# Public Works and Government Services Canada

# Geotechnical Investigation, Millhaven and Bath Institutions, Loyalist, ON

## Geotechnical Investigation Report

Date: June 2012
O/Ref. N°: 033-B-0001193-1-GE-R-0001-00

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# Public Works and Government Services Canada

# Geotechnical Investigation
# Millhaven and Bath Institutions
# Loyalist, Ontario

## Geotechnical Investigation Report

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# INTRODUCTION

LVM inc was retained by Public Works and Government Services Canada (PWGSC) to carry out a geotechnical investigation for the construction of new buildings at Millhaven and Bath Institutions in Loyalist, Ontario.

The purpose of the investigation was to determine the nature and properties of the soils and groundwater conditions at the sites by means of twelve (12) geotechnical boreholes (BH-07-12 to BH-18-12) and soil sampling.

The information gathered allowed the formulation of geotechnical recommendations for the temporary excavation of the site, the structure of the foundations and temporary and permanent drainage solutions.

Some soil samples were taken in three (3) boreholes (BH-11-12, BH-13-12 and BH-18-12) for environmental purposes. The objective of the environmental characterisation was to obtain soil quality information on the subject sites for excavated soils management purposes during the eventual construction work.

The investigation was performed in accordance to our proposal dated March 27, 2012 (O/Ref.:12-0098-033).

This report contains a description of the sites and the methodology used during the site investigations as well as a detailed description of the soil's nature, their properties and the groundwater level at the locations. It also contains a section in which geotechnical recommendations are provided for the design of the project. The recommendations provided in this report are in accordance with the "National Building Code of Canada, 2005" (NBC 2005). The environmental characterization is presented in Section 6.

At the moment of the redaction of this report, the details of the design and construction for the intended structures are unknown. Once structures are design, it is recommended (if required) that LVM be mandated for the review of the geotechnical recommendations in relation with the final concept.

The specific limitations of the investigation, outlined in Appendix 1, should be read jointly with this report.

# 1 SITE AND PROJECT DESCRIPTION

## 1.1 PROJECT DESCRIPTION

Based on the information provided from PWGSC, geotechnical services were required to investigate two (2) sites for the construction of three (3) new buildings located in Bath and Millhaven Institution.

The projected buildings are two (2) storeys in height and have an area of 2 500 square meters with the intended purpose for storage and program space. The structure will be mainly pre-fabricated steel frames and the foundation loads will be line loads from bearing walls.

## 1.2 SITE DESCRIPTION

### 1.2.1 Millhaven Institution

Millhaven Institution is located on 5775 Bath Road, village of Bath, Ontario. Two (2) areas were investigated at that site, one inside and one outside the perimeter walls.

Figure 1 shows an aerial view of Millhaven Institution and the location of the studied areas.

Figure 1: Millhaven Institution (Source: Google Earth)

### 1.2.2 Bath Institution

Bath Institution is located directly south of Millhaven Institution at the same address. The studied site is located at the east side of “BT06”, an existing building.

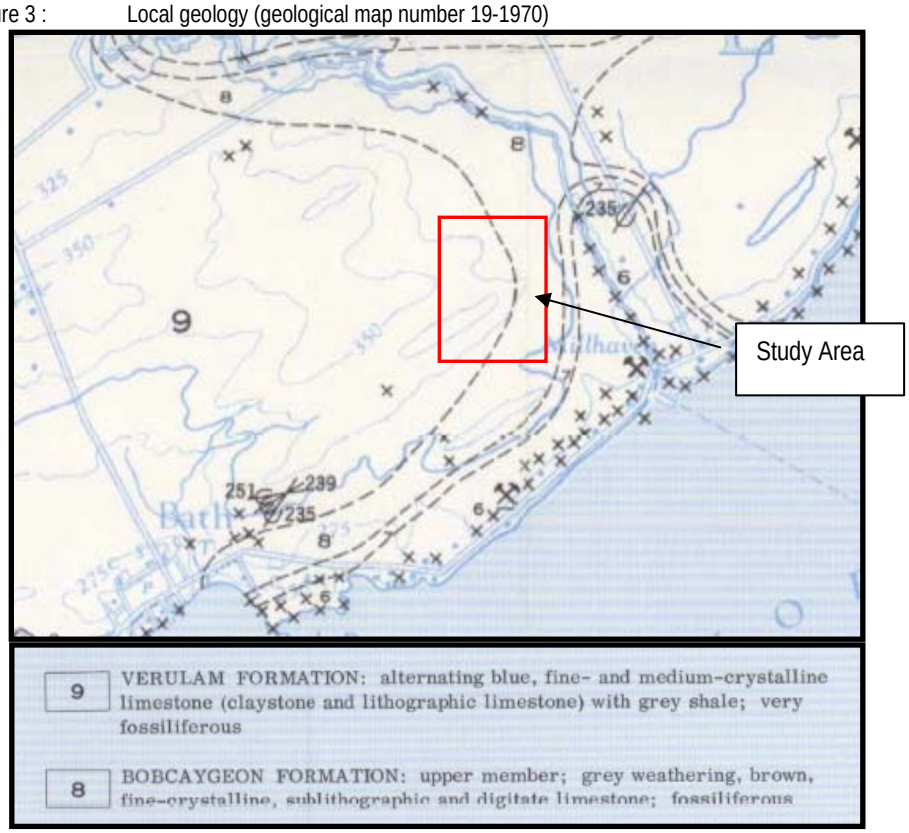
Figure 2 shows an aerial view of Bath Institution and the location of the studied site.

Figure 2: Bath Institution (Source: Google Earth)


## 1.3 LOCAL GEOLOGY

The local geology is illustrated on the geological map number 19-1970, Bath area, by the Geological Survey of Canada. Within the area studied, two (2) rock units are present and consist mainly of limestone with some shale layers.

Figure 3 : Local geology (geological map number 19-1970)




# 2 INVESTIGATION PROCEDURES (FIELDWORK)

## 2.1 LOCATION OF THE BOREHOLES

A site survey, to determine the borehole locations, was carried out by LVM representatives. The elevations of the boreholes were taken from a plan transmitted by the Client at the beginning of the fieldwork. The locations of the boreholes are shown on the drawings 033-B-0001193-1-GE-D-0002 and 033-B-0001193-1-GE-D-0003 included in Appendix 4.

## 2.2 FIELDWORK

The fieldwork was performed May 22 and 23, 2012. A total of twelve (12) boreholes were carried out under the full-time supervision of a qualified technician from LVM. The boreholes were identified BH-07-12 to BH-18-12. Boreholes BH-07-12 to BH-10-12 were performed at the Bath Institution and boreholes BH-11-12 to BH-18-12 were performed at the Millhaven Institution.

The boreholes were carried out, using a CME-55 drill rig with hollow stem augers, down to a total depth ranging from 0.18 m to 4.57 m. Soil sampling and Standard Penetration Testing, in accordance with ASTM Standard D 1586, were performed with a standard split-spoon sampler of 51 mm outer diameter. Dynamic cone penetration tests were completed on boreholes BH-14-12, BH-15-12 and BH-17-12 until depths varying between 1.60 m and 1.73 m; at which point, a refusal was reached on probable rock or very dense soil.

Boreholes BH-07-12, BH-11-12 and BH-18-12 were followed with core sampling to confirm the presence of rock and to determine its quality.

A perforated pipe was installed into borehole BH-11-12, in order to allow the measurement of the groundwater level.

Soil samples were collected for environmental purposes from boreholes BH-11-12, BH-13-12 and BH-18-12. The results of the analyses are presented in section 6 of this report.

The subsoil details are presented in the individual borehole logs inserted in Appendix 2.

## 2.3 LABORATORY TESTING

All recovered samples were carefully preserved and transported to LVM's laboratory for identification, laboratory testing and classification. All soil samples were examined by a geotechnical engineer and were classified in accordance with the requirements specified in ASTM D2488. Representative soil samples from the geotechnical boreholes were submitted for one (1) grain size analysis and three (3) rock core samples were submitted to unconfined compressive strength tests. The complete laboratory test results are presented in Appendix 3 and are also included on the borehole logs in Appendix 2.

All geotechnical samples recovered from boreholes which were not consumed during laboratory analysis will be stored for a period of six (6) months from the date of completion of the fieldwork; after which, they will be destroyed unless written instructions on the sample storage and/or disposition are received from the Client by LVM.

Following the geotechnical fieldwork, a laboratory performed chemical analyses on some of the soil samples collected for environmental purposes from boreholes BH-11-12, BH-13-12 and BH-18-12. The analyses were carried out by *Exova* of Ottawa (Ontario), an independent laboratory accredited by Ontario's Ministry of the Environment (MOE). Section 6 presents a detailed description of the analytical program and the chemical analysis results.

# 3 NATURE AND PROPERTIES OF SUBSOIL

The following paragraphs present a summary of the different soil layers encountered in the borehole. The locations of the twelve (12) boreholes completed at Bath and Millhaven Institution are presented on the plan n° 033-B-0001193-1-GE-D-0002 and 033-B-0001193-1-GE-D-0003 in Appendix 4. The detailed borehole logs are presented in Appendix 2.

Table 1 : Borehole summary

| Site | Borehole n° | Surface Organic Soil (m) | Natural Deposit - Granular (m) | Natural Deposit – Silt (m) | Rock Depth (m) | End of borehole (m) |
|---|---|---|---|---|---|---|
| Bath | BH-07-12 | 0.00 – 0.10 | 0.10 – 0.15 | (2) | 0.15 ≥ 3.07 | 3.07 |
| | BH-08-12 | 0.00 – 0.13 | 0.13 – 0.28 | (2) | 0.28(1) | 0.28 |
| | BH-09-12 | 0.00 – 0.10 | 0.10 – 0.69 | (2) | 0.69(1) | 0.69 |
| | BH-10-12 | 0.00 – 0.10 | 0.10 – 0.18 | (2) | 0.18(1) | 0.18 |
| Millhaven (Exterior) | BH-11-12 | 0.00 – 0.10 | 0.10 – 0.76 | 0.76 – 1.40 | 1.40 ≥ 4.29 | 4.29 |
| | BH-12-12 | 0.00 – 0.10 | 0.10 – 0.76 | 0.76 – 1.65 | 1.65(1) | 1.65 |
| | BH-13-12 | 0.00 – 0.13 | *** | 0.13 – 1.65 | 1.65(1) | 1.65 |
| | BH-14-12 | (3) | (3) | (3) | 1.73(1) | 1.73 |
| Millhaven (Interior) | BH-15-12 | (3) | (3) | (3) | 1.42(1) | 1.42 |
| | BH-16-12 | 0.00 – 0.08 | 0.08 – 1.60 | | 1.60(1) | 1.60 |
| | BH-17-12 | (3) | (3) | (3) | 1.60(1) | 1.60 |
| | BH-18-12 | 0.00 – 0.05 | 0.05 – 1.65 | (2) | 1.65 – 4.57 | 4.57 |

(1) Probable rock depth
(2) Stratigraphic unit not encountered
(3) Borehole without soil sample

## 3.1 ORGANIC SOIL

Directly on the surface of all boreholes, a layer of organic soil was intercepted on a thickness varying between 0.05 m and 0.13 m.

## 3.2 NATURAL DEPOSIT - GRANULAR

A natural deposit of sand and/or gravel was intercepted in all the boreholes immediately beneath the topsoil and organic matter. This deposit was intercepted on a thickness varying between 0.05 m and 1.60 m.

## 3.3 NATURAL DEPOSIT – SILT

A natural silt deposit was intercepted in boreholes BH-11-12 to BH-13-12. This layer was found on a thickness varying between 0.64 m and 1.52 m.

One (1) sieve analyses were done based on a representative samples. Table 2 shows the results of the analysis.

Table 2 : Sieve analysis of natural deposit of silt

| Borehole n° | Depth (m) | Gravel > 4.75 mm (%) | Sand < 4.75 mm and > 75 µm (%) | Silt and Clay < 75 µm (%) |
|---|---|---|---|---|
| BH-13-12 | 1.65 – 1.83 | 1.2 | 8.0 | 90.8 |

The grain size distribution shows that this material is sandy silt. According to the Unified Soil Classification System (USCS), the deposit is classified as a ML.

## 3.4 BEDROCK

Underlying the natural deposit described above, bedrock was intercepted and cored in boreholes BH-07-12, BH-11-12 and BH-18-12 at a depth of 0.15 m, 1.40 m and 1.65 m respectively. This bedrock was drilled with a core barrel on a length of about 3 m to confirm its presence and to determine its quality.

The rock was identified as a grey-brown limestone. The Rock Quality Designation (RQD) is an indirect appreciation of the number of fractures and of the degree of rock alteration. The RQD was calculated six (6) times on the rock recovered from the boreholes and varies from 0% to 50% on the first 2.0 m and varies from 50% to 92% on the lower 1.5 m. The quality of the rock can generally be qualified as «poor to good».

Three (3) unconfined compressive strength of rock core analyses were performed on representative rock samples. Table 3 shows the results of the analyses which are also presented in Appendix 3.

Table 3 : Compressive strength results

| Borehole # | Sample # | Depth (m) | Uniaxial compressive strength (U) MPa |
|---|---|---|---|
| BH-07-12 | RC-3 | 2.14 – 2.40 | 171 |
| BH-11-12 | RC-3 | 2.26 – 2.52 | 102 |
| BH-18-12 | RC-4 | 4.31 – 4.46 | 136 |

# 4 GROUNDWATER

One (1) perforated plastic tube was installed into borehole BH-11-12 in order to allow further readings of the groundwater level. Groundwater levels were recorded June 12th, 2012. The result is shown in Table 4.

Table 4 : Groundwater levels

| Borehole n° | Type | Date Recorded | Depth of Water Level (m) |
|---|---|---|---|
| BH-11-12 | Perforated pipe | 2012-06-12 | 4.00 |

It is important to note that the groundwater level can be influenced by several factors including rainfalls, snow melts and modifications made to the immediate and surrounding physical environment and, thus, it can vary along seasons and over time.

# 5 DISCUSSION AND RECOMMENDATIONS

## 5.1 GENERAL REMARKS

Based on the information provided from PWGSC, geotechnical services were required to investigate various sites for the construction of three (3) new buildings located in Bath and Millhaven Institution, in Loyalist, Ontario.

The projected buildings are two (2) storeys in height and have an area of 2 500 square meters with the intended purpose for storage and program space. The structure will be mainly pre-fabricated steel frames and the foundation loads will be line loads from bearing walls.

On the basis of the information gathered from the boreholes completed on the site, the subsurface stratigraphy is mainly characterized by the presence of a loose to dense granular deposit. This deposit was intercepted on a thickness varying from 0.10 to 1.67 m at investigated location. Under this granular deposit, the rack was intercepted at a depth from 0.15 m to 1.73 m. The rock is composed of a limestone of the Bobcaygeon Formation. The joints observed in the rock masses are generally close and horizontal to sub-horizontal. The unconfined compressive strength performed on the rock sample has given values from 102 MPa to 171 MPa.

