**GENERAL**

The following changes are effective immediately and shall be incorporated in the Contract Documents.

**SPECIFICATIONS:**

**SPECIAL PROVISIONS**

1. Specification Section – 01100 – Provisional Items:
   1. Add item 2.3 as follows:

   "**2.3 ITEM NO. P3 – APPLICATION OF ACRYLIC RESURFACER AND COLOUR COATING**

   .1 Include in this provisional lump sum item all costs to supply and install two coats of an Acrylic Resurfacer and three coats of a coloured coating system to the entire Pickleball/Tennis Court Area as shown on drawing D-2 and as described in section 02762."
2. Section 02315 – Excavating, trenching and backfilling
   1. Add the following item:

      "1.11 – Geotechnical Reports

      .1 There was not a project specific geotechnical report completed for this project, but the Town has completed geotechnical investigations on the sites immediately north and south of the subject area. The following three geotechnical reports from previous projects are being made available for reference only:

      .1 Geotechnical Investigation Proposed Prescott Arena – Lascelles Engineering dated May 2019.

      .2 Geotechnical Investigation Proposed Prescott Arena (Alternate Site) – Lascelles Engineering dated December 2019

      .3 Geotechnical Investigation Proposed Prescott Arena – Alternate Site Northeast intersection of Sophia St. and Churchill Road West dated July 2020."
   2. Add the attached three referenced geotechnical reports to the end of section 02315.
3. Add Section 02762 – Textured Acrylic Asphalt Surfacing (attached).
4. Specification Section – 02762 Textured Acrylic Asphalt Surfacing
   1. Modify Item 2.1 – Product as follows:

      "1. Plexipave (ITF Category 3, Medium Pace) as supplied by California Products Corporation and as supplied by Barber Sports Surfaces (905) – 475-1611 or Ancaster Court Surfaces – (905) 648-4444

      2. Sportmaster Acrylic Resurfacer and Sportmaster Picklemaster Colour Top Coat as by Sportmaster Sport Surfaces and as supplied by ChrisSmith Canada Court (613)738-3721."

**DRAWINGS:**

1. Drawing C1.1 – Site Servicing Plan
   1. Change Label on PECB2 to read:

      T/G – 92.22m

      INV. N – 91.34m

      INV. S – 91.33m

      INV. W – 91.53m
2. Drawing D-2 – Sports Court Details
   1. Modify detail 1 – Tennis/Pickleball Courts – Layout Plan as per attached updated drawing D-2.

**QUESTIONS AND ANSWERS**

Q1. Is the construction fence to remain erected throughout the winter months? Does the construction fence require geofabric or privacy screening?

A1. No, it does not need to be maintained through the winter months nor does it require geofabric or privacy screening.

Q2. For the storm drain, it appears that the sub-drain from the play-area is to be tied into PECB2. Should this structure have three inverts? If so what is the NW INV and what is the the T/G?

A2. Refer to changes made in this Addendum.

Q3. There are a number of items "NIC" when it comes to the sports equipment and benches. Could we get a list of what the town is providing and what the contractor is providing? It seems that basketball nets/post, tennis and pickle ball nets/posts/sleeves are all to be supplied by the contractor but would like to confirm.

A3. The Town will be supplying and installing the 3-tier bleachers, player benches, soccer goal/nets. The Town will be supplying the playground equipment for contractor installation, as described on contract drawings. All other works described in drawings and specifications to be completed by contractor.

Q4. Is there information on the playground that the Town is supplying? Is there instructions as to what's involved in assembling it? Do we know that the play structure is CSA certifiable?

A4. The senior play structure and swings was originally supplied by Little Tikes, and the playground layout compliance was CSA certified. The supplier of the Junior equipment is unknown.

Q5. Has the stock pile of material on site to be used been quantified?

A5. This fill material was measured and used in determining the design elevations needed to achieve a relatively balanced cut/fill.

Q6. I see a note that the Town of Prescott is supplying the play equipment. Who is the equipment manufacturer so we can obtain an installation quote?

A6. See answer A4.

Q7. Has a Geotechnical Investigation been completed for this project? If so, could you please provide the report?

A7. There are geotechnical reports completed in the area, intended for other projects. These reports are being made available for information purposes only via this addendum.

Q8. Does the owner have a receiving site available to accept excess materials?

A8. Yes, refer to drawing L-2. Surplus topsoil and fill can be stockpiled in Phase 2 lands.

Q9. Will the AC be indexed on this project?

No.

Q10. The Details/Spec. calls for 47.6mm top rail (which is not typical) and they do not make fittings that fit that diameter of pipe. The standard diameter of top rail is 42.8mm. Can 42.8mm can be used?

A10. 42.8mm top rail can be used.

Q11. The Details/Spec. calls for 1-3/4” x 6 gauge Galvanized mesh. The price of this mesh will be extremely expensive and our supplier is checking to see if they have a machine that can weave it. The standard chain-link mesh is 2“ x 9 gauge. Can you please confirm if this would be acceptable?

A11. 6 gauge mesh is required as specified.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 General Requirements

.1 The General Requirements, Bid Form, Instructions to Bidders, Bid Policies, Special Provisions, The Agreement and the Contract Drawings shall form part of this specification in the same manner as if they were recited in full herewith.

.2 Refer to other Specifications in these Documents to determine their effect upon the work of this section.

### 1.2 Work Included

.1 The Contractor is to supply all necessary labour, materials, tools, services and incidentals to supply and install the specified textured acrylic asphalt surfacing as shown on the drawings and as specified herein.

### 1.3 Related Sections

.1 Section 02740 – Asphalt Paving

### 1.4 References

.1 National Asphalt Paving Association (NAPA)

.2 American Sport Builder Association (ASBA)

.3 Pickleball Canada

.4 Tennis Canada

.5 International Tennis Federation (ITF)

### 1.5 Quality Assurance

.1 Surfacing shall conform to the guidelines of the ASBA for planarity.

.2 All surface coating products shall be supplied by a single manufacturer.

.3 The Contractor shall record the batch number of each product used on the site and maintain it through the warranty period.

.4 The Contractor shall provide the inspector, upon request, an estimate of the volume of each product to be used on the site.

.5 The installer shall be an authorized applicator of the specified system.

.6 The manufacturer's representative shall be available to help resolve material questions.

**1.6 Installer Qualifications**

.1 Installer shall be regularly engaged in construction and surfacing of acrylic tennis courts, play courts or similar surfaces.

.2 Installer shall be an Authorized Applicator of the specified surface system.

**1.7 Submittals**

.1 Provide manufacturer's specifications for components, color chart and installation instructions.

.2 Provide Authorized Applicator certificate from the surface system manufacturer.

.3 Provide ITF classification certificate for the system to be installed.

**1.8 Site Examination**

.1 Verify all site conditions which may affect the performance of this section.

.2 Report in writing all conditions which may adversely affect the work of this section.

.3 Commencement of work implies acceptance of all surfaces and site conditions. No claims for damages or extras after commencement of the work will be accepted, except where such damages or extras are due to conditions which could not be determined prior to construction.

**1.9 Protection**

.1 Protect and maintain completed paving from time of installation until acceptance of work.

.2 Keep areas clean and neat at all times.

.3 Project must comply with Health and Safety, WSIB, Ontario Traffic Control Plan, and a Registered Notice of Project.

**1.10 Warranty**

.1 The Contractor shall warranty all material and workmanship for a period of two (2) years from the date of Preliminary Acceptance / Substantial Performance.

## PART 2 - PRODUCTS

### 2.1 Product

Plexipave (ITF Category 3, Medium Pace), or approved equal.

Colours to be as noted on drawings.

.1 Manufacturer:

California Products Corporation
150 Dascomb Road
Andover, Massachusetts 01810 USA
(800) 225-1141

.2 Suppliers:

Barber Sport Surfaces
P.O. Box 3091
Markham, Ontario L3R 6G4
(905) 475-1611

Ancaster Court Surfaces
1412 Plains Road West
Burlington, Ontario L7T 1H6
(905) 648-4444

## PART 3 - EXECUTION

### 3.1 Weather Limitations

.1 Do not install when rainfall is imminent or extremely high humidity prevents drying.

.2 Do not apply unless surface and air temperature are 10°C and rising.

.3 Do not apply if surface temperature is in excess of 60°C.

### 3.2 Preparation for Acrylic Color Playing System

.1 Clean surfaces of loose dirt, oil, grease, leaves and other debris in strict accordance with manufacturer's directions. Pressure washing will be necessary to adequately clean areas to be coated. Any areas previously showing algae growth shall be treated with Clorox bleach or approved product to kill the organisms and then be properly rinsed.

.2 Holes and Cracks: shall be cleaned in a suitable soil sterilant, as approved by the Consultant, shall be applied to kill all vegetation 14 days prior to use of patching mix according to manufacturer's directions.

.3 Depressions: depressions holding enough water to cover a five cent piece shall be filled with patching mix, as per manufacturer's recommendation. The contractor shall flood all the courts and then allow drainage. Define and mark all areas holding enough water to cover a nickel. After defined areas are dry, prime with tack coat mixture of 2 parts water and 1 part patching mix. Allow tack coat to dry completely. Spread patching mix true to grade using a straight edge (never a squeegee) for strike off. Steel trowel or wood float the patch so that the texture matches the surrounding area. Never add water to mix. Light misting on surface and edges to feather in is allowed as needed to maintain work ability. Allow to dry thoroughly and cure.

.4 No work from this stage on shall commence until an inspector has accepted the surface.

.5 Filler Course: Filler course shall be applied to the clean underlying surface in one application to obtain a total quantity of not less than .06 gallon per square yard based on the material prior to any dilution. Acrylic filler course may be used to pre-coat depression and crack/hole repairs to achieve better planarity prior to fill course application.

1. On new asphalt, two coats of acrylic filler course shall be used to properly fill all voids in the asphalt surface.

2. Mix the ingredients thoroughly using accepted mixing devices and use a 70 Durometer rubber bladed squeegee to apply each coat of acrylic filler course as required.

3. Allow the application of acrylic filler course to dry thoroughly. Scrape off all ridges and rough spots to any subsequent application of acrylic filler course or subsequent cushion or color surface system.

**3.3 Application of Acrylic Color Playing Surface**

.1 All areas to be color coated shall be clean, free from sand, clay, grease, dust, salt or other foreign matters. The Contractor shall obtain the Consultant's approval prior to applying any surface treatment.

.2 Blend color base and acrylic color playing surface with a mechanical mixer to achieve a uniform mixture.

.3 Application shall be made by 50 durometer rubber faced squeegees. The mixture should be poured on the court surface and spread to a uniform thickness in a regular patter.

.4 A total of 3 applications shall be made to achieve a total application rate of not less than .15 gal/sy. No application should be made until the previous application is thoroughly dry.

**3.4 Line Painting**

.1 Line shall be 2” wide unless otherwise noted on the drawings. Lines shall be carefully laid out in accordance with applicable guidelines and details. The area to be marked shall be taped to ensure a crisp line. The line paint shall have a texture similar to the surrounding play surface. Application shall be made by brush or roller at the rate of 150-200 sg./gal.

**3.5 Protection**

.1 Erect temporary barriers to protect coatings during drying and curing.

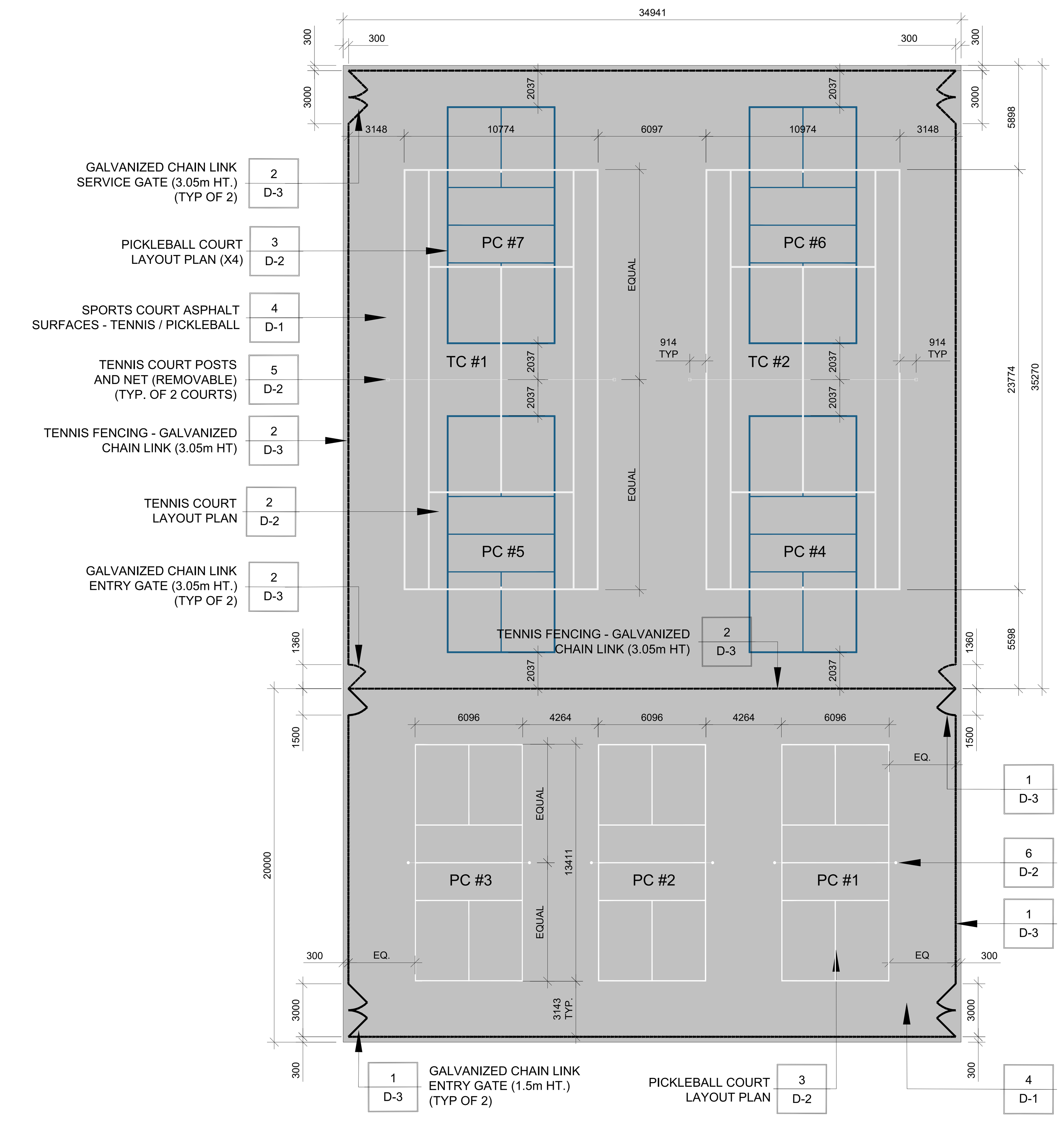
.2 Lock gates to prevent use until acceptance by the Consultant.

**3.6 Clean Up**

.1 Remove all containers, surplus materials and debris. Dispose of materials in accordance with municipal, regional and provincial regulations.

.2 Leave site in a clean and orderly condition.

**END OF SECTION**




ASPHALT SURFACE TO EXTEND 300mm BEYOND FENCE LINES. REFER TO PAVING DETAILS.

COURT PLAYING LINE COLOURS SHALL BE:

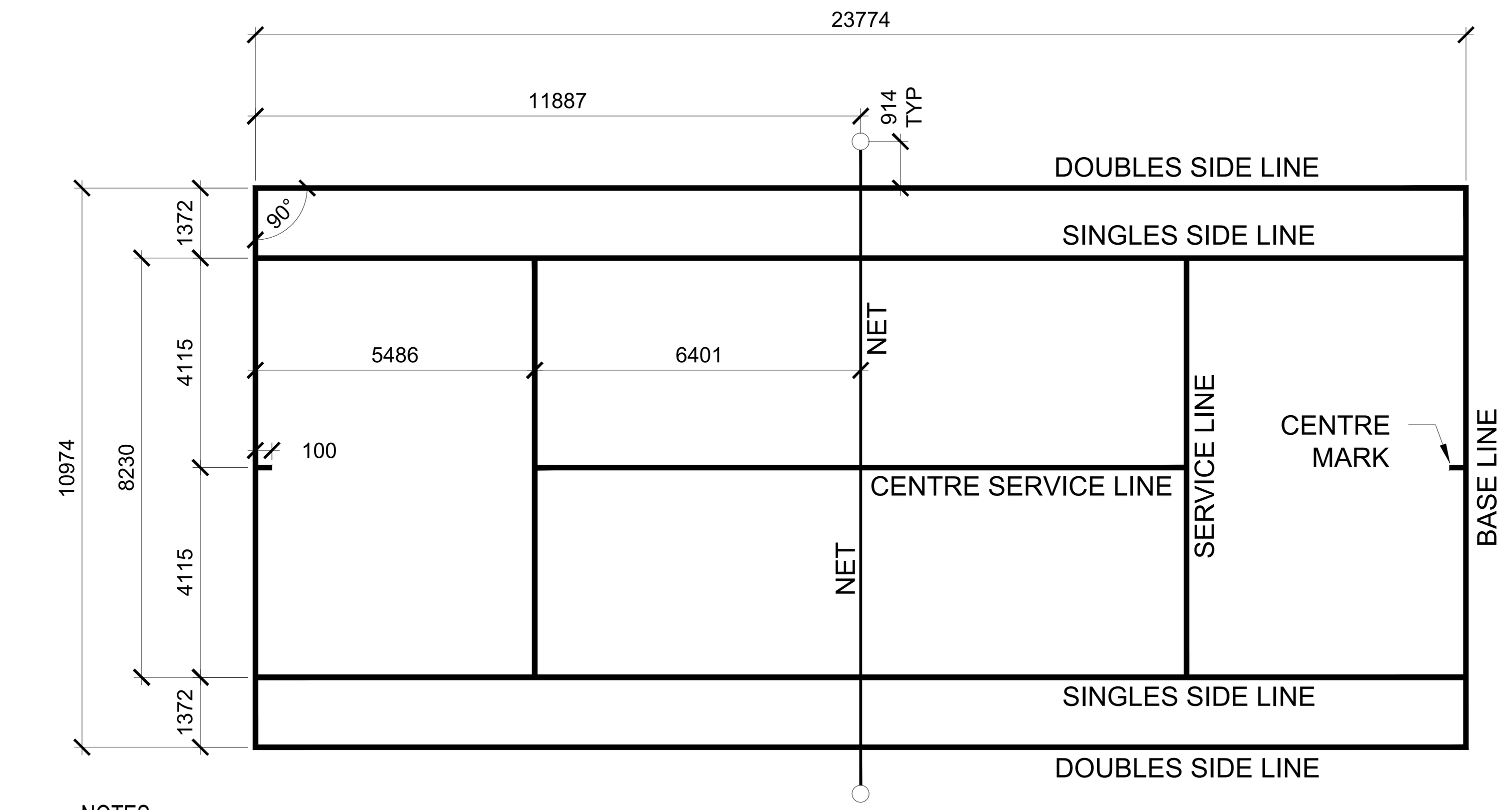
- WHITE ON TENNIS COURTS #1 AND #2.
- WHITE ON PICKLEBALL COURTS #1, #2, AND #3.
- BLUE ON PICKLEBALL COURTS #4, #5, #6, AND #7.
- TENNIS COURT LINES SHALL BE THE PRIMARY LINES ON COMBINATION TENNIS AND PICKLEBALL COURTS.

**PROVISIONAL PRICE ITEMS:**

**TENNIS COURT SURFACE TO BE PLEXIPAVE BY CALIFORNIA SPORTS SURFACES OR APPROVED EQUAL:**
- INNER COURT COLOUR: DARK BLUE
- OUTER COURT COLOUR: MEDIUM GREEN
- TENNIS LINES: WHITE
- PICKLEBALL LINES: LIGHT BLUE

**PICKLEBALL COURT SURFACE TO BE PLEXIPAVE BY CALIFORNIA SPORTS SURFACES OR APPROVED EQUAL:**
- INNER COURT COLOUR: LIGHT BLUE (NON-VOLLEY ZONES) / DARK BLUE (SERVICE AREAS)
- OUTER COURT COLOUR: RED
- PICKLEBALL LINES: WHITE

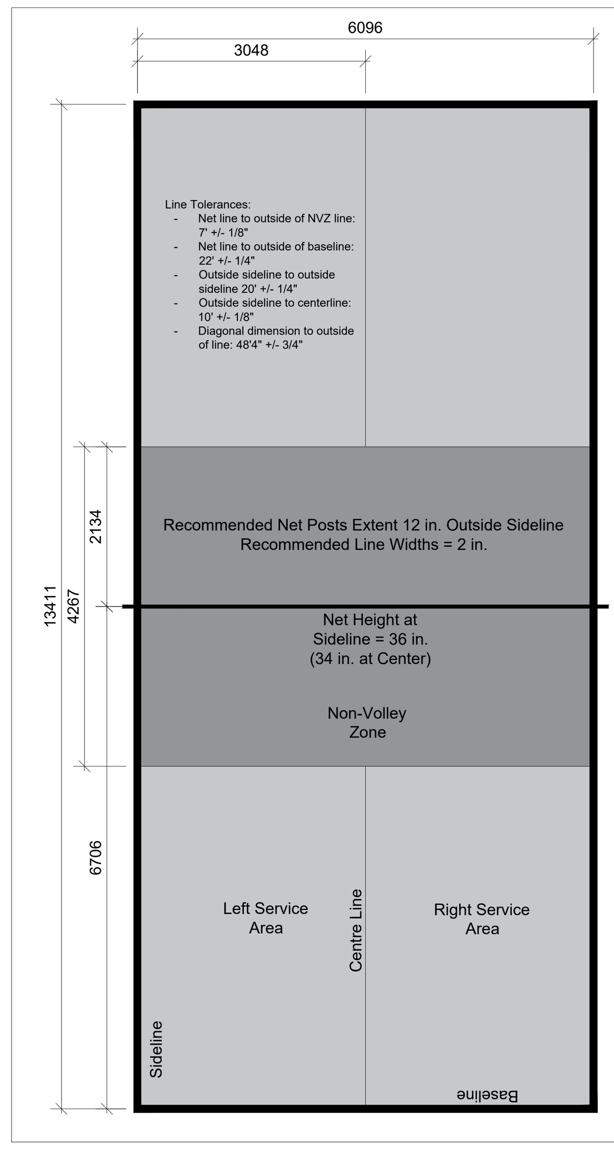
1 TENNIS / PICKLEBALL COURTS - LAYOUT PLAN N.T.S.



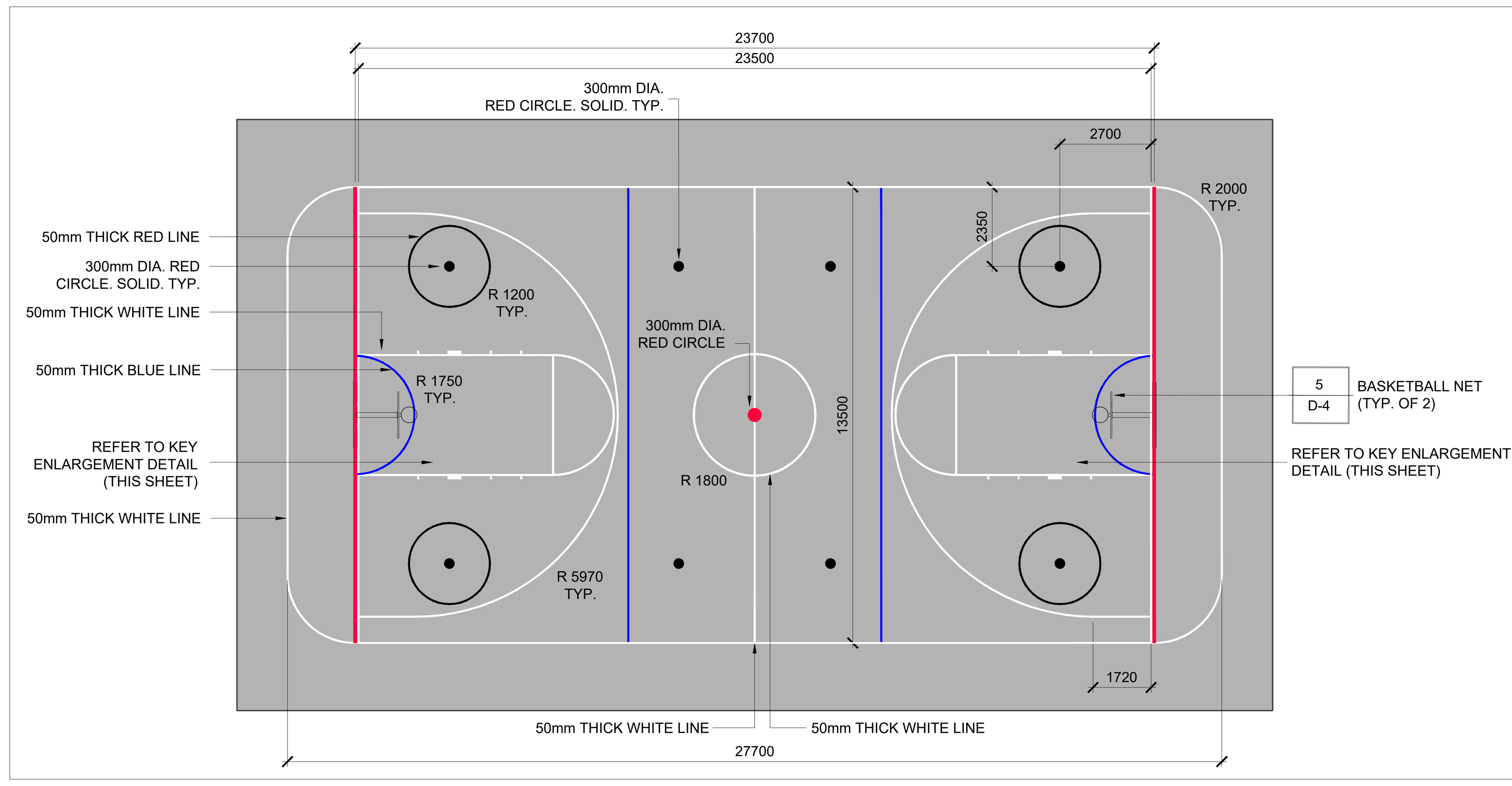

NOTES:

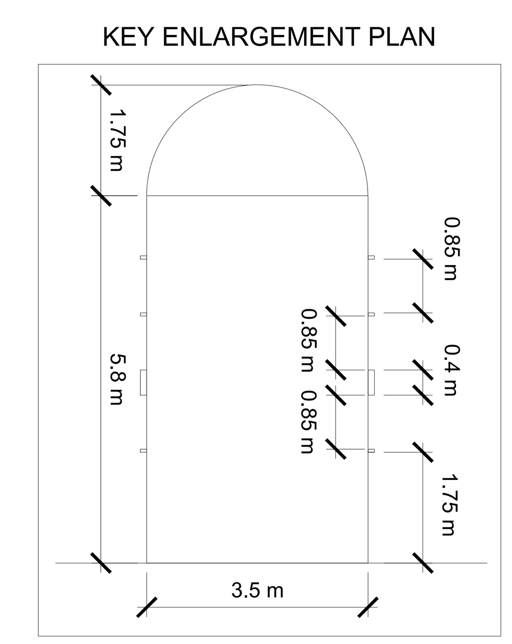
1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE NOTED
2. ENSURE MINIMUM OFFSET FROM ASPHALT EDGES AND FENCES, WHERE APPLICABLE. REFER TO PLAN.
3. ALL TO BE INSTALL PRIOR TO INSTALLATION OF ASPHALT SURFACE.
4. REFER TO SPECIFICATIONS FOR LINE PAINT.
5. ALL LINE PAINTING TO BE 100mm THICK WHITE LINES

2 TENNIS COURT LAYOUT PLAN N.T.S.

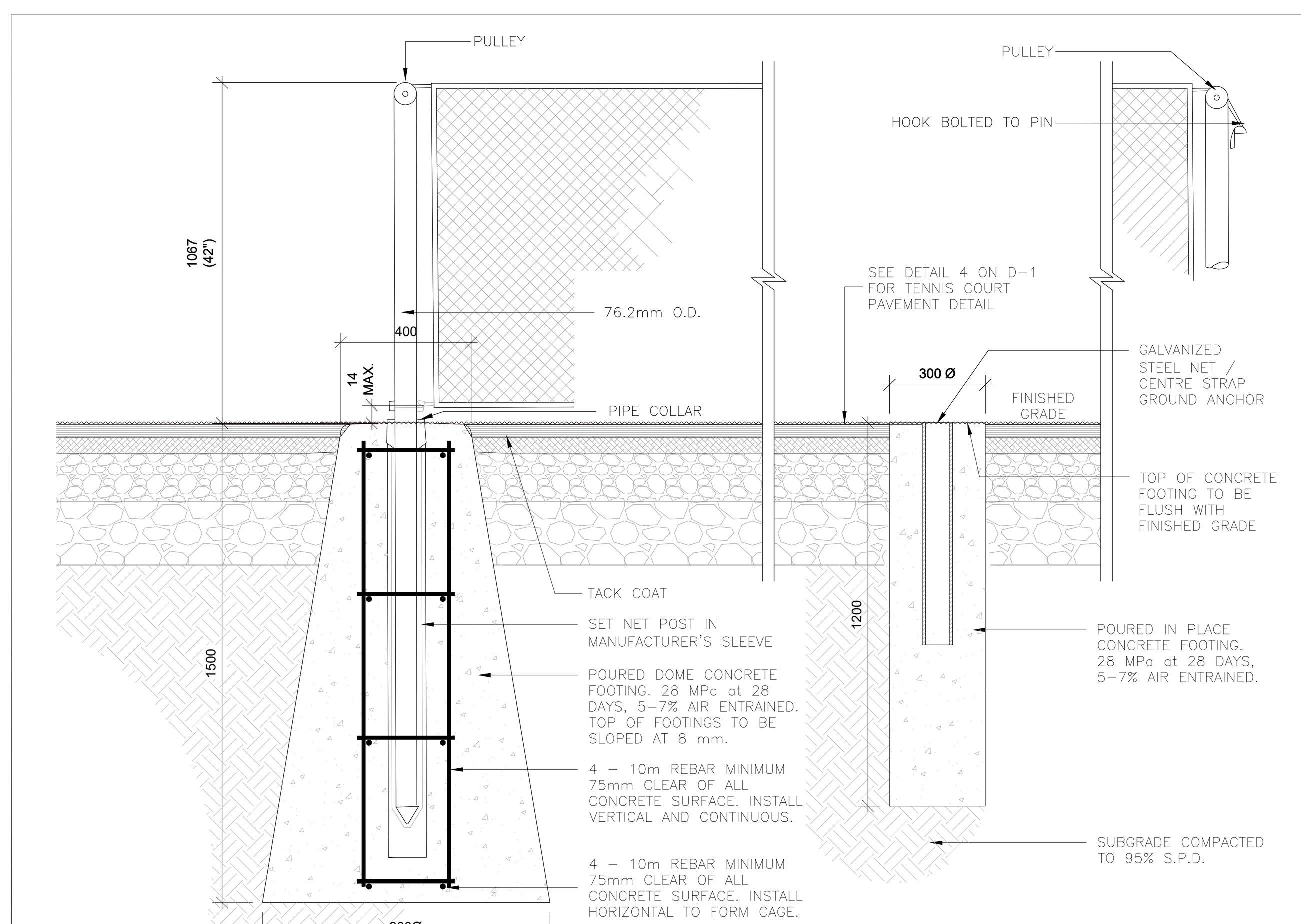



3 PICKLEBALL COURT LAYOUT PLAN N.T.S.



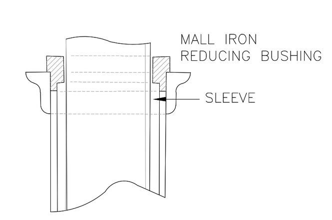




4 MULTI-USE COURT LAYOUT PLAN N.T.S.



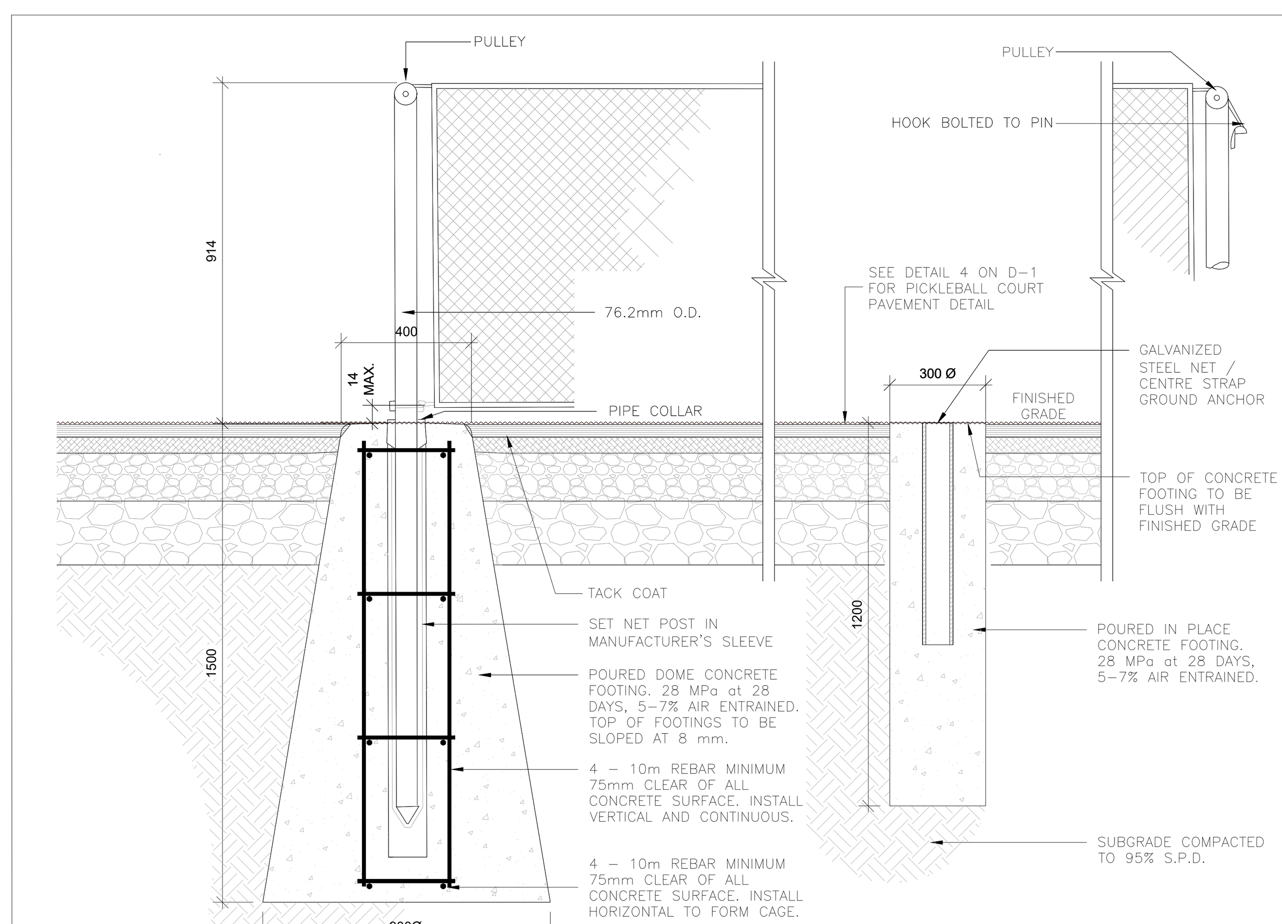

NOTES:

1. CONTRACTOR TO PROVIDE THE FOLLOWING EQUIPMENT FOR EACH COURT:
   1.1. 2 NET POST SOCKETS/SLEEVES WITH CAPS/PLUGS
   1.2. 2 SINGLES STICKS (75mm ø MAX)
   1.3. 2 NET POSTS (1067mm HT.)
   1.4. 1 NET TENSION SYSTEM (NET TENSION TO BE 1.8-2.0 +/- 0.1 kN).
   1.5. 1 CENTRE STRAP (50mm WIDE MAX.)
2. POSTS WITH SLEEVE TO BE MODEL SE-DS-63051 (ROUND / BLACK) BY SPORTS SYSTEMS CANADA OR APPROVED EQUAL.
3. GROUND SLEEVES TO BE MODEL SE-DS-63171 (2-7/8" DIA.) BY SPORTS SYSTEMS CANADA OR APPROVED EQUAL.
4. NETS TO BE MODEL TN-30 (SE-DS-30029) BY SPORTS SYSTEMS CANADA OR APPROVED EQUAL. NET TO BE 1067mm HT. AT SIDELINES AND 914 AT CENTRE WITH A MESH SIZE OF 45-50mm MAX.
5. CENTRE PIPE ANCHORS TO BE MODEL SE-DS63428 BY SPORTS SYSTEMS CANADA OR APPROVED EQUAL.
6. CENTRE STRAPS TO BE MODEL SE-DS-206x BY SPORTS SYSTEMS CANADA OR APPROVED EQUAL.
7. T-PLUGS FOR GROUND SLEEVES TO BE MODEL SE-DS-63420 (ROUND) BY SPORTS SYSTEMS CANADA OR APPROVED EQUAL.
8. ALL COMPONENTS TO BE INSTALLED IN ACCORDANCE WITH MANUFACTURER'S INSTALLATION INSTRUCTIONS.
9. CONTRACTOR TO PROVIDE SHOP DRAWINGS FOR APPROVAL BY LANDSCAPE ARCHITECT.



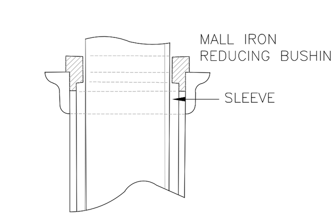

SECTION OF PIPE COLLAR

5 TENNIS COURT POST AND NET (REMOVABLE) N.T.S.




NOTES:

1. CONTRACTOR TO PROVIDE THE FOLLOWING EQUIPMENT FOR EACH COURT:
   1.1. 2 NET POST SOCKETS/SLEEVES WITH CAPS/PLUGS
   1.2. 2 NET POSTS (914mm HT.)
   1.3. 1 NET TENSION SYSTEM (NET TENSION TO BE 1.8-2.0 +/- 0.1 kN).
   1.4. 1 CENTRE STRAP (50mm WIDE MAX.)
2. POSTS WITH SLEEVE TO BE MODEL SE-DS-63075 (ROUND / BLACK) BY SPORTS SYSTEMS CANADA OR APPROVED EQUAL.
3. GROUND SLEEVES TO BE MODEL SE-DS-63171 (2-7/8" DIA.) BY SPORTS SYSTEMS CANADA OR APPROVED EQUAL.
4. NET TO BE MODEL SE-DS-20105 BY SPORTS SYSTEMS CANADA OR APPROVED EQUAL. NET TO BE 914mm HT. AT SIDELINES AND 863mm AT CENTRE WITH A MESH SIZE OF 45-50mm MAX.
5. CENTRE PIPE ANCHORS TO BE MODEL SE-DS63428 BY SPORTS SYSTEMS CANADA OR APPROVED EQUAL.
6. 6. CENTRE STRAPS TO BE MODEL SE-DS-206x BY SPORTS SYSTEMS CANADA OR APPROVED EQUAL.
7. T-PLUGS FOR GROUND SLEEVES TO BE MODEL SE-DS-63420 (ROUND) BY SPORTS SYSTEMS CANADA OR APPROVED EQUAL.
8. ALL COMPONENTS TO BE INSTALLED IN ACCORDANCE WITH MANUFACTURER'S INSTALLATION INSTRUCTIONS.
9. CONTRACTOR TO PROVIDE SHOP DRAWINGS FOR APPROVAL BY LANDSCAPE ARCHITECT.




SECTION OF PIPE COLLAR

6 PICKLEBALL COURT POST AND NET (REMOVABLE) N.T.S.

Key Plan - N.T.S.


## Sports Court - Colour Playing Lines:

1. All line widths shall be sport specific and as identified on the drawings.
2. Line paint shall be Plexicolour Line Paint or approved equal.
3. Line paint shall be:
   3.1. Suitable for use over asphalt or tar emulsion surfaces including slurry coats.
   3.2. 100% acrylic emulsion type containing no alkyds, butadiene styrene, or vinyls, and shall be diluted with water only.
   3.3. Suitable for application by brush or roller.
4. All materials used in the paint shall be of good commercial quality entirely for the purpose intended under normal use.
5. The Contractor shall verify all site conditions and report (in writing) to the Client Representative all conditions that may adversely affect the work.
6. Asphalt surface preparation shall be as per the manufacturer's requirements.
7. Lines shall be carefully laid out in accordance with applicable guidelines and details.
8. Install materials as per manufacturer's instructions.
9. Protect and maintain completed work from time of installation until acceptance of the work.
10. Remove all containers, surplus materials and debris. Dispose of materials in accordance with municipal, regional and provincial regulations.

| No | Date | Revisions | By |
|---|---|---|---|
| 1. | 08.30.2024 | Issued for Tender | JJ |
| 1. | 07.31.2024 | Issued for Client Review | JJ |



ONTARIO ASSOCIATION OF LANDSCAPE ARCHITECTS Jonathan D. Joyce OALA MEMBER

Designed By

North Arrow

Client:

PRESCOTT EST 1784 THE FORT TOWN

Consultant:
the mbtw group
landscape architecture | urban design | design guidance | architecture | golf design | leisure design
255 Wicksteed Ave., Unit 1A | Toronto, Ontario, Canada M4H 1G8
T: (416) 449-7767 | F: (416) 449-1803 | www.mbtw-wai.com

DO NOT SCALE DRAWINGS:
Contractors must check and verify all site conditions. Notify the Owner's Representative in writing before proceeding with the work if discrepancies are evident between the drawings and the site condition. No extras to the contract will be allowed if discrepancies were evident prior to start of work.

Project Name: PRESCOTT RECREATION COMPLEX

Landowner: Town of Prescott

Sheet Title: SPORTS COURT DETAILS

| Designed: | Drawn: | Scale: | Drawing No.: |
|---|---|---|---|
| JJ | JJ | ~ | D-2 |
| Date of Drawing: JULY 2024 | | Job No.: TOP002 | |

# GEOTECHNICAL INVESTIGATION
# PROPOSED PRESCOTT ARENA
# SOPHIA STREET, PRESCOTT, ONTARIO

Prepared for

EVB Engineering Ltd.
Attn: Mr. Greg Esdale, P. Eng.
208 Pitt Street
Cornwall, Ontario
K6J 3P6

By

Lascelles Engineering & Associates Limited
1010 Spence Avenue – Suite 14
Hawkesbury, Ontario
K6A 3H9

LASCELLES
ENGINEERING & ASSOCIATES

Lascelles File No: 180480 May 2019

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## TABLES



## APPENDICES

# 1 INTRODUCTION

The Town of Prescott, through a consulting agreement with EVB Engineering Ltd. (EVB), retained the services of Lascelles Engineering & Associates Ltd. (Lascelles) to conduct a geotechnical investigation for a proposed new arena to be constructed on a vacant piece of land fronting Sophia Street within the Town's industrial park.

The purpose of the investigation was to identify the subsurface soil and groundwater conditions within the proposed project area by means of a limited number of test pits and boreholes, and based on the factual information obtained, provide preliminary guidelines on the geotechnical engineering aspects of the design of the proposed foundations and roadways, including construction considerations which may influence the said design.

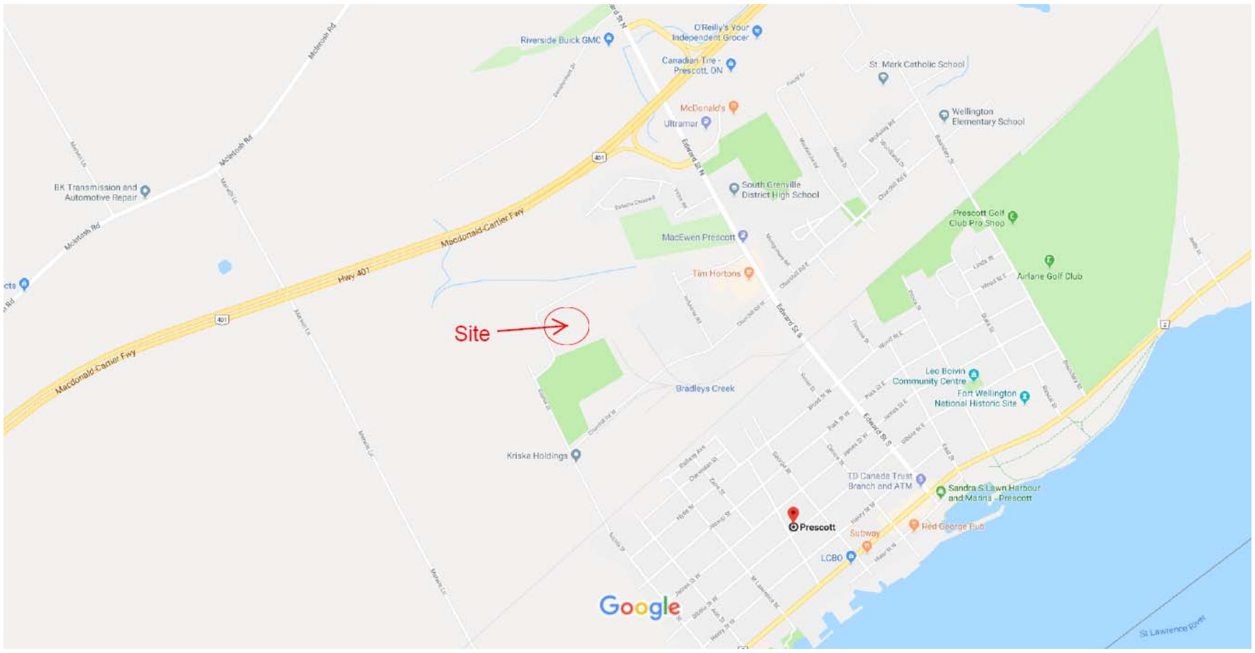
Should there be any changes in the design features, which may relate to the guidelines provided in the report, Lascelles Engineering & Associates Ltd. should be advised in order to review the report recommendations.

# 2 PROJECT AND SITE DESCRIPTION

The site under consideration is located within the western portion of the Town of Prescott and within its industrial park. Refer to **Figure** 1 for location.

The site is currently vacant, has no civic address and fronts Sophia Street. The property has an irregular rectangular shape being about 180m wide (east-west) by 190m deep (north-south) for an approximate surface area of 3.42ha (8.45acres). The site is fairly flat and low lying with some areas lacking surficial drainage. It is covered with overgrown wild grasses along with scattered shrubs and trees.

**Figure 1: Site Location**

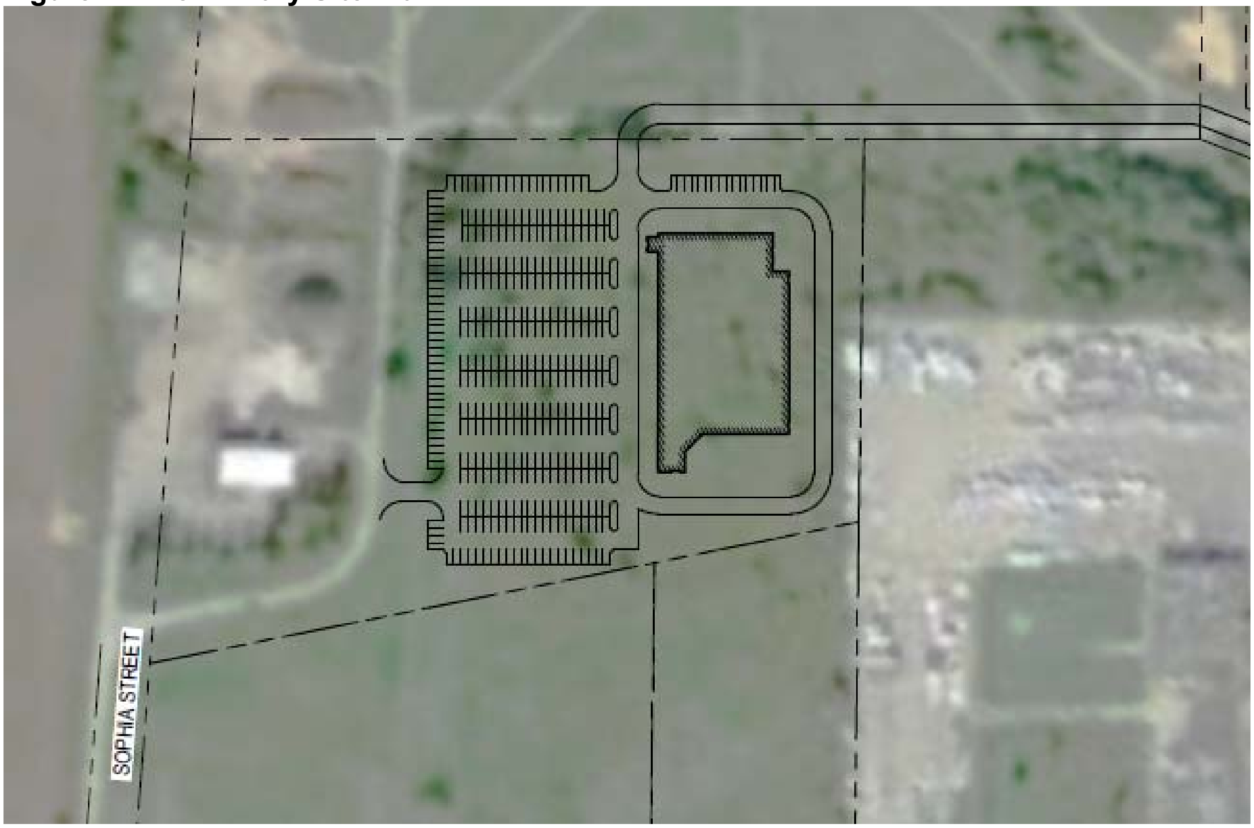



It is our understanding that the project will consist of the construction of an arena having a total surface area of about 4,410m$^2$. The arena building will consist of a one-storey structure for the area of the ice surface and spectator seating. The remaining portion of the arena will consist of a two-storey structure, which will hold the amenities such as change rooms, canteen, washroom, community rooms, a lobby with a viewing area, mech/elec room, etc. No basement is proposed for this building. Access lanes and a large parking area are also proposed. The said building will be serviced by municipal water and sewers. A preliminary concept plan prepared by EVB is presented as part of **Figure 2**.

## 3 PROCEDURE

The fieldwork for this investigation was carried out in two (2) phases; a preliminary investigation and a detailed investigation. The preliminary investigation was performed on December 05, 2018 and consisted of digging eight (8) test pit (TP-1 to TP-8) to establish the surficial soil and groundwater conditions across the property of the arena location. The approximate locations of the test pits were plotted on a Google Earth aerial photograph and are presented in **Appendix A**. Prior to any fieldwork, the test pit locations were cleared for the presence of any underground services and utilities.

**Figure 2: Preliminary Site Plan**




The test pits were completed using a backhoe operated by Ken Miller Excavating. The test pits were taken to depths of 2.74 to 3.66m below ground surface (bgs). Upon completion, the test pits were backfilled with the excavated overburden materials and lightly compacted. The fieldwork was supervised throughout by a member of our engineering staff who monitored the digging of the test pits, coordinated the testing of the materials and logged the subsurface conditions encountered at each location. Sampling of the overburden materials encountered in the test pits was carried out by means of grab samples taken either directly from the excavation walls or from the bucket of the excavator.

Standpipes were installed in four (4) of the test pits prior to backfilling them to measure the static groundwater level in the area. The standpipes consisted of 25mm diameter PVC piping that were slotted and placed within the overburden prior to backfilling them. The standpipes were used strictly to establish the static water level of the overburden water table.

Upon assessing and reviewing the preliminary findings, it was concluded that a more detailed investigation was required to establish the deeper soil deposits as well as the depth of the bedrock. Consequently, a borehole drilling program was established. The detailed investigation was carried out between February 20 to 22, 2019, where six (6) boreholes were drilled on the property of the arena; which are referred to as BH-14 to BH-19. The approximate locations of the boreholes were plotted on a Google Earth aerial photograph and are presented in **Appendix A**. It is noted that BH-1 to BH-13 were part of a separate investigation carried out on the road/street leading up to the proposed arena and the future municipal services, and therefore, will be presented in a separate report.

The boreholes were advanced using a track mounted drill rig equipped with continuous flight hollow stem augers supplied and operated by George Downing Estate Drilling Inc. A “two man” crew experienced with geotechnical drilling operated the drill rig and equipment. The boreholes were advanced by auguring through the overburden down to auger refusal over the inferred bedrock encountered between 14.78m to 17.22m below ground surface (bgs).

Sampling of the overburden materials encountered in the boreholes was carried out at regular depth intervals using a 50mm diameter drive open conventional split spoon sampler in conjunction with standard penetration testing (“N” value). In addition, field vanes were conducted on the cohesive soil encountered.

All soil samples collected from test pits and boreholes were placed and sealed in plastic bags to prevent loss of moisture. The recovered soil samples collected were classified based on visual and tactile examination and the results of the in-situ testing (standard penetration test and field vane).

Upon auger refusal, BH-16 was were further advanced by core drilling techniques using an NQ-size (ø47.7mm) double-tube wire line core barrel from 14.78m to 16.23m bgs in order to confirm the bedrock. The recovered cores were visually described, measured and placed in core boxes for further identification and observation by our geotechnical engineer.

The fieldwork was supervised throughout by a member of our engineering staff who supervised the digging of the test pits and the drilling of the boreholes, coordinated the testing of the materials, cared for the samples collected and logged the subsurface conditions encountered at each location. All soil and rock samples were transported to our office for further examination by our geotechnical engineer. All samples collected during this project will be kept in storage for a period of six (6) months at which time, they will be disposed of, unless a written or verbal notice is received, requesting otherwise.

All boreholes were surveyed and located using a GPS (Global Positioning System) receiver using NAD 83 (North American Datum). An elevation survey of the test pits and boreholes was also conducted using a laser level and referenced to a temporary benchmark given to the top of flange of the fire hydrant located on the west side of Sophia Street fronting the southwest corner of the site under investigation; assumed elevation 100.00m (refer to location in **Appendix A**).

# 4 SUBSURFACE SOIL AND GROUNDWATER CONDITIONS

## 4.1 General

A review of the surficial geology maps for this area suggests that the site would be within transitional geological units consisting of Champlain Sea Sand gradually changing northerly to Champlain Sea Clay.

The Champlain Sea Sand is described as uniform buff sand, commonly reworked by wind into dunes, while the Champlain Sea Clay is described as blue-grey clay, silty clay to silt, which is locally overlain by thin layer of sand. The drift thickness within this area varies significantly to shallow bedrock increasing in depth northerly to more than 20m. The bedrock for this area consists of either the March Formation (southern portion) or the Oxford Formation (northern portion). In this area, the March is described interbedded sandstone, dolostone and sandy dolostone, while the Oxford formation is described as dolostone.

The subsurface conditions encountered in the test pits and boreholes were classified based on visual and tactile examination of the materials recovered from the test pits and boreholes and the results of the in-situ testing and field observations. The soil descriptions presented in this report are based on commonly accepted methods of classification and identification of soil employed in geotechnical practice. Classification and identification of soil involves judgement and Lascelles does not guarantee descriptions as exact, but infers accuracy to the extent that is common in current geotechnical practice.

The subsurface soil conditions encountered at each borehole location are given in the Test Pit and Borehole Logs presented in **Appendix B**. These logs indicate the subsurface conditions encountered at specific test locations only. Boundaries between zones on the logs are often not distinct, but are rather transitional and have been interpreted as such.

## 4.2 Topsoil

Topsoil was encountered in all test pits and boreholes conducted across the site. The thickness of the topsoil was measured to be 150mm to 610mm and is described as dark brown sandy loam. The topsoil was found resting over sand-silt deposit in all test pit and borehole.

The material classified as topsoil was based on colour and the presence of organic materials and is intended as identification for geotechnical purposes only. This does not constitute a statement as to the suitability of this layer for cultivation and sustaining plant growth.

## 4.3 Sand-Silt Deposit

A sand-silt deposit was encountered in all test pits and boreholes conducted on this property. The composition of deposit varies with depth and generally starts with a sand layer at the surface, which is described as uniform, fine grained with some silt to silty. It is brown in colour near the surface with some reddish oxidation stains, and becomes greyish brown with depth. The sand become progressively more silty with depth and changes to a silt-sand mixture (silty sand to sandy silt) and starts to contain trace to some clay. The silt and clay content continue to increase with depth and the deposit changes to silt and eventually clayey silt on approaching to the clay stratum. Thin beds and horizons of pure sand or silt are also found within this deposit.

The soil layer was found to be in a compact to loose state with some areas being in a very loose state. Finally, the deposit was found to be moist to wet and very sensitive below the water table. Several samples of this soil unit were submitted for laboratory testing, which included gradation and hydrometer analysis. The following **Table 1** presents a summary of the analysis results, while the laboratory reports are presented in **Appendix C.**

**Table 1: Laboratory Analysis Summary – Sand-Silt**

| Test Pit and Bore Hole | Sample # | Depth (m) | Percent for each soil gradation | | | |
|---|---|---|---|---|---|---|
| | | | Gravel (%) | Sand (%) | Silt (%) | Clay (%) |
| TP-3 | S2 | 3.60 | 0 | 37.1 | 62.9 | |
| TP-7 | S1 | 0.90 | 0 | 83.7 | 16.3 | |
| BH-14 | SS3 | 3.0 – 3.6 | 0 | 37.1 | 62.9 | |
| BH-18 | SS-2 | 1.5 – 2.1 | 0 | 58.7 | 41.5 | |
| BH-19 | SS-6 | 3.8 – 4.4 | 0 | 38.6 | 61.4 | |
| BH-14 | SS5 | 6.1 – 6.7 | 0 | 1.20 | 52.8 | 46.0 |
| BH-17 | SS4 | 4.5 – 5.2 | 0 | 11.8 | 74.2 | 14.0 |

The samples would be classified as SP-SM (poorly graded sand to silty sand to silt-sand mixture) to SM-SC (silt-sand to clay-sand mixture) as per the unified classification system. All test pits were terminated within this deposit, however, the boreholes established that this deposit extends 6.09m to 7.62m bgs and rests over a clay deposit.

### 4.4 Clay

A clay deposit was found underlying the sand-silt layer in all boreholes. It is described as silty, with traces of sand, grey in colour and with very stiff to hard (Cu. greater than 110 kPa – over-consolidated) consistency and of low plasticity. Several samples of the clay unit were submitted for laboratory analysis that consisted of hydrometer and Atterberg Limits. The hydrometer was carried out on a sample collected from BH-18 (SS9) between the depths of 12.2m and 12.8m bgs. The analysis revealed that the clay contains no gravel, 1.7% of sand, 36.3% of silt and 62% clay. The Atterberg limits test indicates that the clay samples have a liquid limit varying between 30.4 and 40.9 percent, a plastic limit varying between 17.0 and 20.0 percent and the plasticity index varies between 13.3 and 20.9 percent. The clay is classified as low plasticity clay (CL) as per the Unified Soil Classification System. The clay layer was found to extend to 13.7m to 16.7m bgs and rest over a glacial till deposit in all boreholes. A summary of the Atterberg Limit results and Hydrometer analysis is presented in **Table 2** below, while the laboratory reports are presented in **Appendix C**.

**Table 2: Laboratory Analysis Summary – Clay**

| Borehole | Sample # | Depth (m) | Moisture content (percent) | | |
|---|---|---|---|---|---|
| | | | Liquid limit | Plastic Limit | Plasticity Index |
| BH-14 | SS-106 | 13.7 – 14.3 | 30.4 | 17.0 | 13.3 |
| BH-18 | SS-5 | 6.1 – 6.7 | 40.9 | 20.0 | 20.9 |

| Borehole | Sample # | Depth (m) | Percent for each soil gradation | | | |
|---|---|---|---|---|---|---|
| | | | Gravel (%) | Sand (%) | Silt (%) | Clay (%) |
| BH-18 | SS9 | 12.2 – 12.8 | 0 | 1.7 | 36.3 | 62.0 |

### 4.5 Glacial Till

A thin deposit (0.25m to 1.52m thick) of glacial till was encountered in all boreholes mantling the bedrock. The till was described as sandy to clayey with some gravel. It is grey in colour, in compact to dense state and wet.

### 4.6 Bedrock

Auger refusal over bedrock was encountered in all boreholes between the depths of 14.78m and 17.23m bgs. The bedrock was cored in BH-16 (1.45m run) to confirm the quality of the rock, which is the shallowest refusal obtained. The bedrock is described a light grey sandy dolostone. The bedrock is relatively sound with very little weathering observed at its surface. The rock core recovery was measured to be 96%, while the Rock Quality Designation (RQD) was calculated to be 77%, which is indicative of good bedrock quality. A picture of the recovered rock cores from BH-16 is presented as part of **Appendix B**.

### 4.7 Groundwater Conditions

It is noted that the during the digging of the test pits, minor groundwater infiltrations were observed originating from the sand-silt deposit as noted in the test pit logs. The static water level was measured within the standpipes installed within TP-3, TP-4, TP-5 and TP-8 using a water meter on April 11, 2018 and results are shown on the test pit logs presented in **Appendix B**. The depth of the groundwater was found to range from 0.10m to 1.35m bgs. These water levels would be considered the seasonal high water table (spring freshet) considering time of year of the measurement and that the site lacks drainage, and consequently, it is anticipated that the water table would be slightly lower during the drier summer months.

