicles travelling to or from the facility, or the maximum daily trips generated, and accordingly there should be little to no impact to the surrounding road network or along the haul routes within the greater context.

Although the future development is not expected to increase its average daily tonnage received or the daily tonnage limits, a traffic analysis[8] was prepared under the assumption that 100% of the daily tonnage limits would be met for landfill waste, on weekdays and on Saturdays. This represents a very conservative estimate of future site trip generation, particularly for Saturday.

This data was used to project future traffic volumes for the facility under the following assumptions:

- The maximum daily limit of 4,000 tonnes of total waste (landfill and compost material) is received.
- The 4,000 tonnes received includes receipt of 900 tonnes of compost materials (e.g., maximum allowable 400 tonnes of feedstock (biosolids, non-hazardous organic waste and/or non-hazardous liquid organic waste) and 500 tonnes of bulking agents (e.g., leaf and yard waste and/or wood waste) but no Special Risk Materials). On this basis, 3,100 tonnes of landfill waste would be received for both weekdays and weekends.
- The ratio of compost to landfill trips over the peak hour is equal to that over the full day. According to the weigh scale data, compost trips account for 27.2% and 76.2% during the weekday and Saturday, respectively.
- Employee traffic volumes remain unchanged.
- Traffic associated with the existing land uses south of Laflèche Road will not change.

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[8] HDR Corporation. 2022. Transportation Effects Assessment Report. Eastern Ontario Waste Handling Facility Future Development Environmental Assessment.

- The origins/destinations of site traffic do not change.
- Haul routes do not change.
- The hourly, daily, and seasonal patterns remain stable.
- The breakdown of vehicle types and average vehicle loads remain stable.

Due to COVID-19, it was not possible to conduct existing 2020 turning movement counts (TMCs) along Highway 138; therefore, the site traffic volumes observed in the 2016 TMCs were used to create a 2020 baseline by applying general background growth rates from Annual Average Daily Traffic (AADT) and Winter Average Daily Traffic (WADT) data from the Ontario Ministry of Transportation (MTO). The 2020 baseline was then validated using the traffic data from weigh scale tickets. These adjusted 2020 estimates were correlated with the daily tonnage received on the same day to derive separate trip generation rates for light and heavy vehicles. The resulting trip generation is summarized in **Table 2-3**.

Table 2-3. Projected Maximum Vehicular Peak Hour Site Trip Generation vs. Observed Site Operations

Component	Observed Site Operations (April 2020)			Projected (3,100 t/d)		
	AM	PM	SAT	AM	PM	SAT
Daily Tonnage	1,717		106	3,100		
Two-Way Landfill Trips	27	28	4	50	53	105

It is projected that the site may theoretically generate up to 50, 53, and 105 two-way trips during the weekday AM and PM, and Saturday midday peak hours, respectively. The nature of the site (waste disposal) means that there are no active transportation or transit trips anticipated. Thus, the vehicular site trip generation represents all trips generated by the facility.

Under existing, future background, and future total conditions, during both horizon years (2025 and 2035) there is, and will continue to be, residual capacity in the off-site road network, even under the conservative assumption that the maximum daily tonnage is received. No off-site road network improvements are required to accommodate the extension of the facility's operating life to approximately 2035.

Traffic related to landfill construction (e.g., landfill cell preparation in advance of waste placement) consists of importation of granular material for the LCS and other materials such as piping and geosynthetics, as well as importation of some soils related to cover material). The future development is not anticipated to generate additional measurable traffic related to construction due to the nature of the on-site soil materials and their suitability for use as the base liner and cover.

2.10 Landfill Operations

2.10.1 Operating Hours

The hours of operation for receiving waste at the existing EOWHF are:

- Monday to Friday 7:00 AM to 6:00 PM; and
- Saturday 7:00 AM to 5:00 PM.

Receiving hours for specified risk material are Monday to Friday from 7:00 AM to 3:00 PM.

The hours of operation for on-site equipment extend beyond the above receiving hours in order to carry out regular site activities such as site preparation and placement and removal of daily/interim cover:

- Monday to Friday 6:30 AM to 6:30 PM; and
- Saturday 6:30 AM to 5:30 PM.

The site is closed on Sunday and all statutory holidays. It is anticipated that these hours of operation will continue for the future development. The hours of operation may be reduced if waste quantities are consistently low over an extended period.

2.10.2 Site Equipment

The type and number of landfill equipment used at the existing landfill will continue to be used for the future development. The type and number of equipment may be revised based on day-to-day operational requirements as well as when equipment is taken out of service for maintenance or repairs. The equipment roster is anticipated to consist of:

- 2 bulldozers for levelling, compacting, and grading waste;
- 2 landfill compactors for levelling, compacting, and grading waste;
- 2 loaders for loading, snow removal, and waste processing;
- 2 articulating dump trucks for general site maintenance and hauling daily cover;
- 1 excavator for excavating, soil movement, and waste processing;
- 1 water truck for dust control; and
- 1 roll-off truck for moving and emptying 20-40 yd waste bins.

Other equipment (e.g., pick-up trucks, maintenance vehicles, mowers, tractors, and roll-off trucks) may be used for tasks such as landscaping and maintenance and may be provided by outside third parties.

2.10.3 Waste Placement

Once a landfill cell is prepared, waste will initially be placed in a thin layer over the entire base, starting in the outer perimeter and pushed out over the LCS, to prevent damage to the LCS from subsequent equipment traffic or frost. This initial layer will act as a travelling surface for equipment and waste haul vehicles.

Waste haul vehicles will access the working face via a well-maintained granular surface access road. Upon arriving at the active face, a spotter will screen the load and direct the haul vehicle to the active face. The length of the active face will be confined to an area that is as small as possible while maintaining efficient and timely waste disposal service and providing sufficient space between haul vehicles to safely unload.

Landfilling will be carried out using the ‘area’ method, where waste is spread over the underlying waste lifts and compacted by repeated passes of the compaction equipment over the layered waste. Additional layers of waste are placed and compacted using a bulldozer and compactor until a total average depth of about 5 m of waste has been placed. For stability, the working face will be sloped locally at a ratio of 4H :1V and in accordance with the temporary interior waste slope geometry approved for the existing landfill.

2.10.4 Daily and Intermediate Cover

Soil will be imported from off-site for use as daily cover although alternative covers may be used as per the landfill’s ECA and subject to the conditions described in Section 35 of the current ECA. Alternative cover may be used as follows:

- Geosynthetic Materials – Enviro Cover system (plastic cover material).
- Waste materials considered to be solid non-hazardous waste – contaminated soils and dewatered and digested sewage and pulp mill stabilized sludges.
- Spray applied materials – including polymer-based foams and recycled cellulose material.
- Waste materials considered to be solid non-hazardous waste – auto fluff, shredder fluff, dredged materials, grill ash, tire shreds, processed organic shingles, wood chips, compost, and foundry sand.
- Non-hazardous waste fines material from the waste disposal site located at 197 Putman Industrial Road in Belleville, Ontario.

The working face will be graded and compacted at the end of each working day with daily cover consisting of soil or approved alternative cover. Soil daily cover will be placed approximately 0.15 m deep. Areas that have not had waste placed for more than six months will be covered with at least 0.3 m of interim cover.

2.10.5 Nuisance Controls

GFL employs a variety of proactive measures to minimize nuisance effects related to dust, noise, odour, litter, and vectors and vermin on the surrounding environment. These established measures, detailed below, are expected to continue at the EOWHF and future development until landfill closure.

Dust

Dust is common in landfilling operations, particularly during dry conditions and during construction. The main sources of dust on-site at the landfill are access roads, particularly traffic on unpaved roads, and equipment movement around landfill working areas. Dust control measures may include the following:

- The use of gravel as the surface material of unpaved roads, which includes the areas from the scales to the working area. Low-silt concrete or wood waste materials may also be used.
- The application of water or dust suppressants on roads during dry periods as necessary.
- Regular maintenance of roads as part of normal site operations.
- Speed limits of 19 km/h imposed to reduce the agitation of dust and particulates from the road.
- Operating on the working face of the landfill below the grade level of the surrounding lands on windy days, where possible.

The distance from Highway 138 to the proposed future development site entrance is approximately 500 m, which is anticipated to minimize the amount of mud tracked from the site onto public highways. GFL may also consider use of wheel wash equipment to minimize mud tracking, which has not been required to-date.

Noise

The future development will operate according to the MECP's *Noise Guidelines for Landfill Sites*. Throughout the landfilling of Stages 5 through 9, standard noise control practices will be followed such as:

- Minimizing equipment noise by carrying out regular manufacturer-specified maintenance.
- Confining construction activities under normal conditions to regular operating hours, weather permitting.
- Developing the stages such that the landfill mound acts as a barrier to minimize noise impact between equipment and hauling routes and the site perimeter, where possible.
- Constructing and maintaining screening buffers for Stages 5 through 9 along the northern, eastern, and southern portions of the site perimeter.
- Maintaining the existing screening berms along the northern and western portions of the existing EOWHF site perimeter for Stage 5.
- Planting trees to enhance noise screening.

Litter

Litter control for the future development is anticipated to include the following:

- The working face of the landfill will be kept to a minimum width to reduce litter generation, and lightweight waste material will be covered with other waste or soil, as soon as possible.

- Waste trucks will be required to properly cover their waste loads to contain waste and will only be permitted to remove tarps in a dedicated tarp removal area provided close to the working face. Trucks with loads not properly secured will be refused entry to the landfill and these occurrences will be recorded.
- Portable litter control fences will be placed around, and immediately downwind, of the working area to capture wind-blown litter. These modular litter fence units are skid-mounted, can be moved by landfill equipment as-needed, and can be joined together to create varying lengths of fencing as needed. Typical dimensions of the fencing are 7 m long and 3 m high.
- Perimeter fencing in strategic areas around the site can also act as litter fencing.
- Litter pickup will be conducted as required with extra staff collecting litter following exceptionally windy days and snowmelt when snow cover is no longer preventing litter from being visible. Special attention will be given to the spaces between portable and permanent fences, and litter control fences will be cleaned regularly.
- Litter will be collected on off-site adjacent properties on an as-needed basis.

Vectors and Vermin

Vectors and vermin (e.g., birds, rodents, insects) may be attracted to the landfill as the site can provide food or habitat. Control measures already in effect at the EOWHF will be maintained throughout the development of Stages 5 through 9. These control measures can include:

- Minimizing the size of the working face to the degree possible subject to the waste placement requirements identified in Section 2.10.3.
- Use of daily and intermediate cover materials as identified in Section 2.10.4.
- Encouraging the growth of tall grass and vegetated banks (including around stormwater management ponds) to discourage birds from loafing.
- Placing specified risk material (SRM) immediately into the landfill upon receipt and covering SRM with sufficient cover material in accordance with Canadian Food Inspection Agency (CFIA) requirements.
- Using bird-scaring pyrotechnics (e.g., bangers) to discourage gulls from gathering overhead and from congregating on tipping faces and loafing areas.
- Using falconry contractors with trained birds of prey to frighten gulls away from the landfill.
- Daily observations of seagull numbers.
- Obtaining damage or danger permits from the Canadian Wildlife Service on an annual basis.

Odour

The main potential sources of odour during the active phases of each stage will be the waste at the working face, LFG, the leaf and yard waste area, and the composting facility. The application of cover soils at the end of the working day controls odour.

GFL carries out a consistent landfill surface scan program to identify and repair leaks in the landfill cover to maximize LFG capture. Any leaks in the cover detected as a result of these regular inspections will be repaired to reduce emission of LFG. The LFG collection system will be installed once cells are filled prior to capping, and will be connected to the existing LFGTE plant while the excess gas will be diverted to the on-site flare. The LFG connection system will be progressively expanded each year as site development occurs. The low permeability final cover will be constructed progressively and will also serve to minimize the emission of LFG-related odours.

GFL will continue to strive to keep odours to a minimum through continued utilization of the following additional measures:

- Continued operation of the LFGTE plant.
- Negative air pressure in the composting facility.
- Exterior biofilter system for the compost facility.
- Daily cover used on tipping face.
- Odour control misting systems.
- Avoidance of processing of leaf and yard waste material when southerly winds are occurring.
- Installation of a full-scale weather station to gauge wind direction and velocity.
- Monitoring of weather conditions that may increase potential for odours with certain activities.

3. Conceptual Design of Alternative Method 2

3.1 Overview

Alternative Method 2 consists of implementing the future development through four stages: one stage adjacent to and north of the existing landfill (Stage 5); and three stages oriented north-south within the future development lands (Stages 6 through 8). Stages 6 and 7 will be similar in size, while Stages 5 and 8 will be smaller. Stage 8 is located east of Stage 7. The layout for Alternative Method 2 is shown on **Figure 3-1**. The overall design of Alternative Method 2 will be similar to Alternative Method 1 as follows:

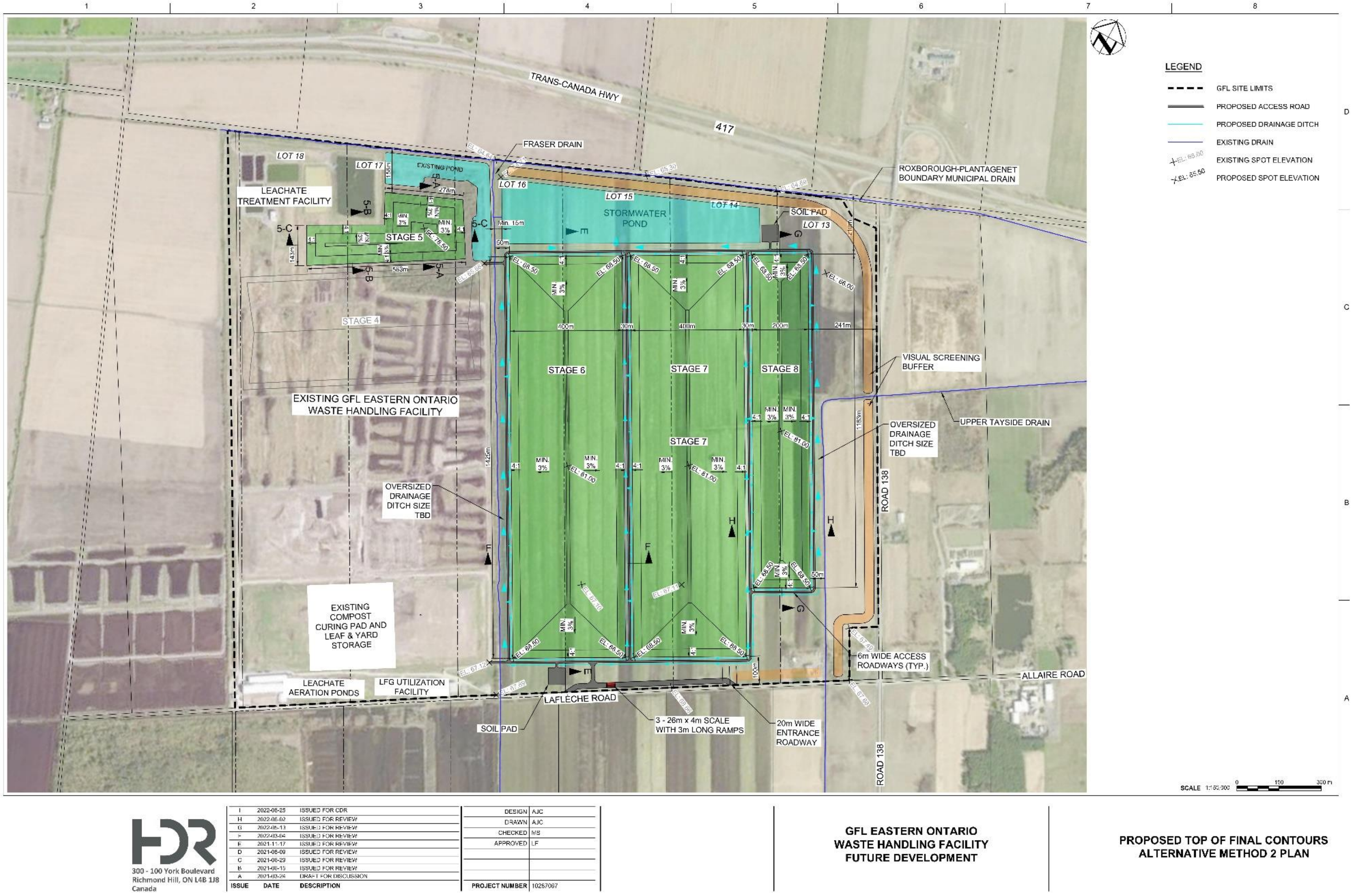
- Base excavation into native soils (e.g., into natural low permeability barrier).
- Construction of perimeter berms utilizing either existing low-permeability soils, or compacted soils overlain by a GCL keyed into native soils at the inside toe of the berm.

- LCS consisting of granular layers and a piping network with collected leachate conveyed to leachate aeration ponds located in the southern portion of the existing landfill and then to a leachate treatment plant located north of the existing landfill. The capacity of the leachate treatment plant will be expanded to accept leachate generated from the existing landfill as well as from the future development.
- Final contours reflecting a 4H to 1V slope at the perimeter of the stage transitioning to an approximately 3% slope on the top of the stage.
- Low permeability final cover consisting of a soil/geomembrane composite.
- LFG collection system consisting of vertical extraction wells and lateral and header piping within the waste. Collected LFG will be conveyed to the existing LFG plant located south of Stage 1 and which includes internal combustion reciprocating engines which generate power as well as an enclosed LFG flare. LFG condensate will be re-introduced into the waste or conveyed to the leachate treatment plant.
- Stormwater management system consisting of conveyance ditches around the perimeter of each stage and a retention pond located north of Stages 6 and 7. The existing pond located northeast of Stage 5 will be modified to attenuate peak flows if required

Other key design features include:

- Visual screening to be constructed along the north and east perimeters and a portion of the south perimeter consisting of earthen berms and/or vegetation plantings.
- New road entrance from Laflèche Road, including new scale facility with three 26 m long scales.
- Soil storage pad adjacent to the new scale facility and to the north of Stage 8.
- Internal road network permitting access to the new stages.

Figure 3-1. Alternative Method 2



3.2 Landfill Design and Geometry

The geometry of Alternative Method 2 is shown in plan view on **Figure 3-1** and in cross-section on **Figure 3-2** and **Figure 2-3**. This alternative method consists of four stages with 36 cells as shown in **Table 3-1**. The areas and volumes of the Stages and Cells shown in **Table 3-1** are approximate and will be confirmed through detailed design. However, the total landfill volume of Alternative Method 2 will remain at 15,100,000 m³.

Table 3-1. Stage Areas and Volumes Alternative Method 2

Stage/Cell	Area (m²)	Volume (m³)
Stage 5 (CELLS 1 and 2)	102,948	755,000
Stage 6 (CELLS 1 and 2)	92,804	896,456
Stage 6 (CELLS 3 and 4)	80,926	896,621
Stage 6 (CELLS 5 and 6)	80,926	896,621
Stage 6 (CELLS 7 and 8)	60,750	665,468
Stage 6 (CELLS 9 and 10)	80,926	896,621
Stage 6 (CELLS 11 and 12)	80,926	896,621
Stage 6 (CELLS 13 and 14)	92,804	896,456
Stage 7 (CELLS 1 and 2)	92,804	896,456
Stage 7 (CELLS 3 and 4)	80,926	896,621
Stage 7 (CELLS 5 and 6)	80,926	896,621
Stage 7 (CELLS 7 and 8)	60,750	665,468
Stage 7 (CELLS 9 and 10)	80,926	896,621
Stage 7 (CELLS 11 and 12)	80,926	896,621
Stage 7 (CELLS 13 and 14)	92,804	896,456
Stage 8 (CELLS 1 and 2)	87,743	830,052
Stage 8 (CELLS 3 and 4)	87,743	830,052
Stage 8 (CELLS 5 and 6)	64,917	595,168
TOTAL	**1,483,475**	**15,100,000**

As shown on **Figure 3-1**, the maximum elevation of the top of final cover will be similar to Alternative 1 and will range as follows:

- Stage 5: 78.5 masl.
- Stages 6 and 7: 81.0 masl.
- Stage 8: 81.0 masl.

The subsurface conditions for Alternative Method 2 are the same as Alternative Method 1 as described in Section 0. It is noted that the configuration of the Alternative Method 2 footprint avoids the area of shallowest bedrock in the south east part of the site however further investigation of bedrock depth in this area is warranted during detailed design.

The proposed design of Alternative Method 2 is a natural containment landfill that utilizes the existing in situ low permeability clay as a hydraulic barrier with performance criteria equivalent to or exceeding a generic composite liner system. This will be overlain by a leachate collection system (LCS), which consists of a leachate collection blanket of coarse stones (incorporating a leachate piping network) overlain by a protective layer of finer granular material acting as a filter, consistent with the design criteria set out in O. Reg. 232/98, Schedule 1.

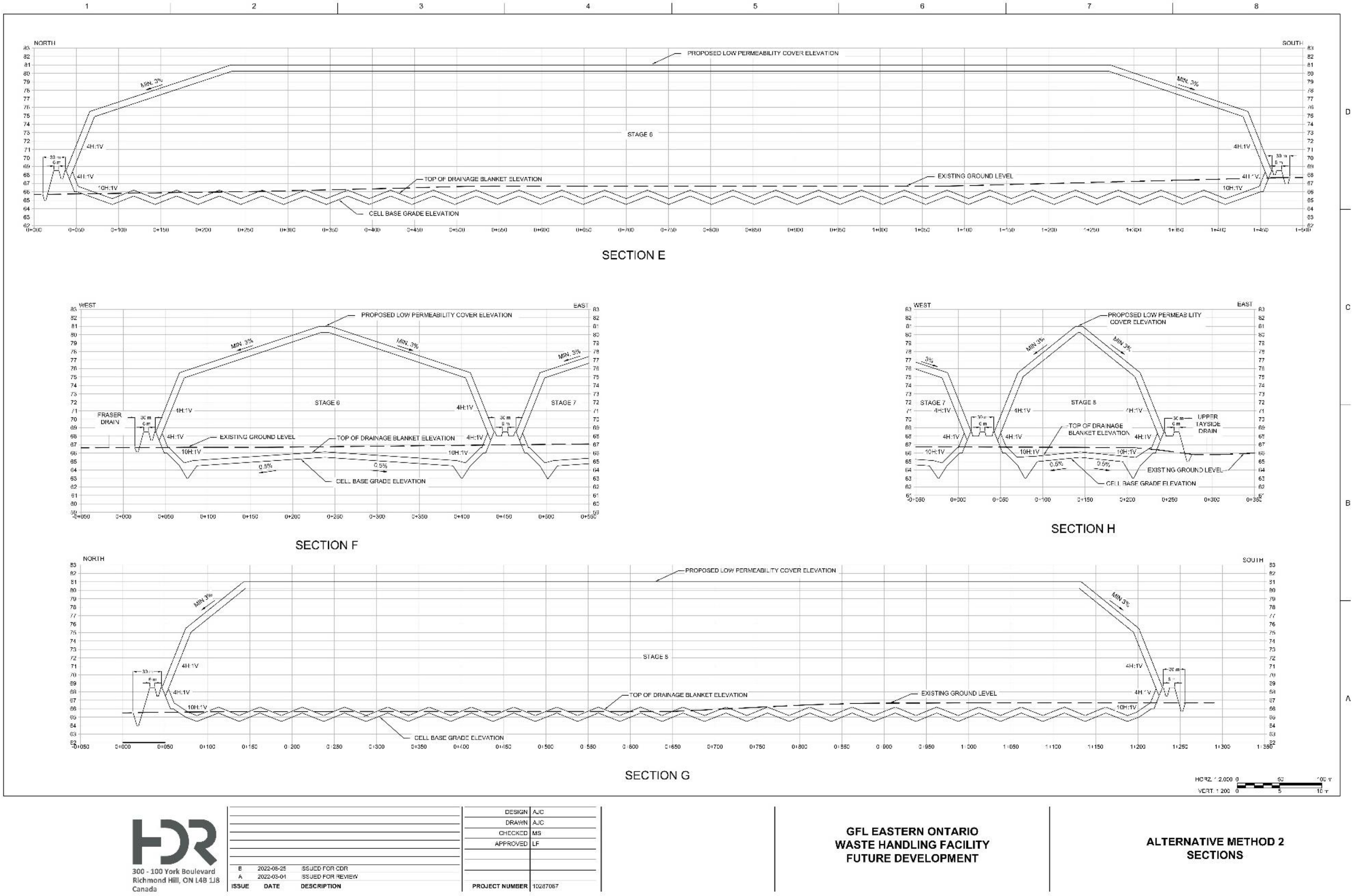
The conceptual cell base grade elevations have been based on the interpreted contours for the bottom of the desiccated zone within the silty clay while also maintaining sufficient slope to facilitate leachate drainage to the LCS and reduce the head of leachate on the base of the cells. The depth of the conceptual base grade will vary between about 63.5 to 65.5 masl, which is up to several metres below existing grade.

The base in each of Stages 6 through 8 will be excavated to form a north-south oriented central ridge with an approximately 0.6% slope away from the central ridge towards both the east and west perimeters of the stage. As well, the base will be excavated to form a series of smaller ridges and valleys such that a steeper slope (e.g., about 4%) will exist toward LCS piping within each valley.

The maximum width of the new stages (Stages 6 and 7) will be 400 m, which is consistent with the maximum stage width developed in the existing landfill. A compacted earthen berm with 4H to 1V slopes will be constructed around the perimeter of each stage utilizing either existing low-permeability soils, or compacted soils overlain by a geosynthetic clay liner (GCL) keyed into native soils at the inside toe of the berm. The berm will be approximately 33 m in width and constructed to an elevation of between 64.5 to 68.5 masl.

The slope stability analyses described in Section 0 are valid for Alternative Method 2. The results indicate that the proposed internal slope geometry of 4 horizontal to 1 vertical is feasible provided that a stability berm is utilized along the inside base of the landfill stage to increase passive resistance to slope movement. A stability berm has been accounted for in the volumetric design of the landfill. The geometry and extent of the stability berms throughout the landfill future development area will be refined and confirmed during detailed design.

Figure 3-2. Alternative Method 2 Cross Section



3.3 Buffer Zones

Alternative Method 2 will provide the following minimum buffer widths between the limits of waste placement and property boundaries:

- North limit Stage 5 to north property boundary: 158 m.
- North limit of Stages 6, 7 and 8 to north property boundary: 210 m.
- East limit of Stage 8 to east property boundary: 241 m.
- South limit of Stage 6 to south property boundary: 100 m.

3.4 Site Development

3.4.1 Phasing and Schedule of Site Development

For the purposes of the EA, it was assumed that landfilling would commence in Stage 5 with filling progressing from east to west and, upon completion of Stage 5, filling would progress to each of Stages 6 through 8 moving from south to north within each stage. The planned landfilling sequence may be modified by GFL prior to or during implementation of the future development.

The landfill future development for Alternative Method 2 will be filled over a period of 20 years. GFL anticipates that, as the landfill is developed, a maximum of up to two cells will be active in any given year (e.g., landfilling occurring within an area of between 8 to 10 ha), and that similar area would be inactive (e.g., some waste placed, with a soil intermediate cover). The maximum combined area of active landfill and intermediate covered landfill in any given year will be up to approximately 17.4 ha, with the remaining site area closed with final cover after the waste fill reaches the final contours.

3.4.2 Construction Activities

The activities involved in preparation of cells for landfilling in Alternative Method 2 will be the same as for Alternative Method 1, as described in Section 2.4.2.

3.5 Leachate Management

Alternative Method 2 will be developed over a 20-year period (the same as for Alternative Method 1) and GFL proposes that operations in the future development area will be similar to Stage 4 at the existing landfill. This reflects that, in a given year:

- four cells (approximately 17.4 ha) would be active.
- two of the four active cells would be in an open cell condition (e.g., active landfilling and all precipitation managed as leachate).
- two of the four cells will be in an intermediate cover condition; however, GFL has indicated that stormwater runoff is not released from the intermediate covered cells. As such, these cells were assumed to be equivalent to the open cell condition for the purpose of estimating leachate generation.
- The remainder of developed area under final cover conditions.

Leachate generation for Alternative Method 2 was estimated using the HELP model, as discussed in Section 2.5.1. On this basis, the maximum leachate generation is estimated to occur in approximately Year 19 when 17.4 ha are active (entire area modeled as an open cell condition), and 130.9 ha is in a final covered condition, corresponding to between 131,000 m³ and 141,000 m³ of leachate.

The potential effect that climate change may have on leachate generation has been considered in Section 4. As discussed in Section 2.5.1, under the highest scenario considered (RCP 8.5), average annual precipitation in the Ottawa River Basin could increase by 56 mm/yr over the period from 2011 to 2040, with a maximum projected increase of 128 mm/yr over the same period. This range represents an increase of approximately 6% to 14% over the annual average precipitation used in the HELP model. A conservative assumption is that maximum leachate generation could increase by the same amount to a range of 131,000 m³/yr to 141,000 m³/yr, approximately the same as for Alternative Method 1.

As for Alternative Method 1 discussed in Section 2.5.2, leachate collected in the future development LCS will be conveyed to the on-site leachate treatment plant and managed as per current practices. Based on leachate generation projections and planned upgrades to the leachate treatment plant, it is anticipated that the upgraded plant will have the capacity to treat all leachate from the existing landfill and the future development.

Condition 36.3 of ECA No. A420018 includes an approved contingency for leachate management at the existing landfill comprising the removal of leachate for treatment at an off-site wastewater treatment facility. This contingency will be maintained for the future development.

3.6 Landfill Gas Management

Alternative Method 2 has the same waste volume at final closure, waste deposition rate and operations as Alternative Method 1. As such LFG generation and management will be the same as for Alternative Method 1 as described in Section 2.6.

LFG generation from the future development is expected to peak one year after closure in 2046 at approximately 8,680 m³/hr, or 5,110 cfm. LFG generation is expected to decline approximately 5% per year after closure reaching a value of approximately 1,750 m³/hr (1,030 cfm) in 2078.

As described in Section 2.6.2, LFG collection efficiency is expected to increase, possibly up to 95%, at landfill closure. It is estimated that the average collection efficiency over the past four years for the existing EOWHF is in the order of 84%. However, by utilizing a 75% collection efficiency assumption the assessment of effects is expected to be the worst case for air emissions when the landfill is operating. As such the potential LFG recovery is expected to peak one year after closure in 2046 at approximately 6,510 m³/hr (3,830 cfm). Potential LFG recovery is expected to decline approximately 5% per year after closure reaching a value of approximately 1,315 m³/hr (775 cfm) in 2078.

LFG production from the existing site is estimated to peak one year after its closure in 2027 at 9,000 m³/hr (5,300 cfm) and then decline, as LFG generation from the future development area begins to increase (as discussed in Section 2.6.1). The combined generation from the existing site and the expansion would peak one year after closure of the future development in 2046 at 14,300 m^3/hr (8,400 cfm). A collection efficiency range of 75% to 95% corresponds to collection and management of between approximately 6,300 to 8,000 cfm of LFG.

3.7 Stormwater Management

The proposed general components of the stormwater management system for Alternative Method 2 are the same as for Alternative Method 1. They will consist of a proposed wet pond in the northwest corner of the site and oversized drainage ditches. The wet pond for Alternative Method 2 has a longer length to width ratio along the north perimeter of the future development site than Alternative Method 1. Additionally, the length of the oversized drainage ditches that will be located around the perimeter and between the proposed landfill stages is greater compared to Alternative Method 1.

The contributing drainage area and percent imperviousness for Alternative Method 2 is similar to Alternative Method 1. Accordingly, the estimated permanent pool, extended detention, and quantity control volumes are also similar. An orifice plate will be provided in the outlet structure for extended detention. The actual pond location and footprint size, and the storage volume within the perimeter ditches will be confirmed during detailed design.

The proposed SWM system for Alternative Method 2 is shown on **Figure 3-1**. The estimated required storage volumes in the proposed facilities are indicated in **Table 3-2**.

Table 3-2. Estimated Required Stormwater Volumes for Alternative Method 2

Facility ID	Quality Control	Quantity Control	Volumes (m^3)		
			Permanent Pool[1]	Extended Detention[1]	Active Storage[2]
Wet Pond	80% Long-Term TSS removal	100-year storm	39,700	8,600	64,300
Perimeter Ditch	N/A	100-year storm	N/A	N/A	N/A

[1] As per the MECP SWM Manual Table 3.2 for “Enhanced” Protection.

[2] Based on a controlled peak release rate of 5.7 m /s, excluding permanent pool and extended detention storage.

3.8 Ancillary Facilities

The construction of Stages 6 through 8 will require the development of a new network of perimeter roadways, entrance roadway, and weigh scale facility with three scale decks as shown on **Figure 3-1**. The road access will be at the southern limit of the future development lands, off of Laflèche Road. There will be a 12 m wide entrance prior to the scale and 12 m wide exit. Access to the cells will be through three 26 m x 4 m scales with 3 m long ramps. A 6 m roadway will be built around the perimeters of Stages 6 through 8, with two access bridges over the Fraser Drain, to the existing EOWHF lands, at the south end and north end of Stage 6. The access bridges will be designed to allow the passage of landfill equipment as well as to convey infrastructure (e.g., leachate pipeline and gas mains) as required.

3.9 Site Traffic

Alternative Method 2 will have the same entrance and traffic flow as Alternative Method 1 and therefore the same site traffic conditions, as described in Section 2.9.

3.10 Landfill Operations

All aspects of operations for Alternative Method 2 will be the same as for Alternative Method 1 as described in Section 2.10.

4. Climate Change Considerations

4.1 Effects of Climate Change on Landfill Design and Operations

Climate change has resulted in extreme weather events including increasingly severe rainfall and wind events, temperature extremes, and reduced snow cover. The potential impacts of these events are expected to influence mainly the design of the stormwater management system as well as routine site operations. These events are not expected to have a significant influence on the design of the landfill gas or leachate management systems, although they may influence the rate of generation of leachate and LFG.

4.1.1 Effects of Climate Change on Stormwater Management Design

Extreme weather events caused by climate change are relevant to the design of stormwater management systems in the diversion/control of runoff, as well as erosion and sedimentation control. O. Reg. 232/98 requires that the stormwater management systems be designed relative to specific storm events, including:

- External diversion elements, and a continuous overland flow route or drainage system, sized to convey peak flow from the higher of the 100-year design storm or prevailing Regional Storm.
- Internal conveyance elements sized to convey peak flow from a 25-year design storm.
- Water quality enhancement elements (e.g., sedimentation ponds) sized to temporarily store runoff volume from a 4-hour, 25 mm storm.
- Surface water quantity controls sized to temporarily store runoff volume from the higher of the 24-hour, 100-year design storm or prevailing Regional Storm, and release at or below existing condition peak flows.

The design of the stormwater management system is based on the use of local rainfall intensity-duration-frequency (IDF) curves developed using historical rainfall data. Prediction of extreme rainfall events requires the assumption that historic meteorological conditions can be used to predict future conditions; with changing climatic conditions, the validity of this assumption is reduced.

Climate change effects will be addressed in the detailed design of the future development by addressing MECP design criteria for ECA approval under the *Ontario Water Resources Act*, in addition to the landfill-specific requirements in O. Reg. 232/98. These will include:

- The use of the latest available local airport IDF curves, as modified for Climate Change, for the rainfall/snowmelt event analysis.
- The post-development peak discharge from a development site will be controlled to the equivalent pre-development level for the 2- to 100-year return period design storms.
- Providing 250 m^3/ha in storage volume for stormwater quality control, in accordance with MECP guidelines for 80% Enhanced Removal at an impervious level of 85%.
- Any proposed control measure sized to provide “Enhanced” protection (level 1), i.e., the removal of 80% long-term suspended solids, and meet the SWM design requirements of the Ministry of the Environment’s Stormwater Management Planning and Design (MECP Manual).

4.1.2 Effects of Climate Change on Landfill Operations

Extreme rainfall and wind events can influence landfill operations although these influences can be mitigated by adapting operating practices as follows:

- Higher rainfall may lead to a more rapid degradation of internal site roadways (e.g., road surface softening or erosion) necessitating a higher level of effort in road maintenance (e.g., reconstruction, resurfacing).
- Higher rainfall may increase the level of effort required for stormwater management along internal site roadways and the landfill working face (e.g., temporary ditching, pumping).
- High wind events may increase nuisance effects of dust and litter, necessitating increased efforts in dust control as well as litter collection.

4.1.3 Landfill Gas Management System Design

The rate of generation of methane (e.g., Methane Generation Rate, k) is highly dependent upon the moisture in the waste mass, and the overall methane generation capacity (e.g., Methane Generation Capacity, L_o) depends on the type and composition of waste in the landfill.

Extreme weather events caused by climate change may influence the amount of moisture within the waste and therefore the rate at which methane is generated. If climate change results in a lowering of moisture content, the generation rate will be reduced; conversely if the moisture content increases the generation rate will be increased.

The proposed landfill design includes a low permeability soil/geomembrane final cover that will be constructed progressively as the site is developed, and as the final covered area increases, the effect of variations in rain events on moisture content of the waste will be diminished. GFL will monitor the landfill gas generation rate throughout the life of the site and will ensure that adequate gas destruction capability (e.g., use of reciprocating engines and gas flaring) is maintained. The existing gas management system has sufficient capacity to manage up to 8,850 scfm, which is greater than the estimated gas generation rate.

4.1.4 Leachate Collection System Design

Extreme weather events resulting from climate change are not expected to have a significant long-term effect on precipitation infiltration and generation of leachate because the site will be progressively capped with a low permeability final cover. Increased infiltration will result in an increase in leachate generation of active open cells, but the effect will be reduced by moisture initially going into storage in the waste mass, as well as the progressive closure of the site. The detailed design of the leachate collection system will account for any climate-related changes.

4.2 Effects of the Landfill on Climate Change

The greatest potential influence of the landfill on climate change relates to the generation and emission of LFG, which is comprised primarily of methane and carbon dioxide, both of which are greenhouse gases (GHGs). This effect is anticipated to be minimal given the following aspects of the landfill design:

- The future development will incorporate an active LFG collection system which will limit emission of LFG to the atmosphere.
- Collected LFG will be combusted in either reciprocating engines or flares at the site's LFGTE plant or potentially utilized as renewable natural gas (RNG).
- The landfill will be progressively covered with a soil/geomembrane final cover which significantly reduces emissions as compared to a soil cover.

A

Terrapex Geotechnical Feasibility Report

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GEOTECHNICAL FEASIBILITY REPORT

Proposed Landfill Expansion
Lot 13, 14, 15, and 16, Concession Road 10

17125 Lafleche Road
Moose Creek, Ontario

Revised September 12, 2022

CO749.02

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1.0 INTRODUCTION

Terrapex Environmental Ltd. (Terrapex) has been retained by GFL Environmental Inc. (GFL, Client) to prepare a Geotechnical Feasibility Report in support of the proposed expansion of the Eastern Ontario Waste Handling Facility (Project, EOWHF), located at 17125 Lafleche Road in Moose Creek, Ontario. Authorization to proceed with this study was given by Mr. Greg van Loenen of GFL.

This report is subject to the limitations shown in Appendix A. The report is prepared for the sole use of the Client, and reliance on it by any third party, is the responsibility of such third party. This Geotechnical Investigation undertaken for this study was carried out in conjunction with a Hydrogeological Assessment that is reported under separate cover.

This report presents the results of the investigation performed in accordance with the general terms of reference outlined above. It is understood that the Project will be performed in accordance with applicable codes and standards within its jurisdiction.

2.0 SITE AND PROJECT DESCRIPTION

2.1 Site Description

GFL operates its EOWHF on lands located on the western half of Lot 16 and Lots 17 and 18, Concession 10, Township of North Stormont, United Counties of Stormont, Dundas and Glengarry, near the intersection of Highway 417 and Highway 138. The municipal street address for the facility is 17125 Lafleche Road, Moose Creek, Ontario.

The EOWHF is rectangular with approximate dimensions of 1,880 m in a north-south direction and 1,340 m in the east-west direction. It is bound by Road 700 on the north, the eastern portion of Lot 16, Concession 10 on the east, Lafleche Road on the south and Lot 19, Concession 10 to the west.

The proposed expansion (hereafter referenced to as “the Site”) consists of the Eastern half of Lot 16, and Lots 13-15 of Concession 10, Township of North Stormont, United Counties of Stormont Dundas and Glengarry.

The Site is an approximate rectangle of 235 hectares extending approximately 1,800 m in the north-south direction and 1,400 m in the east-west direction. It is bound by Road 700 on the north, Highway 138 on the east, Lafleche Road on the south and the EOWHF Site on the west.

The current land use at the Site is agricultural crop pasture. With the exception of the EOWHF to the west, most of the surrounding area is used for agricultural purposes.

The ground surface topography of the Site slopes down gently from the south to the north. The ground surface elevations at the borehole locations are within 2.95 m.

2.2 Project Description

Terrapex's understanding of the Project is based on the information, files, and discussion with the Client and HDR Inc. (Designer). We understand that the Client is proposing to expand the EOWHF by constructing the following:

- Landfill cells constructed at a minimum bottom elevation of 66.00 meters above sea level (masl) to a maximum top elevation of 81 masl with a slope of 4H:1V;
- 3 m wide drainage ditches;
- 4 m high screening berms with 3 m top having 4H:1V side slopes;
- 60 x 60 m contaminated soil pads;
- Scale ramps;
- Access roads; and,
- Stormwater ponds.

Updated conceptual plans were provided by the Designer, and are enclosed in Appendix F for reference.

A previous Geotechnical Investigation was carried out by Golder Associates Ltd. (Golder) in March 1996 for the currently operational portion of the EOWHF situated west of the proposed expansion area. The borehole log sheets enclosed with the Golder report were provided for our review and use by GFL. Three (3) boreholes designated as 96-1, 96-2, and 96-3 situated along the east limit of active landfill are utilized in this report to provide further coverage of the subsurface soil and groundwater conditions for the west section of the proposed landfill expansion area and are enclosed in Appendix C of this report.

3.0 FIELDWORK

The fieldwork for this study was carried out from January 21 to February 7, 2020. It consisted of eighteen (18) boreholes advanced using the mud rotary method by a drilling contractor commissioned by **Terrapex**. The boreholes are designated as MW20-1 through MW20-18 and were advanced to depths ranging from 4.0 to 25.3 m below ground surface (mbgs). Boreholes MW20-12 through MW20-16, and MW20-18 were advanced without soil sampling in order to install monitoring wells and/or to delineate the depths to glacial till and inferred bedrock.

A total of 37 monitoring wells were installed at the Site for the Hydrogeological Assessment. A cluster of three (3) monitoring wells were installed at eleven (11) of the borehole locations designated as MW20-1 through MW20-11, with the letter following the monitoring well designation indicating "D" for deep, "C" for clay, "T" for till and "S" for shallow, which identify the stratum in which the well screen is installed.

Single monitoring wells were installed in four (4) of the boreholes designated as MW20-12S, MW20-15T, MW20-17S, and MW20-18D.

The locations of the boreholes and monitoring wells were chosen for the Hydrogeological Assessment to provide coverage of the proposed landfill expansion area and are shown on the Borehole Location Plan enclosed in Appendix B.

Standard penetration tests (SPT, ASTM D-1586) were carried out in the course of advancing the boreholes to take representative soil samples and to measure penetration index values (N-values) to characterize the condition of the various soil materials. The number of blows of the striking hammer required to drive the split spoon sampler through 300 mm depth increments were recorded.

In situ vane shear tests (ASTM D-2573) were carried out at frequent intervals of depth in the boreholes within the silty clay deposit in order to measure the undrained shear strength of the material. The results of SPT and in situ vanes shear tests are presented on the borehole log sheets in Appendix C and discussed in Section 5 of this report.

Seven (7) undisturbed samples of silty clay material were obtained from the boreholes using thin walled “Shelby” tube samplers for laboratory one-dimensional consolidation testing.

Boreholes MW20-1(D) through MW20-11(D) were extended into bedrock using a diamond tipped core barrel to obtain samples of the bedrock in order to assess the quality and continuity of the bedrock.

Groundwater level observations were made in all boreholes during advancement of the boreholes and in the monitoring wells on January 29, 31, February 5, 26, March 5, and 8, 2020.

The ground surface elevations at the locations of the boreholes and monitoring wells were established by **Terrapex** using a TopCon HiPer V GNSS receiver; coordinates and elevations are referenced to the UTM NAD 1983 Zone 18 North coordinate system.

The fieldwork for this project was carried out under the supervision of experienced technicians from this office who laid out the locations of the boreholes in the field, arranged locates of buried services, supervised the field drilling, sampling and in situ testing, observed groundwater conditions, recorded borehole locations and elevations, and prepared field borehole log sheets.

4.0 LABORATORY TESTS

The soil samples recovered from the split spoon sampler were properly sealed, labelled and brought to our laboratory. They were visually classified and water content tests were conducted on 26 soil samples retained from the boreholes. The results of the classification, water contents, shear strength, and SPT are presented on the borehole log sheets in Appendix C.

Grain-size analyses were carried out on nine (9) samples of silty clay and four (4) samples of sand and gravel till, Atterberg limits on six (6) silty clay samples, and one-dimensional consolidation tests on six (6) undisturbed samples of silty clay obtained using thin walled “Shelby” tube samplers. The results of the laboratory tests are presented below in Section 5 and attached at the end of this report in Appendix D.

5.0 SUBSURFACE AND GROUNDWATER CONDITONS

Full details of the subsurface and groundwater conditions at the Site are given on the Borehole Log Sheets attached in Appendix C of this report.

The following paragraphs present a description of the Site and a commentary on the engineering properties of the various soil materials contacted in the boreholes.

It should be noted that the boundaries of soil types indicated on the borehole logs are inferred from non-continuous soil sampling and observations made during drilling. These boundaries are intended to reflect transition zones for the purpose of geotechnical design, and therefore, should not be construed as exact planes of geological change.

5.1 TOPSOIL

Topsoil is present at the ground surface in all sampled boreholes. The thickness of the topsoil at the borehole locations ranges between approximately 0.3 to 2.0 m. It should be noted that topsoil thickness will vary between boreholes. Thicker topsoil than that found in the boreholes may be present in places.

5.2 SILTY CLAY

Cohesive soil deposits consisting of variable fractions of silt and clay to silty clay with traces of sand and gravel are present below the topsoil in all boreholes; extending to depths ranging from 4.8 to 17.8 mbgs, which correspond to elevations near 48.7 to 62.4 masl.

In most of the boreholes, this deposit contained a weathered crust at the top, which was stiff to very stiff in consistency with varying thicknesses ranging between 0.2 to 2.0 m. In all the boreholes, below the weathered crust was an unweathered grey silty clay, which was typically firm to very soft in consistency.

The water content of the silty clay samples obtained from the boreholes ranged from 54 to 96%, by weight. SPT carried out in the silty clay provided N-values ranging from 0 to 8, typically being 0. In situ vane shear tests in the silty clay measured undrained shear strengths ranging from 9 to 117 kPa, typically being in the range of 9 to 33 KPa. Based on the results of SPT and vane shear tests, the silty clay possesses a stiff to very stiff consistency at the top (weathered crust) and becoming firm to very soft (unweathered grey clay) with depth.

Grain size analyses by hydrometer were carried out on nine (9) representative samples of silty clay. The test results are enclosed in Appendix D as Figures D-1 through D-9 and are summarized in the following table.

Sample ID	Sample Depth (mbgs).	Sample Description	% Gravel	% Sand	% Silt	% Clay
MW20-1D, Sample 6	8.9	SILTY CLAY	0	2	22	76
MW20-1D, Sample 8	12.1	CLAY, some silt, trace sand, trace gravel	2	3	20	75
MW20-2D, Sample 7	7.6	CLAY, some silt, trace sand	0	1	15	84
MW20-2D, Sample 11	13.7	SILT and CLAY, trace sand	0	3	42	55
MW20-6D, Sample 4	3.8	SILT and CLAY, trace sand	0	8	41	51
MW20-8D, Sample 7	7.3	SILTY CLAY, trace sand	0	1	22	77
MW20-9D, Sample 7	9.1	SILTY CLAY, trace sand	0	1	23	76
MW20-9D, Sample 8	12.1	CLAY, some silt, trace sand	0	2	11	87
MW20-11D, Sample 7	10.3	CLAY, some silt	0	0	14	86

Based on the results of the grain size analyses, the soil is best described as silt and clay to silty clay with trace sand.

Atterberg limit tests were carried out on six (6) samples of the silty clay obtained from thin walled “Shelby” tube samplers in Boreholes MW20-2D, MW20-3D, MW20-8, MW20-9D, MW20-10D, and MW20-11D. The test results are presented on the plasticity chart enclosed in Appendix D as Figure D-14 and are summarized in the following table.

Sample ID	Sample Depth (mbgs)	Liquid Limit	Plastic Limit	Plasticity Index
MW20-2D, Sample 5	5.0	50	25	25
MW20-3D, Sample 7	6.1	54	24	30
MW20-8, Sample 4	3.0	55	26	29
MW20-9D, Sample 6	8.0	61	23	38
MW20-10D, Sample 7	9.8	57	24	33
MW20-11D, Sample 7	11.0	57	25	32

The soil classification, based on the plasticity chart on Figure D-14, is Inorganic Clay of High Plasticity.

One-dimensional consolidation tests were performed on six (6) undisturbed samples of silty clay obtained using thin walled “Shelby” tube samplers from Boreholes MW20-2D, MW20-3D, MW20-8, MW20-9D, MW20-10D, and MW20-11D, from various depths. The results of these tests are enclosed in Appendix D as Figures D-15 through D-20. The following table summarizes the locations and depths of the samples analyzed, along with interpreted values of pre-consolidation pressure, Coefficient of Consolidation (c_v), Oedometric Modulus (D), and Coefficient of Permeability (k) on the basis of the test results.

Sample ID	Sample Depth (mbgs)	Pre-consolidation Pressure (kpa)	Coefficient of Consolidation (m^2/sec)	Oedometric Modulus (MPa)	Coefficient of Permeability (cm/sec)
MW20-2D, Sample 5	5.0	25	2.0×10^{-9}	0.4	4.8×10^{-9}
MW20-3D, Sample 7	6.1	95	8.0×10^{-9}	0.6	1.3×10^{-8}
MW20-8, Sample 4	3.0	60	3.0×10^{-9}	0.6	5.1×10^{-9}
MW20-9D, Sample 6	8.0	90	4.0×10^{-9}	0.4	9.5×10^{-9}
MW20-10D, Sample 7	9.8	75	7.0×10^{-9}	0.7	1.0×10^{-8}
MW20-11D, Sample 7	11.0	65	3.0×10^{-9}	0.6	4.7×10^{-9}

The values of c_v, D, and k have been calculated based on the laboratory virgin compression section of the oedometer test curves.