On June 12, 2012, groundwater level was recorded at a depth of 4.00 m from the surface.

According to the available data and the information obtained from the boreholes, our geotechnical commentaries and recommendations for the conception of the project are presented in the following sections.

## 5.2 FROST PROTECTION

According to the Environment Canada database, the average frost index is 725°C-day in the project region. Based on that information, the anticipated frost penetration depth in the soil is assessed at 1.50 m in the region. However, in the presence of competent rock, the foundations can be installed directly on the rock, if the overturning conditions are respected. Competent rock is defined as bedrock disencumbered of mechanically detachable part using a hydraulic excavator of equivalent capacity of the Caterpillar excavator, model 235.

## 5.3 EXCAVATION

In order to reach the foundation implementation level of 1.5 m, excavation will be required in the granular deposit and in the rock mass.

### 5.3.1 Temporary excavation in granular deposit

If there is sufficient space, the required excavation to reach the footings can be done by doing open trenches. Because the slopes are only temporary, the contractor will be responsible for their stability.

The excavations must be done in accordance to the specifications of “Ontario Ministry of Labour”. If excavations without any support system stay open for a long duration, it is recommended that frequent inspections be done by specialized geotechnical personnel, in order to detect any risk of soil slip and to determine the measures to be taken to correct any anomalies.

It is recommended to avoid parking any vehicles at the top of the excavation at a distance lower than the depth of the excavation. It is also suggested to avoid any vehicle circulation at the top of the excavation at a distance lower than the depth of the excavation, in order to minimize the vibrations.

It will be important to keep a distance of at least equal to the depth of the excavation between the top of the slope and the base of the excavated material pile on site. This condition must be respected at all times, unless studies are carried out for any specific case.

### 5.3.2 Temporary excavation in rock masses

The over excavation in rock may be required depending on the construction level and not because of roc bearing capacity.

It should be possible to be able to excavate the rock masse mechanically, but depending on the depth of the excavation, the use of explosives may be required. The contractor should take all precautions for this type of work for the protection of public as well as the existing buildings.

At the beginning of the excavation work, it is highly recommended to proceed with an inspection of the rock by a geologist in order to verify the state of the upper part of the rock masses. On the basis of the inspection, the geologist may recommend to clean detachable/friable parts or to use anchor bolts to consolidate portion of rock masses that are unfavourably oriented. All the excavation walls must be inspected until a depth corresponding to the implantation foundation level.

### 5.3.3 Temporary drainage

It is recommended that an adequate pumping system be available in order to evacuate surface run-off and infiltration water that could accumulate at the bottom of the excavations, depending on the weather conditions, to allow a dry working environment.

## 5.4 FOUNDATION

A geotechnical rock resistance value at ultimate limit state (ULS) of 2 MPa may be used for the design of the footing supported by competent rock. A resistance factor of 0.5 must be applied to the ULS.

Considering the local stratigraphy and the elevation of the implantation of the foundation level, the support foundation surface will be the competent rock qualified of good at that elevation. A geotechnical rock resistance value at serviceability limit state (SLS) of 700 kPa may be used for the design of the footing, of 1.2 m or less in width, supported by competent rock. Since the rock constitutes the foundation material, the settlements that will be generated are null or negligible.

No foundation shall be set on topsoil or fill material met on site. It should be completely removed down to the bedrock within the foundation resting area.

Once the excavation has reached the elevation of the projected foundation, it is recommended to proceed with an inspection of rock by a geologist in order to verify the state of all the foundation support surfaces. On the basis of the inspection, the geologist may recommend to continue the excavation to clean the more friable interbed layer, to use anchor bolts to consolidate the layers or to inject or seal the fractures.

Following the rock inspection, the cavities and over excavation will be filled with a filling concrete having a minimal compression resistance of 15 MPa.

## 5.5 REUSE OF THE EXCAVATION MATERIAL

The excavated material would be mainly composed of silty material, having high frost susceptibility. For that reason, it is recommended to not reuse this material for the backfilling of the excavation.

## 5.6 BACKFILLING ALONG THE WALL

The backfill of the excavations inside and outside the foundation walls of the building must be done using compactable granular material of type “Granular B”, as defined by the Ontario Provincial Standards for Roads and Public Works “OPSS”.

This material must be set up in layers of a maximum thickness of 300 mm and must be compacted to at least 95 percent of the maximum dry density. Backfill must be brought up evenly on both sides of the walls, because these walls are not designed to resist lateral pressures.

## 5.7 SLAB-ON-GRADE

It is recommended that any organic soil or granular material, which would be present at the level of the proposed slab, be excavated completely under the occupied surface by the building slab of the projected building.

In addition, directly under the slab of the building, the NBC 2005 recommends the installation of a cushion of at least 100 mm in thickness, composed of clear stone materials.

The slab of the building must be placed on a mat of at least 300 mm thickness, composed of granular materials satisfying the grain size distribution requirements of crushed stone of type ``Granular A``, as defined by the Ministry of Transportation of Ontario (M.T.O). This material must be compacted to at least 98 percent of the Standard Proctor. If the excavation is higher than 400 mm, the cushion must be preceded by a granular material of type “Granular B” compacted to at least 95 percent of the Standard Proctor.

Moreover, it is very important that all the new granular materials used not contain any clayed materials potentially expansive materials, such as shale limestone, which may cause important heaving of the slab. The material should be non susceptible to pyrite reaction.

## 5.8 SEISMIC DATA

### 5.8.1 Site class

The parameters used for the calculation of earthquake load and effects have been determined using the general stratigraphy of the site. Based on the information obtained from the borehole, the site class ``C`` must be used for the study.

If the client wishes to have a site class that is more precise (A or B), a seismic survey (MASW) could be completed to measure the shear wave velocities in the soils and rock for the calculation of the $V_{S30}$ values.

### 5.8.2 Spectral response acceleration

The values of spectral response acceleration for different periods and the values of Peak Ground Acceleration (PGA) for different municipalities (for a site class C) are indicated in the NBC 2005. The data's for the region of Kingston are presented in Table 5.

Table 5 : Spectral acceleration and PGA (for seismic site class C)

| Area of Investigated Site | Seismic Data (g) | | | | |
|---|---|---|---|---|---|
| | $S_a(0,2)$ | $S_a(0,5)$ | $S_a(1,0)$ | $S_a(2,0)$ | PGA |
| Kingston | 0.30 | 0.16 | 0.084 | 0.024 | 0.16 |

# 6 PRELIMINARY ENVIRONMENTAL SOIL CHARACTERIZATION

### 6.1.1 Methodology

Twelve (12) boreholes (BH-7-12 to BH-18-12) were completed under the supervision of LVM. The boreholes were positioned in order to respect the geotechnical requirements of the project and, whenever possible, to obtain supplementary information on the environmental quality of the soil on the subject property. No groundwater samples were collected during this study.

The LVM technician collected representative soil samples during the fieldwork. The presence of visual and/or olfactory indications of substances or materials that could affect the environmental quality of the soil was also verified during sampling. These observations were taken into account when selecting the samples for chemical analyses. Organoleptic observations are included in the borehole and test pit logs appended. Three (3) of the collected soil samples were selected for chemical analyses.

Sampling, transportation and preservation procedures for samples were carried out based on the methodologies suggested by the *Guidance on Sampling and Analytical Methods for Use at Contaminated Site in Ontario, 1996*.

### 6.1.2 Analytical program

Chemical analyses were performed by *Exova* of Ottawa. This laboratory is accredited by the Canadian Association for Laboratory Accrediation (CALA) with regards to the analytical parameters requested in this project. Selected soil samples were analyzed for one or more of the following parameters:

- PCB
- Total Organic Carbon
- Total Phosphorus
- Metals
- TCLP – Inorganics and metals

The analytical results and analytical methods are presented in the certificate of analysis appended.

The laboratory will keep samples according to current environmental standards and for duration of thirty (30) days from the date of the certificate. The samples will be disposed-of unless instructions to the contrary are received from the client.

### 6.1.3 Analytical results for the soil samples

The results and comments presented in this section are based on the Fill Quality Guide and Good Management Practices for Shore Infilling in Ontario and on the O.Reg 558/00 Waste Management.

The soil samples were collected in the field and transported to the analytical laboratory while adhering to the procedures prescribed by the MOE's guideline « Guidance on Sampling and Analytical Methods for Use at Contaminated Sites in Ontario » (MOE, 1996).

Chemical analysis results for the soil samples are presented in the certificates appended in appendix 5.

The chemical analysis results on the selected soil samples indicated the following:

- The soil samples show concentrations in total phosphorus, in chromium, in copper, in iron, in manganese and in nickel exceeding the applicable criteria for unconfined shore infilling.
- The soil sample analysed for the Toxicity Characteristic Leaching Procedure (TCLP) shows concentrations indicating that the soil is not leaching toxic substances.

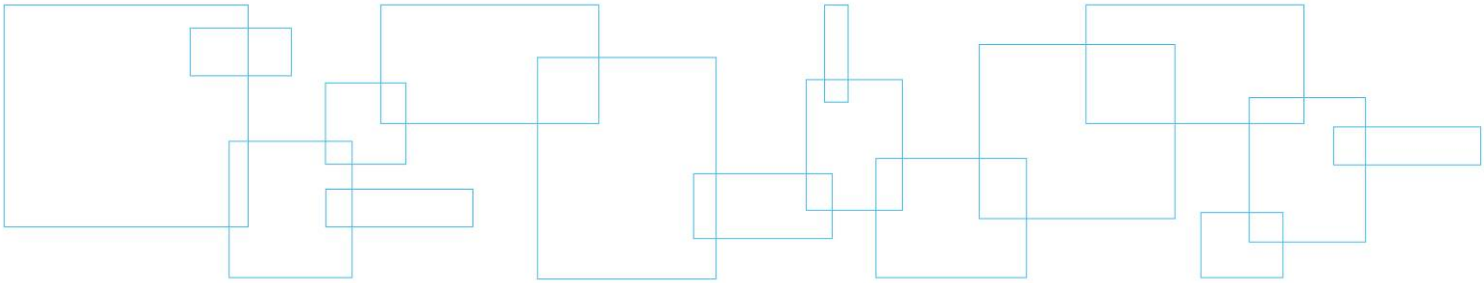
## 6.2 COMMENTS

The proposed work involves the excavation of soils. For that purpose, PWGSC requested that selected soil samples be tested to assess whether excavated material meets Ministry of Environment open water lakefill, or landfill disposal criteria.

On the basis of the laboratory results, the excavated soil cannot be used for open water lakefill as per the Fill Quality Guide and Good Management Practices for Shore Infilling in Ontario.

However the soil can be disposed of at any municipal landfill as they do not leach toxic substances as per Ontario Regulation 558/00.

# Appendix 1 Scope and Limitations of the Study



# SCOPE OF THE GEOTECHNICAL AND ENVIRONMENTAL STUDY

## *1.0 Soil and Rock Characteristics*

The soil and rock characteristics described in this report originate from geotechnical investigations conducted within a given period and correspond to the nature of the terrain only at the specific locations where these investigations were carried out.

Soil and rock formations have natural variations. The limits between the different formations presented in the sounding logs must therefore be considered as transitions between the formations rather than set boundaries. The precision of these limits depends on the type and number of soundings, the sounding methods used, as well as sampling frequency and methods.

The descriptions of the samples taken are based on recognized identification and classification methods used in geotechnics. They can call into play the judgement and interpretation of the personnel who carried out the examination of materials and can be presumed to be accurate and correct in keeping with current best practices in the field of geotechnics. Finally, if tests were carried out, the results of these tests apply solely to the samples tested, as described in this report.

The properties of the soil and rock can undergo significant modifications in the wake of construction activities such as excavation, blasting, pile driving or drainage activities, carried out on the site under study or an adjacent site. They can also be indirectly modified by the exposure of the soil or rock to freezing or weather stresses.

## *2.0 Groundwater Conditions*

The groundwater conditions presented in this report apply only to the site under study. The accuracy and representation of these conditions must be interpreted based on the type of instrumentation used, as well as the period, duration, and number of observations carried out. These conditions can vary depending on precipitation, the seasons and, ultimately, the tides. They can also vary as a result of construction activities or the modification of physical elements on the site under study or in its vicinity. The problematic of ferrous ochre and its effects is not covered in this report.

## *3.0 Use of the Report*

The comments and recommendations contained in this report are intended primarily for the project's design team. The number of soundings required to identify all of the underground conditions that could impact construction costs, techniques, the choice of equipment and planning of operations could be greater than the number required for design purposes. All contractors bidding on or carrying out the work on the site under study must undertake their own interpretation of the results of the soundings and, if need be, carry out their own investigations to determine how site conditions could influence their operations or work methods.

Any modifications to the design, position and elevation of the works must be quickly communicated to LVM, allowing the validity of the recommendations presented to be verified. Complementary site or laboratory work could ultimately be required.



## *4.0 Project Follow-up*

The interpretation of the on-site and laboratory results obtained, as well as the recommendations presented in this report, apply solely to the site under study and to the information available about the project at the time this report was drafted.

Information available concerning the site and groundwater conditions increases as construction work progresses. As site conditions were interpreted and correlated between sounding points, LVM should be allowed to verify these conditions, during site visits conducted as work progresses, in order to confirm the information provided by the drillings soundings. If it is not possible for us to conduct these verifications, LVM shall assume no responsibility for geotechnical interpretations by third parties concerning recommendations contained in this report, particularly if the design has been modified or if site conditions different from those described in this report are encountered. The identification of such changes requires experience and must be carried out by an experienced geotechnical engineer.

## *5.0 Environment*

Information and comments relating to the environmental conditions of the site are to be considered as summary and limited. They relate solely to the environmental quality of the soil samples taken from the soundings, and not to the environmental quality of the groundwater.

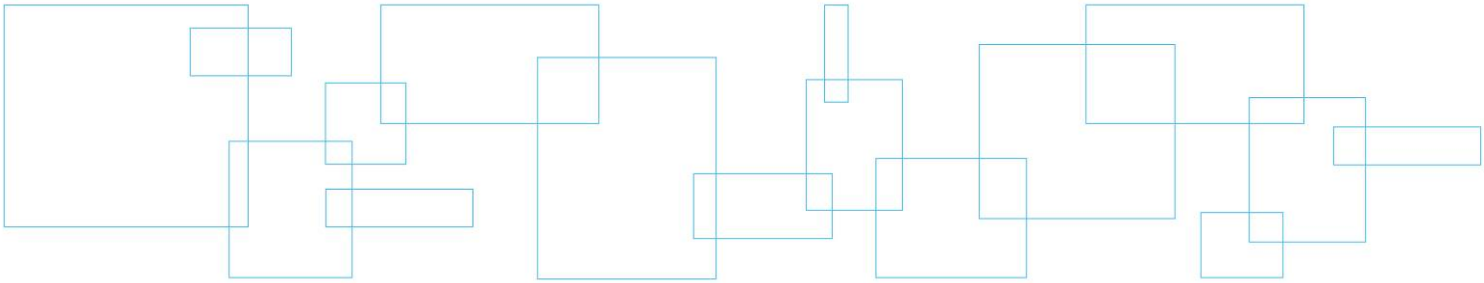
Unless otherwise noted, the interpretation of the data, the environmental comments and the recommendations contained in this report are based, to the best of our knowledge, on the policies, criteria and environmental regulations in effect at the time this project was carried out, within their applicable limits, according to the specific nature of the project and the intended use of the site under study. If these policies, criteria and regulations differ from those presumed to be in effect, or if they have undergone changes following the production of this report, LVM must be consulted in order to revise the recommendations according to these changes. In the event that no policies, criteria or regulations are available to permit the interpretation of data, the comments and recommendations expressed by LVM are based on our best possible knowledge of accepted best professional practices applicable to the project involved.

