December 5, 2019

The University of British Columbia
Infrastructure Development, Project Services
1100 – 2329 West Mall
Vancouver, BC V6T 1Z4

e-mail: nmcnally@mail.ubc.ca

Attention: Noel McNally, Project Manager

**Re:** EXP Reference No. VAN-00256357-A0
Preliminary Geotechnical Engineering Recommendations
UBC MacLeod Building Renewal + Seismic Upgrading
2356 Main Mall, UBC Vancouver Campus, BC

Dear Sir:

## 1.0 INTRODUCTION

EXP Services Inc. ("EXP") was retained by the University of British Columbia ("UBC") to prepare a geotechnical engineering assessment report for the above-referenced project. The subject site showing the footprint of the proposed upgrading is illustrated on the attached Figure 1. The Terms of Reference for this geotechnical assessment were provided in our proposal 999-00068166-PP dated October 9, 2019.

Our scope of services for this project included a desktop study of the available information with respect to existing building foundations, review of historical information with regards to subsurface soil and groundwater conditions in the vicinity of the subject site, conducting a subsurface investigation in the area of the proposed construction, performing geotechnical analyses, and preparation of this report providing geotechnical engineering recommendations for the proposed construction. Our scope of services did not include assessment of site soil or groundwater with respect to environmental contaminant considerations.

The purpose of this geotechnical assessment was to evaluate the subsurface conditions at the site and to provide comments and geotechnical engineering recommendations for the proposed construction.

The following sources of information were reviewed as part of this assessment:

- A visual reconnaissance of the subject property;
- Surficial Geology Map 1486A covering the subject site and published by the Geological Survey of Canada;

- Review of geotechnical reports completed within the proximity of the subject site, available in EXP's database;
- Structural design drawings for the existing MacLeod building, prepared by Choukalos, Woodburn & McKenziue Ltd. dated March 1962;
- A geotechnical assessment report prepared by GeoPacific Consultants Ltd. titled as "Preliminary Geotechnical Investigation Report, Proposed Engineering Student Centre, Engineering Road, UBC", dated January 27, 2011;
- A drawing showing the topographic information of the subject site, prepared by Murray & Associates, dated September 25, 2019;
- Schematic structural design drawings prepared by Weiler Smith Bowers (WSB) dated November 29, 2019; and,
- A site-specific geotechnical exploration program recently completed at the project site by EXP and described herein.

## 2.0 SITE DESCRIPTION AND PROPOSED DEVELOPMENT

The existing MacLeod Building is located at 2356 Main Mall, within the University of British Columbia (UBC) Vancouver campus. Subject building is surrounded by grass covered areas along north and southwest sides, existing Kaiser building on the west side, and areas along the east side are surfaced with asphalt pavement. The existing grade along the north and southwest sides are approximately 1.2m higher than that of east side. The bottom most floor slab is located approximately 1.5m below the existing grade along and north southwest sides of the building.

Seismic upgrading of the existing building will be carried out in accordance with 2018 British Columbia Building Code (2018 BCBC). Based on our communications with project Structural Engineer WSB, we understand that seismic upgrading of the building will comprise of construction of additional interior and exterior strip/pad footings, new structural concrete wall, inclusion of seismic soil anchors in newly constructed large core footings.

## 3.0 DESKTOP STUDY

Review of the information provided indicates that the bottom of existing footing elevations ranges from El. 396'-4" to El. 393'-0". Based on our experience working on the seismic upgrading project for Museum of Anthropology, 91.5 feet should be subtracted from the above elevations in order to convert into current geodetic elevations. Consequently, the elevations for bottom of footings range from 304'-10" (~92.9m) to 301'-6" (~91.9m), geodetic.

GeoPacific conducted a total of four (4) auger test holes within the Engineering Student Centre building courtyard area located at the north-east side of the MacLeaod building. Approximate locations of GeoPacific teastholes are shown on the attached Figure 1. Based on the topographic survey plan and GeoPacific testhole location plan provided, the ground surface elevations at the testhole locations ranged

approximately from El.95.0m to El. 95.4m. The subsurface soil conditions described in the GeoPacific testhole soil logs generally comprised of 1.8m to 2.4m thick fill underlain by till-like soils. Based on that, the elevations of the top of till-like soils encountered in the GeoPacific subsurface exploration, ranged approximately from El. 93.0m to El. 93.2m, geodetic.

During our recent subsurface exploration program as discussed below, approximate ground elevations at the locations of the test holes ranged from El. 94.7m to 93.5m. Based on the test hole soil logs, till-like soils were encountered approximately 0.3m to 0.5m below grade in the above test holes, respectively. Therefore, top of the till-like soils encountered in the EXP test holes ranged from 93.0m to 94.1m, geodetic.

Consequently, it is inferred that the existing building foundations were constructed over native till-like soils.

## 4.0 SUBSURFACE EXPLORATION

To evaluate the soil and groundwater conditions at the site, on November 22, 2019, EXP advanced a total of three (3) testholes (AH19-01 and AH19-03) using a track-mounted auger drill rig equipped with solid-stem flight augers. AH19-01 & AH19-02 were located on the grassed area along the southwest side of the existing building, and AH19-03 was located on the existing paved area on north-east corner of the building.

The testholes extended to depths ranging from 4.6m to 12.2m, below existing grade. The approximate locations of testholes are shown on the attached Figure 1. Early auger refusal was encountered in AH19-01 at a depth of about 4.6m.

Dynamic Cone Penetration Tests (DCPTs) were conducted adjacent to all the testholes, to assess the in-situ relative density/consistency of the soils. The DCPTs extended to depths of about 1.8m, 1.6m, and 0.9m below existing grade at the locations of AH19-01 to AH19-03, respectively, where refusals to DCPT cone were met (i.e., > 100 blows per 305mm).

The soil and groundwater conditions encountered at the testholes were logged in the field by a member of EXP's geotechnical staff. Disturbed soil samples were collected from the auger flights for visual classification, moisture content determination purposes.

The testholes were backfilled in conformance with provincial groundwater protection requirements upon completion of drilling. Surface at location of AH19-03 was patched with cold-mix asphalt.

