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Geotechnical Investigation
Proposed Addition
Canadian Bank Note
975 Gladstone Avenue
Ottawa, Ontario

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Submitted to:

J.L. Richards & Associates Limited
864 Lady Ellen Place
Ottawa, ON
K1Z 5M2

Geotechnical Investigation
Proposed Addition
Canadian Bank Note
975 Gladstone Avenue
Ottawa, Ontario

January 28, 2020
Project: 62463.84

experience • knowledge • integrity

GEMTEC Consulting Engineers and Scientists Limited
32 Steacie Drive
Ottawa, ON, Canada
K2K 2A9

January 28, 2020

File: 62463.84

J.L. Richards & Associates Limited
864 Lady Ellen Place
Ottawa, Ontario
K1Z 5M2

Attention: Lauren Toikka, P.Eng

Re: Geotechnical Investigation
Proposed Addition
Canadian Bank Note,
975 Gladstone Avenue
Ottawa, Ontario

Please find enclosed our geotechnical investigation report for the above noted project based on the scope of work provided in our proposal dated May 3, 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 addition to be constructed at 975 Gladstone Avenue 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 May 3, 2019.

2.0 BACKGROUND

2.1 Project Description

It is understood that consideration is being given to constructing an addition adjacent to the northwest corner of the Canadian Bank Note building at 975 Gladstone Avenue. It is also understood that the addition will consist of a warehouse facility that measures about 21 metres by 46 metres in plan dimension and about 11 metres in height. In addition, the structure will be designed using slab-on-grade construction (i.e. with no basement).

The site is currently being used as a parking area for the Canadian Bank Note building.

2.2 Previous Investigations

GEMTEC Consulting Engineers and Scientists Ltd. (GEMTEC) completed several previous investigation in the area the Canadian Bank Note between 2016 and 2018. Based on the results of those investigation, the subsurface conditions at the site likely consist of weathered crust, silty clay, and glacial till underlain by limestone bedrock at depths between about 5 and 8 metres below the ground surface.

Fill material associated with past development of the site could also be expected.

3.0 SUBSURFACE INVESTIGATION

The field work for the borehole investigation was carried out on May 27, 2019. During that time, four (4) boreholes, numbered 19-1 to 19-4, inclusive, were advanced within the footprint of the proposed building using a truck mounted drill rig supplied and operated by George Downing Estate Drilling Ltd. of Grenville-Sur-La-Rouge, Quebec. The boreholes were advanced to depths between approximately 6.7 and 7.4 metres below the existing ground surface level.

Standard penetration tests were carried out in the boreholes at regular depth intervals and samples of the soils encountered were recovered using a 50 millimetre diameter split barrel sampler.

The field work was supervised throughout by a member of our engineering staff, who located the boreholes, directed the drilling operations, observed the in situ testing and logged the samples and boreholes.

A monitoring well was installed in borehole 19-1 to allow subsequent measurement of the groundwater level at the site. The groundwater level was measured on June 5, 2019.

Following completion of the drilling, the soil samples were returned to our laboratory for examination by a geotechnical engineer. The laboratory testing included water contents, Atterberg limits and grain size distribution testing.

One (1) soil sample obtained from borehole 19-3 was sent to Paracel Laboratories Limited 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 locations of the boreholes are shown on the Borehole Location Plan, Figure 1. The results of the laboratory classification testing are provided on the Record of Borehole sheets and in Appendix B. The results of the chemical analysis related to corrosion of buried steel and concrete on the soil sample collected is provided in Appendix C.

The borehole locations were selected by GEMTEC. The ground surface elevations at the location of the boreholes were determined using a Trimble R10 global positioning system. The elevations are referenced to geodetic datum and are considered to be accurate within the tolerance of the instrument.

4.0 SUBSURFACE CONDITIONS

4.1 General

The soil and groundwater conditions logged in the boreholes are given 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 Pavement Structure

An approximately 50 to 100 millimetre thick layer of asphaltic concrete was encountered at ground surface at all of the borehole locations. The asphaltic concrete is underlain by a layer of granular base material, varying in thickness from about 200 to 220 millimetres, and a subbase material, varying in thickness from 0.5 to 1.8 metres. The base material encountered can generally be described as dark grey brown sand and gravel with trace silt. The subbase material can generally be described as brown silty sand with some gravel and trace clay.

The water content measured in the pavement structure is about 20 percent.

4.3 Former Topsoil Layer

A former topsoil layer, with a thickness ranging from about 0.3 to 0.8 metres, was encountered in all boreholes below the base/subbase material at depths varying between about 0.8 and 2.1 metres below the existing ground surface. The topsoil layer can generally be described as dark brown to black sandy silt and some clay, with organic material.

The water content measured in the topsoil is about 14 percent.

4.4 Silty Clay

4.4.1 Weathered Crust

A layer of weathered crust was encountered below the topsoil at depths between about 1.4 and 2.6 metres below the existing ground surface and has a thickness ranging between about 2.4 to 3.5 metres. The weathered crust can generally be described as grey brown to red brown silty clay with trace to some sand.

