Preliminary Geotechnical Investigation Report

Proposed Development – 1495 Heron Road

Ottawa, Ontario

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1.0 INTRODUCTION

Canada Lands Company Ltd. (CLC) (Company) has retained Stantec Consulting Ltd. (Stantec) to provide engineering services including a geotechnical investigation for the proposed redevelopment of the Site located at 1495 Heron Road in Ottawa, Ontario.

This report presents the results of the geotechnical investigation and preliminary recommendations for design of the proposed development.

The work was carried out in general accordance with the scope of work for a geotechnical investigation as outlined in Stantec's proposal dated May 10, 2021.

This report has been prepared specifically and solely for the project described herein. It presents the factual results of the investigation and provides preliminary geotechnical recommendations for the design and construction for the proposed development. The preliminary recommendations provided in this report should be reviewed and updated as the design of the proposed development progresses.

Limitations associated with this report and its contents are provided in the statement of general conditions included in Appendix A.

2.0 PROJECT DESCRIPTION

2.1 PROPOSED DEVELOPMENT

The project site location is shown on the Borehole Location Plan, Drawing No. 1 in Appendix B.

The property boundaries, proposed site layout and configuration are also shown on Drawing No. 1 in Appendix B which are based on the concept developed by the Stantec design team in June 2022. The proposed development is expected to include new buildings ranging from 1 to 9 storeys. The proposed buildings will be a combination of mixed-use buildings (retail & multifamily), stacked townhouses, multifamily buildings and civic buildings. It is understood that all parking will be below grade, with up to two below grade parking levels beneath the proposed development. The proposed development also includes a heritage courtyard, open green space, and stormwater infrastructure. A number of the existing buildings are proposed to be retained as part of the Preferred Development Plan.

2.2 SITE DESCRIPTION AND BACKGROUND

The site is an 18.1-hectare (44.7-acre) institutional site consisting of 12 buildings, formerly owned by the federal government for use as a training centre. The existing buildings consist of a total floor area of approximately 20,312 sq.m. The exterior portions of the property include surface parking and two tennis courts. The northwestern portion of the property contains 3.8 acres of non-developable wooded land.

The federal government identified the property as surplus to its requirements and disposed of the lands to CLC in 2020 with the intent to redevelop the site as a mixed-use development consisting of residential, commercial, retail and open space.

Based on available information including geological mapping and historical boreholes including the 2015 boreholes by DST, the stratigraphy is generally expected to consist of clay and till over shallow bedrock. The depth to bedrock was typically found to be less than 5 m below ground surface. The 2015 DST boreholes are included in Appendix C.

3.0 SCOPE OF WORK

The scope of work for this geotechnical investigation included the following:

- Advance twelve (12) sampled boreholes to a depth of 7 m or refusal if shallower within the site to characterize the subsurface conditions.
- Core bedrock at eight locations for a length of approximately 1.5 m.
- Install three monitoring wells in the boreholes.
- Characterize the soil and rock with laboratory testing.
- Prepare a Preliminary Geotechnical Investigation Report for the development with a summary of the field investigation results and observations, laboratory test results, a borehole location plan, and geotechnical engineering recommendations for the design and construction of the project including:
  - Site descriptions (local geology, historical soils information, existing conditions, and existing development)
  - A summary of subsurface conditions and groundwater levels encountered in the boreholes;
  - Site preparation and grading and re-use of site generated materials;
  - General foundation design geotechnical bearing resistance values at ULS and SLS for the site;
  - Groundwater level measurements and foundation drainage recommendations;
  - Seismic design considerations including assessment of the Seismic Site classification;
  - Comments on soil liquefaction;
  - Frost protection recommendations;
  - Comments on temporary excavations;
  - Grade raise restrictions and site development restrictions;
  - Pavement recommendations for parking, access roads and pathways;
  - Excavation and backfill requirements;
  - Pipe bedding and backfill;
  - Corrosivity analysis;
  - Tree planting restrictions; and
  - Slope stability analysis (if required).

4.0 METHOD OF INVESTIGATION

4.1 GEOTECHNICAL FIELD INVESTIGATION

Prior to commencing the field work, public and private utility locates were completed to confirm the locations of underground utilities at the site.

Between June 20, 2022 and July 11, 2022, boreholes BH22-1 to BH22-12 were advanced. The approximate locations of the boreholes and monitoring wells are shown on Drawing No. 1 in Appendix B.

The boreholes were advanced using truck-mounted and track-mounted CME drill rigs. Soil samples were collected at regular intervals while conducting Standard Penetration Tests (SPTs). The subsurface stratigraphy encountered in each hole was recorded in the field by Stantec personnel. Bedrock was cored at eight locations using NQ-size or HQ-size coring equipment. The boreholes were backfilled with auger cuttings and bentonite hole plug. Monitoring wells were installed at four locations (MW22-4, MW22-7, MW22-8 and MW22-11) to allow for the groundwater levels to be measured.

All recovered soil samples and rock cores were transported to the Stantec Ottawa laboratory for detailed geotechnical classification and testing.

4.2 SURVEYING

Borehole locations were surveyed using a Trimble GPS unit with decimeter accuracy. It is noted that accuracy may be affected by satellite coverage at the time of survey. Geodetic elevations at borehole locations are shown on the Borehole Records in Appendix C.

4.3 LABORATORY TESTING

All samples returned to the laboratory were subjected to detailed visual examination and classification by a geotechnical engineer. Selected samples were tested for moisture contents, Atterberg Limits, and grain size analyses and samples were submitted to Paracel Laboratories in Ottawa for pH, Sulphate content and Resistivity testing. Rock core samples were tested for intact rock core strength.

The results of the laboratory tests are discussed in the text of this report and are provided on the Borehole Records in Appendix C and the test results are provided in Appendix D.

Samples will be stored for a period of three (3) months after issuance of this report unless we are otherwise directed by the client.

5.0 RESULTS OF INVESTIGATION

5.1 SUBSURFACE INFORMATION

The subsurface profile varies across the site. Generally, the subsurface profile consists of surficial topsoil over till materials overlying bedrock.

The subsurface conditions observed in the boreholes are presented in detail on the Borehole Records and Field Bedrock Core Logs provided in Appendix C. An explanation of the symbols and terms used to describe the Borehole Records is also provided in Appendix C.

A general overview of the soil, rock and groundwater conditions encountered in the boreholes is provided below.

5.1.1 Surficial Materials

Topsoil was encountered at surface in six boreholes. The thickness of topsoil ranged from 125 mm to 610 mm. The table below outlines the topsoil thickness encountered at the borehole locations.

The moisture content of the topsoil was around 16% in a tested sample.

Table 5.1: Summary of Topsoil Thickness

Borehole/Monitoring Well Location	Topsoil Thickness (mm)
BH22-2	200
BH22-3	240
MW22-4	125
MW22-8	610
BH22-10	225
BH22-12	125

Asphalt was encountered at surface in two boreholes. The thickness of asphalt ranged from 40 mm to 75 mm. The table below outlines the asphalt thickness encountered at the borehole locations.

Table 5.2: Summary of Asphalt Thickness

Borehole/Monitoring Well Location	Asphalt Thickness (mm)
BH22-5	75
MW22-11	40

5.1.2 Fill

Fill was encountered at ground surface or beneath asphalt in boreholes BH22-6, MW22-7, BH22-9, and MW22-11. The fill consisted of silty sand with gravel. The thickness of the fill ranged from 0.4 m to 0.6 m.

The Standard Penetration Test (SPT) N values in the fill were 15 to 32 indicating a compact to dense state.

Moisture contents of the fill ranged from 3% to 13%.

5.1.3 Silty Sand with Gravel (SM)

A layer of brown silty sand with gravel and with trace topsoil and rootlets was encountered below the topsoil in MW22-8. The silty sand with gravel layer was approximately 0.8 m thick.

The Standard Penetration Test (SPT) N value in this layer was 7 indicating a loose compactness.

Moisture content of this silty sand layer was 21%.

5.1.4 Glacial Till

A till deposit was encountered in all of the boreholes.

The till was variable throughout the site, it was described as silty SAND with gravel, clayey SAND, clayey SAND with gravel and sandy lean CLAY with frequent cobbles and boulders noted at some locations.

The glacial till in the Ottawa-Gatineau area is usually crowded with cobbles and boulders set in a matrix of finer-grained material (gravel, sand, silt and clay); large boulders in excess of 1.0 m are common. It is unsorted and without stratification, but in places contains discontinuous layers or irregular shaped masses of sand and silt. Where glacial till deposits are identified, cobbles and boulders are present and permeable layers of sand and silt may randomly be present; due to the unsorted and unstratified nature of the glacial till, it is possible to advance boreholes while encountering only matrix material.

Standard Penetration Test (SPT) N values varied from 6 to greater than 50 indicating a loose to very dense compactness. The clay till was too stiff to carry out field vane tests

The moisture content of the till ranged from 3% to 24%.

Fourteen representative samples of the till were tested for grain size analysis and the results are summarized in the table below and on Figure No. 1 in Appendix D.

Table 5.3: Summary of Grain Size Analysis of Glacial Till

Borehole/Monitoring Well No.	Sample No.	Depth (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	USCS Classification
BH22-1	SS2	0.8 – 1.4	10	43	29	18	Clayey SAND (SC)
BH22-2	SS4	2.3 – 2.9	28	39	23	10	Silty SAND with Gravel (SM)
BH22-3	SS2	0.8 – 1.4	3	28	38	31	Sandy Lean CLAY (CL)
BH22-3	SS6	3.8 – 4.4	19	45	26	10	Silty SAND with Gravel (SM)
MW22-4	SS2	0.8 – 1.4	10	39	30	19	Sandy Lean CLAY (CL)
MW22-4	SS5	3.1 – 3.7	5	45	31	19	Clayey SAND (SC)
BH22-6	SS3	1.5 – 2.1	25	42	22	11	Silty SAND with Gravel (SM)
BH22-6	SS7	4.6 – 5.2	29	33	27	11	Silty SAND with Gravel (SM)
MW22-7	SS2	0.8 – 1.4	10	40	29	21	Clayey SAND (SC)
MW22-8	SS4	2.3 – 2.9	11	50	26	13	Clayey SAND (SC)
BH22-9	SS3	1.5 – 2.1	17	47	24	12	Clayey SAND with Gravel (SC)
MW22-11	SS2	0.8 – 1.4	15	31	27	27	Clayey SAND with Gravel (SC)
BH22-10	SS3	1.5 – 2.1	15	50	23	12	Clayey SAND with Gravel (SC)
BH22-12	SS4	2.3 – 2.9	14	43	28	15	Clayey SAND (SC)

Atterberg Limit tests were carried out on six samples of the clay till. The results are summarized in the table below with the calculated Liquidity Index. The results of the Atterberg Limit testing are also detailed on the Borehole Records in Appendix C and on Figure No. 2 in Appendix D.

Table 5.4: Atterberg Limits and Liquidity Index of Glacial Till

Borehole /Monitoring Well No.	Sample No.	Depth (m)	Moisture Content, w_n (%)	Liquid Limit, LL	Plastic Limit, PL	Plasticity Index	Liquidity Index, LI (%)
MW22-4	SS2	0.8 – 1.4	14.8	33	20	13	0.4
MW22-7	SS2	0.8 – 1.4	15.1	31	17	14	0.1
MW22-8	SS4	2.3 – 2.9	7.9	20	12	8	0.5
BH22-9	SS3	1.5 – 2.1	8.0	20	12	8	0.5
MW22-11	SS2	0.8 – 1.4	13.9	28	17	11	0.3
BH22-12	SS4	2.3 – 2.9	10.9	25	15	10	0.4

In accordance with the Unified Soil Classification System (USCS), the till soil can be classified as silty SAND with gravel (SM), clayey SAND (SC), clayey SAND with gravel (SC) and sandy lean CLAY (CL).

5.1.5 Fat CLAY (CH)

A layer of fat clay was encountered in borehole BH22-5 at a depth of approximately 2.3 m. The thickness of the clay encountered was approximately 0.8 m.

The Standard Penetration Test (SPT) N value with the clay was 12 indicating a stiff consistency. The clay was stiff to carry out field vane testing.

The moisture content of the fat clay was approximately 16%.

One representative sample of the fat clay was tested for grain size analysis and the results are summarized in the table below and on Figure No. 3 in Appendix D.

Table 5.5: Summary of Grain Size Analysis of Fat CLAY (CH)

Borehole/Monitoring Well No.	Sample No.	Depth (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	USCS Classification
BH22-5	SS4	2.4 – 3.0	0	2	39	59	Fat CLAY (CH)

Atterberg Limit tests were carried out on one sample of the fat clay. The results are summarized in the table below with the calculated Liquidity Index. The results of the Atterberg Limit testing are also detailed on the Borehole Records in Appendix C and on Figure No. 2 in Appendix D.

Table 5.6: Atterberg Limits and Liquidity Index of Fat CLAY (CH)

Borehole /Monitoring Well No.	Sample No.	Depth (m)	Moisture Content, w_n (%)	Liquid Limit, LL	Plastic Limit, PL	Plasticity Index	Liquidity Index, LI (%)
BH22-5	SS4	2.3 – 2.9	16.0	59	23	36	0.2

In accordance with the USCS, the soil can be classified as fat CLAY (CH).

5.1.6 Bedrock

Bedrock was proven by coring in eight boreholes. Auger refusal on inferred bedrock was encountered in one borehole. The depth to bedrock at the site ranged from 3.1 m to 6.1 m below existing ground surface. The bedrock consisted of a combination of shale and limestone. The bedrock at the site falls within the Carlsbad Formation shale, which is a pyritic shale, additional comments about construction within pyritic shale are provided later in this report.

The Total Core Recovery (TCR) ranged from 90% to 100% and the Rock Quality Designation (RQD) ranged from 0% to 100% indicating a very poor to excellent rock quality. Bedding joints were typically very close to closely spaced within the cored bedrock. The bedrock was typically fresh to slightly weathered. Photographs of the rock cores and the detailed field bedrock core logs are provided in Appendix C.

Bedrock proven and inferred depths are provided in the table below.

Table 5.7: Depth to Bedrock and Bedrock Type

Borehole No.	Depth to Bedrock (m)	Depth to Refusal (m)	Bedrock Elevation (m)	Comments	Bedrock Type
BH22-1	6.1		92.7	Bedrock proven by coring	Shale
BH22-3	5.0		91.5	Bedrock proven by coring	Shale
MW22-4	4.6		92.2	Bedrock proven by coring	Shale
BH22-5		3.5	92.9	Bedrock inferred from auger refusal	-
BH22-6	6.0		89.8	Bedrock proven by coring	Limestone
MW22-8	4.3		91.7	Bedrock proven by coring	Limestone with Shale and Quartz interbedded
BH22-9	5.0		90.2	Bedrock proven by coring	Shale
MW22-11	3.1		93.0	Bedrock proven by coring	Limestone with Shale interbedded
BH22-12	3.8		93.6	Bedrock proven by coring	Shale with Limestone interbedded

Unconfined compressive strength tests were carried out on selected intact rock cores. The results of the unconfined compressive strength tests ranged from 29 MPa to 98 MPa indicating the bedrock is medium strong to strong.

