GOLDER
MEMBER OF WSP

REPORT

Geotechnical and Hydrogeological Investigation

New Ottawa Hospital Development

Phase 1 - New Parkade Structure

Ottawa, Ontario

Submitted to:

Parsons Corporation

100-1223 Michael Street
Gloucester, ON
K1J 7T2

Submitted by:

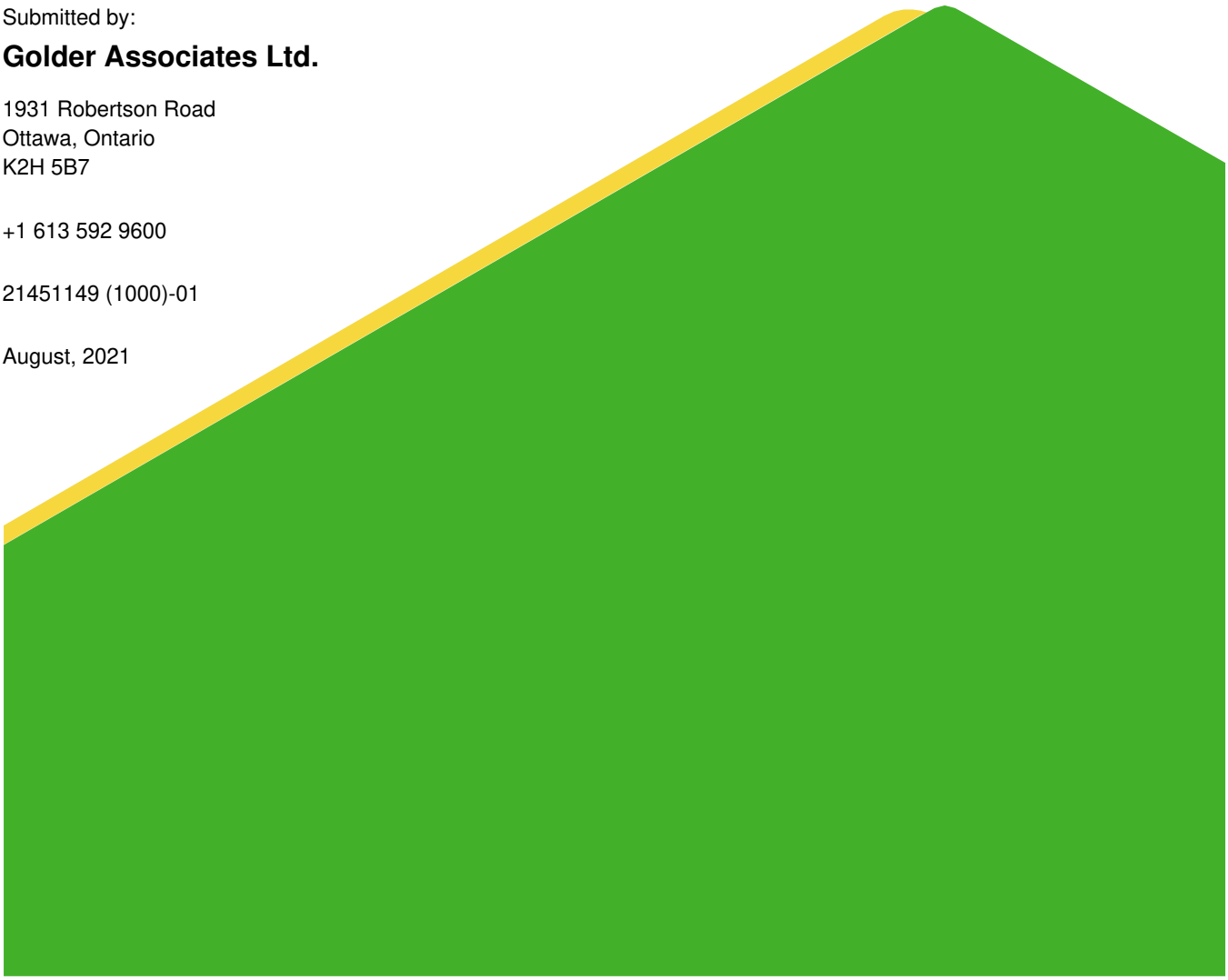
Golder Associates Ltd.

1931 Robertson Road
Ottawa, Ontario
K2H 5B7

+1 613 592 9600

21451149 (1000)-01

August, 2021



Distribution List

1 ecopy: Parsons Coporation (Parsons)

1 ecopy: The Ottawa Hospital

1 ecopy: Golder Associates Ltd. (Golder)

Table of Contents

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

This report presents the results of a geotechnical investigation carried out in support of the proposed development of the new campus of The Ottawa Hospital (TOH) on an approximately 50-acre site located in the northeast corner of the Canadian Experimental Farm in the City of Ottawa. The site is located in the southwest quadrant of the intersection of Carling Avenue and Preston Street.

The overall development includes a number of major components including:

- Design and construction of a new parkade structure located on the east side of the site. The parkade structure will be bounded by Carling Ave. and a future LRT expansion to the north, Preston St. to the east and Prince of Wales Dr. to the south.
- Design and construction of a new main hospital complex on the west side of the site.
- Three future towers, referred to as Carling Village, at the northeast corner of the site to accommodate hospital related uses, including stay facilities and service and retail uses.
- A future research facility in the northwest portion of the site along Carling Ave.
- A new University of Ottawa Heart Institute in the southern portion of the site.

This report has been prepared in support of the design and construction of the new Parkade structure. Concurrent with the investigations completed for this report, additional investigations were completed for the main hospital complex. These investigations are presented under separate cover. Environmental investigations formed part of this assignment and are also presented under separate cover.

The purpose of this geotechnical investigation is to assess the general subsurface conditions at the location of the proposed new parkade structure by means of 13 new boreholes and limited laboratory testing. Based on interpretation of the new and existing factual information (from our archives as well as from previous studies) engineering guidelines are provided. This study makes use of available subsurface information from previous studies at this site completed by Golder as well as previous investigation data (completed by others) supplied by the client. The results of previous investigations completed by others and provided to us have been assumed to be accurate, but have not been independently confirmed by Golder.

The reader is referred to the “Important Information and Limitations of This Report”, which follows the text but forms an integral part of this document.

2.0 DESCRIPTION OF PROJECT AND SITE

Plans are being prepared for development of the first phase of the development of the new Civic Hospital campus of The Ottawa Hospital located at the southwest corner of Preston Street and Carling Avenue in a portion of what was the Ottawa Experimental Farm (see Site Plan, Figure 1). The first portion of the development will include a new parkade structure on the east side of the site and sections of the new internal road network, currently identified as roads A and B, for those portions of the site south of the existing escarpment.

The following is a summary of the proposed Parkade Structure, based on information provided to us:

- The site of the proposed Parkade is located in the northeast corner of the campus (see Figure 1).

- The new Parkade Structure which will be 4 storeys in height. Approximately one level of parking will be below grade on the west side of the site, while the lowest level will be approximately at the existing grade on the east side of the site.
- The lowest parking level 'P1' is at a proposed elevation of 66.475 m.
- The parking structure will have a connection to Prince of Wales to the south at the P1 level, connections to the proposed internal road network to the west at approximately elevation 71.4 m and a green roof at approximately 80.4 m elevation.
- The new parking structure will span both sides of the existing OLRT right-of-way and will be required to "bridge" the right-of-way (which is currently lowered below the existing grade in a trench.
- The proposed parkade will be approximately 200 m by 150 m wide, with an area of approximately 30,000 m^2.

Golder Associates, McRostie and Associates (later acquired by Golder) along with others have completed several geotechnical and environmental investigations within the vicinity of the proposed parkade. The results of these investigations were included in the following reports (some of which were obtained from Golder's archive, and some of which were provided to Golder by the client for use as part of this study):

- McRostie and Associates Report to Public Work and Government Service Canada, titled "*Subsurface Investigation, Carling Avenue, Central Experimental Farm, New Sir John Carling Building, Ottawa, Ontario*", dated November 2000 (Report No. SF-4654).
- Stantec Consulting Ltd. "*Phase II Environmental Site Assessment, New Ottawa Hospital Civic Campus, Ottawa, ON*" dated September 2017.
- Intera Engineering Ltd. Report to National Capital Commission "*Phase I/II Environmental Site Assessment, Former Dow's Lake Landfill, National Capital Commission Property Asset #784, Ottawa, Ontario"* dated January 2004.
- Intera Engineering Ltd. Report to National Capital Commission "*Screening-Level Risk Assessment Former Dow's Lake Landfill and Commissioner's Park, NCC Property Assets #96654 and #784, Ottawa, Ontario"* dated October 2005.

Based on the existing subsurface information and published geological mapping, the ground conditions at the site consist of fill material and glacial till, overlying bedrock at depths estimated to range from less than 1 m to 4 m. Bedrock mapping shows the east side of the OLRT to be underlain by Lindsay Formation nodular limestone, with Bobcaygeon Formation limestone and shale bands underlying the western side.

3.0 PROCEDURE

The fieldwork for this investigation was carried out between May 13th and June 11th, 2021. At that time, seven boreholes (numbered 21-01 to 21-07) were advanced within the proposed parkade footprint at the approximate locations shown on the attached Site Plan, Figure 1. An additional six boreholes (numbered 21-08 to 21-13) were advanced along the west side of the structure where proposed new internal roads (Roads A and B) will be located along the outside of the parkade.

The boreholes were advanced to depths ranging from 1.2 to 10.9 m below the existing ground surface using track and truck-mounted continuous flight hollow-stem auger drill rigs, supplied and operated by George Downing Estate Drilling of Hawkesbury, Ontario.

Standard Penetration Tests (SPTs) were carried out in the boreholes at regular intervals of depth and samples of the soils encountered were recovered using split spoon sampling equipment.

Boreholes 21-02, 21-03, 21-05, 21-06, 20-07, 21-09, 21-10, 21-12 and 21-13 were extended into the bedrock using rotary diamond drilling techniques while retrieving NQ or HQ sized core. Within these boreholes, the cored lengths in the bedrock ranged between 1.6 and 8.4 m.

Monitoring wells were sealed into boreholes 21-01, 21-02, 21-03, 21-05, 21-06 and 21-10 to allow subsequent measurement of the groundwater level at the site. The groundwater levels in these devices were measured on May 28 and June 23, 2021.

In addition to the monitoring wells, a Vertical Seismic Profile (VSP) casing was installed into borehole 21-07 to allow for confirmatory geophysical testing in a later phase of the project.

The fieldwork was supervised by a member of our engineering staff who located the boreholes, directed the drilling operations and in situ testing, and logged the boreholes and samples.

Upon completion of the drilling operations, samples of the soil and rock obtained in the boreholes were transported to our laboratory for further examination and laboratory testing. The laboratory testing included natural water content determinations and grain size distribution testing as well as determination of Uniaxial Compressive Strength of rock cores.

Three groundwater samples from boreholes 21-02, 21-05 and 21-10 were submitted to AGAT Laboratories for basic chemical analysis related to potential sulphate attack on buried concrete elements and corrosion of buried ferrous elements.

The borehole locations were selected, marked in the field, and subsequently surveyed by Golder Associates personnel. The borehole coordinates and ground surface elevations were determined using a Trimble R8 GPS survey unit. The geodetic reference system used for the survey is the North American Datum of 1983 (NAD83). The borehole coordinates are based on the Universal Transverse Mercator (UTM Zone 18) coordinate system. The elevations are referenced to Geodetic datum (CGVD28).

4.0 SUBSURFACE CONDITIONS

4.1 General

Information on the subsurface conditions is provided as follows:

- The Record of Borehole Sheets from the current investigation are provided in Appendix A.
- The results of the natural water content determinations and Atterberg limit tests are provided on the Record of Borehole Sheets.
- Photographic records of the rock core are provided in Appendix B.
- The Record of Borehole Sheets from the previous boreholes advanced in the area of the site are provided in Appendix C.

- The results of the basic chemical analysis are provided in Appendix D.
- Laboratory testing results are provided on Figures 2 to 6.
- Results of the Uniaxial Compressive Strength (UCS) testing on the bedrock will be included in the final report.

In general, the subsurface conditions on this site consist of pavement structure or topsoil and fill, overlying thin, discontinuous deposits of glacial till, and shallow limestone bedrock.

The following sections present a more detailed overview of the subsurface conditions on this site. It should be noted that the subsurface conditions encountered in previous investigations have also been used to supplement the current investigations.

4.2 Pavement Structure, Topsoil and Fill

Borehole 21-01 was advanced through the pavement structure of the existing parking lot at the site. The pavement structure at this borehole location consists of 50 mm of asphaltic concrete, underlain by 560 mm of granular base/subbase.

Topsoil exists at the ground surface at boreholes 21-02 to 21-07 inside the parkade footprint as well as in 21-08 to 21-12 located around the western exterior of the footprint. The topsoil has a thickness ranging from about 150 to 300 mm at the borehole locations within the parkade footprint.

Heterogeneous fill was encountered below the pavement structure, topsoil or at ground surface at all of the borehole locations advanced during the current investigation. The fill ranged in thickness from 0.8 m to 3.5 m and varied in consistency from silty clay, silty sand, gravelly sand, gravel and sand to sandy gravel with various amounts of cobbles, organics, wood, brick, ash, concrete, and other debris.

At borehole 21-05, 0.6 m of buried concrete was encountered at a depth of 1.2 m below existing ground surface.

Standard penetration tests carried out within the fill deposit gave SPT ‘N’ values ranging from 5 to greater than 50 blows per 0.3 m of penetration, but more typically in the range of 5 to 30 blows per 0.3 m of penetration, indicating a loose to compact state of packing.

The results of gradation testing carried out on the gravelly, silty, sand, sand and gravel and silty sand fill are provided on Figures 2 to 4. The measured water content of eleven samples of the fill ranged from 3 to 31%.

4.3 Glacial Till

At boreholes 21-03, and previous borehole 00-107 a deposit of glacial was encountered below the fill at depths of 1.5 and 2.25 m below existing ground surface. Glacial till was also encountered in borehole 21-13 to the west of the proposed parkade structure at a depth of 0.8 m below ground surface. Based on the borehole information, the glacial till appears to be discontinuous across the site.

In general, the glacial till consists of a heterogeneous mixture of cobbles, boulders, and gravel in a matrix of silty sand. The presence of cobbles and boulders within the glacial till was not directly observed during the current investigation; however, cobbles and boulders are typically present in the glacial till in the area and should be anticipated during construction.

The glacial till deposit extends to depths of 1.7 to 3.0 m below the existing ground surface (i.e., elevations 63.3 m and 63.8 m) where encountered within the parkade structure.

The results of one standard penetration test carried out within the glacial till gave SPT 'N' values ranging from 10 to greater than 50 blows per 0.3 m of penetration, indicating a compact to very dense state of packing, though the higher values may be due to the presence of cobbles/ boulders or the bedrock surface rather than the density of the soil matrix.

The results of gradation testing carried out on one sample of the glacial till is provided on Figure 5. The measured water content of two samples of the glacial till were 7 and 8%.

4.4 Refusal and Bedrock

Auger refusal was encountered below the fill and/or glacial till and/or silty sand at all locations (with the exception of two boreholes on the proposed access road to the west which were terminated at shallow depth). Refusal to augering was encountered at depths ranging from about 0.6 to 5.8 m below existing ground surface (i.e., Elevations from 63.1 to 65.3 m) within the parkade footprint during the current investigation.

Upon encountering refusal to augering, boreholes 21-02, 21-03, 21-05, 21-06, 21-07, 21-09, 21-10, 21-12 and 21-13 were extended into the bedrock using rotary diamond drilling techniques while retrieving NQ or HQ sized core. Within these boreholes, the cored lengths in the bedrock ranged from 3.4 to 8.4 m (i.e., to total depths ranging between 5.3 to 10.9 m below the existing ground surface). The cored bedrock generally consists of fresh, thinly to medium bedded, grey to dark grey, fine to medium grained, non-porous, shaley, nodular limestone bedrock.

The Rock Quality Designation (RQD) values measured on the recovered bedrock core samples ranges from 50% and 100% but are typically between 80% and 100% indicating good to excellent quality rock. It is common for bedrock in the area to be more weathered and disturbed in the upper 1 m to 2 m and improve in quality below that depth.

Results of Uniaxial Compressive Strength (UCS) testing carried out six samples of bedrock gave strengths ranging from 95 to 130 MPa, corresponding to a strong to very strong bedrock.

Photographs of the bedrock core are provided in Appendix B.

The depth and elevations of the bedrock surface, as well as the ground surface elevation, at the borehole locations in the current and previous investigations are summarized in the table below.

Table 1: Summary of Auger Refusal/Bedrock Depths and Elevations

Report no.	BH no.	Ground Surface Elevation (m)	Refusal Depth (m)	Bedrock Elevation (m)
Current	21-01	65.05	1.91[R]	63.14[R]
	21-02	65.67	1.27	64.40
	21-03	64.97	1.68	63.29
	21-04	67.61	3.81[R]	63.80[R]
	21-05	65.58	1.95	63.63
	21-06	67.00	2.03	64.97
	21-07	66.70	2.54	64.16

Report no.	BH no.	Ground Surface Elevation (m)	Refusal Depth (m)	Bedrock Elevation (m)
	21-08	66.02	1.22[R]	64.80[R]
	21-09	66.35	1.57	64.78
	21-10	66.19	2.14	64.05
	21-11	67.35	1.68[R]	65.67[R]
	21-12	68.72	1.40	67.32
	21-13	66.27	2.97	63.30
SF-4654	00-104	67.51	2.22	65.29
	00-105	66.13	1.80	64.33
	00-106	66.38	3.30	63.08
	00-107	66.57	2.75	63.82
	00-108	66.75	2.24	64.51
Intera 2004 Investigation	03-BH1	-	2.90[R]	-
	MW2	-	1.80	-
	03-BH3	-	1.30	-
	MW 4	-	1.80[R]	-
	MW 5	-	1.50	-
	03-BH6	-	0.60[R]	-
Intera 2005 Investigation	04-BH1	-	1.07[R]	-
	04-BH2	-	1.68[R]	-
	04-BH3	-	1.98[R]	-
	04-BH4	-	1.52[R]	-
	04-BH5	-	2.38[R]	-
	04-BH6	-	1.83[R]	-
Stantec Phase II ESA	MW 17-01	-	0.91	-
	MW 17-02	-	1.91	-

Note [R] Denotes auger refusal, bedrock surface not confirmed through coring.

4.5 Groundwater

Monitoring wells were sealed into boreholes 21-01, 21-02, 21-03, 21-05, 21-06 and 21-10 as part of the current investigation. The following table summarizes the measured groundwater levels and hydraulic conductivity testing carried out in both the current and previous investigations.

Table 2: Summary of Groundwater Conditions

Report No.	Borehole No.	Ground Surface Elevation (m)	Groundwater Level			Hydraulic Conductivity (cm/s)	Geological Strata Screened
			Date	Depth (m below ground surface)	Elevation (m)		
Current	21-01	65.05	June 9, 2021	Dry	-	N/A	Fill
	21-02	65.67	May 28, 2021	2.09	63.59	N/A	Bedrock
	21-03	64.97	May 28, 2021	2.59	62.38	$1x10^{-5}$	Bedrock
			June 23, 2021	2.67	62.30		
	21-05	65.58	May 28, 2021	2.72	62.86	$1x10^{-5}$	Bedrock
			June 2, 2021	2.73	62.85		
	21-06	67.00	May 27, 2021	1.19	65.82	$1x10^{-5}$	Bedrock
			June 23, 2021	2.70	64.31		
	21-10	66.19	May 28, 2021	2.66	63.53	$3x10^{-5}$	Bedrock
			June 23, 2021	2.66	63.53		
SF-4654	00-104	67.51	Oct. 27, 2000	2.13	65.38	N/A	N/A
	00-105	66.13	Oct. 27, 2000	2.89	63.24		
	00-106	66.38	Oct. 27, 2000	2.58	63.80		
	00-107	66.57	Oct. 27, 2000	4.06	62.51		
	00-108	66.75	Oct. 27, 2000	3.05	63.70		
Stantec Phase II ESA	MW17-01	-	Aug. 3, 2017	1.61	-	N/A	Bedrock
	MW17-02	-	Aug. 3, 2017	2.12	-		Bedrock

It should be noted that groundwater levels are expected to fluctuate seasonally. Higher groundwater levels are expected during wet periods of the year, such as spring.

5.0 DISCUSSION

5.1 General

This section of the report provides engineering guidelines on the geotechnical design aspects of the proposed Parkade, internal road network and municipal services based on our interpretation of the factual information and project requirements. Reference should be made to the “Important Information and Limitations of This Report”, which follows the text but forms an integral part of this document.

5.2 Seismic Design Considerations

5.2.1 Liquefaction Assessment

The site is not considered to be susceptible to seismic liquefaction.

5.2.2 Seismic Site Classification

Because the parkade will be founded on or very close to bedrock, it is anticipated a seismic Site Class A or B could be applied at this site. Applying a Site Class more favourable than a C, however, must be confirmed with a geophysical study confirming the shear wave velocity of the soil and bedrock profile in accordance with the 2019 OBC.

A Vertical Seismic Profile (VSP) casing has been installed at borehole 21-07 in anticipation of completing a shear wave velocity measurement to allow for assignment of a higher site class. For the purposes of the preliminary design and planning it can be assumed the site will likely be classified as Site Class A pending completion of the geophysical test.

5.3 Site Grading & Excavations

5.3.1 Site Grading

Based on preliminary concept plans and additional project correspondence, it is understood the proposed Parkade Structure will have four levels of parking, with the lowest level ‘P1’ underground at a proposed elevation of 66.475 m. A higher connection between the parkade and the main hospital will be constructed at the elevation of the green roof. It is understood, however, that this connection will be structural (i.e., a “bridge” type structure).

In addition to the Parkade structure, it is understood that municipal services (storm, water and/or sanitary) will be constructed as part of the Phase 1 construction. The exact depths and locations of the services are unknown; however, it is assumed service installations would be typical of water-bearing services, involving trenches of 3 m to 4 m depth. In general, across the site, the subsurface conditions consist of topsoil and fill overlying localized areas of glacial till over bedrock ranging from depths of 0.6 m to 3.8 m below ground surface.

In general, the subsurface conditions in the east portion of the Parkade Structure, between Preston Street and the OLRT (boreholes 21-01 to 21-03, and previous boreholes 03-BH1, MW2, 03-BH3, MW4, MW5, 03-BH6, 04-BH1, 04-BH2, 04-BH3, 04-BH4 and MW17-1) consist of about 0.9 to 2.9 m of variable fill overlying localized glacial till (to a depth of 1.7 m at borehole 21-03, though it may be present in other areas), which in turn overlies bedrock at Elevations of 63.1 to 64.4 m.

The subsurface conditions within the west portion of the Parkade Structure, west of the OLRT (boreholes 21-04 to 21-07 and previous boreholes 00-104 to 00-108 and MW 17-2) consist of about 1.2 to 3.3 m of variable fill overlying bedrock at Elevations ranging from 63.1 to 65.3 m.

Given the site is underlain by shallow bedrock it is unlikely that there would be any practical limit on grade raises for the site. There are no concerns (from a geotechnical perspective) with the relatively small grade raises which are required to construct the parkade and associated works.

As a more general guideline regarding the site grading, if required the preparation for filling of the site should include stripping the topsoil (including buried topsoil) as well as any deleterious fill material. The excavation can be brought up to grade with compacted engineered fill consisting of Granular B Type II (S.P. F-3147). Engineered fill should be placed in maximum 300 mm thick lifts and should be compacted to at least 95% of the material's Standard Proctor Maximum Dry Density (SPMDD). It is possible that portions of the existing granular fill material could be suitable for re-use as engineered fill below non-structural elements (i.e., not below foundations) if needed, but the material would need to be reviewed during construction and suitable portions of the soil set aside for re-use.

The topsoil and any excess fill material should be stockpiled separately for re-use in landscaping applications only.

5.3.2 Excavations

The existing elevation of the west side of the site is as high as 68 m to 69 m (based on the approximate borehole elevations; Golder has not completed accurate surveys of the site topography).

Based on the information provided, for the Parkade structure, the P1 floor level will be at 66.475 m. In addition, slightly deeper localized excavations would be required at the foundation locations to reach the bedrock surface. Assuming foundation excavations will extend to bedrock within the Parkade footprint, they will likely need to extend through soil to as much as 1.5 m to 3 m below the proposed P1 floor level (though in some cases, such as BH21-12 in the southwest corner of the site the rock may actually be higher than the proposed floor elevation). This corresponds to depths of 1 m to 4 m below the ground surface at the current borehole locations.

On the east side of OLRT excavations would likely be required to a depth of 2 m to 3.5 m below the P1 floor level to place the footings on bedrock. This corresponds to depths of 1 to 2 m below the existing ground surface at the current borehole locations.

Excavations for the parkade structure will be through topsoil, variable heterogeneous fill, native glacial till (where present) and into bedrock in many locations. Excavations will likely extend below the groundwater level in some locations, which was encountered at depths ranging from 1.2 to 3 m below ground surface.

Based on typical municipal service installation depths of 3 to 4 m below ground surface, excavations for site servicing will be through topsoil, variable heterogeneous fill, native glacial till (where present) and into bedrock through a majority of the site. Excavations for site services will likely extend below the groundwater level in some locations.

5.3.2.1 Overburden

No unusual problems are anticipated in excavating the majority of the overburden materials using conventional hydraulic excavating equipment. Additional effort may be required to break and remove the buried concrete near borehole 21-05 (and other locations should it be encountered) as the extent and quality of this concrete is not known. Cobbles and boulders should be expected in the fill and in the glacial till. Debris (e.g., organics, brick, metal, wood, stone, concrete, etc.) should also be expected in the fill.