Standard penetration tests (SPT) carried out in the layer of weathered crust in all boreholes gave N values ranging from 4 to 16 blow per 0.3 metres of penetration, which reflects a stiff to very stiff consistency, based on our local experience with clays in the Ottawa area.

The results of two grain size distribution tests and Atterberg limits tests on samples of the weathered crust are provided in Appendix B.

The results of Atterberg limit testing carried out on two samples of the weathered crust gave plasticity index values of about 32 and 37 percent and liquid limit values of about 57 and 69 percent, indicating a soil of generally high plasticity.

The water content measured in the weathered crust layer ranges from about 39 to 54 percent. Note that the water content of the weathered crust is between the measured plastic and liquid limit values.

4.4.2 Grey Silty Clay

An approximately 1.1 metre thick layer of grey silty clay was encountered below the weathered crust at a depth of about 4.6 metres below the existing ground surface in borehole 19-4.

One SPT N value of 3 blows per 0.3 metres of penetration was recorded within the grey silty clay, which reflects a stiff to very stiff consistency.

The results of a grain size distribution test and Atterberg limits test on a sample of the silty clay are provided in Appendix B.

The results of the Atterberg limit testing carried out on the sample of the grey silty clay gave a plasticity index value of about 25 percent and a liquid limit value of about 48 percent, indicating a soil of generally low plasticity. The water content measured in the silty clay is about 65 percent. Note that the water content of the silty clay is greater than the measured liquid limit value.

4.5 Glacial Till

A deposit of glacial till was encountered beneath the silty clay at all of the borehole locations at depths between about 4.7 and 5.6 metres below the existing ground surface. The glacial till can generally be described as grey gravelly silty sand with some clay and probable cobbles and boulders.

SPT N values recorded within the glacial till range from 2 to 5 blows per 0.3 metres of penetration, which reflects a very loose to loose consistency. A standard penetration test attempted in the glacial till at borehole 19-2 gave greater than 50 blows for 100 millimetres of penetration, which likely indicates the presence of the cobbles and boulders within the glacial till deposit.

The results of a grain size distribution test on a sample of the glacial till are provided in Appendix B.

The water content measured in the glacial till layer ranges from about 13 to 14 percent

4.6 Auger Refusal and Inferred Bedrock

Practical refusal to augering was encountered in all of the boreholes at depths between about 6.7 and 7.4 metres below the existing ground surface. It should be noted that practical refusal to augering could indicate cobbles or boulder within the glacial till or the bedrock surface.

4.7 Groundwater Levels

The groundwater level within the monitoring well installed in borehole 19-1 was measured on June 5, 2019. At that time the groundwater level was measured at a depth of about 3.5 metres below the existing ground surface (elevation 61.7 metres).

It should be noted that 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 a soil sample recovered from borehole 19-3 are provided in Appendix C and are summarized in Table 4.1 below.

Table 4.1 – Summary of Corrosion Testing

Parameter	Borehole 19-3 Sample No. 3
Chloride Content (µg/g)	334
Resistivity (Ohm.m)	13.2
pH	7.53
Sulphate Content (µg/g)	67

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.

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 off-site sources are outside the terms of reference for this report.

5.2 Proposed Building

5.2.1 Excavation

The excavation for the proposed structure will be carried out through the existing granular pavement structure, former topsoil, and weathered crust. 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 fill 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.

The former topsoil layer is considered to be compressible and should be removed from below any foundations and slabs on grade. Therefore, the existing pavement structure, fill material, and former topsoil should be excavated from the building area. Based on the results of the boreholes, an allowance should be made for subexcavation of the pavement structure, fill, and former topsoil to between 1.3 and 2.5 metres below ground surface. The excavation should be sized to accommodate a pad of imported granular material which extends at least 0.3 metres horizontally beyond the edge of the footings and down and out from this point at 1 horizontal to 1 vertical, or flatter.

From a geotechnical perspective, it may be possible to reuse the existing base/subbase material on-site during construction (e.g., foundation wall backfill, grade raise fill material below slab on grade). The existing base/subbase material could be excavated, stockpiled on-site, and tested for grain size distribution to assess whether the existing materials could be reused on site in the proposed construction.

In areas where space constraints dictate, the sides of the excavation could be supported with temporary shoring. If required, geotechnical parameters for the selection and design of temporary shoring could be provided.

Groundwater inflow, if any, from the overburden deposits 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.

5.2.2 Footing Design

Based on the results of the current investigation, the proposed structure could be founded on conventional spread footings bearing on or within native weathered crust or on engineered fill above native weathered crust. The former topsoil layer is considered to be compressible and should be removed from below any foundations and slabs on grade.

Following removal of the former topsoil layer, 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. The excavations for the foundation should be sized to accommodate this fill placement.