5.2 GROUNDWATER

Monitoring wells were installed at four of the boreholes. The groundwater levels were measured on July 6, 2022.

Table 5.8: Summary of Measured Groundwater Levels

Borehole/Monitoring Well Location	Groundwater Depth Below Ground Surface on July 6, 2022 (m)	Groundwater Elevation (m) on July 6, 2022
MW22-4	1.0	95.8
MW22-7	1.7	94.0
MW22-8	1.7	94.3
MW22-11	1.1	95.0

Fluctuations in the groundwater levels due to seasonal variations or in response to particular precipitation events should be anticipated.

Three in-situ percolation tests were carried out at the site using a Guelph Permeameter apparatus. The results will be included in the final report.

6.0 DISCUSSION AND RECOMMENDATIONS

This section of the report provides preliminary geotechnical engineering input related to the proposed redevelopment of 1495 Heron Road. These recommendations are all preliminary in nature and should be reviewed prior to the final design at the site.

6.1 OVERVIEW OF SUBSURFACE CONDITIONS AND GEOTECHNICAL ISSUES

The subsurface soil conditions encountered at the site generally consist primarily of till materials over shale and limestone bedrock. The depth to bedrock at the site ranged from approximately 3.1 m to 6.1 m below existing ground surface. The bedrock consisted of a combination of shale and limestone. The bedrock at the site falls within the Carlsbad Formation shale which is a pyritic shale.

Based on the above conditions, the following is noted for the proposed development:

- The site soils consist mostly of a till deposit containing varying amounts of clay and its compactness increases with depth from loose to very dense compactness. A clay layer 0.8 m thick was also encountered in one of the boreholes, however, the clay was found to have a relatively low in-situ moisture content and to be in a typically stiff consistency.
- Conventional spread footing foundations are considered a feasible foundation system for the support of the proposed buildings at this site.
- It is understood that the proposed buildings and parking structures will include multiple below grade levels. It is anticipated that most foundations will be founded on bedrock.
- Bedrock excavation may be required depending on the founding level of the proposed buildings and utilities. The shale bedrock at the site can be classified as a pyritic shale which is referred to as “expansive shale” due to the potential for heaving when exposed to water and air. In this regard, additional measures will be required to protect the shale bedrock.
- Groundwater was encountered at relatively shallow depths in the monitoring wells. Excavation depths greater than 1.5 m below ground surface may require special dewatering techniques.

6.2 TREE PLANTING

The site soils mostly consisted of a granular till deposit containing some amounts of clay. A tree planting restriction is not anticipated to be required at this site.

6.3 PRELIMINARY GRADING PLAN AND GRADE RAISE RESTRICTION

The till deposit encountered at the site included varying amounts of clay soils. The thickness of the clay till layer was generally limited to less than 2 m thick. A grade raise is not recommended at the site. If grade raises of greater than 2 m above existing site grades are proposed, a detailed analysis should be carried out.

6.4 SITE PREPARATION

6.4.1 Beneath Spread Footings and Floor Slabs

The removal of all existing fill, topsoil/rootmat and other deleterious materials from beneath the building floor slabs and from within the influence zone of the foundations is recommended for this site. The influence zone is defined by a line drawn from the edges of the footings/floor slabs outward at 1H:1V and extending downward to native undisturbed soils.

Any soft or loose areas exposed must be removed and replaced with compacted Structural Fill as directed by geotechnical personnel. Any grade adjustments beneath foundations and floor slabs should be conducted using approved Structural Fill material.

If bedrock is encountered, exposed bedrock surfaces should be free of loose bedrock, soil, water, bedrock irregularities and sloping surfaces. Hand cleaning and pressure washing the rock bearing areas to remove any loose materials will be required to achieve the recommended bearing pressure.

Within building excavations, cover exposed pyritic shale with a 50 mm mudmat within 24 hours of exposure; for vertical faces such as utility trenches and footing excavations, shotcrete or other spray-on sealing membranes may be used. This includes areas to be later backfilled.

Prepared subgrade surfaces should be inspected by experienced geotechnical personnel.

6.4.2 Beneath Driveways and Parking Areas

All existing facilities or structures, topsoil/rootmat, vegetation and organic soils must be entirely removed from proposed pavement areas (driveways and parking areas). Exposed subgrades in proposed pavement areas should be surface compacted with a large vibratory roller and inspected by geotechnical personnel. Soft, loose or disturbed soils within pavement areas should be sub-excavated to 500 mm below the design subgrade line and backfilled with compacted Subgrade Fill. The slopes of the sub excavation should be no steeper than 3H:1V within 1.2 m of finished grade to minimize the effects of differential frost heave.

It is recommended that both subgrade and finished pavement surfaces be graded to direct water towards suitable drainage. A frost taper of 3H:1V must be incorporated into the subgrade surface as a transition between differing pavement structures. It is recommended that the lateral extent of the subbase and base layers not be terminated vertically behind curb lines a taper with a grade of 3H:1V is recommended in the subgrade line to minimize differential frost heave problems under curbs and sidewalks.

6.4.3 Structural Fill and Subgrade Fill

Structural Fill for use beneath the footings or concrete floor slabs should consist of clean granular material such as OPSS Granular B Type II or OPSS Granular A. Structural Fill should be tested and approved by geotechnical personnel prior to placement. Structural Fill should be placed in lifts no thicker than 300 mm then compacted to a minimum of 100% Standard Proctor Maximum Dry Density (SPMDD).

Imported Subgrade Fill in paved areas, if required, should consist of materials meeting the requirements of OPSS Select Subgrade Material (SSM). Fill materials should be tested and approved by a Geotechnical Engineer prior to delivery to the site. Subgrade Fill should be placed in lifts no thicker than 300 mm then compacted using suitable equipment to a minimum of 95% SPMDD.

Re-use of site generated materials will be restricted to landscaping fill, the site soils are not suitable for re-use as subgrade fill, trench backfill, or exterior foundation wall backfill.

Note that construction techniques and weather conditions will influence the proportion of materials suitable for re-use.

Inspection and testing services will also be required to ensure that all fill is placed and compacted to the required degree.

6.4.4 Pyritic Shale

In Ottawa the pyritic shale of the Billings or Carlsbad formations typically present the following constraints to construction projects.

- The initial bacterial oxidation of pyrite produces ferrous sulphate and ferric sulphate which both attack concrete (i.e., sulphate attack).
- The weathering in the combined presences of water and oxygen produces sulphuric acid which results in an acidic environment that is aggressive towards steel and concrete.
- The sulphuric acid reacts with calcite seams (or thin layers) found within the shale converting it to gypsum. When calcite converts to gypsum, its volume increases by a factor of two which can result in destructive heaving; floor slabs and lightly loaded structures are particularly prone. The Billings and Carlsbad shale are colloquially referred to as “expansive shale”.

Autotrophic bacteria consume oxygen in the oxidation process and are believed to be most active between temperatures of 30 to 35 degrees Celsius. Restricting the air supply is generally viewed as an effective method of minimizing both the chemical and bacterial oxidation process.

The following conditions are typically considered favorable to the oxidation process:

- Features that allow air to enter the pyritic rock.
- Drained conditions or low groundwater table.
- Fissures or crushed zones in drained rock.
- Vertical cuts, such as utility trenches, permitting lateral air entry into the rock mass.
- A warm basement environment particularly close to the shale.
- Use of excavated shale as a fill material, which maximizes rock surface exposure to oxygen.

Common considerations when constructing within the expansive pyritic shale include:

- Excavate without disturbing the rock mass to avoid airflow within newly created fractures.
- Within building excavations, cover exposed pyritic shale with a 50 mm mudmat within 24 hours of exposure; for vertical faces such as utility trenches and footing excavations, shotcrete or other spray-on sealing membranes may be used. This includes areas to be later backfilled.

- Within building excavations, if possible excavate to a single level to avoid vertical faces within footing and utility trenches, otherwise protection of vertical faces is required.
- Within building excavations, if footing and utility trenches are excavated and backfilled within 24 hours, backfilling with concrete to the top of rock would protect the vertical faces.
- Use sulphate resistance concrete in areas exposed to the rock, including buried pipes.
- Insulate basement floors where spaces will have above normal temperatures.
- Avoid lowering the water table to a level lower than the top of rock left beneath the building.
- Avoid drained shafts or pits that could lower the water table beneath the building. If elevator pits, or similar features, are required, the design should include water-tight constructions.
- Do not use pyritic shale as a rock-fill or a crushed soil borrow source.
- Pyritic shale that will have a minimum of 1.0 m of natural soil cover is generally left untreated.
- Shale underlying heave sensitive structures or utilities should be protected from exposure to prevent differential movements. Shale underlying pavements, sidewalks, and landscaped areas are typically left unprotected but may require heave related maintenance in the long-term.
- Where the shale is left unprotected, consider the impact of a corrosive acidic environment on buried features including metallic bodies (column bases, piping, conduits, etc.); protection of horizontal and vertical shale faces within 24 hours of exposure may be warranted on this basis.
- Permanently exposed pyritic rock faces will rapidly deteriorate from their initial exposed condition.
- Inclusion of a vapour barrier beneath the slabs-on-ground to provide protection against aggressive vapours which may accumulate beneath the concrete slabs.

6.5 SEISMIC SITE CLASS

The seismic Site Class value, as defined in Section 4.1.8.4 of the 2012 Ontario Building Code (OBC), contains a seismic analysis and design methodology which uses a seismic site response and site classification system defined by the shear stiffness of the upper 30 metres of the ground below the foundation level. There are six site classes (from A to F), decreasing in stiffness from A (hard rock) to E (soft soil); Site Class F denotes problematic soils for which a site-specific evaluation is required.

Based on the results of the preliminary site investigation, it is appropriate to classify the existing ground conditions at the subject site as a Site Class of C. We note that a building founded on the bedrock can likely be designed with a better site class (i.e. a Site Class of A or B); however, the OBC requires measurement of shear wave velocities in the bedrock be carried out before these site classes can be used in design.

A copy of the NBC Seismic Hazard Calculation Data sheet is provided in Appendix E for reference.

6.6 FOUNDATIONS

It is anticipated that based on the proposed below grade levels, foundations will be founded on bedrock.

6.6.1 Geotechnical Bearing Resistance for Foundations

Geotechnical bearing resistances are provided for preliminary design purposes and are not intended for final design purposes.

Table 6.1: Geotechnical Bearing Resistance for Shallow Footings

Footing Founding Condition	ULS (kPa)	SLS (kPa)
Footings (2m or less in Width) on bedrock	500	-
Footings (2m or less in Width) on native till or on Structural Fill placed above the native till	300	250

The Ultimate Limit State (ULS) bearing resistance includes a resistance factor of 0.5. The Serviceability Limit State (SLS) bearing resistance corresponds to total settlement of 25 mm. Differential settlements between footings are expected to be less than 19 mm. The settlement of foundations founded on bedrock is expected to be negligible and therefore, Serviceability Limit States (SLS) are not anticipated to control design for footings bearing on the bedrock at this site.

All perimeter footings and interior footings located within 1 m from the exterior walls will require an equivalent minimum soil cover of 1.5 m for protection against frost action. Footings in unheated areas or exterior footings for unheated garages, signs, etc. should be founded at least 1.8 m below exterior grade to protect against frost action.

Where proposed footings have insufficient soil cover for frost protection, the use of insulation will be required. Where footings are placed on sound bedrock, the minimum soil cover can be reduced to 0.6 m.

For footings founded on bedrock, the footings should be founded on above a relatively level rock surface. All soil, and broken, fractured and/or loose bedrock should be removed to expose the competent bedrock surface.

The subgrade surfaces beneath all footings must be inspected by qualified geotechnical personnel prior to placing concrete to verify assumed foundation bearing conditions and integrity.

The unfactored horizontal resistance to sliding of the spread foundations may be calculated using the following unfactored coefficient of friction:

0.65 between bedrock and cast-in-place concrete

0.45 between till and cast-in-place concrete

In accordance with Table 8.1 of the Canadian Foundation Engineering Manual 4th Edition (CFEM), a resistance factor (ϕ) against sliding of 0.8 should be applied to obtain the factored resistance at ULS.

6.6.2 Foundation Wall Backfill

Foundation walls should be protected with damp-proofing and backfilled with free-draining granular material such as OPSS Granular B Type I. The zone of free-draining backfill should extend a horizontal distance of at least 500 mm out from the foundation wall.

Foundation backfill should be placed in lifts no thicker than 300 mm and compacted to 95% SPMDD. Care should be taken immediately adjacent to walls to avoid over compaction of the soil resulting in damage to the walls.

In areas where hard surfacing (e.g., concrete slabs, sidewalks) surround the building, differential frost heaving will occur between the granular fill backfill zone and other areas. To reduce this differential heaving, a frost taper of the granular backfill is recommended. The frost taper should extend up from 1.5 metres below finished exterior grade (at the foundation wall) at a slope of 3 horizontal to 1 vertical, or flatter, to the base of the pavement subgrade level.

Perimeter drains are required at this site in accordance with the OBC 2012.

6.7 FLOOR SLABS

The floor slabs for the lowest level of the proposed buildings are anticipated to be located below the final exterior grades. This level should either be designed to be waterproof/watertight or an underslab drainage system should be provided to prevent hydrostatic pressure build-up beneath the floor due to fluctuations in the water table and/or infiltration of surface water.

At least 300 mm of free draining material, such as 16 mm clear crushed stone, should be provided beneath the base of the slab. These materials should be lightly-compacted to provide a level surface and improve trafficability during construction. Subdrains consisting of 100 mm diameter perforated pipes should be provided at approximately 6 m spacings within the floor slab bedding and should be connected to a frost-free gravity outlet or a sump from which the water is pumped. The requirements for a underslab vapour barrier should be in accordance with the requirements of the Ontario Building Code.

The proposed building is anticipated to be supported on shallow foundations. If fill materials are present beneath the proposed founding elevation (e.g. areas previously excavated for service construction) or if the bedrock surface is found to be irregular, all fill materials and/or loose rock should be removed to expose the competent bedrock surface and the grade brought up to the founding level by placing 5 MPa concrete; the limits of the concrete placement should be determined on site by a geotechnical engineer.

The floor slabs constructed with a rock subgrade may be designed using a soil modulus of subgrade reaction, k, for a 0.3 m (1 ft.) square plate of 75 MPa/m.

A modulus of subgrade reaction, k, for a 0.3 m (1 ft.) square plate of 40 MPa/m may be used for a slab underlain by Structural Fill overlying the glacial till.

Where construction is undertaken during winter conditions, floor slab fill should be protected from freezing. Alternatively, the floor slab fill should be completely thawed, and then proof rolled prior to placing concrete.

6.8 TEMPORARY EXCAVATIONS

All temporary excavations should be carried out in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. Care should be taken to direct surface water away from the open excavations.

The excavation side slopes should be protected from precipitation or surface runoff to prevent further softening that could lead to additional sloughing and caving. If sloughing and cave-in are encountered in the excavation, the slopes should be further flattened to achieve a stable configuration. It is noted that boulders may be encountered during excavation at this site.