Soil logs with detailed description of the soil and groundwater conditions encountered at the test holes are enclosed in Appendix A of this report. The soil logs graphically illustrate the moisture contents of disturbed soil samples collected during drilling. DCPT penetration resistance N-values in blows per 305mm are also shown on the respective soil logs.

A summary description of the soil and groundwater conditions at the site encountered in the testholes is provided in the following section of this report. A detailed description of the subsurface conditions is

provided on the attached soil logs and should be used in preference to the general summary of soil conditions provided below.

It should be noted that the test holes indicate subsurface conditions encountered at the respective test hole locations only. The subsurface conditions may vary outside the test hole locations and below the depth explored.

## 4.0 SOIL AND GROUNDWATER CONDITIONS

### 4.1 Surficial Geology

Based on the Geological Survey of Canada surficial geology map covering the project site (Map 1486A), the site is underlain by a Vashon Drift and Capilano Sediments (VCb). The VCb units are described as lodgement and minor flow till, lenses, and interbeds of sub-stratified glacio-fluvial sand and gravel, and lenses and interbeds of glacio-lacustrine laminated stony silts.

The findings of the desktop study completed as part of this assessment are generally consistent with published surficial geology maps of the area. Based on our review of the available test hole information, the UBC Campus is generally covered by a nominal amount of fill with various compositions which is underlain by very dense glacial "Till-like" soil (sandy silt/silty sand). This Till-like layer thickness is known to vary from 2m to in excess of 15m across the UBC Campus.

In general, the Till-like soils is underlain by a dense to very dense Quadra Sand (medium to fine-grained sand with occasional thin silt layers and scattered gravel). An interbedded dense sand and hard silt with some organic layers containing occasional cemented gravel and very stiff silty clay exists below the Quadra sand at depth.

### 4.2 EXP Testholes

The following generalized soil profile was encountered at the testholes drilled at the site:

- **Topsoil / Asphalt** – about 200 to 300mm thick topsoil was encountered at AH19-01 & AH19-02 locations. AH19-03 borehole was surfaces with approximately 80mm thick asphalt.
- **Fill (sand and gravel)** – surficial topsoil / asphalt was underlain by a layer of fill with thickness ranging between 300mm and 200mm, in AH19-02 and AH19-03, respectively. Fill was comprised of sand and gravel. Based on the DCPT blow counts encountered within this deposit, the relative density of fill was judged to be loose to compact.
- **Till-Like Soils** – surficial topsoil in AH19-01 and fill in AH19-02 and AH19-03 was underlain by till-like soils extended to the termination depths of the test holes. Till-like soils comprised of sand, mixed with some gravel / gravelly, and silt with varied contents ranging from trace to some in quantities. In AH19-03, till-like sand turned in to sand and gravel below approximately 7.6m and extended to a depth of about 9.1m, below grade. Based on the DCPT blow counts encountered within this deposit, the relative density of the till-like soils was judged to be dense to very dense.

Moisture contents of the soil samples collected from the till-like soils deposit ranged from 6 to 14 percent.

### 4.3 Groundwater conditions

No groundwater seepage was observed in any of the test holes at the time of drilling. The regional groundwater table has been typically measured to be at depth greater than 45m below the ground surface in the UBC campus. However, localized areas of perched groundwater conditions may be expected to be present at various locations across the site.

## 5.0 DISCUSSION AND RECOMMENDATIONS

### 5.1 General

Based on the estimated as-constructed elevations of the existing footing undersides, very dense till-like soils are expected to be present at the bottom of foundation levels. It is considered feasible to support the new structural elements on conventional spread and strip footings placed on the above-mentioned subgrade soils. Specific recommendations for foundation design are presented in the following subsections.

The soils encountered in the test holes drilled within the vicinity of the building are considered to be sufficiently dense that they would not be subject to liquefaction or strain softening under the design earthquake having a 2% probability of occurrence over the next 50 years (1:2475-year design basis earthquake).

### 5.2 Site Preparation

It is expected that very dense till-like soils will be exposed at design elevations. The exposed subgrade should be reviewed and approved by the Geotechnical Engineer prior to placement of concrete/ reinforcing. Unsuitable soils found at subgrade level would need to be removed.

It is possible that large boulders could be encountered during excavation that may require rock splitting for removal.

It is anticipated that perched groundwater and rainwater entering temporary excavations could be adequately controlled using conventional sumps and pumps. Discharge of water collected from temporary excavations should be conducted in accordance with UBC's requirements. The excavation should be graded to direct surface water to the temporary sumps.

### 5.3 Temporary Excavation

Temporary unsupported excavations should be conducted in accordance with the WorkSafeBC requirements. A maximum inclination of 3H:4V (Horizontal:Vertical) is considered appropriate for temporary excavations deeper than 1.2m, but less than 3m deep. Unsupported excavations greater than 3m in depth should be sloped at no steeper than 1 H:1V (from top to bottom). Excavation should not

extend to deeper than the underside of any existing adjacent footings without consultation with the Geotechnical Engineer.

Surcharge loads from soil stockpiles, construction vehicles and construction material stockpiles should be avoided by keeping such items away from the excavation crest a minimum distance of 3m. Temporary excavations located adjacent to surcharge loads should be approved by a Geotechnical Engineer prior to excavation.

Temporary unsupported excavations steeper than recommended that require worker access should be approved in writing by a Geotechnical Engineer prior to workers entering or working adjacent to such excavations.

## 5.4 Structural Fill

Structural fill is defined in this report as fill material used to develop site grades beneath slabs, sidewalks, and other hard surfaced areas (including asphalt pavement), but not footings. Imported structural fill should consist of free draining, well graded, 75mm minus pit run sand and gravel pit run with a maximum 5 percent fines (material passing the 0.075mm sieve) by weight, or equivalent approved by the Geotechnical Engineer. The Geotechnical Engineer should be given the opportunity to approve candidate sources of engineered fill, prior to their delivery to the site, to assess their suitability for use.

Structural fill should be placed in loose lifts not exceeding 300mm in thickness with each lift compacted to the required densities as recommended below.