It should be noted that groundwater levels could fluctuate with seasonal weathered conditions, (i.e.: rainfall, droughts, spring thawing) as well as from any changes in the water level of the nearby river. In addition, it can be locally affected by the presence of existing ditches and underground services trenches at or in the vicinity of the site.

# 5 GEOTECHNICAL CONSIDERATIONS

## 5.1 General

This section of the report provides general engineering guidelines on the geotechnical design aspects of the project based on our interpretation and review of the information obtained from the test pits and boreholes as well as the project requirements.

It is our understanding that the project will consist of the construction of an arena that has a total surface area of about 4,410m$^2$. The arena building will consist of a one-storey structure for the area of the ice surface and spectator seating. The remaining portion of the arena will consist of a two-storey structure, which will hold the amenities such as change rooms, canteen, washroom, community rooms, a lobby with a viewing area, mech/elec room, etc. No basement is proposed for this building. Access lanes and a large parking area are also proposed. The said building will be serviced by municipal water and sewers. A preliminary concept plan prepared by EVB is presented as part of **Figure 2**.

## 5.2 Foundations

The current investigation confirmed that the site is underlined by a sand-silt deposit that is in saturated condition and is in compact and to loose state. Under seismic loading, portions of this soil layer would be considered liquefiable and could settle above allowable tolerances generally acceptable in structural design (greater than 25mm). Therefore, it is not recommended to found the proposed arena building on this surficial soil deposit. Discussions with a soil improvement specialist concluded that the deposit was too fine and contained clay, and therefore, could not be properly compacted to ensure a uniform bearing capacity. Consequently, deep pile foundations extending to the bedrock should be considered.

It is recommended that the proposed arena structure be supported on end bearing piles driven to refusal over the underlying bedrock. The depth to bedrock was established to range at about 14.78m and 17.22m bgs. The overburden found on this site consists of a sand-silt deposit followed by a silty clay deposit resting over a thin (less than 1.5m) layer of sandy to clayey glacial till. Therefore, it is unlikely that the piles will encounter significant obstructions during the piling activities.

For driven piles, the use of steel H-piles or steel tube piles filled with concrete are considered acceptable and would have the structural capacity to support the anticipated loads of the proposed building. To minimize the potential damage to the pile tips during driving, the piles should be provided with a driving shoe as per OPSD standards 3000.100 and 3001.100, for H-pile and steel tube piles, respectively. For steel piles founded over bedrock, the anticipated design valued of the factored resistance at Ultimate Limit State (USL) and the Serviceability Limit State (SLS) should be equal to the structural capacity of the pile. When the pile is properly founded on bedrock, the settlement of the pile head is directly dependent of the elastic compression of the pile from the applied load.

As a design example, the allowable load on a 245mm diameter steel pipe pile with a wall thickness of 8.9mm could be taken as 915 kilonewtons. This assumes that the steel has a minimum yield strength of 340 MPa and that the pipe pile is filled with 30MPa concrete. Pipe piles should be equipped with a base plate having a thickness of at least 20mm to limit damage to the pile tip during driving.

The structural design of the piles shall consider the downdrag load due to potential settlement following an earthquake, unless this load is eliminated by using special measures, such as covering the exterior surface of the piles with a relevant coating, or other appropriate means. It is recommended to use the following equation to calculate the drag down loading on a pile.

$Q_n = q_n * C * D_n$

C: circumference of the shalt of the pile
$q_n$: unit negative skin friction along the shaft of the pile $q_n = \beta * \sigma'_v$
$D_n$ : length of the pile submitted to downdrag; for this site the depth would be the first xm.
$\beta$: combine shaft resistance factor
$\sigma'_v$ : vertical effective stress adjacent to the pile at the concerned depth.

All of the piles should be driven to refusal. The driving resistance criteria will be highly dependent on the required allowable load and the contractor's pile driving equipment. Typically, for drop hammer type piling rigs available in the Eastern Ontario, a refusal criterion of 20 blows for the last 25 millimetres of penetration would be sufficient to achieve the above allowable loads, assuming that about 27 kilojoules of energy is transferred to the pile per blow. The contractor should be required to submit to the geotechnical engineer a copy of the proposed pile size, piling equipment, methodology and driving resistance criteria prior to construction. The pile foundations shall be designed according to Part 4 of the Ontario Building Code (latest edition).

An allowance should be made in the specifications for this project for re-striking all of the piles at least once to confirm the design set and/or the permanence of the refusal and to check for upward displacement due to driving adjacent piles. Piles that do not meet the design set criteria on the first re-strike should receive additional re-striking until the design set criteria are met. All re-striking should be performed after 48 hours of the previous set. Furthermore, the specifications for this project should make provisions for dynamic load tests on test piles and for dynamic testing and analysis on selected production piles to verify the driving resistance criteria and pile capacities. The post construction settlement of elements of the structure, other than the elastic shortening of the piles, should be negligible for end bearing piles driven to refusal over bedrock.

### 5.3 Grade Raise Restrictions

Due to the high-water table at this site, it is very likely that the site will require the finished grade to be raised. In considering that the existing underlying clay deposit is over-consolidated, the maximum allowable grade raise for this site would be 2.5m above the existing grades.

### 5.4 Seismic Design

Based on the results of the geotechnical investigation, the subsurface at this property can be classified as a Class "E" as per the Site Classification for Seismic Site Response in accordance with the latest version of the Ontario Building Code. It is noted that a greater seismic site response class may be obtained by carrying out seismic velocity testing using a multichannel analysis of surface waves (MASW).

## 5.5 Liquefaction Potential

The investigation has identified the presence of a saturated sand-silt deposit across the site that is in a loose state, and therefore, has the potential for liquefaction under seismic loading. The liquefaction potential, as well as the magnitude of settlement, was verified by comparing the cyclic shear stresses (i.e., represented as the cyclic stress ratio [CSR] applied to soil by the design earthquake to the cyclic shear strength (i.e., represented as cyclic resistance ratio [CRR]) offered by the soil.

The CSR is primarily a function of the total and effective overburden pressures, ground acceleration, and earthquake magnitude specific to the site. As part of this analysis, an earthquake of 7.5 magnitude with a peak ground acceleration (PGA) of 0.224g at a probability of exceedance of 2% in 50 years was used as per the Ontario Build Code.

The CRR is primarily related to the relative density of clean sand soil (i.e. less than 5 percent fines). The relative density of a soil is typically measured using in-situ testing techniques such as the Standard Penetration Test (SPT) using hollow-stem auger drilling methods and an automated hammer system. These in-situ test results ("N" values) are then normalized to account for various factors such as effective overburden pressure, penetration energy, and fines content of the soil, and the groundwater level estimated for the site. With these corrections (Seed et al, 1985), “N” values were corrected to a standardized parameter $(N_1)_{60cs}$ (i.e., corrected to an overburden pressure of 1 ton per square foot [96 kilopascals], 60 percent of the theoretical penetration energy, and an equivalent clean sand). The Factor of Safety (FS) against soil liquefaction can be expressed by the ratio of CRR/CSR; generally, a factor of safety over 1.4 is considered safe.

The following **Table 3** presents a summary of the estimated settlement that could occur at each borehole location based on the information collected during the drilling operation and the above noted calculations:

**Table 3: Estimated Settlement from liquefaction**

| Borehole | Estimated total settlement (mm) |
|---|---|
| BH-14 | 87.7 |
| BH-15 | 70.2 |
| BH-16 | 32.9 |
| BH-17 | 52.1 |
| BH-18 | 103.9 |
| BH-19 | 32.5 |

In conclusion, the analysis reveals that sand-silt layer could be subjected to settlement in the range of 32.5mm to 103.9mm under seismic loading. The analysis also suggests that two adjacent boreholes located in the southern portion of the site yield the lowest settlement value; BH-16 (32.9mm) and BH-19 (32.5mm) respectively. It is therefore recommended that the proposed arena building should be moved in the southern portion of the site (rotate 90 degree and face north) in order to limit the settlement of soil during a potential seismic event.

### 5.6 Slab-on-Grade Construction

As noted herein, subsurface settlement could occur as a result of soil liquefaction under seismic loading of the sand-silt soil stratum underlying this site. At the recommended location of the arena building (southern portion of the site), the estimated settlement would be range from 32.5 to 32.9mm, which exceeds the generally accepted tolerance of 25mm under normal circumstances. Should these anticipated settlements be considered acceptable to the designer and the owner, where under a seismic event that would create soil liquefaction, some minor aesthetic damages could be sustained to the concrete slabs of the building, then a slab-on-grade construction would be possible. Otherwise, all floor slabs will need to be designed as structural slab and be supported by the pile foundations.

For predictable performance of the proposed concrete floor slab-on-grade, it shall rest over native soil or structural fill only. Furthermore, the proposed concrete floor slab-on-grade shall be set 0.3m above the high-water table establish at this site, if no drainage system is provided. Therefore, all organic, deleterious or otherwise objectionable fill material encountered shall be removed from the building’s footprint. The native surficial sand layer will provide a minimum bearing capacity of 25 kPa for the design of the slab. The modulus of subgrade reaction (ks) for the design of the slabs set over till is 18 MPa/m.

The exposed native subgrade surface should be inspected and approved by geotechnical personnel once it has been stripped of topsoil. Any soft areas evident should be sub-excavated and replaced with suitable engineered fill however disturbances should be minimized as much as possible.

Any underfloor fill needed to raise the general floor grade shall consist of OPSS Granular B Type I material or an approved equivalent, compacted to 98 percent of its SPMDD. The final lift shall be compacted to 100 percent of its SPMDD. In order to create a bridging layer in the event of soil liquefaction, a 400mm layer of OPSS Granular A material shall be placed under the slab and compacted in maximum lifts of 200mm, and to at least 100 percent of the SPMDD.

In order to minimize and control cracking, the floor slab shall be provided with wire or fibre mesh reinforcement and crack control joints. The crack control joints should be spaced equal distance in both directions and where possible not exceeding a spacing of 4.5 metres. The mesh reinforcement should be carried through the joints.

## 5.7 Frost Protection

All exterior pile cap system, and those located in any unheated portion of the proposed arena building should be provided with at least 1.5m of earth cover for frost protection purposes. Exterior pile cap system constructed in areas that are to be cleared of snow during the winter period should be provided with at least 1.7m of earth cover for frost protection purposes. Alternatively, the required frost protection could be provided using a combination of earth cover and extruded polystyrene insulation. Lascelles should review the detailed design of frost protection with the use of equivalent insulation prior to construction.

In the event that foundations are to be constructed during winter months, foundation soils are required to be protected from freezing temperatures using suitable construction techniques. Therefore, the base of all excavations should be insulated from freezing temperature immediately upon exposure, until the time that heat can be supplied to the building interior and footings have sufficient soil cover to prevent freezing of the subgrade soils.

## 5.8 Foundation Drainage

It is our understanding that the proposed arena building will not contain any basement level, including crawl spaces, pipe chase, etc. and that the finished grade of all interior floors will be constructed at higher elevation than the finished ground elevation near the building. Consequently, perimeter drainage is not required.

In order to reduce the potential for ponding of water adjacent to the foundation walls, roof water should be controlled by a roof drainage system that directs water away from the building and the exterior grade should be sloped to promote water away from the foundation walls.

## 5.9 Foundation Wall Backfill

To prevent possible lateral loading on the grade beams, the backfill against the beams should consist of free draining, non-frost susceptible material such as sand or sand and gravel meeting OPSS Granular B Type I grading requirements. The foundation fill should be compacted in 300mm thick lifts, and to 95 percent of its SPMDD using light compaction equipment, where no loads will be set over top. Where the backfill material will ultimately support a pavement structure, walkways or slabs, it is suggested that the foundation wall backfill material be compacted in 200mm thick lifts, and to 98 percent of the SPMDD. The backfilling against foundation walls should be carried out on both sides of the wall at the same time.

## 5.10 Retaining Walls and Shoring

The following **Table 4** below provides the suggested soil parameters for the design of retaining wall and/or shoring systems. For excavations near existing services and structures, the coefficient of earth pressure at rest ($K_o$) should be used.

**Table 4: Material Properties for Shoring and Permanent Wall Design (Static)**

| Type of Material | Bulk Density ($kg/m^3$) | Pressure Coefficient | |
|---|---|---|---|
| | | Active ($K_a$) | At Rest ($K_o$) |
| Clay | 18 | 0.45 | 0.80 |
| Sand | 19 | 0.33 | 0.50 |
| Till | 22 | 0.27 | 0.50 |
| Granular B Type I | 20 | 0.33 | 0.50 |
| Granular B Type II | 23.1 | 0.31 | 0.47 |
| Granular A | 23.5 | 0.27 | 0.43 |

The above values are for a flat surface behind the wall, a straight wall and a wall friction angle of 0 degrees. The designer should consider any difference between these coefficients, and make appropriate corrections for a sloped surface behind the wall, angled wall or wall friction as required. The bearing capacity for the design of a retaining wall are the same as provided for the building structures provided it is founded over native soil or properly prepared and approved structural fill.

Retaining walls should also be designed to resist the earth pressures produces under seismic conditions. The use of the combined coefficients of static and seismic earth pressure is recommended, referred to as $K_{AE}$ for active conditions and $K_{PE}$ for passive conditions for routine design purposes.

The total active and passive loads under seismic conditions can be calculated using the following two equations;

$P_{AE} = ½ K_{AE} \gamma H^2 (1-k_V)$
$P_{PE} = ½ K_{PE} \gamma H^2 (1-k_V)$
Where;
$K_{AE}$ = Combined Static and Seismic Active Earth Pressure Coefficient
$K_{PE}$ = Combined static and seismic passive earth pressure coefficient
H = Total Height of the Wall (m)
$K_h$ = horizontal acceleration coefficient
$K_v$ = vertical acceleration coefficient
$\gamma$ = bulk density ($kg/m^3$)

These equations are based on a horizontal slope behind the wall and a vertical back of the retaining wall and zero wall friction. For this site, the following design parameters were used to develop the recommended $K_{AE}$ and $K_{PE}$ values.

A = Zonal acceleration ratio = 0.2
$K_h$ = Horizontal acceleration coefficient = 0.1
$K_V$ = Horizontal acceleration coefficient = 0.067

The above value of $K_h$ corresponds to ½ of the A value and the value $K_V$ of corresponds to 0.67 of the $K_h$ value. The angle of friction between the soil and the wall has been set at 0° to provide a conservative estimate. The following **Table 5** provides the parameters for seismic design of retaining structures.

**Table 5: Material Properties for Shoring and Permanent Wall Design (Seismic)**

| Parameter | OPSS Granular B Type I | OPSS Granular A, Granular Fill and Granular B Type II | Clay and Clayey Material |
|---|---|---|---|
| Bulk Unit Weight, γ (kN/m$^3$) | 20 | 23.3 | 18 |
| Effective Friction Angle (degrees) | 30 | 32 | 28 |
| Angle of Internal Friction Between wall and Backfill (degrees) | 0 | 0 | 0 |
| **Yielding Wall** | | | |
| Active Seismic Earth Pressure Coefficient ($K_{AE}$) | 0.37 | 0.33 | 0.45 |
| Height of the Application of $P_{AE}$ from the base of the wall as a ration of its height (H) | 0.36 | 0.37 | 0.36 |
| Passive Seismic Earth Pressure Coefficient ($K_{PE}$) | 3.06 | 3.48 | 4.0 |
| Height of the Application of $P_{PE}$ from the base of the wall as a ration of its height (H) | 0.30 | 0.30 | 0.30 |

# 6 Potential of Corrosive Environment

## 6.1 Sulphate Attack on Buried Concrete

Two (2) soil samples collected from TP-4 (S1 – 3.0m bgs) and TP-8 (S1 – 2.0m bgs) were submitted for a sulphate analysis. The laboratory analysis was performed was performed by Paracel Laboratories Ltd, an accredited chemical testing laboratory. The results of the analysis found the soil to contain a sulphate concentration of 14 µg/g and less 5 µg/g or 0.014 % and less 0.005%). The laboratory Certificates of Analysis are presented in **Appendix D.**

Based on the CAN/CSA - A23.1 standards (Concrete Materials and Methods of Concrete Construction), a sulphate concentration of 0.1% (1000 µg/g) or less in soil falls within the negligible category for sulphate attack on buried concrete. As such, buried concrete for foundation or manholes will not require any special additive to resist sulphate attack and the use of normal Portland cement is acceptable.

### 6.2 Corrosivity Analysis for Buried Steel

The two (2) noted samples were also submitted for analysis of pH, Resistivity and Redox Potential. The purpose of this testing was to assess the potential for corrosive environment on any buried steel (i.e. piles). The laboratory Certificates of Analysis are presented in **Appendix D**.

The potential for an aggressive corrosive soil environment was established in reviewing the above measured parameters and according to standard provided by the American Water Works Association (AWWA) C-105/A21.5-10. Based on the noted standard, corrosion protection for buried steel is only required where a corrosivity index of 10 or greater is encountered. Based on the results, the calculated corrosivity index was found to be less than 10. As such, any buried steel as part of this project would not require any special or specific corrosion protection measures.

## 7 Excavation and Groundwater Control

### 7.1 Excavation Requirements

It is anticipated that shallow excavation in the overburden would not exceed 3.0m bgs for the foundation and the installation of the associated underground services. Most of the shallow excavation will be through sand-silt deposit. According to the Ontario's Occupational Health and Safety Act (OHSA), O. Reg. 213/91 and its amendments, the surficial overburden anticipated to be excavated into at this site can be classified as Type 3 for fully drained excavations. Therefore, shallow temporary excavation in the overburden soil classified as Type

3 can be cut at 1 horizontal to 1 vertical for a fully drained excavation starting at the base of the excavation and as per requirements of the OHSA regulations. If excavation occurs into saturated soil or if the water table is not lowered below the depth of the excavation, the soil should be classified as Type 4 and as such would require to slope the excavation to 3 horizontal to 1 vertical or shallower from the base of the excavation.

Any excavated material stockpiled near a trench or open excavation should be stored at a distance equal to or greater than the depth of the excavated soil within the trench or open excavation and equipment circulation should be restricted away from the top of the slope excavation.

In the event that the aforementioned slopes are not possible to achieve due to space restrictions, the excavation should be shored according to OHSA O. Reg. 213/91 and its amendments. A geotechnical engineer should design and approve the shoring and establish the shoring depth under the excavation profile. Refer to the parameters provided in **Tables 4 and 5** in **Section 5.10** for use in the design of any shoring structures. The excavation for the underground services could be carried out within tightly fitting, braced steel trench boxes, approved by a professional engineer.

### 7.2 Groundwater Control

Groundwater seepage and infiltration entering shallow and temporary excavations performed within the overburden should be mitigated by pumping from sumps installed in the excavation. Surface water runoff into the excavation should be avoided and diverted away from the excavation.

It is anticipated that the invert of underground services may be founded below the water table. The overburden consists of sand-silt deposits, which are within a compact to loose state and sensitive below the water table and consequently, may also be susceptible to piping and scouring from water pressure at the base of the excavation. Special consideration should be given to water control such as pre-pumping using wells or sand points. Furthermore, the base of the excavation should not be exposed for prolonged periods of time and should be backfilled as soon as possible.

### 7.3 Pipe Bedding Requirements

It is recommended that the bedding for any underground service be placed over native material or structural fill only. Consequently, any fill or organic material should be removed from the loading influence of the proposed underground service. It is anticipated that any sewers or watermain installed as part of this project will be founded over silty sand to sandy silt deposit.

Bedding, thickness of cover material and compaction requirements for the underground services should conform to the manufacturers design requirements and to the requirements and detailed installations outlined in the Ontario Provincial Standard Specifications (OPSS) and any applicable standards or requirements from the Town of Prescott.

Where the invert of an underground service will be founded below the groundwater table and within sand and silt deposit, these soils may be sensitive to disturbances and may also be susceptible to piping and scouring from water pressure at the base of the excavation. Therefore, special precautions should be taken in these areas to stabilize and confine the base of the excavation such as using recompression (thicker bedding) and/or dewatering methods (pre-pumping). In order to properly compact the bedding, the water table should be kept at least 0.30m below the base of the excavation at all time during the installation of the underground services.

As an alternative to Granular A bedding and only where wet conditions are encountered, the use of “clear stone” bedding, such as 19mm clear stone, OPSS 1004, may be considered only in conjunction with a suitable geotextile filter. Without proper filtering, there may be entry of fines from native soils and trench backfill into the bedding, which could result in loss of support to the pipes and possible surface settlements.

The sub-bedding, bedding and cover materials should be compacted in maximum 200mm thick lifts to at least 95 percent of the standard Proctor maximum dry density (SPMDD) using suitable vibratory compaction equipment.

### 7.4 Trench Backfill

All service trenches should be backfilled using compactable material, free of organics, debris and large cobbles or boulders. Acceptable native materials should be used as backfill between the roadway subgrade level and the depth of seasonal frost penetrations (i.e. 1.8 metres below finished grade) in order to reduce the potential for differential frost heaving between the new excavated trench and the adjacent section of roadway. Where native backfill is used, it should match the native materials exposed on the trench walls. Any boulders larger than 300 millimetres in size should not be used as trench backfill. Backfill below the zone of seasonal frost penetration could consist of either acceptable native material or imported granular material conforming at minimum to OPSS Granular B Type I.

To minimize future settlement of the backfill and achieve an acceptable subgrade for the roadway, the trench should be compacted in maximum 300mm thick lifts to at least 95 percent of the SPMDD. The specified density may be reduced where the trench backfill is not located within or in close proximity to existing roadways or any other structures.

## 8 SUITABILITY OF ON-SITE SOILS

The surficial overburden found at this project locations consists of silty sand to sandy silt and is considered frost susceptible and is not recommended for engineered fill or backfilling against foundation wall or underneath concrete slabs. The existing overburden could be reused as general backfill material (service trenches, general landscaping/backfilling), if the material can be compacted according to the specifications outlined herein at the time of construction. Any boulders larger than 300mm in size should not be used as service trench backfill. Any imported material should conform to OPSS Granular B- Type I.

It should be noted that the adequacy of a material for reuse as backfill will depend on its water content at the time of its use and on the weather conditions prevailing prior and during that time. Therefore, all excavated materials to be reused should be stockpiled in a manner that will minimise any significant changes in its moisture content, especially during wet conditions. Any excavated materials proposed for reuse as part of this project should be stockpiled in order to allow the material to be properly inspected and approved prior to reuse by a geotechnical engineer.

# 9 PAVEMENT DESIGN

For predictable performance of the pavement areas, any objectionable fill, organic, soft or deleterious materials should be removed from the proposed pavement areas to expose native undisturbed subgrade soil or properly compacted fill. The exposed subgrade should be inspected and approved by geotechnical personnel and any evidently loose and unstable areas should be sub-excavated and replaced with suitable earth borrow approved by the geotechnical engineer. Following approval of the preparation of the subgrade, the granular subbase may be placed.

It is anticipated that the subgrade soils for the new parking and access road will consist of silty sand to sandy silt. The construction of access road and parking areas will be acceptable over this subgrade once that all organic material, objectionable fill or otherwise deleterious material are removed from the subgrade. The recommended pavement structures for the proposed light duty parking areas and heavy duty access roads (fire route) are provided below.

For light vehicle parking areas and access lanes, the pavement structure should consist of:

50 millimetres of hot mix asphaltic concrete surface layer (HL3) over
150 millimetres of OPSS Granular A base over
350 millimetres of OPSS Granular B, Type II subbase

For heavy duty access roads, the pavement should consist of:

40 millimetres of hot mix asphaltic concrete surface layer (HL3) over
50 millimetres of hot mix asphaltic concrete binder layer (HL8) over
150 millimetres of OPSS Granular A base over
450 millimetres of OPSS Granular B, Type II subbase

The base and subbase granular materials should conform to OPSS Form 1010 material specifications. Prior to importing any granular material onto the site, it should be tested and approved by a geotechnical engineer prior to delivery to the site and should be compacted to 100% SPMDD. Compaction of the granular pavement materials should be carried out in maximum 200 mm thick loose lifts to 100% of its SPMDD using suitable vibratory compaction equipment.

The Job Mix Formula (JMF) of the asphaltic concrete should be in accordance with OPSS 1150 for Material Specification for Hot Mix Asphalt. The asphaltic concrete should be placed in accordance to OPSS 310 for Construction Specification for Hot Mix Asphalt. The asphaltic concrete should compacted to a minimum of 92% of the Maximum Relative Density. The JMF and its constituents should be reviewed, tested and approved by a geotechnical engineer prior to delivery to the site.

## 9.1 Paved Areas and Subgrade Preparation

The proposed access lanes and parking areas should be stripped of vegetation, topsoil, debris and other obvious objectionable fill material. Following the backfilling and satisfactory compaction of any underground service trenches up to the subgrade level, the subgrade should be shaped, crowned and proof-rolled using heavy roller with any resulting soft areas sub-excavated down to an adequate bearing layer and replaced with approved backfill. Following approval of the preparation of the subgrade, the pavement structure may be placed.

If the roadway subgrade is disturbed or wetted due to construction operations or precipitation, the granular thicknesses given above may not be adequate and it may be necessary to increase the thickness of the Granular B Type II subbase and/or incorporate a non-woven geotextile separator between the roadway subgrade surface and the granular subbase material.

For areas of the site that require the subgrade to be raised, the material should consist of OPSS Granular B Type 1 or approved equivalent. Any materials proposed for this use should be approved by the geotechnical engineer before placement. Materials used for raising the subgrade to the proposed roadway subgrade level should be placed in maximum 300 mm thick loose lifts and be compacted to at least 95% of the SPMDD using suitable compaction equipment.

The performance of the pavement structure is highly dependent on the subsurface groundwater conditions and maintaining the subgrade and pavement structure in a dry condition. To intercept excess subsurface water within the pavement structure granular materials, sub-drains with suitable outlets should be installed below the pavement structure subgrade, if adequate overland flow drainage is not provided (i.e. ditches). The surface of the pavement should be properly graded to direct runoff water towards suitable drainage features. It is recommended that the lateral extent of the subbase and base layers not be terminated vertically immediately behind any proposed curb/edge of pavement line but be extended beyond the curb.

The preparation of subgrade should be scheduled and carried out in such a manner that a protective cover of overlying granular material is placed as quickly as possible in order to avoid unnecessary circulation by heavy equipment over the subgrade. Frost protection of the surface should be implemented (i.e. insulated tarps, etc.), if works are carried out during the winter months.

Transitions should be constructed between new and existing pavement structures where new parking/access lanes will meet with existing paved areas. In areas where the new pavement will abut existing pavement, the depths of granular materials should be tapered up or down at 5 horizontal to 1 vertical, or flatter, to match the depths of the granular material(s) exposed in the existing pavement

Where the existing asphaltic concrete surface of a parking/roadway is affected by the excavating process, the damaged zones should be saw cut and any damaged or loose pieces of asphaltic concrete should be removed down to the binder course or its entire depth, where only one layer exist. The existing base should be scarified and proof-rolled with any soft areas excavated and replaced to the proper level with OPSS Granular A. Where two layers of asphalt exist on an access lane, the surface course should be grinded over a width of 150mm to allow the new surface course to overlap the binder layer and not create one straight vertical joint. On existing streets, the overlap should be increased to 300mm.

## 10 CONSTRUCTION CONSIDERATIONS

It is suggested that the final design drawings for this project, including the proposed site grading plan, be reviewed by the geotechnical engineer to ensure that the guidelines provided in this report have been interpreted as intended.

The engagement of the services of the geotechnical consultant during construction is recommended to confirm that the subsurface conditions throughout the proposed development do not materially differ from those given in the report and that the construction activities do not adversely affect the intent of the design. Any pile driving operations shall be supervised by geotechnical personnel on a full-time basis to ensure that the pile have reach and met the establish refusal criteria and the pile final location does not deviate horizontally and vertically from its design location. All footing areas and any engineered fill areas (if required) for the proposed project should be inspected by Lascelles Engineering and Associates Ltd. to ensure that a suitable subgrade has been reached and properly prepared. The placing and compaction of any granular materials beneath the foundations (if required) should be inspected to ensure that the materials used conforms to the gradation and compaction specifications.

The subgrade for the pavement areas, watermain and sewers should be inspected and approved by geotechnical personnel. In-situ density testing should be carried out on the pavement granular materials and pipe bedding and backfill to ensure the materials meet the specifications from a compaction point of view.

## 11 REPORT CONDITIONS AND LIMITATIONS

It is stressed that the information presented in this report is provided for the guidance of the designers and is intended for this project only. The use of this report as a construction document is neither intended nor authorized by Lascelles Engineering & Associates Ltd. Contractors bidding on or undertaking the works should examine the factual results of the investigation, satisfy themselves as to the adequacy of the information for construction, and make their own interpretation of the factual data as it affects their construction techniques, schedule, safety and equipment capabilities.

The professional services for this project include only the geotechnical aspects of the subsurface conditions at this site. The presence or implications of possible subsurface contamination resulting from previous uses or activities at this site or adjacent properties, and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this report.

The recommendations provided in this report are based on subsurface data obtained at the specific test locations only. Experience indicates that the subsurface soil and groundwater conditions can vary significantly between and beyond the test locations. For this reason, the recommendations given in this report are subject to a field verification of the subsurface soil conditions at the time of construction.

The report recommendations are applicable only to the project described in the report. Any changes to the project will require a review by Lascelles Engineering & Associates Ltd., to ensure compatibility with the recommendations contained in this project. Any changes to the project will require a review by Lascelles Engineering & Associates Ltd., to insure compatibility with the recommendations contained in this report.

We trust this report provides sufficient information for your present purposes. If you have any questions concerning this report or if we may be of further services to you, please do not hesitate to contact our office.

**Yours truly,**
**Lascelles Engineering & Associates Ltd.**

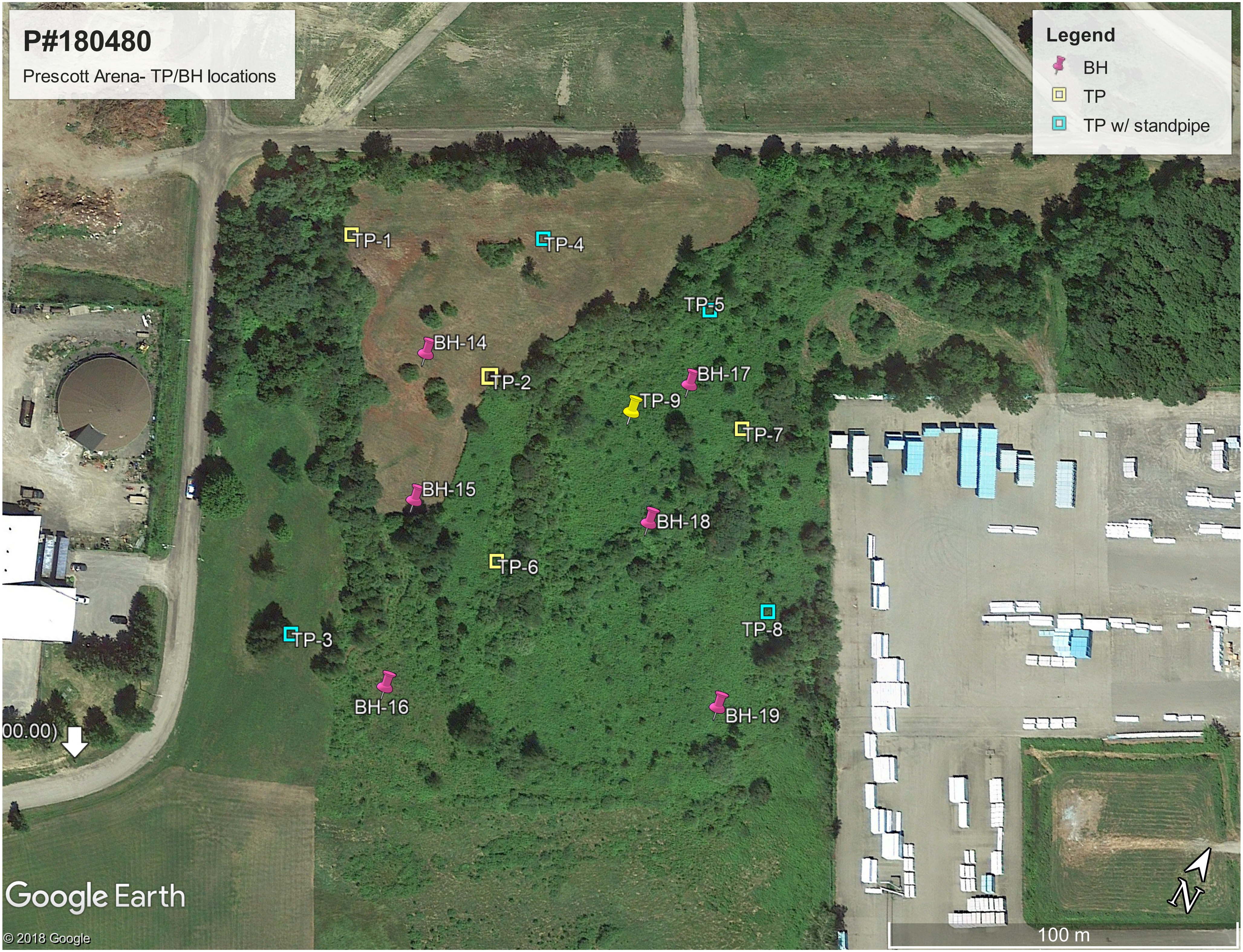
Shuang Chang, EIT

Mario Elie, Project Manager

Will Ball, P.Eng.

# Appendix A

# Test Pit and Borehole Location Plan



P#180480
Prescott Arena- TP/BH locations
Legend
BH
TP
TP w/ standpipe
TP-1
TP-4
TP-5
BH-14
TP-2
BH-17
TP-9
TP-7
BH-15
BH-18
TP-6
TP-8
TP-3
BH-16
BH-19
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# Appendix B

# Test Pit and Borehole Logs

# &

# Rock Core Photograph

LASCELLES ENGINEERING & ASSOCIATES

# TEST PIT LOG: TP-1

**PROJECT:** Geotechnical Investigation - Proposed Prescott Arena
**CLIENT:** EVB Engineering Ltd.
**LOCATION:** North of Churchill Rd. W and East of Sophia St., Prescott, Ontario
**DATE:** December 05, 2018

**PROJECT No.:** 180480
**LOGGED BY:** S.C.
**CONTRACTOR:** Ken Miller Excavating
**EXCAVATION METHOD:** Backhoe

## SOIL PROFILE

| DEPTH (m) | DESCRIPTION | ELEV. | SAMPLE # | SHEAR STRENGTH kPa (20 40 60 80 100) | Water Level (Standpipe or Open Excavation) |
|---|---|---|---|---|---|
| | Ground Surface | 98.42 | | | |
| 0.0 | **Topsoil:** 150mm of dark brown sandy loam. | 0.00 | | | |
| 1.0 | **Sand:** Fine grained to silty with depth, brown to greyish brown in colour with reddish oxidation bands near the surface, sensitive, moist to wet. | | S1 | | |
| 1.52 | | 96.90<br>1.52 | | | |
| 2.0 | | | S2 | | |
| 2.5 | **Silt-Sand:** Sandy silt to silty sand, brown to greyish brown in colour, sensitive, loose and wet. | | | | |
| 3.66 | | 94.76<br>3.66 | | | |
| | End of Test Pit | | | | |

**Easting:** 458015
**Northing:** 4951552
**Site Datum:** Assumed
**Groundsurface Elevation:** 98.42m
**Width of Excavation:** 2m
**Length of Excavation:**

**COMMENTS:**

LASCELLES ENGINEERING & ASSOCIATES

## TEST PIT LOG: TP-2

**PROJECT:** Geotechnical Investigation - Proposed Prescott Arena
**CLIENT:** EVB Engineering Ltd.
**LOCATION:** North of Churchill Rd. W and East of Sophia St., Prescott, Ontario
**DATE:** December 05, 2018

**PROJECT No.:** 180480
**LOGGED BY:** S.C.
**CONTRACTOR:** Ken Miller Excavating
**EXCAVATION METHOD:** Backhoe

### SOIL PROFILE

| DEPTH (m) | DESCRIPTION | ELEV. | SAMPLE # | SHEAR STRENGTH kPa (20 40 60 80 100) | Water Level (Standpipe or Open Excavation) |
|---|---|---|---|---|---|
| | Ground Surface | 98.82 | | | |
| 0.0 – 0.61 | **Topsoil:** Dark brown sandy loam. | 0.00 | | | |
| 0.61 – 1.52 | **Sand:** Fine grained to silty, brown to greyish brown in colour with reddish oxidation bands near the surface, sensitive and moist to wet.<br><br>Water infiltration observed at 0.9m bgs | 98.21<br>0.61 | | | |
| 1.52 – 3.66 | **Silt-Sand:** Sandy silt to silty sand, brown to greyish brown in colour, sensitive, loose and wet. | 97.30<br>1.52 | | | |
| 3.66 | End of Test Pit | 95.16<br>3.66 | | | |

Depth scale (m): 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5, 10.0

**Easting:** 458071
**Northing:** 4951535
**Site Datum:** Assumed
**Groundsurface Elevation:** 98.82m
**Width of Excavation:** 2m
**Length of Excavation:**

**COMMENTS:**

LASCELLES ENGINEERING & ASSOCIATES

## TEST PIT LOG: TP-3

**PROJECT:** Geotechnical Investigation - Proposed Prescott Arena
**CLIENT:** EVB Engineering Ltd.
**LOCATION:** North of Churchill Rd. W and East of Sophia St., Prescott, Ontario
**DATE:** December 05, 2018

**PROJECT No.:** 180480
**LOGGED BY:** S.C.
**CONTRACTOR:** Ken Miller Excavating
**EXCAVATION METHOD:** Backhoe

### SOIL PROFILE

| DEPTH (m) | DESCRIPTION | ELEV. | SAMPLE # | SHEAR STRENGTH kPa (20 40 60 80 100) | Water Level (Standpipe or Open Excavation) |
|---|---|---|---|---|---|
| | Ground Surface | 98.71 | | | |
| 0.0 | **Topsoil:** 150mm of dark brown sandy loam. | 0.00 | | | |
| 1.0 | **Sand:** Fine grained to silty, brown to grey in colour with reddish oxidation bands near the surface, moist to wet. | | S1 | | 1.35 m (04-11-2019) |
| 1.5 | | 97.19<br>1.52 | | | |
| 2.5 | **Silt:** Sandy, brown to greyish brown in colour, sensitive, loose and wet.<br><br>Water infiltration observed at 1.83m bgs | | | | |
| 3.5 | | 95.05<br>3.66 | S2 | | |
| 4.5 | End of Test Pit | | | | |

Depth scale: 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5, 10.0

**Easting:** 458057
**Northing:** 4951442
**Site Datum:** Assumed
**Groundsurface Elevation:** 98.71m
**Width of Excavation:** 2m
**Length of Excavation:**

**COMMENTS:**

LASCELLES ENGINEERING & ASSOCIATES

## TEST PIT LOG: TP-4

**PROJECT:** Geotechnical Investigation - Proposed Prescott Arena
**CLIENT:** EVB Engineering Ltd.
**LOCATION:** North of Churchill Rd. W and East of Sophia St., Prescott, Ontario
**DATE:** December 05, 2018

**PROJECT No.:** 180480
**LOGGED BY:** S.C.
**CONTRACTOR:** Ken Miller Excavating
**EXCAVATION METHOD:** Backhoe

### SOIL PROFILE

| DEPTH (m) | DESCRIPTION | ELEV. | SAMPLE # | SHEAR STRENGTH kPa (20 40 60 80 100) | Water Level (Standpipe or Open Excavation) |
|---|---|---|---|---|---|
| 0.0 | Ground Surface | 98.94 / 0.00 | | | 0.1 m (04-11-2019) |
| 0.0–0.5 | **Topsoil:** 150mm of dark brown sandy loam. | | | | |
| 1.0–1.5 | **Sand:** Fine grained to silty, brown to greyish brown in colour with reddish oxidation bands near the surface, sensitive and moist to wet. | 97.42 / 1.52 | | | |
| 2.5–3.5 | **Silt-Sand:** Sandy silt to silty sand, brown to greyish brown in colour, sensitive, loose and wet. | 95.28 / 3.66 | S1 | | |
| 3.66 | End of Test Pit | | | | |

Depth scale (m): 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5

**Easting:** 458065
**Northing:** 4951578
**Site Datum:** Assumed
**Groundsurface Elevation:** 98.94m
**Width of Excavation:** 2m
**Length of Excavation:**

**COMMENTS:**

## TEST PIT LOG: TP-5

LASCELLES ENGINEERING & ASSOCIATES

**PROJECT:** Geotechnical Investigation - Proposed Prescott Arena
**CLIENT:** EVB Engineering Ltd.
**LOCATION:** North of Churchill Rd. W and East of Sophia St., Prescott, Ontario
**DATE:** December 05, 2018

**PROJECT No.:** 180480
**LOGGED BY:** S.C.
**CONTRACTOR:** Ken Miller Excavating
**EXCAVATION METHOD:** Backhoe

### SOIL PROFILE

| DEPTH (m) | DESCRIPTION | ELEV. | SAMPLE # | SHEAR STRENGTH kPa (20 40 60 80 100) | Water Level (Standpipe or Open Excavation) |
|---|---|---|---|---|---|
| 0.0 | Ground Surface | 98.49 / 0.00 | | | |
| 0.0–0.46 | **Topsoil:** 460mm of dark brown sandy loam. | | | | |
| 0.46–1.52 | **Sand:** Fine grained to silty, brown to greyish brown in colour with reddish oxidation bands near the surface, sensitive and moist to wet. | 96.97 / 1.52 | S1 | | 1.15 m (04-11-2019) |
| 1.52–3.66 | **Silt-Sand:** Sandy silt to silty sand, brown to greyish brown in colour, sensitive, loose and wet. | 94.83 / 3.66 | S2 | | |
| 3.66 | End of Test Pit | | | | |

**Easting:** 458118
**Northing:** 4951583
**Site Datum:** Assumed
**Groundsurface Elevation:** 98.49m
**Width of Excavation:** 2m
**Length of Excavation:**

**COMMENTS:**

## TEST PIT LOG: TP-6

LASCELLES ENGINEERING & ASSOCIATES

**PROJECT:** Geotechnical Investigation - Proposed Prescott Arena
**CLIENT:** EVB Engineering Ltd.
**LOCATION:** North of Churchill Rd. W and East of Sophia St., Prescott, Ontario
**DATE:** December 05, 2018

**PROJECT No.:** 180480
**LOGGED BY:** S.C.
**CONTRACTOR:** Ken Miller Excavating
**EXCAVATION METHOD:** Backhoe

### SOIL PROFILE

| DEPTH (m) | DESCRIPTION | ELEV. | SAMPLE # | SHEAR STRENGTH kPa (20 40 60 80 100) | Water Level (Standpipe or Open Excavation) |
|---|---|---|---|---|---|
| | Ground Surface | 98.84 | | | |
| 0.0 | **Topsoil:** 460mm of dark brown sandy loam. | 0.00 | | | |
| 1.52 | **Sand:** Fine grained to silty, brown to greyish brown in colour with reddish oxidation bands near the surface, sensitive, moist to wet. | 97.32<br>1.52 | | | |
| 2.74 | **Silt-Sand:** Sandy silt to silty sand, brown in colour, sensitive, loose and wet.<br><br>Test pit collapsed. | 96.10<br>2.74 | | | |
| | End of Test Pit | | | | |

Depth scale (m): 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5, 10.0

**Easting:** 458099
**Northing:** 4951489
**Site Datum:** Assumed
**Groundsurface Elevation:** 98.84m
**Width of Excavation:** 2m
**Length of Excavation:**

**COMMENTS:**

## TEST PIT LOG: TP-7

**PROJECT:** Geotechnical Investigation - Proposed Prescott Arena
**CLIENT:** EVB Engineering Ltd.
**LOCATION:** North of Churchill Rd. W and East of Sophia St., Prescott, Ontario
**DATE:** December 05, 2018

**PROJECT No.:** 180480
**LOGGED BY:** S.C.
**CONTRACTOR:** Ken Miller Excavating
**EXCAVATION METHOD:** Backhoe

LASCELLES ENGINEERING & ASSOCIATES

| DEPTH (m) | SOIL PROFILE – DESCRIPTION | ELEV. | SAMPLE # | SHEAR STRENGTH kPa (20 40 60 80 100) | Water Level (Standpipe or Open Excavation) |
|---|---|---|---|---|---|
| | Ground Surface | 98.76 | | | |
| 0.0 | **Topsoil:** 300mm of dark brown sandy loam. | 0.00 | | | |
| 1.0 | **Sand:** Fine grained to silty, brown to greyish brown in colour with reddish oxidation bands near the surface, sensitive and moist to wet. | 97.24 / 1.52 | S1 | | |
| 2.8 | **Silt:** Sandy silt to silty sand, grey in colour; sensitive, loose and wet. Water infiltration observed at 1.83m bgs. | 95.10 / 3.66 | S2 | | |
| 5.0 | End of Test Pit | | | | |

Depth scale: 0.0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5, 10.0

**Easting:** 458143
**Northing:** 4951557
**Site Datum:** Assumed
**Groundsurface Elevation:** 98.76m
**Width of Excavation:** 2m
**Length of Excavation:**

**COMMENTS:**

## TEST PIT LOG: TP-8

LASCELLES ENGINEERING & ASSOCIATES

**PROJECT:** Geotechnical Investigation - Proposed Prescott Arena
**CLIENT:** EVB Engineering Ltd.
**LOCATION:** North of Churchill Rd. W and East of Sophia St., Prescott, Ontario
**DATE:** December 05, 2018

**PROJECT No.:** 180480
**LOGGED BY:** S.C.
**CONTRACTOR:** Ken Miller Excavating
**EXCAVATION METHOD:** Backhoe

### SOIL PROFILE

| DEPTH (m) | DESCRIPTION | ELEV. | SAMPLE # | SHEAR STRENGTH kPa (20 40 60 80 100) | Water Level (Standpipe or Open Excavation) |
|---|---|---|---|---|---|
| | Ground Surface | 98.70 | | | 0.31 m (04-11-2019) |
| 0.00 | **Topsoil:** 300mm of dark brown sandy loam. | | | | |
| 0.30 | **Sand:** Fine grained to silty, brown to greyish brown in colour with reddish oxidation bands near the surface, sensitive and moist to wet. | | | | |
| 1.52 | **Silt-Sand:** Sandy silt to silty sand, brown to greyish brown in colour, sensitive, loose and wet. | 97.18 | S1 | | |
| 3.66 | End of Test Pit | 95.04 | | | |

**Easting:** 458175
**Northing:** 4951514
**Site Datum:** Assumed
**Groundsurface Elevation:** 98.70m
**Width of Excavation:** 2m
**Length of Excavation:**

**COMMENTS:**

LASCELLES ENGINEERING & ASSOCIATES

RECORD OF BOREHOLE: BH-14

PROJECT: Geotechnical Investigation - Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: North of Churchill Rd. W and East of Sophia St, Prescott, Ontario
DATE: February 21, 2019

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Truck-mounted CME55
DRILLING METHOD: Hollow Stem Auger

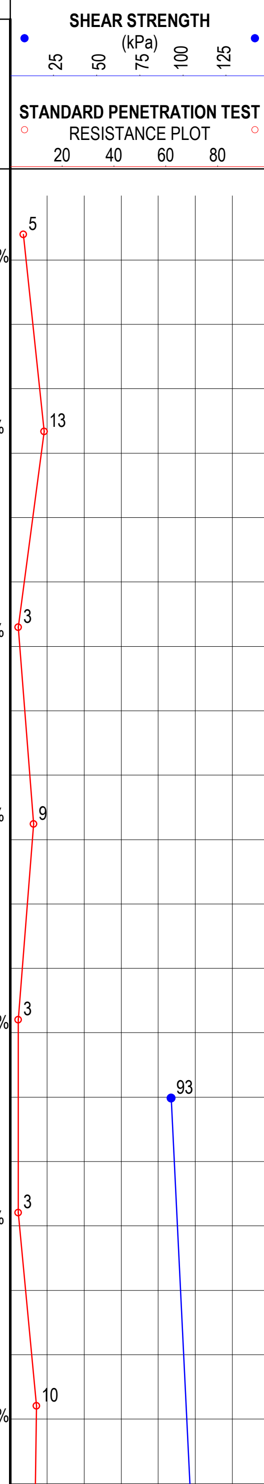
## SOIL PROFILE

| DEPTH (m) | DESCRIPTION | ELEV. |
|---|---|---|
| | Ground Surface | 98.81 |
| 0.0 | **Topsoil:** 460mm of dark brown sandy loam. | 0.00 |
| | **Sand:** Fine grained to silty, brown in colour, compact, and wet. | 98.35<br>0.46 |
| | **Silt-Sand** Sandy silt to silty sand, brown to grey in colour, very loose and wet. | 97.29<br>1.52 |
| | **Silt:** With some clay and trace of sand, grey in colour, loose and wet. | 94.39<br>4.42 |
| | **Clay-Silt** Clayey silt to silty clay with trace of sand, grey in colour, stiff in consistency, wet. | 92.72<br>6.09 |
| | **Clay:** Silty, grey in colour, very stiff to very hard in consistency, with low plasticity and wet. | 91.19<br>7.62 |

Depth scale: ft 0.0 – 32.0; m 0.0 – 9.0

## SAMPLES

| NUMBER | TYPE | N-VALUE / RQD | RECOVERY |
|---|---|---|---|
| SS1 | | 5 | 100% |
| SS2 | | 13 | 83% |
| SS3 | | 3 | 91% |
| SS4 | | 10 | 75% |
| SS5 | | 3 | 100% |
| SS6 | | 3 | 83% |
| SS7 | | 10 | 100% |




WATER CONTENT (%)
20 40 60 80

WATER LEVEL

Easting: 458052
Site Datum: Assumed
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951528
Groundsurface Elev.: 98.81m
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

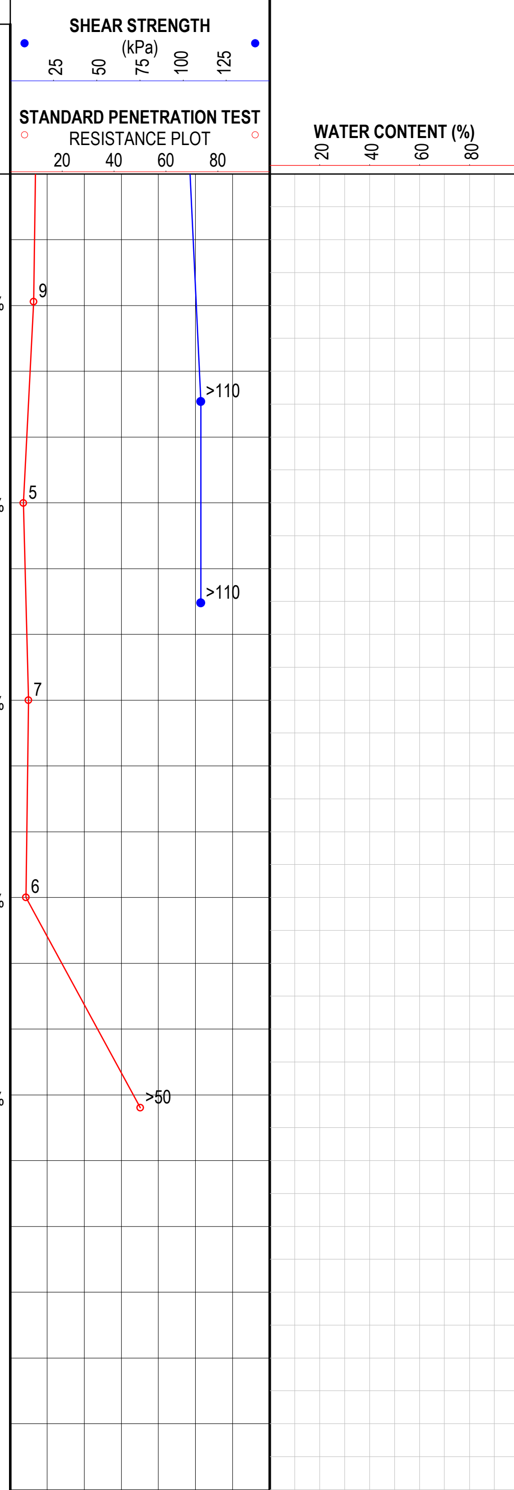
LASCELLES
ENGINEERING & ASSOCIATES

RECORD OF BOREHOLE: BH-14

PROJECT: Geotechnical Investigation - Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: North of Churchill Rd. W and East of Sophia St, Prescott, Ontario
DATE: February 21, 2019

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Truck-mounted CME55
DRILLING METHOD: Hollow Stem Auger

| SOIL PROFILE | | SAMPLES | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| DEPTH (m) | DESCRIPTION | ELEV. | NUMBER | TYPE | N-VALUE / RQD | RECOVERY | SHEAR STRENGTH / STANDARD PENETRATION TEST | WATER CONTENT (%) | WATER LEVEL |
| 11.0 | | | SS8 | | 9 | 86% | | | |
| 12.0 | | | | | | | | | |
| 13.0 | | | SS9 | | 5 | 98% | | | |
| 14.0 | | | SS10 | | 7 | 76% | | | |
| 15.0 | | 83.11 / 15.70 | SS11 | | 6 | 75% | | | |
| 16.0 | **Glacial Till:** Sandy with some gravel and trace of clay, dense and wet. | | | | | | | | |
| 17.0 | Auger refusal over inferred bedrock. | 81.59 / 17.22 | SS12 | | 50R | 60% | | | |
| | End of Borehole | | | | | | | | |
| 18.0 | | | | | | | | | |
| 19.0 | | | | | | | | | |




Easting: 458052
Site Datum: Assumed
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951528
Groundsurface Elev.: 98.81m
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

RECORD OF BOREHOLE: BH-15

LASCELLES ENGINEERING & ASSOCIATES

PROJECT: Geotechnical Investigation - Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: North of Churchill Rd. W and East of Sophia St, Prescott, Ontario
DATE: February 21, 2019

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Truck-mounted CME55
DRILLING METHOD: Hollow Stem Auger

## SOIL PROFILE

| DEPTH (m) | DESCRIPTION | ELEV. |
|---|---|---|
| 0.00 | Ground Surface | 98.80 |
| 0.00 | **Topsoil:** 460mm of dark brown sandy loam. | 98.80 |
| 0.46 | **Sand:** Fine grained to silty, brown in colour, loose and moist to wet. | 98.34 |
| 1.52 | **Silt-Sand:** Sandy silt to silty sand, brown to greyish brown in colour, loose and wet. | 97.28 |
| 4.42 | **Silt:** With some clay and trace of sand, grey in colour, loose and wet. | 94.38 |
| 6.09 | **Silt-Clay:** Clayey silt to silty clay with trace of sand, grey in colour, very stiff in consistency, and wet. | 92.71 |
| 7.62 | **Clay:** Silty, grey in colour, very stiff to hard in consistency, with low plasticity, and wet. | 91.18 |

## SAMPLES

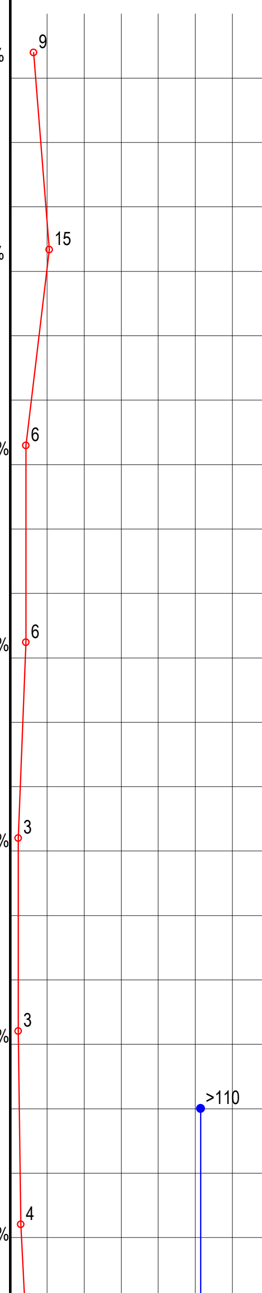
| NUMBER | TYPE | N-VALUE / RQD | RECOVERY |
|---|---|---|---|
| SS1 | Split spoon | 9 | 85% |
| SS2 | Split spoon | 15 | 83% |
| SS3 | Split spoon | 6 | 100% |
| SS4 | Split spoon | 6 | 100% |
| SS5 | Split spoon | 3 | 100% |
| SS6 | Split spoon | 3 | 100% |
| SS7 | Split spoon | 4 | 100% |

SHEAR STRENGTH (kPa) 25 50 75 100 125

STANDARD PENETRATION TEST RESISTANCE PLOT 20 40 60 80

WATER CONTENT (%) 20 40 60 80

WATER LEVEL




Easting: 458070
Site Datum: Assumed
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951489
Groundsurface Elev.: 98.80m
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

LASCELLES ENGINEERING & ASSOCIATES

RECORD OF BOREHOLE: BH-15

PROJECT: Geotechnical Investigation - Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: North of Churchill Rd. W and East of Sophia St, Prescott, Ontario
DATE: February 21, 2019

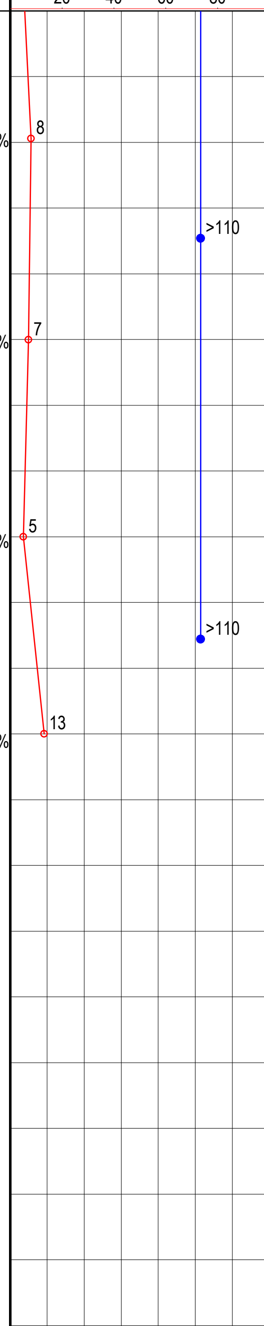
PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Truck-mounted CME55
DRILLING METHOD: Hollow Stem Auger

## SOIL PROFILE / SAMPLES

| DEPTH (m) | DESCRIPTION | ELEV. | NUMBER | TYPE | N-VALUE / RQD | RECOVERY |
|---|---|---|---|---|---|---|
| 11.0 | | | SS8 | | 8 | 100% |
| 12.0 | | | SS9 | | 7 | 100% |
| 14.0 | | | SS10 | | 5 | 100% |
| 15.60 | **Glacial Till:** Sandy with some gravel and trace of clay, dense and wet. | 83.20 | SS11 | | 13 | 100% |
| 16.31 | Auger refusal over inferred bedrock. | 82.49 | | | | |
| | End of Borehole | | | | | |

Depth scale (m): 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0, 18.0, 19.0

SHEAR STRENGTH (kPa): 25, 50, 75, 100, 125
STANDARD PENETRATION TEST RESISTANCE PLOT: 20, 40, 60, 80




WATER CONTENT (%): 20, 40, 60, 80

WATER LEVEL

Easting: 458070
Site Datum: Assumed
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951489
Groundsurface Elev.: 98.80m
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

RECORD OF BOREHOLE: BH-16

PROJECT: Geotechnical Investigation - Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: North of Churchill Rd. W and East of Sophia St, Prescott, Ontario
DATE: February 20, 2019

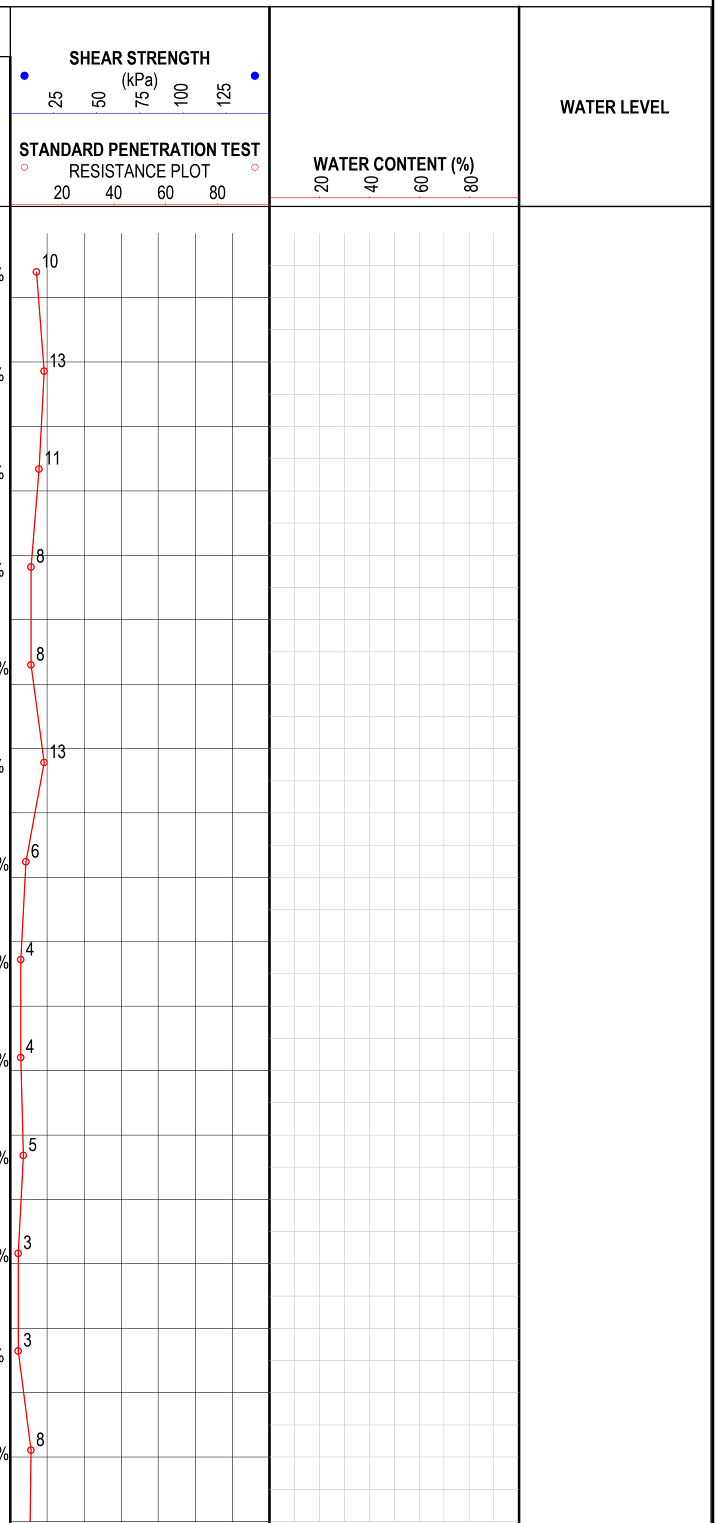
PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Truck-mounted CME55
DRILLING METHOD: Hollow Stem Auger