6.8.1 Excavations in Soil

The existing fill materials and native overburden soils are considered to be Type 3 soil in accordance with the Occupational Health and Safety Act (OHSA) and Regulations for Construction Projects. Temporary excavations in the overburden may be supported or should be sloped at 1 horizontal to 1 vertical from the base of the excavation as per the requirement of OHSA.

Excavations should be inspected regularly for signs of instability and flattened as required. At locations where significant groundwater inflow is encountered, the soil would be classified as Type 4, excavations should be sloped no steeper than 3H:1V from the base of the excavation.

Based on OHSA requirements, the soil must be classified as the type with highest classification of the types of soils present if an excavation contains more than one soil type (i.e. if Type 3 and Type 4 soils are present, the excavation must be sloped or supported in accordance with the requirements for Type 4 soils).

The stability of the wall of the excavation can also be affected by:

- Surcharge loads
- Stockpiles
- Groundwater seepage conditions

The excavations must be developed in a manner to ensure that adequate support is provided for any existing structures, utilities or underground services located adjacent to the excavations. Where there is insufficient space to develop open cuts without resultant loss of support for existing features, the installation of a shoring system meeting the requirements of the OHSA would be required. All shoring systems should be designed and approved by a qualified Professional Engineer.

6.8.2 Excavations in Bedrock

The bedrock encountered during the investigation consisted of limestone and shale bedrock. For shallow depths of bedrock excavation, it may be possible to carry out the bedrock removal using mechanical methods (such as hydraulic excavators and hoe ramming with pneumatic rock breakers).

Excavations within the high strength bedrock may require drill and blast techniques or hoe ramming in conjunction with closely spaced line drilling. If heritage structures are present near the site, vibration limits for the heritage structure may limit the use of blasting techniques.

Temporary excavation in bedrock may be carried out at near vertical slopes. The boreholes encountered very poor quality fractured rock in some locations, a temporary rock catchment system such as a wire mesh system and rock bolts should be used to stabilize the fractured bedrock. The catchment system should be designed to contain and/or prevent loose rock particles from falling on workers within the excavation. During winter conditions, ice build-up on the surface of the rock face could occur. Additional precautions should be taken to mitigate the risk of ice falls.

Bedrock excavation sidewalls adjacent to existing building foundations should be supported to ensure the stability of the existing buildings and should be reviewed by a Geotechnical Engineer.

6.9 DEWATERING

The groundwater level in the monitoring wells was measured between 1.0 m and 1.7 m below existing ground surface. Site grading should include the excavation of perimeter ditches to improve surface drainage and to reduce ground disturbances from construction activities. It is anticipated that excavations for utilities and structures may encounter groundwater and/or surface run-off. It is expected that groundwater and/or surface run-off may be controlled by sump and pump methods for excavations to as much as 1.5 m below ground surface. Excavation depths greater than 1.5 m below ground surface may require special dewatering techniques.

Basement floor slabs will likely be below the groundwater table and as such, perimeter and under slab drainage systems connected to a frost-free sump are recommended.

Site drainage should also be such that the run-off onto adjacent properties is controlled.

If dewatering activities are anticipated to exceed 50,000L/day, a Ministry of the Environment Permit to Take Water (PTTW) would be required. It is recommended that a hydrogeological assessment be completed to provide further detail on dewatering.

The quality of groundwater removed during the construction activities should be assessed at that time to determine if it may be disposed of directly to the local sanitary/storm sewer without treatment, under a permit that would be required from the city of Ottawa Sewer Use Program. The construction contractor has the responsibility to obtain a permit under the City of Ottawa Sewer Program and testing/discharge of water to sanitary or storm sewer.

6.10 MUNICIPAL SERVICES

Bedding for utilities should be placed in accordance with the pipe design and municipal requirements. It is recommended that a minimum of 150 mm to 300 mm of OPSS Granular A be placed below the pipe invert as bedding material and shall meet the City of Ottawa standards. Pipe cover materials should also consist of OPSS Granular A material. A minimum of 300 mm vertical and side cover should be provided.

These materials should be compacted to at least 95% of the material's SPMDD in lifts no greater than 300 mm. Clear crushed stone backfill should not be permitted as pipe bedding materials.

Backfill for service trenches in landscaped areas may consist of excavated material replaced and compacted in lifts. Where the service trenches extend below paved areas, the trench should be backfilled with Subgrade Fill material as defined in Section 6.4.3 from the top of the pipe cover to within 1.2 m of the proposed pavement surface, placed in lifts and compacted to at least 95% of SPMDD. The material used within the upper 1.2 m and below the subgrade line should be similar to that exposed in the trench walls to prevent differential frost heave, placed in lifts and compacted to at least 95% of SPMDD. Alternatively, where abutting materials within this zone are not similar a 3 horizontal to 1 vertical frost taper is required in order to minimize the effects of differential frost heaving.

Excavations for catch basins and manholes should be backfilled with OPSS Granular B Type I or II. A 3H:1V frost taper should be incorporated around catch basins and manholes within 1.2 m of finished grades. Joints between manhole and catch basin sections should be wrapped with a non-woven geotextile.

Service trenches within the clay should be provided with clay water stops to minimize potential long-term groundwater lowering in the area. Water stops should be constructed at a nominal spacing of 200 m and at utility trench junctions. The water stops should be constructed full width from trench bottom to 1.5 m from finished grade. The water stops should consist of compactable silty clay material placed in lifts no thicker than 300 mm and compacted to at least 95% SPMDD.

Backfill should be compacted in lifts not exceeding 300 mm. Materials testing and inspection should be carried out during construction to ensure the materials meet the project specifications and required level of compaction.

6.11 DRIVEWAYS

The subgrade in pavement areas should be prepared as described in Section 6.4.2. The pavement structures presented below have been recommended without detailed traffic data for the site. The pavement design should be reviewed once the traffic data is available.

The recommended minimum pavement design is outlined in the table below.

Table 6.2: Recommended Pavement Structure

Material	Roadway Pavement Structure (mm)
Superpave SP 12.5 Asphalt (PG 58-34, Traffic Level A)	40
Superpave SP 19 Asphalt (PG 58-34, Traffic Level A)	50
Base (Granular A)	150
Subbase (Granular B Type II)	500

It is estimated that the service life prior to major rehabilitation for the recommended pavement structures is 20 years provided it is properly maintained. It is recommended that both subgrade and finished pavement surfaces be graded to direct water towards suitable drainage.

All granular materials should be tested and approved by a geotechnical engineer prior to delivery to the site. Both base and subbase materials should be compacted to at least 100% SPMDD. Asphalt should be compacted to at least 97% Marshall Bulk density.

The clay subgrade is easily disturbed, the placement of a geotextile over the subgrade can be used to protect the subgrade from disturbances.

A 3H:1V frost taper should be included along the subgrade line at the transition between abutting pavement structures.

It is recommended that the lateral extent of the subbase and base layers not be terminated in a vertical fashion immediately behind the curb line. A taper with a grade of 3H:1V is recommended in the subgrade line to minimize differential frost heave problems under curbs and sidewalks.

6.12 CEMENT TYPE AND CORROSION POTENTIAL

Five representative soil samples were submitted to Paracel Laboratories Limited in Ottawa, Ontario, for resistivity, pH, sulphate and chloride testing. The results of the testing are as follows:

Table 6.3: Results of Chemical Analysis

Borehole	Sample	Depth (m)	pH	Sulphate (µg/g)	Chloride (µg/g)	Resistivity (Ohm-m)
BH22-3	SS3	1.5 to 2.1	7.56	39	18	53.3
MW22-4	SS4	2.3 to 2.9	7.66	346	<5	24.3
BH22-6	SS4	2.3 to 2.9	7.87	437	195	13.0
MW22-8	SS3	1.5 to 2.1	7.59	45	674	52.2
BH22-9	SS5	3.1 to 3.7	7.72	491	657	10.7

The concentration of soluble sulphate provides an indication of the degree of sulphate attack that is expected for concrete in contact with soil and groundwater at the site. Soluble sulphate concentrations less than 1000 µg/g generally indicate that a low degree of sulphate attack is expected for concrete in contact with soil and groundwater. Type GU Portland Cement should therefore be suitable for use in concrete at this site.

The pH, resistivity and chloride concentration provide an indication of the degree of corrosiveness of the sub-surface environment. The test results provided may be used to aid in the selection of coatings and corrosion protection systems for buried steel objects.

6.13 VIBRATION MONITORING AND PRE-CONSTRUCTION SURVEYS

The required construction activities for the proposed site will generate some vibrations that will be perceptible to nearby residents. The vibrations are expected to be greatest during bedrock excavation by blasting/mechanical methods. It is recommended that pre-construction surveys of all structures and utilities be carried out in accordance with OPSS 120 “General Specifications for the Use of Explosives”.

It is recommended that construction vibrations generally be limited to a maximum peak particle velocity as outlined in OPSS 120. The structures in the area that are more sensitive to vibrations (i.e. heritage structures), more stringent specifications should be developed by a vibration specialist. For instance, the particle velocity should be limited to 10 mm/sec if there is any heritage/historic building in the area. Vibration monitoring should be carried out prior to and throughout the construction period.

No blasting should be carried out within a distance of 200 m from any hydro infrastructure, water storage reservoir, pumping station, water works transformer station or water storage tank without prior approval by the owner of the facility. The construction vibrations should generally be limited to the maximum, frequency dependent peak particle velocities outlined below.

Frequency Range (Hz)	**Vibration Limits (mm/sec)**
< 10	5
10 to 40	5 to 50 (sliding scale)
> 40	50

The contractor should be required to submit a complete and detailed blasting design and monitoring proposal prepared by a blasting/vibration specialist prior to commencing blasting. This would have to be reviewed and accepted in relation the requirements of the blasting specifications.

6.14 ADDITIONAL INVESTIGATION

Additional geotechnical information may be required for the detailed design of the site depending on the final layout of the site.

7.0 CLOSURE

Use of this report is subject to the Statement of General Conditions provided in Appendix A. It is the responsibility of Canada Lands Group Limited, who is identified as "the Client" within the Statement of General Conditions, and its agents to review the conditions and to notify Stantec Consulting Ltd. should any of these not be satisfied. The Statement of General Conditions addresses the following:

- Use of the report
- Basis of the report
- Standard of care
- Interpretation of site conditions
- Varying or unexpected site conditions
- Planning, design or construction

This report has been prepared by Katurah Firdawsi and reviewed by Ramy Saadeldin.

Respectfully submitted,

STANTEC CONSULTING LTD.

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APPENDIX A

A.1 STATEMENT OF GENERAL CONDITIONS

STATEMENT OF GENERAL CONDITIONS

USE OF THIS REPORT: This report has been prepared for the sole benefit of the Client or its agent and may not be used by any third party without the express written consent of Stantec Consulting Ltd. and the Client. Any use which a third party makes of this report is the responsibility of such third party.

BASIS OF THE REPORT: The information, opinions, and/or recommendations made in this report are in accordance with Stantec Consulting Ltd.'s present understanding of the site specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time of the investigation or study. If the proposed site specific project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Stantec Consulting Ltd. is requested by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

STANDARD OF CARE: Preparation of this report, and all associated work, was carried out in accordance with the normally accepted standard of care in the state or province of execution for the specific professional service provided to the Client. No other warranty is made.

INTERPRETATION OF SITE CONDITIONS: Soil, rock, or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Stantec Consulting Ltd. at the time of the work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behavior. Extrapolation of in situ conditions can only be made to some limited extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

VARYING OR UNEXPECTED CONDITIONS: Should any site or subsurface conditions be encountered that are different from those described in this report or encountered at the test locations, Stantec Consulting Ltd. must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Stantec Consulting Ltd. will not be responsible to any party for damages incurred as a result of failing to notify Stantec Consulting Ltd. that differing site or sub-surface conditions are present upon becoming aware of such conditions.

PLANNING, DESIGN, OR CONSTRUCTION: Development or design plans and specifications should be reviewed by Stantec Consulting Ltd., sufficiently ahead of initiating the next project stage (property acquisition, tender, construction, etc), to confirm that this report completely addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Site work relating to the recommendations included in this report should only be carried out in the presence of a qualified geotechnical engineer; Stantec Consulting Ltd. cannot be responsible for site work carried out without being present.

APPENDIX B

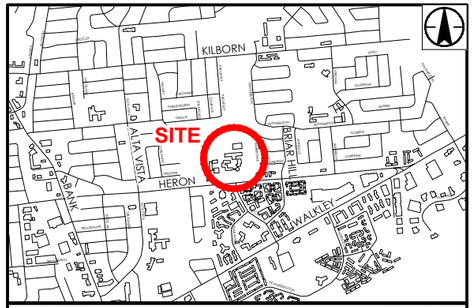
B.1 DRAWING NO. 1 – BOREHOLE LOCATION PLAN

Stantec

300 - 1331 Clyde Avenue
Ottawa, ON, Canada K2C 3G4
www.stantec.com

LEGEND

- BOREHOLE (STANTEC, 2022)
- MONITORING WELL (STANTEC, 2022)
- BOREHOLE/MONITORING WELL (DST, 2015)



KEY PLAN 1 : 40 000

NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 18N.
2. IMAGERY: © 2022 MICROSOFT CORPORATION © 2022 MAXAR © CNES (2022) DISTRIBUTION AIRBUS DS.

12.5m 0 12.5 25.0m
1 : 1250

AUGUST 2022
Project No. 160410368.301.101

Client/Project
CANADA LANDS COMPANY LIMITED
GEOTECHNICAL INVESTIGATION
1495 HERON ROAD, OTTAWA, ONTARIO

Drawing No.
1

Title
BOREHOLE LOCATION PLAN

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2022/08/05 10:55 AM By: Briones, Gliceria

APPENDIX C

C.1 SYMBOLS AND TERMS USED ON BOREHOLE RECORDS

C.2 BOREHOLE RECORDS

C.3 FIELD BEDROCK CORE LOGS

C.4 ROCK CORE PHOTOGRAPHS

C.5 HISTORICAL BOREHOLES

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

Rootmat	- vegetation, roots and moss with organic matter and topsoil typically forming a mattress at the ground surface
Topsoil	- mixture of soil and humus capable of supporting vegetative growth
Peat	- mixture of visible and invisible fragments of decayed organic matter
Till	- unstratified glacial deposit which may range from clay to boulders
Fill	- material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

Desiccated	- having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
Fissured	- having cracks, and hence a blocky structure
Varved	- composed of regular alternating layers of silt and clay
Stratified	- composed of alternating successions of different soil types, e.g. silt and sand
Layer	- > 75 mm in thickness
Seam	- 2 mm to 75 mm in thickness
Parting	- < 2 mm in thickness

Terminology describing soil types:
The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488) which excludes particles larger than 75 mm. For particles larger than 75 mm, and for defining percent clay fraction in hydrometer results, definitions proposed by Canadian Foundation Engineering Manual, 4th Edition are used. The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):
Terminology describing materials outside the USCS, (e.g. particles larger than 75 mm, visible organic matter, and construction debris) is based upon the proportion of these materials present:

Trace, or occasional	Less than 10%
Some	10-20%
Frequent	> 20%

Terminology describing compactness of cohesionless soils:
The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test (SPT) N-Value - also known as N-Index. The SPT N-Value is described further on page 3. A relationship between compactness condition and N-Value is shown in the following table.

