# 495 JINKINSON RD – GEOTECHNICAL REPORT

Project No.: CP-17-0613

Prepared for:

J.R. Brisson Equipment Ltd.
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Prepared by:

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June 2018

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GEOTECHNICAL INVESTIGATION and
FOUNDATION DESIGN RECOMMENDATION REPORT
495 Jinkinson Rd, Stittsville, Ontario

## 1.0 INTRODUCTION

This report presents the factual findings obtained as part of a geotechnical investigation performed at 495 Jinkinson Road in Stittsville, Ontario. The field work was carried out on April 23, 2018 and consisted of six boreholes advanced to a maximum depth of 4 m below the existing ground surface.

The purpose of this investigation was to explore the subsurface conditions at the above-mentioned site and to provide anticipated geotechnical conditions influencing the design and construction of the proposed building and storage yard.

McIntosh Perry Consulting Engineers Ltd (McIntosh Perry) carried out this investigation at the request of JR. Brisson Equipment Ltd.

## 2.0 SITE DESCRIPTION

The property under considerations for the proposed development is located at 495 Jinkinson Rd, south of Highway 7 in Stittsville, Ontario. The property is located in a rural area and was well wooded prior to clearing. Currently, trees and a post/wire fence line the property edge with mulch/cuttings covering the ground's surface. Some areas of the property are swampy possibly due to depressions left from the removal of large stumps and snow melt.

The proposed structure is a heavy equipment and vehicle dealership building (no basement) and storage yard to be used for commercial purposes. The property's location is shown in Figure 1 included in Appendix B.

## 3.0 FIELD PROCEDURES

Prior to drilling, Staff from Mcintosh Perry Consulting Engineers (McIntosh Perry) visited the proposed site to determine borehole locations and drill rig access. Utility clearance was carried out by USL-1 on April 2, 2018 on behalf of McIntosh Perry. Public and private utility authorities were informed and all utility clearance documents were obtained before the commencement of drilling work.

CCC Geotechnical & Environmental Drilling Ltd. (Ottawa) provided and operated drilling equipment. Boreholes were advanced using hollow stem augers and the use of a portable drilling rig. All boreholes were advanced to refusal. In boreholes BH18-1 to 18-3, soil samples were taken using a 50 mm outside diameter split spoon sampler in accordance with the Standard Penetration Test (SPT) procedure. An oversized split spoon (LPT) sampler was used for soil samples BH18-4, BH18-5 and BH18-6. Boreholes BH18-1 to 18-3 were advanced beyond refusal into bedrock through the use of a NQ diamond core drilling, comprised of a double tube core barrel, diamond drill bit and a wire-line core retriever. Boreholes were backfilled with hole plug and a standpipe was installed in Borehole 18-1 at a depth of 3.7 m. Borehole locations are shown in Figure 2 included in Appendix B.

# 4.0 LABORATORY TEST PROCEDURES

In accordance with ASTM-D7012 Method C, LRL Associates Ltd. laboratories in Ottawa, Ontario performed the compressive strength test on retrieved rock core. Test results for the Compressive Strength Test are included in Appendix D.

The soil and rock samples for this project will be stored by McIntosh Perry in a storage facility for a period of one month after the submission of the final report. After this one-month period, samples will be disposed of unless otherwise requested in writing by the Client.

# 5.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

## 5.1 Site Geology

Based on published data by the Ontario Geological Survey (OGS) the site is located within the physiographic region of the Smith Falls Limestone Plain. Surficial geology maps of southern Ontario identify the area as Paleozoic bedrock specifically grey limestone in an inferred karstic area.

The Smiths Falls Limestone Plain is a lower-middle Ordovician limestone dominated region that includes grey limestone, magnesian limestone, blue-grey dolostone, calcareous sandstone (part of the Beekmantown Group) underlying a thin layer of soil and extending south towards the St. Lawrence River. In some faulted areas, specifically those north of Carleton Place, depressions filled with clay can be found. The Smiths Falls Limestone Plain is almost level (slight gradient to the northeast) and due to this, has poor drainage and is home to extensive wetland areas most notably abundant in the Rideau, Montague, Beckwith and Wolford townships.

## 5.2 Subsurface Conditions

The site stratigraphy, consists of a shallow layer of overburden material underlain by Paleozoic bedrock (limestone). The stratigraphy can be divided into two separate zones: overburden and, limestone. The soils encountered along with the field and laboratory testing performed for this investigation, can be found in the Record of Borehole sheets included in Appendix C. Descriptions of the strata are provided below.

### *5.2.1 Overburden*

Overlying the bedrock, a 0.2 to 0.6 m thick layer of soil can be found in each borehole. The overburden is mainly topsoil over a relatively thin layer of mix of sand and gravel size particles which can be a mix of weathered rock and the product of natural deposit. Topsoil material varying in thickness, 0.2 to 0.5m, was observed in all boreholes. In BH18-1 and BH18-2, a layer of sand and gravel was found beneath the topsoil layer and is observed to be grey to brown with traces of silt. SPT 'N' values were observed to be between 4 to 2/300 mm for this layer. Overburden transitioned to bedrock at approximately El. 135.7 to 135.2 m.

#### 5.2.2 Limestone

Underlying the overburden highly fractured and highly weathered limestone bedrock was encountered. Core recovery (CR) for BH18-2 and BH18-3 are 100% while the first core run of BH18-2 had a core recovery (CR) value of 63%. Rock quality designation (RQD) for BH18-1 ranged from 26% to 80%, indicating poor to good quality and improving with depth. RQD values for BH18-2 ranged from 60% to 79% (fair to good quality) and for BH18-3 from 37% to 86% (poor to good quality) with their lowest values being from the shallowest runs.

Select rock core samples were taken from BH18-1, BH18-2 and BH18-3 to determine the uniaxial compressive strength. The average compressive strength for the rock cores sampled is 70.4 MPa. The results of the Compressive Strength Test can be found below in Table 5.1.

**Table 5.1: Compressive Strength Test**

| Borehole | Run No | Depth (m) | L/D Ratio | Strength (MPa) | Description of Failure |
|---|---|---|---|---|---|
| BH18-1 | 4 | 2.90-3.00 | 2.13:1 | 65.0 | Vertical breaking with a relatively well-formed cone on one end |
| BH18-1 | 4 | 3.15-3.25 | 2.00:1 | 89.7 | Vertical breaking with a relatively well-formed cone on one end |
| BH18-2 | 2 | 0.89-0.99 | 2.09:1 | 60.7 | Vertical breaking with a relatively well-formed cone on one end |
| BH18-3 | 3 | 1.19-1.32 | 2.11:1 | 77.8 | Vertical breaking with a relatively well-formed cone on one end |
| BH18-3 | 4 | 2.77-2.90 | 2.13:1 | 59.0 | Vertical breaking with a relatively well-formed cone on one end |

### 5.3 Groundwater

In standpipe piezometer installed in borehole BH18-1, water level was observed to be at 0.36 m below the ground surface, El. 135.44, on May 1, 2018. Groundwater level may be expected to fluctuate due to seasonal changes.

## 6.0 DISCUSSIONS AND RECOMMENDATIONS

### 6.1 General

This section of the report provides recommendations for the design of a two-storey commercial dealership, with no basement. The recommendations are based on interpretation of the factual information obtained from the boreholes advanced during the subsurface investigation. The discussions and recommendations presented are intended to provide sufficient information to the designer of the proposed building to select the suitable types of foundation to support the structure.