In accordance with the Occupational Health and Safety Act (OHSA) of Ontario, the soils above the water table at this site would be generally classified as a Type 3 soil. As such, excavations in these materials may be made with side slopes at 1 Horizontal to 1 Vertical (1H:1V). Boulders larger than 0.3 m in size should be removed from the excavation side slopes for worker safety. Excavations within the silty and sandy soils (both fill and native) *below the water table* would be classified as a Type 4 soil; therefore, these excavations would require side slopes at a minimum slope of 3H:1V (i.e., flatter than 3H:1V). If the groundwater levels are lowered below the depth of excavation, unsupported side slopes may be steepened to 1H:1V. It is expected that open-cut methods and/or will generally be feasible in most areas provided sufficient space exists to accommodate the excavations.

Alternatively, if sufficient space does not exist, the excavations could be carried out in soil using steeper side slopes with all manual labour carried out within fully braced, steel trench boxes or shoring systems for worker safety.

Stockpiling of soil/rock beside the excavations should be avoided; the weight of the stockpiled material could lead to slope instability for unsupported excavations.

5.3.2.2 Bedrock

Based on the proposed underground parking level ‘P1’ elevation of 66.475 m (which is the finished floor elevation; the thickness of the slab and any foundations would further extend the excavations). Bedrock removal may be required for construction of the parkade; in localized areas towards the southwest where the rock is present above the P1 elevation, and may also be required for the municipal services at this site for typical installation depths of up to 4 m below ground surface, as well as at other locations to accommodate foundations and utilities.

The bedrock encountered consists of fresh, thinly to medium bedded, grey to dark grey, fine to medium grained, non-porous, shaley nodular limestone bedrock. Shallow, localized bedrock excavation may potentially be carried out using mechanical excavating methods such as hoe ramming, however, more extensive rock excavation will be more economical using drill and blast techniques. Closely spaced line drilling is typically used to control the extent of excavation (for both mechanical excavation and blasting) and to reduce the potential for overbreak and unexpected over excavation.

Loose rock should be removed from the sidewalls of the excavations. Where significant disturbance of the rock face exists, either naturally or as a result of damage due to excavation, localized rockfall protection such as mesh or bolts may be required for the safety of workers at the base of the excavation. Relatively steep to near-vertical walls in the bedrock would be expected to stand unsupported for the construction period. The rock walls should be inspected at the time of excavation so that the guidelines can be confirmed.

Vibrations induced by excavation activities will need to be considered when assessing potential impacts to adjacent structures. Caution should be exercised in carrying out bedrock removal around services and structures which may be sensitive to vibrations (including the OLRT tunnel). Bedrock removal should therefore be controlled to limit the peak particle velocities at all adjacent structures and services such that the risk of vibration induced damage will be mitigated. If blasting is the chosen method of construction, a blasting plan designed by a specialist in this field will be required, and the contractor should be limited to only small, controlled shots.

If practical, vibration intensive construction activities (e.g., hoe-ramming, and blasting) should commence at the furthest points from sensitive receptor structures or services to assess the ground vibration attenuation characteristics and to confirm the anticipated ground vibration levels.

The contractor should be required to submit a detailed vibration monitoring plan, prepared by a vibration specialist, prior to carrying out any construction activities. This plan should provide detail on the proposed excavation methods, vibration monitoring equipment, monitoring locations, frequency of readings, etc. This plan would have to be reviewed and accepted in relation to the requirements of the vibration specifications given above.

5.3.3 Groundwater Control

Based on the conditions observed in the monitoring wells groundwater levels were recorded at Elevations ranging from 62.3 m to 65.8 m. Groundwater levels are expected to fluctuate seasonally. Higher groundwater levels are expected during wet periods of the year, such as spring.

The proposed parking level ‘P1’ elevation is indicated to be at 66.475 m elevation. It is assumed that the bulk excavation for the Parkade will therefore be to a depth of 66.475 plus the thickness of the floor structure, with localized excavations to reach bedrock at footing locations (which ranged in elevation from 63.1 m to 67.3 m at the borehole locations, but could be somewhat lower or higher at other locations). Assuming the excavations are completed under similar groundwater conditions as were encountered during the geotechnical investigation, the excavations may extend locally below the level of the groundwater at some locations.

The rate of groundwater inflow to excavations (which could extend below the groundwater level in some locations) will depend on many factors, including: the contractor’s schedule and rate of excavation, the size of the excavation, the number of working areas being excavated at one time, and the time of year at which the excavation is made. Also, there may be instances where precipitation collects in an open excavation and must be pumped out. In general, it is anticipated that dewatering in the fill, glacial till and bedrock units can be handled by pumping from properly constructed and filtered sumps located within small, localized excavations.

Based on the hydraulic conductivity estimated for the bedrock, the temporary excavations for parking level ‘P1’ would not be expected to require registration in the Environmental Activity and Sector Registry (EASR; which is required if pumping volumes exceed 50,000 l/day) or a Permit to Take Water (PTTW; which is required if pumping volumes exceed 400,000 l/day). It is possible that an EASR registration may be required for localized deep utility excavations. The final locations and depths of new utility excavations should be reviewed during detailed design.

Golder can undertake additional, more detailed review and analysis based on detailed excavation plans once they are developed (particularly if they differ significantly from those described in this report). If, following the more detailed review and analysis is carried out, an EASR or PTTW is determined to be required (particularly if the final design is significantly different from the current plans), Golder can assist with preparing the analysis and documentation to support these applications.

5.3.4 Impacts to Adjacent Structures

Based on the information provided, there are few structures or services within a likely zone of influence of the proposed parkade construction, particularly considering the shallow bedrock at the site.

Where the zone of influence of foundations or critical, movement sensitive, services are within the zone of influence of excavations (and within soil), it is recommended that any temporary protection systems be designed

by the contractor in accordance with OPSS.MUNI 539 to prevent movement. The required Performance Level for the protection system should be determined by the structural engineer based on the vulnerability of the structure/services to movement. In addition, monitoring of structures for tilt, cracks and/or settlement would be warranted. Where foundations are confirmed to be within rock these zones of influence are typically much smaller (i.e., the foundations or structures may be closer without significant risk) however these areas should be reviewed on a case-by-case basis.

Excavation support, as well as the design of any sloped excavations for excavations will need to consider nearby structures/foundations or any existing services that are to be protected during construction. Where excavations do not intersect the zone of influence of foundations or existing services, no issues would be anticipated. The zone of influence is defined by a theoretical 1 Horizontal to 1 Vertical (1H:1V) surface extending down and away from the underside of the footings to the outside edge of the excavation.

As discussed in Section 5.3.2.2, bedrock excavation can induce vibrations. Vibration monitoring in conjunction with preconstruction surveys would help to protect the City against unfounded damage claims during construction. Vibration specifications should be in accordance with City S.P. F-1201.

Based on experience with other projects in the vicinity of the OLRT right-of-way it is assumed that an impact study will be required to assess the potential impacts of project on the OLRT. It is not considered that vibrations from the parkade construction are likely to be a major issue, but this will need to be addressed as part of the impact study, and vibration specifications may need to be modified to accommodate the OLRT requirements.

5.4 Foundations

The following guidelines are applicable to the design of the foundations for the proposed Parkade Structure based on our understanding of the project details and soils encountered in the boreholes advanced during this investigation.

5.4.1 Shallow Foundations

It is considered that conventional shallow footings will be feasible for the proposed parkade structure. The existing fill is not considered suitable to support the proposed structures and bedrock is shallow relative to the foundation level over most of the site, it is therefore recommended that the foundations be placed on bedrock.

Bedrock was encountered at elevations ranging from 63.1 m to 67.3 m (where the elevation is known; it may be somewhat shallower or deeper at other locations). The P1 level is indicated to be at 66.475 m with the footings being deeper (allowing for the thickness of the floor structure and the footing itself). Where the rock is higher than the proposed foundation elevation localized rock excavation will be required. Where the rock surface is lower than the proposed foundation elevation then two options could be considered:

- Lower the foundation elevation to the as-found rock surface and adjust the column length;
- Construct a concrete pier to fill in the gap between the rock surface and the underside of footing (essentially thickening the concrete).

If it is desirable to reduce the uncertainty associated with the exact depth to bedrock, then additional borehole probing could be considered once the final foundation layout and depths are known.

The following geotechnical bearing resistances may be assumed for shallow foundations on rock:

Prepared Bearing Stratum	Factored ULS Bearing Resistance (kPa)	SLS Bearing Resistance (kPa)
Slightly Weathered to Fresh Bedrock (Footings on Bedrock, or Concrete Piers on Bedrock)	5,000	N/A

The above values are based on the following assumptions:

- The bedrock has not been excessively disturbed, and any loose/broken rock has been removed.
- The water table must be drawn down below the bottom of the excavation and should be maintained at that level throughout the placement of concrete.
- There is no practical limit on the size of footings on rock.

The above values are based on the bearing resistance of the rock (i.e., the geotechnical resistance of the foundation). If the option to place additional concrete between the as-found rock surface and the underside of the footing is adopted, it will have no impact on the bearing resistance of the rock (and the values above may be used). The suitability of the concrete pier should, however, be assessed the structural engineer to confirm the pier itself has adequate capacity.

Settlement of footings on bedrock is typically negligible under services loads and SLS conditions do not govern the design of foundations on rock for typical building foundation loads.

For lateral sliding resistance, an unfactored interface friction coefficient of 0.7 may be used for the design of foundations placed on competent bedrock, and 0.55 may be used for foundations (or other concrete elements) placed on soil. A resistance factor of 0.8 should be applied to the sliding resistance.

5.4.2 Foundation Set-Back

It is understood the proposed parkade will span across the existing OLRT tracks. The existing rail is located in an existing below-grade trench. The invert of the trench is at an elevation of approximately 56.5 m to 57.5 m in the area below the proposed parkade. Assuming the parkade foundations are at an elevation of approximately 63 m this implies the effective height of the rock walls of the trench (to the underside of foundation) will be order of 5 m to 7 m.

On the east side of the OLRT tracks there is a significant distance between the existing tracks and the outside edge of the right-of-way (which is shown as being 12 m to 14 m east of the centreline of the tracks. At this distance (i.e., assuming the parkade foundations will remain outside the OLRT right-of-way), the foundation loading would not be expected to have any significant impact on the stability of the OLRT trench (or vice-versa).

On the west side of the OLRT, the drawings provided indicate that the trench may be widened to accommodate a second set of tracks (to have dedicated northbound and southbound tracks). The drawings suggest that in most areas this widening will leave approximately 3 m to 4 m between the excavation and the edge of the right-of-way. In these areas the foundations would not be expected to have a significant impact on the rock walls of the trench.

There is, however, a section near chainage 34+220 where the excavation will extend to the right-of-way. In this area, if the parkade foundations extended right to the edge of the property there would effectively be no off-set between the foundations and the walls of trench.

Based on our experience with the limestone in the area, as well as the generally good quality of the rock, it is not expected that the foundation loading would cause a stress-related failure of the rock mass. A more common stability mechanism, however, would be jointing within the rock mass that creates the possibility of sliding wedges or blocks which could fail, potentially impacting the foundation. If this were the case, then these wedges or blocks could require additional support such as bolts, dowels, anchors, dentition buttresses, etc. to preserve the condition of the rock face. The limestone bedrock in the area typically has a set of near-horizontal joints combined with two orthogonal sets of near-vertical joints. These combine to form a “blocky” structure which is relatively stable and does not normally have widespread joint sets which pose a major stability problem. It is possible, however, that localized joints or loose blocks and wedges could require additional support.

For the purposes of the preliminary design, it is suggested that it can be assumed that this is not a significant problem, though additional on-site review should be completed once the initial layout of the foundations is determined. This review would require access to the OLRT right-of-way to review the existing rock face on the west side of the trench. Final confirmation of any remedial measures (if required at all) can only be made once the excavation to widen the trench has been completed and the freshly excavated rock face can be observed, and so any localized remedial work would need to be incorporated into the widening at the time of the excavation.

It should also be noted that building up to the right-of-way line will also reduce any access to the structure from outside the right-of-way, which may have future maintenance impacts. If the structure is set back slightly to allow for some level of access to the area above the trench, then it will further reduce the possibility that any remedial work would be required during excavation of the west side of the right-of-way.

5.4.3 Static Lateral Earth Pressures

The lateral earth pressures acting on below-grade portions of the structure will depend on the type and method of placement of the backfill materials, the nature of the soils behind the backfill, the magnitude of surcharge including construction loadings, the freedom of lateral movement of the structure, and the drainage conditions behind the walls.

The following recommendations are made concerning the design of the walls:

- Select, free draining granular fill meeting the specifications and compaction as discussed in Section 5.7 should be used as backfill behind the walls. Longitudinal drains or weep holes should be installed to provide positive drainage of the granular backfill.
- A minimum compaction surcharge of 12 kPa should be included in the lateral earth pressures for the structural design of the walls. Care must be taken during the compaction operation not to overstress the wall. Heavy construction equipment should be maintained at a distance of at least 1 m away from the walls while the backfill soils are being placed. Hand-operated compaction equipment should be used to compact the backfill soils within a 1 m wide zone adjacent to the walls. Other surcharge loadings should be accounted for in the design, as required.

The following values in the table below provide preliminary guidelines for the lateral earth pressures for static (i.e., not earthquake) loading conditions for planning purposes. These lateral earth pressure coefficients assume that the ground above the wall will be flat, not sloping. If the inclination of the slope above the wall changes, new lateral earth pressures will need to be calculated (or the soil above the wall treated as a surcharge).

Material	Granular A and Granular B Type II	Granular B Type I, Earth Fill and SSM
Soil Unit Weight:	21 to 22 kN/m^3	20 kN/m3
Coefficients of static lateral earth pressure: Active, K_a At rest, K_o Passive, K_P	 0.27 0.43 3.70	 0.33 0.50 3.00

The following values in the table below provide guidelines for the dynamic lateral earth pressures for earthquake loading conditions for planning purposes. These lateral earth pressure coefficients assume that the ground above the wall will be flat, not sloping. If the inclination of the slope above the wall changes, new lateral earth pressures will need to be calculated.

Material	Granular A and Granular B Type II	Granular B Type I, Earth Fill and SSM
Soil Unit Weight:	21 to 22 kN/m^3	20 kN/m3
Coefficients of lateral earth pressures during earthquake loading: Active, K_{ae} (Non-Yielding) Active, K_{ae} (Yielding) Passive, K_{Pe} (Non-Yielding) Passive, K_{Pe} (Yielding)	 0.41 0.34 3.66 3.68	 0.49 0.41 2.94 2.97

- If the wall allows lateral yielding, active earth pressures may be used in the geotechnical design of the structure. The movement to allow active pressures to develop within the backfill, and thereby assume an unrestrained structure, may be taken as:
  - Rotation of approximately 0.002 about the base of a vertical wall (where the rotation is calculated as the horizontal displacement divided by the height of the wall);
  - Horizontal translation of 0.001 times the height of the wall; or,
  - A combination of both.
- If the wall does not allow lateral yielding (i.e., restrained structure where the rotational or horizontal movement is not sufficient to mobilize an active earth pressure condition), at-rest earth pressures (plus any compaction surcharge) should be assumed for geotechnical design.

5.5 Slab on grade

If a slab on grade construction is used for the new structure, then any existing organic matter, and any wet or disturbed material should be removed from within the proposed footprint to provide more predictable performance of the new floor slab. Portions of the existing fill at this site could remain below the new floor slab, provided that the surface of the fill at subgrade level is proof rolled to expose soft or weak areas in the presence of geotechnical personnel. Any soft or weak areas should be excavated and replaced with engineered fill or additional granular base. Provision should be made for at least 150 mm of S.P. F-3147 Granular A to form the base for the floor slab. Any engineered fill required to raise the grade to the underside of the Granular A, including the repair of weak or soft areas, should consist of S.P. F-3147 Granular B Type II. The underslab fill should be placed in maximum 300 mm thick lifts and should be compacted to at least 100% of the material's SPMDD using suitable vibratory compaction equipment.

The modulus of subgrade reaction for a slab-on-grade construction can be taken as 35 MPa/m where founded on granular materials and 150 MPa/m where founded on competent bedrock. These values should be confirmed by Golder during detailed design based on the actual foundation details and loading.

Groundwater elevations at the time of the investigation were generally found to be below the depth of the proposed lower floor slab, though the levels measured in the investigation are unlikely to be the highest groundwater levels which will exist over the life of the structure. It is recommended that the floor slab be provided with nominal sub-floor drainage to accommodate unforeseen higher groundwater elevations. These drains could consist of typical perforated pipe encased in clear stone, wrapped in a non-woven geotextile at regular intervals. For preliminary design it can be assumed that 6 m spacing would be sufficient for the drains. All drains should be provided with positive drainage to a discharge point.

5.6 Frost Protection

All perimeter and exterior foundation elements or interior foundation elements in unheated areas should be provided with a minimum of 1.5 m of earth cover for frost protection purposes. Isolated, unheated exterior footings/pile caps adjacent to surfaces which are cleared of snow cover during winter months should be provided with a minimum of 1.8 m of earth cover.

Insulation of the bearing surface with high density polystyrene rigid foam insulation could be considered as an alternative to earth cover for frost protection. Additional guidance on insulation details can be provided if and when required.

Sound limestone bedrock is not typically considered to be frost-susceptible provided it does not contain pervasive joints or seams of frost-susceptible soil. For the purposes of preliminary design, it can be assumed that foundations placed on bedrock with proper drainage do not require frost protection. This assumption, however, must be confirmed during construction. This is typically done by drilling a series of shallow holes into the rock within the foundation footprints and observing the condition of the rock to confirm these seems or joints are not present.

5.7 Foundation Wall Backfill

The fill materials and natural silty clay at this site are considered frost susceptible and should not be used as backfill against exterior, unheated, or well insulated foundation elements. To avoid problems with frost adhesion and heaving, the foundation walls, trenches and excavations should be backfilled with non-frost susceptible sand or sand and gravel conforming to the requirements for S.P. F-3147 Granular B Type I or II.

To avoid ground settlements around the foundations, which could affect site grading and drainage, all of the backfill materials should be placed in 300 mms lifts and be compacted to at least 95 % of the materials SPMDD.

In areas where pavements or other hard surfacing will abut the building, differential frost heaving could occur between the granular fill and other areas. To reduce this differential heaving, the backfill adjacent to the wall should be placed to form a frost taper. The frost taper should be brought up to pavement subgrade level from 1.5 m below finished exterior grade at a slope of 3H:1V, or flatter, away from the wall where hard surfaces which would be sensitive to differential heaving are present. The fill should be placed in maximum 300 mm thick lifts and should be compacted to at least 95 % of the material's SPMDD using suitable vibratory compaction equipment.

5.8 Site Servicing

Excavations for site servicing should be carried out per guidelines in Section 5.3.

Bedding for the service pipes, maintenance holes, or valve chamber structures may be placed on undisturbed native inorganic soil or the limestone bedrock. The existing fill is potentially compressible and is generally considered unsuitable for support of service pipes and structures. Therefore, the existing fill (where present) should be subexcavated and replaced up to the bottom of the bedding layer using engineered fill. Engineered fill, if required, should consist of either imported Granular B Type II (City of Ottawa SP F-3147) or materials previously excavated at the site (including pavement structure, inorganic sandy fill, or compactable glacial till) can potentially be re-used for this purpose. The suitability of re-using the existing fill and native soil would need to be confirmed at the time of construction by the geotechnical engineer. Re-use of excavated materials would also need to take into account soil quality considerations. Further discussion on soil quality and the potential for re-use of the existing fill is provided in the Phase II ESA report, which is provided under separate cover. Engineered fill (either imported or re-used on site) should be placed in maximum 300 mm thick lifts and compacted to at least 95% of the material's SPMDD using suitable vibratory compaction equipment. The engineered fill should extend down and away from the bottom of the bedding to the undisturbed native subgrade at a slope of 1 horizontal to 1 vertical. If this cannot be achieved due to space restrictions, the geotechnical engineer should be consulted to assess potential alternatives.

At least 150 mm of Granular A (OPSS.MUNI 1010) should be used as pipe bedding for sewer and water pipes. Where unavoidable disturbance to the subgrade surface occurs during construction, it may be necessary to place a sub-bedding layer consisting of 300 mm of compacted Granular B Type II (S.P. F-3147) beneath the Granular A. The bedding material should in all cases extend to the spring line of the pipe and should be compacted to at least 95% of the material's SPMDD. The use of clear crushed stone as a bedding layer should not be permitted anywhere on this project since fine particles from the sandy backfill materials and native soils could potentially migrate into the voids in the clear crushed stone and cause loss of lateral pipe support.

Where the trench will be covered with hard surfaced areas (e.g., pavements and sidewalks), the type of material placed in the frost zone (down to 1.8 m depth) should match the soil exposed on the trench walls for frost heave compatibility.

5.9 Trench Backfill

All trench backfill should conform to City of Ottawa specification SP F-2120.

Trench backfill above the pipe cover material may consist of approved excavated material such as the existing fill (provided that it is free of organic matter and other deleterious materials) and non-clayey native soils, where the service pipes will be overlain by pavements or other hard surfacing. The fill that contains organic matter or deleterious materials is not suitable for reuse as trench backfill and should be wasted upon excavation.

Imported backfill, if required, should consist of compactable and inorganic earth borrow (OPSS.MUNI 206/212) or Select Subgrade Material (SP F-3147).

Excavated bedrock may be acceptable as backfill for the lower portion of the trench, provided that the rock fill is broken/crushed to form a well-graded granular material. However, the reuse of such rock fill should be reviewed and approved by the geotechnical engineer at the time of construction once the grading of the material proposed for reuse can be determined. The rock fill should only be placed higher than at least 300 mm above the pipe to minimize the potential for damage due to impact or point load. The pieces of the rock fill used as trench backfill should be limited to a maximum of 300 mm in nominal size and the rock fill should be disseminated throughout (i.e., nests of large rock pieces should not be permitted).

It is important for frost heave compatibility that the trench backfill within the frost zone (i.e., between the pavement subgrade level and 1.8 metres depth below pavement grade) matches the soil exposed on the trench walls. Since the new sewers and watermains will be installed within an existing roadway, the trench backfill should match the existing subsoil including fill below the depth of the new pavement. This will require some separation of materials upon excavation. If shallow services are installed within the 1.8 metre frost zone, frost tapers should be used, as per OPSD 803.030 and 803.031.

All trench backfill should be placed in maximum 300 mm loose lifts and be uniformly compacted to at least 95 % of the material's SPMDD. Backfilling operations during cold weather should avoid inclusions of frozen lumps of material, snow, and ice.

If the construction schedule allows, delay between service installation/trench backfilling and final paving should be made to allow for settlement of the trench backfill material, which will reduce the magnitude of differential movement (i.e., sagging) of pavements placed over backfilled trenches.

5.10 Pavement Design

It is understood that new internal access roads and a roundabout will be required as part of the new development.

5.10.1 Profile Grade

It is anticipated that the proposed road profile (top of pavement) will require a grade raise of up to about 3 m. Because the site is underlain predominantly by granular soils and rock, no significant post-construction primary consolidation or secondary compression settlements of the subgrade soils are expected. Some settlement above the service trenches should be expected due to settlement of backfill; however, the magnitude of settlement should be within tolerable limits, provided that compaction of service trench backfill is carried out in accordance with the guidelines provided above.

5.10.2 Subgrade Preparation

The pavement subgrade will generally consist of the existing heterogenous fill. The subgrade may also include backfill in existing utility trenches and other previous excavations, as well as existing fill material or glacial till (where present at subgrade elevation).

Portions of the existing fill will need to be removed to accommodate the full depth of the new pavement structure. As a general guideline, in preparation for pavement construction, all deleterious material (i.e., loose, disturbed or contaminated soil, or soil containing organic material) should be removed from all pavement areas. It should generally be feasible to leave the existing inorganic fill in place beneath the pavement structure. Where this is the case, the subgrade should be proof rolled prior to the placement of new fill. The purpose of the proof rolling is to provide surficial densification of the existing inorganic fill and to locate any isolated areas of soft or loose soil, which would require subexcavation and replacement with suitable fill.

Sections requiring grade raising to the proposed subgrade level should be filled using acceptable (compactable and inorganic) earth borrow (OPSS.MUNI 206/212), Select Subgrade Material (OPSS.MUNI 1010) or additional granular base if grade changes are minor. All fill should be placed in maximum 300 mm thick lifts and should be compacted to at least 95 % of the material's Standard Proctor Maximum Dry Density (SPMDD) using suitable vibratory compaction equipment.

5.10.3 Pavement Drainage

The subgrade surface should be crowned or sloped to promote drainage of the roadway granular structure. Perforated pipe subdrains should be provided along the low sides of the roadway along the entire length. The geotextile should consist of a Class I nonwoven geotextile to OPSS 1860. The geotextile should have a maximum Apparent Opening Size A.O.S. of 212 µm. The subdrains should be connected to the catch basins such that the pavement structure will be positively drained and will intercept flows within the subbase. Subdrains should not be allowed to drain on the existing slope.

Backfilling of catch basin laterals located below subgrade level should be completed using acceptable native soils or fill which match the material types exposed on the lateral trench walls. This will reduce potential problems associated with differential frost heaving.

5.10.4 Granular Pavement Materials

Good drainage significantly improves the freeze-thaw resistance of the asphaltic concrete and decreases the frequency of transverse cracking, thereby extending the life of the pavement. The granular base for new construction should consist of Granular A (S.P. F-3147).

