

Final Geotechnical ReportMulti-Level Building at 250 Parkdale Avenue Ottawa, ON

Prepared for:

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May 2012

FINAL GEOTECHNICAL REPORT

Table of Contents

1.0	INTRODUCTION	1
2.0	SITE DESCRIPTION AND BACKGROUND	1
3.0	SCOPE OF WORK	1
	METHOD OF INVESTIGATION	
4.1	GEOTECHNICAL FIELD INVESTIGATION	2
5.0	RESULTS OF INVESTIGATION	3
5.1	SUBSURFACE INFORMATION	3
	5.1.1 Surficial Materials	
	5.1.2 Bedrock Bedrock	
5.2	GROUNDWATER	4
6.0	DISCUSSION AND RECOMMENDATIONS	5
6.1	SITE GRADING AND PREPARATION	5
	6.1.1 Building Footprint	
	6.1.2 Paved Areas	
	FOUNDATIONS	
	SEISMIC SITE CLASSIFICATION	
	GROUNDWATER CONTROL	
	PIPE BEDDING AND BACKFILL	
6.6	TEMPORARY EXCAVATIONS AND BACKFILLING	
	6.6.1 Excavations in Soil	
	6.6.2 Excavations in Bedrock	
	6.6.3 Groundwater	
	6.6.5 Rock Anchors	
	6.6.6 Foundation Backfill	
6 7	CEMENT TYPE AND CORROSION POTENTIAL	
	PAVEMENT STRUCTURE RECOMMENDATIONS	
	VIBRATIONS MONITORING AND PRE-CONSTRUCTION SURVEYS	
	OCLOSURE	
Lis	st of Tables	
Tab	ole 5.1: Unconfined Compressive Strength of Rock Cores	4
Tab	ble 6.1: Geotechnical Bearing Resistance for Foundations on Bedrock	6
Tab	ole 6.2: Shear Wave Velocity Information of Selected Boreholes	7
	ole 6.3: Lateral Earth Pressure Parameters	
	ble 6.4: Unfactored Friction Coefficients	
	ble 6.5: pH, Sulphate, Chloride and Resistivity Analysis Results	
Tab	ble 6.6: Recommended Pavement Design	10

FINAL GEOTECHNICAL REPORT

May 2012

APPENDICES

APPENDIX A Statement of General Conditions

APPENDIX B Key Plan

Borehole Location Plan

V_{S30} Measurement Location Plan

Fault Location Plan

APPENDIX C Symbols and Terms Used on Borehole Records

Borehole Records Field Core Logs

Bedrock Core Photos

APPENDIX D Laboratory Test Results

APPENDIX E Rock Anchor: Resistance to Rock Mass Failure

1.0 Introduction

This report presents the results of the Geotechnical Investigation and recommendations carried out for the proposed 28-storey building near the corner of Parkdale Ave. & Scott St., Ottawa, ON. This building will include five below grade parking levels.

The work was carried out in general accordance with our Proposal Number 1224-B11221, dated December 5, 2011.

This report has been prepared specifically and solely for the project described herein. It presents the factual results of the investigation and provides geotechnical recommendations for the design and construction of the proposed building.

2.0 Site Description and Background

It is understood that the proposed 28-storey building is to be located at the southwest corner of Parkdale Avenue and Scott Street. The building is approximately 85 m high and has five underground parking levels. The finish floor elevation of the ground floor has been assumed to be near elevation 62.70 m. The finish floor elevation of the first parking level has been assumed to be near elevation 59.70 m and the finish floor elevation of the fifth parking level is estimated to be 47.7 m. The site area is approximately 1,157 m² and the total gross building floor area (above grade) is approximately 16,357 m².

The location of the proposed building is shown on Drawing No. 1 in Appendix B.

Surficial soil maps indicate the soil conditions in the area consist of fill/glacial till over shallow bedrock within 3 m of ground surface.

3.0 Scope of Work

The scope of work for this investigation included the following:

- Advance five boreholes. Two boreholes were cored to the depths of approximately 16.5 m and 19.7 m below the ground surface. Three boreholes were terminated on shallow bedrock confirmed by auger refusal.
- Install two monitoring wells to measure groundwater levels.
- Survey the ground surface elevations at the borehole locations with reference to a geodetic benchmark.
- Complete a geotechnical laboratory testing program to characterize the soil and rock.

FINAL GEOTECHNICAL REPORT

May 2012

- Prepare a Geotechnical Report outlining the field observations, laboratory results and providing geotechnical recommendations for design and construction of the proposed building including:
 - Bearing capacity of rock for shallow foundations;
 - Lateral earth pressures for shoring systems;
 - Seismic site classification in accordance with 2006 Ontario Building Code;
 - Design recommendations for rock anchors extending to bedrock;
 - Groundwater levels and construction dewatering requirements.

4.0 Method of Investigation

4.1 GEOTECHNICAL FIELD INVESTIGATION

Prior to carrying out the investigation, Stantec Consulting Limited (SCL) personnel marked out the proposed borehole locations at the site. As a component of our standard procedures and due diligence, Stantec arranged to have the borehole locations cleared of both private and public underground utilities.

The field drilling program was carried out on January, 12 and 13, 2012. The five boreholes were advanced, at the locations shown on Drawing No. 2 in Appendix B, with a truck mounted CME 55 auger drill rig. The subsurface stratigraphy encountered in each borehole was recorded in the field by SCL personnel while performing Standard Penetration Tests (SPT). Split spoon samples were collected for surficial fill materials. Bedrock was cored with HQ size coring equipment in boreholes MW 12-3 and MW 12-4 to the depths of 16.5 m and 19.7 m below the ground surface respectively.

