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Geotechnical Investigation
Proposed Residential Development
114, 118, 122 Russell Avenue
Ottawa, Ontario

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Submitted to:

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Geotechnical Investigation
Proposed Residential Development
114, 118, 122 Russell Avenue
Ottawa, Ontario

October 25, 2019
Project: 65003.01

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October 25, 2019 File: 65003.01

Nicolino Scaffidi Argentina
114 Russell Avenue
Ottawa, ON

Re: Geotechnical Investigation
Proposed Residential Development
114, 118, and 122 Russell Avenue
Ottawa, Ontario

Enclosed is our revised geotechnical investigation report for the above noted project, which now includes details pertaining to corrosivity of concrete and steel following our receipt of laboratory analysis results in this regard. This report was prepared by Matthew Rainville, C.E.T. and reviewed by Johnathan A. Cholewa, Ph.D., P.Eng.

Matthew Rainville, C.E.T.

MR/JC

Enclosures
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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

This report presents the results of a geotechnical investigation carried out for the proposed residential development at 114, 118, and 122 Russell Avenue (herein known as 'the site') in Ottawa, Ontario (see Key Plan, Figure 1). 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.

2.0 PROJECT DESCRIPTION AND SITE GEOLOGY

2.1 Project Description

The site currently consists of three developed residential lots, each containing a residential building. It is understood that the existing buildings will be removed and that two low-rise residential apartment complexes will be constructed at the site. It is further understood that the proposed buildings will consist of slab-on-grade construction and that at-grade parking will be included in the development.

Based on existing site conditions, it is assumed that the proposed building will have a maximum finished ground floor elevation of about 58.5 metres.

2.2 Site Geology

Surficial geology maps of the Ottawa area indicate that the site is underlain by erosional terraces of marine deposits (silt and clay). Bedrock geology and drift thickness maps of the Ottawa area show that the overburden has a thickness of about 10 to 15 metres and is underlain by interbedded limestone and shale of the Verulam Formation.

3.0 METHODOLOGY

3.1 Geotechnical Investigation

The field work for this investigation was carried out on September 27, 2019. During that time, four (4) boreholes, numbered 19-1 to 19-4, were advanced at the site by George Downing Estate Drilling Ltd., to depths ranging between 1.8 and 2.6 metres below existing grade (elevation 55.5 to 56.0 metres).

Standard penetration tests (SPT) were carried out in the boreholes and samples of the soils encountered were recovered using a 50 millimetre diameter split barrel sampler. Vane shear strength testing was not attempted due to the apparent stiffness of the silty clay deposit.

The field work was observed throughout by a member of our engineering staff who directed the drilling operations and logged the samples and boreholes.

Standpipe piezometers were installed and sealed in the overburden at boreholes 19-2 and 19-4 to facilitate groundwater level measurements and groundwater sampling.

Following completion of the drilling, the soil samples were returned to our laboratory for examination by a geotechnical engineer. A sample of the soil recovered from borehole 19-3 was sent to Paracel Laboratories Ltd. for basic chemical testing relating to corrosion of buried concrete and steel.

The results of the boreholes are provided on the Record of Borehole sheets in Appendix A. The approximate locations and ground surface elevations of the boreholes are shown on the Borehole Location Plan, Figure 1. The results of the laboratory classification tests on the soil samples are provided on the Soils Grading Chart and Plasticity chart in Appendix B. The results of the chemical analysis of a sample of soil relating to corrosion of buried concrete and steel are provided in Appendix C.

The borehole locations were selected by GEMTEC and positioned on site relative to the proposed building footprints and site accessibility. The ground surface elevations at the location of the boreholes were determined using a Trimble R10 global positioning system combined with level survey equipment. The coordinates of the boreholes were estimated relative to NAD83 (CSRS) Epoch 2010, while their elevations are relative to vertical network CGVD28 and are considered to be accurate within the tolerance of the instruments.

4.0 SUBSURFACE CONDITIONS

4.1 General

As previously indicated, the soil and groundwater conditions identified in the boreholes are given on the Record of Borehole sheets in Appendix A. The 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. The precision with which subsurface conditions are indicated depends on the method of drilling and excavation, the frequency and recovery of samples, the method of sampling, and the uniformity of the subsurface conditions. Subsurface conditions at other than the test locations may vary from the conditions encountered in the boreholes and test pits. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties.

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 groundwater conditions described in this report refer only to those observed at the place and time of observation noted in the report. Groundwater conditions may vary seasonally or as a consequence of construction activities in the area.

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

4.2 Existing Pavement Structure

4.2.1 Asphaltic Concrete

A layer of asphaltic concrete was encountered at surface at all boreholes. The thickness of the asphaltic concrete is about 30 to 40 millimetres.

4.2.2 Base/Subbase Material

Base/Subbase material was encountered below the asphaltic concrete at boreholes 19-2, 19-3, and 19-4. The base/subbase material consists of sand and gravel and extends to depths of about 0.1 to 0.2 metres below surface grade.

The moisture content of a sample of the base/subbase material recovered from borehole 19-4 was found to be 5 percent.

4.3 Fill

Fill material was encountered below the asphaltic concrete at borehole 19-1, and below the base/subbase material at boreholes 19-2 and 19-3. The fill material can generally be described as black/dark brown/brown/grey brown silty sand with some clay and gravel, as well as brick fragments, cinders, organic material, and shale fragments. The thickness of the fill ranges between 0.6 to 0.7 metres, and extends to a depth of about 0.8 metres below existing grade (approximate elevation of 57.1 to 57.4 metres).

The moisture content of a sample of the fill material recovered from borehole 19-1 was found to be 48 percent.

4.4 Silty Clay (Weathered Crust)

A native deposit of grey brown clay with some silt and trace of sand and gravel (weathered crust) was encountered below the fill at boreholes 19-1, 19-2, and 19-3, and below the pavement structure at borehole 19-4. The thickness of the weathered crust ranges between 0.8 to 1.4 metres, and extends to a depth of about 1.5 metres below existing grade at all boreholes (approximate elevation between 56.3 to 56.8 metres).