## SOIL PROFILE

| ELEV. / DEPTH (m) | DESCRIPTION |
|---|---|
| 98.70 | Ground Surface |
| 0.00 | **Topsoil:** 200mm of dark brown sandy loam. |
| | **Sand:** Fine grained to silty, brown in colour, loose to compact and wet. |
| 97.18 / 1.52 | **Silt-Sand:** Sandy silt to silty sand, brown to greyish brown in colour, compact to loose and wet. |
| 94.28 / 4.42 | **Silt:** With some clay and trace of sand, grey in colour, loose and wet. |
| 92.61 / 6.09 | **Clay-Silt:** Clayey silt to silty clay with trace of sand, grey in colour, very stiff in consistency, and wet. |
| 91.08 / 7.62 | **Clay:** Silty, grey in colour, very stiff to hard in consistency, with low plasticity, and wet. |

## SAMPLES

| NUMBER | TYPE | N-VALUE / RQD | RECOVERY |
|---|---|---|---|
| SS1 | | 10 | 75% |
| SS2 | | 13 | 75% |
| SS3 | | 11 | 83% |
| SS4 | | 8 | 83% |
| SS5 | | 8 | 100% |
| SS6 | | 13 | 85% |
| SS7 | | 6 | 100% |
| SS8 | | 4 | 100% |
| SS9 | | 4 | 100% |
| SS10 | | 5 | 100% |
| SS11 | | 3 | 100% |
| SS12 | | 3 | 87% |
| SS13 | | 8 | 100% |




Easting: 458089
Site Datum: Assumed
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951438
Groundsurface Elev.: 98.7m
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

LASCELLES ENGINEERING & ASSOCIATES

RECORD OF BOREHOLE: BH-16

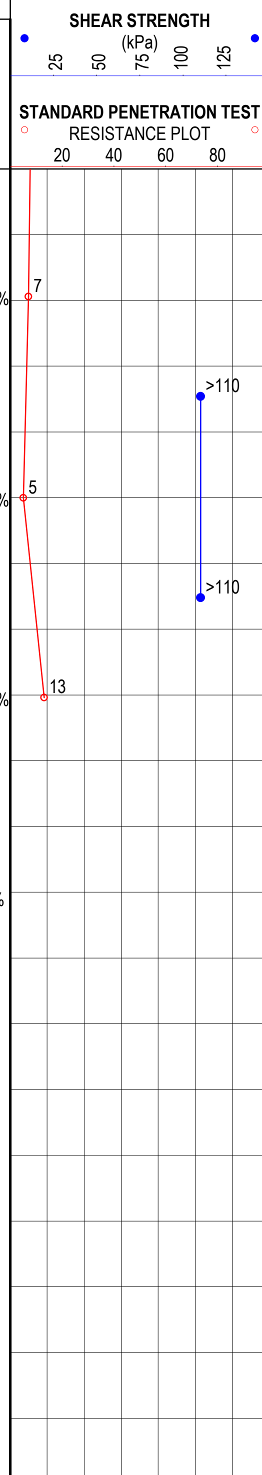
PROJECT: Geotechnical Investigation - Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: North of Churchill Rd. W and East of Sophia St, Prescott, Ontario
DATE: February 20, 2019

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Truck-mounted CME55
DRILLING METHOD: Hollow Stem Auger

## SOIL PROFILE / SAMPLES

| DEPTH (m) | DESCRIPTION | ELEV. | NUMBER | TYPE | N-VALUE / RQD | RECOVERY |
|---|---|---|---|---|---|---|
| 11.0 | | | SS14 | | 7 | 100% |
| 12.0 | | | SS15 | | 5 | 100% |
| 13.0 | | | | | | |
| 13.72 | **Silt:** Clayey with trace of sand, grey in colour, compact and wet. | 84.98 / 13.72 | SS16 | | 13 | 100% |
| 14.17 | | 84.53 / 14.17 | | | | |
| 14.78 | **Glacial Till:** Sandy and clayey with some gravels, grey in colour, compact and wet. | 83.92 / 14.78 | C17 | | 77% | 96% |
| 16.23 | **Bedrock:** Light grey sandy dolostone. | 82.47 / 16.23 | | | | |
| | End of Borehole | | | | | |

Depth scale: 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0, 18.0, 19.0
Elevation scale: 84.0, 85.0, 86.0, 87.0, 88.0, 89.0, 40.0, 41.0, 42.0, 43.0, 44.0, 45.0, 46.0, 47.0, 48.0, 49.0, 50.0, 51.0, 52.0, 53.0, 54.0, 55.0, 56.0, 57.0, 58.0, 59.0, 60.0, 61.0, 62.0, 63.0, 64.0, 65.0




WATER CONTENT (%)
20 40 60 80

WATER LEVEL

Easting: 458089
Site Datum: Assumed
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951438
Groundsurface Elev.: 98.7m
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:


bottom
Top

RECORD OF BOREHOLE: BH-17

LASCELLES ENGINEERING & ASSOCIATES

PROJECT: Geotechnical Investigation - Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: North of Churchill Rd. W and East of Sophia St, Prescott, Ontario
DATE: February 22, 2019

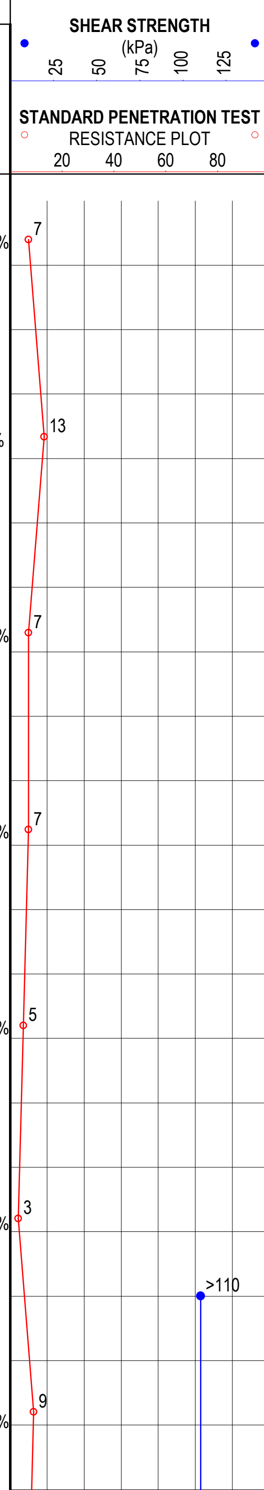
PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Truck-mounted CME55
DRILLING METHOD: Hollow Stem Auger

## SOIL PROFILE

| DEPTH (m) | DESCRIPTION | ELEV. |
|---|---|---|
| 0.0 | Ground Surface | 98.71 / 0.00 |
| 0.0–0.30 | **Topsoil:** 300mm of dark brown sandy loam. | 98.41 / 0.30 |
| 0.30–1.52 | **Sand:** Fine grained to silty, brown in colour, loose to compact and moist to wet. | 97.19 / 1.52 |
| 1.52–4.42 | **Silt-Sand:** Sandy silt to silty sand, brown to greyish brown in colour, compact to loose and wet. | 94.29 / 4.42 |
| 4.42–6.09 | **Silt:** With some clay and trace of sand, grey in colour, loose and wet. | 92.62 / 6.09 |
| 6.09–7.62 | **Clay-Silt:** Clayey silt to silty clay with trace of sand, grey in colour, stiff in consistency, and wet. | 91.09 / 7.62 |
| 7.62– | **Clay:** Silty, grey in colour, very stiff to hard in consistency, with low plasticity, and wet. | |

## SAMPLES

| NUMBER | TYPE | N-VALUE / RQD | RECOVERY |
|---|---|---|---|
| SS1 | | 7 | 100% |
| SS2 | | 13 | 83% |
| SS3 | | 7 | 100% |
| SS4 | | 7 | 100% |
| SS5 | | 5 | 100% |
| SS6 | | 3 | 100% |
| SS7 | | 9 | 100% |




WATER CONTENT (%)
20 40 60 80

WATER LEVEL

Easting: 458124
Site Datum: Geodetic
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951557
Groundsurface Elev.: 98.71m
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

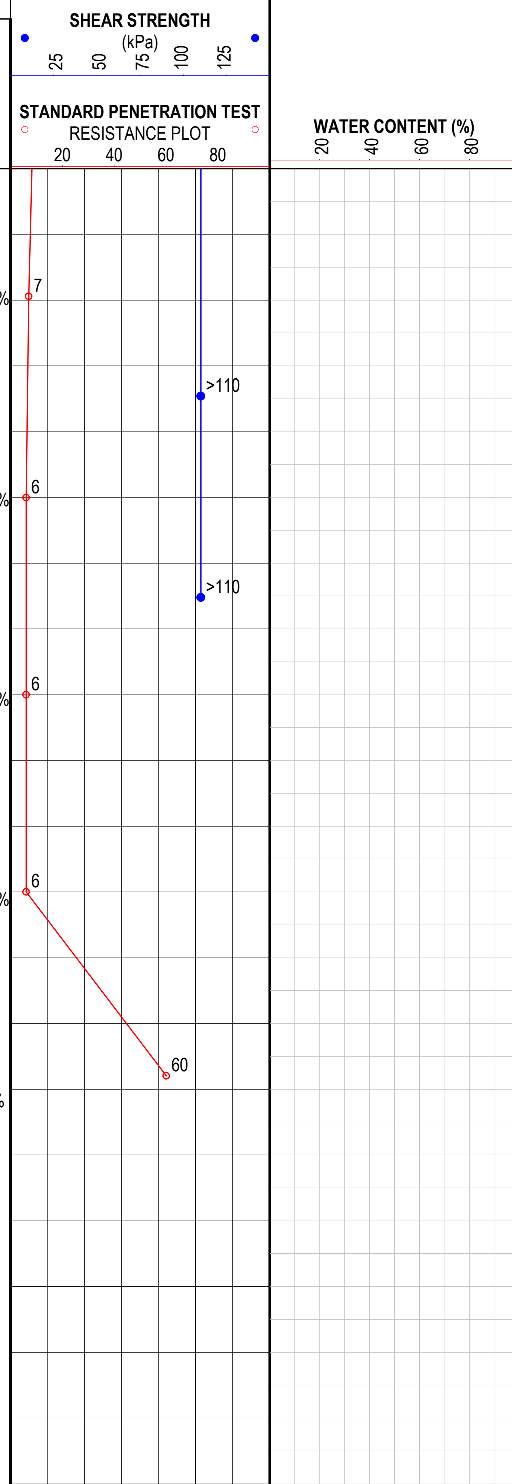
COMMENTS:

RECORD OF BOREHOLE: BH-17

PROJECT: Geotechnical Investigation - Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: North of Churchill Rd. W and East of Sophia St, Prescott, Ontario
DATE: February 22, 2019

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Truck-mounted CME55
DRILLING METHOD: Hollow Stem Auger

| SOIL PROFILE | | SAMPLES | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| DEPTH (m) | DESCRIPTION | ELEV. | NUMBER | TYPE | N-VALUE / RQD | RECOVERY | SHEAR STRENGTH (kPa) / STANDARD PENETRATION TEST RESISTANCE PLOT | WATER CONTENT (%) | WATER LEVEL |
| 11.0 | | | SS8 | | 7 | 100% | | | |
| 12.0 | | | | | | | | | |
| | | | SS9 | | 6 | 100% | | | |
| 13.0 | | | | | | | | | |
| 14.0 | | | SS10 | | 6 | 100% | | | |
| 15.0 | | | | | | | | | |
| | | | SS11 | | 6 | 100% | | | |
| 16.0 | | | | | | | | | |
| 17.0 | **Glacial Till:** Sandy and clayey with some gravel, dense and wet. Auger refusal over inferred bedrock. | 81.95 / 16.76 | SS12 | | 60 | 75% | | | |
| | | 81.70 / 17.01 | | | | | | | |
| 18.0 | End of Borehole | | | | | | | | |
| 19.0 | | | | | | | | | |




Easting: 458124
Site Datum: Geodetic
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951557
Groundsurface Elev.: 98.71m
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

RECORD OF BOREHOLE: BH-18

LASCELLES
ENGINEERING & ASSOCIATES

PROJECT: Geotechnical Investigation - Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: North of Churchill Rd. W and East of Sophia St, Prescott, Ontario
DATE: February 22, 2019

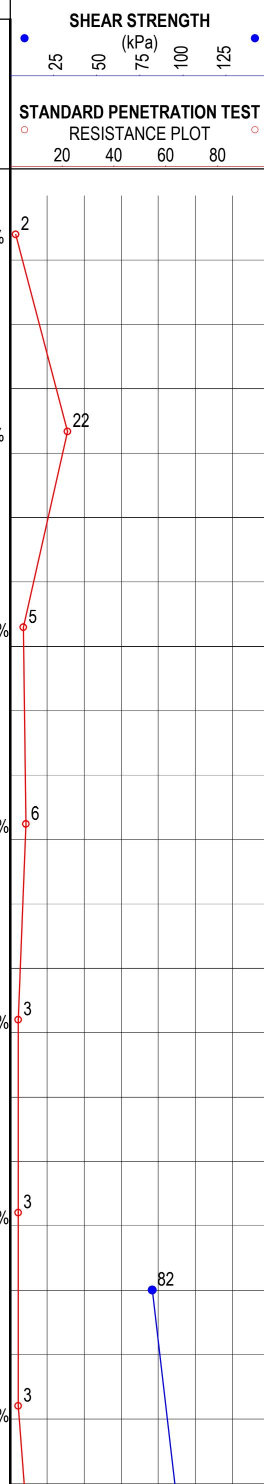
PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Truck-mounted CME55
DRILLING METHOD: Hollow Stem Auger

## SOIL PROFILE

| DESCRIPTION | ELEV. / DEPTH (m) |
| --- | --- |
| Ground Surface | 98.70 / 0.00 |
| **Topsoil:** 300mm of dark brown sandy loam. | 98.40 / 0.30 |
| **Sand:** Fine grained to silty, brown to greyish brown in colour, compact and wet. | 97.18 / 1.52 |
| **Silt-Sand:** Sandy silt to silty sand, brown to grey in colour, compact to loose and wet. | 94.28 / 4.42 |
| **Silt:** With some clay and trace of sand, grey in colour, loose and wet. | 92.61 / 6.09 |
| **Clay** Silty, grey in colour, stiff to hard in consistency, with low plasticity and wet. | |

## SAMPLES

| NUMBER | TYPE | N-VALUE / RQD | RECOVERY |
| --- | --- | --- | --- |
| SS1 | | 2 | 75% |
| SS2 | | 22 | 83% |
| SS3 | | 5 | 100% |
| SS4 | | 6 | 100% |
| SS5 | | 3 | 100% |
| SS6 | | 3 | 100% |
| SS7 | | 3 | 100% |




WATER CONTENT (%)
20 40 60 80

WATER LEVEL

Easting: 458133
Site Datum: Assumed
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951516
Groundsurface Elev.: 98.70m
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

LASCELLES ENGINEERING & ASSOCIATES

RECORD OF BOREHOLE: BH-18

PROJECT: Geotechnical Investigation - Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: North of Churchill Rd. W and East of Sophia St, Prescott, Ontario
DATE: February 22, 2019

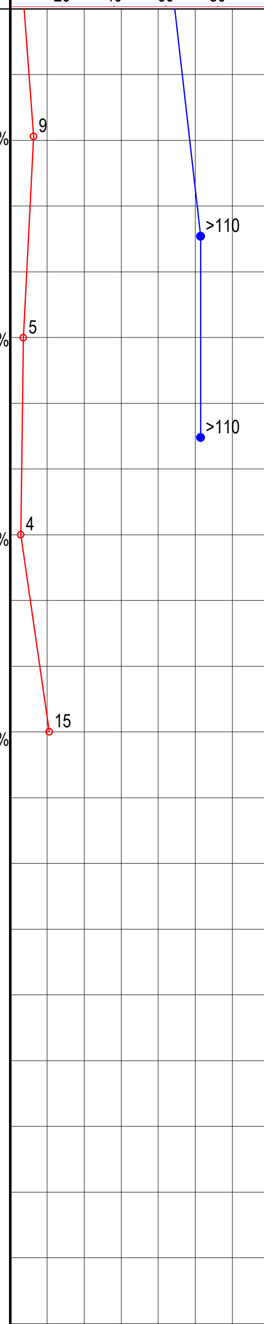
PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Truck-mounted CME55
DRILLING METHOD: Hollow Stem Auger

| DEPTH (m) | DESCRIPTION | ELEV. | NUMBER | TYPE | N-VALUE / RQD | RECOVERY |
|---|---|---|---|---|---|---|
| 11.0 | | | SS8 | | 9 | 100% |
| 12.0 | | | | | | |
| | | | SS9 | | 5 | 100% |
| 13.0 | | | | | | |
| 14.0 | | | SS10 | | 4 | 100% |
| 15.0 | | | SS11 | | 15 | 100% |
| 16.0 | | 82.55 / 16.15 | | | | |
| | **Glacial Till:** Inferred the glacial till deposit. Auger refusal over inferred bedrock. | 82.30 / 16.40 | | | | |
| 17.0 | | | | | | |
| | End of Borehole | | | | | |
| 18.0 | | | | | | |
| 19.0 | | | | | | |

Elevation scale: 84.0, 85.0, 86.0, 87.0, 88.0, 89.0, 40.0, 41.0, 42.0, 43.0, 44.0, 45.0, 46.0, 47.0, 48.0, 49.0, 50.0, 51.0, 52.0, 53.0, 54.0, 55.0, 56.0, 57.0, 58.0, 59.0, 60.0, 61.0, 62.0, 63.0, 64.0, 65.0

SHEAR STRENGTH (kPa): 25 50 75 100 125

STANDARD PENETRATION TEST RESISTANCE PLOT: 20 40 60 80




WATER CONTENT (%): 20 40 60 80

WATER LEVEL

Easting: 458133
Site Datum: Assumed
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951516
Groundsurface Elev.: 98.70m
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

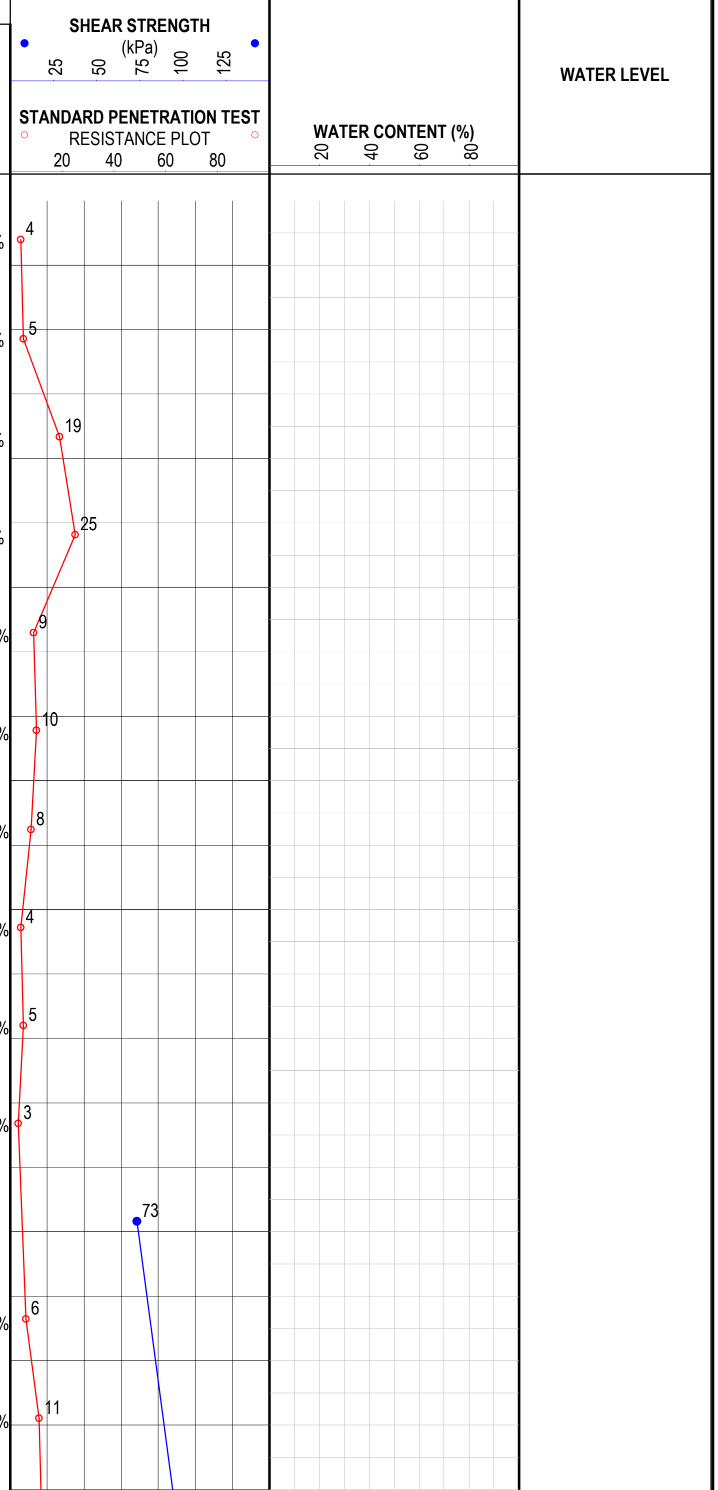
RECORD OF BOREHOLE: BH-19

LASCELLES ENGINEERING & ASSOCIATES

PROJECT: Geotechnical Investigation - Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: North of Churchill Rd. W and East of Sophia St, Prescott, Ontario
DATE: February 18, 2019

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Truck-mounted CME55
DRILLING METHOD: Hollow Stem Auger

| DESCRIPTION (SOIL PROFILE) | ELEV. / DEPTH (m) | NUMBER | N-VALUE / RQD | RECOVERY |
|---|---|---|---|---|
| Ground Surface | 98.80 / 0.00 | | | |
| **Topsoil:** 200mm of dark brown sandy loam. | | SS1 | 4 | 75% |
| **Sand:** Fine grained to silty, brown to greyish brown in colour, loose and moist to wet. | | SS2 | 5 | 87% |
| **Silt-Sand:** Sandy silt to silty sand, brown to grey in colour, compact to loose and wet. | 97.26 / 1.54 | SS3 | 19 | 83% |
| | | SS4 | 25 | 75% |
| | | SS5 | 9 | 100% |
| | | SS6 | 10 | 100% |
| **Silt:** With some clay and trace of sand, grey in colour, loose and wet. | 94.38 / 4.42 | SS7 | 8 | 100% |
| | | SS8 | 4 | 100% |
| **Clay-Silt:** Clayey silt to silty clay with trace of sand, grey in colour, very stiff in consistency and wet. | 92.71 / 6.09 | SS9 | 5 | 100% |
| | | SS10 | 3 | 100% |
| **Clay:** Silty, grey in colour, stiff to hard in consistency, with low plasticity and wet. | 91.18 / 7.62 | | | |
| | | SS11 | 6 | 100% |
| | | SS12 | 11 | 100% |




Easting: 458176
Site Datum: Assumed
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951479
Groundsurface Elev.: 98.80m
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

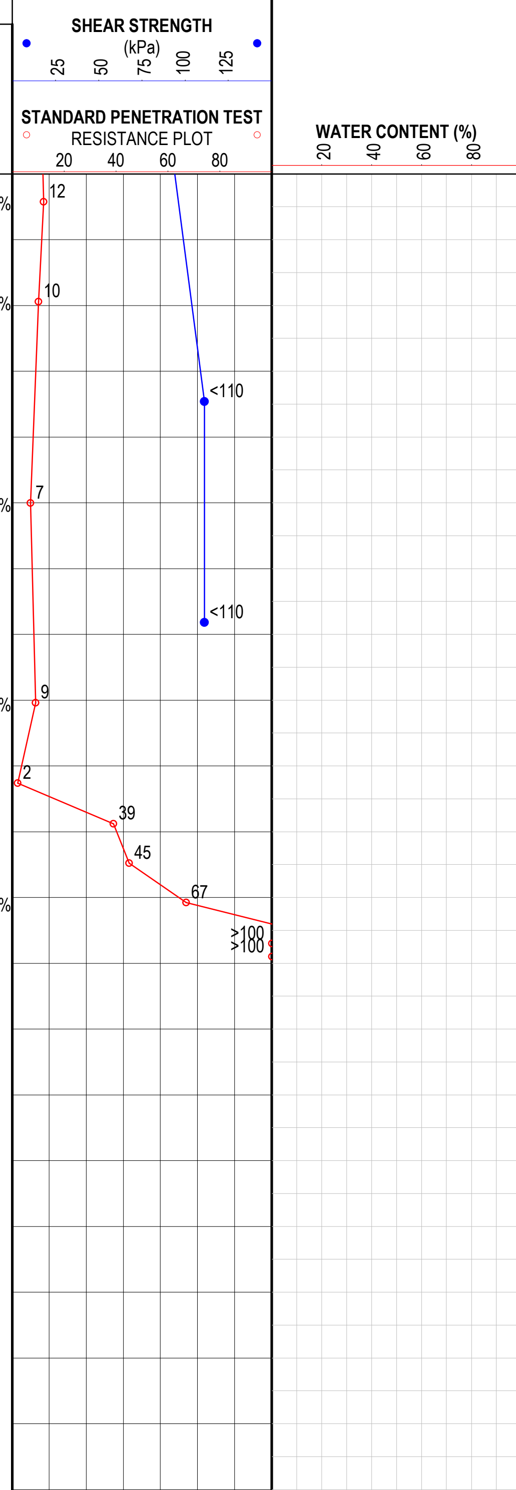
LASCELLES
ENGINEERING & ASSOCIATES

RECORD OF BOREHOLE: BH-19

PROJECT: Geotechnical Investigation - Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: North of Churchill Rd. W and East of Sophia St, Prescott, Ontario
DATE: February 18, 2019

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Truck-mounted CME55
DRILLING METHOD: Hollow Stem Auger

| SOIL PROFILE | | SAMPLES | | | | | | | WATER LEVEL |
|---|---|---|---|---|---|---|---|---|---|
| DEPTH (m) | DESCRIPTION | ELEV. | NUMBER | TYPE | N-VALUE / RQD | RECOVERY | SHEAR STRENGTH (kPa) / STANDARD PENETRATION TEST RESISTANCE PLOT | WATER CONTENT (%) | |
| | | | SS13 | | 12 | 100% | | | |
| 11.0 | | | SS14 | | 10 | 100% | | | |
| 12.0 | | | SS15 | | 7 | 100% | | | |
| 13.0 | | | | | | | | | |
| 14.0 | | | SS16 | | 9 | 100% | | | |
| | **Note**: Dynamic cone from 14.33m bgs. | 83.90 | | | | | | | |
| 15.0 | **Glacial Till:** Inferred the glacial till deposit. | 14.90 | | | | 100% | | | |
| 16.0 | Dynamic cone refusal over inferred bedrock. | 82.85<br>15.95 | | | | | | | |
| | End of Borehole | | | | | | | | |
| 17.0 | | | | | | | | | |
| 18.0 | | | | | | | | | |
| 19.0 | | | | | | | | | |




Depth scale (ft): 34.0, 35.0, 36.0, 37.0, 38.0, 39.0, 40.0, 41.0, 42.0, 43.0, 44.0, 45.0, 46.0, 47.0, 48.0, 49.0, 50.0, 51.0, 52.0, 53.0, 54.0, 55.0, 56.0, 57.0, 58.0, 59.0, 60.0, 61.0, 62.0, 63.0, 64.0, 65.0

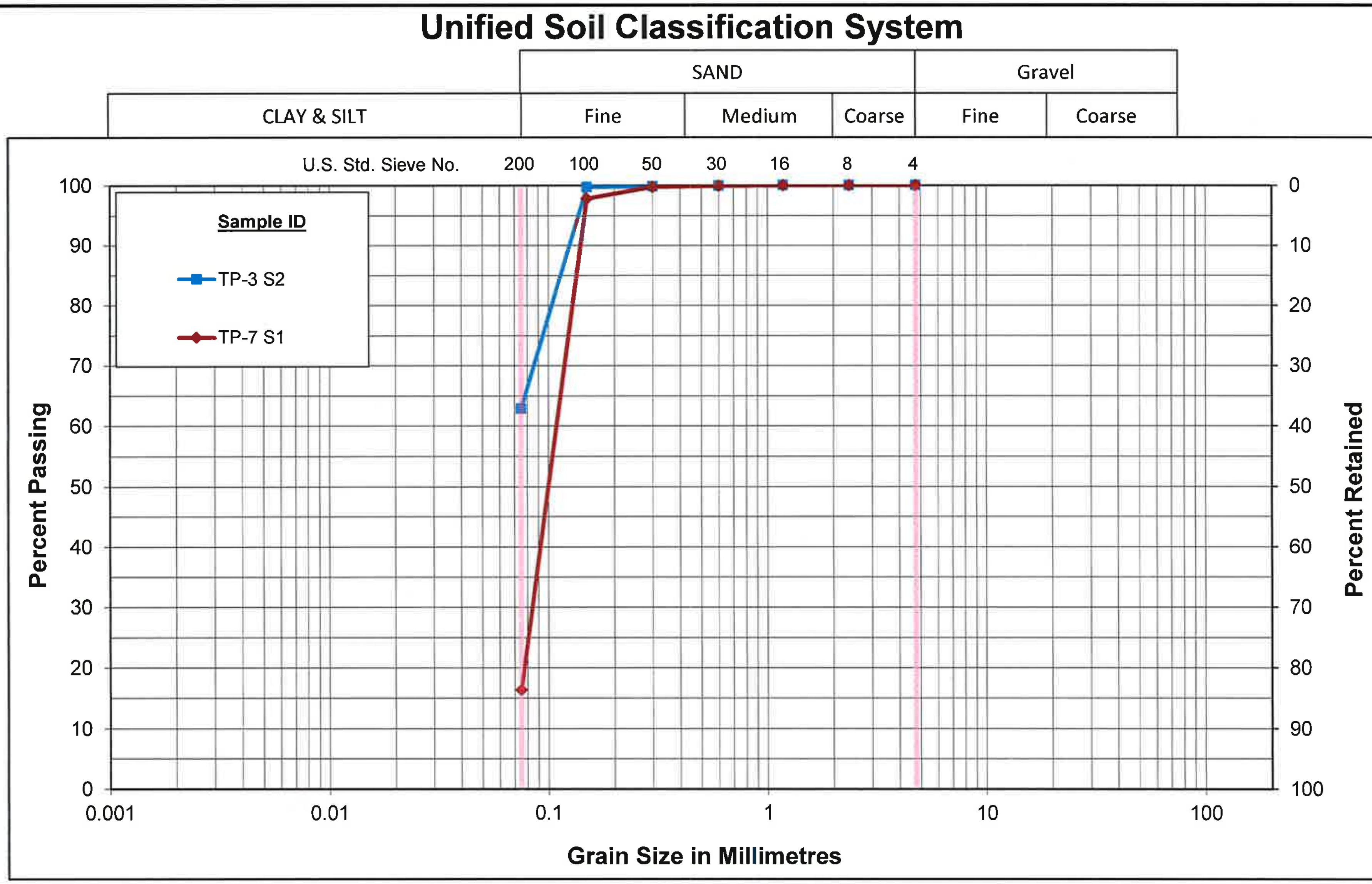
Easting: 458176
Site Datum: Assumed
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951479
Groundsurface Elev.: 98.80m
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

# Appendix C

# Laboratory Test Reports




| | | |
|---|---|---|
| Stantec | GRAIN SIZE DISTRIBUTION<br>Lascelles Engineering, File #180480 | Figure No.<br>Project No. 121621867 |

**Stantec** 2781 Lancaster Road
Ottawa ON, K1B 1A7

# Sieve Analysis
**LS 602**
**ASTM C136**

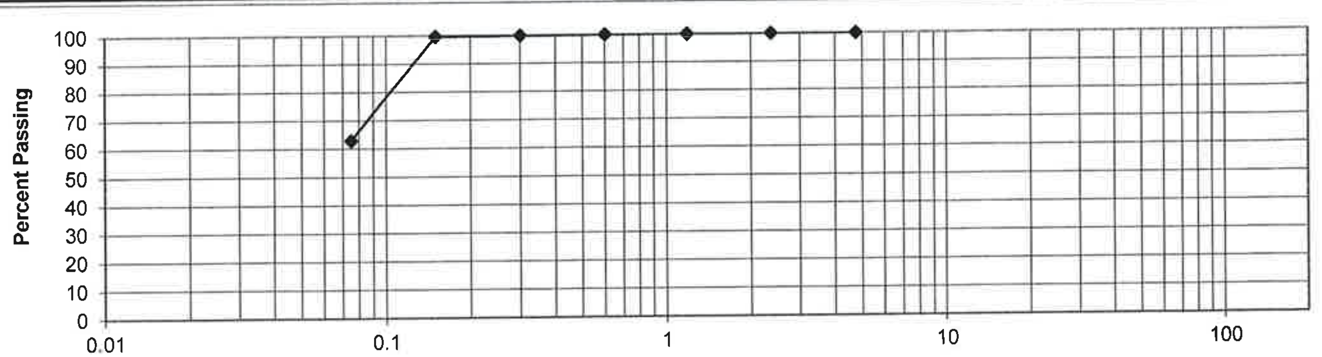
| | | | |
|---|---|---|---|
| Client: | **Lascelles Engineering, File #180480** | Project Number: | **121621867** |
| Project: | **EVB** | | |
| Material Type: | **Soils / Aggregates:** | | |
| Proposed Use: | **Fill/Granulars** | | |
| Source: | **TP-3** | | |
| Sample Number: | **S2** | | |
| Sampled Depth: | **12'** | | |
| Sampled By: | **Lascelles Engineering** | Tested By: | **Brian Prevost** |
| Date Sampled: | **December 5, 2018** | Date Tested: | **December 11, 2018** |

| Sieve Test Data | | Wash Test Data | | |
|---|---|---|---|---|
| Sample Weight Before Sieve, (g): | 5026.6 | Sample Weight Before Wash, (g): | 254.6 | Corrected |
| Sample Weight After Sieve, (g): | 5022.8 | Sample Weight After Wash, (g): | 142 | |
| Percent Loss In Sieve, (%): | 0.08 | Percent Passing No. 200, (%): | 44.2 | 44.2 |

**Sieve Analysis**

| Sieve No. | Size of Opening | | Weight Retained | Cumulative Weight Retained | Percent Passing | No Envelope | |
|---|---|---|---|---|---|---|---|
| | Inches | mm | g | g | % | Minimum | Maximum |
| | 6 | 150 | | | | | |
| | 4 | 106 | | | | | |
| | 3 | 76.2 | | | | | |
| | 2 | 53.0 | | | | | |
| | 1.5 | 37.5 | | | | | |
| | 1 | 26.5 | | | | | |
| | 3/4 | 19.0 | | | | | |
| | 5/8 | 16.0 | | | | | |
| | 1/2 | 13.2 | | | | | |
| | 3/8 | 9.5 | | | | | |
| +4 | 0.187 | 4.75 | 0.0 | 0.0 | 100.0 | | |
| | | - 4.75 | 5022.8 | 5022.8 | | | |
| 8 | 0.0937 | 2.36 | | 0.0 | 100.0 | | |
| 16 | 0.0469 | 1.18 | | 0.0 | 100.0 | | |
| 30 | 0.234 | 0.600 | | 0.2 | 99.9 | | |
| 50 | 0.0117 | 0.300 | | 0.4 | 99.8 | | |
| 100 | 0.0059 | 0.150 | | 0.8 | 99.7 | | |
| 200 | 0.0029 | 0.075 | | 94.5 | 62.9 | | |
| | | Pan | | 139.9 | | | |

**Classification of Sample:** % Gravel: 0.0 % Sand: 37.1 % Silt & Clay: 62.9




**Remarks:**

**Reviewed By:** Brian Prevost **Date:** December 14/2018

Stantec 2781 Lancaster Road
Ottawa ON, K1B 1A7

# Sieve Analysis
**LS 602**
**ASTM C136**

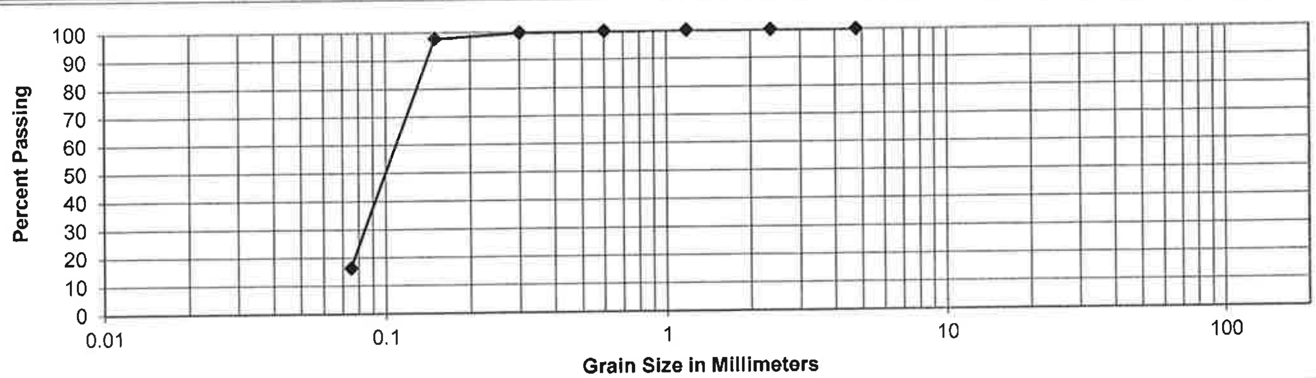
| | | | |
|---|---|---|---|
| Client: | **Lascelles Engineering, File #180480** | Project Number: | **121621867** |
| Project: | **EVB** | | |
| Material Type: | **Soils / Aggregates:** | | |
| Proposed Use: | **Fill/Granulars** | | |
| Source: | **TP-7** | | |
| Sample Number: | **S1** | | |
| Sampled Depth: | **3'** | | |
| Sampled By: | **Lascelles Engineering** | Tested By: | **Brian Prevost** |
| Date Sampled : | **December 5, 2018** | Date Tested: | **December 11, 2018** |

| Sieve Test Data | | Wash Test Data | | |
|---|---|---|---|---|
| Sample Weight Before Sieve, (g): | 4217.4 | Sample Weight Before Wash, (g): | 277.9 | Corrected |
| Sample Weight After Sieve, (g): | 4214.5 | Sample Weight After Wash, (g): | 246.3 | |
| Percent Loss In Sieve, (%): | 0.07 | Percent Passing No. 200, (%): | 11.4 | 11.4 |

## Sieve Analysis

| Sieve No. | Size of Opening Inches | mm | Weight Retained g | Cumulative Weight Retained g | Percent Passing % | No Envelope Minimum | Maximum |
|---|---|---|---|---|---|---|---|
| | 6 | 150 | | | | | |
| | 4 | 106 | | | | | |
| | 3 | 76.2 | | | | | |
| | 2 | 53.0 | | | | | |
| | 1.5 | 37.5 | | | | | |
| | 1 | 26.5 | | | | | |
| | 3/4 | 19.0 | | | | | |
| | 5/8 | 16.0 | | | | | |
| | 1/2 | 13.2 | | | | | |
| | 3/8 | 9.5 | | | | | |
| +4 | 0.187 | 4.75 | 0.0 | 0.0 | 100.0 | | |
| | | - 4.75 | 4214.5 | 4214.5 | | | |
| 8 | 0.0937 | 2.36 | | 0.0 | 100.0 | | |
| 16 | 0.0469 | 1.18 | | 0.0 | 100.0 | | |
| 30 | 0.234 | 0.600 | | 0.3 | 99.9 | | |
| 50 | 0.0117 | 0.300 | | 0.8 | 99.7 | | |
| 100 | 0.0059 | 0.150 | | 6.2 | 97.8 | | |
| 200 | 0.0029 | 0.075 | | 232.5 | 16.3 | | |
| | | Pan | | 245.6 | | | |

**Classification of Sample:** % Gravel: 0.0 % Sand: 83.7 % Silt & Clay: 16.3




**Remarks:**

**Reviewed By:** Brian Prevost **Date:** December 14/2018

V:\01216\active\laboratory_standing_offers\2018 Laboratory Standing Offers\121621867 Lascelles Engineering\December 5, Two Sieves, Lascelles #180480\Sieve Analysis Split, Geo May2017.xlsx

Stantec

**Stantec Consulting Ltd**
2781 Lancaster Rd
Ottawa, ON K1B 1A7
Tel: (613) 738-6075
Fax: (613) 722-2799

Date: March 11, 2019
File: 121621867

**Attention:** **Shuang Chang, Lascelles Engineering Associates**

**Reference:** **Lascelles File #180480, ASTM D4318 Atterberg Limit**

The following table summarizes Atterberg Limit results for BH-14 & BH-18.

| Source | Depth | Liquid Limit | Plastic Limit | Plasticity Index |
|---|---|---|---|---|
| BH-14 SS-10 | 45’-47’ | 30.4 | 17.0 | 13.3 |
| BH-18 SS-5 | 20’-22’ | 40.9 | 20.0 | 20.9 |

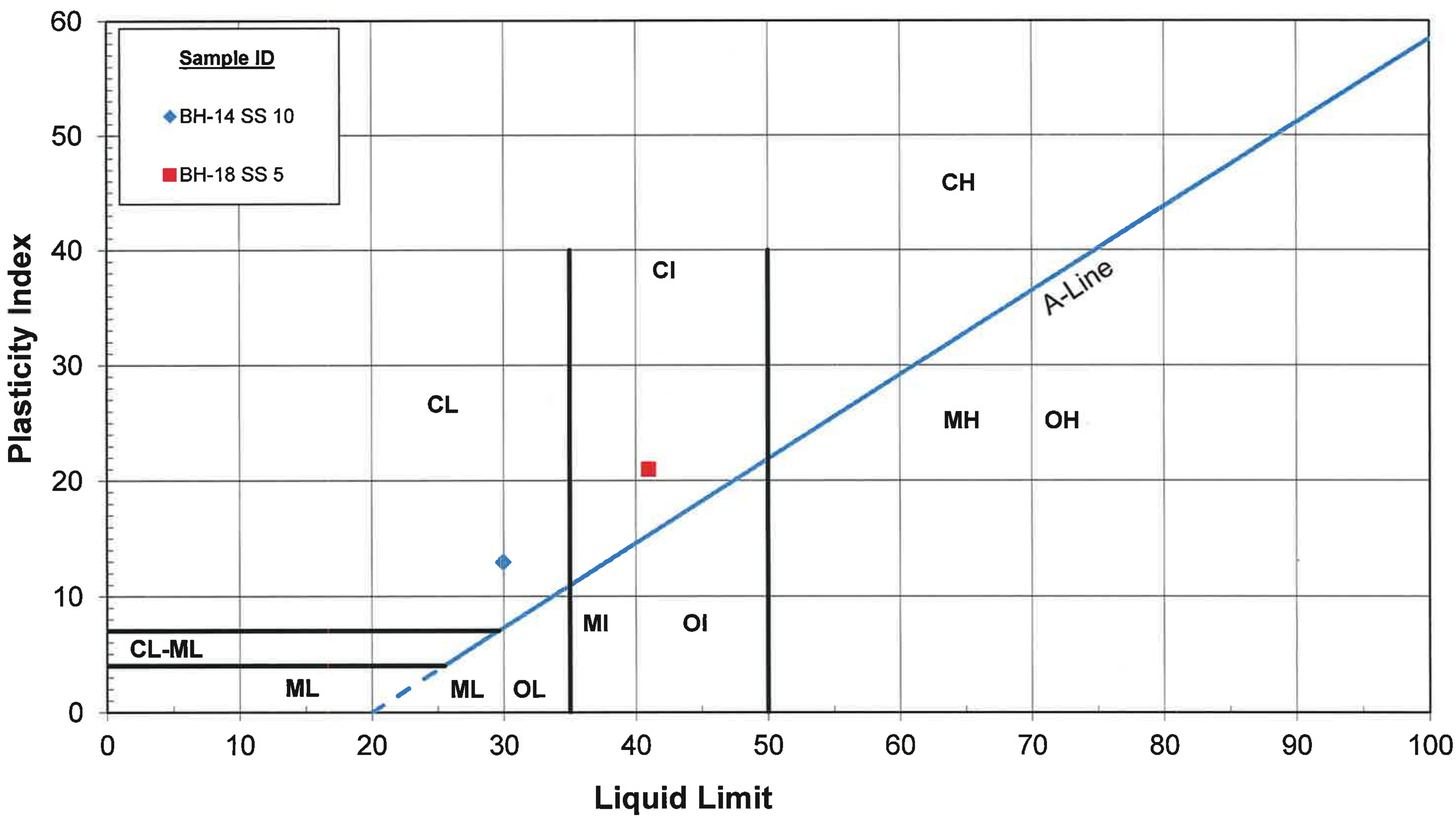
Sincerely,

**Stantec Consulting Ltd**

Brian Prevost

Brian Prevost
Laboratory Supervisor
Tel: 613-738-6075
Fax: 613-722-2799
brian.prevost@stantec.com

Attachments: Atterberg Limit Plasticity Chart




Stantec

Lascelles Engineering, File #180480

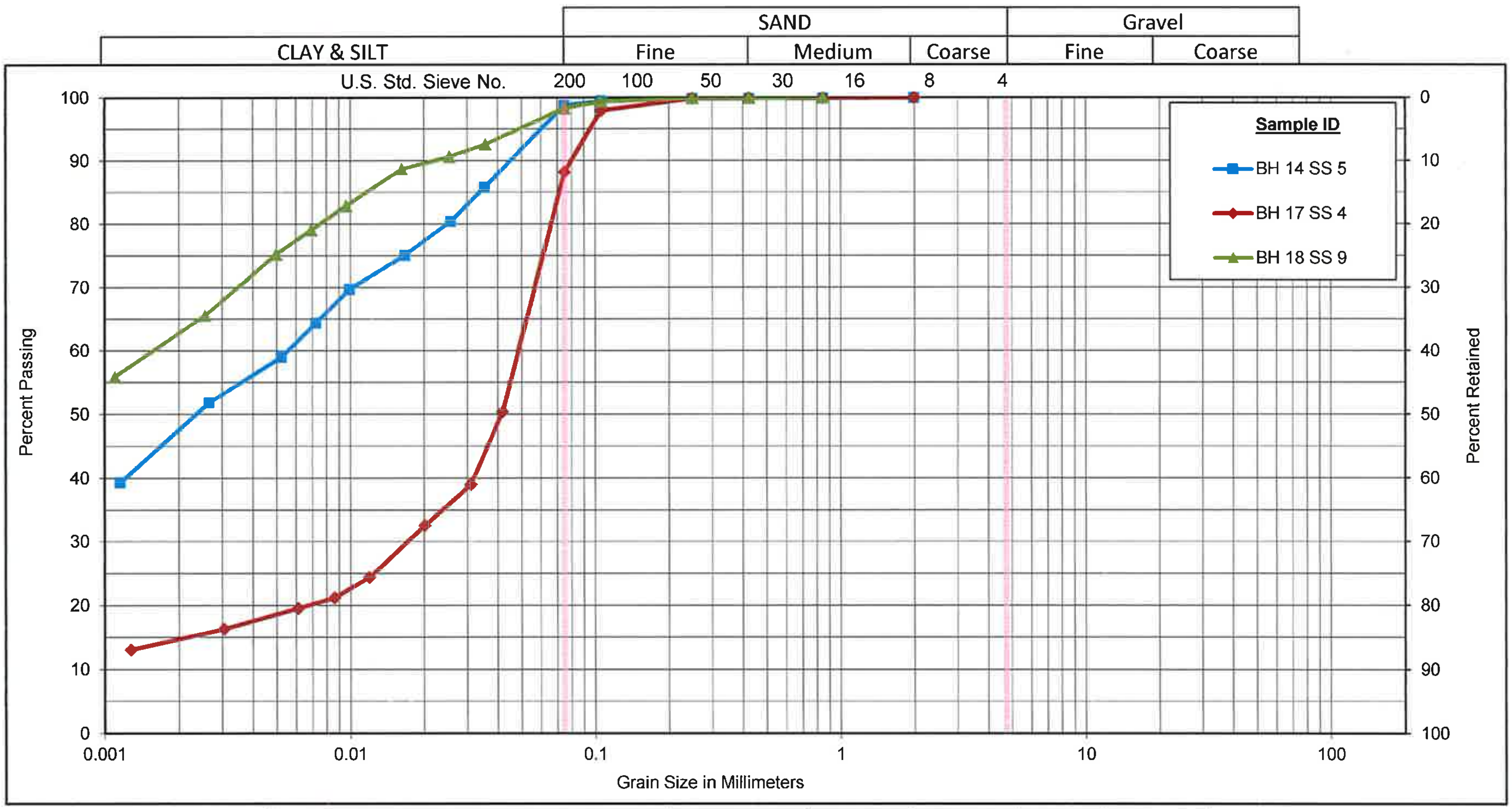
EVB Engineering

# PLASTICITY CHART

Figure No.

Project No. 121621867

## Unified Soil Classification System




| Sample ID | Depth (m) | % Gravel | % Sand | % Silt | % Clay |
|---|---|---|---|---|---|
| BH 14 SS 5 | 20'-22' | 0.0 | 1.2 | 52.8 | 46.0 |
| BH 17 SS 4 | 15'-17' | 0.0 | 11.8 | 74.2 | 14.0 |
| BH 18 SS 9 | 40'-42' | 0.0 | 1.7 | 36.3 | 62.0 |

Stantec

# GRAIN SIZE DISTRIBUTION Lascelles

File #180480

Figure No.

Project No. 121621867

Stantec

# Particle-Size Analysis of Soils
LS702
ASTM D422

## PROJECT DETAILS

| | | | |
|---|---|---|---|
| Client: | Lascelles Engineering, File# 180480 | Project No.: | 121621867 |
| Project: | EVB Engineering | Test Method: | LS702 |
| Material Type: | Soil | Sampled By: | Lascelles Engineering |
| Source: | BH 14 | Date Sampled: | February 21, 2019 |
| Sample No.: | SS 5 | Tested By: | Denis Rodriguez |
| Sample Depth | 20'-22' | Date Tested: | March 6, 2019 |

## WASH TEST DATA

| | |
|---|---|
| Oven Dry Mass In Hydrometer Analysis (g) | 54.74 |
| Sample Weight after Hydrometer and Wash (g) | 0.68 |
| Percent Passing No. 200 Sieve (%) | 98.8 |
| Percent Passing Corrected (%) | 98.76 |

## PERCENT LOSS IN SIEVE

| | |
|---|---|
| Sample Weight Before Sieve (g) | 225.40 |
| Sample Weight After Sieve (g) | 225.40 |
| Percent Loss in Sieve (%) | 0.00 |

## SOIL INFORMATION

| | | |
|---|---|---|
| Liquid Limit (LL) | | |
| Plasticity Index (PI) | | |
| Soil Classification | | |
| Specific Gravity ($G_s$) | 2.750 | |
| Sg. Correction Factor ($\alpha$) | 0.978 | |
| Mass of Dispersing Agent/Litre | 40 | g |

## CALCULATION OF DRY SOIL MASS

| | |
|---|---|
| Oven Dried Mass ($W_o$), (g) | 52.86 |
| Air Dried Mass ($W_a$), (g) | 53.30 |
| Hygroscopic Corr. Factor ($F=W_o/W_a$) | 0.9917 |
| Air Dried Mass in Analysis ($M_a$), (g) | 55.20 |
| Oven Dried Mass in Analysis ($M_o$), (g) | 54.74 |
| Percent Passing 2.0 mm Sieve ($P_{10}$), (%) | 100.00 |
| Sample Represented (W), (g) | 54.74 |

## SIEVE ANALYSIS

| Sieve Size mm | Cum. Wt. Retained | Percent Passing |
|---|---|---|
| 75.0 | | 100.0 |
| 63.0 | | 100.0 |
| 53.0 | | 100.0 |
| 37.5 | | 100.0 |
| 26.5 | | 100.0 |
| 19.0 | | 100.0 |
| 13.2 | | 100.0 |
| 9.5 | | 100.0 |
| 4.75 | | 100.0 |
| 2.00 | 0.0 | 100.0 |
| Total (C + F)[1] | 225.40 | |
| 0.850 | 0.05 | 99.91 |
| 0.425 | 0.06 | 99.89 |
| 0.250 | 0.08 | 99.85 |
| 0.106 | 0.28 | 99.49 |
| 0.075 | 0.66 | 98.79 |
| PAN | 0.68 | |

Note 1: (C + F) = Coarse + Fine

## HYDROMETER DETAILS

| | |
|---|---|
| Volume of Bulb ($V_B$), ($cm^3$) | 63.0 |
| Length of Bulb ($L_2$), (cm) | 14.47 |
| Length from '0' Reading to Top of Bulb ($L_1$), (cm) | 10.29 |
| Scale Dimension ($h_s$), (cm/Div) | 0.155 |
| Cross-Sectional Area of Cylinder (A), ($cm^2$) | 27.25 |
| Meniscus Correction ($H_m$), (g/L) | 1.0 |

**START TIME** 11:09 AM

## HYDROMETER ANALYSIS

| Date | Time | Elapsed Time T Mins | $H_s$ Divisions g/L | $H_c$ Divisions g/L | Temperature $T_c$ °C | Corrected Reading $R = H_s - H_c$ g/L | Percent Passing P % | L cm | η Poise | K | Diameter D mm |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 06-Mar-19 | 11:10 AM | 1 | 55.0 | 7.0 | 23.5 | 48.0 | 85.78 | 7.68904 | 9.28431 | 0.012744 | 0.03534 |
| 06-Mar-19 | 11:11 AM | 2 | 52.0 | 7.0 | 23.5 | 45.0 | 80.42 | 8.15404 | 9.28431 | 0.012744 | 0.02573 |
| 06-Mar-19 | 11:14 AM | 5 | 49.0 | 7.0 | 23.5 | 42.0 | 75.06 | 8.61904 | 9.28431 | 0.012744 | 0.01673 |
| 06-Mar-19 | 11:24 AM | 15 | 46.0 | 7.0 | 23.5 | 39.0 | 69.70 | 9.08404 | 9.28431 | 0.012744 | 0.00992 |
| 06-Mar-19 | 11:39 AM | 30 | 43.0 | 7.0 | 23.0 | 36.0 | 64.34 | 9.54904 | 9.39251 | 0.012818 | 0.00723 |
| 06-Mar-19 | 12:09 PM | 60 | 40.0 | 7.0 | 23.0 | 33.0 | 58.98 | 10.01404 | 9.39251 | 0.012818 | 0.00524 |
| 06-Mar-19 | 3:19 PM | 250 | 36.0 | 7.0 | 22.5 | 29.0 | 51.8278 | 10.63404 | 9.50295 | 0.012894 | 0.00266 |
| 07-Mar-19 | 11:09 AM | 1440 | 29.0 | 7.0 | 23.0 | 22.0 | 39.3176 | 11.71904 | 9.39251 | 0.012818 | 0.00116 |

Remarks:

Reviewed By: Brian Prevost
Date: March 11/2019

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Stantec

# Particle-Size Analysis of Soils
LS702
ASTM D422

## PROJECT DETAILS

| | | | |
|---|---|---|---|
| Client: | Lascelles Engineering, File# 180480 | Project No.: | 121621867 |
| Project: | EVB Engineering | Test Method: | LS702 |
| Material Type: | Soil | Sampled By: | Lascelles Engineering |
| Source: | BH 17 | Date Sampled: | February 22, 2019 |
| Sample No.: | SS 4 | Tested By: | Denis Rodriguez |
| Sample Depth | 15'-17' | Date Tested: | March 6, 2019 |

## WASH TEST DATA

| | |
|---|---|
| Oven Dry Mass In Hydrometer Analysis (g) | 60.19 |
| Sample Weight after Hydrometer and Wash (g) | 9.17 |
| Percent Passing No. 200 Sieve (%) | 84.8 |
| Percent Passing Corrected (%) | 84.77 |

## PERCENT LOSS IN SIEVE

| | |
|---|---|
| Sample Weight Before Sieve (g) | 703.30 |
| Sample Weight After Sieve (g) | 703.30 |
| Percent Loss in Sieve (%) | 0.00 |

## SOIL INFORMATION

| | | |
|---|---|---|
| Liquid Limit (LL) | | |
| Plasticity Index (PI) | | |
| Soil Classification | | |
| Specific Gravity ($G_s$) | 2.750 | |
| Sg. Correction Factor ($\alpha$) | 0.978 | |
| Mass of Dispersing Agent/Litre | 24 | g |

## CALCULATION OF DRY SOIL MASS

| | |
|---|---|
| Oven Dried Mass ($W_o$), (g) | 86.22 |
| Air Dried Mass ($W_a$), (g) | 86.50 |
| Hygroscopic Corr. Factor ($F=W_o/W_a$) | 0.9968 |
| Air Dried Mass in Analysis ($M_a$), (g) | 60.39 |
| Oven Dried Mass in Analysis ($M_o$), (g) | 60.19 |
| Percent Passing 2.0 mm Sieve ($P_{10}$), (%) | 100.00 |
| Sample Represented (W), (g) | 60.19 |

## SIEVE ANALYSIS

| Sieve Size mm | Cum. Wt. Retained | Percent Passing |
|---|---|---|
| 75.0 | | 100.0 |
| 63.0 | | 100.0 |
| 53.0 | | 100.0 |
| 37.5 | | 100.0 |
| 26.5 | | 100.0 |
| 19.0 | | 100.0 |
| 13.2 | | 100.0 |
| 9.5 | | 100.0 |
| 4.75 | | 100.0 |
| 2.00 | 0.0 | 100.0 |
| Total (C + F)[1] | 703.30 | |
| 0.850 | 0.04 | 99.93 |
| 0.425 | 0.06 | 99.90 |
| 0.250 | 0.07 | 99.88 |
| 0.106 | 1.24 | 97.94 |
| 0.075 | 7.09 | 88.22 |
| PAN | 9.16 | |

Note 1: (C + F) = Coarse + Fine

## HYDROMETER DETAILS

| | |
|---|---|
| Volume of Bulb ($V_B$), ($cm^3$) | 63.0 |
| Length of Bulb ($L_2$), (cm) | 14.47 |
| Length from '0' Reading to Top of Bulb ($L_1$), (cm) | 10.29 |
| Scale Dimension ($h_s$), (cm/Div) | 0.155 |
| Cross-Sectional Area of Cylinder (A), ($cm^2$) | 27.25 |
| Meniscus Correction ($H_m$), (g/L) | 1.0 |

**START TIME** 11:26 AM

## HYDROMETER ANALYSIS

| Date | Time | Elapsed Time T Mins | $H_s$ Divisions g/L | $H_c$ Divisions g/L | Temperature $T_c$ °C | Corrected Reading $R = H_s - H_c$ g/L | Percent Passing P % | L cm | η Poise | K | Diameter D mm |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-Mar-19 | 11:27 AM | 1 | 35.0 | 4.0 | 23.5 | 31.0 | 50.39 | 10.78904 | 9.28431 | 0.012744 | 0.04186 |
| 6-Mar-19 | 11:28 AM | 2 | 28.0 | 4.0 | 23.5 | 24.0 | 39.01 | 11.87404 | 9.28431 | 0.012744 | 0.03105 |
| 6-Mar-19 | 11:31 AM | 5 | 24.0 | 4.0 | 23.5 | 20.0 | 32.51 | 12.49404 | 9.28431 | 0.012744 | 0.02015 |
| 6-Mar-19 | 11:41 AM | 15 | 19.0 | 4.0 | 23.5 | 15.0 | 24.38 | 13.26904 | 9.28431 | 0.012744 | 0.01199 |
| 6-Mar-19 | 11:56 AM | 30 | 17.0 | 4.0 | 23 | 13.0 | 21.13 | 13.57904 | 9.39251 | 0.012818 | 0.00862 |
| 6-Mar-19 | 12:26 PM | 60 | 16.0 | 4.0 | 23.0 | 12.0 | 19.50 | 13.73404 | 9.39251 | 0.012818 | 0.00613 |
| 6-Mar-19 | 3:36 PM | 250 | 14.0 | 4.0 | 22.5 | 10.0 | 16.25 | 14.04404 | 9.50295 | 0.012894 | 0.00306 |
| 7-Mar-19 | 11:26 AM | 1440 | 12.0 | 4.0 | 23 | 8.0 | 13.00 | 14.35404 | 9.39251 | 0.012818 | 0.00128 |

