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Geotechnical Investigation
Proposed Forest and Nature Child Care Centre
411 Corkstown Road
Ottawa, Ontario

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Submitted to:

Andrew Fleck Children's Services
600 – 700 Industrial Avenue
Ottawa, Ontario
K1G 0Y9

Geotechnical Investigation Proposed Forest and Nature Child Care Centre 411 Corkstown Road

Ottawa, Ontario

April 23, 2020
Project: 85062.01

experience • knowledge • integrity

GEMTEC Consulting Engineers and Scientists Limited
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April 23, 2020 File: 85062.01

Andrew Fleck Children's Services
600 - 700 Industrial Avenue
Ottawa, Ontario
K1G 0Y9

Attention: Kim Hiscott, Executive Director

Re: Geotechnical Investigation, Proposed Forest and Nature Child Care Centre, 411 Corkstown Road, Ottawa, Ontario

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Please find enclosed our updated geotechnical investigation report for the above noted project based on the scope of work provided in our proposal dated November 8, 2019. This report was prepared by Mr. Joseph Berkers, and reviewed by Mr. John Cholewa, Ph.D., P.Eng.

Do not hesitate to contact the undersigned if you have any questions or require additional information.

Joseph Berkers

John Cholewa, Ph.D., P.Eng.

JB/JC

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1.0 INTRODUCTION

This report presents the results of a subsurface investigation carried out for the proposed child care centre to be constructed at 411 Corkstown Road in Ottawa, Ontario. The purpose of the investigation was to identify the general subsurface conditions at the site by means of a limited number of boreholes and, based on the factual information obtained, to provide engineering guidelines on the geotechnical design aspects of the project, including construction considerations that could influence design decisions.

The subsurface investigation was carried out in general accordance with our proposal dated November 8, 2019.

2.0 BACKGROUND

2.1 Project Description

The proposed development is located at 411 Corkstown Road in Ottawa, Ontario. The proposed site is primarily undeveloped, heavily treed woodlands. The proposed structure is a two-storey building with childcare area on the ground floor and research area on the second floor, totaling a 743 square metres (8,000 square feet) with no basements. In addition, a 113 square metre (1,217 square foot) parking area comprised of a gravel surface is also proposed to service the childcare and research building.

2.2 Review of Geology Maps

Based on historical geological mapping, the overburden deposit within the vicinity of the proposed development generally consists of a combination of glacial till deposits consisting of sand with large boulders to stratified silty sand. Areas within the vicinity of the site are known to be underlain by relatively shallow sandstone bedrock of the Nepean Formation. Historical maps show that interbedded sandstone and sandy dolomite of the March Formation is possible towards the north end of the site.

3.0 SUBSURFACE INVESITGATION

The field work for the borehole investigation was carried out on March 27, 2020. At that time, five (5) boreholes, numbered 20-1 to 20-5, were advanced at the site using both hollow stem auger and rotary diamond drilling techniques, supplied and operated by George Downing Estate Drilling Ltd. of Grenville-sur-la-Rouge, Quebec. The boreholes were advanced to depths between approximately 0.2 and 3.9 metres below existing surface grade.

Auger and split spoon samples were obtained where possible within the overburden deposits. The underlying bedrock was cored in borehole 20-2 using N size rotary diamond drilling equipment to identify the type and quality of the bedrock. A well screen was sealed in the bedrock at borehole 20-2.

Following the borehole drilling work, the soil and bedrock samples were returned to our laboratory for examination by a geotechnical engineer. Descriptions of the subsurface conditions logged in the boreholes advanced at the site are provided on the Record of Borehole sheets in Appendix A.

The field work was supervised throughout by a member of our engineering staff.

The borehole locations were selected by GEMTEC Consulting Engineers and Scientists Limited (GEMTEC) personnel. The location of the boreholes were determined using a Trimble R10 global positioning system.

4.0 SUBSURFACE CONDITIONS

4.1 General

The soil and groundwater conditions logged in the boreholes are provided on the Record of Borehole sheets in Appendix A. The borehole logs indicate the subsurface conditions at the specific test locations only. Boundaries between zones on the logs are often not distinct, but rather are transitional and have been interpreted. Subsurface conditions at other than the borehole locations may vary from the conditions encountered in the boreholes. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site.

The soil descriptions in this report are based on commonly accepted methods of classification and identification employed in geotechnical practice. Classification and identification of soil involves judgement and GEMTEC does not guarantee descriptions as exact, but infers accuracy to the extent that is common in current geotechnical practice.

The following presents an overview of the subsurface conditions encountered in the boreholes advanced during this investigation.

4.2 Topsoil

Dark brown organic topsoil, having a thickness of about 0.1 metres, was encountered at ground surface at all borehole locations.

4.3 Sand and Gravel

Sand and gravel, having a thickness of between about 0.1 and 0.5 metres, was encountered below the topsoil in all boreholes at depths of about 0.1 metres. The composition of the sand and gravel can generally be described as ranging from gravel and sand to gravelly sand with trace silt.

The moisture content of the sand and gravel encountered in boreholes 20-1 and 20-4 was found to be 14 and 4 percent, respectively. The results of grain size distribution tests carried out on samples of the sand and gravel are provided in Appendix B.

4.4 Bedrock

Bedrock was encountered in boreholes 20-2 at a depth of 0.2 metres below ground surface and cored to a depth of 3.9 metres below ground surface. Auger refusal on inferred bedrock occurred at depths ranging from 0.1 to 0.5 metres below ground surface at boreholes 20-1, 20-3, 20-4, and 20-5.

The bedrock recovered from the borehole 20-2 showed a total core recovery (TCR) of 71 to 100 percent, solid core recovery (SCR) of 56 to 95 percent, and rock quality designation (RQD) values of 0 to 55 percent. The bedrock can generally be described as grey brown slightly weathered, sandstone bedrock. The RQD values indicate that the recovered bedrock core is of very poor to fair quality. A photograph of the bedrock core recovered from boreholes 20-2 is provided on Figure C1 in Appendix C.

The results of unconfined compressive strength tests on four samples of the recovered bedrock core are provided in Appendix C and indicate compressive strengths ranging from 54 to 253 Megapascals. Based on these results the bedrock can be classified as strong to very strong.

4.5 Groundwater Levels

The groundwater level measured in the well screen at borehole 20-2 on April 7, 2020 was 0.8 metres below ground surface.

The groundwater levels may be higher during wet periods of the year such as the early spring or following periods of precipitation.

4.6 Groundwater Chemistry Relating to Corrosion

The results of chemical testing on a groundwater sample recovered from borehole 20-2 are provided in Appendix D and summarized in Table 4.1.