The comments made on the construction are intended to highlight aspects which could have impact or affect the detailed design of the building, for which special provisions may be required in the Contract Documents. Those who requiring information on construction aspects should make their own interpretation of the factual data presented in the report. Interpretation of the data presented may affect equipment selection, proposed construction methods, and scheduling of construction activities.

## 6.2 Project Design

### *6.2.1 Existing Site Condition*

Detailed site condition is provided in Section 2. The majority of the property is forested, with a small section cleared for the proposed construction near Jinkinson Road. The location of the site is shown on Figure 1 included in Appendix B.

### *6.2.2 Proposed Development*

It is understood that the proposed development will be a single-story warehouse/dealership building without a basement and will likely be a conventional slab on grade with shallow footing foundation.

## 6.3 Frost Protection

Based on applicable building codes, a minimum earth cover of 1.8 m, or the thermal equivalent of insulation, should be provided for all exterior footings to reduce the effects of frost action. The frost penetration depth is measured from the top of the earth cover to the bottom of footings. No major frost issues are expected from foundations built on bedrock. Bedrock is not considered frost susceptible. However if the founding level is above expected frost line (approximately 1.8 m) and there is water accumulation within the rock cracks and joints, then there will be chance of frost heave damage. The design should consider removing the water from footings by proper drainage. Providing adequate earth cover or synthetic insolation can also reduce the risk of frost damage.

## 6.4 Site Classification for Seismic Site Response

Selected spectral responses in the general vicinity of the site for 10% chance of exceedance in 50 years (475 years return period) are as indicated in Table 6-1, shown below and in Appendix D;

**Table 6-1: Selected Seismic Spectral Responses (10% in 50 Yrs)**

| Sa(0.2) | Sa(0.5) | Sa(2.0) | PGA | PGV |
|---|---|---|---|---|
| 0.138 | 0.079 | 0.019 | 0.085 | 0.061 |

The site can be classified as a Site Class “C” for soft rock for the purposes of site-specific seismic response to earthquakes based on Table 4.1.8.4.A OBC 2012.

## 6.5 Slabs-on-Grade

Free-floating Slabs-on-grade should be supported on minimum 200 mm of Granular A compacted to 100% SPMDD. In the event the subgrade needs to be raised, Granular B type II or Granular A can be placed, compacted to minimum 96% SPMDD. If the slab-on-grade is designed to support internal columns, the fill used for the grade raise shall be compacted to minimum 100% SPMDD. The fill should be placed in horizontal lifts of uniform thickness of no more than 300 mm before compaction, at appropriate moisture content. The requirements for fill material and compaction may be addressed with a note on the structural drawing for foundation or grading drawing and/or with a Non-Standard Special Provision (NSSP).

All slab-on-grade units shall float independently from all load-bearing structural elements.

## 6.6 Shallow Foundations

Considering the order of structural loads expected at the foundation level, provision of conventional strip footings and isolated pad footings will be adequate. Footings are expected to be buried to resist overturning and sliding and also to provide protection against frost action.

The excavation should extend at a minimum to the top of Limestone bedrock, any existing overburden material must be removed from the footprint of the proposed building. Extremely weathered bedrock and all loose pieces of rock shall be removed from the footprint of the proposed footings. A geotechnical staff shall attend the site upon completion of excavation and approve the subgrade. The rock may need to be excavated beyond the target depth due to weather and poor rock quality.

If the rock has to be over-excavated due to very poor rock quality, the grade can also be raised by lean concrete instead of engineered fill within the influence zone of the footings. The influence zone of the footing is defined by a line going outward and downward from the edge of the footing to the subgrade. The lean concrete shall provide compression strength equal or higher than the Ultimate Limit State (ULS) bearing capacity. Compression strength of lean concrete shall not be less than the provided shale bearing capacity.

Over-excavated subgrade can be also raised by granular material only if the fill conforms to OPSS Granular A and compacted to minimum 100% Standard Proctor Maximum Dry Density.

### *6.6.1 Bearing Capacity*

Assuming the strip footings are constructed through excavating the fill and exposing the weathered but relatively intact native shale, and following the recommendation note Section 6.6, the following bearing capacity values can be used for structural design;

A factored beading pressure at Ultimate Limit State (ULS) of 150 kPa can be used for the design on approved limestone subgrade. If the rock is excavated to a depth with RQD over 50, then a ULS bearing capacity of 250 kPa can be used for the design. RQD over 50 is expected below elevation El. 134.7 m. If footings are placed on rock, the serviceability settlements are expected to be minimal and there is no relevance to serviceability limit state (SLS).

Strip footings shall not be less than 0.6 m in width.

### 6.7 Lateral Earth Pressure

Free draining material should be used as backfill material for foundation walls. If the proper drainage is provided "at rest" condition may be assumed for calculation of earth pressure on foundation walls. The following parameters are recommended for the granular backfill.

**Table 6-1: Backfill Material Properties**

| Borehole | Granular "A" | Granular "B" |
|---|---|---|
| Effective Internal Friction Angle, $\phi'$ | 35° | 30° |
| Unit Weight, $\gamma$ $(kN/m^3)$ | 22.8 | 22.8 |

## 7.0 CONSTRUCTION CONSIDERATIONS

Any organic material and existing overburden material of any kind, shall be removed from the footprint of the footings and all structurally load bearing elements. If grade raise above the native subgrade is required suitable fill material to conform to specifications of OPSS Granular criteria shall be used. The Structural Fill should be free from any recycled or deleterious material, it should not be placed in lifts thicker than 300 mm and should be compacted as specified. The fill to be placed directly below footings has to be Granular A.

It is not clear if the founding level will be below groundwater at the time of construction. If water infiltrates into the excavation, a conventional sump and pump method can be applied. Groundwater elevation is expected to fluctuate seasonally. If the construction season coincides with high groundwater season, water infiltration through weathered limestone might be substantial. However grouting the exposed rock surfaces can reduce the risk of infiltration in case of occurrence.

Considering the quality of the bedrock within the depth of investigation, rock excavation may be conducted through line drilling in conjunction with hoe-ramming, which will have minimal impact on the environment. If any blasting is employed for deeper rock excavation, the peak particle velocity during blasting shall be limited to 50 mm per second to avoid any damage to the adjoining structures and it should be limited to 10 mm per second to prevent any discomfort to residents. OPSS.PROV 202 specifies requirements of rock excavation.

The excavation should be completed in accordance with Ontario Regulation (O.Reg.) 213/91 under the Occupational Health and Safety Act (OHSA) with specific reference to acceptable size slopes and stabilization requirements. Except the thin overburden at the top, the encountered bedrock does not fall into any of the OHSA Soil Types and the Ontario Provincial Standards Specification (OPSS) for rock excavation should be specified.

A geotechnical engineer or technician should attend the site to confirm the suitability of subgrade, type of imported material and the level of compaction.

Foundation walls should be backfilled with free-draining material such as OPSS Granular types A or B. Sub-drains with positive drainage to the City sewer or ditches should be provided at foundation level.

# 8.0 RECOMMENDATIONS FOR PAVEMENT DESIGN

It is understood that the paved area surrounding the proposed buildings will be used frequently by heavy weight trucks. Pavement structure likely to be placed on weathered bedrock. If the pavement is to be constructed on weathered bedrock, the topsoil and overburden is to be excavated to the required depth to accommodate the pavement structure. Adequate drainage must be provided for all pavement elements; access roads, loading docks and parking lots.

McIntosh Perry recommends the use of the proposed pavement structure included in Table 8-1. The structure detailed will be adequate for use in the warehouse area, sections used by transport trucks, heavy duty vehicles, and the access road.