Based on the results of the subsurface investigation, the existing fill within the project limits would generally not meet the requirements for Granular A or Granular B Type II. As outlined in Section 5.11 the existing fill material could be re-used as general trench backfill or as subgrade material for pavements.

5.10.5 Pavement Design

Traffic data, along with the layout for the new proposed internal roadways were provided by Parsons in an email dated July 19, 2021. Based on the data provided, the design for the roadways were subdivided into three categories:

- Parking Areas

- Local Routes (which will not be subjected to Bus Traffic or Heavy Truck Traffic)
  - The local routes were also evaluated using the traffic data using the highest AADT value of 2,575 with an assumed 1% Growth Rate and 2% Commercial to confirm structural capacity.
- Collector/Bus Routes

5.10.5.1 Parking Areas

The pavement structure for parking areas should be:

Pavement Component	Thickness (mm)
Asphaltic Concrete	50
S.P.F-3147 Granular A Base	150
S.P.F-3147 Granular B Type II Subbase	400

The composition of the asphaltic concrete pavement should be as follows:

- Superpave 12.5 mm Surface Course – One lift of 50 mm

The asphaltic concrete should meet the requirements of City of Ottawa specification F-3106. The Performance Graded Asphalt Cement (PGAC) should consist of PG 58-34 for Traffic Category B. For granular requirements, refer to Section 5.10.4.

5.10.5.2 Local Routes (No Buses)

The pavement structure for local and access roads, not exposed to bus or heavy truck traffic, should be:

Pavement Component	Thickness (mm)
Asphaltic Concrete	90
S.P.F-3147 Granular A Base	150
S.P.F-3147 Granular B Type II Subbase	400

The composition of the asphaltic concrete pavement should be as follows:

- Superpave 12.5 mm Surface Course – One lift of 40 mm
- Superpave 19.0 mm Binder Course – One lift of 50 mm

The asphaltic concrete should meet the requirements of City of Ottawa specification F-3106. The Performance Graded Asphalt Cement (PGAC) should consist of PG 58-34 for Traffic Category B. For granular requirements, refer to Section 5.10.4.

5.10.5.3 Collector Routes

The pavement structure for local and access roads, not exposed to bus or heavy truck traffic, should be:

Pavement Component	Thickness (mm)
Asphaltic Concrete	120
S.P.F-3147 Granular A Base	150
S.P.F-3147 Granular B Type II Subbase	400

The composition of the asphaltic concrete pavement should be as follows:

- Superpave 12.5 FC1 mm Surface Course – One lift of 50 mm*
- Superpave 19.0 mm Binder Course – One lift of 70 mm*

The asphaltic concrete should meet the requirements of City of Ottawa specification F-3106. The Performance Graded Asphalt Cement (PGAC) should consist of PG 64-34* for Traffic Category C. For granular requirements, refer to Section 5.10.4.

*Considering that the pavement within the roundabout will be prone to shoving and/or rutting, consideration should be given to the AC be “bumped up” to PGAC 70-34 for use in the Surface and Binder courses on the roundabout.

The above pavement designs assume that the trench backfill has been acceptably prepared (i.e., where the bottom of the excavation is free of organics, has been adequately compacted to the required density, and the subgrade surface is not disturbed by construction operations or precipitation).

5.10.6 Pavement Structure Compaction

Adequate compaction of the granular roadway materials will be essential to the continued acceptable performance of the roadway. Compaction should be carried out in conformance with procedures outlined in OPSS 501 “Construction Specification for Compacting” with compacted densities of the various materials being in accordance with Subsection 501.08.02 Method A. The granular base and subbase material should be uniformly compacted to at least 100 % of the Standard Proctor Maximum Dry Density (SPMDD) using suitable vibratory compaction equipment. Compaction of the asphaltic concrete should be carried out in accordance with OPSS 310, Table 10.

The placement and compaction of any engineered fill, as well as sewer and watermain bedding and backfill, should be inspected to ensure that the materials used conform to the specifications from both a grading and compaction viewpoint. In addition, compaction testing and sampling of the asphaltic concrete used on site should be carried out to make sure that the materials used, and level of compaction achieved, during construction meet the project requirements.

5.10.7 Joints, Tie-ins with Existing Pavements, Pavement Resurfacing

At intersections, the new pavement structure should be continued at least to the limits of construction or the end of the curb “return” (i.e., the start of the constant width portion of the side road). At these streets, the pavement should be milled back beyond the curb return an additional 300 mm to a depth of 40 mm to accept the surface course asphaltic concrete.

The pavement granular and subgrade level should be tapered between the new and existing pavements by using 10H:1V tapers up or down as required.

A tack coat should be provided on all and vertical and milled horizontal surfaces. The tack coat should consist of SS-1 emulsified asphalt diluted with an equal amount of water. The undiluted and emulsified asphalt shall be in conformance with OPSS 1103.

5.11 Reuse of Existing Soils

From a geotechnical perspective, the native glacial till (provided it has suitable water content to be compactable), may be reused on this project as backfill within service trenches, provided the materials are frost compatible. However, these materials are not likely be suitable for reuse as pavement structure base or subbase materials. The heterogeneous fill and buried topsoil encountered on site contains organic matter and debris, and therefore would also not be considered suitable for reuse as base and subbase material (but portions may be used for trench backfill and site grading if reviewed and approved during excavation).

Reclaimed asphalt pavement (RAP) and/or reclaimed concrete material (RCM) may be used on this project as granular material as stated in OPSS.MUNI 1010 “Material Specification for Aggregates – Base, Subbase, Select Subgrade and Backfill Material”.

Reclaimed asphalt pavement may be used in the asphaltic concrete mixes in accordance with OPSS.MUNI 1151.

5.12 Corrosion and Cement Type

Groundwater samples from boreholes 21-02, 21-05 and 21-10 were submitted to AGAT Laboratories for basic chemical analyses related to potential sulphate attack on buried concrete elements and potential corrosion of buried ferrous elements. The results of this testing are provided in Appendix D and are summarized in the following table.

Table 3: Results of Basic Chemical Testing

Borehole Number	Sample Type	Chloride (mg/L)	Sulphate (mg/L)	Electrical Conductivity (µS/cm)	pH	Resistivity (Ohm-cm)
21-02	Groundwater	3440	233	11300	7.70	88
21-05	Groundwater	5.45	436	1200	7.95	833
21-10	Groundwater	4.73	458	1460	7.53	-

The water-soluble sulphate (SO4) content in the tested samples was above 150 mg/L and below 1,500 mg/L. As such, concrete made with Moderate Sulfate Resistance (S-3) type cement should be acceptable for buried concrete elements.

Based on ASTM STP1013 (Chaker and Palmer, 1989), a soil with a resistivity of less than 2,000 Ohm-centimetre is considered very corrosive, a soil with a resistivity between 2,000 and 5,000 Ohm-centimetre is considered corrosive, and a soil with a resistivity between 5,000 and 10,000 Ohm-centimetre is considered moderately corrosive. Based on these parameters, the results of the resistivity testing also indicate an elevated potential for corrosion of exposed ferrous metal (e.g., steel, iron, etc.), which should be considered in the design of substructures. Corrosion protection systems or steel coatings may be required but should be selected by a structural engineer. The results also indicate a higher chloride content, which should be considered in the design of substructures.

6.0 ADDITIONAL CONSIDERATIONS

At the time of the writing of this report, only preliminary details for the proposed parkade were available. Golder Associates should be retained to review the final drawings and specifications for this project prior to construction to ensure that the guidelines in this report have been adequately interpreted.

All prepared subgrade surfaces for roadways, parking areas, floor slabs, foundations, etc. should be reviewed by geotechnical to ensure that they have been adequately prepared. The placing and compaction of any engineered fill should be inspected and tested to ensure that the materials used conform to the specifications from both a grading and compaction viewpoint.

It should also be noted that the soil samples retrieved as part of the geotechnical investigation are generally only maintained for a period of 3 months following issuance of the report.

Ontario Regulation 903 would ultimately require abandonment of the monitoring wells installed within the boreholes for this investigation; however, these devices may be useful during construction. It is therefore proposed that decommissioning of these devices be made part of the construction contract. Some of those devices may be useful during the initial stages of dewatering, to monitoring the progress of the groundwater level lowering.

7.0 CLOSURE

We trust this report satisfies your current requirements. If you have any questions regarding this report, please contact the undersigned.

Signature Page

Golder Associates Ltd.

Kim Macdonald, P.Eng.
Geotechnical Engineer

Chris Hendry, P.Eng.
Associate, Senior Geotechnical Engineer

KM/CH/hdw

https://golderassociates.sharepoint.com/sites/140130/project files/6 deliverables/geotechnical/1000 - ph 1 parkade/final/21451149 (1000) final geo-hydro phase 1 - 2021'07'22.docx

Attachments: Important Information and Limitations of This Report

GOLDER
MEMBER OF WSP

IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practicing under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client **Parsons Corporation.** The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder cannot be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then the client may authorize the use of this report for such purpose by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process, provided this report is not noted to be a draft or preliminary report, and is specifically relevant to the project for which the application is being made. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client cannot rely upon the electronic media versions of Golder's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder cannot be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Groundwater Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. **The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report.** The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

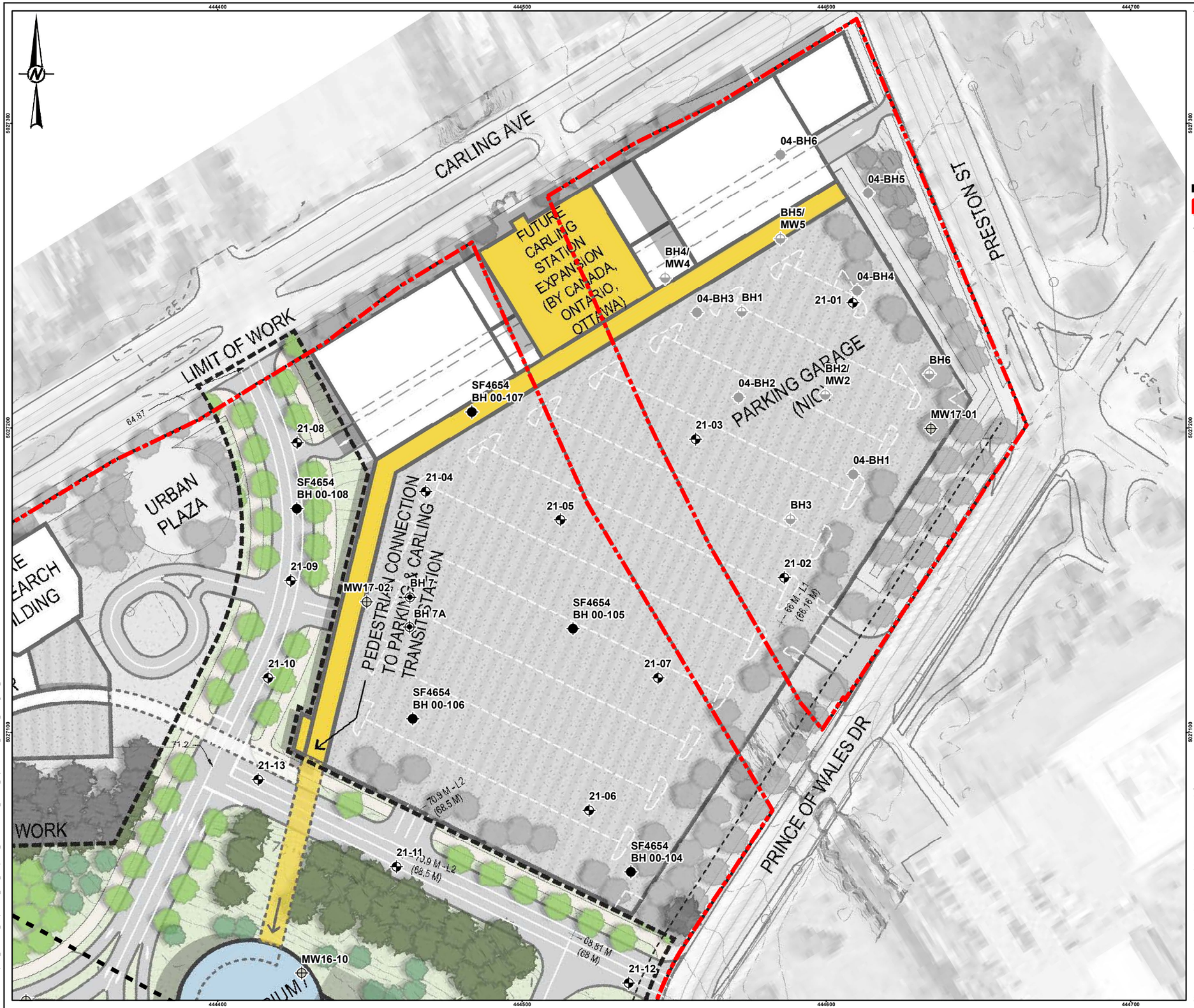
Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder's report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder's report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder's report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.



LEGEND

- APPROXIMATE BOREHOLE LOCATION
- PREVIOUS ENVIRONMENTAL BOREHOLE OR MONITORING WELL LOCATION (STANTEC, 2017)
- PREVIOUS ENVIRONMENTAL BOREHOLE OR MONITORING WELL LOCATION (INTERA, 2004 SUPP PHASE II)
- PREVIOUS ENVIRONMENTAL BOREHOLE OR MONITORING WELL LOCATION (INTERA, 2004 PHASE I/II)
- PREVIOUS ENVIRONMENTAL BOREHOLE OR MONITORING WELL LOCATION (PATERSON, 2017)
- HISTORICAL TESTHOLE LOCATION
- PATERSON REMEDIATION AREA
- STUDY AREA

REFERENCE(S)

1. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: MTM ZONE 9, VERTICAL DATUM: CGVD28

0 12.5 25 50

1:1,250 METRES

CLIENT
PARSONS INC.

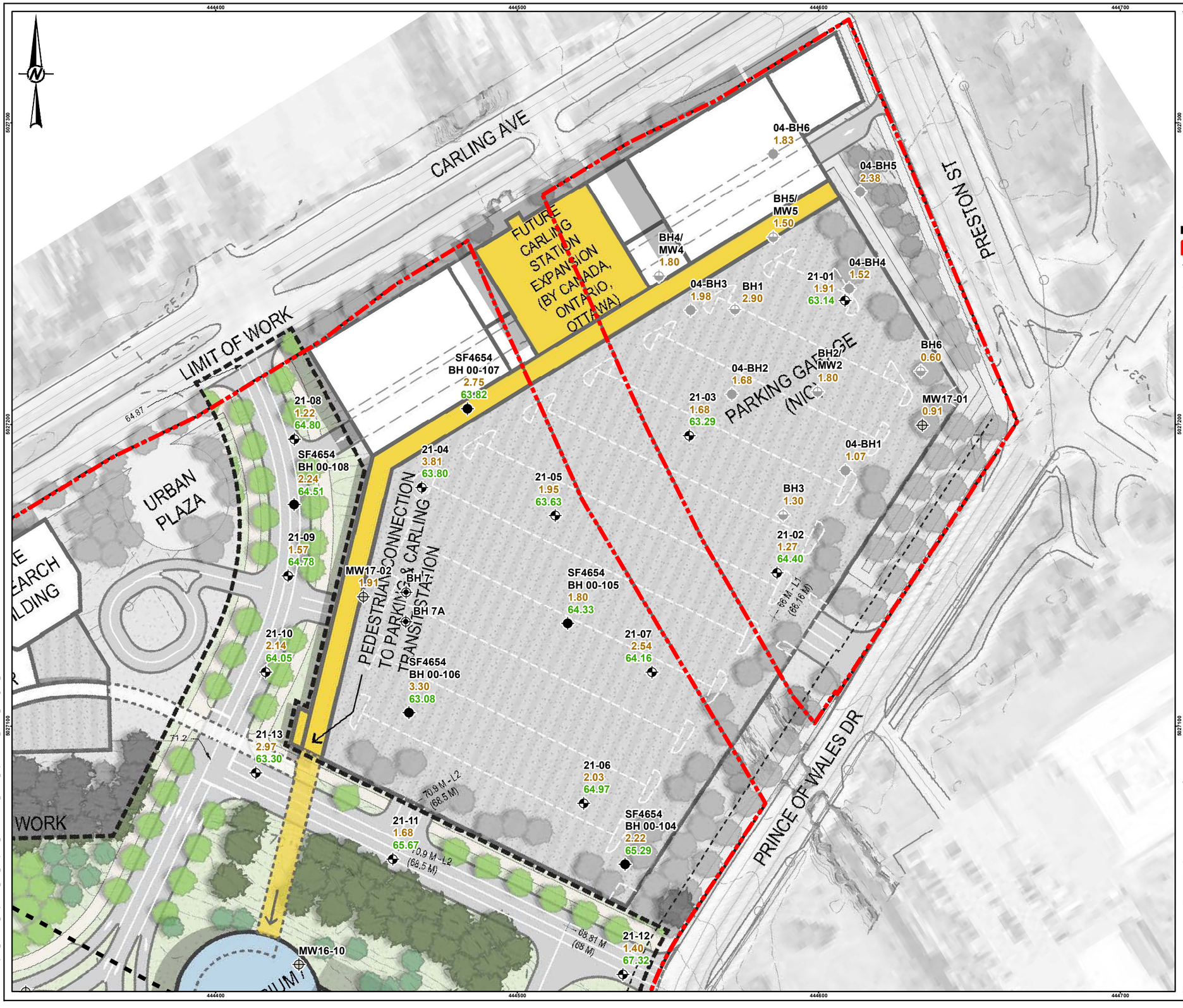
PROJECT
GEOTECHNICAL INVESTIGATION
OTTAWA HOSPITAL NEW CIVIC CAMPUS PARKADE

TITLE
SITE PLAN

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-07-23
DESIGNED	----
PREPARED	JEM
REVIEWED	KM
APPROVED	CH

PROJECT NO.	CONTROL	REV.	FIGURE
21451149	0003	0	**1-A**



LEGEND

- APPROXIMATE BOREHOLE LOCATION
- PREVIOUS ENVIRONMENTAL BOREHOLE OR MONITORING WELL LOCATION (STANTEC, 2017)
- PREVIOUS ENVIRONMENTAL BOREHOLE OR MONITORING WELL LOCATION (INTERA, 2004 SUPP PHASE II)
- PREVIOUS ENVIRONMENTAL BOREHOLE OR MONITORING WELL LOCATION (INTERA, 2004 PHASE I/II)
- PREVIOUS ENVIRONMENTAL BOREHOLE OR MONITORING WELL LOCATION (PATERSON, 2017)
- HISTORICAL TESTHOLE LOCATION
- 2.5 DEPTH TO BEDROCK, mbgs
- 99.99 BEDROCK SURFACE ELEVATION, mASL
- PATERSON REMEDIATION AREA
- STUDY AREA

REFERENCE(S)

1. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: MTM ZONE 9, VERTICAL DATUM: CGVD28

0 12.5 25 50
1:1,250 METRES

CLIENT
PARSONS INC.

PROJECT
GEOTECHNICAL INVESTIGATION
OTTAWA HOSPITAL NEW CIVIC CAMPUS PARKADE

TITLE
NEW OTTAWA HOSPITAL - PARKADE STRUCTURE, BEDROCK SURFACE DEPTH AND ELEVATION

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-07-23
DESIGNED	---
PREPARED	JEM
REVIEWED	KM
APPROVED	CH

PROJECT NO.	CONTROL	REV.	FIGURE
21451149	0003	0	**1-B**

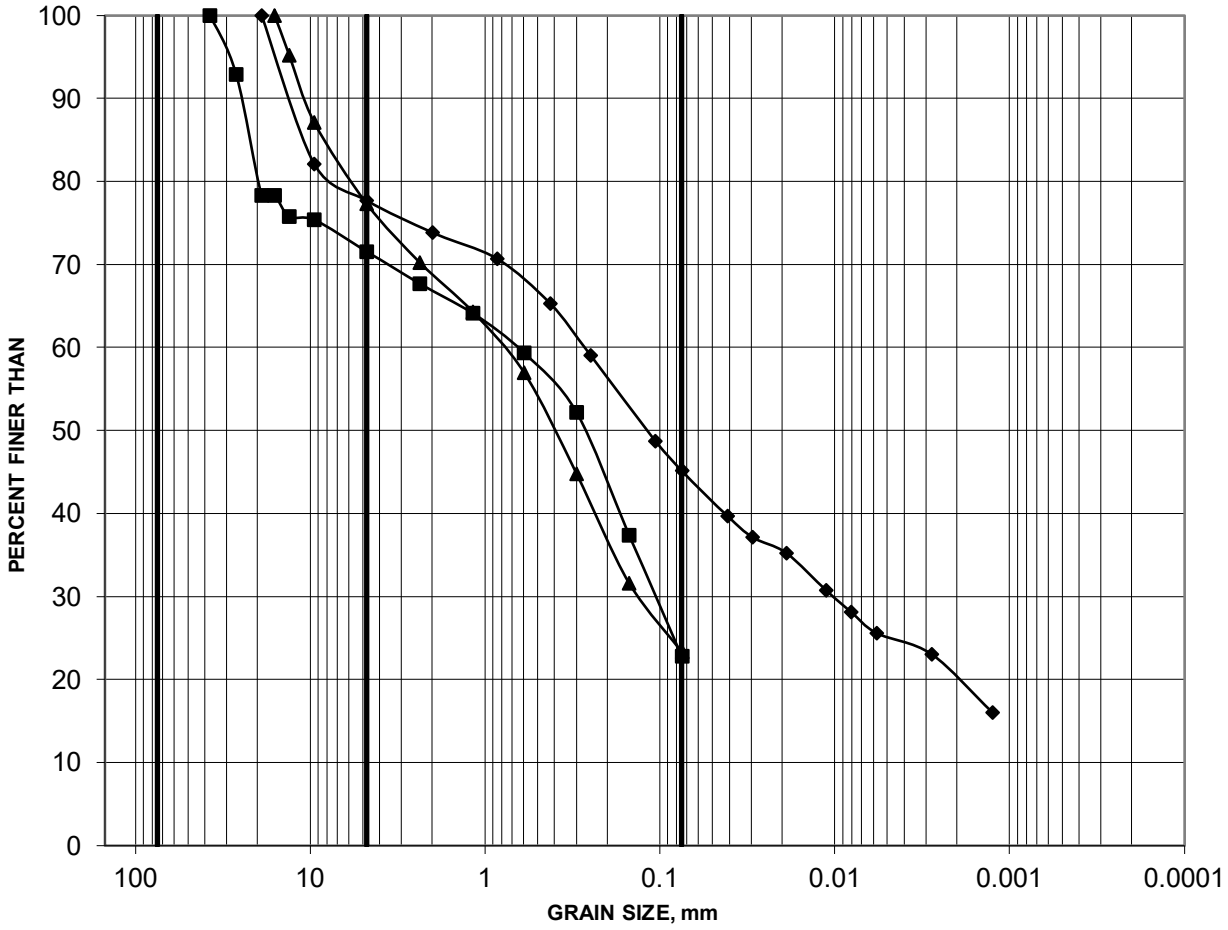
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM:
25mm
0

Path: N:\Active\Spatial_IM\Ottawa_Hospital\New_Civic_Campus\99_PROJ\21451149_Parsons_Expansion\0003_Geotech_Investigation_Parkade\21451149-0003-BG-0002.mxd

GRAIN SIZE DISTRIBUTION

FIGURE 2

GRAVELLY SILTY SAND (FILL)



COBBLE SIZE	GRAVEL SIZE		SAND SIZE			SILT AND CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

	Borehole	Sample	Depth (m)	Constituents (%) Gravel	Sand	Silt	Clay
■	21-02	1	0.00-0.61	28	49		23
◆	21-05	2	0.76-1.17	22	33	25	20
▲	21-09	2	0.76-1.37	23	54		23