Standard penetration tests carried out within this deposit gave N values ranging between 5 to 11 blows per 0.3 metres of penetration. Based on the standard penetration test results, the weather crust has a stiff to very stiff consistency. Given the apparent consistency of the deposit noted at the time of our field investigation, carrying out in situ vane strength tests in the deposit was determined to not be feasible and therefore not undertaken.

The results of grain size distribution testing on a sample of the clay are provided on the Soils Grading Chart in Appendix B and summarized in Table 4.1.

Table 4.1 – Summary of Grain Size Distribution Testing

Location	Sample Number	Sample Depth (metres)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
19-2	2	0.8 – 1.4	0.1	3.6	14.8	81.6

The results of Atterberg limit testing carried out on a sample of the silty clay are provided on Plasticity Chart in Appendix B and summarized in Table 4.2.

Table 4.2 – Summary of Atterberg Limit Testing

Borehole	Sample Number	Sample Depth (metres)	Water Content (%)	LL (%)	PL (%)	PI (%)
19-2	2	0.8 – 1.4	41.1	60.4	31.7	28.7

Moisture content testing carried out on samples of the clay weathered crust indicate moisture contents ranging from about 41 to 50 percent.

4.5 Glacial Till

A native deposit of glacial till was encountered at all boreholes at a depth of about 1.5 metres below existing grade (elevation 56.3 to 56.8 metres). Glacial till is a heterogeneous mixture of all grain sizes, however, the glacial till encountered at this site can be described as dark brown to grey brown silty sand with some clay and gravel, including shale fragments. Boreholes 19-1, 19-3, and 19-4 were terminated due to refusal to further advancement on inferred bedrock at a depths of about 1.8 to 1.9 metres below existing grade (elevation 56.0 to 56.4 metres).

Standard penetration test refusal occurred within the glacial till, which indicates the presence of cobbles/boulders within the glacial till, a very dense relative density, or possibly the upper surface of the bedrock.

Moisture content testing carried out on samples of the glacial till indicate moisture contents ranging from about 10 to 15 percent.

4.6 Bedrock

A borehole 19-2, shale bedrock was encountered at a depth of about 1.8 metres below existing grade (elevation 56.3 metres) and was penetrated to at a depth of about 2.6 metres below existing grade (elevation 55.5 metres) within the vibratory casing; the borehole was terminated at 2.6 metres depth due to refusal to further advancement of the borehole.

4.7 Groundwater Levels

The groundwater level in the well screens installed in boreholes 19-2 and 19-4 were measured on October 9, 2019. A summary of the groundwater level is provided in Table 4.3.

Table 4.3 – Summary of Measured Groundwater (October 9, 2019)

Borehole	Ground Surface Elevation (metres)	Groundwater Level (metres)	Groundwater Elevation (metres)
19-2	58.11	2.5	55.7
19-4	58.27	ND*	N/A

*The maximum depth the well could be probed was 1.3 metres below ground surface. No groundwater was present within this depth.

It should be noted that the groundwater levels may be higher during wet periods of the year such as the early spring or following periods of precipitation.

4.8 Soil Chemistry Relating to Corrosion

The results of chemical testing on the soil sample recovered from borehole 19-3 are provided in Appendix C and are summarized in Table 4.4.

Table 4.4 – Summary of Corrosion Testing

Parameter	Borehole 19-3 SA2
Chloride Content	18 ug/g
Sulphate Content	13 ug/g
Conductivity	97 uS/cm
pH	7.33

Parameter	Borehole 19-3 SA2
Resistivity	103 Ohm.m

5.0 GEOTECHNICAL GUIDELINES AND RECOMMENDATIONS

5.1 General

This section of the report provides engineering guidelines on the geotechnical design aspects of the project based on our interpretation of the boreholes advanced as part of this investigation and the project requirements. It is stressed that the information in the following sections is provided for the guidance of the designers and is intended for 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.

The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at this site. The presence or implications of possible surface and/or subsurface contamination resulting from previous uses or activities of this site or adjacent properties, and/or resulting from the introduction onto the site from materials from offsite sources are outside the terms of reference for this report and have not been investigated or addressed.

5.2 Excavation

Based on the available subsurface information, excavations for the structure and services within the site will be carried out through fill material, silty clay, and possibly glacial till.

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, excavation slopes within the native soils at this site. As an alternative to sloping the excavations, the service installations could be carried out within a tightly fitting, braced steel trench box, which is specifically designed and approved for this purpose.

For adjacent existing structures founded on overburden, the proposed excavation should not encroach within a line extending downwards and outwards from the existing foundations at an inclination of 1 vertical to 1 horizontal. For adjacent existing structures founded on bedrock, the proposed excavation should not encroach within a line extending downwards and outwards from the existing foundations at an inclination of 2 vertical to 1 horizontal

The groundwater inflow should be controlled throughout the excavation and pipe laying operations by pumping from sumps within the excavation. Notwithstanding, it should be noted that silty clay deposits are very sensitive to disturbance from ponded water and construction traffic. Some disturbance and loosening of the subgrade materials could occur, and allowance should be made for subexcavation, as discussed further in the following sections of this report.

Depending on the depth of the excavation, in order to avoid subgrade disturbance, allowance could be made for a 50 to 75 millimetre thick mud mat of low strength concrete. The mud mat should be placed over the silty clay subgrade surface immediately after exposure and inspection.

5.3 Groundwater Pumping

Based on our experience, groundwater inflow from the silty clay deposits into the excavations could be controlled by pumping from filtered sumps within the excavations. It is not expected that short term pumping during excavation will have any significant affect on nearby structures and services.

Suitable detention and filtration will be required before discharging water. The contractor should be required to submit an excavation and groundwater management plan for review.

Depending on the depth of proposed services and groundwater level at the time of construction, an Environmental Activity and Sector Registry (EASR) in accordance with Environmental Protection Act Part II may be required. Further details could be provided as the design progresses.

5.4 Grade Raise Restriction

Based on the results of the investigation, a grade raise restriction does not apply to this site.

5.5 Spread Footing Design

Based on the results of the current investigation, the proposed structure could be founded on conventional footings bearing on or within native, undisturbed silty clay, glacial till, or shale bedrock.

