Complementary Geotechnical Data Report

Proposed PCA Artifact Storage Facility at 555 Avenue des Entreprises, Gatineau, QC

Prepared for:
Public Works and Government Services Canada
340 rue Albert Street, Ottawa, ON
K1A 0S5

Prepared by:
Stantec Consulting Ltd.
400 – 1331 Clyde Avenue
Ottawa, ON K2C 3G4

Project No. 121623165
Contract No. EP168-200399/001/FE

March 2020

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1.0 INTRODUCTION

Public Works and Government Services Canada (PWGSC) has retained Stantec Consulting Ltd. (Stantec) to carry out a geotechnical investigation to provide subsurface information on bedrock depths to complement the existing geotechnical information for the proposed PCA Artifact Storage Facility located at 555 Avenue des Entreprises in Gatineau, QC. This complementary geotechnical data report (GDR) presents the results of this complementary geotechnical investigation and should be read in conjunction with Stantec's geotechnical reports titled, "Geotechnical Data Report – Revision 1, Proposed PCA Artifact Storage Facility at 555 Avenue des Entreprises, Gatineau, QC", dated December 2019 and "Geotechnical Design Memorandum, PCA Artifact Facility , 555 Avenue des Entreprises, Gatineau, QC", dated December 2019.

The work was carried out in general accordance with the scope of work for a complementary geotechnical investigation as outlined in Stantec's proposal dated January 13, 2020.

This report has been prepared specifically and solely for the project described herein. It presents the factual results of the complementary investigation to assist with the design and construction of the proposed building.

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

2.0 SITE DESCRIPTION AND BACKGROUND

It is understood that the proposed building will have an overall gross area of approximately 6,500 m^2 to 10,000 m^2 with either one or two storeys above grade and up to one level below grade. The building will include a loading dock and a paved parking lot with up to 25 spaces. It is understood that the footprint and dimensions of the building have yet to be finalized.

The location of the site is shown on Drawing No. 1 in Appendix B.

The site is currently a paved parking lot that was snow covered at the time of this investigation. North of the site is a building with a footprint of approximately 13,700 m^2.

Several investigations were previously carried out at this site by John D. Patterson and Associates and by Stantec. The findings of these investigations have been described in Stantec's December 2019 reports.

3.0 SCOPE OF WORK

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

- Advancing three (3) unsampled boreholes to refusal on bedrock and coring approximately 1.5 m into bedrock.
- Advancing three (3) Dynamic Cone Penetration Tests (DCPTs) to refusal.

- Carrying out a seismic refraction survey to obtain a bedrock profile along two lines within the proposed building footprint.
- Prepare a complementary Geotechnical Data Report (GDR) with the results of the geotechnical investigation.

4.0 METHOD OF INVESTIGATION

4.1 GEOTECHNICAL FIELD INVESTIGATION

As a component of our standard procedures and due diligence, Stantec contacted the public utility authorities to clear the locations of both private and public underground utilities.

The field drilling program was carried out between January 27 and January 31, 2020 and consisted of three boreholes and three DCPT holes. The seismic refraction survey was carried out on February 17, 2020, by Sigma Geophysics. The borehole and DCPT locations and the seismic refraction lines are shown on Drawing No. 2 in Appendix B.

The boreholes and DCPTs were advanced using a truck-mounted CME drill rig. Drilling observations were recorded in the field by experienced Stantec personnel while retrieving bedrock core samples. Bedrock was cored using HQ size coring equipment in all boreholes.

The boreholes and DCPT holes were backfilled with the augered material and sealed at the surface with cold patch asphalt.

All recovered rock cores were stored and transported to the Ottawa laboratory for detailed geotechnical classification.

4.2 SURVEYING

The ground surface elevation at each borehole location was obtained from spot elevations obtained from PSPC Plan No. NCA-18-33141/1 titled, “Plan Accompagnant le Certificat de Localisation Certificat de Piquetage et Plan Topographique”, dated 7 June 2018.

The coordinates and elevations at the borehole, DCPT and CPT locations from both the 2018 and 2020 investigations are summarized in Table 4.1. Geodetic elevations at the borehole locations are also shown on the Borehole Records in Appendix C.

Table 4.1: Summary of Borehole Coordinates and Elevations (2018 & 2020 Investigations)

Borehole	Elevation (m)	Northing	Easting
BH20-1	101.90	5040077.002	449090.733
BH20-2	101.90	5040082.594	449138.902
BH20-3	102.20	5040033.877	449140.26
DCPT-1	101.90	5040087.131	449159.923
DCPT-2	102.20	5040036.115	449168.632

Borehole	Elevation (m)	Northing	Easting
DCPT-3	102.30	5040029.041	449083.035
BH18-1	101.83	5040042.708	449066.872
BH18-2	101.92	5040067.459	449114.155
BH18-3	101.69	5040096.493	449154.298
BH18-4	101.80	5040056.266	449157.804
CPT18-1	101.70	5040079.173	449062.793
CPT18-2	101.62	5040096.618	449109.742
CPT18-3	102.10	5040033.975	449110.209

Coordinates are displayed in UTM Zone 18T (NAD 83)

5.0 RESULTS OF INVESTIGATION

The location of the site is shown on Drawing No. 1 in Appendix B and the borehole locations from both Stantec's 2018 and 2020 investigations are shown on Drawing No. 2 in Appendix B. At the time of the investigation, the site for the proposed building was a snow covered, paved parking lot.

5.1 SUBSURFACE INFORMATION

In general, the subsurface profile at this site consisted of asphalt over fill over a deposit of clay underlain by a thin layer of till followed by cobbles and boulders over bedrock. The depth to inferred bedrock was variable throughout the site with the depth to bedrock generally decreasing towards the western limit of the site.

5.1.1 Summary of Overburden Material

Based on the 2018 geotechnical investigation, the asphalt encountered at ground surface ranged in thickness from 75 mm to 150 mm. Beneath the asphalt was a layer of fill ranging in thickness from 600 mm to 700 mm and was described as well-graded sand with silt and gravel (SW-SM). A layer of firm to very stiff, sensitive Champlain Sea clay was encountered beneath the fill and ranged in thickness from 17.5 m (BH18-1) to about 43.3 m (inferred in BH20-2). Silty sand and gravel till was encountered beneath the clay and consisted of cobbles and boulders. Bedrock was encountered (and proven by coring) beneath the glacial till at depths ranging between 19.5 m (BH18-1) and 46.5 m (BH20-2)

5.1.2 Bedrock

During the 2018 investigation bedrock was encountered at a depth of 19.5 m. Bedrock was not encountered within the three remaining boreholes (BH18-2, 18-3 and 18-4), borehole termination depths in these three boreholes varied from 41.6 m to 47.6 m. Rock was cored in BH18-3 from a depth of 42.9 m to 44.7 m, the cored rock was determined to be boulders.

As part of the 2020 investigation bedrock was proven by coring in three boreholes (BH20-1 to BH20-3). Bedrock was encountered at depths ranging from 24.4 m in BH20-3 to 46.5 m in BH20-2. The bedrock

encountered consisted of grey gneiss and was described as fresh to slightly weathered with Rock Quality Designation (RQD) values ranging from 31% to 95% indicating a poor to excellent rock quality.

Unconfined compressive strength testing carried out as part of the 2018 investigation indicated that the compressive strength of the rock ranged from 99 MPa to 145 MPa indicating a strong to very strong intact rock strength.

DCPT refusal was encountered either within the till or on the bedrock surface in DCPT-1 to DCPT-3. Refusal depths occurred at 45.1 m, 30.5 m and 23.8 m, respectively. Based on nearby borehole information these refusal depths may be anticipated bedrock levels. Table 5.1 summarizes bedrock depth information for the 2018 and 2020 investigations.

Bedrock elevations are shown at each borehole location on Drawing No. 2 in Appendix B. These elevations along with the information obtained from the seismic refraction survey were used to generate subsurface profiles shown on Drawing Nos. 3, 4 and 5 in Appendix B.

Table 5.1: Summary of Bedrock Depths

Borehole	Bedrock Depth/Elevation (m)	Comments
BH 18-1	19.5/82.4	
BH 18-2	-	Bedrock not encountered. Borehole terminated at 47.6 m below grade.
BH 18-3	-	Bedrock not encountered. Borehole terminated in inferred cobble and boulder layer at 44.7 m below grade.
BH 18-4	-	Bedrock not encountered. DCPT refusal at 41.6 m below grade in inferred till layer.
BH 20-1	43.2/58.7	Excellent quality gneiss bedrock.
BH 20-2	46.5/55.4	Fair quality gneiss bedrock.
BH 20-3	24.7/77.5	Poor to excellent quality gneiss bedrock.
DCPT 1	-	Refusal at 45.1 m below grade.
DCPT 2	-	Refusal at 30.5 m below grade.
DCPT 3	-	Refusal at 23.8 m below grade.

5.2 GROUNDWATER

Groundwater levels were not able to be observed during this investigation.

5.3 SEISMIC REFRACTION SURVEY

5.3.1 Methodology

A seismic refraction survey was carried out by Sigma Geophysics Inc. on February 17, 2020, along two lines. The purpose of the survey was to develop a bedrock profile as well as any anomalies in the bedrock such as potential fault zones, along the two test lines (labelled SL-01-20 and SL-02-20) located within the proposed building footprint. Each test line measured approximately 135 m. The survey was carried out using spreads of 19 geophones spaced at about 7.5 m and a high velocity explosive on either end of the lines was detonated while inner shots were released using a high-energy mechanical source.

The method used measures the elapsed time between the energy emission and the arrival of acoustic waves (“P” and “S” waves) at known distances from the source which is used to determine depth and mechanical properties of materials.

The accuracy of the seismic refraction method used computes the overburden thickness within 15% of the actual thickness and due to physical/geological conditions (velocity inversion, hidden layers, shear zones, deep valleys and vertical faults), the depth to bedrock could vary thus the use of other methods such as boreholes should be used in conjunction with the seismic refraction data.

Seismic cross sections were generated to show the profile at the top of each of the refracting horizons observed from the seismic refraction data as well as the top of bedrock profile. The hatched line in the cross-section was used to show the distinction between the overburden and bedrock. For this survey all refractors exhibiting a seismic velocity of greater than 3000 m/s was considered to be bedrock. For the deepest refractor, all seismic velocities less than 4200 m/s were considered to be abnormally low and are highlighted with a bold red line.

5.3.2 Bedrock Profile

Along test line SL-01-20, the bedrock generally dipped from west to east from about 17 m west of BH 20-1 to about 10 m east of BH 20-2 with bedrock elevations ranging between 59.5 m and 50.0 m. From approximately 5 m east of BH 18-3 to about 59 m east of BH 18-3, bedrock elevations ranged between 58.5 m and 47.7 m. The bedrock elevation difference between the nearby boreholes, BH 20-1 and BH 20-2, and the seismic refraction top of bedrock profile was ranged between 0.2 m and 1.7 m.

A seismic velocity anomaly (seismic velocity of 3400 m/s) was encountered between about 6 m west of BH 18-3 and about 2 m east of BH 18-3 along SL-01-20. The anomaly may be due to the presence of fractured bedrock or a change in the bedrock geology.

Along test line SL-02-20, the bedrock generally dipped from west to east with the bedrock elevation varying from 80.0 m approximately 16 m east of BH 18-1 to elevation 65.5 m about 47 m east of BH 20-3. The bedrock elevation difference between the nearby boreholes and the seismic refraction top of bedrock profile was about 3 m and BH 20-3.

The seismic survey cross sections are included in the Sigma Geophysics Inc. memorandum included in Appendix D. Drawing Nos. 3, 4 and 5 included in Appendix B also include the bedrock profile obtained from the seismic refraction testing.

Based on the seismic refraction survey and drilled holes, it appears that the bedrock topography plunges toward the north of the site with a potential fracture zone (seismic anomaly) encountered along SL-01-20 (Section BB’) as discussed above.

6.0 CLOSURE

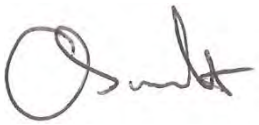
Use of this report is subject to the Statement of General Conditions provided in Appendix A. It is the responsibility of Public Works and Government Services Canada, who is identified as "the Client" within the Statement of General Conditions, and its agents to review the conditions and to notify Stantec 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 of unexpected site conditions
- Planning, design or construction

This report has been prepared by Bridgit Bocage and reviewed by Chris McGrath and Raymond Haché.

Respectfully submitted,

STANTEC CONSULTING LTD.