The conditions indicated in this report correspond to those detected at the locations and dates of the observations as indicated herein. They can vary over time, resulting from activities carried out on the site under study or on adjacent sites, or following natural events, natural reactions or other occurrences.

Concentrations identified in the soil samples are determined based on the results of chemical analyses carried out on a limited number of samples. Concentrations between sampling points can vary based on the conditions encountered at the locations where the analyzed samples were taken.

The fact that a certain parameter has not been analyzed does not exclude the possibility that it may be present in concentrations greater than the background noise or the detection limit for said parameter.

# Appendix 2 Explanation Notes and Borehole Log Reports



# EXPLANATION NOTE ON SOUNDING LOGS

The following sounding logs summarize soils and rock geotechnical properties as well as ground water conditions, as collected during field work and/or obtained from laboratory tests. This note explains the different symbols and abbreviations used in these logs.

## STRATIGRAPHIC UNITS

**Elevation/Depth:** Reference to the geodesic elevation of the soil or to a bench mark of arbitrary elevation, at the location of the sounding. Depth of the different geological boundaries as measured from ground surface. On the left, the scale is in meters while on the right, it is in feet.

**Description of the stratigraphic units:** Every geological formation is detailed.

The proportion of the different elements of the soil, defined according to the size of the particles, is given following the classification hereafter. The relative compactness of cohesionless soils is defined by the "N" index of the Standard Penetration Test. The consistency of cohesive soils is defined by their shear resistance.

| Classification | Particle size (mm) |
|---|---|
| Clay | < 0.002 |
| Clay and silt (undifferentiated) | < 0.08 |
| Sand | 0.08 to 5 |
| Gravel | 5 to 80 |
| Cobble | 80 to 300 |
| Boulder | > 300 |

| Descriptive terminology | Proportion (%) |
|---|---|
| "Traces" (tr.) | 1 to 10 |
| "Some" (s.) | 10 to 20 |
| Adjective (ex.: sandy, silty) | 20 to 35 |
| "And" (ex.: sand and gravel) | 35 to 50 |

| Compactness of cohesionless soils | Standard Penetration Test index ("N" value), ASTM D-1586 (blows for a 300mm penetration) |
|---|---|
| Very loose | 0 to 4 |
| Loose | 4 to 10 |
| Compact | 10 to 30 |
| Dense | 30 to 50 |
| Very dense | > 50 |

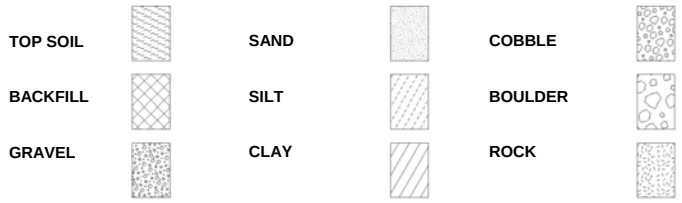
| Consistency of cohesive soils | Undrained shear strength (kPa) |
|---|---|
| Very soft | < 12 |
| Soft | 12 to 25 |
| Firm | 25 to 50 |
| Stiff | 50 to 100 |
| Very stiff | 100 to 200 |
| Hard | > 200 |

| Plasticity of cohesive soils | Liquid limit (%) |
|---|---|
| Low | < 30 |
| Medium | 30 to 50 |
| High | > 50 |

| Sensitivity of cohesive soils | $S_t = (C_u/C_{ur})$ |
|---|---|
| Low | $S_t < 2$ |
| Medium | $2 < S_t < 4$ |
| High | $4 < S_t < 8$ |
| Extra-sensitive | $8 < S_t < 16$ |
| Quick (sensitive) clay | $S_t > 16$ |

| Classification of rock | RQD (%) |
|---|---|
| Very poor quality | < 25 |
| Poor quality | 25 to 50 |
| Fair quality | 50 to 75 |
| Good quality | 75 to 90 |
| Excellent quality | 90 to 100 |

## SYMBOLS




## WATER LEVEL

This column shows the ground water level, as measured at a given time during the geotechnical investigation. The details of the installation (type and depth) are also illustrated in this column.

## SAMPLES

**Type and number:** Each sample is labelled in accordance with the number of this column and the given notation refers to samples types.

**Sub-sample:** When a sample contains two or more different stratigraphic units, it is sometimes necessary to separate it and create sub-samples. This column allows for the identification of the latter and the association to *in situ* or laboratory measurements to these sub-samples.

**Condition:** The position, length and condition of each sample are shown in this column. The symbol shows the condition of the sample, following the legend given on the sounding log.

**Size:** This column indicates the split spoon sampler size.

**"N" index** The standard penetration index shown in this column is expressed with the letter "N". This index is obtained with the Standard Penetration Test. It corresponds to the number of blows required to drive the last 300mm of the split spoon, using a 622 Newton hammer falling freely from a height of 762mm (ASTM D-1586). For a 610mm long split spoon, the "N" index is obtained by adding the number of blows required for the driving of the 2nd and 3rd 150mm of the split spoon. Refusal (R) indicates a number of blows greater than 100. A set of numbers such as 28-30-50/60mm indicates that the number of blows required to drive the 1st and 2nd 150mm of the split spoon are respectively 28 and 30. Moreover, it indicates that 50 blows were necessary to get a penetration of 60mm, whereupon the test was suspended.

**RQD index:** Rock Quality Designation index: This index is defined as the ratio between the total length of all rock cores of 100mm and more in length over the total length of the core run. The RQD index is an indirect measurement of the number of "natural" fractures and of the amount of the alteration in a rock mass.

## TESTS

**Results:** This column shows, for the corresponding depth, the results of tests carried out in the field or in the laboratory (shear strength, dynamic penetration, Atterberg limits with the cone, etc.). For more information, please refer to the legend in the upper part of the sounding log. However, an abbreviation indicating the type of analysis performed is shown next to the sample tested.

**Graph:** This graph shows the undrained shear strength resistance of cohesive soils, as measured *in situ* or in the laboratory (NQ 2501-200). It is also used to present the Dynamic Cone Penetration Test (NQ 2501-145) results.

Moreover, this graph is used for the representation of the water content and Atterberg limits test results.

Client :

**PUBLIC WORKS & GOVERNMENT SERVICES CANADA**

# BOREHOLE REPORT

File n°: **B-0001193-1**
Borehole n°: **BH-07-12**
Date: **2012-05-22**

Project: **Sub-surface Investigation, Various Institutions (Millhaven, Joyceville and Bath)**

Location: **Bath Institution, Loyalist, Ontario**

Coordinates (m): North 4894660,0 (Y)
East 359891,0 (X)
Elevation **0,00 (Z)**
Bedrock: 0,15 m End depth: 3,07 m

**Sample condition**

Intact | Remoulded | Lost | Core

**Organoleptic soil examination:**

Visual aspect: Non-existent(N); Disseminated(D); Soaked(S)
Odor: Non-existent(N); Light(L); Medium(M); Persistent(P)

**Sample type**

| | |
|---|---|
| SS | Split Spoon |
| TM | Thin wall Tube |
| PS | Piston Tube |
| RC | Rock core |
| AS | Auger |
| MA | Bulk sample |
| TU | Transparent tube |
| PW | LVM Mega-Sampler |
| FG | Frozen ground |

**Tests**

| | | | | | |
|---|---|---|---|---|---|
| L | Consistency Limits | O.M. | Organic Matter (%) | | Water Level |
| $W_L$ | Liquid Limit (%) | K | Permeability (cm/s) | N | Std Penetration test (blows/300mm) |
| $W_P$ | Plastic Limit (%) | UW | Unit Weight (kN/m³) | $N_C$ | Dyn. Penetration test (blows/300mm) ● |
| $I_P$ | Plasticity Index (%) | A | Absorption (l/min. m) | $\sigma'_P$ | Preconsolidation Pressure (kPa) |
| $I_L$ | Liquidity Index | U | Uniaxial Compressive strength (MPa) | SCI | Soil Corrosivity Index |
| W | Natural Water Content (%) | RQD | Rock Quality Designation (%) | | |
| GS | Grain Size Analysis | CA | Chemical Analysis | | **Undrained shear strength** (Field ▲ / Laboratory ■) |
| S | Hydrometer analysis | $P_L$ | Limit Pressure (kPa) | $C_U$ | Undisturbed (kPa) ▲ ■ |
| R | Refusal | $E_M$ | Pressuremeter Modulus (MPa) | $C_{UR}$ | Remoulded (kPa) △ □ |
| VBS | Methylene Blue Value | $E_r$ | Modulus of subgrade reaction (MPa) | | |
| WR | Weight of Rods | $SP_O$ | Segregation Potential (mm²/H °C) | | |

| DEPTH - ft | DEPTH - m | ELEVATION - m / DEPTH - m | SOIL OR BEDROCK DESCRIPTION | SYMBOLS | WATER LEVEL (m) / DATE | TYPE AND NUMBER | SUB-SAMPLE | CONDITION | SIZE | RECOVERY % | Blows/150mm | "N" or RQD | Organo. Exam: Odor | Organo. Exam: Visual | RESULTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0,00 | | | | | | | | | | | | | |
| 1 | | 0,00 | Topsoil and organic matter | | | SS-1 | | | | 100 | 6 | R | | | |
| 2 | | -0,10 / 0,10 | Gravel with some sand and trace silt | | | | | | | | | | | | |
| 3 | 1 | -0,15 / 0,15 | ***Rock :*** Limestone | | | RC-2 | | | | 100 | | 17 | | | |
| 4 | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | |
| 7 | 2 | | | | | RC-3 | | | | 100 | | 57 | | | U=171MPa |
| 8 | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | |
| 10 | 3 | -3,07 | | | | | | | | | | | | | |
| 11 | | 3,07 | End of borehole | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | |
| 13 | 4 | | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | | | | |
| 17 | 5 | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | |
| 20 | 6 | | | | | | | | | | | | | | |
| 21 | | | | | | | | | | | | | | | |
| 22 | | | | | | | | | | | | | | | |
| 23 | 7 | | | | | | | | | | | | | | |
| 24 | | | | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | | | | |
| 26 | | | | | | | | | | | | | | | |
| 27 | 8 | | | | | | | | | | | | | | |
| 28 | | | | | | | | | | | | | | | |
| 29 | | | | | | | | | | | | | | | |

NATURAL WATER CONTENT AND LIMITS (%) — Wp W WL — 20 40 60 80 100 120

UNDRAINED SHEAR STRENGTH (kPa) OR DYNAMIC PENETRATION — 20 40 60 80 100 120

Vertical Scale = 1 : 75

Remarks:

Borehole type: **Borehole**

Boring equipment: **CME-75**

Prepared by: **S. Séguin, tech.**

Approved by: **T. Lampron**

2012-06-14

Page: 1 of 1

Client :

**PUBLIC WORKS & GOVERNMENT SERVICES CANADA**

# BOREHOLE REPORT

File n°: **B-0001193-1**
Borehole n°: **BH-08-12**
Date: **2012-05-22**

Project: **Sub-surface Investigation, Various Institutions (Millhaven, Joyceville and Bath)**

Location: **Bath Institution, Loyalist, Ontario**

Coordinates (m): North 4894651,0 (Y)
East 359901,0 (X)
Elevation **0,00 (Z)**
Bedrock: 0,28 m End depth: 0,28 m

**Sample condition**

Intact | Remoulded | Lost | Core

**Organoleptic soil examination:**

Visual aspect: Non-existent(N); Disseminated(D); Soaked(S)
Odor: Non-existent(N); Light(L); Medium(M); Persistent(P)

**Sample type**

| | |
|---|---|
| SS | Split Spoon |
| TM | Thin wall Tube |
| PS | Piston Tube |
| RC | Rock core |
| AS | Auger |
| MA | Bulk sample |
| TU | Transparent tube |
| PW | LVM Mega-Sampler |
| FG | Frozen ground |

**Tests**

| | | | | | |
|---|---|---|---|---|---|
| L | Consistency Limits | O.M. | Organic Matter (%) | | Water Level |
| $W_L$ | Liquid Limit (%) | K | Permeability (cm/s) | N | Std Penetration test (blows/300mm) |
| $W_P$ | Plastic Limit (%) | UW | Unit Weight (kN/m³) | $N_C$ | Dyn. Penetration test (blows/300mm) ● |
| $I_P$ | Plasticity Index (%) | A | Absorption (l/min. m) | $\sigma'_P$ | Preconsolidation Pressure (kPa) |
| $I_L$ | Liquidity Index | U | Uniaxial Compressive strength (MPa) | SCI | Soil Corrosivity Index |
| W | Natural Water Content (%) | RQD | Rock Quality Designation (%) | | |
| GS | Grain Size Analysis | CA | Chemical Analysis | | **Undrained shear strength** (Field ▲ / Laboratory ■) |
| S | Hydrometer analysis | $P_L$ | Limit Pressure (kPa) | $C_U$ | Undisturbed (kPa) ▲ ■ |
| R | Refusal | $E_M$ | Pressuremeter Modulus (MPa) | $C_{UR}$ | Remoulded (kPa) △ □ |
| VBS | Methylene Blue Value | $E_r$ | Modulus of subgrade reaction (MPa) | | |
| WR | Weight of Rods | $SP_O$ | Segregation Potential (mm²/H °C) | | |

| DEPTH - ft | DEPTH - m | ELEVATION - m / DEPTH - m | SOIL OR BEDROCK DESCRIPTION | SYMBOLS | WATER LEVEL (m) / DATE | TYPE AND NUMBER | SUB-SAMPLE | CONDITION | SIZE | RECOVERY % | Blows/150mm | "N" or RQD | Organo. Exam: Odor | Organo. Exam: Visual | RESULTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0,00 | | | | | | | | | | | | | |
| 1 | | 0,00<br>-0,13<br>0,13<br>-0,28<br>0,28 | Topsoil and organic matter<br>Sand and gravel with some silt<br>End of borehole after obtaining a refusal on dense soil or probable rock at 0.28 m | | | SS-1 | | | | 100 | 3-50 /13 cm | R | | | |
| 2 | | | | | | | | | | | | | | | |
| 3 | 1 | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | |
| 6 | 2 | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | |
| 10 | 3 | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | |
| 13 | 4 | | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | |
| 16 | 5 | | | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | |
| 20 | 6 | | | | | | | | | | | | | | |
| 21 | | | | | | | | | | | | | | | |
| 22 | | | | | | | | | | | | | | | |
| 23 | 7 | | | | | | | | | | | | | | |
| 24 | | | | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | | | | |
| 26 | 8 | | | | | | | | | | | | | | |
| 27 | | | | | | | | | | | | | | | |
| 28 | | | | | | | | | | | | | | | |
| 29 | | | | | | | | | | | | | | | |