Structural fill should be compacted to not less than 95 percent of its Modified Proctor maximum dry density (MPMDD) per ASTM D 1557. The structural fill should extend out from all load bearing areas a horizontal distance at least equal to the thickness of structural fill placed below the load bearing areas. The Geotechnical Engineer's representative should be given the opportunity to conduct in-situ soil density testing on the engineered fill as it is being placed to confirm that adequate compaction is achieved.

## 5.5 Seismic Considerations

### 5.5.1 *Liquefaction Potential*

A geotechnical seismic evaluation was conducted to assess the liquefaction susceptibility of the subsoils using the available data obtained from the subsurface exploration at the site and our general experience in the vicinity. Evaluation was conducted based on a design earthquake which has a return period of 2,475 years (2 percent probability of exceedance over the next 50 years). This equates to a Peak Horizontal Ground Acceleration (PGA) of 0.382g[1] for the subject site.

[1] Source of provided PGA: 2010 National Building Code Seismic Hazard Calculation using site specific UTM coordinates.

Based on the available information and liquefaction analysis results, the subsoils are considered to have high resistance to liquefaction during a 1:2475 year design earthquake. Consequently, we do not expect there to be seismic induced displacements due to liquefaction.

### 5.5.2 *Seismic Site Class*

Engineering judgment was used to evaluate the appropriate seismic Site Class to be applied for design. Based on the anticipated foundation depth, information of the test holes conducted and our experience in the UBC area. Results of our evaluation indicate that Site Class "C" may be used for estimating the seismic site response at the subject site.

## 5.6 Foundation Design

The existing building footings or any additional conventional footings can be assessed / designed based on the following serviceability limit state (SLS) and factored ultimate limit state (ULS) soil bearing resistances, which is expected to be founded directly on the native till-like soils:

- SLS soil bearing resistance of 500 kPa.
- Factored ULS soil bearing resistance of 750 kPa.

The above-noted values are based on the assumptions that strip footings have a minimum width of 450mm and that pad footings have minimum dimensions of 0.6m by 0.6m. Soil bearing resistance values can be increased if the actual footing sizes are greater than what we have assumed above.

A Soil Modulus of Subgrade Reaction Value of 50 MPa/m may be used for preliminary design purposes, provided that foundations are constructed over till-like soils.

The underside of foundations should be located below a 2H:1V influence line projected up from the base of adjacent deeper excavations for other foundations, underground utilities, etc. or the soil bearing resistances provided above would need to be reviewed.

The Geotechnical Engineer should review the soil conditions at foundation grade prior to the construction of foundation formwork to confirm that the soil bearing resistance values provided above are appropriate for the exposed subgrade.

Foundation areas should be kept free of standing water, and any disturbed or water softened soils should be removed prior to the placement of concrete.

## 5.7 Seismic Soil Anchors (Tie Down Anchors)

Schematic structural design drawings of the proposed upgrading indicate that seismic soil anchors are required to resist tensile and compressive loads only (i.e. not lateral). The seismic soil anchors should consist of a central steel threadbar (Dywidag-Systems International GEWI-Bar) shop grouted within a corrugated PVC sheathing and further encased in cement grout inside a drilled hole. The grout cylinder

completely encases the central threadbar / sheathing assembly from the base of the drilled hole to the underside of the bearing plate at the foundation and is referred to as a "double corrosion protected" system.

Each soil anchor should be provided with a minimum 1.5m free stressing length to allow for confirmatory load testing in tension. EXP recommends a factored ULS load resistance of 85 kN/m of bond length below the free stressing length for the anchor design. For performance/efficiencies, the bond lengths should be less than 15m. This value is based on number of successful tensile load tests of GEWI-piles installed at the UBC campus and subsurface soil information collected from the recent and historical test hole soil logs.

The soil anchors should be installed in a cased hole drilled with nominal 150mm diameter temporary casing, pressure grouted, and tested prior to the foundation being constructed. The design length of the soil anchors will be a function of the applied load, grout-to-soil skin friction, and anchor spacing. The detailing of the pile head and bearing plate(s) will be a function of the construction sequence, and whether the soil anchors are designed to support tension only or a combination of tension and compression loads.

The soil anchor load resistance should be confirmed based on tensile load testing in accordance with Post Tensioning Institute guidelines provided in "Recommendations for Prestressed Rock and Soil Anchors", 2004 edition, under the review of the Geotechnical Engineer.

Once the information regarding factored structural loading per soil anchor become available, EXP can complete the detailed design of the soil anchors. EXP can provide detailed design support for the soil anchor design to the Structural Engineer, if requested. Specifications for the installation and load testing would also be provided during detailed design.

### 5.8 Settlement

It is anticipated that total post-construction settlement of foundations constructed in accordance with the recommendations for site preparation and foundation design provided in this report would not exceed 25mm. Differential post-construction settlement is not expected to exceed 15mm over a horizontal distance of 10m.

### 5.9 Slab-on-Grade

Concrete floor slab-on-grade should be underlain by a minimum 150mm thick layer of 19mm minus well-graded crushed sandy gravel or clean sand containing less than 5 percent fines (material passing the 0.075mm sieve) by weight compacted to an equivalent of 95% of the material's MPMDD. Compaction of the underslab fill should be reviewed by the Geotechnical Engineer.

### 5.10 Drainage Provision

A drainage system is recommended behind the perimeter retaining walls leading to a suitable discharge location. The perimeter drains should be surrounded with minimum 150mm of 19mm clear crushed gravel, which in turn should be surrounded with minimum 150mm of birdseye gravel as a filter. The

remaining backfill should consist of free draining structural fill. The invert level of the retaining wall drain pipe should be located at least 150mm above the underside of the retaining wall footings.

### 5.11 Lateral Earth Pressures for Foundations Walls and Retaining Walls

"Active" earth pressure theory is considered valid for the design of retaining structures, including foundation walls, which are permitted to rotate by 0.2% of the wall height. Recommended lateral earth pressures are shown in the attached Figure 2. The incremental seismic earth pressure for design of the retaining walls was estimated using the pseudo-static Mononobe-okabe[2] equations. The seismic coefficient input into the M-O analysis was taken as 75% of the site-specific Peak Ground Acceleration (PGA). At this site, the PGA is 0.382g for the design basis earthquake (2 percent of probability of exceedance in 50 years).