Chris McGrath, B.Eng., P.Eng.(ON)
Senior Associate – Geotechnical Engineering

Raymond Haché, M.Sc., P.Eng.(ON), ing. (QC)
Senior Principal and Central Canada Practice Lead

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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 KEY PLAN

B.2 BOREHOLE LOCATION PLAN

B.3 SUBSURFACE PROFILE CROSS SECTIONS

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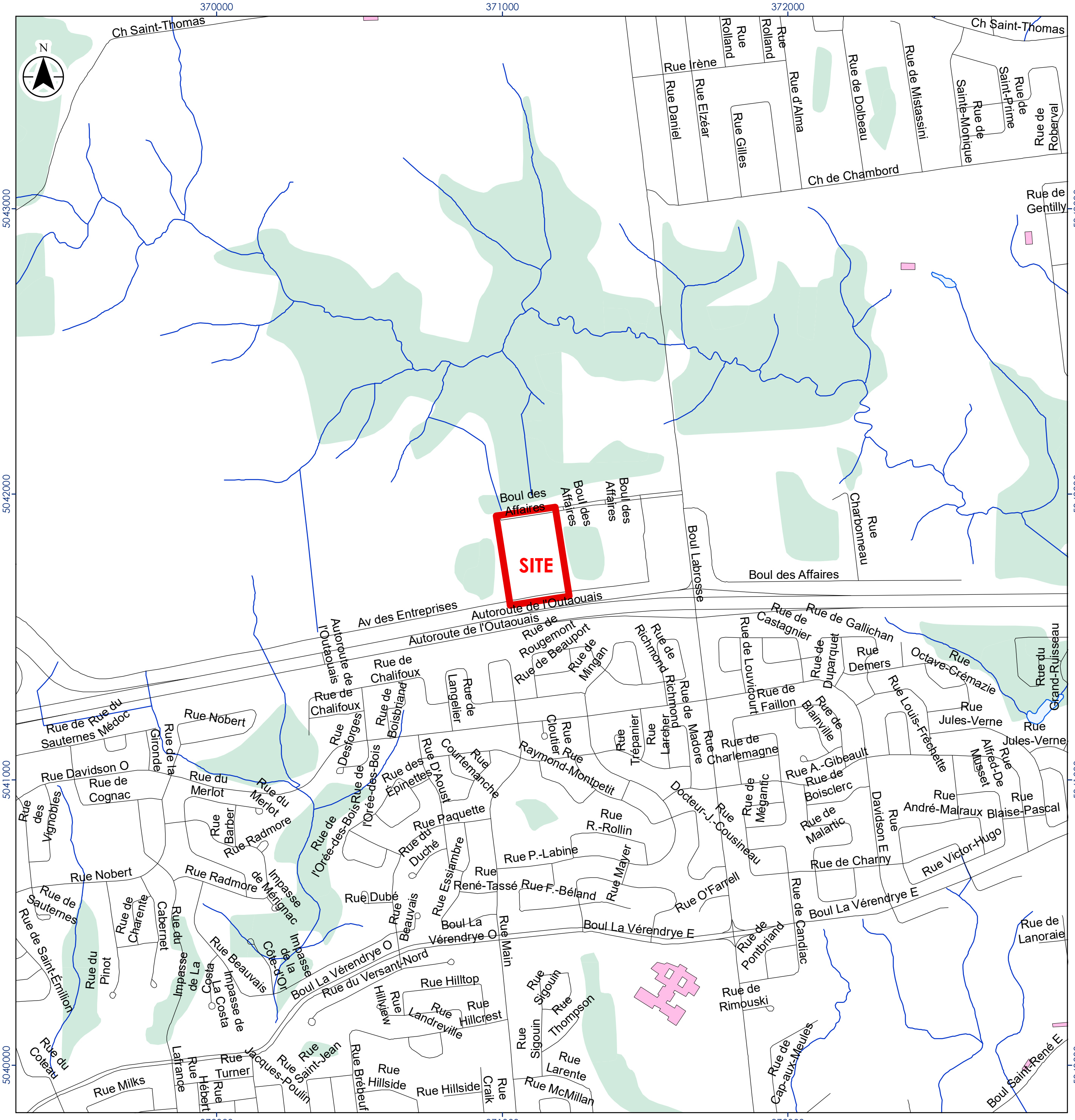

Legend

- Road
- Trail
- Railway
- Watercourse
- Building Area
- Wooded Area

0 400 800 metres

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Stantec

Project Location
555 Avenue Des Enterprises
Gatineau, QC

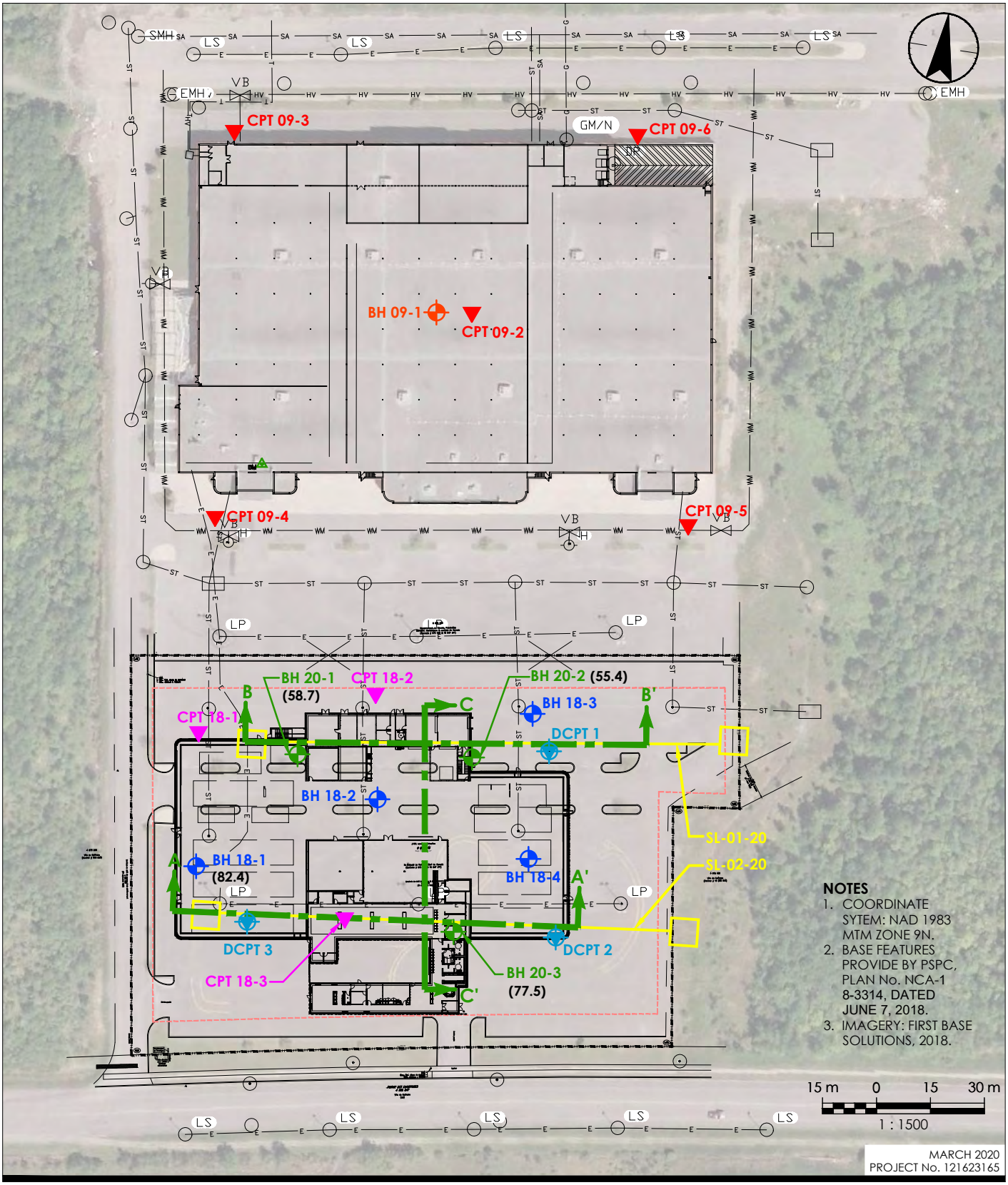
Project No. 121623165
Prepared by Gliceria Briones on 2020-02-04

Client/Project
PSPC
PCA ARTIFACT FACILITY COMPLEMENTARY GEOTECHNICAL STUDY, PARKING LOT SOUTH OF 555 AVENUE DES ENTERPRISES

Drawing No.
1

Title
Key Plan

Notes
1. Coordinate System: NAD 1983 MTM 9.
2. Base features from Canvec, 2018.
3. Imagery provided by Esri, 2019.



NOTES

1. COORDINATE SYTEM: NAD 1983 MTM ZONE 9N.
2. BASE FEATURES PROVIDE BY PSPC, PLAN No. NCA-1 8-3314, DATED JUNE 7, 2018.
3. IMAGERY: FIRST BASE SOLUTIONS, 2018.

MARCH 2020
PROJECT No. 121623165

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LEGEND

- BH 20 — BOREHOLE (2020)
- BH 18 — BOREHOLE (2018)
- BH 09 — BOREHOLE (2009)
- DCPT 2 — DCPT (2020)
- CPT 18 — CPT (2018)
- CPT 09 — CPT (2009)
- A A' — CROSS SECTION LINE (REFER TO DWG. No. 3, 4, 5)
- (50.0) — BEDROCK ELEVATION IN METERS
- SEISMIC SURVEY LINE

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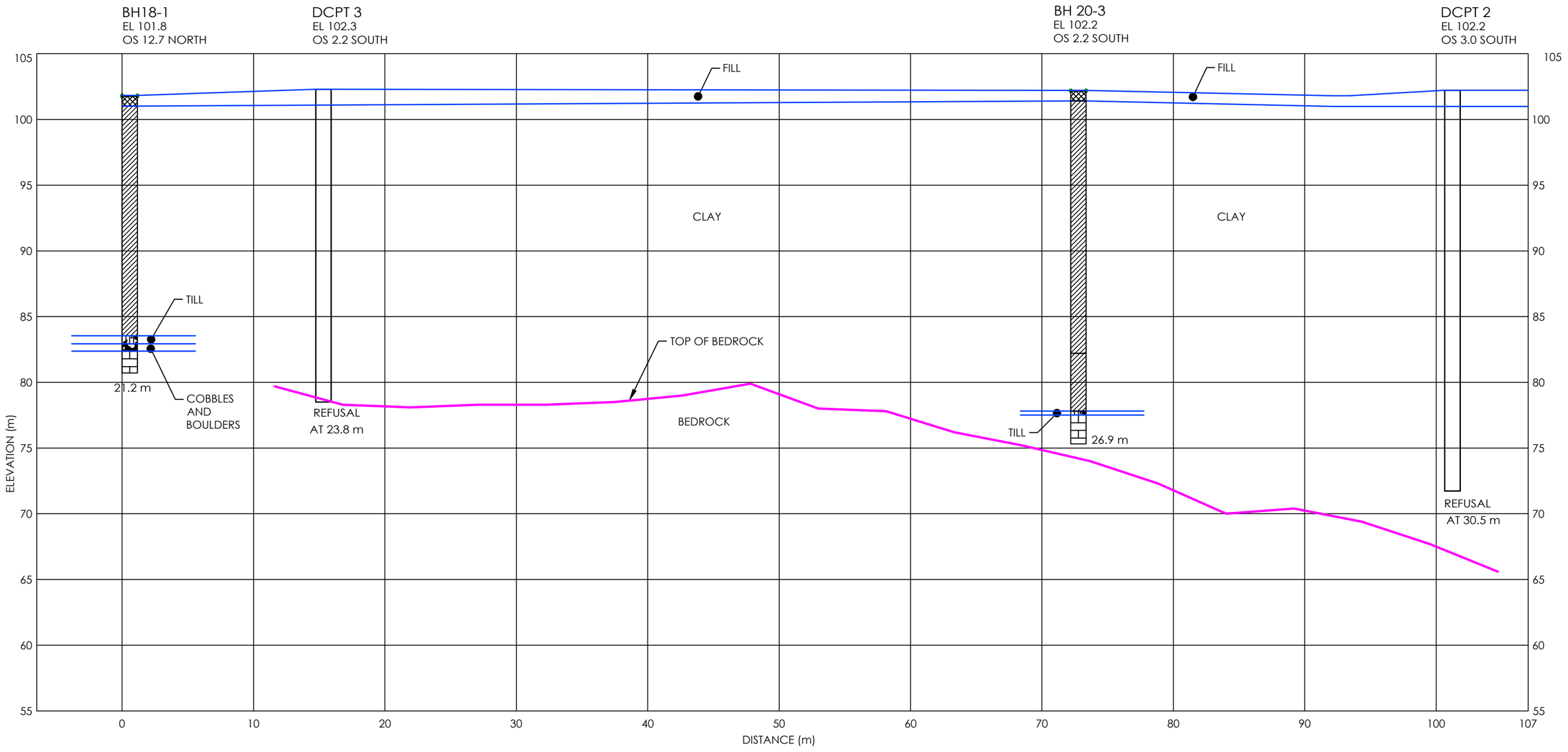
Drawing No.
2

Title
BOREHOLE LOCATION PLAN
PARKING LOT SOUTH OF 555 AVENUE DES ENTREPRISES, GATINEAU, QC



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SOIL AND ROCK KEY

- BOULDERS, COBBLES & GRAVELS
- SAND & GRAVEL
- SAND
- SILTY SAND
- SILT
- CLAY
- SILTY CLAY
- TILL
- FILL
- ORGANICS
- BEDROCK

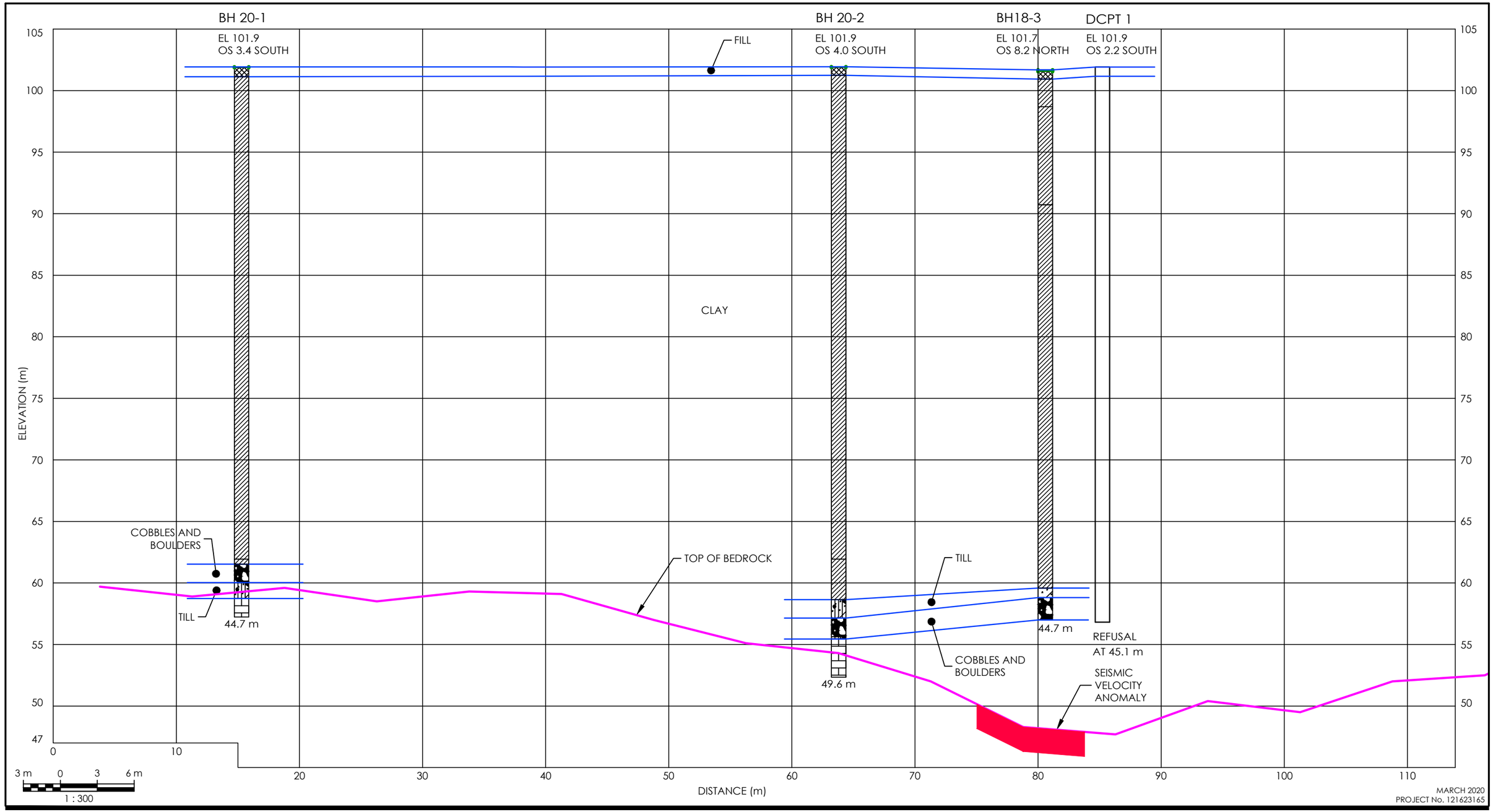
LEGEND

21.2 m	DEPTH BELOW GRADE
EL 101.8	BOREHOLE ELEVATION IN METERS
OS 12.7	OFFSET FROM CROSS SECTION LINE IN METERS
— — —	INFERRED TOP OF BEDROCK PROFILE OBTAINED FROM MARCH 20, 2020 SEISMIC REFRACTION SURVEY BY SIGMA GEOPHYSICS INC. THE GENERAL ACCURACY WAS NOTED AS BEING WITHIN 15% OF THE OVERBURDEN THICKNESS. REFER TO SIGMA GEOPHYSICS REPORT FOR FULL DETAILS.