Remarks:

Reviewed By: Brian Prevost
Date: March 11/2019

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Stantec

# Particle-Size Analysis of Soils
LS702
ASTM D422

## PROJECT DETAILS

| | | | |
|---|---|---|---|
| Client: | Lascelles Engineering, File# 180480 | Project No.: | 121621867 |
| Project: | EVB Engineering | Test Method: | LS702 |
| Material Type: | Soil | Sampled By: | Lascelles Engineering |
| Source: | BH 18 | Date Sampled: | February 22, 2019 |
| Sample No.: | SS 9 | Tested By: | Denis Rodriguez |
| Sample Depth | 40'-42' | Date Tested: | March 6, 2019 |

## WASH TEST DATA

| | |
|---|---|
| Oven Dry Mass In Hydrometer Analysis (g) | 50.76 |
| Sample Weight after Hydrometer and Wash (g) | 0.85 |
| Percent Passing No. 200 Sieve (%) | 98.3 |
| Percent Passing Corrected (%) | 98.33 |

## PERCENT LOSS IN SIEVE

| | |
|---|---|
| Sample Weight Before Sieve (g) | 256.70 |
| Sample Weight After Sieve (g) | 256.70 |
| Percent Loss in Sieve (%) | 0.00 |

## SOIL INFORMATION

| | | |
|---|---|---|
| Liquid Limit (LL) | | |
| Plasticity Index (PI) | | |
| Soil Classification | | |
| Specific Gravity ($G_s$) | 2.750 | |
| Sg. Correction Factor (α) | 0.978 | |
| Mass of Dispersing Agent/Litre | 48 | g |

## CALCULATION OF DRY SOIL MASS

| | |
|---|---|
| Oven Dried Mass ($W_o$), (g) | 61.88 |
| Air Dried Mass ($W_a$), (g) | 62.38 |
| Hygroscopic Corr. Factor ($F=W_o/W_a$) | 0.9920 |
| Air Dried Mass in Analysis ($M_a$), (g) | 51.17 |
| Oven Dried Mass in Analysis ($M_o$), (g) | 50.76 |
| Percent Passing 2.0 mm Sieve ($P_{10}$), (%) | 100.00 |
| Sample Represented (W), (g) | 50.76 |

## SIEVE ANALYSIS

| Sieve Size mm | Cum. Wt. Retained | Percent Passing |
|---|---|---|
| 75.0 | | 100.0 |
| 63.0 | | 100.0 |
| 53.0 | | 100.0 |
| 37.5 | | 100.0 |
| 26.5 | | 100.0 |
| 19.0 | | 100.0 |
| 13.2 | | 100.0 |
| 9.5 | | 100.0 |
| 4.75 | | 100.0 |
| 2.00 | 0.0 | 100.0 |
| Total (C + F)[1] | 256.70 | |
| 0.850 | 0.00 | 100.00 |
| 0.425 | 0.04 | 99.92 |
| 0.250 | 0.05 | 99.90 |
| 0.106 | 0.33 | 99.35 |
| 0.075 | 0.84 | 98.35 |
| PAN | 0.85 | |

Note 1: (C + F) = Coarse + Fine

## HYDROMETER DETAILS

| | |
|---|---|
| Volume of Bulb ($V_B$), ($cm^3$) | 63.0 |
| Length of Bulb ($L_2$), (cm) | 14.47 |
| Length from '0' Reading to Top of Bulb ($L_1$), (cm) | 10.29 |
| Scale Dimension ($h_s$), (cm/Div) | 0.155 |
| Cross-Sectional Area of Cylinder (A), ($cm^2$) | 27.2 |
| Meniscus Correction ($H_m$), (g/L) | 1.0 |

START TIME 11:34 AM

## HYDROMETER ANALYSIS

| Date | Time | Elapsed Time T Mins | $H_s$ Divisions g/L | $H_c$ Divisions g/L | Temperature $T_c$ °C | Corrected Reading $R = H_s - H_c$ g/L | Percent Passing P % | L cm | η Poise | K | Diameter D mm |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-Mar-19 | 11:35 AM | 1 | 55.0 | 7.0 | 23.0 | 48.0 | 92.52 | 7.68691 | 9.39251 | 0.012818 | 0.03554 |
| 6-Mar-19 | 11:36 AM | 2 | 54.0 | 7.0 | 23.0 | 47.0 | 90.59 | 7.84191 | 9.39251 | 0.012818 | 0.02538 |
| 6-Mar-19 | 11:39 AM | 5 | 53.0 | 7.0 | 23.0 | 46.0 | 88.66 | 7.99691 | 9.39251 | 0.012818 | 0.01621 |
| 6-Mar-19 | 11:49 AM | 15 | 50.0 | 7.0 | 23.0 | 43.0 | 82.88 | 8.46191 | 9.39251 | 0.012818 | 0.00963 |
| 6-Mar-19 | 12:04 PM | 30 | 48.0 | 7.0 | 23 | 41.0 | 79.03 | 8.77191 | 9.39251 | 0.012818 | 0.00693 |
| 6-Mar-19 | 12:34 PM | 60 | 46.0 | 7.0 | 23.0 | 39.0 | 75.17 | 9.08191 | 9.39251 | 0.012818 | 0.00499 |
| 6-Mar-19 | 3:44 PM | 250 | 41.0 | 7.0 | 22.5 | 34.0 | 65.53 | 9.85691 | 9.50295 | 0.012894 | 0.00256 |
| 7-Mar-19 | 11:34 AM | 1440 | 36.0 | 7.0 | 23 | 29.0 | 55.90 | 10.63191 | 9.39251 | 0.012818 | 0.00110 |

Remarks:

Reviewed By: Brian Prevost
Date: March 11/2019

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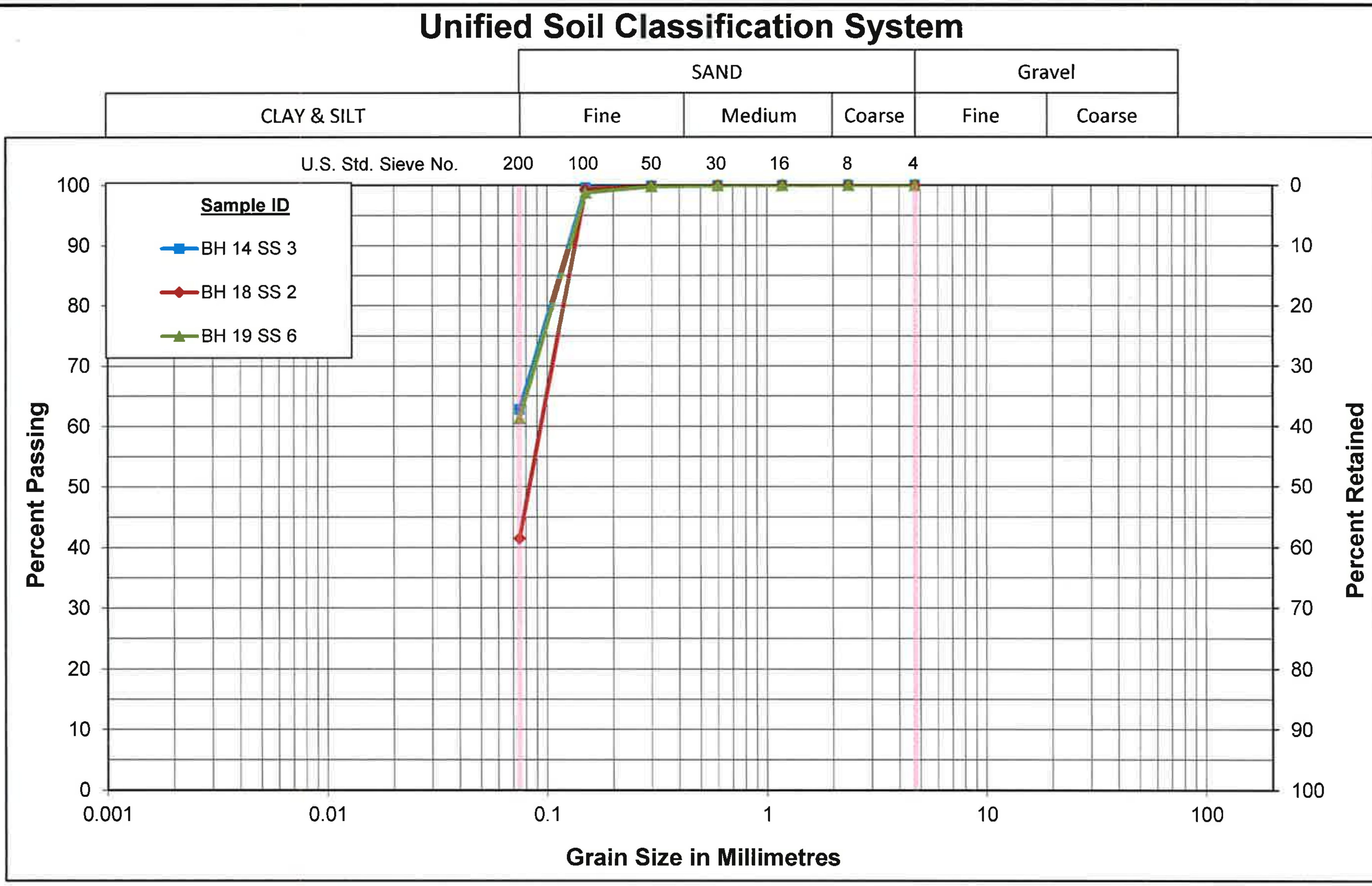



# GRAIN SIZE DISTRIBUTION

Lascelles Engineering File #180480

EVB Engineering

Figure No.

Project No. 121621867

# Stantec

2781 Lancaster Road
Ottawa ON, K1B 1A7

**Sieve Analysis**
**LS 602**
**ASTM C136**

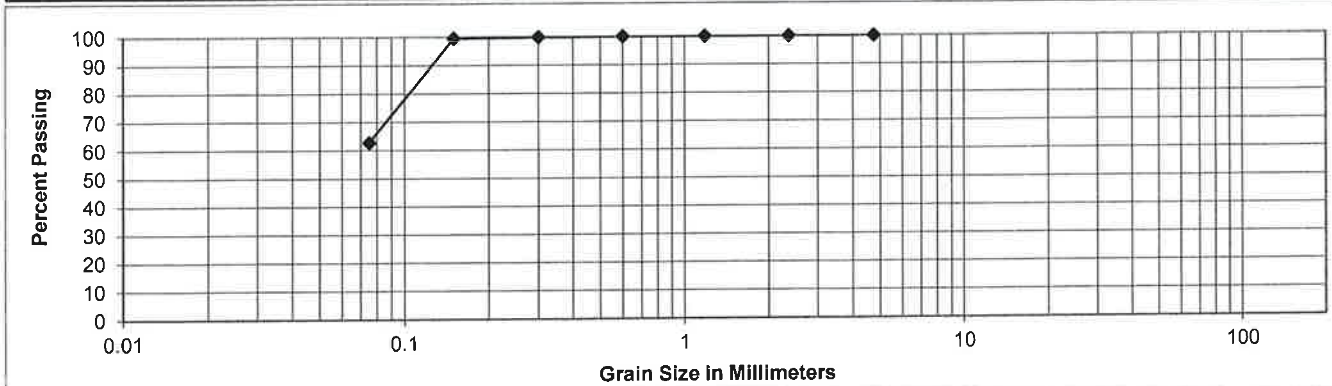
| | | | |
|---|---|---|---|
| Client: | **Lascelles Engineering File #180480** | Project Number: | **121621867** |
| Project: | **EVB Engineering** | | |
| Material Type: | **Soils / Aggregates:** | | |
| Proposed Use: | **Fill/Granulars** | | |
| Source: | **BH 14** | | |
| Sample Number: | **SS 3** | | |
| Sampled Depth: | **10'-12'** | | |
| Sampled By: | **Lascelles Engineering Associates** | Tested By: | **Denis Rodriguez** |
| Date Sampled: | **February 21, 2019** | Date Tested: | **March 5, 2019** |

| Sieve Test Data | | Wash Test Data | | |
|---|---|---|---|---|
| Sample Weight Before Sieve, (g): | 667.3 | Sample Weight Before Wash, (g): | 269.2 | Corrected |
| Sample Weight After Sieve, (g): | 667.3 | Sample Weight After Wash, (g): | 124.6 | |
| Percent Loss In Sieve, (%): | 0.00 | Percent Passing No. 200, (%): | 53.7 | 53.7 |

**Sieve Analysis**

| Sieve No. | Size of Opening Inches | Size of Opening mm | Weight Retained g | Cumulative Weight Retained g | Percent Passing % | No Envelope Minimum | No Envelope Maximum |
|---|---|---|---|---|---|---|---|
| | 6 | 150 | | | | | |
| | 4 | 106 | | | | | |
| | 3 | 76.2 | | | | | |
| | 2 | 53.0 | | | | | |
| | 1.5 | 37.5 | | | | | |
| | 1 | 26.5 | | | | | |
| | 3/4 | 19.0 | | | | | |
| | 5/8 | 16.0 | | | | | |
| | 1/2 | 13.2 | | | | | |
| | 3/8 | 9.5 | | | | | |
| +4 | 0.187 | 4.75 | 0.0 | 0.0 | 100.0 | | |
| | | - 4.75 | 667.3 | 667.3 | | | |
| 8 | 0.0937 | 2.36 | | | 100.0 | | |
| 16 | 0.0469 | 1.18 | | 0.1 | 100.0 | | |
| 30 | 0.234 | 0.600 | | 0.2 | 99.9 | | |
| 50 | 0.0117 | 0.300 | | 0.4 | 99.9 | | |
| 100 | 0.0059 | 0.150 | | 1.2 | 99.6 | | |
| 200 | 0.0029 | 0.075 | | 100.0 | 62.9 | | |
| | | Pan | | 124.6 | | | |

**Classification of Sample:** % Gravel: 0.0 % Sand: 37.1 % Silt & Clay: 62.9




**Remarks:**

**Reviewed By:** Brian Prevost

**Date:** March 11/2019

V:\01216\active\laboratory_standing_offers\2019 Laboratory Standing Offers\121621867 Lascelles Engineering Associates\February 21, Three Limits, Hydros, Two Sieve\Sieve.xlsx

Stantec 2781 Lancaster Road
Ottawa ON, K1B 1A7

# Sieve Analysis
**LS 602**
**ASTM C136**

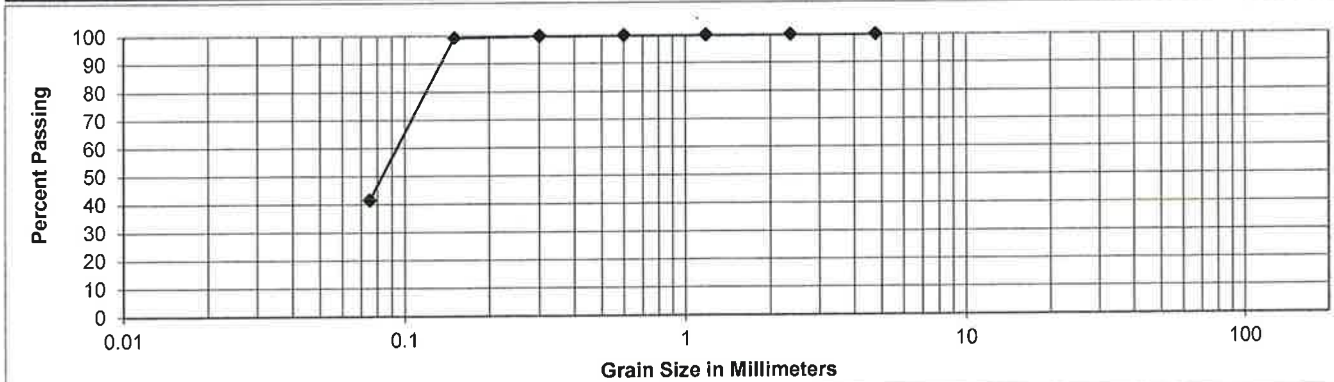
| | | | |
|---|---|---|---|
| Client: | **Lascelles Engineering File #180480** | Project Number: | **121621867** |
| Project: | **EVB Engineering** | | |
| Material Type: | **Soils / Aggregates:** | | |
| Proposed Use: | **Fill/Granulars** | | |
| Source: | **BH 18** | | |
| Sample Number: | **SS 2** | | |
| Sampled Depth: | **5'-7'** | | |
| Sampled By: | **Lascelles Engineering Associates** | Tested By: | **Denis Rodriguez** |
| Date Sampled : | **February 22, 2019** | Date Tested: | **March 5, 2019** |

| Sieve Test Data | | Wash Test Data | | Corrected |
|---|---|---|---|---|
| Sample Weight Before Sieve, (g): | 614.9 | Sample Weight Before Wash, (g): | 282.0 | |
| Sample Weight After Sieve, (g): | 614.9 | Sample Weight After Wash, (g): | 193.1 | |
| Percent Loss In Sieve, (%): | 0.00 | Percent Passing No. 200, (%): | 31.5 | 31.5 |

## Sieve Analysis

| Sieve No. | Size of Opening | | Weight Retained | Cumulative Weight Retained | Percent Passing | No Envelope | |
|---|---|---|---|---|---|---|---|
| | Inches | mm | g | g | % | Minimum | Maximum |
| | 6 | 150 | | | | | |
| | 4 | 106 | | | | | |
| | 3 | 76.2 | | | | | |
| | 2 | 53.0 | | | | | |
| | 1.5 | 37.5 | | | | | |
| | 1 | 26.5 | | | | | |
| | 3/4 | 19.0 | | | | | |
| | 5/8 | 16.0 | | | | | |
| | 1/2 | 13.2 | | | | | |
| | 3/8 | 9.5 | | | | | |
| +4 | 0.187 | 4.75 | 0.0 | 0.0 | 100.0 | | |
| | | - 4.75 | 614.9 | 614.9 | | | |
| 8 | 0.0937 | 2.36 | | 0.0 | 100.0 | | |
| 16 | 0.0469 | 1.18 | | 0.1 | 100.0 | | |
| 30 | 0.234 | 0.600 | | 0.2 | 99.9 | | |
| 50 | 0.0117 | 0.300 | | 0.5 | 99.8 | | |
| 100 | 0.0059 | 0.150 | | 2.0 | 99.3 | | |
| 200 | 0.0029 | 0.075 | | 165.0 | 41.5 | | |
| | | Pan | | 193.0 | | | |

**Classification of Sample:** % Gravel: 0.0 % Sand: 58.5 % Silt & Clay: 41.5




**Remarks:**

**Reviewed By:** Brian Prevost **Date:** March 11/2019

V:\01216\active\laboratory_standing_offers\2019 Laboratory Standing Offers\121621867 Lascelles Engineering Associates\February 21, Three Limits, Hydros, Two Sieve\Sieve.xlsx

Stantec 2781 Lancaster Road
Ottawa ON, K1B 1A7

# Sieve Analysis
**LS 602**
**ASTM C136**

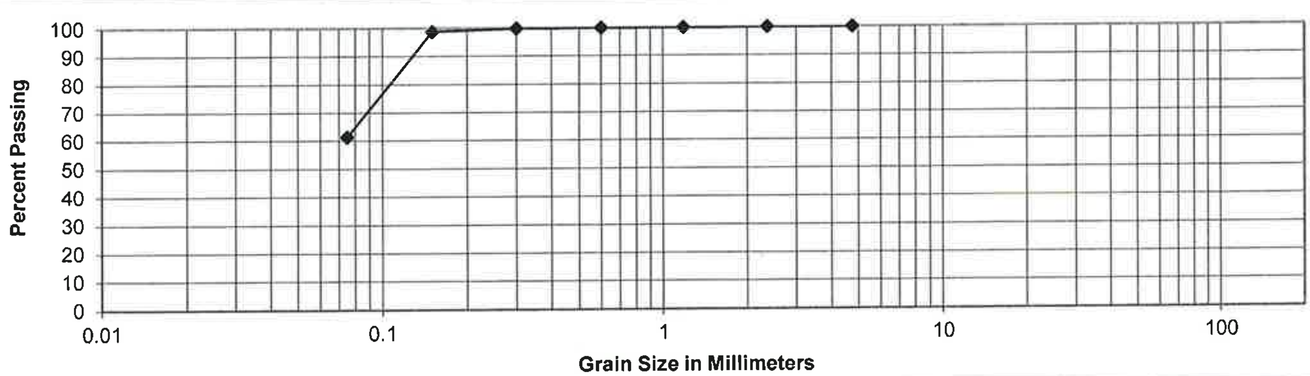
| | | | |
|---|---|---|---|
| Client: | **Lascelles Engineering File #180480** | Project Number: | **121621867** |
| Project: | **EVB Engineering** | | |
| Material Type: | **Soils / Aggregates:** | | |
| Proposed Use: | **Fill/Granulars** | | |
| Source: | **BH 19** | | |
| Sample Number: | **SS 6** | | |
| Sampled Depth: | **12'6"-14'6"** | | |
| Sampled By: | **Lascelles Engineering Associates** | Tested By: | **Denis Rodriguez** |
| Date Sampled: | **February 19, 2019** | Date Tested: | **March 5, 2019** |

| Sieve Test Data | | Wash Test Data | | |
|---|---|---|---|---|
| Sample Weight Before Sieve, (g): | 824.9 | Sample Weight Before Wash, (g): | 273.6 | Corrected |
| Sample Weight After Sieve, (g): | 824.9 | Sample Weight After Wash, (g): | 144.8 | |
| Percent Loss In Sieve, (%): | 0.00 | Percent Passing No. 200, (%): | 47.1 | 47.1 |

## Sieve Analysis

| Sieve No. | Size of Opening Inches | Size of Opening mm | Weight Retained g | Cumulative Weight Retained g | Percent Passing % | No Envelope Minimum | No Envelope Maximum |
|---|---|---|---|---|---|---|---|
| | 6 | 150 | | | | | |
| | 4 | 106 | | | | | |
| | 3 | 76.2 | | | | | |
| | 2 | 53.0 | | | | | |
| | 1.5 | 37.5 | | | | | |
| | 1 | 26.5 | | | | | |
| | 3/4 | 19.0 | | | | | |
| | 5/8 | 16.0 | | | | | |
| | 1/2 | 13.2 | | | | | |
| | 3/8 | 9.5 | | | | | |
| +4 | 0.187 | 4.75 | 0.0 | 0.0 | 100.0 | | |
| | | - 4.75 | 824.9 | 824.9 | | | |
| 8 | 0.0937 | 2.36 | | 0.0 | 100.0 | | |
| 16 | 0.0469 | 1.18 | | 0.1 | 100.0 | | |
| 30 | 0.234 | 0.600 | | 0.2 | 99.9 | | |
| 50 | 0.0117 | 0.300 | | 0.6 | 99.8 | | |
| 100 | 0.0059 | 0.150 | | 3.4 | 98.8 | | |
| 200 | 0.0029 | 0.075 | | 105.7 | 61.4 | | |
| | | Pan | | 144.8 | | | |

**Classification of Sample:** % Gravel: 0.0 % Sand: 38.6 % Silt & Clay: 61.4




**Remarks:**

**Reviewed By:** Brian Prevost **Date:** March 11/2019

V:\01216\active\laboratory_standing_offers\2019 Laboratory Standing Offers\121621867 Lascelles Engineering Associates\February 21, Three Limits, Hydros, Two Sieve\Sieve.xlsx

# Appendix D

# Laboratory Certificates of Analysis

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1-800-749-1947
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# Certificate of Analysis

**Lascelles Engineering Ltd.**

870 James St
Hawkesbury, ON K6A2W8
Attn: Shuang Chang

Client PO: 180480
Project: 180480
Custody: 43345

Report Date: 14-Dec-2018
Order Date: 10-Dec-2018

**Order #: 1850066**

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

| Paracel ID | Client ID |
|---|---|
| 1850066-01 | TP-4 S1 |
| 1850066-02 | TP-8 S1 |

Approved By: Mark Foto

Mark Foto, M.Sc.
Lab Supervisor

## Analysis Summary Table

| Analysis | Method Reference/Description | Extraction Date | Analysis Date |
|---|---|---|---|
| Anions | EPA 300.1 - IC, water extraction | 12-Dec-18 | 12-Dec-18 |
| pH, soil | EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext. | 11-Dec-18 | 11-Dec-18 |
| Resistivity | EPA 120.1 - probe, water extraction | 13-Dec-18 | 13-Dec-18 |
| Solids, % | Gravimetric, calculation | 13-Dec-18 | 13-Dec-18 |

Certificate of Analysis

**Client: Lascelles Engineering Ltd.**

**Client PO: 180480**

Report Date: 14-Dec-2018

Order Date: 10-Dec-2018

**Project Description: 180480**

| | | | | | |
|---|---|---|---|---|---|
| | **Client ID:** | TP-4 S1 | TP-8 S1 | - | - |
| | **Sample Date:** | 12/05/2018 09:00 | 12/05/2018 10:00 | - | - |
| | **Sample ID:** | 1850066-01 | 1850066-02 | - | - |
| | **MDL/Units** | Soil | Soil | - | - |
| **Physical Characteristics** | | | | | |
| % Solids | 0.1 % by Wt. | 82.3 | 78.7 | - | - |
| **General Inorganics** | | | | | |
| pH | 0.05 pH Units | 7.85 | - | - | - |
| Resistivity | 0.10 Ohm.m | 121 | - | - | - |
| **Anions** | | | | | |
| Chloride | 5 ug/g dry | <5 | - | - | - |
| Sulphate | 5 ug/g dry | 14 | <5 | - | - |

## *Method Quality Control: Blank*

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

## *Method Quality Control: Duplicate*

| Analyte | Result | Reporting Limit | Units | Source Result | %REC | %REC Limit | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **Anions** | | | | | | | | | |
| Chloride | 62.1 | 5 | ug/g dry | 57.2 | | | 8.2 | 20 | |
| Sulphate | 132 | 5 | ug/g dry | 116 | | | 12.7 | 20 | |
| **General Inorganics** | | | | | | | | | |
| pH | 7.74 | 0.05 | pH Units | 7.84 | | | 1.3 | 10 | |
| Resistivity | 42.7 | 0.10 | Ohm.m | 41.0 | | | 4.3 | 20 | |
| **Physical Characteristics** | | | | | | | | | |
| % Solids | 70.2 | 0.1 | % by Wt. | 72.1 | | | 2.7 | 25 | |

Certificate of Analysis
**Client: Lascelles Engineering Ltd.**
**Client PO: 180480**

Report Date: 14-Dec-2018
Order Date: 10-Dec-2018
**Project Description: 180480**

## *Method Quality Control: Spike*

| Analyte | Result | Reporting Limit | Units | Source Result | %REC | %REC Limit | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **Anions** | | | | | | | | | |
| Chloride | 146 | 5 | ug/g | 57.2 | 89.0 | 78-113 | | | |
| Sulphate | 215 | 5 | ug/g | 116 | 98.8 | 78-111 | | | |

**Qualifier Notes:**

None

**Sample Data Revisions**

None

**Work Order Revisions / Comments:**

None

**Other Report Notes:**

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.

Soil results are reported on a dry weight basis when the units are denoted with 'dry'.
Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

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# Subcontracted Analysis

**Lascelles Engineering Ltd.**
870 James St
Hawkesbury, ON K6A2W8
Attn: Shuang Chang

Tel: (613) 632-0241
Fax: (613) 632-0241

| | |
|---|---|
| Paracel Report No | **1850066** |
| Client Project(s): | **180480** |
| Client PO: | **180480** |
| Reference: | **Standing Offer** |
| CoC Number: | **43345** |

Order Date: 10-Dec-18
Report Date: 14-Dec-18

Sample(s) from this project were subcontracted for the listed parameters. A copy of the subcontractor's report is attached

| **Paracel ID** | **Client ID** | **Analysis** |
|---|---|---|
| 1850066-01 | TP-4 S1 | Redox potential, soil |

**TESTMARK Laboratories Ltd.**
*Committed to Quality and Service*

# CERTIFICATE OF ANALYSIS

| | | | |
|---|---|---|---|
| Client: | Mark Foto | Work Order Number: | 361974 |
| Company: | Paracel Laboratories Ltd.- Ottawa | PO #: | |
| Address: | 300-2319 St. Laurent Blvd. | Regulation: | None |
| | Ottawa, ON, K1G 4J8 | Project #: | 1850066 |
| Phone/Fax: | (613) 731-9577 / (613) 731-9064 | DWS #: | |
| Email: | mfoto@paracellabs.com | Sampled By: | |

| | | | |
|---|---|---|---|
| Date Order Received: | 12/11/2018 | Analysis Started: | 12/14/2018 |
| Arrival Temperature: | 9.9 °C | Analysis Completed: | 12/14/2018 |

## WORK ORDER SUMMARY

ANALYSES WERE PERFORMED ON THE FOLLOWING SAMPLES AS RECEIVED. RESULTS RELATE ONLY TO THE ITEMS TESTED.

| Sample Description | Lab ID | Matrix | Type | Comments | Date Collected | Time Collected |
|---|---|---|---|---|---|---|
| TP-4 S1 | 1404566 | Soil | None | | 12/5/2018 | |

## METHODS AND INSTRUMENTATION

THE FOLLOWING METHODS WERE USED FOR YOUR SAMPLE(S):

| Method | Lab | Description | Reference |
|---|---|---|---|
| RedOx - Soil (T06) | Mississauga | Determination of RedOx Potential of Soil | Modified from APHA-2580B |

This report has been approved by:

Marc Creighton
Laboratory Director

TESTMARK Laboratories Ltd.
Committed to Quality and Service

# CERTIFICATE OF ANALYSIS

Paracel Laboratories Ltd.- Ottawa

Work Order Number: 361974

## WORK ORDER RESULTS

| Sample Description | TP - 4 S1 |
|---|---|
| Lab ID | 1404566 |

| General Chemistry | Result | MDL | Units |
|---|---|---|---|
| RedOx (vs. S.H.E.) | 498<br>[499] | N/A | mV |

## LEGEND

Dates: Dates are formatted as mm/dd/year throughout this report.

MDL: Method detection limit or minimum reporting limit.

[ ]: Results for laboratory replicates are shown in square brackets immediately below the associated sample result for ease of comparison.

Quality Control: All associated Quality Control data is available on request.

Exceedences: HIGHLIGHTED CELLS INDICATE THAT THE RESULT EXCEEDS A REGULATORY LIMIT. CALCULATED UNCERTAINTY ESTIMATIONS ARE NOT APPLIED FOR DETERMINING SAMPLE EXCEEDANCES..


6820 Kitimat Road Unit 4, Mississauga, ON, L5N 5M3
Phone: (905) 821-1112 Fax: (905) 821-2095 Web: www.testmark.ca

# Geotechnical Investigation
# Proposed Prescott Arena (Alternate Site)
# Sophia Street and Churchill Road West
# Prescott, Ontario

Prepared for

EVB Engineering Ltd.
Attn: Mr. Greg Esdale, P. Eng.
208 Pitt Street
Cornwall, Ontario
K6J 3P6

By

Lascelles Engineering & Associates Limited
1010 Spence Avenue – Suite 14
Hawkesbury, Ontario
K6A 3H9

LASCELLES
ENGINEERING & ASSOCIATES

Lascelles File No: 180480

December 2019

# TABLE OF CONTENTS

# TABLES



# APPENDICES

# 1 INTRODUCTION

The Town of Prescott, through a consulting agreement with EVB Engineering Ltd. (EVB), retained the services of Lascelles Engineering & Associates Ltd. (Lascelles) to conduct a geotechnical investigation on an alternate site for the construction of a proposed new arena. The alternate site is located approximately 150m south of the original proposed location, and fronts Churchill Road West. This investigation is being carried out in hopes of obtaining more favourable soil conditions versus those obtained as part of the previous geotechnical investigation (Report dated May 2019).

The purpose of the investigation was to identify the subsurface soil and groundwater conditions within the proposed project area by means of a limited number of boreholes, and based on the factual information obtained, provide guidelines on the geotechnical engineering aspects of the design of the proposed foundations and roadways, including construction considerations which may influence the said design.

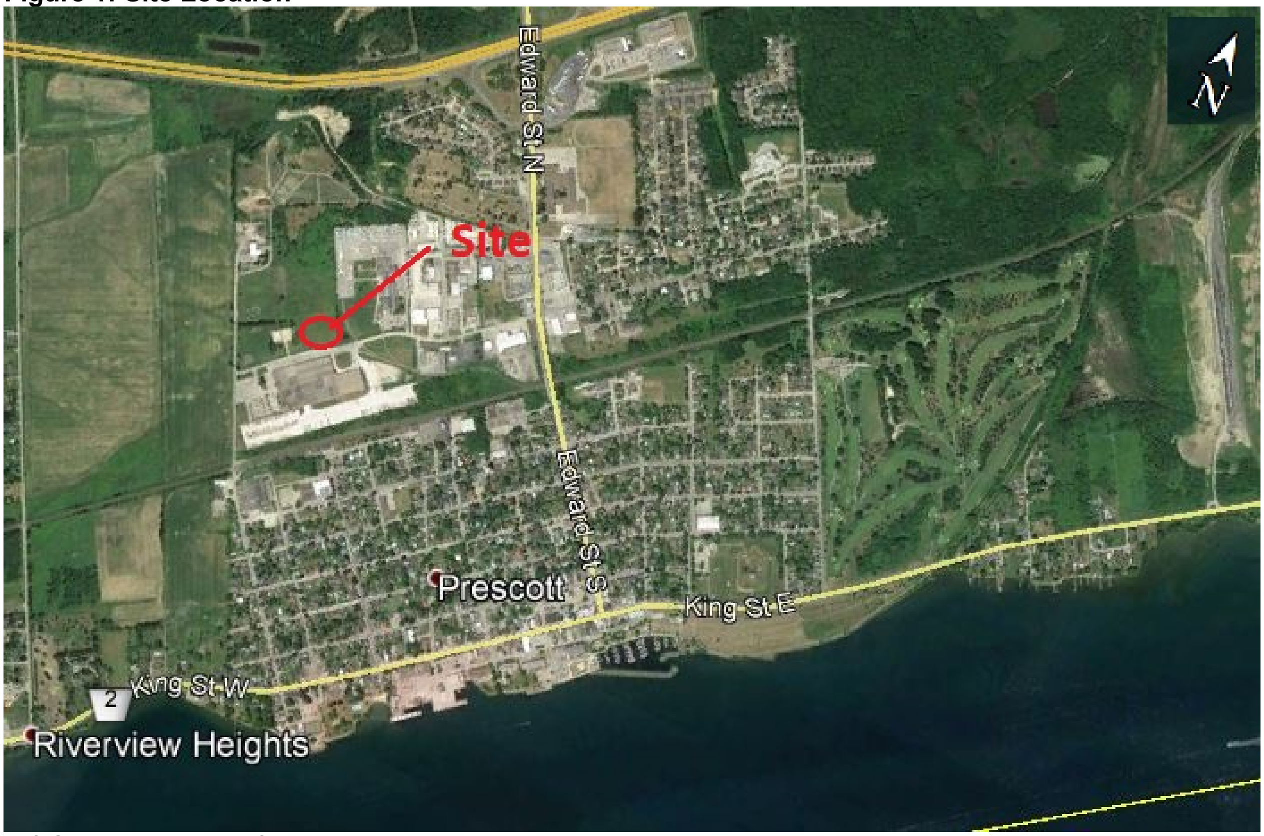
Should there be any changes in the design features, which may relate to the guidelines provided in the report, Lascelles Engineering & Associates Ltd. should be advised in order to review the report recommendations.

# 2 PROJECT AND SITE DESCRIPTION

The site under consideration is located within the western portion of the Town of Prescott and within its recreational park. Refer to **Figure** 1 for location.

Currently, the site is a soccer field with no civic address and fronts Churchill Road West. It has an irregular rectangular shape being about 140m wide (east-west) by 105m deep (north-south) for an approximate surface area of 1.47ha (3.63acres). The site is fairly flat with a shallow swale around the perimeter providing surficial drainage.

**Figure 1: Site Location**



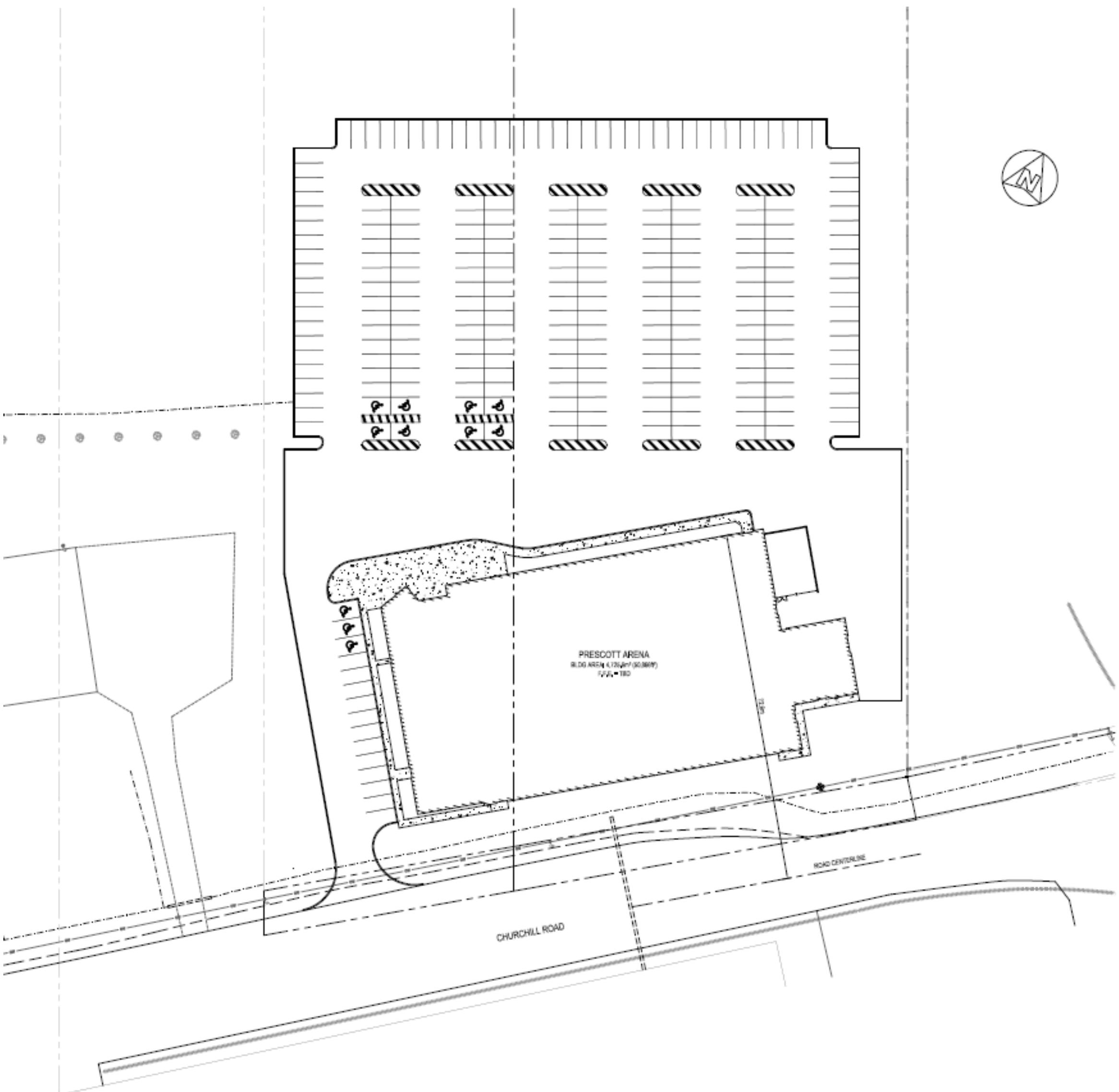

Ref: Google Earth - Date of Image 2018

It is our understanding that the project will consist of the construction of an arena having a total surface area of about 4,410m$^2$. The arena building will consist of a one-storey structure for the area of the ice surface and spectator seating. The remaining portion of the arena will consist of a two-storey structure, which will hold the amenities such as change rooms, canteen, washroom, community rooms, a lobby with a viewing area, mech/elec room, etc. No basement is proposed for this building. The building would be located in the southern portion of the site, while access lanes and a large surface parking area would be located to the north of the building. The said building will be serviced by municipal water and sewers. A preliminary concept Site Plan prepared by EVB is presented as part of **Figure 2**.

## 3 PROCEDURE

The preliminary fieldwork for this investigation was carried out on August 21, 2019. At the time, six (6) borehole (BH-1 to BH-6) were drilled across the arena site. Following the review of the soil conditions obtained, Lascelles staff returned to the site on September 26, 2019, to drill an additional six (6) boreholes (BH-7 to BH-12). Prior to any fieldwork, the borehole locations were cleared for the presence of any underground services and utilities.

**Figure 2: Preliminary Site Plan**




The boreholes were advanced using a track mounted drill rig equipped with continuous flight hollow stem augers supplied and operated by George Downing Estate Drilling Inc. A “two man” crew experienced with geotechnical drilling operated the drill rig and equipment. The boreholes were advanced by auguring through the overburden down to auger refusal over the inferred bedrock encountered between 1.88m to 8.56m below ground surface (bgs).

Sampling of the overburden materials encountered in the boreholes was carried out at regular depth intervals using a 50mm diameter drive open conventional split spoon sampler in conjunction with standard penetration testing (“N” value).

All soil samples collected from boreholes were placed and sealed in plastic bags to prevent loss of moisture. The recovered soil samples collected were classified based on visual and tactile examination and the results of the in-situ testing (standard penetration test and field vane).

Upon auger refusal, BH-4 and BH-6 were further advanced by core drilling techniques using an NQ-size (ø47.7mm) double-tube wire line core barrel from 2.67m to 4.14m bgs, and from 2.03m to 3.65m bgs, respectively, in order to confirm the bedrock. The recovered cores were visually described, measured and placed in core boxes for further identification and observation by our geotechnical engineer.

Standpipes were installed in four (4) of the boreholes prior to backfilling them to measure the static groundwater level in the area. The standpipes consisted of 20mm diameter PVC piping that were slotted and placed within the overburden prior to backfilling them. The standpipes were used strictly to establish the static water level of the overburden water table.

The fieldwork was supervised throughout by a member of our engineering staff who supervised drilling of the boreholes, coordinated the testing of the materials, cared for the samples collected and logged the subsurface conditions encountered at each location. All soil and rock samples were transported to our office for further examination by our geotechnical engineer. All samples collected during this project will be kept in storage for a period of six (6) months at which time, they will be disposed of, unless a written or verbal notice is received, requesting otherwise.

All boreholes were located using a GPS (Global Positioning System) receiver using NAD 83 (North American Datum). The approximate locations of the boreholes were plotted on a Google Earth aerial photograph and are presented in **Appendix A**.

# 4 SUBSURFACE SOIL AND GROUNDWATER CONDITIONS

## 4.1 General

A review of the surficial geology maps for this area suggests that the site would be within transitional geological units consisting of Champlain Sea Sand gradually changing northerly to Champlain Sea Clay.

The Champlain Sea Sand is described as uniform buff sand, commonly reworked by wind into dunes, while the Champlain Sea Clay is described as blue-grey clay, silty clay to silt, which is locally overlain by thin layer of sand. The drift thickness within this area varies significantly from shallow bedrock increasing in depth northerly to more than 20m. The bedrock for this area consists of either the March Formation (southern portion) or the Oxford Formation (northern portion). In this area, the March is described interbedded sandstone, dolostone and sandy dolostone, while the Oxford formation is described as dolostone.

The subsurface conditions encountered in the boreholes were classified based on visual and tactile examination of the materials recovered from the boreholes and the results of the in-situ testing and field observations. The soil descriptions presented in this report are based on commonly accepted methods of classification and identification of soil employed in geotechnical practice. Classification and identification of soil involves judgement and Lascelles does not guarantee descriptions as exact, but infers accuracy to the extent that is common in current geotechnical practice.

The subsurface soil conditions encountered at each borehole location are given in the Borehole Logs presented in **Appendix B**. These logs indicate the subsurface conditions encountered at specific test locations only. Boundaries between zones on the logs are often not distinct, but are rather transitional and have been interpreted as such.

## 4.2 Topsoil

A thin (100mm to 150mm) layer of topsoil was encountered in all boreholes drilled across the site. The topsoil is described as dark brown sandy loam. The topsoil was found resting over a sand-silt deposit in all boreholes.

The material classified as topsoil was based on colour and the presence of organic materials and is intended as identification for geotechnical purposes only. This does not constitute a statement as to the suitability of this layer for cultivation and sustaining plant growth.

## 4.3 Sand-Silt Deposit

A sand-silt deposit was encountered in all boreholes drilled at this site. The deposit is described as silty sand to sandy silt, brown near the surface become greyish brown to grey with depth. It is in loose state of packing near the surface (first meter), but becomes compact to dense with depth, and moist to wet. A sample of this soil unit collected from BH-8 at an approximate depth of 1.05m was submitted to Stantec Laboratories, an accredited material testing laboratory, in order to perform a gradation analysis. The gradation analysis revealed that that this soil units contains 0.3% gravel, 37.1% of sand and 62.6% of silt and clay. This soil would be classified as SM (poorly graded sand to silty sand to silt-sand mixture) as per the unified classification system. The laboratory report is provided as part of **Appendix C**.

The sand-silt deposit was found to extend between 1.88 to 4.11m bgs, where it transitions into a silt deposit in most boreholes. In BH-4, BH-6 and BH-12, the sand-silt deposit was found resting over glacial till and directly over bedrock in BH-5.

## 4.4 Silt

A silt deposit was found underlying the sand-silt layer in all the boreholes, except for BH-4, BH-6 and BH-12. The silt was described as clayey with beds of stiff silty clay near its upper portion, and with traces of sand. It is grey in colour, within a compact state and moist to wet. The silt deposit was found to extend between 3.05m to 8.23m bgs and rest over glacial till in BH-1, BH-2, and BH-8, or directly over bedrock in BH-3, BH-7, BH-9, BH-10 and BH-11.

A sample of this soil unit collected from BH-9 at a depth of 4.11m was submitted to Stantec Laboratories to perform a hydrometer analysis. The results of the hydrometer analysis revealed that the soil contains no gravel, 0.3% of sand, 73.7% of silt and 26.0% of clay. This soil would be classified as SM-SC (silt-sand to clay-sand mixture) as per the unified classification system. The laboratory report is provided as part of **Appendix C**.

### 4.5 Glacial Till

A thin deposit of glacial till was encountered in BH-1, BH-2, BH-4, BH-6, BH-8 and BH-12. The layer is thin and sporadically across the site, varying from 0.05m to 1.37m in thickness. The till is described as sandy with some silt and clay and traces of gravel. It is grey in colour, in compact to dense state and wet. The glacial till was found mantling the bedrock.

### 4.6 Bedrock

Auger refusal over bedrock was encountered in all boreholes between the depths of 1.88m (BH-5) to 8.56m (BH-1) bgs. This would suggest that the bedrock is sloped northerly. The bedrock was cored in BH-4 (1.47m run) and BH-6 (1.53m run) to confirm its quality. The bedrock is described a light grey sandy dolostone. The bedrock is found to be weathered at the surface and became relatively better in quality with depth. The recoveries of the rock cores were measured to be 100% (BH-4) and 98% (BH-6) with respective Rock Quality Designation (RQD) of 63% and 38%, indicating a poor to fair bedrock quality. A picture of the recovered rock cores from BH-4 and BH-6 are presented as part of **Appendix B**.

### 4.7 Groundwater Conditions

The static water level was measured within the standpipes installed within BH-1, BH-4, BH-5 and BH-6 using a water meter on September 26, 2019 and results are shown on the borehole logs presented in **Appendix B**. The depth of the groundwater was found to range from 0.85m to 2.62m bgs. The flow of the overburden water table appears to be northerly.

It should be noted that groundwater levels could fluctuate with seasonal weather conditions, (i.e.: rainfall, droughts, spring thawing) as well as from any presence of existing ditches and underground services trenches at or in the vicinity of the site.

# 5 GEOTECHNICAL CONSIDERATIONS

## 5.1 General

This section of the report provides general engineering guidelines on the geotechnical design aspects of the project based on our interpretation and review of the information obtained from the boreholes as well as the project requirements.

It is our understanding that the project will consist of the construction of an arena having a total surface area of about 4,410m$^2$. The arena building will consist of a one-storey structure for the area of the ice surface and spectator seating. The remaining portion of the arena will consist of a two-storey structure, which will hold the amenities such as change rooms, canteen, washroom, community rooms, a lobby with a viewing area, mech/elec room, etc. No basement is proposed for this building. The building would be located in the southern portion of the site, while access lanes and a large surface parking area would be located to the north of the building. The said building will be serviced by municipal water and sewers. A preliminary concept Site Plan prepared by EVB is presented as part of **Figure 2**.

## 5.2 Foundations

The current investigation confirmed that the site is underlined by a sand-silt deposit. The deposit was found to be loose only near the surface (less 1m bgs) and becoming compact to very dense with the depth. Furthermore, in the area of the proposed building, the groundwater table was found to be located near 1m bgs in general. The sand-silt deposit was found to extend 1.88m to 4.11m bgs and rest over a clayey silt deposit or glacial till deposit, which are both compact to dense. Under seismic loading, only the very upper portion (first 1m) of the sand-silt deposit would be considered liquefiable. Therefore, it is recommended the proposed arena building be founded at approximately 1m bgs over the surficial compact sand-silt deposit. It is not recommended to set the foundation deeper due to the groundwater table, unless the groundwater table would be permanently lowered prior to excavation.

Alternatively, deep pile foundations extending to the bedrock could also be considered. The depth to bedrock within the area of the proposed building would range approximately between 3.05m to 5.41m bgs increasing northerly. The overburden found on this site consists of a sand-silt deposit followed by a clayey silt deposit resting over a thin layer of glacial till. Therefore, it is unlikely that the piles will encounter significant obstructions during the piling activities.

### 5.3 Shallow Conventional Foundations

Conventional strip and column footings set on the native undisturbed soil, or properly compacted and approved structural fill, may be designed using a maximum allowable bearing pressure of 100kPa for serviceability limit state (SLS) and 150kPa for ultimate limit state (ULS) factored bearing resistance. This bearing capacity is contingent on a minimum founding depth of 1.0m below the existing ground surface to remove the loose layer of sand-silt. In addition, a minimum width of strip footing of 0.9m and a minimum width of 1.2m on any sides for pad footings is recommended.

Any disturbed soil as well as any large cobbles and boulders found at the subgrade level will need to be removed from the footprint of the footings. Due to the sensitivity of the founding soil to worker circulation and to obtain a uniform founding stratum, a 150mm granular mat is recommended. The granular mat must consist of OPSS Granular A crushed stone compacted to 100 percent of its Standard Proctor Maximum Dry Density (SPMDD).

Provided that any loose and/or disturbed soil is removed from the bearing surfaces prior to pouring concrete or placing of structural fill, foundations set over the recommended native soil or structural fill designed using the recommended serviceability limit state capacity value, the total settlement will be less than 25mm. The differential settlement between adjacent column footings is anticipated to be 15mm or less.

### 5.4 Deep Foundations

For driven piles, the use of steel H-piles or steel tube piles filled with concrete are considered acceptable and would have the structural capacity to support the anticipated loads of the proposed building. To minimize the potential damage to the pile tips during driving, the piles should be provided with a driving shoe as per OPSD standards 3000.100 and 3001.100, for H-pile and steel tube piles, respectively. For steel piles founded over bedrock, the anticipated design valued of the factored resistance at Ultimate Limit State (USL) and the Serviceability Limit State (SLS) should be equal to the structural capacity of the pile. When the pile is properly founded on bedrock, the settlement of the pile head is directly dependent of the elastic compression of the pile from the applied load.

As a design example, the allowable load on a 245mm diameter steel pipe pile with a wall thickness of 8.9mm could be taken as 915 kilonewtons. This assumes that the steel has a minimum yield strength of 340 MPa and that the pipe pile is filled with 30MPa concrete. Pipe piles should be equipped with a base plate having a thickness of at least 20mm to limit damage to the pile tip during driving.

All of the piles should be driven to refusal. The driving resistance criteria will be highly dependent on the required allowable load and the contractor’s pile driving equipment. Typically, for drop hammer type piling rigs available in the Eastern Ontario, a refusal criterion of 20 blows for the last 25 millimetres of penetration would be sufficient to achieve the above allowable loads, assuming that about 27 kilojoules of energy is transferred to the pile per blow. The contractor should be required to submit to the geotechnical engineer a copy of the proposed pile size, piling equipment, methodology and driving resistance criteria prior to construction. The pile foundations shall be designed according to Part 4 of the Ontario Building Code (latest edition).

An allowance should be made in the specifications for this project for re-striking all of the piles at least once to confirm the design set and/or the permanence of the refusal and to check for upward displacement due to driving adjacent piles. Piles that do not meet the design set criteria on the first re-strike should receive additional re-striking until the design set criteria are met. All re-striking should be performed after 48 hours of the previous set. Furthermore, the specifications for this project should make provisions for dynamic load tests on test piles and for dynamic testing and analysis on selected production piles to verify the driving resistance criteria and pile capacities. The post construction settlement of elements of the structure, other than the elastic shortening of the piles, should be negligible for end bearing piles driven to refusal over bedrock.

### 5.5 Grade Raise Restrictions

Based on the soil conditions established at this site, the maximum allowable grade raise should be kept to 2.5m or less above the existing grades.

### 5.6 Seismic Design

Based on the results of the geotechnical investigation, the subsurface at this property can be classified as a Class "E" as per the Site Classification for Seismic Site Response in accordance with the latest version of the Ontario Building Code. It is noted that a greater seismic site response class may be obtained by carrying out seismic velocity testing using a multichannel analysis of surface waves (MASW).

### 5.7 Liquefaction Potential

Provided that the foundations are set below loose sand-silt layer (below 1m bgs) as recommended above, the potential of soil liquefaction is not considered to be a concern.

### 5.8 Structural Fill

Where excavation below the underside of the footing is performed, consideration shall be given to support the footings on structural fill. The structural fill must extend 0.6m beyond the outside edge of the footings and extend outward and down at a 1 Horizontal to 1 Vertical profile out from the edge equal to the depth of the structural fill set below the footing. The recommended material to be used as structural fill to support the footings shall consist of Granular B Type II crushed stone, or an approved equivalent material.

The structural fill shall be placed over undisturbed native soils in layers not exceeding 300mm and compacted to a minimum of 98 percent of its Standard Proctor Maximum Dry Density (SPMDD) as per ASTM D-698. Prior to placing any structural fill or to pouring the footings, it is required that any disturbed soils along the base of the footing be removed and that the subgrade soils be inspected and approved by the geotechnical engineer. Furthermore, the structural fill must be tested to ensure that the specified compaction level was achieved.

## 5.9 Slab-on-Grade Construction

For predictable performance of proposed concrete slab-on-grade, it is recommended that they rest over native soil or structural fill only. Therefore, all organic, deleterious or otherwise objectionable fill material encountered shall be removed from the building's footprint.

The exposed native subgrade surface should then be inspected and approved by geotechnical personnel. The subgrade shall be compacted using a heavy roller. Any evidently soft areas should be sub-excavated and replaced with suitable engineered fill; however, disturbances should be minimized as much as possible.

Any underfloor fill needed to raise the general floor grade shall consist of OPSS Granular B Type II material or an approved equivalent, compacted to 95 percent of its SPMDD. The final lift shall be compacted to 98 percent of its SPMDD. A 200mm layer of OPSS Granular A material shall be placed under the slab and compacted to at least 100 percent of the SPMDD.

The modulus of subgrade reaction (ks) for the design of the slabs over native sand, glacial till or structural fill is 18 MPa/m.

In order to minimize and control cracking, the floor slab should be provided with wire or fiber mesh reinforcement and crack control joints. The crack control joints should be spaced at equal distance in both directions and where possible not exceeding a spacing of 4.5 metres. The mesh reinforcement should be carried through the joints.

## 5.10 Frost Protection

All exterior footings, and those located in any unheated portion of the proposed building should be provided with at least 1.5m of earth cover for frost protection purposes. Exterior footings constructed in areas that are to be cleared of snow during the winter period should be provided with at least 1.7m of earth cover for frost protection purposes. Alternatively, the required frost protection could be provided using a combination of earth cover and extruded polystyrene insulation. Lascelles should review the detailed design of frost protection with the use of equivalent insulation prior to construction.

In the event that foundations are to be constructed during winter months, foundation soils are required to be protected from freezing temperatures using suitable construction techniques. Therefore, the base of all excavations should be insulated from freezing temperature immediately upon exposure, until the time that heat can be supplied to the building interior and footings have sufficient soil cover to prevent freezing of the subgrade soils.

### 5.11 Foundation Drainage

It is our understanding that the proposed arena building will not contain any basement level, including crawl spaces, pipe chase, etc. and that the finished grade of all interior floors will be constructed at higher elevation than the finished ground elevation near the building. Consequently, perimeter drainage is not required.

In order to reduce the potential for ponding of water adjacent to the foundation walls, roof water should be controlled by a roof drainage system that directs water away from the building and the exterior grade should be sloped to promote water away from the foundation walls.

### 5.12 Foundation Wall Backfill

To prevent possible foundation frost jacking of foundation wall, the backfill material should consist of free draining, non-frost susceptible material such as sand or sand and gravel meeting OPSS Granular B Type I grading requirements.

The foundation fill should be compacted in 300mm thick lifts, and to 95 percent of its SPMDD using light compaction equipment, where no loads will be set over top. Where the backfill material will ultimately support a pavement structure, walkways or slabs, it is suggested that the foundation wall backfill material be compacted in 200mm thick lifts, and to 98 percent of the SPMDD. The backfilling against foundation walls should be carried out on both sides of the wall at the same time.

### 5.13 Retaining Walls and Shoring

The following **Table 1** below provides the suggested soil parameters for the design of retaining wall and/or shoring systems. For excavations near existing services and structures, the coefficient of earth pressure at rest ($K_o$) should be used.

**Table 1: Material Properties for Shoring and Permanent Wall Design (Static)**

| Type of Material | Bulk Density ($kg/m^3$) | Pressure Coefficient | |
|---|---|---|---|
| | | Active ($K_a$) | At Rest ($K_o$) |
| Clay | 18 | 0.45 | 0.80 |
| Sand | 19 | 0.33 | 0.50 |
| Till | 22 | 0.27 | 0.50 |
| Granular B Type I | 20 | 0.33 | 0.50 |
| Granular B Type II | 23.1 | 0.31 | 0.47 |
| Granular A | 23.5 | 0.27 | 0.43 |

The above values are for a flat surface behind the wall, a straight wall and a wall friction angle of 0 degrees. The designer should consider any difference between these coefficients, and make appropriate corrections for a sloped surface behind the wall, angled wall or wall friction as required. The bearing capacity for the design of a retaining wall are the same as provided for the building structures provided it is founded over native soil or properly prepared and approved structural fill.

Retaining walls should also be designed to resist the earth pressures produces under seismic conditions. The use of the combined coefficients of static and seismic earth pressure is recommended, referred to as $K_{AE}$ for active conditions and $K_{PE}$ for passive conditions for routine design purposes.

The total active and passive loads under seismic conditions can be calculated using the following two equations;

$P_{AE} = ½ K_{AE} \gamma H^2 (1-k_V)$

$P_{PE} = ½ K_{PE} \gamma H^2 (1-k_V)$

Where;

$K_{AE}$ = Combined Static and Seismic Active Earth Pressure Coefficient

$K_{PE}$ = Combined static and seismic passive earth pressure coefficient

H = Total Height of the Wall (m)

$K_h$ = horizontal acceleration coefficient

$K_v$ = vertical acceleration coefficient

$\gamma$ = bulk density ($kg/m^3$)

These equations are based on a horizontal slope behind the wall and a vertical back of the retaining wall and zero wall friction. For this site, the following design parameters were used to develop the recommended $K_{AE}$ and $K_{PE}$ values.

A = Zonal acceleration ratio = 0.2
$K_h$ = Horizontal acceleration coefficient = 0.1
$K_V$ = Vertical acceleration coefficient = 0.067

The above value of $K_h$ corresponds to ½ of the A value and the value $K_V$ of corresponds to 0.67 of the $K_h$ value. The angle of friction between the soil and the wall has been set at 0° to provide a conservative estimate. The following **Table 2** provides the parameters for seismic design of retaining structures.

**Table 2: Material Properties for Shoring and Permanent Wall Design (Seismic)**

| Parameter | OPSS Granular B Type I | OPSS Granular A, Granular Fill and Granular B Type II | Clay and Clayey Material |
|---|---|---|---|
| Bulk Unit Weight, γ ($kN/m^3$) | 20 | 23.3 | 18 |
| Effective Friction Angle (degrees) | 30 | 32 | 28 |
| Angle of Internal Friction Between wall and Backfill (degrees) | 0 | 0 | 0 |
| **Yielding Wall** | | | |
| Active Seismic Earth Pressure Coefficient ($K_{AE}$) | 0.37 | 0.33 | 0.45 |
| Height of the Application of $P_{AE}$ from the base of the wall as a ration of its height (H) | 0.36 | 0.37 | 0.36 |
| Passive Seismic Earth Pressure Coefficient ($K_{PE}$) | 3.06 | 3.48 | 4.0 |
| Height of the Application of $P_{PE}$ from the base of the wall as a ration of its height (H) | 0.30 | 0.30 | 0.30 |

# 6 Potential of Corrosive Environment

## 6.1 Sulphate Attack on Buried Concrete

Two (2) soil samples collected from BH-10, SS3 – 1.8m bgs and SS4 – 2.6m bgs, were submitted for a sulphate analysis. The laboratory analysis was performed was performed by Paracel Laboratories Ltd, an accredited chemical testing laboratory. The results of the analysis found the soil to contain a sulphate concentration of 18 µg/g and less 133 µg/g or 0.0018 % and less 0.0133%). The laboratory Certificates of Analysis are presented in **Appendix D.**

Based on the CAN/CSA - A23.1 standards (Concrete Materials and Methods of Concrete Construction), a sulphate concentration of 0.1% (1000 µg/g) or less in soil falls within the negligible category for sulphate attack on buried concrete. As such, buried concrete for foundation or manholes will not require any special additive to resist sulphate attack and the use of normal Portland cement is acceptable.