The lateral earth pressure diagrams in Figure 2 assumed the following:

- Drainage is provided such that no hydrostatic pressure can develop against the foundation walls.
- Retained soil consists of granular soil.
- Horizontal backfill surface

Surcharge loads from adjacent properties should be incorporated into the wall design as required.

Equivalent factored fluid pressures of 45 kPa/m and 70 kPa/m may be used to estimate the factored ultimate passive resistance of soil in front of the retaining wall footings (assuming resistance factor of 0.50 and 0.80) for long term and transient loading conditions, respectively. A factored coefficient of friction of 0.45 may be used to estimate the sliding resistance along the soil-footing interface where the retaining wall foundation is constructed on compacted structural fill or native till-like soil subgrade.

Retaining wall backfill should consist of structural fill with not more than 5 percent passing the 0.075mm sieve. The backfill should be placed in horizontal lifts and be compacted to not less than 95 percent of the material's MPMDD. The backfill should be compacted by walk behind vibratory plate tampers within 1.5m of the retaining wall. The lift thickness should not exceed 200mm and the compaction should be verified by in-place soil density testing.

## 6.0 DETAILED DESIGN AND GEOTECHNICAL FIELD REVIEW

During detailed design, site preparation and construction, it is recommended that the Geotechnical Engineer be provided with the opportunity to review the following:

[2] Mononobe, N and Matsuo M (1929). "On the Determination of Earth Pressures During Earthquakes" Proc. World Eng. Congress, 9, pp 179 -187

- Foundation design drawings;
- Seismic soil anchor design and specifications;
- Temporary unsupported excavations;
- Soil conditions at footing subgrade elevations;
- Seismic soil anchor installation and load testing; and,
- Structural fill gradation and compaction.

## 7.0 CLOSURE

Please note that this report has been prepared based on the information provided by the Client and our understanding of the proposed development as described in Section 2.0 above.

Also note that this report was prepared for the exclusive use of our Client, University of British Columbia and their designated agents, and may not be used by other parties without written consent of EXP. A copy of our "Interpretation & Use of Study and Report" is enclosed. These instructions form an integral part of this report and must be included with any copies of this report.

The soil and groundwater conditions described in this report and on the attached soil logs are those encountered at discrete test hole locations. Actual soil and groundwater conditions at the site may vary from those encountered at the test holes. Contractors should make their own assessment of subsurface conditions and select the construction means and methods most appropriate to the site conditions. This geotechnical report should not be included in contract specifications without suitable qualifications and prior review by EXP Services Inc. However, the geotechnical report may be used as an attachment to contract specifications, for information purposes only.

We trust the information provided in this report meets with your immediate requirements. If you have any questions or require further information, please contact the undersigned

Sincerely,

EXP Services Inc.


Pranay Saha, M.Eng., P.Eng.
Geotechnical Engineer

Reviewed by:

Kai-Sing Hui, P.Eng.
Manager, Geotechnical Division

Enclosures: Interpretation & Use of Study and Report

Figure 1: Testhole Location Plan
Figure 2: Lateral Earth Pressure Diagrams
Appendix A: Testhole Soil Logs (AH19-01 to AH19-03)

# INTERPRETATION & USE OF STUDY AND REPORT

**1. STANDARD OF CARE**

This study and Report have been prepared in accordance with generally accepted engineering consulting practices in this area. No other warranty, expressed or implied, is made. Engineering studies and reports do not include environmental consulting unless specifically stated in the engineering report.

**2. COMPLETE REPORT**

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report which is of a summary nature and is not intended to stand alone without reference to the instructions given to us by the Client, communications between us and the Client, and to any other reports, writings, proposals or documents prepared by us for the Client relative to the specific site described herein, all of which constitute the Report.

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

**3. BASIS OF THE REPORT**

The Report has been prepared for the specific site, development, building, design or building assessment objectives and purpose that were described to us by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the document are only valid to the extent that there has been no material alteration to or variation from any of the said descriptions provided to us unless we are specifically requested by the Client to review and revise the Report in light of such alteration or variation.

**4. USE OF THE REPORT**

The information and opinions expressed in the Report, or any document forming the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT OUR WRITTEN CONSENT. WE WILL CONSENT TO ANY REASONABLE REQUEST BY THE CLIENT TO APPROVE THE USE OF THIS REPORT BY OTHER PARTIES AS “APPROVED USERS”. The contents of the Report remain our copyright property and we authorise only the Client and Approved Users to make copies of the Report only in such quantities as are reasonably necessary for the use of the Report by those parties. The Client and Approved Users may not give, lend, sell or otherwise make the Report, or any portion thereof, available to any party without our written permission. Any use which a third party makes of the Report, or any portion of the Report, are the sole responsibility of such third parties. We accept no responsibility for damages suffered by any third party resulting from unauthorised use of the Report.

**5. INTERPRETATION OF THE REPORT**

a. Nature and Exactness of Descriptions: Classification and identification of soils, rocks, geological units, contaminant materials, building envelopment assessments, and engineering estimates have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature and even comprehensive sampling and testing programs, implemented with the appropriate equipment by experienced personnel, may fail to locate some conditions. All investigations, or building envelope descriptions, utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarising such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and all persons making use of such documents or records should be aware of, and accept, this risk. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b. Reliance on Provided information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to us. We have relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, we cannot accept responsibility for any deficiency, misstatement or inaccuracy contained in the report as a result of misstatements, omissions, misrepresentations or fraudulent acts of persons providing information.