5.3 SAND AND GRAVEL (TILL)

A glacial deposit consisting of variable fractions of predominantly sand and gravel, with a silt fraction ranging from trace to silty, and trace clay is present below the silty clay in all boreholes with the exception of Borehole MW20-8(D). The sand and gravel extended to depths ranging from approximately 5.8 to 19.2 mbgs, which correspond to elevations near 46.8 to 61.5 masl.

The sand and gravel till is grey in colour and wet in appearance. The water content of the sand and gravel till samples obtained from the boreholes range from 10 to 12%, by weight.

SPT in the sand and gravel till provided N-values ranging from 1 to 50 blows for 130 mm of penetration, indicating a very loose to very dense compactness condition.

Grain size analyses were carried out on four (4) representative samples of sand and gravel till obtained from Boreholes MW20-3D, MW20-5D, and MW20-9D. The test results are enclosed in Appendix D as Figures D-10 through D-13 and are summarized in the following table.

Borehole No.	Sample Depth (mbgs)	Sample Description	% Gravel	% Sand	% Silt	% Clay
MW20-3D, Sample 12	10.4	SANDY GRAVEL, some silt, trace clay	59	23	15	3

Borehole No.	Sample Depth (mbgs)	Sample Description	% Gravel	% Sand	% Silt	% Clay
MW20-5D, Sample 5B	8.1	SILTY SANDY GRAVEL, trace clay	33	32	28	7
MW20-5D, Sample 7	10.3	SANDY SILTY GRAVEL, trace clay	44	25	25	6
MW20-9D, Sample 10	14.2	GRAVELLY SILTY SAND, trace clay	21	50	25	4

Based on the grain size analyses results, the soil is best described as sandy to silty gravel with trace clay.

5.4 BEDROCK

Bedrock consisting of shale and limestone was encountered below the silty clay in Borehole MW20-8(D) and below the sand and gravel till in Boreholes MW20-1(D) through MW20-7(D) and MW20-9(D) through MW20-11(D). The bedrock was contacted at depths ranging from 5.8 to 19.2 mbgs, which correspond to elevations near 46.8 to 61.5 masl.

The bedrock was cored in the above referenced boreholes using a diamond tipped core barrel in order to extract samples to assess the quality of the bedrock. In general, the upper approximately 1.0 m of the bedrock is moderately to highly weathered and fractured, becoming competent and sound below this depth.

It is noted that the upper approximately 3.7 m of the bedrock in Borehole MW20-2(D) consists of moderate to highly weathered and fractured shale with occasional silt and clay seams, becoming competent limestone below this depth.

Inferred bedrock was contacted in Boreholes BH20-13 through BH20-16, and in MW20-18(D), however, the bedrock was not investigated (cored) at these locations. It was contacted at depths ranging from 10.2 to 17.4 mbgs in these boreholes.

5.5 GROUNDWATER

Groundwater levels were measured in the monitoring wells following their installation. The groundwater level measurements are presented in the table enclosed in Appendix E of this report.

The Hydrogeological Assessment Report by **Terrapex** should be referred to for interpretation of the groundwater conditions at the Site.

6 DISCUSSION AND RECOMMENDATIONS

The following discussion and recommendations are based on our current understanding of the Project. Any changes to the Project will require a review to assess the impact on the recommendations given herein. The recommendations contained in this report are based on the factual data obtained from the boreholes advanced at the Site by **Terrapex** and are intended for use by the client and designers only. Contractors bidding on this project or conducting work associated with this Project should make their own interpretation of the factual data and/or carry out their own investigations.

Important factors to be considered for the design and construction of the proposed Project are expected to include the following:

- **Excavations:** Excavations through the clay should be completed with smooth-edged buckets to minimize disturbance and softening of subgrades.
- **Protection of Sensitive Subgrades:** The sensitive clays at the Site are subject to softening when exposed to excess moisture or disturbance. Contractors should employ construction methods which limit construction traffic over exposed clay subgrade surfaces and keep exposure to excess moisture to a minimum.
- **Grade Raise: Terrapex** understands that the construction of landfill cells will be up to approximately 13 m in height. Consolidation and long-term settlement of the sensitive clays are expected to be generally in the range of 1000 to 2700 mm. Further details regarding proposed thickness for granular work platform, settlement analyses and considerations are provided in the sections below.
- **Slope Stability Assessment: Terrapex** completed a slope stability analysis and provided recommendations of side slopes for the landfill mounds. The Client and Designer are to refer to these analyses in section 6.5.

On the basis of our fieldwork, laboratory tests, and subsurface conditions encountered in the boreholes, the following comments and recommendations are provided.

6.1 GENERAL SITE PREPARATION

Grading of the Site should be completed in the early stages of construction to provide for positive control of surface water, directing it away from excavations and subgrades. Adequate ditching and/or using a sum pump may be necessary to collect any surface runoff and groundwater accumulation. This will be necessary to protect subgrades, and to allow for dry working conditions.

6.2 EXCAVATIONS

The excavations for this Project are anticipated to consist of shallow open excavations. All excavations must be carried out in accordance with the Occupational Health and Safety Act of

Ontario (OHSA). The following recommendations for excavations should be considered a supplement to, and not a replacement of the OHSA requirements.

Designers and Contractors are cautioned that the brown stiff to very stiff weathered clay crust on this Site is underlain by a sensitive grey unweathered firm to very soft clay. Excavation depths should be limited to as shallow as practical.

6.2.1 Open Excavations

In the case that shallow open excavations are used during construction, the following OHSA recommendations should be considered:

- Any FILL soils at the Site would be considered “Type 3 Soils” according to OHSA. “Type 3 Soils” must be sloped from its bottom with a slope having a minimum gradient of 1H:1V;
- The native weathered brown clay crust would be considered “Type 3 Soils” according to OHSA. “Type 3 Soils” must be sloped from its bottom with a slope having a minimum gradient of 1H:1V;
- The native unweathered grey clay would be considered as a “Type 4 Soil”. Excavations in “Type 4 Soils” must be sloped from its bottom with a slope having a minimum gradient of 3H:1V.
- For excavations through multiple soil types, the side slope geometry is governed by the soil with the highest number designation. Excavation side-slopes should not be unduly left exposed to inclement weather.

Excavations into the fill and native soils should be relatively straightforward with conventional excavation equipment

Where workers must enter excavations extending deeper than 1.2 m below grade, the excavation side-walls must be suitably sloped and/or braced in accordance with OHSA and Regulations for Construction Projects.

6.2.2 Dewatering

As part of this Geotechnical Investigation, **Terrapex** installed a total of ten (10) monitoring wells within the Site. The water levels recorded in the monitoring wells are provided in Appendix E, and based on our observations, the ground water levels are very shallow; near the ground surface. We understand that excavations for the landfill cells will extend to a maximum depth of 2.0 mbgs, and therefore, the excavations are expected to be below the water table.

Groundwater seepage is expected in all excavations and will need to be controlled. Water quantities will depend on seasonal conditions, depths of excavations, presence and lateral extents of water bearing silt and sand seams, and the duration that excavations are left open. Groundwater will travel easily through the fill material, and especially near the fill-native interface. Furthermore, any existing utility trenches or drainage channels which join or intersect the excavations may act as a drain and supply water into the excavations. These may need to be plugged or grouted at the outset of construction to mitigate this possibility.

Construction dewatering by a dewatering contractor will be required during construction. This may include pumping from sumps, and/or ditches. Designers and Contractors are referred to the hydrogeological assessment for further information on the groundwater conditions at the Site.

6.2.3 Subgrade Preparation

Subgrade preparation for the landfill cells, contaminated soil pads, scale ramps, and access roads will involve the removal of all fill soils, organics, disturbed/reworked or previously excavated soils to expose a native undisturbed clayey subgrade.

The clayey soils at the Site are subject to significant strength loss upon disturbance, especially when these soils are subjected to elevated moisture or improper management of excavations. Specifications should make some allowance for this issue; Contractors will need to use construction practices, methods, and equipment that minimize the risk of subgrade disturbance.

Clay subgrades should not be left exposed for any significant period. The process of final excavation to the design depth, and inspection should be coordinated sequentially within a short period of time to limit the risk of damaging clay subgrades.

6.3 SETTLEMENT ANALYSES

The settlement analyses consisted of preparing specific settlement estimates for the landfill cells based on the information from the boreholes, consolidation test results presented in section 5.2, and the latest information from the Designer’s conceptual plans, attached in Appendix F.

The following parameters were used for the settlement analyses.

Parameter	Stiff to Firm Weathered Clay Crust	Very Soft Unweathered Grey Clay	Till	Waste Material
Unit Weight (kN/m3)	18	16	20	14
Oedometric Modulus (MPa)	20	1	50	-
Poisson Ratio	0.35	0.45	0.3	-

The table below presents the anticipated settlement estimates given the maximum grade raise proposed for the landfill mounds, dimensions, and depths/elevations of cells.

Borehole No.	Bottom of Stiff to Firm Weathered Clay Crust (mbgs)	Bottom of Very Soft Unweathered Grey Clay (mbgs)	Bottom of Till (mbgs)	Total Settlement with 13.15 m high waste pile (mm)
MW20-1	3.0	12.5	15.0	1700
MW20-2	3.7	17.8	19.2	2400
MW20-3	4.0	9.2	14.5	1000
MW20-4	2.5	8.2	9.5	1100
MW20-5	-	8.2	13.8	1500
MW20-6	4.8	-	5.5	50

MW20-7	4.0	13.0	14.0	1600
MW20-8	-	9.5	-	1700
MW20-9	5.0	13.2	19.0	1500
MW20-10	-	15.5	-	2700
MW20-11	2.0	17.5	19.0	2600
96-1	3.0	12.4	23.7	1700
96-2	3.0	11.5	17.0	1500
96-3	2.5	15.0	15.5	2200

Based on the consolidation testing completed to date, and the anticipated loads and elevations provided by the Designer, it is estimated that 1000 to 2700 mm of total consolidation settlement could be experienced. The major part of the settlement is assumed to take place during the first 10 to 15 years after the waste is placed; this is based on an assumption that the cell will reach full waste height in only a few years.

It is recommended that additional boreholes be advanced and sophisticated in situ testing using the Marchetti Flat Plate Dilatometer (DMT) be competed to provide additional soil data which will be instrumental in settlement analyses during the detailed design stage. The locations and depths of the boreholes and DMTs to be advanced during the next phase of investigation will be selected based on the proposed landfill design.

6.4 WORK PLATFORM

Based on the findings of the field program completed to date, the stiff to very stiff weathered clay crust does not exist throughout all areas of the Site. **Terrapex** is recommending that the future excavations be as shallow as possible; limited within the weathered clay crust in order to provide a stable work surface to facilitate the construction of the basal leachate collection system (LCS). The weathered clay crust subgrade will generally be stiff to very stiff in consistency and will allow for normal working conditions during construction.

The findings of the field investigation also reveal that locally, the proposed excavations will extend to contact firm to very soft clay which will not be capable of supporting construction traffic. Firm to very soft subgrades will need to be strengthened and stabilized using a granular pad underlain by a layer of geosynthetic reinforcement in order to support construction loads.

Following excavation into firm to very soft native clay, the subgrade should be inspected and approved by Geotechnical staff. A layer of woven geotextile (such as Mirafi® HP570 to Mirafi® HP770, or equivalent) should be placed on the subgrade as a separation and reinforcing layer between the clayey subgrade and granular material. The woven geotextile should be placed with overlap between layers to ensure continuity of the reinforcing layer.

The granular material should consist of 300 to 600 mm thick layer OPSS Granular B Type II or similar large particle crushed limestone material compacted to a dense state with a large smooth drum compacter.

Further assessment of the subgrade could be completed by excavating test pits to the base of the proposed excavations in order to refine the minimum depth of granular material required to provide a stable subgrade for construction works.

Material	Stiff to Very Stiff Weathered Clay Crust Subgrade	Firm to Very Soft Unweathered Grey Clay Subgrade
OPSS Granular B Type II	300 mm	300 to 600 mm
Non-woven geotextile	Yes	-
Mirafi® HP570 to Mirafi® HP770, or equivalent woven geotextile	-	Yes
Reviewed and Approved Subgrade by Geotechnical Staff		

6.5 SLOPE STABILITY ASSESSMENT

Terrapex has carried out a slope stability analysis of the proposed landfill design to determine if the stability of the landfill slopes is satisfactory. The slope stability analysis also accounts for the leachate level rising close to the top of landfill mound as shown in the Hydrogeological landfill modelling.

The Conceptual Design Report for EOWHF Future Development, Moose Creek, Ontario prepared by HDR dated April 5, 2022 was provided for our review and reveals that two conceptual design alternatives are being considered. Design Alternative 1 consists of landfill cells oriented in an east-west direction, and Design Alternative 2 proposes landfill cells in a north-south direction.

The landfill geometry incorporates a 30 m wide stability / containment berm 3.5 m high with 4 horizontal to 1 vertical side slopes. The top of the containment berm is situated at Elevation 68.5 m. The landfill mound rises at an inclination of 4 horizontal to 1 vertical to elevation 75.5 m, and further rises at 3% to Elevation 81 m.

The proposed landfill geometry utilized for our analysis in the Conceptual Design Report by HDR is enclosed in Appendix F. Terrapex has carried out an assessment of the stability of the highest section of proposed landfill geometry shown on Cross Section A for Design Alternative 1. It is noted that Cross Section E for Design Alternative 2 shows the same geometry, and accordingly the results of the analysis of Cross Section A would also apply to Cross Section E.

The slope stability analysis was carried out utilizing the soil and groundwater information obtained during the Geotechnical Investigation and Hydrogeological Assessment. The subsurface soil profile adopted for our analysis consists of the most adverse soil conditions encountered at the Site; in Borehole MW20-2.

The stability analyses were carried out using the GEO5 2022 Slope Stability software package. The program was configured to calculate the minimum factor of safety for moment equilibrium assuming circular failure surfaces. The Bishop method employing both effective and total stresses were used to calculate the minimum factors of safety against circular failure for drained and undrained conditions, respectively.

The soil and groundwater conditions used in the analyses were based on the findings of the boreholes, monitoring wells, and results of laboratory testing. The properties of the waste material were determined based on information provided by the client, laboratory results in published papers, and our experience on similar projects. The soil properties selected for the analysis are summarized in the following table:

Parameter	Stiff Clay	Firm Clay	Soft Clay	Till	Waste Material
Unit Weight (kN/m^3)	18	17	16	20	14
Undrained Shear Strength (kPa)	100	40	20	-	-
Internal Angle of Friction (degrees)	28	25	22	32	29
Effective Cohesion (kPa)	0	0	0	0	20

The seismic analysis was carried out by the inclusion of a Horizontal Seismic Coefficient (K_h) to the static slope stability analysis. The K_h value was calculated based on the Peak Ground Acceleration (PGA) of the subject Site prescribed in the Ontario Building Code 2015 of 0.375 g. The determination of K_h for the analysis of earth berms is obtained by factoring PGA by a value ranging from 0.33 to 0.50. As a conservative measure, the upper limit of the range (0.50 of PGA) was selected for the analysis which provides a K_h value of 0.1875. For earth berms which may tolerate minor displacement, K_{hE} may be used for analysis which was calculated by factoring K_h by 0.5. The K_{hE} coefficient selected for the analysis of the landfill cell is 0.0938.

For the purpose of landfill design, the acceptable factor of safety with regards to static slope stability is 1.50. The minimum factor of safety for seismic analysis is 1.0.

The results of the stability analysis for Cross Section A, with worst case soil conditions, and leachate level near the top of the landfill are included with this report in Appendix G and are summarized in the following table. It should however be noted that assuming the leachate level near the top of the landfill due to failure in leachate collection system coinciding with an earthquake event is a conservative assumption, with negligible likelihood.

Static Analysis		**Pseudo-Static Seismic Analysis**	
Undrained Conditions	Drained Conditions	Undrained Conditions	Drained Conditions
1.88	2.21	1.01	1.29

The results of the stability analyses reveal that undrained seismic conditions are the controlling conditions for the design of the proposed landfill cells. The results of our analysis reveal that the proposed landfill geometry for the worse case soil and leachate level conditions meet their respective factors of safety and are therefore considered to be satisfactory for slope stability.

6.6 CONCLUSIONS

Based on the results of the Geotechnical Investigation and the landfill design concept proposed for the Site, construction of a landfill at this Site is feasible from a Geotechnical perspective provided that the landfill and LCS designs account for the anticipated total and differential settlement resulting from the applied loads from the landfill cells, and that a stable subgrade is provided to facilitate construction of the LCS.

6.7 CONSTRUCTION INSPECTIONS AND MONITORING

The recommendations presented in this report are based on the assumption that adequate and satisfactory inspections and monitoring during construction by qualified geotechnical personnel will be provided.

7 LIMITATIONS OF REPORT

The Limitations of Report, as quoted in Appendix ‘A’, are an integral part of this report.

Yours respectfully,
Terrapex Environmental Ltd.

LICENSED PROFESSIONAL ENGINEER
V. NERSESIAN
33778705
Sept 13, 2022
PROVINCE OF ONTARIO

Kellen Campbell, C.Tech.
Manager, Geotechnical Investigations

Vic Nersesian, P.Eng.
Senior Geotechnical Engineer

APPENDIX A

LIMITATIONS OF REPORT

LIMITATIONS OF REPORT

The findings and soil data presented in this report are based on information determined at the inspection locations. Soil and groundwater conditions between and beyond the test holes may differ from those encountered at the test hole locations, and conditions may become apparent during construction which could not be detected or anticipated at the time of the soil investigation.

The data given in this report are applicable only to the project described in the text, and then only if constructed substantially in accordance with details of alignment stated in the report.

This report was prepared for GFL Environmental Inc. by Terrapex. The material in it reflects Terrapex's judgement in light of the information available to it at the time of preparation. Any use which a Third Party makes of this report, or any reliance on decisions which the Third Party may make based on it, are the sole responsibility of such Third Parties.

We recommend, therefore, that we be retained during the final design stage to review the design drawings and to verify that they are consistent with our assumptions made during the investigation. We recommend also that we be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in the test holes. In cases where these recommendations are not followed, the company's responsibility is limited to accurately interpreting the conditions encountered at the test holes, only.

The number of inspection locations may not be sufficient to determine all the factors that may affect construction methods and costs. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work.

APPENDIX B

BOREHOLE LOCATION PLAN

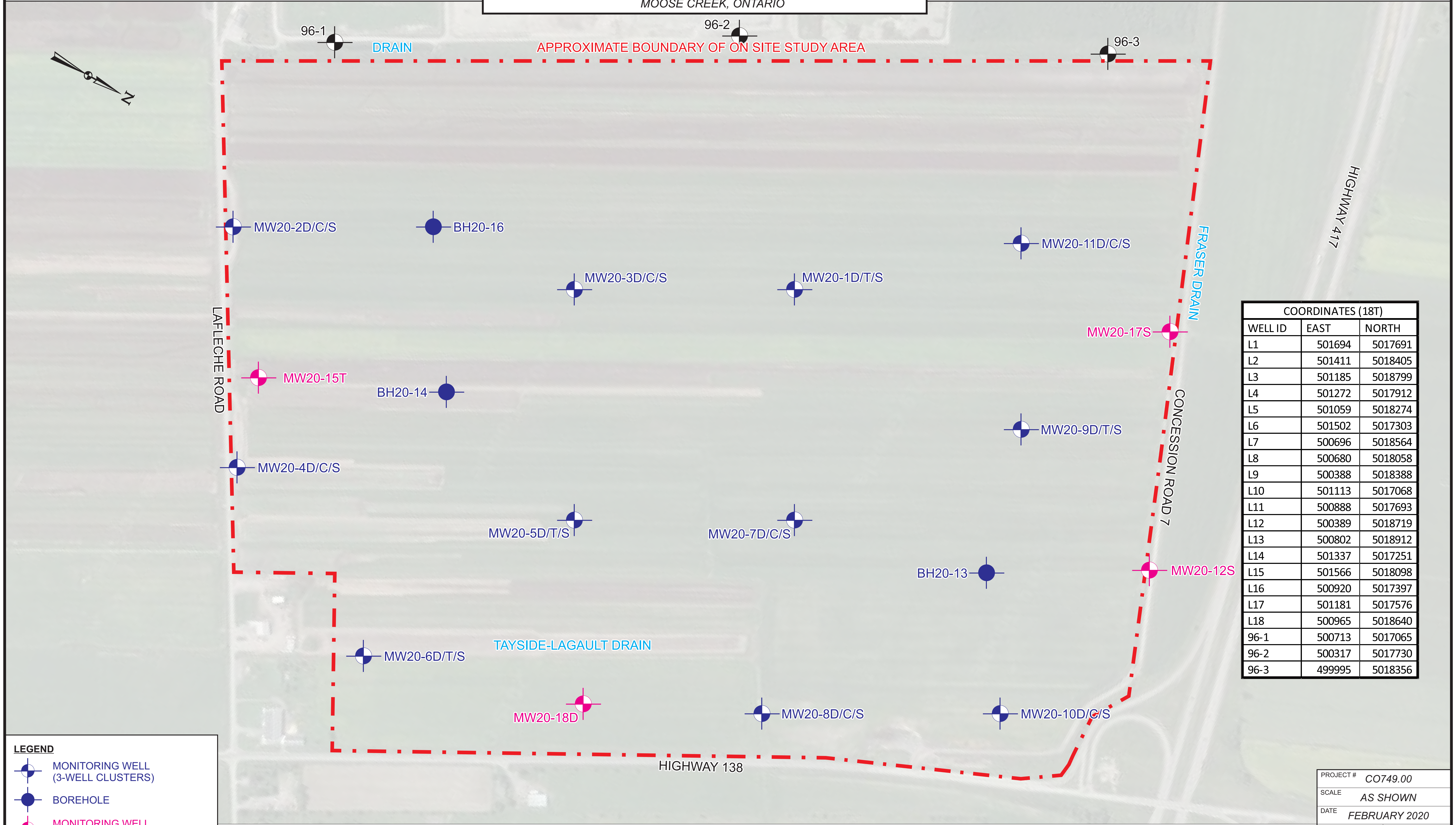
TERRAPEX

BOREHOLE LOCATION PLAN

EASTERN HALF OF LOT 16 & LOTS 13-15
OF CONCESSION 10, TWP. OF NORTH STORMONT
MOOSE CREEK, ONTARIO

CLIENT

GFL environmental



COORDINATES (18T)		
WELL ID	EAST	NORTH
L1	501694	5017691
L2	501411	5018405
L3	501185	5018799
L4	501272	5017912
L5	501059	5018274
L6	501502	5017303
L7	500696	5018564
L8	500680	5018058
L9	500388	5018388
L10	501113	5017068
L11	500888	5017693
L12	500389	5018719
L13	500802	5018912
L14	501337	5017251
L15	501566	5018098
L16	500920	5017397
L17	501181	5017576
L18	500965	5018640
96-1	500713	5017065
96-2	500317	5017730
96-3	499995	5018356

LEGEND

- ⊕ MONITORING WELL (3-WELL CLUSTERS)
- ● BOREHOLE
- ⊕ MONITORING WELL (SINGLE INSTALLATION)
- ⊕ EXISTING MONITORING WELL

SOURCE: VU MAP FIRST BASE SOLUTIONS, 2018 IMAGERY.

NOTES: DEEP WELL INSTALLED IN BEDROCK. SHALLOW WELL INSTALLED IN WEATHERED CLAY. INTERMEDIATE WELL INSTALLED IN CLAY (CL) OR TILL (T).

0 100m 200m
(APPROXIMATE)

PROJECT # CO749.00
SCALE AS SHOWN
DATE FEBRUARY 2020
DRAWN SW
CHECKED
DRAWING #
FIGURE 1

APPENDIX C

BOREHOLE LOG SHEETS

CLIENT: GFL

PROJECT: GFL EOWHF Expansion Project

LOCATION: 17125 Lafleche Road, Moosecreek

METHOD: Casing/coring/split spoon sampling

PROJECT ENGINEER:

ELEV. (m) 66.64

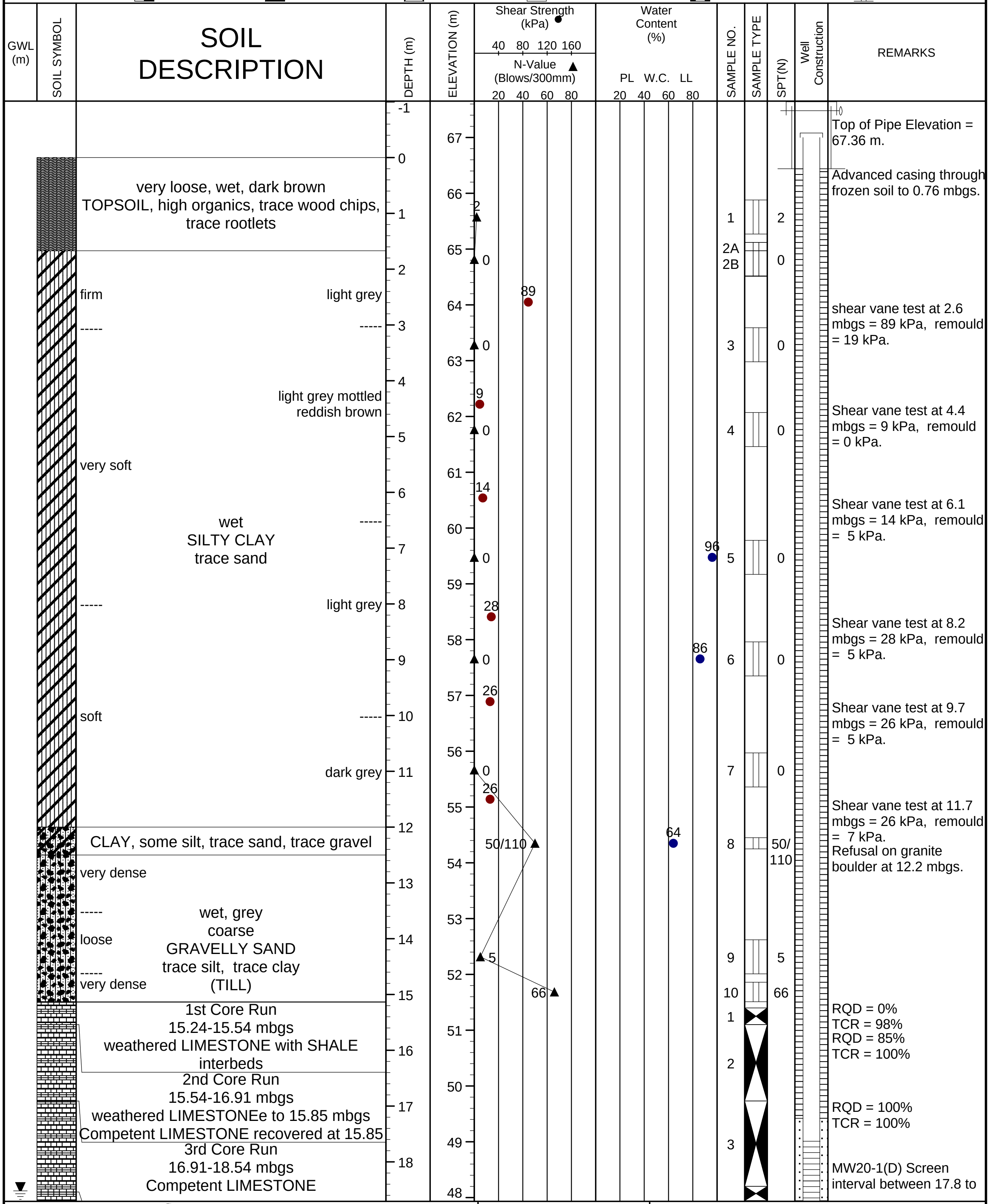
NORTHING: 5018053

EASTING: 500681

MW20-1(D)

PROJECT NO.: CO749.00

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON



SOIL DESCRIPTION

very loose, wet, dark brown
TOPSOIL, high organics, trace wood chips,
trace rootlets

firm — light grey
-----
light grey mottled reddish brown
very soft
-----
wet
SILTY CLAY
trace sand
-----
light grey
soft
-----
dark grey

CLAY, some silt, trace sand, trace gravel

very dense
-----
loose
-----
very dense
wet, grey
coarse
GRAVELLY SAND
trace silt, trace clay
(TILL)

1st Core Run
15.24-15.54 mbgs
weathered LIMESTONE with SHALE
interbeds

2nd Core Run
15.54-16.91 mbgs
weathered LIMESTONEe to 15.85 mbgs
Competent LIMESTONE recovered at 15.85

3rd Core Run
16.91-18.54 mbgs
Competent LIMESTONE

SAMPLE NO.	SPT(N)
1	2
2A 2B	0
3	0
4	0
5	0
6	0
7	0
8	50/ 110
9	5
10	66
1	
2	
3	

REMARKS

Top of Pipe Elevation = 67.36 m.

Advanced casing through frozen soil to 0.76 mbgs.

shear vane test at 2.6 mbgs = 89 kPa, remould = 19 kPa.

Shear vane test at 4.4 mbgs = 9 kPa, remould = 0 kPa.

Shear vane test at 6.1 mbgs = 14 kPa, remould = 5 kPa.

Shear vane test at 8.2 mbgs = 28 kPa, remould = 5 kPa.

Shear vane test at 9.7 mbgs = 26 kPa, remould = 5 kPa.

Shear vane test at 11.7 mbgs = 26 kPa, remould = 7 kPa.
Refusal on granite boulder at 12.2 mbgs.

RQD = 0%
TCR = 98%
RQD = 85%
TCR = 100%

RQD = 100%
TCR = 100%

MW20-1(D) Screen interval between 17.8 to

TERRAPEX

LOGGED BY: RH

REVIEWED BY: SR

DRILLING DATE: Jan 21-22, 2020

CLIENT: GFL	METHOD: Casing/coring/split spoon sampling		**MW20-1(D)**
PROJECT: GFL EOWHF Expansion Project	PROJECT ENGINEER:	ELEV. (m) 66.64	
LOCATION: 17125 Lafleche Road, Moosecreek	NORTHING: 5018053	EASTING: 500681	PROJECT NO.: CO749.00

SAMPLE TYPE ◨ AUGER ◢ DRIVEN ⧓ CORING ⬒ DYNAMIC CONE ▯ SHELBY ⌶ SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) ● 40 80 120 160 N-Value (Blows/300mm) ▲ 20 40 60 80	Water Content (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	Well Construction	REMARKS
	▦	50 mm clay seam at 17.1 mbgs 4th Core Run 18.54-19.38 mbgs Competent LIMESTONE	19				4	⧓			19.4 mbgs. RQD = 100% TCR = 100%
		END OF BOREHOLE									

TERRAPEX

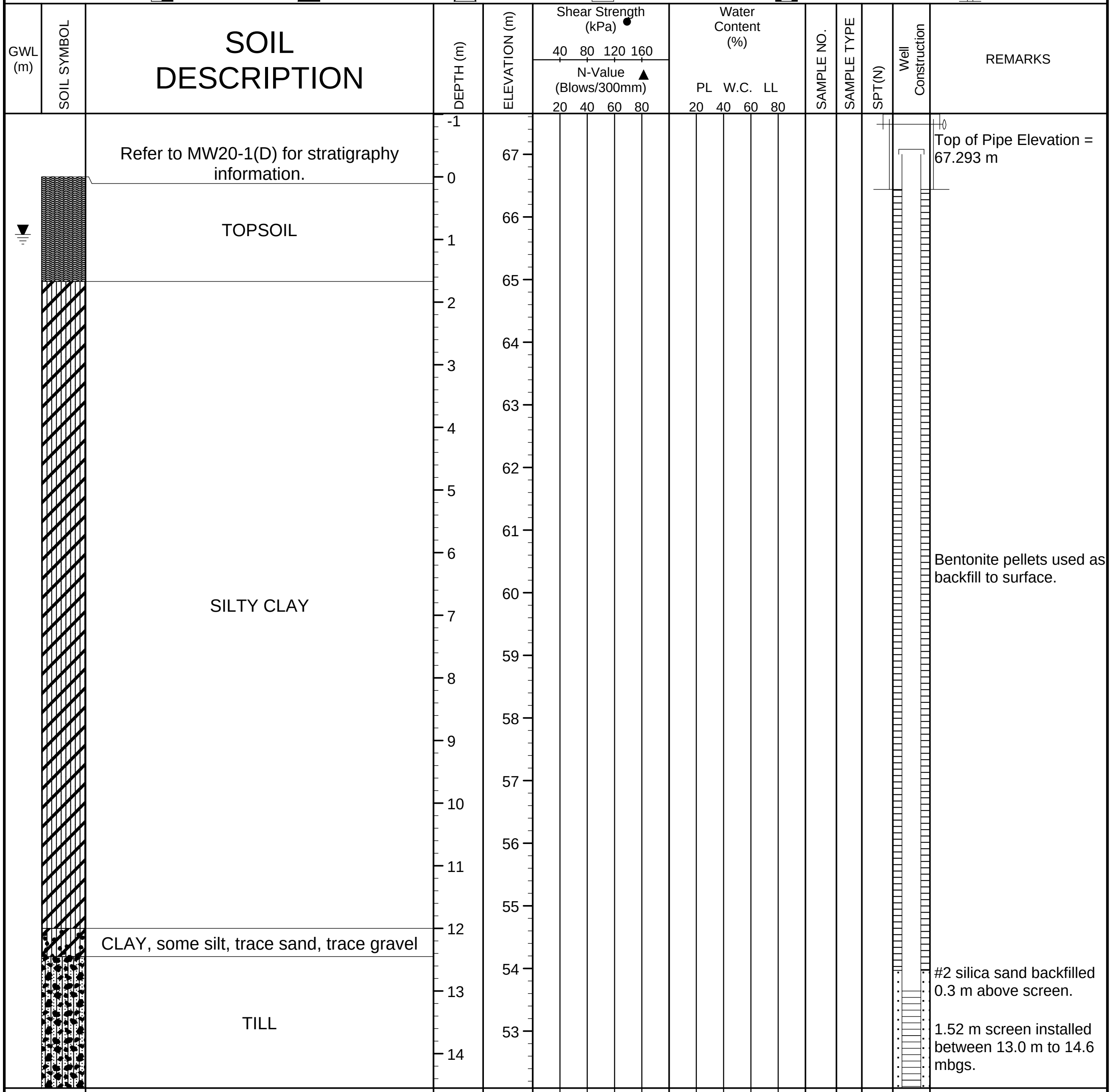
LOGGED BY: RH

DRILLING DATE: Jan 21-22, 2020

REVIEWED BY: SR

CLIENT: GFL	METHOD: Casing		**MW20-1(T)**
PROJECT: GFL EOWHF Expansion Project	PROJECT ENGINEER:	ELEV. (m) 66.64	
LOCATION: 17125 Lafleche Road, Moosecreek	NORTHING: 5018054	EASTING: 500679	PROJECT NO.: CO749.00

SAMPLE TYPE ◨ AUGER ◢ DRIVEN ⧓ CORING ⬒ DYNAMIC CONE ▯ SHELBY ⌶ SPLIT SPOON



SOIL DESCRIPTION

Refer to MW20-1(D) for stratigraphy information.

TOPSOIL

SILTY CLAY

CLAY, some silt, trace sand, trace gravel

TILL

END OF BOREHOLE

REMARKS

Top of Pipe Elevation = 67.293 m

Bentonite pellets used as backfill to surface.

#2 silica sand backfilled 0.3 m above screen.

1.52 m screen installed between 13.0 m to 14.6 mbgs.

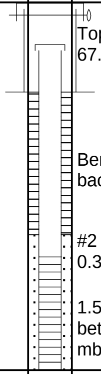
TERRAPEX

	LOGGED BY: RH	DRILLING DATE: Jan 24, 2020
	REVIEWED BY: SR	Page 1 of 1

CLIENT: GFL	METHOD: Casing		# MW20-1(S)
PROJECT: GFL EOWHF Expansion Project	PROJECT ENGINEER:	ELEV. (m) 66.64	
LOCATION: 17125 Lafleche Road, Moosecreek	NORTHING: 5018055	EASTING: 500680	PROJECT NO.: CO749.00

SAMPLE TYPE ◧ AUGER ◪ DRIVEN ⧓ CORING ⬒ DYNAMIC CONE ▯ SHELBY ⌶ SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) ● 40 80 120 160 N-Value (Blows/300mm) ▲ 20 40 60 80	Water Content (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	Well Construction	REMARKS
		Refer to MW20-1(D) for stratigraphy information.	-1	67							Top of Pipe Elevation = 67.277 m.
▼	▩	TOPSOIL	0 1	66 65							Bentonite pellets used as backfill to surface.
	▨	SILTY CLAY	2 3	64 63							#2 silica sand backfilled 0.3 m above screen. 1.52 m screen installed between 2.4 m to 3.8 mbgs.
		END OF BOREHOLE									



TERRAPEX	LOGGED BY: RH	DRILLING DATE: Jan 24, 2020
	REVIEWED BY: SR	Page 1 of 1

CLIENT: GFL

METHOD: Casing/coring/split spoon sampling

MW20-2(D)

PROJECT: GFL EOWHF Expansion Project

PROJECT ENGINEER:

ELEV. (m) 67.94

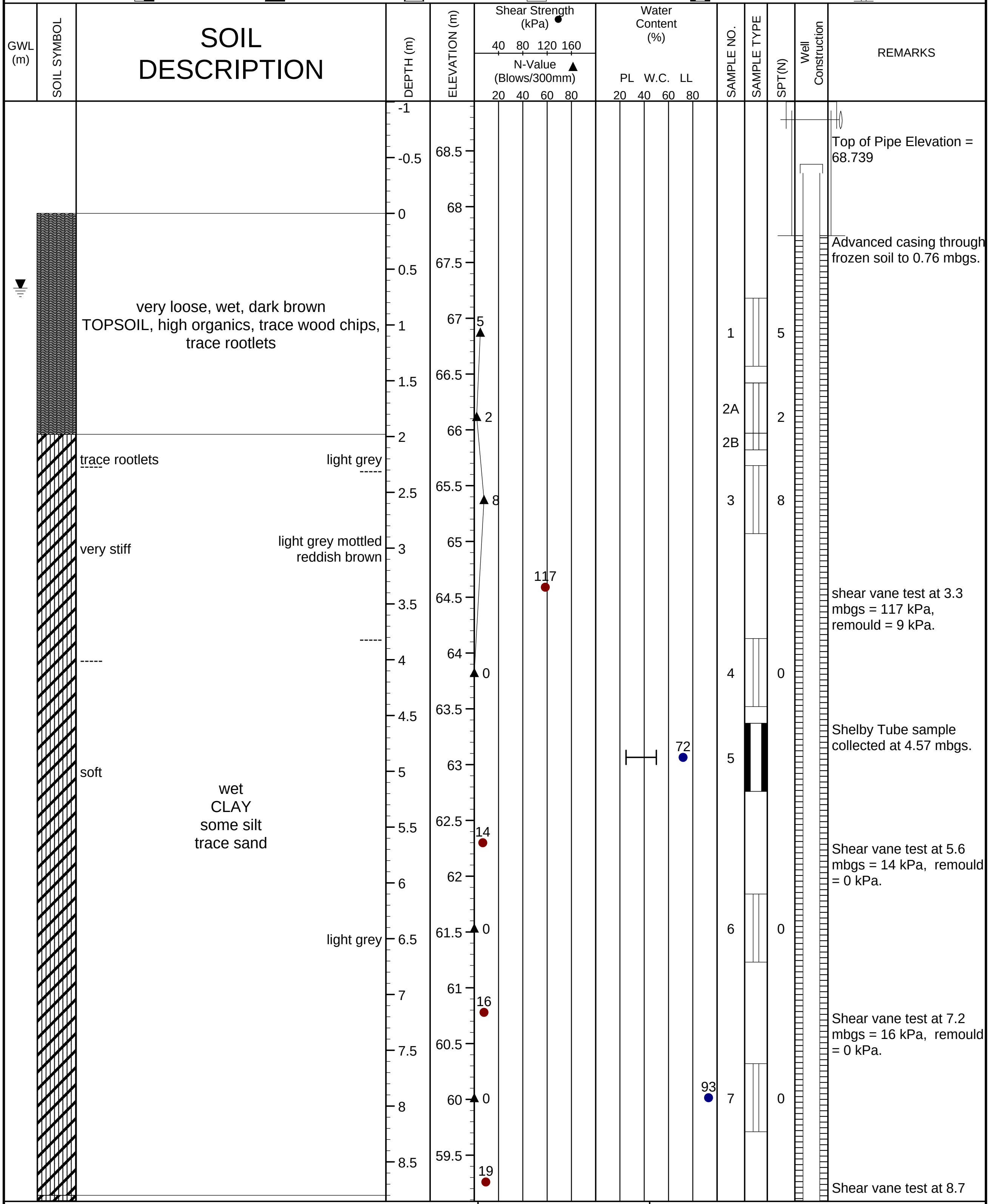
LOCATION: 17125 Lafleche Road, Moosecreek

NORTHING: 5017078

EASTING: 501125

PROJECT NO.: CO749.00

SAMPLE TYPE AUGER DRIVEN CORING DYNAMIC CONE SHELBY SPLIT SPOON



SOIL DESCRIPTION

very loose, wet, dark brown TOPSOIL, high organics, trace wood chips, trace rootlets

trace rootlets

light grey

very stiff

light grey mottled reddish brown

soft

wet CLAY some silt trace sand

light grey

REMARKS

Top of Pipe Elevation = 68.739

Advanced casing through frozen soil to 0.76 mbgs.

shear vane test at 3.3 mbgs = 117 kPa, remould = 9 kPa.

Shelby Tube sample collected at 4.57 mbgs.

Shear vane test at 5.6 mbgs = 14 kPa, remould = 0 kPa.

Shear vane test at 7.2 mbgs = 16 kPa, remould = 0 kPa.

Shear vane test at 8.7

TERRAPEX

LOGGED BY: RH

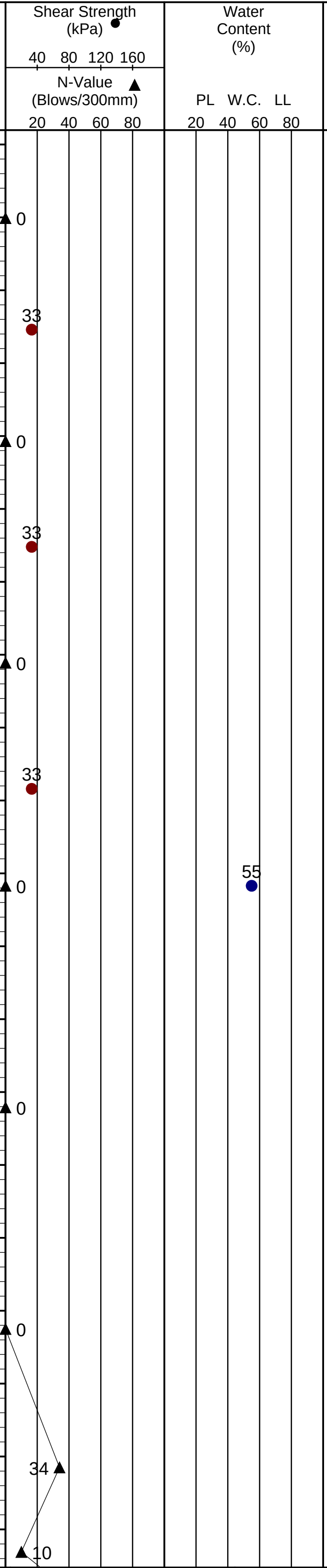
DRILLING DATE: Jan 23-27, 2020

REVIEWED BY: SR

CLIENT: GFL	METHOD: Casing/coring/split spoon sampling	**MW20-2(D)**
PROJECT: GFL EOWHF Expansion Project	PROJECT ENGINEER:	ELEV. (m) 67.94
LOCATION: 17125 Lafleche Road, Moosecreek	NORTHING: 5017078	EASTING: 501125
		PROJECT NO.: CO749.00

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON

GWL (m)	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	SAMPLE NO.	SPT(N)	REMARKS
	CLAY some silt trace sand; soft, light grey	9	59			mbgs = 19 kPa, remould = 1 kPa.
		9.5	58.5	8	0	
	----- firm, dark grey	10	58			Shear vane test at 10.2 mbgs = 33 kPa, remould = 4 kPa.
		10.5	57.5			
		11	57	9	0	
		11.5	56.5			Shear vane test at 11.7 mbgs = 33 kPa, remould = 2 kPa.
	wet CLAY and SILT trace sand	12	56			
		12.5	55.5	10	0	
		13	55			Shear vane test at 13.3 mbgs = 33 kPa, remould = 4 kPa.
		13.5	54.5			
		14	54	11	0	
		14.5	53.5			
	----- grey with black speckling	15	53			
		15.5	52.5	12	0	
		16	52			
	----- grey	16.5	51.5			
		17	51	13	0	
		17.5	50.5			
	----- wet, grey, coarse GRAVELLY SAND trace silt, trace clay (TILL); dense	18	50	14	34	Encountered Till layer at 17.8 mbgs.
	----- compact	18.5	49.5	15	10	



LOGGED BY: RH	DRILLING DATE: Jan 23-27, 2020
REVIEWED BY: SR	Page 2 of 3

CLIENT: GFL

METHOD: Casing/coring/split spoon sampling

MW20-2(D)

PROJECT: GFL EOWHF Expansion Project

PROJECT ENGINEER:

ELEV. (m) 67.94

LOCATION: 17125 Lafleche Road, Moosecreek

NORTHING: 5017078

EASTING: 501125

PROJECT NO.: CO749.00

SAMPLE TYPE AUGER DRIVEN CORING DYNAMIC CONE SHELBY SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) ● 40 80 120 160 / N-Value ▲ (Blows/300mm) 20 40 60 80	Water Content (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	Well Construction	REMARKS
		wet, grey, coarse GRAVELLY SAND trace silt, trace clay (TILL) ----- very dense	19	49	70/125 ▲		16		70/ 125		
		1st Core Run 19.2 - 20.0 mbgs dark grey to black highly weathered SHALE (possible TILL)	19.5	48.5			1				RQD = 22% TCR = 42%
		2nd Core Run 20.0 - 21.5 mbgs dark grey to black moderate to highly fractured SHALE with clay seams	20 20.5 21	48 47.5 47			2				RQD = 9% TCR = 53%
		3rd Core Run 21.5 - 21.8 mbgs dark grey moderate to highly fractured, weathered SHALE with occassional silt and clay seams	21.5 22	46.5 46			3 4				RQD = 0% TCR = 87% RQD = 57% TCR = 73%
		4th Core Run 21.8 - 23.0 mbgs dark grey moderately fractured competent LIMESTONE 50 mm clay seam at 22.2 mbgs.	22.5 23	45.5 45							RQD = 72% TCR = 98%
		5th Core Run 23.0 - 24.4 mbgs dark grey competent LIMESTONE with SHALE interbeds 127 mm void at 23.7 mbgs.	23.5 24	44.5 44			5				MW20-2(D) Screen interval between 23.8 to 25.3 mbgs.
		6th Core Run 24.4 - 25.3 mbgs dark grey copmetent LIMESTONE with SHALE interbeds	24.5 25	43.5 43			6				RQD = 94% TCR = 98%
		END OF BOREHOLE									

TERRAPEX

LOGGED BY: RH

DRILLING DATE: Jan 23-27, 2020

REVIEWED BY: SR

CLIENT: GFL

METHOD: Casing

MW20-2(C)

PROJECT: GFL EOWHF Expansion Project

PROJECT ENGINEER:

ELEV. (m) 67.94

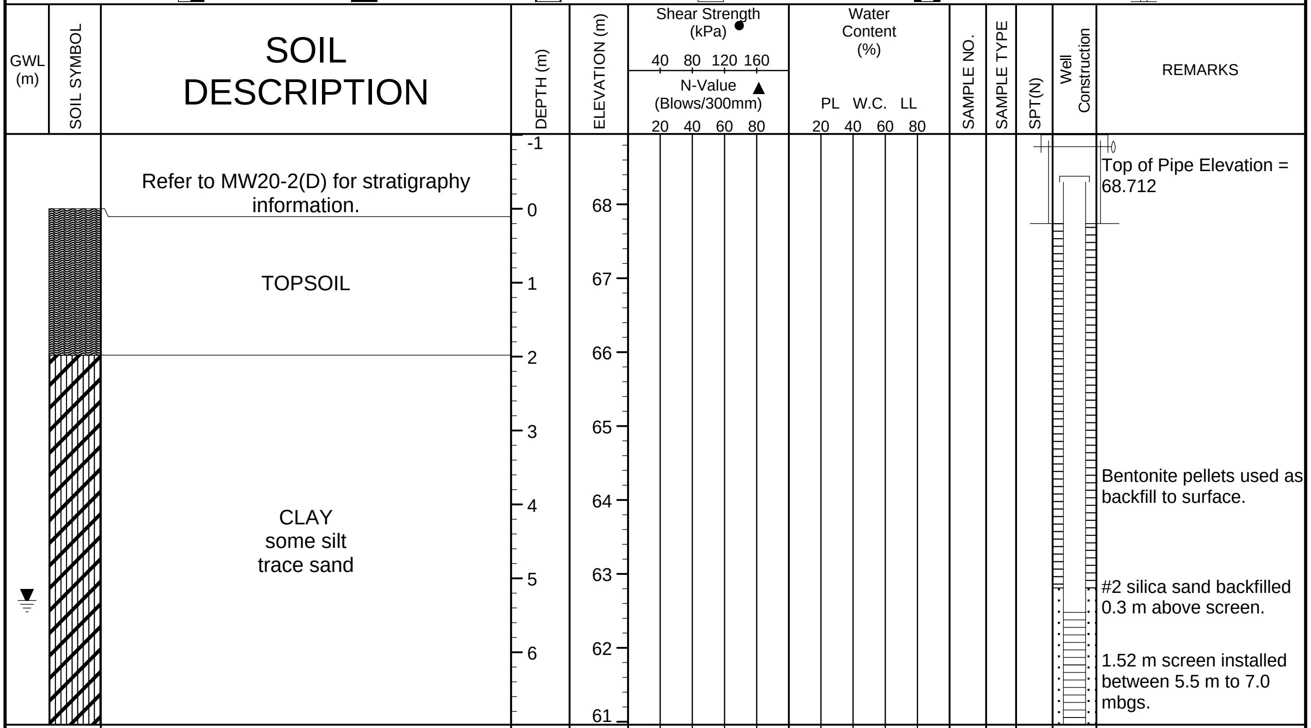
LOCATION: 17125 Lafleche Road, Moosecreek

NORTHING: 5017079

EASTING: 501124

PROJECT NO.: CO749.00

SAMPLE TYPE: ◧ AUGER ◪ DRIVEN ⧓ CORING ▀ DYNAMIC CONE ▯ SHELBY ⌶ SPLIT SPOON



SOIL DESCRIPTION

Refer to MW20-2(D) for stratigraphy information.