**Table 8-1: Proposed Pavement Structure**

| Material | | Thickness (mm) |
|---|---|---|
| Surface | Superpave 12.5, Design Category B, PG 58-34 | 40 |
| Binder | Superpave 19.0, Design Category B, PG 58-34 | 50 |
| Base | OPSS Granular A | 150 |
| Sub-base | OPSS Granular B or SSM | 450 |

If sections of the asphalt construction are identified as light use, at the digression of the client, the pavement structure may be reduced to structure specified in Table 8-2. It should be understood that a reduction in the thickness of the asphalt structure will result in a reduced performance and lifespan.

**Table 8-2: Proposed Pavement Structure for Light Vehicle Parking Lots**

| Material | | Thickness (mm) |
|---|---|---|
| Surface | Superpave 12.5, Design Category C, PG 58-34 | 50 |
| Base | OPSS Granular A | 150 |
| Sub-base | OPSS Granular B or SSM | 350 |

The base and sub base materials, i.e., Granular A for base and Granular Type B, shall be in accordance with OPSS 1010. Both base and sub-base should be compacted to 100% SPMDD. Asphalt layers should be compacted to comply with OPSS 310.

Above recommended Superpave 12.5 and 19.0 can be replaced with HL-3 and HL-8 if required. If the required quantity of SP-19/HL-8 is small, and to avoid providing multiple asphalt mix designs, SP-19 can be replaced with SP-12.5 as long as they are placed in two separate layers. McIntosh Perry will not be responsible for cost implications of such decision.

For areas to be left as a gravel lot without asphalt the following cross section can be used.

**Table 8-3: Proposed Gravel Lot Structure**

| Material | | Thickness (mm) |
|---|---|---|
| Base | OPSS Granular A | 150 |
| Sub-base | OPSS Granular B or SSM | 350 |

# 9.0 CEMENT TYPE AND CORROSION POTENTIAL

Among samples retrieved during the investigation, there was not adequate sample recovery encountered for chemical testing. It is expected the building will be founded on limestone bedrock, and backfilled with granular material. No sulphate attack is expected from limestone bedrock; therefore General Use (Type GU) Portland cement will be adequate. Based on the composition of the proposed backfill (OPSS Granular) it is typically expected to be non-aggressive or mildly-aggressive, for buried steel elements in contact with existing fill. The contractor shall confirm with the material source.

# 10.0 CLOSURE

We trust this geotechnical investigation and foundation design report meets requirements of your project. The "Limitations of Report" presented in Appendix A are an integral part of this report. Please do not hesitate to contact the undersigned should you have any questions or concerns.

**McIntosh Perry Consulting Engineers Ltd.**

LICENSED PROFESSIONAL ENGINEER
M. E. GLEESON
100211206
June 7-18
PROVINCE OF ONTARIO

Mary-Ellen Gleeson, M.Eng., P.Eng
Geotechnical Engineer

N'eem Tavakkoli, M.Eng., P.Eng.
Senior Geotechnical Engineer

# 11.0 REFERENCES

Canadian Geotechnical Society, “Canadian Foundation Engineering Manual”, 4th Edition, 2006.

Armstrong, D.K., Dodge, J.E.P., 2007. Paleozoic Geology of Southern Ontario, Ontario Geological Survey: Sedimentary Geoscience Section, p.4.

Carson, D.M., 1981. Preliminary Report on the Paleozoic Geology of the Peterborough-Campbellford Area, Southern Ontario, Ontario Geological Survey CFR 5331, p. 9-10.

Ontario Ministry of Natural Resources (OMNR), Ontario Geological Survey, Special Volume 2, “The Physiography of Southern Ontario”, 3rd Edition, 1984.

Google Earth, Google, 2015.

# APPENDIX A
# LIMITATIONS OF REPORT

# LIMITATIONS OF REPORT

McIntosh Perry Consulting Engineers Ltd. (McIntosh Perry) carried out the field work and prepared the report. This document is an integral part of the Foundation Investigation and Design report presented.

The conclusions and recommendations provided in this report are based on the information obtained at the borehole locations where the tests were conducted. Subsurface and groundwater conditions between and beyond the boreholes may differ from those encountered at the specific locations where tests were conducted and conditions may become apparent during construction, which were not detected and could not be anticipated at the time of the site investigation. The benchmark level used and borehole elevations presented in this report are primarily to establish relative differenced in elevations between the borehole locations and should not be used for other purposes such as to establish elevations for grading, depth of excavations or for planning construction.

The recommendations presented in this report for design are applicable only to the intended structure and the project described in the scope of the work, and if constructed in accordance with the details outlined in the report. Unless otherwise noted, the information contained in this report does not reflect on any environmental aspects of either the site or the subsurface conditions.

The comments or recommendation provided in this report on potential construction problems and possible construction methods are intended only to guide the designer. The number of boreholes advanced at this site may not be sufficient or adequate to reveal all the subsurface information or factors that may affect the method and cost of construction. The contractors who are undertaking the construction shall make their own interpretation of the factual data presented in this report and make their conclusions, as to how the subsurface conditions of the site may affect their construction work.

The boundaries between soil strata presented in the report are based on information obtained at the borehole locations. The boundaries of the soil strata between borehole locations are assumed from geological evidences. If differing site conditions are encountered, or if the Client becomes aware of any additional information that differs from or is relevant to the McIntosh Perry findings, the Client agrees to immediately advise McIntosh Perry so that the conclusions presented in this report may be re-evaluated.