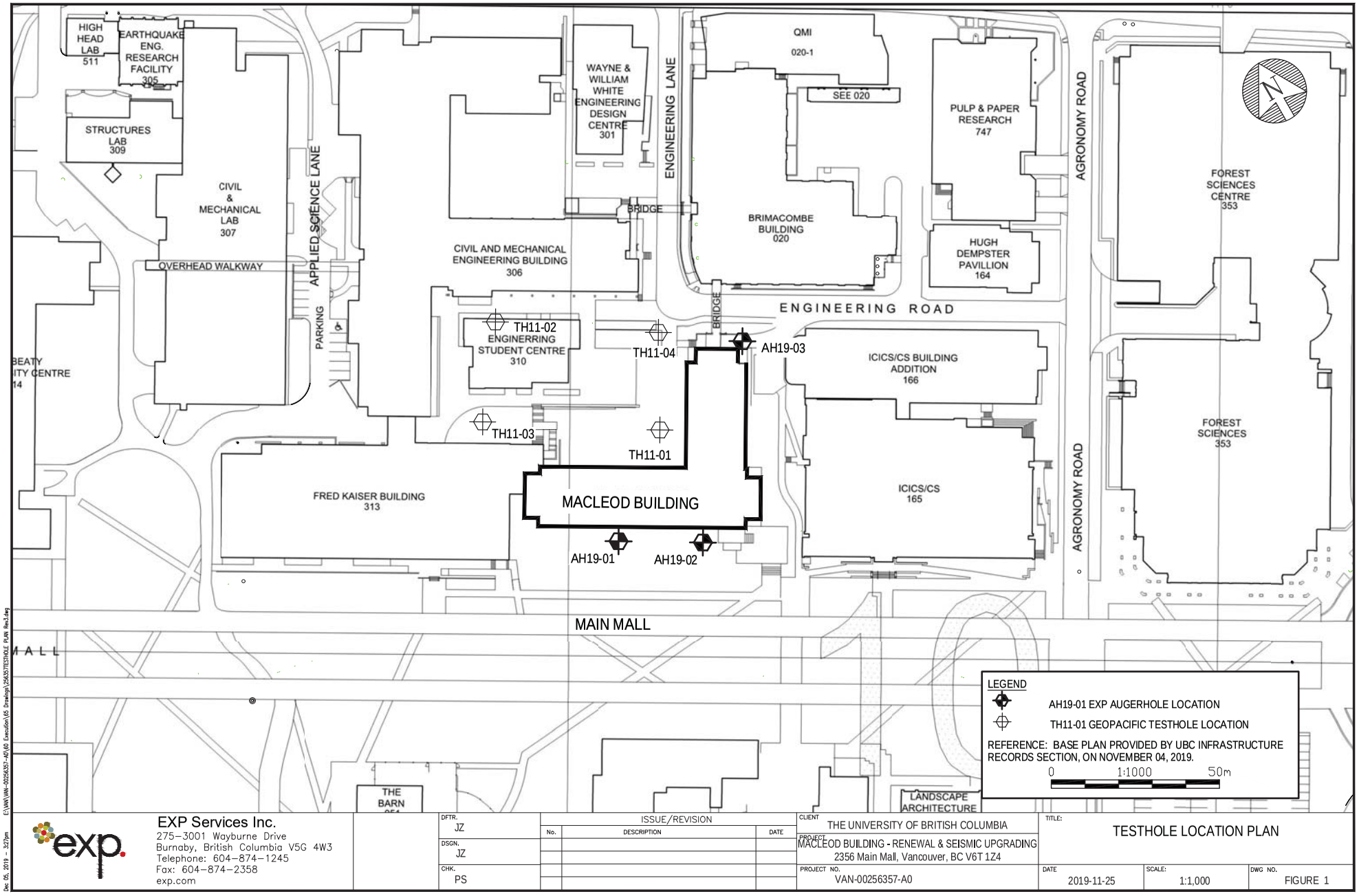
c. To avoid misunderstandings, EXP Services Inc. (EXP) should be retained to work with the other design professionals to explain relevant engineering findings and to review their plans, drawings, and specifications relative to engineering issues pertaining to consulting services provided by EXP. Further, EXP should be retained to provide field reviews during the construction, consistent with building codes guidelines and generally accepted practices. Where applicable, the field services recommended for the project are the minimum necessary to ascertain that the Contractor’s work is being carried out in general conformity with EXP’s recommendations. Any reduction from the level of services normally recommended will result in EXP providing qualified opinions regarding adequacy of the work.

**6.0 ALTERNATE REPORT FORMAT**

When EXP submits both electronic file and hard copies of reports, drawings and other documents and deliverables (EXP’s instruments of professional service), the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding. The hard copy versions submitted by EXP shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancy, the hard copy versions shall govern over the electronic versions. Furthermore, the Client agrees and waives all future right of dispute that the original hard copy signed version archived by EXP shall be deemed to be the overall original for the Project.

The Client agrees that both electronic file and hard copy versions of EXP’s instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except EXP. The Client warrants that EXP’s instruments of professional service will be used only and exactly as submitted by EXP.

The Client recognizes and agrees that electronic files submitted by EXP have been prepared and submitted using specific software and hardware systems. EXP makes no representation about the compatibility of these files with the Client’s current or future software and hardware systems.




EXP Services Inc.
275–3001 Wayburne Drive
Burnaby, British Columbia V5G 4W3
Telephone: 604–874–1245
Fax: 604–874–2358
exp.com

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| DFTR. | JZ |
| DSGN. | JZ |
| CHK. | PS |

ISSUE/REVISION

| No. | DESCRIPTION | DATE |
|---|---|---|
| | | |

CLIENT: THE UNIVERSITY OF BRITISH COLUMBIA
PROJECT: MACLEOD BUILDING - RENEWAL & SEISMIC UPGRADING
2356 Main Mall, Vancouver, BC V6T 1Z4
PROJECT NO.: VAN-00256357-A0