### 6.2 Corrosivity Analysis for Buried Steel

BH-10 SS4 was also submitted for analysis of pH, Resistivity and Redox Potential. The purpose of this testing was to assess the potential for corrosive environment on any buried steel (i.e. piles). The laboratory Certificates of Analysis are presented in **Appendix D**.

The potential for an aggressive corrosive soil environment was established in reviewing the above measured parameters and according to standard provided by the American Water Works Association (AWWA) C-105/A21.5-10. Based on the noted standard, corrosion protection for buried steel is only required where a corrosivity index of 10 or greater is encountered. Based on the results, the calculated corrosivity index was found to be less than 10. As such, any buried steel as part of this project would not require any special or specific corrosion protection measures.

## 7 EXCAVATION AND GROUNDWATER CONTROL

### 7.1 Excavation Requirements

It is anticipated that shallow excavation for this project will not exceed 3.6m bgs for the foundation and the installation of the associated underground services. Most of the shallow excavation will be through topsoil, sand-silt, clayey silt or glacial till deposits as well as potentially bedrock. Considering the high-water table found at this site, most of these soils are located below the water table.

According to the Ontario's Occupational Health and Safety Act (OHSA), O. Reg. 213/91 and its amendments, the surficial overburden soil anticipated to be excavated into at this site can be classified as Type 3 for fully drained excavations. Therefore, shallow temporary excavation in the overburden soil classified as Type 3 can be cut at 1 horizontal to 1 vertical for a fully drained excavation starting at the base of the excavation and as per requirements of the OHSA regulations.

The listed slopes are for fully drained excavations. Gentler slopes could be required under undrained excavations or below the water table, where localised water infiltrations can occur and where the excavations are exposed for a prolonged period of time.

Any excavated material stockpiled near a trench or open excavation should be stored at a distance equal to or greater than the depth of the excavated soil within the trench or open excavation and equipment circulation should be restricted away from the top of the slope excavation.

In the event that the aforementioned slopes are not possible to achieve due to space restrictions, the excavation should be shored according to OHSA O. Reg. 213/91 and its amendments. A geotechnical engineer should design and approve the shoring and establish the shoring depth under the excavation profile. Refer to the parameters provided in Tables 1 and 2 in Section 5.13 for use in the design of any shoring structures. The excavation for the underground services could be carried out within tightly fitting, braced steel trench boxes, approved by a professional engineer.

Rock excavation will be required for the installation of some underground services at this site. It is anticipated that any weathered portion of the bedrock may be excavated using a large excavator and that the remaining bedrock will require the use of hoe-rams. Furthermore, it is possible that large boulders (greater than 1m in size) may be encountered as part of the glacial till, and may need to be broken up in order to excavate.

The slopes of the rock excavation may be vertical with a 1m wide bench at the soil-rock interface on all sides of the excavation. Any loose pieces of rock from the sidewalls of the excavation should be removed and the bottom of the excavation should be sufficiently flattened and exempt of rock ledges.

A condition survey of any nearby structures and services should be undertaken prior to commencing any construction. In view of the potential for vibration during excavating and removal of the bedrock, it is recommended that the excavation activities be monitored throughout the project by a vibration specialist engineer or consultant and that the vibration limits be established based on the local conditions and nearby structures to ensure that ground vibration are not exceeded.

### 7.2 Groundwater Control

Groundwater seepage and infiltration entering shallow and temporary excavations performed within the overburden should be mitigated by pumping from sumps installed in the excavation. Surface water runoff into the excavation should be avoided and diverted away from the excavation.

It is anticipated that the invert of underground services may be founded below the water table. Although the sand-silt, silt and glacial till deposits are in a compact to dense state, they are nevertheless sensitive below the water table and may also be susceptible to piping and scouring from water pressure at the base of the excavation. Therefore, the base of the excavation should not be exposed for prolonged periods of time and should be backfilled as soon as possible.

### 7.3 Pipe Bedding Requirements

It is recommended that the bedding for any underground service be placed over native material or structural fill only. Consequently, any fill or organic material should be removed from the loading influence of the proposed underground service. It is anticipated that the sewers and watermain installed as part of this project will be founded over various soil deposit, including bedrock.

Bedding, thickness of cover material and compaction requirements for the underground services should conform to the manufacturers design requirements and to the requirements and detailed installations outlined in the Ontario Provincial Standard Specifications (OPSS) and any applicable standards or requirements from the Town of Prescott.

Where the invert of an underground service will be founded below the groundwater table and within sandy to silty deposits, these soils may be sensitive to disturbances and may also be susceptible to piping and scouring from water pressure at the base of the excavation. Therefore, special precautions should be taken in these areas to stabilize and confine the base of the excavation such as using recompression (thicker bedding) and/or dewatering methods (pre-pumping). In order to properly compact the bedding, the water table should be kept at least 0.30m below the base of the excavation at all time during the installation of the underground services.

As an alternative to Granular A bedding and only where wet conditions are encountered, the use of “clear stone” bedding, such as 19mm clear stone, OPSS 1004, may be considered only in conjunction with a suitable geotextile filter. Without proper filtering, there may be entry of fines from native soils and trench backfill into the bedding, which could result in loss of support to the pipes and possible surface settlements.

The sub-bedding, bedding and cover materials should be compacted in maximum 200mm thick lifts to at least 95 percent of the standard Proctor maximum dry density (SPMDD) using suitable vibratory compaction equipment.

### 7.4 Trench Backfill

All service trenches should be backfilled using compactable material, free of organics, debris and large cobbles or boulders. Acceptable native materials should be used as backfill between the roadway subgrade level and the depth of seasonal frost penetrations (i.e. 1.8 metres below finished grade) in order to reduce the potential for differential frost heaving between the new excavated trench and the adjacent section of roadway. Where native backfill is used, it should match the native materials exposed on the trench walls. Any boulders larger than 300 millimetres in size should not be used as trench backfill. Backfill below the zone of seasonal frost penetration could consist of either acceptable native material or imported granular material conforming at minimum to OPSS Granular B Type I.

To minimize future settlement of the backfill and achieve an acceptable subgrade for the roadway, the trench should be compacted in maximum 300mm thick lifts to at least 95 percent of the SPMDD. The specified density may be reduced where the trench backfill is not located within or in close proximity to existing roadways or any other structures.

# 8 SUITABILITY OF ON-SITE SOILS

The surficial overburden found at this project locations consists of sand-silt, silty clay, clayey silt and glacial till, which are all considered frost susceptible and is not recommended for engineered fill or backfilling against foundation wall or underneath concrete slabs. The existing overburden could be reused as general backfill material (service trenches, general landscaping/backfilling), if the material can be compacted according to the specifications outlined herein at the time of construction. Any boulders larger than 300mm in size should not be used as service trench backfill. Any imported material should conform to OPSS Granular B-Type I. It is anticipated that any rock excavation carry out as part of this project would yield only minimum quantities and would not justify attempting crushing the rock for re-use on-site.

It should be noted that the adequacy of a material for reuse as backfill will depend on its water content at the time of its use and on the weather conditions prevailing prior and during that time. Therefore, all excavated materials to be reused should be stockpiled in a manner that will minimise any significant changes in its moisture content, especially during wet conditions. Any excavated materials proposed for reuse as part of this project should be stockpiled in order to allow the material to be properly inspected and approved prior to reuse by a geotechnical engineer.

# 9 PAVEMENT DESIGN

For predictable performance of the pavement areas, any objectionable fill, organic, soft or deleterious materials should be removed from the proposed pavement areas to expose native undisturbed subgrade soil or properly compacted fill. The exposed subgrade should be inspected and approved by geotechnical personnel and any evidently loose and unstable areas should be sub-excavated and replaced with suitable earth borrow approved by the geotechnical engineer. Following approval of the preparation of the subgrade, the granular subbase may be placed.

It is anticipated that the subgrade soils for the new parking and access road will consist of silt-sand deposit. The construction of access road and parking areas will be acceptable over this subgrade once that all organic material, objectionable fill or otherwise deleterious material are removed from the subgrade. The recommended pavement structures for the proposed light duty parking areas and heavy duty access roads (fire route) are provided below.

For light vehicle parking areas and access lanes, the pavement structure should consist of:

50 millimetres of hot mix asphaltic concrete surface layer (HL3) over
150 millimetres of OPSS Granular A base over
350 millimetres of OPSS Granular B, Type II subbase

For heavy duty access roads, the pavement should consist of:

40 millimetres of hot mix asphaltic concrete surface layer (HL3) over
50 millimetres of hot mix asphaltic concrete binder layer (HL8) over
150 millimetres of OPSS Granular A base over
450 millimetres of OPSS Granular B, Type II subbase

The base and subbase granular materials should conform to OPSS Form 1010 material specifications. Prior to importing any granular material onto the site, it should be tested and approved by a geotechnical engineer prior to delivery to the site and should be compacted to 100% SPMDD. Compaction of the granular pavement materials should be carried out in maximum 200 mm thick loose lifts to 100% of its SPMDD using suitable vibratory compaction equipment.

The Job Mix Formula (JMF) of the asphaltic concrete should be in accordance with OPSS 1150 for Material Specification for Hot Mix Asphalt. The asphaltic concrete should be placed in accordance to OPSS 310 for Construction Specification for Hot Mix Asphalt. The asphaltic concrete should compacted to a minimum of 92% of the Maximum Relative Density. The JMF and its constituents should be reviewed, tested and approved by a geotechnical engineer prior to delivery to the site.

### 9.1 Paved Areas and Subgrade Preparation

The proposed access lanes and parking areas should be stripped of vegetation, topsoil, debris and other obvious objectionable fill material. Following the backfilling and satisfactory compaction of any underground service trenches up to the subgrade level, the subgrade should be shaped, crowned and proof-rolled using heavy roller with any resulting soft areas sub-excavated down to an adequate bearing layer and replaced with approved backfill. Following approval of the preparation of the subgrade, the pavement structure may be placed.

If the roadway subgrade is disturbed or wetted due to construction operations or precipitation, the granular thicknesses given above may not be adequate and it may be necessary to increase the thickness of the Granular B Type II subbase and/or incorporate a non-woven geotextile separator between the roadway subgrade surface and the granular subbase material.

For areas of the site that require the subgrade to be raised, the material should consist of OPSS Granular B Type 1 or approved equivalent. Any materials proposed for this use should be approved by the geotechnical engineer before placement. Materials used for raising the subgrade to the proposed roadway subgrade level should be placed in maximum 300 mm thick loose lifts and be compacted to at least 95% of the SPMDD using suitable compaction equipment.

The performance of the pavement structure is highly dependent on the subsurface groundwater conditions and maintaining the subgrade and pavement structure in a dry condition. To intercept excess subsurface water within the pavement structure granular materials, sub-drains with suitable outlets should be installed below the pavement structure subgrade, if adequate overland flow drainage is not provided (i.e. ditches). The surface of the pavement should be properly graded to direct runoff water towards suitable drainage features. It is recommended that the lateral extent of the subbase and base layers not be terminated vertically immediately behind any proposed curb/edge of pavement line but be extended beyond the curb.

The preparation of subgrade should be scheduled and carried out in such a manner that a protective cover of overlying granular material is placed as quickly as possible in order to avoid unnecessary circulation by heavy equipment over the subgrade. Frost protection of the surface should be implemented (i.e. insulated tarps, etc.), if works are carried out during the winter months.

Transitions should be constructed between new and existing pavement structures where new parking/access lanes will meet with existing paved areas. In areas where the new pavement will abut existing pavement, the depths of granular materials should be tapered up or down at 5 horizontal to 1 vertical, or flatter, to match the depths of the granular material(s) exposed in the existing pavement

Where the existing asphaltic concrete surface of a parking/roadway is affected by the excavating process, the damaged zones should be saw cut and any damaged or loose pieces of asphaltic concrete should be removed down to the binder course or its entire depth, where only one layer exist. The existing base should be scarified and proof-rolled with any soft areas excavated and replaced to the proper level with OPSS Granular A. Where two layers of asphalt exist on an access lane, the surface course should be grinded over a width of 150mm to allow the new surface course to overlap the binder layer and not create one straight vertical joint. On existing streets, the overlap should be increased to 300mm.

## 10 CONSTRUCTION CONSIDERATIONS

It is suggested that the final design drawings for this project, including the proposed site grading plan, be reviewed by the geotechnical engineer to ensure that the guidelines provided in this report have been interpreted as intended.

The engagement of the services of the geotechnical consultant during construction is recommended to confirm that the subsurface conditions throughout the proposed development do not materially differ from those given in the report and that the construction activities do not adversely affect the intent of the design. Any pile driving operations shall be supervised by geotechnical personnel on a full-time basis to ensure that the pile have reach and met the establish refusal criteria and the pile final location does not deviate horizontally and vertically from its design location. All footing areas and any engineered fill areas (if required) for the proposed project should be inspected by Lascelles Engineering and Associates Ltd. to ensure that a suitable subgrade has been reached and properly prepared. The placing and compaction of any granular materials beneath the foundations (if required) should be inspected to ensure that the materials used conforms to the gradation and compaction specifications.

The subgrade for the pavement areas, watermain and sewers should be inspected and approved by geotechnical personnel. In-situ density testing should be carried out on the pavement granular materials and pipe bedding and backfill to ensure the materials meet the specifications from a compaction point of view.

## 11 REPORT CONDITIONS AND LIMITATIONS

It is stressed that the information presented in this report is provided for the guidance of the designers and is intended for this project only. The use of this report as a construction document is neither intended nor authorized by Lascelles Engineering & Associates Ltd. Contractors bidding on or undertaking the works should examine the factual results of the investigation, satisfy themselves as to the adequacy of the information for construction, and make their own interpretation of the factual data as it affects their construction techniques, schedule, safety and equipment capabilities.

The professional services for this project include only the geotechnical aspects of the subsurface conditions at this site. The presence or implications of possible subsurface contamination resulting from previous uses or activities at this site or adjacent properties, and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this report.

The recommendations provided in this report are based on subsurface data obtained at the specific test locations only. Experience indicates that the subsurface soil and groundwater conditions can vary significantly between and beyond the test locations. For this reason, the recommendations given in this report are subject to a field verification of the subsurface soil conditions at the time of construction.

The report recommendations are applicable only to the project described in the report. Any changes to the project will require a review by Lascelles Engineering & Associates Ltd., to ensure compatibility with the recommendations contained in this project.

We trust this report provides sufficient information for your present purposes. If you have any questions concerning this report or if we may be of further services to you, please do not hesitate to contact our office.

**Yours truly,**
**Lascelles Engineering & Associates Ltd.**

Prepared by:

Shuang Chang, P. Eng.


Reviewed by:

Mario Elie, Project Manager

Will Ball, P.Eng.

# Appendix A

# Borehole Location Plan

# 180480 - APPENDIX A

BH Location Plan

# Appendix B

# Borehole Logs

# &

# Rock Core Photograph

LASCELLES ENGINEERING & ASSOCIATES

# RECORD OF BOREHOLE: BH-1

PROJECT: Geotechnical Investigation - Proposed Precott Arena (Alternate Site)
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road W, Prescott, Ontario
DATE: August 21, 2019

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CME-55
DRILLING METHOD: Hollow Stem Auger

| SOIL PROFILE | | SAMPLES | | | | |
|---|---|---|---|---|---|---|
| DEPTH (m) | DESCRIPTION | ELEV. | NUMBER | TYPE | N-VAL/RQD | RECOVERY |
| 0.0 | Ground Surface | | | | | |
| 0.00 | **Topsoil:** 150mm dark brown sandy loam. | 0.00 | SS1 | | 8 | 85% |
| | **Sand-Silt:** Silty sand to sandy silt, brown to grey in colour, loose near the surface becoming compact to very dense with depth, moist becoming wet below 2.0m. | | SS2 | | 7 | 100% |
| | | | SS3 | | 29 | 100% |
| | | | SS4 | | 28 | 100% |
| | | | SS5 | | 50 | 100% |
| 3.66 | **Silt:** Clayey with beds of stiff silty clay at the upper portion and trace of sand, grey in colour, in a compact state of packing and moist to wet. | 3.66 | SS6 | | 4 | 100% |
| | | | SS7 | | 6 | 100% |
| | | | SS8 | | 10 | 100% |
| | | | SS9 | | 18 | 100% |
| | | | SS10 | | 12 | 100% |
| | | | SS11 | | 16 | 100% |
| 8.23 | **Glacial Till:** Sandy with some silt, clay and trace of gravel, grey in colour, very dense and moist. | 8.23 | SS12 | | 50R | 100% |
| 8.56 | Auger refusal over inferred bedrock. End of Borehole | 8.56 | | | | |

SHEAR STRENGTH (kPa): 25, 50, 75, 100, 125

STANDARD PENETRATION TEST RESISTANCE PLOT: 20, 40, 60, 80

SPT N-values plotted: 8, 7, 29, 28, 50, 4, 6, 10, 18, 12, 16, 50R

WATER CONTENT %: 10, 20, 30, 40, 50, 60, 70, 80, 90

WATER LEVEL: 2.62 m (09-26-2019)

Easting: 458180
Site Datum: Assumed
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951298
Groundsurface Elev.: NA
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

LASCELLES ENGINEERING & ASSOCIATES

RECORD OF BOREHOLE: BH-2

PROJECT: Geotechnical Investigation - Proposed Precott Arena (Alternate Site)
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road W, Prescott, Ontario
DATE: August 21, 2019

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CME-55
DRILLING METHOD: Hollow Stem Auger

## SOIL PROFILE

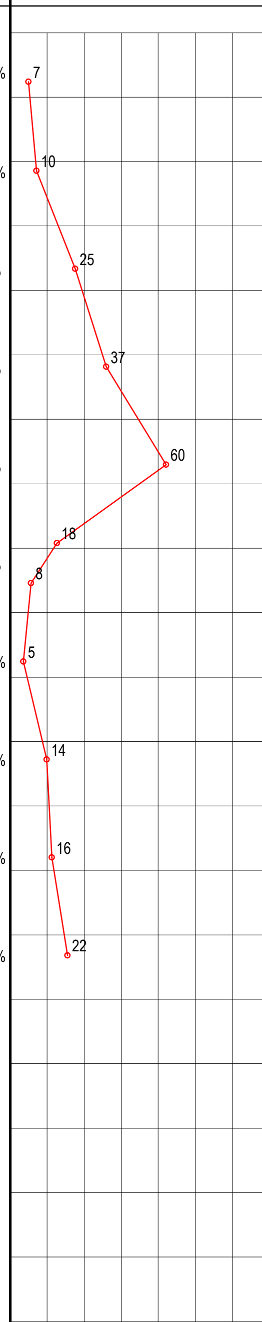
| DEPTH (m) | DESCRIPTION | ELEV. |
|---|---|---|
| 0.0 | Ground Surface | 0.00 |
| 0.0 | **Topsoil:** 150mm dark brown sandy loam. | |
| | **Sand-Silt:** Silty sand to sandy silt, brown to grey in colour, loose near the surface becoming compact to very dense with depth, moist becoming wet below 2.0m. | |
| 4.11 | **Silt:** Clayey with beds of silty clay at the upper portion and trace of sand, grey in colour, in a compact state of packing, and moist to wet. | 4.11 |
| 6.86 | **Glacial Till:** Sandy with some clay, gravel,and trace of clay grey in colour, very dense and moist. Auger refusal over inferred bedrock. | 6.86 |
| 7.29 | End of Borehole | 7.29 |

## SAMPLES

| NUMBER | TYPE | N-VAL/RQD | RECOVERY |
|---|---|---|---|
| SS1 | | 7 | 100% |
| SS2 | | 10 | 100% |
| SS3 | | 25 | 75% |
| SS4 | | 37 | 75% |
| SS5 | | 60 | 75% |
| SS6 | | 18 8 | 85% |
| SS7 | | 5 | 100% |
| SS8 | | 14 | 100% |
| SS9 | | 16 | 100% |
| SS10 | | 22 | 100% |

SHEAR STRENGTH (kPa) 25 50 75 100 125

STANDARD PENETRATION TEST RESISTANCE PLOT 20 40 60 80




WATER CONTENT % 10 20 30 40 50 60 70 80 90

WATER LEVEL

Easting: 458229
Site Datum: Assumed
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951329
Groundsurface Elev.: NA
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

LASCELLES ENGINEERING & ASSOCIATES

# RECORD OF BOREHOLE: BH-3

PROJECT: Geotechnical Investigation - Proposed Precott Arena (Alternate Site)
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road W, Prescott, Ontario
DATE: August 21, 2019

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CME-55
DRILLING METHOD: Hollow Stem Auger

## SOIL PROFILE

| DEPTH (m) | DESCRIPTION | ELEV. |
|---|---|---|
| | Ground Surface | |
| 0.0 | **Topsoil:** 150mm dark brown sandy loam. | 0.00 |
| | **Sand-Silt:** Silty sand to sandy silt, brown to grey in colour, compact near the surface becoming dense to very dense with depth, moist becoming wet below 2.0m. | |
| 3.0 | **Silt:** Clayey with beds of stiff silty clay at the upper portion and trace of sand and gravel, grey in colour, in a compact state of packing and moist to wet. Auger refusal over inferred bedrock. | 3.05 |
| 6.0 | End of Borehole | 5.99 |

## SAMPLES

| NUMBER | TYPE | N-VAL/RQD | RECOVERY |
|---|---|---|---|
| SS1 | | 11 | 100% |
| SS2 | | 24 | 100% |
| SS3 | | 50 | 75% |
| SS4 | | 43 | 75% |
| SS5 | | 7 | 75% |
| SS6 | | 10 | 85% |
| SS7 | | 18 | 100% |
| SS8 | | 22 | 100% |

SHEAR STRENGTH (kPa): 25 50 75 100 125

STANDARD PENETRATION TEST RESISTANCE PLOT: 20 40 60 80

WATER CONTENT %: 10 20 30 40 50 60 70 80 90

WATER LEVEL

Easting: 458278
Northing: 4951356
Site Datum: Assumed
Groundsurface Elev.: NA
Top of Casing Elev.: NA
Top of Riser Elev.: NA
Borehole Diameter: 200mm
Monitoring Well Diameter: NA

COMMENTS:

LASCELLES ENGINEERING & ASSOCIATES

RECORD OF BOREHOLE: BH-4

PROJECT: Geotechnical Investigation - Proposed Precott Arena (Alternate Site)
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road W, Prescott, Ontario
DATE: August 21, 2019

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CME-55
DRILLING METHOD: Hollow Stem Auger

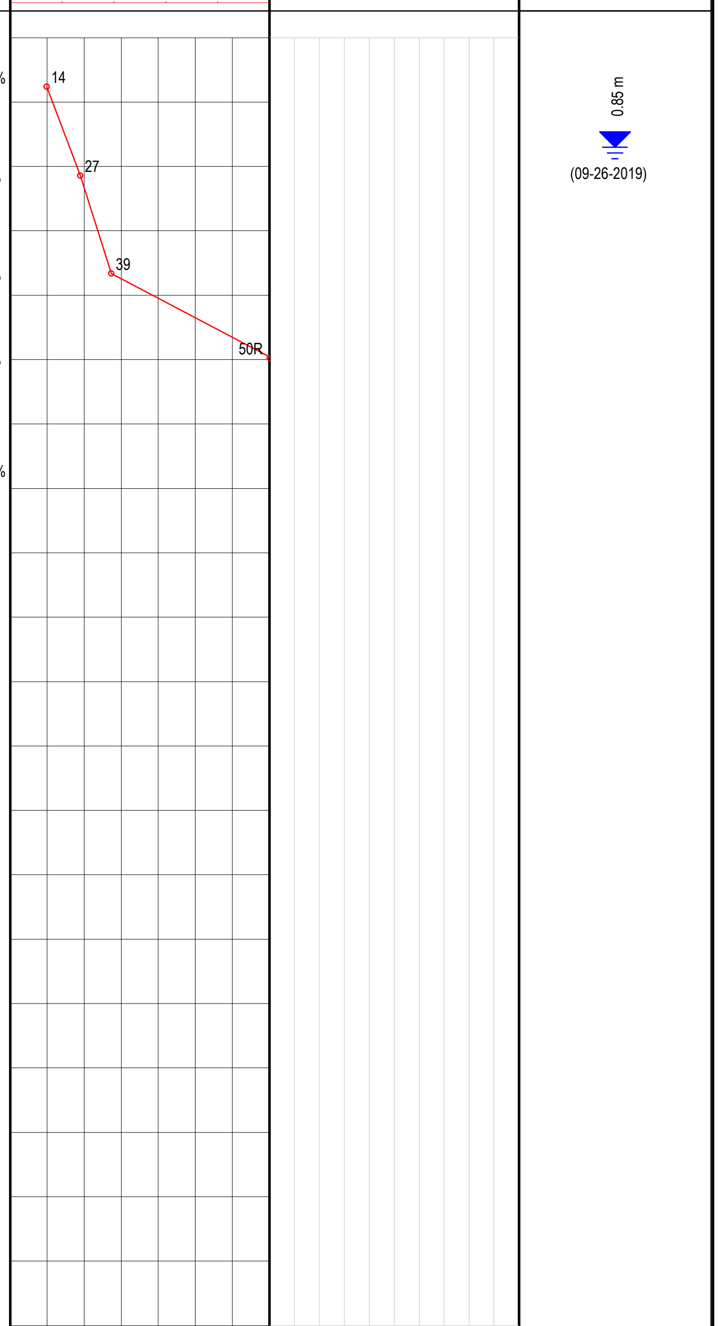
| DEPTH (m) | DESCRIPTION | ELEV. | NUMBER | TYPE | N-VAL/RQD | RECOVERY |
|---|---|---|---|---|---|---|
| 0.0 | Ground Surface | 0.00 | | | | |
| | **Topsoil:** 150mm dark brown sandy loam. | | SS1 | | 14 | 100% |
| | **Sand-Silt:** Silty sand to sandy silt, brown in colour, compact near the surface becoming dense with depth, moist becoming wet below 1.20m. | | SS2 | | 27 | 75% |
| | | | SS3 | | 39 | 75% |
| 2.11 | **Glacial Till:** Sandy silt with trace of gravel and clay, grey in colour, compact and wet. | 2.11 | SS4 | | 50R | 75% |
| 2.67 | **Bedrock:** Light grey sandy dolostone; fair quality. | 2.67 | CR5 | | 63% | 100% |
| 4.14 | End of Borehole | 4.14 | | | | |

SHEAR STRENGTH (kPa) 25 50 75 100 125

STANDARD PENETRATION TEST RESISTANCE PLOT 20 40 60 80

WATER CONTENT % 10 20 30 40 50 60 70 80 90

WATER LEVEL




Easting: 458238
Site Datum: Assumed
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951218
Groundsurface Elev.: NA
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

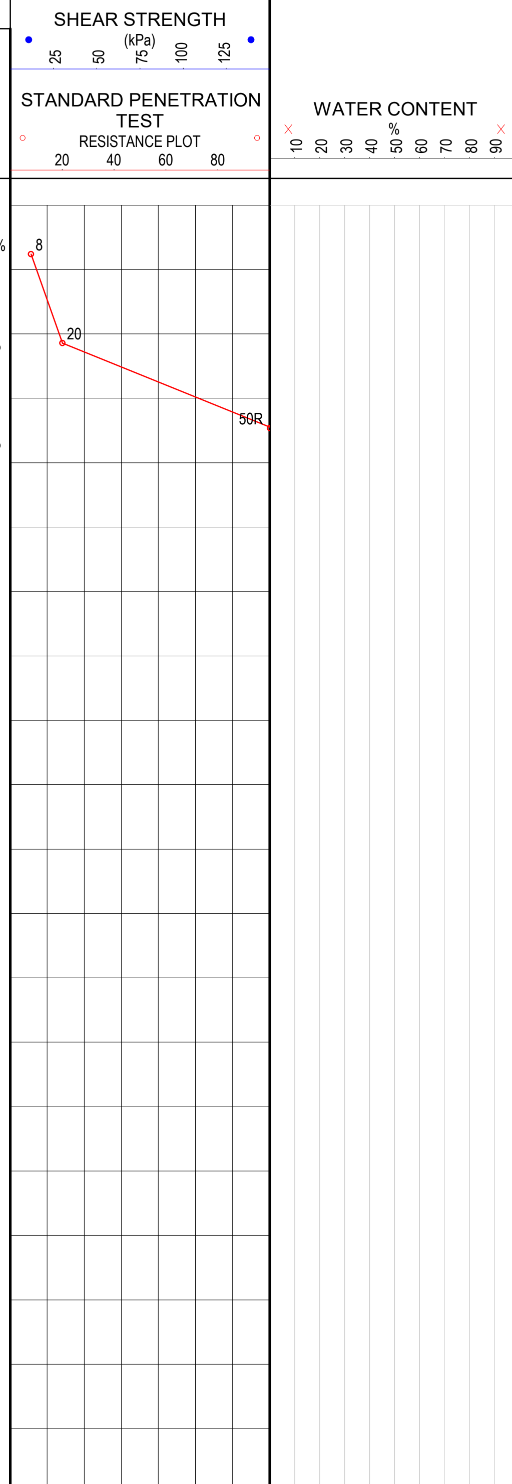
LASCELLES ENGINEERING & ASSOCIATES

RECORD OF BOREHOLE: BH-5

PROJECT: Geotechnical Investigation - Proposed Precott Arena (Alternate Site)
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road W, Prescott, Ontario
DATE: August 21, 2019

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CME-55
DRILLING METHOD: Hollow Stem Auger

| DEPTH (m) | DESCRIPTION | ELEV. | NUMBER | TYPE | N-VAL/RQD | RECOVERY | WATER LEVEL |
|---|---|---|---|---|---|---|---|
| | Ground Surface | | | | | | |
| 0.0 | **Topsoil:** 150mm dark brown sandy loam. | 0.00 | SS1 | | 8 | 100% | |
| | **Sand-Silt:** Silty sand to sandy silt, brown in colour, compact near the surface becoming dense with depth, moist becoming wet below 1.20m. | | SS2 | | 20 | 75% | 1 m (09-26-2019 |
| | Auger refusal over inferred bedrock. | | SS3 | | 50R | 75% | |
| 2.0 | End of Borehole | 1.88 | | | | | |




Easting: 458286
Site Datum: Assumed
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951258
Groundsurface Elev.: NA
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

RECORD OF BOREHOLE: BH-6

PROJECT: Geotechnical Investigation - Proposed Precott Arena (Alternate Site)
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road W, Prescott, Ontario
DATE: August 21, 2019

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CME-55
DRILLING METHOD: Hollow Stem Auger

LASCELLES ENGINEERING & ASSOCIATES

| DEPTH (m) | DESCRIPTION | ELEV. | NUMBER | TYPE | N-VAL/RQD | RECOVERY | SPT (RESISTANCE PLOT) | WATER LEVEL |
|---|---|---|---|---|---|---|---|---|
| 0.0 | Ground Surface | 0.00 | | | | | | |
| | **Topsoil:** 150mm dark brown sandy loam. | | SS1 | | 7 | 100% | 7 | |
| | **Sand-Silt:** Silty sand to sandy silt, brown in colour, loose near the surface becoming compact to dense with depth, moist becoming wet below 1.00m. | | SS2 | | 16 | 75% | 16 | 1.18 m (09-26-2019) |
| | | | SS3 | | 21 50R | 75% | 21, 50R | |
| 2.0 | **Glacial Till:** 50mm sandy silt with some gravel and trace of clay, brown in colour, very dense, and wet. | 1.98 | | | | | | |
| | **Bedrock:** Light grey sandy dolostone; poor quality. | | CR4 | | 38% | 98% | | |
| | End of Borehole | 3.56 | | | | | | |

SHEAR STRENGTH (kPa): 25, 50, 75, 100, 125
STANDARD PENETRATION TEST RESISTANCE PLOT: 20, 40, 60, 80
WATER CONTENT %: 10, 20, 30, 40, 50, 60, 70, 80, 90

Easting: 458317
Site Datum: Assumed
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951280
Groundsurface Elev.: NA
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

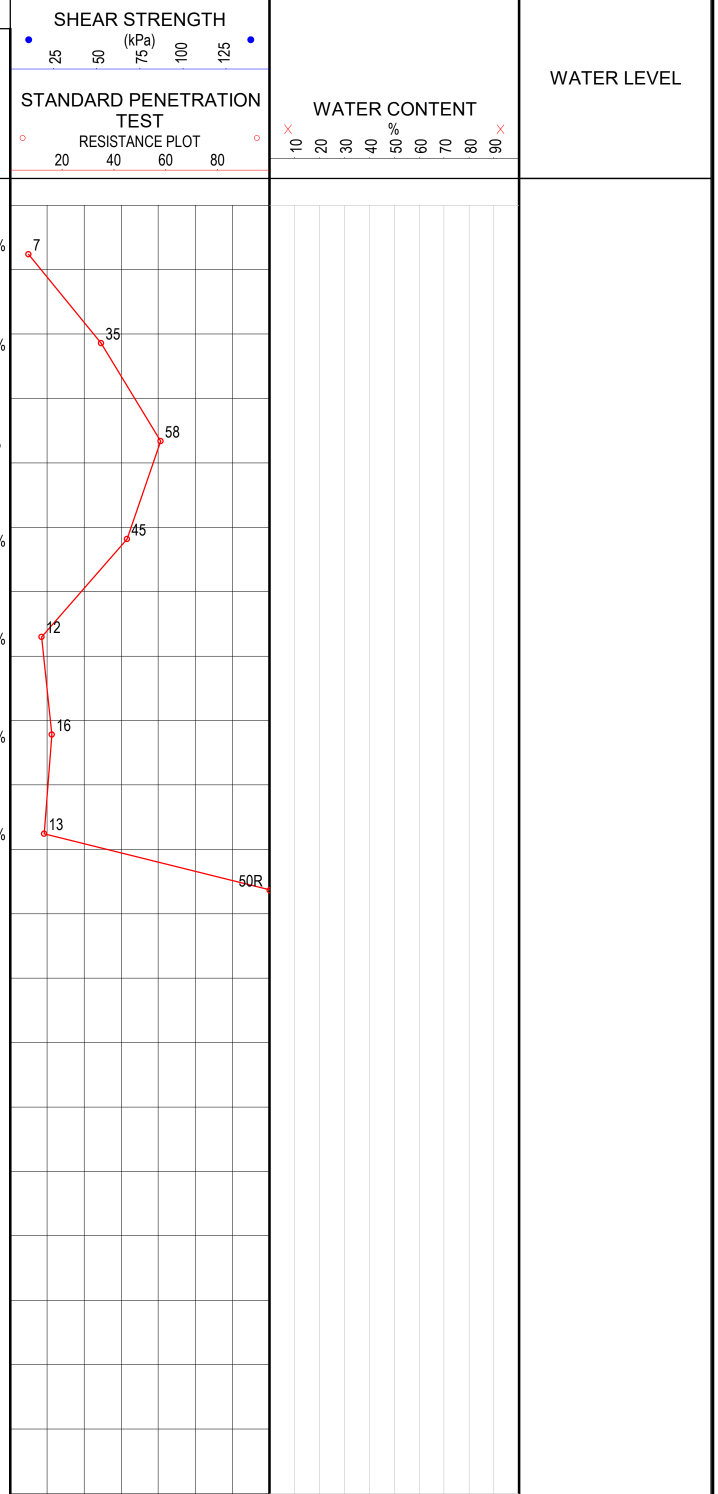
LASCELLES ENGINEERING & ASSOCIATES

RECORD OF BOREHOLE: BH-7

PROJECT: Geotechnical Investigation - Proposed Precott Arena (Alternate Site)
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road W, Prescott, Ontario
DATE: September 26, 2019

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CME-55
DRILLING METHOD: Hollow Stem Auger

| DEPTH (m) | SOIL PROFILE: DESCRIPTION | ELEV. | SAMPLES: NUMBER | TYPE | N-VAL/RQD | RECOVERY |
|---|---|---|---|---|---|---|
| | Ground Surface | | | | | |
| 0.0 | **Topsoil:** 100mm dark brown sandy loam. | 0.00 | SS1 | | 7 | 100% |
| | **Sand-Silt:** Silty sand to sandy silt, brown in colour, loose near the surface becoming compact to very dense with depth, moist becoming wet below 2.00m. | | SS2 | | 35 | 100% |
| | | | SS3 | | 58 | 75% |
| | | | SS4 | | 45 | 100% |
| 3.0 | **Silt:** Clayey with beds of stiff silty clay at the upper portion and trace of sand, grey in colour, in a compact state of packing and moist. | 3.05 | SS5 | | 12 | 100% |
| | | | SS6 | | 16 | 100% |
| | | | SS7 | | 13 | 100% |
| | Auger refusal over inferred bedrock. | | SS8 | | 50R | 0% |
| | End of Borehole | 5.41 | | | | |




Depth scale: ft 0.0–32.0; m 0.0–9.0

Easting: 458214
Site Datum: Assumed
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951250
Groundsurface Elev.: NA
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

LASCELLES ENGINEERING & ASSOCIATES

# RECORD OF BOREHOLE: BH-8

PROJECT: Geotechnical Investigation - Proposed Precott Arena (Alternate Site)
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road W, Prescott, Ontario
DATE: September 26, 2019

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CME-55
DRILLING METHOD: Hollow Stem Auger

## SOIL PROFILE

Ground Surface

| DEPTH (m) | DESCRIPTION | ELEV. |
|---|---|---|
| 0.0 | **Topsoil:** 100mm dark brown sandy loam. | 0.00 |
| | **Sand-Silt:** Silty sand to sandy silt, brown in colour, loose near the surface becoming compact to dense with depth, moist becoming wet below 2.00m. | |
| 3.0 | **Silt:** Clayey, with beds of stiff silty clay at the upper portion and trace of sand, grey in colour, in a compact state of packing and moist. | 3.05 |
| | **Glacial Till:** Sandy silt with trace of clay and gravel, and presence of boulders, grey in colour, very dense and moist. | 3.81 |
| | Auger refusal over inferred bedrock. | 5.18 |

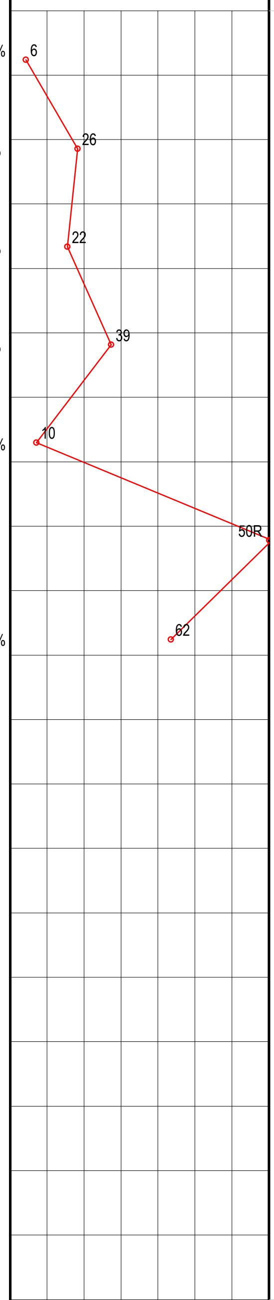
End of Borehole

## SAMPLES

| NUMBER | TYPE | N-VAL/RQD | RECOVERY |
|---|---|---|---|
| SS1 | | 6 | 100% |
| SS2 | | 26 | 75% |
| SS3 | | 22 | 75% |
| SS4 | | 39 | 75% |
| SS5 | | 10 | 100% |
| SS6 | | 50R | 0% |
| SS7 | | 62 | 100% |

SHEAR STRENGTH (kPa): 25 50 75 100 125

STANDARD PENETRATION TEST
RESISTANCE PLOT: 20 40 60 80




WATER CONTENT %: 10 20 30 40 50 60 70 80 90

WATER LEVEL

Easting: 458242
Site Datum: Assumed
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951275
Groundsurface Elev.: NA
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

RECORD OF BOREHOLE: BH-9

LASCELLES ENGINEERING & ASSOCIATES

PROJECT: Geotechnical Investigation - Proposed Precott Arena (Alternate Site)
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road W, Prescott, Ontario
DATE: September 26, 2019

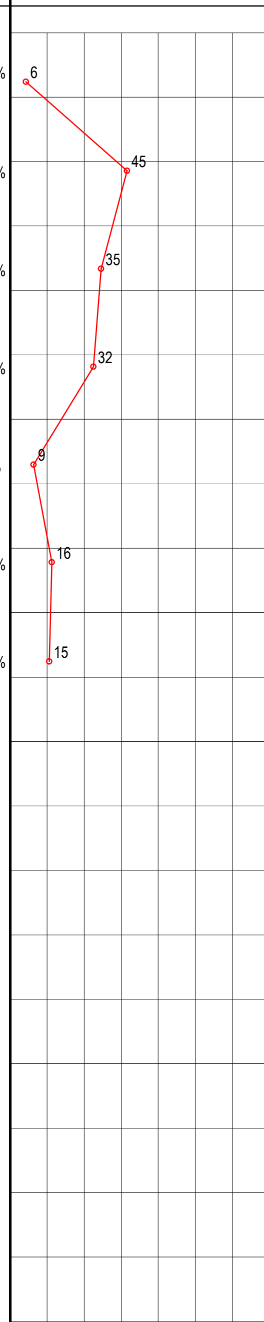
PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CME-55
DRILLING METHOD: Hollow Stem Auger

| DEPTH (m) | DESCRIPTION | ELEV. | NUMBER | TYPE | N-VAL/RQD | RECOVERY | WATER LEVEL |
|---|---|---|---|---|---|---|---|
| 0.0 | Ground Surface | 0.00 | | | | | |
| 0.0–0.1 | **Topsoil:** 100mm dark brown sandy loam. | | SS1 | | 6 | 100% | |
| 0.1–3.05 | **Sand-Silt:** Silty sand to sandy silt, presence of gravel near silt interface, brown to grey in colour, loose near the surface becoming compact to dense with depth, moist becoming wet below 2.00m. | | SS2 | | 45 | 100% | |
| | | | SS3 | | 35 | 100% | |
| | | | SS4 | | 32 | 100% | |
| 3.05–5.33 | **Silt:** Clay with beds of stiff silty clay at the upper portion and trace of sand, grey in colour, in a compact state of packing and moist. | 3.05 | SS5 | | 9 | 75% | |
| | | | SS6 | | 16 | 100% | |
| | Auger refusal over inferred bedrock. | | SS7 | | 15 | 100% | |
| 5.33 | End of Borehole | 5.33 | | | | | |

SHEAR STRENGTH (kPa): 25 50 75 100 125

STANDARD PENETRATION TEST RESISTANCE PLOT: 20 40 60 80

WATER CONTENT %: 10 20 30 40 50 60 70 80 90




Depth scale: ft 0.0–32.0; m 0.0–9.0

Easting: 458273
Site Datum: Assumed
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951300
Groundsurface Elev.: NA
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

LASCELLES ENGINEERING & ASSOCIATES

RECORD OF BOREHOLE: BH-10

PROJECT: Geotechnical Investigation - Proposed Precott Arena (Alternate Site)
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road W, Prescott, Ontario
DATE: September 26, 2019

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CME-55
DRILLING METHOD: Hollow Stem Auger

| SOIL PROFILE | | SAMPLES | | | | | SHEAR STRENGTH (kPa) / STANDARD PENETRATION TEST RESISTANCE PLOT | WATER CONTENT % | WATER LEVEL |
|---|---|---|---|---|---|---|---|---|---|
| DEPTH (m) | DESCRIPTION | ELEV. | NUMBER | TYPE | N-VAL/RQD | RECOVERY | | | |
| 0.0 | Ground Surface | 0.00 | | | | | | | |
| 0.0–0.1 | **Topsoil:** 100mm dark brown sandy loam. | | SS1 | | 5 | 100% | 5 | | |
| 0.1–3.05 | **Sand-Silt:** Silty sand to sandy silt, brown to grey in colour, loose near the surface becoming compact to dense with depth, moist becoming wet below 2.00m. | | SS2 | | 31 | 100% | 31 | | |
| | | | SS3 | | 39 | 75% | 39 | | |
| | | | SS4 | | 22 | 100% | 22 | | |
| 3.05–4.60 | **Silt:** Clayey with beds of stiff silty clay at the upper portion, grey in colour, in a compact state of packing and moist. Auger refusal over inferred bedrock. | 3.05 | SS5 | | 12 | 100% | 12 | | |
| | | | SS6 | | 19 | 100% | 19 | | |
| 4.60 | End of Borehole | 4.60 | | | | | | | |

Easting: 458228
Site Datum: Assumed
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951235
Groundsurface Elev.: NA
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

RECORD OF BOREHOLE: BH-11

LASCELLES ENGINEERING & ASSOCIATES

PROJECT: Geotechnical Investigation - Proposed Precott Arena (Alternate Site)
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road W, Prescott, Ontario
DATE: September 26, 2019

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CME-55
DRILLING METHOD: Hollow Stem Auger

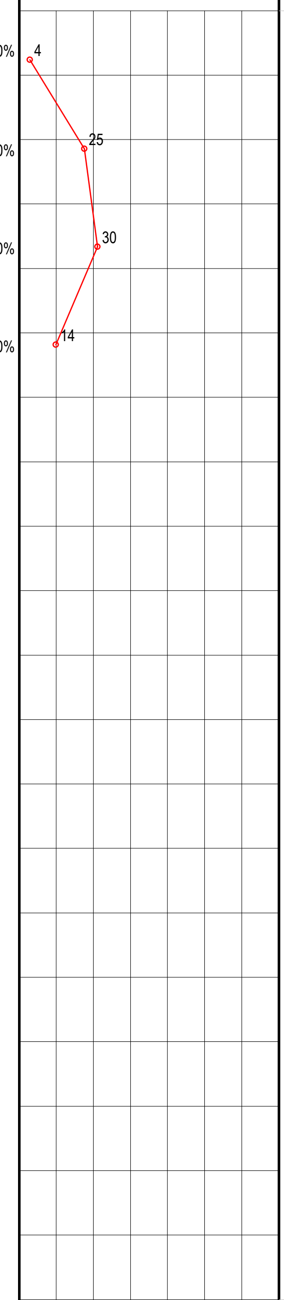
| DEPTH (m) | DESCRIPTION | ELEV. | NUMBER | TYPE | N-VAL/RQD | RECOVERY |
|---|---|---|---|---|---|---|
| 0.0 | Ground Surface | | | | | |
| 0.0 | **Topsoil:** 100mm dark brown sandy loam. | 0.00 | SS1 | | 4 | 100% |
| | **Sand-Silt:** Silty sand to sandy silt, presence of gravel near silt interface, brown to grey in colour, loose near the surface becoming compact to dense with depth, moist becoming wet below 2.00m. | | SS2 | | 25 | 100% |
| | | | SS3 | | 30 | 100% |
| 2.29 | **Silt:** Clayey with beds of stiff silty clay at the upper portion, grey in colour, in a compact state of packing and moist. | 2.29 | SS4 | | 14 | 100% |
| 3.05 | Auger refusal over inferred bedrock. | 3.05 | | | | |
| | End of Borehole | | | | | |

SHEAR STRENGTH (kPa): 25, 50, 75, 100, 125

STANDARD PENETRATION TEST RESISTANCE PLOT: 20, 40, 60, 80

WATER CONTENT %: 10, 20, 30, 40, 50, 60, 70, 80, 90

WATER LEVEL



Easting: 458259
Site Datum: Assumed
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951257
Groundsurface Elev.: NA
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

RECORD OF BOREHOLE: BH-12

LASCELLES
ENGINEERING & ASSOCIATES

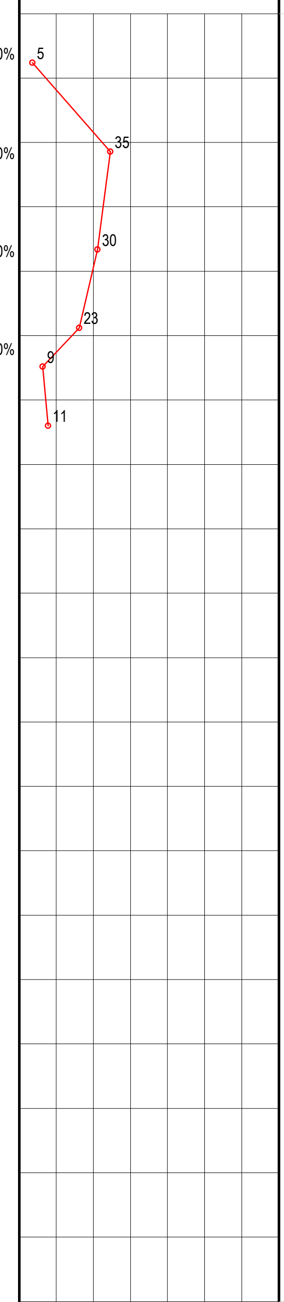
PROJECT: Geotechnical Investigation - Proposed Precott Arena (Alternate Site)
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road W, Prescott, Ontario
DATE: September 26, 2019

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CME-55
DRILLING METHOD: Hollow Stem Auger

| DEPTH (m) | DESCRIPTION | ELEV. | NUMBER | TYPE | N-VAL/RQD | RECOVERY |
|---|---|---|---|---|---|---|
| 0.0 | Ground Surface | 0.00 | | | | |
| | **Topsoil:** 150mm dark brown sandy loam. | | SS1 | | 5 | 100% |
| | **Sand-Silt:** Silty sand to sandy silt, presence of gravel near silt interface, brown to grey in colour, loose near the surface becoming compact to dense with depth, moist becoming wet below 2.00m. | | SS2 | | 35 | 100% |
| | | | SS3 | | 30 | 100% |
| 2.13 | **Glacial Till:** Mix of sand gravel with beds of clay to clayey silt, grey in colour and moist. | 2.13 | SS4 | | 23 9 | 100% |
| | Auger refusal over inferred bedrock. | | SS5 | | 11 | |
| 3.40 | End of Borehole | 3.40 | | | | |

SHEAR STRENGTH (kPa) 25 50 75 100 125

STANDARD PENETRATION TEST RESISTANCE PLOT 20 40 60 80




WATER CONTENT % 10 20 30 40 50 60 70 80 90

WATER LEVEL

Depth scale: ft 0.0–32.0; m 0.0–9.0

Easting: 458288
Site Datum: Assumed
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951279
Groundsurface Elev.: NA
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:


BH-4
Top: 2.67m bgs.
Bottom: 4.14m bgs


BH-6
Top: 2.03m bgs
Bottom: 3.56m bgs.

# Appendix C

# Laboratory Test Reports

**Stantec** 2781 Lancaster Road
Ottawa ON, K1B 1A7

# Sieve Analysis
**LS 602**
**ASTM C136**

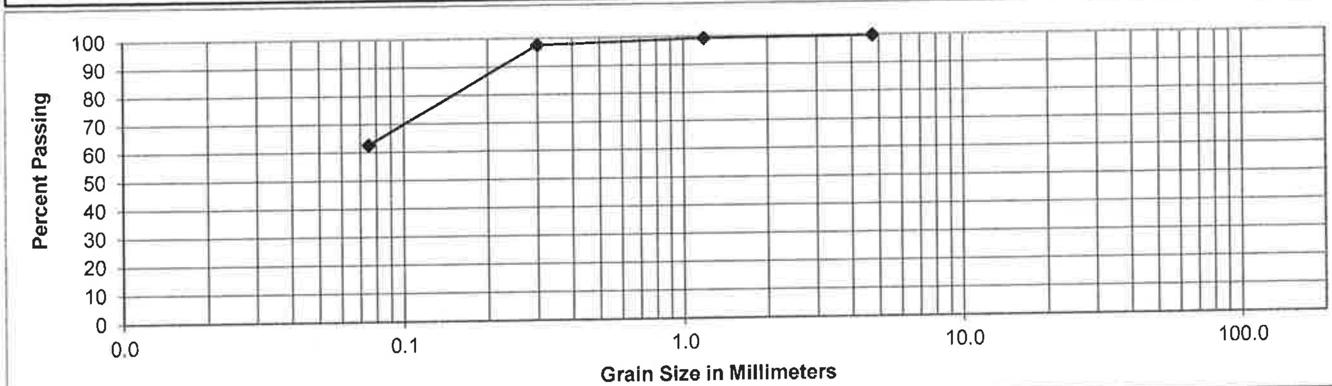
| | | | |
|---|---|---|---|
| Client: | **Lascelles Engineering, File #180480-A** | Project Number: | **121621867** |
| Project: | **Proposed Arena, Prescott** | | |
| Material Type: | **Soils / Aggregates:** | | |
| Proposed Use: | **Fill/Granulars** | | |
| Source: | **BH-8** | | |
| Sample Number: | **SS2** | | |
| Sampled Depth: | **2'6"-4'6"** | | |
| Sampled By: | **Lascelles Engineering** | Tested By: | **Brian Prevost** |
| Date Sampled: | **September 26, 2019** | Date Tested: | **October 8,2019** |

| Sieve Test Data | | Wash Test Data | | |
|---|---|---|---|---|
| Sample Weight Before Sieve, (g): | 482.4 | Sample Weight Before Wash, (g): | 250.6 | **Corrected** |
| Sample Weight After Sieve, (g): | 482.2 | Sample Weight After Wash, (g): | 98.8 | |
| Percent Loss In Sieve, (%): | 0.04 | Percent Passing No. 200, (%): | 60.6 | 60.4 |

## Sieve Analysis

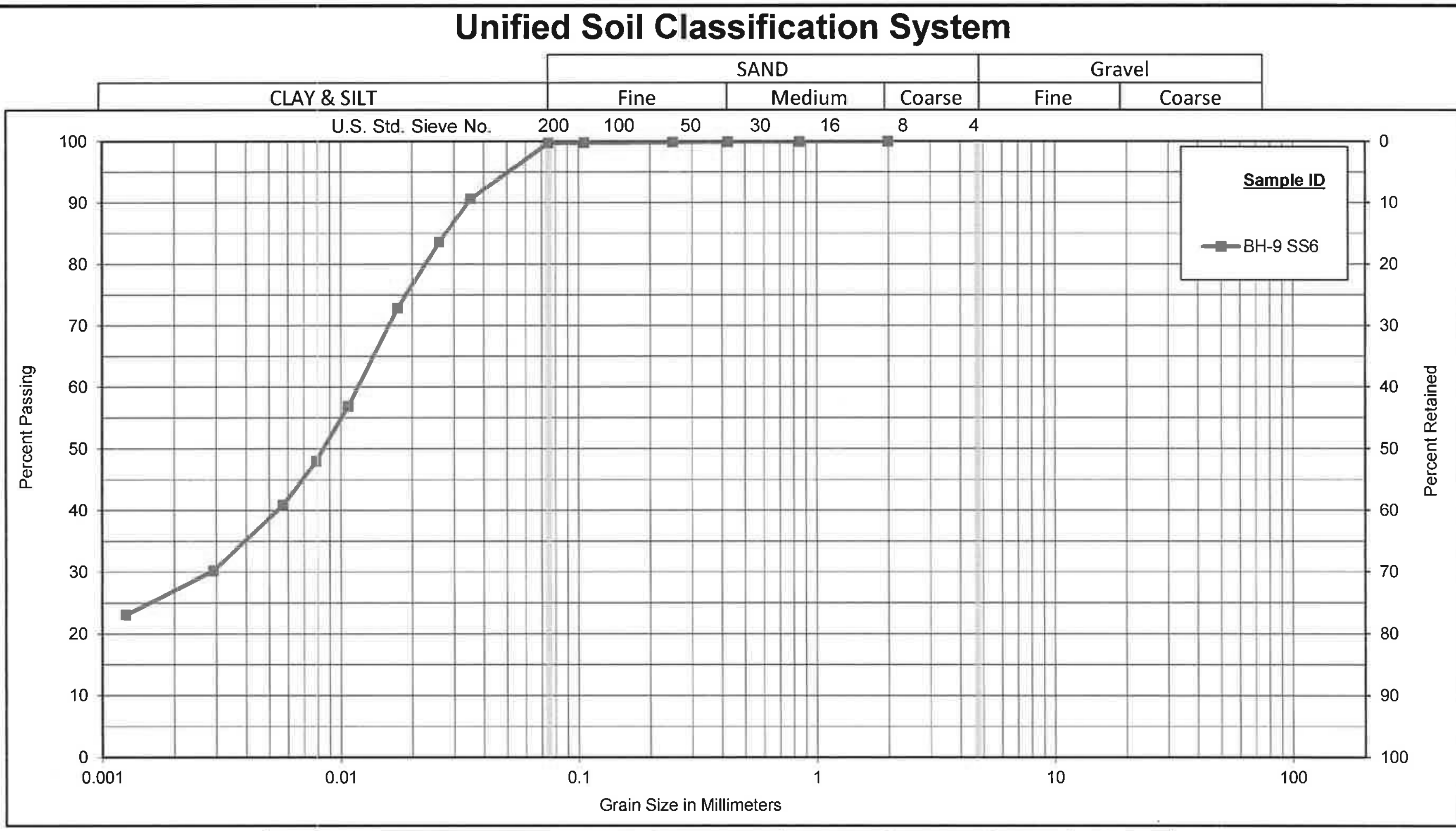
| Sieve No. | Size of Opening | | Weight Retained | Cumulative Weight Retained | Percent Passing | No Envelope | |
|---|---|---|---|---|---|---|---|
| | Inches | mm | g | g | % | Minimum | Maximum |
| | 6 | 150 | | | | | |
| | 4 | 106 | | | | | 100 |
| | 3 | 76.2 | | | | | |
| | 2 | 53.0 | | | | | |
| | 1.5 | 37.5 | | | | | |
| | 1 | 26.5 | | | | | |
| | 3/4 | 19.0 | | | | | |
| | 5/8 | 16.0 | | | | | |
| | 1/2 | 13.2 | | | | | |
| | 3/8 | 9.5 | 0.0 | 0.0 | 100.0 | | |
| +4 | 0.187 | 4.75 | 1.3 | 1.3 | 99.7 | | |
| | | - 4.75 | 480.9 | 482.2 | | | |
| 8 | 0.0937 | 2.36 | | 0.2 | 99.7 | | |
| 16 | 0.0469 | 1.18 | | 0.9 | 99.4 | | |
| 30 | 0.234 | 0.600 | | 1.6 | 99.1 | | |
| 50 | 0.0117 | 0.300 | | 5.5 | 97.5 | | |
| 100 | 0.0059 | 0.150 | | 13.7 | 94.3 | | |
| 200 | 0.0029 | 0.075 | | 93.3 | 62.6 | | |
| | | Pan | | 98.4 | | | |

**Classification of Sample:** % Gravel: 0.3 % Sand: 37.1 % Silt & Clay: 62.6




**Remarks:**

**Reviewed By:** Brian Prevost **Date:** October 11/2019




| Sample ID | Depth (m) | % Gravel | % Sand | % Silt | % Clay |
|---|---|---|---|---|---|
| BH-9 SS6 | 12'6"-14'6" | 0.0 | 0.3 | 73.7 | 26.0 |

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# GRAIN SIZE DISTRIBUTION

Lascelles Engineering, File #180480-A
Proposed Arena, Prescott

Figure No.