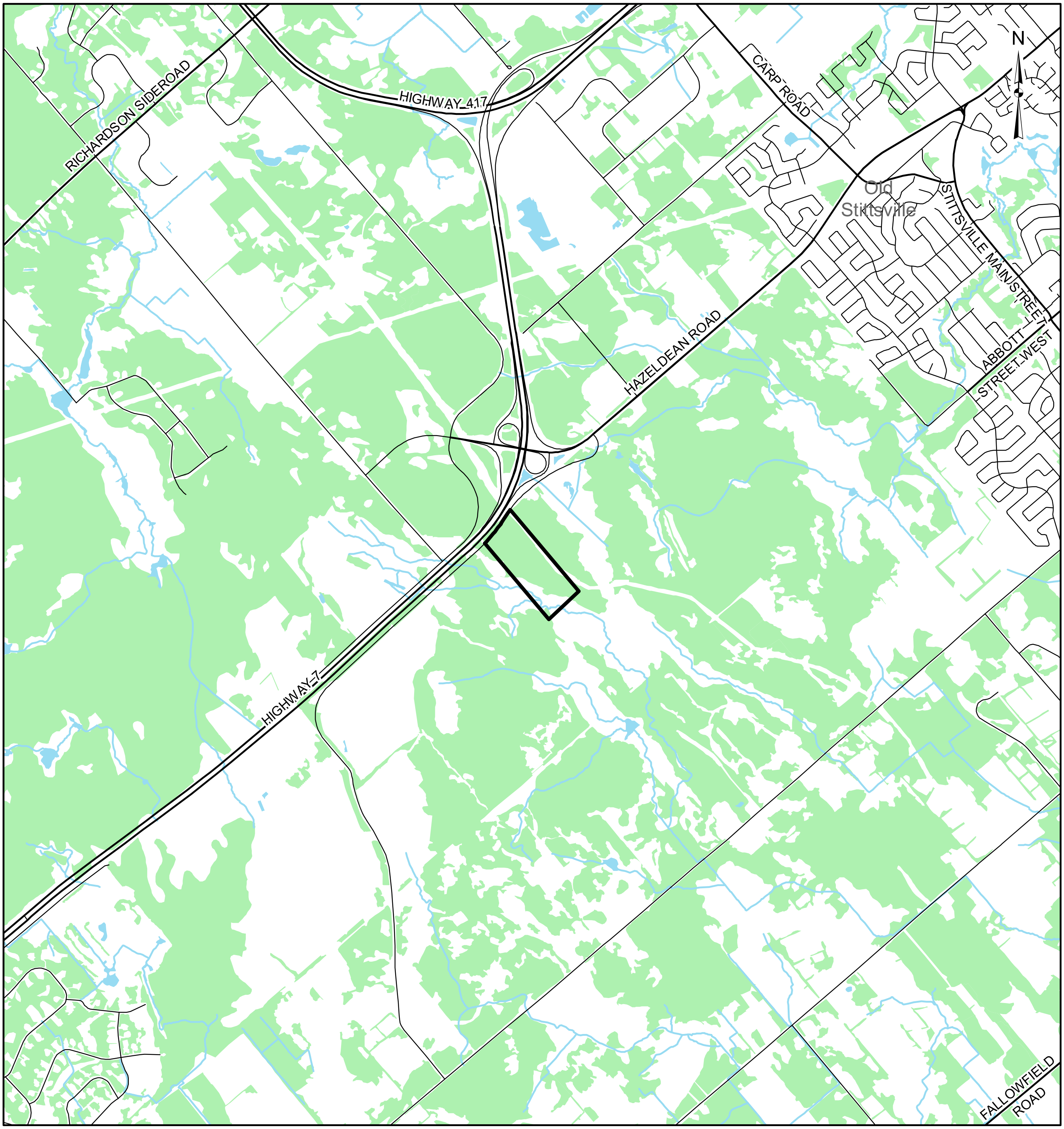
Under no circumstances shall the liability of McIntosh Perry for any claim in contract or in tort, related to the services provided and/or the content and recommendations in this report, exceed the extent that such liability is covered by such professional liability insurance from time to time in effect including the deductible therein, and which is available to indemnify McIntosh Perry. Such errors and omissions policies are available for inspection by the Client at all times upon request, and if the Client desires to obtain further insurance to protect it against any risks beyond the coverage provided by such policies, McIntosh Perry will co-operate with the Client to obtain such insurance.

McIntosh Perry prepared this report for the exclusive use of the Client. Any use which a third party makes of this report, or any reliance on or decision to be made based on it, are the responsibility of such third parties. McIntosh Perry accepts no responsibility and will not be liable for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

# 495 JINKINSON ROAD

## APPENDIX B
## FIGURES

McINTOSH PERRY




1,000 500 0 1,000

Scale 1:40,000 Metres

LEGEND

- Property Boundary
- Local Road
- Major Road
- Wooded Area
- Watercourse
- Waterbody

REFERENCE

GIS data provided by the Ontario Ministry of Natural Resources and Forestry, 2018.

| | |
|---|---|
| CLIENT: | J.R. BRISSON EQUIPMENT |
| PROJECT: | GEOTECHNICAL INVESTIGATION<br>495 JINKINSON ROAD |
| TITLE: | SITE LOCATION |


McINTOSH PERRY

115 Walgreen Road, RR3, Carp, ON K0A1L0
Tel: 613-836-2184 Fax: 613-836-3742
www.mcintoshperry.com


| PROJECT NO:CP-17-0613 | | FIGURE: |
|---|---|---|
| Date | May., 03, 2018 | 1 |
| GIS | JD | |
| Checked By | MG | |

H:\01 Project - Proposals\2017 Jobs\CP\0CP-17-0613 - J.R. Brisson – Site Plan Control – 495 Jinkinson Road\07 - GIS\mxd\Geotechnical\CP-17-0613_Geotechnical01_SiteLocation.mxd


LEGEND

Property Boundary

Borehole Location

REFERENCE

GIS data provided by the Ontario Ministry of Natural Resources and Forestry, 2018.

CLIENT: J.R. BRISSON EQUIPMENT

PROJECT: GEOTECHNICAL INVESTIGATION
495 JINKINSON ROAD

TITLE: BOREHOLE AND TEST PIT LOCATIONS

McINTOSH PERRY
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www.mcintoshperry.com

| | | |
|---|---|---|
| PROJECT NO:CP-17-0613 | | FIGURE: |
| Date | May., 03, 2018 | 2 |
| GIS | JD | |
| Checked By | MG | |

# 495 JINKINSON ROAD

## APPENDIX C
## BOREHOLE LOGS

McINTOSH PERRY

# EXPLANATION OF TERMS USED IN REPORT

N-VALUE: THE STANDARD PENETRATION TEST (SPT) N-VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5 kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N-VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N-VALUE IS DENOTED THUS $\overline{N}$.

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH ($c_u$) AS FOLLOWS:

| $C_u$ (kPa) | 0 – 12 | 12 – 25 | 25 – 50 | 50 – 100 | 100 – 200 | >200 |
|---|---|---|---|---|---|---|
| | *VERY SOFT* | *SOFT* | *FIRM* | *STIFF* | *VERY STIFF* | *HARD* |

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

| N (BLOWS/0.3m) | 0 – 5 | 5 – 10 | 10 – 30 | 30 – 50 | >50 |
|---|---|---|---|---|---|
| | *VERY LOOSE* | *LOOSE* | *COMPACT* | *DENSE* | *VERY DENSE* |

ROCKS ARE DESCRIBED BY THEIR COMPOSION AND STRUCUTRAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY IS:

| RQD (%) | 0 – 25 | 25 – 50 | 50 – 75 | 75 – 90 | 90 – 100 |
|---|---|---|---|---|---|
| | *VERY POOR* | *POOR* | *FAIR* | *GOOD* | *EXCELLENT* |

JOINT AND BEDDING:

| SPACING | 50mm | 50 – 300mm | 0.3m – 1m | 1m – 3m | >3m |
|---|---|---|---|---|---|
| JOINTING | *VERY CLOSE* | *CLOSE* | *MOD. CLOSE* | *WIDE* | *VERY WIDE* |
| BEDDING | *VERY THIN* | *THIN* | *MEDIUM* | *THICK* | *VERY THICK* |

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

| | | | |
|---|---|---|---|
| SS | SPLIT SPOON | TP | THINWALL PISTON |
| WS | WASH SAMPLE | OS | OSTERBERG SAMPLE |
| ST | SLOTTED TUBE SAMPLE | RC | ROCK CORE |
| BS | BLOCK SAMPLE | PH | TW ADVANCED HYDRAULICALLY |
| CS | CHUNK SAMPLE | PM | TW ADVANCED MANUALLY |
| TW | THINWALL OPEN | FS | FOIL SAMPLE |

### STRESS AND STRAIN

| | | |
|---|---|---|
| $u_w$ | kPa | PORE WATER PRESSURE |
| $r_u$ | 1 | PORE PRESSURE RATIO |
| $\sigma$ | kPa | TOTAL NORMAL STRESS |
| $\sigma'$ | kPa | EFFECTIVE NORMAL STRESS |
| $\tau$ | kPa | SHEAR STRESS |
| $\sigma_l$, $\sigma_2$, $\sigma_3$ | kPa | PRINCIPAL STRESSES |
| $\varepsilon$ | % | LINEAR STRAIN |
| $\varepsilon_1$, $\varepsilon_2$, $\varepsilon_3$ | % | PRINCIPAL STRAINS |
| E | kPa | MODULUS OF LINEAR DEFORMATION |
| G | kPa | MODULUS OF SHEAR DEFORMATION |
| $\mu$ | 1 | COEFFICIENT OF FRICTION |