TITLE: TESTHOLE LOCATION PLAN

| DATE | SCALE | DWG NO. |
|---|---|---|
| 2019-11-25 | 1:1,000 | FIGURE 1 |

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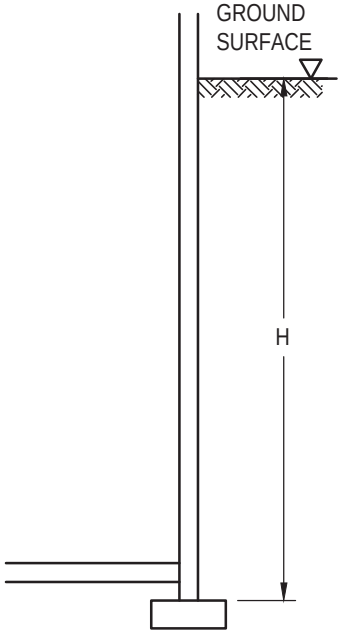
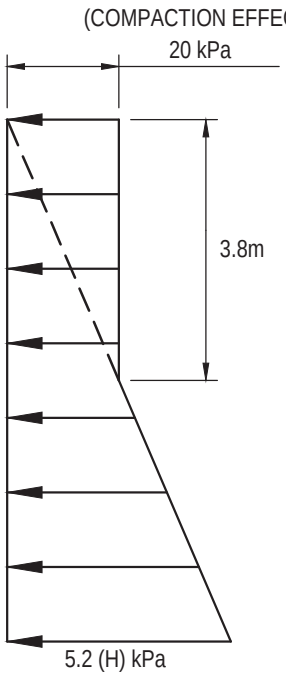
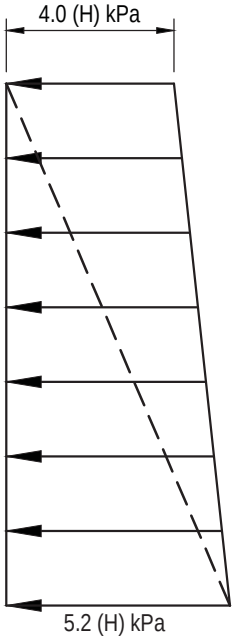
Dec 05, 2019 - 3:27pm



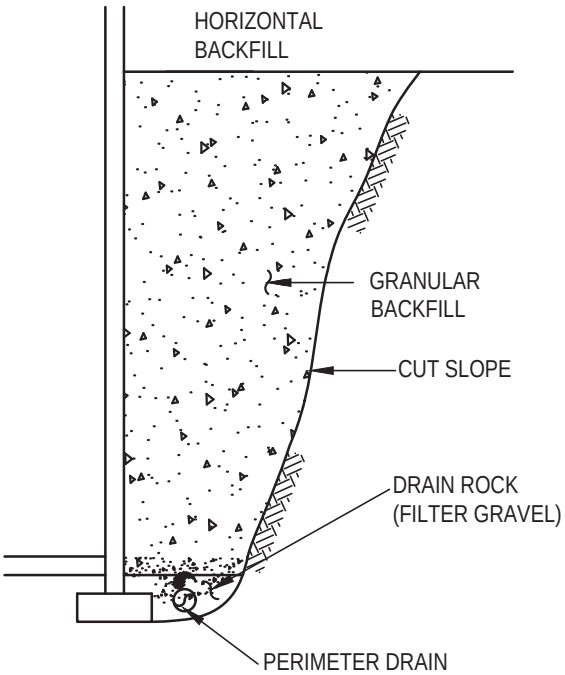

TYPICAL RETAINING WALL




STATIC LOAD




SEISMIC+STATIC LOAD




## NOTES:

- ALL METRIC UNITS IN (m) AND (kPa)
- ABOVE SKETCHES ARE NOT TO SCALE
- ASSUMED DRAINAGE PROVIDED, SUCH THAT HYDROSTATIC PRESSURE DOES NOT DEVELOP AGAINST THE RETAINING WALL
- ALL LOADS ARE UNFACTORED
- SURCHARGE PRESSURE DUE TO LIVE LOAD, ADJOINING STRUCTURES, ETC. TO BE INCLUDED WHERE APPLICABLE

## ASSUMPTIONS:

- TOP OF WALL FREE TO ROTATE 0.2% OF WALL HEIGHT
- NO HYDROSTATIC PRESSURE BUILD-UP BEHIND WALL
- PEAK HORIZONTAL GROUND ACCELERATION ( 1 IN 2475 YEARS) = 0.382g
- SEISMIC CO-EFFICIENT USED = 0.75 X PGA = 0.286g

exp.

CLIENT: UNIVERCITY OF BRITISH COLUMBIA

PROJECT: MacLEOD BUILDING - RENEWAL & SEISMIC UPGRADE
2356 MAIN MALL, VACNOUVER, BC

TITLE: LATERAL EARTH PRESSURE DIAGRAMS

| PROJECT NO. | DFTR. | DSGN. | CHK. | DATE | SCALE: | DWG NO. |
|---|---|---|---|---|---|---|
| VAN-00256357-A0 | PS | PS | KSH | 2019-12-3 | NTS | FIGURE 2 |

Dec 05, 2019 - 4:29pm E:\VAN\VAN-00256357-A0\60 Execution\05 Drawings\0256357-A0 Lateral earth pressure diagram.dwg

EXP Services Inc
3001 Wayburne Drive, Unit 275
Burnaby, BC V5G 4W3
Telephone: 604-874-1245

# RECORD OF AUGERHOLE : AH19-01



**PROJECT NUMBER** VAN-00256357-A0
**CLIENT** The University of British Columbia
**PROJECT NAME** UBC MacLeod Building Renewal & Seismic Upgrading
**PROJECT LOCATION** 2356 Main Mall, UBC, Vancouver, BC
**DRILLING DATE** 2019-11-22
**AUGERHOLE LOCATION** ZONE: 10 N: 5456580 E: 481831
**DRILLING CONTRACTOR** Southland Drilling Co. Ltd.
**ELEVATION** (approximate)
**DRILLING METHOD** Solid Stem Auger
**GROUND WATER DEPTHS:** ▽ **AT TIME OF DRILLING** --- no groundwater observed
▼ **AT END OF DRILLING** ---
**EQUIPMENT TYPE** Track Mounted Auger Drill
▼ **AFTER DRILLING** ---
**LOGGED BY** JZ **CHECKED BY** PS