TOPSOIL

CLAY
some silt
trace sand

END OF BOREHOLE

REMARKS:

Top of Pipe Elevation = 68.712

Bentonite pellets used as backfill to surface.

#2 silica sand backfilled 0.3 m above screen.

1.52 m screen installed between 5.5 m to 7.0 mbgs.

TERRAPEX

LOGGED BY: RH

DRILLING DATE: Jan 27, 2020

REVIEWED BY: SR

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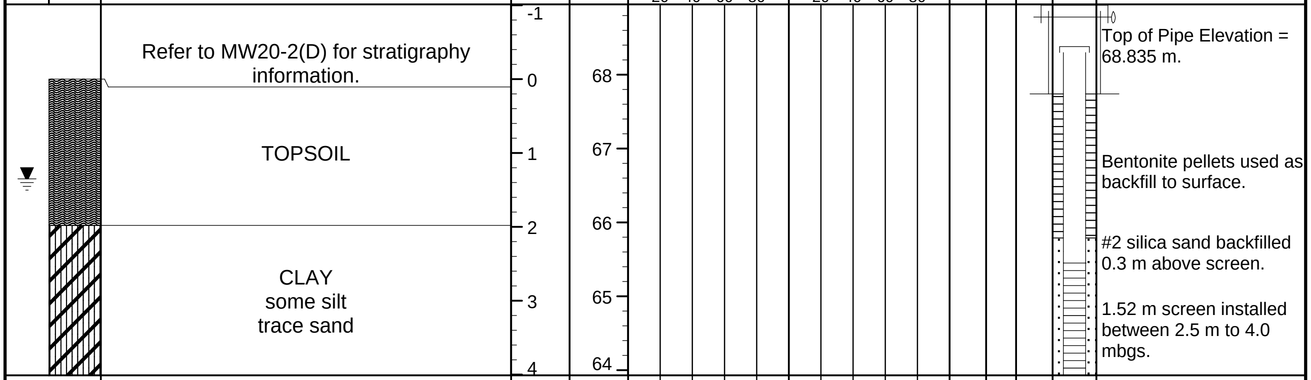
CLIENT: GFL	METHOD: Casing		**MW20-2(S)**
PROJECT: GFL EOWHF Expansion Project	PROJECT ENGINEER:	ELEV. (m) 67.94	
LOCATION: 17125 Lafleche Road, Moosecreek	NORTHING: 5017078	EASTING: 501123	PROJECT NO.: CO749.00

SAMPLE TYPE ▮ AUGER ◢ DRIVEN ⧓ CORING ▀ DYNAMIC CONE ▯ SHELBY ⌶ SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) ● 40 80 120 160 N-Value (Blows/300mm) ▲ 20 40 60 80	Water Content (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	Well Construction	REMARKS



Refer to MW20-2(D) for stratigraphy information.

TOPSOIL

CLAY
some silt
trace sand

END OF BOREHOLE

Top of Pipe Elevation = 68.835 m.

Bentonite pellets used as backfill to surface.

#2 silica sand backfilled 0.3 m above screen.

1.52 m screen installed between 2.5 m to 4.0 mbgs.

TERRAPEX

LOGGED BY: RH	DRILLING DATE: Jan 27, 2020
REVIEWED BY: SR	Page 1 of 1

CLIENT: GFL

METHOD: Casing/coring/split spoon sampling

MW20-3(D)

PROJECT: GFL EOWHF Expansion Project

PROJECT ENGINEER:

ELEV. (m) 67.21

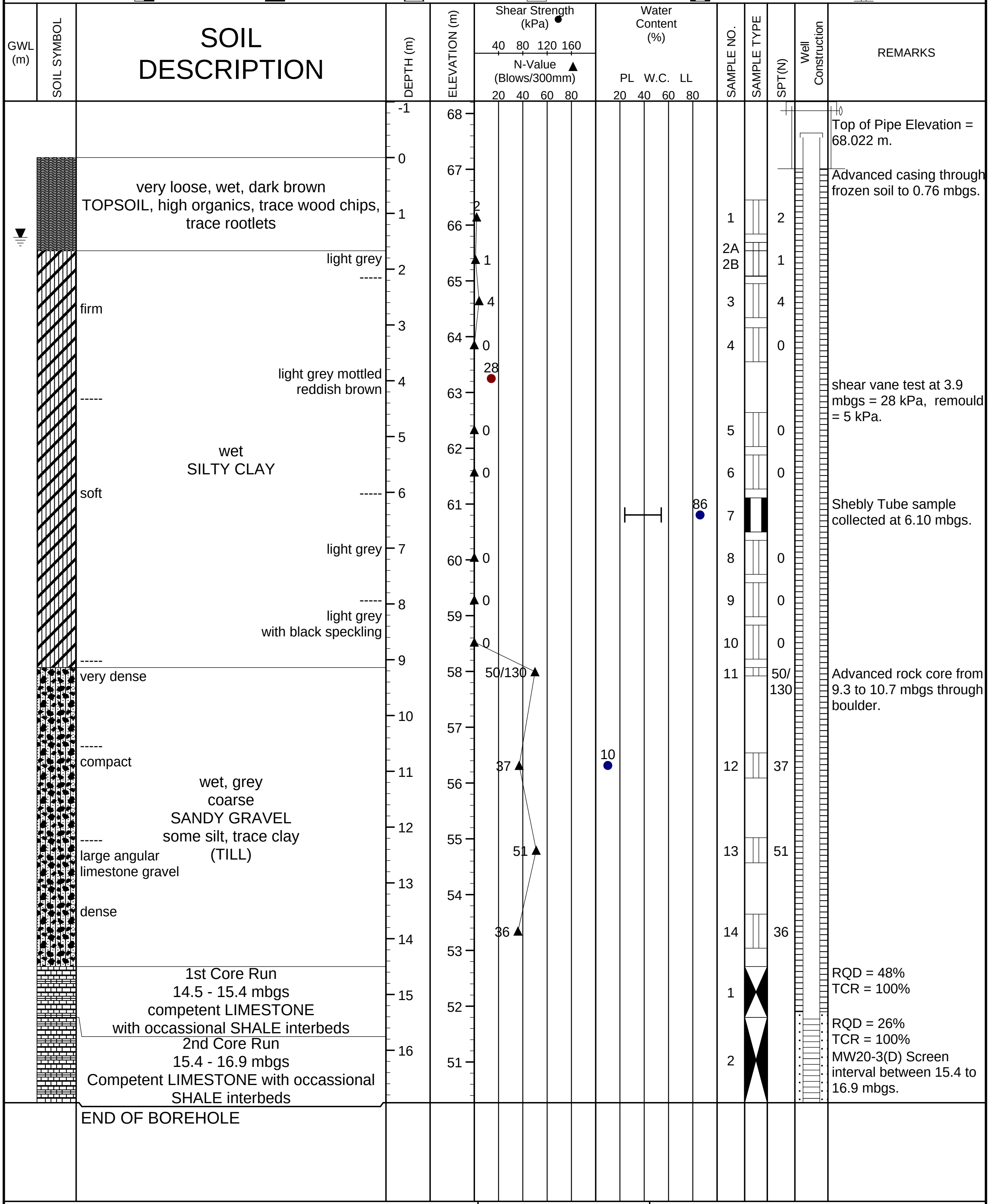
LOCATION: 17125 Lafleche Road, Moosecreek

NORTHING: 5017691

EASTING: 500889

PROJECT NO.: CO749.00

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON



very loose, wet, dark brown TOPSOIL, high organics, trace wood chips, trace rootlets

wet SILTY CLAY

light grey

firm

light grey mottled reddish brown

soft

light grey

light grey with black speckling

wet, grey coarse SANDY GRAVEL some silt, trace clay (TILL)

very dense

compact

large angular limestone gravel

dense

1st Core Run 14.5 - 15.4 mbgs competent LIMESTONE with occassional SHALE interbeds

2nd Core Run 15.4 - 16.9 mbgs Competent LIMESTONE with occassional SHALE interbeds

END OF BOREHOLE

SAMPLE NO.	SPT(N)
1	2
2A 2B	1
3	4
4	0
5	0
6	0
7	
8	0
9	0
10	0
11	50/130
12	37
13	51
14	36
1	
2	

Top of Pipe Elevation = 68.022 m.

Advanced casing through frozen soil to 0.76 mbgs.

shear vane test at 3.9 mbgs = 28 kPa, remould = 5 kPa.

Shebly Tube sample collected at 6.10 mbgs.

Advanced rock core from 9.3 to 10.7 mbgs through boulder.

RQD = 48%
TCR = 100%

RQD = 26%
TCR = 100%
MW20-3(D) Screen interval between 15.4 to 16.9 mbgs.

TERRAPEX

LOGGED BY: JM

DRILLING DATE: Jan 24-27, 2020

REVIEWED BY: SR

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MW20-3(C)

CLIENT: GFL

PROJECT: GFL EOWHF Expansion Project

LOCATION: 17125 Lafleche Road, Moosecreek

METHOD: Casing

PROJECT ENGINEER:

NORTHING: 5017693

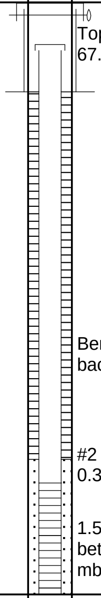
ELEV. (m) 67.21

EASTING: 500888

PROJECT NO.: CO749.00

SAMPLE TYPE ▌ AUGER ◢ DRIVEN ⧓ CORING ▀ DYNAMIC CONE ▐▌ SHELBY ⌶ SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) ● 40 80 120 160 N-Value (Blows/300mm) ▲ 20 40 60 80	Water Content (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	Well Construction	REMARKS
		Refer to MW20-3(D) for stratigraphy information.	-1	68							Top of Pipe Elevation = 67.918 m.
	▩	TOPSOIL	0 1	67 66							
▼	▨	SILTY CLAY	2 3 4 5 6 7	65 64 63 62 61							Bentonite pellets used as backfill to surface. #2 silica sand backfilled 0.3 m above screen. 1.52 m screen installed between 5.5 m to 7.0 mbgs.
		END OF BOREHOLE									



TERRAPEX

LOGGED BY: RH

REVIEWED BY: SR

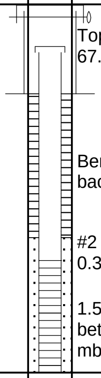
DRILLING DATE: Jan 27, 2020

CLIENT: GFL
METHOD: Casing
PROJECT: GFL EOWHF Expansion Project
PROJECT ENGINEER:
ELEV. (m) 67.21

MW20-3(S)

LOCATION: 17125 Lafleche Road, Moosecreek
NORTHING: 5017695
EASTING: 500887
PROJECT NO.: CO749.00

SAMPLE TYPE ▮ AUGER ◩ DRIVEN ⧗ CORING ▬ DYNAMIC CONE ▯ SHELBY ⌶ SPLIT SPOON



GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) ● 40 80 120 160 N-Value (Blows/300mm) ▲ 20 40 60 80	Water Content (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	Well Construction	REMARKS
		Refer to MW20-3(D) for stratigraphy information.	-1	68							Top of Pipe Elevation = 67.913 m.
		TOPSOIL	0 1	67 66							Bentonite pellets used as backfill to surface.
▼		SILTY CLAY	2 3	65 64							#2 silica sand backfilled 0.3 m above screen. 1.52 m screen installed between 2.5 m to 3.9 mbgs.
		END OF BOREHOLE									

TERRAPEX
LOGGED BY: RH
DRILLING DATE: Jan 29, 2020
REVIEWED BY: SR
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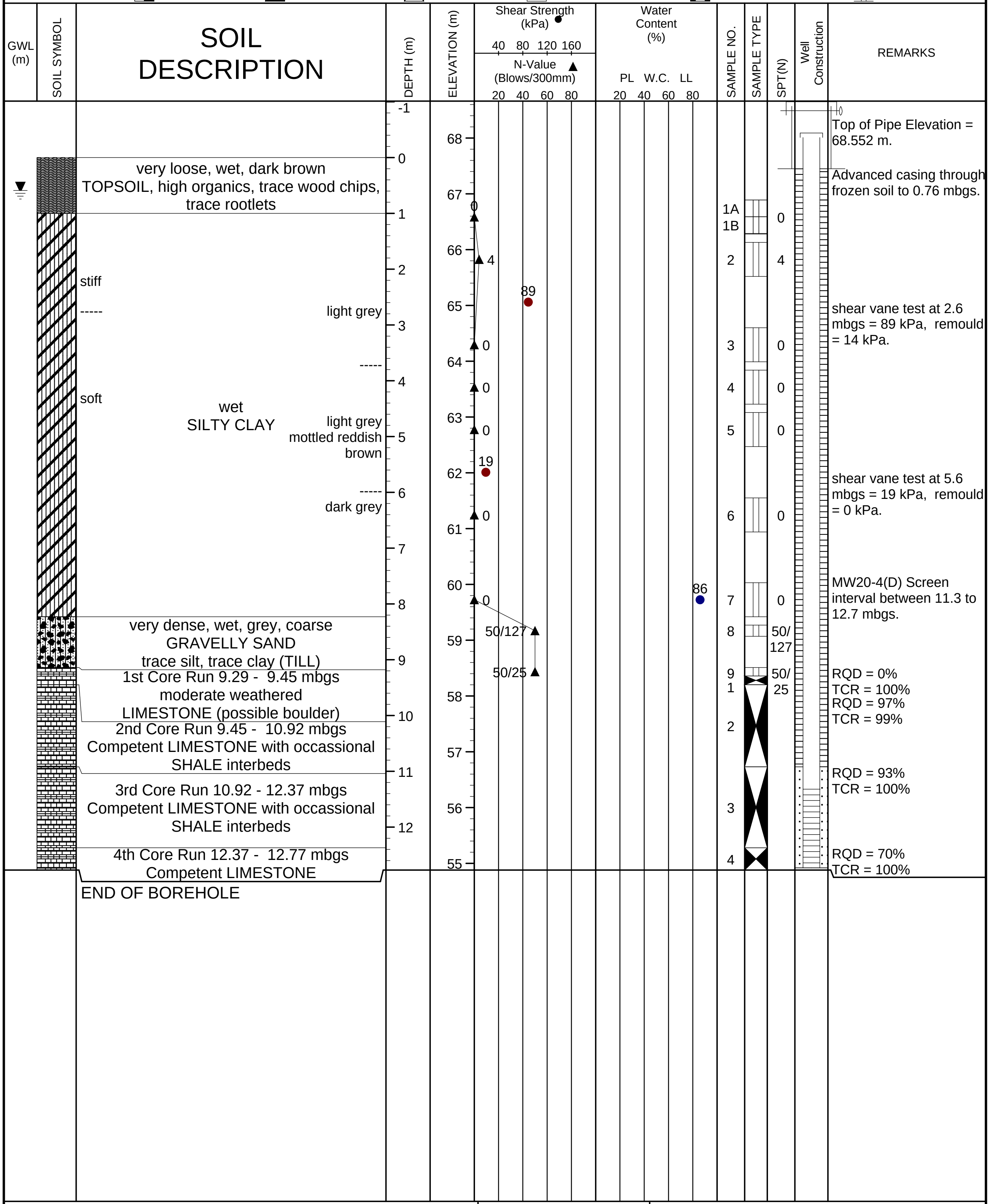
CLIENT: GFL	METHOD: Casing/coring/split spoon sampling		**MW20-4(D)**
PROJECT: GFL EOWHF Expansion Project	PROJECT ENGINEER:	ELEV. (m) 67.65	
LOCATION: 17125 Lafleche Road, Moosecreek	NORTHING: 5017309	EASTING: 501501	PROJECT NO.: CO749.00

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON



very loose, wet, dark brown TOPSOIL, high organics, trace wood chips, trace rootlets

wet SILTY CLAY
stiff
-----
light grey
-----
soft
light grey
mottled reddish brown
-----
dark grey

very dense, wet, grey, coarse GRAVELLY SAND trace silt, trace clay (TILL)

1st Core Run 9.29 - 9.45 mbgs moderate weathered LIMESTONE (possible boulder)

2nd Core Run 9.45 - 10.92 mbgs Competent LIMESTONE with occassional SHALE interbeds

3rd Core Run 10.92 - 12.37 mbgs Competent LIMESTONE with occassional SHALE interbeds

4th Core Run 12.37 - 12.77 mbgs Competent LIMESTONE

END OF BOREHOLE

SAMPLE NO.	SPT(N)	REMARKS
		Top of Pipe Elevation = 68.552 m.
		Advanced casing through frozen soil to 0.76 mbgs.
1A 1B	0	
2	4	
		shear vane test at 2.6 mbgs = 89 kPa, remould = 14 kPa.
3	0	
4	0	
5	0	
		shear vane test at 5.6 mbgs = 19 kPa, remould = 0 kPa.
6	0	
		MW20-4(D) Screen interval between 11.3 to 12.7 mbgs.
7	0	
8	50/ 127	
9	50/ 25	RQD = 0% TCR = 100%
1		RQD = 97% TCR = 99%
2		
		RQD = 93% TCR = 100%
3		
4		RQD = 70% TCR = 100%

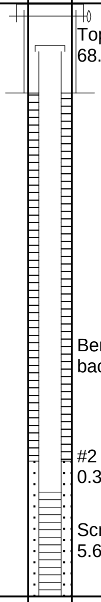
TERRAPEX

LOGGED BY: JM	DRILLING DATE: Jan 28-29, 2020
REVIEWED BY: SR	Page 1 of 1

CLIENT: GFL	METHOD: Casing		**MW20-4(C)**
PROJECT: GFL EOWHF Expansion Project	PROJECT ENGINEER:	ELEV. (m) 67.65	
LOCATION: 17125 Lafleche Road, Moosecreek	NORTHING: 5017310	EASTING: 501500	PROJECT NO.: CO749.00

SAMPLE TYPE ▯ AUGER ◪ DRIVEN ⧗ CORING ⬒ DYNAMIC CONE ▯ SHELBY ⌶ SPLIT SPOON

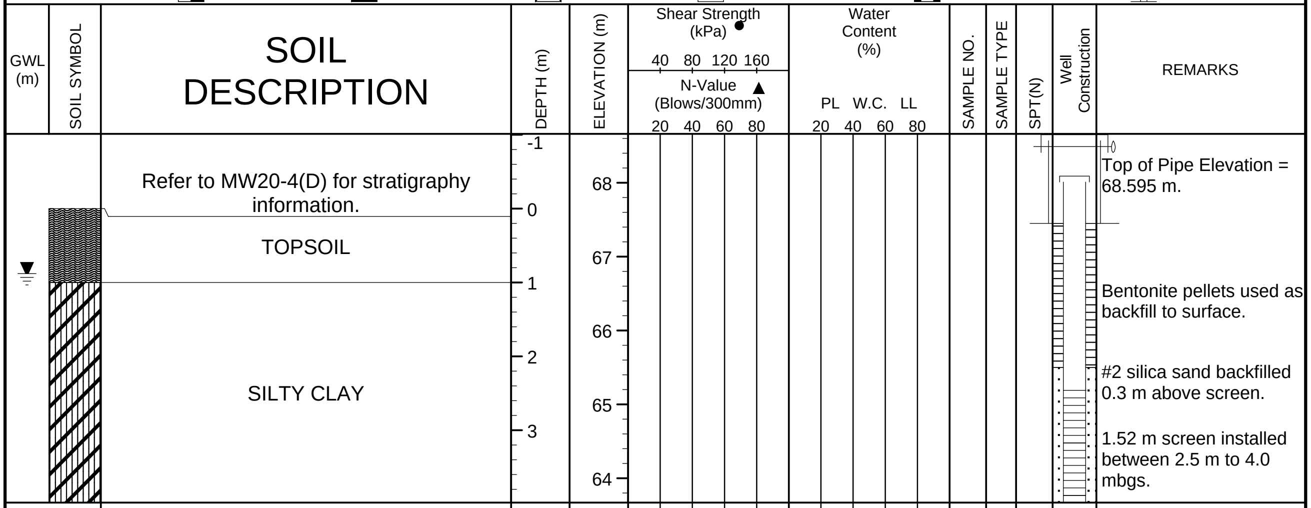
GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) ● 40 80 120 160 N-Value (Blows/300mm) ▲ 20 40 60 80	Water Content (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	Well Construction	REMARKS
		Refer to MW20-4(D) for stratigraphy information.	-1 to 0	68							Top of Pipe Elevation = 68.639
	▨	TOPSOIL	0 to 1	67							
▼	▨	SILTY CLAY	1 to 7	66, 65, 64, 63, 62, 61							Bentonite pellets used as backfill to surface. #2 silica sand backfilled 0.3 m above screen. Screen installed between 5.6 m to 7.0 mbgs.
		END OF BOREHOLE									



TERRAPEX	LOGGED BY: RH	DRILLING DATE: Jan 29, 2020
	REVIEWED BY: SR	Page 1 of 1

CLIENT: GFL	METHOD: Casing		**MW20-4(S)**
PROJECT: GFL EOWHF Expansion Project	PROJECT ENGINEER:	ELEV. (m) 67.65	
LOCATION: 17125 Lafleche Road, Moosecreek	NORTHING: 5017308	EASTING: 501500	PROJECT NO.: CO749.00

SAMPLE TYPE ◨ AUGER ◪ DRIVEN ⧓ CORING ⬒ DYNAMIC CONE ▯ SHELBY ⌶ SPLIT SPOON



SOIL DESCRIPTION

Refer to MW20-4(D) for stratigraphy information.

TOPSOIL

SILTY CLAY

END OF BOREHOLE

REMARKS

Top of Pipe Elevation = 68.595 m.

Bentonite pellets used as backfill to surface.

#2 silica sand backfilled 0.3 m above screen.

1.52 m screen installed between 2.5 m to 4.0 mbgs.

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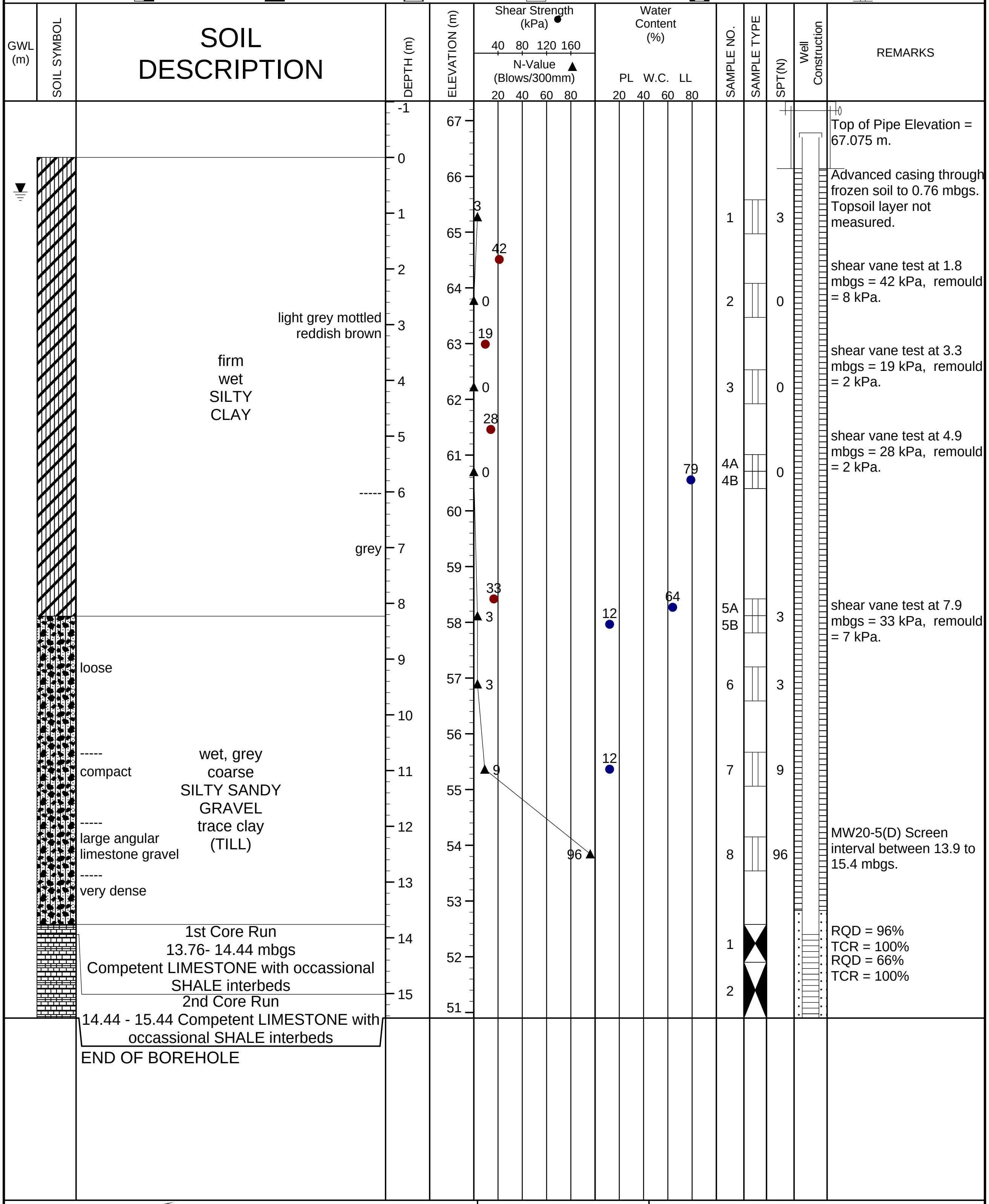
REVIEWED BY: SR	Page 1 of 1

CLIENT: GFL	METHOD: Casing/coring/split spoon sampling		**MW20-5(D)**
PROJECT: GFL EOWHF Expansion Project	PROJECT ENGINEER:	ELEV. (m) 66.34	
LOCATION: 17125 Lafleche Road, Moosecreek	NORTHING: 5017917	EASTING: 501278	PROJECT NO.: CO749.00

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON



light grey mottled reddish brown

firm
wet
SILTY
CLAY

-----

grey

loose

-----
compact

wet, grey
coarse
SILTY SANDY
GRAVEL
trace clay
(TILL)

-----
large angular limestone gravel
-----
very dense

1st Core Run
13.76- 14.44 mbgs
Competent LIMESTONE with occassional SHALE interbeds

2nd Core Run
14.44 - 15.44 Competent LIMESTONE with occassional SHALE interbeds

END OF BOREHOLE

REMARKS

Top of Pipe Elevation = 67.075 m.

Advanced casing through frozen soil to 0.76 mbgs. Topsoil layer not measured.

shear vane test at 1.8 mbgs = 42 kPa, remould = 8 kPa.

shear vane test at 3.3 mbgs = 19 kPa, remould = 2 kPa.

shear vane test at 4.9 mbgs = 28 kPa, remould = 2 kPa.

shear vane test at 7.9 mbgs = 33 kPa, remould = 7 kPa.

MW20-5(D) Screen interval between 13.9 to 15.4 mbgs.

RQD = 96%
TCR = 100%
RQD = 66%
TCR = 100%

LOGGED BY: JM	DRILLING DATE: Jan 28-29, 2020
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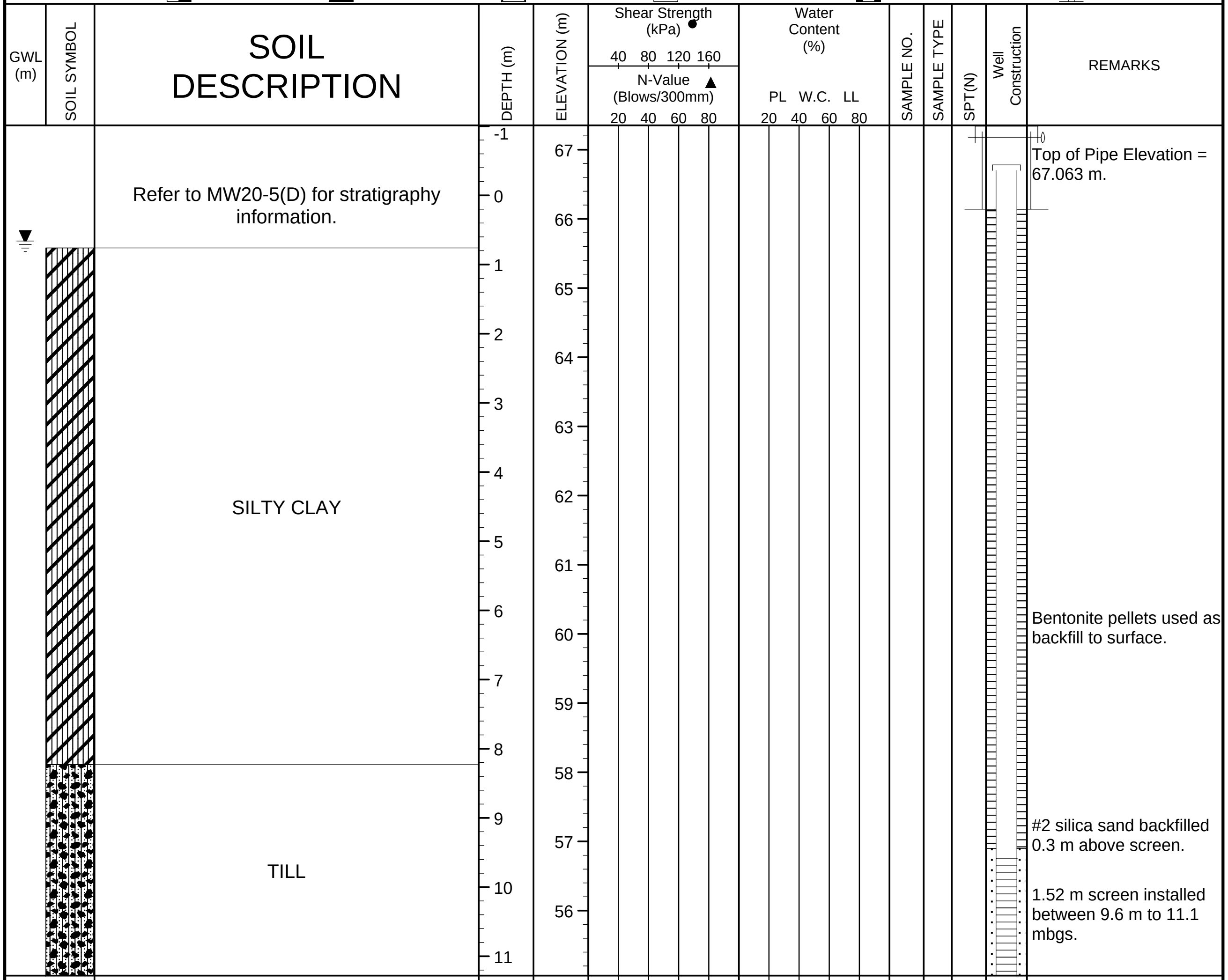
CLIENT: GFL	METHOD: Casing		**MW20-5(T)**
PROJECT: GFL EOWHF Expansion Project	PROJECT ENGINEER:	ELEV. (m) 66.34	
LOCATION: 17125 Lafleche Road, Moosecreek	NORTHING: 5017918	EASTING: 501277	PROJECT NO.: CO749.00

SAMPLE TYPE ▮ AUGER ◢ DRIVEN ⧓ CORING ▀ DYNAMIC CONE ▯ SHELBY ⌶ SPLIT SPOON



SOIL DESCRIPTION	REMARKS
Refer to MW20-5(D) for stratigraphy information.	Top of Pipe Elevation = 67.063 m.
SILTY CLAY	Bentonite pellets used as backfill to surface.
TILL	#2 silica sand backfilled 0.3 m above screen. 1.52 m screen installed between 9.6 m to 11.1 mbgs.
END OF BOREHOLE	

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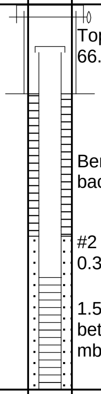
TERRAPEX

CLIENT: GFL	METHOD: Casing		**MW20-5(S)**
PROJECT: GFL EOWHF Expansion Project	PROJECT ENGINEER:	ELEV. (m) 66.34	
LOCATION: 17125 Lafleche Road, Moosecreek	NORTHING: 5017920	EASTING: 501276	PROJECT NO.: CO749.00

SAMPLE TYPE ◧ AUGER ◢ DRIVEN ⧓ CORING ⬒ DYNAMIC CONE ▯ SHELBY ⌶ SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) ● 40 80 120 160 N-Value (Blows/300mm) ▲ 20 40 60 80	Water Content (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	Well Construction	REMARKS
		Refer to MW20-5(D) for stratigraphy information.	-1 0	67 66							Top of Pipe Elevation = 66.724 m
▼	▨	SILTY CLAY	1 2 3 4	65 64 63							Bentonite pellets used as backfill to surface. #2 silica sand backfilled 0.3 m above screen. 1.52 m screen installed between 2.7 m to 4.2 mbgs.
		END OF BOREHOLE									

TERRAPEX

LOGGED BY: JM	DRILLING DATE: Jan 29, 2020
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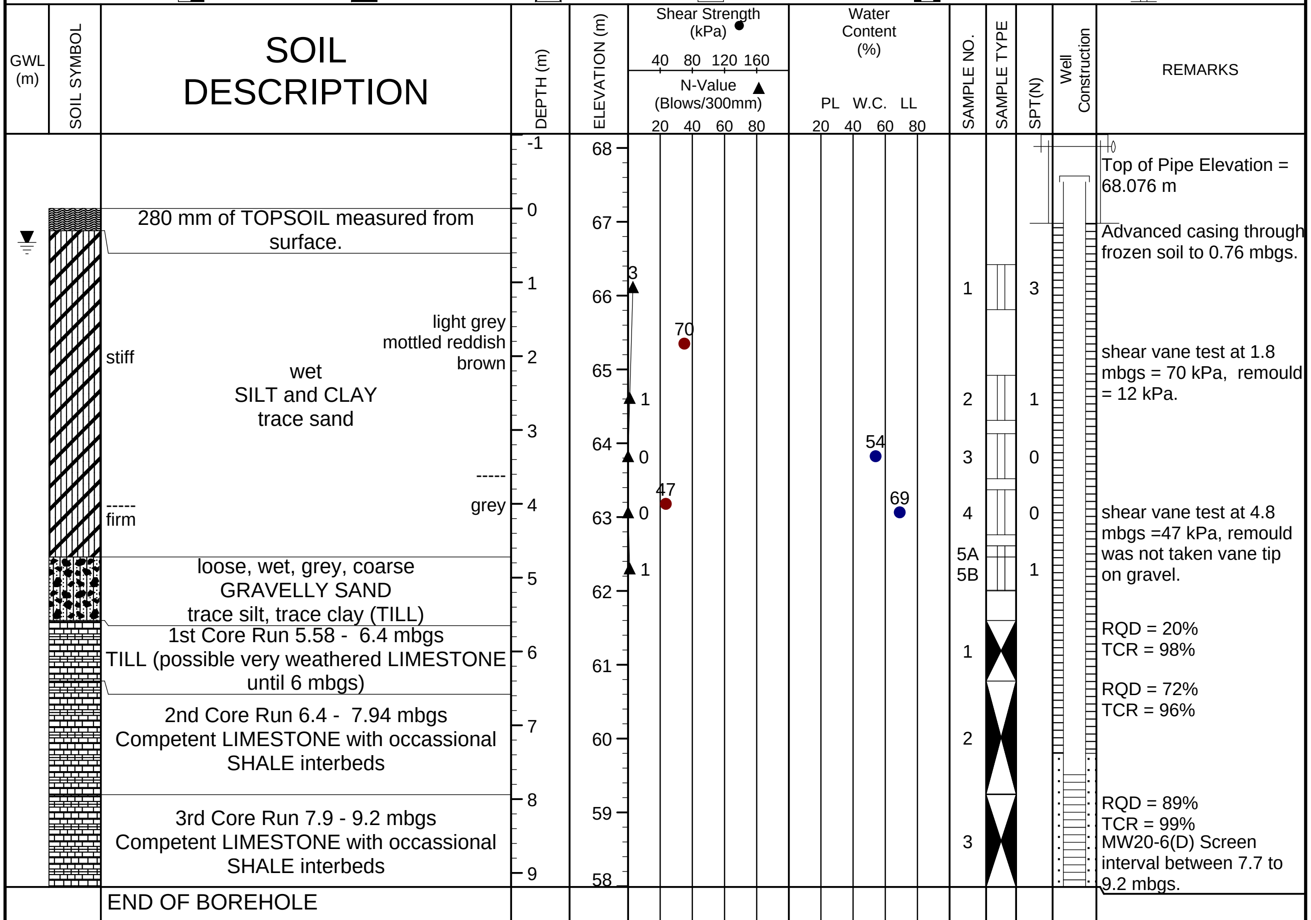
MW20-6(D)

CLIENT: GFL	METHOD: Casing/coring/split spoon sampling	
PROJECT: GFL EOWHF Expansion Project	PROJECT ENGINEER:	ELEV. (m) 67.18
LOCATION: 17125 Lafleche Road, Moosecreek	NORTHING: 5017680	EASTING: 501685
		PROJECT NO.: CO749.00

SAMPLE TYPE ▯ AUGER ◪ DRIVEN ⧓ CORING ▬ DYNAMIC CONE ▯ SHELBY ⌶ SPLIT SPOON



280 mm of TOPSOIL measured from surface.

stiff

light grey mottled reddish brown

wet SILT and CLAY trace sand

----- firm

grey

loose, wet, grey, coarse GRAVELLY SAND trace silt, trace clay (TILL)

1st Core Run 5.58 - 6.4 mbgs TILL (possible very weathered LIMESTONE until 6 mbgs)

2nd Core Run 6.4 - 7.94 mbgs Competent LIMESTONE with occassional SHALE interbeds

3rd Core Run 7.9 - 9.2 mbgs Competent LIMESTONE with occassional SHALE interbeds

END OF BOREHOLE

SAMPLE NO.	SPT(N)
1	3
2	1
3	0
4	0
5A 5B	1
1	
2	
3	

REMARKS

Top of Pipe Elevation = 68.076 m

Advanced casing through frozen soil to 0.76 mbgs.

shear vane test at 1.8 mbgs = 70 kPa, remould = 12 kPa.

shear vane test at 4.8 mbgs =47 kPa, remould was not taken vane tip on gravel.

RQD = 20%
TCR = 98%

RQD = 72%
TCR = 96%

RQD = 89%
TCR = 99%
MW20-6(D) Screen interval between 7.7 to 9.2 mbgs.

TERRAPEX

LOGGED BY: RH	DRILLING DATE: Jan 29-30, 2020
REVIEWED BY: SR	Page 1 of 1

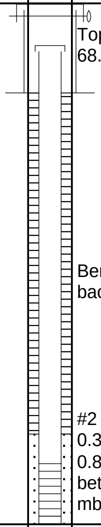
CLIENT: GFL
METHOD: Casing
PROJECT: GFL EOWHF Expansion Project
PROJECT ENGINEER:
ELEV. (m) 67.18

MW20-6(T)

LOCATION: 17125 Lafleche Road, Moosecreek
NORTHING: 5017681
EASTING: 501686
PROJECT NO.: CO749.00

SAMPLE TYPE AUGER DRIVEN CORING DYNAMIC CONE SHELBY SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) ● 40 80 120 160 N-Value (Blows/300mm) ▲ 20 40 60 80	Water Content (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	Well Construction	REMARKS
▼		Refer to MW20-6(D) for stratigraphy information.	-1 0	68 67							Top of Pipe Elevation = 68.099 m.
	▨	SILT and CLAY	1 2 3 4	66 65 64 63							Bentonite pellets used as backfill to surface.
	▩	TILL	5 6	62							#2 silica sand backfilled 0.3 m above screen. 0.82 m screen installed between 5.2 m to 6.0 mbgs.



END OF BOREHOLE

TERRAPEX

LOGGED BY: RH
DRILLING DATE: Jan 30, 2020
REVIEWED BY: SR

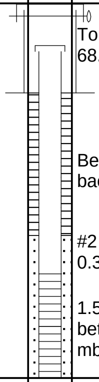
CLIENT: GFL
PROJECT: GFL EOWHF Expansion Project
LOCATION: 17125 Lafleche Road, Moosecreek
METHOD: Casing
PROJECT ENGINEER:
NORTHING: 5017681
ELEV. (m) 67.18
EASTING: 501685

MW20-6(S)

PROJECT NO.: CO749.00

SAMPLE TYPE ▮ AUGER ◢ DRIVEN ⧓ CORING ▀ DYNAMIC CONE ▯ SHELBY ⌶ SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) ● 40 80 120 160 N-Value (Blows/300mm) ▲ 20 40 60 80	Water Content (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	Well Construction	REMARKS
▼		Refer to MW20-6(D) for stratigraphy information.	-1 0	68 67							Top of Pipe Elevation = 68.093 m.
	▨	SILT and CLAY	1 2 3 4	66 65 64							Bentonite pellets used as backfill to surface. #2 silica sand backfilled 0.3 m above screen. 1.52 m screen installed between 2.7 m to 4.1 mbgs.
		END OF BOREHOLE									



TERRAPEX

LOGGED BY: RH
REVIEWED BY: SR
DRILLING DATE: Jan 30, 2020
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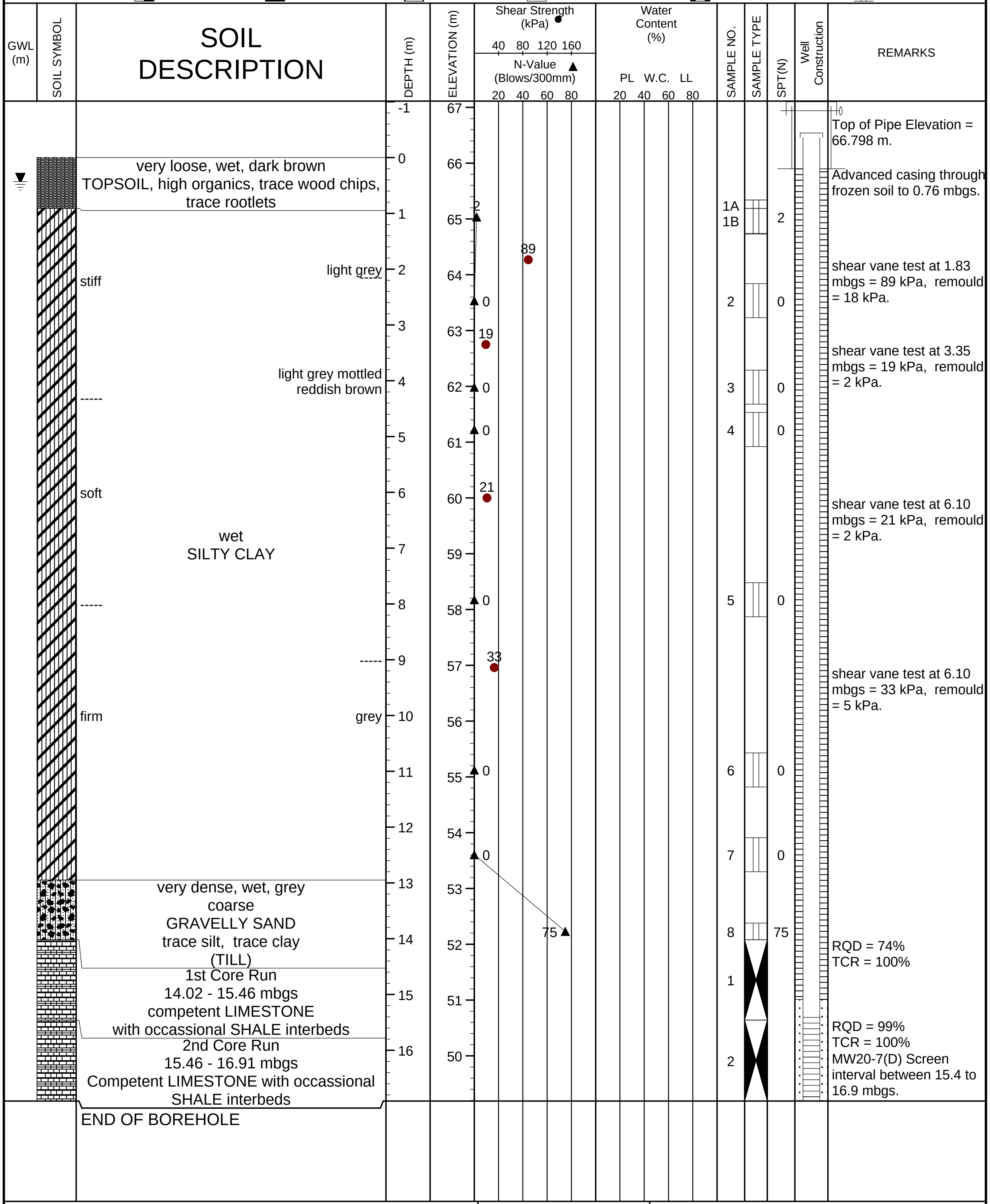
CLIENT: GFL	METHOD: Casing/coring/split spoon sampling		**MW20-7(D)**
PROJECT: GFL EOWHF Expansion Project	PROJECT ENGINEER:	ELEV. (m) 66.10	
LOCATION: 17125 Lafleche Road, Moosecreek	NORTHING: 5018283	EASTING: 501078	PROJECT NO.: CO749.00

SAMPLE TYPE ▮ AUGER ◢ DRIVEN ⧗ CORING ▀ DYNAMIC CONE ▯ SHELBY ⌶ SPLIT SPOON



very loose, wet, dark brown TOPSOIL, high organics, trace wood chips, trace rootlets

stiff

light grey

light grey mottled reddish brown

-----

soft

wet SILTY CLAY

-----

firm

grey

very dense, wet, grey coarse GRAVELLY SAND trace silt, trace clay (TILL)

1st Core Run 14.02 - 15.46 mbgs competent LIMESTONE with occassional SHALE interbeds

2nd Core Run 15.46 - 16.91 mbgs Competent LIMESTONE with occassional SHALE interbeds

END OF BOREHOLE

SAMPLE NO.	SPT(N)
1A 1B	2
2	0
3	0
4	0
5	0
6	0
7	0
8	75
1	
2	

REMARKS

Top of Pipe Elevation = 66.798 m.

Advanced casing through frozen soil to 0.76 mbgs.

shear vane test at 1.83 mbgs = 89 kPa, remould = 18 kPa.

shear vane test at 3.35 mbgs = 19 kPa, remould = 2 kPa.

shear vane test at 6.10 mbgs = 21 kPa, remould = 2 kPa.

shear vane test at 6.10 mbgs = 33 kPa, remould = 5 kPa.

RQD = 74%
TCR = 100%

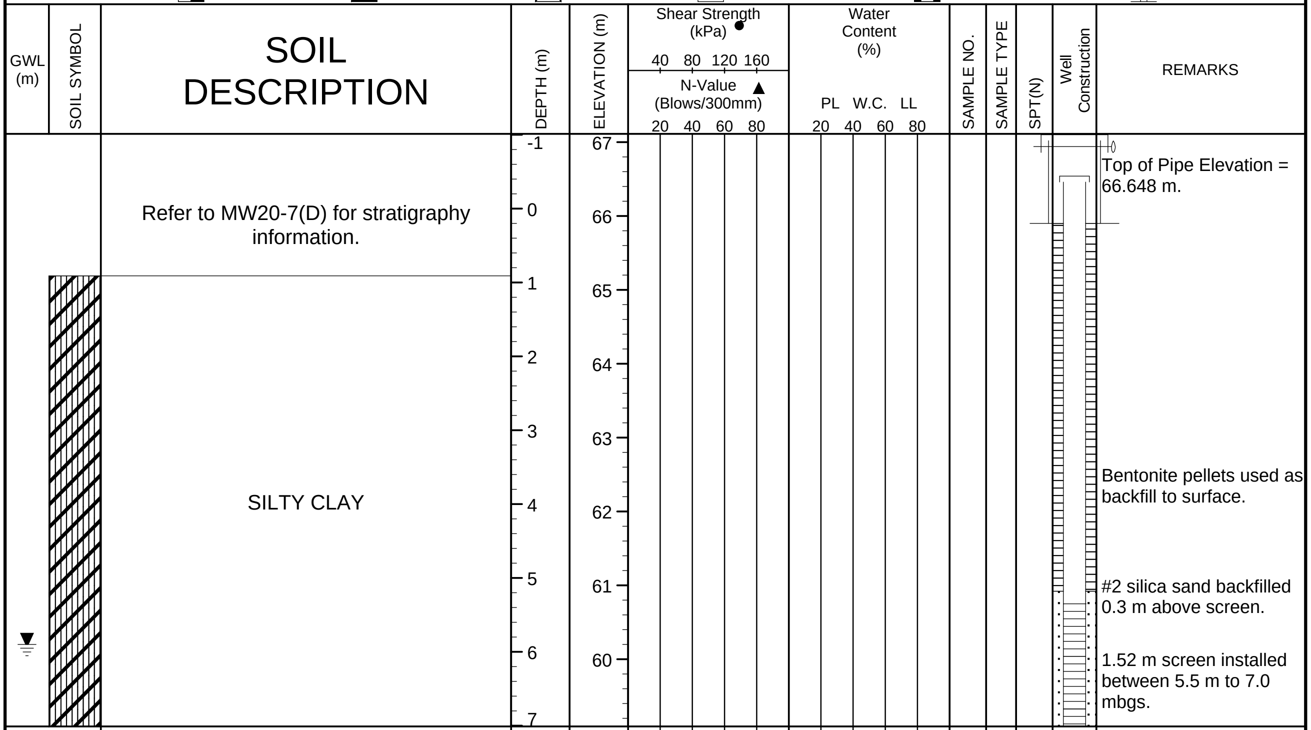
RQD = 99%
TCR = 100%
MW20-7(D) Screen interval between 15.4 to 16.9 mbgs.