Table 4.1 – Summary of Groundwater Corrosion Testing

Parameter	Borehole 20-2
Chloride Content (mg/L)	14
Resistivity (Ohm.m)	26.0
pH	7.3
Sulphate Content (mg/L)	33

5.0 RECOMMENDATIONS AND GUIDELINES

5.1 General

The information in the following sections is provided for the guidance of the design engineers and is intended for the design of this project only. 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.

This report includes only the geotechnical aspects of the subsurface conditions at this site.

5.2 Proposed Building

5.2.1 Excavation

The excavation for the footings of the proposed structure will be carried out mostly through topsoil, sand and gravel, and possibly into bedrock.

5.2.1.1 Overburden Excavation

The sides of the excavation in overburden should be sloped in accordance with the requirements in Ontario Regulation 213/91 under the Occupational Health and Safety Act. According to the Act, the native material at this site can be classified as Type 3 soil and, accordingly, allowance should be made for excavation side slopes of 1 horizontal to 1 vertical, or flatter for overburden excavations deeper than 1.2 metres below ground surface.

As discussed in the following sections, all topsoil should be removed from the building area (i.e., below the foundations and slab on grade).

5.2.1.2 Bedrock Excavation

The bedrock at this site is known to be hard and abrasive on drilling steel and pneumatic hoe ram equipment. As such, drill and blasting techniques could be considered for bedrock excavation at this site. Excavations in bedrock should stand near vertically; however, the sides of the excavations should be scaled to remove any loose bedrock material.

Any blasting should be carried out under the supervision of a blasting specialist engineer. As a guideline for blasting, a maximum peak particle velocity of 50 millimetres per second could be used as the vibration criteria at the nearest structure or service. It is pointed out that this criteria, although conservative, was established to prevent damage to existing buildings and services; more stringent criteria may be required to prevent damage to freshly placed (uncured) concrete. The bedrock in this area is known to contain random joints. To reduce, not prevent, over break and under break of bedrock in the excavation, line drilling on close centres is suggested along the design limits of the excavation. It should be noted that bedrock removal using drill and blasting techniques within about 6 metres of the existing structure or services would require additional measures to reduce the risk of damage to the existing structure and may be cost prohibitive.

As an alternative to drill and blasting techniques, consideration could be given to trimming to the design limits using a combination of hoe ramming techniques and line drilling. For this case, it is suggested that the perimeter of excavation be defined by line drilling on close centers in order to reduce over break and/or under break of the bedrock. For the bedrock at this site, it is suggested that allowance be made for line drilling 75 to 100 millimetre diameter holes on 200 to 300 millimetre centres. As previously indicated, the bedrock at this site is known to be hard and abrasive on pneumatic hoe ram equipment. In addition to line drilling along the perimeter of the excavation, drilled holes, positioned on a grid pattern within the footprint of the planned excavation, could be used to assist in breaking the bedrock using hoe ram equipment.

Monitoring of the blasting should be carried out throughout the blasting period to ensure that the blasting meets the limiting vibration criteria. The vibration effects of hoe ramming are usually minor and localized. Monitoring of the hoe ramming should be carried out, at least initially, to measure the vibrations to ensure that they are below the acceptable threshold value. Further details on vibration monitoring are provided in the Vibration Monitoring section of this report (Section 6.3).

5.2.1.3 Groundwater Management

The groundwater level on April 7, 2020 was measured at 0.8 metres below ground surface in borehole 20-2, which is below the bedrock surface. It is anticipated that relatively shallow depth excavations will be required to construct the proposed building (i.e., less than about 1.2 metres depth). For this case, groundwater inflow from the overburden and bedrock should be relatively small and controlled by pumping from filtered sumps within the excavation. It is not expected that short term pumping during excavation will have a significant effect on nearby structures and services. GEMTEC should review this recommendation once the planned excavation depth is known.

5.2.2 Spread Footing Design

Based on the results of the investigation, the building will likely be founded on bedrock. Spread footing foundations bearing on or within the competent limestone bedrock could be sized using a factored bearing resistance at Ultimate Limit State (ULS) of 1,000 kilopascals. This bearing pressure assumes that all soil and any weathered or fractured rock is removed from the bearing surfaces, but takes into account some minor blast induced damage to the bedrock below founding level. Post construction settlements from spread footings founded on or within competent sandstone bedrock should be negligible, provided that all loose and disturbed bedrock is removed from the footing areas.

As an alternative to the above, consideration could be given to founding the structure on a leveling layer of compacted granular material above the bedrock (engineered fill). The engineered fill should consist of at least 150 millimetres of OPSS Granular B Type II throughout the building footprint, and should be compacted in maximum 200 millimetre thick lifts to at least 98 percent of the standard Proctor dry density value. To allow adequate spread of load below the footings, the engineered fill should extend at least 0.3 metres beyond the edge of the footings and down and out from this point at 1 horizontal to 1 vertical, or flatter. Spread footings founded on compacted engineered fill above competent bedrock could be sized using Serviceability Limit State (SLS) and ULS bearing pressures of 200 and 500 kilopascals, respectively. In this case, the post constructed total and differential settlement of the footings should be less than 25 and 20 millimetres, respectively, provided that all loose or disturbed soil is removed from below the footings.

5.2.3 Frost Protection of the Foundations

All exterior footings for heated portions of the structure should be provided with at least 1.5 metres of earth cover for frost protection purposes. Footings located within unheated portions of the building or isolated footings outside the building footprint should be provided with at least 1.8 metres of earth cover for frost protection purposes. If the required depth of earth cover is not practicable, a combination of earth cover and polystyrene insulation could be considered.

For insulation placed below the footings, in preparation for the insulation, a levelling mat consisting of 25 millimetres of concrete/mortar sand or 50 millimetres of lean concrete should be placed on the approved bearing surface. Care must be taken to ensure that the insulation is not damaged during construction. Joints should be carefully lap jointed and glued where and if possible. Footings may then be constructed on the surface of the insulation. The type of insulation should be selected such that the bearing pressure on the insulation placed under the footings does not exceed about 35 percent of the insulation’s quoted compressive strength. This is due to the time dependant creep characteristics of this material.

For example, the allowable bearing pressures for several grades of insulation are:

Table 5.1 – Summary of Insulation Bearing Resistance

Insulation Type	SLS Resistance (kilopascals)
Dow SM	75
Dow Highload 40	95
Dow Highload 60	145

Insulation Type	SLS Resistance (kilopascals)
Dow Highload 100	240

The allowable bearing resistance at SLS will be dependant on the type of insulation chosen and the presence of compacted engineered fill above the insulation. For footings supported on insulation, the lower SLS bearing resistance provided in Section 5.2.2 and Table 5.1 will govern.