Compactness Condition	SPT N-Value
Very Loose	<4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

Terminology describing consistency of cohesive soils:
The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests. Consistency may be crudely estimated from SPT N-Value based on the correlation shown in the following table (Terzaghi and Peck, 1967). The correlation to SPT N-Value is used with caution as it is only very approximate.

Consistency	Undrained Shear Strength		Approximate SPT N-Value
	kips/sq.ft.	kPa	
Very Soft	<0.25	<12.5	<2
Soft	0.25 - 0.5	12.5 - 25	2-4
Firm	0.5 - 1.0	25 - 50	4-8
Stiff	1.0 - 2.0	50 – 100	8-15
Very Stiff	2.0 - 4.0	100 - 200	15-30
Hard	>4.0	>200	>30

ROCK DESCRIPTION

Except where specified below, terminology for describing rock is as defined by the International Society for Rock Mechanics (ISRM) 2007 publication "The Complete ISRM Suggested Methods for Rock Characterization, Testing and Monitoring: 1974-2006"

Terminology describing rock quality:

RQD	Rock Mass Quality
0-25	*Very Poor Quality*
25-50	*Poor Quality*
50-75	*Fair Quality*
75-90	*Good Quality*
90-100	*Excellent Quality*

Alternate (Colloquial) Rock Mass Quality	
Very Severely Fractured	*Crushed*
Severely Fractured	*Shattered or Very Blocky*
Fractured	*Blocky*
Moderately Jointed	*Sound*
Intact	*Very Sound*

RQD (Rock Quality Designation) denotes the percentage of intact and sound rock retrieved from a borehole of any orientation. All pieces of intact and sound rock core equal to or greater than 100 mm (4 in.) long are summed and divided by the total length of the core run. RQD is determined in accordance with ASTM D6032.

SCR (Solid Core Recovery) denotes the percentage of solid core (cylindrical) retrieved from a borehole of any orientation. All pieces of solid (cylindrical) core are summed and divided by the total length of the core run (It excludes all portions of core pieces that are not fully cylindrical as well as crushed or rubble zones).

Fracture Index (FI) is defined as the number of naturally occurring fractures within a given length of core. The Fracture Index is reported as a simple count of natural occurring fractures.

Terminology describing rock with respect to discontinuity and bedding spacing:

Spacing (mm)	Discontinuities	Bedding
>6000	*Extremely Wide*	-
2000-6000	*Very Wide*	*Very Thick*
600-2000	*Wide*	*Thick*
200-600	*Moderate*	*Medium*
60-200	*Close*	*Thin*
20-60	*Very Close*	*Very Thin*
<20	*Extremely Close*	*Laminated*
<6	-	*Thinly Laminated*

Terminology describing rock strength:

Strength Classification	Grade	Unconfined Compressive Strength (MPa)
Extremely Weak	R0	<1
Very Weak	R1	1 – 5
Weak	R2	5 – 25
Medium Strong	R3	25 – 50
Strong	R4	50 – 100
Very Strong	R5	100 – 250
Extremely Strong	R6	>250

Terminology describing rock weathering:

Term	Symbol	Description
Fresh	W1	No visible signs of rock weathering. Slight discoloration along major discontinuities
Slightly	W2	Discoloration indicates weathering of rock on discontinuity surfaces. All the rock material may be discolored.
Moderately	W3	Less than half the rock is decomposed and/or disintegrated into soil.
Highly	W4	More than half the rock is decomposed and/or disintegrated into soil.
Completely	W5	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.
Residual Soil	W6	All the rock converted to soil. Structure and fabric destroyed.

STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.

Boulders Cobbles Gravel | Sand | Silt | Clay | Organics | Asphalt | Concrete | Fill | Igneous Bedrock | Meta-morphic Bedrock | Sedi-mentary Bedrock

SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
DP	Direct-Push sample (small diameter tube sampler hydraulically advanced)
PS	Piston sample
BS	Bulk sample
HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond coring bits.

WATER LEVEL MEASUREMENT

measured in standpipe, piezometer, or well

inferred

RECOVERY

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock core, recovery is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

N-VALUE

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (63.5 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (300 mm) into the soil. In accordance with ASTM D1586, the N-Value equals the sum of the number of blows (N) required to drive the sampler over the interval of 6 to 18 in. (150 to 450 mm). However, when a 24 in. (610 mm) sampler is used, the number of blows (N) required to drive the sampler over the interval of 12 to 24 in. (300 to 610 mm) may be reported if this value is lower. For split spoon samples where insufficient penetration was achieved and N-Values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N-values corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to 'A' size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (300 mm) into the soil. The DCPT is used as a probe to assess soil variability.

OTHER TESTS

S	Sieve analysis
H	Hydrometer analysis
k	Laboratory permeability
γ	Unit weight
G_s	Specific gravity of soil particles
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct Shear
C	Consolidation
Q_u	Unconfined compression
I_p	Point Load Index (I_p on Borehole Record equals $I_p(50)$ in which the index is corrected to a reference diameter of 50 mm)

	Single packer permeability test; test interval from depth shown to bottom of borehole
	Double packer permeability test; test interval as indicated
	Falling head permeability test using casing
	Falling head permeability test using well point or piezometer

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BOREHOLE RECORD

N: 5 025 448 E: 448 836

BH22-1

CLIENT Canada Lands Company Limited — BOREHOLE No. BH22-1

LOCATION 1495 Heron Road, Ottawa, ON — PROJECT No. 160410368

DATES: BORING July 11, 2022 — WATER LEVEL — DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	98.77							
		Loose to compact brown to grey clayey sand (SC) TILL - Moist			SS	1	425	13
1					SS	2	350	10
2					SS	3	200	6
					SS	4	375	13
3					SS	5	450	7
4					SS	6	400	15
5					SS	7	450	22
					SS	8	600	
6	92.7							
		Grey SHALE - Fair quality - Fresh - Close joint spacing - Flat discontinuities - UCS = 33.3 MPa at 6.6 m - UCS = 28.8 MPa at 7.2 m (See Field Bedrock Core Log)			NQ	1	97%	54%
7	91.2							
		End of Borehole						
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

Stantec

BOREHOLE RECORD

N: 5 025 610 E: 448 861

BH22-2

CLIENT Canada Lands Company Limited — BOREHOLE No. BH22-2

LOCATION 1495 Heron Road, Ottawa, ON — PROJECT No. 160410368

DATES: BORING June 21, 2022 — WATER LEVEL — DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	**96.78**							
	96.6	TOPSOIL						
		Firm to stiff brown sandy lean clay (CL) TILL - Moist - Auger grinding on inferred cobbles/boulders			SS	1	350	9
1					SS	2	475	6
	95.3							
		Compact to very dense brown to grey silty sand with gravel (SM) TILL - Moist to dry			SS	3	500	27
2					SS	4	575	31
3					SS	5	500	34
4					SS	6	575	61
	92.4							
		End of Borehole						
5								
6								
7								
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

Stantec

BOREHOLE RECORD

N: 5 025 615 E: 448 908

BH22-3

CLIENT Canada Lands Company Limited — BOREHOLE No. BH22-3

LOCATION 1495 Heron Road, Ottawa, ON — PROJECT No. 160410368

DATES: BORING June 21, 2022 — WATER LEVEL — DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	**96.51**							
	96.3	TOPSOIL						
		Stiff to very stiff brown sandy lean clay (CL) TILL - Moist			SS	1	450	24
1					SS	2	350	9
	95.0							
		Compact to very dense brown to grey compact to very dense silty sand with gravel (SM) TILL - Moist - Auger grinding on inferred cobbles/boulders			SS	3	475	32
2					SS	4	425	50/ 125 mm
3					SS	5	450	21
4					SS	6	550	21
	91.9							
	91.5	Very dense grey silty sand with gravel TILL - frequent shale pieces - Moist to dry			SS	7	275	50/ 125 mm
5		Grey SHALE - Very poor to poor quality - Fresh - Very close to close joint spacing			NQ	1	99%	27%
6	89.9				NQ	2	90%	10%
		- Flat to vertical discontinuities - UCS = 44.4 MPa at 5.5 m (See Field Bedrock Core Log)						
7		End of Borehole						
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

STN13-STAN-GEO 160410368_1495_HERON.GPJ SMART.GDT 8/4/22

Stantec

MONITORING WELL RECORD

N: 5 025 633 E: 448 966

MW22-4

CLIENT Canada Lands Company Limited — BOREHOLE No. MW22-4

LOCATION 1495 Heron Road, Ottawa, ON — PROJECT No. 160410368

DATES: BORING June 21, 2022 — WATER LEVEL July 6, 2022 — DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
	96.75							
0	96.6	TOPSOIL			SS	1	500	8
		Firm brown sandy lean clay (CL) TILL - Moist						
1					SS	2	75	8
	95.2							
		Compact to dense brown to grey clayey sand (SC) TILL - Moist			SS	3	500	16
2								
					SS	4	525	29
3								
					SS	5	250	24
4								
	92.5				SS	6	425	31
	92.2	Dense to very dense grey silty sand with gravel (SM) TILL - frequent shale pieces - Moist to wet			SS	7	125	50/ 125 mm
5		Grey SHALE - Very poor quality - Slightly weathered to Fresh - Very close joint spacing			HQ	1	100%	0%
6	90.5	- Flat to vertical discontinuities (See Field Bedrock Core Log)			HQ	2	100%	0%
		End of Borehole Monitoring Well Installed						
7								
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

STN13-STAN-GEO 160410368_1495_HERON.GPJ SMART.GDT 8/4/22

Stantec

BOREHOLE RECORD

N: 5 025 557 E: 448 983

BH22-5

CLIENT Canada Lands Company Limited — BOREHOLE No. BH22-5

LOCATION 1495 Heron Road, Ottawa, ON — PROJECT No. 160410368

DATES: BORING June 22, 2022 — WATER LEVEL — DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	**96.41**							
	96.3	75 mm ASPHALT						
		Compact to dense brown silty sand with gravel (SM) TILL - Dry - Auger grinding on inferred cobbles/boulders			SS	1	375	41
1					SS	2	325	19
2					SS	3	550	25
	94.1							
		Stiff grey fat clay (CH) - Moist			SS	4	600	12
3	93.2							
	93.0	Very dense silty sand with gravel (SM) TILL - Frequent shale pieces - Moist			SS	5	400	50/ 25 mm
4		End of Borehole Auger Refusal on Inferred Bedrock						
5								
6								
7								
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

□ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

STN13-STAN-GEO 160410368_1495_HERON.GPJ SMART.GDT 8/4/22

Stantec

BOREHOLE RECORD

N: 5 025 484 E: 448 963

BH22-6

CLIENT Canada Lands Company Limited — BOREHOLE No. BH22-6

LOCATION 1495 Heron Road, Ottawa, ON — PROJECT No. 160410368

DATES: BORING June 20, 2022 — WATER LEVEL — DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	**95.79**							
	95.4	FILL: Brown silty sand with gravel (SM)			SS	1	600	27
	95.2	Stiff brown lean clay (CL) TILL - Moist						
1		Compact brown silty sand with gravel (SM) TILL			SS	2	600	13
	94.3	- Moist						
2		Compact to dense brown to grey silty sand with gravel (SM) TILL - Moist			SS	3	450	30
					SS	4	525	17
3					SS	5	75	28
4					SS	6	200	12
					SS	7	575	14
5					SS	8	350	50/ 125 mm
	89.8							
6		Grey LIMESTONE - Good to excellent quality - Fresh - Close joint spacing - Flat discontinuities - UCS = 72.5 MPa at 6.4 m			NQ	1	100%	77%
7		- UCS = 98.1 MPa at 7.2 m			NQ	2	100%	100%
	88.0	(See Field Bedrock Core Log)						
8		End of Borehole						
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

STN13-STAN-GEO 160410368_1495_HERON.GPJ SMART.GDT 8/4/22

Stantec

MONITORING WELL RECORD

N: 5 025 409 E: 449 006

MW22-7

CLIENT Canada Lands Company Limited — BOREHOLE No. MW22-7

LOCATION 1495 Heron Road, Ottawa, ON — PROJECT No. 160410368

DATES: BORING June 22, 2022 — WATER LEVEL July 6, 2022 — DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	**95.73**							
		FILL: brown silty sand with gravel (SM)			SS	1	375	32
	95.1	Compact brown to grey clayey sand (SC) TILL - Moist			SS	2	300	14
1								
				▼	SS	3	600	18
2								
					SS	4	525	27
	92.7							
3		Loose to compact black silty sand with gravel (SM) TILL - Moist			SS	5	600	18
4					SS	6	325	8
					SS	7	475	10
5	90.6							
		End of Borehole Monitoring Well Installed						
6								
7								
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

STN13-STAN-GEO 160410368_1495_HERON.GPJ SMART.GDT 8/4/22

Stantec

MONITORING WELL RECORD

N: 5 025 362 E: 448 961

MW22-8

CLIENT Canada Lands Company Limited — BOREHOLE No. MW22-8

LOCATION 1495 Heron Road, Ottawa, ON — PROJECT No. 160410368

DATES: BORING June 20, 2022 — WATER LEVEL July 6, 2022 — DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	**95.97**							
	95.4	TOPSOIL			SS	1	425	13
1	94.6	Loose brown silty SAND with gravel (SM) - Trace topsoil and rootlets - Moist			SS	2	450	7
2		Compact to very dense brown to grey clayey sand (SC) TILL - Fractured rock at 4 m - Moist		▼	SS	3	288	30
3					SS	4	550	20
4	91.6				SS	5	475	18
					SS	6	288	50/ 300 mm
5		Grey LIMESTONE with shale and quartz interbedded - Poor quality - Slightly weathered - Very close to close joint spacing			HQ	1	100%	27%
6	90.1	- Flat to vertical discontinuities (See Field Bedrock Core Log)						
		End of Borehole Monitoring Well Installed						
7								
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

STN13-STAN-GEO 160410368_1495_HERON.GPJ SMART.GDT 8/4/22

Stantec

BOREHOLE RECORD

N: 5 025 427 E: 448 952

BH22-9

CLIENT Canada Lands Company Limited — BOREHOLE No. BH22-9

LOCATION 1495 Heron Road, Ottawa, ON — PROJECT No. 160410368

DATES: BORING June 21, 2022 — WATER LEVEL — DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	**95.24**							
	94.6	FILL: brown silty sand with gravel (SM)			SS	1	325	18
1		Compact to very dense brown to grey clayey sand with gravel (SC) TILL - Fractured bedrock at 5 m - Moist			SS	2	400	15
2					SS	3	550	22
3					SS	4	250	20
4					SS	5	500	19
5	90.2				SS	6	0	57
		Grey SHALE - Very poor quality - Slightly weathered - Close joint spacing - Flat to vertical discontinuities - UCS = 50.7 MPa at 5.5 m			SS	7	300	53
6	88.7	- UCS = 42.3 MPa at 5.7 m (See Field Bedrock Core Log)			NQ	1	98%	23%
7		End of Borehole						
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m