For design purposes, footings bearing on the native, undisturbed soil, or on a pad of engineered fill above native, undisturbed soil should be sized using a geotechnical reaction at Serviceability Limit State (SLS) of 150 kilopascals and a factored geotechnical resistance at Ultimate Limit State (ULS) of 300 kilopascals.

Based on our previous experience in this area, it is possible that the upper 0.3 to 0.5 metre portion of the weathered silty clay deposit has been affected by past frost action and may be unavoidably disturbed during the excavation for the footings. Allowance should be made to remove and replace any disturbed silty clay with compacted sand or sand and gravel, such as that meeting OPSS Granular B Type II, where required. The Granular B Type II should be compacted in maximum 200 millimetre thick lifts to at least 95 percent of the standard Proctor dry density value.

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

To reduce the potential for cracking in the footings, foundation walls, and concrete slabs on grade where the footings transition between different subgrade materials, the foundation walls should be reinforced for a distance of 3 metres on both sides of the transition areas or as recommended by the structural engineer.

5.2.3 Seismic Design of Proposed Structure

The proposed structure should be designed for seismic Site Class D. It may be possible to improve the seismic Site Class to C if shear wave velocity testing is carried out. Additional details on shear wave velocity testing could be provided as the design progresses.

There is no potential for liquefaction of the overburden deposits at this site.

5.2.4 Frost Protection of the Foundations

All exterior footings in unheated portions of the proposed building should be provided with at least 1.5 metres of earth cover for frost protection purposes. Isolated, unheated exterior footings adjacent to surfaces which are cleaned of snow cover during the winter months should be provided with a minimum of 1.8 metres of earth cover. The required depth of frost protection can be reduced by the thickness of any engineered fill beneath the foundations. Alternatively, the required frost protection could be provided by means of a combination of earth cover and extruded polystyrene insulation. An insulation detail could be provided upon request.

5.2.5 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 such as that meeting OPSS Granular B Type I or II requirements. The existing base and subbase material could be excavated, where required, stockpiled on site, and tested for grain size distribution to assess whether it could be reused on the site for foundation wall backfill.

Where the backfill will ultimately support areas of hard surfacing (pavement, sidewalks or other similar surfaces), the backfill should be placed in maximum 200 millimetre thick lifts and should be compacted to at least 95 percent of the standard Proctor maximum dry density value using suitable vibratory compaction equipment. Light, walk behind compaction equipment should be used next to foundation walls to avoid excessive compaction induced stress on the foundation walls. Where future landscaped areas will exist next to the proposed structure 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 (pavement or pathways, etc.) 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 areas underlain by existing frost susceptible 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 to the underside of the granular 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 a slab on grade structure at this site, provided that the floor slab level is above the finished exterior ground surface level.

5.2.6 Slab on Grade Support

Based on the results of the investigation, the area of the proposed addition is underlain by asphaltic concrete, base/subbase material and former topsoil followed by native deposits of silty clay and glacial till. The existing asphaltic concrete should be removed from the area of the proposed addition. The former topsoil will need to be removed from beneath the slab on grade, which will require excavation through the base/subbase material.

The grade within the proposed building could be raised, where necessary, with granular material meeting OPSS requirements for Granular B Type I or II. The use of Granular B Type II material is preferred under wet conditions. As previously indicated, from a geotechnical perspective, it may be possible to reuse the existing base/subbase material on-site during construction (e.g., foundation wall backfill, grade raise fill material below slab on grade). The existing base/subbase material could be excavated, stockpiled on-site, and tested for grain size distribution to assess whether the existing materials could be reused on site in the proposed construction.

The granular base for the proposed slab on grade should consist of at least 150 millimetres of OPSS Granular A.

All 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 ground surface level.

Thermal protection of the concrete slab on grade is required in areas that will remain unheated during the winter period.

5.3 Pavement Reinstatement

Prior to placing granular material, the subgrade surface should be proof rolled with a large steel drum roller under dry conditions. Any soft areas should be subexcavated and replaced with compacted earth borrow. The earth borrow should match the subexcavated materials.

It is suggested that the following minimum pavement structure be used to reinstate the existing asphaltic concrete:

- 50 millimetres of Superpave 12.5 (Traffic Level A or B), over
- 150 millimetres of OPSS Granular A, over
- 300 millimetres of OPSS Granular B Type II (100 millimetre minus crushed stone)

For any areas which will be used by heavy trucks or fire trucks, the following pavement structure is suggested:

- 90 millimetres of Superpave 12.5 (Traffic Level A or B), placed in two (2) 45-millimetre-thick layers, over
- 150 millimetres of OPSS Granular A, over
- 450 millimetres of OPSS Granular B Type II (100 millimetre minus crushed stone)

Performance grade PG 58-34 asphaltic concrete should be specified.

The granular base and subbase materials should be compacted in maximum 200 millimetre thick lifts to at least 98 percent of the standard Proctor maximum dry density value.