The requirement for minimum depths of soil cover or insulation for frost protection could likely be waived for footings founded on or within relatively sound bedrock. An evaluation of the frost susceptibility of the bedrock at subgrade level could be carried out by geotechnical personnel at the time of construction.

5.2.4 Foundation Wall Backfill and Drainage

To avoid frost adhesion and possible heaving, the foundations should be backfilled with imported, free-draining, non-frost susceptible granular material meeting OPSS Granular B Type I or II requirements. The backfill should be placed in maximum 200 millimetre thick lifts and compacted to at least 95 percent of the standard Proctor maximum dry density value using suitable vibratory compaction equipment.

Where areas of hard surfacing (concrete, sidewalk, pavement, etc.) abut the proposed building, a gradual transition should be provided between those areas of hard surfacing underlain by non-frost susceptible granular wall backfill and those areas underlain by existing frost susceptible materials to reduce the effects of differential frost heaving. It is suggested that granular frost tapers be constructed from the bottom of the overburden within the excavation or 1.5 metres below finished grade, whichever is less, to the underside of the granular base/subbase material for the hard surfaced areas. The frost tapers should be sloped at 1 horizontal to 1 vertical, or flatter.

Perimeter foundation drainage is not considered necessary for the slab on grade (i.e., basementless) structure, provided that the floor slab level is above the exterior finished grade.

5.2.5 Seismic Site Class and Liquefaction Potential

Based on the results of the subsurface investigation, the site classification for seismic site response may be taken as Site Class C. There is no potential for liquefaction of the overburden deposits at this site.

Due to the fact that the foundations will likely bear on or within the bedrock, Site Class A or B could likely be assigned to this site, however, in accordance with the Ontario Building Code, shear wave velocity testing would be required to improve the classification to above Site Class C. Based on our experience, depending on the design of the structure, significant savings in construction costs could be realized by improving to Seismic Site Class A or B; therefore, we recommend consulting with the designers and structural engineer to determine the potential savings related to improving the seismic site classification.

5.2.6 Grade Raise Restriction and Site Grading

The proposed buildings will be founded on or within near surface bedrock, therefore, there are no grade raise restrictions for this site from a geotechnical perspective. As part of the overall site grading for the proposed building and access roads/parking areas, grades should be proposed to promote drainage away from all structures and hard surface areas to ditches and/or catch basins.

5.2.7 Slab on Grade Support

To provide predictable settlement performance of the floor slab, topsoil and any fill or disturbed soil and debris should be removed from the slab area. The base for the floor slab should consist of at least 300 millimetres of OPSS Granular A. OPSS documents allow recycled asphaltic concrete and concrete to be used in Granular A material. Since the source of recycled material cannot be determined or controlled, it is suggested that any imported Granular A materials be composed of 100 percent crushed rock only, for environmental reasons.

All imported granular materials placed below the proposed floor slab should be compacted in maximum 200 millimetre thick lifts to at least 95 percent of the standard Proctor maximum dry density value.

Underfloor drainage is not considered necessary provided that the floor slab level is above the finished exterior grade.

The floor slab should be wet cured to minimize shrinkage cracking and slab curling. The slab should be saw cut to about 1/3 the thickness of the slab as soon as curing of the concrete permits, in order to minimized shrinkage cracks.

Proper moisture protection with a vapour retarder should be used for any slab on grade where the floor will be covered by moisture sensitive flooring material or where moisture sensitive equipment, products or environments will exist. The “Guide for Concrete Floor and Slab Construction”, ACI 302.1R-04 should be considered for the design and construction of vapour retarders below the floor slab.

5.3 Infiltration Characteristics of Native Soil

The results of our grain size testing indicates a permeability (K) of 1 x 10^{-4} metres per second for the overburden soil below the topsoil. This corresponds to an infiltration rate of about 160 millimetres per hour. We recommend allowing for unfactored infiltration rates ranging from 140 to 210 millimetres per hour.

5.4 Access Roadways, Parking Areas and Pathways

5.4.1 Subgrade Preparation

In preparation for the construction of the access roadways, parking areas, and pathways, any loose/soft, wet, organic, deleterious and fill materials should be removed from the proposed subgrade surface. Any grade raise fill for the access roadways, parking areas, and pathways could consist of material which meets OPSS specifications for Granular B Type I or II, Select Subgrade Material, or suitable earth borrow. The granular materials, Select Subgrade Material or earth borrow should be placed in maximum 300 millimetres thick lifts and compacted to at least 98 percent of the standard Proctor maximum dry density value using vibratory compaction equipment.

The subgrade surfaces should be proof rolled with a 10 tonne (minimum) smooth steel drum roller and shaped and crowned to promote drainage of the granular materials.

The pavement structures provided below assume that any trench backfill is adequately compacted, and that the access roadway and parking lot subgrade surfaces are prepared as described above. If the subgrade surfaces become disturbed or wetted due to construction operations or precipitation, the granular subbase thickness given below may not be adequate and it may be necessary to increase the thickness of the subbase and/or to incorporate a woven geotextile separator between the subgrade surfaces and the granular subbase material. The adequacy of the design pavement thickness should be assessed by geotechnical personnel at the time of construction.

5.4.2 Pavement Structures

5.4.2.1 Access Roadways and Parking Areas

For the light duty, gravel surfaced parking areas to be used by light vehicles (cars, etc.), the following minimum pavement structure is recommended:

- 150 millimetres of OPSS Granular A base; over
- 300 millimetres of OPSS Granular B Type II (or 450 millimetres of Granular B Type I), subbase.

For heavy duty, gravel surfaced parking areas and access roadways to be used by heavy truck traffic (including emergency vehicles), the suggested minimum pavement structure is:

- 150 millimetres of OPSS Granular A base; over
- 450 millimetres of OPSS Granular B Type II (or 525 millimetres of Granular B Type I), subbase.

The granular base and subbase materials should be compacted in maximum 200 millimetre thick lifts to at least 99 percent of the standard Proctor maximum dry density value.

In areas where the proposed pavement structure directly overlies bedrock, the subbase thickness could be reduced to at least 150 millimetres of OPSS Granular B Type II material.

If the granular pavement materials are to be used by construction traffic, it may be necessary to increase the thickness of the granular subbase layer, install a woven geotextile separator between the roadway subgrade surface and the granular subbase material, or a combination of both, to prevent disturbance to the subbase material. The contractor should be made responsible for their construction access.

5.4.2.2 Pathways

The pathway should be constructed using the following minimum pavement structure as per City of Ottawa Standard Detail Drawing SC25 (Stonedust Path):

- 100 millimetres of limestone screenings compacted to 98 percent of the standard Proctor maximum dry density value, over
- 150 millimetres of OPSS Granular A compacted to 100 percent of the standard Proctor maximum dry density value.