In areas where subexcavation of disturbed material is required below proposed founding level, the grade could be raised with compacted granular material (engineered fill). The engineered fill should consist of granular material meeting Ontario Provincial Standard Specifications (OPSS) requirements for Granular B Type II and should be compacted in maximum 200 millimetre thick lifts to at least 95 percent of the standard Proctor maximum dry density. To provide adequate spread of load beneath the footings, the engineered fill should extend horizontally at least 0.3

metres beyond the footings and then down and out from this point at 1 horizontal to 1 vertical, or flatter.

For preliminary planning and design purposes, foundation bearing values for the proposed building are provided in Tables 5.1.

Table 5.1 – Foundation Bearing Values (Proposed Slab on Grade Building)

Subgrade Material	Net Geotechnical Reaction at Serviceability Limit State[1] (kilopascals)	Factored Net Geotechnical Resistance at Ultimate Limit State (kilopascals)
Native Silty Clay	100	250
Glacial Till	120	300
Compacted Engineered Fill (overlying native silty clay and/or glacial till)	120	300
Bedrock	-	300

Provided that any loose or disturbed soil is removed from the bearing surfaces, the post construction total and differential settlement of the footings at SLS should be less than 25 and 20 millimetres.

5.6 Frost Protection of Foundations

All exterior footings and those in any heated parts of the structures should be provided with at least 1.5 metres of earth cover for frost protection purposes. Isolated footings located outside of the building footprint or footings located within unheated areas of the building (i.e. garage, isolated piers) should be provided with at least 1.8 metres of frost cover. Futhermore, if the foundation and\or basement floor slab is insulated in a way which reduces heat loss towards the surrounding soil, the required depth of earth cover over the footings should conform to that of an unheated structure (i.e. 1.8 metres).

If the required depth of earth cover for foundations is not practicable, a combination of earth cover and extruded polystyrene insulation could be considered. The provided frost protection requirements do not apply where footings will be installed on sound, non-frost susceptible bedrock. It is recommended that the bedrock be assessed by a qualified geotechnical engineer for this determination.

5.7 Foundation Wall Backfill

The foundation walls should be backfilled with imported, free draining, non-frost susceptible granular material such as that meeting OPSS Granular B Type I or II requirements.

Where the backfill will ultimately support areas of hard surfacing (pavement, concrete sidewalks or other similar surfaces), the backfill should be placed in maximum 200 millimetre thick lifts and should be compacted to at least 98 percent of the standard Proctor maximum dry density value using suitable compaction equipment. Where future landscaped areas will exist next to the proposed building and if some settlement of the backfill is acceptable, the backfill could be compacted to at least 90 percent of the standard Proctor maximum dry density value.

Where areas of hard surfacing (concrete, sidewalks, pavement, etc.) will abut the proposed structure, a gradual transition should be provided between those areas of hard surfacing underlain by non-frost susceptible granular wall backfill and those existing, adjacent areas of hard surfacing underlain by frost susceptible fill material, to reduce the effects of differential frost heaving. It is suggested that granular frost tapers be constructed from 1.5 metres below finished grade up to the underside of the granular subbase of the existing, adjacent hard surfaced areas. The frost tapers should be sloped at 1 horizontal to 1 vertical, or flatter.

5.8 Slab on Grade Support (Slab Surface above Finished Grade)

To provide predictable settlement performance of the concrete slab on grade, the existing pavement structure and fill material should be removed from the area of the proposed slab on grade. Any disturbed soil, organic material, or deleterious material should also be removed to expose the native undisturbed soil deposits.

The subgrade surface should be proof rolled with a vibratory drum roller under dry conditions and any noted soft areas should be sub excavated. The grade within the proposed slab area could be raised, where necessary, with compacted granular material meeting OPSS requirements for Granular B Type I or II. The use of Granular B Type II is preferred under wet conditions. The granular base for the proposed floor slab should consist of at least 150 millimetres of OPSS Granular A. The 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 for concrete floor slabs that are at the finished exterior ground surface level.

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.

If any areas of the building are to remain unheated during the winter period, thermal protection of the slab on grade may be required. Further details on the insulation requirements could be provided, if necessary.

5.9 Seismic Site Classification and Liquefaction Potential

Based on the subsurface conditions encountered during this investigation, along with the recorded blow counts (N), it is our opinion that Site Class C could be used for the seismic design of the structures. It is pointed out that based on available shear wave velocity mapping, the site could potentially be classified as Site Class A or B, however, site specific testing would be required to confirm this opinion. Multi Channel Analysis of Surface Waves (MASW), a non-intrusive geophysical test method could be considered for this purpose.

In our opinion, there is no potential for liquefaction of the overburden deposits at this site.

5.10 Site Services

5.10.1 Pipe Bedding and Cover

The bedding for the sanitary and storm sewer and watermain laterals should be in accordance with OPSD 802.010/802.013 for flexible and rigid pipes, respectively. The pipe bedding should consist of at least 150 millimetres of well graded crushed stone meeting OPSS requirements for Granular A. OPSS documents allow recycled asphaltic concrete and concrete to be used in Granular A and Granular B Type II material. Since the source of recycled material cannot be determined, it is suggested that any granular materials used in the service trenches be composed of virgin (i.e., not recycled) material only.

Allowance should be made for subexcavation of any existing fill, organic deposits, or disturbed material encountered at subgrade level.

Cover material, from pipe spring line to at least 300 millimetres above the top of the pipe, should consist of granular material, such as OPSS Granular A.

The use of clear crushed stone should not be permitted for the installation of site services, since it could exacerbate groundwater lowering of the overburden materials due to "French Drain" effects.

The bedding and cover materials should be compacted in maximum 200 millimetre thick lifts to at least 95 percent of the standard Proctor maximum dry density using suitable vibratory compaction equipment.

5.10.2 Trench Backfill

The general backfilling procedures should be carried out in a manner that is compatible with the future use of the area above the service trenches.