Project: 21451149/1000

GOLDER
MEMBER OF WSP

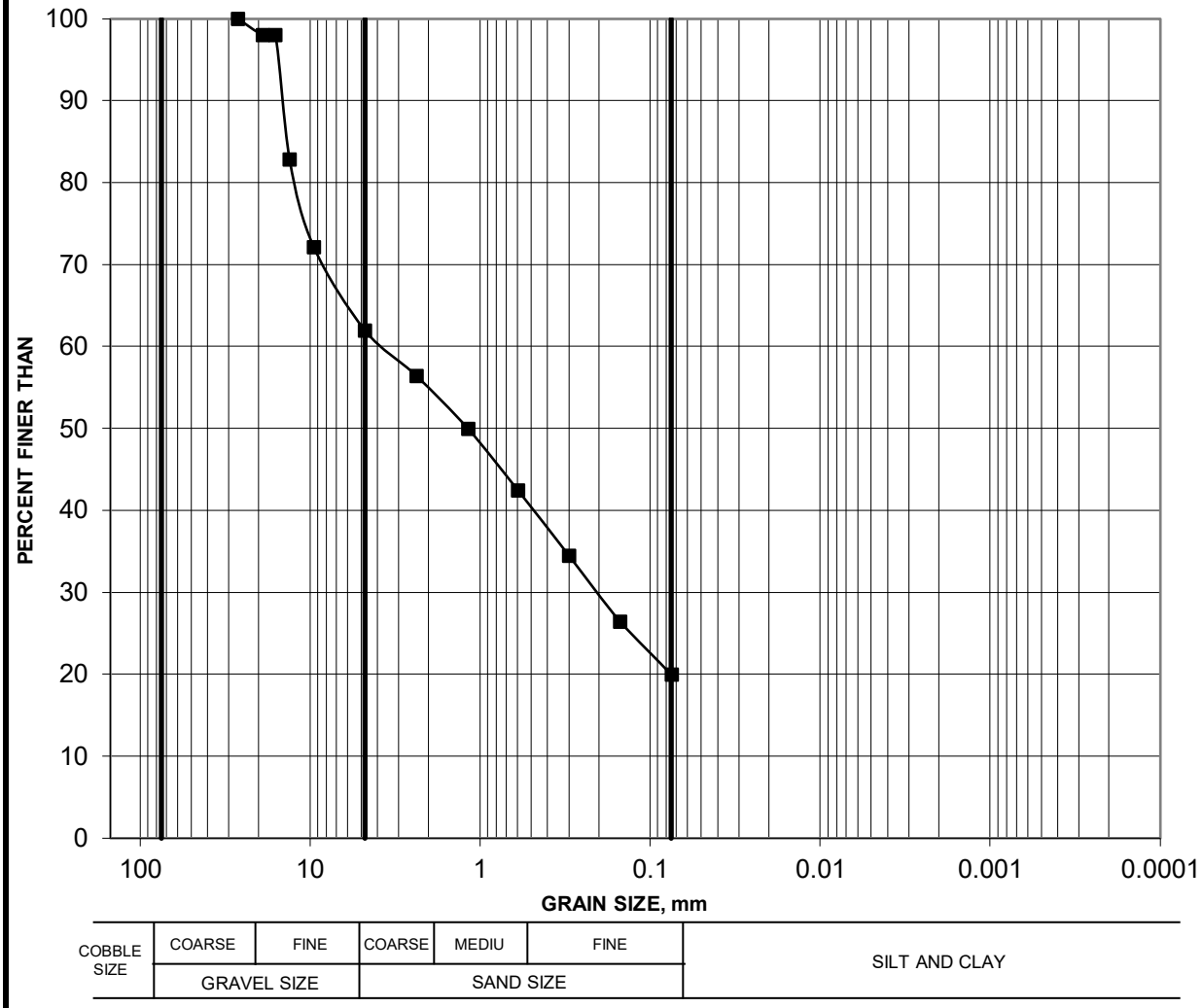
Created by: CW
Checked by: MI

https://golderassociates.sharepoint.com/sites/35409g/Shared Documents/Active/2021/21451149/figures/

GRAIN SIZE DISTRIBUTION

FIGURE 3

GRAVEL AND SAND (FILL)



				Constituents (%)			
	Borehole	Sample	Depth (m)	Gravel	Sand	Silt	Clay
—■—	21-04	4	2.29-2.90	38	42	20	

Project: 21451149/1000

GOLDER
MEMBER OF WSP

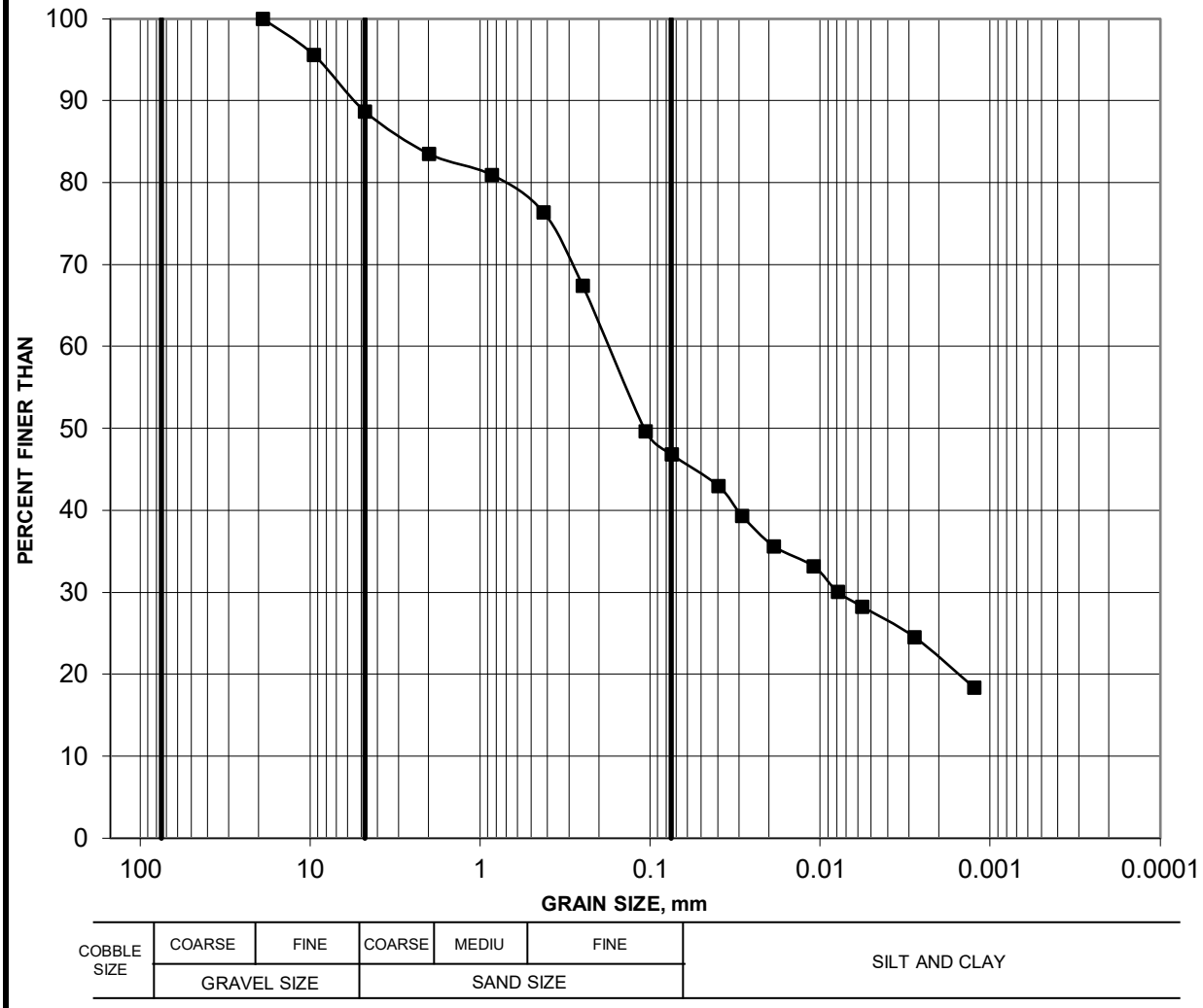
Created by: CW

Checked by: MI

GRAIN SIZE DISTRIBUTION

FIGURE 4

SILTY SAND (FILL)



	Borehole	Sample	Depth (m)	Constituents (%) Gravel	Sand	Silt	Clay
—■—	21-06	3	1.52-1.96	11	42	25	22

Project: 21451149/1000

GOLDER
MEMBER OF WSP

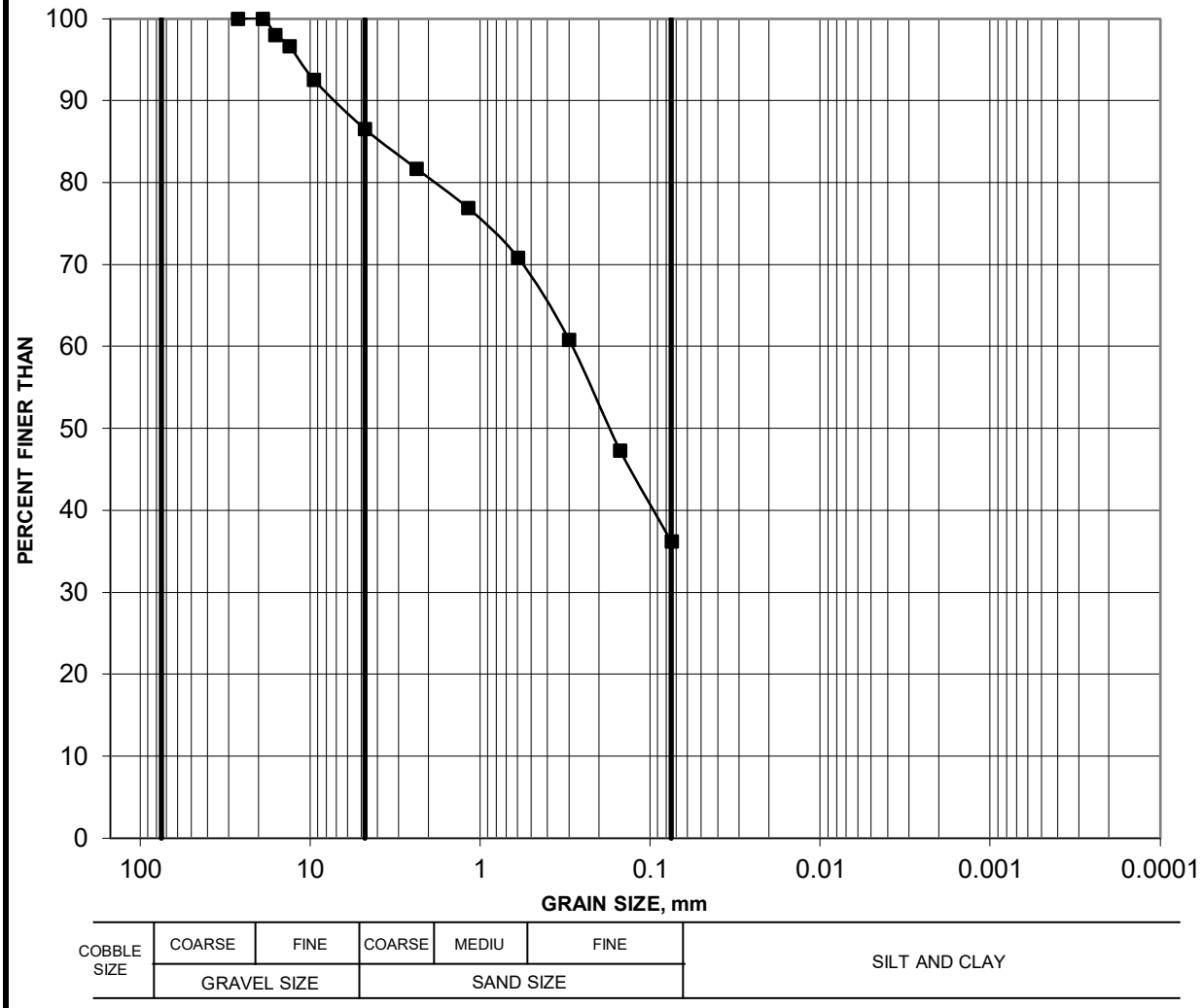
Created by: CW

Checked by: MI

GRAIN SIZE DISTRIBUTION

FIGURE 5

GLACIAL TILL



	Borehole	Sample	Depth (m)	Constituents (%) Gravel	Sand	Silt	Clay
—■—	21-13	2	0.76-1.37	13	51	36	

Project: 21451149/1000

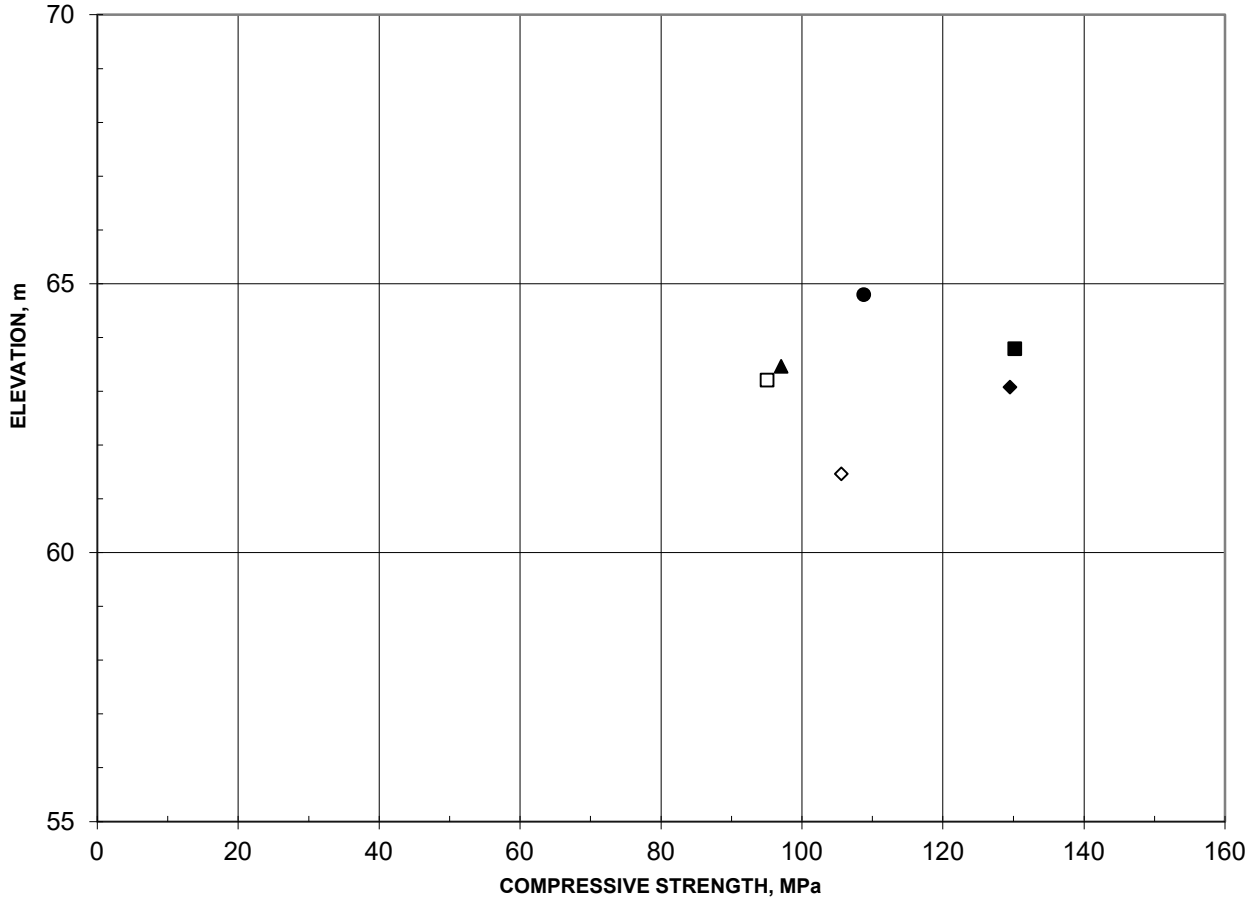
GOLDER
MEMBER OF WSP

Created by: CW

Checked by: MI

ASTM D7012 - Method C
UNCONFINED COMPRESSIVE STRENGTH OF ROCK CORE
SUMMARY OF LABORATORY TEST RESULTS

FIGURE 6



Borehole	Depth (m)	L/D	Bulk Density (kg/m^3)	Lithology	UCS (MPa)	Failure Type
BH21-02 RC1	1.9	2.3	2693	Limestone	130	1
BH21-03 RC1	1.9	2.3	2698	Limestone	130	1
BH21-05 RC1	2.1	2.3	2684	Limestone	97	1
BH21-06 RC1	2.2	2.3	2697	Limestone	109	1
BH21-07 RC1	3.5	2.4	2704	Limestone	95	1
BH21-07 RC2	5.2	2.4	2715	Limestone	106	1

Notes:

Failure Types

1. Well formed cones on both ends

Remarks

- Cores tested in vertical direction.
- Cores tested in air-dry condition.
- Time to failure > 2 and < 15 minutes.

Project: 21451149

GOLDER
MEMBER OF WSP

Tested by: CW
Checked by: MI

https://golderassociates.sharepoint.com/sites/35409g/Shared Documents/Active/2021/21451149/figures/

APPENDIX A

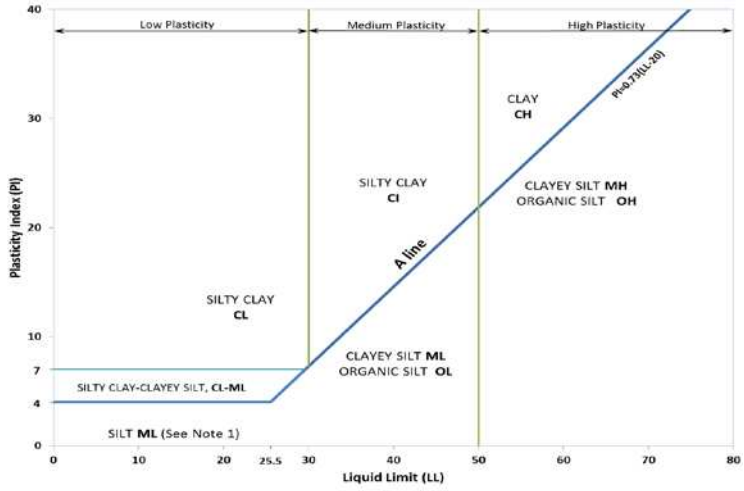
Record of Borehole Logs, Current Investigation Method of Soil Classification and Terms Lithological and Geotechnical Rock Description Terminology

METHOD OF SOIL CLASSIFICATION

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$	$Cc = \frac{(D_{30})^2}{D_{10} x D_{60}}$	Organic Content	USCS Group Symbol	Group Name
INORGANIC (Organic Content ≤30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Gravels with ≤12% fines (by mass)	Poorly Graded	<4	≤1 or ≥3	≤30%	GP	GRAVEL
				Well Graded	≥4	1 to 3		GW	GRAVEL
			Gravels with >12% fines (by mass)	Below A Line	n/a			GM	SILTY GRAVEL
				Above A Line	n/a			GC	CLAYEY GRAVEL
		SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	Sands with ≤12% fines (by mass)	Poorly Graded	<6	≤1 or ≥3		SP	SAND
				Well Graded	≥6	1 to 3		SW	SAND
			Sands with >12% fines (by mass)	Below A Line	n/a			SM	SILTY SAND
				Above A Line	n/a			SC	CLAYEY SAND

Organic or Inorganic	Soil Group	Type of Soil	Laboratory Tests	Field Indicators					Organic Content	USCS Group Symbol	Primary Name
				Dilatancy	Dry Strength	Shine Test	Thread Diameter	Toughness (of 3 mm thread)			
INORGANIC (Organic Content ≤30% by mass)	FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm)	SILTS (Non-Plastic or PI and LL plot below A-Line on Plasticity Chart below)	Liquid Limit <50	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT
				Slow	None to Low	Dull	3mm to 6 mm	None to low	<5%	ML	CLAYEY SILT
				Slow to very slow	Low to medium	Dull to slight	3mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT
			Liquid Limit ≥50	Slow to very slow	Low to medium	Slight	3mm to 6 mm	Low to medium	<5%	MH	CLAYEY SILT
				None	Medium to high	Dull to slight	1 mm to 3 mm	Medium to high	5% to 30%	OH	ORGANIC SILT
		CLAYS (PI and LL plot above A-Line on Plasticity Chart below)	Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0% to 30% **(see Note 2)**	CL	SILTY CLAY
			Liquid Limit 30 to 50	None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium		CI	SILTY CLAY
			Liquid Limit ≥50	None	High	Shiny	<1 mm	High		CH	CLAY
HIGHLY ORGANIC SOILS (Organic Content >30% by mass)		Peat and mineral soil mixtures							30% to 75%	PT	SILTY PEAT, SANDY PEAT
		Predominantly peat, may contain some mineral soil, fibrous or amorphous peat							75% to 100%		PEAT



Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.
Note 2 – For soils with <5% organic content, include the descriptor "trace organics" for soils with between 5% and 30% organic content include the prefix "organic" before the Primary name.

Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.
For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between "clean" and "dirty" sand or gravel.
For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.
A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to indicate a range of similar soil types within a stratum.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (*i.e.,* SAND and GRAVEL)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample

SOIL TESTS

w	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests anisotropically consolidated prior to shear are shown as CAD, CAU.

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[2]

Term	SPT 'N' (blows/0.3m)[1]
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

1. SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.
2. Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grainsize. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N'[1,2] (blows/0.3m)
Very Soft	<12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation
w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
NP	non-plastic
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan δ
c′	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERINGS STATE

Fresh: no visible sign of rock material weathering.

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	Less than 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: * Grains greater than 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)
The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)
The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)
The percentage of solid drill core, greater than 100 mm length, as measured along the centerline axis of the core, relative to the length of the total core run. RQD varies from 0% for completely broken core to 100% for core in solid segments.

DISCONTINUITY DATA

Fracture Index
A count of the number of naturally occuring discontinuities (physical separations) in the rock core. Mechanically induced breaks caused by drilling are not included.

Dip with Respect to Core Axis
The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90^{o} angle is horizontal.

Description and Notes
An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

JN	Joint	PL	Planar
FLT	Fault	CU	Curved
SH	Shear	UN	Undulating
VN	Vein	IR	Irregular
FR	Fracture	K	Slickensided
SY	Stylolite	PO	Polished
BD	Bedding	SM	Smooth
FO	Foliation	SR	Slightly Rough
CO	Contact	RO	Rough
AXJ	Axial Joint	VR	Very Rough
KV	Karstic Void		
MB	Mechanical Break		

PROJECT: 21451149

RECORD OF BOREHOLE: 21-01

SHEET 1 OF 1

LOCATION: N 5028807.8 ;E 366831.0

BORING DATE: June 11, 2021

DATUM: NAD 1983

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ ND = Not Detected (20 40 60 80) / HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ ND = Not Detected (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp — W — Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		65.05							
0	Power Auger 200 mm Diam. (Hollow Stem)	ASPHALTIC CONCRETE		0.05							Flush Mount Casing
		FILL - (SW/GW) gravelly SAND to sandy GRAVEL, angular; grey (PAVEMENT STRUCTURE)		64.44	1	SS	14	ND			Backfill; Bentonite Seal
		FILL - (SW) gravelly SILTY SAND; dark brown to brown; non-cohesive, moist to wet, compact		0.61							Silica Sand
1				63.85	2	SS	18		105		
		FILL - Wood; brown; non-cohesive, moist		1.20							52 mm Diam. PVC #10 Slot Screen
				1.30							
		FILL/WASTE - (SM) gravelly SILTY SAND; dark brown to black, contains asphalt; non-cohesive, moist, compact		1.45							
				63.37	3	SS	>50				
		FILL - (SM) gravelly SILTY SAND; brown, with black staining; non-cohesive, moist to wet, compact		1.68							
				63.14							Cave
2		FILL - (GW) sandy GRAVEL; grey; non-cohesive, moist, very dense		1.91							
		End of Borehole Auger Refusal									
3											
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE
1 : 50

GOLDER

LOGGED: RI
CHECKED: KM

MIS-BHS 001 21451149.GPJ GAL-MIS.GDT 7/23/21

PROJECT: 21451149

RECORD OF BOREHOLE: 21-02

SHEET 1 OF 2

LOCATION: N 5028720.9 ;E 366811.1

BORING DATE: May 18, 2021

DATUM: NAD 1983

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ (ND = Not Detected) 20 40 60 80 / HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ (ND = Not Detected) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp W Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		65.67						
0	Power Auger 200 mm Diam. (Holow Stem)	TOPSOIL - (SM) SILTY SAND; dark brown, contains organic matter (rootlets); non-cohesive, moist loose		0.00	1	SS	9	⊕ ND	○	M
		FILL - (SM) gravelly SILTY SAND; dark brown, contains brick, ash, organic matter and silty clay layers; non-cohesive, moist, loose to compact		0.15						Bentontie Seal
1					2	SS	>50	□ ⊕ ND		
				64.40						
		Borehole continued on RECORD OF DRILLHOLE 21-02		1.27						
2										
3										
4										
5										
6										
7										
8										
9										
10										

DEPTH SCALE

1 : 50

GOLDER

LOGGED: RI

CHECKED: KM

MIS-BHS 001 21451149.GPJ GAL-MIS.GDT 7/23/21

PROJECT: 21451149

RECORD OF DRILLHOLE: 21-02

SHEET 2 OF 2

LOCATION: N 5028720.9 ;E 366811.1

DRILLING DATE: May 18, 2021

DATUM: NAD 1983

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75

DRILLING CONTRACTOR: Downing Drilling

JN - Joint; FLT - Fault; SHR- Shear; VN - Vein; CJ - Conjugate
BD - Bedding; FO- Foliation; CO- Contact; OR- Orthogonal; CL - Cleavage
PL - Planar; CU- Curved; UN- Undulating; ST - Stepped; IR - Irregular
PO- Polished; K - Slickensided; SM- Smooth; Ro - Rough; MB- Mechanical Break
BR - Broken Rock
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	
		BEDROCK SURFACE		64.40															
2	Rotary Drill NQ Core	Fresh, thinly to medium bedded, grey to dark grey, fine to medium grained, non-porous, medium strong SHALEY NODULAR LIMESTONE - Broken core from 1.44 m to 1.55 m		1.27	1	100													Bentontie Seal Silica Sand UCS = 130 MPa
3					2	100													32 mm Diam. PVC #10 Slot Screen
4																			
5					3	100													
6																			Silica Sand
7				58.38	4	100													
		End of Drillhole Note(s): 1. Water level in screen measured at 2.09 m (Elev. 63.59 m) on May 28, 2021		7.29															
8																			
9																			
10																			
11																			