5.4.3 Pavement Drainage

Adequate drainage of the pavement granular materials and subgrade is important for the long term performance of the pavement at this site. The subgrade surfaces should be crowned and shaped to drain to the catch basins to promote drainage of the pavement granular materials. Catch basins should be equipped with 3 metre long stub drains extending in at least 2 directions.

5.5 Proposed Services

5.5.1 Excavation

In the overburden, the excavation for flexible service pipes should be in accordance with Ontario Provincial Standard Drawing (OPSD) 802.010 for Type 3 soil. The excavation for rigid service pipes should be in accordance with OPSD 802.031 for Type 3 soil. The sides of the excavations within overburden soils should be sloped in accordance with the requirements in Ontario Regulation 213/91 under the Occupational Health and Safety Act. According to the Act, the soils at this site can be classified as Type 3 soils. Therefore, for design purposes, allowance should be made for 1 horizontal to 1 vertical, or flatter, slopes. As an alternative or where space constraints dictate, the service installations could be carried out within a tightly fitting, braced steel trench box, which is specifically designed for this purpose.

Based on the results of the boreholes, bedrock removal will likely be required in order to install the site services. The excavation for flexible and rigid service pipes in bedrock should be in accordance with OPSD 802.013 and 802.033, respectively. Recommendations for bedrock removal at this site are provided in Section 5.2.1.2.

The groundwater level on April 7, 2020 was measured at 0.8 metres below ground surface in boreholes 20-2 and, as such, it is anticipated that the excavation for site servicing will extend below the groundwater level. As a precaution, an Environmental Activity and Sector Registry (EASR) in accordance with Environmental Protection Act Part II.2 Section 20.21 for water takings between 50,000 and 400,000 litres per day is recommended. This recommendation could be reviewed by GEMTEC when the planned excavation depth for site servicing becomes available. It is noted that short term pumping during excavation is not expected to have any significant effect on nearby structures and services.

5.5.2 Pipe Bedding

The bedding for sewers and watermains should be in accordance with OPSD 802.010 and 802.031 for flexible and rigid pipes in Type 3 soils, respectively. The bedding for flexible and rigid service pipes in bedrock should be in accordance with OPSD 802.013 and 802.033, respectively.

The bedding for service pipes should consist of at least 150 millimetres of crushed stone meeting OPSS requirements for Granular A. Cover material, from spring line to at least 300 millimetres above the tops of the pipes, should consist of granular material, such as that meeting OPSS Granular A.

Where bedrock excavation is required, some overbreak should be expected and allowance should be made for thickening the bedding material, as required.

In areas where the subsoil is disturbed or where unsuitable material (fill or organic material) exists below the pipe subgrade level, the disturbed/unsuitable material should be removed and replaced with a subbedding layer of compacted granular material, such as that meeting OPSS Granular B Type I or II. To provide adequate support for the sewer pipes in the long term in areas where subexcavation of material is required below design subgrade level, the excavations should be sized to allow a 1 horizontal to 1 vertical or 2 horizontal to 1 vertical spread of granular material down and out from the bottom of the pipes.

The granular bedding and subbedding materials should be compacted in maximum 200 millimetre thick lifts to at least 99 percent of the standard Proctor dry density value.

The use of clear crushed stone should not be permitted on this project.

5.5.3 Trench Backfill

In areas where the service trench will be located below or in close proximity to existing or future areas of hard surfacing (pavement, sidewalk, etc.), acceptable native materials should be used as backfill between the roadway subgrade level and the depth of seasonal frost penetration in order to reduce the potential for differential frost heaving between the area over the trench and the adjacent hard surfaced area. The depth of frost penetration in exposed areas can normally be taken as 1.8 metres below finished grade. Where native backfill is used, it should match the native materials exposed on the trench walls. Backfill below the zone of seasonal frost penetration could consist of either acceptable native material, imported granular material conforming to OPSS Granular B Type I, or well shattered and graded excavated bedrock.

It is anticipated that most of the inorganic overburden materials encountered during the subsurface investigation will be acceptable for reuse as trench backfill. Any former topsoil and existing asphaltic concrete should be wasted from the trench. If on site excavated bedrock is used as backfill within the service trench, it should be mostly 300 millimetres, or smaller, in size and should be well graded. To prevent ingress of fine material into voids in the blast rock, the upper surface of the blast rock should be blinded with well graded crushed stone, such as OPSS Granular B Type II.

To minimize future settlement of the backfill and achieve an acceptable subgrade for the parking area, the trench backfill should be compacted in maximum 300 millimetre thick lifts to at least 95 percent of the standard Proctor dry density value. Rock fill should be placed in maximum 500 millimetre thick lifts and compacted with the haulage and spreading equipment. The specified density for compaction of the backfill materials may be reduced where the trench backfill is not located below or in close proximity to existing or future areas of hard surfacing and/or structures.

5.6 Corrosion of Buried Concrete and Steel

The measured sulphate concentration in a sample of the groundwater collected from borehole 20-2 was found to be 33 mg/L. According to the Canadian Standards Association “Concrete Materials and Methods of Concrete Construction” (CSA A23.1-14 Table 3), the concentration of sulphate in the groundwater recovered from borehole 20-2 is less than the minimum concentration for ‘Moderate’ sulfate exposure (150 to 1500 milligrams of sulphate per litre). Therefore any concrete in contact with the native soil or bedrock could be batched with General Use (GU) cement. Other factors (structurally reinforced or non-structurally reinforced, freeze-thaw environment, chloride exposure) should be considered in selecting the Class of Exposure and associated air entrainment and concrete mix proportions for any concrete.

Based on the resistivity and pH of the groundwater, the groundwater sampled from borehole 20-2 can be classified as non-aggressive toward unprotected steel. The manufacturer of any buried steel elements that will be in contact with the groundwater should be consulted to ensure that the durability of the intended product is appropriate. It is noted that the corrosivity of the groundwater could vary throughout the year due to the application of de-icing chemicals.

6.0 ADDITIONAL CONSIDERATIONS

6.1 Winter Construction

Provision must be made to prevent freezing of any soil below the level of any footings, slabs or services. Freezing of the soil could result in heaving related damage.

Any service trenches should be opened for as short a time as practicable and the excavations should be carried out only in lengths which allow all of the construction operations, including backfilling, to be fully completed in one working day. The materials on the sides of the trenches should not be allowed to freeze. In addition, the backfill should be excavated, stored and replaced without being disturbed by frost or contaminated by snow or ice.

6.2 Tree Planting

From a geotechnical perspective, there are no restrictions to landscaping with respect to City Guidelines for clay soils.