**FIELD AND LABORATORY TESTS**

NATURAL WATER CONTENT AND LIMITS (%) Wp W WL
20 40 60 80 100 120

UNDRAINED SHEAR STRENGTH (kPa) OR DYNAMIC PENETRATION
20 40 60 80 100 120

Vertical Scale = 1 : 75

Remarks:

Borehole type: **Borehole**

Boring equipment: **CME-75**

Prepared by: **S. Séguin, tech.**

Approved by: **T. Lampron**

2012-06-14

Page: 1 of 1

Client :

**PUBLIC WORKS & GOVERNMENT SERVICES CANADA**

# BOREHOLE REPORT

File n°: **B-0001193-1**
Borehole n°: **BH-09-12**
Date: **2012-05-22**

Project: **Sub-surface Investigation, Various Institutions (Millhaven, Joyceville and Bath)**

Location: **Bath Institution, Loyalist, Ontario**

Coordinates (m): North 4894676,0 (Y)
East 359906,0 (X)
Elevation **0,00 (Z)**
Bedrock: m End depth: 0,69 m

**Sample condition**

Intact | Remoulded | Lost | Core

**Organoleptic soil examination:**

Visual aspect: Non-existent(N); Disseminated(D); Soaked(S)
Odor: Non-existent(N); Light(L); Medium(M); Persistent(P)

**Sample type**

| | |
|---|---|
| SS | Split Spoon |
| TM | Thin wall Tube |
| PS | Piston Tube |
| RC | Rock core |
| AS | Auger |
| MA | Bulk sample |
| TU | Transparent tube |
| PW | LVM Mega-Sampler |
| FG | Frozen ground |

**Tests**

| | | | | | |
|---|---|---|---|---|---|
| L | Consistency Limits | O.M. | Organic Matter (%) | | Water Level |
| $W_L$ | Liquid Limit (%) | K | Permeability (cm/s) | N | Std Penetration test (blows/300mm) |
| $W_P$ | Plastic Limit (%) | UW | Unit Weight (kN/m³) | $N_C$ | Dyn. Penetration test (blows/300mm) ● |
| $I_P$ | Plasticity Index (%) | A | Absorption (l/min. m) | $\sigma'_P$ | Preconsolidation Pressure (kPa) |
| $I_L$ | Liquidity Index | U | Uniaxial Compressive strength (MPa) | SCI | Soil Corrosivity Index |
| W | Natural Water Content (%) | RQD | Rock Quality Designation (%) | | |
| GS | Grain Size Analysis | CA | Chemical Analysis | | **Undrained shear strength** (Field ▲ / Laboratory ■) |
| S | Hydrometer analysis | $P_L$ | Limit Pressure (kPa) | $C_U$ | Undisturbed (kPa) ▲ ■ |
| R | Refusal | $E_M$ | Pressuremeter Modulus (MPa) | $C_{UR}$ | Remoulded (kPa) △ □ |
| VBS | Methylene Blue Value | $E_r$ | Modulus of subgrade reaction (MPa) | | |
| WR | Weight of Rods | $SP_O$ | Segregation Potential (mm²/H °C) | | |

| DEPTH - ft | DEPTH - m | ELEVATION - m / DEPTH - m | SOIL OR BEDROCK DESCRIPTION | SYMBOLS | WATER LEVEL (m) / DATE | TYPE AND NUMBER | SUB-SAMPLE | CONDITION | SIZE | RECOVERY % | Blows/150mm | "N" or RQD | Organo. Exam: Odor | Organo. Exam: Visual | RESULTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0,00 | | | | | | | | | | | | | |
| 1 | | 0,00 / -0,10 | Topsoil and organic matter<br>Sand and gravel with some silt | | | SS-1 | | | | 83 | 20-35<br>58-42 | 93 | | | |
| 2 | | 0,10 / -0,69 | | | | SS-2 | | | | 100 | 50 /8 cm | R | | | |
| 3 | 1 | 0,69 | End of borehole after obtaining a refusal on dense soil or probable rock at 0.69 m | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | |
| 6 | 2 | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | |
| 10 | 3 | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | |
| 13 | 4 | | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | |
| 16 | 5 | | | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | |
| 20 | 6 | | | | | | | | | | | | | | |
| 21 | | | | | | | | | | | | | | | |
| 22 | | | | | | | | | | | | | | | |
| 23 | 7 | | | | | | | | | | | | | | |
| 24 | | | | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | | | | |
| 26 | 8 | | | | | | | | | | | | | | |
| 27 | | | | | | | | | | | | | | | |
| 28 | | | | | | | | | | | | | | | |
| 29 | | | | | | | | | | | | | | | |

**STRATIGRAPHY** | **SAMPLES** | **FIELD AND LABORATORY TESTS**

RESULTS: NATURAL WATER CONTENT AND LIMITS (%) — Wp W WL — 20 40 60 80 100 120
UNDRAINED SHEAR STRENGTH (kPa) OR DYNAMIC PENETRATION — 20 40 60 80 100 120

Vertical Scale = 1 : 75

Remarks:

Borehole type: **Borehole**

Boring equipment: **CME-75**

Prepared by: **S. Séguin, tech.**

Approved by: **T. Lampron**

2012-06-14

Page: 1 of 1

Client :

**PUBLIC WORKS & GOVERNMENT SERVICES CANADA**

# BOREHOLE REPORT

File n°: **B-0001193-1**
Borehole n°: **BH-10-12**
Date: **2012-05-22**

Project: **Sub-surface Investigation, Various Institutions (Millhaven, Joyceville and Bath)**

Location: **Bath Institution, Loyalist, Ontario**

Coordinates (m): North 4894667,0 (Y)
East 359918,0 (X)
Elevation **0,00 (Z)**
Bedrock: 0,18 m End depth: 0,18 m

**Sample condition**

Intact | Remoulded | Lost | Core

**Organoleptic soil examination:**

Visual aspect: Non-existent(N); Disseminated(D); Soaked(S)
Odor: Non-existent(N); Light(L); Medium(M); Persistent(P)

**Sample type**

| | |
|---|---|
| SS | Split Spoon |
| TM | Thin wall Tube |
| PS | Piston Tube |
| RC | Rock core |
| AS | Auger |
| MA | Bulk sample |
| TU | Transparent tube |
| PW | LVM Mega-Sampler |
| FG | Frozen ground |

**Tests**

| | | | | | |
|---|---|---|---|---|---|
| L | Consistency Limits | O.M. | Organic Matter (%) | | Water Level |
| $W_L$ | Liquid Limit (%) | K | Permeability (cm/s) | N | Std Penetration test (blows/300mm) |
| $W_P$ | Plastic Limit (%) | UW | Unit Weight (kN/m³) | $N_C$ | Dyn. Penetration test (blows/300mm) ● |
| $I_P$ | Plasticity Index (%) | A | Absorption (l/min. m) | $\sigma'_P$ | Preconsolidation Pressure (kPa) |
| $I_L$ | Liquidity Index | U | Uniaxial Compressive strength (MPa) | SCI | Soil Corrosivity Index |
| W | Natural Water Content (%) | RQD | Rock Quality Designation (%) | | |
| GS | Grain Size Analysis | CA | Chemical Analysis | | **Undrained shear strength** (Field ▲ / Laboratory ■) |
| S | Hydrometer analysis | $P_L$ | Limit Pressure (kPa) | $C_U$ | Undisturbed (kPa) ▲ ■ |
| R | Refusal | $E_M$ | Pressuremeter Modulus (MPa) | $C_{UR}$ | Remoulded (kPa) △ □ |
| VBS | Methylene Blue Value | $E_r$ | Modulus of subgrade reaction (MPa) | | |
| WR | Weight of Rods | $SP_O$ | Segregation Potential (mm²/H °C) | | |

| DEPTH - ft | DEPTH - m | ELEVATION - m / DEPTH - m | SOIL OR BEDROCK DESCRIPTION | SYMBOLS | WATER LEVEL (m) / DATE | TYPE AND NUMBER | SUB-SAMPLE | CONDITION | SIZE | RECOVERY % | Blows/150mm | "N" or RQD | Organo. Exam: Odor | Organo. Exam: Visual | RESULTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0,00 | | | | | | | | | | | | | |
| 1 | | 0,00 | Topsoil and organic matter | | | SS-1 | | | | 85 | 4-50 /3 cm | R | | | |
| 2 | | -0,10 | Rock fragments with some sand and trace of silt | | | | | | | | | | | | |
| 3 | 1 | 0,10 | | | | | | | | | | | | | |
| 4 | | -0,18 | End of borehole after obtaining a refusal on dense soil or probable rock at 0.18 m | | | | | | | | | | | | |
| 5 | | 0,18 | | | | | | | | | | | | | |
| 6 | 2 | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | |
| 10 | 3 | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | |
| 13 | 4 | | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | | | | |
| 17 | 5 | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | |
| 20 | 6 | | | | | | | | | | | | | | |
| 21 | | | | | | | | | | | | | | | |
| 22 | | | | | | | | | | | | | | | |
| 23 | 7 | | | | | | | | | | | | | | |
| 24 | | | | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | | | | |
| 26 | | | | | | | | | | | | | | | |
| 27 | 8 | | | | | | | | | | | | | | |
| 28 | | | | | | | | | | | | | | | |
| 29 | | | | | | | | | | | | | | | |

**FIELD AND LABORATORY TESTS**

NATURAL WATER CONTENT AND LIMITS (%) — Wp W WL — 20 40 60 80 100 120

UNDRAINED SHEAR STRENGTH (kPa) OR DYNAMIC PENETRATION — 20 40 60 80 100 120

Vertical Scale = 1 : 75

Remarks:

Borehole type: **Borehole**

Boring equipment: **CME-75**

Prepared by: **S. Séguin, tech.**

Approved by: **T. Lampron**

2012-06-14

Page: 1 of 1

Client :

**PUBLIC WORKS & GOVERNMENT SERVICES CANADA**

# BOREHOLE REPORT

File n°: **B-0001193-1**
Borehole n°: **BH-11-12**
Date: **2012-05-23**

Project: **Sub-surface Investigation, Various Institutions (Millhaven, Joyceville and Bath)**

Location: **Millhaven Institution, Loyalist, Ontario**

Coordinates (m): North 4895057,0 (Y)
East 359860,0 (X)
Elevation **96,20 (Z)**
Bedrock: 1,40 m End depth: 4,29 m

**Sample condition**

Intact | Remoulded | Lost | Core

**Organoleptic soil examination:**

Visual aspect: Non-existent(N); Disseminated(D); Soaked(S)
Odor: Non-existent(N); Light(L); Medium(M); Persistent(P)

**Sample type**

| | |
|---|---|
| SS | Split Spoon |
| TM | Thin wall Tube |
| PS | Piston Tube |
| RC | Rock core |
| AS | Auger |
| MA | Bulk sample |
| TU | Transparent tube |
| PW | LVM Mega-Sampler |
| FG | Frozen ground |

**Tests**

| | | | | | |
|---|---|---|---|---|---|
| L | Consistency Limits | O.M. | Organic Matter (%) | | Water Level |
| $W_L$ | Liquid Limit (%) | K | Permeability (cm/s) | N | Std Penetration test (blows/300mm) |
| $W_P$ | Plastic Limit (%) | UW | Unit Weight (kN/m³) | $N_C$ | Dyn. Penetration test (blows/300mm) ● |
| $I_P$ | Plasticity Index (%) | A | Absorption (l/min. m) | $\sigma'_P$ | Preconsolidation Pressure (kPa) |
| $I_L$ | Liquidity Index | U | Uniaxial Compressive strength (MPa) | SCI | Soil Corrosivity Index |
| W | Natural Water Content (%) | RQD | Rock Quality Designation (%) | | |
| GS | Grain Size Analysis | CA | Chemical Analysis | | **Undrained shear strength** (Field ▲ / Laboratory ■) |
| S | Hydrometer analysis | $P_L$ | Limit Pressure (kPa) | $C_U$ | Undisturbed (kPa) ▲ ■ |
| R | Refusal | $E_M$ | Pressuremeter Modulus (MPa) | $C_{UR}$ | Remoulded (kPa) △ □ |
| VBS | Methylene Blue Value | $E_r$ | Modulus of subgrade reaction (MPa) | | |
| WR | Weight of Rods | $SP_O$ | Segregation Potential (mm²/H °C) | | |

| DEPTH - ft | DEPTH - m | ELEVATION - m / DEPTH - m | SOIL OR BEDROCK DESCRIPTION | SYMBOLS | WATER LEVEL (m) / DATE | TYPE AND NUMBER | SUB-SAMPLE | CONDITION | SIZE | RECOVERY % | Blows/150mm | "N" or RQD | Organo. Exam: Odor | Organo. Exam: Visual | RESULTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 96,20 | | | | | | | | | | | | | |
| 1 | | 0,00 / 96,10 | Topsoil and organic matter | | | | | | | | | | | | |
| 2 | | 0,10 / 95,44 | ***Granular Fill :*** Gray gravelly sand with some silt and trace clay | | | SS-1 | | | | 71 | 3-8 5-4 | 13 | | | |
| 3 | 1 | 0,76 / 94,80 | ***Natural deposit :*** Silt with some clay, trace of gravel and traces of sand | | | SS-2 | | | | 50 | 5-2 5-6 | 7 | | | |
| 4 | | 1,40 | ***Rock :*** Limestone | | | | | | | | | | | | |
| 5 | | | | | | RC-3 | | | | 100 | | 36 | | | U = 102 MPa |
| 6 | 2 | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | |
| 10 | 3 | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | |
| 12 | | | | | | RC-4 | | | | 100 | | 92 | | | |
| 13 | 4 | | | | | | | | | | | | | | |
| 14 | | 91,91 / 4,29 | End of borehole | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | | | | |
| 17 | 5 | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | |
| 20 | 6 | | | | | | | | | | | | | | |
| 21 | | | | | | | | | | | | | | | |
| 22 | | | | | | | | | | | | | | | |
| 23 | 7 | | | | | | | | | | | | | | |
| 24 | | | | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | | | | |
| 26 | 8 | | | | | | | | | | | | | | |
| 27 | | | | | | | | | | | | | | | |
| 28 | | | | | | | | | | | | | | | |
| 29 | | | | | | | | | | | | | | | |