TERRAPEX

LOGGED BY: JM	DRILLING DATE: Jan 29-30, 2020
REVIEWED BY: SR	Page 1 of 1

CLIENT: GFL	METHOD: Casing		**MW20-7(C)**
PROJECT: GFL EOWHF Expansion Project	PROJECT ENGINEER:	ELEV. (m) 66.10	
LOCATION: 17125 Lafleche Road, Moosecreek	NORTHING: 5018284	EASTING: 501077	PROJECT NO.: CO749.00

SAMPLE TYPE ▮ AUGER ◢ DRIVEN ⧓ CORING ▀ DYNAMIC CONE ▯ SHELBY ⌶ SPLIT SPOON



Depth (m)	SOIL DESCRIPTION	REMARKS
-1 to 0.9	Refer to MW20-7(D) for stratigraphy information.	Top of Pipe Elevation = 66.648 m.
0.9 to 7	SILTY CLAY	Bentonite pellets used as backfill to surface. #2 silica sand backfilled 0.3 m above screen. 1.52 m screen installed between 5.5 m to 7.0 mbgs.

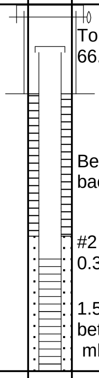
END OF BOREHOLE

TERRAPEX	LOGGED BY: JM	DRILLING DATE: Jan 30, 2020
	REVIEWED BY: SR	Page 1 of 1

CLIENT: GFL	METHOD: Casing		**MW20-7(S)**
PROJECT: GFL EOWHF Expansion Project	PROJECT ENGINEER:	ELEV. (m) 66.10	
LOCATION: 17125 Lafleche Road, Moosecreek	NORTHING: 5018286	EASTING: 501076	PROJECT NO.: CO749.00

SAMPLE TYPE ◧ AUGER ◢ DRIVEN ⧗ CORING ⬒ DYNAMIC CONE ▯ SHELBY ⌶ SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) ● 40 80 120 160 N-Value (Blows/300mm) ▲ 20 40 60 80	Water Content (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	Well Construction	REMARKS
		Refer to MW20-7(D) for stratigraphy information.	-1 0	67 66							Top of Pipe Elevation = 66.733 m
▼	▨	SILTY CLAY	1 2 3	65 64 63							Bentonite pellets used as backfill to surface. #2 silica sand backfilled 0.3 m above screen. 1.52 m screen installed between 2.4 m to 4.0 mbgs.
		END OF BOREHOLE									



TERRAPEX

LOGGED BY: JM	DRILLING DATE: Jan 30, 2020
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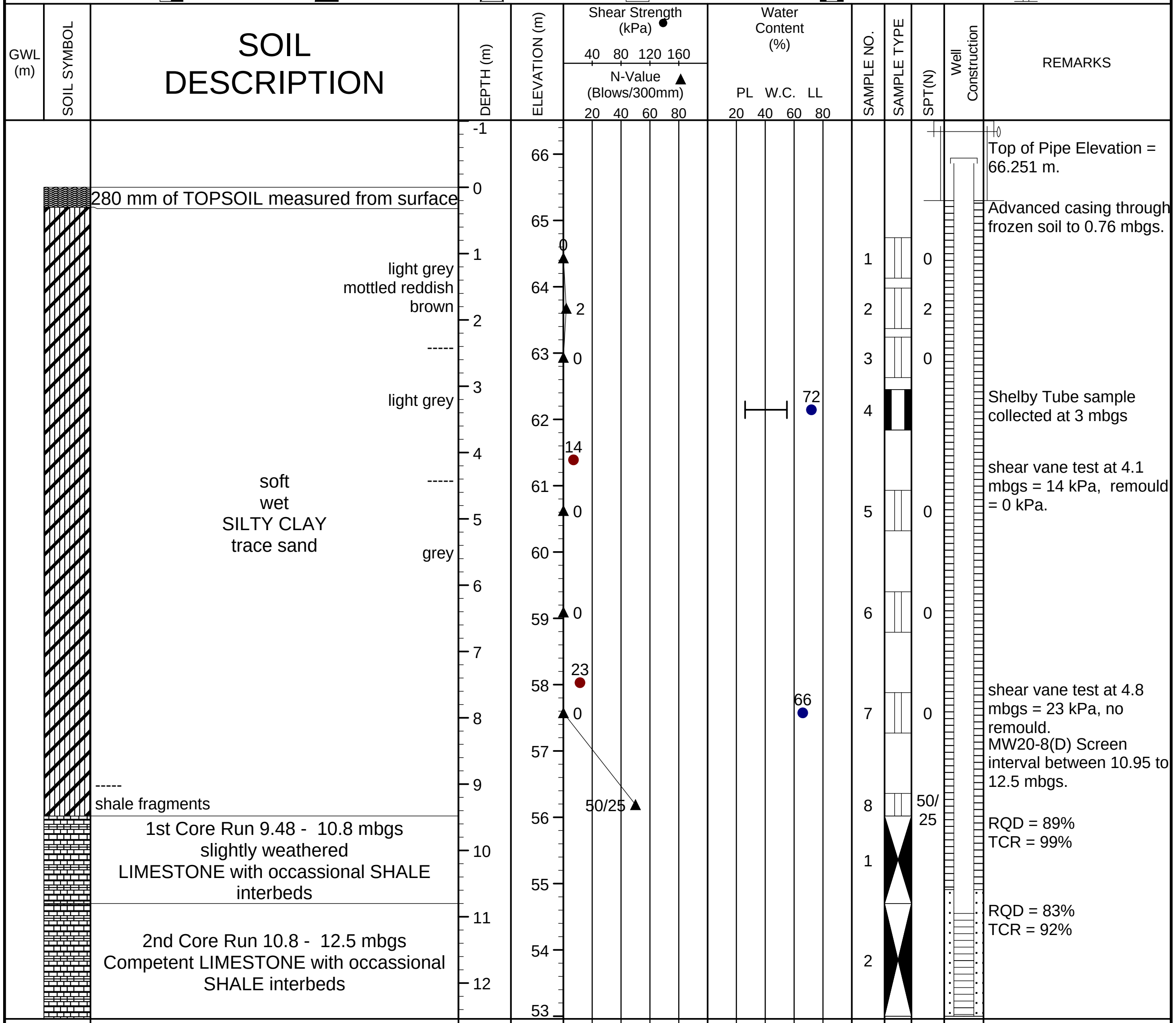
CLIENT: GFL
METHOD: Casing/coring/split spoon sampling

MW20-8(D)

PROJECT: GFL EOWHF Expansion Project
PROJECT ENGINEER:
ELEV. (m) 65.5

LOCATION: 17125 Lafleche Road, Moosecreek
NORTHING: 5018409
EASTING: 501404
PROJECT NO.: CO749.00

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON



280 mm of TOPSOIL measured from surface

light grey
mottled reddish
brown

-----

light grey

soft
wet
SILTY CLAY
trace sand

-----

grey

-----
shale fragments

1st Core Run 9.48 - 10.8 mbgs
slightly weathered
LIMESTONE with occassional SHALE
interbeds

2nd Core Run 10.8 - 12.5 mbgs
Competent LIMESTONE with occassional
SHALE interbeds

END OF BOREHOLE

Top of Pipe Elevation = 66.251 m.

Advanced casing through frozen soil to 0.76 mbgs.

Shelby Tube sample collected at 3 mbgs

shear vane test at 4.1 mbgs = 14 kPa, remould = 0 kPa.

shear vane test at 4.8 mbgs = 23 kPa, no remould.

MW20-8(D) Screen interval between 10.95 to 12.5 mbgs.

RQD = 89%
TCR = 99%

RQD = 83%
TCR = 92%

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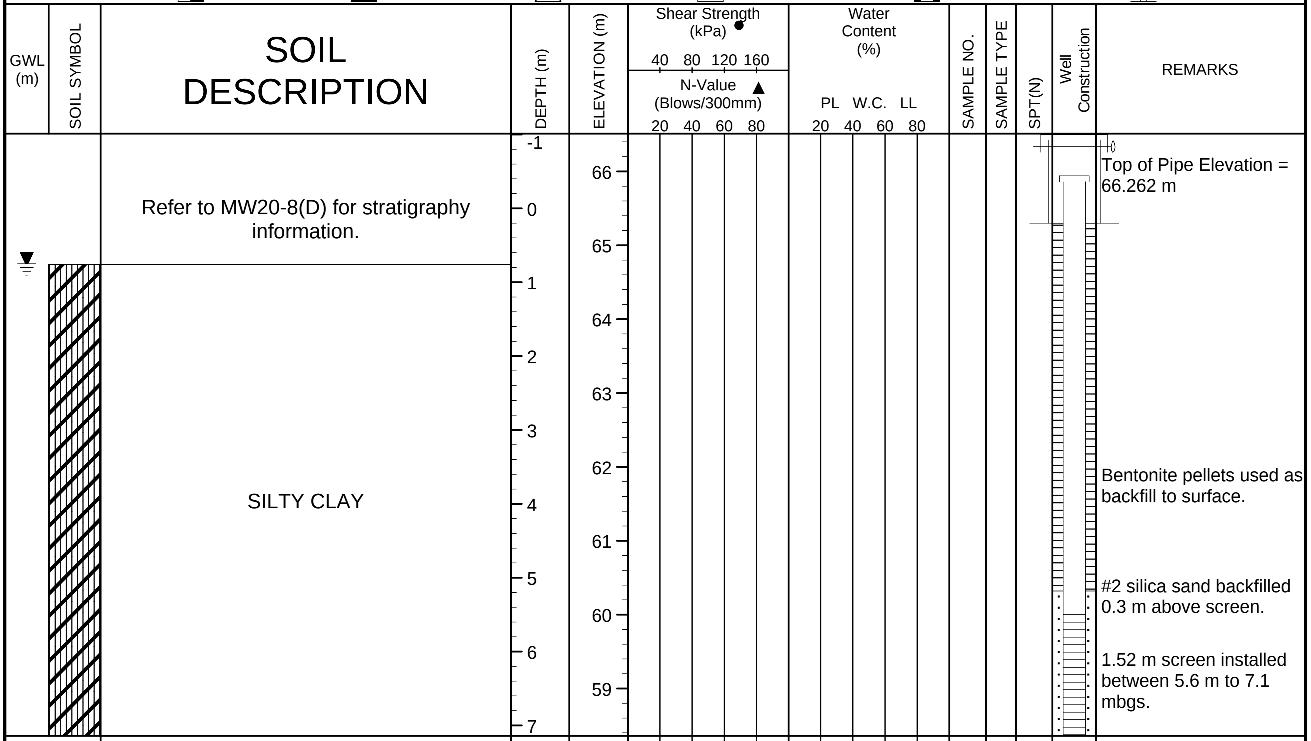
CLIENT: GFL	METHOD: Casing		# MW20-8(C)
PROJECT: GFL EOWHF Expansion Project	PROJECT ENGINEER:	ELEV. (m) 65.5	
LOCATION: 17125 Lafleche Road, Moosecreek	NORTHING: 5018410	EASTING: 501403	PROJECT NO.: CO749.00

SAMPLE TYPE ◧ AUGER ◢ DRIVEN ⧓ CORING ⬒ DYNAMIC CONE ▮ SHELBY ⌶ SPLIT SPOON



Refer to MW20-8(D) for stratigraphy information.

SILTY CLAY

END OF BOREHOLE

Top of Pipe Elevation = 66.262 m

Bentonite pellets used as backfill to surface.

#2 silica sand backfilled 0.3 m above screen.

1.52 m screen installed between 5.6 m to 7.1 mbgs.

TERRAPEX	LOGGED BY: RH	DRILLING DATE: Jan 30, 2020
	REVIEWED BY: SR	Page 1 of 1

CLIENT: GFL

METHOD: Casing

MW20-8(S)

PROJECT: GFL EOWHF Expansion Project

PROJECT ENGINEER:

ELEV. (m) 65.5

LOCATION: 17125 Lafleche Road, Moosecreek

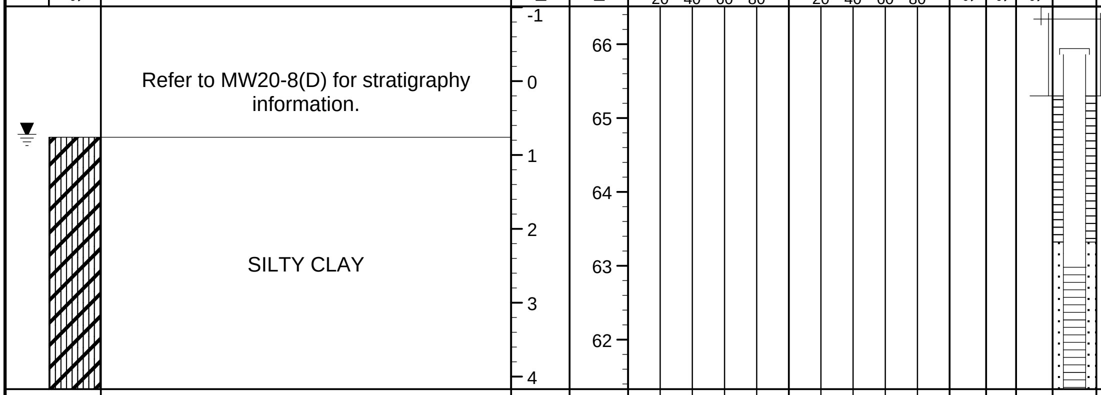
NORTHING: 5018410

EASTING: 501404

PROJECT NO.: CO749.00

SAMPLE TYPE: AUGER | DRIVEN | CORING | DYNAMIC CONE | SHELBY | SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) ● 40 80 120 160 N-Value (Blows/300mm) ▲ 20 40 60 80	Water Content (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	Well Construction	REMARKS
		Refer to MW20-8(D) for stratigraphy information.									Top of Pipe Elevation = 66.216 m
		SILTY CLAY									Bentonite pellets used as backfill to surface. #2 silica sand backfilled 0.3 m above screen. 1.52 m screen installed between 2.5 m to 4.1 mbgs.
		END OF BOREHOLE									



LOGGED BY: RH

DRILLING DATE: Feb 3, 2020

REVIEWED BY: SR

CLIENT: GFL

METHOD: Casing/coring/split spoon sampling

MW20-9(D)

PROJECT: GFL EOWHF Expansion Project

PROJECT ENGINEER:

ELEV. (m) 65.94

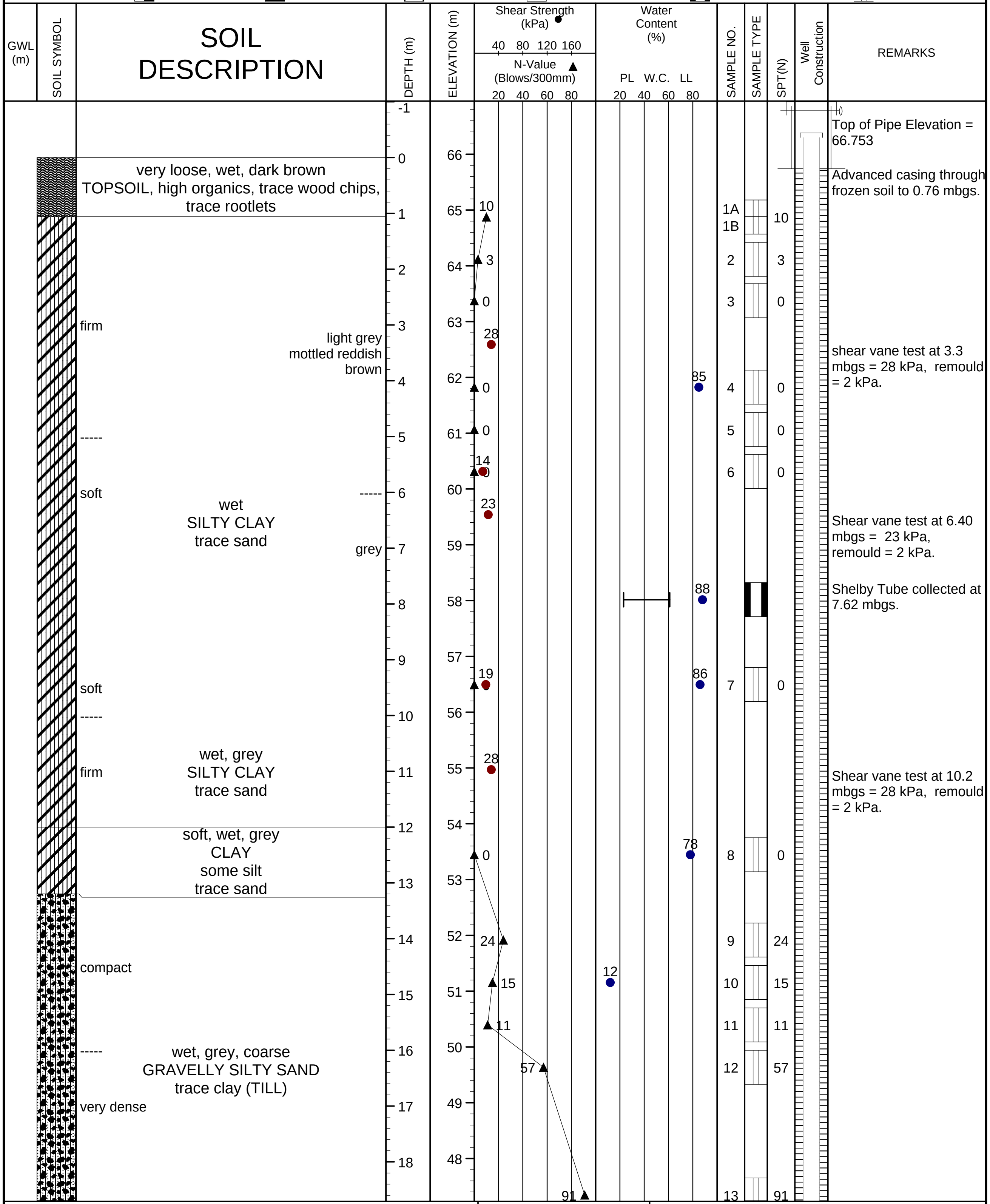
LOCATION: 17125 Lafleche Road, Moosecreek

NORTHING: 5018528

EASTING: 500716

PROJECT NO.: CO749.00

SAMPLE TYPE ◨ AUGER ◩ DRIVEN ⧗ CORING ▀ DYNAMIC CONE ▮ SHELBY ⌶ SPLIT SPOON



very loose, wet, dark brown TOPSOIL, high organics, trace wood chips, trace rootlets

firm

light grey mottled reddish brown

-----

soft

-----

wet SILTY CLAY trace sand

grey

soft

-----

firm

wet, grey SILTY CLAY trace sand

soft, wet, grey CLAY some silt trace sand

compact

-----

wet, grey, coarse GRAVELLY SILTY SAND trace clay (TILL)

very dense

Top of Pipe Elevation = 66.753

Advanced casing through frozen soil to 0.76 mbgs.

shear vane test at 3.3 mbgs = 28 kPa, remould = 2 kPa.

Shear vane test at 6.40 mbgs = 23 kPa, remould = 2 kPa.

Shelby Tube collected at 7.62 mbgs.

Shear vane test at 10.2 mbgs = 28 kPa, remould = 2 kPa.

TERRAPEX

LOGGED BY: RH

DRILLING DATE: Jan 31 - Feb 3, 2020

REVIEWED BY: SR

CLIENT: GFL	METHOD: Casing/coring/split spoon sampling		**MW20-9(D)**
PROJECT: GFL EOWHF Expansion Project	PROJECT ENGINEER:	ELEV. (m) 65.94	
LOCATION: 17125 Lafleche Road, Moosecreek	NORTHING: 5018528	EASTING: 500716	PROJECT NO.: CO749.00

SAMPLE TYPE: AUGER DRIVEN CORING DYNAMIC CONE SHELBY SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) ● 40 80 120 160 N-Value (Blows/300mm) ▲ 20 40 60 80	Water Content (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	Well Construction	REMARKS
			19	47							
		1st Core Run 19.10 - 19.96 mbgs dark grey weathered LIMESTONE					1				RQD = 40% TCR = 100%
▼		2nd Core Run 19.96 - 21.46 mbgs dark grey, moderately fractured LIMESTONE with occassional SHALE interbeds	20	46			2				RQD = 82% TCR = 98%
			21	45							MW20-9(D) Screen interval between 20.9 to 22.4 mbgs.
		3rd Core Run 21.46 - 22.42 mbgs dark grey LIMESTONE with occassional SHALE interbeds	22	44			3				RQD = 98% TCR = 100%

END OF BOREHOLE

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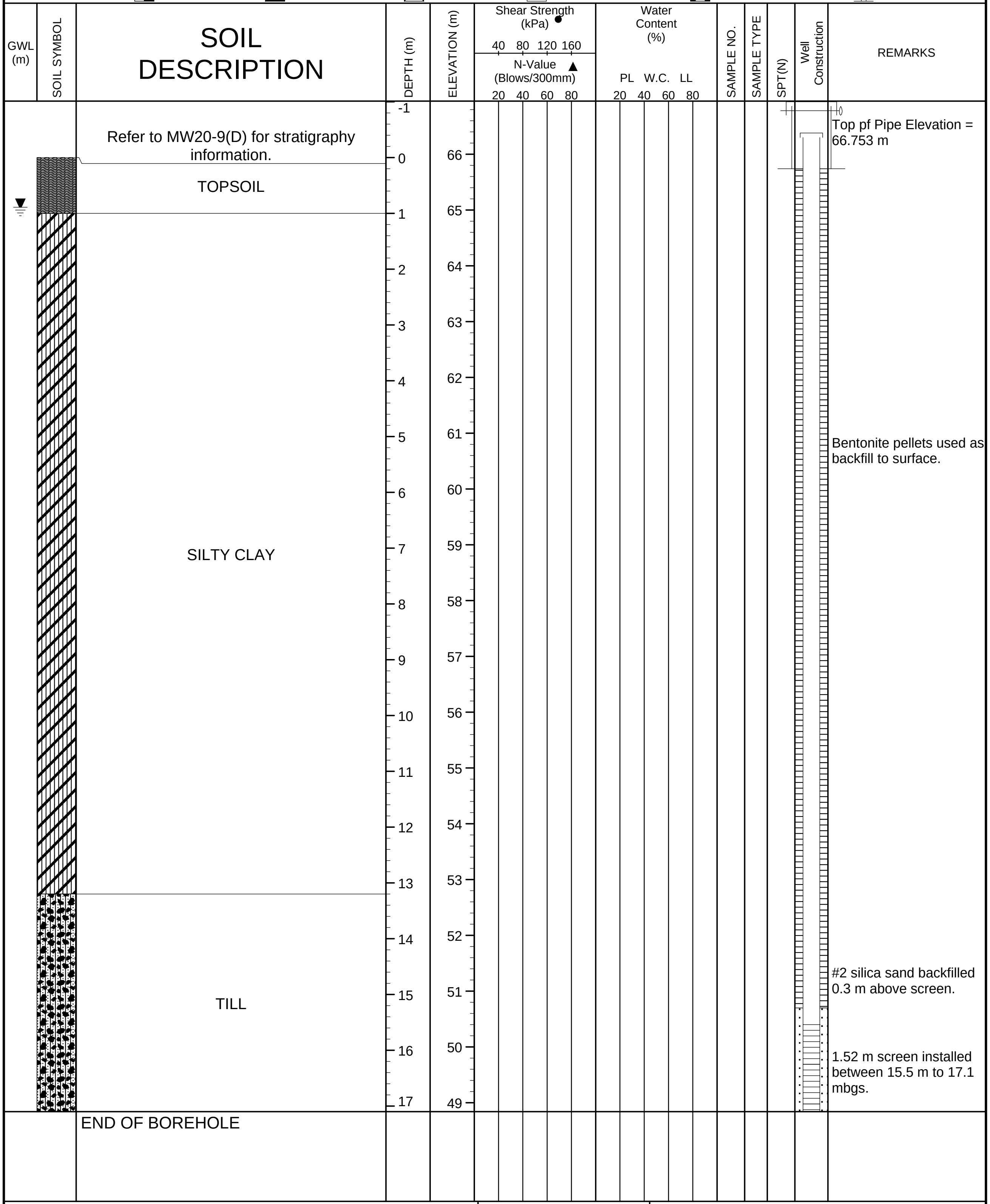
REVIEWED BY: SR	Page 2 of 2

CLIENT: GFL
METHOD: Casing
PROJECT: GFL EOWHF Expansion Project
PROJECT ENGINEER:
ELEV. (m) 65.94

MW20-9(T)

LOCATION: 17125 Lafleche Road, Moosecreek
NORTHING: 5018530
EASTING: 500715
PROJECT NO.: CO749.00

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON



SOIL DESCRIPTION

Refer to MW20-9(D) for stratigraphy information.

TOPSOIL

SILTY CLAY

TILL

END OF BOREHOLE

REMARKS

Top pf Pipe Elevation = 66.753 m

Bentonite pellets used as backfill to surface.

#2 silica sand backfilled 0.3 m above screen.

1.52 m screen installed between 15.5 m to 17.1 mbgs.

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REVIEWED BY: SR
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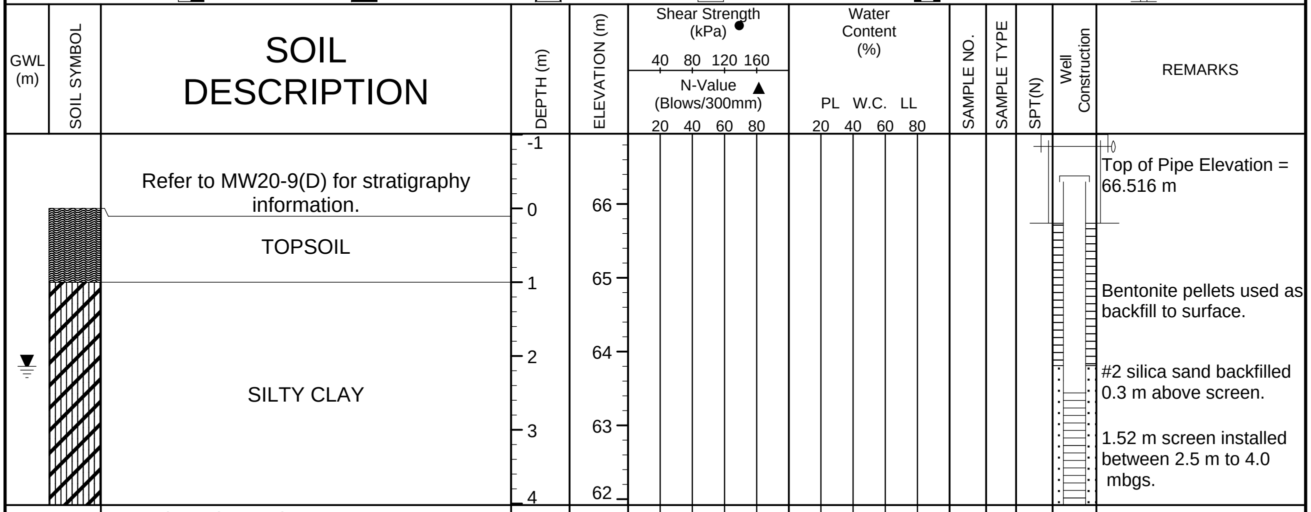
CLIENT: GFL	METHOD: Casing		**MW20-9(S)**
PROJECT: GFL EOWHF Expansion Project	PROJECT ENGINEER:	ELEV. (m) 65.94	
LOCATION: 17125 Lafleche Road, Moosecreek	NORTHING: 5018531	EASTING: 500714	PROJECT NO.: CO749.00

SAMPLE TYPE ▮ AUGER ◪ DRIVEN ⧗ CORING ▀ DYNAMIC CONE ▯ SHELBY ⌶ SPLIT SPOON



Refer to MW20-9(D) for stratigraphy information.

TOPSOIL

SILTY CLAY

Top of Pipe Elevation = 66.516 m

Bentonite pellets used as backfill to surface.

#2 silica sand backfilled 0.3 m above screen.

1.52 m screen installed between 2.5 m to 4.0 mbgs.

END OF BOREHOLE

TERRAPEX	LOGGED BY: jm	DRILLING DATE: Feb 4, 2020
	REVIEWED BY: SR	Page 1 of 1

CLIENT: GFL

METHOD: Casing/coring/split spoon sampling

MW20-10(D)

PROJECT: GFL EOWHF Expansion Project

PROJECT ENGINEER:

ELEV. (m) 64.93

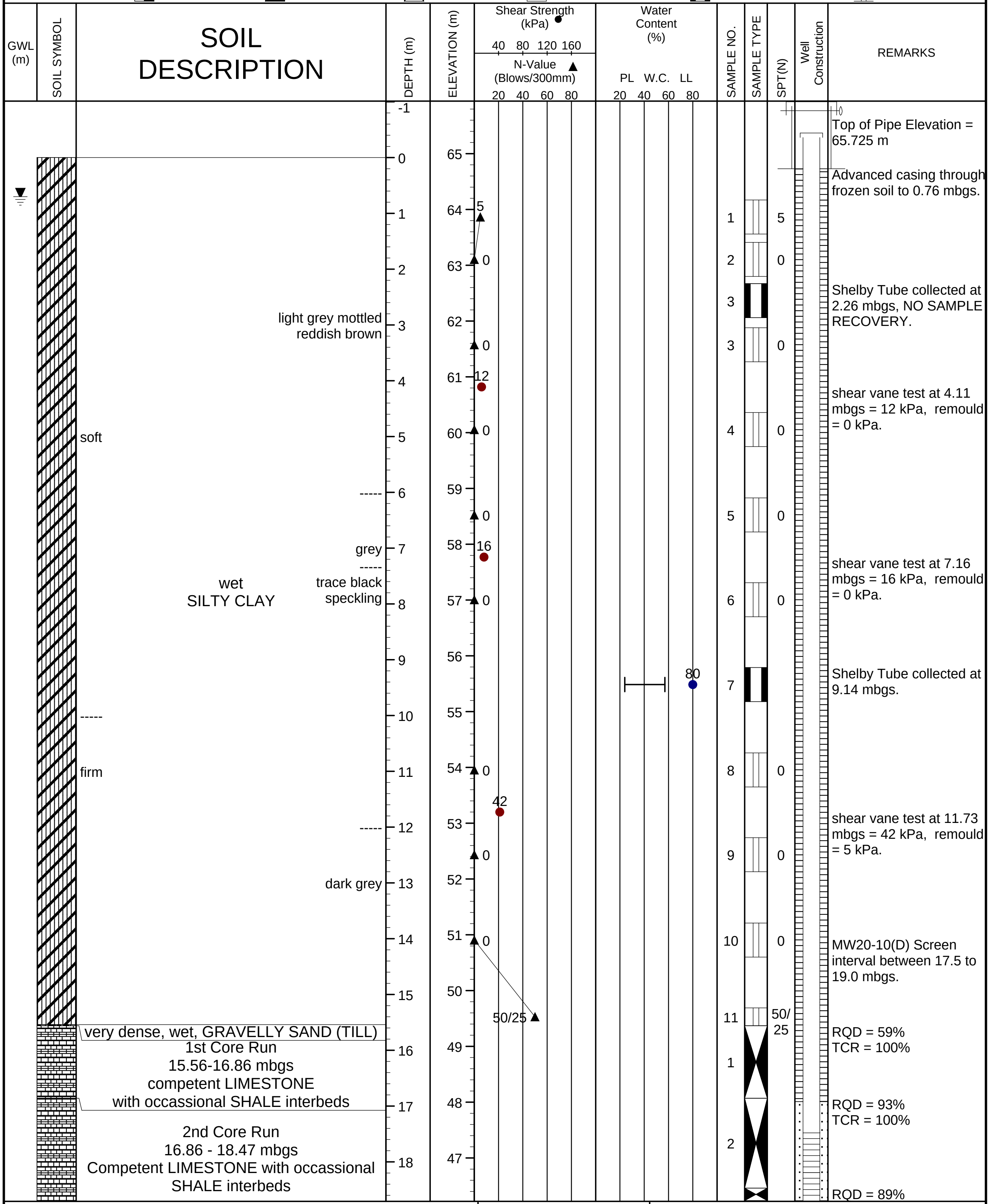
LOCATION: 17125 Lafleche Road, Moosecreek

NORTHING: 5018801

EASTING: 501191

PROJECT NO.: CO749.00

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON



SOIL DESCRIPTION:

wet SILTY CLAY

light grey mottled reddish brown

soft

-----

grey

-----

trace black speckling

-----

firm

-----

dark grey

very dense, wet, GRAVELLY SAND (TILL)

1st Core Run
15.56-16.86 mbgs
competent LIMESTONE
with occassional SHALE interbeds

2nd Core Run
16.86 - 18.47 mbgs
Competent LIMESTONE with occassional
SHALE interbeds

REMARKS:

Top of Pipe Elevation = 65.725 m

Advanced casing through frozen soil to 0.76 mbgs.

Shelby Tube collected at 2.26 mbgs, NO SAMPLE RECOVERY.

shear vane test at 4.11 mbgs = 12 kPa, remould = 0 kPa.

shear vane test at 7.16 mbgs = 16 kPa, remould = 0 kPa.

Shelby Tube collected at 9.14 mbgs.

shear vane test at 11.73 mbgs = 42 kPa, remould = 5 kPa.

MW20-10(D) Screen interval between 17.5 to 19.0 mbgs.

RQD = 59%
TCR = 100%

RQD = 93%
TCR = 100%

RQD = 89%

TERRAPEX

LOGGED BY: RH

DRILLING DATE: Feb 3, 2020

REVIEWED BY: SR

CLIENT: GFL	METHOD: Casing/coring/split spoon sampling		**MW20-10(D)**
PROJECT: GFL EOWHF Expansion Project	PROJECT ENGINEER:	ELEV. (m) 64.93	
LOCATION: 17125 Lafleche Road, Moosecreek	NORTHING: 5018801	EASTING: 501191	PROJECT NO.: CO749.00

SAMPLE TYPE ◧ AUGER ◢ DRIVEN ⧓ CORING ⬒ DYNAMIC CONE ▯ SHELBY ⌶ SPLIT SPOON

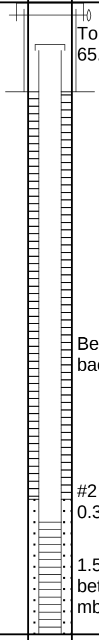
GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) ● 40 80 120 160 N-Value (Blows/300mm) ▲ 20 40 60 80	Water Content (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	Well Construction	REMARKS
	▦	3nd Core Run 18.47- 19.00 mbgs Competent LIMESTONE with occassional SHALE interbeds		46			3	⧓			TCR = 100%
		END OF BOREHOLE									

TERRAPEX	LOGGED BY: RH	DRILLING DATE: Feb 3, 2020
	REVIEWED BY: SR	Page 2 of 2

CLIENT: GFL	METHOD: Casing		# MW20-10(C)
PROJECT: GFL EOWHF Expansion Project	PROJECT ENGINEER:	ELEV. (m) 64.93	
LOCATION: 17125 Lafleche Road, Moosecreek	NORTHING: 5018801	EASTING: 501190	PROJECT NO.: CO749.00

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) ● 40 80 120 160 / N-Value (Blows/300mm) ▲ 20 40 60 80	Water Content (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	Well Construction	REMARKS
		Refer to MW20-10(D) for stratigraphy information.	-1 to 1	65							Top of Pipe Elevation = 65.806 m
	▨	SILTY CLAY	1 to 7	64 to 58							Bentonite pellets used as backfill to surface. #2 silica sand backfilled 0.3 m above screen. 1.52 m screen installed between 6.0 m to 7.5 mbgs.
		END OF BOREHOLE									



TERRAPEX	LOGGED BY: RH	DRILLING DATE: Feb 4, 2020
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CLIENT: GFL

PROJECT: GFL EOWHF Expansion Project

LOCATION: 17125 Lafleche Road, Moosecreek

METHOD: Casing

PROJECT ENGINEER:

NORTHING: 5018802

ELEV. (m) 64.93

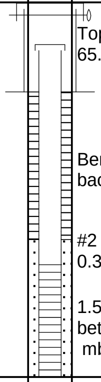
EASTING: 501190

MW20-10(S)

PROJECT NO.: CO749.00

SAMPLE TYPE ▐ AUGER ◢ DRIVEN ⧓ CORING ▀ DYNAMIC CONE ▌▐ SHELBY ⌶ SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) ● 40 80 120 160 N-Value (Blows/300mm) ▲ 20 40 60 80	Water Content (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	Well Construction	REMARKS
			-1								Top of Pipe Elevation = 65.744 m
		Refer to MW20-10(D) for stratigraphy information.	0	65							
▼	▨	SILTY CLAY	1	64							Bentonite pellets used as backfill to surface.
			2	63							#2 silica sand backfilled 0.3 m above screen.
			3	62							1.52 m screen installed between 2.5 m to 4.1 mbgs.
			4	61							
		END OF BOREHOLE									



TERRAPEX

LOGGED BY: RH

REVIEWED BY: SR

DRILLING DATE: Feb 4, 2020

CLIENT: GFL	METHOD: Casing/coring/split spoon sampling		**MW20-11(D)**
PROJECT: GFL EOWHF Expansion Project	PROJECT ENGINEER:	ELEV. (m) 66.25	
LOCATION: 17125 Lafleche Road, Moosecreek	NORTHING: 5017065	EASTING: 501123	PROJECT NO.: CO749.00

SAMPLE TYPE: ▮ AUGER ◢ DRIVEN ⧗ CORING ▬ DYNAMIC CONE ▯ SHELBY ⌶ SPLIT SPOON

SOIL DESCRIPTION

very loose, wet, dark brown
TOPSOIL, high organics, trace wood chips,
trace rootlets

stiff ----- light grey -----

light grey mottled reddish brown

soft

wet
SILTY CLAY
trace sand

-----

firm

soft — light grey mottled reddish brown

SILTY CLAY
trace sand

-----

soft

----- grey

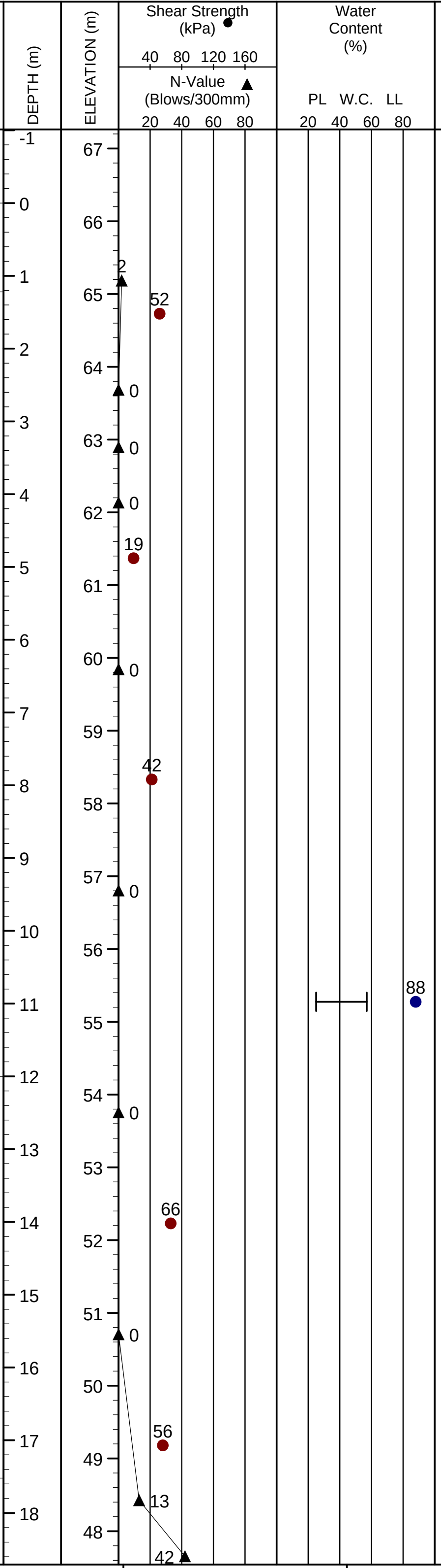
wet
CLAY
some silt

stiff

-----

compact ----- dense

wet, grey, coarse
GRAVELLY SAND
trace silt, trace clay (TILL)



SAMPLE NO.	SPT(N)
1A	2
1B	
2	0
3	0
4	0
5	0
6	0
7	
8	0
9	0
10	13
11	42

GWL (m)

Well Construction

REMARKS

Top of Pipe Elevation = 67.001 m

Advanced casing through frozen soil to 0.76 mbgs.

shear vane test at 1.83 mbgs = 52 kPa, remould = 2 kPa.

Shear vane test at 4.88 mbgs = 19 kPa, remould = 2 kPa.

Shear vane test at 7.9 mbgs = 42 kPa, remould = 2 kPa.

Shelby Tube collected at 10.67 mbgs.

Shear vane test at 14.02 mbgs = 66 kPa, remould = 5 kPa.

Shear vane test at 17 mbgs = 56 kPa, remould = 5 kPa.

MW20-11(D) Screen interval between 21.6 to

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CLIENT: GFL	METHOD: Casing/coring/split spoon sampling		**MW20-11(D)**
PROJECT: GFL EOWHF Expansion Project	PROJECT ENGINEER:	ELEV. (m) 66.25	
LOCATION: 17125 Lafleche Road, Moosecreek	NORTHING: 5017065	EASTING: 501123	PROJECT NO.: CO749.00

SAMPLE TYPE AUGER DRIVEN CORING DYNAMIC CONE SHELBY SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) ● 40 80 120 160 N-Value (Blows/300mm) ▲ 20 40 60 80	Water Content (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	Well Construction	REMARKS
		1st Core Run 18.90 - 19.86 mbgs LIMESTONE with occassional horizontal fractures	19	47			1	⧗			23.1 mbgs. RQD = 80% TCR = 100%
		2nd Core Run 19.86 - 21.34 mbgs LIMESTONE with occassional horizontal fractures	20 21	46 45			2	⧗			RQD = 98% TCR = 100%
▼		3rd Core Run 21.34 - 23.17 mbgs LIMESTONE with occassional horizontal fractures	22 23	44			3	⧗			RQD = 92% TCR = 100%
		END OF BOREHOLE									

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REVIEWED BY: SR	Page 2 of 2

CLIENT: GFL

METHOD: Casing

MW20-11(C)

PROJECT: GFL EOWHF Expansion Project

PROJECT ENGINEER:

ELEV. (m) 66.25

LOCATION: 17125 Lafleche Road, Moosecreek

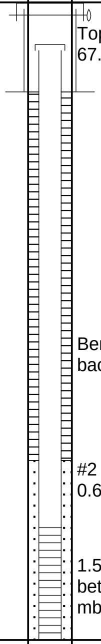
NORTHING: 5018348

EASTING: 500398

PROJECT NO.: CO749.00

SAMPLE TYPE: ▐ AUGER ◢ DRIVEN ⧗ CORING ▀ DYNAMIC CONE ▌▐ SHELBY ⌶ SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) ● 40 80 120 160 N-Value (Blows/300mm) ▲ 20 40 60 80	Water Content (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	Well Construction	REMARKS
		Refer to MW20-11(D) for stratigraphy information.	-1 to 1	67 to 65							Top of Pipe Elevation = 67.097 m
▼	▨	SILTY CLAY	1 to 7	65 to 59							Bentonite pellets used as backfill to surface. #2 silica sand backfilled 0.6 m above screen. 1.52 m screen installed between 6.1 m to 7.6 mbgs.
		END OF BOREHOLE									



TERRAPEX

LOGGED BY: JM

DRILLING DATE: Feb 5, 2020

REVIEWED BY: SR

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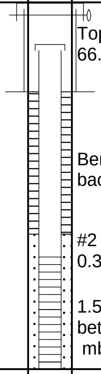
CLIENT: GFL	METHOD: Casing		**MW20-11(S)**
PROJECT: GFL EOWHF Expansion Project	PROJECT ENGINEER:	ELEV. (m) 66.25	
LOCATION: 17125 Lafleche Road, Moosecreek	NORTHING: 5018349	EASTING: 500397	PROJECT NO.: CO749.00

SAMPLE TYPE ◧ AUGER ◩ DRIVEN ⧓ CORING ⬒ DYNAMIC CONE ▯ SHELBY ⌶ SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) ● 40 80 120 160 N-Value (Blows/300mm) ▲ 20 40 60 80	Water Content (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	Well Construction	REMARKS
		Refer to MW20-11(D) for stratigraphy information.	-1 0 1	67 66 65							Top of Pipe Elevation = 66.821 m Bentonite pellets used as backfill to surface.
▼	▨	SILTY CLAY	2 3	64 63							#2 silica sand backfilled 0.3 m above screen. 1.52 m screen installed between 2.4 m to 4.0 mbgs.
		END OF BOREHOLE									



TERRAPEX

LOGGED BY: JM	DRILLING DATE: Feb 5, 2020
REVIEWED BY: SR	Page 1 of 1

CLIENT: GFL

METHOD: Casing

PROJECT: GFL EOWHF Expansion Project

PROJECT ENGINEER:

ELEV. (m) 64.86

MW20-12(S)

LOCATION: 17125 Lafleche Road, Moosecreek

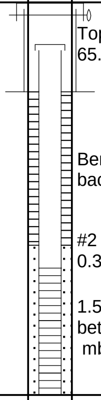
NORTHING: 5018908

EASTING: 500862

PROJECT NO.: CO749.00

SAMPLE TYPE: ◨ AUGER ◪ DRIVEN ⧓ CORING ⬒ DYNAMIC CONE ▮ SHELBY ⌶ SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) ● 40 80 120 160 N-Value (Blows/300mm) ▲ 20 40 60 80	Water Content (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	Well Construction	REMARKS
▼		Refer to MW20-10(D) for stratigraphy information.	-1 0	65							Top of Pipe Elevation = 65.581 m
	▨	SILTY CLAY	1 2 3 4	64 63 62 61							Bentonite pellets used as backfill to surface. #2 silica sand backfilled 0.3 m above screen. 1.52 m screen installed between 2.8 m to 4.3 mbgs.
		END OF BOREHOLE									



TERRAPEX

LOGGED BY: RH

DRILLING DATE: Feb 4, 2020

REVIEWED BY: SR

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CLIENT: GFL
METHOD: Casing
PROJECT: GFL EOWHF Expansion Project
PROJECT ENGINEER:
ELEV. (m) 65.5

BH No.: 20-13

LOCATION: 17125 Lafleche Road, Moosecreek
NORTHING: 5018640
EASTING: 500965
PROJECT NO.: CO749.00

SAMPLE TYPE ▌ AUGER ◪ DRIVEN ⧓ CORING ▀ DYNAMIC CONE ▐▌ SHELBY ⌶ SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) ● 40 80 120 160 N-Value (Blows/300mm) ▲ 20 40 60 80	Water Content (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	Well Construction	REMARKS
	▨	SILTY CLAY	0 – 13.64								Advanced casing from surface to bedrock, borehole was not sampled. Inferred TILL layer was encountered at 13.64 mbgs.
	▩	TILL	13.64 – 14.25								Inferred bedrock was encountered at 14.25 mbgs.
		END OF BOREHOLE									

DEPTH (m): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14

ELEVATION (m): 65, 64, 63, 62, 61, 60, 59, 58, 57, 56, 55, 54, 53, 52

TERRAPEX

LOGGED BY: RH
DRILLING DATE: Feb 5, 2020
REVIEWED BY: SR
Page 1 of 1

CLIENT: GFL	METHOD: Casing		**BH No.: 20-14**
PROJECT: GFL EOWHF Expansion Project	PROJECT ENGINEER:	ELEV. (m) 67.15	
LOCATION: 17125 Lafleche Road, Moosecreek	NORTHING: 5017523	EASTING: 501207	PROJECT NO.: CO749.00

SAMPLE TYPE ▮ AUGER ◪ DRIVEN ⧓ CORING ⬒ DYNAMIC CONE ▯ SHELBY ⌶ SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) ● 40 80 120 160 N-Value (Blows/300mm) ▲ 20 40 60 80	Water Content (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	Well Construction	REMARKS
	▨	SILTY CLAY	0 1 2 3 4 5 6 7 8 9 10 11 12	67 66 65 64 63 62 61 60 59 58 57 56 55							Advanced casing from surface to bedrock, borehole was not sampled. Inferred TILL layer was encountered at 12.63 mbgs.
	▒	TILL	13 14 15 16	54 53 52							Inferred bedrock was encountered at 16.02 mbgs.
		END OF BOREHOLE									

TERRAPEX

LOGGED BY: RH	DRILLING DATE: Feb 5, 2020
REVIEWED BY: SR	Page 1 of 1

CLIENT: GFL
METHOD: Casing
PROJECT: GFL EOWHF Expansion Project
PROJECT ENGINEER:
ELEV. (m) 67.36

MW20-15(T)

LOCATION: 17125 Lafleche Road, Moosecreek
NORTHING: 5017257
EASTING: 501345
PROJECT NO.: CO749.00

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) ● 40 80 120 160 N-Value (Blows/300mm) ▲ 20 40 60 80	Water Content (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	Well Construction	REMARKS
		Adavanced casing without sampling; soil descriptions are inferred.	-1	68							Top pf Pipe Elevation = 68.342 m
▼	▨	SILTY CLAY	0 1 2 3 4 5 6 7 8 9	67 66 65 64 63 62 61 60 59 58							Note: Monitoring well installed in seperate borehole. Bentonite pellets used as backfill to surface.
		TILL	10 11 12 13 14 15 16	57 56 55 54 53 52 51							#2 silica sand backfilled 0.3 m above screen. 1.52 m screen installed between 12.2 m to 13.7 mbgs.
		END OF BOREHOLE									Inferred Bedrock at 16.4 mbgs.