STANDARD PENETRATION TEST, BLOWS/0.3m

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

STN13-STAN-GEO 160410368_1495_HERON.GPJ SMART.GDT 8/4/22

Stantec

BOREHOLE RECORD

N: 5 025 448 E: 448 836

BH22-10

CLIENT Canada Lands Company Limited — BOREHOLE No. BH22-10

LOCATION 1495 Heron Road, Ottawa, ON — PROJECT No. 160410368

DATES: BORING July 7, 2022 — WATER LEVEL — DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	**96.23**							
	96.0	TOPSOIL			SS	1	450	34
		Loose to very dense brown to grey clayey sand with gravel (SC) TILL - Moist			SS	2	300	9
1					SS	3	450	26
2					SS	4	475	32
3					SS	5	475	34
4	92.2				SS	6	250	50/ 100 mm
		End of Borehole Auger Refusal on Inferred Bedrock						
5								
6								
7								
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

Stantec

MONITORING WELL RECORD

N: 5 025 525 E: 448 795

MW22-11

CLIENT Canada Lands Company Limited — BOREHOLE No. MW22-11

LOCATION 1495 Heron Road, Ottawa, ON — PROJECT No. 160410368

DATES: BORING June 20, 2022 — WATER LEVEL July 6, 2022 — DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	**96.05**							
	96.0	40 mm ASPHALT			SS	1	400	15
	95.4	FILL: Brown silty sand with gravel (SM)						
1		Compact to very dense brown to grey clayey sand with gravel (SC) to silty sand (SM) TILL - Moist - Auger grinding on inferred cobbles/boulders		▼	SS	2	500	10
2					SS	3	575	26
					SS	4	0	50/ 125 mm
3	92.9				SS	5	0	50/ 125 mm
		Grey LIMESTONE with shale interbeded - Very poor to excellent quality - Slightly weathered to fresh - Very close to close joint spacing			HQ	1	100%	0%
4					HQ	2	100%	100%
	91.3	- Flat to vertical discontinuities - UCS = 80.9 MPa at 4.4 m - UCS = 64.2 MPa at 4.6 m (See Field Bedrock Core Log)						
5		End of Borehole						
		Monitoring Well Installed						
6								
7								
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

STN13-STAN-GEO 160410368_1495_HERON.GPJ SMART.GDT 8/4/22

Stantec

BOREHOLE RECORD

N: 5 025 491 E: 448 748

BH22-12

CLIENT Canada Lands Company Limited — BOREHOLE No. BH22-12

LOCATION 1495 Heron Road, Ottawa, ON — PROJECT No. 160410368

DATES: BORING July 11, 2022 — WATER LEVEL — DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	97.43							
	97.3	TOPSOIL			SS	1	325	18
		Loose to compact brown clayey sand (SC) TILL						
1					SS	2	350	10
2					SS	3	400	8
					SS	4	575	24
3	94.4							
		Very dense to dense grey silty sand with gravel (SM) TILL			SS	5	475	40
		- Fractured shale bedrock						
	93.6	- Moist			SS	6	0	50/100 mm
4		Grey SHALE with limestone interbedded						
		- Poor quality						
		- Slightly weathered			NQ	1	99%	33%
5		- Close joint spacing						
		- Flat to vertical discontinuities						
	91.8	- UCS = 50.3 MPa at 5.3 m						
		(See Field Bedrock Core Log)						
6		End of Borehole						
7								
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

STN13-STAN-GEO 160410368_1495_HERON.GPJ SMART.GDT 8/4/22

Stantec

Field Bedrock Core Log

Client: Canada Lands Company Limited
Project: 1495 Heron Road
Contractor: Downing Drilling

Project No.: 160410368
Date: 11-Jul-22
Borehole No.: BH22-1
Logger: BH

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
6.10	NQ-1	97%	54%	7.62	Grey Shale - UCS = 33.3 MPa at 6.6 m - UCS = 28.8 MPa at 7.2 m	R3	W1		BD	F	C	RU	C	O		

STRENGTH (MPa)

Grade/Classification	Est. Strength (MPa)
R0 Extremely Week	0.25 - 1.0
R1 Very Weak	1.0 - 5.0
R2 Weak	5.0 - 25.0
R3 Medium Strong	25.0 - 50.0
R4 Strong	50.0 - 100.0
R5 Very Strong	100.0 - 250.0
R6 Extremely Strong	>250.0

JOINT TYPE
BD = Bedding
JN = Joint
FOL = Foliation
CON = Contact
FLT = Fault
VN = Vein

ORIENTATION
F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

JOINT APERTURE
C = Closed = < 0.5 mm
G = Gapped = 0.5 to 10 mm
O = Open = > 10 mm

FILLING
T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

WEATHERING

Grade/Classification	Description
W1 Fresh	No Visible Signs of Weathering
W2 Slightly	Discoloration, Weathering on Discontinuities
W3 Moderately	<50% of Rock Material is Decomposed, Fresh Core Stones
W4 Highly	>50% Decomposed to soil: Fresh Core Stones
W5 Completely	100% Decomposed to Soil: Original Structure Intact
W6 Residual Soil	All Rock Converted to Soil, Structure and Fabric Destroyed

DISCONTINUITY SPACING

Spacing (mm)	
EW = >6000	Extremely Wide
VW = 2000 - 6000	Very Wide
W = 600 - 2000	Wide
M = 200 - 600	Moderate
C = 60 - 200	Close
VC = 20 - 60	Very Close
EC = <20	Extremely Close

JOINT ROUGHNESS

Jr	Description
4	DJ = Discontinuous Joints
3	RU = Rough, Irregular, Undulating
1.5	SU = Smooth, Undulating
1.5	LU = Slickensided, Undulating
1.0	RP = Rough or Irregular, Planar
0.5	SP = Smooth, Planar
2	LP = Slickensided, Planar

Stantec

Field Bedrock Core Log

Client: Canada Lands Company Limited
Project: 1495 Heron Road
Contractor: Downing Drilling

Project No.: 160410368
Date: 21-Jun-22
Borehole No.: BH22-3
Logger: BH

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
5.03	NQ-1	99%	27%	6.35	Grey Shale - UCS = 44.4 MPa at 5.5 m	R3	W1		BD JN	F V	VC C	RP RP	G G	O O		
6.35	NQ-2	90%	10%	6.60	Grey Shale		W1		JN	V	C	RP	G	O		

STRENGTH (MPa)

Grade/Classification	Est. Strength (MPa)
R0 Extremely Week	0.25 - 1.0
R1 Very Weak	1.0 - 5.0
R2 Weak	5.0 - 25.0
R3 Medium Strong	25.0 - 50.0
R4 Strong	50.0 - 100.0
R5 Very Strong	100.0 - 250.0
R6 Extremely Strong	>250.0

JOINT TYPE
BD = Bedding
JN = Joint
FOL = Foliation
CON = Contact
FLT = Fault
VN = Vein

ORIENTATION
F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

JOINT APERTURE
C = Closed = < 0.5 mm
G = Gapped = 0.5 to 10 mm
O = Open = > 10 mm

FILLING
T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

WEATHERING

Grade/Classification	Description
W1 Fresh	No Visible Signs of Weathering
W2 Slightly	Discoloration, Weathering on Discontinuities
W3 Moderately	<50% of Rock Material is Decomposed, Fresh Core Stones
W4 Highly	>50% Decomposed to soil: Fresh Core Stones
W5 Completely	100% Decomposed to Soil: Original Structure Intact
W6 Residual Soil	All Rock Converted to Soil, Structure and Fabric Destroyed

DISCONTINUITY SPACING

Spacing (mm)	
EW = >6000	Extremely Wide
VW = 2000 - 6000	Very Wide
W = 600 - 2000	Wide
M = 200 - 600	Moderate
C = 60 - 200	Close
VC = 20 - 60	Very Close
EC = <20	Extremely Close

JOINT ROUGHNESS

Jr	Description
4	DJ = Discontinuous Joints
3	RU = Rough, Irregular, Undulating
1.5	SU = Smooth, Undulating
1.5	LU = Slickensided, Undulating
1.0	RP = Rough or Irregular, Planar
0.5	SP = Smooth, Planar
2	LP = Slickensided, Planar

Stantec

Field Bedrock Core Log

Client: Canada Lands Company Limited
Project: 1495 Heron Road
Contractor: Downing Drilling

Project No.: 160410368
Date: 21-Jun-22
Borehole No.: MW22-4
Logger: BH

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
4.57	HQ-1	100%	0%	5.99	Grey Shale		W1		BD	F	VC	RP	G	O	Granite / clay at top	
									JN	V	VC	RP	G	O		
5.99	HQ-2	100%	0%	6.27	Grey Shale		W1/ W2		BD	F	VC	RP	G	O		
									JN	V	VC	RP	G	O		

STRENGTH (MPa)

Grade/Classification	Est. Strength (MPa)
R0 Extremely Week	0.25 - 1.0
R1 Very Weak	1.0 - 5.0
R2 Weak	5.0 - 25.0
R3 Medium Strong	25.0 - 50.0
R4 Strong	50.0 - 100.0
R5 Very Strong	100.0 - 250.0
R6 Extremely Strong	>250.0

JOINT TYPE
BD = Bedding
JN = Joint
FOL = Foliation
CON = Contact
FLT = Fault
VN = Vein

ORIENTATION
F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

JOINT APERTURE
C = Closed = < 0.5 mm
G = Gapped = 0.5 to 10 mm
O = Open = > 10 mm

FILLING
T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

WEATHERING

Grade/Classification	Description
W1 Fresh	No Visible Signs of Weathering
W2 Slightly	Discoloration, Weathering on Discontinuities
W3 Moderately	<50% of Rock Material is Decomposed, Fresh Core Stones
W4 Highly	>50% Decomposed to soil: Fresh Core Stones
W5 Completely	100% Decomposed to Soil: Original Structure Intact
W6 Residual Soil	All Rock Converted to Soil, Structure and Fabric Destroyed

DISCONTINUITY SPACING

Spacing (mm)	
EW = >6000	Extremely Wide
VW = 2000 - 6000	Very Wide
W = 600 - 2000	Wide
M = 200 - 600	Moderate
C = 60 - 200	Close
VC = 20 - 60	Very Close
EC = <20	Extremely Close

JOINT ROUGHNESS

Jr	Description
4	DJ = Discontinuous Joints
3	RU = Rough, Irregular, Undulating
1.5	SU = Smooth, Undulating
1.5	LU = Slickensided, Undulating
1.0	RP = Rough or Irregular, Planar
0.5	SP = Smooth, Planar
2	LP = Slickensided, Planar

Stantec

Field Bedrock Core Log

Client:	Canada Lands Company Limited	**Project No.:**	160410368
Project:	1495 Heron Road	**Date:**	20-Jun-22
Contractor:	Downing Drilling	**Borehole No.:**	BH22-6
		Logger:	BH

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
6.02	NQ-1	100%	77%	7.16	Grey Limestone - UCS = 72.5 MPa at 6.4 m	R4	W1		BD	F	C	SP	C	T		
7.16	NQ-2	100%	100%	7.77	Grey Limestone - UCS = 98.1 MPa at 7.2 m	R4	W1		BD	F	C	SP	C	T		

STRENGTH (MPa)

Grade/Classification	Est. Strength (MPa)
R0 Extremely Week	0.25 - 1.0
R1 Very Weak	1.0 - 5.0
R2 Weak	5.0 - 25.0
R3 Medium Strong	25.0 - 50.0
R4 Strong	50.0 - 100.0
R5 Very Strong	100.0 - 250.0
R6 Extremely Strong	>250.0

JOINT TYPE

BD = Bedding
JN = Joint
FOL = Foliation
CON = Contact
FLT = Fault
VN = Vein

ORIENTATION

F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

JOINT APERTURE

C = Closed = < 0.5 mm
G = Gapped = 0.5 to 10 mm
O = Open = > 10 mm

FILLING

T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

WEATHERING

Grade/Classification	Description
W1 Fresh	No Visible Signs of Weathering
W2 Slightly	Discoloration, Weathering on Discontinuities
W3 Moderately	<50% of Rock Material is Decomposed, Fresh Core Stones
W4 Highly	>50% Decomposed to soil: Fresh Core Stones
W5 Completely	100% Decomposed to Soil: Original Structure Intact
W6 Residual Soil	All Rock Converted to Soil, Structure and Fabric Destroyed

DISCONTINUITY SPACING

Spacing (mm)	
EW = >6000	Extremely Wide
VW = 2000 - 6000	Very Wide
W = 600 - 2000	Wide
M = 200 - 600	Moderate
C = 60 - 200	Close
VC = 20 - 60	Very Close
EC = <20	Extremely Close

JOINT ROUGHNESS

Jr	Description
4	DJ = Discontinuous Joints
3	RU = Rough, Irregular, Undulating
1.5	SU = Smooth, Undulating
1.5	LU = Slickensided, Undulating
1.0	RP = Rough or Irregular, Planar
0.5	SP = Smooth, Planar
2	LP = Slickensided, Planar

Stantec

Field Bedrock Core Log

Client: Canada Lands Company Limited
Project: 1495 Heron Road
Contractor: Downing Drilling

Project No.: 160410368
Date: 20-Jun-22
Borehole No.: MW22-8
Logger: BH

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
4.34	HQ-1	100%	27%	5.87	GreyLimestone with Shale and Quartz Interbedded		W2		BD	F / V	VC / C	RU	G	S		

STRENGTH (MPa)

Grade/Classification	Est. Strength (MPa)
R0 Extremely Week	0.25 - 1.0
R1 Very Weak	1.0 - 5.0
R2 Weak	5.0 - 25.0
R3 Medium Strong	25.0 - 50.0
R4 Strong	50.0 - 100.0
R5 Very Strong	100.0 - 250.0
R6 Extremely Strong	>250.0

JOINT TYPE
BD = Bedding
JN = Joint
FOL = Foliation
CON = Contact
FLT = Fault
VN = Vein

ORIENTATION
F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

JOINT APERTURE
C = Closed = < 0.5 mm
G = Gapped = 0.5 to 10 mm
O = Open = > 10 mm

FILLING
T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

WEATHERING

Grade/Classification	Description
W1 Fresh	No Visible Signs of Weathering
W2 Slightly	Discoloration, Weathering on Discontinuities
W3 Moderately	<50% of Rock Material is Decomposed, Fresh Core Stones
W4 Highly	>50% Decomposed to soil: Fresh Core Stones
W5 Completely	100% Decomposed to Soil: Original Structure Intact
W6 Residual Soil	All Rock Converted to Soil, Structure and Fabric Destroyed

DISCONTINUITY SPACING

Spacing (mm)	
EW = >6000	Extremely Wide
VW = 2000 - 6000	Very Wide
W = 600 - 2000	Wide
M = 200 - 600	Moderate
C = 60 - 200	Close
VC = 20 - 60	Very Close
EC = <20	Extremely Close

JOINT ROUGHNESS

Jr	Description
4	DJ = Discontinuous Joints
3	RU = Rough, Irregular, Undulating
1.5	SU = Smooth, Undulating
1.5	LU = Slickensided, Undulating
1.0	RP = Rough or Irregular, Planar
0.5	SP = Smooth, Planar
2	LP = Slickensided, Planar