Client/Project
PSPC
PCA ARTIFACT FACILITY COMPLEMENTARY GEOTECHNICAL STUDY
SOUTH OF 555 AVENUE DES ENTERPRISES, GATINEAU, QC

Drawing No.
3

Title
CROSS SECTION A-A'



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SOIL AND ROCK KEY

- BOULDERS, COBBLES & GRAVELS
- SAND & GRAVEL
- SAND
- SILTY SAND
- SILT
- CLAY
- SILTY CLAY
- TILL
- FILL
- ORGANICS
- BEDROCK

LEGEND

44.7 m	DEPTH BELOW GRADE
EL 101.9	BOREHOLE ELEVATION IN METERS
OS 3.4	OFFSET FROM CROSS SECTION LINE IN METERS
	INFERRED TOP OF BEDROCK PROFILE OBTAINED FROM MARCH 20, 2020 SEISMIC REFRACTION SURVEY BY SIGMA GEOPHYSICS INC. THE GENERAL ACCURACY WAS NOTED AS BEING WITHIN 15% OF THE OVERBURDEN THICKNESS. REFER TO SIGMA GEOPHYSICS REPORT FOR FULL DETAILS.

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SOUTH OF 555 AVENUE DES ENTERPRISES, GATINEAU, QC

Drawing No.
4

Title
CROSS SECTION B-B'

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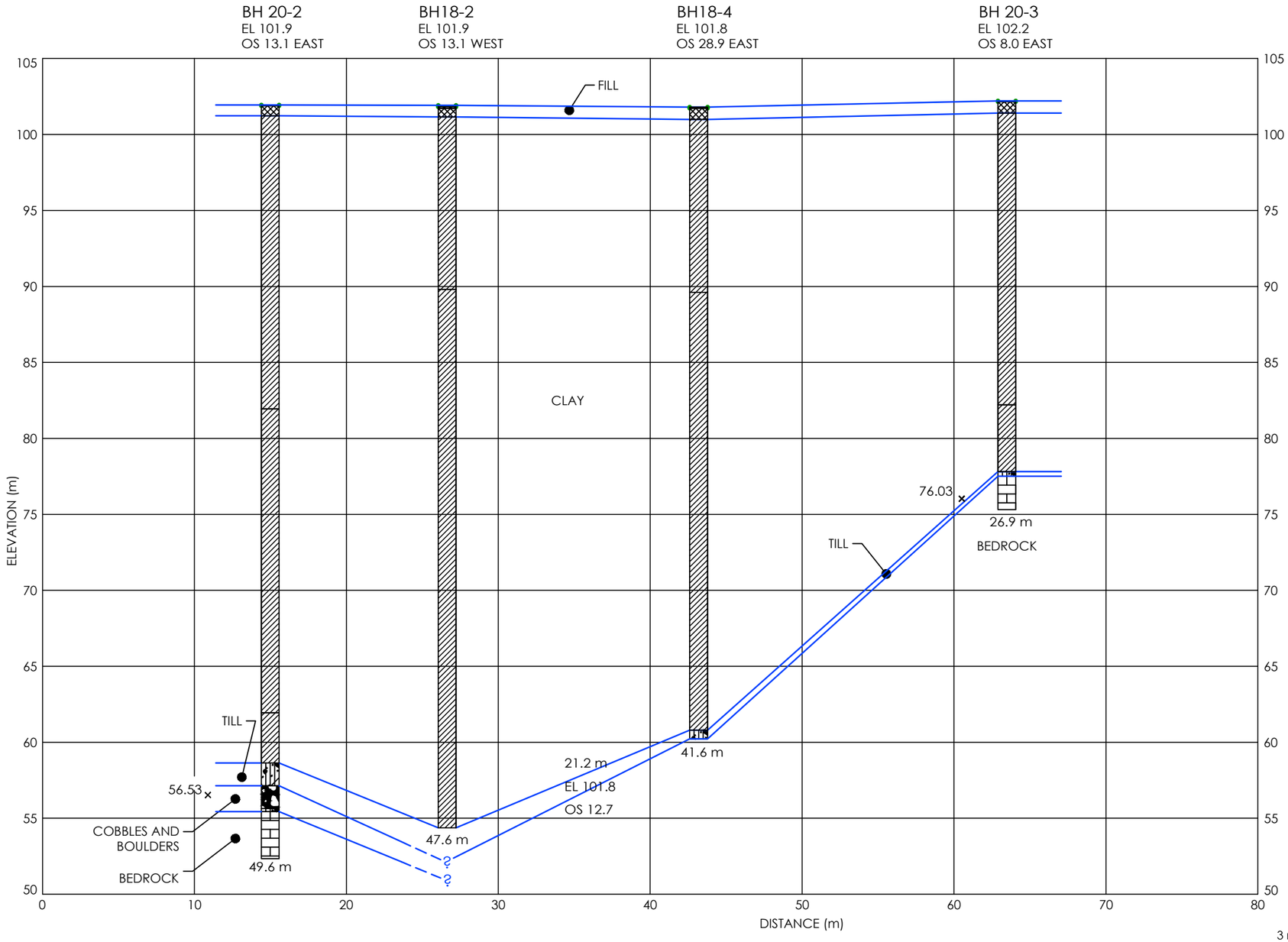
PROJECT No. 121623165



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SOIL AND ROCK KEY

- BOULDERS, COBBLES & GRAVELS
- SAND & GRAVEL
- SAND
- SILTY SAND
- SILT
- CLAY
- SILTY CLAY
- TILL
- FILL
- ORGANICS
- BEDROCK

LEGEND

49.6 m	DEPTH BELOW GRADE
EL 101.9	BOREHOLE ELEVATION IN METERS
OS 13.1	OFFSET FROM CROSS SECTION LINE IN METERS
56.53 ×	INFERRED BEDROCK POINT FROM MARCH 20, 2020 SEISMIC REFRACTIONS SURVEY

Client/Project
PSPC
PCA ARTIFACT FACILITY COMPLEMENTARY GEOTECHNICAL STUDY
SOUTH OF 555 AVENUE DES ENTERPRISES, GATINEAU, QC

Drawing No.
5

Title
CROSS SECTION C-C'

Appendix C

C.1 SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

C.2 BOREHOLE RECORDS

C.3 FIELD BEDROCK CORE LOGS

C.4 ROCK CORE PHOTOGRAPHS

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

Stantec

BOREHOLE RECORD

N: 5 040 043 E: 449 067

BH18-1

CLIENT Public Works and Government Services Canada — BOREHOLE No. BH18-1

LOCATION 555 Avenue des Entreprises, Gatineau, Quebec — PROJECT No. 121622309

DATES: BORING November 7, 2018 — WATER LEVEL June 7, 2019 — 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	**101.83**							
	101.8	75 mm ASPHALT			SS	1	330	9
	101.0	FILL: brown well-graded sand with silt and gravel (SW-SM)			SS	2	584	4
1		Firm to very stiff brown CLAY of high plasticity (CH)			SS	3	610	5
2					SS	4	610	3
3								
4					SS	5	610	3
5				▽	ST	1		
6					SS	6	610	0
7								
8					SS	7	610	0
9				▼	SS	8	610	0
10								
11					ST	2		
12								
13					SS	9	610	0
14								
15					SS	10	610	0

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: 5 040 043 E: 449 067

BH18-1

CLIENT Public Works and Government Services Canada — BOREHOLE No. BH18-1

LOCATION 555 Avenue des Entreprises, Gatineau, Quebec — PROJECT No. 121622309

DATES: BORING November 7, 2018 WATER LEVEL June 7, 2019 — DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
15		*continued* Firm to very stiff brown CLAY of high plasticity (CH)			ST	3		
16								
17								
18	84.0							
	83.5	Cobbles and Boulders - granite and gneiss			NQ	11	42%	
	82.9	Compact brown silty sand with gravel (SM) TILL			SS	12	229	18
19	82.4	Cobbles and Boulders - granite and gneiss			NQ	13	18%	
20		Good to excellent quality GNEISS BEDROCK - strong to very strong intact rock strength - extremely close spaced fractures - orientation 0 to 20 degrees (flat) - fresh to slightly weathered (Refer to Field Bedrock Core Log)			NQ	14	95%	80%
21	80.7				NQ	15	100%	91%
22		End of Borehole						
23								
24		Standpipe Installed: 19.6 m - 18.8 m (Bentonite) 18.8 m - 17.3 m (Screen) 18.8 m - 17.0 m (Sand) 17.0 m - 0 m (Bentonite/Cuttings) Stick-up Well Cap						
25								
26								
27		Water level was measured at 8.8 m on June 7, 2019 and 9.1 m on June 13, 2019						
28								
29								
30								

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: 5 040 067 E: 449 114

BH18-2

CLIENT Public Works and Government Services Canada — BOREHOLE No. BH18-2

LOCATION 555 Avenue des Entreprises, Gatineau, Quebec — PROJECT No. 121622309

DATES: BORING November 6, 2018 — 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	**101.92**							
	101.8	100 mm ASAPHALT			SS	1	279	20
	101.7	FILL: Grey-brown well-graded sand with silt and gravel (SW-SM)			SS	2	508	4
	101.2	FILL: Brown well-graded sand with silt and gravel (SW-SM)						
2		Firm to very stiff grey CLAY of high plasticity (CH) - moist - traces of sand at 0.76 m			SS	3	610	3
3				▽	SS	4	610	1
5					SS	5	610	2
6					SS	6	610	0
8					SS	7	610	0
9					SS	8	610	0
11					SS	9	610	0
12	89.8	Start of Dynamic Cone Penetration Test (DCPT) (Inferred CLAY from 12 m to 47.6 m)						
15								

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: 5 040 067 E: 449 114

BH18-2

CLIENT Public Works and Government Services Canada — BOREHOLE No. BH18-2

LOCATION 555 Avenue des Entreprises, Gatineau, Quebec — PROJECT No. 121622309

DATES: BORING November 6, 2018 — 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
15		*continued* (Inferred CLAY from 12 m to 47.6 m)						

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

16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

Stantec

BOREHOLE RECORD

N: 5 040 067 E: 449 114

BH18-2

CLIENT Public Works and Government Services Canada — BOREHOLE No. BH18-2

LOCATION 555 Avenue des Entreprises, Gatineau, Quebec — PROJECT No. 121622309

DATES: BORING November 6, 2018 — 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
30		*continued* (Inferred CLAY from 12 m to 47.6 m)						
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								
41								
42								
43								
44								
45								

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: 5 040 067 E: 449 114

BH18-2

CLIENT Public Works and Government Services Canada — BOREHOLE No. BH18-2

LOCATION 555 Avenue des Entreprises, Gatineau, Quebec — PROJECT No. 121622309

DATES: BORING November 6, 2018 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
45		*continued* (Inferred CLAY from 12 m to 47.6 m)						
46								
47	54.4							
48		End of Borehole Vibrating Wire Piezometer Installed to 12.1 m below ground surface						
49								
50								
51								
52								
53								
54								
55								
56								
57								
58								
59								
60								

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: 5 040 096 E: 449 154

BH18-3

CLIENT Public Works and Government Services Canada — BOREHOLE No. BH18-3

LOCATION 555 Avenue des Entreprises, Gatineau, Quebec — PROJECT No. 121622309

DATES: BORING November 9, 2018 — 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	**101.69**							
	101.5	150 mm ASPHALT			SS	1	127	13
	100.9	FILL: brown well-graded sand with silt and gravel (SW-SM)			SS	2	406	5
1		Very stiff brown CLAY of high plasticity (CH)						
					SS	3	610	5
2								
	98.7			▽				
3		Firm to stiff CLAY of high plasticity (CH) - wet			SS	4	610	0
4								
					SS	5	610	0
5					ST	1		
					SS	6	610	0
6								
7								
					SS	7	610	0
8								
9					SS	8	610	
10								
	90.7							
11		Firm to very stiff silty CLAY (CL) - wet			ST	2		
12								
					SS	9	610	0
13								
					SS	10	610	0
14								
15								

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 121622309 - PCA ARTIFACT FACILITY.GPJ SMART.GDT 6/14/19

Stantec

BOREHOLE RECORD

N: 5 040 096 E: 449 154

BH18-3

CLIENT Public Works and Government Services Canada — BOREHOLE No. BH18-3

LOCATION 555 Avenue des Entreprises, Gatineau, Quebec — PROJECT No. 121622309

DATES: BORING November 9, 2018 — 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
15		*continued* Firm to very stiff silty CLAY (CL) - wet			ST	3		
16								
17								
18					SS	11	610	0
19								
20								
21					SS	12	508	0
22								
23								
24					SS	13	330	0
25								
26								
27								
28		- higher plasticity clay in sample SS14			SS	14	610	0
29								
30								