In areas where a service trench will be located below or in close proximity to existing or future roadway/laneway/parking lot area, acceptable native materials should be used as backfill between the roadway/laneway/parking lot area 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 section of roadway/laneway/parking lot area. 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 or imported granular material conforming to OPSS Granular B Type I. The depth of frost penetration in areas that are kept clear of snow is expected to be about 1.8 metres. Where cover requirements are not practicable, the pipes could be protected from frost using a combination of earth cover and insulation. Further details regarding insulation could be provided, if required.

It is anticipated that most of the inorganic overburden materials encountered during the subsurface investigation will be acceptable for reuse as trench backfill. Topsoil or other organic material should be wasted from the trench.

To minimize future settlement of the backfill and achieve an acceptable subgrade for the reinstatement of the roadways, parking lot, curbs, etc., the trench backfill should be compacted in maximum 300 millimetre thick lifts to at least 95 percent of the standard Proctor dry density value. 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.

The native silty clay from the excavations may have moisture contents above optimum for compaction. Furthermore, most of the overburden deposits at this site are sensitive to changes in moisture content. Unless these materials are allowed to dry, the specified densities will not likely be possible to achieve and, as a consequence, some settlement of these backfill materials could occur. Consideration could be implementing one or a combination of the following measures to reduce post construction settlement above the trenches, depending on the weather conditions encountered during the construction:

- Allow the overburden materials to dry prior to compaction.
- Reuse any wet materials in the lower part of the trenches and make provision to defer final paving of such areas for 6 months, or longer, to allow some of the trench backfill settlement to occur and thereby improve the final roadway appearance.

- Reuse any wet materials outside hard surfaced areas and where post construction settlement is less of a concern (such as landscaped areas).

5.10.3 Seepage Barriers

The granular bedding in the service trenches could act as a “French Drain”, which could promote groundwater lowering. As such, we suggest that seepage barriers be installed along the service trenches at strategic locations, such as where the proposed laterals meet the property line at Russell Avenue. The seepage barriers should begin at subgrade level and extend vertically through the granular pipe bedding and granular surround to within the native backfill materials, and horizontally across the full width of the service trench excavation. The seepage barriers could consist of 1.5 metre wide dykes of compacted silty clay. The silty clay should be compacted in maximum 300 millimetre thick lifts to at least 95 percent of the standard Proctor dry density value. Locations of the seepage barriers could be recommended as the design progresses.

5.10.4 Winter Construction

The soils that exist at this site are highly frost susceptible and are prone to significant ice lensing. In order to carry out the work during freezing temperatures and maintain adequate performance of the trench backfill as a roadway subgrade, the 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 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.

5.11 Laneway/Parking Lot Areas

5.11.1 Subgrade Preparation

In preparation for laneway/parking lot construction at this site, any soft, wet or deleterious materials should be removed from the proposed laneway and parking lot areas. This need not include removal of the existing fill materials, provided that some post-construction settlement of the laneway/parking lot areas can be tolerated.

Prior to placing granular material for laneway and parking areas, the exposed subgrade should be inspected and approved by geotechnical personnel. Any soft areas should be subexcavated and replaced with suitable, dry material, meeting OPSS specifications for earth borrow material or Select Subgrade Material that is frost compatible with the materials exposed on the sides of the area of subexcavation. The grade raise material should be placed in maximum 300 millimetre thick lifts and compacted to at least 95 percent of the standard Proctor maximum dry density value using vibratory compaction equipment.

Truck traffic should be avoided on the native soil subgrade or the trench backfill within the roadways/parking lot areas especially under wet conditions.

5.11.2 Pavement Structure

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

- 50 millimetres of hot mix asphaltic concrete (Superpave 12.5 Traffic Level B), over
- 150 millimetres of OPSS Granular A base, over
- 300 millimetres of OPSS Granular B, Type II subbase

For laneways and parking areas to be used by heavy truck traffic the suggested minimum pavement structure is:

- 100 millimetres of hot mix asphaltic concrete (40 millimetres of Superpave 12.5 Traffic Level B over 60 millimetres of Superpave 19.0 Traffic Level B), over
- 150 millimetres of OPSS Granular A base, over
- 450 millimetres of OPSS Granular B, Type II subbase

The above pavement structures assume that laneway and parking area subgrade surfaces are prepared as described in this report. If the subgrade surfaces become disturbed or wetted due to construction operations or precipitation, the granular subbase thicknesses given above 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 thicknesses should be assessed by geotechnical personnel at the time of construction.

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 pumping and disturbance to the subbase material. The contractor should be made responsible for their construction access.

5.11.3 Asphalt Cement Type

Performance grade PG 58-34 asphalt cement should be specified for Superpave asphaltic concrete mixes.

5.11.4 Pavement Transitions

Where new pavement will abut existing pavement, the following is suggested to improve the performance of the joint between the new and the existing pavements:

- Neatly saw cut the existing asphaltic concrete;

- Remove the asphaltic concrete and slope the bottom of the excavation within the existing granular base and subbase at 1 horizontal to 1 vertical, or flatter, to avoid undermining the existing asphaltic concrete.
- To avoid cracking of the asphaltic concrete due to an abrupt change in the thickness of the roadway granular materials where new pavement areas join with the existing pavements, the granular depths should taper up or down at 5 horizontal to 1 vertical, or flatter, to match the existing pavement structure.
- Milling the existing asphaltic concrete at the joint may not be feasible due to its thickness; as such a butt joint between the new and existing asphaltic concrete is considered the preferred option.

5.11.5 Pavement Drainage

Adequate drainage of the pavement granular materials and subgrade is important for the long term performance of the pavement at this site. Where feasible, the subgrade surfaces should be crowned and shaped to drain to ditches and/or catch basins to promote drainage of the pavement granular materials.

Catch basins should be equipped with minimum 3 metre long stub drains extending in two directions at the subgrade level.

5.11.6 Granular Material Compaction

The granular base and subbase materials should be compacted in maximum 300 millimetre thick lifts to at least 98 percent of the standard Proctor maximum dry density value.

6.0 ADDITIONAL CONSIDERATIONS

6.1 Corrosion of Buried Concrete and Steel

The measured sulphate concentration in the sample of soil recovered from borehole 19-3 is 13 micrograms per gram. According to Canadian Standards Association (CSA) “Concrete Materials and Methods of Concrete Construction”, the concentration of sulphate can be classified as low. Therefore any concrete in contact with the native soil could be batched with General Use (GU) cement. The effects of freeze thaw in the presence of de-icing chemical (sodium chloride) use on the roadway/parking lot should be considered in selecting the air entrainment and the concrete mix proportions for any concrete.