Project No. 121621867

# Particle-Size Analysis of Soils
LS702
ASTM D422

Stantec

## PROJECT DETAILS

| | | | |
|---|---|---|---|
| Client: | Lascelles Engineering, File #180480-A | Project No.: | 121621867 |
| Project: | Proposed Arena, Prescott | Test Method: | LS702 |
| Material Type: | Soil | Sampled By: | Lascelles Engineering |
| Source: | BH-9 | Date Sampled: | September 26, 2019 |
| Sample No.: | SS6 | Tested By: | Daniel Boateng |
| Sample Depth | 12'6"-14'6" | Date Tested: | October 9, 2019 |

## WASH TEST DATA

| | |
|---|---|
| Oven Dry Mass In Hydrometer Analysis (g) | 55.03 |
| Sample Weight after Hydrometer and Wash (g) | 0.14 |
| Percent Passing No. 200 Sieve (%) | 99.7 |
| Percent Passing Corrected (%) | 99.75 |

## PERCENT LOSS IN SIEVE

| | |
|---|---|
| Sample Weight Before Sieve (g) | 268.30 |
| Sample Weight After Sieve (g) | 268.10 |
| Percent Loss in Sieve (%) | 0.07 |

## SOIL INFORMATION

| | | |
|---|---|---|
| Liquid Limit (LL) | | |
| Plasticity Index (PI) | | |
| Soil Classification | | |
| Specific Gravity ($G_s$) | 2.750 | |
| Sg. Correction Factor (α) | 0.978 | |
| Mass of Dispersing Agent/Litre | 40 | g |

## CALCULATION OF DRY SOIL MASS

| | |
|---|---|
| Oven Dried Mass ($W_o$), (g) | 102.89 |
| Air Dried Mass ($W_a$), (g) | 103.51 |
| Hygroscopic Corr. Factor ($F=W_o/W_a$) | 0.9940 |
| Air Dried Mass in Analysis ($M_a$), (g) | 55.36 |
| Oven Dried Mass in Analysis ($M_o$), (g) | 55.03 |
| Percent Passing 2.0 mm Sieve ($P_{10}$), (%) | 100.00 |
| Sample Represented (W), (g) | 55.03 |

## SIEVE ANALYSIS

| Sieve Size mm | Cum. Wt. Retained | Percent Passing |
|---|---|---|
| 75.0 | | 100.0 |
| 63.0 | | 100.0 |
| 53.0 | | 100.0 |
| 37.5 | | 100.0 |
| 26.5 | | 100.0 |
| 19.0 | | 100.0 |
| 13.2 | | 100.0 |
| 9.5 | | 100.0 |
| 4.75 | | 100.0 |
| 2.00 | 0.0 | 100.0 |
| Total (C + F)[1] | 268.10 | |
| 0.850 | 0.02 | 99.96 |
| 0.425 | 0.04 | 99.93 |
| 0.250 | 0.08 | 99.85 |
| 0.106 | 0.12 | 99.78 |
| 0.075 | 0.14 | 99.75 |
| PAN | 0.14 | |

Note 1: (C + F) = Coarse + Fine

## HYDROMETER DETAILS

| | |
|---|---|
| Volume of Bulb ($V_B$), ($cm^3$) | 63.0 |
| Length of Bulb ($L_2$), (cm) | 14.47 |
| Length from '0' Reading to Top of Bulb ($L_1$), (cm) | 10.29 |
| Scale Dimension ($h_s$), (cm/Div) | 0.155 |
| Cross-Sectional Area of Cylinder (A), ($cm^2$) | 27.25 |
| Meniscus Correction ($H_m$), (g/L) | 1.0 |

**START TIME** 8:02 AM

## HYDROMETER ANALYSIS

| Date | Time | Elapsed Time T Mins | $H_s$ Divisions g/L | $H_c$ Divisions g/L | Temperature $T_c$ °C | Corrected Reading $R = H_s - H_c$ g/L | Percent Passing P % | L cm | η Poise | K | Diameter D mm |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 09-Oct-19 | 8:03 AM | 1 | 57.0 | 6.0 | 22.0 | 51.0 | 90.67 | 7.37904 | 9.61570 | 0.012970 | 0.03523 |
| 09-Oct-19 | 8:04 AM | 2 | 53.0 | 6.0 | 22.0 | 47.0 | 83.56 | 7.99904 | 9.61570 | 0.012970 | 0.02594 |
| 09-Oct-19 | 8:07 AM | 5 | 47.0 | 6.0 | 22.0 | 41.0 | 72.90 | 8.92904 | 9.61570 | 0.012970 | 0.01733 |
| 09-Oct-19 | 8:17 AM | 15 | 38.0 | 6.0 | 22.0 | 32.0 | 56.89 | 10.32404 | 9.61570 | 0.012970 | 0.01076 |
| 09-Oct-19 | 8:32 AM | 30 | 33.0 | 6.0 | 22.0 | 27.0 | 48.00 | 11.09904 | 9.61570 | 0.012970 | 0.00789 |
| 09-Oct-19 | 9:02 AM | 60 | 29.0 | 6.0 | 22.0 | 23.0 | 40.89 | 11.71904 | 9.61570 | 0.012970 | 0.00573 |
| 09-Oct-19 | 12:12 PM | 250 | 23.0 | 6.0 | 22.0 | 17.0 | 30.2250 | 12.64904 | 9.61570 | 0.012970 | 0.00292 |
| 10-Oct-19 | 8:02 AM | 1440 | 19.0 | 6.0 | 21.5 | 13.0 | 23.1132 | 13.26904 | 9.73081 | 0.013047 | 0.00125 |

Remarks:

Reviewed By: Bryan Prevost
Date: October 11/2019

V:\01216\active\laboratory_standing_offers\2019 Laboratory Standing Offers\121621867 Lascelles Engineering Associates\September 26, Sieve & Hydrometer, Lascelles #180480A\Hydrometer.xlsx

# Appendix D

# Laboratory “Certificates of Analysis”

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# Certificate of Analysis

**Lascelles Engineering Ltd.**

1010 Spence Ave, Unit 1014
Hawkesbury, ON K6A 3H9
Attn: Shuang Chang

Client PO:
Project: 180480-A
Custody: 48078

Report Date: 11-Oct-2019
Order Date: 7-Oct-2019

**Order #: 1941055**

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

| Paracel ID | Client ID |
|---|---|
| 1941055-01 | BH-10 SS3 |
| 1941055-02 | BH-10 SS4 |

Approved By: Mark Foto

Mark Foto, M.Sc.
Lab Supervisor

Certificate of Analysis | Report Date: 11-Oct-2019
**Client: Lascelles Engineering Ltd.** | Order Date: 7-Oct-2019
**Client PO:** | **Project Description: 180480-A**

## Analysis Summary Table

| Analysis | Method Reference/Description | Extraction Date | Analysis Date |
|---|---|---|---|
| Anions | EPA 300.1 - IC, water extraction | 11-Oct-19 | 8-Oct-19 |
| pH, soil | EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext. | 9-Oct-19 | 9-Oct-19 |
| Resistivity | EPA 120.1 - probe, water extraction | 9-Oct-19 | 9-Oct-19 |
| Solids, % | Gravimetric, calculation | 10-Oct-19 | 8-Oct-19 |

Certificate of Analysis

**Client: Lascelles Engineering Ltd.**

**Client PO:**

Report Date: 11-Oct-2019

Order Date: 7-Oct-2019

**Project Description: 180480-A**

| | | | | | |
|---|---|---|---|---|---|
| | **Client ID:** | BH-10 SS3 | BH-10 SS4 | - | - |
| | **Sample Date:** | 26-Sep-19 14:00 | 26-Sep-19 14:15 | - | - |
| | **Sample ID:** | 1941055-01 | 1941055-02 | - | - |
| | **MDL/Units** | Soil | Soil | - | - |
| **Physical Characteristics** | | | | | |
| % Solids | 0.1 % by Wt. | 84.1 | 79.7 | - | - |
| **General Inorganics** | | | | | |
| pH | 0.05 pH Units | - | 7.67 | - | - |
| Resistivity | 0.10 Ohm.m | - | 34.2 | - | - |
| **Anions** | | | | | |
| Chloride | 5 ug/g dry | - | 7 | - | - |
| Sulphate | 5 ug/g dry | 18 | 133 | - | - |

## *Method Quality Control: Blank*

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

## *Method Quality Control: Duplicate*

| Analyte | Result | Reporting Limit | Units | Source Result | %REC | %REC Limit | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **Anions** | | | | | | | | | |
| Chloride | 502 | 5 | ug/g dry | 486 | | | 3.1 | 20 | |
| Sulphate | 123 | 5 | ug/g dry | 122 | | | 0.6 | 20 | |
| **General Inorganics** | | | | | | | | | |
| pH | 7.16 | 0.05 | pH Units | 7.13 | | | 0.4 | 2.3 | |
| Resistivity | 90.0 | 0.10 | Ohm.m | 89.9 | | | 0.2 | 20 | |
| **Physical Characteristics** | | | | | | | | | |
| % Solids | 95.9 | 0.1 | % by Wt. | 95.4 | | | 0.5 | 25 | |

## *Method Quality Control: Spike*

| Analyte | Result | Reporting Limit | Units | Source Result | %REC | %REC Limit | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **Anions** | | | | | | | | | |
| Chloride | 576 | 5 | ug/g | 486 | 90.0 | 82-118 | | | |
| Sulphate | 229 | 5 | ug/g | 122 | 107 | 80-120 | | | |

**Qualifier Notes:**

None

**Sample Data Revisions**

None

**Work Order Revisions / Comments:**

None

**Other Report Notes:**

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.

Soil results are reported on a dry weight basis when the units are denoted with 'dry'.
Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

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# Subcontracted Analysis

**Lascelles Engineering Ltd.**
1010 Spence Ave, Unit 1014
Hawkesbury, ON K6A 3H9
Attn: Shuang Chang

Tel: (613) 632-0241
Fax: (613) 632-0241

Paracel Report No **1941055**
Client Project(s): **180480-A**
Client PO:
Reference: **Standing Offer**
CoC Number: **48078**

Order Date: 07-Oct-19
Report Date: 17-Oct-19

Sample(s) from this project were subcontracted for the listed parameters. A copy of the subcontractor's report is attached

| Paracel ID | Client ID | Analysis |
|---|---|---|
| 1941055-02 | BH-10 SS4 | Redox potential, soil |

**TESTMARK Laboratories Ltd.**
*Committed to Quality and Service*

# CERTIFICATE OF ANALYSIS

| | | | |
|---|---|---|---|
| Client: | Dale Robertson | Work Order Number: | 384811 |
| Company: | Paracel Laboratories Ltd.- Ottawa | PO #: | |
| Address: | 300-2319 St. Laurent Blvd.<br>Ottawa, ON, K1G 4J8 | Regulation: | Information not provided |
| | | Project #: | 1941055 |
| Phone/Fax: | (613) 731-9577 / (613) 731-9064 | DWS #: | |
| Email: | drobertson@paracellabs.com | Sampled By: | |
| Date Order Received: | 10/8/2019 | Analysis Started: | 10/16/2019 |
| Arrival Temperature: | 15.1 °C | Analysis Completed: | 10/16/2019 |

## WORK ORDER SUMMARY

ANALYSES WERE PERFORMED ON THE FOLLOWING SAMPLES. THE RESULTS RELATE ONLY TO THE ITEMS TESTED.

| Sample Description | Lab ID | Matrix | Type | Comments | Date Collected | Time Collected |
|---|---|---|---|---|---|---|
| BH-10 SS4 | 1483690 | Soil | None | | 9/26/2019 | 2:15 PM |

## METHODS AND INSTRUMENTATION

THE FOLLOWING METHODS WERE USED FOR YOUR SAMPLE(S):

| Method | Lab | Description | Reference |
|---|---|---|---|
| RedOx - Soil (T06) | Mississauga | Determination of RedOx Potential of Soil | Modified from APHA-2580B |

This report has been approved by:

Marc Creighton
Laboratory Director


6820 Kitimat Road Unit 4, Mississauga, ON, L5N 5M3
Phone: (905) 821-1112 Fax: (905) 821-2095 Web: www.testmark.ca

**TESTMARK Laboratories Ltd.**
*Committed to Quality and Service*

# CERTIFICATE OF ANALYSIS

Paracel Laboratories Ltd.- Ottawa

Work Order Number: 384811

## WORK ORDER RESULTS

| | |
|---|---|
| Sample Description | BH - 10 SS4 |
| Sample Date | 9/26/2019 2:15 PM |
| Lab ID | 1483690 |

| General Chemistry | Result | MDL | Units |
|---|---|---|---|
| RedOx (vs. S.H.E.) | 324<br>[322] | N/A | mV |

## LEGEND

Dates: Dates are formatted as mm/dd/year throughout this report.

[rr]: After a parameter name indicates a re-run of that parameter. If multiple re-runs exist they are suffixed by a number. Sample may not have been handled according to the recommended temperature, hold time and head space requirements of the method after the initial analysis.

MDL: Method detection limit or minimum reporting limit.

[ ]: Results for laboratory replicates are shown in square brackets immediately below the associated sample result for ease of comparison.

Quality Control: All associated Quality Control data is available on request.

Exceedences: HIGHLIGHTED CELLS INDICATE THAT THE RESULT EXCEEDS A REGULATORY LIMIT. CALCULATED UNCERTAINTY ESTIMATIONS ARE NOT APPLIED FOR DETERMINING SAMPLE EXCEEDANCES.

Benzo(b)fluoranthene: Results for benzo(b)fluoranthene may include contributions from benzo(j)fluoranthene.

Field Data: Reports containing Field Parameters represent data that has been collected and provided by the client. Testmark is not responsible for the validity of this data which may be used in subsequent calculations.

Sample Condition Deviations: A noted sample condition deviation may affect the validity of the result.



6820 Kitimat Road Unit 4, Mississauga, ON, L5N 5M3
Phone: (905) 821-1112 Fax: (905) 821-2095 Web: www.testmark.ca

# GEOTECHNICAL INVESTIGATION
# PROPOSED PRESCOTT ARENA - ALTERNATE SITE
# NORTHEAST INTERSECTION OF SOPHIA STREET AND CHURCHILL ROAD WEST
# PRESCOTT, ONTARIO

Prepared for

EVB Engineering Ltd.
Attn: Mr. Greg Esdale, P. Eng.
208 Pitt Street
Cornwall, Ontario
K6J 3P6

By

Lascelles Engineering & Associates Limited
1010 Spence Avenue – Suite 14
Hawkesbury, Ontario
K6A 3H9

LASCELLES
ENGINEERING & ASSOCIATES

Lascelles File No: 180480

July 2020

# TABLE OF CONTENTS

# TABLES



# APPENDICES

# 1 INTRODUCTION

The Town of Prescott, through a consulting agreement with EVB Engineering Ltd. (EVB), retained the services of Lascelles Engineering & Associates Ltd. (Lascelles) to conduct a geotechnical investigation on an alternate site being considered for the construction of a proposed arena facility. The alternate site is located near the northeast intersection of Churchill Road West and Sophia Street.

The purpose of the investigation was to identify the subsurface soil and groundwater conditions within the proposed project area by means of a limited number of boreholes, and based on the factual information obtained, provide guidelines on the geotechnical engineering aspects of the design of the proposed foundations and roadways, including construction considerations which may influence the said design.

Should there be any changes in the design features, which may relate to the guidelines provided in the report, Lascelles Engineering & Associates Ltd. should be advised in order to review the report recommendations.

# 2 PROJECT AND SITE DESCRIPTION

The site under consideration is located within the western portion of the Town of Prescott and within its recreational park. Refer to **Figure** 1 for the location.

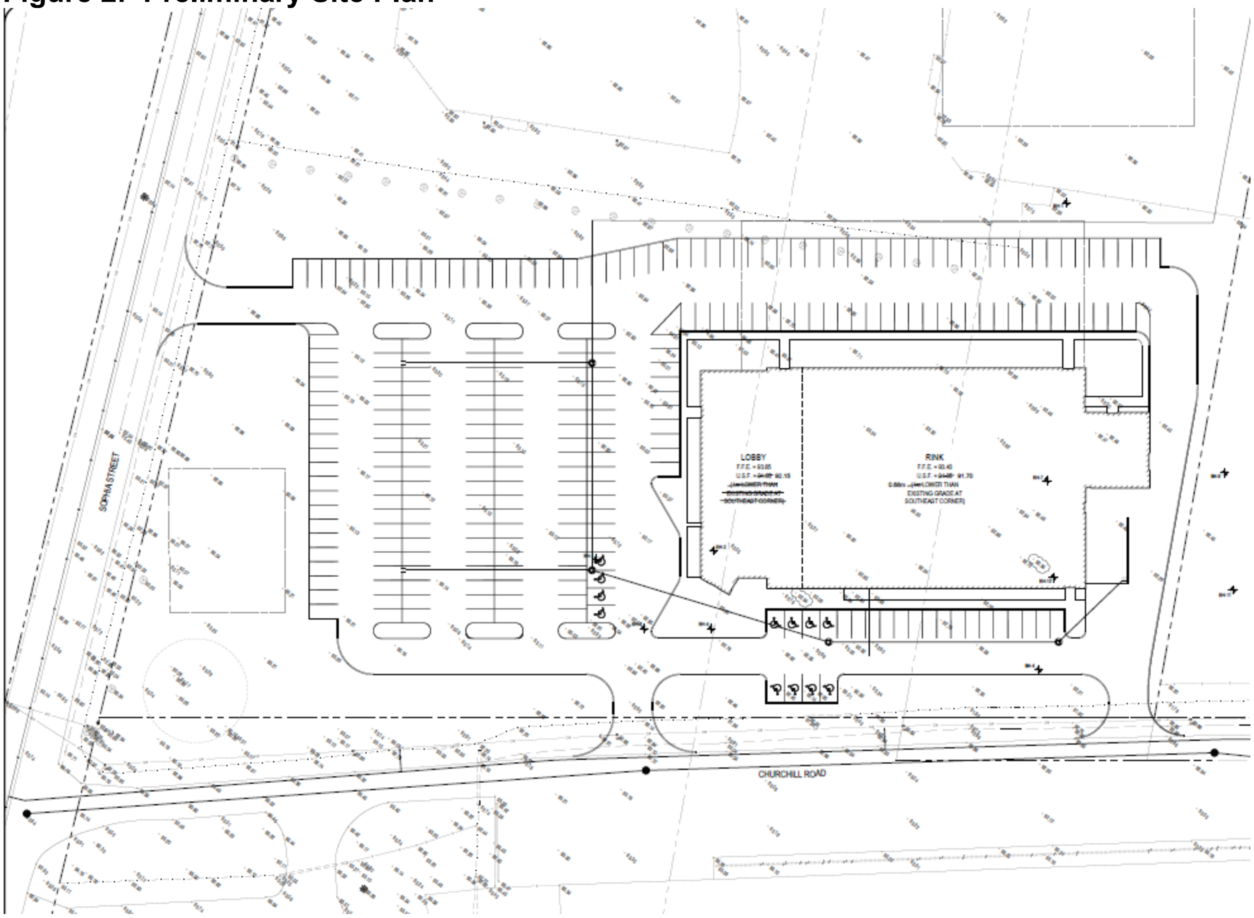
Currently, the site is occupied by a baseball diamond in its western portion, a skate park in its central portion, a public washroom in its northwestern portion and a soccer field withing its eastern portion. The property under investigation has no civic address and fronts Churchill Road West. The proposed arena property will have an irregularly rectangular shape being about 155m wide (east-west) by 95m deep (north-south) for an approximate surface area of 1.63ha (4.02acres). The property is mostly covered with landscape grassed with some gravel area near the skate park for parking. Scattered mature trees are found along the perimeter of the site and south of the stake park. The site is fairly flat with ground surface elevation in the range of 92-93m with a gentle slope towards the northeast.

**Figure 1: Site Location**


Ref: Google Earth - Date of Image 2018

It is our understanding that the project will consist of the construction of an arena having a total surface area of about 4,726m$^2$. The arena building will consist of a one-storey structure for the area of the ice surface and spectator seating. The remaining portion of the arena will consist of a two-storey structure, which will hold the amenities such as change rooms, canteen, washroom, community rooms, a lobby with a viewing area, mech/elec room, etc. No basement is proposed for this building. The building will be located in the central eastern portion of the project site, with some access lanes and parking located both to the north and south of the building and a large surface parking area located to the west of the building. Access to the facility will be from both Sophia Street and Churchill Road. The said building will be serviced by municipal water and sewers. A preliminary concept Site Plan prepared by EVB is presented as part of **Figure 2**.

**Figure 2: Preliminary Site Plan**




## 3 PROCEDURE

The fieldwork for this project consisted of an amalgamation of several individual geotechnical investigations of the site, which includes one drilling program occurred on August 21, 2019, involving advancing six (6) boreholes in the eastern portion of the site; one drilling program occurred on August 28, 2019, involving advancing four (4) boreholes in the western portion of the site; one drilling program occurred on September 26, 2019, involving advancing six (6) boreholes in the central eastern of the site; and one more recently drilling program occurred between June 04 and June 05, involving advancing eleven (11) across the proposed project area. For the simplicity of interpreting this report, some boreholes from pervious drilling program, which were taken into consideration as part of preparing this report, whose identifications have been revised, notably:

1. BH-1 to BH-4 drilled on August 21 and September 26, 2019, as part of an alternate location for the proposed arena; report dated December 2019.

2. BH-5 to BH-8 drilled on August 28, 2019, as part of a proposed elevated water storage tank to be located south of the skate park; report dated February 2020.

The boreholes were advanced using a track-mounted drill rig equipped with continuous flight hollow stem augers supplied and operated by George Downing Estate Drilling Inc. Prior to any fieldwork, the borehole locations were cleared for the presence of any underground services and utilities. A “two-man” crew experienced with geotechnical drilling operated the drill rig and equipment. The boreholes were advanced by auguring through the overburden down to auger refusal over the inferred bedrock encountered between 2.67m to 8.56m below ground surface (bgs), except for BH-14 to BH-19, which were terminated at 4.42m to 5.18m bgs.

Sampling of the overburden materials encountered in the boreholes was carried out at regular depth intervals using a 50mm diameter drive open conventional split spoon sampler in conjunction with standard penetration testing (“N” value). All soil samples collected from boreholes were placed and sealed in plastic bags to prevent loss of moisture. The recovered soil samples collected were classified based on visual and tactile examination and the results of the in-situ testing (standard penetration test and field vane).

BH-4, BH-5, and BH-8 were further advanced upon auger refusal by core drilling techniques in order to confirm the presence of bedrock and its quality. Coring was carried out using an NQ-size (ø47.7mm) double-tube wire line core barrel and extended the borehole between 1.40 to 1.52m into the bedrock.

Standpipes were installed in eight (8) of the boreholes prior to backfilling them to measure the static groundwater level in the area. The standpipes consisted of 20mm diameter PVC piping that were slotted and placed within the overburden prior to backfilling them. The standpipes were used strictly to establish the static water level of the overburden water table.

The fieldwork was supervised throughout by a member of our engineering staff who supervised the drilling of the boreholes, coordinated the testing of the materials, cared for the samples collected and logged the subsurface conditions encountered at each location. All soil and rock samples were transported to our office for further examination by our geotechnical engineer. All samples collected during this project will be kept in storage for a period of six (6) months at which time, they will be disposed of, unless a written or verbal notice is received, requesting otherwise.

Finally, all boreholes were surveyed and located using a GPS (Global Positioning System) receiver (Trimble/Spectra Precision SP60 GNSS) using NAD 83 datum (North American Datum) and have been plotted on a google earth aerial photograph and are presented as part of **Appendix A**. Furthermore, the geodetic positioning of the boreholes are given on the borehole logs presented in **Appendix B**. The borehole elevations were referenced to a site benchmark given to the top of the spindle of the fire hydrant located at the southwest corner of the intersection of Sophia Street and Churchill Road West; Elevation. 94.758m considered geodetic.

# 4 SUBSURFACE SOIL AND GROUNDWATER CONDITIONS

## 4.1 General

A review of the surficial geology maps for this area suggests that the site would be within transitional geological units consisting of Champlain Sea Sand gradually changing northerly to Champlain Sea Clay.

The Champlain Sea Sand is described as uniform buff sand, commonly reworked by wind into dunes, while the Champlain Sea Clay is described as blue-grey clay, silty clay to silt, which is locally overlain by thin layer of sand. The drift thickness within this area varies significantly from shallow bedrock increasing in depth northerly to more than 20m. The bedrock for this area consists of either the March Formation (southern portion) or the Oxford Formation (northern portion). In this area, the March is described interbedded sandstone, dolostone and sandy dolostone, while the Oxford formation is described as dolostone.

The subsurface conditions encountered in the boreholes were classified based on visual and tactile examination of the materials recovered from the boreholes and the results of the in-situ testing and field observations. The soil descriptions presented in this report are based on commonly accepted methods of classification and identification of soil employed in geotechnical practice. Classification and identification of soil involves judgement and Lascelles does not guarantee descriptions as exact but infers accuracy to the extent that is common in current geotechnical practice.

The subsurface soil conditions encountered at each borehole location are given in the Borehole Logs presented in **Appendix B**. These logs indicate the subsurface conditions encountered at specific test locations only. Boundaries between zones on the logs are often not distinct but are rather transitional and have been interpreted as such.

## 4.2 Topsoil

A thin (100mm to 300mm) layer of topsoil was encountered in all boreholes drilled across the site except BH-13. The topsoil is described as dark brown sandy loam. The topsoil was found resting over a sand-silt deposit in all boreholes except for BH-14.

The material classified as topsoil was based on colour and the presence of organic materials and is intended as identification for geotechnical purposes only. This does not constitute a statement as to the suitability of this layer for cultivation and sustaining plant growth.

## 4.3 Fill

A layer of fill was encountered directly at the surface or underlying the topsoil in BH-13, BH-14 and 16. In BH-13, which is drilled near the skate park, the fill consisted of 200mm stone dust underlain by a layer of sand that extends down to 1.63m bgs. In BH-14, which is drill near the baseball diamond, the fill consisted of a thin layer (310mm) of sand that extends to a depth of 0.61m bgs. Finally, in BH-16, which is drilled near the washroom building, the fill consisted of a thin (770mm) layer of sand that extends to a depth of 1.07m bgs. The sand fill is generally described as fine-grained to silty with trace of clay, brown in colour and in a loose to compact state of packing. The sand fill likely originated from the construction of the nearby structure as noted above.

## 4.4 Sand-Silt Deposit

A sand-silt deposit was encountered in all boreholes drilled at this site. The deposit is described as silty sand to sandy silt, brown near the surface become greyish brown to grey with depth. It is generally in a loose state of packing near the surface (first meter) but becomes compact to dense with depth, and moist to wet with depth. The sand-silt deposit was found directly underlying the topsoil or fill material extending to depths between 2.11m and 3.96m bgs, where it transitions into a silt deposit in most boreholes. However, in BH-4, and BH-13 to BH-17, the sand-silt deposit was found resting over a glacial till deposit.

Several samples of this soil unit were submitted to Stantec Laboratories, an accredited material testing laboratory, in order to perform a gradation analysis. A summary of the results is represented in Table 1 below, while the laboratory report is provided as part of **Appendix C**.

**Table 1: Laboratory Analysis Summary – Sand-Silt**

| Bore Hole | Sample # | Depth (m) | Percent for each soil gradation | | |
|---|---|---|---|---|---|
| | | | Gravel (%) | Sand (%) | Silt & Clay (%) |
| BH-5 | SS3&4 | 1.52 – 2.29 | 0.0 | 52.4 | 47.6 |
| BH-8 | SS2&3 | 0.76 – 2.29 | 0.0 | 48.1 | 51.9 |
| BH-18 | SS4 | 2.29 – 2.90 | 0.0 | 46.3 | 53.7 |

The gradation analysis revealed that that this soil unit contains 0.0% of gravel, 46.3 to 52.4% of sand and 47.6 to 53.7% of silt and clay. This soil would be classified as SM (silty sand to silt-sand mixture) as per the unified classification system.

## 4.5 Silt

A silt deposit was found underlying the sand-silt layer in all the boreholes, except for BH-4 and BH-13 to BH-17. The silt was described as clayey with beds of stiff silty clay near its upper portion, and with traces of sand. It is grey in colour, in a compact state of packing and moist to wet. The silt deposit was found to extend between 3.04m and 8.23m bgs and rest either over glacial till or directly over bedrock.

Several samples of this soil unit were submitted to Stantec Laboratories, an accredited material testing laboratory, in order to perform hydrometer analysis. A summary of the results is represented in **Table 2** below, while the laboratory report is provided as part of **Appendix C**.

**Table 2: Laboratory Analysis Summary – Silt**

| Bore Hole | Sample # | Depth (m) | Percent for each soil gradation | | | |
|---|---|---|---|---|---|---|
| | | | Gravel (%) | Sand (%) | Silt (%) | Clay (%) |
| BH-6 | SS5 | 3.05 - 3.66 | 0 | 10.3 | 66.7 | 23.0 |
| BH-6 | SS7 | 4.57 – 5.18 | 0 | 0.7 | 89.3 | 10.0 |
| **Borehole** | **Sample #** | **Depth (m)** | **Moisture content (percent)** | | | |
| | | | **Moisture Content** | **Liquid limit** | **Plastic Limit** | **Plasticity Index** |
| BH-10 | SS6 | 3.81 – 4.42 | 31.0 | NA | NA | NA |
| BH-10 | SS7 | 4.57 – 5.18 | 26.7 | NA | NA | NA |
| BH-10 | SS8 | 5.33 – 5.94 | 24.7 | 26.1 | 16.0 | 10.1 |

The results of the hydrometer analysis revealed that the soil contains no gravel, 0.7% to 10.3% of sand, 66.7 to 89.3% of silt and 10.0 to 23.0% of clay. This soil would be classified as ML (inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with low plasticity) as per the unified classification system. The results of the moisture content revealed that the soil has a moisture content between 24.7 percent to 31.0 percent decreasing with depth. The Atterberg limits test indicates that the soil has a liquid limit of 26.1 percent, a plastic limit between 16.0 percent and a plasticity index of 10.1 percent.

### 4.6 Glacial Till

A deposit of glacial till was encountered mantling the inferred bedrock in most boreholes drilled on this site expect for BH-2, BH-3, BH-5, BH-7, BH-10, BH-11 and BH-18. The thickness and composition of the glacial till deposit was found to vary significantly across the site; but generally speaking, the thickness increases westerly from 0.15m to 4.28m, and the composition consists of silty clay to silty sand with trace to some gravel, grey in colour, in a compact to very dense of packing, and has a moist to wet water content.

### 4.7 Bedrock

Auger refusal over (inferred) bedrock was encountered in all boreholes except for BH-14 to BH-19, which were terminated within the glacial till at depths of 4.42m to 5.18m bgs. The depth of bedrock was established to vary between 2.67m (BH-4) to 8.56m (BH-1) bgs., suggesting it is sloped north-westerly. The bedrock was cored in BH-4 (1.47m run), BH-5 (1.40 m run) and BH-8 (1.52m run) to confirm its quality. Based on our review of recovered rock cores, the bedrock consists of light grey sandy dolostones, and was found to be weathered at the surface but became competent with depth. The recoveries of the rock cores were measured to be between 96% and 100%, and the respective Rock Quality Designation (RQD) was calculated to range from of 63% and 88%, indicating a fair to good bedrock quality. Pictures of the recovered rock cores are presented as part of **Appendix B**.

In addition, a section of rock core collected from BH-8 (CR8) at approximately 5.8m bgs was submitted to Stantec Laboratories to perform an unconfined compressive strength test. The result revealed that the rock core has a compressive strength of 211.2 MPa, which is very hard rock. The laboratory report is provided as part of **Appendix C**.

### 4.8 Groundwater Conditions

The static water level was measured within the standpipes installed within BH-1, BH-4, BH-5, BH-6, BH-8, BH-12, BH-13 and BH-18 using a water meter on June 20, 2020, as well as on September 26, 2019, for the boreholes that were part of the previous geotechnical investigation. The water levels are shown on the borehole logs presented in **Appendix B**. The depth of the groundwater was found to range from 1.12m to 2.18m bgs on June 20, 2020. The flow direction of the overburden water table appears to be north-easterly.

It should be noted that groundwater levels could fluctuate with seasonal weather conditions (i.e., rainfall, droughts, spring thawing) as well as from any presence of existing ditches and underground services trenches at or in the vicinity of the site.

# 5 GEOTECHNICAL CONSIDERATIONS

## 5.1 General

This section of the report provides general engineering guidelines on the geotechnical design aspects of the project based on our interpretation and review of the information obtained from the boreholes as well as the project requirements.

It is our understanding that the project will consist of the construction of an arena having a total surface area of about 4,726m$^2$. The arena building will consist of a one-storey structure for the area of the ice surface and spectator seating. The remaining portion of the arena will consist of a two-storey structure, which will hold the amenities such as change rooms, canteen, washroom, community rooms, a lobby with a viewing area, mech/elec room, etc. No basement is proposed for this building. The building would be located in the central eastern portion of the project site, with some access lanes and parking both to the north and south of the building and a large surface parking area located to the west of the building. Access to the facility would be from both Sophia Street and Churchill Road. The said building will be serviced by municipal water and sewers. A preliminary concept Site Plan prepared by EVB is presented as part of **Figure 2**.

## 5.2 Foundations

The field investigations have confirmed that the site is underlined by a sand-silt deposit. The deposit was found to be loose only near the surface (less 1m bgs) and becoming compact to very dense with the depth. Furthermore, in the area of the proposed building, the groundwater table was found to be located near 1m bgs in general. The sand-silt deposit was found to extend 2.11m to 3.96m bgs and rest over a clayey silt deposit or glacial till deposit, which are both compact to dense. Under seismic loading, only the very upper portion (first 1m) of the sand-silt deposit would be considered liquefiable. Therefore, it is recommended the proposed arena building be founded at approximately 1m bgs over the surficial compact sand-silt deposit. It is not recommended to set the foundation deeper than 1m due to the relatively high groundwater table unless the groundwater table would be permanently lowered prior to excavation.

### 5.3 Shallow Conventional Foundations

Conventional strip and column footings set on the native undisturbed soil, or properly compacted and approved structural fill, may be designed using a maximum allowable bearing pressure of 100kPa for serviceability limit state (SLS) and 150kPa for ultimate limit state (ULS) factored bearing resistance. This bearing capacity is contingent on a minimum founding depth of 1.0m below the existing ground surface to remove the loose layer of sand-silt. In addition, a minimum width of strip footing of 0.9m and a minimum width of 1.2m on any sides for pad footings is recommended.

Any disturbed soil as well as any large cobbles and boulders found at the subgrade level will need to be removed from the footprint of the footings. Due to the sensitivity of the founding soil to worker circulation and to obtain a uniform founding stratum, a 150mm granular mat is recommended. The granular mat must consist of OPSS Granular A crushed stone compacted to 100 percent of its Standard Proctor Maximum Dry Density (SPMDD).

Provided that any loose and/or disturbed soil is removed from the bearing surfaces prior to pouring concrete or placing of structural fill, foundations set over the recommended native soil or structural fill designed using the recommended serviceability limit state capacity value, the total settlement will be less than 25mm. The differential settlement between adjacent column footings is anticipated to be 15mm or less.

### 5.4 Deep Foundations

Alternatively, deep pile foundations extending to the bedrock could also be considered. The depth to bedrock within the area of the proposed building would range approximately between 2.67m to 5.18m bgs, increasing northerly. The overburden found on this site consists of a sand-silt deposit followed by a clayey silt deposit resting over a relatively thin layer of glacial till. Therefore, it is unlikely that the piles will encounter significant obstructions during the piling activities.

For driven piles, the use of steel H-piles or steel tube piles filled with concrete are considered acceptable and would have the structural capacity to support the anticipated loads of the proposed building. To minimize the potential damage to the pile tips during driving, the piles should be provided with a driving shoe as per OPSD standards 3000.100 and 3001.100, for H-pile and steel tube piles, respectively. For steel piles founded over bedrock, the anticipated design valued of the factored resistance at Ultimate Limit State (USL) and the Serviceability Limit State (SLS) should be equal to the structural capacity of the pile. When the pile is properly founded on bedrock, the settlement of the pile head is directly dependent on the elastic compression of the pile from the applied load.

As a design example, the allowable load on a 245mm diameter steel pipe pile with a wall thickness of 8.9mm could be taken as 915 kilonewtons. This assumes that the steel has a minimum yield strength of 340 MPa and that the pipe pile is filled with 30MPa concrete. Pipe piles should be equipped with a base plate having a thickness of at least 20mm to limit damage to the pile tip during driving.

All of the piles should be driven to refusal. The driving resistance criteria will be highly dependent on the required allowable load and the contractor's pile driving equipment. Typically, for drop hammer type piling rigs available in the Eastern Ontario, a refusal criterion of 20 blows for the last 25 millimetres of penetration would be sufficient to achieve the above allowable loads, assuming that about 27 kilojoules of energy is transferred to the pile per blow. The contractor should be required to submit to the geotechnical engineer a copy of the proposed pile size, piling equipment, methodology and driving resistance criteria prior to construction. The pile foundations shall be designed according to Part 4 of the Ontario Building Code (latest edition).

An allowance should be made in the specifications for this project for re-striking all of the piles at least once to confirm the design set and/or the permanence of the refusal and to check for upward displacement due to driving adjacent piles. Piles that do not meet the design set criteria on the first re-strike should receive additional re-striking until the design set criteria are met. All re-striking should be performed after 48 hours of the previous set. Furthermore, the specifications for this project should make provisions for dynamic load tests on test piles and for dynamic testing and analysis on selected production piles to verify the driving resistance criteria and pile capacities. The post construction settlement of elements of the structure, other than the elastic shortening of the piles, should be negligible for end bearing piles driven to refusal over bedrock.

## 5.5 Grade Raise Restrictions

Based on the soil conditions established at this site, the maximum allowable grade raise should be kept to 2.5m or less above the existing grades.

## 5.6 Seismic Design

Based on the results of the geotechnical investigation, the subsurface at this property can be classified as a Class "E" as per the Site Classification for Seismic Site Response in accordance with the latest version of the Ontario Building Code. It is noted that a greater seismic site response class may be obtained by carrying out seismic velocity testing using a multichannel analysis of surface waves (MASW).

## 5.7 Liquefaction Potential

Provided that the foundations are set below the loose sand-silt layer (below 1m bgs) as recommended above, the potential of soil liquefaction is not considered to be a concern.

## 5.8 Structural Fill

Where excavation below the underside of the footing is performed, consideration shall be given to support the footings on structural fill. The structural fill must extend 0.6m beyond the outside edge of the footings and extend outward and down at a 1 Horizontal to 1 Vertical profile out from the edge equal to the depth of the structural fill set below the footing. The recommended material to be used as structural fill to support the footings shall consist of Granular B Type II crushed stone or an approved equivalent material.

The structural fill shall be placed over undisturbed native soils in layers not exceeding 300mm and compacted to a minimum of 98 percent of its Standard Proctor Maximum Dry Density (SPMDD) as per ASTM D-698. Prior to placing any structural fill or to pouring the footings, it is required that any disturbed soils along the base of the footing be removed and that the subgrade soils be inspected and approved by the geotechnical engineer. Furthermore, the structural fill must be tested to ensure that the specified compaction level was achieved.

## 5.9 Slab-on-Grade Construction

For predictable performance of proposed concrete slab-on-grade, it is recommended that they rest over native soil or structural fill only. Therefore, all organic, deleterious or otherwise objectionable fill material encountered shall be removed from the building's footprint.

The exposed native subgrade surface should then be inspected and approved by geotechnical personnel. The subgrade shall be compacted using a heavy roller. Any evidently soft areas should be sub-excavated and replaced with suitable engineered fill; however, disturbances should be minimized as much as possible.

Any underfloor fill needed to raise the general floor grade shall consist of OPSS Granular B Type II material or an approved equivalent, compacted to 95 percent of its SPMDD. The final lift shall be compacted to 98 percent of its SPMDD. A 200mm layer of OPSS Granular A material shall be placed under the slab and compacted to at least 100 percent of the SPMDD.

The modulus of subgrade reaction (ks) for the design of the slabs over native sand, glacial till or structural fill is 18 MPa/m.

In order to minimize and control cracking, the floor slab should be provided with wire or fiber mesh reinforcement and crack control joints. The crack control joints should be spaced at equal distance in both directions and where possible, not exceeding a spacing of 4.5 metres. The mesh reinforcement should be carried through the joints.

## 5.10 Frost Protection

All exterior footings and those located in any unheated portion of the proposed building should be provided with at least 1.5m of earth cover for frost protection purposes. Exterior footings constructed in areas that are to be cleared of snow during the winter period should be provided with at least 1.7m of earth cover for frost protection purposes. Alternatively, the required frost protection could be provided using a combination of earth cover and extruded polystyrene insulation. Lascelles should review the detailed design of frost protection with the use of equivalent insulation prior to construction.

In the event that foundations are to be constructed during winter months, foundation soils are required to be protected from freezing temperatures using suitable construction techniques. Therefore, the base of all excavations should be insulated from freezing temperature immediately upon exposure, until the time that heat can be supplied to the building interior and footings have sufficient soil cover to prevent freezing of the subgrade soils.

### 5.11 Foundation Drainage

It is our understanding that the proposed arena building will not contain any basement level, including crawl spaces, pipe chase, etc. and that the finished grade of all interior floors will be constructed at a higher elevation than the finished ground elevation near the building. Consequently, perimeter drainage is not required.

In order to reduce the potential for ponding of water adjacent to the foundation walls, roof water should be controlled by a roof drainage system that directs water away from the building and the exterior grade should be sloped to promote water away from the foundation walls.

### 5.12 Foundation Wall Backfill

To prevent possible foundation frost jacking of the foundation wall, the backfill material should consist of free-draining, non-frost susceptible material such as sand or sand and gravel meeting OPSS Granular B Type I grading requirements.

The foundation fill should be compacted in 300mm thick lifts, and to 95 percent of its SPMDD using light compaction equipment, where no loads will be set over top. Where the backfill material will ultimately support a pavement structure, walkways or slabs, it is suggested that the foundation wall backfill material be compacted in 200mm thick lifts, and to 98 percent of the SPMDD. The backfilling against foundation walls should be carried out on both sides of the wall at the same time.

### 5.13 Retaining Walls and Shoring

The following **Table 3** below provides the suggested soil parameters for the design of retaining wall and/or shoring systems. For excavations near existing services and structures, the coefficient of earth pressure at rest ($K_o$) should be used.

## Table 3: Material Properties for Shoring and Permanent Wall Design (Static)

| Type of Material | Bulk Density ($kg/m^3$) | Pressure Coefficient: Active ($K_a$) | Pressure Coefficient: At Rest ($K_o$) |
|---|---|---|---|
| Clay | 18 | 0.45 | 0.80 |
| Sand | 19 | 0.33 | 0.50 |
| Till | 22 | 0.27 | 0.50 |
| Granular B Type I | 20 | 0.33 | 0.50 |
| Granular B Type II | 23.1 | 0.31 | 0.47 |
| Granular A | 23.5 | 0.27 | 0.43 |

The above values are for a flat surface behind the wall, a straight wall and a wall friction angle of 0 degrees. The designer should consider any difference between these coefficients, and make appropriate corrections for a sloped surface behind the wall, angled wall or wall friction as required. The bearing capacity for the design of a retaining wall is the same as provided for the building structures provided it is founded over native soil or properly prepared and approved structural fill.

Retaining walls should also be designed to resist the earth pressures produces under seismic conditions. The use of the combined coefficients of static and seismic earth pressure is recommended, referred to as $K_{AE}$ for active conditions and $K_{PE}$ for passive conditions for routine design purposes.

The total active and passive loads under seismic conditions can be calculated using the following two equations;

$P_{AE} = ½ K_{AE} \gamma H^2 (1-k_V)$

$P_{PE} = ½ K_{PE} \gamma H^2 (1-k_V)$

Where;

$K_{AE}$ = Combined Static and Seismic Active Earth Pressure Coefficient

$K_{PE}$ = Combined static and seismic passive earth pressure coefficient

H = Total Height of the Wall (m)

$K_h$ = horizontal acceleration coefficient

$K_v$ = vertical acceleration coefficient

$\gamma$ = bulk density ($kg/m^3$)

These equations are based on a horizontal slope behind the wall and a vertical back of the retaining wall and zero wall friction. For this site, the following design parameters were used to develop the recommended $K_{AE}$ and $K_{PE}$ values.

A = Zonal acceleration ratio = 0.2
$K_h$ = Horizontal acceleration coefficient = 0.1
$K_V$ = Vertical acceleration coefficient = 0.067

The above value of $K_h$ corresponds to ½ of the A value and the value $K_V$ of corresponds to 0.67 of the $K_h$ value. The angle of friction between the soil and the wall has been set at $0^o$ to provide a conservative estimate. The following **Table 4** provides the parameters for seismic design of retaining structures.

**Table 4: Material Properties for Shoring and Permanent Wall Design (Seismic)**

| Parameter | OPSS Granular B Type I | OPSS Granular A, Granular Fill and Granular B Type II | Clay and Clayey Material |
|---|---|---|---|
| Bulk Unit Weight, γ ($kN/m^3$) | 20 | 23.3 | 18 |
| Effective Friction Angle (degrees) | 30 | 32 | 28 |
| Angle of Internal Friction Between wall and Backfill (degrees) | 0 | 0 | 0 |
| **Yielding Wall** | | | |
| Active Seismic Earth Pressure Coefficient ($K_{AE}$) | 0.37 | 0.33 | 0.45 |
| Height of the Application of $P_{AE}$ from the base of the wall as a ration of its height (H) | 0.36 | 0.37 | 0.36 |
| Passive Seismic Earth Pressure Coefficient ($K_{PE}$) | 3.06 | 3.48 | 4.0 |
| Height of the Application of $P_{PE}$ from the base of the wall as a ration of its height (H) | 0.30 | 0.30 | 0.30 |

# 6 POTENTIAL OF CORROSIVE ENVIRONMENT

## 6.1 Sulphate Attack on Buried Concrete

Four (4) soil samples collected from BH-8 (SS4 & SS6), BH-13 (SS4) and BH-15 (SS4) were submitted for a sulphate analysis. The laboratory analysis was performed was performed by Paracel Laboratories Ltd, an accredited chemical testing laboratory. The results of the analysis found the soil to contain a sulphate concentration between less 5 µg/g to 133 µg/g or 0.0005 % to 0.0133%). The laboratory Certificates of Analysis are presented in **Appendix D.**

Based on the CAN/CSA - A23.1 standards (Concrete Materials and Methods of Concrete Construction), a sulphate concentration of 0.1% (1000 µg/g) or less in soil falls within the negligible category for sulphate attack on buried concrete. As such, buried concrete for foundation or manholes will not require any special additive to resist sulphate attack and the use of normal Portland cement is acceptable.

## 6.2 Corrosivity Analysis for Buried Steel

In addition, three (3) soil samples (BH-8 SS 6, BH-13 SS4 and BH-15 SS4) were also submitted for analysis of pH, Resistivity and Redox Potential. The purpose of this testing was to assess the potential for corrosive environment on any buried steel (i.e. piles). The laboratory Certificates of Analysis are presented in **Appendix D**.

The potential for an aggressive corrosive soil environment was established in reviewing the above-measured parameters and according to the standard provided by the American Water Works Association (AWWA) C-105/A21.5-10. Based on the noted standard, corrosion protection for buried steel is only required where a corrosivity index of 10 or greater is encountered. Based on the results, the calculated corrosivity index was found to be less than 10. As such, any buried steel as part of this project would not require any special or specific corrosion protection measures.

# 7 EXCAVATION AND GROUNDWATER CONTROL

## 7.1 Excavation Requirements

It is anticipated that shallow excavation for this project will not exceed 3.6m bgs for the foundation and the installation of the associated underground services. Most of the shallow excavation will be through topsoil, some fill, sand-silt, clayey silt or glacial till deposits as well as potentially bedrock in very localised area. Considering the high-water table found at this site, most of these soils are located below the water table.

According to the Ontario's Occupational Health and Safety Act (OHSA), O. Reg. 213/91 and its amendments, the surficial overburden soil anticipated to be excavated into at this site can be classified as Type 3 for fully drained excavations. Therefore, shallow temporary excavation in the overburden soil classified as Type 3 can be cut at 1 horizontal to 1 vertical for a fully drained excavation starting at the base of the excavation and as per requirements of the OHSA regulations.

The listed slopes are for fully drained excavations. Gentler slopes could be required under undrained excavations or below the water table, where localised water infiltrations can occur and where the excavations are exposed for a prolonged period of time.

Any excavated material stockpiled near a trench or open excavation should be stored at a distance equal to or greater than the depth of the excavated soil within the trench or open excavation and equipment circulation should be restricted away from the top of the slope excavation.

In the event that the aforementioned slopes are not possible to achieve due to space restrictions, the excavation should be shored according to OHSA O. Reg. 213/91 and its amendments. A geotechnical engineer should design and approve the shoring and establish the shoring depth under the excavation profile. Refer to the parameters provided in **Tables 3** and **4** in Section 5.13 for use in the design of any shoring structures. The excavation for the underground services could be carried out within tightly fitting, braced steel trench boxes, approved by a professional engineer.

Although it is anticipated to be very limited, rock excavation may be required for the installation of some underground services at this site. It is anticipated that any weathered portion of the bedrock may be excavated using a large excavator and that the remaining bedrock will require the use of hoe-rams. Furthermore, it is possible that large boulders (greater than 1m in size) may be encountered as part of the glacial till, and may need to be broken up in order to excavate.

The slopes of the rock excavation may be vertical with a 1m wide bench at the soil-rock interface on all sides of the excavation. Any loose pieces of rock from the sidewalls of the excavation should be removed, and the bottom of the excavation should be sufficiently flattened and exempt from rock ledges.

A condition survey of any nearby structures and services should be undertaken prior to commencing any construction. In view of the potential for vibration during excavating and removal of the bedrock, it is recommended that the excavation activities be monitored throughout the project by a vibration specialist engineer or consultant and that the vibration limits be established based on the local conditions and nearby structures to ensure that ground vibration are not exceeded.

### 7.2 Groundwater Control

Groundwater seepage and infiltration entering shallow and temporary excavations performed within the overburden should be mitigated by pumping from sumps installed in the excavation. Surface water runoff into the excavation should be avoided and diverted away from the excavation.

It is anticipated that the invert of underground services may be founded below the water table. Although the sand-silt, silt and glacial till deposits are in a compact to dense state, they are nevertheless sensitive below the water table and may also be susceptible to piping and scouring from water pressure at the base of the excavation. Therefore, the base of the excavation should not be exposed for prolonged periods of time and should be backfilled as soon as possible.

### 7.3 Pipe Bedding Requirements

It is recommended that the bedding for any underground service be placed over native material or structural fill only. Consequently, any fill or organic material should be removed from the loading influence of the proposed underground service. It is anticipated that the sewers and watermain installed as part of this project will be founded over various soil deposits, including bedrock.

Bedding, thickness of cover material and compaction requirements for the underground services should conform to the manufacturers' design requirements and to the requirements and detailed installations outlined in the Ontario Provincial Standard Specifications (OPSS) and any applicable standards or requirements from the Town of Prescott.

Where the invert of an underground service will be founded below the groundwater table and within sandy to silty deposits, these soils may be sensitive to disturbances and may also be susceptible to piping and scouring from water pressure at the base of the excavation. Therefore, special precautions should be taken in these areas to stabilize and confine the base of the excavation, such as using recompression (thicker bedding) and/or dewatering methods (pre-pumping). In order to properly compact the bedding, the water table should be kept at least 0.30m below the base of the excavation at all times during the installation of the underground services.

As an alternative to Granular A bedding and only where wet conditions are encountered, the use of “clear stone” bedding, such as 19mm clear stone, OPSS 1004, may be considered only in conjunction with a suitable geotextile filter. Without proper filtering, there may be entry of fines from native soils and trench backfill into the bedding, which could result in loss of support to the pipes and possible surface settlements.

The sub-bedding, bedding and cover materials should be compacted in maximum 200mm thick lifts to at least 95 percent of the standard Proctor maximum dry density (SPMDD) using suitable vibratory compaction equipment.

### 7.4 Trench Backfill

All service trenches should be backfilled using compactable material, free of organics, debris and large cobbles or boulders. Acceptable native materials should be used as backfill between the roadway subgrade level and the depth of seasonal frost penetrations (i.e. 1.8 metres below finished grade) in order to reduce the potential for differential frost heaving between the newly excavated trench and the adjacent section of roadway. Where native backfill is used, it should match the native materials exposed on the trench walls. Any boulders larger than 300 millimetres in size should not be used as trench backfill. Backfill below the zone of seasonal frost penetration could consist of either acceptable native material or imported granular material conforming at minimum to OPSS Granular B Type I.

To minimize future settlement of the backfill and achieve an acceptable subgrade for the roadway, the trench should be compacted in maximum 300mm thick lifts to at least 95 percent of the SPMDD. The specified density may be reduced where the trench backfill is not located within or in close proximity to existing roadways or any other structures.

## 8 SUITABILITY OF ON-SITE SOILS

The surficial overburden found at this project locations consists of sand-silt, clayey silt and glacial till, which are all considered frost susceptible and are not recommended for engineered fill or backfilling against foundation wall or underneath concrete slabs. The existing overburden could be reused as general backfill material (service trenches, general landscaping/backfilling), if the material can be compacted according to the specifications outlined herein at the time of construction. Any boulders larger than 300mm in size should not be used as service trench backfill. Any imported material should conform to OPSS Granular B- Type I. It is anticipated that any rock excavation to be carried out as part of this project would yield only minimum quantities and would not justify attempting crushing the rock for re-use on-site.

It should be noted that the adequacy of a material for reuse as backfill will depend on its water content at the time of its use and on the weather conditions prevailing prior and during that time. Therefore, all excavated materials to be reused should be stockpiled in a manner that will minimise any significant changes in its moisture content, especially during wet conditions. Any excavated materials proposed for reuse as part of this project should be stockpiled in order to allow the material to be properly inspected and approved prior to reuse by a geotechnical engineer.

# 9 Pavement Design

For predictable performance of the pavement areas, any objectionable fill, organic, soft or deleterious materials should be removed from the proposed pavement areas to expose native undisturbed subgrade soil or properly compacted fill. The exposed subgrade should be inspected and approved by geotechnical personnel, and any evidently loose and unstable areas should be sub-excavated and replaced with suitable earth borrow approved by the geotechnical engineer. Following approval of the preparation of the subgrade, the granular subbase may be placed.

It is anticipated that the subgrade soils for the new parking and access road will consist of a silt-sand deposit. The construction of access road and parking areas will be acceptable over this subgrade once that all organic material, objectionable fill or otherwise deleterious material are removed from the subgrade. The recommended pavement structures for the proposed light duty parking areas and heavy duty access roads (fire route) are provided below.

For light vehicle parking areas and access lanes, the pavement structure should consist of:

> 50 millimetres of hot mix asphaltic concrete surface layer (HL3) over
> 150 millimetres of OPSS Granular A base over
> 350 millimetres of OPSS Granular B, Type II subbase

For heavy duty access roads, the pavement should consist of:

> 40 millimetres of hot mix asphaltic concrete surface layer (HL3) over
> 50 millimetres of hot mix asphaltic concrete binder layer (HL8) over
> 150 millimetres of OPSS Granular A base over
> 450 millimetres of OPSS Granular B, Type II subbase

The base and subbase granular materials should conform to OPSS Form 1010 material specifications. Prior to importing any granular material onto the site, it should be tested and approved by a geotechnical engineer prior to delivery to the site and should be compacted to 100% SPMDD. Compaction of the granular pavement materials should be carried out in a maximum of 200 mm thick loose lifts to 100% of its SPMDD using suitable vibratory compaction equipment.

The Job Mix Formula (JMF) of the asphaltic concrete should be in accordance with OPSS 1150 for Material Specification for Hot Mix Asphalt. The asphaltic concrete should be placed in accordance with OPSS. MUNI 310 for Construction Specification for Hot Mix Asphalt. The asphaltic concrete should be compacted to a minimum of 92% of the Maximum Relative Density. The JMF and its constituents should be reviewed, tested and approved by a geotechnical engineer prior to delivery to the site.

### 9.1 Paved Areas and Subgrade Preparation

The proposed access lanes and parking areas should be stripped of vegetation, topsoil, debris and other obvious objectionable fill material. Following the backfilling and satisfactory compaction of any underground service trenches up to the subgrade level, the subgrade should be shaped, crowned and proof-rolled using a heavy roller with any resulting soft areas sub-excavated down to an adequate bearing layer and replaced with approved backfill. Following approval of the preparation of the subgrade, the pavement structure may be placed.

If the roadway subgrade is disturbed or wetted due to construction operations or precipitation, the granular thicknesses given above may not be adequate, and it may be necessary to increase the thickness of the Granular B Type II subbase and/or incorporate a non-woven geotextile separator between the roadway subgrade surface and the granular subbase material.

For areas of the site that require the subgrade to be raised, the material should consist of OPSS Granular B Type 1 or approved equivalent. Any materials proposed for this use should be approved by the geotechnical engineer before placement. Materials used for raising the subgrade to the proposed roadway subgrade level should be placed in maximum 300 mm thick loose lifts and be compacted to at least 95% of the SPMDD using suitable compaction equipment.

The performance of the pavement structure is highly dependent on the subsurface groundwater conditions and maintaining the subgrade and pavement structure in a dry condition. To intercept excess subsurface water within the pavement structure granular materials, sub-drains with suitable outlets should be installed below the pavement structure subgrade, if adequate overland flow drainage is not provided (i.e. ditches). The surface of the pavement should be properly graded to direct runoff water towards suitable drainage features. It is recommended that the lateral extent of the subbase and base layers not be terminated vertically immediately behind any proposed curb/edge of the pavement line but be extended beyond the curb.

The preparation of subgrade should be scheduled and carried out in such a manner that a protective cover of overlying granular material is placed as quickly as possible in order to avoid unnecessary circulation by heavy equipment over the subgrade. Frost protection of the surface should be implemented (i.e., insulated tarps, etc.), if works are carried out during the winter months.

Transitions should be constructed between new and existing pavement structures where new parking/access lanes will meet with existing paved areas. In areas where the new pavement will abut existing pavement, the depths of granular materials should be tapered up or down at 5 horizontal to 1 vertical, or flatter, to match the depths of the granular material(s) exposed in the existing pavement

Where the existing asphaltic concrete surface of a parking/roadway is affected by the excavating process, the damaged zones should be saw cut, and any damaged or loose pieces of asphaltic concrete should be removed down to the binder course or its entire depth, where only one layer exist. The existing base should be scarified and proof-rolled with any soft areas excavated and replaced to the proper level with OPSS Granular A. Where two layers of asphalt exist on an access lane, the surface course should be ground over a width of 150mm to allow the new surface course to overlap the binder layer and not create one straight vertical joint. On existing streets, the overlap should be increased to 300mm.

## 10 CONSTRUCTION CONSIDERATIONS

It is suggested that the final design drawings for this project, including the proposed site grading plan, be reviewed by the geotechnical engineer to ensure that the guidelines provided in this report have been interpreted as intended.

The engagement of the services of the geotechnical consultant during construction is recommended to confirm that the subsurface conditions throughout the proposed development do not materially differ from those given in the report and that the construction activities do not adversely affect the intent of the design. Any pile driving operations shall be supervised by geotechnical personnel on a full-time basis to ensure that the piles have reached and met the established refusal criteria, and the final pile location does not deviate horizontally and vertically from its design location. All footing areas and any engineered fill areas (if required) for the proposed project should be inspected by Lascelles Engineering and Associates Ltd. to ensure that a suitable subgrade has been reached and properly prepared. The placing and compaction of any granular materials beneath the foundations (if required) should be inspected to ensure that the materials used conform to the gradation and compaction specifications.

The subgrade for the pavement areas, watermain and sewers should be inspected and approved by geotechnical personnel. In-situ density testing should be carried out on the pavement granular materials and pipe bedding and backfill to ensure the materials meet the specifications from a compaction point of view.

## 11 REPORT CONDITIONS AND LIMITATIONS

It is stressed that the information presented in this report is provided for the guidance of the designers and is intended for this project only. The use of this report as a construction document is neither intended nor authorized by Lascelles Engineering & Associates Ltd. Contractors bidding on or undertaking the works should examine the factual results of the investigation, satisfy themselves as to the adequacy of the information for construction, and make their own interpretation of the factual data as it affects their construction techniques, schedule, safety and equipment capabilities.

The professional services for this project include only the geotechnical aspects of the subsurface conditions at this site. The presence or implications of possible subsurface contamination resulting from previous uses or activities at this site or adjacent properties, and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this report.

The recommendations provided in this report are based on subsurface data obtained at the specific test locations only. Experience indicates that the subsurface soil and groundwater conditions can vary significantly between and beyond the test locations. For this reason, the recommendations given in this report are subject to a field verification of the subsurface soil conditions at the time of construction.

The report recommendations are applicable only to the project described in the report. Any changes to the project will require a review by Lascelles Engineering & Associates Ltd., to ensure compatibility with the recommendations contained in this project.

We trust this report provides sufficient information for your present purposes. If you have any questions concerning this report or if we may be of further services to you, please do not hesitate to contact our office.

**Yours truly,**
**Lascelles Engineering & Associates Ltd.**

Prepared by:

Shuang Chang, M.A.Sc., P. Eng.