The above pavement structure assumes that the foundation wall backfill is adequately compacted and that the subgrade surface is prepared as described in this report. If the subgrade surface is disturbed or wetted due to construction operations or precipitation, the granular thicknesses given above may not be adequate and it may be necessary to increase the thickness of the Granular B Type II subbase and/or to incorporate a woven geotextile separator between the roadway subgrade surface 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 Corrosion of Buried Concrete and Steel

The measured sulphate concentration in the soil sample from borehole 19-3 is 67 micrograms per gram. According to Canadian Standards Association (CSA) 'Concrete Materials and Methods of Concrete Construction', the concentration of sulphate of the soil can be classified as low. For this value, any concrete that will be in contact with the soil could be batched with General Use (formerly known as Type 10) cement. The design of any concrete should take into consideration freeze thaw effects and the presence of chlorides or other de-icing chemicals.

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

6.0 ADDITIONAL CONSIDERATIONS

6.1 Site Servicing

For the purposes of this report, we have assumed that the proposed addition will be serviced by connecting to existing services within the main building. If required, geotechnical recommendations and guidelines could be provided as the design progresses for the installation of any new services.

6.2 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.

6.3 Effects of Construction Induced Vibration

Some of the construction operations (such as granular material compaction, excavation, foundation construction 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. We recommend that preconstruction surveys be carried out on the adjacent structures and that vibration monitoring be carried out during the construction so that any construction related claims can be dealt with in a fair manner.

6.4 Disposal of Excess Soil

It is noted that 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, including naturally occurring sources of contamination, are outside the terms of reference for this report.

6.5 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

LICENSED PROFESSIONAL ENGINEER
J. A. CHOLEWA
100119055
28 Jan 2020
PROVINCE OF ONTARIO

Johnathan A. Cholewa, Ph.D., P.Eng.

KEY PLAN
1:50,000

LEGEND

BOREHOLE LOCATION WITH MONITORING WELL
(current investigation by GEMTEC)

BOREHOLE LOCATION
(current investigation by GEMTEC)

BH # ← BOREHOLE ID
XX.XX ← GROUND SURFACE ELEVATION, IN METRES GEODETIC DATUM

Scale 1:500

0 10 20 30m

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Client	J.L. RICHARDS & ASSOCIATES LTD	Project	62463.84
Location	CANADIAN BANK NOTE 975 GLADSTONE AVE, OTTAWA, ON		
Drwn by P.C.	Chkd by J.B.	BOREHOLE LOCATION PLAN	
Date JANUARY 2020	Rev. 0	FIGURE 1	

P:\0. Files\62400\62463.84\Drafting\Drawings\62463.84_FG1_V01_2019-0607.dwg, FIGURE 1, 21-Jun-19 1:37:08 PM

APPENDIX A

List of Abbreviations and Terminology
Record of Borehole Sheets

Report to: J.L. Richards & Associates Limited
Project: 62463.84 (January 28, 2020)

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

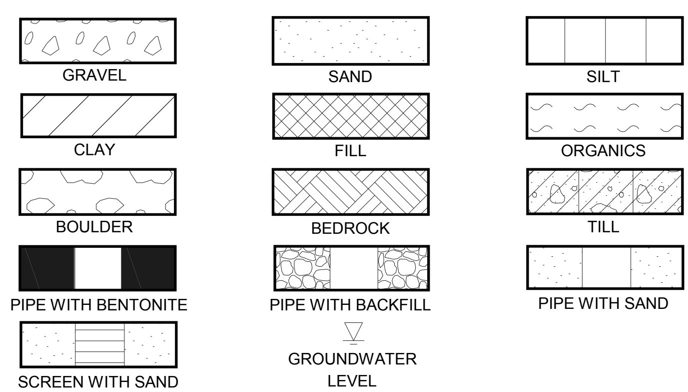
PENETRATION RESISTANCE

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

Scale (mm): 0.01, 0.1, 1.0, 10, 100, 1000mm

SILT CLAY	SAND			GRAVEL	COBBLE	BOULDER
	Fine	Medium	Coarse			

Boundaries (mm): 0.08, 0.4, 2, 5, 80, 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: J.L. Richards & Associates Ltd.
PROJECT: Geotechnical Investigation - Proposed Addition
JOB#: 62463.84
LOCATION: See Borehole Location Plan, Figure 1

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

Boring method: Power Auger — Hollow Stem Auger (210mm OD)

Description	Elev. (m) / Depth (m)	Sample Number	Type	Recovery, mm	Blows/0.3m	Additional Lab. Testing
Ground Surface	65.22					
ASPHALTIC CONCRETE	65.15 / 0.08					
Dark grey brown sand and gravel, trace silt (BASE MATERIAL)	64.92 / 0.30	1	GS			
Brown silty sand, some gravel, trace clay (SUBBASE MATERIAL)		2	SS	300	14	
Black sandy silt, some clay with organic material (FORMER TOPSOIL)	63.39 / 1.83	3	SS	380	15	
Stiff to very stiff, grey brown silty clay, trace to some sand (WEATHERED CRUST)	62.93 / 2.29	4	SS	600	16	MH
		5	SS	600	13	
		6	SS	600	11	
Very loose to loose, grey gravelly silty sand, some clay, with probable cobbles and boulders (GLACIAL TILL)	60.50 / 4.72	7	SS	600	5	
		8	SS	450	4	MH
		9	SS	450	2	
End of Borehole Auger Refusal	58.51 / 6.71					