### MECHANICALL PROPERTIES OF SOIL

| | | |
|---|---|---|
| $m_v$ | $kPa^{-1}$ | COEFFICIENT OF VOLUME CHANGE |
| $c_c$ | 1 | COMPRESSION INDEX |
| $c_s$ | 1 | SWELLING INDEX |
| $c_a$ | 1 | RATE OF SECONDARY CONSOLIDATION |
| $c_v$ | $m^2/s$ | COEFFICIENT OF CONSOLIDATION |
| H | m | DRAINAGE PATH |
| $T_v$ | 1 | TIME FACTOR |
| U | % | DEGREE OF CONSOLIDATION |
| $\sigma'_{vo}$ | kPa | EFFECTIVE OVERBURDEN PRESSURE |
| $\sigma'_p$ | kPa | PRECONSOLIDATION PRESSURE |
| $\tau_f$ | kPa | SHEAR STRENGTH |
| $c'$ | kPa | EFFECTIVE COHESION INTERCEPT |
| $\Phi'$ | $-^o$ | EFFECTIVE ANGLE OF INTERNAL FRICTION |
| $c_u$ | kPa | APPARENT COHESION INTERCEPT |
| $\Phi_u$ | $-^o$ | APPARENT ANGLE OF INTERNAL FRICTION |
| $\tau_R$ | kPa | RESIDUAL SHEAR STRENGTH |
| $\tau_r$ | kPa | REMOULDED SHEAR STRENGTH |
| $S_t$ | 1 | SENSITIVITY = $c_u / \tau_r$ |

### PHYSICAL PROPERTIES OF SOIL

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $\rho_s$ | $kg/m^3$ | DENSITY OF SOLID PARTICLES | e | 1,% | VOID RATIO | $e_{min}$ | 1,% | VOID RATIO IN DENSEST STATE |
| $\gamma_s$ | $kN/m^3$ | UNIT WEIGHT OF SOLID PARTICLES | n | 1,% | POROSITY | $I_D$ | 1 | DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$ |
| $\rho_w$ | $kg/m^3$ | DENSITY OF WATER | w | 1,% | WATER CONTENT | D | mm | GRAIN DIAMETER |
| $\gamma_w$ | $kN/m^3$ | UNIT WEIGHT OF WATER | $s_r$ | % | DEGREE OF SATURATION | $D_n$ | mm | N PERCENT – DIAMETER |
| $\rho$ | $kg/m^3$ | DENSITY OF SOIL | $w_L$ | % | LIQUID LIMIT | $C_u$ | 1 | UNIFORMITY COEFFICIENT |
| $\gamma$ | $kN/m^3$ | UNIT WEIGHT OF SOIL | $w_P$ | % | PLASTIC LIMIT | h | m | HYDRAULIC HEAD OR POTENTIAL |
| $\rho_d$ | $kg/m^3$ | DENSITY OF DRY SOIL | $w_s$ | % | SHRINKAGE LIMIT | q | $m^3/s$ | RATE OF DISCHARGE |
| $\gamma_d$ | $kN/m^3$ | UNIT WEIGHT OF DRY SOIL | $I_P$ | % | PLASTICITY INDEX = $(W_L - W_L)$ | v | m/s | DISCHARGE VELOCITY |
| $\rho_{sat}$ | $kg/m^3$ | DENSITY OF SATURATED SOIL | $I_L$ | 1 | LIQUIDITY INDEX = $(W - W_P)/ I_P$ | i | 1 | HYDAULIC GRADIENT |
| $\gamma_{sat}$ | $kN/m^3$ | UNIT WEIGHT OF SATURATED SOIL | $I_C$ | 1 | CONSISTENCY INDEX = $(W_L - W) / 1_P$ | k | m/s | HYDRAULIC CONDUCTIVITY |
| $\rho'$ | $kg/m^3$ | DENSITY OF SUBMERED SOIL | $e_{,max}$ | 1,% | VOID RATIO IN LOOSEST STATE | j | $kN/m^3$ | SEEPAGE FORCE |
| $\gamma'$ | $kN/m^3$ | UNIT WEIGHT OF SUBMERGED SOIL | | | | | | |

McINTOSH PERRY

# RECORD OF BOREHOLE No 18-1

| | | | | | |
|---|---|---|---|---|---|
| **DATE:** | 23/04/2018 - | **LOCATION:** | 495 Jinkinson Road () | **ORIGINATED BY:** | PH |
| **PROJECT:** | CP-17-0613JINKINSON | **COORDINATES:** | Lat: 45.243412 , Lon: -75.972306 | **COMPILED BY:** | MG |
| **CLIENT:** | J.R. Brisson Equipment | **DATUM:** | Geodetic | **CHECKED BY:** | NT |
| **ELEVATION:** | 135.8 m | **REMARK:** | | **REPORT DATE:** | 10/05/2018 |

| ELEVATION - m / DEPTH - m | DESCRIPTION (SOIL PROFILE) | SAMPLES: TYPE AND NUMBER | RECOVERY | "N" or RQD | GROUNDWATER CONDITIONS | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|---|
| 135.8 | Natural ground surface | | | | | |
| 0.0 | Topsoil | | | | | |
| 135.5 / 0.3 | Sand and gravel, traces of silt, grey to brown, moist, loose. | SS-01 | 36 | 4 | 0.36 m | |
| 135.2 / 0.6 | Limestone Bedrock, with interbedded Shale seams, highly weathered, poor to good quality. | RC-02 | 63 | 26 | | |
| | | RC-03 | 100 | 76 | | |
| | | RC-04 | 100 | 80 | | 65.0 MPa<br>89.7 MPa |
| 132.1 / 3.7 | **END OF BOREHOLE** | | | | | |

DEPTH - feet: 5, 10, 15, 20, 25, 30

DEPTH - meters: 1, 2, 3, 4, 5, 6, 7, 8, 9

DYNAMIC CONE PEN. RESISTANCE PLOT: 20 40 60 80

SHEAR STRENGTH (kPa): Vane test ◇ Intact ◆ Remolded; Lab vane □ Intact ■ Remolded; 20 40 60 80 100

WATER CONTENT and LIMITS (%): $W_P$ W $W_L$; 25 50 75

G S M C

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McINTOSH PERRY

# RECORD OF BOREHOLE No 18-2

| | | | | | |
|---|---|---|---|---|---|
| **DATE:** | 23/04/2018 - | **LOCATION:** | 495 Jinkinson Road () | **ORIGINATED BY:** | PH |
| **PROJECT:** | CP-17-0613JINKINSON | **COORDINATES:** | Lat: 45.243518 , Lon: -75.972389 | **COMPILED BY:** | MG |
| **CLIENT:** | J.R. Brisson Equipment | **DATUM:** | Geodetic | **CHECKED BY:** | NT |
| **ELEVATION:** | 135.7 m | **REMARK:** | | **REPORT DATE:** | 10/05/2018 |

| ELEVATION - m / DEPTH - m | DESCRIPTION (SOIL PROFILE) | SAMPLES: TYPE AND NUMBER | RECOVERY | "N" or RQD | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|
| 135.7 | Natural ground surface | | | | |
| 0.0 | Topsoil | SS-01 | 24 | 2 | |
| 135.3 / 0.5 | Sand and gravel, traces of silt, grey to brown, moist, loose. | | | | |
| 135.2 / 0.5 | Limestone, interbedded with shale seams, highly weathered, fair to good quality. | RC-02 | 107 | *60* | 60.7 MPa |
| | | RC-03 | 100 | *86* | |
| | | RC-04 | 100 | *79* | |
| 131.5 / 4.3 | **END OF BOREHOLE** | | | | |