| DEPTH (m) | STRATA | SOIL DESCRIPTION | ELEV. DEPTH (m) | SAMPLES NUMBER | SAMPLES TYPE | SAMPLES RECOVERY % | SPT N VALUE BLOWS/0.3m ▲ 20 40 60 80 / DYNAMIC CONE BLOWS/0.3m ▨ 20 40 60 80 | POCKET PEN. (kPa) ⊙ 100 200 300 400 / FIELD VANE SHEAR (kPa) Peak ● Remold ○ 40 80 120 160 | FINES CONTENT (%) □ 20 40 60 80 / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL 20 40 60 80 |
|---|---|---|---|---|---|---|---|---|---|
| | | SILTY SAND, trace organics, brown, moist, (loose), (TOPSOIL) | | S1 | AU | | 8 | | 23 |
| | | SAND, some silt to silty, some gravel, grey, damp to moist, (dense to very dense), (TILL-LIKE) | 0.3 | | | | 40 | | |
| 1 | | | | S2 | AU | | 72 | | 13 |
| | | | | | | | 95 | | |
| | | | | | | | 74 | | |
| 2 | | | | | | | 100+ | | |
| | | | | S3 | AU | | | | 9 |
| 3 | | - becoming some silt, trace to some gravel, damp at about 3.0 m depth | | | | | | | |
| | | | | S4 | AU | | | | 9 |
| 4 | | | | | | | | | |
| | | | | S5 | AU | | | | 10 |
| | | - refusal to auger at about 4.6 m depth, possible cobbles | | | | | | | |

**Bottom of hole at 4.6m.**

# RECORD OF AUGERHOLE : AH19-02

EXv Ser0ices Inc
HQQ> %ahm6rne Dri0e, Bnit CR5
/ 6rnamh, / 8 K5p 1%H
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vAp E > y . C

**PROJECT NUMBER** KANfQQC5UH5RfAQ
**PROJECT NAME** B/ 8 WacLeob / 6i0ing - ene( aQl Seisl ic B3grabing
**DRILLING DATE** CQ>9f>>fCC
**DRILLING CONTRACTOR** So6tu@nb Dri0ing 8 o2Ltb2
**DRILLING METHOD** So0b Stel A6ger
**EQUIPMENT TYPE** TracwWo6nteb A6ger Dri0
**LOGGED BY** JZ **CHECKED BY** v S

**CLIENT** Tue Bni0ersith o7/ ritisu 8 o6l mia
**PROJECT LOCATION** CH5U Wain Wa0B/ 8 , Kanco60er, / 8
**AUGERHOLE LOCATION** Zy NE: >Q N: 515U5UQ E: 1M>M1>
**ELEVATION** )a33roxil ateP
**GROUND WATER DEPTHS:** ▽ **AT TIME OF DRILLING** fff no gro6nb( ater om6ser0eb
▼ **AT END OF DRILLING** fff
▼ **AFTER DRILLING** fff

| DEvTV )l P | ST-ATA | Sy IL DES8 - Iv TIy N | ELEK2 DEv TV )l P | SAWv LES NBW/ E- | SAWv LES TYvE | SAWv LES - E8 y KE- Y G | SvT N KALBE / Ly % SkQ2H ▲ CQ 1Q UQ MQ | DYNAWI8 8 y NE / Ly % SkQ2H CQ 1Q UQ MQ | v y 84ET v EN2 )w aP ⊙ >QQ QQQ HQQ 1QQ | . IELD KANE SVEA- )w aP veaw - el o0 1Q MQ >QQ >UQ | . INES 8 y NTENT )G P □ CQ 1Q UQ MQ | v LASTI8 d LIF BID LIWT Wy ISTB- E 8 y NTENT vL W8 LL CQ 1Q UQ MQ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SILTY SAND, trace organics, barwmro( n, l oist, )@oseP, )Ty v Sy ILP | | S> | AB | | M | | | | >R | |
| | | SAND d p - AKEL, rebbisu mro( n, l oist, @ose to col 3act, ). ILLP | QQC | SC | AB | | >H | | | | | |
| | | SAND, sol e gra0eQsol e si0to si0h, greh, bal 3, )0erh benseP, )TILLfLI4 EP | Q25 | | | | 1> | | | | | |
| v | | | | | | | | M> | | | >Q | |
| | | | | SH | AB | | | >QQ+ | | | | |
| | | | | | | | 5:1 m@( s in >QQ[ I | | | | | |
| C | | | | | | | | | | | | |
| | | | | S1 | AB | | | | | | M | |
| H | | | | | | | | | | | | |
| 1 | | | | S5 | AB | | | | | | M | |
| | | f mecol ing sol e si0 trace gra0e@at amo6t 125 l be3tu | | | | | | | | | | |
| 5 | | | | SU | AB | | | | | | M | |
| U | | f mecol ing trace si0 mro( n at amo6t U2> l be3tu | | | | | | | | | | |
| | | | | SR | AB | | | | | | R | |
| R | | | | | | | | | | | | |
| M | | f mecol ing gra0e@ at amo6t R2U l be3tu | | | | | | | | | | |
| | | | | SM | AB | | | | | | U | |

*(Continued Next Page)*

EXv Ser0ices Inc
HQQ> %ahm6rne Dri0e, Bnit OR5
/ 6rnamh, / 8 K5p 1%H
Te@3uone: UQ1fMR1f>C15

# RECORD OF AUGERHOLE : AH19-02

vApE C y. C

**PROJECT NUMBER** KANfQQC5UH5RfAQ
**CLIENT** Tue Bni0ersith o7/ ritisu 8 o@l mia
**PROJECT NAME** B/ 8 WacLeob / 6i@ing - ene( aQl Seisl ic B3grabing
**PROJECT LOCATION** CH5U Wain WaQB/ 8 , Kanco60er, / 8
**DRILLING DATE** CQ>9f>>fCC
**AUGERHOLE LOCATION** Zy NE: >Q N: 515U5UQ E: 1M>MI>
**DRILLING CONTRACTOR** So6tu@nb Dri@ng 8 o2Ltb2
**ELEVATION** )a33roxil ateP
**DRILLING METHOD** So@b Stel A6ger
**GROUND WATER DEPTHS:** ▽ **AT TIME OF DRILLING** fff no gro6nb( ater om0ser0eb
**EQUIPMENT TYPE** TracwWo6nteb A6ger Dri@
▼ **AT END OF DRILLING** fff
**LOGGED BY** JZ **CHECKED BY** v S
▼ **AFTER DRILLING** fff

| DEvTV )l P | ST-ATA | Sy IL DES8 - Iv Tly N | ELEK2 DEv TV )l P | SAWv LES NBW/ E- | TYvE | - E8 y KE- Y G | SvT N KALBE / Ly % SK@H CQ 1Q UQ MQ | vy 84ET vEN2 )wvaP >QQ CQQ HQQ 1QQ | . INES 8 y NTENT )GP CQ 1Q UQ MQ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | DYNAWI8 8 y NE / Ly % SK@H CQ 1Q UQ MQ | . IELD KANE SVEA- )wvaP veaw - el o@ 1Q MQ >CQ >UQ | vLASTI8 d LIF BID LIWT Wy ISTB- E 8 y NTENT vL W8 LL CQ 1Q UQ MQ |
| 9 | | p - AKELLY SAND, trace si@ mro( n, bal 3, )0erh benseP, )TILLfLI4 EP | | | | | | | |