6.3 Vibration Monitoring

Some of the construction operations (such as granular material compaction, excavation, hoe ramming, blasting foundation construction etc.) will cause ground vibration on and off the site. The vibrations will attenuate with distance from the source, but may be felt at nearby structures. We recommend that preconstruction surveys be carried out on the adjacent structures and that vibration monitoring be carried out during the construction, or at least initially, so that any construction related claims can be dealt with in a fair manner.

6.4 Design Review and Construction Observation

The details for the proposed construction were not available to us at the time of preparation of this report. It is recommended that the final design drawings be reviewed by the geotechnical engineer as the design progresses 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 excavations do not materially differ from those given in the report and that the construction activities do not adversely affect the intent of the design. The subgrade surfaces for the building and site should be inspected by experienced geotechnical personnel to ensure that suitable materials have been reached and properly prepared. The placing and compaction of earth fill and imported granular materials should be inspected to ensure that the materials used conform to the grading and compaction specifications. In accordance with Ontario Building Code requirements, full time compaction testing is required for engineered fill below buildings.

We trust this report provides sufficient information for your present purposes. If you have any questions concerning this report, please do not hesitate to contact our office.

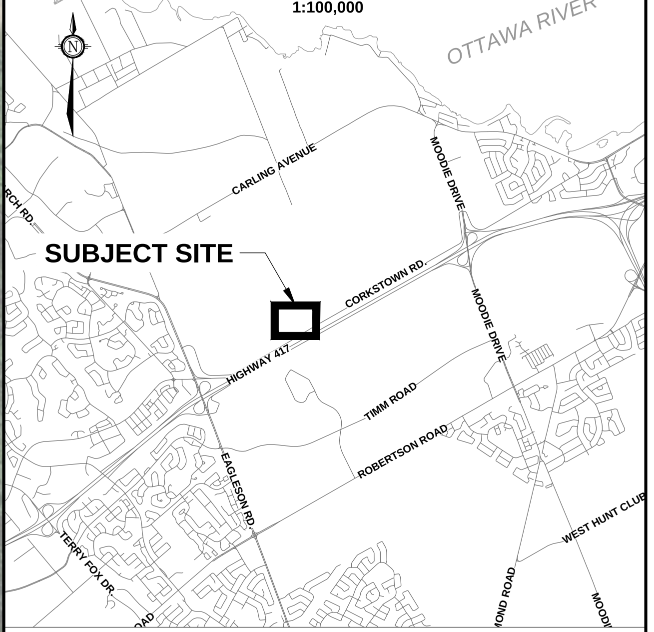
Joseph Berkers, B.Eng.

John Cholewa, Ph.D., P.Eng.

LICENSED PROFESSIONAL ENGINEER
J. A. CHOLEWA
100119055
23 Apr 2020
PROVINCE OF ONTARIO

KEY PLAN

1:100,000



LEGEND

— · · — · · —	APPROXIMATE DEVELOPMENT AREA
BH# ⊕	**BOREHOLE LOCATION IN PLAN** (current investigation by GEMTEC)

Scale

1:1250

0 25 50 75m

GEMTEC
CONSULTING ENGINEERS
AND SCIENTISTS

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Drawing
BOREHOLE LOCATION PLAN

Client
CSV ARCHITECTS

Project
85062.01

GEOTECHNICAL
INVESTIGATION
411 CORKSTOWN RD.
OTTAWA, ONTARIO

Drwn by	Chkd by
P.C.	J.B.

Date
APRIL 2020

Rev.
0

FIGURE 1

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APPENDIX A

List of Abbreviations and Terminology
Record of Borehole Sheets

ABBREVIATIONS AND TERMINOLOGY USED ON RECORDS OF BOREHOLES AND TEST PITS

SAMPLE TYPES	
AS	Auger sample
CA	Casing sample
CS	Chunk sample
BS	Borros piston sample
GS	Grab sample
MS	Manual sample
RC	Rock core
SS	Split spoon sampler
ST	Slotted tube
TO	Thin-walled open shelby tube
TP	Thin-walled piston shelby tube
WS	Wash sample

SOIL TESTS	
w	Water content
PL, w_p	Plastic limit
LL, w_L	Liquid limit
C	Consolidation (oedometer) test
D_R	Relative density
DS	Direct shear test
G_S	Specific gravity
M	Sieve analysis for particle size
MH	Combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	Organic content test
UC	Unconfined compression test
γ	Unit weight

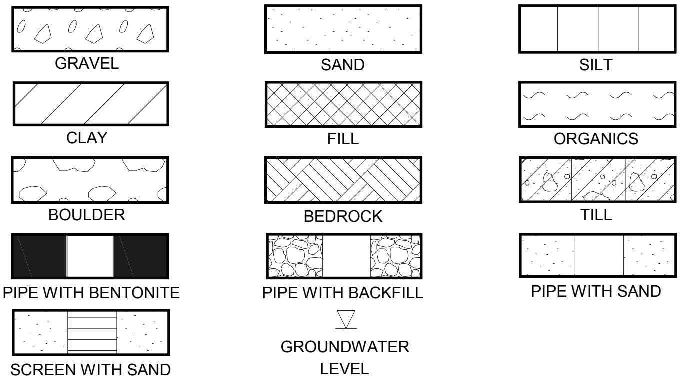
PENETRATION RESISTANCE

Standard Penetration Resistance, N
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 millimetres (30 in.) required to drive a 50 mm split spoon sampler for a distance of 300 mm (12 in.). For split spoon samples where less than 300 mm of penetration was achieved, the number of blows is reported over the sampler penetration in mm.

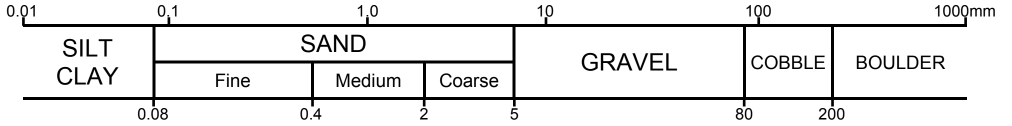
Dynamic Penetration Resistance
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive a 50 mm (2 in.) diameter 60° cone attached to 'A' size drill rods for a distance of 300 mm (12 in.).

WH	Sampler advanced by static weight of hammer and drill rods
WR	Sampler advanced by static weight of drill rods
PH	Sampler advanced by hydraulic pressure from drill rig
PM	Sampler advanced by manual pressure

COHESIONLESS SOIL Compactness		COHESIVE SOIL Consistency	
SPT N-Values	Description	Cu, kPa	Description
0-4	Very Loose	0-12	Very Soft
4-10	Loose	12-25	Soft
10-30	Compact	25-50	Firm
30-50	Dense	50-100	Stiff
>50	Very Dense	100-200	Very Stiff
		>200	Hard



GRAIN SIZE



DESCRIPTIVE TERMINOLOGY

(Based on the CANFEM 4th Edition)

0	10	20	35
TRACE	SOME	ADJECTIVE	noun > 35% and main fraction
trace clay, etc	some gravel, etc.	silty, etc.	sand and gravel, etc.