DEPTH SCALE
1 : 50

GOLDER

LOGGED: RI
CHECKED: KM

MIS-RCK 004 21451149.GPJ GAL-MISS.GDT 7/23/21

PROJECT: 21451149

RECORD OF BOREHOLE: 21-03

SHEET 1 OF 2

LOCATION: N 5028765.9 ;E 366781.2

BORING DATE: May 18, 2021

DATUM: NAD 1983

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ (ND = Not Detected) 20 40 60 80 / HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ (ND = Not Detected) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp W Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		64.97						
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (SM) SILTY SAND, trace gravel; dark brown, contains organic matter (rootlets); non-cohesive, moist, loose		0.00 64.72	1	SS	5	□ ND ⊕		
				0.25						
1		FILL - (SM) SILTY SAND, trace gravel; dark brown to grey brown, contains organic matter and brick fragments; non-cohesive, moist, compact			2	SS	10	□ ND ⊕		Bentontie Seal
				63.45						
		(SM) gravelly SILTY SAND; grey brown (GLACIAL TILL); non-cohesive, moist, compact		1.52	3	SS	>50	⊕ ND		
				1.68						
2		Borehole continued on RECORD OF DRILLHOLE 21-03								
3										
4										
5										
6										
7										
8										
9										
10										

DEPTH SCALE

1 : 50

GOLDER

LOGGED: RI

CHECKED: KM

MIS-BHS 001 21451149.GPJ GAL-MIS.GDT 7/23/21

PROJECT: 21451149

RECORD OF DRILLHOLE: 21-03

SHEET 2 OF 2

LOCATION: N 5028765.9 ;E 366781.2

DRILLING DATE: May 18, 2021

DATUM: NAD 1983

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75

DRILLING CONTRACTOR: Downing Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate | BD - Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage | PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular | PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break | BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	
		BEDROCK SURFACE		63.29															
2	Rotary Drill, NQ Core	Fresh, thinly to medium bedded, grey to dark grey, fine to medium grained, non-porous, medium strong SHALEY NODULAR LIMESTONE - Broken core from 2.05 m to 2.07 m		1.68	1	100													Bentontie Seal UCS = 130 MPa Silica Sand
3					2	100													
4		- Broken core from 3.57 m to 3.58 m																	32 mm Diam. PVC #10 Slot Screen
5		- Broken core from 4.64 m to 4.66 m			3	100													
				59.66															
6		End of Drillhole Note(s): 1. Water level in screen measured at 2.59 m (Elev. 62.38 m) on May 28, 2021 2. Water level in screen measured at 2.67 m (Elev. 62.30 m) on June 23, 2021		5.31															
7																			
8																			
9																			
10																			
11																			

DEPTH SCALE

1 : 50

GOLDER

LOGGED: RI

CHECKED: KM

PROJECT: 21451149

RECORD OF BOREHOLE: 21-04

SHEET 1 OF 1

LOCATION: N 5028747.0 ;E 366692.9

BORING DATE: May 13, 2021

DATUM: NAD 1983

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ (ND = Not Detected) 20 40 60 80	HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ (ND = Not Detected) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3}	WATER CONTENT PERCENT Wp W Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		67.61									
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (ML) sandy SILT; dark brown, contains organic matter (rootlets); non-cohesive, moist, very loose		0.00									
				67.31	1	SS	5	⊕ ND	□				
		FILL - (CL/CI) SILTY CLAY, trace to some sand, trace gravel; grey brown, contains concrete fragments and organic matter; cohesive, w>PL, firm		0.30									
1					2	SS	6	⊕ ND	□		○		
					3	SS	5	⊕ ND	□				
2				65.32									
		FILL - (SM/ SP/GP) SILTY GRAVEL and SAND; dark brown, contains concrete, brick and wood fragments; non-cohesive, moist to wet, compact to very loose		2.29	4	SS	18	⊕ ND	□		○	M	
3					5	SS	1	⊕	□				
				63.80	6	SS	>50	⊕	□				
4		End of Borehole Auger Refusal		3.81									
5													
6													
7													
8													
9													
10													

DEPTH SCALE
1 : 50

GOLDER

LOGGED: RI
CHECKED: KM

MIS-BHS 001 21451149.GPJ GAL-MIS.GDT 7/23/21

PROJECT: 21451149

RECORD OF BOREHOLE: 21-05

SHEET 1 OF 2

LOCATION: N 5028738.6 ;E 366737.3

BORING DATE: May 14, 2021

DATUM: NAD 1983

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ (ND = Not Detected) 20 40 60 80 / HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ (ND = Not Detected) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp W Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		65.58						
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (ML/SM) SILTY SAND to sandy SILT, trace gravel; dark brown, contains brick fragments and organic matter (rootlets); non-cohesive, moist, loose		0.00 65.35 0.23	1	SS	12	⊕ □		
1		FILL - (SM/SP) gravelly SILTY SAND, some low-plastisity fines; dark brown, contains concrete, carpet and organic matter (rootlets); non-cohesive, moist, compact to loose		64.34	2	SS	>55	□ ⊕	○	MH
	Rotary Drill NQ Core	CONCRETE		1.24 63.79	1	RC	DD			
2		FILL - (SM) gravelly SILTY SAND; brown; non-cohesive, moist to wet		1.79 1.95						
		Borehole continued on RECORD OF DRILLHOLE 21-05								

Bentonite Seal

Bentonite Seal

3 4 5 6 7 8 9 10

DEPTH SCALE

1 : 50

GOLDER

LOGGED: RI

CHECKED: KM

MIS-BHS 001 21451149.GPJ GAL-MIS.GDT 7/23/21

PROJECT: 21451149

RECORD OF DRILLHOLE: 21-05

SHEET 2 OF 2

LOCATION: N 5028738.6 ;E 366737.3

DRILLING DATE: May 14, 2021

DATUM: NAD 1983

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75

DRILLING CONTRACTOR: Downing Drilling

JN - Joint; FLT - Fault; SHR- Shear; VN - Vein; CJ - Conjugate
BD - Bedding; FO- Foliation; CO- Contact; OR- Orthogonal; CL - Cleavage
PL - Planar; CU- Curved; UN- Undulating; ST - Stepped; IR - Irregular
PO- Polished; K - Slickensided; SM- Smooth; Ro - Rough; MB- Mechanical Break
BR - Broken Rock
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	
		BEDROCK SURFACE		63.63															
2	Rotary Drill / NQ Core	Fresh, thinly to medium bedded, grey to dark brey, fine to medium grained, non-porous, mediuum strong SHALEY NODULAR LIMESTONE		1.95															UCS = 97 MPa
3					2	0													Bentonite Seal
4					3	0-25													Silica Sand
5																			
6					4	0-25													38 mm Diam. PVC #10 Slot Screen
7				58.64															
		End of Drillhole		6.94															
		Note(s):																	
		1. Water level in screen measured at 2.72 m (Elev. 62.86 m) on May 28, 2021																	
		2. Water level in screen measured at 2.73 m (Elev. 62.85 m) on June 2, 2021																	
8																			
9																			
10																			
11																			

DEPTH SCALE

1 : 50

GOLDER

LOGGED: RI

CHECKED: KM

MIS-RCK 004 21451149.GPJ GAL-MISS.GDT 7/23/21

PROJECT: 21451149

RECORD OF BOREHOLE: 21-06

SHEET 1 OF 2

LOCATION: N 5028643.3 ;E 366748.4

BORING DATE: May 12, 2021

DATUM: NAD 1983

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ (ND = Not Detected) 20 40 60 80 / HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ (ND = Not Detected) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp W Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		67.00						
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (ML) sandy SILT, trace gravel; dark brown, contains organic matter (rootlets); non-cohesive, moist, loose		0.00						
				0.15	1	SS	11	□ ⊕ ND		Bentonite Seal
1		FILL - (ML/SM) SILTY SAND to sandy SILT, some low-medium plasticity fines, trace gravel; brown to dark brown, with black staining, contains wood, organic matter (rootlets); non-cohesive, moist, compact			2	SS	14	□ ⊕		Backfill
					3	SS	15	⊕ ND	MH	Bentonite Seal
2				64.97						
		Borehole continued on RECORD OF DRILLHOLE 21-06		2.03						
3										
4										
5										
6										
7										
8										
9										
10										

DEPTH SCALE

1 : 50

GOLDER

LOGGED: RI

CHECKED: KM

MIS-BHS 001 21451149.GPJ GAL-MIS.GDT 7/23/21

PROJECT: 21451149

RECORD OF DRILLHOLE: 21-06

SHEET 2 OF 2

LOCATION: N 5028643.3 ;E 366748.4

DRILLING DATE: May 12, 2021

DATUM: NAD 1983

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75

DRILLING CONTRACTOR: Downing Drilling

JN - Joint; FLT - Fault; SHR- Shear; VN - Vein; CJ - Conjugate
BD - Bedding; FO- Foliation; CO- Contact; OR- Orthogonal; CL - Cleavage
PL - Planar; CU- Curved; UN- Undulating; ST - Stepped; IR - Irregular
PO- Polished; K - Slickensided; SM- Smooth; Ro - Rough; MB- Mechanical Break
BR - Broken Rock
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	
		BEDROCK SURFACE		64.97															
3	Rotary Drill / NQ Core	Fresh, thinly to medium bedded, grey to dark grey, fine to medium grained, non-porous, medium strong SHALEY NODULAR LIMESTONE		2.03	1	100													Bentonite Seal UCS = 109 MPa Silica Sand
					2	100													
4		- Broken core from 4.03 m to 4.04 m			3	100													38 mm Diam. PVC #10 Slot Screen
5				61.60															
		End of Drillhole Note(s): 1. Water level in screen measured at 1.19 m (Elev. 65.82 m) on May 27, 2021 2. Water level in screen measured at 2.70 m (Elev. 64.31 m) on June 23, 2021		5.40															

DEPTH SCALE
1 : 50

GOLDER

LOGGED: RI
CHECKED: KM

MIS-RCK 004 21451149.GPJ GAL-MISS.GDT 7/23/21

PROJECT: 21451149

RECORD OF BOREHOLE: 21-07

SHEET 1 OF 2

LOCATION: N 5028686.9 ;E 366770.2

BORING DATE: May 17, 2021

DATUM: NAD 1983

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ (ND = Not Detected) 20 40 60 80 / HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ (ND = Not Detected) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp W Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		66.70						
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (SM/ML) SILTY SAND to sandy SILT, trace gravel, trace clay; dark brown, contains organic matter (rootlets); non-cohesive, moist, loose		0.00 66.47						
		FILL - (SM) SILTY SAND, trace gravel, trace to some clay; dark brown to brown, contains ashr, organic matter, brick fragments, concrete fragments, silty clay layers and wood; non-cohesive, moist, loose to compact		0.23	1	SS	8	⊕ □	○	Bentonite Seal
1					2	SS	19	□ ⊕ ND	○	
					3	SS	>50	□ ⊕	○	64 mm Diam. VSP Pipe
2					4	SS	>50	□ ⊕ ND	○	
				64.16						
		Borehole continued on RECORD OF DRILLHOLE 21-07		2.54						
3										
4										
5										
6										
7										
8										
9										
10										

DEPTH SCALE
1 : 50

GOLDER

LOGGED: RI
CHECKED: KM

MIS-BHS 001 21451149.GPJ GAL-MIS.GDT 7/23/21

PROJECT: 21451149

RECORD OF DRILLHOLE: 21-07

SHEET 2 OF 2

LOCATION: N 5028686.9 ;E 366770.2

DRILLING DATE: May 17, 2021

DATUM: NAD 1983

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75

DRILLING CONTRACTOR: Downing Drilling

JN - Joint; FLT - Fault; SHR- Shear; VN - Vein; CJ - Conjugate
BD - Bedding; FO- Foliation; CO- Contact; OR- Orthogonal; CL - Cleavage
PL - Planar; CU- Curved; UN- Undulating; ST - Stepped; IR - Irregular
PO- Polished; K - Slickensided; SM- Smooth; Ro - Rough; MB- Mechanical Break
BR - Broken Rock
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	
		BEDROCK SURFACE		64.16															
3	Rotary Drill NQ Core	Fresh, thinly to medium bedded, grey to dark grey, fine to medium grained, non-porous, medium strong SHALEY NODULAR LIMESTONE - Lost core from 2.54 m to 2.64 m - Broken core from 3.08 m to 3.10 m		2.54	1	100													
4					2	100													UCS = 95 MPa
5					3	100													UCS = 106 MPa
6		- Broken core from 6.21 m to 6.23 m																	
7					4	100													64 mm Diam. VSP Pipe
8					5	100													
9																			
10					6	100													
				55.79															
11		End of Borehole		10.91															
12																			

DEPTH SCALE
1 : 50

GOLDER

LOGGED: RI
CHECKED: KM

PROJECT: 21451149

RECORD OF BOREHOLE: 21-08

SHEET 1 OF 1

LOCATION: N 5028762.3 ;E 366650.3

BORING DATE: May 18, 2021

DATUM: NAD 1983

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ (ND = Not Detected) 20 40 60 80 / HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ (ND = Not Detected) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp W Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		66.02						
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (SM) gravelly SILTY SAND; brown, contains organics; cohesive, moist, dense		0.00						
		FILL - (SM) gravelly SILTY SAND, trace organics andgravel; brown, contains brick fragments; cohesive, moist, dense to very dense		0.15	1	SS	30	□ ⊕	○	
1					2	SS	>50	□ ⊕	○	
				64.80						
		End of Borehole Auger Refusal		1.22						
2										
3										
4										
5										
6										
7										
8										
9										
10										

DEPTH SCALE

1 : 50

GOLDER

LOGGED: AKP

CHECKED: KM

MIS-BHS 001 21451149.GPJ GAL-MIS.GDT 7/23/21

PROJECT: 21451149

RECORD OF BOREHOLE: 21-09

SHEET 1 OF 2

LOCATION: N 5028717.0 ;E 366649.1

BORING DATE: May 18, 2021

DATUM: NAD 1983

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ (ND = Not Detected) 20 40 60 80 / HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ (ND = Not Detected) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp — W — Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		66.35						
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (SM) gravelly SILTY SAND; brown, contains organics; non-cohesive, moist, loose		0.00						
				0.15	1	SS	10	□ ND ⊕		
1		FILL - (SM) gravelly SILTY SAND; dark brown to brown, trace organics; non-cohesive, moist, loose to dense			2	SS	41	□ ⊕ ND	○	M
				64.78	3	SS	>50	□ ⊕		
		Borehole continued on RECORD OF DRILLHOLE 21-09		1.57						
2										
3										
4										
5										
6										
7										
8										
9										
10										

DEPTH SCALE

1 : 50

GOLDER

LOGGED: AKP

CHECKED: KM

MIS-BHS 001 21451149.GPJ GAL-MIS.GDT 7/23/21

PROJECT: 21451149

RECORD OF DRILLHOLE: 21-09

SHEET 2 OF 2

LOCATION: N 5028717.0 ;E 366649.1

DRILLING DATE: May 18, 2021

DATUM: NAD 1983

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75

DRILLING CONTRACTOR: Downing Drilling

JN - Joint; FLT - Fault; SHR- Shear; VN - Vein; CJ - Conjugate
BD - Bedding; FO- Foliation; CO- Contact; OR- Orthogonal; CL - Cleavage
PL - Planar; CU- Curved; UN- Undulating; ST - Stepped; IR - Irregular
PO- Polished; K - Slickensided; SM- Smooth; Ro - Rough; MB- Mechanical Break
BR - Broken Rock
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	FLUSH	COLOUR % RETURN	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.
		BEDROCK SURFACE		64.78															
2	Rortary Drill / BW Casing	Fresh, thinly bedded, medium to dark brownish grey, fine grained, non-porous, medium strong to weak SHALEY NODULAR LIMESTONE - veritcal join from 2.04 to 2.09 m depth - vertical joint from 2.38 to 2.43 m depth		1.57	1								BD,, BD,, BD,, BD,, BD,, BD,,						
3				63.23															
		End of Drillhole		3.12															
4																			
5																			
6																			
7																			
8																			
9																			
10																			
11																			

DEPTH SCALE

1 : 50

GOLDER

LOGGED: AKP

CHECKED: KM

MIS-RCK 004 21451149.GPJ GAL-MISS.GDT 7/23/21

PROJECT: 21451149

RECORD OF BOREHOLE: 21-10

SHEET 1 OF 2

LOCATION: N 5028684.9 ;E 366642.2

BORING DATE: May 18, 2021

DATUM: NAD 1983

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ (ND = Not Detected) 20 40 60 80 / HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ (ND = Not Detected) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp — W — Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		66.19						
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (SM) gravelly SILTY SAND; brown, contains organics; non-cohesive, moist, loose		0.00						
		FILL - (SM) gravelly SILTY SAND; dark brown to brown, contains organics, brick fragments and clay pockets; non-cohesive, moist, loose to compact		0.15	1	SS	10	⊕ ND		
1					2	SS	15	⊕ ND		Bentonite Seal
					3	SS	>50	⊕ ND		
2				64.01						
		Borehole continued on RECORD OF DRILLHOLE 21-10		2.18						
3										
4										
5										
6										
7										
8										
9										
10										

DEPTH SCALE

1 : 50

GOLDER

LOGGED: AKP

CHECKED: KM

MIS-BHS 001 21451149.GPJ GAL-MIS.GDT 7/23/21

PROJECT: 21451149

RECORD OF DRILLHOLE: 21-10

SHEET 2 OF 2

LOCATION: N 5028684.9 ;E 366642.2

DRILLING DATE: May 18, 2021

DATUM: NAD 1983

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75

DRILLING CONTRACTOR: Downing Drilling

JN - Joint; FLT - Fault; SHR- Shear; VN - Vein; CJ - Conjugate
BD - Bedding; FO- Foliation; CO- Contact; OR- Orthogonal; CL - Cleavage
PL - Planar; CU- Curved; UN- Undulating; ST - Stepped; IR - Irregular
PO- Polished; K - Slickensided; SM- Smooth; Ro - Rough; MB- Mechanical Break
BR - Broken Rock
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	FLUSH / COLOUR % RETURN	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	
		BEDROCK SURFACE		64.01															
3	Rotary Drill / NQ Core	Fresh, thinly to medium bedded, medium grey to brownish grey, fine to medium grained, non-porous, medium strong to weak SHALEY LIMESTONE -broken core from 2.38 to 2.45 m depth - vertical joint from 2.69 to 4.06 m		2.18	1							BD,, BD,, BD,, BD,,							Bentonite Seal Silica Sand
4												BD,,							38 mm Diam. PVC #10 Slot Screen
5		- broken core from 5.1 to 5.22 m depth			2							BD,, BD,,							
				60.70															
6		End of Drillhole Note(s): 1. Water level in screen measured at 2.66 m (Elev. 63.53 m) on May 28, 2021 2. Water level in screen measured at 2.66 m (Elev. 63.53 m) on June 23, 2021		5.49															

DEPTH SCALE
1 : 50

GOLDER

LOGGED: AKP
CHECKED: KM

MIS-RCK 004 21451149.GPJ GAL-MISS.GDT 7/23/21

PROJECT: 21451149

RECORD OF BOREHOLE: 21-11

SHEET 1 OF 1

LOCATION: N 5028623.7 ;E 366685.5

BORING DATE: May 13, 2021

DATUM: NAD 1983

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ (ND = Not Detected) 20 40 60 80	HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ (ND = Not Detected) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3}	WATER CONTENT PERCENT Wp — W — Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		67.35									
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (SM) SILTY SAND, some clay; dark brown, contains organic matter (rootlets); non-cohesive, moist, very loose		0.00	1	SS	3	ND					
				67.05									
		FILL - (SM) gravelly SILTY SAND, trace to some clay; dark brown, contains organic matter; non-cohesive, moist to wet, very loose to compact		0.30									
1					2	SS	11	ND ⊕					
				65.67	3	SS	>50		230 ⊕				
		End of Borehole Auger Refusal		1.68									
2													
3													
4													
5													
6													
7													
8													
9													
10													

DEPTH SCALE

1 : 50

GOLDER

LOGGED: RI

CHECKED:

MIS-BHS 001 21451149.GPJ GAL-MIS.GDT 7/23/21

PROJECT: 21451149

RECORD OF BOREHOLE: 21-12

SHEET 1 OF 2

LOCATION: N 5028586.9 ;E 366762.5

BORING DATE: May 19, 2021

DATUM: NAD 1983

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ (ND = Not Detected) 20 40 60 80 / HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ (ND = Not Detected) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp W Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		68.72						
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (SM) gravelly SILTY SAND; brown, contains organics; non-cohesive, moist, dense		0.00						
				0.15	1	SS	26	□ ND ⊕		
1		FILL - (SM) gravellly SILTY SAND; dark brown to brown with black mottling; non-cohesive, moist, compact to dense			2	SS	20	□ ND ⊕		
				67.32						
		Borehole continued on RECORD OF DRILLHOLE 21-12		1.4						
2										
3										
4										
5										
6										
7										
8										
9										
10										

DEPTH SCALE

1 : 50

GOLDER

LOGGED: AKP

CHECKED:

MIS-BHS 001 21451149.GPJ GAL-MIS.GDT 7/23/21

PROJECT: 21451149

RECORD OF DRILLHOLE: 21-12

SHEET 2 OF 2

LOCATION: N 5028586.9 ;E 366762.5

DRILLING DATE: May 19, 2021

DATUM: NAD 1983

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75

DRILLING CONTRACTOR: Downing Drilling

JN - Joint; FLT - Fault; SHR- Shear; VN - Vein; CJ - Conjugate
BD - Bedding; FO- Foliation; CO- Contact; OR- Orthogonal; CL - Cleavage
PL - Planar; CU- Curved; UN- Undulating; ST - Stepped; IR - Irregular
PO- Polished; K - Slickensided; SM- Smooth; Ro - Rough; MB- Mechanical Break
BR - Broken Rock
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.
		BEDROCK SURFACE		67.32														
2	Rotary Drill / NQ Core	Fresh, thinly bedded, medium to dark brownish grey, fine grained, non-porous, medium strong to weak SHALEY NODULAR LIMESTONE - broken core from 1.61 to 1.70 m depth - broken core from 2.15 to 2.19 m depth		1.40								BD,, BD,, BD,, BD,, BD,, BD,,						
3		End of Drillhole		65.75 2.97														
4																		
5																		
6																		
7																		
8																		
9																		
10																		
11																		

DEPTH SCALE

1 : 50

GOLDER

LOGGED: AKP

CHECKED:

MIS-RCK 004 21451149.GPJ GAL-MISS.GDT 7/23/21

PROJECT: 21451149

RECORD OF BOREHOLE: 21-13

SHEET 1 OF 2

LOCATION: N ;E

BORING DATE: May 13, 2021

DATUM: NAD 1983

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ (ND = Not Detected) 20 40 60 80 / HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] □ (ND = Not Detected) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp W Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		0.00						
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (ML) sandy SILT, trace clay; dark brown, contains organic matter (rootlets); non-cohesive, moist, very loose		0.23	1	SS	6	ND		
		FILL - (CL/CI) SILTY CLAY, trace sand, trace gravel; grey brown, contains organic matter; cohesive, w~PL, firm		0.76						
1		(SM/ML) SILTY SAND to sandy SILT, some gravel to gravelly; grey (GLACIAL TILL); non-cohesive, moist to wet, compact			2	SS	23	ND		M
2					3	SS	10		160	
3		Borehole continued on RECORD OF DRILLHOLE 21-13		2.97						
4										
5										
6										
7										
8										
9										
10										

DEPTH SCALE

1 : 50

GOLDER

LOGGED: RI

CHECKED:

MIS-BHS 001 21451149.GPJ GAL-MIS.GDT 7/23/21

PROJECT: 21451149

RECORD OF DRILLHOLE: 21-13

SHEET 2 OF 2

LOCATION: N ;E

DRILLING DATE: May 13, 2021

DATUM: NAD 1983

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75

DRILLING CONTRACTOR: Downing Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate | BD - Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage | PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular | PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break | BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jcon	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.
		BEDROCK SURFACE																
3	Rotary Drill / NQ Core	Slightly weathered to fresh, thinly to medium bedded, medium grey to brownish grey, fine to medium grained, non-porous, medium strong to weak SHALEY LIMESTONE - broken core from 2.97 to 3.05 m depth - vertical joint from 2.97 to 3.27 m depth		2.97								BD,, BD,, BD,, JN,,						
4		- lost core from 3.88 to 4.30 m depth			1							BD,, BD,, BD,, BD,, Si Sa BD,, Si Sa BD,, Si Sa/Sa Si BD,, Si Sa/Sa Si JN,, BD,,						
5		End of Drillhole		4.98														
6																		
7																		
8																		
9																		
10																		
11																		
12																		

DEPTH SCALE

1 : 50

GOLDER

LOGGED: RI

CHECKED:

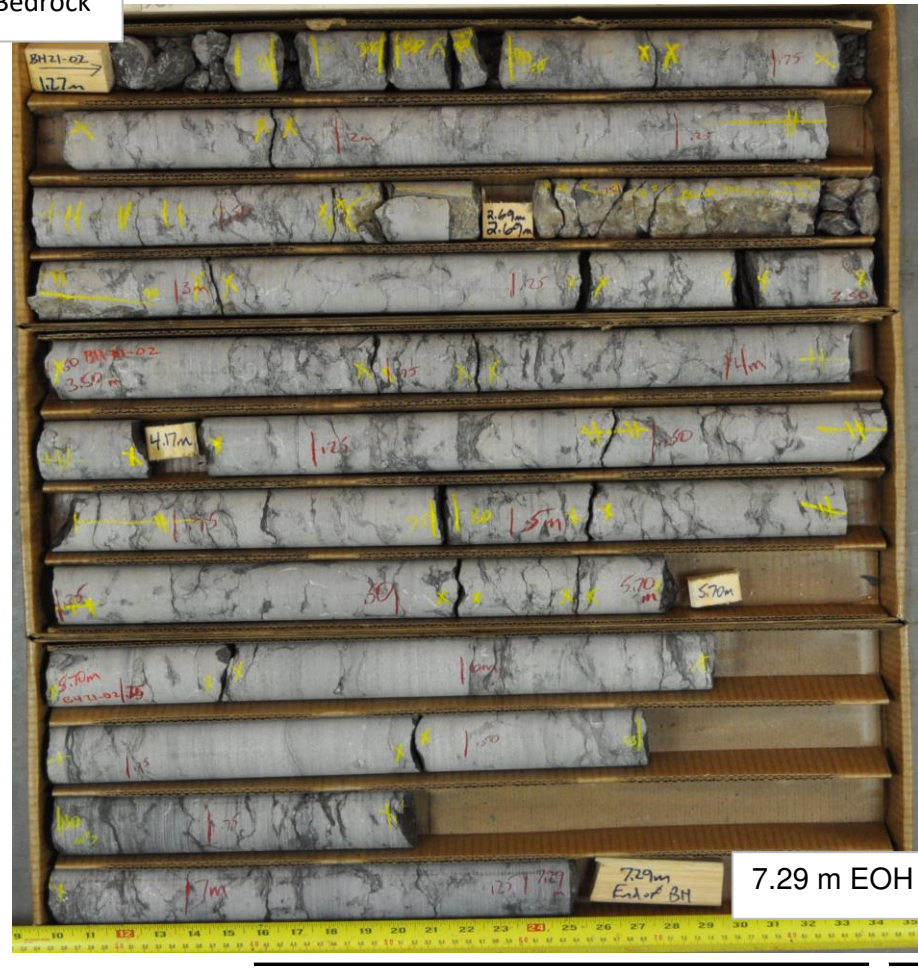
MIS-RCK 004 21451149.GPJ GAL-MISS.GDT 7/23/21

APPENDIX B

Figures B-1 to B-16, Record of Core Photographs

21-02 (Dry)
Cored Length of 1.27 to 7.29 metres
Core Box 1 to 3 of 3

1.27 m Top of Bedrock



7.29 m EOH

CLIENT
Parsons Inc.