TERRAPEX

LOGGED BY: RH
DRILLING DATE: Feb 5, 2020
REVIEWED BY: SR
Page 1 of 1

CLIENT: GFL	METHOD: Casing	**BH No.: 20-16**
PROJECT: GFL EOWHF Expansion Project	PROJECT ENGINEER:	ELEV. (m) 67.23
LOCATION: 17125 Lafleche Road, Moosecreek	NORTHING: 5017392	EASTING: 500921
		PROJECT NO.: CO749.00

SAMPLE TYPE ▮ AUGER ◢ DRIVEN ⧓ CORING ▀ DYNAMIC CONE ▯ SHELBY ⌶ SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)	Shear Strength (kPa) ● 40 80 120 160 N-Value (Blows/300mm) ▲ 20 40 60 80	Water Content (%) PL W.C. LL 20 40 60 80	SAMPLE NO.	SAMPLE TYPE	SPT(N)	Well Construction	REMARKS
	▨	SILTY CLAY	0 – 14	67 – 53							Advanced casing from surface to bedrock, borehole was not sampled; soil descriptions are inferred. TILL was confirmed by samples 1A and 1B.
			14	53	27 ▲		1A 1B	⌶	27		TILL layer was encountered (1B) at 14.02 mbgs.
	▩	TILL	14 – 17	53 – 50							Inferred bedrock was encountered at 17.37 mbgs.
		END OF BOREHOLE									

DEPTH (m): 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

ELEVATION (m): 67 66 65 64 63 62 61 60 59 58 57 56 55 54 53 52 51 50

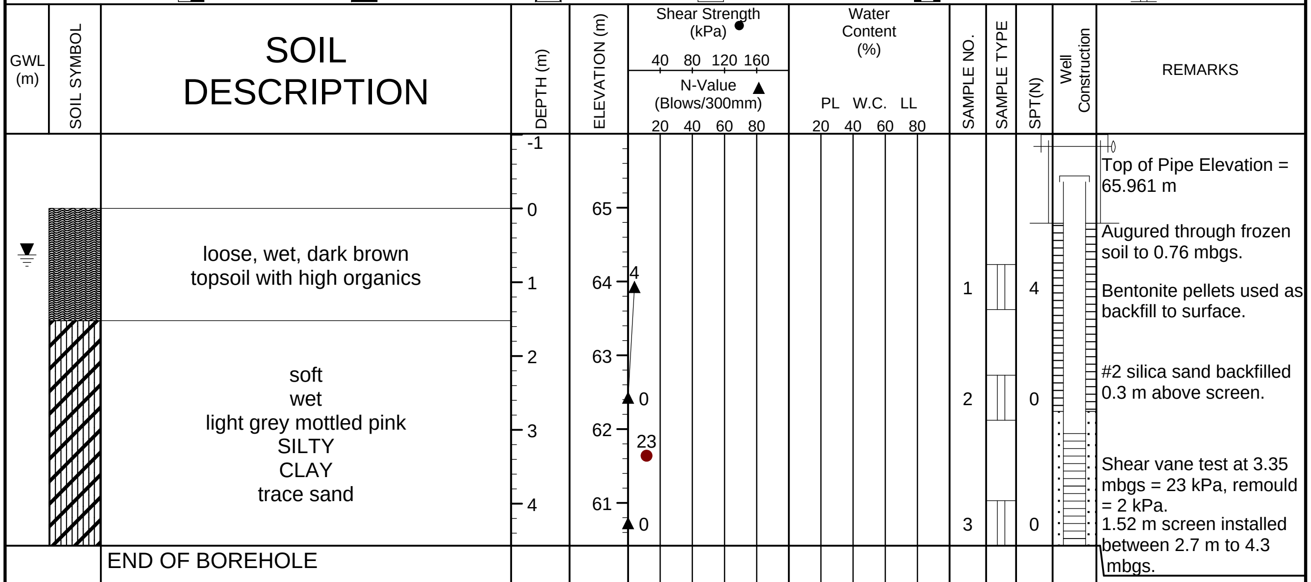
TERRAPEX

LOGGED BY: RH	DRILLING DATE: Feb 5, 2020
REVIEWED BY: SR	Page 1 of 1

MW20-17(S)

CLIENT: GFL	METHOD: Casing		
PROJECT: GFL EOWHF Expansion Project	PROJECT ENGINEER:	ELEV. (m) 64.99	
LOCATION: 17125 Lafleche Road, Moosecreek	NORTHING: 5018699	EASTING: 500354	PROJECT NO.: CO749.00

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON



SOIL DESCRIPTION
loose, wet, dark brown topsoil with high organics
soft wet light grey mottled pink SILTY CLAY trace sand
END OF BOREHOLE

SAMPLE NO.	SPT(N)
1	4
2	0
3	0

REMARKS

Top of Pipe Elevation = 65.961 m

Augured through frozen soil to 0.76 mbgs.

Bentonite pellets used as backfill to surface.

#2 silica sand backfilled 0.3 m above screen.

Shear vane test at 3.35 mbgs = 23 kPa, remould = 2 kPa.
1.52 m screen installed between 2.7 m to 4.3 mbgs.

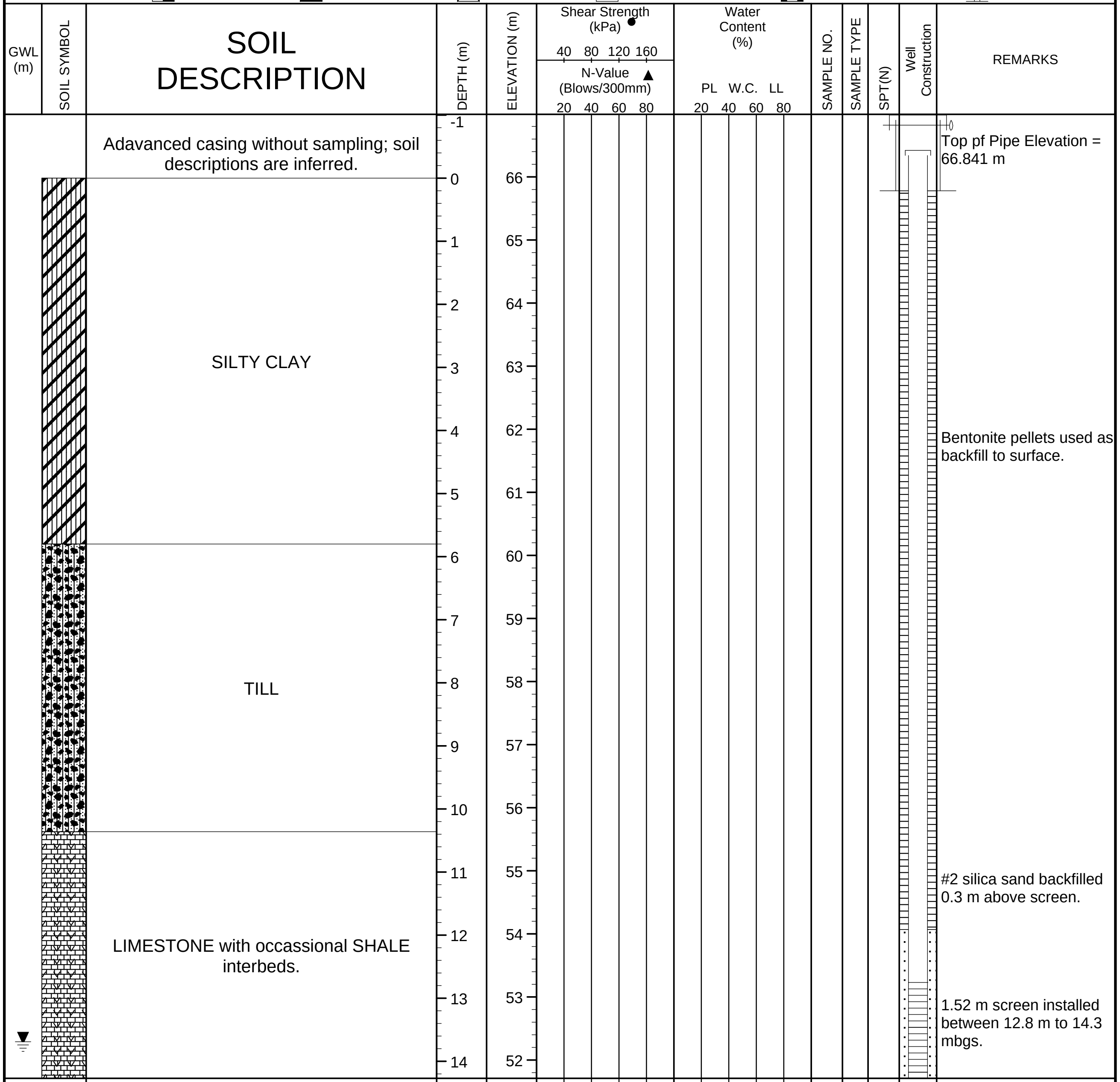
TERRAPEX	LOGGED BY: JM	DRILLING DATE: Feb 6, 2020
	REVIEWED BY: SR	Page 1 of 1

CLIENT: GFL
METHOD: Casing
PROJECT: GFL EOWHF Expansion Project
PROJECT ENGINEER:
ELEV. (m) 65.98

MW20-18(D)

LOCATION: 17125 Lafleche Road, Moosecreek
NORTHING: 5018076
EASTING: 501567
PROJECT NO.: CO749.00

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON



SOIL DESCRIPTION	REMARKS
Adavanced casing without sampling; soil descriptions are inferred.	Top pf Pipe Elevation = 66.841 m
SILTY CLAY	Bentonite pellets used as backfill to surface.
TILL	
LIMESTONE with occassional SHALE interbeds.	#2 silica sand backfilled 0.3 m above screen. 1.52 m screen installed between 12.8 m to 14.3 mbgs.

END OF BOREHOLE

TERRAPEX

LOGGED BY: RH
DRILLING DATE: Feb 7, 2020
REVIEWED BY: SR
Page 1 of 1

PROJECT: 971-2618

RECORD OF BOREHOLE 96-1

SHEET 1 OF 1

LOCATION: See Figure

BORING DATE: Mar.11&12, 1996

DATUM: Geodetic

DIP:

SAMPLER HAMMER, 63.5kg; DROP, 760 mm

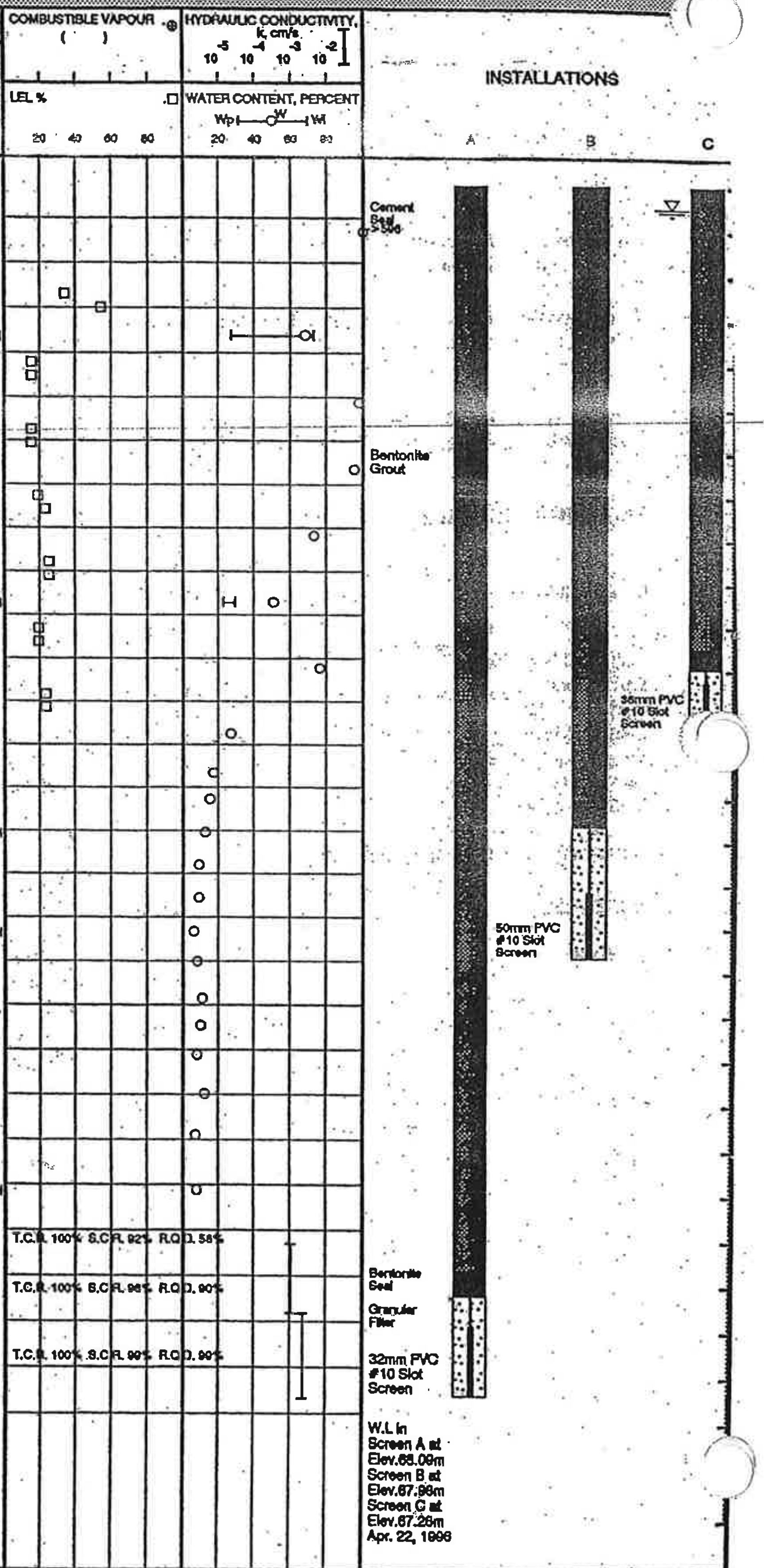
BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
	Ground Surface	67.74
Power Auger 200mm Diam (Hollow Stem)	Soft dark brown fibrous to amorphous PEAT	0.00
	Firm to stiff grey brown and red brown SILTY CLAY (Weathered Crust)	65.67 2.07
	Soft to firm grey SILTY CLAY, occasional red-brown seam	64.84 2.90
	Very loose grey CLAYEY SILT, trace to some sand and gravel	55.40 12.34
	Compact to dense grey sandy silt, some gravel and clay (GLACIAL TILL)	54.63 13.11
	Very dense dark grey sandy silt, some gravel and clay, occasional sand to sandy silt seam and layer, occasional cobble and boulder (GLACIAL TILL)	50.98 16.76
Rotary Drill HW Casing / NQ Core	Fresh to faintly weathered light to dark grey sublithographic to fine crystalline LIMESTONE; some mottled intervals present; stylolites present.	44.03 23.71
	End of Hole	40.37 27.37

NUMBER	TYPE	BLOWS/0.3m	RECOVERY %	LAB. TESTING
1	50 DO	WH		
2	50 DO	WH		
3	50 DO	WH		MH
4	50 DO	PM		
5	75 TP	PM		
6	50 DO	WR WH		
7	50 DO	PM		MH
8	50 DO	WR PM		
9	50 DO	WR WH		
10	50 DO	12		
11	50 DO	12		
12	50 DO	7		MH
13	50 DO	11		
14	50 DO	32		
15	50 DO	52		MH
16	50 DO	>100		
17	50 DO	98		
18	50 DO	>100		
[illegible]	50 DO	>100		
20	50 DO	>100		
21	50 DO	>100		
22	NQ	–		
23	50 DO	>100		MH
24	NQ RC	–		
25	NQ RC	–		
26	NQ RC	–		

T.C.R. 100% S.C.R. 92% R.Q.D. 58%

T.C.R. 100% S.C.R. 98% R.Q.D. 90%

T.C.R. 100% S.C.R. 99% R.Q.D. 99%



W.L in Screen A at Elev.66.09m Screen B at Elev.67.98m Screen C at Elev.67.26m Apr. 22, 1996

DEPTH SCALE METRES 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

DATA INPUT: C:96-1-715.drf

DEPTH SCALE (ALONG HOLE)
1 to 150

Golder Associates

LOGGED: D.J.S
CHECKED: PAS

PROJECT: 971-2818
LOCATION: See Figure
DIP:

RECORD OF BOREHOLE 96-2

BORING DATE: Mar. 21, 1996

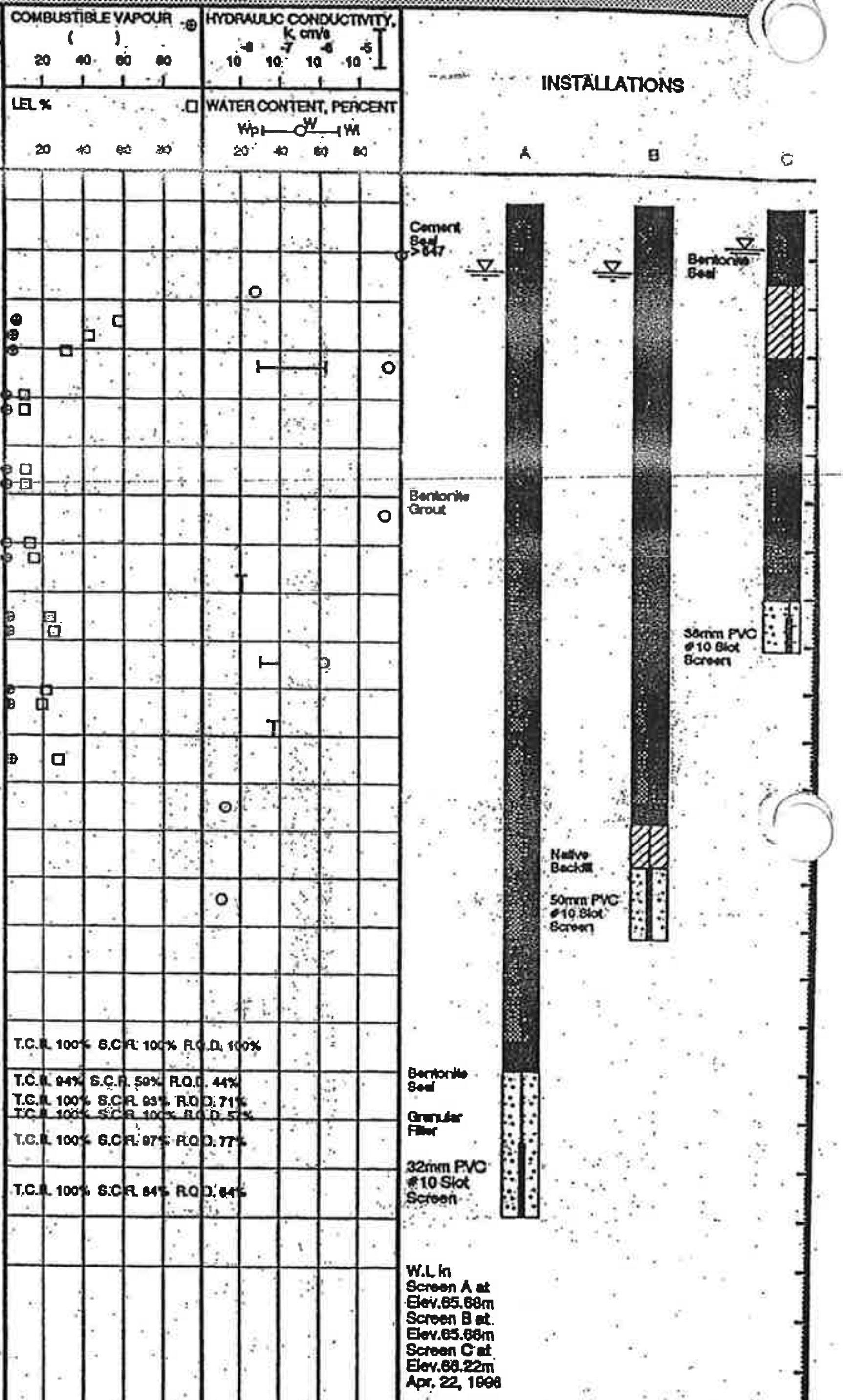
SHEET 1 OF 1
DATUM: Geodetic
SAMPLER HAMMER, 63.5kg; DROP, 760 mm

SOIL PROFILE

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	ELEV. / DEPTH (m)
		Ground Surface	67.00
0	Power Auger 200mm Diam (Hollow Stem)	Dark brown fibrous PEAT	0.00
1.65		Stiff grey brown SILTY CLAY, some brown organics	65.35 1.65
1.98		Firm to stiff grey brown SILTY CLAY (Weathered Crust)	1.98
2.96		Very soft to soft grey SILTY CLAY	64.04 2.96
11.52		Loose grey sandy silt, some gravel and clay (GLACIAL TILL)	55.48 11.52
14.17	Rotary Drill NW Casing	Very dense dark grey sandy silt, some gravel, clay and boulders (GLACIAL TILL)	52.83 14.17
17.01	NQ Core	Fresh to faintly weathered light to dark grey sublithographic to fine crystalline LIMESTONE, some mottled intervals present; stylolites present with some fractures coincident with stylolitic zones.	49.99 17.01
20.97		End of Hole	46.03 20.97

SAMPLES

NUMBER	TYPE	BLOWS/0.3m	RECOVERY %	LAB. TESTING
1	50 DO	WH		
2	50 DO	WH		
3	50 DO	WH		
4	75 TP	PH		
5	50 DO	WR		
6	75 TP	WR		
7	50 DO	WR PM		
8	75 TP	WR		
9	50 DO	6		
10	50 DO	>100		
11	NQ RC	-		
12	NQ RC	-		
13	NQ RC	-		
14	NQ RC	-		
15	NQ RC	-		
16	NQ RC	-		
17				
18	NQ RC	-		
19	NQ RC	-		



T.C.R. 100% S.C.R. 100% R.Q.D. 100%
T.C.R. 94% S.C.R. 59% R.Q.D. 44%
T.C.R. 100% S.C.R. 93% R.Q.D. 71%
T.C.R. 100% S.C.R. 100% R.Q.D. 57%
T.C.R. 100% S.C.R. 97% R.Q.D. 77%
T.C.R. 100% S.C.R. 84% R.Q.D. 64%

W.L in
Screen A at
Elev.65.68m
Screen B at
Elev.65.68m
Screen C at
Elev.66.22m
Apr. 22, 1996

DATA INPUT: C:96-2-715.drf

DEPTH SCALE (ALONG HOLE)
1 to 150

Golder Associates

LOGGED: D.J.S
CHECKED: PAS

PROJECT: 971-2818
LOCATION: See Figure
DIP:

RECORD OF BOREHOLE 96-3

BORING DATE: Mar. 28&29,1996

SAMPLER HAMMER, 63.5 kg; DROP, 760 mm

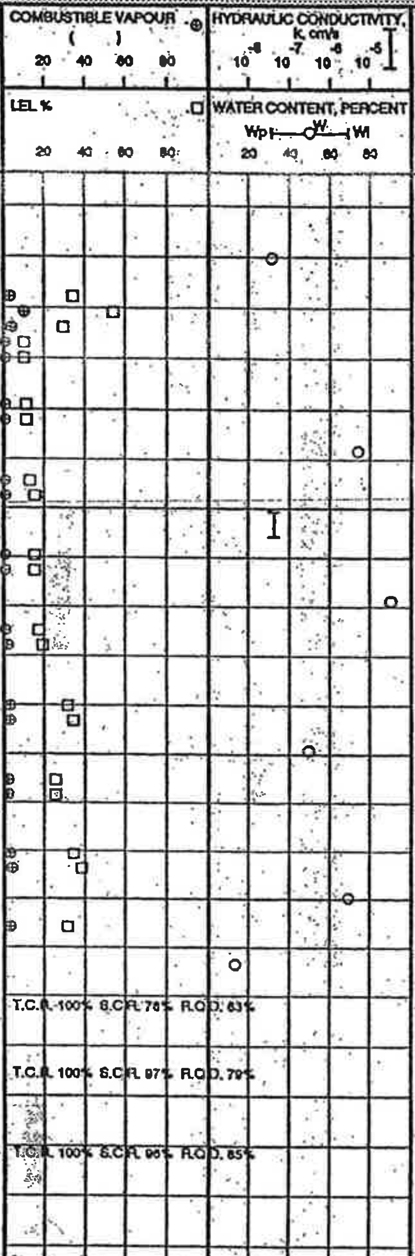
SHEET 1 OF 1
DATUM: Geodetic

SOIL PROFILE

BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)
	Ground Surface		66.04
Power Auger 200mm Diam (Hollow Stem)	Dark brown fibrous PEAT		0.00
	Firm to stiff grey brown SILTY CLAY (Weathered Crust)		64.76 1.28
	Very soft to firm grey SILTY CLAY		63.66 2.38
	Very loose grey SAND and GRAVEL, some cobbles, trace silt		51.17 14.87
Rotary Drill NQ Core NW	Fresh to faintly weathered light to dark grey sublithographic to fine crystalline LIMESTONE, some mottled and stylolitic zones; fracture zones commonly coincident with stylolites.		50.46 15.58
	End of Hole		46.35 19.69

SAMPLES

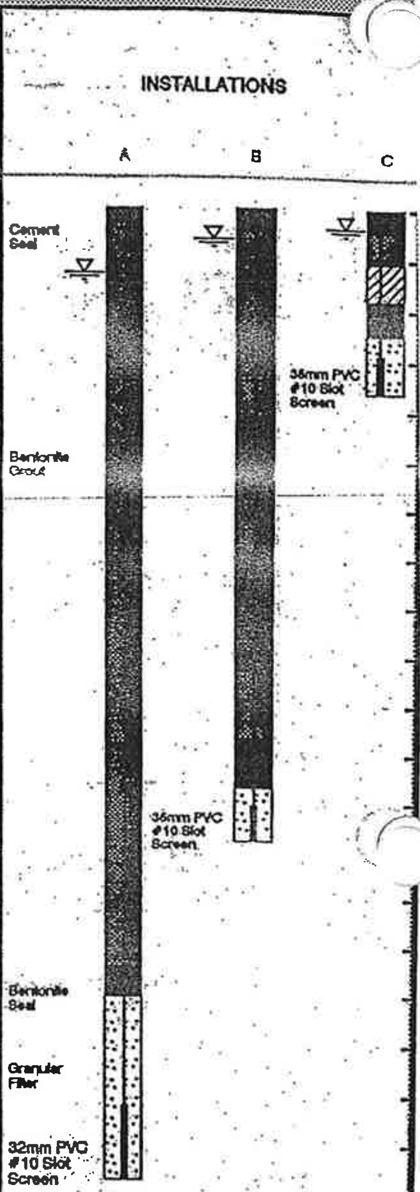
NUMBER	TYPE	BLOWS/0.3m	RECOVERY %	LAB. TESTING
1	50 DO	WH		
2	75 TP	PH		
3	50 DO	WH		
4	75 TP	PH		
5	50 DO	WR		
6	75 TP	WR		
7	50 DO	WR		
8	75 TP	WR		
9	50 DO	PM		
10	50 DO	WH		
11	NQ RC	-		
12	NQ RC	-		
13	NQ RC	-		



T.C.R.-100% S.C.R. 76% R.Q.D. 63%

T.C.R. 100% S.C.R. 97% R.Q.D. 79%

T.C.R. 100% S.C.R. 96% R.Q.D. 85%



W.L in
Screen A at
Elev.64.80m
Screen B at
Elev.65.48m
Screen C at
Elev.65.70m
Apr. 22, 1996

DEPTH SCALE METRES: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

DATA INPUT: C:96-3-715.drf

DEPTH SCALE (ALONG HOLE)
1 to 150

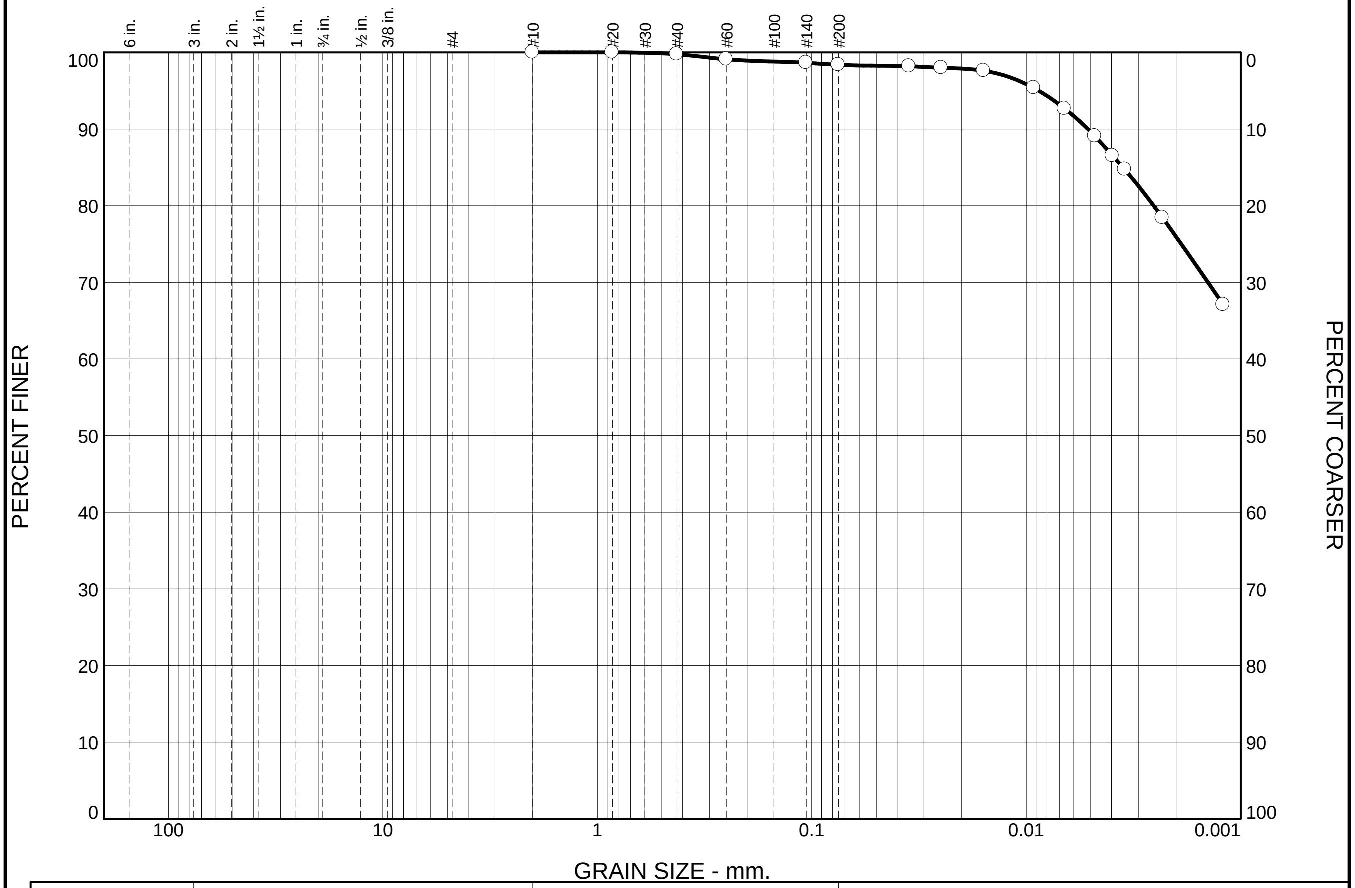
Golder Associates

LOGGED: D.J.S
CHECKED: PAS

APPENDIX D

LABORATORY TEST RESULTS

Grain Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0	0	0	2	22	76

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.0035							

Material Description	USCS	AASHTO
○ SILTY CLAY, trace sand		

Project No. CO749.00 **Client:** GFL Environmental Inc.

Project: EOWHF Expansion- 17125 Lafleche Road, Moose Creek, Ontario

○ **Sample Number:** MW20-1D, Sample 6

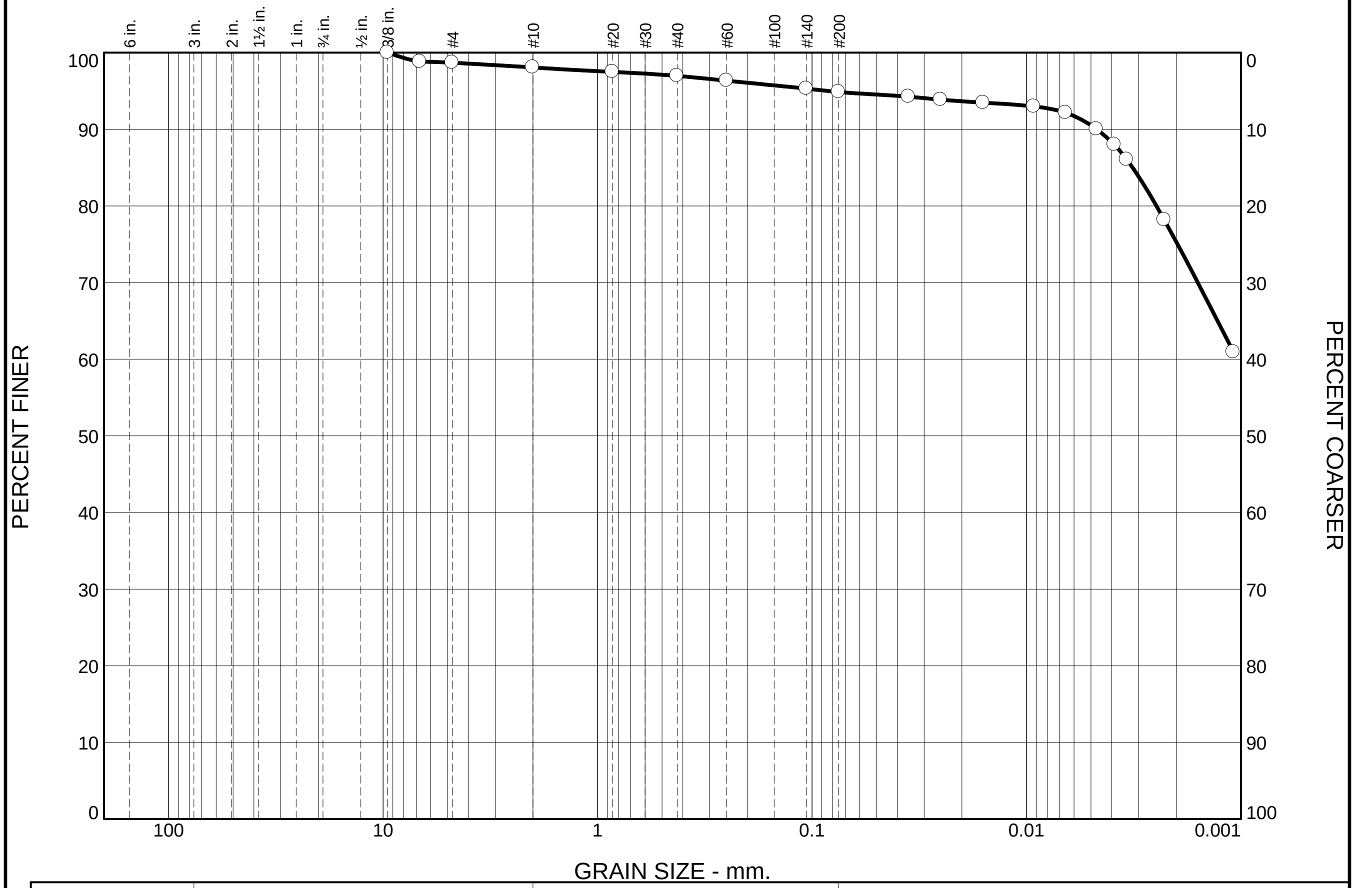
Remarks:

Terrapex

Figure D-1

Tested By: PG/DM **Checked By:** DM

Grain Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0	2	1	2	20	75

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.0032							

Material Description	USCS	AASHTO
○ CLAY, some silt, trace sand, trace gravel		

Project No. CO749.00 **Client:** GFL Environmental Inc.

Project: EOWHF Expansion- 17125 Lafleche Road, Moose Creek, Ontario

○ **Sample Number:** MW20-1D, Sample 8

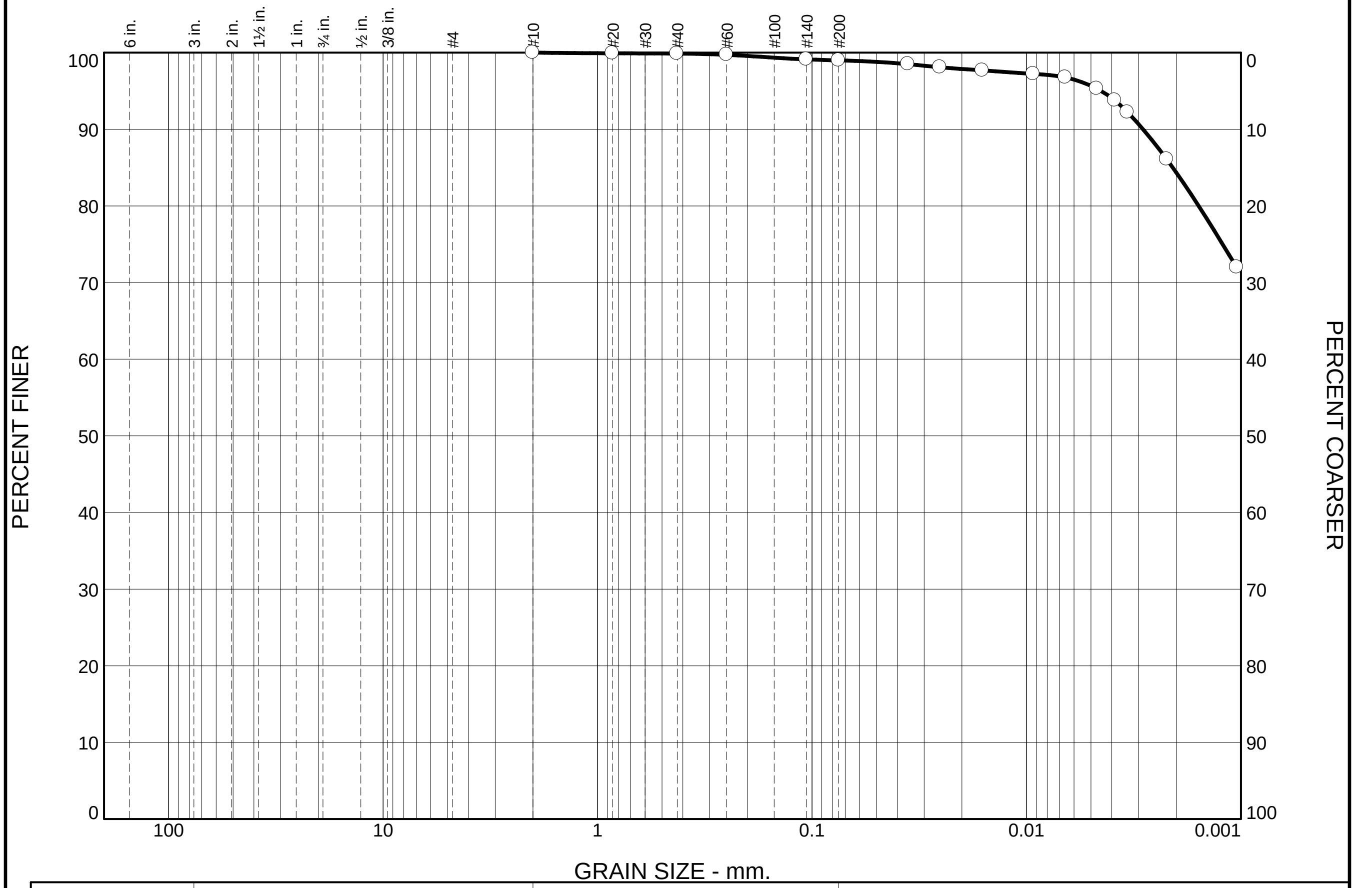
Remarks:

Terrapex

Figure D-2

Tested By: DM/PG **Checked By:** DM

Grain Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0	0	0	1	15	84

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.0021							

Material Description	USCS	AASHTO
○ CLAY, some silt, trace sand		

Project No. CO749.00 **Client:** GFL Environmental Inc.

Project: EOWHF Expansion- 17125 Lafleche Road, Moose Creek, Ontario

○ **Sample Number:** MW20-2D, Sample 7

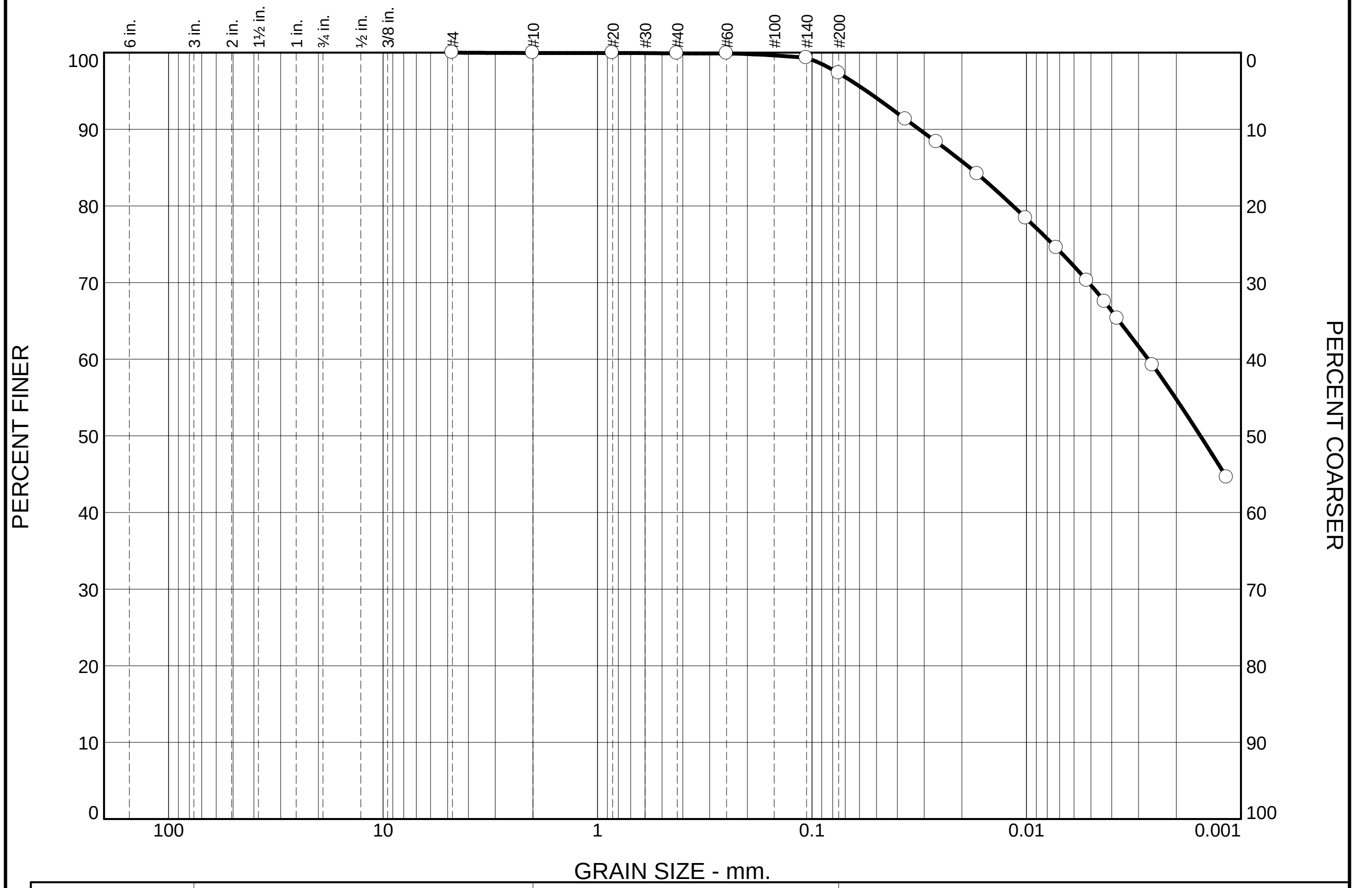
Remarks:

Terrapex

Figure D-3

Tested By: DM/PG **Checked By:** DM

Grain Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0	0	0	3	42	55

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.0184	0.0027	0.0015					

Material Description	USCS	AASHTO
○ SILT and CLAY, trace sand		

Project No. CO749.00 **Client:** GFL Environmental Inc.

Project: EOWHF Expansion- 17125 Lafleche Road, Moose Creek, Ontario

○ **Sample Number:** MW20-2D, Sample 11

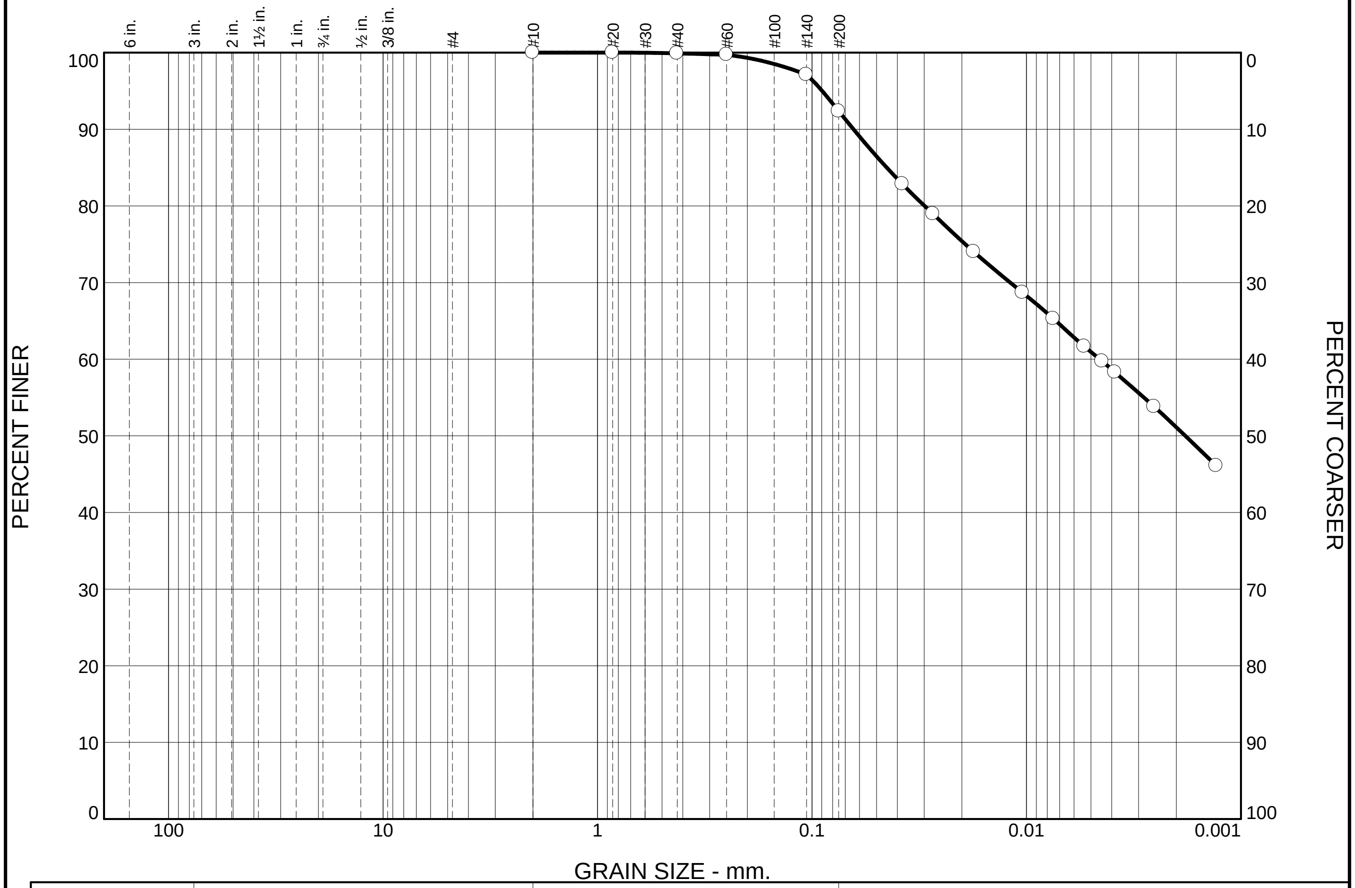
Remarks:

Terrapex

Figure D-4

Tested By: PG **Checked By:** DM

Grain Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0	0	0	8	41	51

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.0448	0.0046	0.0018					

Material Description	USCS	AASHTO
○ SILT and CLAY, trace sand		

Project No. CO749.00 **Client:** GFL Environmental Inc.

Project: EOWHF Expansion- 17125 Lafleche Road, Moose Creek, Ontario

○ **Sample Number:** MW20-6D, Sample 4

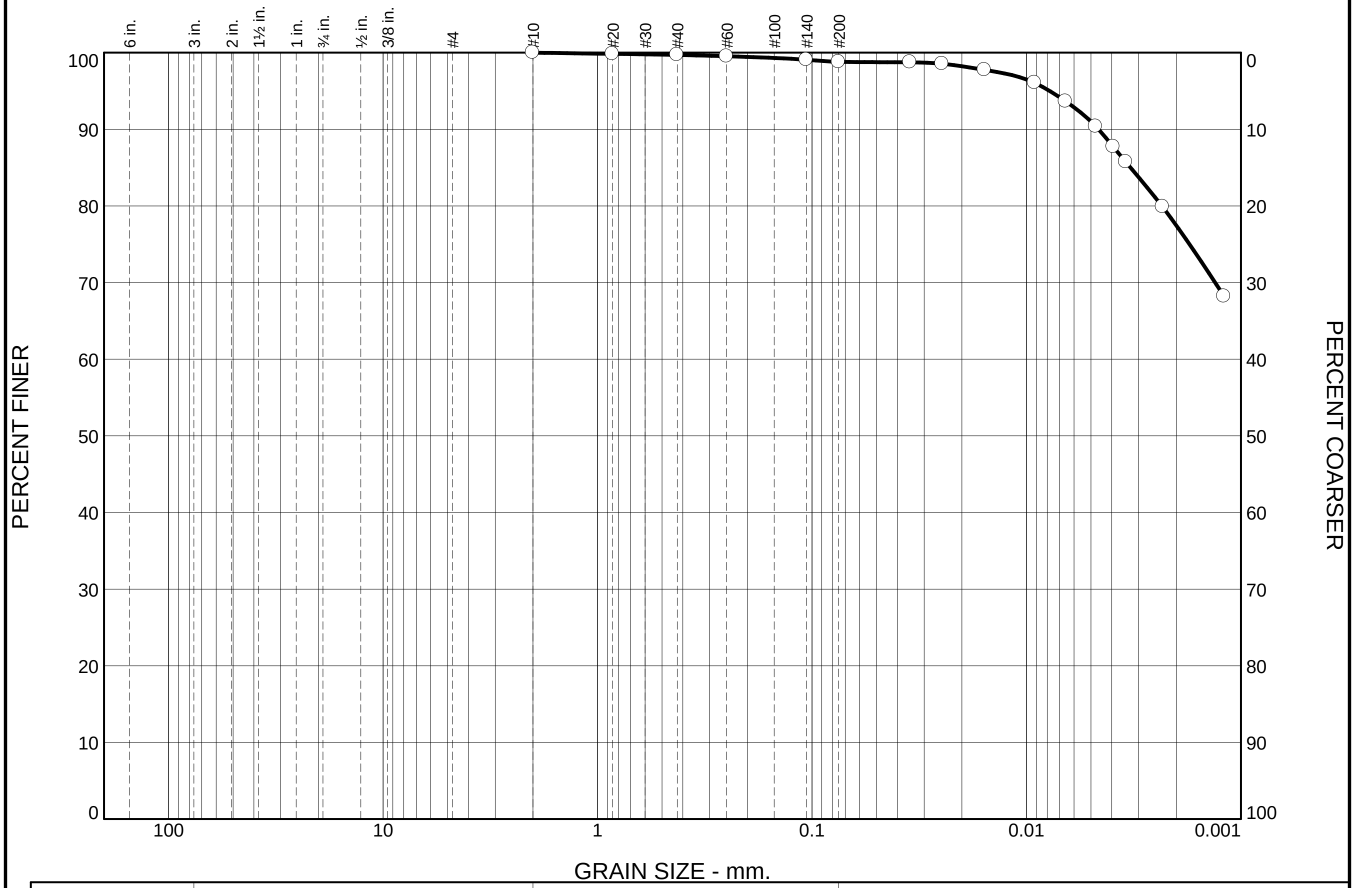
Remarks:

Terrapex

Figure D-5

Tested By: PG/DM **Checked By:** DM

Grain Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0	0	0	1	22	77

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.0033							

Material Description	USCS	AASHTO
○ SILTY CLAY, trace sand		

Project No. CO749.00 **Client:** GFL Environmental Inc.