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: 5 040 096 E: 449 154

BH18-3

CLIENT Public Works and Government Services Canada — BOREHOLE No. BH18-3

LOCATION 555 Avenue des Entreprises, Gatineau, Quebec — PROJECT No. 121622309

DATES: BORING November 9, 2018 — 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
30		*continued* Firm to very stiff silty CLAY (CL) - wet			SS	15	610	0
31								
32								
33								
34					SS	16	610	1
35								
36								
37								
38					SS	17	610	4
39								
40								
41								
42	59.6							
		Very stiff brown sandy silty CLAY (CL)			SS	18	610	17
	58.8							
43		Cobbles and Boulders - granite and gneiss			NQ	19	36%	
44								
	57.0							
45		End of Borehole						

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: 5 040 056 E: 449 158

BH18-4

CLIENT Public Works and Government Services Canada — BOREHOLE No. BH18-4

LOCATION 555 Avenue des Entreprises, Gatineau, Quebec — PROJECT No. 121622309

DATES: BORING November 11, 2018 — WATER LEVEL June 7, 2019 — DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
	101.80							
0	101.7	75 mm ASPHALT			SS	1	229	7
	101.0	FILL: brown well-graded sand with silt and gravel (SW-SM)			SS	2	330	5
1		Stiff to very stiff grey CLAY of high plasticity (CH) - moist - trace sand						
2				▼	SS	3	610	3
3				▽	SS	4	610	2
4								
5					SS	5	610	1
6								
					SS	6	610	1
7								
8					SS	7	610	0
9								
					SS	8	610	0
10								
11					SS	9	610	0
12	89.6	Start of Dynamic Cone Penetration Test (DCPT) (Inferred CLAY from 12 m to 41 m)						
13								
14								
15								

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 121622309 - PCA ARTIFACT FACILITY.GPJ SMART.GDT 6/14/19

Stantec

BOREHOLE RECORD

N: 5 040 056 E: 449 158

BH18-4

CLIENT Public Works and Government Services Canada — BOREHOLE No. BH18-4

LOCATION 555 Avenue des Entreprises, Gatineau, Quebec — PROJECT No. 121622309

DATES: BORING November 11, 2018 — WATER LEVEL June 7, 2019 — DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES: TYPE	SAMPLES: NUMBER	SAMPLES: RECOVERY (mm)	SAMPLES: N-VALUE OR RQD
15		*continued* (Inferred CLAY from 12 m to 41 m)						
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								

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: 5 040 056 E: 449 158

BH18-4

CLIENT Public Works and Government Services Canada — BOREHOLE No. BH18-4

LOCATION 555 Avenue des Entreprises, Gatineau, Quebec — PROJECT No. 121622309

DATES: BORING November 11, 2018 WATER LEVEL June 7, 2019 — DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES: TYPE	SAMPLES: NUMBER	SAMPLES: RECOVERY (mm)	SAMPLES: N-VALUE OR RQD
30		*continued* (Inferred CLAY from 12 m to 41 m)						
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								
41	60.8							
	60.2	- Inferred transition to TILL						
42		End of Borehole DCPT Refusal at 41.6 m Standpipe Installed: 12.2 m - 10.7 m (Screen) 12.2 m - 10.4 m (Sand) 10.4 m - 0 m (Bentonite/Cuttings) Stick-up Well Cap						
43								
44								
45								

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

100

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

□ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

STN13-STAN-GEO 121622309 - PCA ARTIFACT FACILITY.GPJ SMART.GDT 6/14/19

Stantec

BOREHOLE RECORD

N: 5 040 056 E: 449 158

BH18-4

CLIENT Public Works and Government Services Canada — BOREHOLE No. BH18-4

LOCATION 555 Avenue des Entreprises, Gatineau, Quebec — PROJECT No. 121622309

DATES: BORING November 11, 2018 WATER LEVEL June 7, 2019 — DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES: TYPE	SAMPLES: NUMBER	SAMPLES: RECOVERY (mm)	SAMPLES: N-VALUE OR RQD
45		Water level was measured at 2.2 m on June 7, 2019 June 13, 2019						
46								
47								
48								
49								
50								
51								
52								
53								
54								
55								
56								
57								
58								
59								
60								

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	Project No. 121622309.200 Project: PCA Artifact Storage Facility	Rock Core Photographs

Photo No.: 1	Borehole: BH18-01	Depth : 17.81 – 21.16 m

Photo No.: 2	Borehole: BH18-01	Depth: 17.81 – 21.16m

Stantec	Project No. 121622309.200 Project: PCA Artifact Storage Facility	Rock Core Photographs

Photo No.: 3	Borehole: BH18-03	Depth : 42.87 – 44.70 m

Photo No.: 4	Borehole: BH18-03	Depth : 42.87 – 44.70m

Stantec

Field Bedrock Core Log

Client:	Public Works and Government Services Canada (PWGSC)	**Project No.:**	121622309 T200
Project:	PCA Artifact Storage Facility	**Date:**	17-Dec-18
Contractor:	Downing Drilling	**Borehole No.:**	BH18-01
		Logger:	FBP

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		
17.8	11	42	N/A	18.3	Cobbles and Boulders : granite and gneiss	N/A	N/A	N/A								
18.9	13	18	N/A	19.46	Cobbles : granite and gneiss	N/A	N/A	N/A								
19.46	14	95	80	20.57	Gneiss, some angled fractures at the beginning of the run, oxidation present at the level of the fractures (weak layers)	R4-R5	W2	1	FOL	F	EC	3		T		
20.57	15	100	91	21.16	Gneiss, some horizontal fractures, no oxidation at the level of fractures (weak layers)	R5	W1	1	FOL	F	EC	3		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

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

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Stantec

BOREHOLE RECORD

N: 5 040 077 E: 449 091

BH 20-1

CLIENT Public Services and Procurement Canada — BOREHOLE No. BH 20-1

LOCATION 555 Avenue des Entreprises, Gatineau, Quebec — PROJECT No. 121623165

DATES: BORING January 27 & 28, 2020 — 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	**101.90**	**HW casing**						
0	101.8	55 mm ASPHALT						
1	101.1	Inferred FILL (based on BH18-2)						
2		Inferred CLAY - No overburden sampling						
20	81.9							

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: 5 040 077 E: 449 091

BH 20-1

CLIENT Public Services and Procurement Canada — BOREHOLE No. BH 20-1

LOCATION 555 Avenue des Entreprises, Gatineau, Quebec — PROJECT No. 121623165

DATES: BORING January 27 & 28, 2020 — 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
20		**HW casing**						
		continued Inferred CLAY - No overburden sampling						
40	61.9							

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: 5 040 077 E: 449 091

BH 20-1

CLIENT Public Services and Procurement Canada — BOREHOLE No. BH 20-1

LOCATION 555 Avenue des Entreprises, Gatineau, Quebec — PROJECT No. 121623165

DATES: BORING January 27 & 28, 2020 — 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
40		**HW casing**						
	61.5	*continued* Inferred CLAY						
41		Boulder -granite and gneiss			HQ	1	-	-
	60.0	Inferred TILL						
42								
43	58.7							
		Excellent quality GNEISS BEDROCK - strong to very strong intact rock strength - close to moderate spaced fractures - orientation 0 to 20 degrees (flat) - fresh to slightly weathered (Refer to Field Bedrock Core Log)			HQ	2	100%	95%
44	57.2							
45		End of Borehole						
46								
47								
48								
49								
50								
51								
52								
53								
54								
55								
56								
57								
58								
59								
60								

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: 5 040 083 E: 449 139

BH 20-2

CLIENT Public Services and Procurement Canada — BOREHOLE No. BH 20-2

LOCATION 555 Avenue des Entreprises, Gatineau, Quebec — PROJECT No. 121623165

DATES: BORING January 28 & 29, 2020 — 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	**101.90**	**HW casing**						
0	101.9	50 mm ASPHALT						
1	101.2	Inferred FILL (based on BH18-3)						
2		Inferred CLAY						
3		- No overburden sampling						
20	81.9							

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: 5 040 083 E: 449 139

BH 20-2

CLIENT Public Services and Procurement Canada — BOREHOLE No. BH 20-2

LOCATION 555 Avenue des Entreprises, Gatineau, Quebec — PROJECT No. 121623165

DATES: BORING January 28 & 29, 2020 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
20		**HW casing**						
		continued Inferred CLAY - No overburden sampling						
40	61.9							

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: 5 040 083 E: 449 139

BH 20-2

CLIENT Public Services and Procurement Canada — BOREHOLE No. BH 20-2

LOCATION 555 Avenue des Entreprises, Gatineau, Quebec — PROJECT No. 121623165

DATES: BORING January 28 & 29, 2020 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
40		**HW casing**						
		continued Inferred CLAY - No overburden sampling						
43	58.6							
		Inferred TILL - No overburden sampling						
45	57.1	Boulder -granite and gneiss			HQ	1	-	-
46	55.6							
	55.4	Inferred TILL						
47		Fair quality GNEISS BEDROCK - strong to very strong intact rock strength - close to moderate spaced fractures			HQ	2	100%	73%
48								
49					HQ	3	100%	33%
	52.3	- orientation 0 to 50 degrees (flat to dipping) - slightly weathered (Refer to Field Bedrock Core Log)						
50		End of Borehole						
60								

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 121623165_PCA ARTIFACT FACILITY_COMPLEMENTARY.GPJ SMART.GDT 11/3/20

Stantec

BOREHOLE RECORD

N: 5 040 034 E: 449 140

BH 20-3

CLIENT Public Services and Procurement Canada — BOREHOLE No. BH 20-3

LOCATION 555 Avenue des Entreprises, Gatineau, Quebec — PROJECT No. 121623165

DATES: BORING 30 January 2020 — 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	**102.20**	**HW casing**						
0	102.2	50 mm ASPHALT						
1	101.4	Inferred FILL (based on BH18-4)						
2		Inferred CLAY - No overburden sampling						
20	82.2							

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: 5 040 034 E: 449 140

BH 20-3

CLIENT Public Services and Procurement Canada — BOREHOLE No. BH 20-3

LOCATION 555 Avenue des Entreprises, Gatineau, Quebec — PROJECT No. 121623165

DATES: BORING 30 January 2020 — 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
20		**HW casing**						
		continued Inferred CLAY - No overburden sampling						
24	77.8							
25	77.5	Inferred TILL with cobbles and boulders - No overburden sampling			HQ	1	100%	31%
26					HQ	2	100%	95%
	75.3	Poor to excellent quality GNEISS BEDROCK - strong to very strong intact rock strength - close to moderate spaced fractures - orientation 0 to 50 degrees (flat to dpipping) - slightly weathered (Refer to Field Bedrock Core Log)						
27		End of Borehole						
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								

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: 5 040 087 E: 449 160

DCPT 1

CLIENT Public Services and Procurement Canada — BOREHOLE No. DCPT 1

LOCATION 555 Avenue des Entreprises, Gatineau, Quebec — PROJECT No. 121623165

DATES: BORING 31 January 2020 — 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	**101.90**	**Augered to 1.5 m**						
0	101.9	50 mm ASPHALT						
1	101.2	Inferred FILL (based on BH18-3)						
2	100.1	Inferred CLAY (based on BH18-3)						
3		Start of Dynamic Cone Penetration Test (DCPT) at 1.8 m						
4		Inferred CLAY						
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20	81.9							

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: 5 040 087 E: 449 160

DCPT 1

CLIENT Public Services and Procurement Canada — BOREHOLE No. DCPT 1

LOCATION 555 Avenue des Entreprises, Gatineau, Quebec — PROJECT No. 121623165

DATES: BORING 31 January 2020 — 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
20		**Augered to 1.5 m**						
		continued Inferred CLAY						
40	61.9							

UNDRAINED SHEAR STRENGTH - kPa

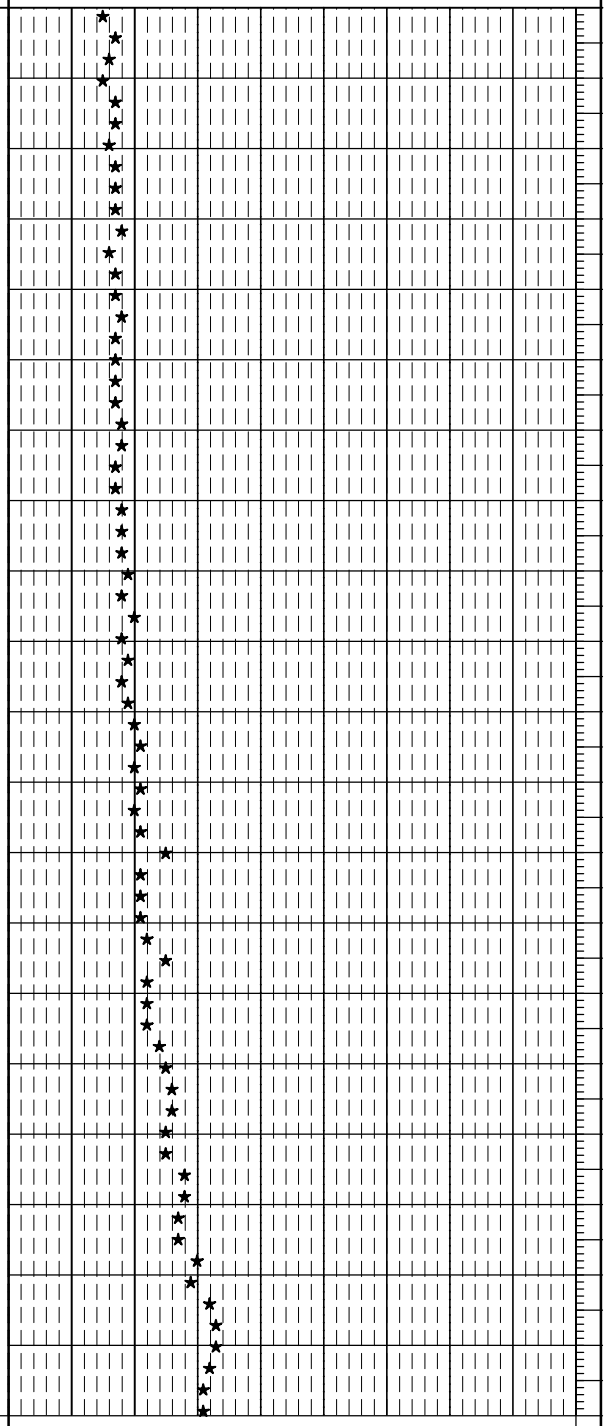
50 100 150 200

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: 5 040 087 E: 449 160

DCPT 1

CLIENT Public Services and Procurement Canada — BOREHOLE No. DCPT 1

LOCATION 555 Avenue des Entreprises, Gatineau, Quebec — PROJECT No. 121623165

DATES: BORING 31 January 2020 — 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
40		**Augered to 1.5 m**						
		continued Inferred CLAY						
42	59.4							
		Inferred TILL						
45	56.8							
		End of Borehole DCPT Refusal at 45.1 m						