NATURAL WATER CONTENT AND LIMITS (%) — Wp W WL — 20 40 60 80 100 120

UNDRAINED SHEAR STRENGTH (kPa) OR DYNAMIC PENETRATION — 20 40 60 80 100 120

Vertical Scale = 1 : 75

Remarks:

Borehole type: **Borehole**

Boring equipment: **CME-75**

Prepared by: **S. Séguin, tech.**

Approved by: **T. Lampron**

2012-06-14

Page: 1 of 1

Client : **PUBLIC WORKS & GOVERNMENT SERVICES CANADA**

# BOREHOLE REPORT

File n°: **B-0001193-1**
Borehole n°: **BH-12-12**
Date: **2012-05-23**

Project: **Sub-surface Investigation, Various Institutions (Millhaven, Joyceville and Bath)**

Location: **Millhaven Institution, Loyalist, Ontario**

Coordinates (m): North 4895078,0 (Y)
East 359872,0 (X)
Elevation **96,14 (Z)**
Bedrock: m End depth: 1,65 m

**Sample condition**
Intact | Remoulded | Lost | Core

**Organoleptic soil examination:**
Visual aspect: Non-existent(N); Disseminated(D); Soaked(S)
Odor: Non-existent(N); Light(L); Medium(M); Persistent(P)

**Sample type**

| | |
|---|---|
| SS | Split Spoon |
| TM | Thin wall Tube |
| PS | Piston Tube |
| RC | Rock core |
| AS | Auger |
| MA | Bulk sample |
| TU | Transparent tube |
| PW | LVM Mega-Sampler |
| FG | Frozen ground |

**Tests**

| | |
|---|---|
| L | Consistency Limits |
| $W_L$ | Liquid Limit (%) |
| $W_P$ | Plastic Limit (%) |
| $I_P$ | Plasticity Index (%) |
| $I_L$ | Liquidity Index |
| W | Natural Water Content (%) |
| GS | Grain Size Analysis |
| S | Hydrometer analysis |
| R | Refusal |
| VBS | Methylene Blue Value |
| WR | Weight of Rods |
| O.M. | Organic Matter (%) |
| K | Permeability (cm/s) |
| UW | Unit Weight (kN/m³) |
| A | Absorption (l/min. m) |
| U | Uniaxial Compressive strength (MPa) |
| RQD | Rock Quality Designation (%) |
| CA | Chemical Analysis |
| $P_L$ | Limit Pressure (kPa) |
| $E_M$ | Pressuremeter Modulus (MPa) |
| $E_r$ | Modulus of subgrade reaction (MPa) |
| $SP_O$ | Segregation Potential (mm²/H °C) |
| | Water Level |
| N | Std Penetration test (blows/300mm) |
| $N_C$ | Dyn. Penetration test (blows/300mm) ● |
| $\sigma'_P$ | Preconsolidation Pressure (kPa) |
| SCI | Soil Corrosivity Index |

**Undrained shear strength** (Field ▲ / Laboratory ■)
$C_U$ Undisturbed (kPa)
$C_{UR}$ Remoulded (kPa) (△ / □)

| DEPTH - ft | DEPTH - m | ELEVATION - m / DEPTH - m | SOIL OR BEDROCK DESCRIPTION | SYMBOLS | WATER LEVEL (m) / DATE | TYPE AND NUMBER | SUB-SAMPLE | CONDITION | SIZE | RECOVERY % | Blows/150mm | "N" or RQD | Organo. Exam: Odor | Organo. Exam: Visual | RESULTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 96,14 | | | | | | | | | | | | | |
| 1 | | 0,00 / 96,04 | Topsoil and organic matter | | | | | | | | | | | | |
| 2 | | 0,10 / 95,38 | ***Granular Fill :*** Grey gravelly sand with some silt | | | CF-1 | | | | 62 | 1-9 17-12 | 26 | | | |
| 3 | 1 | 0,76 | ***Natural deposit :*** Grey-brown clayey silt with traces of sand | | | CF-2 | | | | 62 | 3-4 6-10 | 10 | | | |
| 4 | | 94,62 | | | | | | | | | | | | | |
| 5 | | 1,52 / 94,49 | Silt with some clay grey-brown with traces of sand | | | CF-3 | | | | 100 | 50 /13 cm | R | | | |
| 6 | 2 | 1,65 | End of borehole after obtaining a refusal on dense soil or probable rock at 1.65 m | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | |
| 10 | 3 | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | |
| 13 | 4 | | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | |
| 16 | 5 | | | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | |
| 20 | 6 | | | | | | | | | | | | | | |
| 21 | | | | | | | | | | | | | | | |
| 22 | | | | | | | | | | | | | | | |
| 23 | 7 | | | | | | | | | | | | | | |
| 24 | | | | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | | | | |
| 26 | 8 | | | | | | | | | | | | | | |
| 27 | | | | | | | | | | | | | | | |
| 28 | | | | | | | | | | | | | | | |
| 29 | | | | | | | | | | | | | | | |

**FIELD AND LABORATORY TESTS**
NATURAL WATER CONTENT AND LIMITS (%) — Wp W WL — 20 40 60 80 100 120
UNDRAINED SHEAR STRENGTH (kPa) OR DYNAMIC PENETRATION — 20 40 60 80 100 120

Vertical Scale = 1 : 75

Remarks:

Borehole type: **Borehole**

Boring equipment: **CME-75**

Prepared by: **S. Séguin, tech.**

Approved by: **T. Lampron**

2012-06-14

Page: 1 of 1

Client :

**PUBLIC WORKS & GOVERNMENT SERVICES CANADA**

# BOREHOLE REPORT

File n°: **B-0001193-1**
Borehole n°: **BH-13-12**
Date: **2012-05-23**

Project: **Sub-surface Investigation, Various Institutions (Millhaven, Joyceville and Bath)**

Location: **Millhaven Institution, Loyalist, Ontario**

Coordinates (m): North 4895058,0 (Y)
East 359895,0 (X)
Elevation **95,85 (Z)**
Bedrock: m End depth: 1,70 m

**Sample condition**
Intact | Remoulded | Lost | Core

**Organoleptic soil examination:**
Visual aspect: Non-existent(N); Disseminated(D); Soaked(S)
Odor: Non-existent(N); Light(L); Medium(M); Persistent(P)

**Sample type**

| | |
|---|---|
| SS | Split Spoon |
| TM | Thin wall Tube |
| PS | Piston Tube |
| RC | Rock core |
| AS | Auger |
| MA | Bulk sample |
| TU | Transparent tube |
| PW | LVM Mega-Sampler |
| FG | Frozen ground |

**Tests**

| | | | | | |
|---|---|---|---|---|---|
| L | Consistency Limits | O.M. | Organic Matter (%) | | Water Level |
| $W_L$ | Liquid Limit (%) | K | Permeability (cm/s) | N | Std Penetration test (blows/300mm) |
| $W_P$ | Plastic Limit (%) | UW | Unit Weight (kN/m³) | $N_C$ | Dyn. Penetration test (blows/300mm) ● |
| $I_P$ | Plasticity Index (%) | A | Absorption (l/min. m) | $\sigma'_P$ | Preconsolidation Pressure (kPa) |
| $I_L$ | Liquidity Index | U | Uniaxial Compressive strength (MPa) | SCI | Soil Corrosivity Index |
| W | Natural Water Content (%) | RQD | Rock Quality Designation (%) | | |
| GS | Grain Size Analysis | CA | Chemical Analysis | | Undrained shear strength (Field ▲ / Laboratory ■) |
| S | Hydrometer analysis | $P_L$ | Limit Pressure (kPa) | $C_U$ | Undisturbed (kPa) ▲ ■ |
| R | Refusal | $E_M$ | Pressuremeter Modulus (MPa) | $C_{UR}$ | Remoulded (kPa) △ □ |
| VBS | Methylene Blue Value | $E_r$ | Modulus of subgrade reaction (MPa) | | |
| WR | Weight of Rods | $SP_O$ | Segregation Potential (mm²/H °C) | | |

| DEPTH - ft | DEPTH - m | ELEVATION - m / DEPTH - m | SOIL OR BEDROCK DESCRIPTION | SYMBOLS | WATER LEVEL (m) / DATE | TYPE AND NUMBER | SUB-SAMPLE | CONDITION | SIZE | RECOVERY % | Blows/150mm | "N" or RQD | Organo. Exam: Odor | Organo. Exam: Visual | RESULTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 95,85 | | | | | | | | | | | | | |
| 1 | | 0,00 / 95,72 | Topsoil and organic matter | | | | | | | | | | | | |
| 2 | | 0,13 / 95,09 | Grey-brown silty clay with traces of gravel and traces of sand | | | CF-1 | | | | 67 | 2-4 4-4 | 8 | | | |
| 3 | 1 | 0,76 / 94,33 | Grey-brown silty clay with traces of sand | | | CF-2 | | | | 92 | 3-4 8-10 | 12 | | | |
| 4 | | 1,52 / 94,20 | Grey-brown clayey silt with traces of sand | | | CF-3 | | | | 100 | 9-50 | R | | | GS |
| 5 | | 1,65 | End of borehole after obtaining a refusal on dense soil or probable rock at 1.65 m | | | | | | | | | | | | |
| 6 | 2 | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | |
| 10 | 3 | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | |
| 13 | 4 | | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | |
| 16 | 5 | | | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | |
| 20 | 6 | | | | | | | | | | | | | | |
| 21 | | | | | | | | | | | | | | | |
| 22 | | | | | | | | | | | | | | | |
| 23 | 7 | | | | | | | | | | | | | | |
| 24 | | | | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | | | | |
| 26 | 8 | | | | | | | | | | | | | | |
| 27 | | | | | | | | | | | | | | | |
| 28 | | | | | | | | | | | | | | | |
| 29 | | | | | | | | | | | | | | | |

**FIELD AND LABORATORY TESTS**

NATURAL WATER CONTENT AND LIMITS (%) — Wp W WL — 20 40 60 80 100 120

UNDRAINED SHEAR STRENGTH (kPa) OR DYNAMIC PENETRATION — 20 40 60 80 100 120

Vertical Scale = 1 : 75

Remarks:

Borehole type: **Borehole**

Boring equipment: **CME-75**

Prepared by: **S. Séguin, tech.**

Approved by: **T. Lampron**

2012-06-14

Page: 1 of 1

Client :

**PUBLIC WORKS & GOVERNMENT SERVICES CANADA**

# BOREHOLE REPORT

File n°: **B-0001193-1**
Borehole n°: **BH-14-12**
Date: **2012-05-23**

Project: **Sub-surface Investigation, Various Institutions (Millhaven, Joyceville and Bath)**

Location: **Millhaven Institution, Loyalist, Ontario**

Coordinates (m): North 4895048,0 (Y)
East 359881,0 (X)
Elevation **96,13 (Z)**
Bedrock: m End depth: 1,73 m

**Sample condition**

Intact | Remoulded | Lost | Core

**Organoleptic soil examination:**

Visual aspect: Non-existent(N); Disseminated(D); Soaked(S)
Odor: Non-existent(N); Light(L); Medium(M); Persistent(P)

**Sample type**

| | |
|---|---|
| SS | Split Spoon |
| TM | Thin wall Tube |
| PS | Piston Tube |
| RC | Rock core |
| AS | Auger |
| MA | Bulk sample |
| TU | Transparent tube |
| PW | LVM Mega-Sampler |
| FG | Frozen ground |

**Tests**

| | | | | | |
|---|---|---|---|---|---|
| L | Consistency Limits | O.M. | Organic Matter (%) | | Water Level |
| $W_L$ | Liquid Limit (%) | K | Permeability (cm/s) | N | Std Penetration test (blows/300mm) |
| $W_P$ | Plastic Limit (%) | UW | Unit Weight (kN/m³) | $N_C$ | Dyn. Penetration test (blows/300mm) ● |
| $I_P$ | Plasticity Index (%) | A | Absorption (l/min. m) | $\sigma'_P$ | Preconsolidation Pressure (kPa) |
| $I_L$ | Liquidity Index | U | Uniaxial Compressive strength (MPa) | SCI | Soil Corrosivity Index |
| W | Natural Water Content (%) | RQD | Rock Quality Designation (%) | | |
| GS | Grain Size Analysis | CA | Chemical Analysis | | Undrained shear strength (Field ▲ / Laboratory ■) |
| S | Hydrometer analysis | $P_L$ | Limit Pressure (kPa) | $C_U$ | Undisturbed (kPa) ▲ ■ |
| R | Refusal | $E_M$ | Pressuremeter Modulus (MPa) | $C_{UR}$ | Remoulded (kPa) △ □ |
| VBS | Methylene Blue Value | $E_r$ | Modulus of subgrade reaction (MPa) | | |
| WR | Weight of Rods | $SP_O$ | Segregation Potential (mm²/H °C) | | |

| DEPTH - ft | DEPTH - m | ELEVATION - m / DEPTH - m | SOIL OR BEDROCK DESCRIPTION | SYMBOLS | WATER LEVEL (m) / DATE | SAMPLES: TYPE AND NUMBER | SUB-SAMPLE | CONDITION | SIZE | RECOVERY % | Blows/150mm | "N" or RQD | Organo. Exam: Odor | Organo. Exam: Visual | FIELD AND LABORATORY TESTS: RESULTS | NATURAL WATER CONTENT AND LIMITS (%) Wp W WL (20 40 60 80 100 120) / UNDRAINED SHEAR STRENGTH (kPa) OR DYNAMIC PENETRATION (20 40 60 80 100 120) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 96,13 | | | | | | | | | | | | | | |
| 1 | | 0,00 | Beginning of the dynamic penetration test | | | | | | | | | | | | $N_C$= 9 | ● |
| 2 | | | | | | | | | | | | | | | $N_C$= 8 | ● |
| 3 | 1 | | | | | | | | | | | | | | $N_C$= 4 | ● |
| 4 | | | | | | | | | | | | | | | $N_C$= 5 | ● |
| 5 | | 94,40 | | | | | | | | | | | | | $N_C$= 13 | ● |
| 6 | | 1,73 | End of the dynamic penetration test | | | | | | | | | | | | $N_C$= Refusal | |
| 7 | 2 | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | |
| 10 | 3 | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | |
| 13 | 4 | | | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | |
| 16 | 5 | | | | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | | |
| 20 | 6 | | | | | | | | | | | | | | | |
| 21 | | | | | | | | | | | | | | | | |
| 22 | | | | | | | | | | | | | | | | |
| 23 | 7 | | | | | | | | | | | | | | | |
| 24 | | | | | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | | | | | |
| 26 | 8 | | | | | | | | | | | | | | | |
| 27 | | | | | | | | | | | | | | | | |
| 28 | | | | | | | | | | | | | | | | |
| 29 | | | | | | | | | | | | | | | | |

Vertical Scale = 1 : 75

Remarks:

Borehole type: **Dynamic penetration test**

Boring equipment: **CME-75**

Prepared by: **S. Séguin, tech.**

Approved by: **T. Lampron**

2012-06-14

Page: 1 of 1

Client :

**PUBLIC WORKS & GOVERNMENT SERVICES CANADA**

# BOREHOLE REPORT

File n°: **B-0001193-1**
Borehole n°: **BH-15-12**
Date: **2012-05-23**

Project: **Sub-surface Investigation, Various Institutions (Millhaven, Joyceville and Bath)**

Location: **Millhaven Institution, Loyalist, Ontario**

Coordinates (m): North 4895138,0 (Y)
East 359940,0 (X)
Elevation **95,61 (Z)**
Bedrock: m End depth: 1,42 m

**Sample condition**

Intact | Remoulded | Lost | Core

**Organoleptic soil examination:**

Visual aspect: Non-existent(N); Disseminated(D); Soaked(S)
Odor: Non-existent(N); Light(L); Medium(M); Persistent(P)

**Sample type**

| | |
|---|---|
| SS | Split Spoon |
| TM | Thin wall Tube |
| PS | Piston Tube |
| RC | Rock core |
| AS | Auger |
| MA | Bulk sample |
| TU | Transparent tube |
| PW | LVM Mega-Sampler |
| FG | Frozen ground |

**Tests**

| | | | | | |
|---|---|---|---|---|---|
| L | Consistency Limits | O.M. | Organic Matter (%) | | Water Level |
| $W_L$ | Liquid Limit (%) | K | Permeability (cm/s) | N | Std Penetration test (blows/300mm) |
| $W_P$ | Plastic Limit (%) | UW | Unit Weight (kN/m³) | $N_C$ | Dyn. Penetration test (blows/300mm) ● |
| $I_P$ | Plasticity Index (%) | A | Absorption (l/min. m) | $\sigma'_P$ | Preconsolidation Pressure (kPa) |
| $I_L$ | Liquidity Index | U | Uniaxial Compressive strength (MPa) | SCI | Soil Corrosivity Index |
| W | Natural Water Content (%) | RQD | Rock Quality Designation (%) | | |
| GS | Grain Size Analysis | CA | Chemical Analysis | | Undrained shear strength (Field ▲ / Laboratory ■) |
| S | Hydrometer analysis | $P_L$ | Limit Pressure (kPa) | $C_U$ | Undisturbed (kPa) ▲ ■ |
| R | Refusal | $E_M$ | Pressuremeter Modulus (MPa) | $C_{UR}$ | Remoulded (kPa) △ □ |
| VBS | Methylene Blue Value | $E_r$ | Modulus of subgrade reaction (MPa) | | |
| WR | Weight of Rods | $SP_O$ | Segregation Potential (mm²/H °C) | | |

| DEPTH - ft | DEPTH - m | STRATIGRAPHY: ELEVATION - m / DEPTH - m | SOIL OR BEDROCK DESCRIPTION | SYMBOLS | WATER LEVEL (m) / DATE | SAMPLES: TYPE AND NUMBER | SUB-SAMPLE | CONDITION | SIZE | RECOVERY % | Blows/150mm | "N" or RQD | Organo. Exam: Odor | Organo. Exam: Visual | FIELD AND LABORATORY TESTS: RESULTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 95,61 | | | | | | | | | | | | | |
| | | 0,00 | Beginning of the dynamic penetration test | | | | | | | | | | | | $N_C$= 15<br>$N_C$= 23<br>$N_C$= 53<br>$N_C$= 30<br>$N_C$= Refusal |
| | | 94,19 | | | | | | | | | | | | | |
| | | 1,42 | End of the dynamic penetration test | | | | | | | | | | | | |

NATURAL WATER CONTENT AND LIMITS (%) — Wp W WL — 20 40 60 80 100 120

UNDRAINED SHEAR STRENGTH (kPa) OR DYNAMIC PENETRATION — 20 40 60 80 100 120

Vertical Scale = 1 : 75

Remarks:

Borehole type: **Dynamic penetration test**

Boring equipment: **CME-75**

Prepared by: **S. Séguin, tech.**

Approved by: **T. Lampron**

2012-06-14

Page: 1 of 1

Client :

**PUBLIC WORKS & GOVERNMENT SERVICES CANADA**

# BOREHOLE REPORT

File n°: **B-0001193-1**
Borehole n°: **BH-16-12**
Date: **2012-05-23**

Project: **Sub-surface Investigation, Various Institutions (Millhaven, Joyceville and Bath)**

Location: **Millhaven Institution, Loyalist, Ontario**

Coordinates (m): North 4895150,0 (Y)
East 359918,0 (X)
Elevation **95,69 (Z)**
Bedrock: m End depth: 1,60 m

**Sample condition**
Intact | Remoulded | Lost | Core

**Organoleptic soil examination:**
Visual aspect: Non-existent(N); Disseminated(D); Soaked(S)
Odor: Non-existent(N); Light(L); Medium(M); Persistent(P)

**Sample type**

| | |
|---|---|
| SS | Split Spoon |
| TM | Thin wall Tube |
| PS | Piston Tube |
| RC | Rock core |
| AS | Auger |
| MA | Bulk sample |
| TU | Transparent tube |
| PW | LVM Mega-Sampler |
| FG | Frozen ground |

**Tests**

| | | | | | |
|---|---|---|---|---|---|
| L | Consistency Limits | O.M. | Organic Matter (%) | | Water Level |
| $W_L$ | Liquid Limit (%) | K | Permeability (cm/s) | N | Std Penetration test (blows/300mm) |
| $W_P$ | Plastic Limit (%) | UW | Unit Weight (kN/m³) | $N_C$ | Dyn. Penetration test (blows/300mm) ● |
| $I_P$ | Plasticity Index (%) | A | Absorption (l/min. m) | $\sigma'_P$ | Preconsolidation Pressure (kPa) |
| $I_L$ | Liquidity Index | U | Uniaxial Compressive strength (MPa) | SCI | Soil Corrosivity Index |
| W | Natural Water Content (%) | RQD | Rock Quality Designation (%) | | |
| GS | Grain Size Analysis | CA | Chemical Analysis | | Undrained shear strength (Field ▲ / Laboratory ■) |
| S | Hydrometer analysis | $P_L$ | Limit Pressure (kPa) | $C_U$ | Undisturbed (kPa) |
| R | Refusal | $E_M$ | Pressuremeter Modulus (MPa) | $C_{UR}$ | Remoulded (kPa) △ □ |
| VBS | Methylene Blue Value | $E_r$ | Modulus of subgrade reaction (MPa) | | |
| WR | Weight of Rods | $SP_O$ | Segregation Potential (mm²/H °C) | | |

| DEPTH - ft | DEPTH - m | ELEVATION - m / DEPTH - m | SOIL OR BEDROCK DESCRIPTION | SYMBOLS | WATER LEVEL (m) / DATE | TYPE AND NUMBER | SUB-SAMPLE | CONDITION | SIZE | RECOVERY % | Blows/150mm | "N" or RQD | Organo. Exam: Odor | Organo. Exam: Visual | RESULTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 95,69 | | | | | | | | | | | | | |
| 1 | | 0,00 / 95,61 | Topsoil and organic matter | | | | | | | | | | | | |
| 2 | | 0,08 / 94,93 | ***Granular Fill :*** Grey gravelly sand with some silt | | | CF-1 | | | | 75 | 4-6 5-7 | 11 | | | |
| 3 | 1 | 0,76 | Grey gravelly sand with some silt and rock fragments | | | CF-2 | | | | 54 | 4-6 5-5 | 11 | | | |
| 4 | | 94,17 | | | | | | | | | | | | | |
| 5 | | 1,52 / 94,09 | Grey sand with some silt, some gravel a little wet | | | CF-3 | | | | 33 | 50 /5 cm | R | | | |
| 6 | 2 | 1,60 | End of borehole after obtaining a refusal on dense soil or probable rock 1.6 m | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | |
| 8 | 3 | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | |
| 12 | 4 | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | |
| 16 | 5 | | | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | |
| 20 | 6 | | | | | | | | | | | | | | |
| 21 | | | | | | | | | | | | | | | |
| 22 | | | | | | | | | | | | | | | |
| 23 | 7 | | | | | | | | | | | | | | |
| 24 | | | | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | | | | |
| 26 | 8 | | | | | | | | | | | | | | |
| 27 | | | | | | | | | | | | | | | |
| 28 | | | | | | | | | | | | | | | |
| 29 | | | | | | | | | | | | | | | |

RESULTS: NATURAL WATER CONTENT AND LIMITS (%) Wp W WL — 20 40 60 80 100 120
UNDRAINED SHEAR STRENGTH (kPa) OR DYNAMIC PENETRATION — 20 40 60 80 100 120

Vertical Scale = 1 : 75

Remarks:

Borehole type: **Borehole**

Boring equipment: **CME-75**

Prepared by: **S. Séguin, tech.**

Approved by: **T. Lampron**

2012-06-14

Page: 1 of 1

LVM

Client :

**PUBLIC WORKS & GOVERNMENT SERVICES CANADA**

# BOREHOLE REPORT

File n°: **B-0001193-1**
Borehole n°: **BH-17-12**
Date: **2012-05-23**

Project: **Sub-surface Investigation, Various Institutions (Millhaven, Joyceville and Bath)**

Location: **Millhaven Institution, Loyalist, Ontario**

Coordinates (m): North 4895139,0 (Y)
East 359910,0 (X)
Elevation **95,76 (Z)**
Bedrock: m End depth: 1,60 m

**Sample condition**

Intact | Remoulded | Lost | Core

**Organoleptic soil examination:**

Visual aspect: Non-existent(N); Disseminated(D); Soaked(S)
Odor: Non-existent(N); Light(L); Medium(M); Persistent(P)

**Sample type**

| | |
|---|---|
| SS | Split Spoon |
| TM | Thin wall Tube |
| PS | Piston Tube |
| RC | Rock core |
| AS | Auger |
| MA | Bulk sample |
| TU | Transparent tube |
| PW | LVM Mega-Sampler |
| FG | Frozen ground |

**Tests**

| | | | | | |
|---|---|---|---|---|---|
| L | Consistency Limits | O.M. | Organic Matter (%) | | Water Level |
| $W_L$ | Liquid Limit (%) | K | Permeability (cm/s) | N | Std Penetration test (blows/300mm) |
| $W_P$ | Plastic Limit (%) | UW | Unit Weight (kN/m³) | $N_C$ | Dyn. Penetration test (blows/300mm) ● |
| $I_P$ | Plasticity Index (%) | A | Absorption (l/min. m) | $\sigma'_P$ | Preconsolidation Pressure (kPa) |
| $I_L$ | Liquidity Index | U | Uniaxial Compressive strength (MPa) | SCI | Soil Corrosivity Index |
| W | Natural Water Content (%) | RQD | Rock Quality Designation (%) | | |
| GS | Grain Size Analysis | CA | Chemical Analysis | | Undrained shear strength (Field ▲ / Laboratory ■) |
| S | Hydrometer analysis | $P_L$ | Limit Pressure (kPa) | $C_U$ | Undisturbed (kPa) ▲ ■ |
| R | Refusal | $E_M$ | Pressuremeter Modulus (MPa) | $C_{UR}$ | Remoulded (kPa) △ □ |
| VBS | Methylene Blue Value | $E_r$ | Modulus of subgrade reaction (MPa) | | |
| WR | Weight of Rods | $SP_O$ | Segregation Potential (mm²/H °C) | | |

| DEPTH - ft | DEPTH - m | ELEVATION - m / DEPTH - m | SOIL OR BEDROCK DESCRIPTION | SYMBOLS | WATER LEVEL (m) / DATE | TYPE AND NUMBER | SUB-SAMPLE | CONDITION | SIZE | RECOVERY % | Blows/150mm | "N" or RQD | Organo. Exam: Odor | Organo. Exam: Visual | RESULTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 95,76 | | | | | | | | | | | | | |
| 1-5 | 1 | 0,00 | Beginning of the dynamic penetration test | | | | | | | | | | | | $N_C$= 7<br>$N_C$= 25<br>$N_C$= 23<br>$N_C$= 16<br>$N_C$= 11<br>$N_C$= Refusal |
| | | 94,16 | | | | | | | | | | | | | |
| 6-10 | 2 | 1,60 | End of the dynamic penetration test | | | | | | | | | | | | |
| 11-15 | 3 | | | | | | | | | | | | | | |
| 16-20 | 4 | | | | | | | | | | | | | | |
| 21-25 | 5 | | | | | | | | | | | | | | |
| 26-29 | 6 | | | | | | | | | | | | | | |
| | 7 | | | | | | | | | | | | | | |
| | 8 | | | | | | | | | | | | | | |

NATURAL WATER CONTENT AND LIMITS (%) — Wp W WL — 20 40 60 80 100 120

UNDRAINED SHEAR STRENGTH (kPa) OR DYNAMIC PENETRATION — 20 40 60 80 100 120

Vertical Scale = 1 : 75

Remarks:

Borehole type: **Dynamic penetration test**

Boring equipment: **CME-75**

Prepared by: **S. Séguin, tech.**

Approved by: **T. Lampron**

2012-06-14

Page: 1 of 1

Client :

**PUBLIC WORKS & GOVERNMENT SERVICES CANADA**

# BOREHOLE REPORT

File n°: **B-0001193-1**
Borehole n°: **BH-18-12**
Date: **2012-05-23**

Project: **Sub-surface Investigation, Various Institutions (Millhaven, Joyceville and Bath)**

Location: **Millhaven Institution, Loyalist, Ontario**

Coordinates (m): North 4895123,0 (Y)
East 359933,0 (X)
Elevation **95,55 (Z)**
Bedrock: 1,65 m End depth: 4,57 m

**Sample condition**

Intact | Remoulded | Lost | Core

**Organoleptic soil examination:**

Visual aspect: Non-existent(N); Disseminated(D); Soaked(S)
Odor: Non-existent(N); Light(L); Medium(M); Persistent(P)

**Sample type**

| | |
|---|---|
| SS | Split Spoon |
| TM | Thin wall Tube |
| PS | Piston Tube |
| RC | Rock core |
| AS | Auger |
| MA | Bulk sample |
| TU | Transparent tube |
| PW | LVM Mega-Sampler |
| FG | Frozen ground |