Project: EOWHF Expansion- 17125 Lafleche Road, Moose Creek, Ontario

○ **Sample Number:** MW20-8D, Sample 7

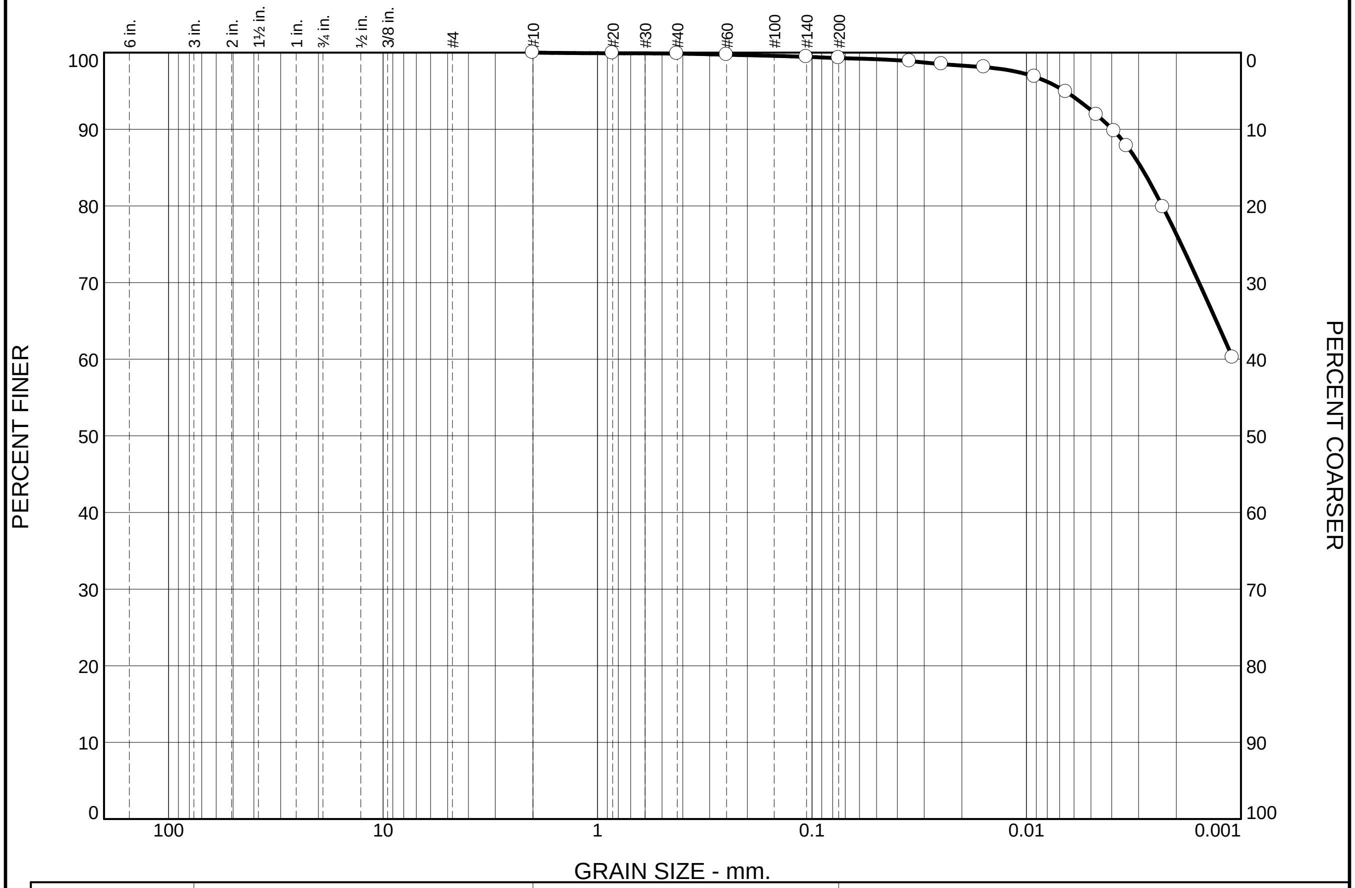
Remarks:

Terrapex

Figure D-6

Tested By: PG/DM **Checked By:** DM

Grain Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0	0	0	1	23	76

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.0029							

Material Description	USCS	AASHTO
○ SILTY CLAY, trace sand		

Project No. CO749.00 **Client:** GFL Environmental Inc.

Project: EOWHF Expansion- 17125 Lafleche Road, Moose Creek, Ontario

○ **Sample Number:** MW20-9D, Sample 7

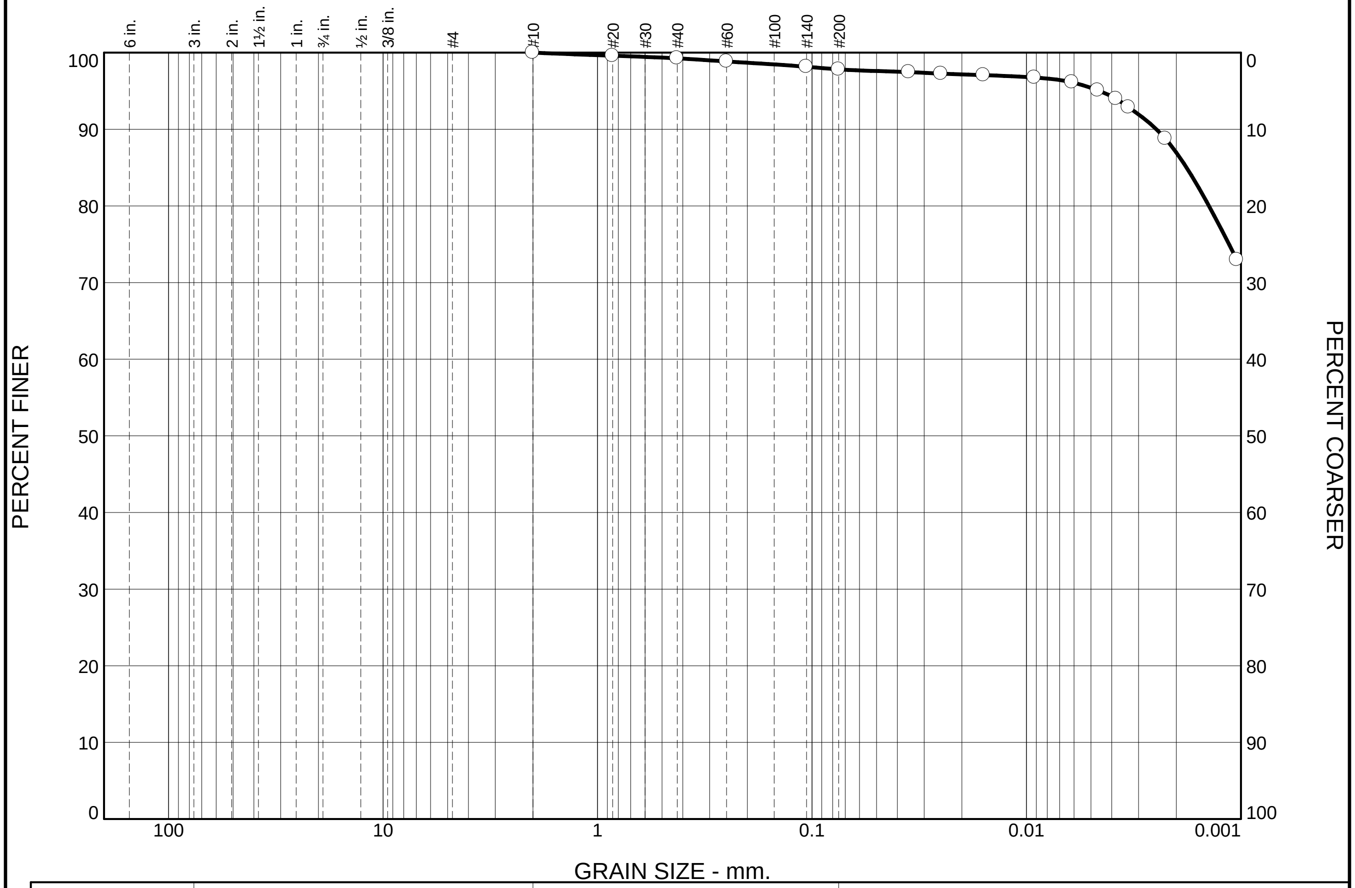
Remarks:

Terrapex

Figure D-7

Tested By: PG/DM **Checked By:** DM

Grain Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0	0	1	1	11	87

╳	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.0018							

Material Description	USCS	AASHTO
○ CLAY, some silt, trace sand		

Project No. CO749.00 **Client:** GFL Environmental Inc.
Project: EOWHF Expansion- 17125 Lafleche Road, Moose Creek, Ontario

○ **Sample Number:** MW20-9D, Sample 8

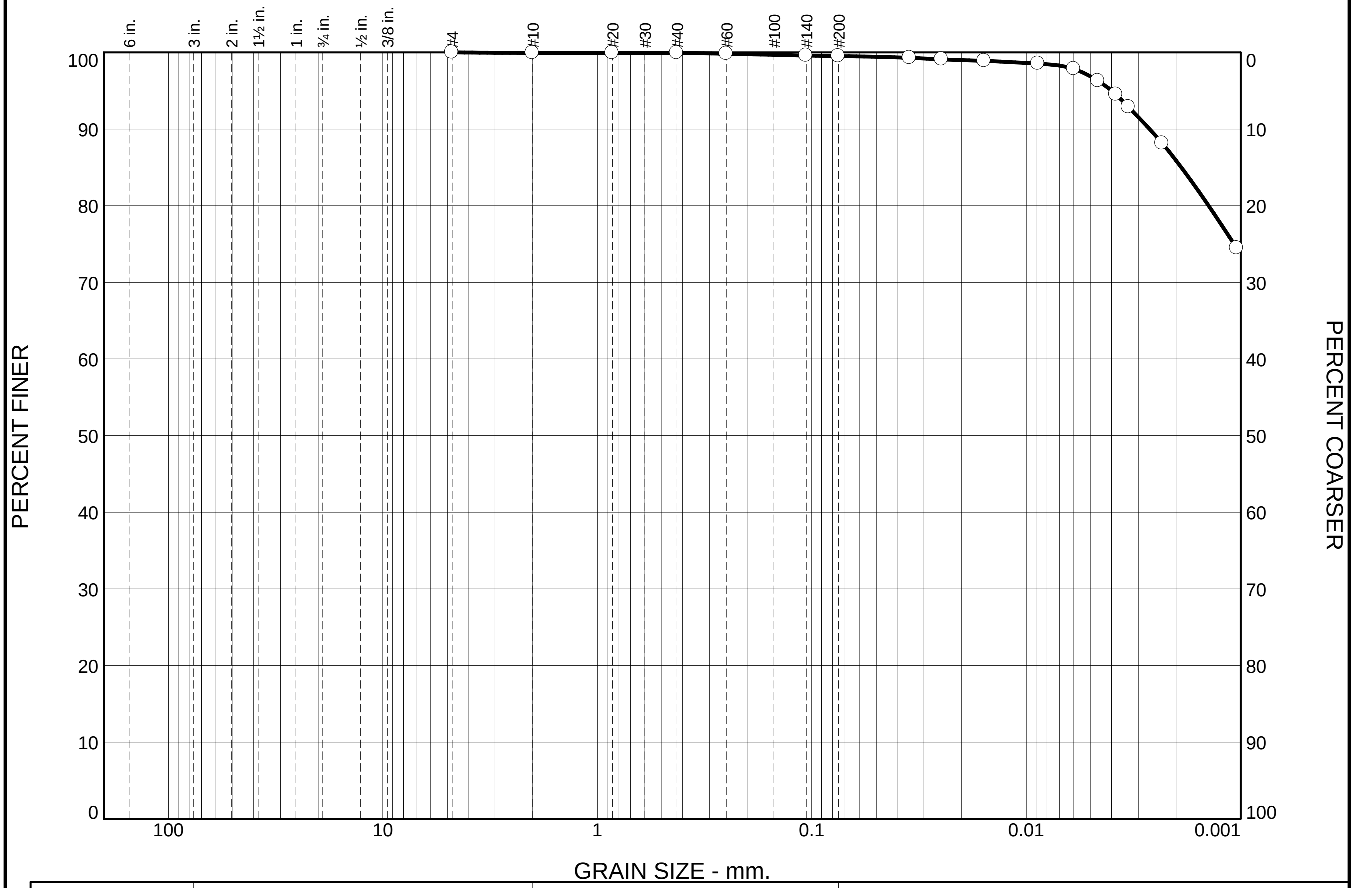
Remarks:

Terrapex

Figure D-8

Tested By: PG/DM **Checked By:** DM

Grain Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0	0	0	0	14	86

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	57	25	0.0019							

Material Description	USCS	AASHTO
○ CLAY, some silt	CH	A-7-6(37)

Project No. CO749.00 **Client:** GFL Environmental Inc.

Project: EOWHF Expansion- 17125 Lafleche Road, Moose Creek, Ontario

○ **Sample Number:** MW20-11D, Sample 7

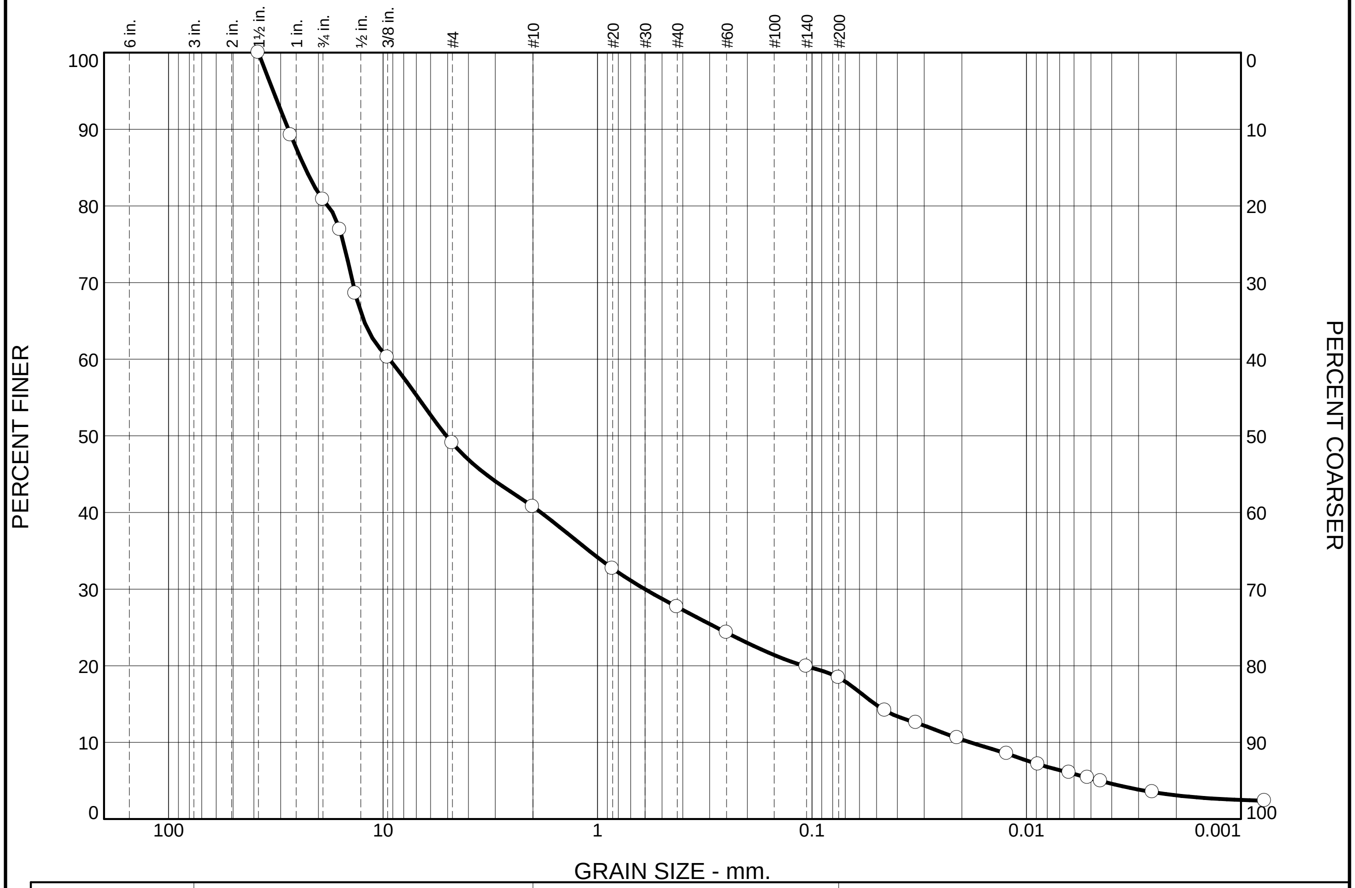
Remarks:

Terrapex

Figure D-9

Tested By: PG/DM **Checked By:** DM

Grain Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0	59	13	10	15	3

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			23.1518	9.3651	5.0684	0.6012	0.0508	0.0182	2.12	513.58

Material Description	USCS	AASHTO
○ SANDY GRAVEL, some silt, trace clay		

Project No. CO749.00 **Client:** GFL Environmental Inc.

Project: EOWHF Expansion- 17125 Lafleche Road, Moose Creek, Ontario

○ **Sample Number:** MW20-3D, Sample 12

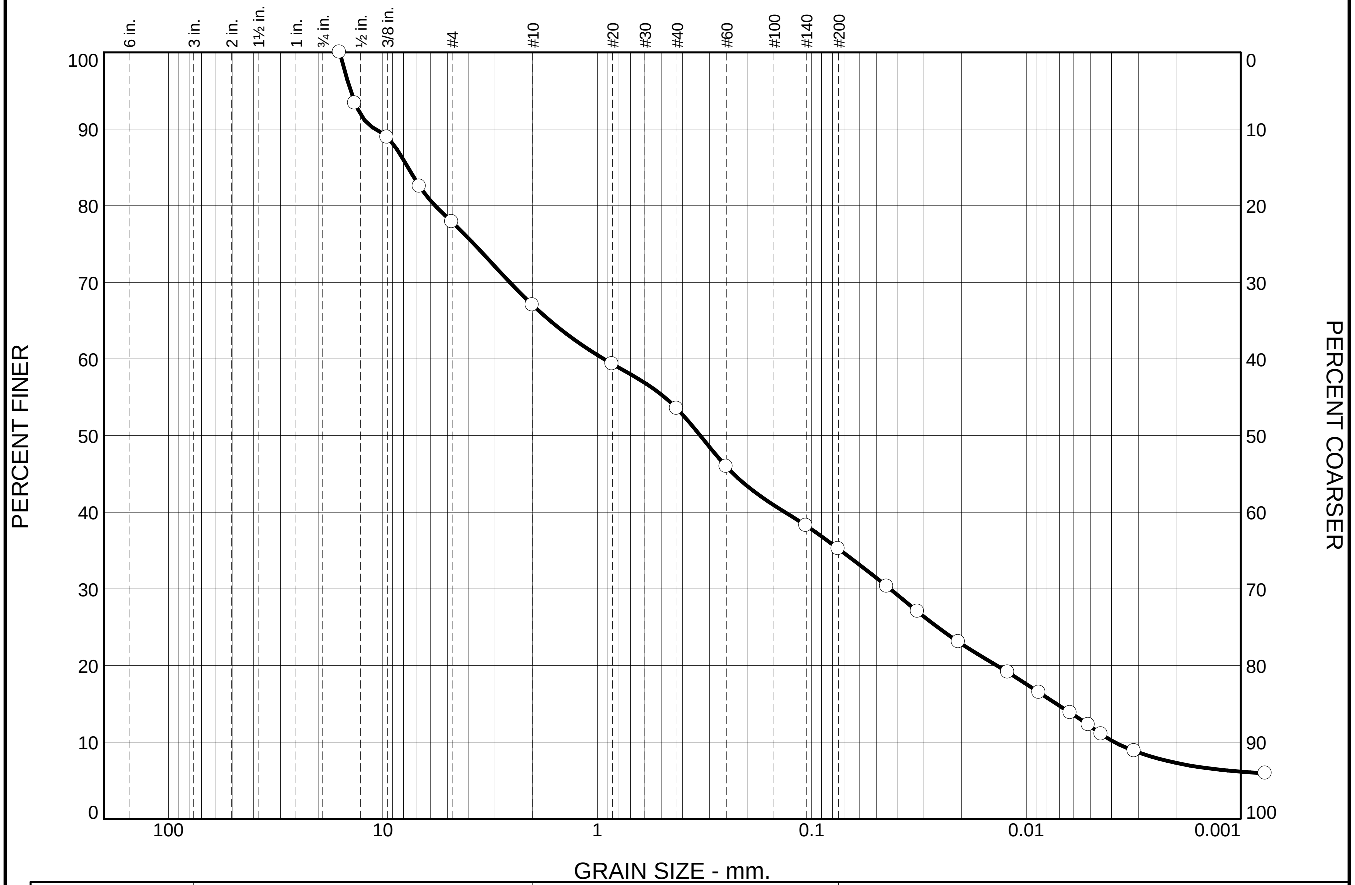
Remarks:

Terrapex

Figure D-10

Tested By: PG/DM **Checked By:** DM

Grain Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0	33	13	19	28	7

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			7.6278	0.9328	0.3309	0.0431	0.0072	0.0039	0.51	240.66

Material Description	USCS	AASHTO
○ SILTY SANDY GRAVEL, trace clay		

Project No. CO749.00 **Client:** GFL Environmental Inc.
Project: EOWHF Expansion- 17125 Lafleche Road, Moose Creek, Ontario

○ **Sample Number:** MW20-5D, Sample 5B

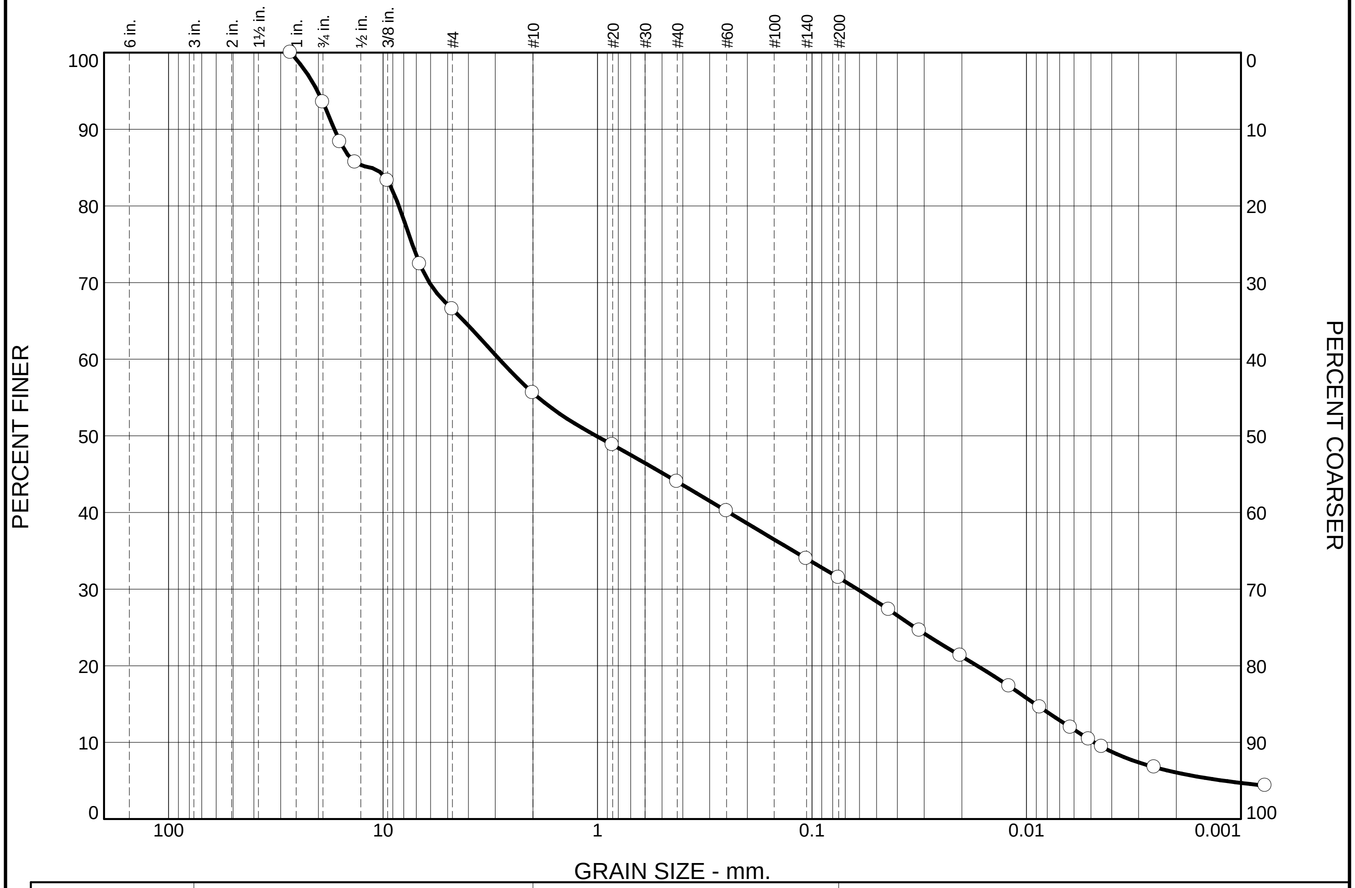
Remarks:

Terrapex

Figure D-11

Tested By: PG/DM **Checked By:** DM

Grain Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0	44	12	13	25	6

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			11.4447	2.8694	1.0146	0.0615	0.0091	0.0048	0.27	593.95

Material Description	USCS	AASHTO
○ SANDY SILTY GRAVEL, trace clay		

Project No. CO749.00 **Client:** GFL Environmental Inc.

Project: EOWHF Expansion- 17125 Lafleche Road, Moose Creek, Ontario

○ **Sample Number:** MW20-5D, Sample 7

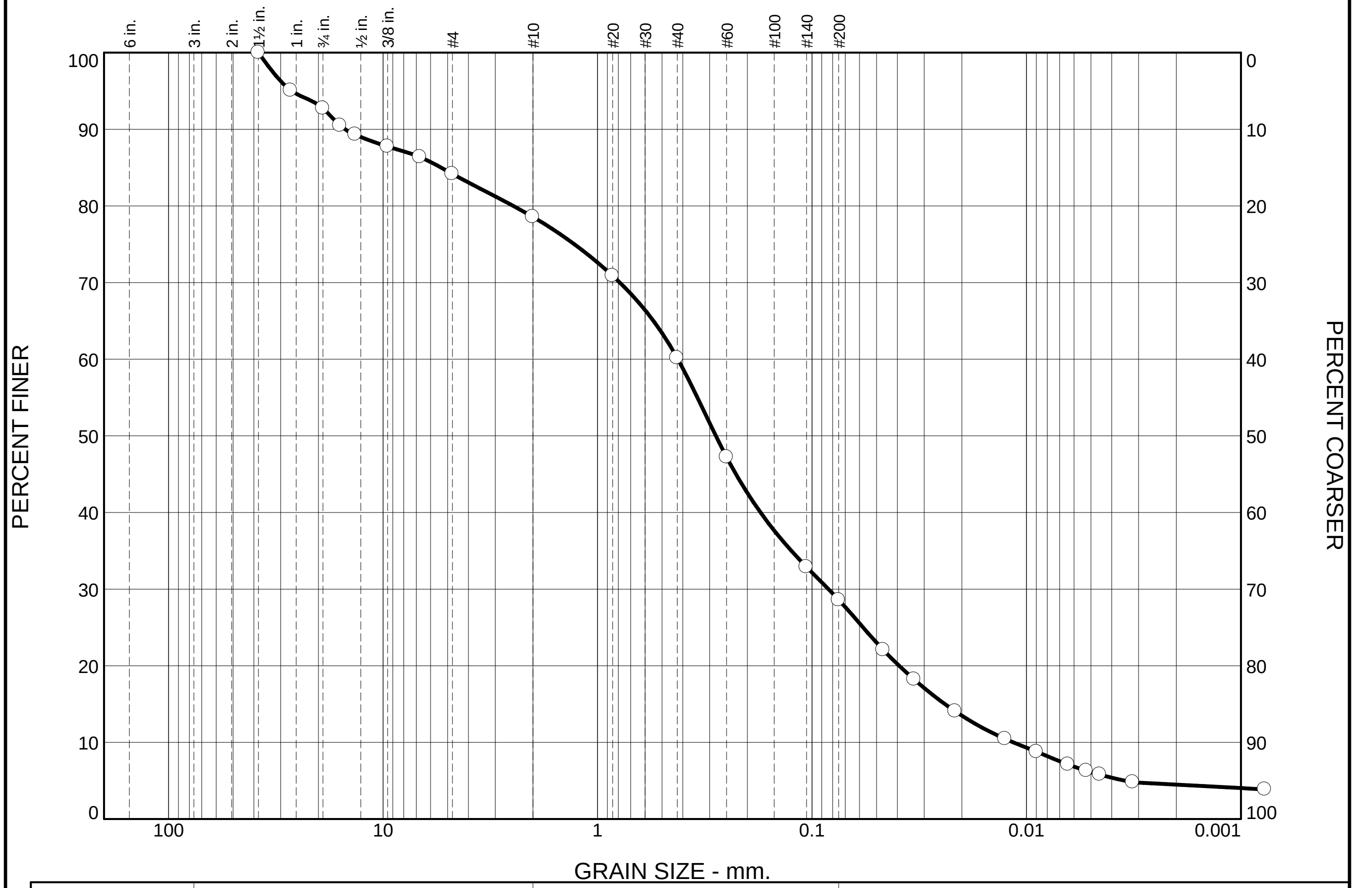
Remarks:

Terrapex

Figure D-12

Tested By: PG/DM **Checked By:** DM

Grain Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0	21	19	31	25	4

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			5.3584	0.4218	0.2807	0.0839	0.0240	0.0115	1.45	36.67

Material Description	USCS	AASHTO
○ GRAVELLY SILTY SAND, trace clay		

Project No. CO749.00 **Client:** GFL Environmental Inc.

Project: EOWHF Expansion- 17125 Lafleche Road, Moose Creek, Ontario

○ **Sample Number:** MW20-9D, Sample 10

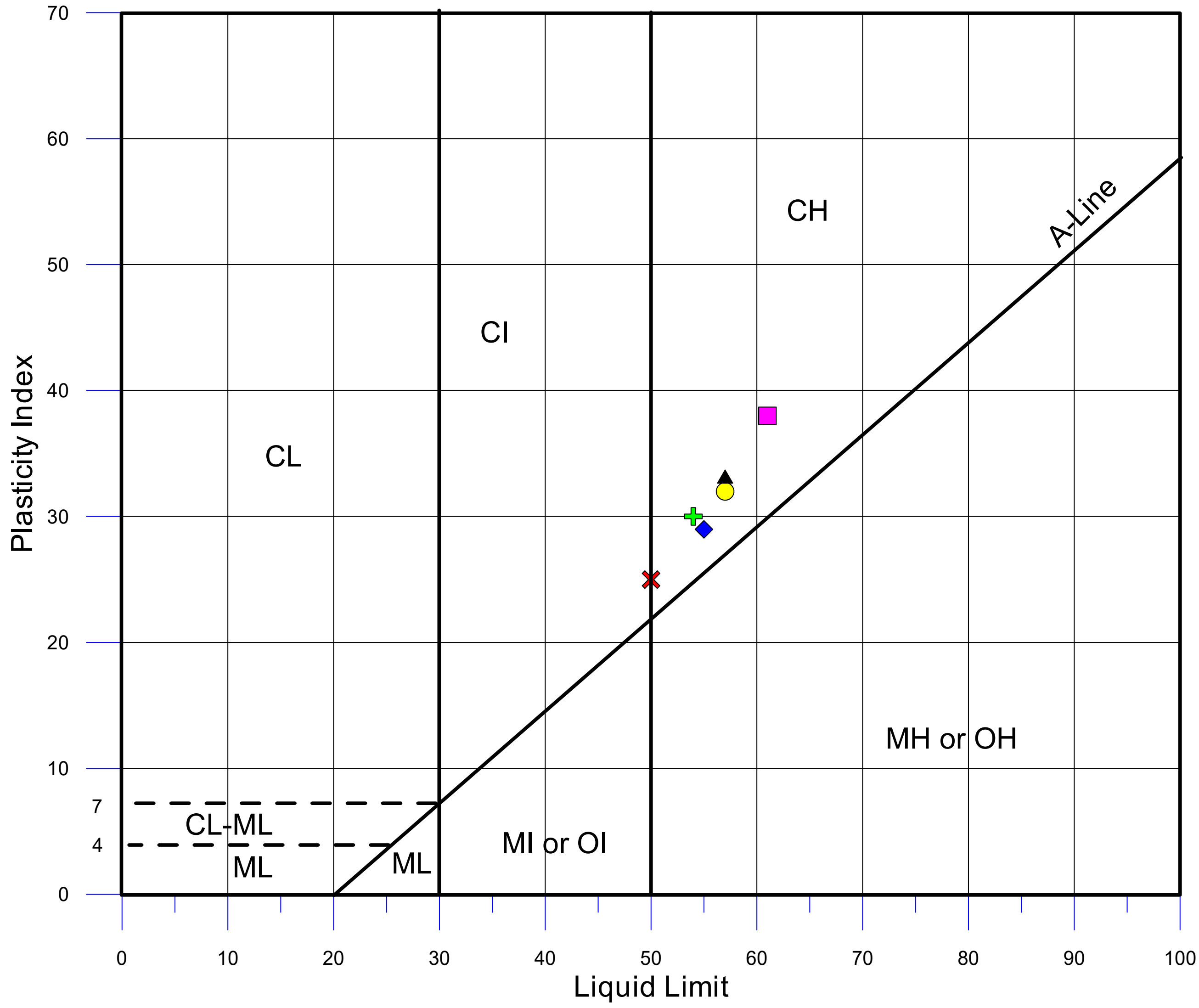
Remarks:

Terrapex

Figure D-13

Tested By: PG/DM **Checked By:** DM

PLASTICITY CHART



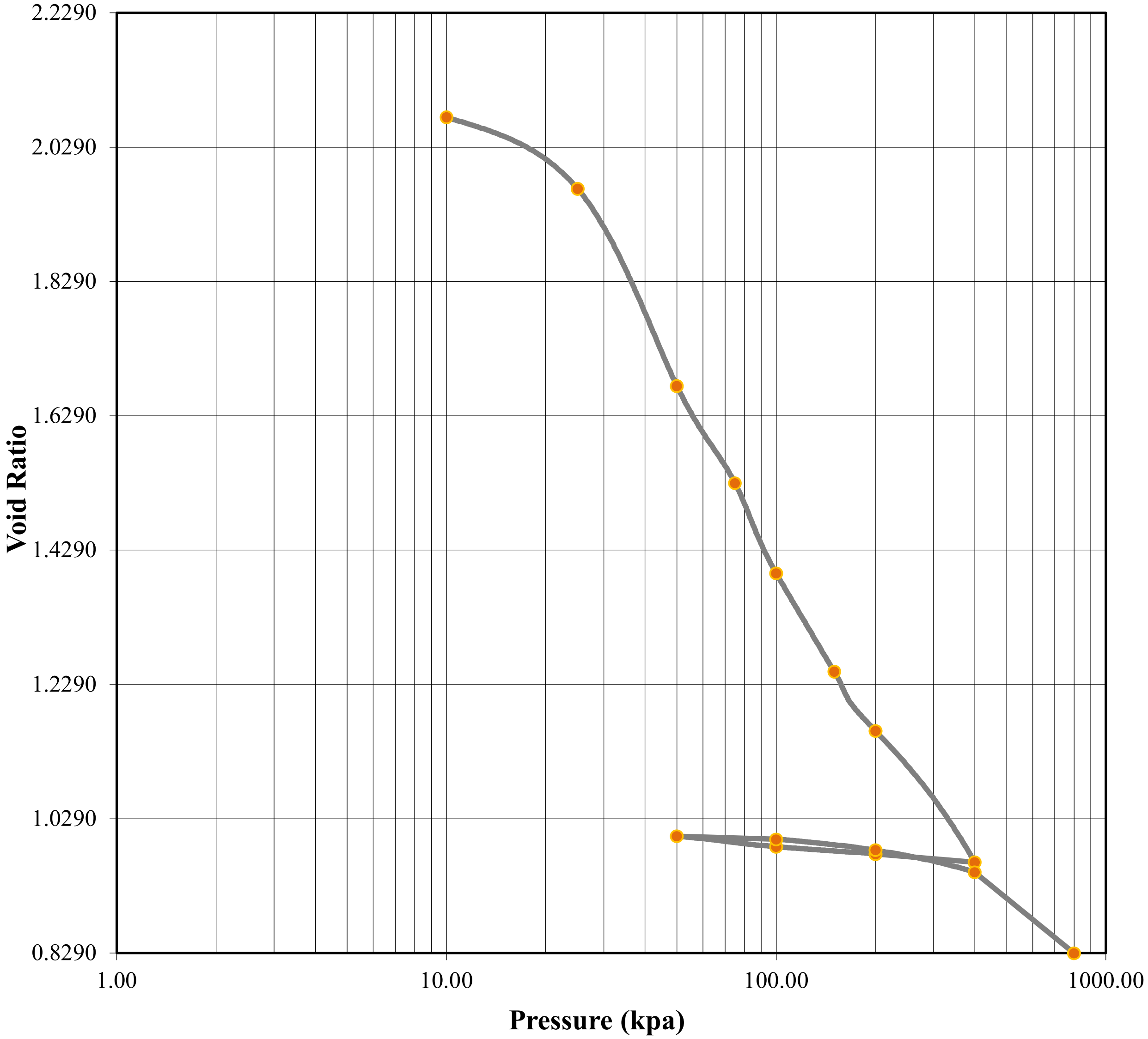
Client: GFL Environmental Inc.
Project: GFL EOWHF Expansion
Ref. No.: CO749.00

Sample	Symbol
MW20-2D, Sample 5	✕
MW20-3D, Sample 7	✚
MW20-8, Sample 4	◆
MW20-9D, between Samples 6 and 7	■
MW20-10D, Sample 7	▲
MW20-11D, Sample 7	●

Remarks:

Figure No. D-14

Consolidation Test
Test Results



	Before	After				
Moisture (%):	72.05	35.46	**Liquid Limits:**	50	**Test Date:**	Mar. 5, 2020
Dry Density (g/cm3):	0.86	1.45	**Plastic Limits:**	25		
Saturation (%):	91.12	114.10	**Plasticity Index (%):**	25		
Void Ratio:	2.0874	0.8276	**Specific Gravity:**	2.650	Assumed	

Soil Description: grey silty clay

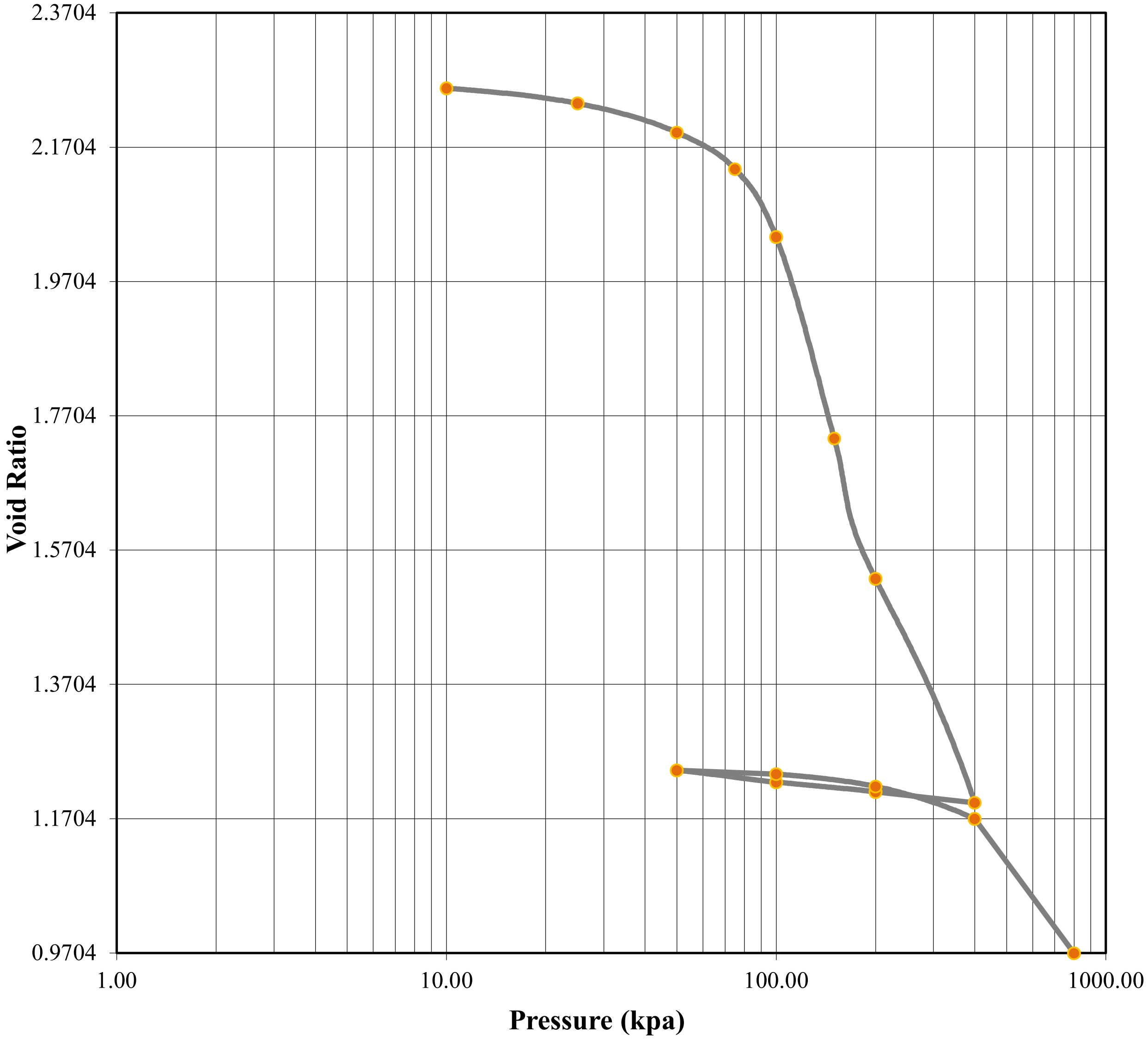
Project Number: CO749.00
Depth: 5.0 m
Sample Number: 5
Boring Number: MW20-2D

Remarks:

Project: GFL EOWHF Expansion
Client: GFL Environmental Inc.
Location: Moose Creek, Ontario

Figure No. D-15

Consolidation Test
Test Results



	Before	After				
	Before	**After**	**Liquid Limits:**	54	**Test Date:**	April 3, 2020
Moisture (%):	86.13	48.21	**Plastic Limits:**	24		
Dry Density (g/cm3):	0.81	1.28	**Plasticity Index (%):**	30		
Saturation (%):	100.41	119.03				
Void Ratio:	2.2653	0.9693	**Specific Gravity:**	2.650	Assumed	

Soil Description:

Project Number: CO749.00 **Depth:** 6.1 m

Sample Number: 7 **Boring Number:** MW20-3D

Project: GFL EOWHF Expansion

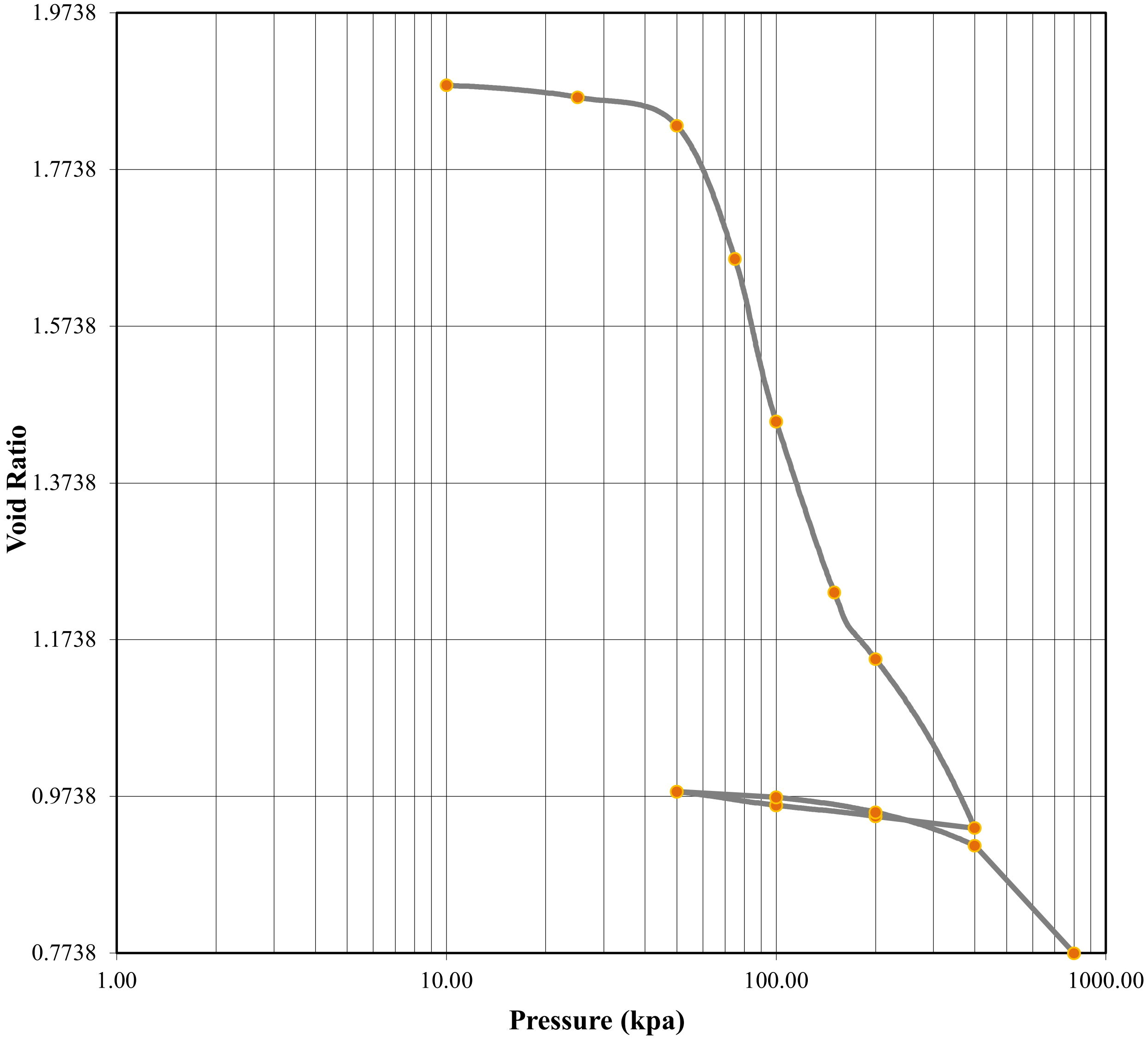
Client: GFL Environmental Inc.