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 10–90)

Piezometer or standpipe installation: Flushmount protector; Backfilled with soil cuttings; Bentonite seal; Filter sand; 52 mm diameter, 1.52 metre long well screen

GROUNDWATER OBSERVATIONS

Date	Depth (m)	Elev. (m)
19-06-05	3.51	61.71

GEMTEC Consulting Engineers and Scientists

LOGGED: M.L.
CHECKED: K.H.

RECORD OF BOREHOLE 19-2

CLIENT: J.L. Richards & Associates Ltd.
PROJECT: Geotechnical Investigation - Proposed Addition
JOB#: 62463.84
LOCATION: See Borehole Location Plan, Figure 1

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

BORING METHOD: Power Auger, Hollow Stem Auger (210mm OD)

DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
0	Ground Surface	64.95					
	ASPHALTIC CONCRETE	64.85 0.10	1	GS			
	Dark grey brown sand and gravel, trace silt (BASE MATERIAL)	64.65 0.30					
1	Brown silty sand, some gravel, trace clay (SUBBASE MATERIAL)		2	SS	300	26	Backfilled with soil cuttings
			3	SS	300	10	
2	Black sandy silt, some clay with organic material (FORMER TOPSOIL)	62.82 2.13					
	Stiff to very stiff, brown silty clay, trace sand (WEATHERED CRUST)	62.36 2.59	4	SS	330	11	
3			5	SS	510	15	
4			6	SS	610	13	
5			7	SS	610	5	Soil samples become wet at about 4.6 metres below ground surface
	Very loose, grey gravelly silty sand, some clay, with probable cobbles and boulders (GLACIAL TILL)	59.61 5.34	8	SS	50	2	
6			9	SS	460	2	
7			10	SS	100	>50 for 100 mm	
	End of Borehole Auger Refusal	57.81 7.14					
8							

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
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LOGGED: M.L.
CHECKED: K.H.

RECORD OF BOREHOLE 19-3

CLIENT: J.L. Richards & Associates Ltd.
PROJECT: Geotechnical Investigation - Proposed Addition
JOB#: 62463.84
LOCATION: See Borehole Location Plan, Figure 1

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

DEPTH SCALE METRES: 0 to 8

BORING METHOD: Power Auger – Hollow Stem Auger (210mm OD)

SOIL PROFILE

DESCRIPTION	ELEV. (m)	DEPTH (m)
Ground Surface	65.15	
ASPHALTIC CONCRETE	65.10	0.05
Dark grey brown sand and gravel, trace silt (BASE MATERIAL)	64.88	0.27
Brown silty sand, some gravel, trace clay (SUBBASE MATERIAL)	64.08	1.07
Black sandy silt, some clay with organic material (FORMER TOPSOIL)	63.78	1.37
Stiff to very stiff, brown to red brown silty clay, trace sand (WEATHERED CRUST)	60.27	4.88
Very loose, grey gravelly silty sand, some clay, with probable cobbles and boulders (GLACIAL TILL)	57.71	7.44
End of Borehole Auger Refusal		

SAMPLES

NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m
1	GS		
2	SS	325	10
3	SS	600	14
4	SS	600	15
5	SS	600	8
6	SS	600	4
7	SS	600	2
8	SS	450	2
9	SS	200	4
10	SS	350	2

● 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

Backfilled with soil cuttings

Soil samples become wet at about 3.8 metres below ground surface

GEMTEC
Consulting Engineers and Scientists

LOGGED: M.L.
CHECKED: K.H.