Based on the resistivity and pH of the sample, the soil in this area can be classified as non-aggressive to slightly aggressive towards unprotected steel. It should be noted that the corrosivity of the soil/groundwater could vary throughout the year due to the application sodium chloride for de-icing.

6.2 Effects of Construction Induced Vibration

Some of the construction operations (such as excavation and granular material compaction, bedrock removal, etc.) will cause ground vibration on and off of the site. The vibrations will attenuate with distance from the source, but may be felt at nearby structures. Assuming that any excavating is carried out in accordance with the guidelines in this report, the magnitude of the vibrations will be much less than that required to cause damage to the nearby structures or services in good condition, but may be felt at the nearby structures. We recommend that preconstruction surveys be carried out on the adjacent structures so that any damage claims can be addressed in a fair manner.

6.3 Winter Construction

The soils that exist at this site are highly frost susceptible and are prone to significant ice lensing. In the event that construction is required during freezing temperatures, the soil below the footings and floor slabs should be protected immediately from freezing using straw, propane heaters and insulated tarpaulins, or other suitable means.

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.

6.4 Excess Soil Management Plan

This report does not constitute an excess soil management plan. The disposal requirements for excess soil from the site have not been assessed.

6.5 Effect of Trees

Based on the results of this investigation, the site is underlain by deposits of clay; a material known to be susceptible to shrinkage with a change/reduction in moisture content. Research has shown that deciduous trees can cause a reduction in moisture content in the silty clay, which can result in significant settlement/damage to shallow foundations and hard surfaced areas, located in the vicinity of the tree(s).

To avoid the potential of settlement related damage to shallow foundations due to the effect of trees, we recommend that, for buildings founded on native silty clay above 2.1 metres in depth, no deciduous trees should be permitted closer to the building (or any ground supported structures which may be affected by settlement) than the ultimate height of the tree. For a group of trees, the separation distance should be 1.5 times the ultimate height of the trees.

Should the planting of trees be proposed in the vicinity of the building and other applicable structures, the following alternatives, based on the City of Ottawa guidelines for tree planting in sensitive marine clay soils (2017), could be considered to reduce the risk of foundation damage:

- Construct the foundations on or within the bedrock, or on a pad of compacted granular material (as described in Section 5.5) placed atop of the bedrock;
- If footings will be installed on the native clay, select an underside of footing (USF) elevation that is 2.1 metres or greater below the lowest finished grade;
- Nominally reinforce the foundation walls to provide ductility (minimum two (2) upper and two (2) lower 15M bars in the foundation walls; and,
- Provide grading around the trees that promotes drainage to the root zone.

It is noted the City of Ottawa tree planting guidelines are based on minimizing, not eliminating, the potential for ground settlement due to soil shrinkage.

6.6 Design Review

It is recommended that the 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 proposed development 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.

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.

Matthew Rainville, C.E.T.
Senior Technologist

LICENSED PROFESSIONAL ENGINEER
J. A. CHOLEWA
100119055
25 Oct 2019
PROVINCE OF ONTARIO

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

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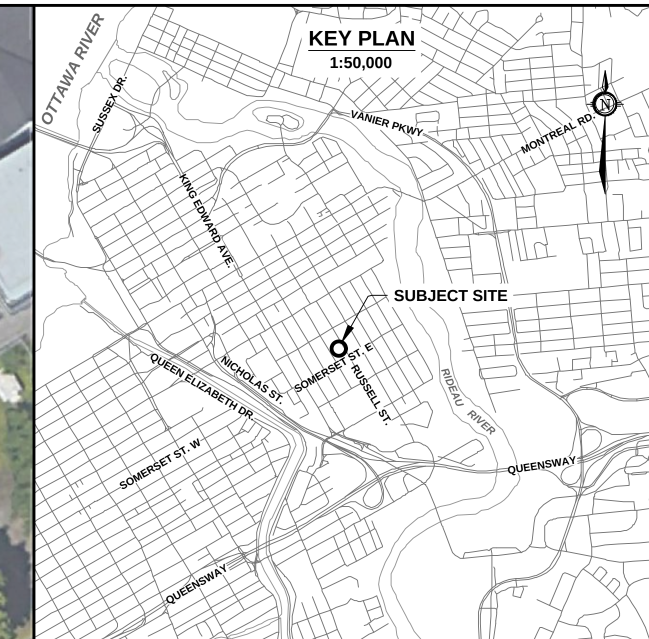

LEGEND

PROPERTY BOUNDARY (APPROX.)

BH # BOREHOLE LOCATION IN PLAN (APPROX.)
(current investigation by GEMTEC)

Scale 1:500

0 10 20 30m

GEMTEC
CONSULTING ENGINEERS AND SCIENTISTS

32 Steacie Drive
Ottawa, ON K2K 2A9
Tel: (613) 836-1422
www.gemtec.ca
ottawa@gemtec.ca

Client	N. ARGENTINA
Project	65003.01
Location	PROPOSED RESIDENTIAL DEVELOPMENT 114, 118, 122 RUSSELL AVE., OTTAWA, ON
Drwn by	P.C.
Chkd by	M.R.
Title	BOREHOLE LOCATION PLAN
Date	OCTOBER 2019
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

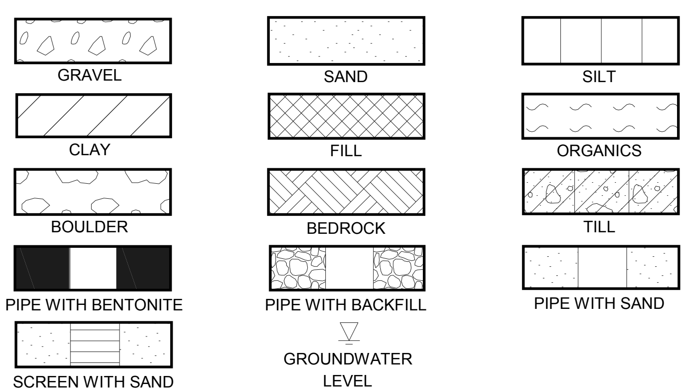
PENETRATION RESISTANCE

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

0.01 | 0.1 | 1.0 | 10 | 100 | 1000mm

SILT CLAY	SAND – Fine	SAND – Medium	SAND – Coarse	GRAVEL	COBBLE	BOULDER
< 0.08	0.08 – 0.4	0.4 – 2	2 – 5	5 – 80	80 – 200	> 200