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descriptive terms.pub
Modified May 2018

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERING STATE

Fresh	No visible sign of rock material weathering
Faintly weathered	Weathering limited to the surface of major discontinuities
Slightly weathered	Penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material
Moderately weathered	Weathering extends throughout the rock mass but the rock material is not friable
Completely weathered	Rock is wholly decomposed and in a friable condition but the rock and structure are preserved

CORE CONDITION

Total Core Recovery (TCR)
The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run

Solid Core Recovery (SCR)
The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)
The percentage of solid drill core, greater than 100 mm length, as measured along the centerline axis of the core, relative to the length of the total core run. RQD varies from 0% for completed broken core to 100% for core in solid segments.

BEDDING THICKNESS

Description	Thickness
Thinly laminated	< 6 mm
Laminated	6 - 20 mm
Very thinly bedded	20 - 60 mm
Thinly bedded	60 - 200 mm
Medium bedded	200 - 600 mm
Thickly bedded	600 - 2000 mm
Very thickly bedded	2000 - 6000 mm

DISCONTINUITY SPACING

Description	Spacing
Very close	20 - 60 mm
Close	60 - 200 mm
Moderate	200 - 600 mm
Wide	600 -2000 mm
Very wide	2000 - 6000 mm

ROCK QUALITY

RQD	Overall Quality
0 - 25	Very poor
25 - 50	Poor
50 - 75	Fair
75 - 90	Good
90 - 100	Excellent

ROCK COMPRESSIVE STRENGTH

Comp. Strength, MPa	Description
1 - 5	Very weak
5 - 25	Weak
25 - 50	Moderate
50 - 100	Strong
100 - 250	Very strong

RECORD OF BOREHOLE 20-1

CLIENT: Andrew Fleck Children's Services
PROJECT: Forest and Nature Child Care Centre
JOB#: 85062.01
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: Geodetic
BORING DATE: Mar 27 2020

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: RECOVERY, mm	SAMPLES: BLOWS/0.3m	● PENETRATION RESISTANCE (N), BLOWS/0.3m; ▲ DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m; SHEAR STRENGTH (Cu), kPA + NATURAL ⊕ REMOULDED; WATER CONTENT, % W_P —○ W— W_L; 10 20 30 40 50 60 70 80 90	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		Ground Surface									
	Power Auger Hollow Stem Auger (210 mm OD)	Dark brown organic TOPSOIL									
		Brown GRAVELLY SAND, trace silt with organics		0.05	1	SS		>50 for 100 mm	○	M	Backfilled with soil cuttings
		End of Borehole Auger Refusal		0.53							
1											
2											
3											
4											
5											

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LOGGED: ML

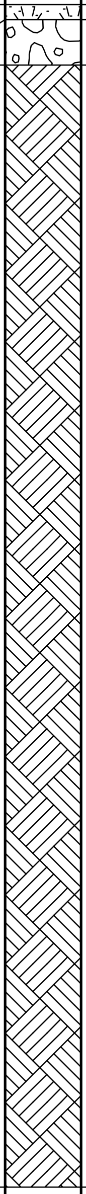
CHECKED: JB

RECORD OF BOREHOLE 20-2

CLIENT: Andrew Fleck Children's Services
PROJECT: Forest and Nature Child Care Centre
JOB#: 85062.01
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: Geodetic
BORING DATE: Mar 27 2020

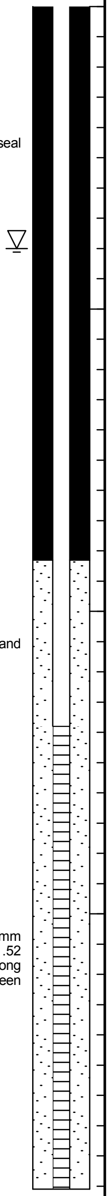
DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
0	Power Auger / Hollow Stem Auger (210 mm OD)	Ground Surface	
		Dark brown organic TOPSOIL	0.05
		Grey brown GRAVEL, some sand	0.20
	Rotary Diamond Core / NQ	Grey brown slightly weathered SANDSTONE BEDROCK	
4		End of Borehole	3.91



SAMPLES NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	SS		>50 for 50 mmm	
2	RC		TCR = 71%, SCR = 56%, RQD = 0%	
3	RC		TCR = 100%, SCR = 95%, RQD = 33%	UC
4	RC		TCR = 100%, SCR = 93%, RQD = 55%	UC UC UC

● PENETRATION RESISTANCE (N), BLOWS/0.3m
▲ DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH (Cu), kPA
+ NATURAL ⊕ REMOULDED
WATER CONTENT, %
W_P — W — W_L
10 20 30 40 50 60 70 80 90

PIEZOMETER OR STANDPIPE INSTALLATION



GROUNDWATER OBSERVATIONS

DATE	DEPTH (m)	ELEV. (m)
20/04/07	1.5 ∇	

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RECORD OF BOREHOLE 20-3

CLIENT: Andrew Fleck Children's Services
PROJECT: Forest and Nature Child Care Centre
JOB#: 85062.01
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: Geodetic
BORING DATE: Mar 27 2020

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE			SAMPLES				● PENETRATION RESISTANCE (N), BLOWS/0.3m ▲ DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m SHEAR STRENGTH (Cu), kPA + NATURAL ⊕ REMOULDED WATER CONTENT, % W_P ⊢ W ⊣ W_L 10 20 30 40 50 60 70 80 90	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m			
	Power Auger Hollow Stem Auger (210 mm OD)	Ground Surface									
0		Dark brown organic TOPSOIL			1	SS		>50 for 100 mm			Backfilled with soil cuttings
		Grey brown GRAVEL, some sand		0.05							
		End of Borehole Auger Refusal		0.15							
1											
2											
3											
4											
5											

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CHECKED: JB

RECORD OF BOREHOLE 20-4

CLIENT: Andrew Fleck Children's Services
PROJECT: Forest and Nature Child Care Centre
JOB#: 85062.01
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: Geodetic
BORING DATE: Mar 27 2020