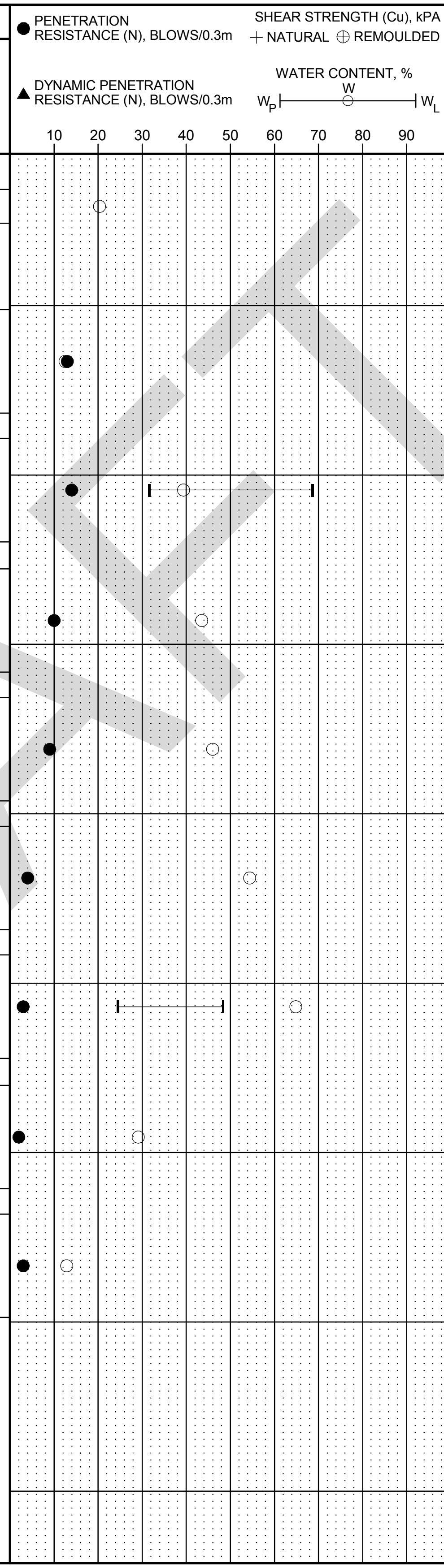
RECORD OF BOREHOLE 19-4

CLIENT: J.L. Richards & Associates Ltd.
PROJECT: Geotechnical Investigation - Proposed Addition
JOB#: 62463.84
LOCATION: See Borehole Location Plan, Figure 1

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

BORING METHOD: Power Auger, Hollow Stem Auger (210mm OD)

SOIL PROFILE – DESCRIPTION	ELEV. / DEPTH (m)	SAMPLE NUMBER	TYPE	RECOVERY, mm	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
Ground Surface	64.74						
ASPHALTIC CONCRETE	64.69 / 0.05						
Dark grey brown sand and gravel, trace silt with brick fragments (BASE MATERIAL)	64.49 / 0.25	1	GS				
Brown silty sand, some gravel, trace clay (SUBBASE MATERIAL)							
Compact, dark brown silty sand, some clay and gravel with organic material (FORMER TOPSOIL)	63.98 / 0.76	2	SS	330	13		Backfilled with soil cuttings
Stiff to very stiff, grey brown silty clay, trace sand (WEATHERED CRUST)	63.22 / 1.52	3	SS	355	14	MH	
		4	SS	250	10		
		5	SS	228	9		
		6	SS	100	4		
Stiff to very stiff, grey SILTY CLAY	60.17 / 4.57	7	SS	600	3	MH	Soil Samples become wet at about 3.8 metres below ground surface
Very loose, grey gravelly silty sand, some clay, with probable cobbles and boulders (GLACIAL TILL)	59.10 / 5.64	8	SS	600	2		
		9	SS	450	3		
End of Borehole Auger Refusal	57.78 / 6.96						