Column headings: DEPTH - feet; DEPTH - meters; SOIL PROFILE; SYMBOL; SAMPLES (TYPE AND NUMBER, STATE, RECOVERY, "N" or RQD); GROUNDWATER CONDITIONS; DYNAMIC CONE PEN. RESISTANCE PLOT (20 40 60 80); SHEAR STRENGTH (kPa) (Vane test: ◇ Intact, ◆ Remolded; Lab vane: □ Intact, ■ Remolded; 20 40 60 80 100); WATER CONTENT and LIMITS (%) ($W_P$ W $W_L$; 25 50 75); REMARKS & GRAIN SIZE DISTRIBUTION (%) (G S M C)

Depth scale - feet: 5, 10, 15, 20, 25, 30
Depth scale - meters: 1, 2, 3, 4, 5, 6, 7, 8, 9

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McINTOSH PERRY

# RECORD OF BOREHOLE No 18-3

| | | | | | |
|---|---|---|---|---|---|
| **DATE:** | 23/04/2018 - | **LOCATION:** | 495 Jinkinson Road () | **ORIGINATED BY:** | PH |
| **PROJECT:** | CP-17-0613JINKINSON | **COORDINATES:** | Lat: 45.243616 , Lon: -75.972451 | **COMPILED BY:** | MG |
| **CLIENT:** | J.R. Brisson Equipment | **DATUM:** | Geodetic | **CHECKED BY:** | NT |
| **ELEVATION:** | 135.7 m | **REMARK:** | | **REPORT DATE:** | 10/05/2018 |

| ELEVATION - m / DEPTH - m | DESCRIPTION (SOIL PROFILE) | TYPE AND NUMBER | RECOVERY | "N" or RQD | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|
| 135.7 | Natural ground surface | | | | |
| 0.0 / 135.4 | Topsoil | SS-01 | 8 | | |
| 0.3 | Limestone Bedrock, interbedded with shale seams, highly weathered, poor to good quality. | RC-02 | 100 | *37* | |
| | | | | | 77.8 MPa |
| | | RC-03 | 100 | *86* | |
| | | | | | 59.0 MPa |
| | | RC-04 | 100 | *73* | |
| 131.5 / 4.2 | **END OF BOREHOLE** | | | | |

Column headings: DEPTH - feet; DEPTH - meters; SYMBOL; STATE; GROUNDWATER CONDITIONS; DYNAMIC CONE PEN. RESISTANCE PLOT (20 40 60 80); SHEAR STRENGTH (kPa) — Vane test: Intact, Remolded; Lab vane: Intact, Remolded (20 40 60 80 100); WATER CONTENT and LIMITS (%) — $W_P$ W $W_L$ (25 50 75); G S M C

DEPTH - feet: 5, 10, 15, 20, 25, 30

DEPTH - meters: 1, 2, 3, 4, 5, 6, 7, 8, 9

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McINTOSH PERRY

# RECORD OF BOREHOLE No 18-4

| | | | | | |
|---|---|---|---|---|---|
| DATE: | 23/04/2018 - | LOCATION: | 495 Jinkinson Road () | ORIGINATED BY: | PH |
| PROJECT: | CP-17-0613JINKINSON | COORDINATES: | Lat: 45.243781 , Lon: -75.972622 | COMPILED BY: | MG |
| CLIENT: | J.R. Brisson Equipment | DATUM: | Geodetic | CHECKED BY: | NT |
| ELEVATION: | 135.7 m | REMARK: | | REPORT DATE: | 10/05/2018 |

| DEPTH - feet | DEPTH - meters | ELEVATION - m / DEPTH - m | SOIL PROFILE: DESCRIPTION | SYMBOL | SAMPLES: TYPE AND NUMBER | STATE | RECOVERY | "N" or RQD | GROUNDWATER CONDITIONS | DYNAMIC CONE PEN. RESISTANCE PLOT (20 40 60 80) / SHEAR STRENGTH (kPa) (20 40 60 80 100) | WATER CONTENT and LIMITS (%) $W_P$ W $W_L$ (25 50 75) | REMARKS & GRAIN SIZE DISTRIBUTION (%) G S M C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 135.7 | Natural ground surface | | | | | | | | | |
| | | 0.0 | Topsoil | | | | | | | | | |
| | | 135.5<br>0.2 | Probable Limestone Bedrock | | SS-01 | | 100 | 94 | | | | |
| | | 135.3<br>0.4 | **END OF BOREHOLE**<br><br>**LPT Sampler Refusal** | | | | | | | | | |

Shear strength legend: Vane test: ◇ Intact, ◆ Remolded; Lab vane: □ Intact, ■ Remolded

Depth scale: feet 5, 10, 15, 20, 25, 30; meters 1, 2, 3, 4, 5, 6, 7, 8, 9

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McINTOSH PERRY

# RECORD OF BOREHOLE No 18-5

| | | | | | |
|---|---|---|---|---|---|
| **DATE:** | 23/04/2018 - | **LOCATION:** | 495 Jinkinson Road () | **ORIGINATED BY:** | PH |
| **PROJECT:** | CP-17-0613JINKINSON | **COORDINATES:** | Lat: 45.243526 , Lon: -75.972773 | **COMPILED BY:** | MG |
| **CLIENT:** | J.R. Brisson Equipment | **DATUM:** | Geodetic | **CHECKED BY:** | NT |
| **ELEVATION:** | 136.0 m | **REMARK:** | | **REPORT DATE:** | 10/05/2018 |

| ELEVATION - m / DEPTH - m | DESCRIPTION | SAMPLES: TYPE AND NUMBER | STATE | RECOVERY | "N" or RQD | GROUNDWATER CONDITIONS | REMARKS & GRAIN SIZE DISTRIBUTION (%) G S M C |
|---|---|---|---|---|---|---|---|
| 136.0 | Natural ground surface | | | | | | |
| 0.0 | Topsoil | | | | | | |
| 135.8 / 0.2 | Sand and gravel, traces of silt, grey to brown, dry, compact. | SS-01 | | 88 | 64 | | |
| 135.6 / 0.4 | Probable Limestone Bedrock | | | | | | |
| 135.5 / 0.4 | **END OF BOREHOLE** | | | | | | |
| | **LPT Sampler Refusal** | | | | | | |

DEPTH - feet: 5, 10, 15, 20, 25, 30
DEPTH - meters: 1, 2, 3, 4, 5, 6, 7, 8, 9

DYNAMIC CONE PEN. RESISTANCE PLOT: 20 40 60 80
SHEAR STRENGTH (kPa): Vane test ◇ Intact ◆ Remolded; Lab vane □ Intact ■ Remolded; 20 40 60 80 100
WATER CONTENT and LIMITS (%): $W_P$ W $W_L$; 25 50 75