PROJECT
PARSONS/ OTTAWA HOSPITAL EXPANSION/ OTTAWA

CONSULTANT
GOLDER
MEMBER OF WSP

YYY/MM/DD	2021-05-20
PREPARED	KM
DESIGN	KM
REVIEW	
APPROVED	

TITLE
COREHOLE 21-02 (DRY)
CORE PHOTOGRAPHS

PROJECT No.	PHASE	Rev.	FIGURE
21451149	1000	0a	B-1

BH 21-02 (Wet)
Cored Length of 1.27 to 7.29 metres
Core Box 1 to 3 of 3

1.27 m Top of bedrock

7.29 m EOH

CLIENT
Parsons Inc.

PROJECT
PARSONS/ OTTAWA HOSPITAL EXPANSION/ OTTAWA

CONSULTANT
GOLDER
MEMBER OF WSP

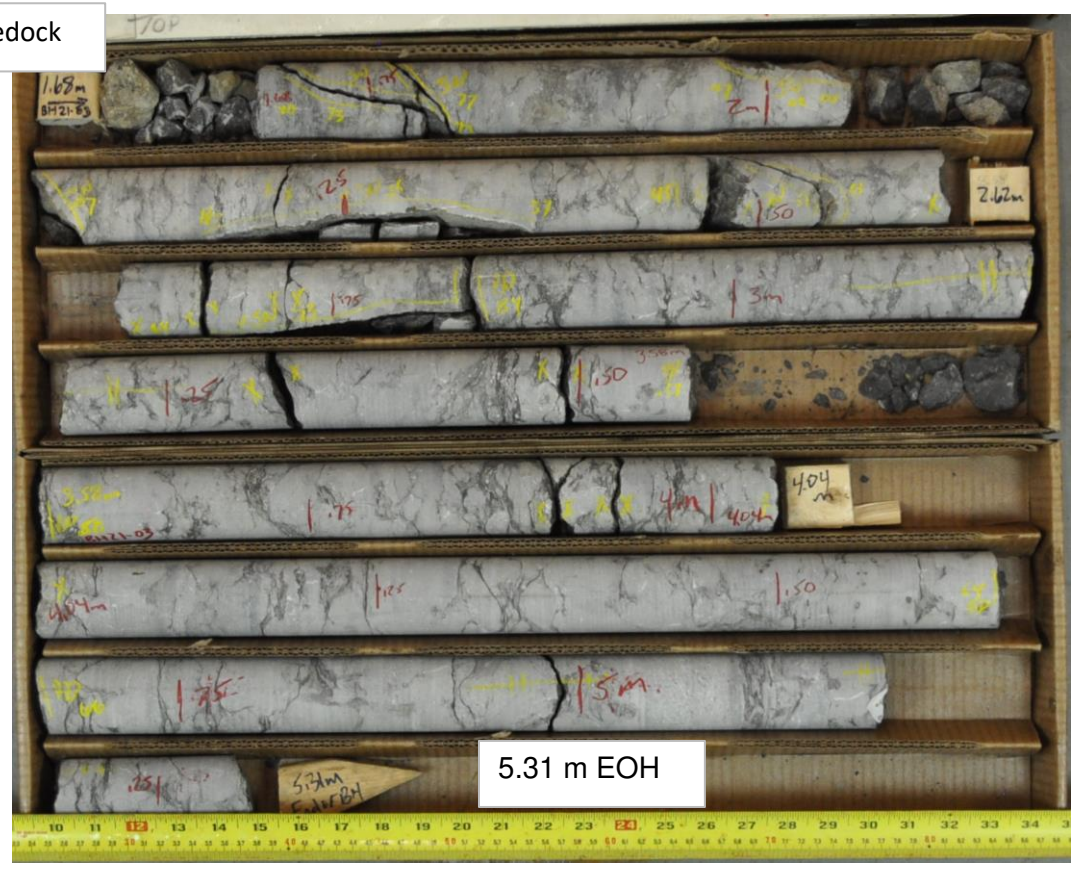
YYY/MM/DD	2021-05-20
PREPARED	KM
DESIGN	KM
REVIEW	
APPROVED	

TITLE
BOREHOLE 21-02 (WET)
CORE PHOTOGRAPHS

PROJECT No.	PHASE	Rev.	FIGURE
21451149	1000	0a	B-2

21-03 (Dry)
Cored Length of 1.68 to 5.31 metres
Core Box 1 to 2 of 2

1.68 m Top of Bedock



5.31 m EOH

CLIENT
Parsons Inc.

PROJECT
PARSONS/ OTTAWA HOSPITAL EXPANSION/ OTTAWA

CONSULTANT
GOLDER
MEMBER OF WSP

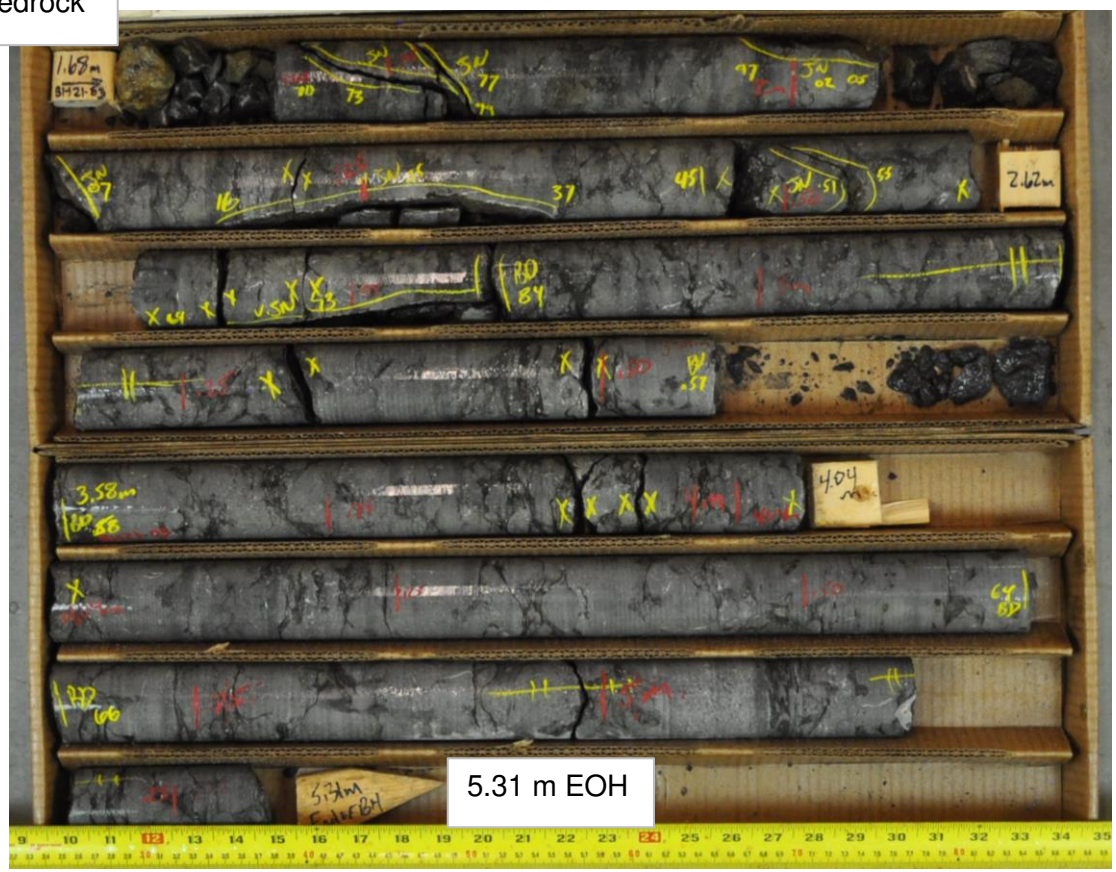
YYY/MM/DD	2021-05-20
PREPARED	KM
DESIGN	KM
REVIEW	
APPROVED	

TITLE
COREHOLE 21-03 (DRY)
CORE PHOTOGRAPHS

PROJECT No.	PHASE	Rev.	FIGURE
21451149	1000	0a	B-3

BH 21-03 (Wet)
Cored Length of 1.68 to 5.31 metres
Core Box 1 to 2 of 2

1.68 m Top of bedrock



5.31 m EOH

CLIENT	Parsons Inc.
PROJECT	PARSONS/ OTTAWA HOSPITAL EXPANSION/ OTTAWA
CONSULTANT	GOLDER MEMBER OF WSP
YYY/MM/DD	2021-05-20
PREPARED	KM
DESIGN	KM
REVIEW	
APPROVED	
TITLE	**BOREHOLE 21-03 (WET) CORE PHOTOGRAPHS**

PROJECT No.	PHASE	Rev.	FIGURE
21451149	1000	0a	B-4

21-05 (Dry)
Cored Length of 1.24 to 6.94 metres
Core Box 1 to 3 of 3

Concrete

1.95 m Top of Bedock

Gravelly Silty Sand

6.94 m EOH

CLIENT
Parsons Inc.

PROJECT
PARSONS/ OTTAWA HOSPITAL EXPANSION/ OTTAWA

CONSULTANT
GOLDER
MEMBER OF WSP

YYY/MM/DD	2021-05-20
PREPARED	KM
DESIGN	KM
REVIEW	
APPROVED	

TITLE
COREHOLE 21-05 (DRY)
CORE PHOTOGRAPHS

PROJECT No.	PHASE	Rev.	FIGURE
21451149	1000	0a	B-5

BH 21-05 (Wet)
Cored Length of 1.24 to 6.94 metres
Core Box 1 to 3 of 3

CLIENT
Parsons Inc.

PROJECT
PARSONS/ OTTAWA HOSPITAL EXPANSION/ OTTAWA

CONSULTANT
GOLDER
MEMBER OF WSP

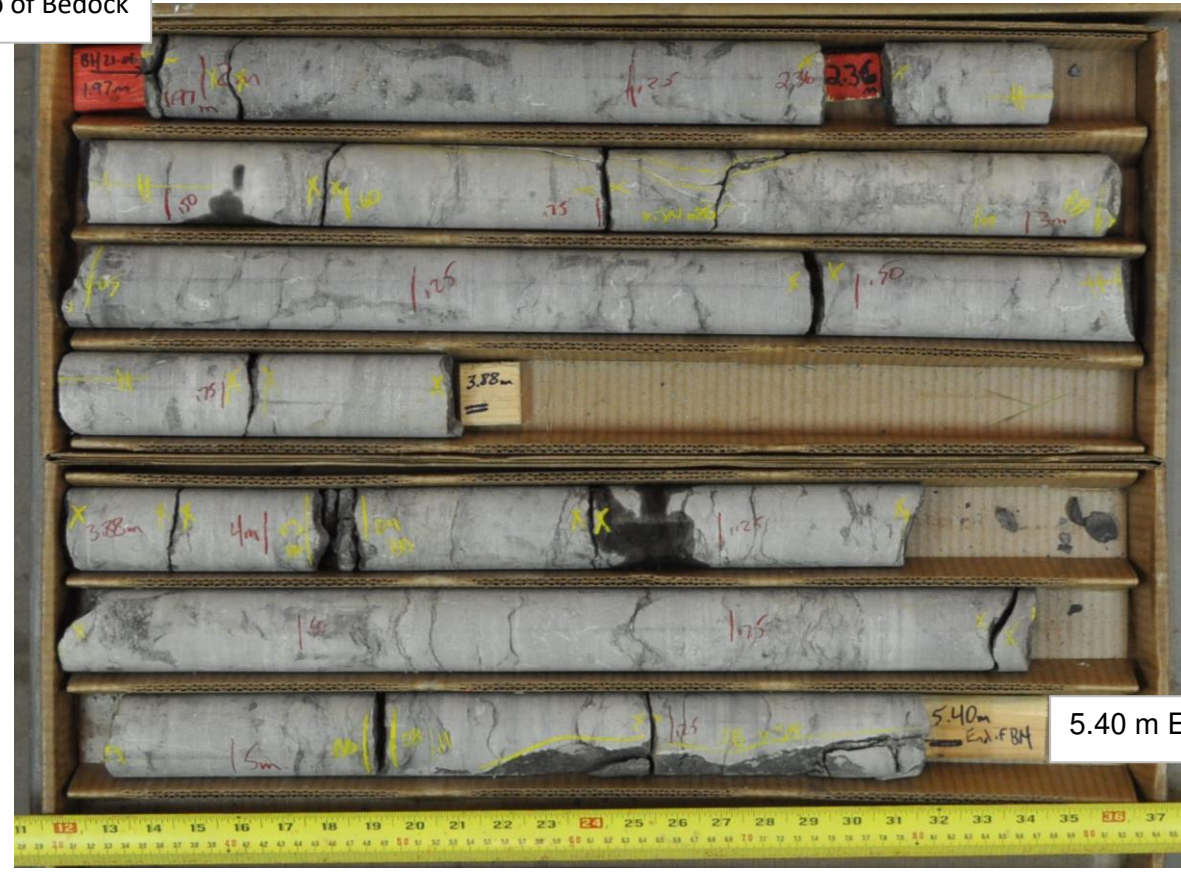
YYY/MM/DD	2021-05-20
PREPARED	KM
DESIGN	KM
REVIEW	
APPROVED	

TITLE
BOREHOLE 21-05 (WET)
CORE PHOTOGRAPHS

PROJECT No.	PHASE	Rev.	FIGURE
21451149	1000	0a	B-6

21-06 (Dry)
Cored Length of 1.97 to 5.40 metres
Core Box 1 to 2 of 2

1.97 m Top of Bedock



5.40 m EOH

CLIENT
Parsons Inc.

PROJECT
PARSONS/ OTTAWA HOSPITAL EXPANSION/ OTTAWA

CONSULTANT
GOLDER
MEMBER OF WSP

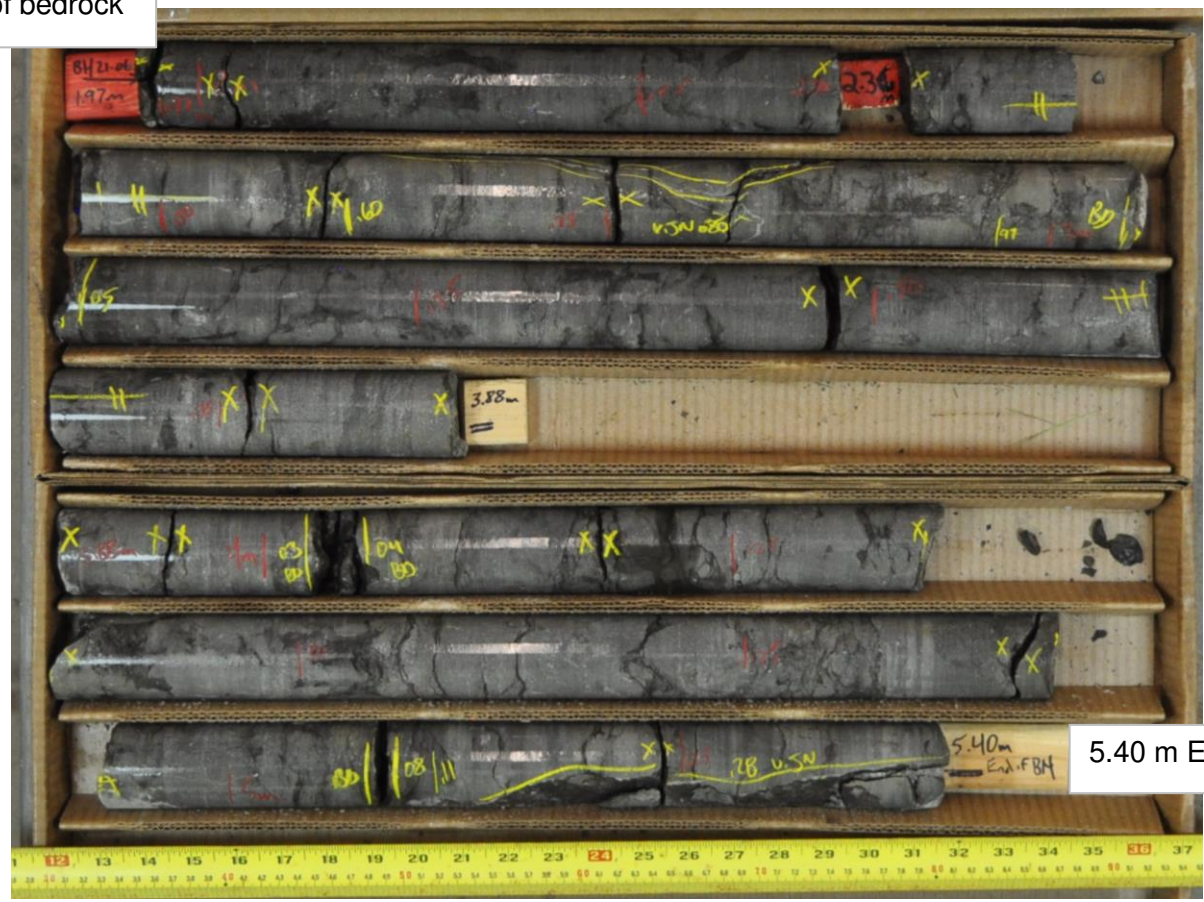
YYY/MM/DD	2021-05-20
PREPARED	KM
DESIGN	KM
REVIEW	
APPROVED	

TITLE
COREHOLE 21-06 (DRY)
CORE PHOTOGRAPHS

PROJECT No.	PHASE	Rev.	FIGURE
21451149	1000	0a	B-7

BH 21-06 (Wet)
Cored Length of 1.97 to 5.40 metres
Core Box 1 to 2 of 2

1.97 m Top of bedrock



5.40 m EOH

CLIENT
Parsons Inc.

PROJECT
PARSONS/ OTTAWA HOSPITAL EXPANSION/ OTTAWA

CONSULTANT
GOLDER
MEMBER OF WSP

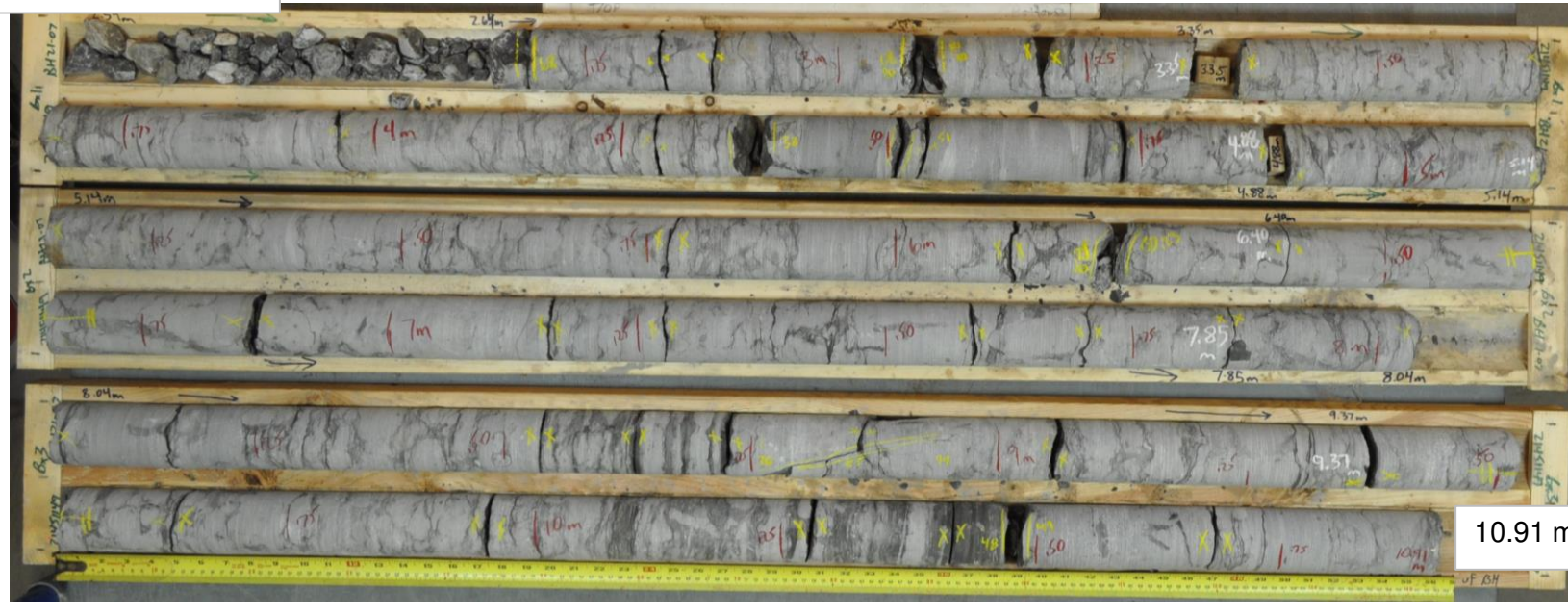
YYY/MM/DD	2021-05-20
PREPARED	KM
DESIGN	KM
REVIEW	
APPROVED	

TITLE
BOREHOLE 21-06 (WET)
CORE PHOTOGRAPHS

PROJECT No.	PHASE	Rev.	FIGURE
21451149	1000	0a	B-8

21-07 (Dry)
Cored Length of 2.54 to 10.91 metres
Core Box 1 to 3 of 3

2.54 m Top of Bedock

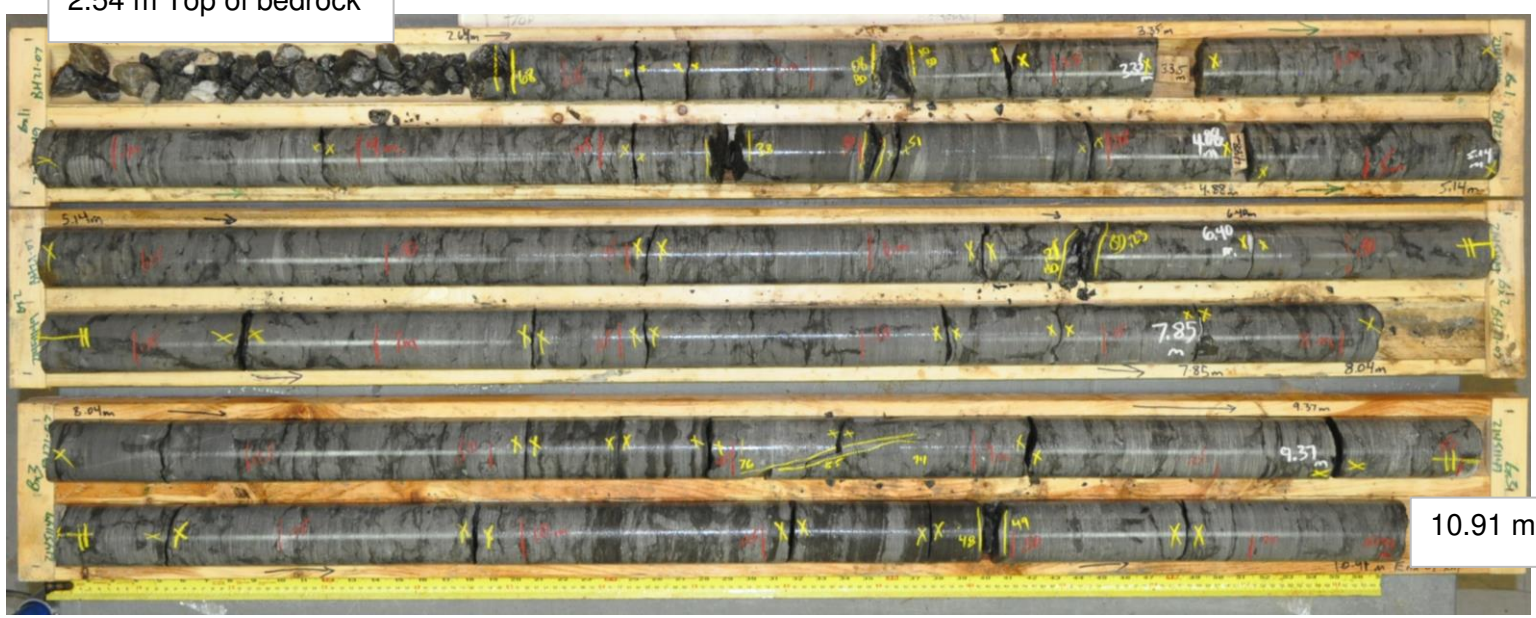


10.91 m EOH

CLIENT	Parsons Inc.
CONSULTANT	GOLDER MEMBER OF WSP
YYY/MM/DD	2021-05-20
PREPARED	KM
DESIGN	KM
REVIEW	
APPROVED	
PROJECT	PARSONS/ OTTAWA HOSPITAL EXPANSION/ OTTAWA
TITLE	**COREHOLE 21-07 (DRY)** **CORE PHOTOGRAPHS**

PROJECT No.	PHASE	Rev.	FIGURE
21451149	1000	0a	B-9

BH 21-07 (Wet)
Cored Length of 2.54 to 10.91 metres
Core Box 1 to 3 of 3



CLIENT
Parsons Inc.