DEPTH SCALE METRES: 0 1 2 3 4 5 6 7 8

GEMTEC
Consulting Engineers and Scientists

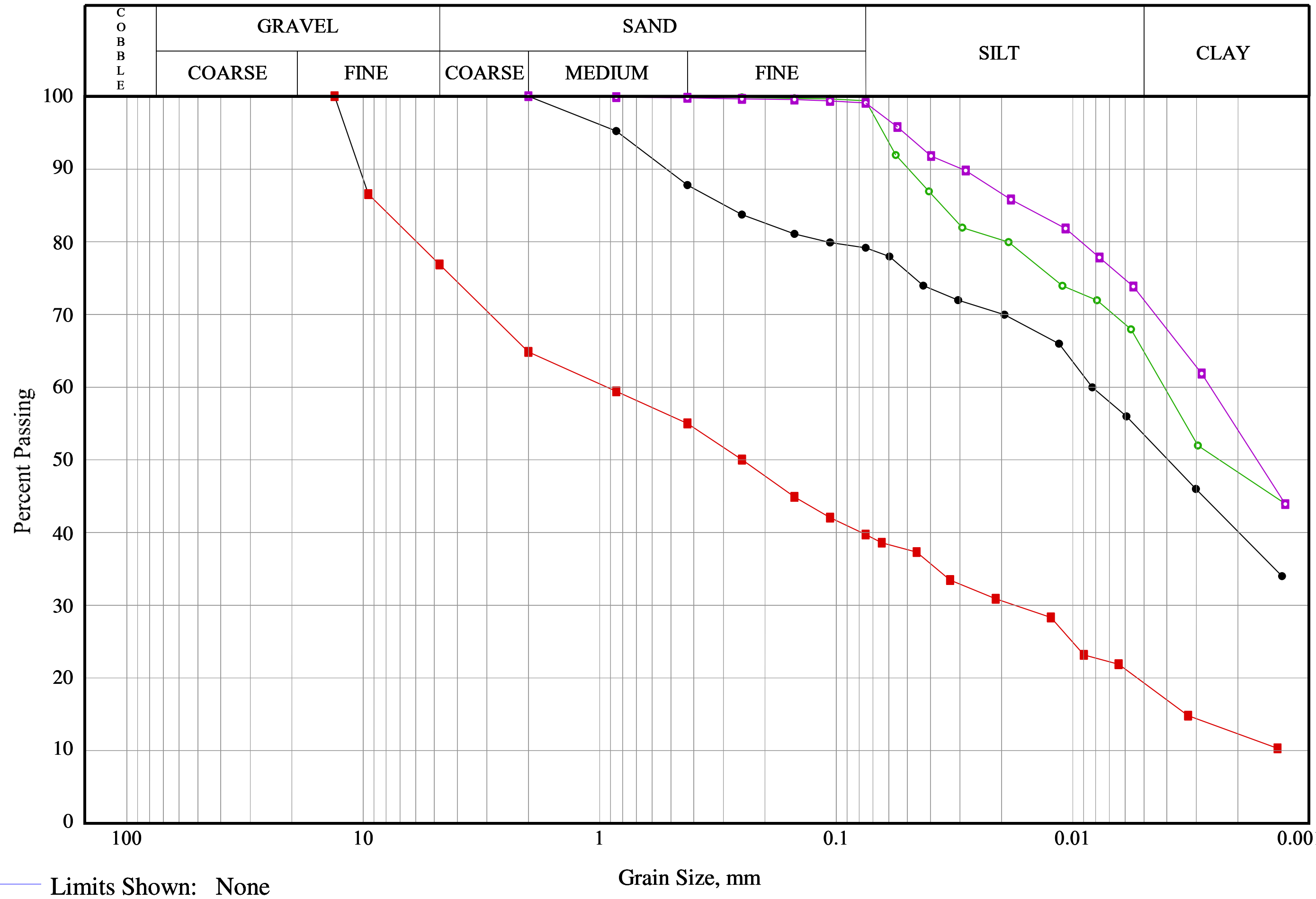
LOGGED: M.L.
CHECKED: K.H.

APPENDIX B

Laboratory Testing
Grain Size Distribution Test Results
Plasticity Chart

Report to: J.L. Richards & Associates Limited
Project: 62463.84 (January 28, 2020)

GEMTEC Consulting Engineers and Scientists	Client: J.L. Richards & Associates Ltd.	Soils Grading Chart
	Project: Geotechnical Investigation, Proposed Addition, Canadian	
	Project #: 6246384	