DESCRIPTIVE TERMINOLOGY
(Based on the CANFEM 4th Edition)

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

RECORD OF BOREHOLE 19-1

CLIENT: Nicolino Scaffidi Argentina
PROJECT: 114, 118, 121 Russell Ave., Ottawa, ON
JOB#: 65003.01
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Sep 27 2019

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE – DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
0	Vibratory Hammer NW (89mm OD)	Ground Surface	57.86					
		Asphaltic concrete	0.03					
		Loose to compact, dark brown tobrown silty sand some gravel and clay, brick fragments (FILL MATERIAL)		1	SS	279	10	
		Very stiff to stiff, grey brown CLAY some silt, trace gravel and sand (weathered crust)	57.10 0.76					
1				2	SS	406	5	
		Grey brown silty sand some clay and gravel (GLACIAL TILL)	56.34 1.52	3	SS	100	>50 for 125 mm	
		Refusal to casing advancement End of borehole	56.03 1.83					
2								No grounwater inflow observed at time of drilling.
3								
4								

Chart headings: PENETRATION RESISTANCE (N), BLOWS/0.3m; DYNAMIC PENETRATION RESISTANCE (N), 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

GEMTEC Consulting Engineers and Scientists

LOGGED: M.L.
CHECKED: MR/JH

RECORD OF BOREHOLE 19-2

CLIENT: Nicolino Scaffidi Argentina
PROJECT: 114, 118, 121 Russell Ave., Ottawa, ON
JOB#: 65003.01
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Sep 27 2019

Boring method: Vibratory Hammer NW (89mm OD)

DEPTH SCALE METRES	DESCRIPTION	ELEV. / DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Ground Surface	58.11						Flushmount protector
	Asphaltic concrete	0.03						
	Grey sand and gravel (BASE/SUBBASE)	57.91 / 0.20						
	Loose to compact, dark brown to black to grey silty sand some gravel and clay, brick and shale fragments (FILL MATERIAL)	57.35 / 0.76	1	SS	355	10		Bentonite seal
1	Very stiff to stiff, grey brown CLAY some silt, trace gravel and sand (weathered crust)	56.59 / 1.52	2	SS	508	10	MH	
	Dark brown to black silty sand some clay and gravel, shale fragments (Glacial Till)	56.28 / 1.83	3	SS	355	>50 for 229 mm		Filter sand
2	Weathered/Highly fractured SHALE.	55.49 / 2.62	4	SS	100	>50 for 100 mm		31 mm Diameter, 0.61 metres long well screen
	Refusal to casing advancement. End of borehole							
3								
4								

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

GROUNDWATER OBSERVATIONS		
DATE	DEPTH (m)	ELEV. (m)
19/10/09	2.46 ▽	55.65

GEMTEC Consulting Engineers and Scientists

LOGGED: M.L.
CHECKED: MR/JH

GEO - BOREHOLE LOG BOREHOLE LOGS_V01_2019_10-18.GPJ GEMTEC 2018.GDT 21/10/19

RECORD OF BOREHOLE 19-3

CLIENT: Nicolino Scaffidi Argentina
PROJECT: 114, 118, 121 Russell Ave., Ottawa, ON
JOB#: 65003.01
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Sep 27 2019

BORING METHOD: Vibratory Hammer NW (89mm OD)

SOIL PROFILE – DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES – NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
Ground Surface	58.08				
Asphaltic concrete	0.03				
Grey sand and gravel (BASE/SUBBASE)	57.93 / 0.15				
Loose to compact, grey brown to dark brown silty sand to sandy silt, some clay and gravel, brick and shale fragments (FILL MATERIAL)	57.32 / 0.76	1	SS	304	4
Very stiff to stiff, grey brown CLAY some silt, trace gravel and sand (weathered crust)	56.56 / 1.52	2	SS	406	5
Grey brown to dark brown silty sand some clay and gravel (Glacial Till)	56.20 / 1.88	3	SS	150	>50 for 178 mm
Refusal to casing advancement. End of borehole					

DEPTH SCALE METRES: 0, 1, 2, 3, 4

● PENETRATION RESISTANCE (N), BLOWS/0.3m
▲ DYNAMIC PENETRATION RESISTANCE (N), 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

No groundwater inflow observed at time of drilling

GEMTEC
CONSULTING ENGINEERS AND SCIENTISTS

LOGGED: M.L.
CHECKED: MRJ/H

RECORD OF BOREHOLE 19-4

CLIENT: Nicolino Scaffidi Argentina
PROJECT: 114, 118, 121 Russell Ave., Ottawa, ON
JOB#: 65003.01
LOCATION: See Borehole Location Plan, Figure 1

SHEET: 1 OF 1
DATUM: CGVD28
BORING DATE: Sep 27 2019

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 / WATER CONTENT, %	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		Ground Surface		58.27							Flushmount protector
		Asphaltic concrete		0.04							
		Grey sand and gravel (BASE/SUBBASE)		58.16 / 0.11							
		Very stiff to stiff, grey brown CLAY some silt, trace gravel and sand (weathered crust)			1	SS	230	5			Bentonite seal
1					2	SS	355	11			Filter sand; 31 mm Diameter, 0.61 metres long well screen
		Grey brown silty sand some clay and gravel (GLACIAL TILL)		56.75 / 1.52	3	SS	125	>50 for 150 mm			
		Refusal to casing advancement End of borehole		56.42 / 1.85							
2											No groundwater detected to within 1.3 m depth on October 9, 2019 (standpipe blocked at 1.3 m)
3											
4											