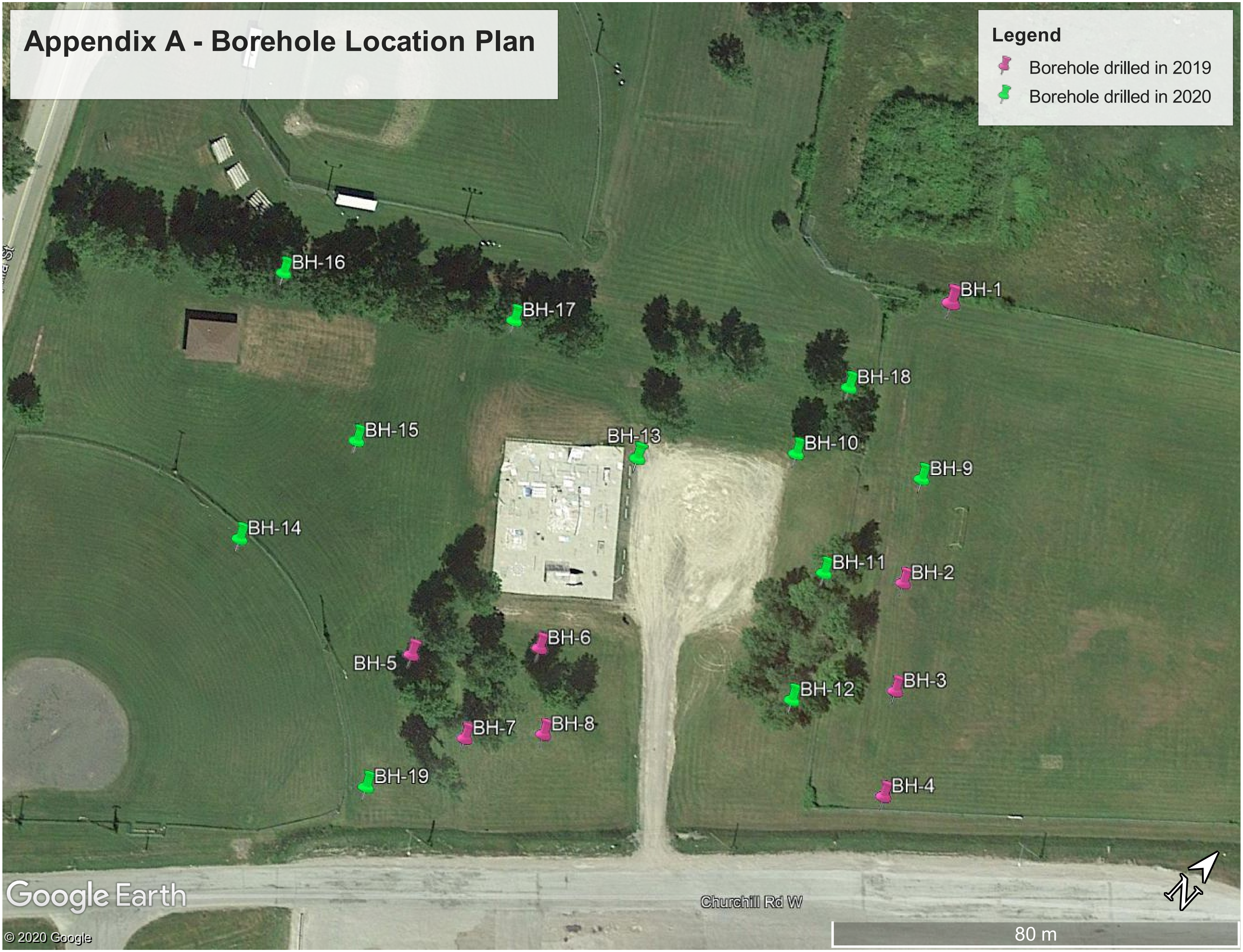
LICENSED PROFESSIONAL ENGINEER
S. CHANG
100524774
July 24, 2020
PROVINCE OF ONTARIO

Reviewed by:

Mario Elie, Project Manager

# Appendix A

# Borehole Location Plan


Appendix A - Borehole Location Plan
Legend
Borehole drilled in 2019
Borehole drilled in 2020
BH-1
BH-2
BH-3
BH-4
BH-5
BH-6
BH-7
BH-8
BH-9
BH-10
BH-11
BH-12
BH-13
BH-14
BH-15
BH-16
BH-17
BH-18
BH-19
Churchill Rd W
Google Earth
© 2020 Google
80 m

# Appendix B

# Borehole Logs

# &

# Rock Core Photograph

LASCELLES ENGINEERING & ASSOCIATES

# RECORD OF BOREHOLE: BH-1

PROJECT: Geotechnical Investigation - Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road West, Prescott, Ontario
DATE: August 21, 2019

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CME-55
DRILLING METHOD: Hollow Stem Auger

## SOIL PROFILE

| DEPTH (m) | DESCRIPTION | ELEV. |
|---|---|---|
| | Ground Surface | 92.52 |
| 0.00 | **Topsoil:** 150mm dark brown sandy loam. | |
| | **Sand-Silt:** Silty sand to sandy silt, brown to grey in colour, loose near the surface becoming compact to very dense with depth, moist becoming wet below 2.0m. | |
| 3.66 | **Silt:** Clayey with beds of stiff silty clay at the upper portion and trace of sand, grey in colour, in a compact state of packing and moist to wet. | 88.86 |
| 8.23 | **Glacial Till:** Sandy with some silt, clay and trace of gravel, grey in colour, very dense and moist. Auger refusal over inferred bedrock. | 84.29 |
| 8.56 | End of Borehole | 83.96 |

## SAMPLES

| NUMBER | TYPE | N-VAL/RQD | RECOVERY |
|---|---|---|---|
| SS1 | SS | 8 | 85% |
| SS2 | SS | 7 | 100% |
| SS3 | SS | 29 | 100% |
| SS4 | SS | 28 | 100% |
| SS5 | SS | 50 | 100% |
| SS6 | SS | 4 | 100% |
| SS7 | SS | 6 | 100% |
| SS8 | SS | 10 | 100% |
| SS9 | SS | 18 | 100% |
| SS10 | SS | 12 | 100% |
| SS11 | SS | 16 | 100% |
| SS12 | SS | 50R | 100% |

SHEAR STRENGTH (kPa) 20 40 60 80 100

STANDARD PENETRATION TEST RESISTANCE PLOT 20 40 60 80

WATER CONTENT % 10 20 30 40 50 60 70 80 90

WATER LEVEL

2.62 m (09/26/2019)

2.18 m (06/20/2020)

Easting: 458183
Northing: 4951299
Site Datum: Geodetic
Groundsurface Elev.: 92.52m
Top of Casing Elev.: NA
Top of Riser Elev.: NA
Borehole Diameter: 200mm
Monitoring Well Diameter: NA

COMMENTS:

RECORD OF BOREHOLE: BH-2

LASCELLES ENGINEERING & ASSOCIATES

PROJECT: Geotechnical Investigation - Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road West, Prescott, Ontario
DATE: September 26, 2019

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CME-55
DRILLING METHOD: Hollow Stem Auger

| DEPTH (m) | DESCRIPTION | ELEV. | NUMBER | TYPE | N-VAL/RQD | RECOVERY |
|---|---|---|---|---|---|---|
| 0.0 | Ground Surface | 92.43 | | | | |
| 0.0 | **Topsoil:** 100mm dark brown sandy loam. | 0.00 | SS1 | | 7 | 100% |
| | **Sand-Silt:** Silty sand to sandy silt, brown in colour, loose near the surface becoming compact to very dense with depth, moist becoming wet below 2.00m. | | SS2 | | 35 | 100% |
| | | | SS3 | | 58 | 75% |
| | | | SS4 | | 45 | 100% |
| 3.05 | **Silt:** Clayey with beds of stiff silty clay at the upper portion and trace of sand, grey in colour, in a compact state of packing and moist. | 89.38 / 3.05 | SS5 | | 12 | 100% |
| | | | SS6 | | 16 | 100% |
| | | | SS7 | | 13 | 100% |
| | Auger refusal over inferred bedrock. | | SS8 | | 50R | 0% |
| 5.41 | End of Borehole | 87.02 / 5.41 | | | | |

SHEAR STRENGTH (kPa): 20, 40, 60, 80, 100
STANDARD PENETRATION TEST RESISTANCE PLOT: 20, 40, 60, 80
WATER CONTENT %: 10, 20, 30, 40, 50, 60, 70, 80, 90
WATER LEVEL

Easting: 458213
Site Datum: Geodetic
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951251
Groundsurface Elev.: 92.43m
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

LASCELLES ENGINEERING & ASSOCIATES

PROJECT: Geotechnical Investigation - Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road West, Prescott, Ontario
DATE: September 26, 2019

# RECORD OF BOREHOLE: BH-3

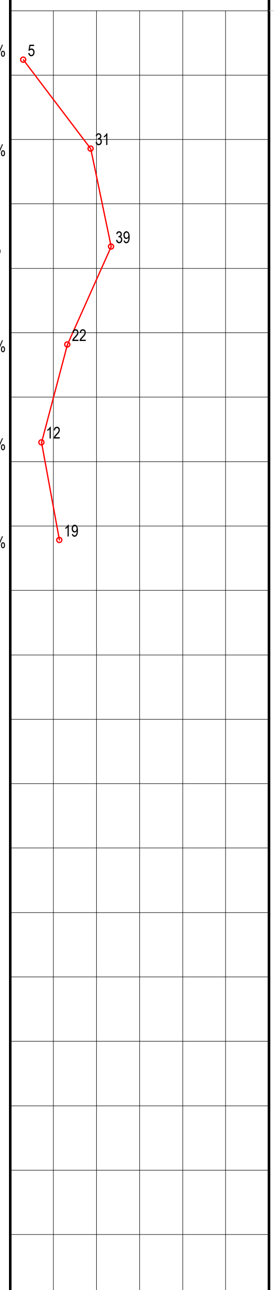
PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CME-55
DRILLING METHOD: Hollow Stem Auger

## SOIL PROFILE / SAMPLES

| DEPTH (m) | DESCRIPTION | ELEV. | NUMBER | TYPE | N-VAL/RQD | RECOVERY |
|---|---|---|---|---|---|---|
| | Ground Surface | 92.44 | | | | |
| 0.00 | **Topsoil:** 100mm dark brown sandy loam. | 0.00 | SS1 | | 5 | 100% |
| | **Sand-Silt:** Silty sand to sandy silt, brown to grey in colour, loose near the surface becoming compact to dense with depth, moist becoming wet below 2.00m. | | SS2 | | 31 | 100% |
| | | | SS3 | | 39 | 75% |
| | | | SS4 | | 22 | 100% |
| 3.05 | **Silt:** Clayey with beds of stiff silty clay at the upper portion, grey in colour, in a compact state of packing and moist. | 89.39 / 3.05 | SS5 | | 12 | 100% |
| | Auger refusal over inferred bedrock. | | SS6 | | 19 | 100% |
| 4.60 | End of Borehole | 87.84 / 4.60 | | | | |

SHEAR STRENGTH (kPa): 20 40 60 80 100

STANDARD PENETRATION TEST RESISTANCE PLOT: 20 40 60 80




WATER CONTENT %: 10 20 30 40 50 60 70 80 90

WATER LEVEL

Easting: 458226
Site Datum: Geodetic
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951234
Groundsurface Elev.: 92.44m
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

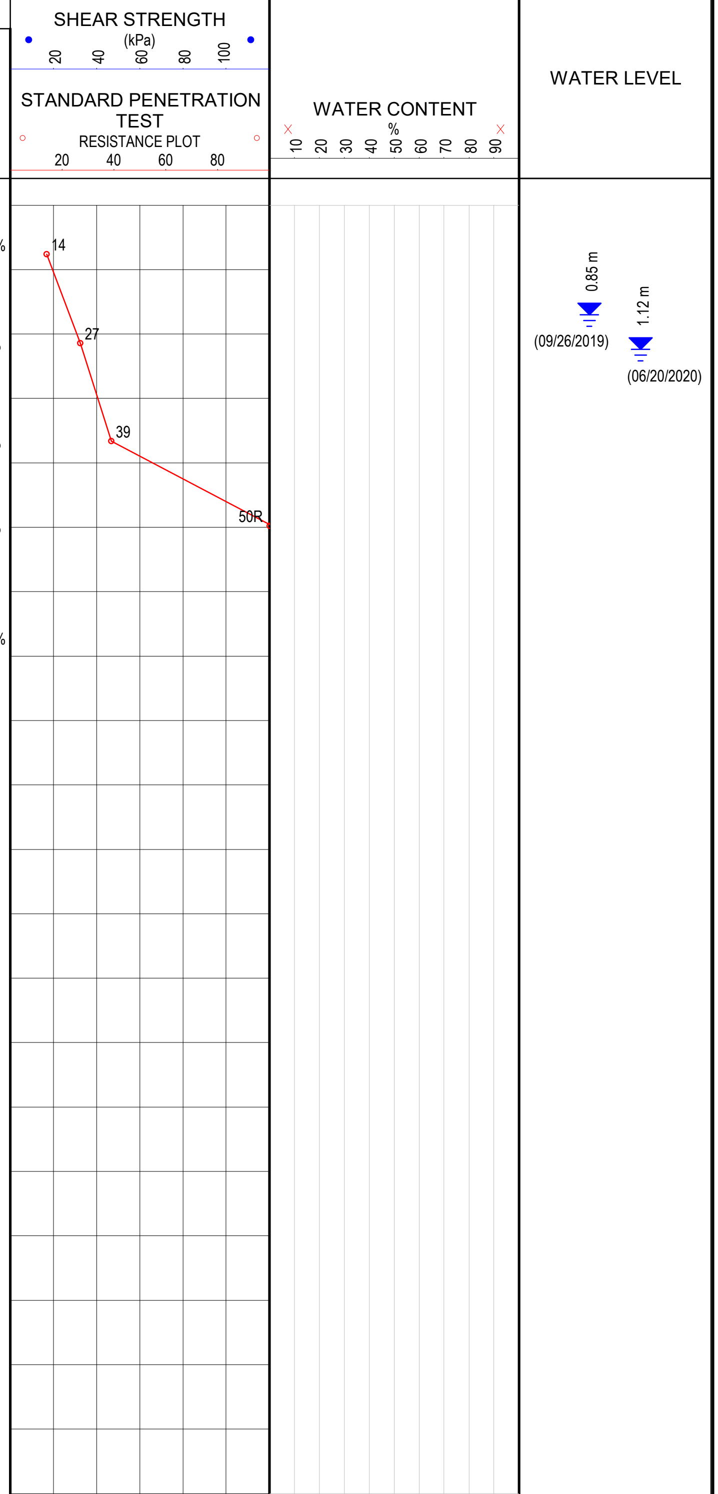
COMMENTS:

RECORD OF BOREHOLE: BH-4

PROJECT: Geotechnical Investigation - Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road West, Prescott, Ontario
DATE: August 21, 2019

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CME-55
DRILLING METHOD: Hollow Stem Auger

| DEPTH (m) | DESCRIPTION | ELEV. | NUMBER | TYPE | N-VAL/RQD | RECOVERY |
|---|---|---|---|---|---|---|
| 0.0 | Ground Surface | 92.26 / 0.00 | | | | |
| | **Topsoil:** 150mm dark brown sandy loam. | | SS1 | | 14 | 100% |
| | **Sand-Silt:** Silty sand to sandy silt, brown in colour, compact near the surface becoming dense with depth, moist becoming wet below 1.20m. | | SS2 | | 27 | 75% |
| | | | SS3 | | 39 | 75% |
| 2.11 | **Glacial Till:** Sandy silt with trace of gravel and clay, grey in colour, compact and wet. | 90.15 / 2.11 | SS4 | | 50R | 75% |
| 2.67 | **Bedrock:** Light grey sandy dolostone; fair quality. | 89.59 / 2.67 | CR5 | | 63% | 100% |
| 4.14 | End of Borehole | 88.12 / 4.14 | | | | |




Easting: 458238
Site Datum: Geodetic
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951217
Groundsurface Elev.: 92.26m
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

LASCELLES ENGINEERING & ASSOCIATES

PROJECT: Geotechnical Investigation- Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road West , Prescott, Ontario
DATE: August 28, 2019

RECORD OF BOREHOLE: BH-5

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CEM-55
DRILLING METHOD: Hollow Stem Auger/ NQ

## SOIL PROFILE

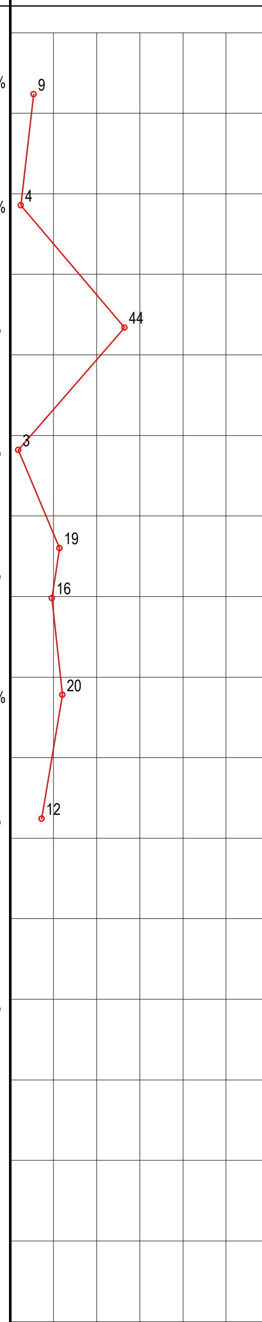
| DEPTH (m) | DESCRIPTION | ELEV. |
|---|---|---|
| 0.0 | Ground Surface | 93.18 / 0.00 |
| 0.0–0.15 | **Topsoil:** 150mm dark brown sandy loam. | |
| 0.15–3.35 | **Sand-Silt:** Silty sand to sandy silt, brown to greyish brown in colour, loose near the surface, becoming compact to very dense with depth, and moist to wet. A layer of mixed graveal and clay was encounted at 2.5m bgs. | |
| 3.35–5.33 | **Silt:** Clayey with beds of clay near the surface and trace of sand, grey in colour, in a compact state of packing, and moist. Auguer refusal over bedrock at 5.33m bgs. | 89.83 / 3.35 |
| 5.33–6.73 | **Bedrock:** Light grey sandy dolostone, good quality and very hard. | 87.85 / 5.33 |
| 6.73 | End of Borehole | 86.45 / 6.73 |

## SAMPLES

| NUMBER | TYPE | N-VAL/RQD | RECOVERY |
|---|---|---|---|
| SS1 | Split spoon | 9 | 100% |
| SS2 | Split spoon | 4 | 100% |
| SS3 | Split spoon | 44 | 85% |
| SS4 | Split spoon | 3 | 85% |
| SS5 | Split spoon | 19 16 | 85% |
| SS6 | Split spoon | 20 | 100% |
| SS7 | Split spoon | 12 | 90% |
| CR8 | Core | 81% | 96% |

SHEAR STRENGTH (kPa) 20 40 60 80 100

STANDARD PENETRATION TEST RESISTANCE PLOT 20 40 60 80




WATER CONTENT % 10 20 30 40 50 60 70 80 90

WATER LEVEL

1.52 m (09/26/2019)

1.61 m (06/20/2020)

Easting: 458150
Site Datum: Geodetic
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951175
Groundsurface Elev.: 93.18m
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

![Lascelles Engineering & Associates logo]

**LASCELLES** ENGINEERING & ASSOCIATES

RECORD OF BOREHOLE: BH-6

PROJECT: Geotechnical Investigation- Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road West , Prescott, Ontario
DATE: August 28, 2019

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CEM-55
DRILLING METHOD: Hollow Stem Auger

## SOIL PROFILE

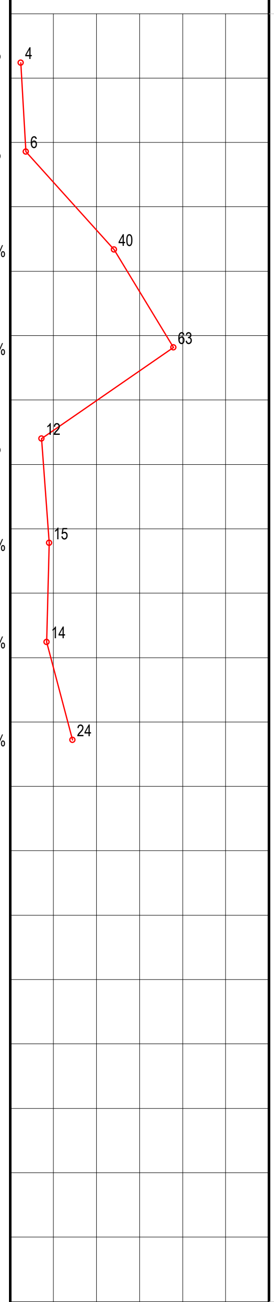
| DEPTH (m) | DESCRIPTION | ELEV. |
|---|---|---|
| | Ground Surface | 92.96 |
| 0.00 | **Topsoil:** 150mm dark brown sandy loam. **Sand-Silt:** Silty sand to sandy silt, brown to greyish brown in colour, loose near the surface, becoming compact to very dense with depth, and moist to wet. | 92.96 / 0.00 |
| 3.05 | **Silt:** Clayey with beds of clay near the surface and trace of sand, greyish brown to grey in colour, in a compact state of packing and moist. | 89.91 / 3.05 |
| 5.18 | **Glacial Till:** Clayey silt with some sand and gravel, grey in colour, compact and moist. | 87.78 / 5.18 |
| 6.07 | Auguer refusal over inferred bedrock at 6.07m bgs. End of Borehole | 86.89 / 6.07 |

## SAMPLES

| NUMBER | TYPE | N-VAL/RQD | RECOVERY |
|---|---|---|---|
| SS1 | | 4 | 85% |
| SS2 | | 6 | 85% |
| SS3 | | 40 | 100% |
| SS4 | | 63 | 100% |
| SS5 | | 12 | 85% |
| SS6 | | 15 | 100% |
| SS7 | | 14 | 100% |
| SS8 | | 24 | 100% |

SHEAR STRENGTH (kPa) 20 40 60 80 100

STANDARD PENETRATION TEST RESISTANCE PLOT 20 40 60 80




WATER CONTENT % 10 20 30 40 50 60 70 80 90

WATER LEVEL

1.66 m (06/20/2020)

2.1 m (09/26/2019)

Easting: 458168
Site Datum: Geodetic
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951193
Groundsurface Elev.: 92.96m
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

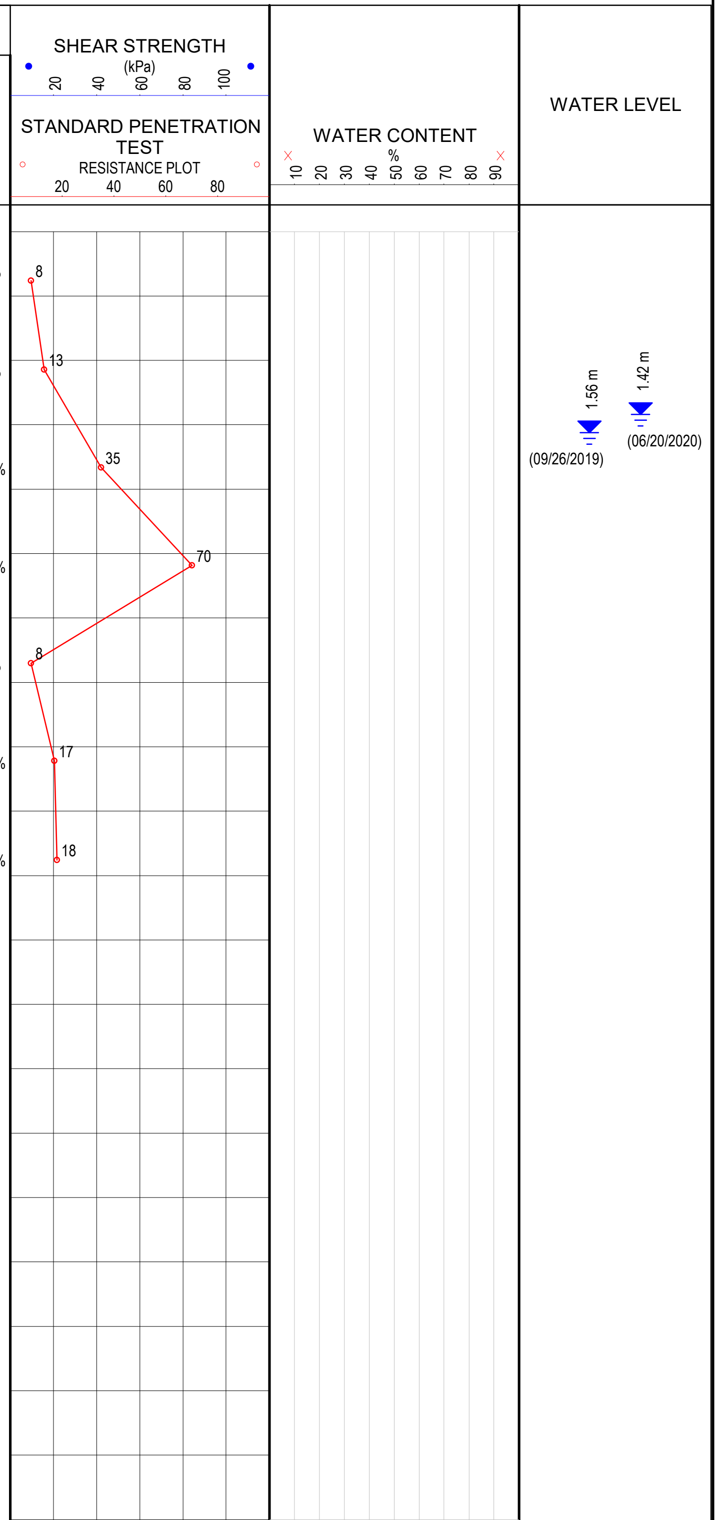
COMMENTS:

RECORD OF BOREHOLE: BH-7

PROJECT: Geotechnical Investigation- Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road West , Prescott, Ontario
DATE: August 28, 2019

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CEM-55
DRILLING METHOD: Hollow Stem Auger

| DEPTH (m) | DESCRIPTION | ELEV. | NUMBER | TYPE | N-VAL/RQD | RECOVERY |
|---|---|---|---|---|---|---|
| | Ground Surface | 93.02 | | | | |
| 0.0 | **Topsoil:** 300mm dark brown sandy loam. | 0.00 | SS1 | | 8 | 85% |
| 0.30 | **Sand-Silt:** Silty sand to sandy silt, brown to greyish brown in colour, loose near the surface, becomming compact to very dense with depth, and moist. | 92.72 / 0.30 | SS2 | | 13 | 85% |
| | | | SS3 | | 35 | 100% |
| | | | SS4 | | 70 | 100% |
| 3.04 | **Silt:** Clayey with beds of clay near the surface and trace of sand, grey in colour, in a compact state of packing, and moist. | 89.98 / 3.04 | SS5 | | 8 | 85% |
| | | | SS6 | | 17 | 100% |
| | Auger refusal over inferred bedrock at 5.08m bgs. | | SS7 | | 18 | 100% |
| 5.08 | End of Borehole | 87.94 / 5.08 | | | | |




Easting: 458169
Site Datum: Geodetic
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951170
Groundsurface Elev.: 93.20m
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

RECORD OF BOREHOLE: BH-8

LASCELLES
ENGINEERING & ASSOCIATES

PROJECT: Geotechnical Investigation- Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road West , Prescott, Ontario
DATE: August 28, 2019

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CEM-55
DRILLING METHOD: Hollow Stem Auger/ NQ

## SOIL PROFILE

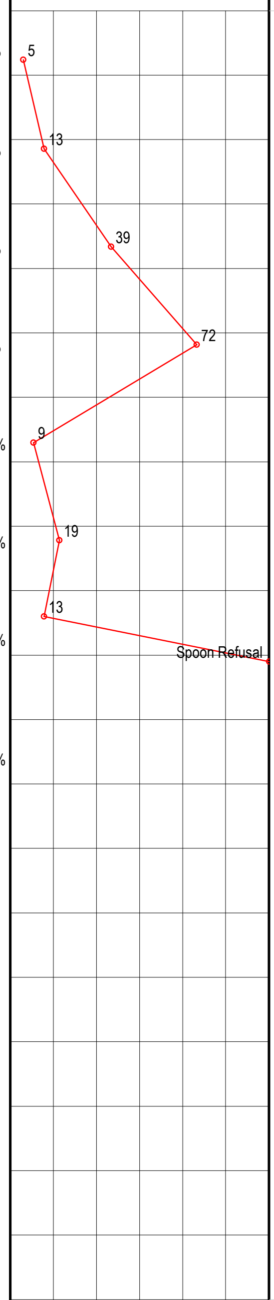
| DEPTH (m) | DESCRIPTION | ELEV. |
|---|---|---|
| 0.0 | Ground Surface | 92.87 / 0.00 |
| 0.0 | **Topsoil:** 100mm dark brown sandy loam. | |
| | **Sand-Silt:** Silty sand to sandy silt, brown to greyish brown in colour, loose near the surface, becoming compact to very dense with depth, and moist to wet. | |
| 3.0 | **Silt:** Clayey with beds of clay near the surface and trace of sand, grey in colour, in a compact state of packing, and moist. | 89.83 / 3.04 |
| 5.0 | **Glacial Till:** Clayey silt with some sand and gravel, grey in colour, very dense, and moist. Auger refusal over inferred bedrock at 5.19m bgs. | 87.84 / 5.03 |
| | **Bedrock:** Light grey sandy dolostone good quality and very hard. | 86.16 / 6.71 |
| | End of Borehole | |

## SAMPLES

| NUMBER | TYPE | N-VAL/RQD | RECOVERY |
|---|---|---|---|
| SS1 | Split spoon | 5 | 75% |
| SS2 | Split spoon | 13 | 80% |
| SS3 | Split spoon | 39 | 75% |
| SS4 | Split spoon | 72 | 90% |
| SS5 | Split spoon | 9 | 100% |
| SS6 | Split spoon | 19 | 100% |
| SS7 | Split spoon | 13 | 100% |
| CR8 | Core | 88% | 100% |

SHEAR STRENGTH (kPa) 20 40 60 80 100

STANDARD PENETRATION TEST RESISTANCE PLOT 20 40 60 80




WATER CONTENT % 10 20 30 40 50 60 70 80 90

WATER LEVEL

Easting: 458180
Site Datum: Geodetic
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951181
Groundsurface Elev.: 92.87m
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

RECORD OF BOREHOLE: BH-9

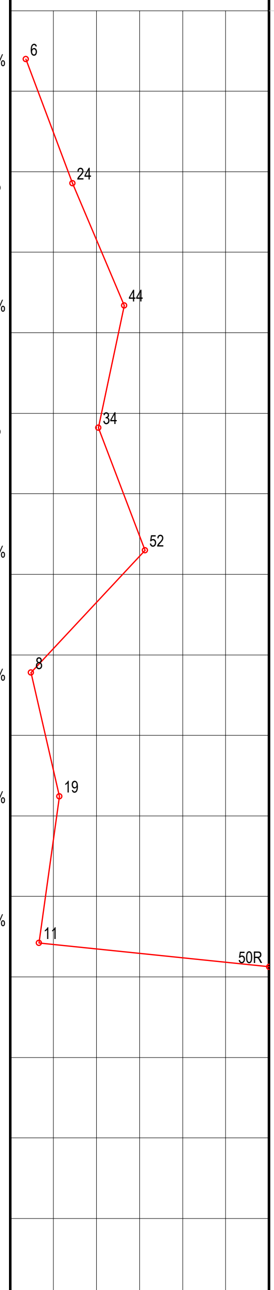
PROJECT: Geotechnical Investigation - Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road West, Prescott, Ontario
DATE: June 05, 2020

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CME-55
DRILLING METHOD: Hollow Stem Auger

| DEPTH (m) | DESCRIPTION | ELEV. | NUMBER | TYPE | N-VAL/RQD | RECOVERY |
|---|---|---|---|---|---|---|
| 0.0 | Ground Surface | 92.52 | | | | |
| 0.00 | **Topsoil:** 200mm dark brown sandy loam. | 0.00 | SS1 | | 6 | 100% |
| 0.20 | **Sand-Silt:** Silty sand to sandy silt, brown to grey in colour, in a loose to very dense state of packing, and moist to very moist. | 92.32 / 0.20 | SS2 | | 24 | 80% |
| | | | SS3 | | 44 | 100% |
| | | | SS4 | | 34 | 80% |
| | | | SS5 | | 52 | 100% |
| 3.65 | **Silt:** Clayey with beds of clay near the surface and trace of sand, grey in colour, in a loose to compact state of packing, and moist. | 88.87 / 3.65 | SS6 | | 8 | 100% |
| | | | SS7 | | 19 | 100% |
| 5.79 | **Glacial Till:** Silty clay with trace of gravel, grey in colour, in a compact to dense state of packing and moist. Note: Auger refusal over inferred bedrock at 5.94m bgs. | 86.73 / 5.79 | SS8 | | 11 / 50R | 100% |
| | End of Borehole | | | | | |

SHEAR STRENGTH (kPa): 20 40 60 80 100

STANDARD PENETRATION TEST RESISTANCE PLOT: 20 40 60 80




WATER CONTENT %: 10 20 30 40 50 60 70 80 90

WATER LEVEL

Easting: 458202
Site Datum: Geodetic
Top of Casing Elev.: 92.52
Borehole Diameter: 200mm

Northing: 4951269
Groundsurface Elev.: 92.52m
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

LASCELLES ENGINEERING & ASSOCIATES

PROJECT: Geotechnical Investigation - Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road West, Prescott, Ontario
DATE: June 05, 2020

# RECORD OF BOREHOLE: BH-10

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CME-55
DRILLING METHOD: Hollow Stem Auger

## SOIL PROFILE

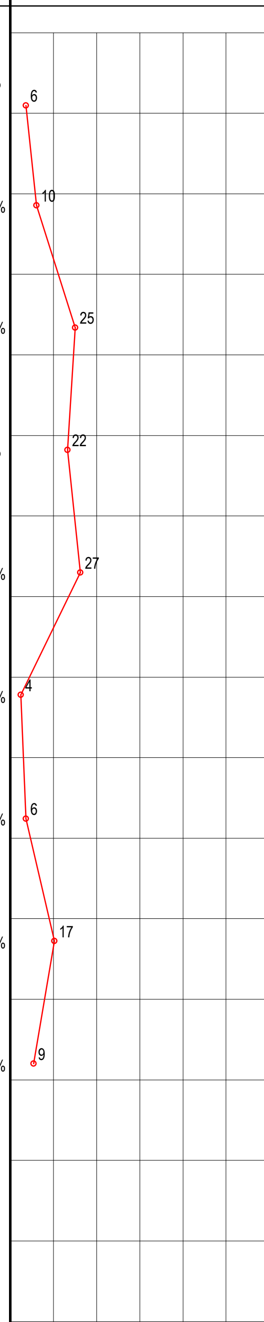
| DEPTH (m) | DESCRIPTION | ELEV. |
|---|---|---|
| 0.00 | Ground Surface | 92.97 |
| 0.00 – 0.30 | **Topsoil:** 300mm dark brown sandy loam. | 92.97 / 0.00 |
| 0.30 – 3.65 | **Sand-Silt:** Silty sand to sandy silt, brown to grey in colour,in a loose to compact state of packing, and moist to very moist. | 92.67 / 0.30 |
| 3.65 – 6.71 | **Silt:** Clayey with beds of clay near the surface and trace of sand, grey in colour, in a loose to compact state of packing, and moist. Note: Auger refusal over inferred bedrock at 6.71mm bgs. | 89.32 / 3.65 |
| 6.71 | End of Borehole | 86.26 / 6.71 |

## SAMPLES

| NUMBER | TYPE | N-VAL/RQD | RECOVERY |
|---|---|---|---|
| SS1 | Split spoon | 6 | 75% |
| SS2 | Split spoon | 10 | 100% |
| SS3 | Split spoon | 25 | 100% |
| SS4 | Split spoon | 22 | 90% |
| SS5 | Split spoon | 27 | 100% |
| SS6 | Split spoon | 4 | 100% |
| SS7 | Split spoon | 6 | 100% |
| SS8 | Split spoon | 17 | 100% |
| SS9 | Split spoon | 9 | 100% |

SHEAR STRENGTH (kPa) 20 40 60 80 100

STANDARD PENETRATION TEST RESISTANCE PLOT 20 40 60 80




WATER CONTENT % 10 20 30 40 50 60 70 80 90

WATER LEVEL

Easting: 458180
Northing: 4951256
Site Datum: Geodetic
Groundsurface Elev.: 92.97m
Top of Casing Elev.: 92.97
Top of Riser Elev.: NA
Borehole Diameter: 200mm
Monitoring Well Diameter: NA

COMMENTS:

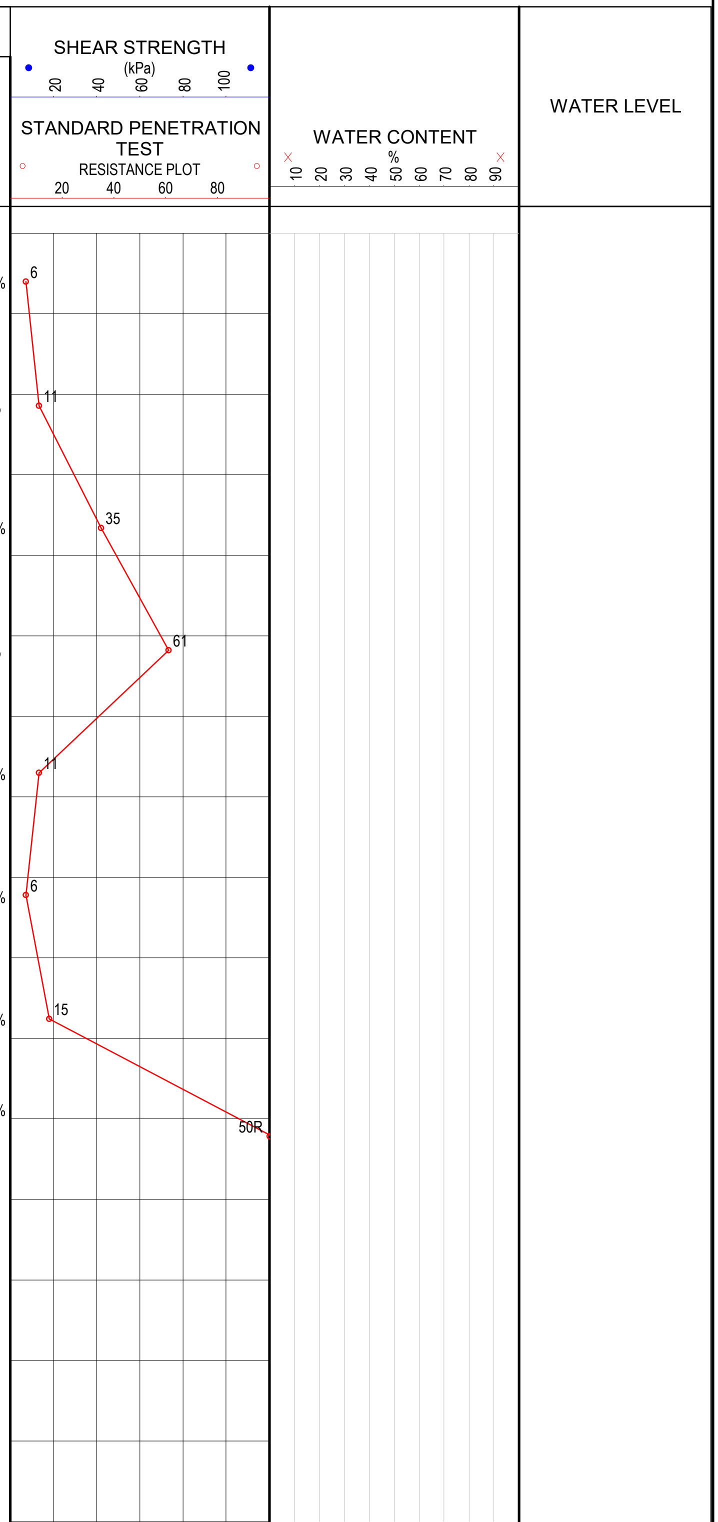
RECORD OF BOREHOLE: BH-11

LASCELLES ENGINEERING & ASSOCIATES

PROJECT: Geotechnical Investigation - Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road West, Prescott, Ontario
DATE: June 05, 2020

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CME-55
DRILLING METHOD: Hollow Stem Auger

| DEPTH (m) | DESCRIPTION | ELEV. | NUMBER | TYPE | N-VAL/RQD | RECOVERY | SPT N (blows) |
|---|---|---|---|---|---|---|---|
| 0.00 | Ground Surface | 92.94 | | | | | |
| 0.00–0.30 | **Topsoil:** 300mm dark brown sandy loam. | 92.94 / 0.00 | SS1 | | 6 | 100% | 6 |
| 0.30–3.04 | **Sand-Silt:** Silty sand to sandy silt, brown to grey in colour,in a loose to very dense state of packing, and moist to very moist. | 92.64 / 0.30 | SS2 | | 11 | 80% | 11 |
| | | | SS3 | | 35 | 100% | 35 |
| | | | SS4 | | 61 | 80% | 61 |
| 3.04–5.61 | **Silt:** Clayey with beds of clay near the surface and trace of sand, grey in colour, in a compact state of packing, and moist. | 89.90 / 3.04 | SS5 | | 11 | 100% | 11 |
| | | | SS6 | | 6 | 100% | 6 |
| | | | SS7 | | 15 | 100% | 15 |
| | Note: Auger refusal over inferred bedrock at 5.61m bgs. | | SS8 | | 50R | 100% | 50R |
| 5.61 | End of Borehole | 87.33 / 5.61 | | | | | |




Easting: 458200
Site Datum: Geodetic
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951242
Groundsurface Elev.: 92.94m
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

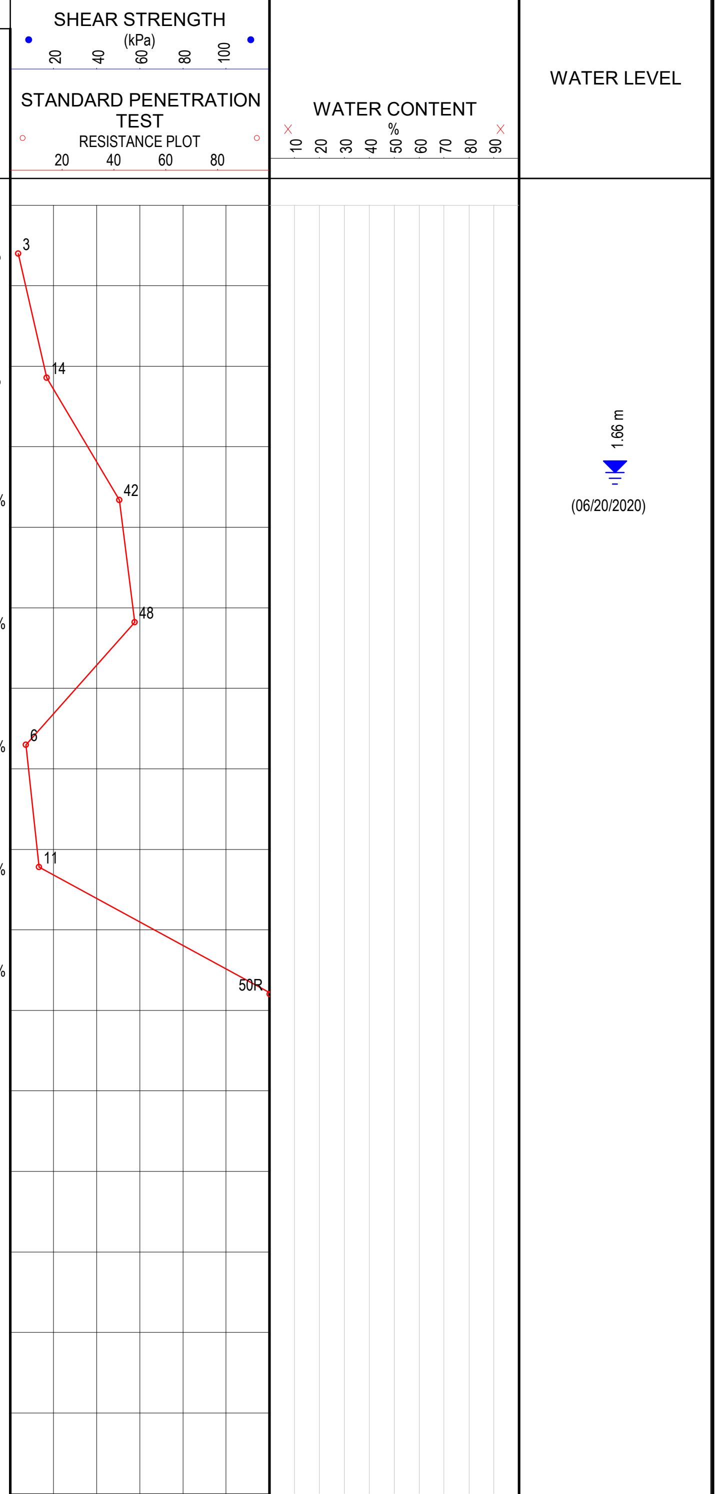
RECORD OF BOREHOLE: BH-12

LASCELLES ENGINEERING & ASSOCIATES

PROJECT: Geotechnical Investigation - Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road West, Prescott, Ontario
DATE: June 05, 2020

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CME-55
DRILLING METHOD: Hollow Stem Auger

| DEPTH (m) | DESCRIPTION | ELEV. | NUMBER | TYPE | N-VAL/RQD | RECOVERY |
|---|---|---|---|---|---|---|
| 0.0 | Ground Surface | 92.85 / 0.00 | | | | |
| | **Topsoil:** 75mm dark brown sandy loam. | | SS1 | | 3 | 50% |
| | **Sand-Silt:** Silty sand to sandy silt, brown to grey in colour,in a loose to dense state of packing, and moist to very moist. | | SS2 | | 14 | 80% |
| | | | SS3 | | 42 | 100% |
| | | | SS4 | | 48 | 100% |
| 3.04 | **Silt:** Clayey with beds of clay near the surface and trace of sand, grey in colour, in a loose state of packing, and moist. | 89.81 / 3.04 | SS5 | | 6 | 100% |
| 3.81 | **Glacial Till:** Silty clay with trace of gravel, grey in colour, in a compact state of packing, and moist. Note: Auger refusal over inferred bedrock at 4.90m bgs. | 89.04 / 3.81 | SS6 | | 11 | 100% |
| | | | SS7 | | 50R | 100% |
| 4.90 | End of Borehole | 87.95 / 4.90 | | | | |




Easting: 458212
Northing: 4951219
Site Datum: Geodetic
Groundsurface Elev.: 92.85m
Top of Casing Elev.: NA
Top of Riser Elev.: NA
Borehole Diameter: 200mm
Monitoring Well Diameter: NA

COMMENTS:

RECORD OF BOREHOLE: BH-13

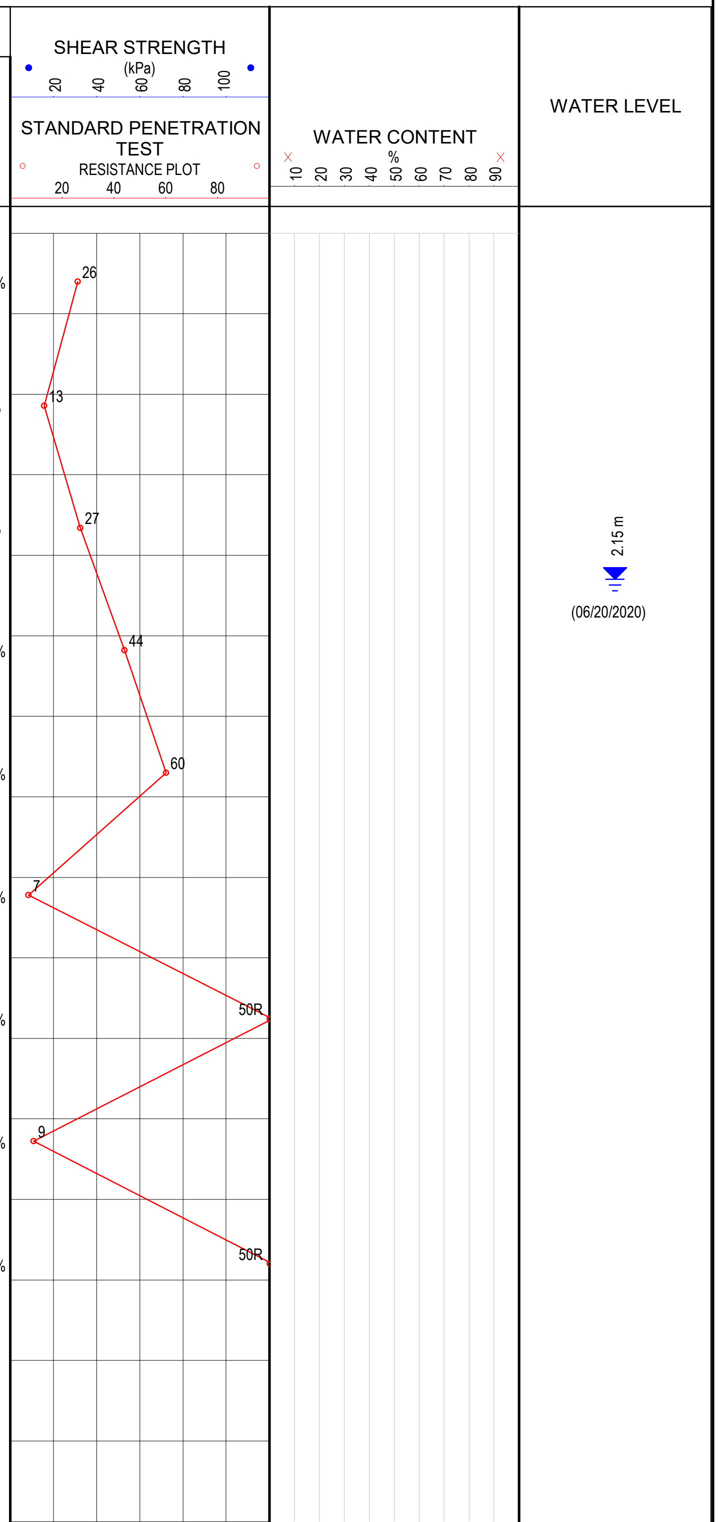
LASCELLES ENGINEERING & ASSOCIATES

PROJECT: Geotechnical Investigation - Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road West, Prescott, Ontario
DATE: June 05, 2020

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CME-55
DRILLING METHOD: Hollow Stem Auger

**SOIL PROFILE** / **SAMPLES**

| DEPTH (m) | DESCRIPTION | ELEV. | NUMBER | TYPE | N-VAL/RQD | RECOVERY |
|---|---|---|---|---|---|---|
| | Ground Surface | 93.10 | | | | |
| 0.00 | **Granulars:** 200mm limestone dust | 0.00 | | | | |
| 0.20 | **Fill:** Fine grained sand, brown in colour, in a compact state of packing, and moist. | 92.90 / 0.20 | SS1 | | 26 | 100% |
| | | | SS2 | | 13 | 80% |
| 1.63 | **Sand-Silt:** Silty sand to sandy silt, brown to grey in colour, in a compact to dense state of packing, and moist to very moist. | 91.47 / 1.63 | SS3 | | 27 | 90% |
| | | | SS4 | | 44 | 100% |
| 3.04 | **Glacial Till:** Silty clay with trace of sand and gravel, presence of boulders, grey in colour, in a loose to very dense of packing, and moist. | 90.06 / 3.04 | SS5 | | 60 | 100% |
| | | | SS6 | | 7 | 100% |
| | | | SS7 | | 50R | 100% |
| | | | SS8 | | 9 | 100% |
| | | | SS9 | | 50R | 100% |
| | Note: Auger refusal over inferred bedrock at 7.32m bgs. | | | | | |
| 7.32 | End of Borehole | 85.78 / 7.32 | | | | |




Easting: 458157
Site Datum: Geodetic
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951234
Groundsurface Elev.: 93.10m
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

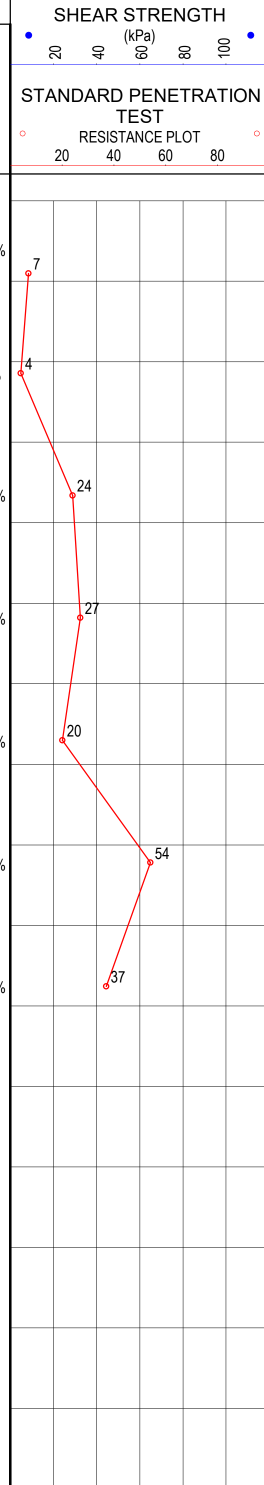
LASCELLES ENGINEERING & ASSOCIATES

PROJECT: Geotechnical Investigation - Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road West, Prescott, Ontario
DATE: June 05, 2020

RECORD OF BOREHOLE: BH-14

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CME-55
DRILLING METHOD: Hollow Stem Auger

| DEPTH (m) | DESCRIPTION | ELEV. | NUMBER | TYPE | N-VAL/RQD | RECOVERY |
|---|---|---|---|---|---|---|
| 0.0 | Ground Surface | 93.18 | | | | |
| 0.00 | **Topsoil:** 300mm dark brown sandy loam. | 0.00 | SS1 | | 7 | 100% |
| 0.30 | **Sand:** Fine grained to silty, with trace of clay, brown in colour, in a loose state of packing, and moist. | 92.88 / 0.30 | | | | |
| 0.61 | **Sand-Silt:** Silty sand to sandy silt, brown to grey in colour, in a loose to compact state of packing, and moist. | 92.57 / 0.61 | SS2 | | 4 | 80% |
| | | | SS3 | | 24 | 100% |
| | | | SS4 | | 27 | 100% |
| 3.04 | **Glacial Till:** Silty sand with some gravel and clay, grey in colour in a compact to very dense state of packing, and moist. | 90.14 / 3.04 | SS5 | | 20 | 100% |
| | | | SS6 | | 54 | 100% |
| | | | SS7 | | 37 | 100% |
| 5.18 | End of Borehole | 88.00 / 5.18 | | | | |




WATER CONTENT %

10 20 30 40 50 60 70 80 90

WATER LEVEL

Easting: 458109
Northing: 4951169
Site Datum: Geodetic
Groundsurface Elev.: 93.18m
Top of Casing Elev.: NA
Top of Riser Elev.: NA
Borehole Diameter: 200mm
Monitoring Well Diameter: NA

COMMENTS:

## RECORD OF BOREHOLE: BH-15

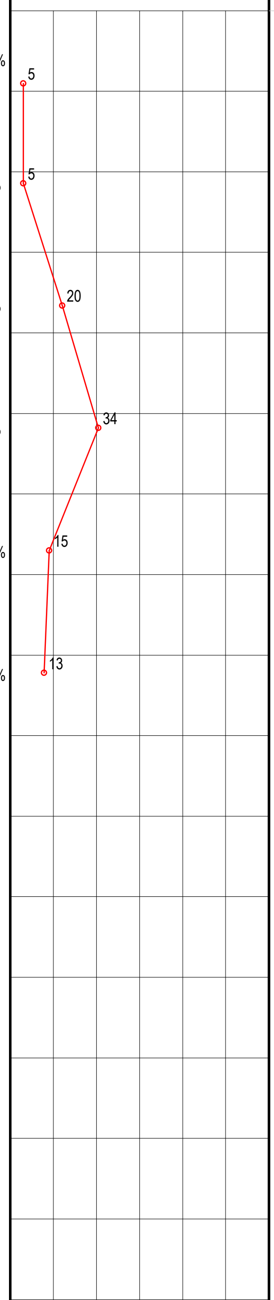
PROJECT: Geotechnical Investigation - Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road West, Prescott, Ontario
DATE: June 05, 2020

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CME-55
DRILLING METHOD: Hollow Stem Auger

| DEPTH (m) | DESCRIPTION | ELEV. | NUMBER | TYPE | N-VAL/RQD | RECOVERY |
|---|---|---|---|---|---|---|
| | Ground Surface | 93.23 | | | | |
| 0.0 | **Topsoil:** 300mm dark brown sandy loam. | 0.00 | | | | |
| 0.30 | **Sand-Silt:** Silty sand to sandy silt, brown to grey in colour, in a loose to dense state of packing, and moist. | 92.93 / 0.30 | SS1 | | 5 | 100% |
| | | | SS2 | | 5 | 50% |
| | | | SS3 | | 20 | 75% |
| | | | SS4 | | 34 | 80% |
| 3.05 | **Glacial Till:** Silty clay with trace of gravel, grey in colour, in a compact state of packing, and moist. | 90.18 / 3.05 | SS5 | | 15 | 100% |
| | | | SS6 | | 13 | 100% |
| 4.42 | End of Borehole | 88.81 / 4.42 | | | | |

SHEAR STRENGTH (kPa) 20 40 60 80 100

STANDARD PENETRATION TEST RESISTANCE PLOT 20 40 60 80




WATER CONTENT % 10 20 30 40 50 60 70 80 90

WATER LEVEL

Easting: 458113
Site Datum: Geodetic
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951199
Groundsurface Elev.: 93.23m
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

LASCELLES ENGINEERING & ASSOCIATES

# RECORD OF BOREHOLE: BH-16

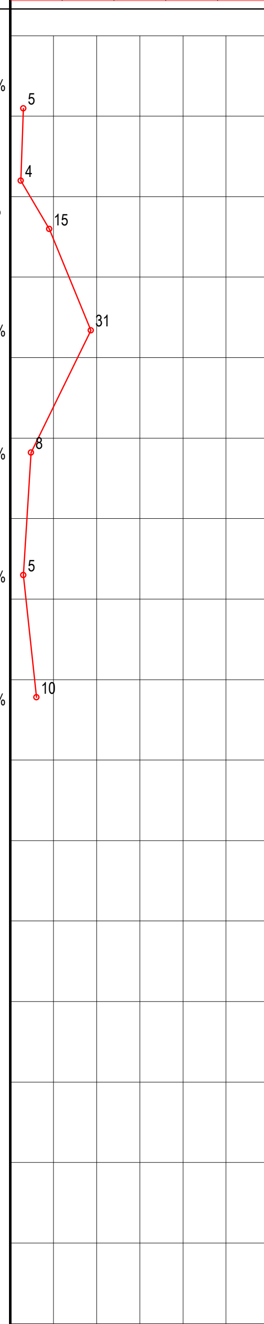
PROJECT: Geotechnical Investigation - Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road West, Prescott, Ontario
DATE: June 05, 2020

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CME-55
DRILLING METHOD: Hollow Stem Auger

| DEPTH (m) | DESCRIPTION | ELEV. | NUMBER | TYPE | N-VAL/RQD | RECOVERY |
|---|---|---|---|---|---|---|
| | Ground Surface | 92.83 | | | | |
| 0.0 | **Topsoil:** 300mm dark brown sandy loam. | 0.00 | SS1 | | 5 | 100% |
| 0.30 | **Fill:** Fine grained to silty sand, with trace of clay brown in colour, in a loose state of packing, and moist. | 92.53 / 0.30 | | | | |
| 1.07 | **Sand-Silt:** Silty sand to sandy silt, brown to grey in colour, in a compact to loose state of packing, and moist. | 91.76 / 1.07 | SS2 | | 4 / 15 | 80% |
| | | | SS3 | | 31 | 100% |
| | | | SS4 | | 8 | 100% |
| 3.04 | **Glacial Till:** Silty sand with some gravel and clay, grey in colour in a loose to compact state of packing, and moist. | 89.79 / 3.04 | SS5 | | 5 | 100% |
| | | | SS6 | | 10 | 100% |
| 4.42 | End of Borehole | 88.41 / 4.42 | | | | |

SHEAR STRENGTH (kPa) 20 40 60 80 100

STANDARD PENETRATION TEST RESISTANCE PLOT 20 40 60 80




WATER CONTENT % 10 20 30 40 50 60 70 80 90

WATER LEVEL

Easting: 458079
Northing: 4951214
Site Datum: Geodetic
Groundsurface Elev.: 92.83m
Top of Casing Elev.: NA
Top of Riser Elev.: NA
Borehole Diameter: 200mm
Monitoring Well Diameter: NA

COMMENTS:

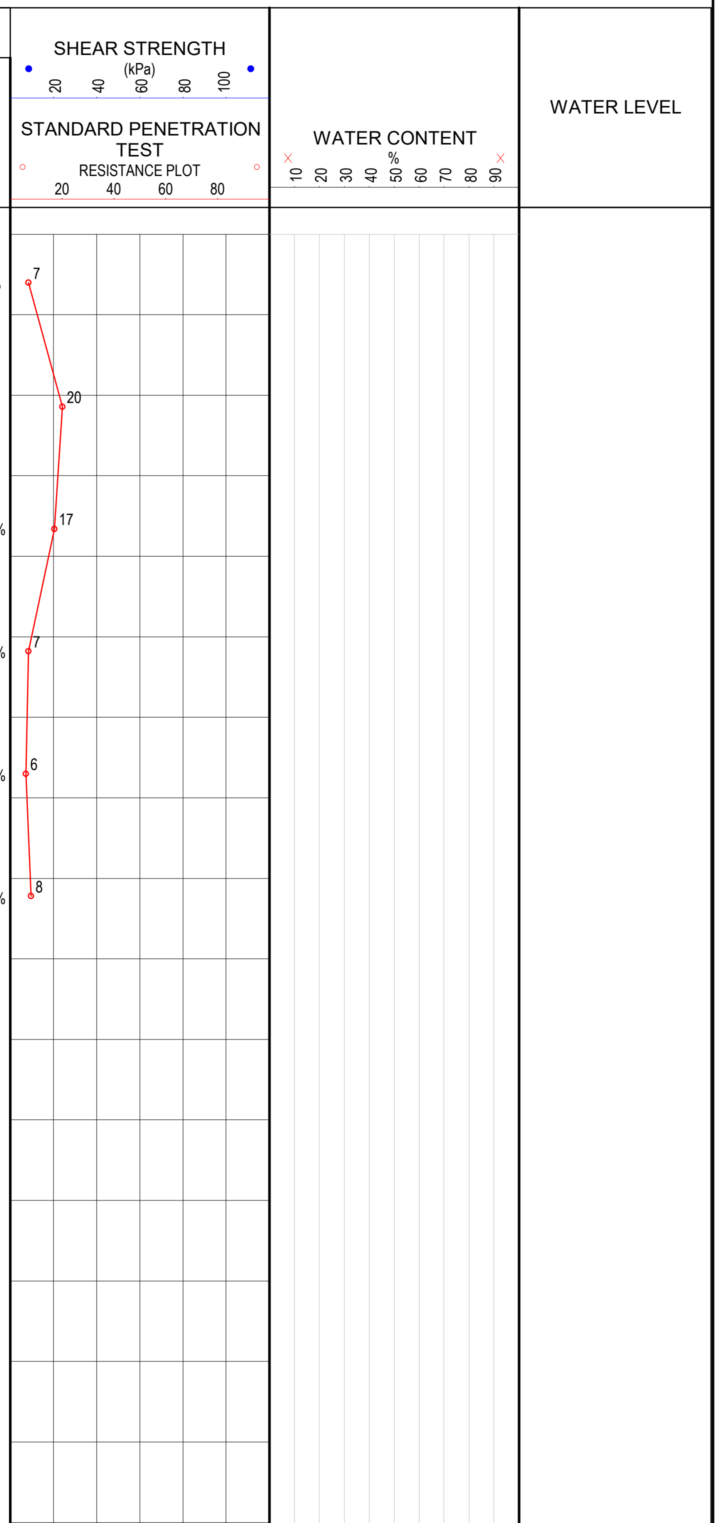
LASCELLES ENGINEERING & ASSOCIATES

# RECORD OF BOREHOLE: BH-17

PROJECT: Geotechnical Investigation - Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road West, Prescott, Ontario
DATE: June 05, 2020

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CME-55
DRILLING METHOD: Hollow Stem Auger

| DEPTH (m) | DESCRIPTION | ELEV. | NUMBER | TYPE | N-VAL/RQD | RECOVERY |
|---|---|---|---|---|---|---|
| 0.0 | Ground Surface | 92.72 / 0.00 | | | | |
| 0.0–0.15 | **Topsoil:** 150mm dark brown sandy loam. | | SS1 | | 7 | 80% |
| 0.15–3.05 | **Sand-Silt:** Silty sand to sandy silt, brown to grey in colour, in a compact to loose state of packing, and moist. | | SS2 | | 20 | 80 |
| | | | SS3 | | 17 | 100% |
| | | | SS4 | | 7 | 100% |
| 3.05–4.42 | **Glacial Till:** Silty clay with trace of gravel, grey in colour, in a loose state of packing, and moist. | 89.67 / 3.05 | SS5 | | 6 | 100% |
| | | | SS6 | | 8 | 100% |
| 4.42 | End of Borehole | 88.30 / 4.42 | | | | |




Easting: 458120
Site Datum: Assumed
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951238
Groundsurface Elev.: 92.72m
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:

LASCELLES ENGINEERING & ASSOCIATES

PROJECT: Geotechnical Investigation - Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road West, Prescott, Ontario
DATE: June 05, 2020

RECORD OF BOREHOLE: BH-18

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CME-55
DRILLING METHOD: Hollow stem auger

## SOIL PROFILE

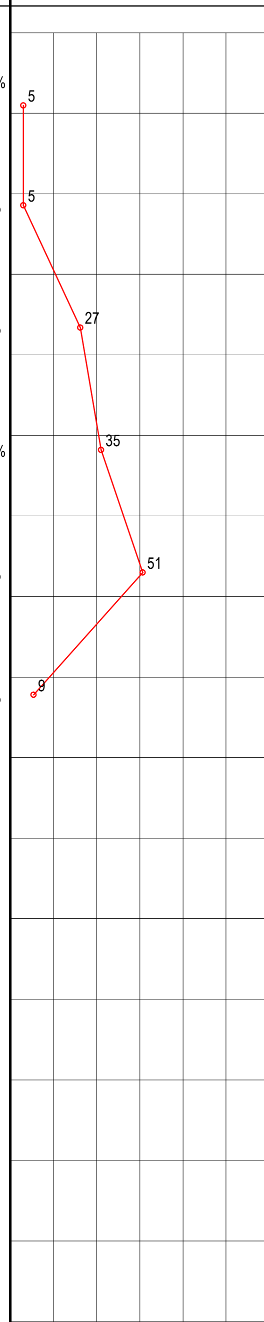
| DEPTH (m) | DESCRIPTION | ELEV. |
|---|---|---|
| 0.0 | Ground Surface | 92.74 / 0.00 |
| 0.0 – 0.30 | **Topsoil:** 300mm dark brown sandy loam. | 92.44 / 0.30 |
| 0.30 – 3.96 | **Sand-Silt:** Silty sand to sandy silt, brown to grey in colour,in a loose to very dense state of packing, and moist to wet. | 88.78 / 3.96 |
| 3.96 – 4.42 | **Silt:** Clayey with beds of clay and trace of sand, grey in colour, in a loose state of packing, and moist. | 88.32 / 4.42 |
| 4.42 | End of Borehole | |

## SAMPLES

| NUMBER | TYPE | N-VAL/RQD | RECOVERY |
|---|---|---|---|
| SS1 | Split spoon | 5 | 100% |
| SS2 | Split spoon | 5 | 90% |
| SS3 | Split spoon | 27 | 70% |
| SS4 | Split spoon | 35 | 100% |
| SS5 | Split spoon | 51 | 80% |
| SS6 | Split spoon | 9 | 60% |

SHEAR STRENGTH (kPa) 20 40 60 80 100

STANDARD PENETRATION TEST RESISTANCE PLOT 20 40 60 80




WATER CONTENT % 10 20 30 40 50 60 70 80 90

WATER LEVEL: 1.73 m (06/20/2020)

Easting: 458179
Northing: 4951273
Site Datum: Geodetic
Groundsurface Elev.: 92.74m
Top of Casing Elev.: NA
Top of Riser Elev.: NA
Borehole Diameter: 200mm
Monitoring Well Diameter: NA

COMMENTS:

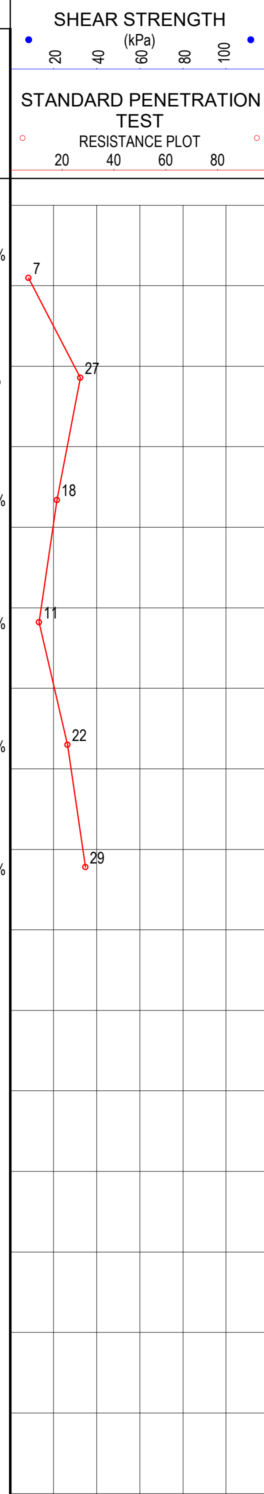
RECORD OF BOREHOLE: BH-19

LASCELLES ENGINEERING & ASSOCIATES

PROJECT: Geotechnical Investigation - Proposed Prescott Arena
CLIENT: EVB Engineering Ltd.
LOCATION: Churchill Road West, Prescott, Ontario
DATE: June 05, 2020

PROJECT No.: 180480
LOGGED BY: S.C.
DRILLER: George Downing Estate Drilling Ltd.
DRILLING EQUIPMENT: Track-mounted CME-55
DRILLING METHOD: Hollow Stem Auger

| DEPTH (m) | DESCRIPTION | ELEV. | NUMBER | TYPE | N-VAL/RQD | RECOVERY |
|---|---|---|---|---|---|---|
| | Ground Surface | 92.78 | | | | |
| 0.0 | **Topsoil:** 300mm dark brown sandy loam. | 0.00 | SS1 | | 7 | 100% |
| 0.30 | **Sand-Silt:** Silty sand to sandy silt, brown to grey in colour, compact state of packing, and moist. | 92.48<br>0.30 | SS2 | | 27 | 80% |
| | | | SS3 | | 18 | 100% |
| 2.13 | **Silt:** Clayey with trance of sand, gery in colour, in a compact state of packing and moist. | 90.65<br>2.13 | SS4 | | 11 | 100% |
| | | | SS5 | | 22 | 100% |
| 3.66 | **Glacial Till:** Sandy silt with some gravel and clay, grey in colour in a compact state of packing, and moist. | 89.12<br>3.66 | SS6 | | 29 | 100% |
| 4.42 | End of Borehole | 88.36<br>4.42 | | | | |




WATER CONTENT %
10 20 30 40 50 60 70 80 90

WATER LEVEL

Easting: 458161
Site Datum: Geodetic
Top of Casing Elev.: NA
Borehole Diameter: 200mm

Northing: 4951150
Groundsurface Elev.: 92.78m
Top of Riser Elev.: NA
Monitoring Well Diameter: NA

COMMENTS:


BH-4
Top: 2.67m bgs.
top
Bottom: 4.14m bgs


BH-5 CR8
Top: 5.33m bgs
Bottom: 6.73m bgs


BH-8 CR8
Top: 5.19 bgs.
Bottom: 6.71m bgs.