Stantec

Field Bedrock Core Log

Client: Canada Lands Company Limited
Project: 1495 Heron Road
Contractor: Downing Drilling

Project No.: 160410368
Date: 21-Jun-22
Borehole No.: BH22-9
Logger: BH

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
									BD	F/V	C	RU	G	O		
5.03	NQ-1	98%	23%	6.58	Grey Shale - UCS = 50.7 MPa at 5.5 m - UCS = 42.3 MPa at 5.7 m	R3/R4	W2									

STRENGTH (MPa)

Grade/Classification	Est. Strength (MPa)
R0 Extremely Week	0.25 - 1.0
R1 Very Weak	1.0 - 5.0
R2 Weak	5.0 - 25.0
R3 Medium Strong	25.0 - 50.0
R4 Strong	50.0 - 100.0
R5 Very Strong	100.0 - 250.0
R6 Extremely Strong	>250.0

JOINT TYPE
BD = Bedding
JN = Joint
FOL = Foliation
CON = Contact
FLT = Fault
VN = Vein

ORIENTATION
F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

JOINT APERTURE
C = Closed = < 0.5 mm
G = Gapped = 0.5 to 10 mm
O = Open = > 10 mm

FILLING
T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

WEATHERING

Grade/Classification	Description
W1 Fresh	No Visible Signs of Weathering
W2 Slightly	Discoloration, Weathering on Discontinuities
W3 Moderately	<50% of Rock Material is Decomposed, Fresh Core Stones
W4 Highly	>50% Decomposed to soil: Fresh Core Stones
W5 Completely	100% Decomposed to Soil: Original Structure Intact
W6 Residual Soil	All Rock Converted to Soil, Structure and Fabric Destroyed

DISCONTINUITY SPACING

Spacing (mm)	
EW = >6000	Extremely Wide
VW = 2000 - 6000	Very Wide
W = 600 - 2000	Wide
M = 200 - 600	Moderate
C = 60 - 200	Close
VC = 20 - 60	Very Close
EC = <20	Extremely Close

JOINT ROUGHNESS

Jr	Description
4	DJ = Discontinuous Joints
3	RU = Rough, Irregular, Undulating
1.5	SU = Smooth, Undulating
1.5	LU = Slickensided, Undulating
1.0	RP = Rough or Irregular, Planar
0.5	SP = Smooth, Planar
2	LP = Slickensided, Planar

Stantec

Field Bedrock Core Log

Client:	Canada Lands Company Limited	**Project No.:**	160410368
Project:	1495 Heron Road	**Date:**	20-Jun-22
Contractor:	Downing Drilling	**Borehole No.:**	MW22-11
		Logger:	BH

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
3.12	HQ-1	100%	0%	4.34	Grey Limestone with Shale interbedded		W2		BD	F/V	VC	SU	G	O		
4.34	HQ-2	100%	100%	4.78	Grey Limestone with Shale interbedded - UCS = 80.9 MPa at 4.4 m - UCS = 64.2 MPa at 4.6 m	R4	W1		BD	F	C	SU	C	O		

STRENGTH (MPa)

Grade/Classification	Est. Strength (MPa)
R0 Extremely Week	0.25 - 1.0
R1 Very Weak	1.0 - 5.0
R2 Weak	5.0 - 25.0
R3 Medium Strong	25.0 - 50.0
R4 Strong	50.0 - 100.0
R5 Very Strong	100.0 - 250.0
R6 Extremely Strong	>250.0

JOINT TYPE

BD = Bedding
JN = Joint
FOL = Foliation
CON = Contact
FLT = Fault
VN = Vein

ORIENTATION

F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

JOINT APERTURE

C = Closed = < 0.5 mm
G = Gapped = 0.5 to 10 mm
O = Open = > 10 mm

FILLING

T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

WEATHERING

Grade/Classification	Description
W1 Fresh	No Visible Signs of Weathering
W2 Slightly	Discoloration, Weathering on Discontinuities
W3 Moderately	<50% of Rock Material is Decomposed, Fresh Core Stones
W4 Highly	>50% Decomposed to soil: Fresh Core Stones
W5 Completely	100% Decomposed to Soil: Original Structure Intact
W6 Residual Soil	All Rock Converted to Soil, Structure and Fabric Destroyed

DISCONTINUITY SPACING

Spacing (mm)	
EW = >6000	Extremely Wide
VW = 2000 - 6000	Very Wide
W = 600 - 2000	Wide
M = 200 - 600	Moderate
C = 60 - 200	Close
VC = 20 - 60	Very Close
EC = <20	Extremely Close

JOINT ROUGHNESS

Jr	Description
4	DJ = Discontinuous Joints
3	RU = Rough, Irregular, Undulating
1.5	SU = Smooth, Undulating
1.5	LU = Slickensided, Undulating
1.0	RP = Rough or Irregular, Planar
0.5	SP = Smooth, Planar
2	LP = Slickensided, Planar

Stantec

Field Bedrock Core Log

Client:	Canada Lands Company Limited	**Project No.:**	160410368
Project:	1495 Heron Road	**Date:**	11-Jul-22
Contractor:	Downing Drilling	**Borehole No.:**	BH22-12
		Logger:	BH

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
3.81	NQ-1	99%	33%	5.64	Grey Shale with Limestone interbedded - UCS = 50.3 MPa at 5.3 m	R4	W2		BD	F	C	RU	C	O		
									JN	V	C	RU	C	O		

STRENGTH (MPa)

Grade/Classification	Est. Strength (MPa)
R0 Extremely Week	0.25 - 1.0
R1 Very Weak	1.0 - 5.0
R2 Weak	5.0 - 25.0
R3 Medium Strong	25.0 - 50.0
R4 Strong	50.0 - 100.0
R5 Very Strong	100.0 - 250.0
R6 Extremely Strong	>250.0

JOINT TYPE

BD = Bedding
JN = Joint
FOL = Foliation
CON = Contact
FLT = Fault
VN = Vein

ORIENTATION

F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

JOINT APERTURE

C = Closed = < 0.5 mm
G = Gapped = 0.5 to 10 mm
O = Open = > 10 mm

FILLING

T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

WEATHERING

Grade/Classification	Description
W1 Fresh	No Visible Signs of Weathering
W2 Slightly	Discoloration, Weathering on Discontinuities
W3 Moderately	<50% of Rock Material is Decomposed, Fresh Core Stones
W4 Highly	>50% Decomposed to soil: Fresh Core Stones
W5 Completely	100% Decomposed to Soil: Original Structure Intact
W6 Residual Soil	All Rock Converted to Soil, Structure and Fabric Destroyed

DISCONTINUITY SPACING

Spacing (mm)	
EW = >6000	Extremely Wide
VW = 2000 - 6000	Very Wide
W = 600 - 2000	Wide
M = 200 - 600	Moderate
C = 60 - 200	Close
VC = 20 - 60	Very Close
EC = <20	Extremely Close

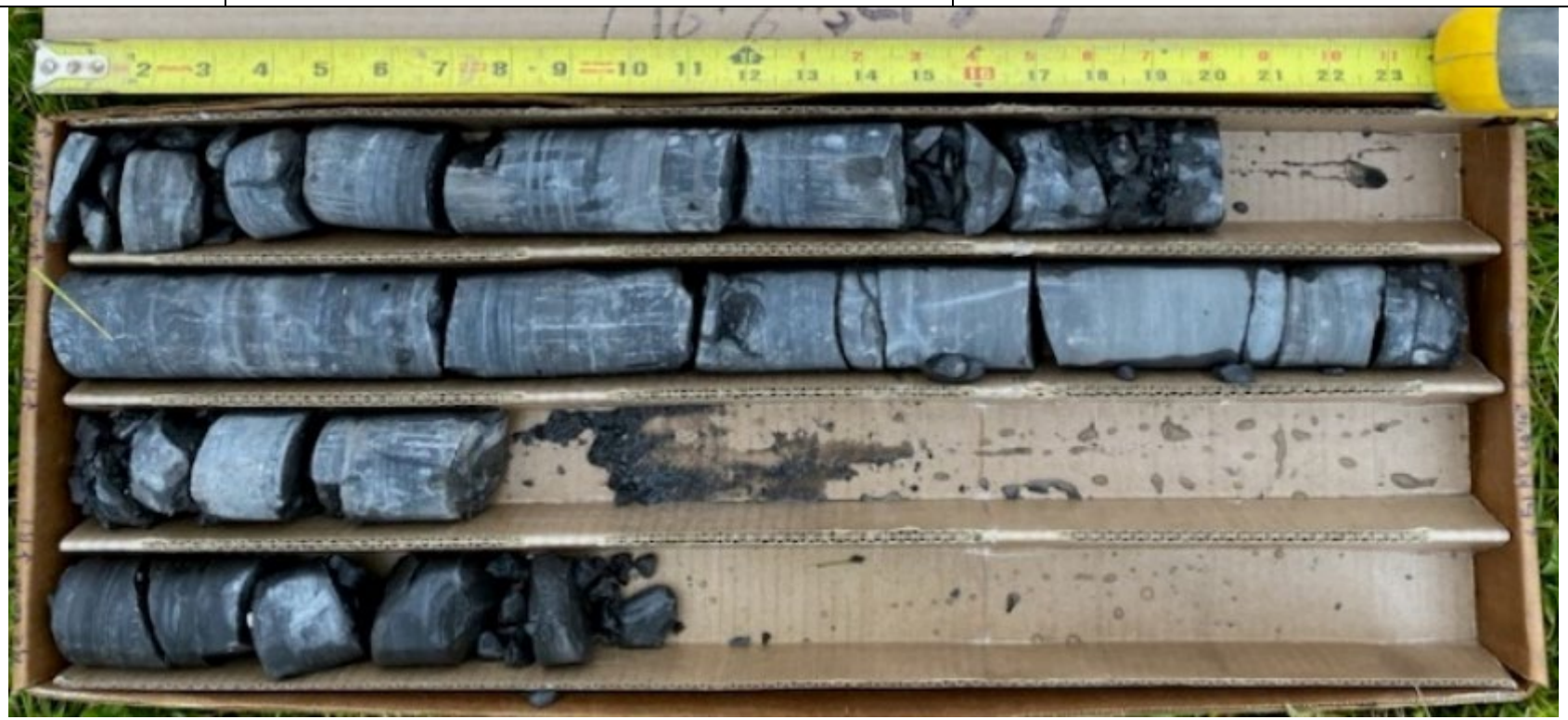
JOINT ROUGHNESS

Jr	Description
4	DJ = Discontinuous Joints
3	RU = Rough, Irregular, Undulating
1.5	SU = Smooth, Undulating
1.5	LU = Slickensided, Undulating
1.0	RP = Rough or Irregular, Planar
0.5	SP = Smooth, Planar
2	LP = Slickensided, Planar

Stantec	Project No.: 160410368 Project Name: 1495 Heron Road	Rock core Photographs

Rock Core Photo No.: 1	Borehole: BH22-1	Depth: 6.1 m to 7.6 m

Stantec	Project No.: 160410368 Project Name: 1495 Heron Road	Rock core Photographs



Rock Core Photo No.: 2	Borehole: BH22-3	Depth: 5.0 m to 6.6 m

Stantec	Project No.: 160410368 Project Name: 1495 Heron Road	Rock core Photographs

Rock Core Photo No.: 3	Borehole: MW22-4	Depth: 4.6 m to 6.3 m

Stantec	Project No.: 160410368	Rock core Photographs
	Project Name: 1495 Heron Road	

Rock Core Photo No.: 4	Borehole: BH22-6	Depth: 6.0 m to 7.8 m

Stantec	Project No.: 160410368 Project Name: 1495 Heron Road	Rock core Photographs

Rock Core Photo No.: 5	Borehole: MW22-8	Depth: 4.3 m to 5.9 m

Stantec	Project No.: 160410368	Rock core Photographs
	Project Name: 1495 Heron Road	

Rock Core Photo No.: 6	Borehole: BH22-9	Depth: 5.0 m to 6.6 m

Stantec	Project No.: 160410368 Project Name: 1495 Heron Road	Rock core Photographs

Rock Core Photo No.: 7	Borehole: MW22-11	Depth: 3.1 m to 4.8 m

Stantec	Project No.: 160410368	Rock core Photographs
	Project Name: 1495 Heron Road	

Rock Core Photo No.: 8	Borehole: BH22-12	Depth: 3.8 m to 5.6 m

L O G O F BOREHOLE BHMW15-1

DST CONSULTING ENGINEERS INC.

REF. No.: OE-OT-019917	
CLIENT: CLC	METHOD: Portable Drilling
PROJECT: Phase II ESA	DIAMETER: 7.6 cm
LOCATION: 1495 Heron Road, Ottawa, Ontario	DATE: 13 March 2015

CVC ■ % LEL 20 40 60 80 ○ PPM 200 400 600 800	CVC Conc. PPM	SAMPLES ID.	Type	SPT N-Value	SYMBL	SUBSURFACE PROFILE MATERIAL DESCRIPTION	DPTH m	ELEV m	Well Installation Details	REMARKS
						SURFACE				
						CONCRETE.				- Monitoring well protected with flush - mount casing.
		SS1				GRANULAR.				
						SILTY SAND - Very fine, equally mixed, grey, no odour or staining.	0.6			- Groundwater level = 0.45 mbgs on (March 13, 2015).
○	150	SS2					1.2			
		SS3				TILL - Sand silty matrix with granitic rock cobbles.	1.8			
						End of Borehole at 1.9 m.	2.4			
							3.0			
							3.6			
							4.2			
							4.8			
							5.4			
							6.0			
							6.6			
							7.2			
							7.8			
							8.4			

DST consulting engineers

Auger Sample
Split Spoon
Bentonite & Riser
Sand Pack & Screen

ND - Non-Detectable
CVC - Combustable Vapour Concentration

GASTECBH OE-OT-019917.GPJ DST_MIN.GDT 31/3/15

L O G O F BOREHOLE BHMW15-2

DST CONSULTING ENGINEERS INC.

REF. No.: OE-OT-019917	
CLIENT: CLC	METHOD: CME 750
PROJECT: Phase II ESA	DIAMETER: 10 cm
LOCATION: 1495 Heron Road, Ottawa, Ontario	DATE: 19 March 2015

CVC ■ % LEL 20 40 60 80 ○ PPM 200 400 600 800	CVC Conc. PPM	SAMPLES ID.	Type	SPT N-Value	SYMBL	SUBSURFACE PROFILE MATERIAL DESCRIPTION	DPTH m	ELEV m	Well Installation Details	REMARKS
						SURFACE				
	125	SS1				TOPSOIL. FILL - Silty, trace gravel, trace sand, brown, dry.				- Monitoring well protected with flush - mount casing.
						- some silt, trace gravel.	0.6			
	100	SS2					1.2			
	95	SS3				TILL - Silty, trace sand, trace gravel, moist. - clayey, trace sand. - wet.	1.8			
						- trace clay, trace gravel, moist.				
	105	SS4					2.4			- Groundwater level = 2.45 mbgs on (March 20, 2015).
	90	SS5					3.0			
						- some sand, trace gravel, wet.				
	90	SS6					3.6			
						- trace sand, trace gravel, wet.				
	65	SS7					4.2			
						FRACTURED BEDROCK (SHALE). End of Borehole at 4.6 m.	4.8			
							5.4			
							6.0			
							6.6			
							7.2			
							7.8			
							8.4			

DST consulting engineers

Auger Sample
Split Spoon
Bentonite & Riser
Sand Pack & Screen

ND - Non-Detectable
CVC - Combustable Vapour Concentration

L O G O F BOREHOLE BHMW15-3

DST CONSULTING ENGINEERS INC.