PENETRATION RESISTANCE (N), BLOWS/0.3m; DYNAMIC PENETRATION RESISTANCE (N), 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

GEMTEC
CONSULTING ENGINEERS AND SCIENTISTS

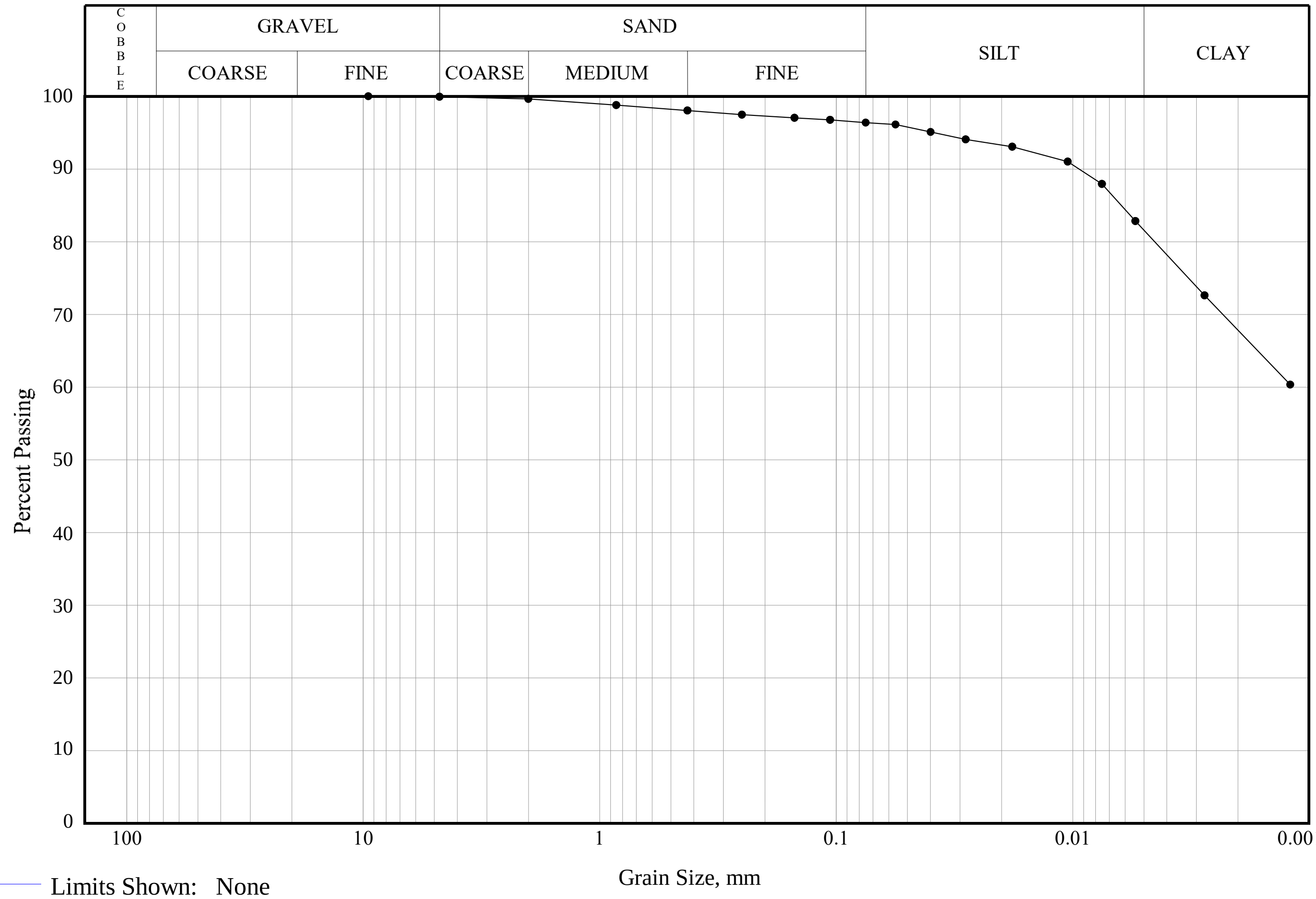
LOGGED: M.L.
CHECKED: MR/JH

APPENDIX B

Laboratory Testing Results
Soils Grading Chart
Plasticity Chart

Report to: Nicolino Scaffidi Argentina
Project: 65003.01 (October 25, 2019)

GEMTEC Consulting Engineers and Scientists	Client: Nicolino Scaffidi Argentina	Soils Grading Chart
	Project: 114, 118 and 122 Russell, Ottawa, Ontario	
	Project #: 6500301	