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McINTOSH PERRY

# RECORD OF BOREHOLE No 18-6



| | | | | | |
|---|---|---|---|---|---|
| **DATE:** | 23/04/2018 - | **LOCATION:** | 495 Jinkinson Road () | **ORIGINATED BY:** | PH |
| **PROJECT:** | CP-17-0613JINKINSON | **COORDINATES:** | Lat: 45.24358 , Lon: -75.972873 | **COMPILED BY:** | MG |
| **CLIENT:** | J.R. Brisson Equipment | **DATUM:** | Geodetic | **CHECKED BY:** | NT |
| **ELEVATION:** | 136.1 m | **REMARK:** | | **REPORT DATE:** | 10/05/2018 |

| ELEVATION - m / DEPTH - m | DESCRIPTION | TYPE AND NUMBER | STATE | RECOVERY | "N" or RQD |
|---|---|---|---|---|---|
| 136.1 | Natural ground surface | | | | |
| 0.0 | Topsoil | | | | |
| 136.0 / 0.2 | Sand and gravel, traces of silt, grey to brown, moist, compact. | SS-01 | | 80 | 66 |
| 135.8 / 0.3 | Probable Limestone Bedrock | | | | |
| 135.7 / 0.4 | **END OF BOREHOLE** | | | | |
| | **LPT Sampler Refusal** | | | | |

Column headings: DEPTH - feet; DEPTH - meters; SOIL PROFILE; SYMBOL; SAMPLES; GROUNDWATER CONDITIONS; DYNAMIC CONE PEN. RESISTANCE PLOT 20 40 60 80; SHEAR STRENGTH (kPa) Vane test ◇ Intact ◆ Remolded, Lab vane □ Intact ■ Remolded, 20 40 60 80 100; WATER CONTENT and LIMITS (%) $W_P$ W $W_L$ 25 50 75; REMARKS & GRAIN SIZE DISTRIBUTION (%) G S M C

Depth scale (feet): 5, 10, 15, 20, 25, 30
Depth scale (meters): 1, 2, 3, 4, 5, 6, 7, 8, 9

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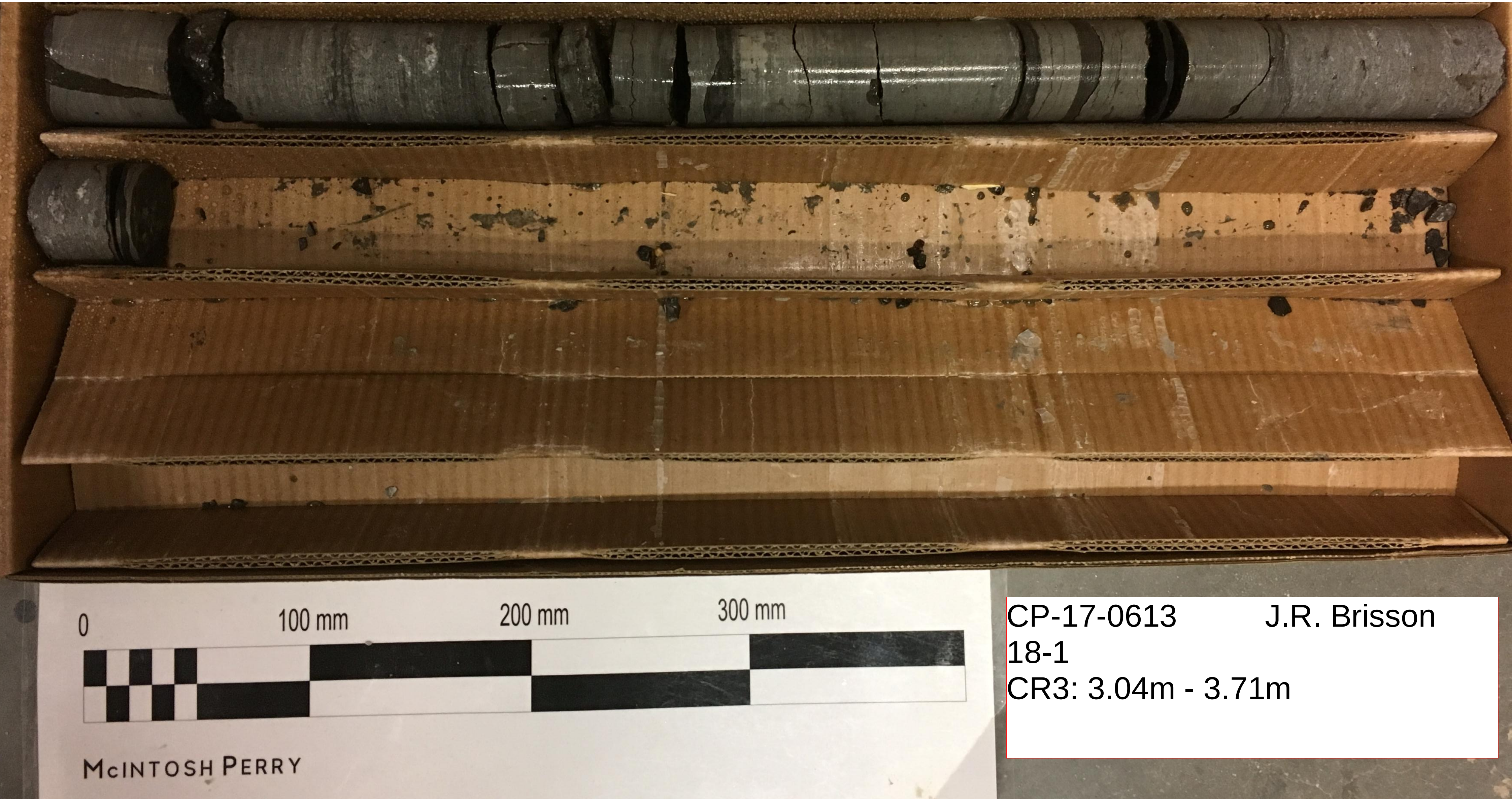
CP-17-0613 J.R. Brisson
18-1
CR1: 0.56m - 0.86m
CR2: 0.86m - 2.38m
CR3: 2.38m - 3.04m