PROJECT
PARSONS/ OTTAWA HOSPITAL EXPANSION/ OTTAWA

CONSULTANT
GOLDER
MEMBER OF WSP

YYY/MM/DD	2021-05-20
PREPARED	KM
DESIGN	KM
REVIEW	
APPROVED	

TITLE
BOREHOLE 21-07 (WET)
CORE PHOTOGRAPHS

PROJECT No.	PHASE	Rev.	FIGURE
21451149	1000	0a	B-10

APPENDIX C

Record of Borehole Logs, Previous Investigations

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH1

Project Number: 03-217-15

Client: NCC

Site Location: Dow's Lake Landfill

Drilling Method: Hollow Stem Auger with Split Spoon

Date Completed: October 21, 2003

Supervisor: ADG

Ground Surface Elevation: Not surveyed

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
0 / 0							GROUND SURFACE	No well installation
0							TOPSOIL	
1			2 4 6 5	0	0		FILL Brown sand fill.	
2								
3 / 1			2 11 35 50	0	0		Cobbles with minor sand fill.	
4								
5			18 35 28 13	0	0			
6 / 2								
7								
8			3 10 50	0	0		SILTY SAND Brown silty sand with gravel. Iron staining, slightly moist.	
9							Borehole terminated on refusal (inferred bedrock) at 2.9 mBGS.	
10 / 3							BOREHOLE TERMINATED	
11								
12								
13 / 4								
14								

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH2 (MW2)

Project Number: 03-217-15

Date Completed: October 28, 2003

Client: NCC

Supervisor: ADG

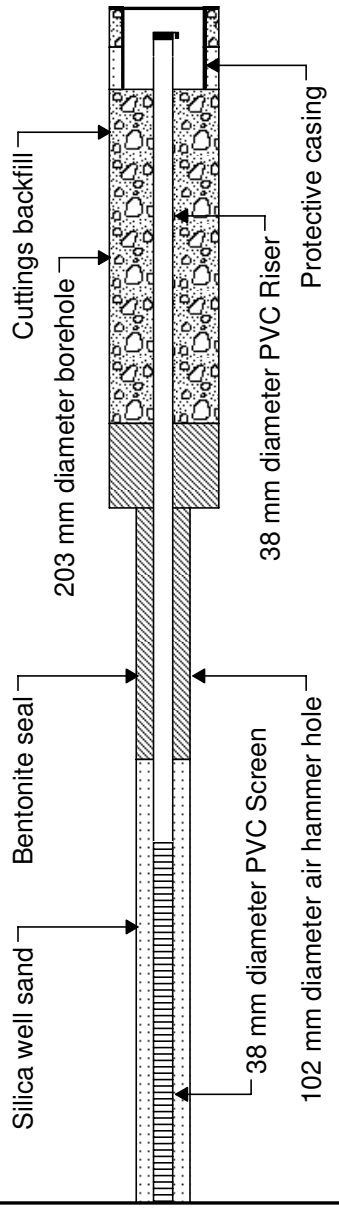
Site Location: Dow's Lake Landfill

Ground Surface Elevation: 100.25 mASD

Drilling Method: Hollow Stem Auger with Split Spoon and Bedrock Air Hammer

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION
0 / 0							GROUND SURFACE
0 / 0							TOPSOIL
1 / 0			4 5 7 13	0	0		FILL Brown sand and gravel fill.
2 / 0							Brown sand and gravel fill with cobbles and wood.
3 / 1		X		0	0		
4 / 1							
5 / 1		X		0			
6 / 2							LIMESTONE BEDROCK Black shaley limestone bedrock encountered at 1.8 mBGS.
7 / 2							
8 / 2							
9 / 2							
10 / 3							
11 / 3							
12 / 3							
13 / 4							
14 / 4							

INSTALLATION



BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH2 (MW2)

Project Number: 03-217-15

Date Completed: October 28, 2003

Client: NCC

Supervisor: ADG

Site Location: Dow's Lake Landfill

Ground Surface Elevation: 100.25 mASD

Drilling Method: Hollow Stem Auger with Split Spoon and Bedrock Air Hammer

DEPTH BGS	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
15								
16								
17	5							
18								
19								
20	6						Borehole terminated in bedrock at 6.1 mBGS.	
21							BOREHOLE TERMINATED	Silica well sand
22								
23	7							Depth of MW2 = 6.1 mBGS
24								
25								
26	8							
27								
28								

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH3

Project Number: 03-217-15

Client: NCC

Site Location: Dow's Lake Landfill

Drilling Method: Hollow Stem Auger with Split Spoon

Date Completed: October 28, 2003

Supervisor: ADG

Ground Surface Elevation: Not surveyed

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
0 / 0							GROUND SURFACE	No well installation
0 / 0							ASPHALT	
1 /				0	0		FILL Brown sand and gravel fill.	
2 /								
3 / 1		X	5 5 39 50	0	0		Brown sand fill with pebbles and cobbles. Iron staining, dry.	
4 /							Borehole terminated on auger refusal (inferred bedrock) at 1.3 mBGS.	
							BOREHOLE TERMINATED	
5 /								
6 / 2								
7 /								
8 /								
9 /								
10 / 3								
11 /								
12 /								
13 / 4								
14 /								

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH4 (MW4)

Project Number: 03-217-15

Date Completed: October 28, 2003

Client: NCC

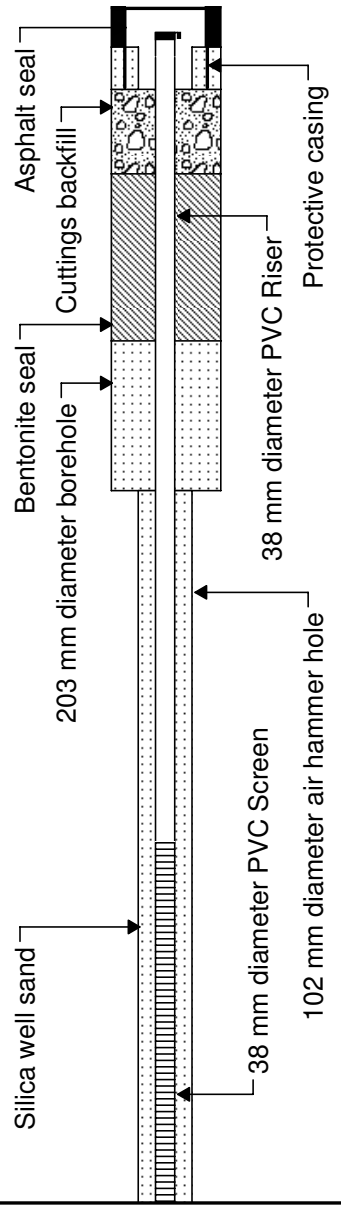
Supervisor: ADG

Site Location: Dow's Lake Landfill

Ground Surface Elevation: 99.31 mASD

Drilling Method: Hollow Stem Auger with Split Spoon and Bedrock Air Hammer

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION
0 / 0							GROUND SURFACE
							ASPHALT
1							FILL Brown sand and gravel fill.
2		X		0	N/A		
3 / 1			17 14 4 9	--			Cobbles, no sample recovery.
4							
5			2 50	0			Brown sand fill with cobbles. Iron staining, dry.
6 / 2							LIMESTONE BEDROCK Black shaley limestone bedrock encountered at 1.8 mBGS.
7							
8							
9							
10 / 3							
11							
12							
13 / 4							
14							



BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH4 (MW4)

Project Number: 03-217-15

Date Completed: October 28, 2003

Client: NCC

Supervisor: ADG

Site Location: Dow's Lake Landfill

Ground Surface Elevation: 99.31 mASD

Drilling Method: Hollow Stem Auger with Split Spoon and Bedrock Air Hammer

DEPTH BGS	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
15								
16								
17	5							
18								
19								
20	6						Borehole terminated in bedrock at 6.1 mBGS.	
21							BOREHOLE TERMINATED	Silica well sand
22								
23	7							Depth of MW4 = 6.1 mBGS
24								
25								
26	8							
27								
28								

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH5 (MW5)

Project Number: 03-217-15

Date Completed: October 28, 2003

Client: NCC

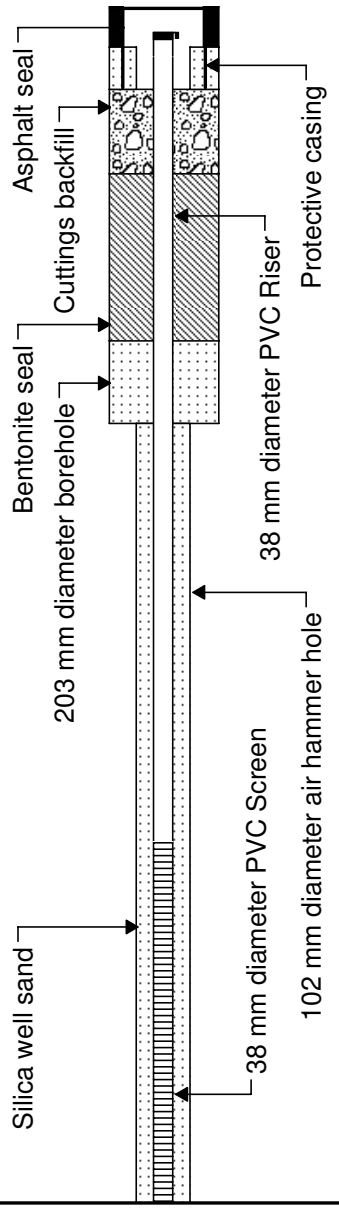
Supervisor: ADG

Site Location: Dow's Lake Landfill

Ground Surface Elevation: 99.45 mASD

Drilling Method: Hollow Stem Auger with Split Spoon and Bedrock Air Hammer

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION
0 / 0							GROUND SURFACE
							ASPHALT
1				0	N/A		FILL Brown sand and gravel fill.
2							
3 / 1		X	5 7 6 5	0			
4							
5		X		2			Grey wood layer. Musty odour, moist.
6 / 2							LIMESTONE BEDROCK Black shaley limestone bedrock encountered at 1.5 mBGS.
7							
8							
9							
10 / 3							
11							
12							
13 / 4							
14							



BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH5 (MW5)

Project Number: 03-217-15

Date Completed: October 28, 2003

Client: NCC

Supervisor: ADG

Site Location: Dow's Lake Landfill

Ground Surface Elevation: 99.45 mASD

Drilling Method: Hollow Stem Auger with Split Spoon and Bedrock Air Hammer

DEPTH BGS	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
15								
16								
17	5							
18								
19								
20	6						Borehole terminated in bedrock at 6.1 mBGS.	Silica well sand
21							BOREHOLE TERMINATED	Depth of MW5 = 6.1 mBGS
22								
23	7							
24								
25								
26	8							
27								
28								

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: BH6

Project Number: 03-217-15

Client: NCC

Site Location: Dow's Lake Landfill

Drilling Method: Hollow Stem Auger with Split Spoon

Date Completed: October 28, 2003

Supervisor: ADG

Ground Surface Elevation: Not surveyed

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
0 / 0				0	0		GROUND SURFACE	No well installation
0 / 0							ASPHALT	
1 /		X					FILL Brown sand and gravel fill.	
							Borehole terminated on auger refusal at 0.6 mBGS.	
2 /							BOREHOLE TERMINATED	
3 / 1								
4 /								
5 /								
6 / 2								
7 /								
8 /								
9 /								
10 / 3								
11 /								
12 /								
13 / 4								
14 /								

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: 04-BH1

MOE Well ID: Not Applicable

Project Number: 04-210-11

Date Completed: August 31, 2004

Client: NCC

Supervisor: MAH

Site Location: Former Dow's Lake Landfill

Ground Surface Elevation: Not Surveyed

Coordinates: Not Applicable

Drilling Method: Hollow Stem Auger with Split Spoon

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
0 / 0							GROUND SURFACE	No well installation.
0 – 2 / 0 – 1			15 8 7 5	12	N/A		FILL Fine to medium grained sand and gravel fill, moist.	
3 / 1		X	14 50	10	N/A		Orangey-brown sand and gravel fill with trace clay, moist. Borehole terminated on auger refusal (inferred bedrock) at 1.07 mBGS.	
							BOREHOLE TERMINATED	

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: 04-BH2

MOE Well ID: Not Applicable

Project Number: 04-210-11

Date Completed: August 31, 2004

Client: NCC

Supervisor: MAH

Site Location: Former Dow's Lake Landfill

Ground Surface Elevation: Not Surveyed

Coordinates: Not Applicable

Drilling Method: Hollow Stem Auger with Split Spoon

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
							GROUND SURFACE	No well installation.
0 / 0			8 10 12 8	12	N/A		FILL Grey-brown, fine grained sand and gravel fill.	
3 / 1		X	5 7 5 6	10	N/A		Black, fine grained sand and gravel fill, moist.	
5 / 2			7 7 50	6	N/A		Grey-brown, medium grained sand and gravel fill, moist. Borehole terminated on auger refusal (inferred bedrock) at 1.68 mBGS.	
							BOREHOLE TERMINATED	

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: 04-BH3

MOE Well ID: Not Applicable

Project Number: 04-210-11

Date Completed: August 31, 2004

Client: NCC

Supervisor: MAH

Site Location: Former Dow's Lake Landfill

Ground Surface Elevation: Not Surveyed

Coordinates: Not Applicable

Drilling Method: Hollow Stem Auger with Split Spoon

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
							GROUND SURFACE	No well installation.
0 / 0			6 8 8 14	16	N/A		ASPHALT FILL Dark brown sand and gravel fill.	
3 / 1			9 11 10 18	12	N/A		Iron staining.	
5 / 1		X	17 15 21 50	16	N/A		Crushed rock fragments. Iron staining.	
7 / 2							Borehole terminated on auger refusal (inferred bedrock) at 1.98 mBGS. BOREHOLE TERMINATED	
10 / 3								
13 / 4								
16								

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: 04-BH4

MOE Well ID: Not Applicable

Project Number: 04-210-11

Date Completed: August 31, 2004

Client: NCC

Supervisor: MAH

Site Location: Former Dow's Lake Landfill

Ground Surface Elevation: Not Surveyed

Coordinates: Not Applicable

Drilling Method: Hollow Stem Auger with Split Spoon

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
0 / 0							GROUND SURFACE	No well installation.
0 – 1 / 0			22 19 15 9	14	N/A		FILL Dark grey-brown sand and gravel fill.	
2 – 3 / 1		X	12 8 7 6	10	N/A		Crushed rock fragments.	
4 – 5 / 1 – 2		X	8 50	22	N/A		Borehole terminated on auger refusal (inferred bedrock) at 1.52 mBGS.	
5 / 2							BOREHOLE TERMINATED	
6 – 16 / 2 – 4								

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: 04-BH5

MOE Well ID: Not Applicable

Project Number: 04-210-11

Date Completed: August 31, 2004

Client: NCC

Supervisor: MAH

Site Location: Former Dow's Lake Landfill

Ground Surface Elevation: Not Surveyed

Coordinates: Not Applicable

Drilling Method: Hollow Stem Auger with Split Spoon

DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
							GROUND SURFACE	No well installation.
0 / 0			2 11 20 12	20	N/A		TOPSOIL FILL Grey-brown sand and gravel fill.	
1 / 0		X						
2 / 0			6 7 10 27	14	N/A		SAND Fine to medium grained sand. FILL Dark grey-brown sandy silt fill with wood, compact, some iron staining.	
3 / 1		X						
4 / 1			8 16 15 18	8	N/A			
5 / 1								
6 / 2			6 6 50	40	N/A		Trace clay. Borehole terminated on bedrock at 2.38 mBGS.	
7 / 2								
8 / 2							BOREHOLE TERMINATED	
9 / 3								
10 / 3								
11 / 3								
12 / 4								
13 / 4								
14 / 4								
15 / 4								
16 / 4								

BOREHOLE STRATIGRAPHIC AND INSTRUMENTATION LOG

Borehole Number: 04-BH6

MOE Well ID: Not Applicable

Project Number: 04-210-11

Date Completed: August 31, 2004

Client: NCC

Supervisor: MAH

Site Location: Former Dow's Lake Landfill

Ground Surface Elevation: Not Surveryed

Coordinates: Not Applicable

Drilling Method: Hollow Stem Auger with Split Spoon

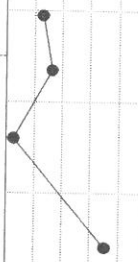
DEPTH BGS (ft / m)	SAMPLES	LAB SAMPLE	BLOW COUNT	CGI (ppm)	PID (ppm)	LOG	STRATIGRAPHIC DESCRIPTION	INSTALLATION
							GROUND SURFACE	No well installation.
0 / 0			3 11 15 12	14	N/A		TOPSOIL	
1 / 2							FILL Dark brown sand and gravel fill.	
3 / 1		X	7 6 15 16	30	N/A		Dark grey-brown sandy silt fill with wood, some iron staining.	
4 / 5			5 5 3 50	32	N/A		Borehole terminated on auger refusal (inferred bedrock) at 1.83 mBGS.	
6 / 2							BOREHOLE TERMINATED	
7 / 8 / 9 / 10 / 3 / 11 / 12 / 13 / 4 / 14 / 15 / 16								

CARLING AVE. NEW – SIR JOHN CARLING BLDG	BM(ELEV 67.61m)geodetic: Top of S.M.H.	BOREHOLE NO: 00–104
	38m+/– S.W. of B.H. 00–104 as per survey	PROJECT NO: E–7913
START DATE: 00/10/25	plan by Webster & Simmonds Surveying Ltd	ELEVATION: 67.51 m

SAMPLE TYPE ■ REMOULDED–AUGER ▨ SHELBY TUBE ⊠ SPLIT–SPOON ▤ NW–CASING ▯ NO RECOVERY ▮ NQ CORE

DEPTH(m)	COMMENTS..SPT (N)	SAMPLE TYPE	SAMPLE NO	% CORE RECOVERY	RQD %	SOIL / ROCK DESCRIPTION	ELEVATION(m)
0.0	6 11	▨	1			FILL – topsoil	67.0
		▨	1A			66.76	
1.0	60/15cm 75 24/15cm	▨	2			FILL clay with some sand, gravel, topsoil, pieces of concrete and asphalt	
	19 4/15cm 12/15cm	▨	3				66.0
2.0	WL Power auger refusal					Water level Oct.27/00 elev 65.38m	
						65.29	65.0
3.0				99	84	LIMESTONE	
4.0						63.76	64.0
				99	84	LIMESTONE	63.0
5.0							
						Bottom of hole 62.24	62.0
6.0							
							61.0
7.0							
							60.0
8.0							

VANE Cu (kPa) ■ 80 160 240 320
▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320
PLASTIC M.C. LIQUID
20 40 60 80



McROSTIE GENEST ST–LOUIS Ottawa, Canada	LOGGED BY: JML	COMPLETION DEPTH: 5.27 m
	REVIEWED BY: **E.S.**	COMPLETE: 00/10/25
	Fig. No: 2	Page 1 of 1

00/11/14 11:15AM (NQ–RQD)

CARLING AVE. NEW – SIR JOHN CARLING BLDG	BM(ELEV 67.61m)geodetic: Top of S.M.H.	BOREHOLE NO: 00–105
	38m+/– S.W. of B.H. 00–104 as per survey	PROJECT NO: E–7913
START DATE: 00/10/24	plan by Webster & Simmonds Surveying Ltd	ELEVATION: 66.13 m

SAMPLE TYPE ■ REMOULDED–AUGER ⧸ SHELBY TUBE ⊠ SPLIT–SPOON ▤ NW–CASING ▥ NO RECOVERY ▮ NQ CORE

DEPTH(m)	COMMENTS..SPT (N)	SAMPLE TYPE	SAMPLE NO	% CORE RECOVERY	RQD %	SOIL / ROCK DESCRIPTION	ELEVATION(m)
0.0						FILL – topsoil	66.0
	6 4/15cm 23/15cm		1			65.83	
1.0	30 25		2			FILL clay with some sand, gravel, topsoil, pieces of concrete and wood	65.0
	29		3				
	split barrel refusal All water lost					64.33	
2.0							64.0
				99	67	LIMESTONE	
	WL					Water level Oct.27/00 elev 63.24m	
3.0							63.0
						62.81	
4.0				100	95	LIMESTONE	62.0
5.0						Bottom of hole 61.27	61.0
6.0							60.0
7.0							59.0
8.0							

VANE Cu (kPa) ■ 80 160 240 320
▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320
PLASTIC M.C. LIQUID
20 40 60 80

McROSTIE GENEST ST–LOUIS
Ottawa, Canada

LOGGED BY: JML	COMPLETION DEPTH: 4.86 m
REVIEWED BY: E.S.	COMPLETE: 00/10/24
Fig. No: 3	Page 1 of 1

00/11/14 12:07PM (NQ–RQD)

CARLING AVE. NEW – SIR JOHN CARLING BLDG	BM(ELEV 67.61m)geodetic: Top of S.M.H.	BOREHOLE NO: 00–106
	38m+/– S.W. of B.H. 00–104 as per survey	PROJECT NO: E–7913
START DATE: 00/10/25	plan by Webster & Simmonds Surveying Ltd	ELEVATION: 66.38 m

SAMPLE TYPE ■ REMOULDED–AUGER ⊘ SHELBY TUBE ⊠ SPLIT–SPOON ▤ NW–CASING ▯ NO RECOVERY ▮ NQ CORE

DEPTH(m)	COMMENTS..SPT (N)	SAMPLE TYPE	SAMPLE NO	% CORE RECOVERY	RQD %	SOIL / ROCK DESCRIPTION	ELEVATION(m)
0.0						FILL – topsoil	
	8 21	⊠	1			66.08	66.0
1.0	Power auger refusal						
						FILL clay with some sand, pieces of concrete, wood and broken rock	65.0
	10/15cm 16 2/15cm	⊠	3				
2.0							
	5 3	⊠	4				64.0
	WL					Water level Oct.27/00 elev 63.80m	
3.0	1/15cm 75/15cm	⊠	5				
	split barrel refusal all water lost					63.08	63.0
4.0				100	50	LIMESTONE	62.0
						61.68	
5.0							
				94	75	LIMESTONE	61.0
6.0							
						Bottom of hole 60.16	60.0
7.0							59.0
8.0							

VANE Cu (kPa) ■ 80 160 240 320
▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320
PLASTIC M.C. LIQUID
20 40 60 80

McROSTIE GENEST ST–LOUIS
Ottawa, Canada

LOGGED BY: JML	COMPLETION DEPTH: 6.22 m
REVIEWED BY: E.S.	COMPLETE: 00/10/25
Fig. No: 4	Page 1 of 1

00/11/14 12:08PM (NQ–RQD)

CARLING AVE. NEW – SIR JOHN CARLING BLDG	BM(ELEV 67.61m)geodetic: Top of S.M.H.	BOREHOLE NO: 00–107
	38m+/– S.W. of B.H. 00–104 as per survey	PROJECT NO: E–7913
START DATE: 00/10/24	plan by Webster & Simmonds Surveying Ltd	ELEVATION: 66.57 m

SAMPLE TYPE ■ REMOULDED–AUGER ⧄ SHELBY TUBE ⊠ SPLIT–SPOON ▤ NW–CASING ▥ NO RECOVERY ◧ NQ CORE

DEPTH(m)	COMMENTS..SPT (N)	SAMPLE TYPE	SAMPLE NO	% CORE RECOVERY	RQD %	SOIL / ROCK DESCRIPTION	ELEVATION(m)
0.0						FILL – topsoil	
	8 18	⊠	1			66.27	66.0
		⊠	1A				
1.0	22 28	⊠	2			FILL clay with some topsoil, sand, gravel, and pieces of asphalt	
	8 5	⊠	3				65.0
2.0							
	5 10/10cm	⊠	4			medium dense sandy TILL 64.32	64.0
	split barrel refusal power auger refusal all water lost					63.82	
3.0				100	46	LIMESTONE	63.0
4.0	WL					Water level Oct.27/00 elev 62.51m	
						62.37	62.0
5.0				96	74	LIMESTONE	
						Bottom of hole 60.85	61.0
6.0							60.0
7.0							59.0
8.0							

VANE Cu (kPa) ■ 80 160 240 320
▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320
PLASTIC M.C. LIQUID
20 40 60 80

McROSTIE GENEST ST–LOUIS
Ottawa, Canada

LOGGED BY: JML	COMPLETION DEPTH: 5.72 m
REVIEWED BY: E.S.	COMPLETE: 00/10/24
Fig. No: 5	Page 1 of 1

00/11/14 11:16AM (NQ–RQD)