REF. No.: OE-OT-019917	
CLIENT: CLC	METHOD: CME 750
PROJECT: Phase II ESA	DIAMETER: 10 cm
LOCATION: 1495 Heron Road, Ottawa, Ontario	DATE: 19 March 2015

CVC ■ % LEL 20 40 60 80 ○ PPM 200 400 600 800	CVC Conc. PPM	SAMPLES ID.	Type	SPT N-Value	SYMBL	SUBSURFACE PROFILE MATERIAL DESCRIPTION	DPTH m	ELEV m	Well Installation Details	REMARKS
						SURFACE				
	55	SS1				TOPSOIL. FILL - Silty, sandy trace gravel, brown.	0.6			- Monitoring well protected with flush - mount casing.
	50	SS2				- some clay, trace gravel, moist.	1.2			
	10	SS3				NO RECOVERY.	1.8			
		SS4				TILL - Silty, trace sand, wet. - not enough recovery to collect sample.	2.4			
		SS5				- some clay, trace sand, trace gravel, wet.	3.0			
	85	SS6				- trace sand, trace gravel, wet.	3.6			- Groundwater level = 3.82 mbgs on (March 25, 2015).
	120	SS7				FRACTURED BEDROCK (SHALE).	4.2			
						End of Borehole at 4.6 m.	4.8			
							5.4			
							6.0			
							6.6			
							7.2			
							7.8			
							8.4			

DST consulting engineers

Auger Sample
Split Spoon
Bentonite & Riser
Sand Pack & Screen

ND - Non-Detectable
CVC - Combustable Vapour Concentration

GASTECBH OE-OT-019917.GPJ DST_MIN.GDT 31/3/15

L O G O F BOREHOLE BHMW15-4

DST CONSULTING ENGINEERS INC.

REF. No.: OE-OT-019917	
CLIENT: CLC	METHOD: CME 750
PROJECT: Phase II ESA	DIAMETER: 10 cm
LOCATION: 1495 Heron Road, Ottawa, Ontario	DATE: 19 March 2015

CVC ■ % LEL 20 40 60 80 ○ PPM 200 400 600 800	CVC Conc. PPM	SAMPLES ID.	Type	SPT N-Value	SYMBL	SUBSURFACE PROFILE MATERIAL DESCRIPTION	DPTH m	ELEV m	Well Installation Details	REMARKS
						SURFACE				
	35	SS1				TOPSOIL.				- Monitoring well protected with flush - mount casing.
						FILL - Sandy, silty, trace gravel, brown.	0.6			
	135	SS2				TILL - Sandy, silty, trace gravel, brown.	1.2			
	85	SS3				- trace sand, trace gravel, brown.	1.8			
	140	SS4				- trace clay, trace gravel, grey, moist.	2.4			
	135	SS5				- trace gravel, grey, moist.	3.0			
	130	SS6				- moist to wet.	3.6			- Groundwater level = 3.63 mbgs on (March 20, 2015).
	130	SS7				- wet.	4.2			
	135	SS8				- wet.	4.8			
	160	SS9				WEATHERED BEDROCK (SHALE). End of Borehole at 5.3 m.	5.4			
							6.0			
							6.6			
							7.2			
							7.8			
							8.4			

DST consulting engineers

Auger Sample
Split Spoon
Bentonite & Riser
Sand Pack & Screen

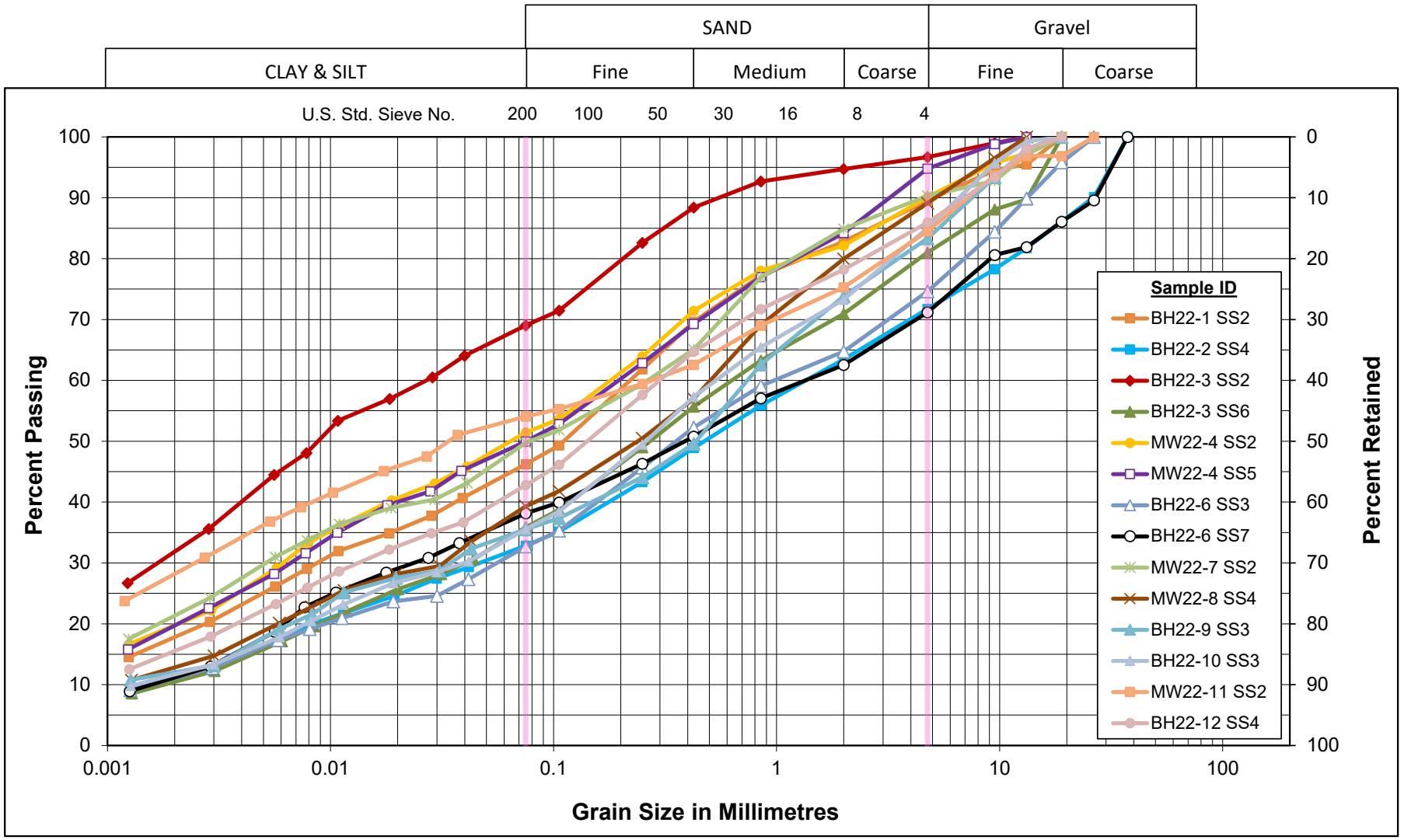
ND - Non-Detectable
CVC - Combustable Vapour Concentration

GASTECBH OE-OT-019917.GPJ DST_MIN.GDT 31/3/15

APPENDIX D

D.1 LABORATORY RESULTS

Unified Soil Classification System



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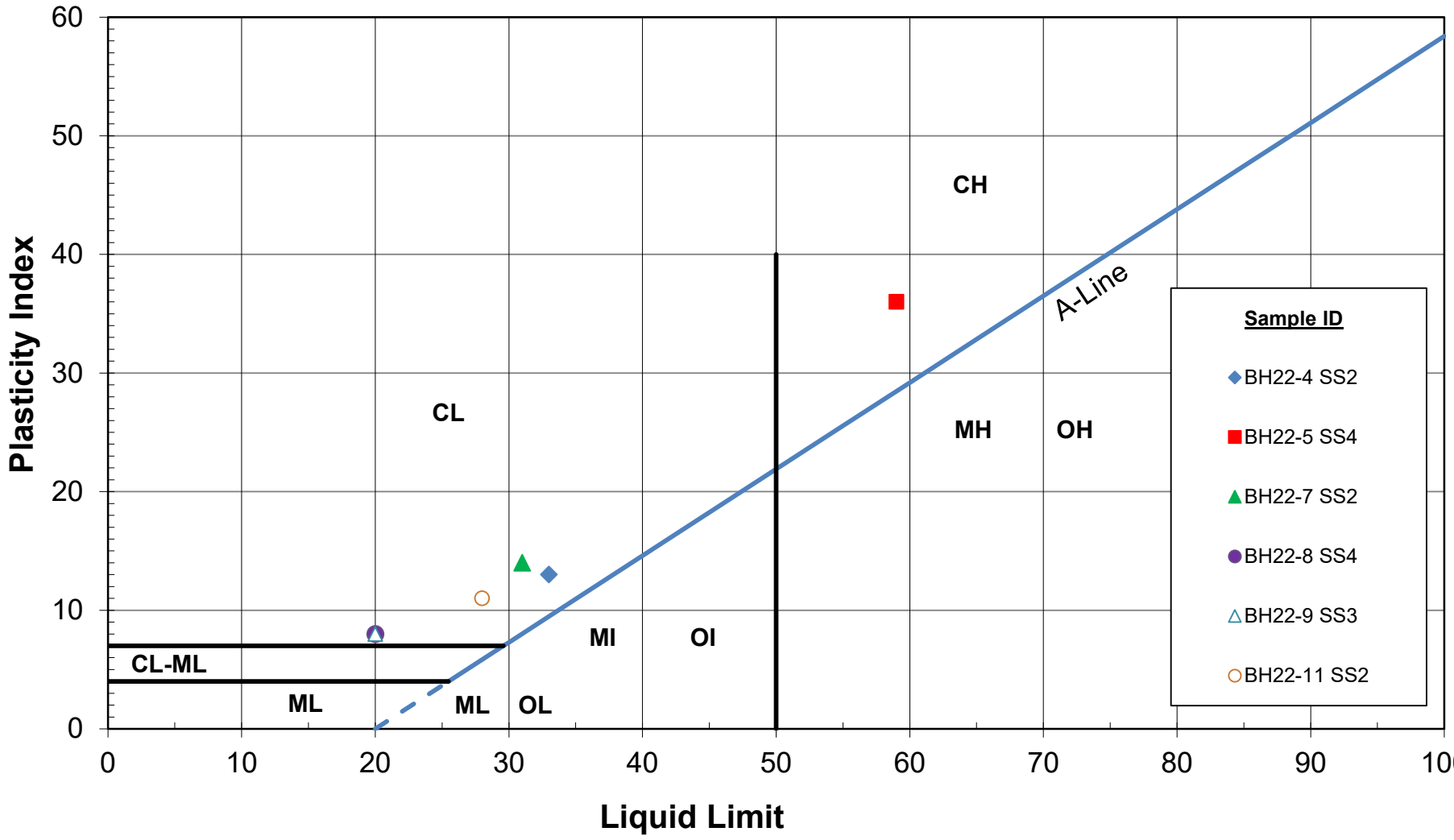
GRAIN SIZE DISTRIBUTION

Sandy Lean Clay (CL) TILL to Silty Sand with Gravel (SM) TILL

Figure No. 1

Project No. 160410368.301.101



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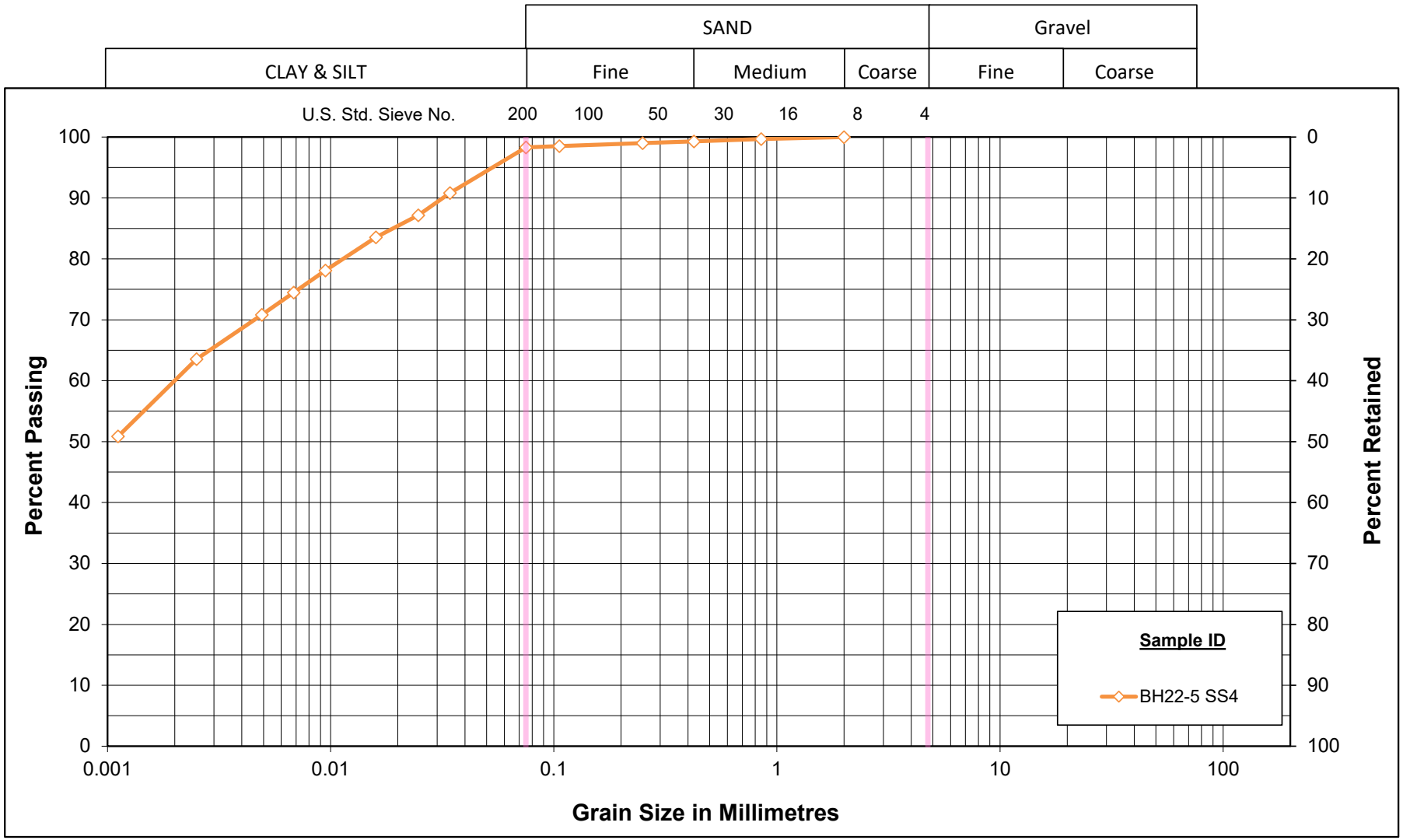
PLASTICITY CHART