Location: Moose Creek, Ontario

Remarks:

Figure No. D-16

Consolidation Test
Test Results



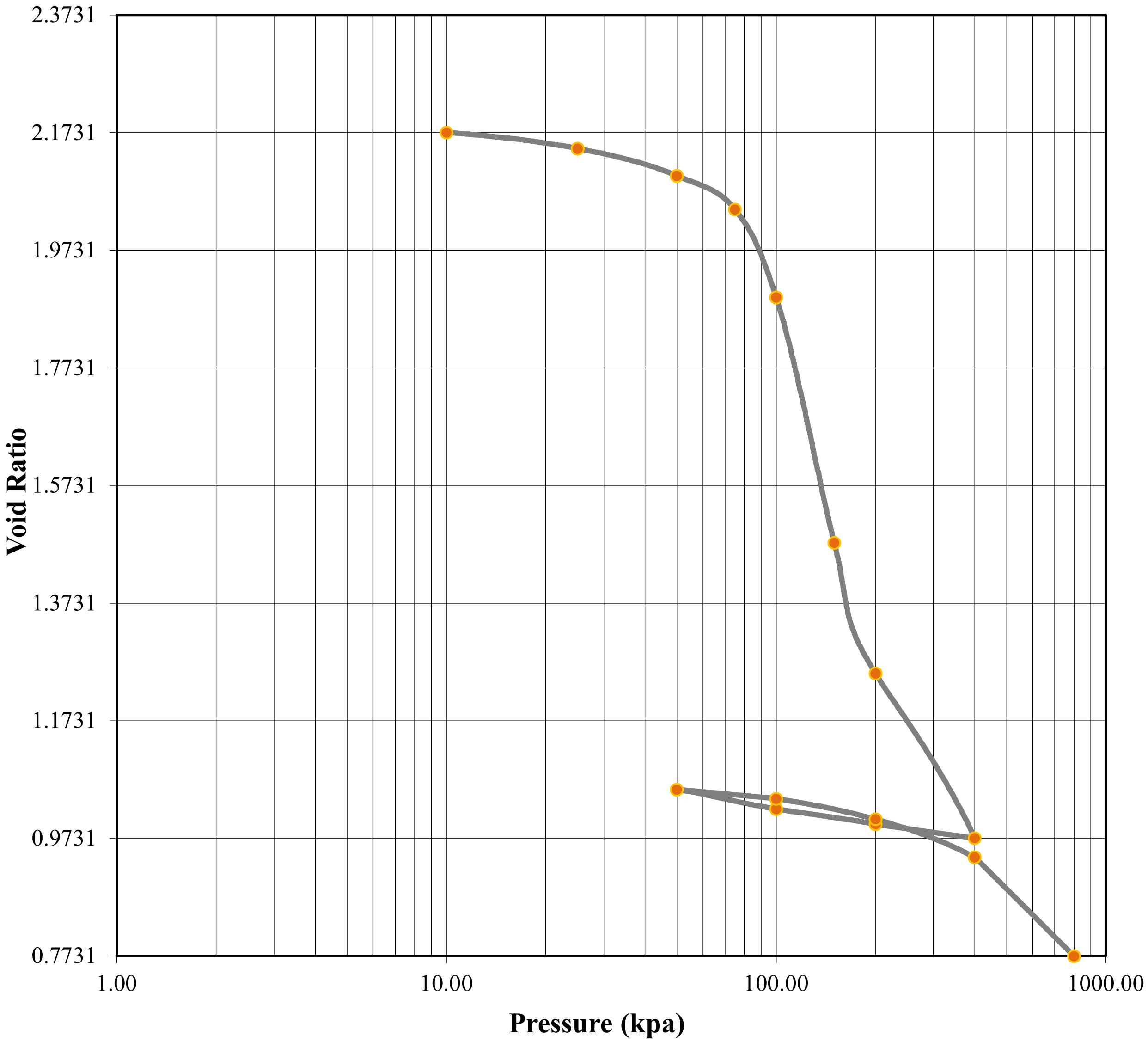
	Before	After				
	Before	**After**	**Liquid Limits:**	55	**Test Date:**	Mar. 8, 2020
Moisture (%):	71.63	41.53	**Plastic Limits:**	26		
Dry Density (g/cm3):	0.92	1.44	**Plasticity Index (%):**	29		
Saturation (%):	100.38	131.08				
Void Ratio:	1.8834	0.7723	**Specific Gravity:**	2.650	Assumed	

Soil Description:	grey silty clay		
Project Number:	CO749.00	**Depth:**	3.0 m
Sample Number:	4	**Boring Number:**	MW20-8
Project:	GFL EOWHF Expansion		
Client:	GFL Environmental Inc.		
Location:	Moose Creek, Ontario		

Remarks:

Figure No. D-17

Consolidation Test
Test Results



	Before	After				
Moisture (%):	87.87	42.04	**Liquid Limits:**	61	**Test Date:**	Mar. 16, 2020
Dry Density (g/cm3):	0.83	1.46	**Plastic Limits:**	23		
Saturation (%):	106.43	135.87	**Plasticity Index (%):**	38		
Void Ratio:	2.1800	0.7718	**Specific Gravity:**	2.650	Assumed	

Soil Description: grey silty clay

Project Number: CO749.00 **Depth:** 8.0 m

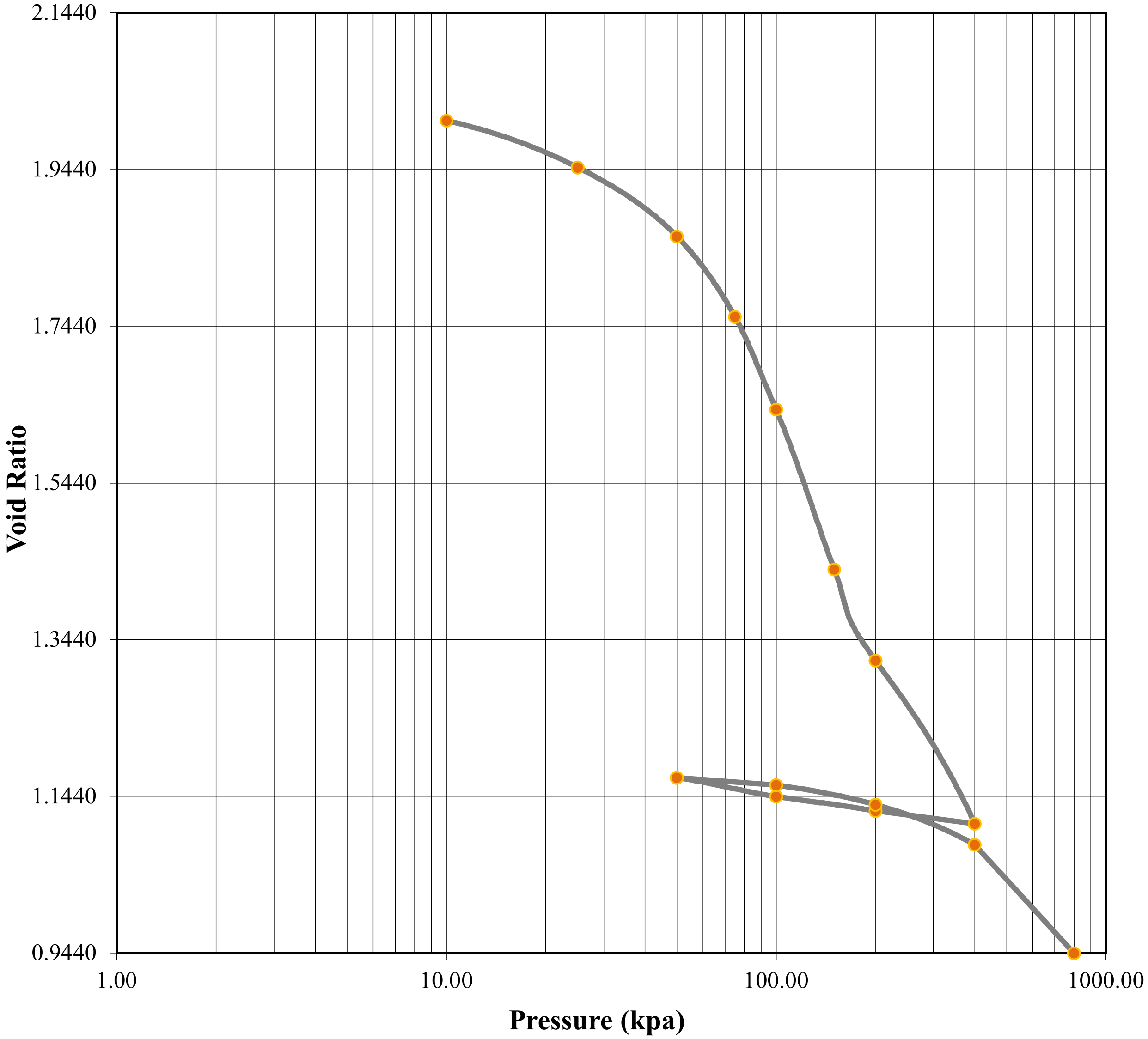
Sample Number: Sample btw 6 and 7 **Boring Number:** MW20-9D

Project: GFL EOWHF Expansion
Client: GFL Environmental Inc.
Location: Moose Creek, Ontario

Remarks:

Figure No. D-18

Consolidation Test
Test Results



	Before	After				
	Before	**After**	**Liquid Limits:**	57	**Test Date:**	Mar. 19, 2020
Moisture (%):	80.26	38.46	**Plastic Limits:**	24		
Dry Density (g/cm3):	0.86	1.37	**Plasticity Index (%):**	33		
Saturation (%):	102.78	109.89				
Void Ratio:	2.0615	0.9425	**Specific Gravity:**	2.650	Assumed	

Soil Description: grey silty clay

Project Number: CO749.00 **Depth:** 9.8 m

Sample Number: 7 **Boring Number:** MW20-10D

Project: GFL EOWHF Expansion

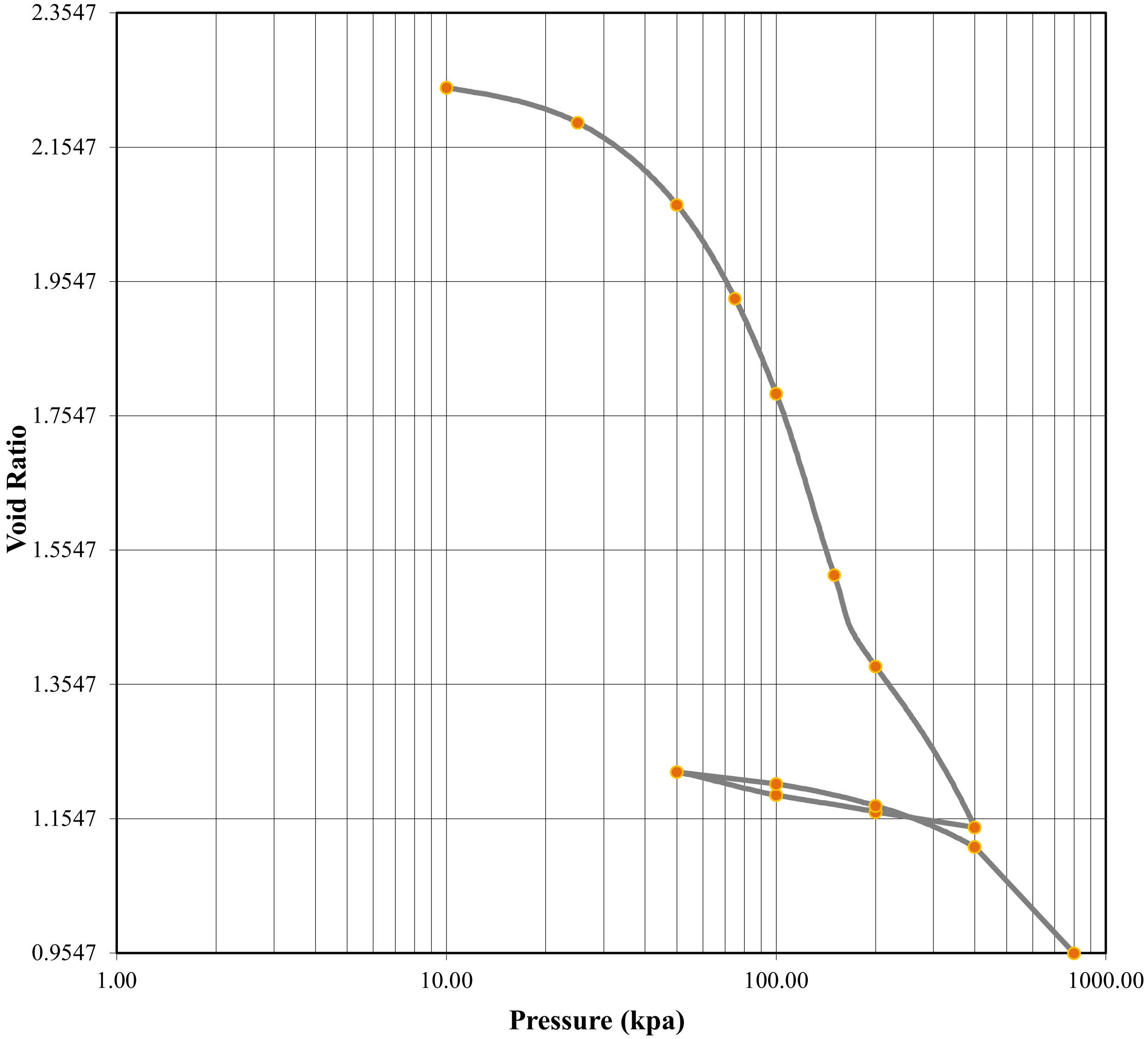
Client: GFL Environmental Inc.

Location: Moose Creek, Ontario

Remarks:

Figure No. D-19

Consolidation Test
Test Results



	Before	After	Liquid Limits:	57	Test Date:	Mar. 3, 2020
Moisture (%):	88.43	52.17	**Plastic Limits:**	25		
Dry Density (g/cm3):	0.81	1.30	**Plasticity Index (%):**	32		
Saturation (%):	103.53	133.30				
Void Ratio:	2.2556	0.9534	**Specific Gravity:**	2.650	Assumed	

Soil Description: grey silty clay

Project Number: CO749.00 **Depth:** 11.0 m

Sample Number: 7 **Boring Number:** MW20-11D

Project: GFL EOWHF Expansion

Client: GFL Environmental Inc.

Location: Moose Creek, Ontario

Remarks:

Figure No. D-20

APPENDIX E

GROUNDWATER LEVELS IN MONITORING WELLS

Observed Groundwater Levels
Lafleche Expansion, Moose Creek, Ontario

Monitoring Well ID	Date	Ground Elev.	Top Pipe Elev.	Well Depth	Groundwater Depth		Groundwater Elevation	Comment
		(m asl)	(m asl)	(m bg)	(m bmp)	(m bg)	(m asl)	
MW20-1S	29-Jan-20	66.64	67.28	3.96	1.76	1.12	65.52	
	31-Jan-20				1.78	1.14	65.50	
	5-Feb-20				1.85	1.21	65.43	
	26-Feb-20				2.00	1.36	65.28	
	5-Mar-20				1.72	1.08	65.56	
	8-Apr-20				1.24	0.60	66.04	
MW20-1T	29-Jan-20	66.64	67.29	14.65	1.66	1.01	65.63	
	31-Jan-20				1.68	1.03	65.61	
	5-Feb-20				1.75	1.10	65.55	
	26-Feb-20				1.82	1.17	65.48	
	5-Mar-20				1.57	0.92	65.72	
	26-Mar-20				1.51	0.86	65.78	
	8-Apr-20				1.52	0.87	65.77	
MW20-1D	29-Jan-20	66.64	67.36	19.38	1.74	1.02	65.62	
	31-Jan-20				1.75	1.03	65.61	
	5-Feb-20				1.80	1.08	65.56	
	26-Feb-20				1.95	1.23	65.41	Well was purged dry during development
	5-Mar-20				19.24	18.52	48.12	
	8-Apr-20				19.04	18.32	48.32	
MW20-2S	29-Jan-20	67.94	68.84	4.09	2.31	1.41	66.53	
	31-Jan-20				2.29	1.39	66.55	
	5-Feb-20				2.35	1.45	66.50	
	26-Feb-20				2.42	1.52	66.42	
	5-Mar-20				2.25	1.35	66.59	
	8-Apr-20				1.88	0.98	66.96	
MW20-2C	29-Jan-20	67.94	68.71	7.20	1.39	0.62	67.33	
	31-Jan-20				1.68	0.91	67.03	
	5-Feb-20				1.99	1.22	66.73	
	26-Feb-20				2.22	1.45	66.49	
	5-Mar-20				6.07	5.30	62.64	Well under pressure
	8-Apr-20				1.92	1.15	66.79	
MW20-2D	29-Jan-20	67.94	68.74	25.56	1.74	0.94	67.00	
	31-Jan-20				1.76	0.96	66.98	
	5-Feb-20				1.79	0.99	66.96	
	26-Feb-20				1.82	1.02	66.92	
	5-Mar-20				1.47	0.67	67.27	
	8-Apr-20				1.67	0.87	67.07	
MW20-3S	29-Jan-20	67.21	67.91	3.90	4.37	3.67	63.55	
	31-Jan-20				3.96	3.26	63.95	
	5-Feb-20				3.13	2.43	64.78	
	26-Feb-20				2.17	1.47	65.74	
	5-Mar-20				3.80	3.10	64.11	
	8-Apr-20				1.64	0.94	66.27	
MW20-3C	29-Jan-20	67.21	67.92	7.00	0.83	0.12	67.09	
	31-Jan-20				1.24	0.53	66.69	
	5-Feb-20				1.80	1.09	66.12	
	26-Feb-20				2.19	1.48	65.73	
	5-Mar-20				5.07	4.36	62.85	
	8-Apr-20				1.84	1.13	66.08	
MW20-3D	29-Jan-20	67.21	68.02	16.99	2.36	1.55	65.66	
	31-Jan-20				2.37	1.56	65.65	
	5-Feb-20				2.44	1.63	65.58	
	26-Feb-20				2.53	1.72	65.49	
	5-Mar-20				2.24	1.43	65.78	
	27-Mar-20				2.19	1.38	65.83	
	8-Apr-20				2.21	1.40	65.81	
MW20-4S	29-Jan-20	67.65	68.60	4.03	1.27	0.32	67.33	
	31-Jan-20				1.90	0.95	66.71	
	5-Feb-20				1.96	1.01	66.64	
	26-Feb-20				2.01	1.06	66.59	
	5-Mar-20				1.83	0.88	66.77	
	8-Apr-20				1.55	0.60	67.05	
MW20-4C	29-Jan-20	67.65	68.64	7.02	0.84	-0.15	67.80	
	31-Jan-20				1.76	0.77	66.88	
	5-Feb-20				1.96	0.97	66.68	
	26-Feb-20				2.04	1.05	66.60	
	5-Mar-20				1.95	0.96	66.69	
	27-Mar-20				1.72	0.73	66.92	
	8-Apr-20				1.69	0.70	66.95	
MW20-4D	29-Jan-20	67.65	68.55	12.80	1.88	0.98	66.67	
	31-Jan-20				1.93	1.03	66.62	
	5-Feb-20				1.98	1.08	66.57	
	26-Feb-20				2.08	1.18	66.47	
	5-Mar-20				1.49	0.59	67.06	
	31-Mar-20				1.55	0.65	67.00	
	8-Apr-20				1.82	0.92	66.73	

Observed Groundwater Levels
Lafleche Expansion, Moose Creek, Ontario

Monitoring Well ID	Date	Ground Elev.	Top Pipe Elev.	Well Depth	Groundwater Depth		Groundwater Elevation	Comment
		(m asl)	(m asl)	(m bg)	(m bmp)	(m bg)	(m asl)	
MW20-5S	31-Jan-20	66.34	66.72	4.21	2.90	2.52	63.82	
	5-Feb-20				1.58	1.20	65.15	
	26-Feb-20				1.47	1.09	65.25	
	5-Mar-20				2.84	2.46	63.88	
	8-Apr-20				0.86	0.48	65.86	
MW20-5T	31-Jan-20	66.34	67.06	11.27	1.49	0.77	65.57	
	5-Feb-20				1.56	0.84	65.51	
	26-Feb-20				1.64	0.92	65.42	
	5-Mar-20				1.38	0.66	65.68	
	27-Mar-20				1.32	0.60	65.74	
	8-Apr-20				1.34	0.62	65.72	
MW20-5D	31-Jan-20	66.34	67.08	15.47	1.48	0.74	65.60	
	5-Feb-20				1.55	0.81	65.53	
	26-Feb-20				1.61	0.87	65.47	
	5-Mar-20				1.36	0.62	65.72	
	8-Apr-20				1.33	0.59	65.76	
MW20-6S	31-Jan-20	67.18	68.09	4.11	2.04	1.13	66.06	
	26-Feb-20				2.15	1.24	65.94	
	5-Mar-20				1.28	0.37	66.82	
	31-Mar-20				1.43	0.52	66.66	
	8-Apr-20				1.78	0.87	66.31	
MW20-6T	31-Jan-20	67.18	68.10	6.02	2.03	1.11	66.07	
	26-Feb-20				2.14	1.22	65.96	
	5-Mar-20				1.25	0.33	66.85	
	8-Apr-20				1.80	0.88	66.30	
MW20-6D	31-Jan-20	67.18	68.08	9.20	2.00	1.10	66.08	
	26-Feb-20				2.14	1.24	65.94	
	5-Mar-20				1.36	0.46	66.72	
	31-Mar-20				1.44	0.54	66.64	
	8-Apr-20				1.77	0.87	66.31	
MW20-7S	31-Jan-20	66.10	66.73	4.00	1.03	0.40	65.70	
	5-Feb-20				1.76	1.13	64.97	
	26-Feb-20				1.90	1.27	64.83	
	5-Mar-20				3.16	2.53	63.57	
	8-Apr-20				1.43	0.80	65.30	
MW20-7C	31-Jan-20	66.10	66.65	7.02	-	-	-	Frozen
	5-Feb-20				-	-	-	Frozen
	26-Feb-20				0.26	-0.29	66.39	
	5-Mar-20				6.45	5.90	60.20	
	27-Mar-20				1.95	1.40	64.70	
	8-Apr-20				2.19	1.64	64.46	
MW20-7D	31-Jan-20	66.10	66.80	16.97	1.25	0.55	65.55	
	5-Feb-20				1.32	0.62	65.49	
	26-Feb-20				1.41	0.71	65.39	
	5-Mar-20				1.13	0.43	65.67	
	8-Apr-20				1.09	0.39	65.71	
MW20-8S	5-Feb-20	65.50	66.22	4.17	1.11	0.39	65.11	
	26-Feb-20				1.65	0.93	64.58	
	5-Mar-20				1.45	0.73	64.78	
	31-Mar-20				1.17	0.45	65.05	
	8-Apr-20				1.50	0.78	64.72	
MW20-8C	5-Feb-20	65.50	66.26	7.14	1.54	0.78	64.72	
	26-Feb-20				1.53	0.77	64.74	
	5-Mar-20				1.52	0.76	64.75	
	31-Mar-20				1.15	0.39	65.11	
	8-Apr-20				1.33	0.57	64.93	
MW20-8D	5-Feb-20	65.50	66.25	12.54	frozen	n/a	n/a	Frozen
	26-Feb-20				frozen	n/a	n/a	Frozen
	5-Mar-20				frozen	n/a	n/a	Frozen
	8-Apr-20				0.50	-0.25	65.75	
MW20-9S	5-Feb-20	65.94	66.52	4.02	1.34	0.76	65.19	
	26-Feb-20				2.00	1.42	64.52	
	5-Mar-20				2.72	2.14	63.80	
	8-Apr-20				1.81	1.23	64.72	
MW20-9T	5-Feb-20	65.94	66.75	17.10	1.74	0.93	65.02	
	26-Feb-20				1.84	1.03	64.91	
	5-Mar-20				1.70	0.89	65.05	
	26-Mar-20				1.57	0.76	65.18	
	8-Apr-20				1.57	0.76	65.18	
MW20-9D	5-Feb-20	65.94	66.75	22.43	1.71	0.90	65.05	
	26-Feb-20				1.81	1.00	64.94	Well was purged dry during development
	5-Mar-20				20.85	20.04	45.91	
	8-Apr-20				11.71	10.90	55.04	

Observed Groundwater Levels
Lafleche Expansion, Moose Creek, Ontario

Monitoring Well ID	Date	Ground Elev. (m asl)	Top Pipe Elev. (m asl)	Well Depth (m bg)	Groundwater Depth		Groundwater Elevation (m asl)	Comment
					(m bmp)	(m bg)		
MW20-10S	5-Feb-20	64.93	65.74	4.20	1.26	0.45	64.48	
	26-Feb-20				1.97	1.16	63.78	
	5-Mar-20				1.52	0.71	64.22	
	8-Apr-20				1.64	0.83	64.10	
MW20-10C	5-Feb-20	64.93	65.81	7.50	frozen	n/a	n/a	Frozen
	26-Feb-20				frozen	n/a	n/a	Frozen
	5-Mar-20				0.91	0.03	64.90	Frozen
	8-Apr-20				1.71	0.83	64.10	
MW20-10D	5-Feb-20	64.93	65.73	19.00	1.58	0.78	64.15	
	26-Feb-20				1.57	0.77	64.16	
	5-Mar-20				1.50	0.70	64.23	
	31-Mar-20				1.37	0.57	64.36	
	8-Apr-20				1.42	0.62	64.31	
MW20-11S	25-Feb-20	66.25	66.82	4.02	1.97	1.40	64.85	
	5-Mar-20				3.08	2.51	63.75	
	26-Mar-20				1.82	1.25	65.00	
	8-Apr-20				1.62	1.05	65.20	
MW20-11C	25-Feb-20	66.25	67.10	7.68	2.14	1.29	64.96	
	5-Mar-20				2.29	1.44	64.81	
	26-Mar-20				2.17	1.32	64.92	
	8-Apr-20				2.25	1.40	64.85	
MW20-11D	25-Feb-20	66.25	67.00	23.17	1.90	1.15	65.11	Well was purged dry during development
	5-Mar-20				23.33	22.58	43.68	
	8-Apr-20				22.46	21.71	44.54	
MW20-12S	26-Feb-20	64.86	65.58	4.31	1.87	1.15	63.71	
	5-Mar-20				1.21	0.49	64.37	
	31-Mar-20				1.23	0.51	64.35	
	8-Apr-20				1.52	0.80	64.06	
MW20-15T	26-Feb-20	67.36	68.34	13.70	1.95	0.97	66.39	
	5-Mar-20				1.71	0.73	66.63	
	27-Mar-20				1.15	0.17	67.19	
	8-Apr-20				1.74	0.76	66.60	
MW20-17S	26-Feb-20	64.99	65.96	4.30	1.82	0.85	64.15	
	5-Mar-20				1.60	0.63	64.36	
	8-Apr-20				1.55	0.58	64.41	
MW20-18D	26-Feb-20	65.98	66.84	14.30	2.18	1.31	64.66	
	5-Mar-20				14.55	13.68	52.30	
	8-Apr-20				13.99	13.12	52.86	
MW96-1A	5-Mar-20	67.51	68.36	-	Blocked	-	n/a	Blocked at 0.95 m, frozen?
MW96-1B	5-Mar-20	67.51	68.28		1.09	0.32	67.19	
MW96-1C	5-Mar-20	67.51	68.67		1.89	0.72	66.78	
MW96-1D	5-Mar-20	67.51	68.71		2.43	1.22	66.28	
MW96-2A	5-Mar-20	66.44	67.12		1.24	0.56	65.88	
MW96-2B	5-Mar-20	66.44	67.46		1.63	0.62	65.83	
MW96-2C	5-Mar-20	66.44	67.37		1.62	0.69	65.75	
MW96-2D	5-Mar-20	66.44	67.57		2.33	1.20	65.24	
MW96-3A	5-Mar-20	65.59	66.67		2.06	0.99	64.60	
MW96-3B	5-Mar-20	65.59	66.45		1.90	1.04	64.55	
MW96-3C	5-Mar-20	65.59	66.38		1.87	1.08	64.51	

Notes

Elevations measured by Topcon GNSS device, to centimetre accuracy
m asl = metres above sea level
m bmp = metres below measurement point (top of pipe)
m bg = metres below ground
Monitoring wells were purged dry for development between February 25 and March 3, 2020

APPENDIX F

DESIGNER CONCEPTUAL PLANS

Figure 3. Proposed Top of Final Contours Alternative 1

![HDR]

300 - 100 York Boulevard
Richmond Hill, ON L4B 1J8
Canada

ISSUE	DATE	DESCRIPTION
F	2022-03-04	ISSUED FOR REVIEW
E	2021-11-17	ISSUED FOR REVIEW
D	2021-08-09	ISSUED FOR REVIEW
C	2021-06-29	ISSUED FOR REVIEW
B	2021-06-15	ISSUED FOR REVIEW
A	2021-03-24	DRAFT FOR DISCUSSION

DESIGN	AJC
DRAWN	AJC
CHECKED	MS
APPROVED	LF
PROJECT NUMBER	10287067

PLANNING PURPOSES ONLY
NOT FOR CONSTRUCTION

GFL ENVIRONMENTAL EASTERN ONTARIO
WASTE HANDLING FACILITY
FUTURE LANDFILL EXPANSION
CONCEPT

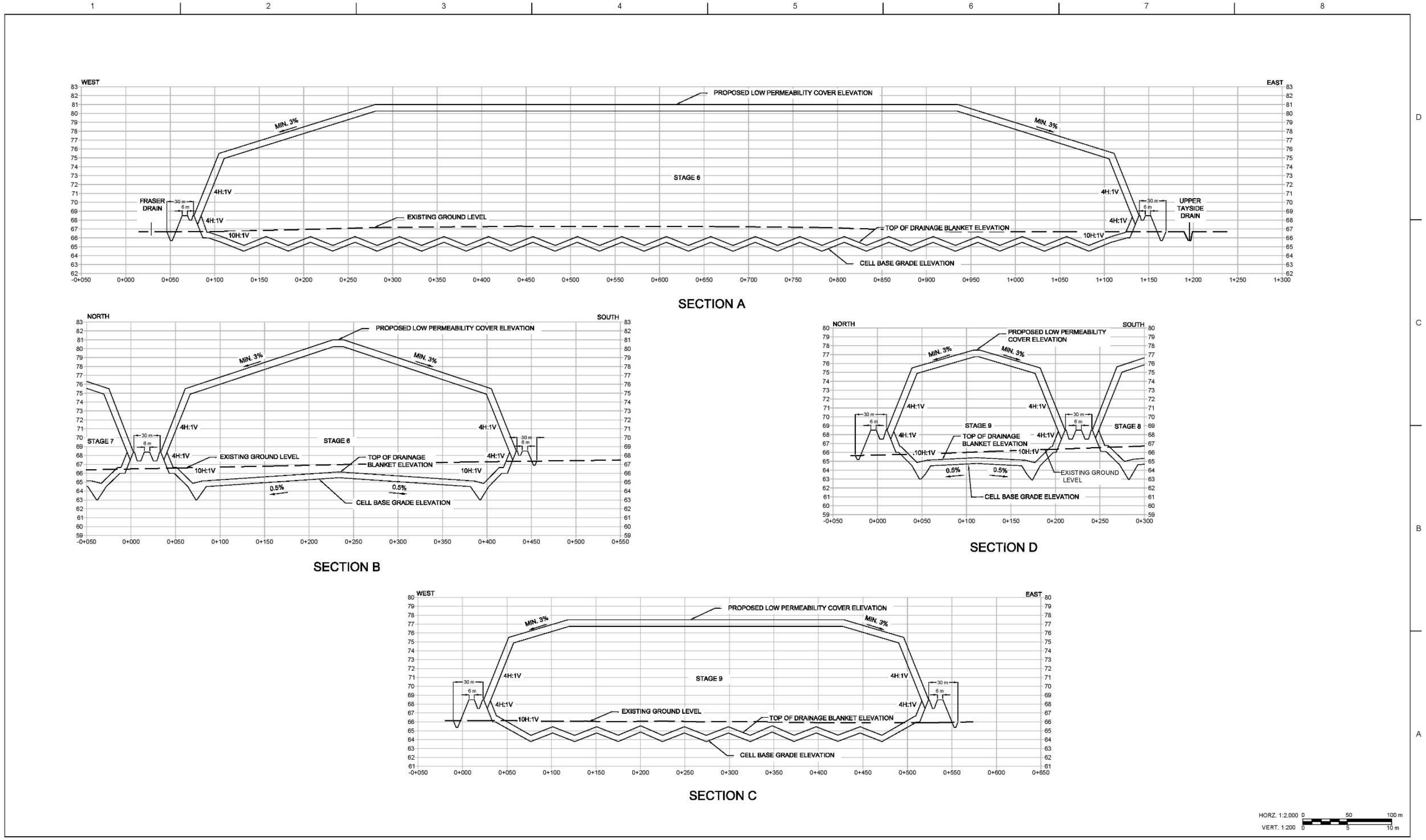
PROPOSED TOP OF FINAL
CONTOURS
ALTERNATIVE 1 PLAN

0 150 300 m

FILENAME C-103.dwg
SCALE 1:150,000

DRAWING
FIG 3

Figure 4. Cross Sections Alternative 1



300 - 100 York Boulevard
Richmond Hill, ON L4B 1J8
Canada

ISSUE	DATE	DESCRIPTION
A	2022-03-04	ISSUED FOR REVIEW

DESIGN	AJC
DRAWN	AJC
CHECKED	MS
APPROVED	LF
PROJECT NUMBER	10287067

PLANNING PURPOSES ONLY
NOT FOR CONSTRUCTION

GFL ENVIRONMENTAL EASTERN ONTARIO
WASTE HANDLING FACILITY
FUTURE LANDFILL EXPANSION
CONCEPT

ALTERNATIVE 1 SECTIONS

FILENAME C-103.dwg
SCALE AS SHOWN
DRAWING
FIG 4

Figure 5. Proposed Top of Final Contours Alternative 2 Plan

300 - 100 York Boulevard
Richmond Hill, ON L4B 1J8
Canada

ISSUE	DATE	DESCRIPTION
F	2022-03-04	ISSUED FOR REVIEW
E	2021-11-17	ISSUED FOR REVIEW
D	2021-08-09	ISSUED FOR REVIEW
C	2021-06-29	ISSUED FOR REVIEW
B	2021-06-15	ISSUED FOR REVIEW
A	2021-03-24	DRAFT FOR DISCUSSION

DESIGN	AJC
DRAWN	AJC
CHECKED	MS
APPROVED	LF
PROJECT NUMBER	10287067

PLANNING PURPOSES ONLY
NOT FOR CONSTRUCTION

GFL ENVIRONMENTAL EASTERN ONTARIO
WASTE HANDLING FACILITY
FUTURE LANDFILL EXPANSION
CONCEPT

PROPOSED TOP OF FINAL
CONTOURS
ALTERNATIVE 2 PLAN

0 150 300 m

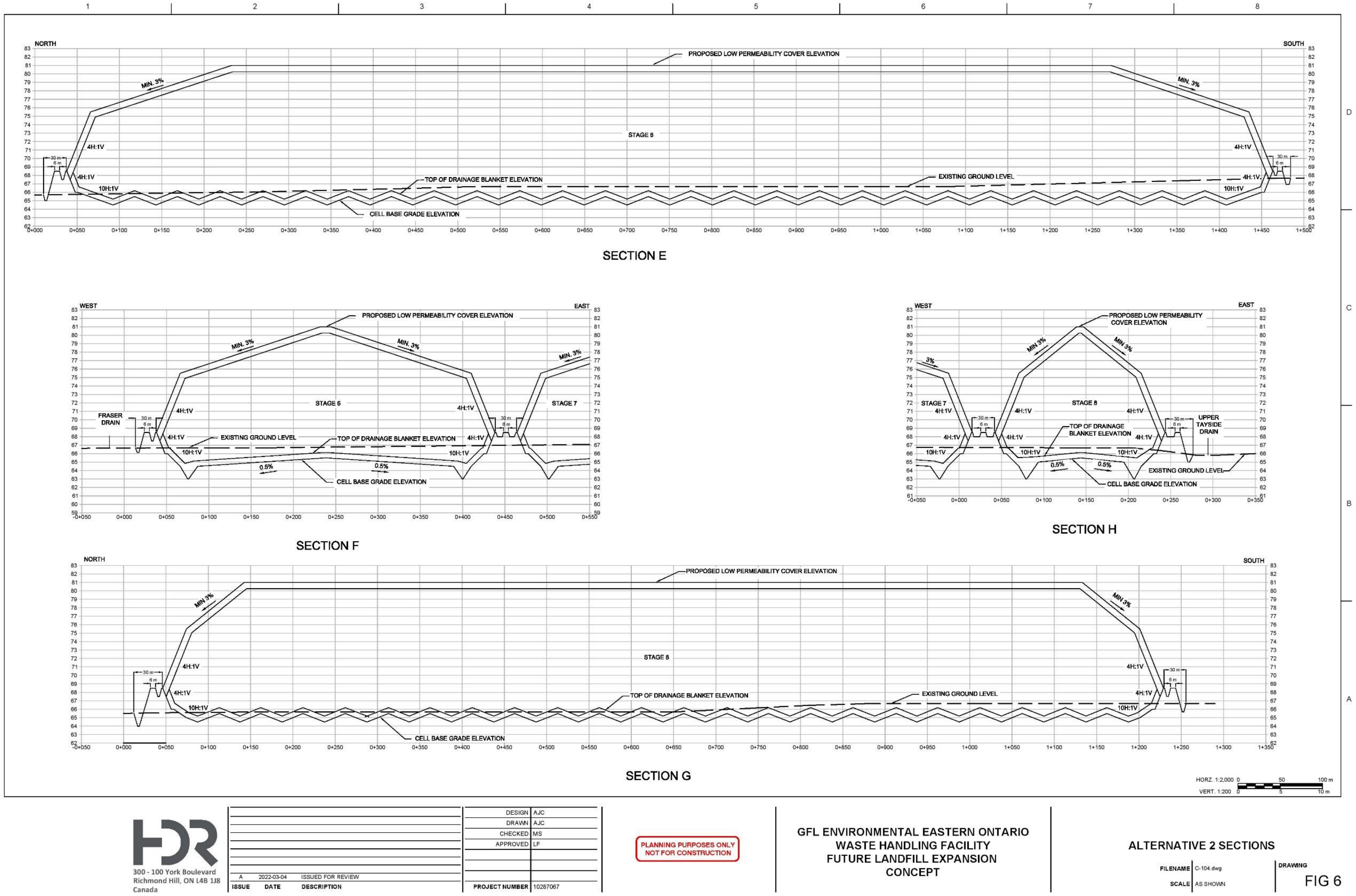
FILENAME C-104.dwg

SCALE 1:150,000

DRAWING

FIG 5

Figure 6. Cross Sections Alternative 2



APPENDIX G

SLOPE STABILITY ANALYSIS

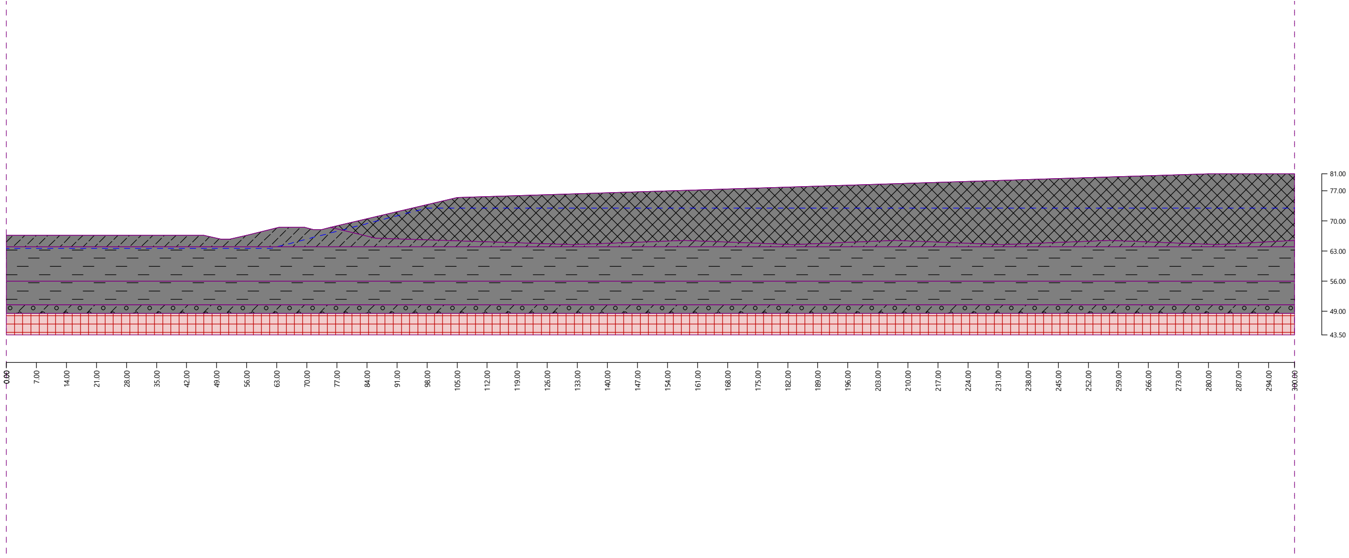
Slope stability analysis

Input data

Project

Task :	Typical Landfill Geometry - Cross Section A - Drained Soil Conditions at MW20-2
Customer :	GFL Environmental Inc.
Author :	KC
Date :	2022-08-15
Project ID :	GFL Landfill Expansion
Project number :	CO749.02

Name : Project **Stage : 1**



Settings

(input for current task)

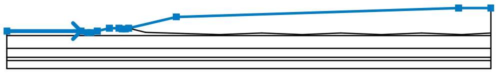
Stability analysis

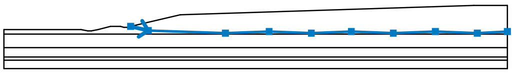
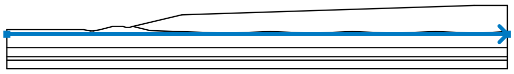
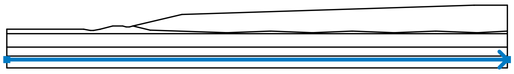
Verification methodology : Safety factors (ASD)
Earthquake analysis : Standard

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.50	[–]

Safety factors			
Seismic design situation			
Safety factor :	SF_s =	1.00	[–]

Interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		0.00	66.70	46.00	66.70	50.00	65.80
		52.00	65.80	56.00	66.70	63.50	68.50
		69.50	68.50	71.50	68.00	73.50	68.00
		75.50	68.50	105.00	75.50	280.00	81.00
		300.00	81.00				

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
2		75.50	68.50	86.00	66.00	132.00	64.50
		158.00	65.50	183.15	64.50	207.00	65.50
		232.00	64.50	257.00	65.50	282.00	64.50
		300.00	65.50				
3		0.00	64.00	300.00	64.00		
4		0.00	56.00	300.00	56.00		
5		0.00	50.50	300.00	50.50		
6		0.00	48.50	300.00	48.50		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
1	Waste Material	▩	29.00	20.00	14.00
2	Soft Silty Clay	▤	22.00	0.00	16.00
3	Gravelly Sand Till	▨	32.00	0.00	20.00
4	Firm Silty Clay	▤	25.00	0.00	17.00
5	Stiff Silty Clay	▨	28.00	0.00	18.00

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [kN/m^3]	γ_s [kN/m^3]	n [–]
1	Waste Material	▩	14.00		
2	Soft Silty Clay	▤	16.00		
3	Gravelly Sand Till	▨	20.00		

No.	Name	Pattern	γ_{sat} [kN/m^3]	γ_s [kN/m^3]	n [–]
4	Firm Silty Clay	▤	17.00		
5	Stiff Silty Clay	▨	20.00		

Soil parameters

Waste Material
Unit weight : γ = 14.00 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 29.00 °
Cohesion of soil : c_{ef} = 20.00 kPa
Saturated unit weight : γ_{sat} = 14.00 kN/m^3

Soft Silty Clay
Unit weight : γ = 16.00 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 22.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 16.00 kN/m^3

Gravelly Sand Till
Unit weight : γ = 20.00 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 20.00 kN/m^3

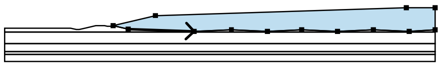
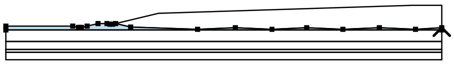
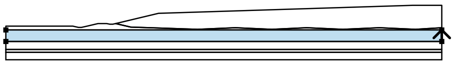
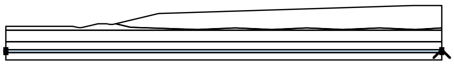
Firm Silty Clay
Unit weight : γ = 17.00 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 25.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 17.00 kN/m^3

Stiff Silty Clay
Unit weight : γ = 18.00 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 28.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 20.00 kN/m^3

Rigid Bodies

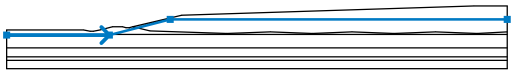
No.	Name	Sample	γ [kN/m^3]
1	Bedrock	▦	24.00

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		86.00	66.00	132.00	64.50	Waste Material
		158.00	65.50	183.15	64.50	▩
		207.00	65.50	232.00	64.50	
		257.00	65.50	282.00	64.50	
		300.00	65.50	300.00	81.00	
		280.00	81.00	105.00	75.50	
		75.50	68.50			
2		300.00	64.00	300.00	65.50	Stiff Silty Clay
		282.00	64.50	257.00	65.50	▨
		232.00	64.50	207.00	65.50	
		183.15	64.50	158.00	65.50	
		132.00	64.50	86.00	66.00	
		75.50	68.50	73.50	68.00	
		71.50	68.00	69.50	68.50	
		63.50	68.50	56.00	66.70	
		52.00	65.80	50.00	65.80	
		46.00	66.70	0.00	66.70	
		0.00	64.00			
3		300.00	56.00	300.00	64.00	Soft Silty Clay
		0.00	64.00	0.00	56.00	▤
4		300.00	50.50	300.00	56.00	Firm Silty Clay
		0.00	56.00	0.00	50.50	▤
5		300.00	48.50	300.00	50.50	Gravelly Sand Till
		0.00	50.50	0.00	48.50	▨
6		0.00	48.50	0.00	43.50	Bedrock
		300.00	43.50	300.00	48.50	▦

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	63.64	61.67	63.64	97.96	73.00
		300.00	73.00				

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1 (stage 1)

Circular slip surface

Slip surface parameters							
Center :	x =	78.52	[m]	Angles :	α_1 =	-35.10	[°]
	z =	109.11	[m]		α_2 =	50.81	[°]
Radius :	R =	52.48	[m]				
The slip surface after optimization.							

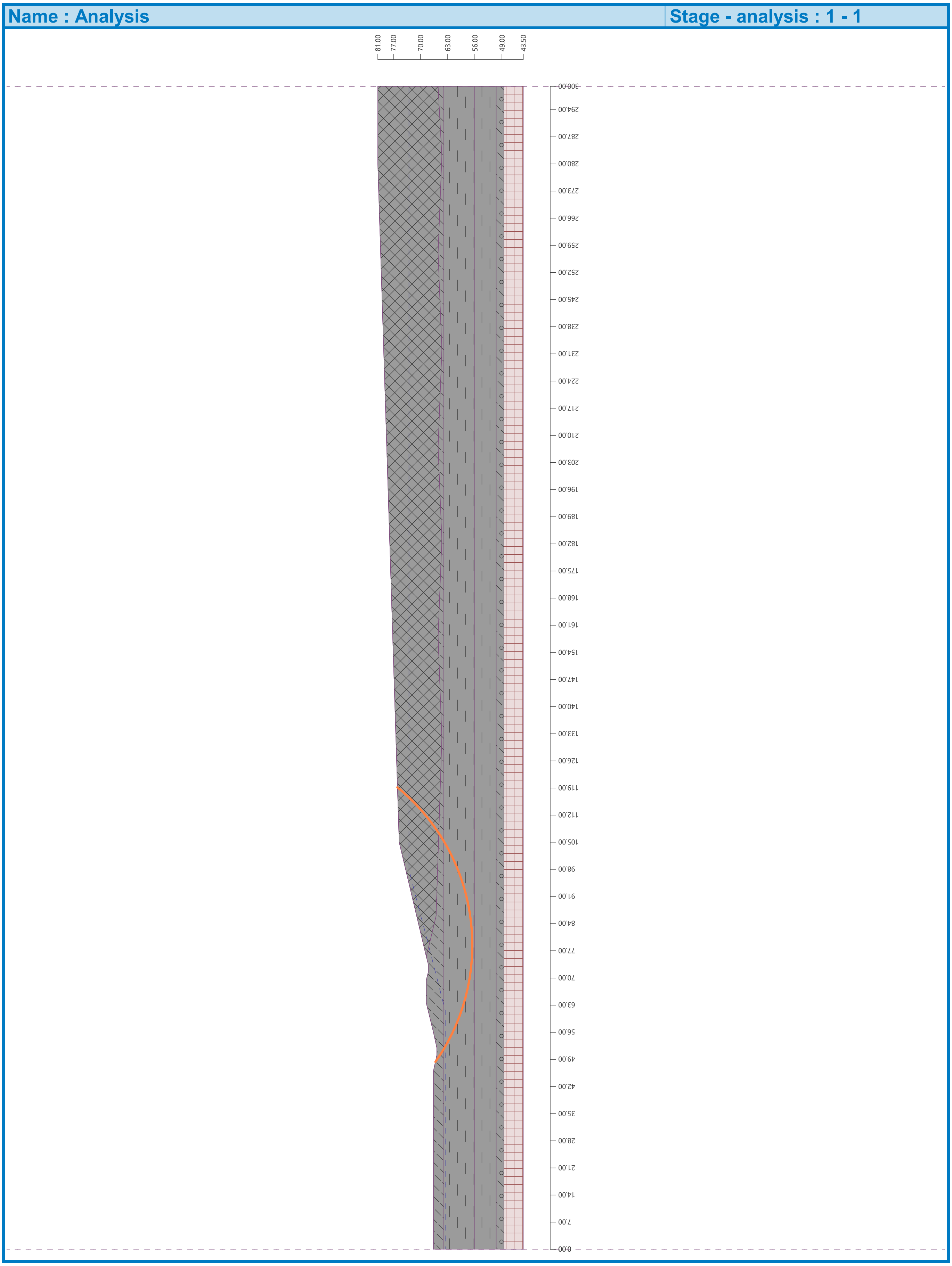
Slope stability verification (Bishop)

Sum of active forces : F_a = 1279.13 kN/m
Sum of passive forces : F_p = 2828.90 kN/m

Sliding moment : M_a = 67128.52 kNm/m
Resisting moment : M_p = 148460.51 kNm/m
Factor of safety = 2.21 > 1.50
Slope stability ACCEPTABLE

Name : Analysis

Stage - analysis : 1 - 1



Input data (Stage of construction 2)

Earthquake

Horizontal seismic coefficient : K_h = 0.0938
Vertical seismic coefficient : K_v = 0.0000

Settings of the stage of construction

Design situation : seismic

Results (Stage of construction 2)

Analysis 1 (stage 2)

Circular slip surface

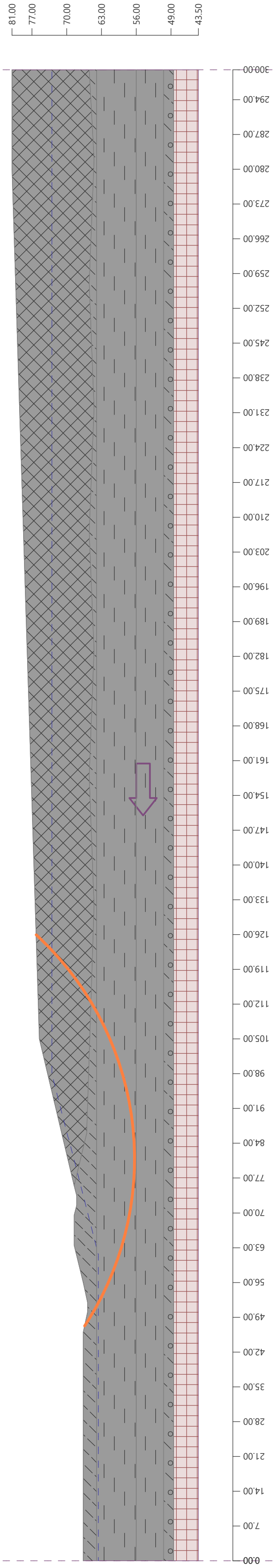
Slip surface parameters							
Center :	x =	80.88	[m]	Angles :	α_1 =	-33.34	[°]
	z =	117.54	[m]		α_2 =	47.45	[°]
Radius :	R =	61.19	[m]				
The slip surface after optimization.							