**Tests**

| | | | | | |
|---|---|---|---|---|---|
| L | Consistency Limits | O.M. | Organic Matter (%) | | Water Level |
| $W_L$ | Liquid Limit (%) | K | Permeability (cm/s) | N | Std Penetration test (blows/300mm) |
| $W_P$ | Plastic Limit (%) | UW | Unit Weight (kN/m³) | $N_C$ | Dyn. Penetration test (blows/300mm) ● |
| $I_P$ | Plasticity Index (%) | A | Absorption (l/min. m) | $\sigma'_P$ | Preconsolidation Pressure (kPa) |
| $I_L$ | Liquidity Index | U | Uniaxial Compressive strength (MPa) | SCI | Soil Corrosivity Index |
| W | Natural Water Content (%) | RQD | Rock Quality Designation (%) | | |
| GS | Grain Size Analysis | CA | Chemical Analysis | | Undrained shear strength (Field ▲ / Laboratory ■) |
| S | Hydrometer analysis | $P_L$ | Limit Pressure (kPa) | $C_U$ | Undisturbed (kPa) |
| R | Refusal | $E_M$ | Pressuremeter Modulus (MPa) | $C_{UR}$ | Remoulded (kPa) |
| VBS | Methylene Blue Value | $E_r$ | Modulus of subgrade reaction (MPa) | | |
| WR | Weight of Rods | $SP_O$ | Segregation Potential (mm²/H °C) | | |

| DEPTH - ft | DEPTH - m | ELEVATION - m / DEPTH - m | SOIL OR BEDROCK DESCRIPTION | SYMBOLS | WATER LEVEL (m) / DATE | TYPE AND NUMBER | SUB-SAMPLE | CONDITION | SIZE | RECOVERY % | Blows/150mm | "N" or RQD | Organo. Exam: Odor | Organo. Exam: Visual | RESULTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 95,55 | | | | | | | | | | | | | |
| 1- | | 0,00 | Topsoil and organic matter | | | | | | | | | | | | |
| 2- | | 95,50 / 0,05 | Granular Fill : Sand and gravel with trace silt | | | CF-1 | | | | 71 | 6-8 11-13 | 19 | | | |
| 3- | 1 | 94,79 / 0,76 | Grey gravelly sand with traces of silt | | | CF-2 | | | | 67 | 11-16 15-50 /10 cm | 31 | | | |
| 4- | | 93,90 | | | | | | | | | | | | | |
| 5- | | 1,65 | ***Rock :*** Limestone | | | | | | | | | | | | |
| 6- | 2 | | | | | | | | | | | | | | |
| 7- | | | | | | | | | | | | | | | |
| 8- | | | | | | RC-3 | | | | 100 | | 0 | | | |
| 9- | | | | | | | | | | | | | | | |
| 10- | 3 | | | | | | | | | | | | | | |
| 11- | | | | | | | | | | | | | | | |
| 12- | | | | | | RC-4 | | | | 100 | | 37 | | | U= 136 MPa |
| 13- | 4 | | | | | | | | | | | | | | |
| 14- | | | | | | | | | | | | | | | |
| 15- | | 90,98 | | | | | | | | | | | | | |
| 16- | | 4,57 | End of borehole at 4.57 m | | | | | | | | | | | | |
| 17- | 5 | | | | | | | | | | | | | | |
| 18- | | | | | | | | | | | | | | | |
| 19- | | | | | | | | | | | | | | | |
| 20- | 6 | | | | | | | | | | | | | | |
| 21- | | | | | | | | | | | | | | | |
| 22- | | | | | | | | | | | | | | | |
| 23- | 7 | | | | | | | | | | | | | | |
| 24- | | | | | | | | | | | | | | | |
| 25- | | | | | | | | | | | | | | | |
| 26- | 8 | | | | | | | | | | | | | | |
| 27- | | | | | | | | | | | | | | | |
| 28- | | | | | | | | | | | | | | | |
| 29- | | | | | | | | | | | | | | | |

**STRATIGRAPHY** | **SAMPLES** | **FIELD AND LABORATORY TESTS**

RESULTS — NATURAL WATER CONTENT AND LIMITS (%) Wp W WL; 20 40 60 80 100 120
UNDRAINED SHEAR STRENGTH (kPa) OR DYNAMIC PENETRATION; 20 40 60 80 100 120

Vertical Scale = 1 : 75

Remarks:

Borehole type: **Dynamic penetration test**

Boring equipment: **CME-75**

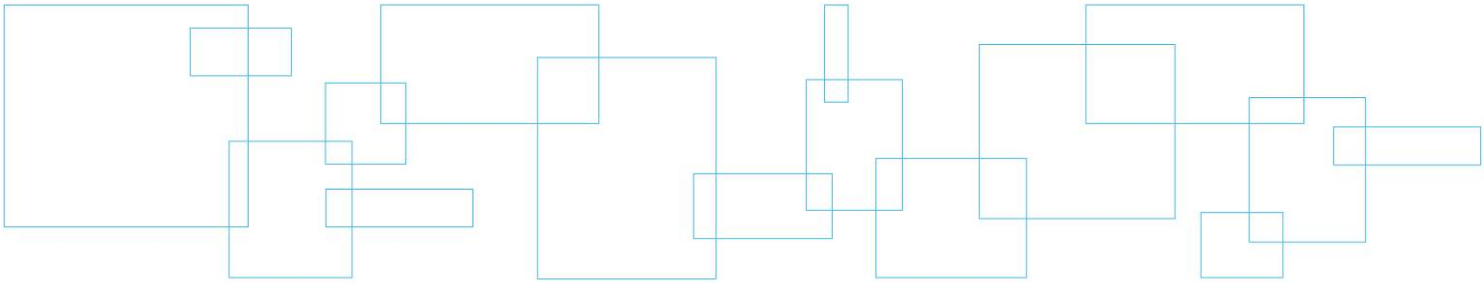
Prepared by: **S. Séguin, tech.**

Approved by: **T. Lampron**

2012-06-14

Page: 1 of 1

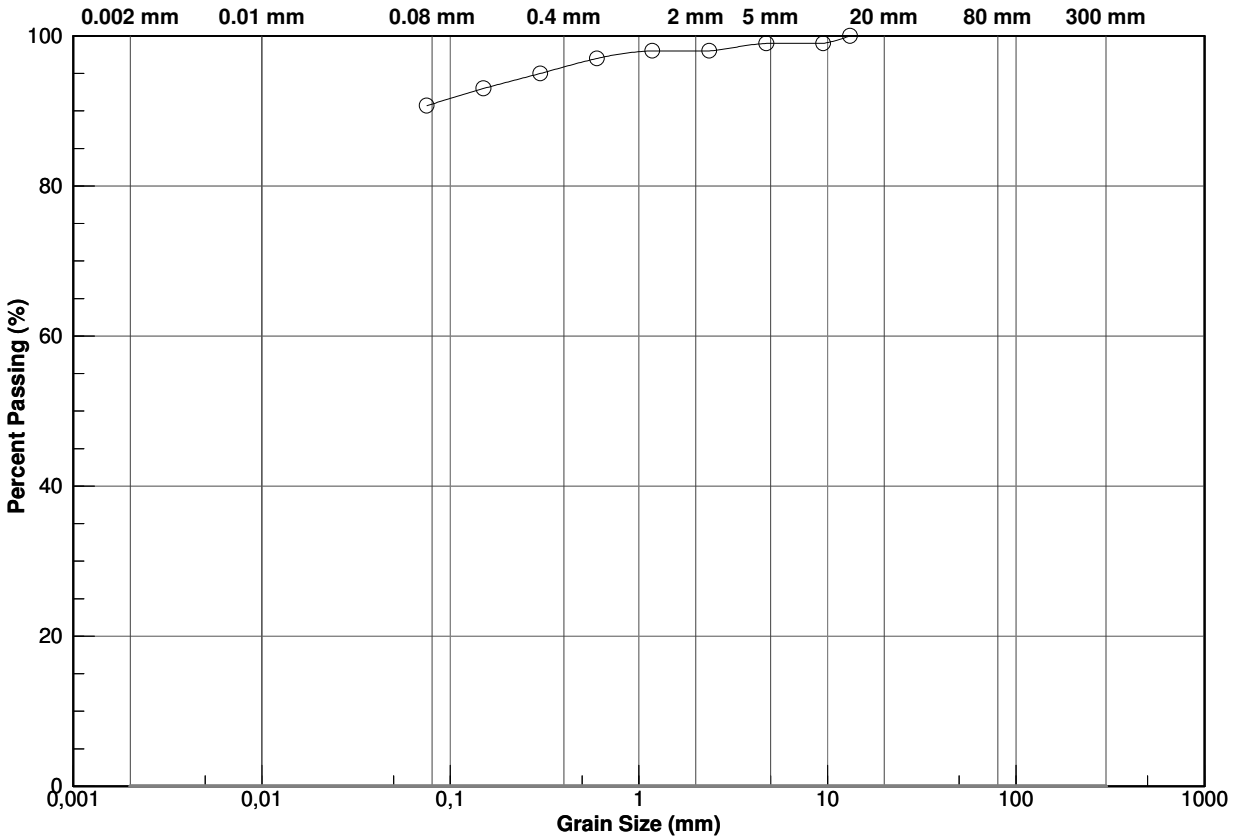
# Appendix 3 Laboratory Test Results



# GRAIN-SIZE ANALYSIS

Project: **Sub-surface Investigation, Various Institutions (Millhaven, Joyceville and Bath)** Figure n° : **1**

Location: **Millhaven Institution, Loyalist, Ontario** File n° : **B-0001193-1**




| CLAY | SILT | SAND | | | GRAVEL | | COBBLE | BOULDER |
|---|---|---|---|---|---|---|---|---|
| | | FINE | MEDIUM | COARSE | FINE | COARSE | | |

| Symbol | Borehole n° | Sample n° | Depth (m) | Description | USCS class. (ASTM D-2487) |
|---|---|---|---|---|---|
| —○— | BH-13-12 | CF-3 | 1.52 - 1.68 | N/A | N/A |

# UNCONFINED COMPRESSIVE STRENGTH OF ROCK CORES

| | |
|---|---|
| Client : **PWGSC** | Date : **2012-06-05** File : **B-0001193-1** |
| | Description of work: **Geotechnical Investigation** |
| Project : **Various Institutions in Kingston** | |
| **(Millhaven and Bath)** | Client Ref.: |

| **SAMPLING OF ROCK CORES** | | | | |
|---|---|---|---|---|
| Laboratory number | : | **B-0001193-1-001** | **B-0001193-1-006** | **B-0001193-1-005** |
| Borehole No | : | **BH-11-12** | **BH-07-12** | **BH-18-12** |
| Core No. | : | **RC-3** | **RC-3** | **RC-4** |
| Length of recovery (m) | : | | | |
| Location | : | **2.26 to 2.52 m** | **2.14 to 2.40 m** | **4.31 to 4.46 m** |
| Sampled by | : | **Sylvain Séguin** | **Sylvain Séguin** | **Sylvain Séguin** |
| Location of boreholes proposed by | : | | | |

| **COMPRESSIVE STRENGTH TESTING** | | | | | |
|---|---|---|---|---|---|
| Conditioning of samples | | Date | **2012-05-24** | **2012-05-24** | **2012-05-24** |
| Compressive strength testing | | Date | **2012-06-05** | **2012-06-05** | **2012-06-05** |
| Preparation of extremities | | : | | | |
| Length after cut | (mm) | : | **164.8** | **166.0** | **144.0** |
| Length after polishing | (mm) | : | **152.6** | **154.2** | **125.4** |
| Diameter of core | (mm) | : | **63.0** | **63.0** | **63.0** |
| Height/diameter ratio (H/d) | | : | **2.422** | **2.448** | **1.990** |
| Correction factor | | : | **1.00** | **1.00** | **1.00** |
| Compressive strength | (MPa) | : | **102.0** | **171.1** | **135.9** |
| Results transmitted to : | | | | Date: | |

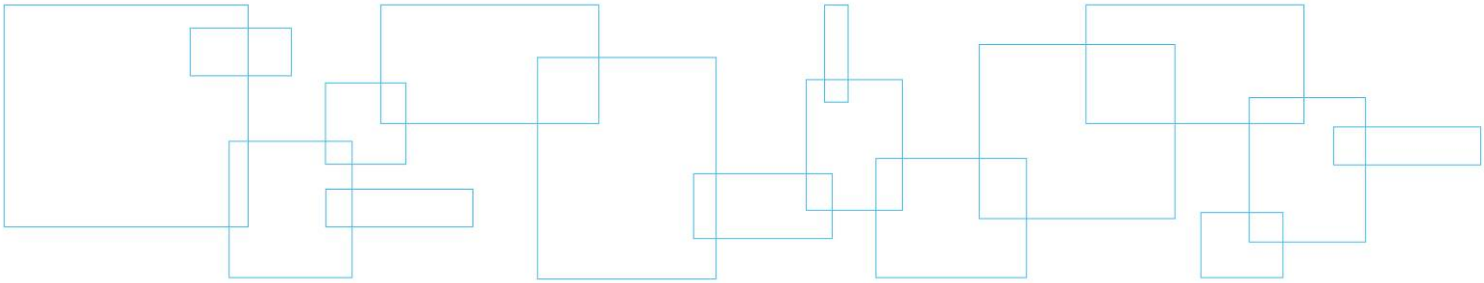
**SAMPLING AND TESTING**

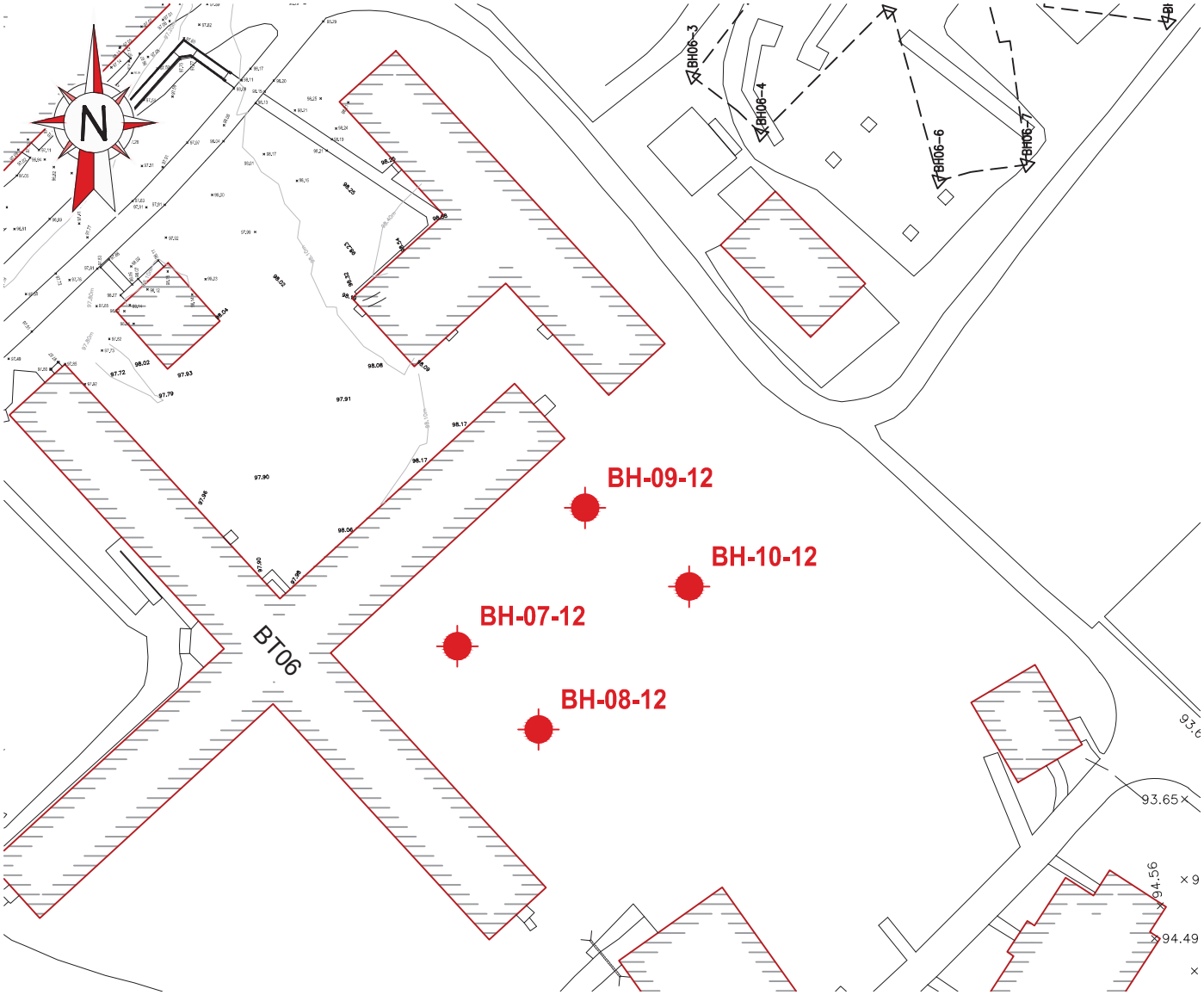
Conditioning : Humidity ☐ Dry ☒

**Remarks:**

| Sanja Tokmacic | Jean-Pierre Lavoie | Jean-Pierre Lavoie. |
|---|---|---|
| Realized by | Verified by | Approved by |