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: 5 040 036 E: 449 169

DCPT 2

CLIENT Public Services and Procurement Canada — BOREHOLE No. DCPT 2

LOCATION 555 Avenue des Entreprises, Gatineau, Quebec — PROJECT No. 121623165

DATES: BORING 31 January 2020 — 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	**102.20**	**Augered to 1.5 m**						
	102.2	50 mm ASPHALT						
1	101.4	Inferred FILL (based on BH18-4)						
	100.4	Inferred CLAY (based on BH18-4)						
2		Start of Dynamic Cone Penetration Test (DCPT) at 1.8 m						
3								
4		Inferred CLAY						
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20	82.2							

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: 5 040 036 E: 449 169

DCPT 2

CLIENT Public Services and Procurement Canada — BOREHOLE No. DCPT 2

LOCATION 555 Avenue des Entreprises, Gatineau, Quebec — PROJECT No. 121623165

DATES: BORING 31 January 2020 — 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
20		**Augered to 1.5 m**						
		continued Inferred CLAY						
30	71.9							
	71.7	Inferred TILL						
		End of Borehole DCPT Refusal at 30.5 m						
40								

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

135

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

□ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

STN13-STAN-GEO 121623165_PCA ARTIFACT FACILITY_COMPLEMENTARY.GPJ SMART.GDT 11/3/20

Stantec

BOREHOLE RECORD

N: 5 040 029 E: 449 083

DCPT 3

CLIENT Public Services and Procurement Canada — BOREHOLE No. DCPT 3

LOCATION 555 Avenue des Entreprises, Gatineau, Quebec — PROJECT No. 121623165

DATES: BORING 31 January 2020 — WATER LEVEL — DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION
0	**102.30**	**Augered to 1.5 m**
0	102.2	75 mm ASPHALT
1	101.5	Inferred FILL (based on BH18-1)
2	100.5	Inferred CLAY (based on BH18-1)
3		Start of Dynamic Cone Penetration Test (DCPT) at 1.8 m
4		Inferred CLAY
20	82.3	

STRATA PLOT | WATER LEVEL | SAMPLES: TYPE, NUMBER, RECOVERY (mm), N-VALUE OR RQD

UNDRAINED SHEAR STRENGTH - kPa

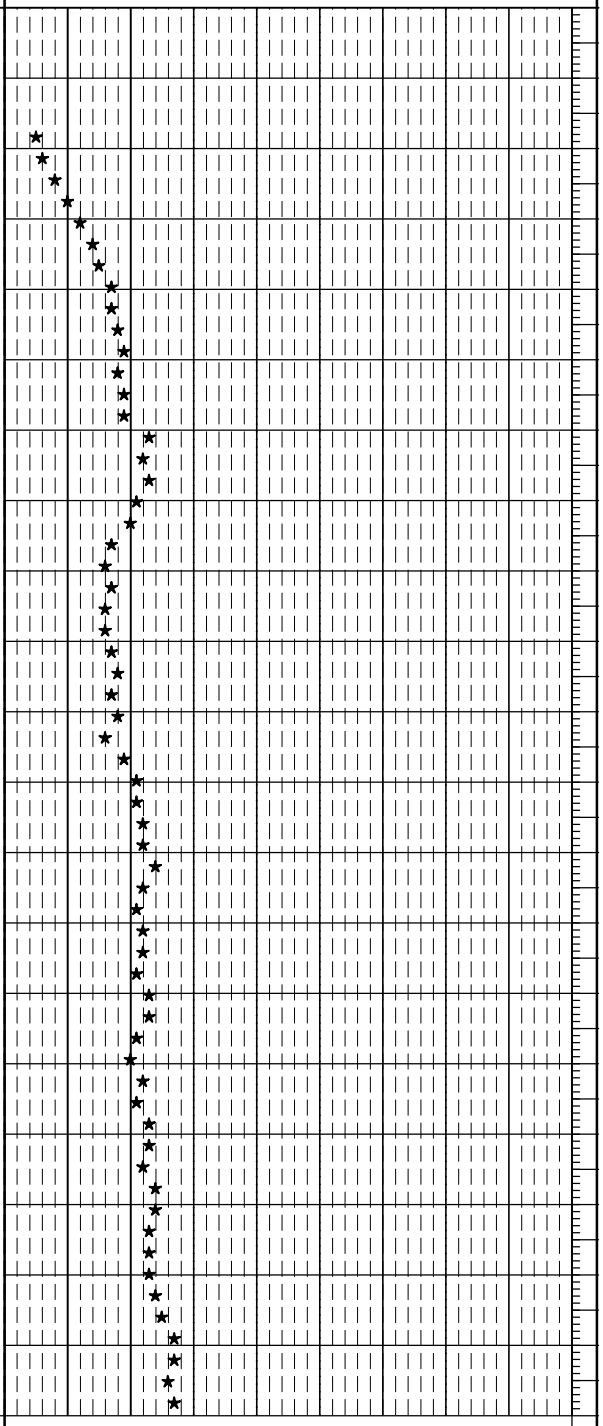
50 100 150 200

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: 5 040 029 E: 449 083

DCPT 3

CLIENT Public Services and Procurement Canada — BOREHOLE No. DCPT 3

LOCATION 555 Avenue des Entreprises, Gatineau, Quebec — PROJECT No. 121623165

DATES: BORING 31 January 2020 — 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
20		**Augered to 1.5 m**						
		continued Inferred CLAY						
23	79.1							
	78.5	Inferred TILL						
24		End of Borehole DCPT Refusal at 23.8 m						

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

106

110

Inferred Groundwater Level

Groundwater Level Measured in Standpipe

Field Vane Test, kPa

Remoulded Vane Test, kPa

Pocket Penetrometer Test, kPa

Stantec

Bedrock Core Log

Client:	Public Services and Procurement Canada	**Project No.:**	121623165
Project:	PCA Artifact Facility Complementary Geotechnical Study	**Date:**	27-Jan-20
Contractor:	George Downing Estate Drilling	**Borehole No.:**	BH20-01
		Logger:	HS

DEPTH FROM (m)	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO (m)	GENERAL DESCRIPTION	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
40.4	HQ1	-	-	41.9	Boulder: grey granite/gneiss; coarse grained.	-	-	-								
43.2	HQ2	100%	96%	44.7	Gneiss: medium grey; coarse grained.	R4-R5	W1	1	JN	F	C-M	RU				

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

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

APERTURE

VT = Very Tight (<0.1mm)
T = Tight (0.1 - 0.25mm)
PO = Partly Open (0.25 - 0.5mm)
O = Open (0.5 - 2.5mm)
MW = Moderately Wide (2.5 - 10mm)
W = Wide (>10mm)
VW = Very Wide (1 - 10cm)
EW = Extremely Wide (10 - 100cm)
C = Cavernous (> 1m)

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

Bedrock Core Log

Client:	Public Services and Procurement Canada	**Project No.:**	121623165
Project:	PCA Artifact Facility Complementary Geotechnical Study	**Date:**	29-Jan-20
Contractor:	George Downing Estate Drilling	**Borehole No.:**	BH20-02
		Logger:	HS

DEPTH FROM (m)	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO (m)	GENERAL DESCRIPTION	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
44.8	HQ1	-	-	46.3	Boulder: light grey gneiss/granite; coarse grained.											
46.5	HQ2	100%	73%	48.0	Gneiss: medium grey; coarse grained.	R4-R5	W2	2	VN JN	F V	C-M	RU RU			quartz observed crystals in flat joints; vertical joint from 47.5 to 48 m.	
48.0	HQ3	100%	33%	49.6	Gneiss: dark to medium grey; coarse grained.	R4-R5	W2	2	JN JN	F V	C-M	RU RU			vertical joint from 48.4 to 49.4 m.	

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

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EW = Extremely Wide (10 - 100cm)
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Stantec

Bedrock Core Log

Client:	Public Services and Procurement Canada	**Project No.:**	121623165
Project:	PCA Artifact Facility Complementary Geotechnical Study	**Date:**	30-Jan-20
Contractor:	George Downing Estate Drilling	**Borehole No.:**	BH20-03
		Logger:	HS

DEPTH FROM (m)	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO (m)	GENERAL DESCRIPTION	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
24.4	HQ1	100%	31%	25.4	Top 0.2 m till with cobbles. Gneiss/Granite: dark grey; coarse grained.		W1	1	JN	F	VC-C	RU				
25.4	HQ2	100%	95%	26.9	Gneiss: medium grey; coarse grained.		W1	1	JN	F-D	C-M	RU			small voids observed in rock core from 25.8 to 26.9 m.	

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
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R5 Very Strong	100.0 - 250.0
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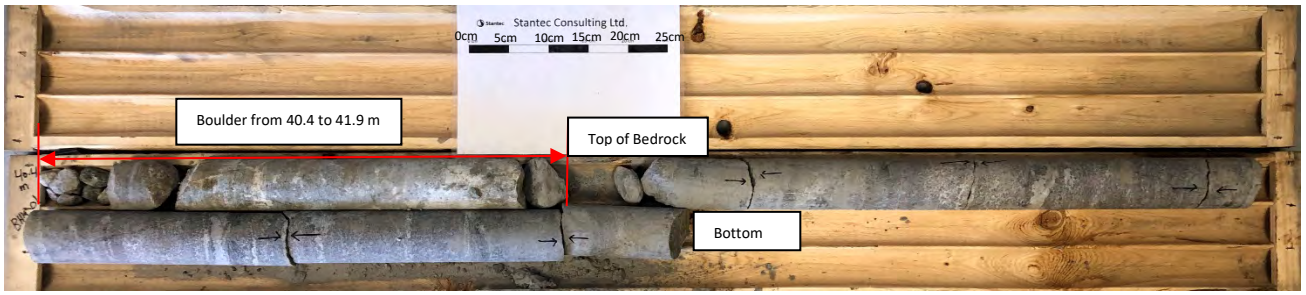
Stantec	Project No.: 121623165 Project Name: PCA Artifact Facility Complementary Geotechnical Study	Rockcore Photographs



Rock Core Photo No.: 1	Borehole: BH20-1	Depth: 40.4 to 44.7 m

Rock Core Photo No.: 2	Borehole: BH20-02	Depth: 44.8 to 49.6 m

Stantec	Project No.: 121623165 Project Name: PCA Artifact Facility Complementary Geotechnical Study	Rockcore Photographs

Rock Core Photo No.: 3	Borehole: BH20-03	Depth: 24.4 to 26.9 m

Appendix D

D.1 SIGMA GEOPHYSICS SEISMIC REFRACTION SURVEY MEMO

Public Works and Government Services Canada

PCA ARTIFACT FACILITY - GATINEAU
Seismic Survey Winter 2020

Presented to

STANTEC INC.
400 - 1331 Clyde Avenue
Ottawa, ON K2C 3G4

March 2020 **C19723-ver2**

SIGMA GEOPHYSICS INC.

1890 Marie-Victorin
ST-BRUNO QC J3V 6B9
Telephone : (450) 441-4600
email : Sigma@geosigma.com

TABLE OF CONTENTS

APPENDICES

1 INTRODUCTION

In February 2020, as requested by **STANTEC INC.**, SIGMA GEOPHYSICS INC. carried out a seismic refraction survey for the **PCA Artefact Facility** in Gatineau, QC.

The purpose of the survey was to acquire a better knowledge of the bedrock topography on the site of a future building. In addition to the main objective, the seismic refraction survey was also used to locate seismic velocity anomalies in the bedrock as they may reflect the presence of fault, shear zones or deeply buried channels.

During the investigations, seismic refraction data were gathered over two seismic lines, for a total of **270 m** of survey.

The present report deals mainly with the results obtained as well as their analysis. Other topics such as field and interpretation methods, site characteristics, equipment and personnel are also briefly discussed herein.

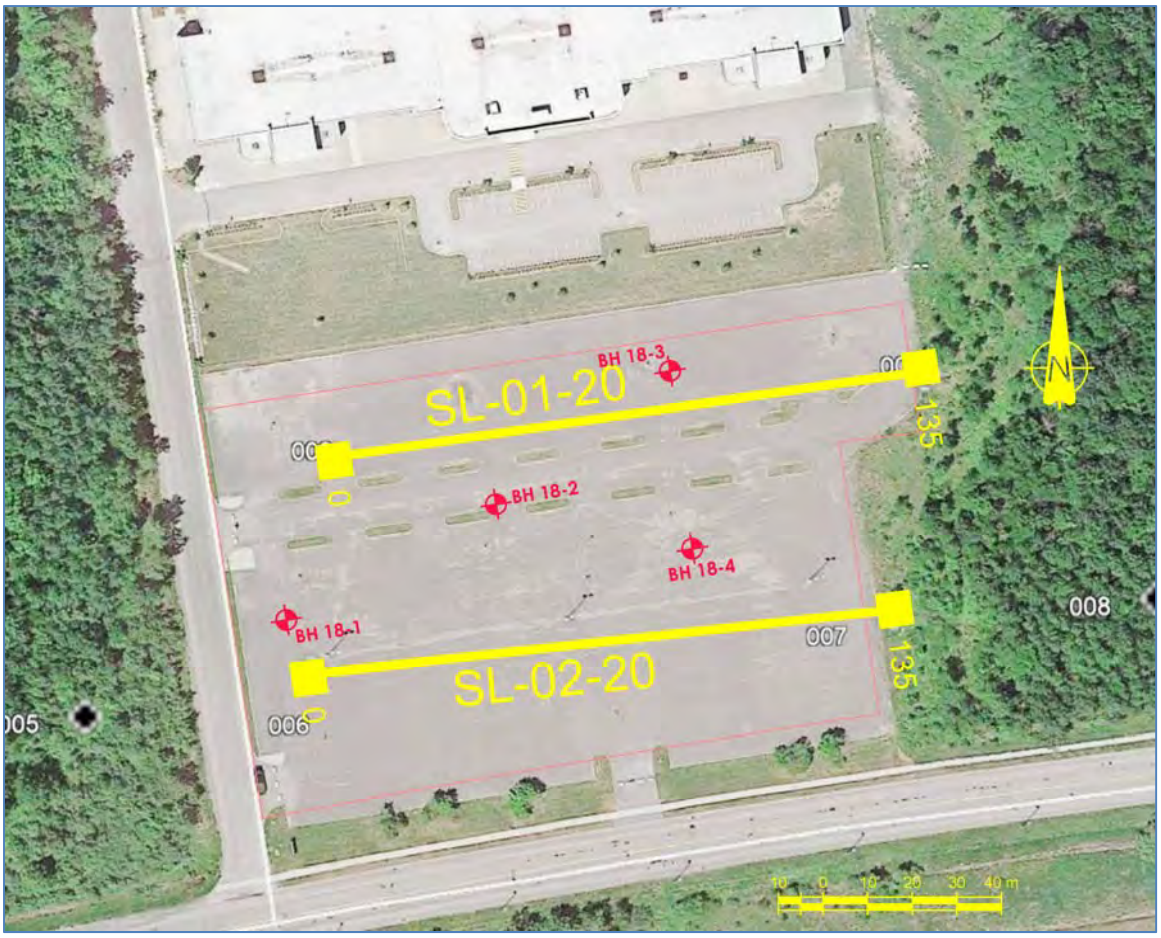
2 BACKGROUND INFORMATION

2.1 Time Schedule

The seismic refraction survey was carried out on February 17th 2020.