Slope stability verification (Bishop)

Sum of active forces : F_a = 2425.77 kN/m
Sum of passive forces : F_p = 3122.32 kN/m

Sliding moment : M_a = 148432.65 kNm/m
Resisting moment : M_p = 191054.79 kNm/m
Factor of safety = 1.29 > 1.00
Slope stability ACCEPTABLE

Name : Analysis | Stage - analysis : 2 - 1



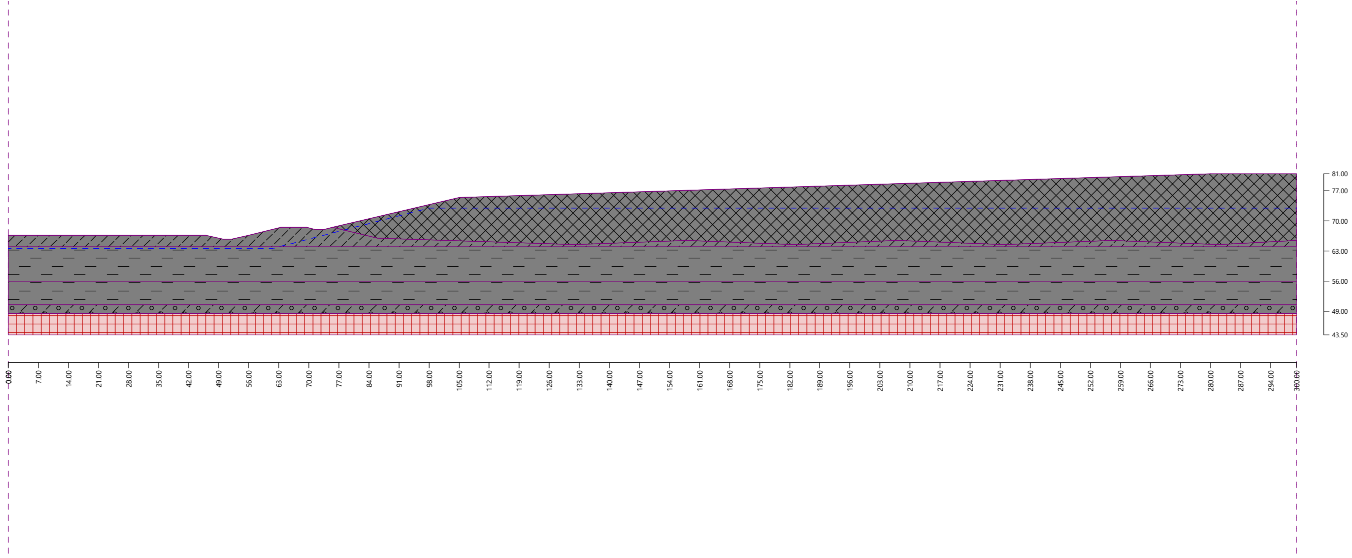
Slope stability analysis

Input data

Project

Task :	Typical Landfill Geometry - Cross Section A - Undrained Soil Conditions at MW20-2
Customer :	GFL Environmental Inc.
Author :	KC
Date :	2022-08-15
Project ID :	GFL Landfill Expansion
Project number :	CO749.02

Name : Project **Stage : 1**



Settings

(input for current task)

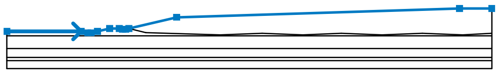
Stability analysis

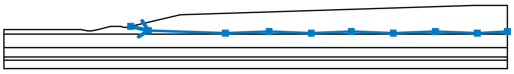
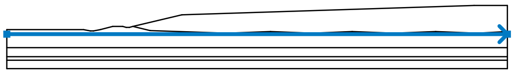
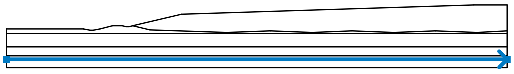
Verification methodology : Safety factors (ASD)
Earthquake analysis : Standard

Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1.50	[–]

Safety factors			
Seismic design situation			
Safety factor :	SF_s =	1.00	[–]

Interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		0.00	66.70	46.00	66.70	50.00	65.80
		52.00	65.80	56.00	66.70	63.50	68.50
		69.50	68.50	71.50	68.00	73.50	68.00
		75.50	68.50	105.00	75.50	280.00	81.00
		300.00	81.00				

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
2		75.50	68.50	86.00	66.00	132.00	64.50
		158.00	65.50	183.15	64.50	207.00	65.50
		232.00	64.50	257.00	65.50	282.00	64.50
		300.00	65.50				
3		0.00	64.00	300.00	64.00		
4		0.00	56.00	300.00	56.00		
5		0.00	50.50	300.00	50.50		
6		0.00	48.50	300.00	48.50		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
1	Waste Material	▩	29.00	20.00	14.00
2	Gravelly Sand Till	▨	32.00	0.00	20.00

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [kN/m^3]	γ_s [kN/m^3]	n [–]
1	Waste Material	▩	14.00		
2	Gravelly Sand Till	▨	20.00		

Soil parameters - total stress state

No.	Name	Pattern	c_u [kPa]	γ [kN/m^3]
1	Soft Silty Clay	▤	20.00	16.00
2	Firm Silty Clay	▤	40.00	17.00

No.	Name	Pattern	c_u [kPa]	γ [kN/m^3]
3	Stiff Silty Clay	▨	100.00	18.00

Soil parameters

Waste Material
Unit weight : γ = 14.00 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 29.00 °
Cohesion of soil : c_{ef} = 20.00 kPa
Saturated unit weight : γ_{sat} = 14.00 kN/m^3

Soft Silty Clay
Unit weight : γ = 16.00 kN/m^3
Stress-state : total
Cohesion of soil : c_u = 20.00 kPa

Gravelly Sand Till
Unit weight : γ = 20.00 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 32.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 20.00 kN/m^3

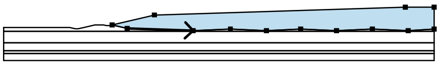
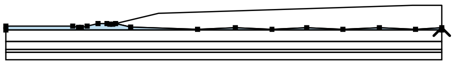
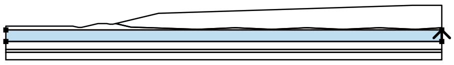
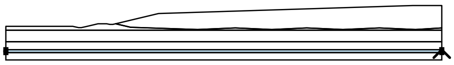
Firm Silty Clay
Unit weight : γ = 17.00 kN/m^3
Stress-state : total
Cohesion of soil : c_u = 40.00 kPa

Stiff Silty Clay
Unit weight : γ = 18.00 kN/m^3
Stress-state : total
Cohesion of soil : c_u = 100.00 kPa

Rigid Bodies

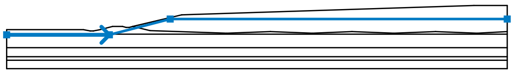
No.	Name	Sample	γ [kN/m^3]
1	Bedrock	▦	24.00

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		86.00	66.00	132.00	64.50	Waste Material
		158.00	65.50	183.15	64.50	▨
		207.00	65.50	232.00	64.50	
		257.00	65.50	282.00	64.50	
		300.00	65.50	300.00	81.00	
		280.00	81.00	105.00	75.50	
		75.50	68.50			
2		300.00	64.00	300.00	65.50	Stiff Silty Clay
		282.00	64.50	257.00	65.50	▨
		232.00	64.50	207.00	65.50	
		183.15	64.50	158.00	65.50	
		132.00	64.50	86.00	66.00	
		75.50	68.50	73.50	68.00	
		71.50	68.00	69.50	68.50	
		63.50	68.50	56.00	66.70	
		52.00	65.80	50.00	65.80	
		46.00	66.70	0.00	66.70	
		0.00	64.00			
3		300.00	56.00	300.00	64.00	Soft Silty Clay
		0.00	64.00	0.00	56.00	▨
4		300.00	50.50	300.00	56.00	Firm Silty Clay
		0.00	56.00	0.00	50.50	▨
5		300.00	48.50	300.00	50.50	Gravelly Sand Till
		0.00	50.50	0.00	48.50	▨
6		0.00	48.50	0.00	43.50	Bedrock
		300.00	43.50	300.00	48.50	▦

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	63.64	61.67	63.64	97.96	73.00
		300.00	73.00				

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1 (stage 1)

Circular slip surface

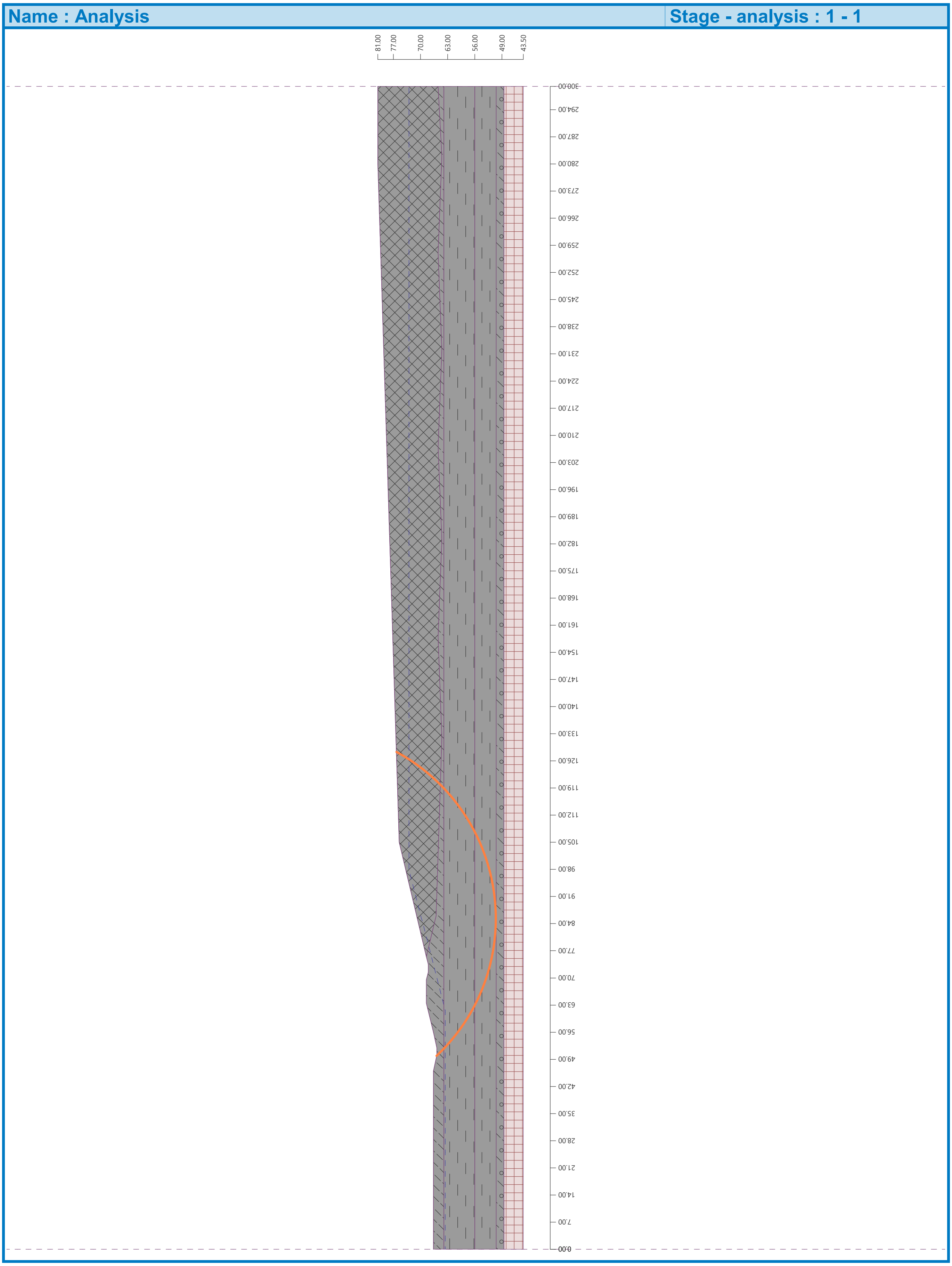
Slip surface parameters							
Center :	x =	85.30	[m]	Angles :	α_1 =	-46.65	[°]
	z =	99.33	[m]		α_2 =	61.74	[°]
Radius :	R =	48.79	[m]				
The slip surface after optimization.							

Slope stability verification (Bishop)

Sum of active forces : F_a = 1730.63 kN/m
Sum of passive forces : F_p = 3249.97 kN/m

Sliding moment : M_a = 84437.39 kNm/m
Resisting moment : M_p = 158565.92 kNm/m
Factor of safety = 1.88 > 1.50
Slope stability ACCEPTABLE

Name : Analysis **Stage - analysis : 1 - 1**



Input data (Stage of construction 2)

Earthquake

Horizontal seismic coefficient : K_h = 0.0938
Vertical seismic coefficient : K_v = 0.0000

Settings of the stage of construction

Design situation : seismic

Results (Stage of construction 2)

Analysis 1 (stage 2)

Circular slip surface

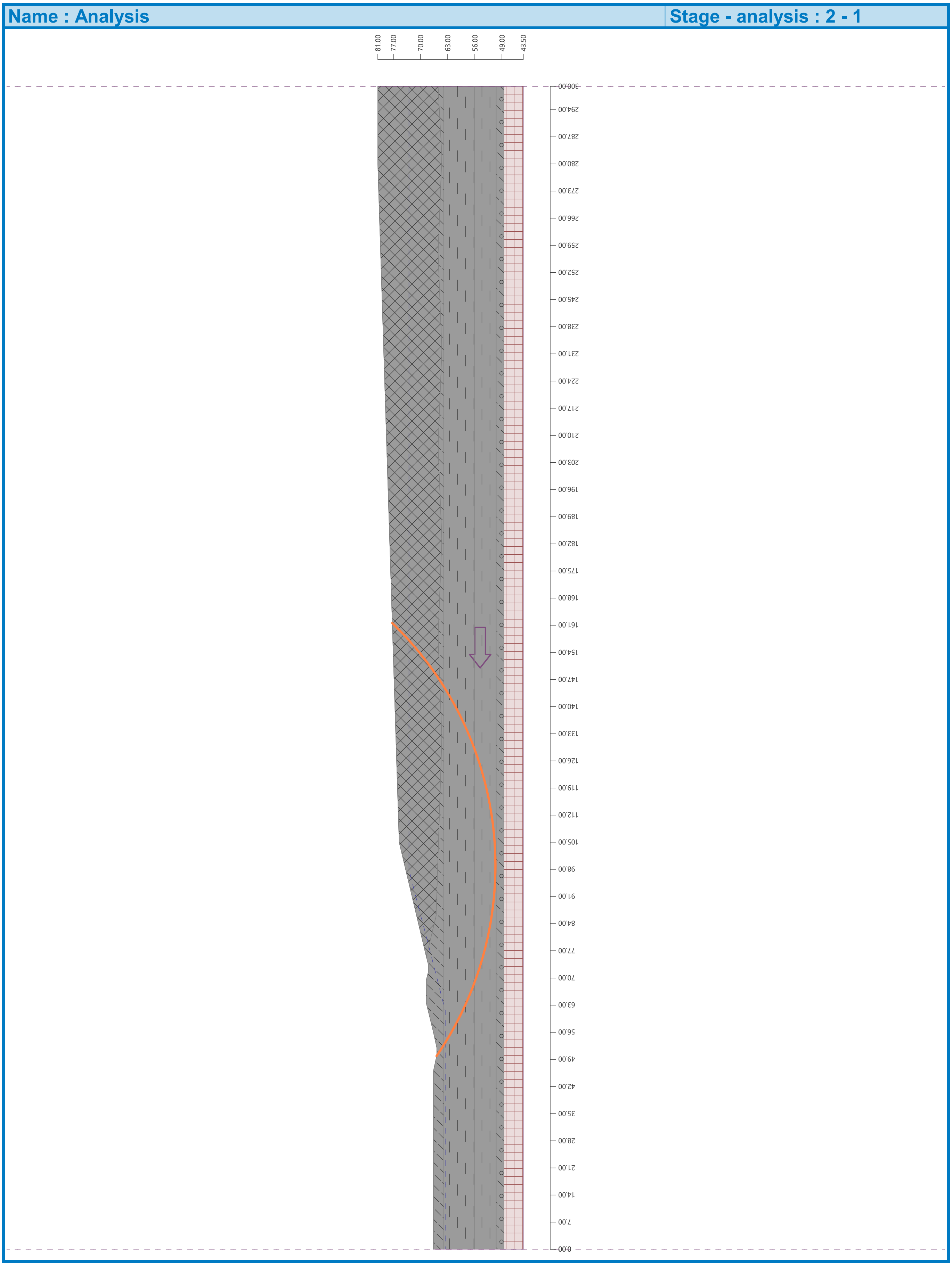
Slip surface parameters							
Center :	x =	98.92	[m]	Angles :	α_1 =	-34.32	[°]
	z =	137.71	[m]		α_2 =	46.02	[°]
Radius :	R =	87.03	[m]				
The slip surface after optimization.							

Slope stability verification (Bishop)

Sum of active forces : F_a = 4305.41 kN/m
Sum of passive forces : F_p = 4331.38 kN/m

Sliding moment : M_a = 374700.15 kNm/m
Resisting moment : M_p = 376959.77 kNm/m
Factor of safety = 1.01 > 1.00
Slope stability ACCEPTABLE

Name : Analysis **Stage - analysis : 2 - 1**



B

Leachate Generation Assessment

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1 Introduction

GFL Environmental Inc. (GFL) is undertaking an Environmental Assessment (EA) for a proposed expansion for additional non-hazardous landfill disposal capacity as part of the future development of its Eastern Ontario Waste Handling Facility (EOWHF). The purpose of the proposed undertaking is to provide approximately 15.1 million cubic metres (m^3) of additional landfill disposal capacity at the existing EOWHF over a 20-year planning period.

A leachate generation assessment was undertaken for the landfill expansion in order to evaluate leachate production at varying stages of phasing throughout the life of the landfill. The evaluation was carried out using the Hydrologic Evaluation of Landfill Performance Model (HELP, Version 4.0). The HELP model is a quasi-two-dimensional computer program used to estimate water balances within a landfill. The primary purpose of the analysis is to evaluate the leachate generation of the site in order to ensure leachate treatment capacity is not exceeded. Design inputs to the HELP model include the configuration of the landfill's base liner system and final cover system.

The modeled liner system (**Figure 1**) is comprised of (from top down):

- 19 mm clear stone protective layer (protective layer and drainage layer).
- 19-50 mm clear stone drainage blanket (drainage layer).
- Separation geotextile (protection layer).
- Native silty clay (in-situ low permeability primary barrier layer).

The modelled final cap system (**Figure 2**) is comprised of (from top down):

- Topsoil (vegetative and erosion layer).
- Separation geotextile (protection layer).
- Drainage layer (drainage layer).
- LLDPE Geomembrane (liner).
- Separation geotextile (protection layer).
- Bedding Sand (Liner bedding material).

These cross-sections are shown in **Figures 1 and 2**.

Figure 1. Base Liner System

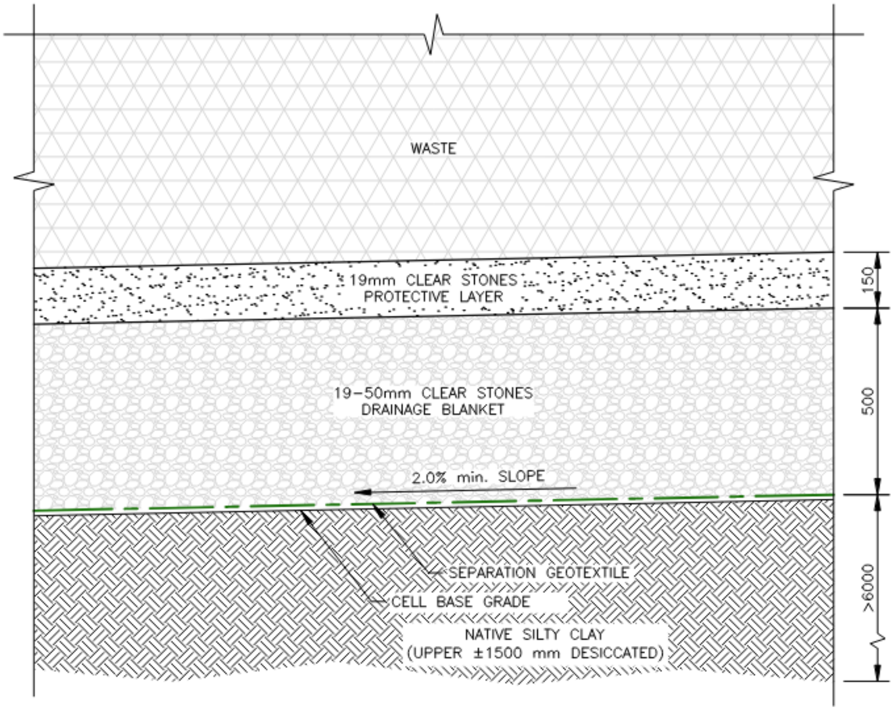
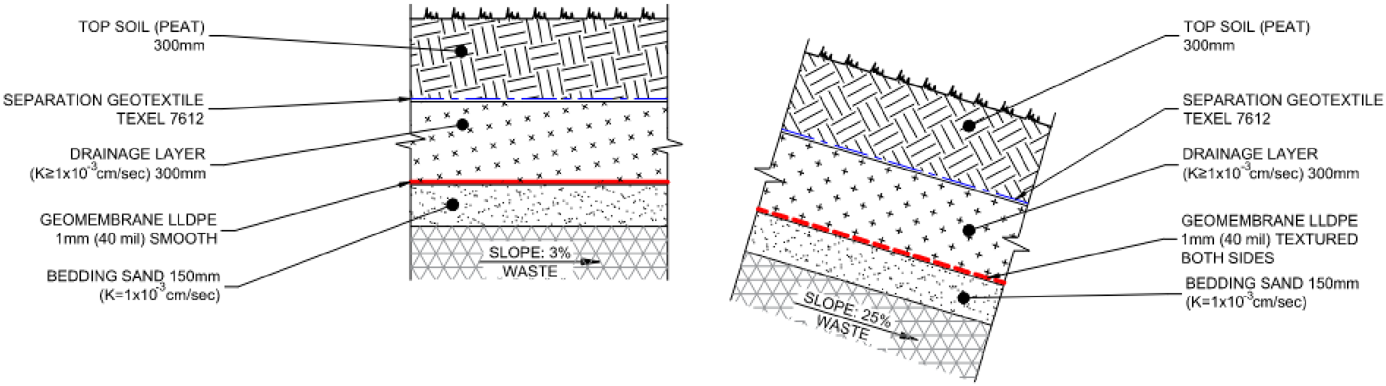


Figure 2. Final Cap System



2 HELP Model Design Parameters

The HELP model accepts inputs such as weather data (e.g., evapotranspiration, precipitation, temperature, and solar radiation) and landfill design (e.g., configuration of cover systems, waste depth, configuration of liner system layers, etc.), and uses solution techniques to estimate the amounts of runoff, evapotranspiration, drainage, leachate collection and liner leakage that may be expected within the landfill. In the current modelling exercise the key focus was to estimate percolation (or leakage) through each of the barrier layers in the liner system, the peak daily values of runoff collected in the leachate collection system, and the head on the primary liner system.

2.1 HELP Model Landfill Parameters

The leachate generation values are based on the phasing of the landfill. This assessment assumed four (4) scenarios of phasing:

- Open Cell Conditions – **Table 1**
    - This scenario is designed to provide leachate generation rates at the construction of a new cell and initial placement of waste. All precipitation is managed as leachate.
- Intermediate Cover Conditions – 5 metres of waste – **Table 2**
    - This scenario is designed to provide leachate generation rates at a period of phasing where there is approximately 5 metres of waste in place covered by 30 centimetres of intermediate soil cover.
- Intermediate Cover Conditions – 10 metres of waste – **Table 3**
    - This scenario is designed to provide leachate generation rates at a period of phasing where there is approximately 10 metres of waste in place covered by 30 centimetres of intermediate soil cover.
- Final Cover Conditions – **Table 4**
    - This scenario is designed to provide leachate generation rates at a period where the landfill is under final cover conditions.

Table 1. Open Cell Design Parameters

Layer	Type of Layer	Thickness (cm)	Hydraulic Conductivity (cm/sec)
Daily Cover	Vertical Percolation	16	2.5×10^{-5}
Waste (MSW)	Vertical Percolation	20	1.0×10^{-3}
Coarse Sand	Lateral Drainage	15	1.0×10^{-2}
Gravel	Lateral Drainage	50	3.0×10^{-1}
Clay Barrier	Barrier Soil	600	1.0×10^{-8}

Table 2. 5-metre Intermediate Cover Design Parameters

Layer	Type of Layer	Thickness (cm)	Hydraulic Conductivity (cm / sec)
Intermediate Cover	Vertical Percolation	30	2.5×10^{-5}
Waste (MSW)	Vertical Percolation	500	1.0×10^{-3}
Coarse Sand	Lateral Drainage	15	1.0×10^{-2}
Gravel	Lateral Drainage	50	3.0×10^{-1}
Clay Barrier	Barrier Soil	600	1.0×10^{-8}

Table 3. 10-metre Intermediate Cover Design Parameters

Layer	Type of Layer	Thickness (cm)	Hydraulic Conductivity (cm/sec)
Intermediate Cover	Vertical Percolation	30	2.5×10^{-5}
Waste (MSW)	Vertical Percolation	1000	1.0×10^{-3}
Coarse Sand	Lateral Drainage	15	1.0×10^{-2}
Gravel	Lateral Drainage	50	3.0×10^{-1}
Clay Barrier	Barrier Soil	600	1.0×10^{-8}

Table 4. Final Cover Design Parameters

Layer	Type of Layer	Thickness (cm)	Hydraulic Conductivity (cm/sec)
Topsoil	Vertical Percolation	30	3.7×10^{-4}
Sand	Later Drainage	30	1.0×10^{-2}
Geomembrane	Membrane	0.1	4.0×10^{-13}
Bedding Sand	Vertical Percolation	15	1.0×10^{-3}
Waste (MSW)	Vertical Percolation	1500	1.0×10^{-3}
Coarse Sand	Lateral Drainage	15	1.0×10^{-2}
Gravel	Lateral Drainage	50	3.0×10^{-1}
Clay Barrier	Barrier Soil	600	1.0×10^{-8}

2.2 HELP Model Weather Configuration and Input Data

HELP v4.0 will generate up to 100 years of daily precipitation, temperature, and solar radiation data stochastically for a location. The synthetic weather generator is based on a routine developed by the USDA Agricultural Research Service. Weather parameter values used in the synthetic weather generator are imported from a database of calculated weather parameters for over 13,000 points located on a 0.25 x 0.25-degree grid. The program retrieves parameter values from the closest grid point in the dataset based on the latitude and longitude specified for the landfill location.

The evapotranspiration, precipitation, temperature, and solar radiation for all models has been synthetically generated based on the longitude and latitude of the site location. The synthetically generated time period has been generated to provide a 30-year scenario.

Each modelled condition uses the 30-year synthetically generated weather in order to determine annual average precipitation and leachate collection by evaluating varying lengths of time as shown in **Table 5**.

3 HELP Model Output Data

The data presented in this section has been taken directly from the appropriate HELP model data output sheets.

Table 5 presents the estimated average annual drainage collection (leachate collected) values from the drainage layer during each condition (as described in Section 2.1 of this Appendix). As noted in Sections 2.5 and 3.5 of this Conceptual Design Report, the landfill expansion will be developed over a 20-year period and GFL proposes that operations in the expansion area will be similar to Stage 4 at the existing landfill. This reflects that in a given year:

- four cells (approximately 17.4 ha) would be active in a given year.
- two of the four active cells would be in an open cell condition (e.g., active landfilling).
- two of the four cells will be in an intermediate cover condition. However, GFL has indicated that stormwater runoff is not released from the intermediate covered cells. As such these were assumed to be equivalent to the open cell condition for the purpose of estimating leachate generation.
- The remainder of developed area under final cover conditions.

Table 5. Average Annual Leachate Collected per Hectare

Condition	Length of Analysis (years)	Cubic Meters/Hectare (m^3/ha)
Open Cell	1	3,956.3
5-metre Intermediate Cover	10	2,146.6
10-metre Intermediate Cover	10	2,146.7
Final Cover	30	419.5

4 Discussion

HDR considers that the HELP model estimates for leachate collected are conservative, and that these values are typically lower in actual field conditions. Furthermore, the model requires numerous assumptions to be made regarding input data and these may vary from actual field conditions.

HELP Model Output

Peak Values Summary

Title: Moose Creek CA
Simulated on: 8/31/2021 9:57

	Peak Values for Years 1 - 1*		
	(millimeters)*		(cubic meters)
Precipitation	44.80		448.0
Runoff	0.000		0.0000
Subprofile1			
Drainage collected from Layer 4	18.7951		188.0
Percolation/leakage through Layer 5	0.008646		0.0865
Average head on Layer 5	4.5341	(cm)	---
Maximum head on Layer 5	7.0152	(cm)	---
Location of maximum head in Layer 4	5.65	(meters from drain)	
Other Parameters			
Snow water	224.4535		2,244.5
Maximum vegetation soil water	0.4334	(vol/vol)	
Minimum vegetation soil water	0.2510	(vol/vol)	

*Note: head on liners expressed in cm

Average Annual Totals Summary

Title: Moose Creek CA
Simulated on: 8/31/2021 9:57

	Average Annual Totals for Years 1 - 1*			
	(millimeters)**	[std dev]	(cubic meters)	(percent)
Precipitation	948.44	[0]	9,484.4	100.00
Runoff	0.000	[0]	0.0000	0.00
Evapotranspiration	549.792	[0]	5,497.9	57.97
Subprofile1				
Lateral drainage collected from Layer 4	395.6286	[0]	3,956.3	41.71
Percolation/leakage through Layer 5	3.149340	[0]	31.5	0.33
Average Head on Top of Layer 5	0.2615		---	---
Water storage				
Change in water storage	-0.1262		-1.2622	-0.01

* Note: Average inches are converted to volume based on the user-specified area.

**Note: head on liners expressed in cm

Peak Values Summary

Title: Moose Creek CA
Simulated on: 8/31/2021 10:05

	Peak Values for Years 1 - 10*		
	(millimeters)*		(cubic meters)
Precipitation	47.60		476.0
Runoff	25.489		254.9
Subprofile1			
Drainage collected from Layer 4	2.9123		29.1
Percolation/leakage through Layer 5	0.008647		0.0865
Average head on Layer 5	4.6932	(cm)	---
Maximum head on Layer 5	8.6773	(cm)	---
Location of maximum head in Layer 4	12.55	(meters from drain)	
Other Parameters			
Snow water	65.1814		651.8
Maximum vegetation soil water	0.4790	(vol/vol)	
Minimum vegetation soil water	0.2510	(vol/vol)	

*Note: head on liners expressed in cm

Average Annual Totals Summary

Title: Moose Creek CA
Simulated on: 8/31/2021 10:05

	Average Annual Totals for Years 1 - 10*			
	(millimeters)**	[std dev]	(cubic meters)	(percent)
Precipitation	928.07	[112.01]	9,280.7	100.00
Runoff	197.495	[29.392]	1,974.9	21.28
Evapotranspiration	511.330	[61.352]	5,113.3	55.10
Subprofile1				
Lateral drainage collected from Layer 4	214.6600	[58.9271]	2,146.6	23.13
Percolation/leakage through Layer 5	3.155289	[0.002959]	31.6	0.34
Average Head on Top of Layer 5	0.9470	[0.2591]	---	---
Water storage				
Change in water storage	1.4339	[18.1077]	14.3	0.15

* Note: Average inches are converted to volume based on the user-specified area.

**Note: head on liners expressed in cm

Peak Values Summary

Title: Moose Creek CA
Simulated on: 8/31/2021 10:11

	Peak Values for Years 1 - 10*		
	(millimeters)*		(cubic meters)
Precipitation	47.60		476.0
Runoff	25.489		254.9
Subprofile1			
Drainage collected from Layer 4	2.8222		28.2
Percolation/leakage through Layer 5	0.008646		0.0865
Average head on Layer 5	4.5479	(cm)	---
Maximum head on Layer 5	8.4231	(cm)	---
Location of maximum head in Layer 4	12.29	(meters from drain)	
Other Parameters			
Snow water	65.1814		651.8
Maximum vegetation soil water	0.4790	(vol/vol)	
Minimum vegetation soil water	0.2510	(vol/vol)	

*Note: head on liners expressed in cm

Average Annual Totals Summary

Title: Moose Creek CA
Simulated on: 8/31/2021 10:11

	Average Annual Totals for Years 1 - 10*			
	(millimeters)**	[std dev]	(cubic meters)	(percent)
Precipitation	928.07	[112.01]	9,280.7	100.00
Runoff	197.495	[29.392]	1,974.9	21.28
Evapotranspiration	511.330	[61.352]	5,113.3	55.10
Subprofile1				
Lateral drainage collected from Layer 4	214.6703	[58.4988]	2,146.7	23.13
Percolation/leakage through Layer 5	3.155334	[0.003004]	31.6	0.34
Average Head on Top of Layer 5	0.9471	[0.2572]	---	---
Water storage				
Change in water storage	1.4235	[18.6124]	14.2	0.15

* Note: Average inches are converted to volume based on the user-specified area.

**Note: head on liners expressed in cm

Average Annual Totals Summary

Title: Moose Creek CA
Simulated on: 8/31/2021 11:28

	Average Annual Totals for Years 1 - 30*			
	(millimeters)**	[std dev]	(cubic meters)	(percent)
Precipitation	919.48	[107.57]	9,194.8	100.00
Runoff	141.012	[55.523]	1,410.1	15.34
Evapotranspiration	565.455	[71.032]	5,654.5	61.50
Subprofile1				
Lateral drainage collected from Layer 2	165.7031	[16.659]	1,657.0	18.02
Percolation/leakage through Layer 3	45.313797	[6.501814]	453.1	4.93
Average Head on Top of Layer 3	33.0637	[4.9911]	---	---
Subprofile2				
Lateral drainage collected from Layer 7	41.9519	[7.5693]	419.5	4.56
Percolation/leakage through Layer 8	3.140668	[0.082605]	31.4	0.34
Average Head on Top of Layer 8	0.1851	[0.0334]	---	---
Water storage				
Change in water storage	2.2152	[42.9774]	22.2	0.24

* Note: Average inches are converted to volume based on the user-specified area.

**Note: head on liners expressed in cm

Average Annual Totals Summary

Title: Moose Creek CA
Simulated on: 8/31/2021 11:32

	Average Annual Totals for Years 1 - 30*			
	(millimeters)**	[std dev]	(cubic meters)	(percent)
Precipitation	919.48	[107.57]	9,194.8	100.00
Runoff	110.318	[37.743]	1,103.2	12.00
Evapotranspiration	495.877	[64.222]	4,958.8	53.93
Subprofile1				
Percolation/leakage through Layer 2	313.166568	[61.888956]	3,131.7	34.06
Average Head on Top of Layer 2	0.2707	[0.0994]	---	---
Subprofile2				
Lateral drainage collected from Layer 3	313.1143	[61.7447]	3,131.1	34.05
Percolation/leakage through Layer 4	0.047561	[0.00858]	0.4756	0.01
Average Head on Top of Layer 4	0.0094	[0.0018]	---	---
Subprofile3				
Lateral drainage collected from Layer 8	0.0001	[0]	0.0008	0.00
Percolation/leakage through Layer 9	0.047391	[0.007518]	0.4739	0.01
Average Head on Top of Layer 9	0.0000	[0]	---	---
Water storage				
Change in water storage	0.1202	[21.0425]	1.2024	0.01

* Note: Average inches are converted to volume based on the user-specified area.

**Note: head on liners expressed in cm

C

Landfill Gas Generation Assessment

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1 Introduction

GFL Environmental Inc. (GFL) is undertaking an Environmental Assessment (EA) for a proposed expansion for additional non-hazardous landfill disposal capacity as part of the future development of its Eastern Ontario Waste Handling Facility (EOWHF). The purpose of the proposed undertaking is to provide approximately 15.1 million cubic metres (m^3) of additional landfill disposal capacity at the existing EOWHF over a 20-year planning period.

A landfill gas (LFG) generation assessment was undertaken for the landfill expansion in order to evaluate LFG production at varying stages of phasing throughout the life of the landfill. The evaluation was carried out using the EPA LandGEM model (version 3.02) which is built upon a first-order decay rate equation as follows:

This model is built upon a first-order decay rate equation as follows:

$$Q_{lfg} = \sum_{i=1}^{n} 2kL_O M_i \left(e^{-kt_i}\right)$$

Where:

Q_{lfg} = maximum expected gas generation flow rate, cubic metres per year
k = methane generation rate constant, per year or $year^{-1}$
L_o = methane generation potential, cubic metres per megagram of solid waste
M_i = mass of solid waste in the i^{th} section, megagrams
t_i = age of the i^{th} section, years

For the LFG modeling completed, only waste projected to be disposed of in the proposed future development alternative methods were included. As both expansion Alternative Methods 1 and 2 have similar volumes at final closure, a single model was completed that represents both Alternative Methods 1 and 2.

2 Waste Data

Annual waste placement used for the model was the approved maximum annual tonnage of 755,000 megagrams (Mg, with 1 Mg equal to 1 metric tonne) per year starting in year 2026 (first full year of receipt of 755,000 tonnes) and remaining constant through the end of 2045 (final year of operation). Composition of the waste was estimated based on the average waste composition being handled at the existing landfill[1]. The average waste composition by weight consisted of the following: 2.7% construction and demolition (C&D); 48.1% institutional, commercial, and light industrial (ICI); 28.7% municipal solid waste (MSW); 0% specified risk material (SRM); and 20.5% cover soils. **Table 1**

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[1] Tetra Tech. Conceptual Design Report, GFL Environmental Inc. Eastern Ontario Waste Handling Facility Landfill Expansion Environmental Assessment, Table 5. October 25, 2017.

provides the waste disposal rates for Alternative Method 1 and Alternative Method 2 based on these assumptions.

Table 1. Alternative 1 and 2 Maximum Annual Waste Disposal Rates

Year	C&D (Mg/yr)	ICI (Mg/yr)	MSW (Mg/yr)	SRM (Mg/yr)	Cover Soil (Mg/yr)	Annual Waste Placement (Mg/yr)	Waste In Place (Mg)
2026	20,385	363,155	216,685	0	154,775	755,000	755,000
2027	20,385	363,155	216,685	0	154,775	755,000	1,510,000
2028	20,385	363,155	216,685	0	154,775	755,000	2,265,000
2029	20,385	363,155	216,685	0	154,775	755,000	3,020,000
2030	20,385	363,155	216,685	0	154,775	755,000	3,775,000
2031	20,385	363,155	216,685	0	154,775	755,000	4,530,000
2032	20,385	363,155	216,685	0	154,775	755,000	5,285,000
2033	20,385	363,155	216,685	0	154,775	755,000	6,040,000
2034	20,385	363,155	216,685	0	154,775	755,000	6,795,000
2035	20,385	363,155	216,685	0	154,775	755,000	7,550,000
2036	20,385	363,155	216,685	0	154,775	755,000	8,305,000
2037	20,385	363,155	216,685	0	154,775	755,000	9,060,000
2038	20,385	363,155	216,685	0	154,775	755,000	9,815,000
2039	20,385	363,155	216,685	0	154,775	755,000	10,570,000
2040	20,385	363,155	216,685	0	154,775	755,000	11,325,000
2041	20,385	363,155	216,685	0	154,775	755,000	12,080,000
2042	20,385	363,155	216,685	0	154,775	755,000	12,835,000
2043	20,385	363,155	216,685	0	154,775	755,000	13,590,000
2044	20,385	363,155	216,685	0	154,775	755,000	14,345,000
2045	20,385	363,155	216,685	0	154,775	755,000	15,100,000
2046	0	0	0	0	0	0	15,100,000

Since cover soils will not degrade and contribute to LFG generation, the waste disposal rates were used to determine the annual degradable waste placement, for input into the LandGEM model, of 600,225 Mg/yr.

Methane Generation Rate Variable (k)

The Methane Generation Rate, k, determines the rate of methane generation for a unit mass of waste in the landfill. This value is highly dependent upon moisture in the waste mass. Per EPA's LandGEM model guidelines, arid landfills are sites located in areas that receive an average of less than 635 millimetres (25 inches) of rainfall per year. A review of the climate data from the Cornwall, Ontario station[2] found at the following link indicates that the actual rainfall values are well above 635 millimetres (25 inches) per

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[2] (https://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?stnID=4255&autofwd=1)

year at approximately 1,011 millimetres (39.8 inches) per year. Therefore, a k value of 0.05 year was chosen for the model, which represents the CAA Conventional default value.

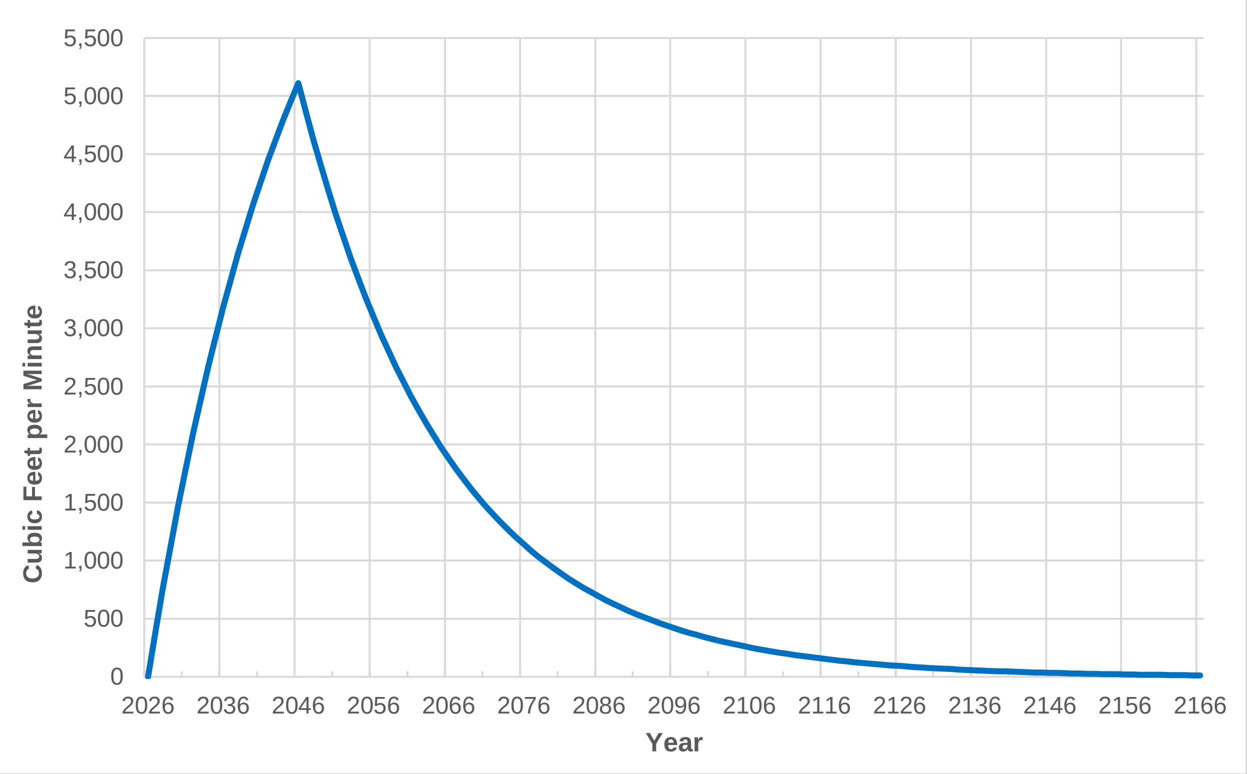
Potential Methane Generation Capacity Variable (L_o)

The Potential Methane Generation Capacity, L_o, depends on the type and composition of waste placed in the landfill. The higher the cellulose content of the waste, the higher the value of L_o. The default L_o values used by LandGEM are generally representative of MSW, but site-specific data can and should be used when available. Sufficiently detailed waste composition data was not available which precluded calculation of a site specific L_o value and as such the EPA Inventory Conventional L_o value of 100 cubic metres per tonne (m³/t) was used for the model.

3 LFG Model Results

Figure 1 presents the LFG curve from the modelling results for Alternative Methods 1 and 2 of the proposed EOWHF future development.

Figure 1. EOWHF Alternative Methods 1 and 2 Total Landfill Gas Generation



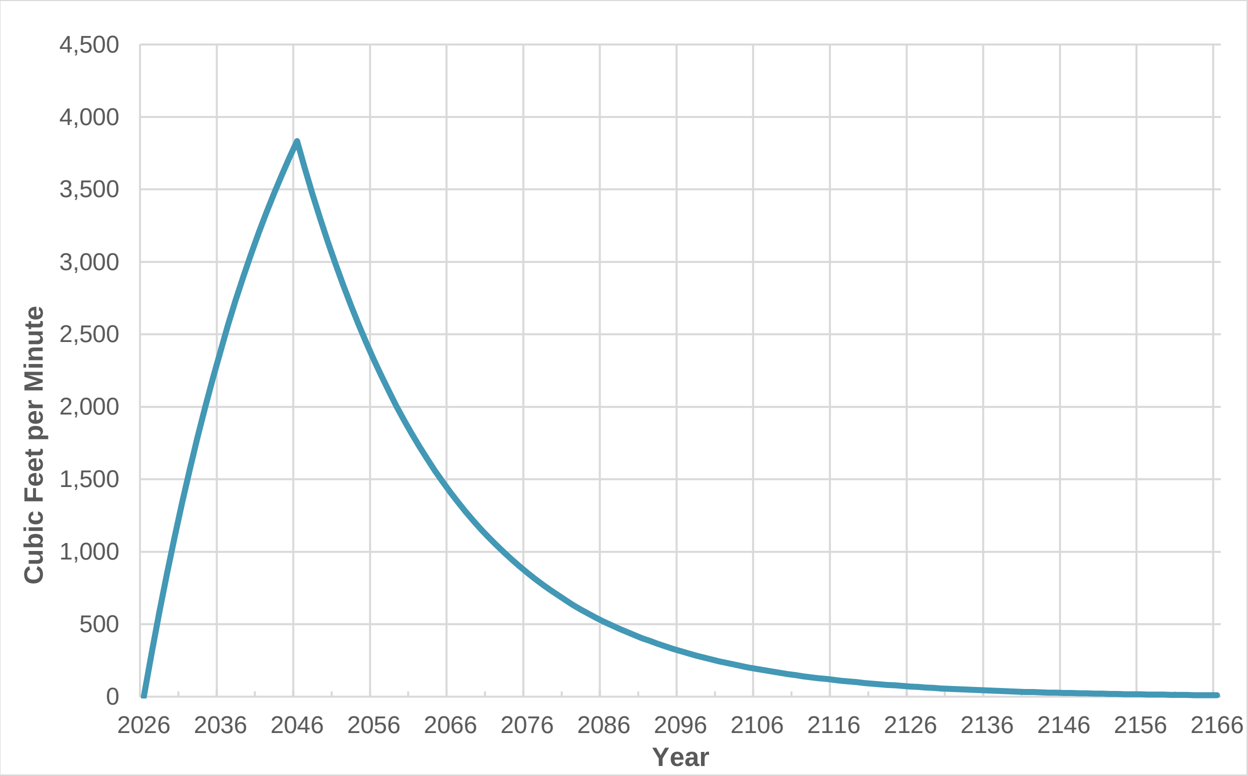
The total LFG generation is expected to peak one year after closure in 2046 at approximately 8,680 cubic metres per hour (m³/hr) (5,110 cubic feet per minute [cfm]). LFG generation is expected to decline approximately 5% per year after closure reaching a value of approximately 1,750 m³/hr (1,030 cfm) in 2078.

4 LFG Recovery

The EOWHF has an existing LFG collection system installed within the waste mass of the existing site. The LFG collection system utilizes vertical extraction wells, a network of buried gas conveyance piping, and condensate drop-out locations. The conveyance piping directs the collected LFG to an existing LFG to Energy (LFGTE) plant, which generates electrical power through LFG combustion within internal combustion reciprocating engines. The existing LFG system also has enclosed flares to thermally oxidize LFG when it is not routed to the LFGTE plant.

It is anticipated that similar collection infrastructure would be installed within the proposed landfill expansion to capture and control LFG. The LFG collection system in the expansion property would be connected to the existing infrastructure and treatment system. **Figure 2** shows a graph generated by applying a 75% collection efficiency (considered typical for municipal landfills) to the LFG generation potential of the proposed landfill expansion.

Figure 2. EOWHF Alternative Methods 1 and 2 Potential Landfill Gas Recovery @ 75% CE



The potential LFG recovery is expected to peak one year after closure in 2046 at approximately 6,510 m³/hr (3,830 cfm). Potential LFG recovery is expected to decline approximately 5% per year after closure reaching a value of approximately 1,315 m³/hr (775 cfm) in 2078.