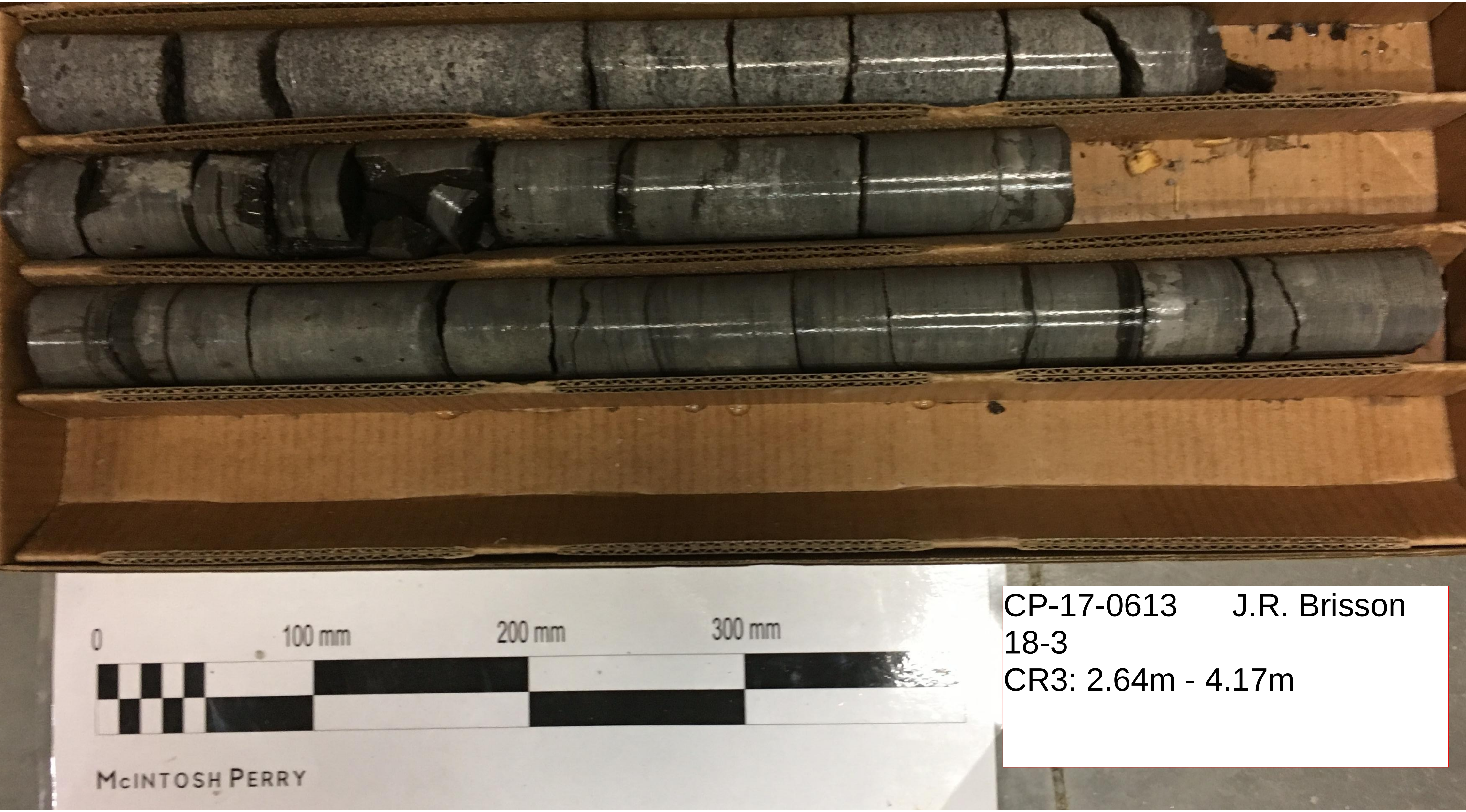



CP-17-0613 J.R. Brisson
18-1
CR3: 3.04m - 3.71m


CP-17-0613 J.R. Brisson
18-2
CR1: 0.53m - 1.30m
CR2: 1.30m - 2.34m


CP17-0613 J.R. Brisson
18-2
CR2: 2.34m - 2.74m
CR3: 2.74m - 4.27m


CP-17-0613 J.R. Brisson
18-3
CR1: 0.30m - 0.99m
CR2: 1.09m - 2.64m




CP-17-0613 J.R. Brisson
18-3
CR3: 2.64m - 4.17m

# 495 JINKINSON ROAD

## APPENDIX D
## LAB RESULTS

MCINTOSH PERRY

LRL Associates Ltd.

# Unconfined Compressive Strength of Intact Rock Core

**ASTM D 7012: Method C**

LRL ENGINEERING INGÉNIERIE

**Client:** McIntosh Perry Consulting Engineers
**Project:** Materials Testing
**Location:** 495 Jinkinson Road

**Reference No.:** CP-17-0613
**File No.:** 170496-29
**Report No.:** 1

## Drill Core Information

**Date(s) Sampled:** April 23, 2018
**Sampled By:** McIntosh Perry Consulting Engineers
**Date Received:** April 30, 2018

| Laboratory Identification | Core No. | Field Identification | Borehole | Run | Depth | Location / Description |
|---|---|---|---|---|---|---|
| C0699 | 1 | | 18-01 | RC-04 | 2.90 m - 3.00 m | 495 Jinkinson Road |
| C0700 | 2 | | 18-01 | RC-04 | 3.15 m - 3.25 m | 495 Jinkinson Road |
| C0701 | 3 | | 18-02 | RC-02 | 0.89 m - 0.99 m | 495 Jinkinson Road |
| C0702 | 4 | | 18-03 | RC-03 | 1.19 m - 1.32 m | 495 Jinkinson Road |
| C0703 | 5 | | 18-03 | RC-04 | 2.77 m - 2.90 m | 495 Jinkinson Road |
| | | | | | | |

## Rock Core Unconfined Compressive Strength Test Data

| Laboratory Identification | Core No. | Conditioning | Length, mm | Diameter, mm | | MPa | Description of Failure |
|---|---|---|---|---|---|---|---|
| C0699 | 1 | As received | 94.8 | 44.6 | | 65.0 | Vertical breaking with a relatively well formed cone on one end |
| C0700 | 2 | As received | 89.4 | 44.6 | | 89.7 | Vertical breaking with a relatively well formed cone on one end |
| C0701 | 3 | As received | 93.4 | 44.6 | | 60.7 | Vertical breaking with a relatively well formed cone on one end |
| C0702 | 4 | As received | 94.3 | 44.6 | | 77.8 | Vertical breaking with a relatively well formed cone on one end |
| C0703 | 5 | As received | 94.9 | 44.6 | | 59.0 | Vertical breaking with a relatively well formed cone on one end |
| | | | | | | | |

**Comments:**

**Date Issued:** May 1, 2018

**Reviewed By:** W.A.McLaughlin (signature)

W.A.M<sup></sup>cLaughlin, Geo.Tech., C.Tech.

# 495 JINKINSON ROAD

## APPENDIX E
## SEISMIC HAZARD CALCULATION

McINTOSH PERRY

# 2015 National Building Code Seismic Hazard Calculation

**INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836**
**Western Canada English (250) 363-6500 Facsimile (250) 363-6565**

May 03, 2018

Site: 45.2436 N, 75.9723 W User File Reference:

Requested by: ,

**National Building Code ground motions: 2% probability of exceedance in 50 years (0.000404 per annum)**

| Sa(0.05) | Sa(0.1) | **Sa(0.2)** | Sa(0.3) | **Sa(0.5)** | **Sa(1.0)** | **Sa(2.0)** | **Sa(5.0)** | **Sa(10.0)** | **PGA (g)** | **PGV (m/s)** |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.383 | 0.453 | **0.381** | 0.291 | **0.208** | **0.106** | **0.051** | **0.014** | **0.0051** | **0.244** | **0.174** |

**Notes.** Spectral (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 $m/s^2$). Peak ground velocity is given in m/s. Values are for "firm ground" (NBCC 2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are specified in **bold** font. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. ***These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.***

Ground motions for other probabilities:

| | | | |
|---|---|---|---|
| Probability of exceedance per annum | 0.010 | 0.0021 | 0.001 |
| Probability of exceedance in 50 years | 40% | 10% | 5% |
| Sa(0.05) | 0.037 | 0.121 | 0.204 |
| Sa(0.1) | 0.052 | 0.156 | 0.253 |
| Sa(0.2) | 0.048 | 0.138 | 0.218 |
| Sa(0.3) | 0.039 | 0.108 | 0.170 |
| Sa(0.5) | 0.028 | 0.079 | 0.123 |
| Sa(1.0) | 0.014 | 0.041 | 0.063 |
| Sa(2.0) | 0.0057 | 0.019 | 0.030 |
| Sa(5.0) | 0.0012 | 0.0044 | 0.0075 |
| Sa(10.0) | 0.0006 | 0.0018 | 0.0030 |
| PGA | 0.028 | 0.085 | 0.139 |
| PGV | 0.019 | 0.061 | 0.098 |

**References**


**National Building Code of Canada 2015 NRCC no. 56190;**
**Appendix C:** Table C-3, Seismic Design Data for Selected Locations in Canada

**User's Guide - NBC 2015, Structural Commentaries NRCC no. xxxxxx** (in preparation)
**Commentary J:** Design for Seismic Effects

**Geological Survey of Canada Open File 7893** Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada


See the websites *www.EarthquakesCanada.ca* and *www.nationalcodes.ca* for more information

*Aussi disponible en français*