2.2 Survey location

The site is located approximately 7 km East of the centre of Gatineau, Quebec. The exact positions of the seismic lines are showed on the location plan included on the drawing presented in Appendix 1, also reproduced on the next page.



LINES POSITIONS

2.3 Surveying

The implementation of the seismic lines was carried out by **Sigma Geophysics Inc.** Soil elevation from the boreholes have been used to establish the elevation profile of the lines. Lines coordinates were obtained using a hand GPS of a precision of around 2 m in XY

2.4 Crew and equipment

Table 1 and table 2 describe the crew and equipment from Sigma Geophysics inc. associated with the data acquisition, interpretation and the report.

TABLE 1 - LIST OF PERSONNEL

NAME	TITLE	DUTY
Claude Provost, P. Eng.	Sr Geophysicist	Administration, interpretation, report
Claude Lachapelle	Sr. technician	Operator, party chief
Jean-Philippe Demers	Technician	Blaster
1 worker	Technician	Helpers

TABLE 2 - LIST OF EQUIPMENT

QTY	DESCRIPTION	MODEL	MAKER
1	Seismograph 24 channels	Geode	Geometrics
2	Geophones cables 12 channels		Geospace
26	Geophones verticals - 14 Hz	L-28	Geospace
1	High voltage blaster	LBV-1	Geometrics
1	Firing cable – 400 m		Geospace
2	Powder magazines		
1	High Energy mechanical source	PAG 5800 joules	Sigma Geophysics

2.5 List of seismic lines

The next table presents the list of the seismic lines carried out on the 2 sites.

Table 3 - SEISMIC LINES

PCA ARTEFACT FACILITY			
SEISMIC LINE	Metric point (m)		Length (m)
	Start	end	
SL-01-20	0	135	135
SL-02-20	0	135	135
		Total (m)	**270**

3 METHODOLOGY

We have included in Appendix 1 a text that describes in detail the seismic refraction method, as well as its limitation and precision.

The seismic survey was executed using spreads of 19 geophones spaced at 7.5 meters. For each spread, two high velocity explosive charges were detonated at both end, while inner shots where executed using a high-energy (5,800 joules) mechanical source.

Accuracy of the results

The typical accuracy of the computed depth for a refraction survey is generally of 1.5 m for depths less than 15 meters and 15 % for depths greater than 15 meters.

However, as explained in Appendix 1, some geological conditions may decrease the expected theoretical accuracy of the seismic refraction method. The error could be greater in the following cases:

- Occurrence of faults or deep valleys
- Abrupt change in the topography of one layer
- Velocity inversion created by a frozen layer or organic soil underneath more coherent layers
- Hidden layer

4 RESULTS

This section provides an overview of the results computed from the geophysical data gathered during the seismic refraction survey. The cross-sections of the lines, presented on one drawing (DWG nº 19723-01), will be found in Appendix 2 of this report. This drawing also includes a location map showing the actual position of the seismic lines.

4.1 Presentation format

The results are presented in the form of seismic cross-sections. A seismic cross-section shows the profile of the top of each of the refractors observed from the analysis of the seismic refraction data, including the top of the bedrock if it was identified properly.

Scale of the cross-sections

The seismic cross-sections are presented at a horizontal and vertical scale of **1:1000**.

Identification of the refractors

Continuous line **:** top a refracting horizon as computed from seismic data.

Dashed line **:** extrapolated or interpolated seismic refractor.

Hatching

A hatch pattern has been used to make a distinction between the overburden and the bedrock and to accentuate anomalies in the bedrock. For this survey, we considered that all refractors exhibiting a seismic velocity above 3,000 m/s were bedrock.

Seismic velocity anomalies in the deepest refractor (bedrock)

For the deepest refractor (which is normally the bedrock), all P-wave seismic velocity lower than 4,200m/s were considered as abnormally low. These zones were highlighted with a bold red line.

4.2 Results analysis

Table 4 gives the minimum and maximum elevation of the top of the bedrock, the maximum and minimum thickness of overburden, as well as the sound bedrock average seismic velocity.

TABLE 4 – PCA ARTEFACT FACILITY - SUMMARY OF RESULTS

SL Nº	Bedrock elevation		Overburden Thickness			Bedrock velocity		
	Min (*m*)	Max (*m*)	min (*m*)	max (*m*)	Ave. (*m*)	min(*m/s*)	max(*m/s*)	Ave.
1	47.7	62.4	39.4	54.1	46.2	3,400	4,600	4,350
2	68.1	81.6	20.3	34.4	25.0	5,500	5,500	5,500

The maximum overburden thickness (*54.15 m*) is on MP 82.5 of line SL-01-20. The overburden thickness seems to increase rapidly toward the north of the site and on LS-01-20 we observe the presence of a low velocity zone into the bedrock, probably caused by the presence of a fractured zone or a change in the bedrock geology.

4.2.1 Seismic velocity analysis

Unconsolidated material

In the overburden, we can observe two different ranges of velocity in the overburden:

<600 m/s This velocity interval is normally representative of unsaturated, unconsolidated or organic material or fill, that have been affected by the seasonal cycles of freezing and thawing.

1,500 m/s This velocity interval is generally representative of a saturated clay.

Bedrock

In the bedrock, the seismic velocity of sound rock varies between 4,600 and 5,500 m/sec and the rock has been identified as a gneiss rock but this large velocity range indicates that the rock quality varies.

5 CONCLUSIONS

The seismic refraction survey carried out in February 2020 over the site of the PCA Artefact Facility in Gatineau, has allowed for the determination of the thickness of the overburden, the bedrock topography and the quality of the rock mass.

The following points can be highlighted:

- The bedrock topography seems to plunge toward the north of the site and a zone of low velocity has been located into the bedrock on one of the line.

This report has been written by Mr Claude Provost, P. Eng..

Claude Provost, P. Eng

SEISMIC REFRACTION

Overview of the seismic refraction method

Summary of the seismic refraction method

In this appendix, we present the techniques used by Sigma Geophysics inc. for the acquisition and the interpretation of seismic refraction data. The basics of the method are also reviewed, paying a particular attention to the limits and the precision of results associated to this method.

Theory

In seismic refraction, an energy source is used to transmit, at a time T0, acoustic waves propagating into the overburden and the underlying rock. These acoustic waves can be classified in four major groups ("P", "S", Love and Rayleigh) depending on their propagation modes. The "P" and "S" waves are mainly used in depth calculation and mechanical properties of materials. "P" waves, or compression waves, propagate at about twice the speed of "S" waves, or shear waves.

"P" and "S" waves propagate into the ground according to the law of Snell-Descartes. Accordingly, in a ground composed of horizontal layers with their respecting wave velocities increasing with depth, a fraction of incident waves will be reflected, while another fraction is refracted through the interface of each layer. Some of these waves are refracted critically, meaning that they propagate parallel to the interface. This last property is used in refraction seismology.

Therefore, the technique is to measure the elapsed time between the energy emission, T0, and the arrival of the different waves at known distances from the source. Close to the source, the first arrivals will be from waves propagating in the first layer. At a certain distance, generally called the critical distance, the first arrival will be from the waves propagating in the second layer, which has greater seismic velocities. In normal conditions, it is then possible to measure critical times, critical distances and the different velocities associated to each layer, thus to compute their respective depths.

Figure 1 illustrates the seismic refraction method.

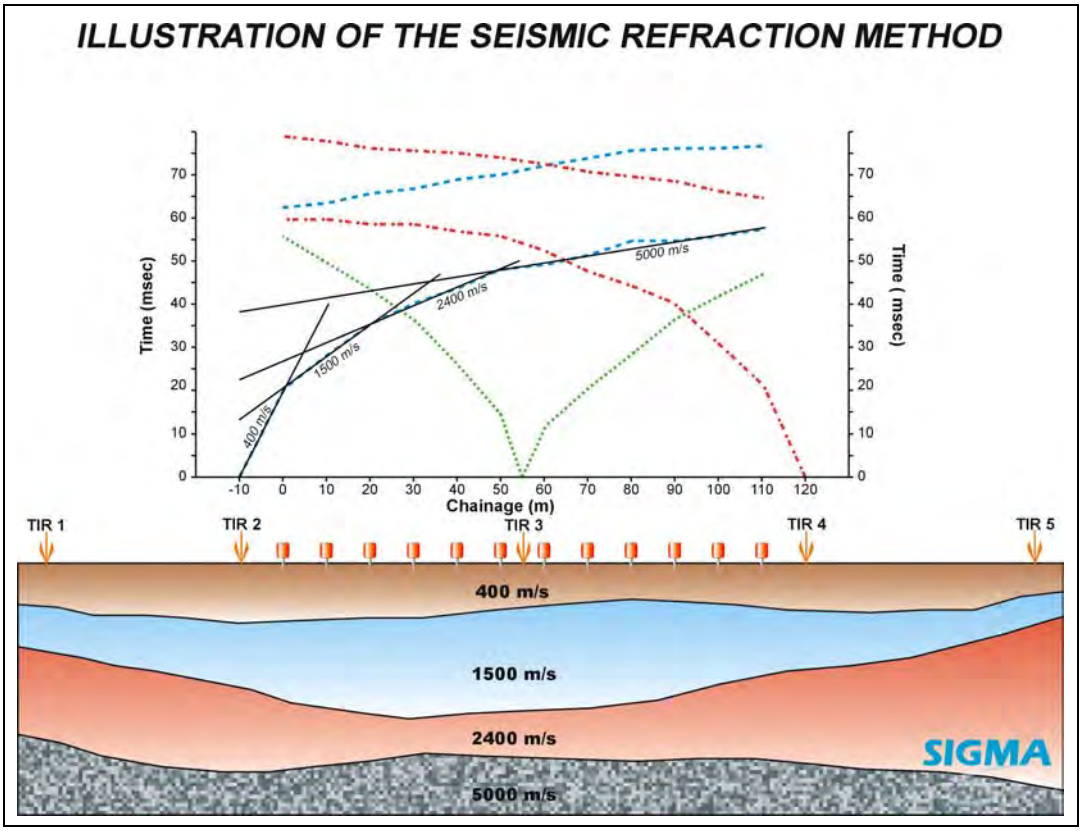


Fig.1 – Illustration of the seismic refraction method

Field procedure

Practically, a set-up similar to the one shown on figure 2 is used to acquire the information. This set-up consisting in a series of twelve (12) to twenty-four (24) geophones are mechanically coupled to the ground at regular interval. The geophones transform the seismic waves into an electric signal, which is transmitted to a 12 or 24 channels digital seismograph which amplifies, filters and memorizes the full waveform recorded by each of the seismic sensors. Afterwards, the results are printed or recorded on magnetic support for further analysis. The arrival times can then be picked and plotted for interpretation.

Generally speaking, five (5) to seven (7) explosive charges are detonated at strategic locations along the seismic line to limit the uncertainties arising from changes in the layers geometry and the variations within the material.

The geophones (or hydrophones for water) are generally spaced 5, 7.5 or 10 metres apart, depending on field conditions and thickness of overburden. The energy source can be dynamite, air gun (for water), hammer and

plate or shotgun. Depending on the source and field conditions, shots are generated at strategic points along the seismic line to give as much and as accurate information as possible.

Figure 2 shows a typical geophones/hydrophones set-up.

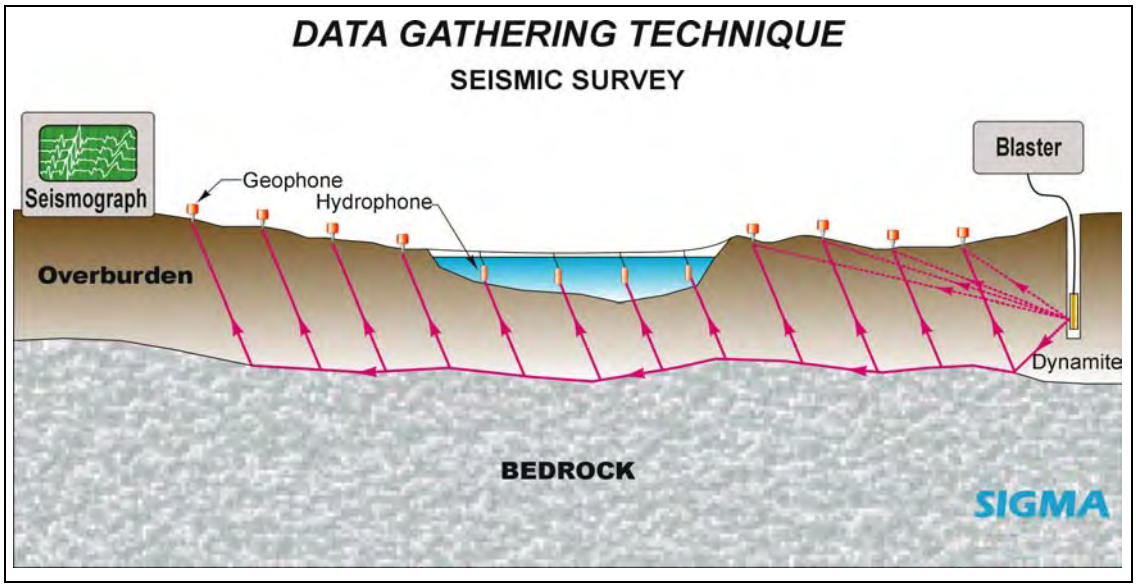


Fig.2 – Data gathering set-up

Interpretation

There are many different computation techniques available. The Hawkins and the critical distance methods are generally used. The Hawkins method allows to compute depths for each sensors, while the second one gives the depth at each shot and is used as a verification method.