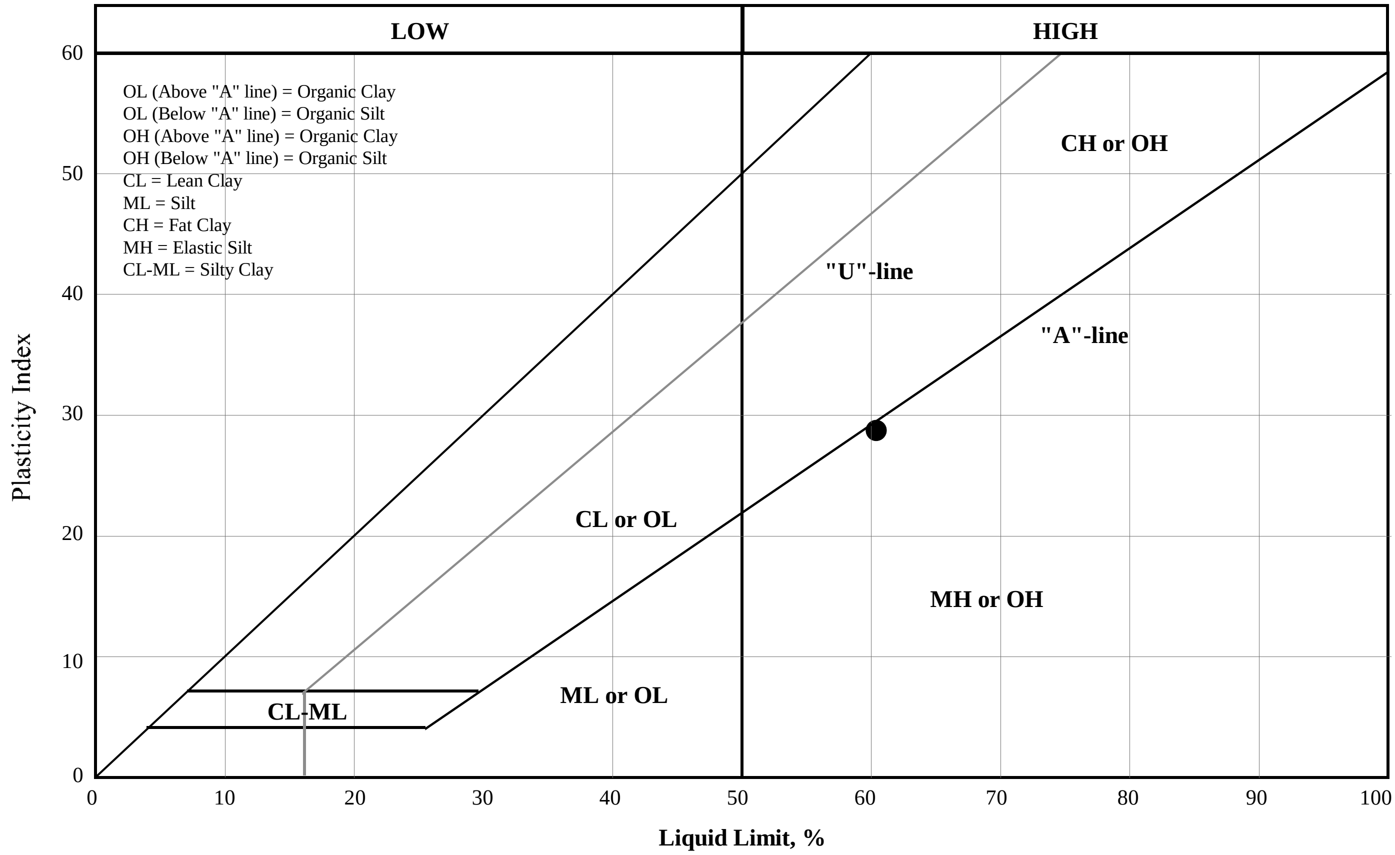


Limits Shown: None

Line Symbol	Sample	Borehole/ Test Pit	Sample Number	Depth	% Cob.+ Gravel	% Sand	% Silt	% Clay
—●—	Clay, some silt, trace gravel, trace sand	19-02	02	0.76-1.37	0.1	3.6	14.8	81.6

Line Symbol	CanFEM Classification	USCS Symbol	D_{10}	D_{15}	D_{30}	D_{50}	D_{60}	D_{85}	% 5-75μm
—●—	Clay , some silt , trace gravel, trace sand	CH	---	---	---	---	---	0.01	13.6

GEMTEC Consulting Engineers and Scientists	Client: Nicolino Scaffidi Argentina	Plasticity Chart
	Project: Geotech, 114, 118 and 122 Russell, Ottawa, Ontario	
	Project #: 6500301	



Symbol	Borehole /Test Pit	Sample Number	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Non-Plastic	Moisture Content, %
●	19-02	02	0.76-1.37	60.4	31.7	28.7	☐	41.09

APPENDIX C

Chemical Analysis of Soil Sample Relating to Corrosion
(Paracel Laboratories Ltd. Order No.

Report to: Nicolino Scaffidi Argentina
Project: 65003.01 (October 25, 2019)

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300 - 2319 St. Laurent Blvd
Ottawa, ON, K1G 4J8
1-800-749-1947
www.paracellabs.com

Certificate of Analysis

GEMTEC Consulting Engineers and Scientists Limited

32 Steacie Drive
Kanata, ON K2K 2A9
Attn: Matt Rainville

Client PO:
Project: 65003.01
Custody:

Report Date: 24-Oct-2019
Order Date: 17-Oct-2019

Revised Report

Order #: 1942367

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

Paracel ID	Client ID
1942367-01	BH19-3, SA2

Approved By: Mark Foto

Mark Foto, M.Sc.
Lab Supervisor

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

Report Date: 24-Oct-2019
Order Date: 17-Oct-2019
Project Description: 65003.01

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	22-Oct-19	22-Oct-19
Conductivity	MOE E3138 - probe @25 °C, water ext	22-Oct-19	23-Oct-19
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	23-Oct-19	23-Oct-19
Solids, %	Gravimetric, calculation	18-Oct-19	18-Oct-19

Certificate of Analysis

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

Client PO:

Report Date: 24-Oct-2019

Order Date: 17-Oct-2019

Project Description: 65003.01

	Client ID:	BH19-3, SA2	-	-	-
	Sample Date:	16-Oct-19 09:00	-	-	-
	Sample ID:	1942367-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	75.2	-	-	-
General Inorganics					
Conductivity	5 uS/cm	97	-	-	-
pH	0.05 pH Units	7.33	-	-	-
Anions					
Chloride	5 ug/g dry	18	-	-	-
Sulphate	5 ug/g dry	13	-	-	-

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									
Conductivity	ND	5	uS/cm						

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

Report Date: 24-Oct-2019
Order Date: 17-Oct-2019
Project Description: 65003.01

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	83.2	5	ug/g dry	84.0			1.0	20	
Sulphate	28.3	5	ug/g dry	27.1			4.2	20	
General Inorganics									
Conductivity	191	5	uS/cm	190			0.7	5	
pH	7.12	0.05	pH Units	7.02			1.4	2.3	
Physical Characteristics									
% Solids	73.4	0.1	% by Wt.	72.4			1.5	25	

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	179	5	ug/g	84.0	94.6	82-118			
Sulphate	136	5	ug/g	27.1	109	80-120			

Qualifier Notes:

Login Qualifiers :

Container(s) - Bottle and COC sample ID don't match -

Applies to samples: BH19-3, SA2

Sample Data Revisions

None

Work Order Revisions / Comments:

Revision 1 This report includes an updated project reference per client.

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.

experience • knowledge • integrity

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

expérience • connaissance • intégrité