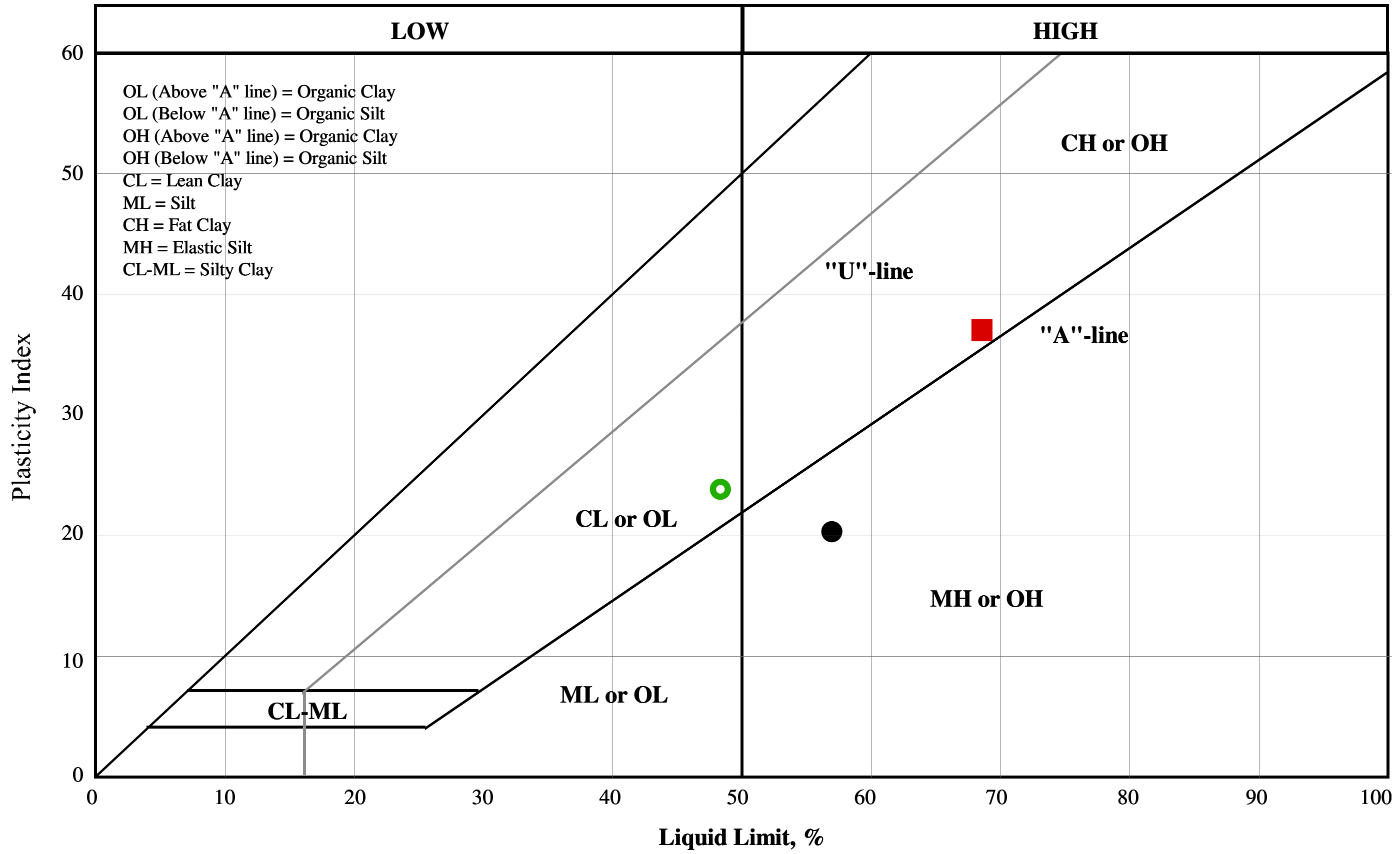


Limits Shown: None

Line Symbol	Sample	Borehole/ Test Pit	Sample Number	Depth	% Cob.+ Gravel	% Sand	% Silt	% Clay
● (black)	Weathered Crust	19-1	04	2.29-2.90	0.0	20.9	25.7	53.5
■ (red)	Glacial Till	19-1	08	5.33-5.94	23.1	37.2	20.4	19.3
○ (green)	Weathered Crust	19-4	03	1.52-2.13	0.0	0.6	34.5	64.9
□ (purple)	Silty Clay	19-4	07	4.57-5.18	0.0	0.9	27.1	72.0

Line Symbol	CanFEM Classification	USCS Symbol	D_{10}	D_{15}	D_{30}	D_{50}	D_{60}	D_{85}	% 5-75µm
● (black)	Sandy silty clay	CH	---	---	---	0.00	0.01	0.30	25.7
■ (red)	Gravelly silty sand , some clay	N/A	---	0.00	0.02	0.25	0.93	8.51	20.4
○ (green)	Silty clay , trace sand	CH	---	---	---	0.00	0.00	0.04	34.5
□ (purple)	Silty clay , trace sand	CL	---	---	---	0.00	0.00	0.02	27.1

GEMTEC Consulting Engineers and Scientists	Client: J.L. Richards & Associates Ltd.	Plasticity Chart
	Project: Geotechnical Investigation, Proposed Addition, Canadian	
	Project #: 6246384	



Symbol	Borehole /Test Pit	Sample Number	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Non-Plastic	Moisture Content, %
●	19-1	04	2.29-2.90	57.0	36.7	20.3	☐	41.23
■	19-4	03	1.52-2.13	68.6	31.6	37.0	☐	39.36
○	19-4	07	4.57-5.18	48.3	24.5	23.8	☐	64.84

APPENDIX C

Soil Chemistry Related to Corrosion
Paracel Laboratories Ltd. Order No. 1922433

Report to: J.L. Richards & Associates Limited
Project: 62463.84 (January 28, 2020)

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Certificate of Analysis

GEMTEC Consulting Engineers and Scientists Limited

32 Steacie Drive
Kanata, ON K2K 2A9
Attn: Kelsey Holkestad

Client PO:
Project: 62463.84
Custody: 121176

Report Date: 5-Jun-2019
Order Date: 30-May-2019

Order #: 1922433

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

Paracel ID	Client ID
1922433-01	19-3 SA-3

Approved By:

Dale Robertson, BSc
Laboratory Director

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

Report Date: 05-Jun-2019
Order Date: 30-May-2019
Project Description: 62463.84

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	4-Jun-19	4-Jun-19
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	4-Jun-19	4-Jun-19
Resistivity	EPA 120.1 - probe, water extraction	5-Jun-19	5-Jun-19
Solids, %	Gravimetric, calculation	4-Jun-19	4-Jun-19

Certificate of Analysis

Client: GEMTEC Consulting Engineers and Scientists Limited

Client PO:

Report Date: 05-Jun-2019

Order Date: 30-May-2019

Project Description: 62463.84

	Client ID:	19-3 SA-3	-	-	-
	Sample Date:	27-May-19 09:00	-	-	-
	Sample ID:	1922433-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	73.9	-	-	-
General Inorganics					
pH	0.05 pH Units	7.53	-	-	-
Resistivity	0.10 Ohm.m	13.2	-	-	-
Anions					
Chloride	5 ug/g dry	334	-	-	-
Sulphate	5 ug/g dry	67	-	-	-

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