The equations associated with each technique are shown below :

$$Z_i = \frac{T_i}{2} \cdot \frac{V_i}{\cos\left(\sin^{-1}\left(\frac{V_i}{V_{i+1}}\right)\right)}$$

Équation 1 – ***Hawkins's method***

$$Z_i = \frac{Xc_i}{2} \cdot \sqrt{\frac{V_{i+1} - V_i}{V_{i+1} + V_i}} + \sum_{1}^{i-1} \left(Z_{i-1} \cdot Y_{i+1,i} \right)$$

Équation.2 – ***Critical distances***

où:

Z_i is the thickness i[th] layer

V_i, V_{i+1} are the propagation velocities through layers i, i+1

Xc_i is the critical distance i (i.e the distance at which the travel time through layer I is equal to the travel time through layer i+1)

It is important to note that these methods were developed taking into account that the different layers are sub-parallel, of sufficient thickness to be detected, and that the velocities are increasing with depth.

Special problems encountered during interpretation

In the majority of cases, the thickness of overburden can be computed within 15 % of the actual thickness. However, physical conditions exist for which the depth to bedrock is grossly wrong. For some of these situations, an better understanding of the problems through the use of other investigation method (drill holes, resistivity soundings) allows for a significant reduction of the margin of error.

The most common problems encountered are the velocity inversion and the hidden layers. Other less common problems are: shear zones, deep valleys and vertical faults. For those last three cases, there is no interpretation technique: the error level could remain high, even with good assumptions.

A more detailed description of these cases follows.

HIDDEN LAYERS

In this case, one layer has a thickness/depth ratio too low to be detected. As a result, bedrock will be estimated shallower than it really is.

Figure 3 illustrates this case, where the wave coming from a saturated sand and a fractured rock layers arrives after the sound rock wave, inducing a 35 % error in the interpretation. The only way to interpret these cases correctly is to identify the arrivals of those hidden layers in the records.

This task is generally very difficult, if possible at all, because those secondary arrivals are often mixed with reflections or shear waves arrivals. In this case, the bedrock will always look shallower than it really is.

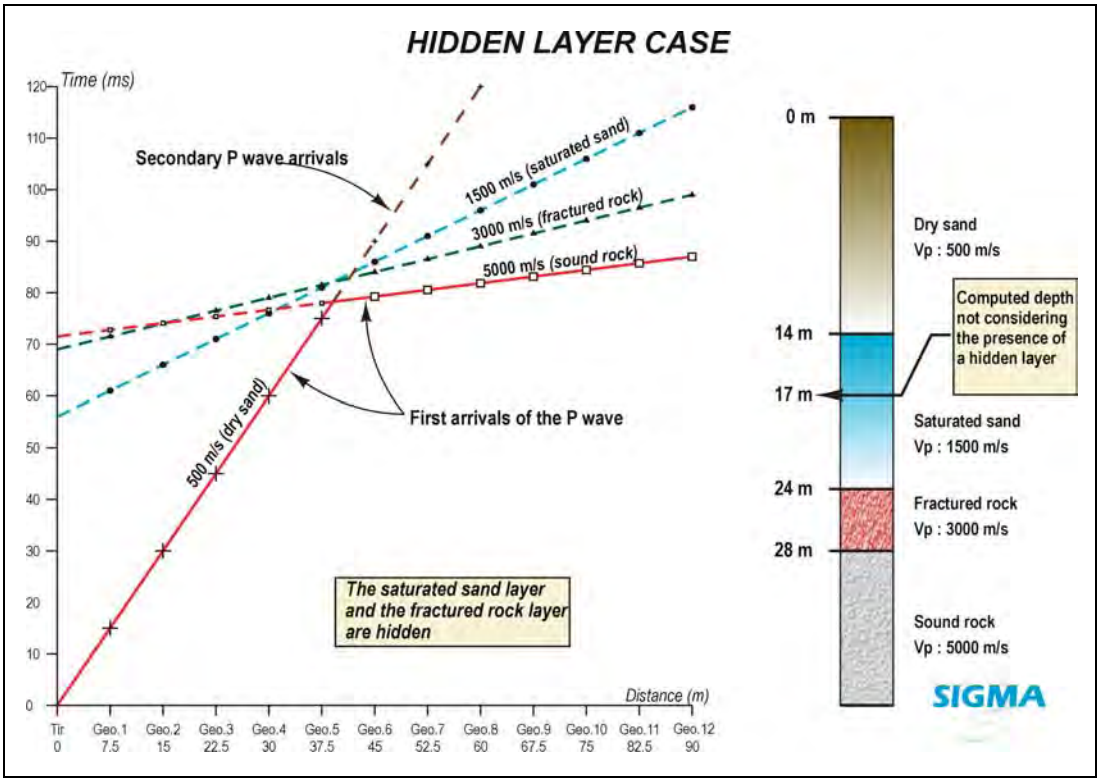


Fig.3 – Example of a hidden layer case

VELOCITY INVERSION – BLIND ZONE

In this rare case, the seismic velocities are not increasing with depth. Since it is impossible to get any refraction signal from a layer slower than the one above it. The error implied in this case can be very important.

A dry sand layer located under a clay layer, which represent a perfect example of this situation, is illustrated in Figure 4. In this example, a 1500 m/s propagation velocity will be applied to all of the measured travel time, even though most of the actual travel time was spent travelling at 500 m/s, resulting in a 100 % error for the interpretation.

Velocity inversions will always show a bedrock surface deeper than it really is.

For winter surveys, the presence of a frozen layer generally forces us to guess the seismic velocity of the overburden, leading to a higher uncertainty for the evaluated bedrock elevation. This problem is less problematic for marine refraction over the ice, since the velocity in the water is known to be 1500 m/s.

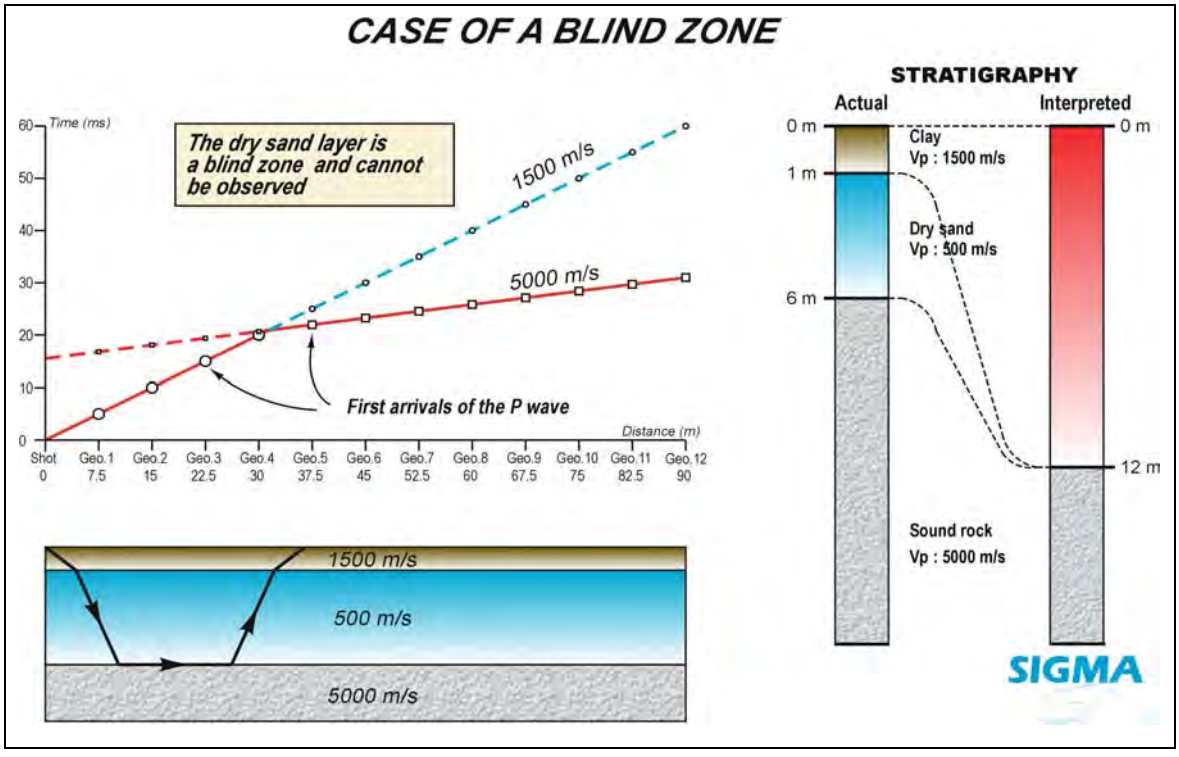


Fig.4 – Example of a blind zone

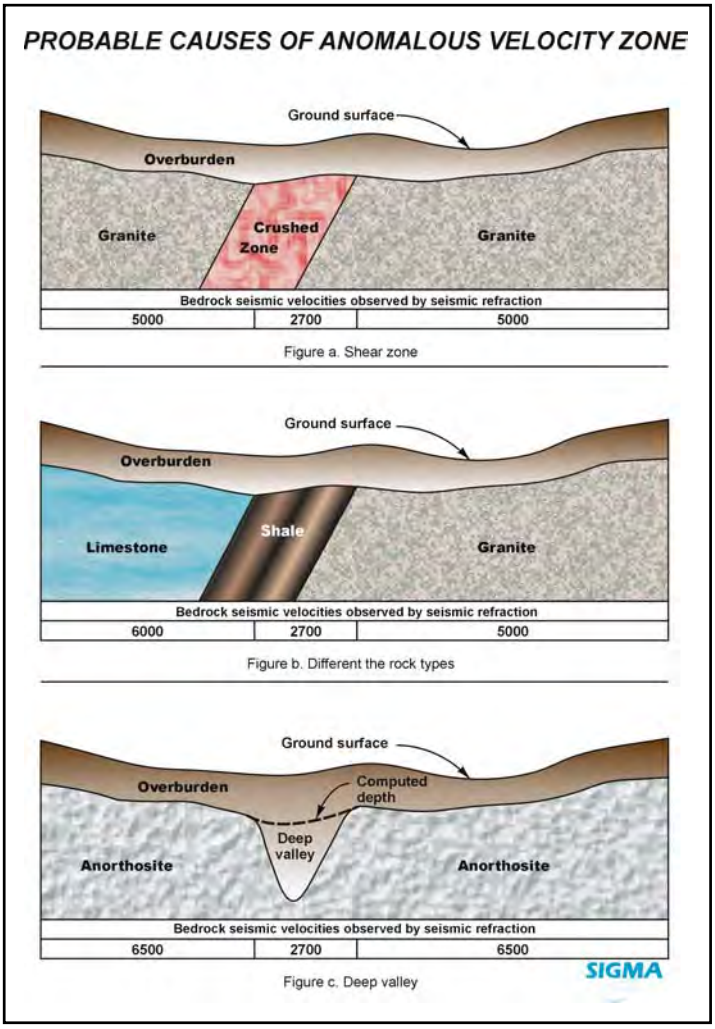
DEEP VALLEY, FAULT

L The following example illustrates different interpretations of velocity anomalies observed in the bedrock.

The first interpretation, shown on figure 5, is the presence of a shear zone, while the second one is a simple change in rock type. Most of the time, a borehole will be the only way to get an answer. However, the estimated depth will be as good as in a normal situation.

The third case is the deep valley case. This problem is generally easy to identify, but there is no efficient way to correct the interpretation. In this case, it is not possible to get information on the wave velocity inside the valley or the depth of the valley, the observed velocities being different from the real velocities (those observed velocities are then put in brackets on the profiles).

Boreholes are in general the only way to get accurate information.



Seismic velocity and geomechanical properties

SEISMIC VELOCITY VS NATURE OF MATERIAL

The velocities shown on the seismic profiles represent the "P" waves velocity measured in the different materials. These velocities are directly related to the density, the structure, the water content and the porosity of the materials.

It is easy to understand that the velocity will change with any of the above parameters, resulting in a possible range of velocities for a single material.

Figure 6 illustrates the different velocity ranges observed worldwide for typical materials. Of course, good knowledge of the local geology and hydrogeology will help reduce velocity range. Generally, for a known type of rock, the velocity range will give information about its degree of fracturation.

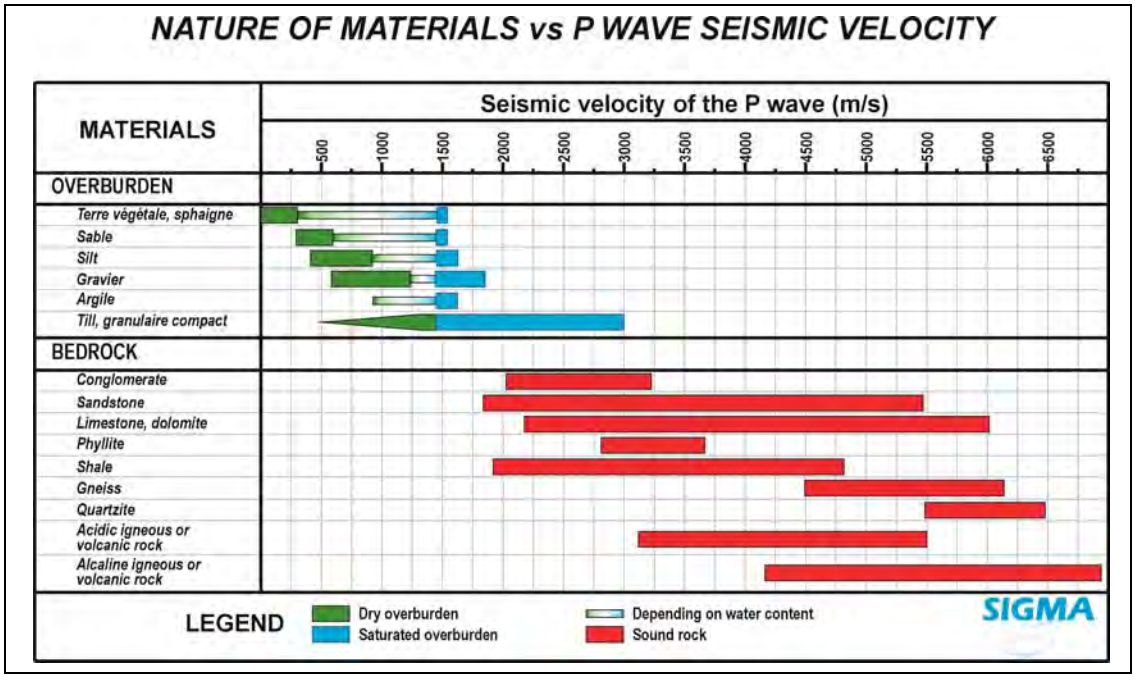


Fig.5 – Nature of material as a function of seismic velocity

One will note that the diagram is divided into two parts to take into account the effect of the water saturation on the seismic velocities.