**Bottom of hole at 9.1m.**

EXP Services Inc
3001 Wayburne Drive, Unit 275
Burnaby, BC V5G 4W3
Telephone: 604-874-1245

# RECORD OF AUGERHOLE : AH19-03



**PROJECT NUMBER** VAN-00256357-A0
**CLIENT** The University of British Columbia
**PROJECT NAME** UBC MacLeod Building Renewal & Seismic Upgrading
**PROJECT LOCATION** 2356 Main Mall, UBC, Vancouver, BC
**DRILLING DATE** 2019-11-22
**AUGERHOLE LOCATION** ZONE: 10 N: 5456578 E: 481899
**DRILLING CONTRACTOR** Southland Drilling Co. Ltd.
**ELEVATION** (approximate)
**DRILLING METHOD** Solid Stem Auger
**GROUND WATER DEPTHS:** ▽ **AT TIME OF DRILLING** --- no groundwater observed
**EQUIPMENT TYPE** Track Mounted Auger Drill
▼ **AT END OF DRILLING** ---
**LOGGED BY** JZ **CHECKED BY** PS
▼ **AFTER DRILLING** ---

| DEPTH (m) | STRATA | SOIL DESCRIPTION | ELEV. DEPTH (m) | SAMPLES NUMBER | SAMPLES TYPE | SAMPLES RECOVERY % | SPT N VALUE BLOWS/0.3m ▲ 20 40 60 80 / DYNAMIC CONE BLOWS/0.3m ▨ 20 40 60 80 | POCKET PEN. (kPa) ⊙ 100 200 300 400 / FIELD VANE SHEAR (kPa) Peak ● Remold ○ 40 80 120 160 | FINES CONTENT (%) □ 20 40 60 80 / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL 20 40 60 80 |
|---|---|---|---|---|---|---|---|---|---|
| | | ASPHALT - about 80 mm | | | | | | | |
| | | SAND & GRAVEL, brown, moist, (compact), (FILL), gravel size up to 25 mm | 0.1 | S1 | AU | | DRILLED OUT | | 8 |
| | | SAND, some gravel, some silt, grey, damp to moist, (very dense), (TILL-LIKE) | 0.3 | S2 | AU | | 26 / 100+ / 100 blows in 250 mm | | 14 |
| 1 | | | | S3 | AU | | | | 9 |
| 2 | | | | S4 | AU | | | | 8 |
| 3 | | | | | | | | | |
| 4 | | | | S5 | AU | | | | 10 |
| 5 | | - becoming some gravel to gravelly, trace silt, grey-brown at about 4.6 m depth | | | | | | | |
| 6 | | | | S6 | AU | | | | 10 |
| 7 | | | | S7 | AU | | | | |
| 8 | | SAND & GRAVEL, brown, moist, (very dense), (TILL-LIKE) | 7.6 | | | | | | |

*(Continued Next Page)*

EXP Services Inc
3001 Wayburne Drive, Unit 275
Burnaby, BC V5G 4W3
Telephone: 604-874-1245

# RECORD OF AUGERHOLE : AH19-03



**PROJECT NUMBER** VAN-00256357-A0
**CLIENT** The University of British Columbia
**PROJECT NAME** UBC MacLeod Building Renewal & Seismic Upgrading
**PROJECT LOCATION** 2356 Main Mall, UBC, Vancouver, BC
**DRILLING DATE** 2019-11-22
**AUGERHOLE LOCATION** ZONE: 10 N: 5456578 E: 481899
**DRILLING CONTRACTOR** Southland Drilling Co. Ltd.
**ELEVATION** (approximate)
**DRILLING METHOD** Solid Stem Auger
**GROUND WATER DEPTHS:** ▽ **AT TIME OF DRILLING** --- no groundwater observed
**EQUIPMENT TYPE** Track Mounted Auger Drill
▼ **AT END OF DRILLING** ---
**LOGGED BY** JZ **CHECKED BY** PS
▼ **AFTER DRILLING** ---

| DEPTH (m) | STRATA | SOIL DESCRIPTION | ELEV. DEPTH (m) | SAMPLES NUMBER | SAMPLES TYPE | SAMPLES RECOVERY % | SPT N VALUE BLOWS/0.3m ▲ 20 40 60 80 / DYNAMIC CONE BLOWS/0.3m ▨ 20 40 60 80 | POCKET PEN. (kPa) ⊙ 100 200 300 400 / FIELD VANE SHEAR (kPa) Peak ● Remold ○ 40 80 120 160 | FINES CONTENT (%) □ 20 40 60 80 / PLASTIC & LIQUID LIMIT MOISTURE CONTENT PL MC LL 20 40 60 80 |
|---|---|---|---|---|---|---|---|---|---|
| 9 | | SAND & GRAVEL, brown, moist, (very dense), (TILL-LIKE) *(continued)* | | S8 | AU | | | | ⬠ 7 |
| | | SAND, some gravel, trace silt, brown, moist, (very dense), (TILL-LIKE) | 9.1 | | | | | | |
| 10 | | | | S9 | AU | | | | |
| 11 | | - becoming trace gravel, trace silt, brown, moist at about 10.7 m depth | | S10 | AU | | | | ⬠ 6 |
| 12 | | | | | | | | | |

**Bottom of hole at 12.2m.**