# Appendix 4 Borehole Locations






This document must be used jointly with the recommendations formulated in the geotechnical study report

LEGEND :

**BH-NN-YY** BOREHOLE-NUMBER-YEAR

## SURVEY COORDINATED

| BOREHOLE | NORTH (Y) | EAST (X) | ELEVATION (m) |
|---|---|---|---|
| BH-07-12 | 4894660 | 359891 | N/A |
| BH-08-12 | 4894651 | 359901 | N/A |
| BH-09-12 | 4894676 | 359906 | N/A |
| BH-10-12 | 4894667 | 359918 | N/A |



Project

# PWGSC
# Sub-surface Investigation, Various Institutions (Millhaven, Joyceville and Bath)

Title

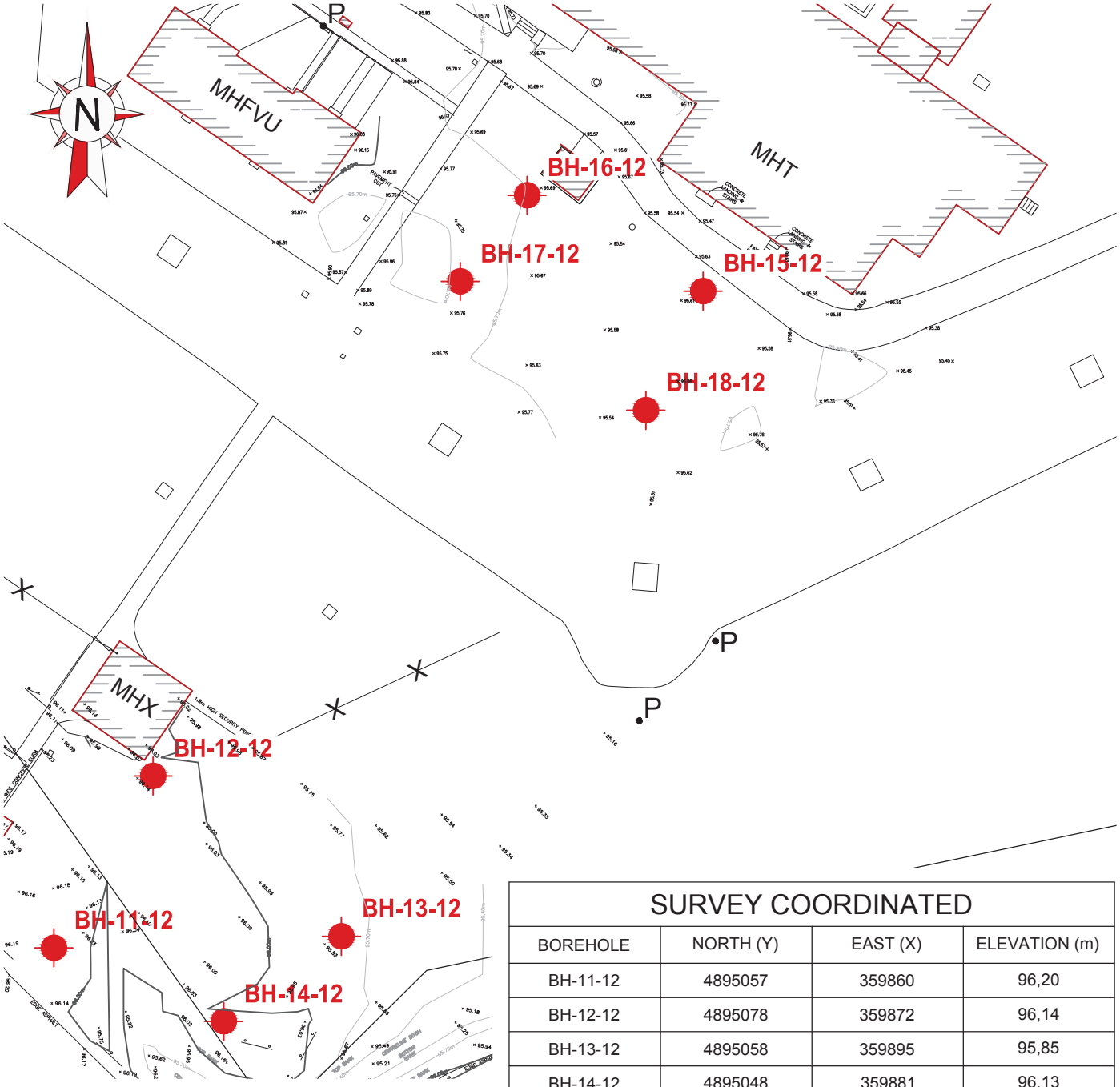
**Boreholes Location**
**Bath Institution**

LVM inc.
556, O'Connor Drive, unit 127
Kingston (Ontario) K7P 1N3
Phone : 613.504.4306
Fax : 613.389.1563

| | | |
|---|---|---|
| Prepared S. Séguin | Discipline GEOTECHNICAL | Project Manager C. Perez |
| Drawn R. FRENETTE | Scale 1:750 | Extract from: Rev.: |
| Checked T. LAMPRON | Date 2012-06-07 | |

| Serv. char. | Project | Wbs | Disc. | Type | Drawing No. | Rev. |
|---|---|---|---|---|---|---|
| 033 | B-0001193 | 1 | GE | D | 0002 | |

G:\033\B-0001193\B-0001193-1IZ5_CAD_INF\033-B-0001193-1.DWG




## SURVEY COORDINATED

| BOREHOLE | NORTH (Y) | EAST (X) | ELEVATION (m) |
|---|---|---|---|
| BH-11-12 | 4895057 | 359860 | 96,20 |
| BH-12-12 | 4895078 | 359872 | 96,14 |
| BH-13-12 | 4895058 | 359895 | 95,85 |
| BH-14-12 | 4895048 | 359881 | 96,13 |
| BH-15-12 | 4895138 | 359940 | 95,61 |
| BH-16-12 | 4895150 | 359918 | 95,69 |
| BH-17-12 | 4895139 | 359910 | 95,76 |
| BH-18-12 | 4895123 | 359933 | 95,55 |

LEGEND :

**BH-NN-YY** BOREHOLE-NUMBER-YEAR



Project

# PWGSC
# Sub-surface Investigation, Various Institutions (Millhaven, Joyceville and Bath)

Title

**Boreholes Location**
**Millhaven Institution**

LVM inc.
556, O'Connor Drive, unit 127
Kingston (Ontario) K7P 1N3
Phone : 613.504.4306
Fax : 613.389.1563

| | | |
|---|---|---|
| Prepared S. Séguin | Discipline GEOTECHNICAL | Project Manager C. Perez |
| Drawn R. FRENETTE | Scale 1:750 | Extract from: Rev.: |
| Checked T. LAMPRON | Date 2012-06-07 | |

| Serv. char. | Project | Wbs | Disc. | Type | Drawing No. | Rev. |
|---|---|---|---|---|---|---|
| 033 | B-0001193 | 1 | GE | D | 0003 | |

G:\033\B-0001193\B-0001193-1IZ5_CAD_INF\033-B-0001193-1.DWG

## Appendix 5 Chemical Analysis Certificate

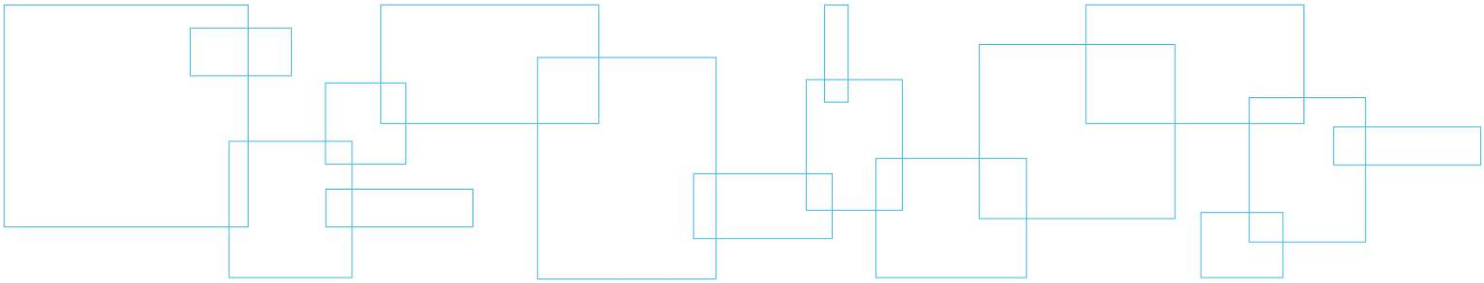


Table 6 : Summary of soil samples results - Toxicity Characteristic Leaching Procedure

| Parametres | Units | Reg 347[1] Sched 4[2] | Analytical results | |
|---|---|---|---|---|
| Samples | | | BH-11-12 SS-1 | BH-18-12 SS-2 |
| Sampling Date | | | 2012-05-22 | 2012-05-22 |
| Depth (m) | | | 0.00 - 0.61 | 0.76 - 1.37 |
| Stratigraphic Unit | | | Fill | Fill |
| Cyanide (free) | mg/L | 20 | < 0.02 | < 0.02 |
| Flash Point | C | | > 70 | > 70 |
| Fluoride | mg/L | 150 | 0,52 | 0,35 |
| NO2+NO3 as N | mg/L | 1,000 | 0,13 | < 0.10 |
| Mercury | mg/L | 0,1 | < 0.001 | < 0.001 |
| Silver | mg/L | 5 | < 0.001 | < 0.001 |
| Arsenic | mg/L | 2,5 | < 0.01 | < 0.01 |
| Boron | mg/L | 500 | 1 | < 1 |
| Barium | mg/L | 100 | 0,8 | 0,5 |
| Cadmium | mg/L | 0,5 | < 0.001 | < 0.001 |
| Chrome | mg/L | 5 | < 0.05 | < 0.05 |
| Lead | mg/L | 5 | < 0.01 | < 0.01 |
| Selenium | mg/L | 1 | < 0.01 | < 0.01 |
| Uranium | mg/L | 10 | < 0.01 | < 0.01 |

Notes:

(1) : Ontario Regulation 558/00 - Waste Management

(2) : Schedule 4 - Leachate Quality Criteria

5,9 : Concentrations higher than the Lowest Effect Level for Unconfined fill

Table 7 : Summary of soil samples results - Inorganics, Metals and PCB

| Paramètres | Units | FQG[1] Table C-2[2] | Analytical results | | |
|---|---|---|---|---|---|
| Samples | | | BH-11-12 SS-1 | BH-13-12 SS-2 | BH-18-12 SS-2 |
| Sampling Date | | | 2012-05-22 | 2012-05-22 | 2012-05-22 |
| Depth (m) | | | 0.00 - 0.61 | 0.76 - 1.37 | 0.76 - 1.37 |
| Stratigraphic Unit | | | Fill | Clay | Fill |
| Electrical Conductivity | mS/cm | | 0,2 | | 0,66 |
| pH | | | 8,5 | | 8,1 |
| Resistivity | ohm-cm | | 5,000 | | 1,520 |
| Sulphate | % | | 0,01 | | 0,07 |
| Total Organic Carbon | % | 1 | 0,46 | 0,62 | 0,72 |
| Total Phosphorus | % | 0.06 | 0,08 | 0,08 | 0,06 |
| Aluminum | ug/g | | 16,400 | 25,300 | 9,130 |
| Barium | ug/g | | 189 | 391 | 121 |
| Beryllium | ug/g | | <1 | <1 | <1 |
| Cadmium | ug/g | 0.6 | <0.5 | <0.5 | <0.5 |
| Chromium | ug/g | 26 | 32 | 49 | 20 |
| Cobalt | ug/g | | 12 | 16 | 6 |
| Copper | ug/g | 16 | 22 | 34 | 13 |
| Iron | ug/g | 20,000 | 24,100 | 34,900 | 15,000 |
| Lead | ug/g | 31 | 16 | 9 | 10 |
| Manganese | ug/g | 460 | 517 | 607 | 280 |
| Molybdenum | ug/g | | <1 | <1 | <1 |
| Nickel | ug/g | 16 | 22 | 33 | 17 |
| Silver | ug/g | | <0.2 | <0.2 | <0.2 |
| Strontium | ug/g | | 139 | 170 | 320 |
| Thallium | ug/g | | <1 | <1 | <1 |
| Vanadium | ug/g | | 44 | 65 | 24 |
| Zinc | ug/g | 120 | 64 | 90 | 37 |
| | | | | | |
| Polychlorinated Biphenyls (PCBs) | ug/g | 0.07 | <0.02 | <0.02 | <0.02 |

Notes:

[1] : Fill Quality Guide and Good Management Practices for Shore Infilling in Ontario

[2] : Table C-2: Unconfined fill Guide Parameter List - Lowest Effect Level

5,9 : Concentration dans la plage B-C des critères de la *Politique* du MDDEP et supérieure aux normes de l'Annexe I du RPRT

300 : Concentration supérieure aux critères C de la *Politique* du MDDEP et supérieure aux normes de l'Annexe II du RPRT

300 : Concentration égale ou supérieure aux normes de l'annexe 1 du Règlement sur l'enfouissement des sols contaminés