Figure No. 2

Project No. 160410368.301.101

Unified Soil Classification System



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GRAIN SIZE DISTRIBUTION

Fat Clay (CH)

Figure No. 3

Project No. 160410368.301.101

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Compressive Strength & Elastic Moduli of Intact Rock Core Speciments under Varying States of Stress and Temperatures

Method C

ASTM D7012 & D4543

Client:	Canada Lands Company Limited	Project No.:	160410368
Project:	1495 Heron Rd		
Material Type:	Rock Core; Diameter ≥ 47.0 mm	Date Received:	July 15 2022
Sampled By:	Ben Heyl	Tested By:	Jaafar Al Sendi
Date Sampled:	No Information	Date Tested:	July 29, 2022

Sample Information				
Borehole Location	**6**	**6**	**9**	**9**
Sample Number	R1	R1	R1	R1
Sample Depth	20' 10" - 21' 6"	23' 6" - 23' 11"	18' 7" - 19' 0"	18' - 18' 6"
Compressive Strength Test Data				
Physical Description	As per Geotechnical Report	As per Geotechnical Report	As per Geotechnical Report	As per Geotechnical Report
Average Sample Diameter (mm) (≥47.0)	47	47	47	47
Average Sample Length (mm)	118	108	118	108
Density (kg/m^3)	2716	2758	2775	2648
Unit Weight (kN/m^3)	**26.6**	**27.1**	**27.2**	**26.0**
L/D Ratio (2.0-2.5)	2.50	2.29	2.50	2.29
Failure Load (lbs)	28470	38510	16690	19920
Compressive Strength (MPa)	**72.5**	**98.1**	**42.3**	**50.7**
Straightness by Procedure S1 (≤0.02inch)	<0.02	<0.02	<0.02	<0.02
Flatness by Procedure FP2 (≤0.001inch)	<0.001	<0.001	<0.001	<0.001
Parallelism by Procedure FP2 (≤0.25°)	#N/A	-0.005	#N/A	#N/A
Perpendicularity by Procedure P2 (≤0.0043)	<0.0043	<0.0043	<0.0043	<0.0043
Moisture Condition	As-Received	As-Received	As-Received	As-Received
Description of Break D7012/11.1.13	Vertical Fracture	Vertical Fracture	Vertical Fracture	Vertical Fracture
Note	0	0	0	0.00

Remarks:

Reviewed by: _____ Date: _____

Stantec

Compressive Strength & Elastic Moduli of Intact Rock Core Speciments under Varying States of Stress and Temperatures

Method C

ASTM D7012 & D4543

Client:	Canada Lands Company Limited	Project No.:	160410368
Project:	1495 Heron Rd		
Material Type:	Rock Core; Diameter ≥ 47.0 mm	Date Received:	July 15 2022
Sampled By:	Ben Heyl	Tested By:	Jaafar Al Sendi
Date Sampled:	No Information	Date Tested:	July 29, 2022

Sample Information				
Borehole Location	**12**	**3**	**1**	**1**
Sample Number	R1	R1	R1	R1
Sample Depth	17' 3" - 17' 8"	18' 2" - 18' 8"	21' 6" - 21' 11"	23' 7" - 24'
Compressive Strength Test Data				
Physical Description	As per Geotechnical Report	As per Geotechnical Report	As per Geotechnical Report	As per Geotechnical Report
Average Sample Diameter (mm) (≥47.0)	47	47	47	47
Average Sample Length (mm)	118	109	91	101
Density (kg/m^3)	2665	2700	2440	2678
Unit Weight (kN/m^3)	**26.1**	**26.5**	**23.9**	**26.3**
L/D Ratio (2.0-2.5)	2.49	2.30	1.92	2.14
Failure Load (lbs)	19950	17620	13150	11390
Compressive Strength (MPa)	**50.3**	**44.4**	**33.3**	**28.8**
Straightness by Procedure S1 (≤0.02inch)	<0.02	<0.02	<0.02	<0.02
Flatness by Procedure FP2 (≤0.001inch)	<0.001	<0.001	<0.001	<0.001
Parallelism by Procedure FP2 (≤0.25°)	-0.002	#N/A	#N/A	#N/A
Perpendicularity by Procedure P2 (≤0.0043)	<0.0043	<0.0043	<0.0043	<0.0043
Moisture Condition	As-Received	As-Received	As-Received	As-Received
Description of Break D7012/11.1.13	Vertical Fracture	Vertical Fracture	Vertical Fracture	Vertical Fracture
Note	0	0	0	0.00

Remarks:

Reviewed by: _____ Date: _____

Stantec

Compressive Strength & Elastic Moduli of Intact Rock Core Speciments under Varying States of Stress and Temperatures

Method C

ASTM D7012 & D4543

Client:	Canada Lands Company Limited	Project No.:	160410368
Project:	1495 Heron Rd		
Material Type:	Rock Core; Diameter ≥ 63.0 mm	Date Received:	July 15 2022
Date Sampled:	No Information	Tested By:	Jaafar Al Sendi
Sampled By:	Ben Heyl	Date Tested:	July 29, 2022

Sample Information				
Borehole Location	**11**	**11**	**0**	**0**
Sample Number	R1	R1	0	0
Sample Depth	15' 2" - 15' 6"	14' 5"- 14' 10"	0	0
Compressive Strength Test Data				
Physical Description	As per Geotechnical Report	As per Geotechnical Report	As per Geotechnical Report	As per Geotechnical Report
Average Diameter (mm) (≥63.0)	62.56	62.38		
Average Sample Length (mm)	125.00	149.00		0.00
Density (kg/m^3)	2602.60	2701.52		
Unit Weight (kN/m^3)	25.53	26.50	#VALUE!	#VALUE!
L/D Ratio (2.0-2.5)	2.00	2.39	#VALUE!	#VALUE!
Failure Load (lbs)	44360	55570	0	0
Compressive Strength (MPa)	**64.2**	**80.9**	**#VALUE!**	**#VALUE!**
Straightness by Procedure S1 (≤0.02inch)	<0.02	<0.02	<0.02	<0.02
Flatness by Procedure FP2 (≤0.001inch)	<0.001	<0.001	<0.001	<0.001
Parallelism by Procedure FP2 (≤0.25°)	#N/A	0.026	#N/A	#N/A
Perpendicularity by Procedure P2 (≤0.0043)	<0.0043	<0.0043	<0.0043	<0.0043
Moisture Condition	As-Received	As-Received	As-Received	As-Received
Description of Break D7012/11.1.13	Vertical Fracture	Vertical Fracture	0	0
Note	0	0	0	0

Remarks:

Reviewed by: _____ Date: _____

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Certificate of Analysis

Stantec Consulting Ltd. (Ottawa)
1331 Clyde Avenue Suite 400
Ottawa, ON K2C 3G4
Attn: Brian Prevost

Client PO:
Project: 160410368.301.101
Custody:

Report Date: 15-Jul-2022
Order Date: 8-Jul-2022

Order #: 2228557

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
2228557-01	BH22-3 SS3
2228557-02	BH22-4 SS4
2228557-03	BH22-6 SS4
2228557-04	BH22-8 SS3
2228557-05	BH22-9 SS5

Approved By:

Alex Enfield, MSc
Lab Manager

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	14-Jul-22	14-Jul-22
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	13-Jul-22	14-Jul-22
Resistivity	EPA 120.1 - probe, water extraction	14-Jul-22	15-Jul-22
Solids, %	Gravimetric, calculation	13-Jul-22	14-Jul-22

Summary of Criteria Exceedances

(If this page is blank then there are no exceedances)

Only those criteria that a sample exceeds will be highlighted in red

Regulatory Comparison:

Paracel Laboratories has provided regulatory guidelines on this report for informational purposes only and makes no representations or warranties that the data is accurate or reflects the current regulatory values. The user is advised to consult with the appropriate official regulations to evaluate compliance. Sample results that are highlighted have exceeded the selected regulatory limit. Calculated uncertainty estimations have not been applied for determining regulatory exceedances.

Sample	Analyte	MDL / Units	Result	-	-

Certificate of Analysis

Report Date: 15-Jul-2022

Client: **Stantec Consulting Ltd. (Ottawa)**

Order Date: 8-Jul-2022

Client PO:

Project Description: 160410368.301.101

	Client ID:	BH22-3 SS3	BH22-4 SS4	BH22-6 SS4	BH22-8 SS3	-	-
	Sample Date:	21-Jun-22 09:00	21-Jun-22 09:00	20-Jun-22 09:00	20-Jun-22 09:00		
	Sample ID:	2228557-01	2228557-02	2228557-03	2228557-04		
	Matrix:	Soil	Soil	Soil	Soil		
	MDL/Units						
Physical Characteristics							
% Solids	0.1 % by Wt.	91.2	90.5	92.2	88.4	-	-
General Inorganics							
pH	0.05 pH Units	7.56	7.66	7.87	7.59	-	-
Resistivity	0.1 Ohm.m	53.3	24.3	13.0	52.2	-	-
Anions							
Chloride	5 ug/g	18	<5	195	674	-	-
Sulphate	5 ug/g	39	346	437	45	-	-

	Client ID:	BH22-9 SS5				-	-
	Sample Date:	20-Jun-22 09:00					
	Sample ID:	2228557-05					
	Matrix:	Soil					
	MDL/Units						
Physical Characteristics							
% Solids	0.1 % by Wt.	91.3	-	-	-	-	-
General Inorganics							
pH	0.05 pH Units	7.72	-	-	-	-	-
Resistivity	0.1 Ohm.m	10.7	-	-	-	-	-
Anions							
Chloride	5 ug/g	657	-	-	-	-	-
Sulphate	5 ug/g	491	-	-	-	-	-

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions								
Chloride	ND	5	ug/g					
Sulphate	ND	5	ug/g					
General Inorganics								
Resistivity	ND	0.10	Ohm.m					

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	290	5	ug/g	321			10.1	20	
Sulphate	50.9	5	ug/g	54.2			6.3	20	
General Inorganics									
pH	7.60	0.05	pH Units	7.55			0.7	10	
Resistivity	38.0	0.10	Ohm.m	38.1			0.3	20	
Physical Characteristics									
% Solids	77.0	0.1	% by Wt.	80.3			4.2	25	

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	420	5	ug/g	321	99.1	82-118			
Sulphate	140	5	ug/g	54.2	86.3	80-120			

Certificate of Analysis

Report Date: 15-Jul-2022

Client: **Stantec Consulting Ltd. (Ottawa)**

Order Date: 8-Jul-2022

Client PO:

Project Description: 160410368.301.101

Qualifier Notes:

Sample Data Revisions:

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable

ND: Not Detected

MDL: Method Detection Limit

Source Result: Data used as source for matrix and duplicate samples

%REC: Percent recovery.

RPD: Relative percent difference.

NC: Not Calculated

Soil results are reported on a dry weight basis unlesss otherwise noted.

Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

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Paracel ID: 2228557

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Page ___ of ___

Client Name:	**Stantec Consulting Ltd.**	Project Reference:	TAT: **[x] Regular** [ ] 3 Day [ ] 2 Day [] 1 Day
Contact Name:	**Brian Prevost**	Task #:	
Address:	**100A&B-2781 Lancaster Rd. Ottawa ON. K1B-1A7**	PO # **160410368.301.101**	Date Required:
Telephone:	**613-738-6075**	Email Address: brian.prevost@stantec.com ; katurah.firdawsi@stantec.com	

Criteria: [ ] O. Reg. 153/04 Table __ [ ] O. Reg. 153/11 (Current) Table __ [ ] RSC Filing [ ] O. Reg. 558/00 [ ] PWQO [ ] CCME [ ] SUB (Storm) [ ] SUB (Sanitary) Municipality:_____ [ ] Other:_____

Matrix Type: **S** (Soil/Sed.) **GW** (Ground Water) **SW** (Surface Water) **SS** (Storm/Sanitary Sewer) **P** (Paint) **A** (Air) **O** (Other)

Paracel Order Number: 2228557

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken Date	Sample Taken Time	Resistivity	PH	Sulphate & Chloride	Required Analyses
1	BH22-3 SS3	S		1	21-Jun-22		X	X	X	
2	BH22-4 SS4	S			21-Jun-22		X	X	X	
3	BH22-6 SS4	S			20-Jun-22		X	X	X	
4	BH22-8 SS3	S			20-Jun-22		X	X	X	
5	BH22-9 SS5	S			20-Jun-22		X	X	X	
6										
7										
8										
9										
10										

Comments:

Method of Delivery: Swift

Relinquished By (Print & Sign): **DANIEL BOATENG**	Received by Driver/Depot:	Received at Lab: Jaspreet Bhinder	Verified By: Blaw
Date/Time: **8-Jul-22**	Date/Time:	Date/Time: Jul 08, 2022 12:30	Date/Time: July 8, 22 16:45
	Temperature: _____ °C	Temperature: 23.5 °C	pH Verified [ ] By:

APPENDIX E

E.1 NBC SEISMIC HAZARD CALCULATION

2020 National Building Code of Canada Seismic Hazard Tool

This application provides seismic values for the design of buildings in Canada under Part 4 of the National Building Code of Canada (NBC) 2020 as prescribed in Article 1.1.3.1. of Division B of the NBC 2020.

Seismic Hazard Values

User requested values

Code edition	NBC 2020
Site designation X_S	X_C
Latitude (°)	45.38
Longitude (°)	-75.653

Please select one of the tabs below.

NBC 2020 | Additional Values | Plots | API | Background Information

The 5%-damped spectral acceleration ($S_a(T,X)$, where T is the period, in s, and X is the site designation) and peak ground acceleration (PGA(X)) values are given in units of acceleration due to gravity (g, 9.81 m/s^2). Peak

ground velocity (PGV(X)) values are given in m/s. Probability is expressed in terms of percent exceedance in 50 years. Further information on the calculation of seismic hazard is provided under the *Background Information* tab.

The 2%-in-50-year seismic hazard values are provided in accordance with Article 4.1.8.4. of the NBC 2020. The 5%- and 10%-in-50-year values are provided for additional performance checks in accordance with Article 4.1.8.23. of the NBC 2020.

See the *Additional Values* tab for additional seismic hazard values, including values for other site designations, periods, and probabilities not defined in the NBC 2020.

NBC 2020 - 2%/50 years (0.000404 per annum) probability

$S_a(0.2, X_C)$	$S_a(0.5, X_C)$	$S_a(1.0, X_C)$	$S_a(2.0, X_C)$	$S_a(5.0, X_C)$	$S_a(10.0, X_C)$	$PGA(X_C)$	$PGV(X_C)$
0.671	0.398	0.212	0.0973	0.0257	0.00846	0.359	0.272

The log-log interpolated 2%/50 year $S_a(4.0, X_C)$ value is : **0.0355**

▶ Tables for 5% and 10% in 50 year values

Download CSV

← Go back to the seismic hazard calculator form

Date modified: 2021-04-06