# Appendix C

# Laboratory Test Reports

**Stantec Consulting Ltd**
2781 Lancaster Rd
Ottawa, ON K1B 1A7
Tel: (613) 738-6075
Fax: (613) 722-2799

Stantec

**Date:** July 9, 2020
**File:** 121621867

**Attention:** **Lascelles Engineering Associates, File #180480 (Arena)**

**Reference:** **ASTM D4318 Atterberg Limit & ASTM D2216 Moisture Content**

The following table summarizes Atterberg Limit & Moisture Content test results.

| Source | Depth | Moisture Content (%) | Liquid Limit | Plastic Limit | Plasticity Index |
|---|---|---|---|---|---|
| BH-10 SS6 | 12.5'-14.5' | 31.0 | | | |
| BH-10 SS7 | 15'-17' | 26.7 | | | |
| BH-10 SS8 | 17.5'-19.5' | 24.7 | 26.1 | 16.0 | 10.1 |

Sincerely,

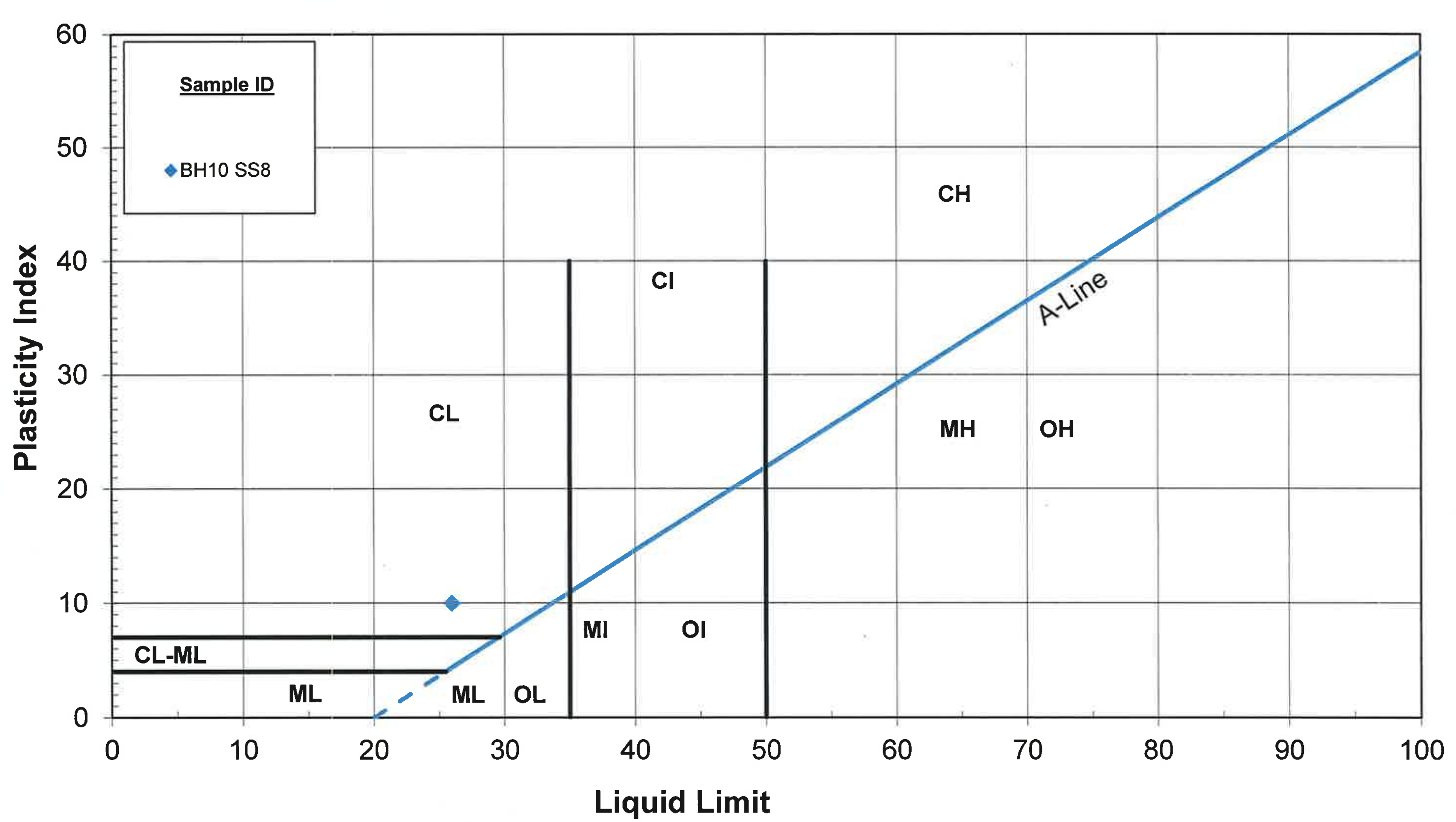
**Stantec Consulting Ltd**

Brian Prevost

Brian Prevost
Laboratory Supervisor
Tel: 613-738-6075
Fax: 613-722-2799
brian.prevost@stantec.com

Attachments: Atterberg Limit Plasticity Chart & Sieve

v:\01216\active\laboratory_standing_offers\2020 laboratory standing offers\121621867 lascelles engineering associates\june 8, 2020 file # 180480-arena\letter, limit.doc




| | | |
|---|---|---|
| Stantec | Lascelles Engineering, File # 180480<br>Proposed Arena,Churchill Road West<br>**PLASTICITY CHART** | Figure No.<br><br>Project No. 121621867 |

Stantec 2781 Lancaster Road
Ottawa ON, K1B 1A7

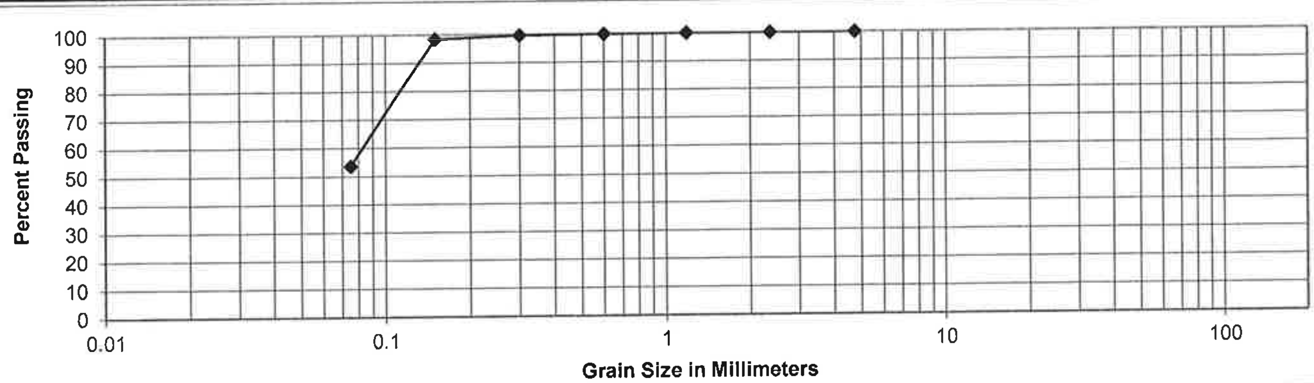
**Sieve Analysis**
**LS 602**
**ASTM C136**

| | | | |
|---|---|---|---|
| Client: | **Lascelles Engineering Associates, File # 180480** | Project Number: | **121621867** |
| Project: | **Proposed Arena, Churchill Rd. West, Prescott** | | |
| Material Type: | **Soils / Aggregates:** | | |
| Proposed Use: | **Fill/Granulars** | | |
| Source: | **BH18** | | |
| Sample Number: | **SS4** | | |
| Sampled Depth: | **7.5'-9.5'** | | |
| Sampled By: | **Lascelles Engineering Associates** | Tested By: | **Denis Rodriguez** |
| Date Sampled: | **June 8, 2020** | Date Tested: | **July 3, 2020** |

| Sieve Test Data | | Wash Test Data | | |
|---|---|---|---|---|
| Sample Weight Before Sieve, (g): | 818.8 | Sample Weight Before Wash, (g): | 259.4 | **Corrected** |
| Sample Weight After Sieve, (g): | 818.8 | Sample Weight After Wash, (g): | 184 | |
| Percent Loss In Sieve, (%): | 0.00 | Percent Passing No. 200, (%): | 29.1 | 29.1 |

**Sieve Analysis**

| Sieve No. | Size of Opening | | Weight Retained | Cumulative Weight Retained | Percent Passing | No Envelope | |
|---|---|---|---|---|---|---|---|
| | Inches | mm | g | g | % | Minimum | Maximum |
| | 6 | 150 | | | | | |
| | 4 | 106 | | | | | |
| | 3 | 76.2 | | | | | |
| | 2 | 53.0 | | | | | |
| | 1.5 | 37.5 | | | | | |
| | 1 | 26.5 | | | | | |
| | 3/4 | 19.0 | | | | | |
| | 5/8 | 16.0 | | | | | |
| | 1/2 | 13.2 | | | | | |
| | 3/8 | 9.5 | | | | | |
| +4 | 0.187 | 4.75 | 0.0 | 0.0 | 100.0 | | |
| | | - 4.75 | 818.8 | 818.8 | | | |
| 8 | 0.0937 | 2.36 | | 0.0 | 100.0 | | |
| 16 | 0.0469 | 1.18 | | 0.0 | 100.0 | | |
| 30 | 0.234 | 0.600 | | 0.5 | 99.8 | | |
| 50 | 0.0117 | 0.300 | | 1.0 | 99.6 | | |
| 100 | 0.0059 | 0.150 | | 3.9 | 98.5 | | |
| 200 | 0.0029 | 0.075 | | 120.1 | 53.7 | | |
| | | Pan | | 180.4 | | | |
| **Classification of Sample:** | | | % Gravel: 0.0 | % Sand: | 46.3 | % Silt & Clay: | 53.7 |

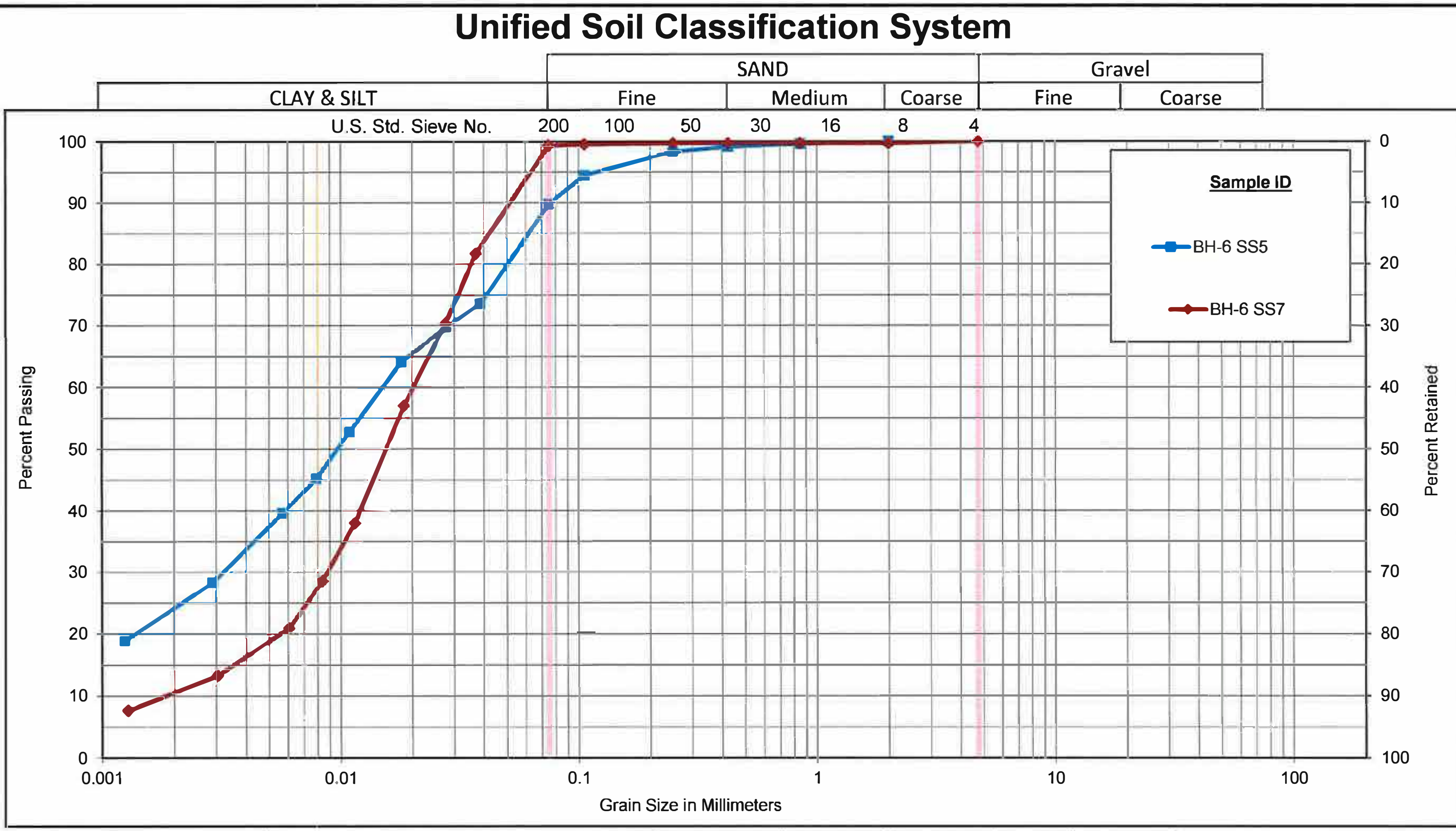



**Remarks:**

**Reviewed By:** Brian Prevost

**Date:** July 9/2020

V:\01216\active\laboratory_standing_offers\2020 Laboratory Standing Offers\121621867 Lascelles Engineering Associates\June 8, 2020 File # 180480-Arena\Sieve Analysis Split.xlsx




| Sample ID | Depth (m) | % Gravel | % Sand | % Silt | % Clay |
|---|---|---|---|---|---|
| BH-6 SS5 | 10'-12' | 0.0 | 10.3 | 66.7 | 23.0 |
| BH-6 SS7 | 15'-17' | 0.0 | 0.7 | 89.3 | 10.0 |

Stantec

# GRAIN SIZE DISTRIBUTION

Lascelles Engineering, File #180480

Churchill Road West, Prescott ON

Figure No.

Project No. 121621867

Stantec

# Particle-Size Analysis of Soils
**LS702**
**ASTM D422**

| PROJECT DETAILS | | | |
|---|---|---|---|
| Client: | Lascelles Engineering, File #180480 | Project No.: | 121621867 |
| Project: | Churchill Road West, Prescott ON | Test Method: | LS702 |
| Material Type: | Soil | Sampled By: | Lascelles Engineering |
| Source: | BH-6 | Date Sampled: | August 28, 2019 |
| Sample No.: | SS5 | Tested By: | Denis Rodriguez |
| Sample Depth | 10'-12' | Date Tested: | September 26, 2019 |

| WASH TEST DATA | |
|---|---|
| Oven Dry Mass In Hydrometer Analysis (g) | 51.96 |
| Sample Weight after Hydrometer and Wash (g) | 6.57 |
| Percent Passing No. 200 Sieve (%) | 87.4 |
| Percent Passing Corrected (%) | 87.36 |

| PERCENT LOSS IN SIEVE | |
|---|---|
| Sample Weight Before Sieve (g) | 134.90 |
| Sample Weight After Sieve (g) | 134.20 |
| Percent Loss in Sieve (%) | 0.52 |

| SOIL INFORMATION | | |
|---|---|---|
| Liquid Limit (LL) | | |
| Plasticity Index (PI) | | |
| Soil Classification | | |
| Specific Gravity ($G_s$) | 2.750 | |
| Sg. Correction Factor ($\alpha$) | 0.978 | |
| Mass of Dispersing Agent/Litre | 40 | g |

| CALCULATION OF DRY SOIL MASS | |
|---|---|
| Oven Dried Mass ($W_o$), (g) | 39.03 |
| Air Dried Mass ($W_a$), (g) | 39.40 |
| Hygroscopic Corr. Factor ($F=W_o/W_a$) | 0.9906 |
| Air Dried Mass in Analysis ($M_a$), (g) | 52.45 |
| Oven Dried Mass in Analysis ($M_o$), (g) | 51.96 |
| Percent Passing 2.0 mm Sieve ($P_{10}$), (%) | 100.00 |
| Sample Represented (W), (g) | 51.96 |

| HYDROMETER DETAILS | |
|---|---|
| Volume of Bulb ($V_B$), ($cm^3$) | 63.0 |
| Length of Bulb ($L_2$), (cm) | 14.47 |
| Length from '0' Reading to Top of Bulb ($L_1$), (cm) | 10.29 |
| Scale Dimension ($h_s$), (cm/Div) | 0.155 |
| Cross-Sectional Area of Cylinder (A), ($cm^2$) | 27.25 |
| Meniscus Correction ($H_m$), (g/L) | 1.0 |

| SIEVE ANALYSIS | | |
|---|---|---|
| Sieve Size mm | Cum. Wt. Retained | Percent Passing |
| 75.0 | | 100.0 |
| 63.0 | | 100.0 |
| 53.0 | | 100.0 |
| 37.5 | | 100.0 |
| 26.5 | | 100.0 |
| 19.0 | | 100.0 |
| 13.2 | | 100.0 |
| 9.5 | | 100.0 |
| 4.75 | | 100.0 |
| 2.00 | 0.0 | 100.0 |
| Total (C + F)[1] | 134.20 | |
| 0.850 | 0.23 | 99.56 |
| 0.425 | 0.49 | 99.06 |
| 0.250 | 0.91 | 98.25 |
| 0.106 | 2.90 | 94.42 |
| 0.075 | 5.37 | 89.66 |
| PAN | 6.30 | |

Note 1: (C + F) = Coarse + Fine

**START TIME** 9:58 AM

| HYDROMETER ANALYSIS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Elapsed Time T Mins | $H_s$ Divisions g/L | $H_c$ Divisions g/L | Temperature $T_c$ °C | Corrected Reading $R = H_s - H_c$ g/L | Percent Passing P % | L cm | $\eta$ Poise | K | Diameter D mm |
| 26-Sep-19 | 9:59 AM | 1 | 47.0 | 8.0 | 22.5 | 39.0 | 73.44 | 8.92904 | 9.50295 | 0.012894 | 0.03853 |
| 26-Sep-19 | 10:00 AM | 2 | 45.0 | 8.0 | 22.5 | 37.0 | 69.67 | 9.23904 | 9.50295 | 0.012894 | 0.02771 |
| 26-Sep-19 | 10:03 AM | 5 | 42.0 | 8.0 | 22.5 | 34.0 | 64.02 | 9.70404 | 9.50295 | 0.012894 | 0.01796 |
| 26-Sep-19 | 10:13 AM | 15 | 36.0 | 8.0 | 22.5 | 28.0 | 52.72 | 10.63404 | 9.50295 | 0.012894 | 0.01086 |
| 26-Sep-19 | 10:28 AM | 30 | 32.0 | 8.0 | 22.5 | 24.0 | 45.19 | 11.25404 | 9.50295 | 0.012894 | 0.00790 |
| 26-Sep-19 | 10:58 AM | 60 | 29.0 | 8.0 | 22.5 | 21.0 | 39.54 | 11.71904 | 9.50295 | 0.012894 | 0.00570 |
| 26-Sep-19 | 2:08 PM | 250 | 23.0 | 8.0 | 22.5 | 15.0 | 28.2454 | 12.64904 | 9.50295 | 0.012894 | 0.00290 |
| 27-Sep-19 | 9:58 AM | 1440 | 18.0 | 8.0 | 22.5 | 10.0 | 18.8302 | 13.42404 | 9.50295 | 0.012894 | 0.00124 |

Remarks:

Reviewed By: Brian Prevost
Date: September 30/2019

V:\01216\active\laboratory_standing_offers\2019 Laboratory Standing Offers\121621867 Lascelles Engineering Associates\Sept_23_August 28, Geotech_Lascelles #180480\Hydrometer Analysis MTO Projects May2014.xlsx

Stantec

# Particle-Size Analysis of Soils
LS702
ASTM D422

## PROJECT DETAILS

| | | | |
|---|---|---|---|
| Client: | Lascelles Engineering, File #180480 | Project No.: | 121621867 |
| Project: | Churchill Road West, Prescott ON | Test Method: | LS702 |
| Material Type: | Soil | Sampled By: | Lascelles Engineering |
| Source: | BH-6 | Date Sampled: | August 28, 2019 |
| Sample No.: | SS7 | Tested By: | Denis Rodriguez |
| Sample Depth | 15'-17' | Date Tested: | September 26, 2019 |

## WASH TEST DATA

| | |
|---|---|
| Oven Dry Mass In Hydrometer Analysis (g) | 51.34 |
| Sample Weight after Hydrometer and Wash (g) | 0.22 |
| Percent Passing No. 200 Sieve (%) | 99.6 |
| Percent Passing Corrected (%) | 99.22 |

## PERCENT LOSS IN SIEVE

| | |
|---|---|
| Sample Weight Before Sieve (g) | 198.50 |
| Sample Weight After Sieve (g) | 197.00 |
| Percent Loss in Sieve (%) | 0.76 |

## SOIL INFORMATION

| | | |
|---|---|---|
| Liquid Limit (LL) | | |
| Plasticity Index (PI) | | |
| Soil Classification | | |
| Specific Gravity ($G_s$) | 2.750 | |
| Sg. Correction Factor ($\alpha$) | 0.978 | |
| Mass of Dispersing Agent/Litre | 40 | g |

## CALCULATION OF DRY SOIL MASS

| | |
|---|---|
| Oven Dried Mass ($W_o$), (g) | 50.08 |
| Air Dried Mass ($W_a$), (g) | 50.88 |
| Hygroscopic Corr. Factor ($F=W_o/W_a$) | 0.9843 |
| Air Dried Mass in Analysis ($M_a$), (g) | 52.16 |
| Oven Dried Mass in Analysis ($M_o$), (g) | 51.34 |
| Percent Passing 2.0 mm Sieve ($P_{10}$), (%) | 99.65 |
| Sample Represented (W), (g) | 51.52 |

## SIEVE ANALYSIS

| Sieve Size mm | Cum. Wt. Retained | Percent Passing |
|---|---|---|
| 75.0 | | 100.0 |
| 63.0 | | 100.0 |
| 53.0 | | 100.0 |
| 37.5 | | 100.0 |
| 26.5 | | 100.0 |
| 19.0 | | 100.0 |
| 13.2 | | 100.0 |
| 9.5 | | 100.0 |
| 4.75 | 0.0 | 100.0 |
| 2.00 | 0.7 | 99.6 |
| Total (C + F)[1] | 197.00 | |
| 0.850 | 0.00 | 99.65 |
| 0.425 | 0.00 | 99.65 |
| 0.250 | 0.00 | 99.65 |
| 0.106 | 0.07 | 99.51 |
| 0.075 | 0.19 | 99.28 |
| PAN | 0.21 | |

Note 1: (C + F) = Coarse + Fine

## HYDROMETER DETAILS

| | |
|---|---|
| Volume of Bulb ($V_B$), ($cm^3$) | 63.0 |
| Length of Bulb ($L_2$), (cm) | 14.47 |
| Length from '0' Reading to Top of Bulb ($L_1$), (cm) | 10.29 |
| Scale Dimension ($h_s$), (cm/Div) | 0.155 |
| Cross-Sectional Area of Cylinder (A), ($cm^2$) | 27.25 |
| Meniscus Correction ($H_m$), (g/L) | 1.0 |

**START TIME** 10:05 AM

## HYDROMETER ANALYSIS

| Date | Time | Elapsed Time T Mins | $H_s$ Divisions g/L | $H_c$ Divisions g/L | Temperature $T_c$ °C | Corrected Reading $R = H_s - H_c$ g/L | Percent Passing P % | L cm | $\eta$ Poise | K | Diameter D mm |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 26-Sep-19 | 10:06 AM | 1 | 51.0 | 8.0 | 23.0 | 43.0 | 81.66 | 8.30904 | 9.39251 | 0.012818 | 0.03695 |
| 26-Sep-19 | 10:07 AM | 2 | 45.0 | 8.0 | 23.0 | 37.0 | 70.26 | 9.23904 | 9.39251 | 0.012818 | 0.02755 |
| 26-Sep-19 | 10:10 AM | 5 | 38.0 | 8.0 | 23.0 | 30.0 | 56.97 | 10.32404 | 9.39251 | 0.012818 | 0.01842 |
| 26-Sep-19 | 10:20 AM | 15 | 28.0 | 8.0 | 22.5 | 20.0 | 37.98 | 11.87404 | 9.50295 | 0.012894 | 0.01147 |
| 26-Sep-19 | 10:35 AM | 30 | 23.0 | 8.0 | 22.5 | 15.0 | 28.48 | 12.64904 | 9.50295 | 0.012894 | 0.00837 |
| 26-Sep-19 | 11:05 AM | 60 | 19.0 | 8.0 | 22.5 | 11.0 | 20.89 | 13.26904 | 9.50295 | 0.012894 | 0.00606 |
| 26-Sep-19 | 2:15 PM | 250 | 15.0 | 8.0 | 22.5 | 7.0 | 13.29 | 13.88904 | 9.50295 | 0.012894 | 0.00304 |
| 27-Sep-19 | 10:05 AM | 1440 | 12.0 | 8.0 | 22.5 | 4.0 | 7.60 | 14.35404 | 9.50295 | 0.012894 | 0.00129 |

Remarks:

Reviewed By: Brian Prescott
Date: September 30/2019

Stantec 2781 Lancaster Road Ottawa ON, K1B 1A7

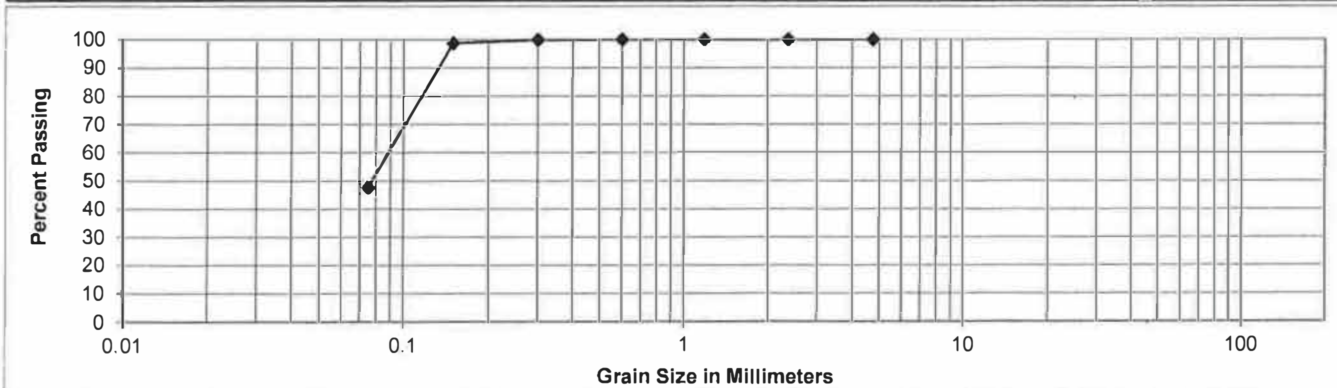
# Sieve Analysis
**LS 602**
**ASTM C136**

| | | | |
|---|---|---|---|
| Client: | **Lascelles Engineering, File #180480** | Project Number: | **121621867** |
| Project: | **Churchill Road West, Prescott ON** | | |
| Material Type: | **Soils / Aggregates:** | | |
| Proposed Use: | **Fill/Granulars** | | |
| Source: | **BH-5** | | |
| Sample Number: | **SS3 & SS4** | | |
| Sampled Depth: | **5'-9.5'** | | |
| Sampled By: | **Lascelles Engineering** | Tested By: | **Denis Rodriguez** |
| Date Sampled: | **August 28, 2019** | Date Tested: | **September 26, 2019** |

| Sieve Test Data | | Wash Test Data | | |
|---|---|---|---|---|
| Sample Weight Before Sieve, (g): | 594.5 | Sample Weight Before Wash, (g): | 256.3 | Corrected |
| Sample Weight After Sieve, (g): | 594.5 | Sample Weight After Wash, (g): | 194.6 | |
| Percent Loss In Sieve, (%): | 0.00 | Percent Passing No. 200, (%): | 24.1 | 24.1 |

## Sieve Analysis

| Sieve No. | Size of Opening Inches | Size of Opening mm | Weight Retained g | Cumulative Weight Retained g | Percent Passing % | No Envelope Minimum | No Envelope Maximum |
|---|---|---|---|---|---|---|---|
| | 6 | 150 | | | | | |
| | 4 | 106 | | | | | |
| | 3 | 76.2 | | | | | |
| | 2 | 53.0 | | | | | |
| | 1.5 | 37.5 | | | | | |
| | 1 | 26.5 | | | | | |
| | 3/4 | 19.0 | | | | | |
| | 5/8 | 16.0 | | | | | |
| | 1/2 | 13.2 | | | | | |
| | 3/8 | 9.5 | | | | | |
| +4 | 0.187 | 4.75 | 0.0 | 0.0 | 100.0 | | |
| | | - 4.75 | 594.5 | 594.5 | | | |
| 8 | 0.0937 | 2.36 | | 0.0 | 100.0 | | |
| 16 | 0.0469 | 1.18 | | 0.0 | 100.0 | | |
| 30 | 0.234 | 0.600 | | 0.0 | 100.0 | | |
| 50 | 0.0117 | 0.300 | | 0.3 | 99.9 | | |
| 100 | 0.0059 | 0.150 | | 3.3 | 98.7 | | |
| 200 | 0.0029 | 0.075 | | 134.2 | 47.6 | | |
| | | Pan | | 192.4 | | | |
| **Classification of Sample:** | | % Gravel: | 0.0 | % Sand: | 52.4 | % Silt & Clay: | 47.6 |




**Remarks:**

**Reviewed By:** Brian Prevost **Date:** September 30/2019

Stantec 2781 Lancaster Road
Ottawa ON, K1B 1A7

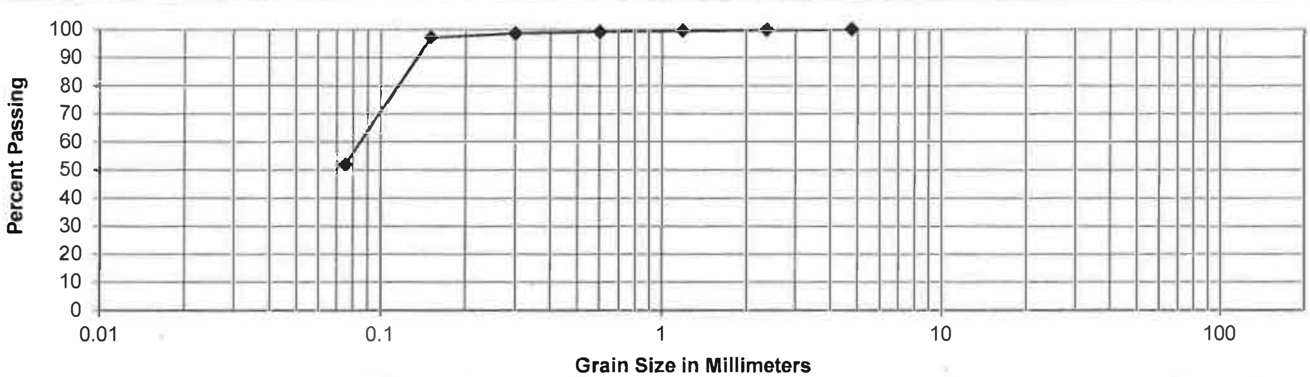
# Sieve Analysis
## LS 602
## ASTM C136

| | | | |
|---|---|---|---|
| Client: | **Lascelles Engineering, File #180480** | Project Number: | **121621867** |
| Project: | **Churchill Road West, Prescott ON** | | |
| Material Type: | **Soils / Aggregates:** | | |
| Proposed Use: | **Fill/Granulars** | | |
| Source: | **BH-8** | | |
| Sample Number: | **SS2 & SS3** | | |
| Sampled Depth: | **2.5'-7'** | | |
| Sampled By: | **Lascelles Engineering** | Tested By: | **Denis Rodriguez** |
| Date Sampled : | **August 28, 2019** | Date Tested: | **September 26, 2019** |

| Sieve Test Data | | Wash Test Data | | |
|---|---|---|---|---|
| Sample Weight Before Sieve, (g): | 581.1 | Sample Weight Before Wash, (g): | 250.2 | Corrected |
| Sample Weight After Sieve, (g): | 581.1 | Sample Weight After Wash, (g): | 177.1 | |
| Percent Loss In Sieve, (%): | 0.00 | Percent Passing No. 200, (%): | 29.2 | 29.2 |

### Sieve Analysis

| Sieve No. | Size of Opening | | Weight Retained | Cumulative Weight Retained | Percent Passing | No Envelope | |
|---|---|---|---|---|---|---|---|
| | Inches | mm | g | g | % | Minimum | Maximum |
| | 6 | 150 | | | | | |
| | 4 | 106 | | | | | |
| | 3 | 76.2 | | | | | |
| | 2 | 53.0 | | | | | |
| | 1.5 | 37.5 | | | | | |
| | 1 | 26.5 | | | | | |
| | 3/4 | 19.0 | | | | | |
| | 5/8 | 16.0 | | | | | |
| | 1/2 | 13.2 | | | | | |
| | 3/8 | 9.5 | | | | | |
| +4 | 0.187 | 4.75 | 0.0 | 0.0 | 100.0 | | |
| | | - 4.75 | 581.1 | 581.1 | | | |
| 8 | 0.0937 | 2.36 | | 0.6 | 99.8 | | |
| 16 | 0.0469 | 1.18 | | 1.2 | 99.5 | | |
| 30 | 0.234 | 0.600 | | 2.0 | 99.2 | | |
| 50 | 0.0117 | 0.300 | | 3.4 | 98.6 | | |
| 100 | 0.0059 | 0.150 | | 7.2 | 97.1 | | |
| 200 | 0.0029 | 0.075 | | 120.3 | 51.9 | | |
| | | Pan | | 175.6 | | | |
| **Classification of Sample:** | | % Gravel: | 0.0 | % Sand: | 48.1 | % Silt & Clay: | 51.9 |




**Remarks:**

**Reviewed By:** Brian Prevost

**Date:** September 30/2019

**Stantec Consulting Ltd**
2781 Lancaster Rd, Suite 100 A&B
Ottawa, ON K1B 1A7
Tel: (613) 738-6075
Fax: (613) 722-2799

Stantec

September 30, 2019
File: 121621867

**Attention:** **Lascelles Engineering, File #180480**

**Reference:** **ASTM D7012, Method C, Unconfined Compressive Strength of Intact Rock Core Churchill Road West, Prescott ON**

The following table summarizes one rock core compressive strength result.

| Location | Sample Depth | Compressive Strength (MPa) | Description of Break |
|---|---|---|---|
| BH-8 CR8 | 19' | 211.2 | Well-formed cones at both ends |

Sincerely,

**Stantec Consulting Ltd**

Brian Prevost

Brian Prevost
Laboratory Supervisor
Tel: 613-738-6075
brian.prevost@stantec.com

# Appendix D

# Laboratory “Certificates of Analysis”

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# Certificate of Analysis

**Lascelles Engineering Ltd.**

1010 Spence Ave, Unit 1014
Hawkesbury, ON K6A 3H9
Attn: Shuang Chang

Client PO:
Project: 180480-arena
Custody: 51357

Report Date: 13-Jul-2020
Order Date: 7-Jul-2020

**Order #: 2028121**

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

| Paracel ID | Client ID |
|---|---|
| 2028121-01 | BH-15 SS4 |
| 2028121-02 | BH-13 SS4 |

Approved By:

Dale Robertson, BSc
Laboratory Director

Certificate of Analysis

**Client: Lascelles Engineering Ltd.**

**Client PO:**

Report Date: 13-Jul-2020

Order Date: 7-Jul-2020

**Project Description: 180480-arena**

## Analysis Summary Table

| Analysis | Method Reference/Description | Extraction Date | Analysis Date |
|---|---|---|---|
| Anions | EPA 300.1 - IC, water extraction | 9-Jul-20 | 9-Jul-20 |
| pH, soil | EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext. | 8-Jul-20 | 8-Jul-20 |
| Resistivity | EPA 120.1 - probe, water extraction | 8-Jul-20 | 8-Jul-20 |
| Solids, % | Gravimetric, calculation | 11-Jul-20 | 11-Jul-20 |

PARACEL
LABORATORIES LTD.

**Order #: 2028121**

Certificate of Analysis

**Client: Lascelles Engineering Ltd.**

**Client PO:**

Report Date: 13-Jul-2020

Order Date: 7-Jul-2020

**Project Description: 180480-arena**

| | | | | | |
|---|---|---|---|---|---|
| | **Client ID:** | BH-15 SS4 | BH-13 SS4 | - | - |
| | **Sample Date:** | 03-Jun-20 09:00 | 03-Jun-20 09:00 | - | - |
| | **Sample ID:** | 2028121-01 | 2028121-02 | - | - |
| | **MDL/Units** | Soil | Soil | - | - |
| **Physical Characteristics** | | | | | |
| % Solids | 0.1 % by Wt. | 84.5 | 87.6 | - | - |
| **General Inorganics** | | | | | |
| pH | 0.05 pH Units | 7.67 [1] | 7.71 [1] | - | - |
| Resistivity | 0.10 Ohm.m | 139 | 139 | - | - |
| **Anions** | | | | | |
| Chloride | 5 ug/g dry | 11 [1] | 11 [1] | - | - |
| Sulphate | 5 ug/g dry | <5 [1] | 16 [1] | - | - |

Certificate of Analysis

Report Date: 13-Jul-2020

**Client: Lascelles Engineering Ltd.**

Order Date: 7-Jul-2020

**Client PO:**

**Project Description: 180480-arena**

## Method Quality Control: Blank

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

## Method Quality Control: Duplicate

| Analyte | Result | Reporting Limit | Units | Source Result | %REC | %REC Limit | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **Anions** | | | | | | | | | |
| Chloride | 79.5 | 5 | ug/g dry | 80.9 | | | 1.7 | 20 | |
| Sulphate | 3220 | 5 | ug/g dry | 3490 | | | 8.1 | 20 | |
| **General Inorganics** | | | | | | | | | |
| pH | 7.71 | 0.05 | pH Units | 7.67 | | | 0.5 | 2.3 | |
| Resistivity | 6.27 | 0.10 | Ohm.m | 6.29 | | | 0.3 | 20 | |
| **Physical Characteristics** | | | | | | | | | |
| % Solids | 81.1 | 0.1 | % by Wt. | 82.3 | | | 1.5 | 25 | |

## Method Quality Control: Spike

| Analyte | Result | Reporting Limit | Units | Source Result | %REC | %REC Limit | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **Anions** | | | | | | | | | |
| Chloride | 176 | 5 | ug/g | 80.9 | 94.7 | 82-118 | | | |
| Sulphate | 97.2 | 5 | ug/g | ND | 97.2 | 87-113 | | | |

**Qualifier Notes:**

***Login Qualifiers :***

Sample - One or more parameter received past hold time -
*Applies to samples: BH-15 SS4, BH-13 SS4*

***Sample Qualifiers :***

1 : Holding time had been exceeded upon receipt of the sample at the laboratory.

**Sample Data Revisions**

None

**Work Order Revisions / Comments:**

None

**Other Report Notes:**

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.
NC: Not Calculated

Soil results are reported on a dry weight basis when the units are denoted with 'dry'.
Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

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# Subcontracted Analysis

**Lascelles Engineering Ltd.**
1010 Spence Ave, Unit 1014
Hawkesbury, ON K6A 3H9
Attn: Shuang Chang

Tel: (613) 632-0241
Fax: (613) 632-0241

Paracel Report No. **2028121**
Client Project(s): **180480-arena**
Client PO:
Reference: **Standing Offer**
CoC Number: **51357**

Order Date: 07-Jul-20
Report Date: 14-Jul-20

Sample(s) from this project were subcontracted for the listed parameters. A copy of the subcontractor’s report is attached

| Paracel ID | Client ID | Analysis |
|---|---|---|
| 2028121-01 | BH-15 SS4 | Redox potential, soil |
| 2028121-02 | BH-13 SS4 | Redox potential, soil |

**TESTMARK Laboratories Ltd.**
*Committed to Quality and Service*

# CERTIFICATE OF ANALYSIS

| | | | |
|---|---|---|---|
| Client: | Dale Robertson | Work Order Number: | 405065 |
| Company: | Paracel Laboratories Ltd.- Ottawa | PO #: | |
| Address: | 300-2319 St. Laurent Blvd. | Regulation: | None |
| | Ottawa, ON, K1G 4J8 | Project #: | 2028121 |
| Phone/Fax: | (613) 731-9577 / (613) 731-9064 | DWS #: | |
| Email: | drobertson@paracellabs.com | Sampled By: | |
| Date Order Received: | 7/8/2020 | Analysis Started: | 7/14/2020 |
| Arrival Temperature: | 18 °C | Analysis Completed: | 7/14/2020 |

## WORK ORDER SUMMARY

ANALYSES WERE PERFORMED ON THE FOLLOWING SAMPLES. THE RESULTS RELATE ONLY TO THE ITEMS TESTED.

| Sample Description | Lab ID | Matrix | Type | Comments | Date Collected | Time Collected |
|---|---|---|---|---|---|---|
| BH-15 SS4 | 1554015 | Soil | None | | 6/3/2020 | |
| BH-13 SS4 | 1554016 | Soil | None | | 6/3/2020 | |

## METHODS AND INSTRUMENTATION

THE FOLLOWING METHODS WERE USED FOR YOUR SAMPLE(S):

| Method | Lab | Description | Reference |
|---|---|---|---|
| RedOx - Soil (T06) | Mississauga | Determination of RedOx Potential of Soil | Modified from APHA-2580B |

This report has been approved by:

Brad Halvorson, B.Sc.
Laboratory Director

# CERTIFICATE OF ANALYSIS

Paracel Laboratories Ltd.- Ottawa

Work Order Number: 405065

## WORK ORDER RESULTS

| Sample Description | BH - 15 SS4 | | BH - 13 SS4 | | | |
|---|---|---|---|---|---|---|
| Sample Date | 6/3/2020 12:00 AM | | 6/3/2020 12:00 AM | | | |
| Lab ID | 1554015 | | 1554016 | | | |
| General Chemistry | Result | MDL | Result | MDL | Units | Criteria: [No Reg - Always Include Reg Report] |
| RedOx (vs. S.H.E.) | 287 | N/A | 268 | N/A | mV | ~ |

## LEGEND

Dates: Dates are formatted as mm/dd/year throughout this report.

[rr]: After a parameter name indicates a re-run of that parameter. If multiple re-runs exist they are suffixed by a number. Sample may not have been handled according to the recommended temperature, hold time and head space requirements of the method after the initial analysis.

MDL: Method detection limit or minimum reporting limit.

~: In a criteria column indicates the criteria is not applicable for the parameter row.

Quality Control: All associated Quality Control data is available on request.

Exceedences: HIGHLIGHTED CELLS INDICATE THAT THE RESULT EXCEEDS A REGULATORY LIMIT. CALCULATED UNCERTAINTY ESTIMATIONS ARE NOT APPLIED FOR DETERMINING SAMPLE EXCEEDANCES.

Benzo(b)fluoranthene: Results for benzo(b)fluoranthene may include contributions from benzo(j)fluoranthene.

Field Data: Reports containing Field Parameters represent data that has been collected and provided by the client.  Testmark is not responsible for the validity of this data which may be used in subsequent calculations.

Sample Condition Deviations: A noted sample condition deviation may affect the validity of the result. Results apply to the sample(s) as received.



7 Margaret Street, Garson, ON, P3L 1E1
Phone: (705) 693-1121   Fax: (705) 693-1124   Web: www.testmark.ca

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Ottawa, ON, K1G 4J8
1-800-749-1947
www.paracellabs.com

# Certificate of Analysis

**Lascelles Engineering Ltd.**

1010 Spence Ave, Unit 1014
Hawkesbury, ON K6A 3H9
Attn: Shuang Chang

Client PO:
Project: 180480-T
Custody: 48085

Report Date: 27-Sep-2019
Order Date: 23-Sep-2019

**Order #: 1939026**

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

| Paracel ID | Client ID |
|---|---|
| 1939026-01 | BH-8 SS4 |
| 1939026-02 | BH-8 SS6 |

Approved By:

Dale Robertson, BSc
Laboratory Director

Certificate of Analysis
**Client: Lascelles Engineering Ltd.**
**Client PO:**

Report Date: 27-Sep-2019
Order Date: 23-Sep-2019
**Project Description: 180480-T**

## Analysis Summary Table

| Analysis | Method Reference/Description | Extraction Date | Analysis Date |
|---|---|---|---|
| Anions | EPA 300.1 - IC, water extraction | 26-Sep-19 | 26-Sep-19 |
| pH, soil | EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext. | 23-Sep-19 | 24-Sep-19 |
| Resistivity | EPA 120.1 - probe, water extraction | 24-Sep-19 | 24-Sep-19 |
| Solids, % | Gravimetric, calculation | 23-Sep-19 | 23-Sep-19 |

Certificate of Analysis

**Client: Lascelles Engineering Ltd.**

**Client PO:**

Report Date: 27-Sep-2019

Order Date: 23-Sep-2019

**Project Description: 180480-T**

| | | | | | |
|---|---|---|---|---|---|
| | **Client ID:** | BH-8 SS4 | BH-8 SS6 | - | - |
| | **Sample Date:** | 28-Aug-19 10:00 | 28-Aug-19 10:00 | - | - |
| | **Sample ID:** | 1939026-01 | 1939026-02 | - | - |
| | **MDL/Units** | Soil | Soil | - | - |
| **Physical Characteristics** | | | | | |
| % Solids | 0.1 % by Wt. | 85.9 | 84.1 | - | - |
| **General Inorganics** | | | | | |
| pH | 0.05 pH Units | - | 7.50 | - | - |
| Resistivity | 0.10 Ohm.m | - | 39.3 | - | - |
| **Anions** | | | | | |
| Chloride | 5 ug/g dry | - | 16 | - | - |
| Sulphate | 5 ug/g dry | 15 | 133 | - | - |

## *Method Quality Control: Blank*

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

## *Method Quality Control: Duplicate*

| Analyte | Result | Reporting Limit | Units | Source Result | %REC | %REC Limit | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **Anions** | | | | | | | | | |
| Chloride | 10.8 | 5 | ug/g dry | 11.5 | | | 6.5 | 20 | |
| Sulphate | 14.6 | 5 | ug/g dry | 15.1 | | | 3.8 | 20 | |
| **General Inorganics** | | | | | | | | | |
| pH | 7.40 | 0.05 | pH Units | 7.39 | | | 0.1 | 2.3 | |
| Resistivity | 34.2 | 0.10 | Ohm.m | 34.0 | | | 0.3 | 20 | |
| **Physical Characteristics** | | | | | | | | | |
| % Solids | 79.4 | 0.1 | % by Wt. | 82.5 | | | 3.8 | 25 | |

## *Method Quality Control: Spike*

| Analyte | Result | Reporting Limit | Units | Source Result | %REC | %REC Limit | RPD | RPD Limit | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **Anions** | | | | | | | | | |
| Chloride | 107 | 5 | ug/g | 11.5 | 95.5 | 82-118 | | | |
| Sulphate | 116 | 5 | ug/g | 15.1 | 101 | 80-120 | | | |

**Qualifier Notes:**

None

**Sample Data Revisions**

None

**Work Order Revisions / Comments:**

None

**Other Report Notes:**

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.

Soil results are reported on a dry weight basis when the units are denoted with 'dry'.
Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

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# Subcontracted Analysis

**Lascelles Engineering Ltd.**
1010 Spence Ave, Unit 1014
Hawkesbury, ON K6A 3H9
Attn: Shuang Chang

Tel: (613) 632-0241
Fax: (613) 632-0241

Paracel Report No. **1939026**
Client Project(s): **180480-T**
Client PO:
Reference: **Standing Offer**
CoC Number: **48085**

Order Date: 23-Sep-19
Report Date: 30-Sep-19

Sample(s) from this project were subcontracted for the listed parameters. A copy of the subcontractor1s report is attached

| Paracel ID | Client ID | Analysis |
|---|---|---|
| 1939026-02 | BH-8 SS6 | Redox potential, soil |

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# CERTIFICATE OF ANALYSIS

| | | | |
|---|---|---|---|
| Client: | Dale Robertson | Work Order Number: | 383650 |
| Company: | Paracel Laboratories Ltd.- Ottawa | PO #: | |
| Address: | 300-2319 St. Laurent Blvd. | Regulation: | Information not provided |
| | Ottawa, ON, K1G 4J8 | Project #: | |
| Phone/Fax: | (613) 731-9577 / (613) 731-9064 | DWS #: | |
| Email: | drobertson@paracellabs.com | Sampled By: | |
| Date Order Received: | 9/24/2019 | Analysis Started: | 9/30/2019 |
| Arrival Temperature: | 21.6 °C | Analysis Completed: | 9/30/2019 |

## WORK ORDER SUMMARY

ANALYSES WERE PERFORMED ON THE FOLLOWING SAMPLES. THE RESULTS RELATE ONLY TO THE ITEMS TESTED.

| Sample Description | Lab ID | Matrix | Type | Comments | Date Collected | Time Collected |
|---|---|---|---|---|---|---|
| BH- SS6 | 1479398 | Soil | None | | 8/28/2019 | 10:15 AM |

## METHODS AND INSTRUMENTATION

THE FOLLOWING METHODS WERE USED FOR YOUR SAMPLE(S):

| Method | Lab | Description | Reference |
|---|---|---|---|
| RedOx - Soil (T06) | Mississauga | Determination of RedOx Potential of Soil | Modified from APHA-2580B |

This report has been approved by:

Marc Creighton
Laboratory Director

# CERTIFICATE OF ANALYSIS

Paracel Laboratories Ltd.- Ottawa

Work Order Number: 383650

## WORK ORDER RESULTS

| Sample Description | BH - 8 SS6 | | |
|---|---|---|---|
| Sample Date | 8/28/2019 10:15 AM | | |
| Lab ID | 1479398 | | |
| **General Chemistry** | **Result** | **MDL** | **Units** |
| RedOx (vs. S.H.E.) | 300<br>[300] | N/A | mV |

## LEGEND

Dates: Dates are formatted as mm/dd/year throughout this report.

[rr]: After a parameter name indicates a re-run of that parameter. If multiple re-runs exist they are suffixed by a number. Sample may not have been handled according to the recommended temperature, hold time and head space requirements of the method after the initial analysis.

MDL: Method detection limit or minimum reporting limit.

[ ]: Results for laboratory replicates are shown in square brackets immediately below the associated sample result for ease of comparison.

Quality Control: All associated Quality Control data is available on request.

LCL: Lower Control Limit.

UCL: Upper Control Limit.

QAQCID: This is a unique reference to the quality control data set used to generate the reported value. Contact our lab for this information, as it is traceable through our LIMS.

Exceedences: HIGHLIGHTED CELLS INDICATE THAT THE RESULT EXCEEDS A REGULATORY LIMIT. CALCULATED UNCERTAINTY ESTIMATIONS ARE NOT APPLIED FOR DETERMINING SAMPLE EXCEEDANCES.

Benzo(b)fluoranthene: Results for benzo(b)fluoranthene may include contributions from benzo(j)fluoranthene.

Field Data: Reports containing Field Parameters represent data that has been collected and provided by the client. Testmark is not responsible for the validity of this data which may be used in subsequent calculations.

Sample Condition Deviations: A noted sample condition deviation may affect the validity of the result.



6820 Kitimat Road Unit 4, Mississauga, ON, L5N 5M3
Phone: (905) 821-1112 Fax: (905) 821-2095 Web: www.testmark.ca

**TESTMARK Laboratories Ltd.**
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# CERTIFICATE OF ANALYSIS

Paracel Laboratories Ltd.- Ottawa

Work Order Number: 383650

## QUALITY CONTROL DATA

THIS SECTION REPORTS QC RESULTS ASSOCIATED WITH THE TEST BATCH; THESE ARE NOT YOUR SAMPLE RESULTS.
QAQC details include only values where sufficient sample data allowed measurement.

### General Chemistry

**Positive Control: ORP Control 240 (7)**

| Parameter | MDL | Units | LCL | Result | UCL | QAQCID |
|---|---|---|---|---|---|---|
| RedOx (vs. S.H.E.) | N/A | mV | 220 | 249 | 260 | 20190930.TM-M.A6B |

**Sample Replicate: % RPD (9)**

| Parameter | MDL | Units | LCL | Result | UCL | QAQCID |
|---|---|---|---|---|---|---|
| RedOx (vs. S.H.E.) | | % | 0 | 0 | 10 | 20190930.TM-M.A6B |

THIS INDEX SHOWS HOW YOUR SAMPLES ARE ASSOCIATED TO THE CONTROLS INCLUDED IN THE IDENTIFIED BATCHES.

| Sample Description | Lab ID | Method | QAQCID | Prep QAQCID |
|---|---|---|---|---|
| BH - 8 SS6 | 1479398 | RedOx - Soil (T06) | 20190930.TM-M.A6B | |
| BH - 8 SS6 | 1479398r | RedOx - Soil (T06) | 20190930.TM-M.A6B | |