CARLING AVE. NEW – SIR JOHN CARLING BLDG	BM(ELEV 67.61m)geodetic: Top of S.M.H.	BOREHOLE NO: 00–108
	38m+/– S.W. of B.H. 00–104 as per survey	PROJECT NO: E–7913
START DATE: 00/10/24	plan by Webster & Simmonds Surveying Ltd	ELEVATION: 66.75 m

SAMPLE TYPE ■ REMOULDED–AUGER ⧸ SHELBY TUBE ☒ SPLIT–SPOON ▤ NW–CASING ▥ NO RECOVERY ▮ NQ CORE

DEPTH(m)	COMMENTS..SPT (N)	SAMPLE TYPE	SAMPLE NO	% CORE RECOVERY	RQD %	SOIL / ROCK DESCRIPTION	ELEVATION(m)
0.0						FILL – topsoil	
	8 8	☒	1			66.45	
1.0	6 5/15cm 17/15cm	☒	2 2A			FILL clay with some sand, gravel, brick, cinders, and pieces of concrete and broken rock	66.0
	33 38	☒	3				
2.0	power auger refusal					64.61	65.0
						LIMESTONE	
3.0	WL			95	51	Water level Oct.27/00 elev 63.70m	64.0
						63.09	63.0
4.0				100	55	LIMESTONE	
5.0							62.0
						Bottom of hole 61.57	
6.0							61.0
							60.0
7.0							
8.0							59.0

VANE Cu (kPa) ■ 80 160 240 320
▲ VANE Cu REMOULDED (kPa) ▲ 80 160 240 320
PLASTIC M.C. LIQUID
20 40 60 80

McROSTIE GENEST ST–LOUIS
Ottawa, Canada

LOGGED BY: JML	COMPLETION DEPTH: 5.18 m
REVIEWED BY: E.S.	COMPLETE: 00/10/24
Fig. No: 6	Page 1 of 1

00/11/13 08:47PM (NQ–RQD)

Monitoring Well: MW17-01

Project:	Phase II Environmental Site Assessment	**Drilling method:**	Geoprobe (direct push)
Client:	Public Services and Procurement Canada	**Date started/completed:**	28-Jul-2017
Location:	870 and 930 Carling Avenue and 520 Preston Street, Ottawa, Ontario	**Ground surface elevation:**	79.39 m RTD
Number:	122170088	**Top of casing elevation:**	79.31 m RTD
Field investigator:	A. Parrott	**Easting:**	444632.4025
Contractor:	Strata Drilling Group	**Northing:**	5027203.643

SUBSURFACE PROFILE				SAMPLE DETAILS					INSTALLATION DETAILS	
Depth (ft)	Depth (m)	Graphic Log	Stratigraphic Description	Elevation (m RTD) Depth (m BGS)	Sample Number	Sample Type	Recovery	Lab Analyses	%LEL Comb▲ 20 40 60 80 / ppm OTOV / Comb ● 200 400 600 800	Diagram	Description
			Ground Surface	79.39							
			ASPHALT/ INTERLOCKING BRICK	0.00							
1			SAND AND GRAVEL brown, moist	79.23							
2	0.5			0.15	1	DP	50%	D-F, Metals, PAHs, PCBs, PHC F1-F4, Phenols, VOCs	<5 ● <0.02 ○		Flushmount protective cover with concrete seal
3			SILTY SAND brown, trace gravel, moist	78.93							Backfilled with bentonite
4	1.0			0.46							50 mm ID PVC pipe
5	1.5		BEDROCK No soil samples recovered	78.47							
6				0.91							Groundwater Level: 1.61 m BGS 3-Aug-17
7	2.0										
8	2.5										Backfilled with silica sand
9					2	RC	n/a				
10	3.0										
11											
12	3.5										
13											
14	4.0										
15	4.5			74.66							50 mm ID slotted PVC pipe
16			End of Borehole	4.72							
17	5.0										
18	5.5										
19											
20	6.0										
21	6.5										
22											
23	7.0										
24	7.5										
25											
26	8.0										
27											
28	8.5										
29	9.0										
30											
31	9.5										
32											
33	10.0										
34	10.5										

Screen Interval: 1.68 - 4.72 m BGS
Sand Pack Interval: 1.37 - 4.72 m BGS
Well Seal Interval: 0.23 - 1.37 m BGS

Notes:
m BGS - metres below ground surface
DP - direct push sample
RC - rock core
ppm - parts per million by volume
n/a - not available

D-F - dioxin and furans
PAHs - polycyclic aromatic hydrocarbons
PCBs - polychlorinated biphenyls
PHC F1-F4 - petroleum hydrocarbon fractions 1 to 4
VOCs - volatile organic compounds
Comb - combustible soil vapour
TOV - total organic vapour

Drawn By/Checked By: T. Pawlick / J. Yaraskavitch

Monitoring Well: MW17-02

Project:	Phase II Environmental Site Assessment	**Drilling method:**	Geoprobe (direct push)
Client:	Public Services and Procurement Canada	**Date started/completed:**	28-Jul-2017
Location:	870 and 930 Carling Avenue and 520 Preston Street, Ottawa, Ontario	**Ground surface elevation:**	79.80 m RTD
Number:	122170088	**Top of casing elevation:**	79.73 m RTD
Field investigator:	A. Parrott	**Easting:**	444449.4352
Contractor:	Strata Drilling Group	**Northing:**	5027137.48

SUBSURFACE PROFILE				SAMPLE DETAILS					INSTALLATION DETAILS	
Depth (ft)	Depth (m)	Graphic Log	Stratigraphic Description	Elevation (m RTD) Depth (m BGS)	Sample Number	Sample Type	Recovery	Lab Analyses	%LEL Comb▲ 20 40 60 80 / ppm OTOV / Comb ● 200 400 600 800	Diagram / Description
			Ground Surface	79.80						
1			TOPSOIL black, organics, moist	0.00 79.50						Flushmount protective cover with concrete seal
2	0.5		SAND (FILL) brown-red, moist	0.30 79.19						
3	1.0		SILTY SAND brown-grey, trace gravel, moist	0.61	1	DP	40%	H-P, Metals, PAHs, PHC F1-F4, Phenols, VOCs	<5 ● ○ <0.02	Backfilled with bentonite
4										
5	1.5									
6				77.90	2	DP	0%			50 mm ID PVC pipe
7	2.0		BEDROCK No soil samples recovered	1.91						Groundwater Level: 2.12 m BGS 3-Aug-17
8	2.5									
9										
10	3.0									
11										
12	3.5									
13	4.0				3	RC	n/a			
14										
15	4.5									Backfilled with silica sand
16										
17	5.0									50 mm ID slotted PVC pipe
18	5.5									
19										
20	6.0			73.71						
21			End of Borehole	6.10						
22	6.5									
23	7.0									
24										
25	7.5									
26	8.0									
27										
28	8.5									
29										
30	9.0									
31	9.5									
32										
33	10.0									
34	10.5									

Screen Interval: 3.05 - 6.10 m BGS
Sand Pack Interval: 2.74 - 6.10 m BGS
Well Seal Interval: 0.23 - 2.74 m BGS

Notes:
m BGS - metres below ground surface
DP - direct push sample
RC - rock core
ppm - parts per million by volume
n/a - not available

H-P - herbicides and pesticides
PAHs - polycyclic aromatic hydrocarbons
PHC F1-F4 - petroleum hydrocarbon fractions 1 to 4
VOCs - volatile organic compounds
Comb - combustible soil vapour
TOV - total organic vapour

Drawn By/Checked By: T. Pawlick / J. Yaraskavitch

APPENDIX D

Basic Chemical Results, AGAT Laboratories Report No.'s 21Z766508 and 21Z753767

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: GOLDER ASSOCIATES LTD
1931 ROBERTSON ROAD
OTTAWA, ON K2H5B7
(613) 592-9600
ATTENTION TO: Laura Jones
PROJECT:
AGAT WORK ORDER: 21Z753767
WATER ANALYSIS REVIEWED BY: Jacky Zhu, Spectroscopy Technician
DATE REPORTED: Jun 07, 2021
PAGES (INCLUDING COVER): 5
VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*Notes

Disclaimer:

- All work conducted herein has been done using accepted standard protocols, and generally accepted practices and methods. AGAT test methods may incorporate modifications from the specified reference methods to improve performance.
- All samples will be disposed of within 30 days after receipt unless a Long Term Storage Agreement is signed and returned. Some specialty analysis may be exempt, please contact your Client Project Manager for details.
- AGAT's liability in connection with any delay, performance or non-performance of these services is only to the Client and does not extend to any other third party. Unless expressly agreed otherwise in writing, AGAT's liability is limited to the actual cost of the specific analysis or analyses included in the services.
- This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
- The test results reported herewith relate only to the samples as received by the laboratory.
- Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, warranties of merchantability, fitness for a particular purpose, or non-infringement. AGAT assumes no responsibility for any errors or omissions in the guidelines contained in this document.
- All reportable information as specified by ISO/IEC 17025:2017 is available from AGAT Laboratories upon request.

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 21Z753767

PROJECT:

CLIENT NAME: GOLDER ASSOCIATES LTD

ATTENTION TO: Laura Jones

SAMPLING SITE:

SAMPLED BY:

(Water) Inorganic Chemistry

DATE RECEIVED: 2021-05-28

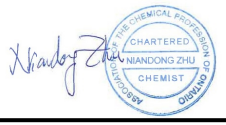
DATE REPORTED: 2021-06-07

			SAMPLE DESCRIPTION:	BH21-05		BH21-02
			SAMPLE TYPE:	Water		Water
			DATE SAMPLED:	2021-05-27 11:45		2021-05-27 10:00
Parameter	Unit	G / S	RDL	2534942	RDL	2535147
Chloride	mg/L		0.12	5.45	2.4	3440
Sulphate	mg/L		0.10	436	1.9	233
Sulphide	mg/L		0.01	<0.01	0.01	<0.01
pH	pH Units		NA	7.95	NA	7.70
Electrical Conductivity	µS/cm		2	1200	2	11300
Resistivity	ohms.cm			833		88
Redox Potential	mV		NA	294	NA	288

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Analysis perfomed at AGAT Toronto (unless marked by *)

Certified By:



AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: GOLDER ASSOCIATES LTD

AGAT WORK ORDER: 21Z753767

PROJECT:

ATTENTION TO: Laura Jones

SAMPLING SITE:

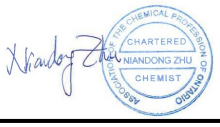
SAMPLED BY:

Water Analysis

RPT Date: Jun 07, 2021			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
(Water) Inorganic Chemistry															
Chloride	2537065		14.3	14.2	0.7%	< 0.10	95%	70%	130%	103%	80%	120%	103%	70%	130%
Sulphate	2537065		38.8	38.7	0.3%	< 0.10	100%	70%	130%	102%	80%	120%	NA	70%	130%
Sulphide	2529751		<0.01	<0.01	NA	< 0.01	99%	90%	110%	101%	90%	110%	98%	80%	120%
pH	2532713		7.87	7.90	0.4%	NA	102%	98%	103%						
Electrical Conductivity	2532713		542	542	0.0%	< 2	104%	90%	110%						
Redox Potential	2534942		294	304	3.3%		100%	90%	110%						

Comments: NA Signifies Not Applicable.
Duplicate NA: results are under 5X the RDL and RPD will not be calculated.
Matrix spike: Spike level < native concentration. Matrix spike acceptance limits do not apply.

Certified By:



AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Method Summary

CLIENT NAME: GOLDER ASSOCIATES LTD

AGAT WORK ORDER: 21Z753767

PROJECT:

ATTENTION TO: Laura Jones

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Chloride	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Sulphate	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Sulphide	INOR-93-6054	modified from SM 4500 S2- D	SPECTROPHOTOMETER
pH	INOR-93-6000	modified from SM 4500-H+ B	PC TITRATE
Electrical Conductivity	INOR-93-6000	modified from SM 2510 B	PC TITRATE
Resistivity		SM 2510 B	EC METER
Redox Potential		SM 2580 B	REDOX POTENTIAL ELECTRODE

AGAT Laboratories

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
webearth.agatlabs.com

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Laboratory Use Only
Work Order #: 21275376?.
Cooler Quantity: two onice.
Arrival Temperatures: 2.9 | 2.9 | 2.6 / 2.4 | 3.2 | 3.2
Custody Seal Intact: ☐Yes ☐No ☐N/A
Notes:

Report Information:
Company: Golder Associates Ltd.
Contact: Kimberley MacDonald
Address: 1931 Robertson Rd, Ottawa, ON
RMathew@golder.com
Phone: 613-592-9600 Fax: 613-592-9601
Reports to be sent to:
1. Email: kimacdonald@golder.com
2. Email: Kimberley_MacDonald@Golder.com

Regulatory Requirements:
(Please check all applicable boxes)
☒ Regulation 153/04 — Table 3 (Indicate One) ☐ Ind/Com ☒ Res/Park ☐ Agriculture
Soil Texture (Check One): ☒ Coarse ☐ Fine
☐ Excess Soils R406 — Table ____ (Indicate One)
☐ Regulation 558
☐ CCME
☐ Sewer Use ☐ Sanitary ☐ Storm — Region ____
☐ Prov. Water Quality Objectives (PWQO)
☐ Other ____ (Indicate One)

Turnaround Time (TAT) Required:
Regular TAT ☒ 5 to 7 Business Days
Rush TAT (Rush Surcharges Apply)
☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day
OR Date Required (Rush Surcharges May Apply): ____
Please provide prior notification for rush TAT
*TAT is exclusive of weekends and statutory holidays
For 'Same Day' analysis, please contact your AGAT CPM

Project Information:
Project: Ottawa Hospital
Site Location:
Sampled By: RMathew
AGAT Quote #: 50 PO: 21451149-2000
Please note: If quotation number is not provided, client will be billed full price for analysis.

Is this submission for a **Record of Site Condition?** ☒ Yes ☐ No

Report Guideline on *Certificate of Analysis* ☐ Yes ☐ No

Invoice Information:
Bill To Same: Yes ☐ No ☐
Company:
Contact:
Address:
Email:

Sample Matrix Legend
B Biota
GW Ground Water
O Oil
P Paint
S Soil
SD Sediment
SW Surface Water

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI, DOC (Y/N)	O. Reg 153: Metals & Inorganics	Metals - ☐CrVI, ☐Hg, ☐HWSB	BTEX, F1-F4 PHCs Analyze F2G if required ☐Yes ☐No	PAHs	PCBs	VOC	O. Reg 558: Landfill Disposal Characterization TCLP: ☐M&I ☐VOCs ☐ABNs ☐B(a)P ☐PCBs	Excess Soils SPLP Rainwater Leach SPLP: ☐Metals ☐VOCs ☐SVOCs	O. Reg 406: Excess Soils Characterization Package pH, ICPMS Metals, BTEX, F1-F4	Salt - EC/SAR	Corrosion							Potentially Hazardous or High Concentration (Y/N)
BH21-05	27/05/21	11:45 AM/PM	17	GW	metals held	Y											✓							
BH21-02	27/05/21	10:00 AM/PM	17	GW	filtered but	Y											✓							
		AM/PM			Corrosion in																			
		AM/PM			Gen chem																			
		AM/PM			Obottle not																			
		AM/PM			field filtered.																			
		AM/PM																						
		AM/PM																						
		AM/PM																						
		AM/PM																						
		AM/PM																						

Samples Relinquished By (Print Name and Sign)	Date	Time	Samples Received By (Print Name and Sign)	Date	Time
Rochelle Mathew Rochelle	May 27/21	15:00	Bertheleil	21/05/28	9h30
to Dino	21/5/28	16h00			

Page 1 of 1
N°: 112532

Document ID: DM-76-1011.028

Pink Copy - Client | Yellow Copy - AGAT | White Copy- AGAT

Date Issued: August 24, 2020

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: GOLDER ASSOCIATES LTD
1931 ROBERTSON ROAD
OTTAWA, ON K2H5B7
(613) 592-9600
ATTENTION TO: Kim MacDonald
PROJECT: 21451149
AGAT WORK ORDER: 21Z766508
WATER ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Lab Manager
DATE REPORTED: Jun 30, 2021
PAGES (INCLUDING COVER): 5
VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*Notes

Disclaimer:

- *All work conducted herein has been done using accepted standard protocols, and generally accepted practices and methods. AGAT test methods may incorporate modifications from the specified reference methods to improve performance.*
- *All samples will be disposed of within 30 days after receipt unless a Long Term Storage Agreement is signed and returned. Some specialty analysis may be exempt, please contact your Client Project Manager for details.*
- *AGAT's liability in connection with any delay, performance or non-performance of these services is only to the Client and does not extend to any other third party. Unless expressly agreed otherwise in writing, AGAT's liability is limited to the actual cost of the specific analysis or analyses included in the services.*
- *This Certificate shall not be reproduced except in full, without the written approval of the laboratory.*
- *The test results reported herewith relate only to the samples as received by the laboratory.*
- *Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, warranties of merchantability, fitness for a particular purpose, or non-infringement. AGAT assumes no responsibility for any errors or omissions in the guidelines contained in this document.*
- *All reportable information as specified by ISO/IEC 17025:2017 is available from AGAT Laboratories upon request.*

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 21Z766508

PROJECT: 21451149

CLIENT NAME: GOLDER ASSOCIATES LTD

SAMPLING SITE:

ATTENTION TO: Kim MacDonald

SAMPLED BY:James Sullivan

(Water) Inorganic Chemistry

DATE RECEIVED: 2021-06-25

DATE REPORTED: 2021-06-30

SAMPLE DESCRIPTION:				BH21-10-GW		BH21-215-GW		BH21-213-GW	BH21-201-GW		BH21-2215-GW
SAMPLE TYPE:				Water		Water		Water	Water		Water
DATE SAMPLED:				2021-06-25 09:00		2021-06-25 09:20		2021-06-25 09:35	2021-06-25 10:05		2021-06-25 09:45
Parameter	Unit	G / S	RDL	2662463	RDL	2662465	RDL	2662466	2662467	RDL	2662468
pH	pH Units		NA	7.53	NA	7.66	NA	7.87	7.79	NA	7.70
Electrical Conductivity	µS/cm		2	1460	2	1980	2	1310	1500	2	2420
Chloride	mg/L		0.12	4.73	0.24	267	0.12	225	216	0.49	497
Sulphate	mg/L		0.10	458	0.19	305	0.10	74.3	130	0.38	169

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

2662463 Dilution required, RDL has been increased accordingly.

Analysis perfomed at AGAT Toronto (unless marked by *)

Certified By: Amanjot Bhela

CHARTERED AMANJOT BHELA CHEMIST

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: GOLDER ASSOCIATES LTD

AGAT WORK ORDER: 21Z766508

PROJECT: 21451149

ATTENTION TO: Kim MacDonald

SAMPLING SITE:

SAMPLED BY:James Sullivan

Water Analysis

RPT Date: Jun 30, 2021			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
(Water) Inorganic Chemistry															
pH	2661074		7.78	7.79	0.1%	NA	101%	98%	103%	NA			NA		
Electrical Conductivity	2661074		1130	1130	0.0%	< 2	108%	90%	110%	NA			NA		
Chloride	2662465	2662465	267	258	3.4%	< 0.10	97%	70%	130%	103%	80%	120%	NA	70%	130%
Sulphate	2662465	2662465	305	295	3.3%	< 0.10	96%	70%	130%	99%	80%	120%	NA	70%	130%

Comments: NA Signifies Not Applicable
Duplicate NA: results are under 5X the RDL and will not be calculated.
Matrix spike NA: Spike level < native concentration. Matrix spike acceptance limits do not apply and are not calculated.

Certified By:

Amanjot Bhela

ASSOCIATION OF THE CHEMICAL PROFESSION OF ONTARIO
CHARTERED
AMANJOT BHELA
CHEMIST

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Method Summary

CLIENT NAME: GOLDER ASSOCIATES LTD

AGAT WORK ORDER: 21Z766508

PROJECT: 21451149

ATTENTION TO: Kim MacDonald

SAMPLING SITE:

SAMPLED BY:James Sullivan

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
pH	INOR-93-6000	modified from SM 4500-H+ B	PC TITRATE
Electrical Conductivity	INOR-93-6000	modified from SM 2510 B	PC TITRATE
Chloride	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Sulphate	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH

AGAT Laboratories

1 med red

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
webearth.agatlabs.com

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Report Information:

Company: GOLDER ASSOCIATES
Contact: KIM MACDONALD
Address: 1931 ROBERTSON RD.
Phone: Fax:
Reports to be sent to:
1. Email: kim_macdonald@golder.com
2. Email:

Project Information:

Project: 21451149
Site Location:
Sampled By: James Sullivan
AGAT ID #: PO:
Please note: If quotation number is not provided, client will be billed full price for analysis.

Invoice Information:

Bill To Same: Yes ☒ No ☐
Company:
Contact:
Address:
Email:

Regulatory Requirements:

(Please check all applicable boxes)

☐ Regulation 153/04
Table _____ *Indicate One*
☐ Ind/Com
☐ Res/Park
☐ Agriculture
Soil Texture *(Check One)*
☐ Coarse
☐ Fine

☐ Excess Soils R406
Table _____ *Indicate One*
☐ Regulation 558
☐ CCME

☐ Sewer Use
☐ Sanitary ☐ Storm
_____ *Region*
☐ Prov. Water Quality Objectives (PWQO)
☐ Other
_____ *Indicate One*

Is this submission for a **Record of Site Condition?** ☐ Yes ☐ No

Report Guideline on *Certificate of Analysis* ☐ Yes ☐ No

Sample Matrix Legend

B	Biota
GW	Ground Water
O	Oil
P	Paint
S	Soil
SD	Sediment
SW	Surface Water

Laboratory Use Only

Work Order #: 21776658
Cooler Quantity: one - ice
Arrival Temperatures: 11.0 | 11.1 | 10.8
LT: 6.9 | 7.1 | 7.4
Custody Seal Intact: ☐Yes ☐No ☐N/A
Notes: ON ICE

Turnaround Time (TAT) Required:

Regular TAT (Most Analysis) ☒ 5 to 7 Business Days
Rush TAT (Rush Surcharges Apply)
☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day
OR Date Required (Rush Surcharges May Apply):
Please provide prior notification for rush TAT
**TAT is exclusive of weekends and statutory holidays*
For 'Same Day' analysis, please contact your AGAT CPM

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI, DOC (Y/N)	O. Reg 153: Metals & Inorganics	Metals - ☐ CrVI, ☐ Hg, ☐ HWSB	BTEX, F1-F4 PHCs Analyze F4G if required ☐ Yes ☐ No	PAHs	Total PCBs ☐ Aroclor	VOC	O. Reg 558: Landfill Disposal Characterization TCLP: ☐ M&I ☐ VOCs ☐ ABNs ☐ B(a)P ☐ PCBs	O. Reg 406: Excess Soils SPLP Rainwater Leach SPLP: ☐ Metals ☐ VOCs ☐ SVOCs	Excess Soils Characterization Package pH, ICPMS Metals, BTEX, F1-F4	Salt - EC/SAR	pH	resistivity conductivity	chlorides	sulphates					Potentially Hazardous or High Concentration (Y/N)
BH 21-10 - GW	21-06-25	900 AM/PM	1	GW													✓	✓	✓	✓					
BH 21-215 - GW	"	920 AM/PM	1	GW													✓	✓	✓	✓					
BH 21-213 - GW	"	935 AM/PM	1	GW													✓	✓	✓	✓					
BH 21-201 - GW	"	10:05 AM/PM	1	GW													✓	✓	✓	✓					
BH 21-2215 - GW	"	9:45 AM/PM	1	GW													✓	✓	✓	✓					
		AM/PM																							
		AM/PM																							
		AM/PM																							
		AM/PM																							
		AM/PM																							
		AM/PM																							

Samples Relinquished By (Print Name and Sign): James Sullivan	Date: 21-06-25	Time: 11:35	Samples Received By (Print Name and Sign): Bethelet Dyu	Date: 21/06/25	Time: 14h06
Samples Relinquished By (Print Name and Sign):	Date: 21/06/25	Time: 14h00	Samples Received By (Print Name and Sign): Avneet Minhas AM	Date: June 26/21	Time: 10:50 am
Samples Relinquished By (Print Name and Sign):	Date: 21/06/25	Time: 16h00	Samples Received By (Print Name and Sign):	Date:	Time:

Page _____ of _____
Nº: T114866

APPENDIX E

Special Provision - Well Abandonment

WELL ABANDONMENT - Item No.

Special Provision

General Requirements

Monitoring wells are located in the work area and shall be properly decommissioned prior to any construction activities being undertaken. The wells are located at boreholes 21-01, 21-02, 21-03, 21-05 and 21-06. The construction details of those wells are provided on the Record of Borehole Sheets in the geotechnical investigation report (no. 21451149-1000-01).

The well abandonment method must satisfy the minimum requirements of Ontario Regulation 903. Approval of the proposed abandonment methodology, including plugging material used, depth of plugging material and limit of the casing removal, must be obtained from the Contract Administrator before proceeding. In addition, the Contractor shall provide a copy of the well record (for the abandonment) to the Contract Administrator.

Without superseding the full scope of Ontario Regulation 903, the abandonment of the wells should at least include plugging the wells using an abandonment barrier, starting from the bottom, up to approximately two metres from the ground surface.

Basis of Payment

Payment at the Contract price for the tender item "Well Abandonment" shall be on a per well basis, the price of which shall include full compensation for all labour, equipment and materials required to properly abandon each monitoring well including reporting and documentation.

END OF SECTION

golder.com