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	● PENETRATION RESISTANCE (N), BLOWS/0.3m ▲ DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m SHEAR STRENGTH (Cu), kPA + NATURAL ⊕ REMOULDED WATER CONTENT, % W_P W W_L 10 20 30 40 50 60 70 80 90	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger Hollow Stem Auger (210 mm OD)	Ground Surface									
		Dark brown organic TOPSOIL		0.05							
		Light brown GRAVEL and SAND, trace silt			1	SS		>50 for 125 mm		M	Backfilled with soil cuttings
		End of Borehole Split Spoon Refusal		0.41							
1											
2											
3											
4											
5											

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RECORD OF BOREHOLE 20-5

CLIENT: Andrew Fleck Children's Services
PROJECT: Forest and Nature Child Care Centre
JOB#: 85062.01
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: Geodetic
BORING DATE: Mar 27 2020

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	● PENETRATION RESISTANCE (N), BLOWS/0.3m ▲ DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m SHEAR STRENGTH (Cu), kPA + NATURAL ⊕ REMOULDED WATER CONTENT, % W_P W W_L 10 20 30 40 50 60 70 80 90	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
	Power Auger Hollow Stem Auger (210 mm OD)	Ground Surface									
0		Dark brown organic TOPSOIL			1	SS		>50 for 125 mm			Backfilled with soil cuttings
		Grey brown GRAVEL, some sand		0.05							
		End of Borehole Split Spoon Refusal		0.15							
1											
2											
3											
4											
5											

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CHECKED: JB

APPENDIX B

Materials Laboratory Testing
Soil Grading Charts

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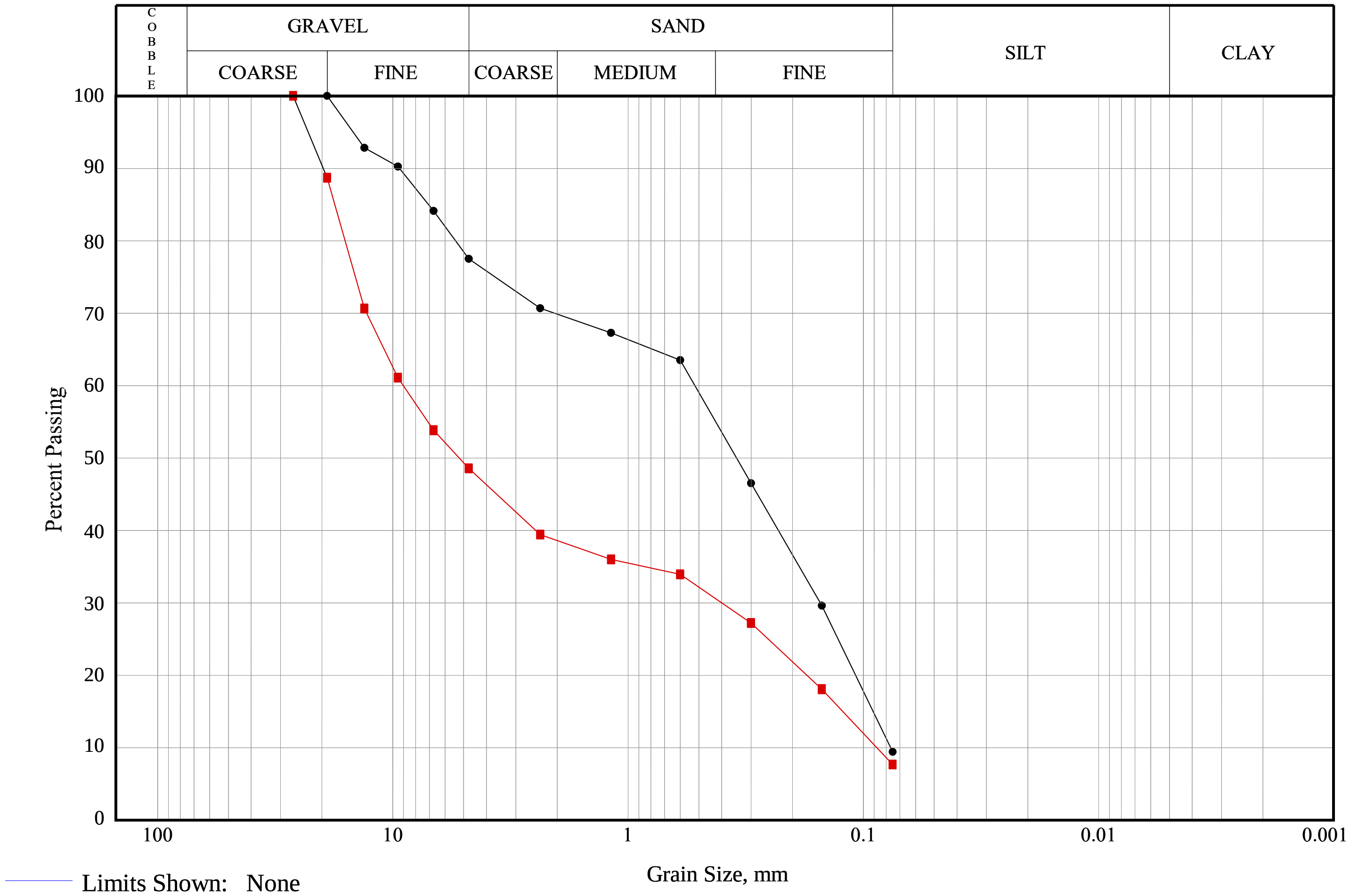
and Scientists

Client: CSV Architects
Project: Geotechnical Investigation - Forest and Nature Child Car
Project #: 8506201

Soils Grading Chart



Line Symbol	Sample	Borehole/ Test Pit	Sample Number	Depth	% Cob.+ Gravel	% Sand	% Silt	% Clay
●	Gravelly Sand	20-1	1	0-0.25	22.5	68.1	9.4	
■	Gravel and Sand	20-4	1	0.05-0.41	51.4	40.9	7.7	

Line Symbol	CanFEM Classification	USCS Symbol	D_{10}	D_{15}	D_{30}	D_{50}	D_{60}	D_{85}	% 5-75µm
●	Gravelly sand , trace silt	N/A	0.08	0.09	0.15	0.35	0.52	7.04	---
■	Gravel and sand , trace silt	N/A	0.09	0.12	0.40	5.22	9.02	17.64	---

APPENDIX C

Unconfined Compressive Strength Tests
Photographs of Bedrock Core
Figure C1

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CONSULTING ENGINEERS AND SCIENTISTS

Client: CSV Architects
Project: Geotechnical Investigation - Forest and Nature Child Care Centre - Corkstown Road
Project #: 8506201