VITESSE SISMIQUE VS QUALITÉ DU ROC

RELATION BETWEEN SEISMIC VELOCITY AND RQD

A mathematical relationship between the RQD and the seismic velocities observed in the field has been developped by Coon and Meritt (1970). This relationship is as follows:

$$RQD = \frac{\log\left(\frac{V_T}{V_L}\right)^2 - \log(0{,}21)}{0{,}0070}$$

Equation 3 - RQD vs V_p

where V_T is the *in situ* propagation velocity

V_L is the propagation velocity measured in the lab on a sound piece of core

For example, it is generally considered that shale, granite and gneiss with RQD of 100 % have respective velocities of 4200 m/s, 5500 m/s and 6200 m/s. Using these values, figure 7 was plotted for different field velocities. It is visible that a good knowledge of the type of rock will be important : a 3700 m/s shale is excellent, while a gneiss with the same field velocity is poor.

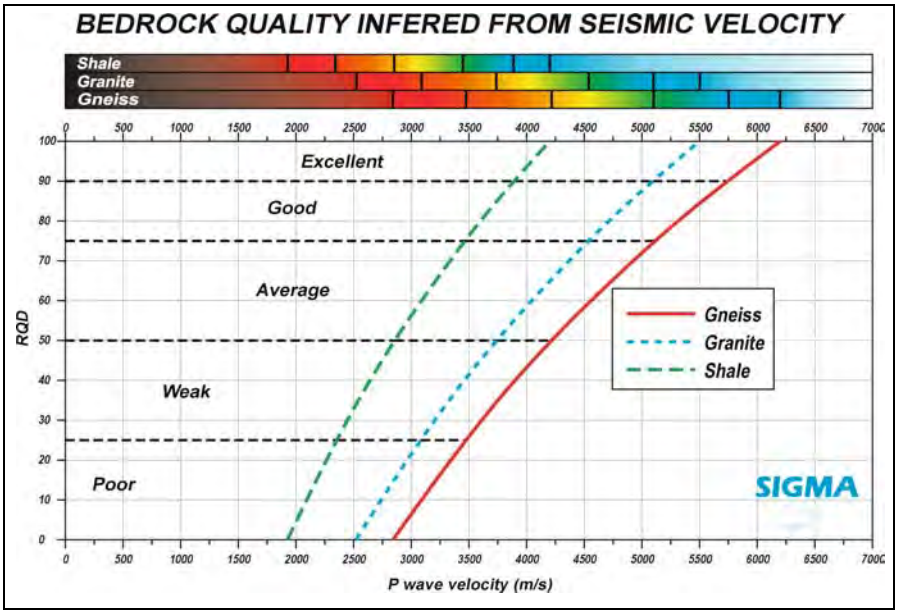


Fig.6 – Bedrock quality vs seismic velocity

RELATION BETWEEN SEISMIC VELOCITY AND ELASTIC PROPERTIES

The Young modulus can be estimated by measuring the velocities of the "P" waves and the "S" waves and by estimating the density of the material. As the "S" wave measurement was not part of the mandate, it is not possible to evaluate precisely this property.However, the Brown and Robertshaw empirical relationship allows to evaluate the Young modulus using only the "P" wave velocity considering a Poisson coefficient of 0.25 :

$$E = V_P^{2,34} \times 1,1112 \times 10^{-7}$$

Equation.4 - Brown-Robertshaw

where V_p is the propagation velocity of the P wave expressed in m/s

E is Young's modulus expressed in Gpa (gigapascal).

Figure 7 illustrates the Young modulus obtained for increasing "P" wave velocities.

It is important to note that the values obtained with the seismic method are dynamic values computed as if the material was isotropic and not permanently modified by the passage of the seismic wave.

A comparison of the static module with the dynamic one shows that the more anisotropic a material is and the lower its velocity is, the higher the dynamic to static modulus ratio is. For a perfectly isotropic material, this ratio is close to 1, rising up to 2.5 for a low velocity, highly anisotropic material.

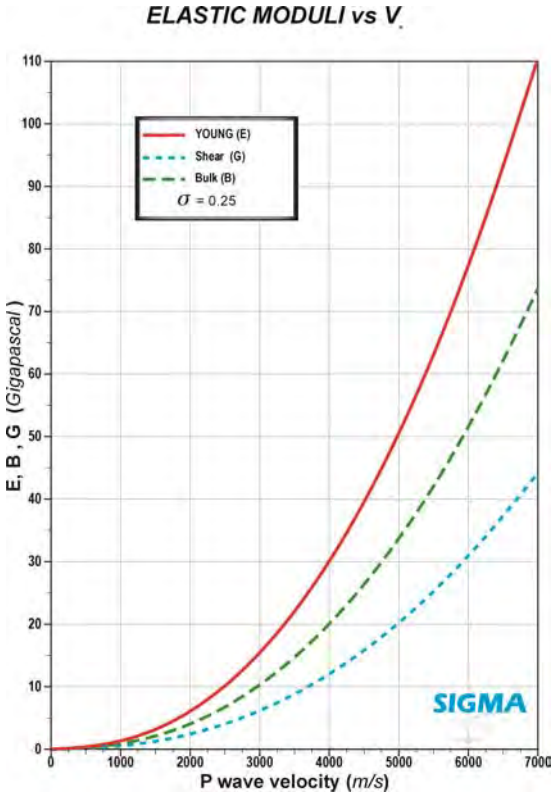


Fig.7 – Elastic moduli vs Vp

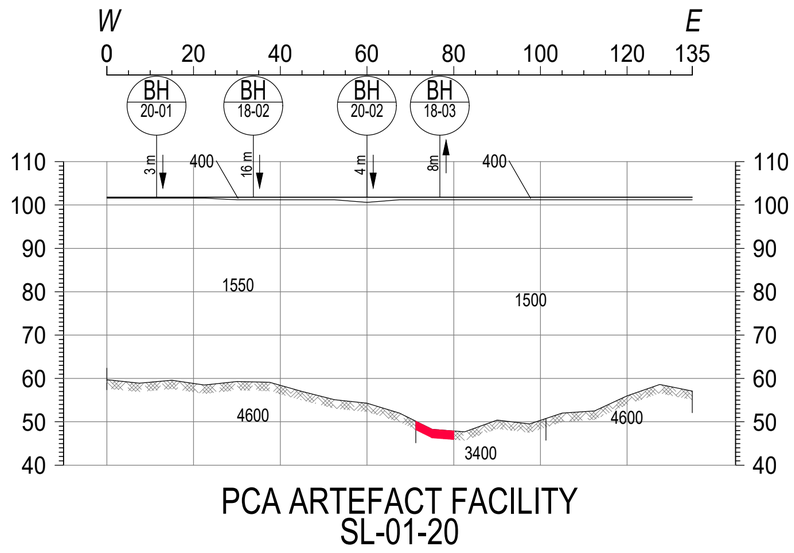
Accuracy

When the basic assumptions sustaining the seismic refraction theory are met:

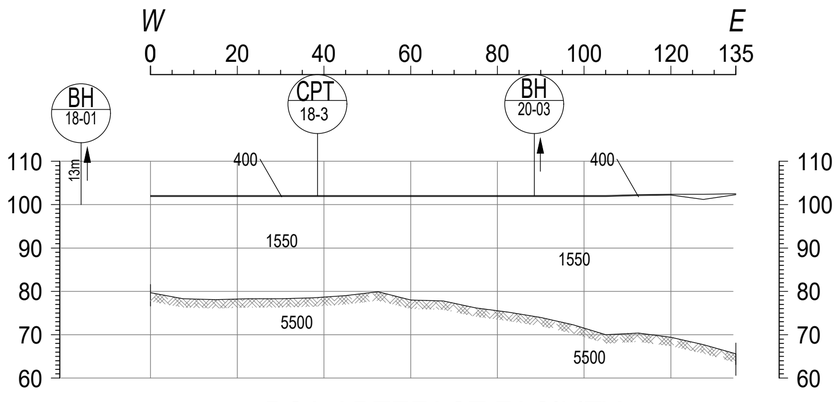
- ***The layers of material are sub-parallel***
- ***The propagation velocity is constant throughout each layer***
- ***The propagation velocity in successive layers is always increasing with depth***
- ***There is no blind zone or hidden layer***

the error on the computed depth is inferior to 15 % of the actual depth for depths greater than 15 m and 1.5 m between the surface and 15 m.

DRAWINGS NO 19723-01

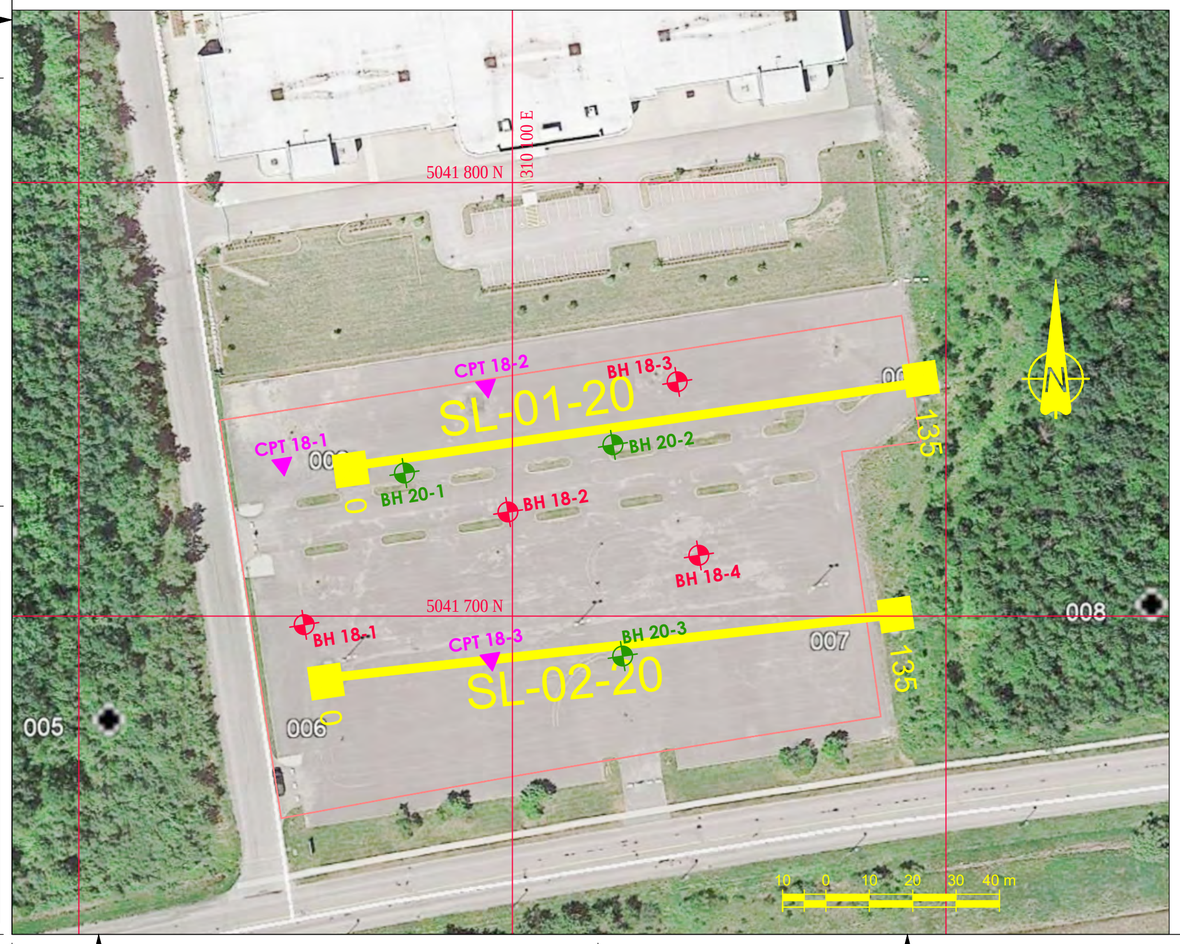


PCA ARTEFACT FACILITY
SL-01-20



PCA ARTEFACT FACILITY
SL-02-20

LOCALISATION 1:1,000



NOTES

1. The seismic lines have been positionned by Sigma Geophysics Inc. with elevation points provided by Stantec Inc..
2. All elevations are in m (MSL).
3. The coordinates are in NAD-83 MTM Zone 9.
4. The survey has been executed in February 2020 by Sigma Geophysics inc. for Stantec inc.

N°	DATE	MODIFICATIONS	SIGMA	CLIENT APPROVED
2	Mar 20 20	2020 boreholes informations entered		
1	Mar 10 20	ISSUED FOR FINAL		
0	Feb 24 20	ISSUED FOR PRELIMINARY		

NO REFERENCES NO

CONSULTANTS
SIGMA GEOPHYSICS INC.
1890, rue Marie-Victorin
Saint-Bruno, QC J3V 6B9
Telephone: (450) 441-4600 sigma@geosigma.com

Drafted	cp	Verified:	C. Provost, P. Eng.
Projected:	C. Provost. P. Eng.	Approved:	C. Provost, P. Eng.

Contract N°:	Drawing N°	Modification	Date
C19723	19723-01	2	Mar 20 2020

SEAL

INGÉNIEUR Claude Provost 35476 QUÉBEC

LEGEND

- TOP OF BEDROCK
- SEISMIC VELOCITY ANOMALY
- TOP OF REFRACTOR
- TOP OF REFRACTOR (interpolated, extrapolated)
- BATHYMETRY
- P-WAVE VELOCITY (metre/seconde) — 5000
- ORIENTATION OF THE SEISMIC LINE — SO
- WATER LEVEL — INT
- SEISMIC LINE INTERSECTION — LS-A1-05 PM 10

SCALE

10 0 10 20 30 40 HOR: 1:1000
10 0 10 20 30 40 VER: 1:1000

DIMENSIONS Metre

Public Works and Government Services Canada

PCA ARTIFACT FACILITY

GATINEAU, QC

SEISMIC SURVEY 2020
SEISMIC SECTIONS
SL-01-20, SL-02-20

Marsh 20 2020 | 19723-01 | Rév. 2

19723-01 Rév.2