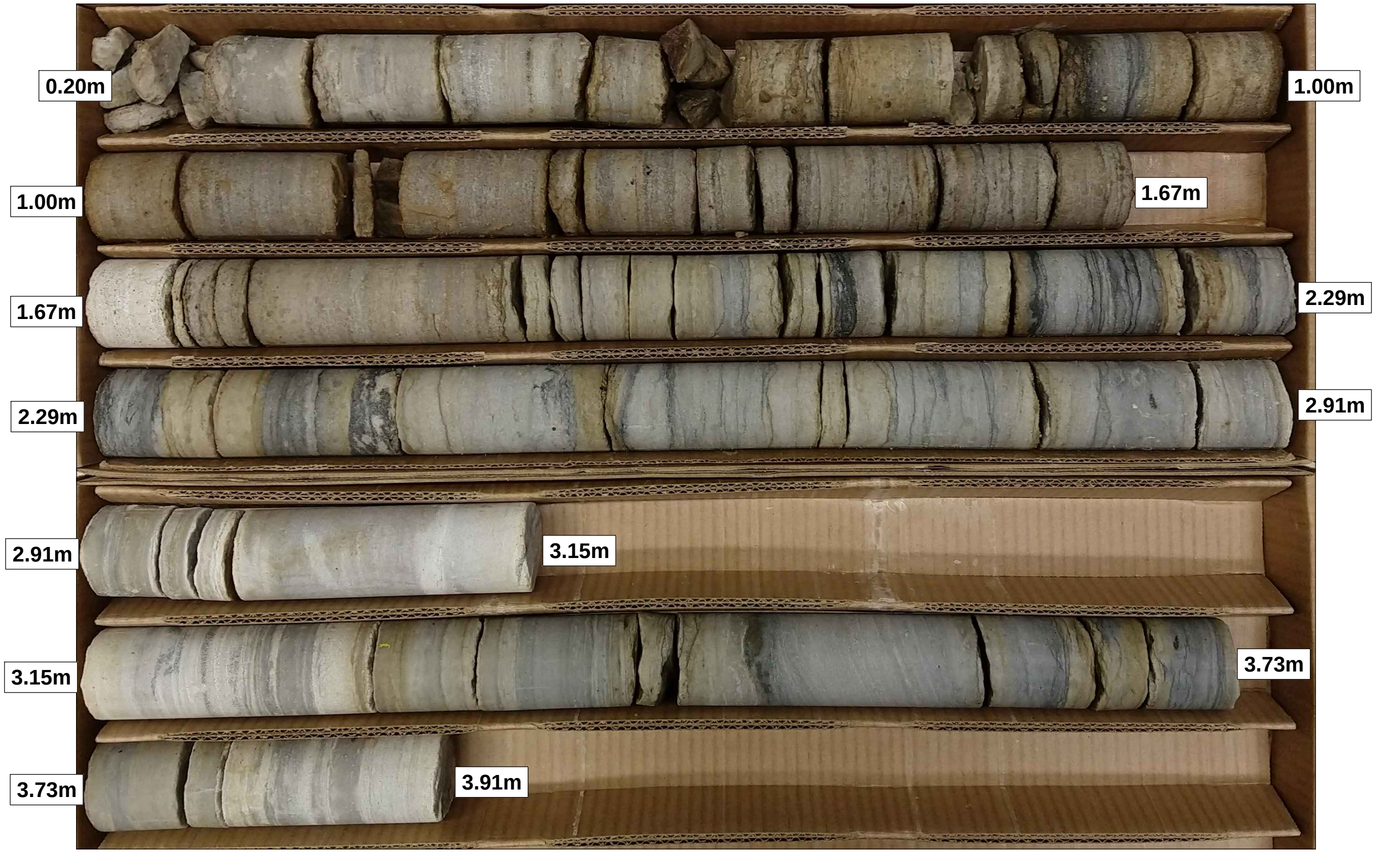
Rock Core Compressive Strength

Date/Time Sampled: 20/04/07 12:27:40 PM

Date/Time Tested: 20/04/07 12:27:40 PM

BH	Sample No	Depth	Description	Diameter, mm	Area, mm²	Length After Capping, mm	L/D	Load, kN	Comp. Str., MPa
20-2 RC2	1	1.75-1.88		47.3	1756	90	1.90	95.670	53.7
20-2 RC3	2	3.00-3.15		47.3	1759	90	1.91	369.150	206.8
20-2 RC4	3	3.15-3.29		48.2	1821	87	1.81	375.200	203.1
20-2 RC4	4	3.44-3.59		47.4	1767	90	1.89	453.160	252.7

BOREHOLE 20-2
BORING DATE: MARCH 27, 2020
DEPTH: 0.20 to 3.91 mbgs



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Project
GEOTECHNICAL INVESTIGATION
PROPOSED FOREST &
NATURE CHILD CARE CENTRE
411 CORKSTOWN RD.
OTTAWA, ON

FIGURE C1

File No.
85062.01

PHOTOGRAPH OF BEDROCK CORE

APPENDIX D

Laboratory Testing
Groundwater Chemistry Relating to Corrosion

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Certificate of Analysis

GEMTEC Consulting Engineers and Scientists Limited

32 Steacie Drive
Kanata, ON K2K 2A9
Attn: Nicole Soucy

Client PO:
Project: 85062.01
Custody: 53436

Report Date: 13-Apr-2020
Order Date: 7-Apr-2020

Order #: 2015140

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

Paracel ID	Client ID
2015140-01	MW19-2

Approved By: Mark Foto

Mark Foto, M.Sc.
Lab Supervisor

Certificate of Analysis
Client: **GEMTEC Consulting Engineers and Scientists Limited**
Client PO:

Report Date: 13-Apr-2020
Order Date: 7-Apr-2020
Project Description: 85062.01

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC	8-Apr-20	8-Apr-20
pH	EPA 150.1 - pH probe @25 °C	13-Apr-20	13-Apr-20
Resistivity	EPA 120.1 - probe	13-Apr-20	13-Apr-20

Certificate of Analysis

Client: **GEMTEC Consulting Engineers and Scientists Limited**

Client PO:

Report Date: 13-Apr-2020
Order Date: 7-Apr-2020
Project Description: 85062.01

	Client ID:	MW19-2	-	-	-
	Sample Date:	07-Apr-20 09:00	-	-	-
	Sample ID:	2015140-01	-	-	-
	MDL/Units	Water	-	-	-
General Inorganics					
pH	0.1 pH Units	7.3	-	-	-
Resistivity	0.01 Ohm.m	26.0	-	-	-
Anions					
Chloride	1 mg/L	14	-	-	-
Sulphate	1 mg/L	33	-	-	-

experience • knowledge • integrity

civil	civil
geotechnical	géotechnique
environmental	environnementale
field services	surveillance de chantier
materials testing	service de laboratoire des matériaux

expérience • connaissance • intégrité