Following the investigation, all boreholes were backfilled with augered material. 50 mm diameter monitoring wells were installed in two holes, MW12-3 and MW12-4. Monitoring well MW12-3 was installed to 16.5 m below ground surface and MW 12-4 was installed to 19.7 m below ground surface.

Samples were returned to the laboratory and subjected to detailed visual examination and additional classification by a geotechnical engineer. Selected samples were tested for moisture content, particle size analysis, and intact rock core strength. Groundwater samples collected from the monitoring wells were submitted to Paracel Laboratories to measure pH, resistivity, chlorides, and sulphate content. Results of this testing are shown in Appendix D and on the Borehole and Test Pit Record in Appendix C.

Samples will be stored for a period of one (1) month after issuance of this report unless we are otherwise directed by the client.

Borehole locations were surveyed in the field by Stantec personnel using a Trimble Geo XH GPS. Geodetic ground surface elevations were obtained for all the boreholes and are accurate to 0.1 m.

The ground surface elevations at the borehole locations are shown on the Borehole Records included in Appendix C.

5.0 Results of Investigation

5.1 SUBSURFACE INFORMATION

The subsurface conditions observed in the boreholes are presented in detail on the Borehole Records, Field Core Logs, and Bedrock Core Photos in Appendix C. An explanation of the symbols and terms used to describe the Borehole and Test Pit Records is also provided in Appendix C. In general, the observed stratigraphy consisted of fill material underlain by shallow bedrock.

A general overview of the soil, rock and groundwater conditions encountered in the boreholes is provided below.

5.1.1 Surficial Materials

Asphalt was encountered at the surface of all the boreholes. The asphalt varied from 25 mm to 76 mm in thickness.

Fill materials were observed in all the boreholes and varied from 0.4 m to 1.5 m in thickness. This material generally consisted of silty sand with gravel with some bricks and rock fragments. The moisture content of this material ranged from 10% to 12%. Gradation tests performed on this material show 13% to 46% gravel, 37% to 54% sand, and 15% to 32% fines (silt and clay). This material can be classified as a silty sand with gravel (SM) and silty gravel with sand (GM), according to the Unified Soil Classification System (USCS).

5.1.2 Bedrock

Limestone with shaly partings bedrock was encountered in all the boreholes. The depth to top of bedrock ranged from 0.4 m to 1.5 m below ground surface. The limestone had very close to wide joint spacing which had generally flat orientation. The rock was unweathered with shale partings.

Generally bedrock quality was good to excellent however the top portion of borehole MW 12-3 (down to 1.3 m depth) was observed to be fair quality. The Rock Quality Designation (RQD) varied from 61% to 100%. The unconfined compressive strength of the rock, which is summarized in Table 5.1, ranged from 77 MPa to 173 MPa. Rock Core logs and photos of the rock core are shown in Appendix C.

FINAL GEOTECHNICAL REPORT

May 2012

Table 5.1: Unconfined Compressive Strength of Rock Cores

Borehole	Depth (m)	Unconfined Compressive Strength (MPa)
	5.2	172.8
NAVA / 4.0. 0	9.7	183.9
MW 12-3	12.8 132.3	132.3
	15.8	77.2
	5.2	162.9
NAVA 4 0 4	9.8	140.4
MW 12-4	14.3	137.7
	19.0	135.8

5.2 **GROUNDWATER**

Groundwater was measured by means of monitoring wells installed in boreholes MW 12-3 and MW 12-4. Groundwater was measured on January 25 and February 3, 2012. At monitoring wells MW 12-3 and MW 12-4, the groundwater level was measured at 9.60 m and 7.76 m below ground surface.

Fluctuation in the groundwater level due to seasonal variations or in response to a particular precipitation event should be anticipated.

6.0 Discussion and Recommendations

The following geotechnical issues should be considered during design activities:

- Conventional spread footings founded on bedrock are appropriate for the design of the multi-storey building at this site.
- Groundwater was encountered at depths within the proposed depth of construction. It is anticipated that surface water run-off and groundwater can be controlled with sump and pump methods during construction.
- The bedrock on this site consists of limestone, with a measured unconfined compressive strength ranging between 77 MPa to 173 MPa which suggest strong to very strong rock.
- The Soluble sulphate concentrations show that a low degree of sulphate attack is expected
 for concrete in contact with soil and groundwater. Type GU Portland Cement should
 therefore be suitable for use in concrete at this site.
- The recommended Site Classification for Seismic Site Response for the site is Site Class A in accordance with 2006 Ontario Building Code.

6.1 SITE GRADING AND PREPARATION

6.1.1 Building Footprint

Footings should be founded on sound bedrock. Exposed bedrock surfaces should be free of loose bedrock, soil, water, bedrock irregularities, bedrock pinnacles and sloping surfaces. Hand cleaning and pressure washing of the bearing areas to remove any loose materials will be required to achieve the recommended bearing pressure.

Temporary frost protection should be provided for all footings if construction is carried out under winter conditions.

Prepared subgrade surfaces should be inspected by experienced geotechnical personnel prior to placement of either Structural Fill or concrete.

Structural Fill should conform to the requirements of OPSS Granular A. Structural Fill placed beneath building should contain no recycled materials such as concrete or asphalt. It should be compacted in lifts no thicker than 300 mm to at least 100% Standard Proctor Maximum Dry Density (SPMDD). This material should be tested and approved by a Geotechnical Engineer prior to delivery to the site.

Earth removals should be inspected by a geotechnical engineer to ensure that all unsuitable materials are removed prior to placement of fill or concrete. Inspection and testing services will be critical to ensure that all fill and concrete used is suitable and is placed competently.

6.1.2 Paved Areas

All vegetation, topsoil, existing asphalt and other deleterious material should be removed from beneath pavement areas. The subgrade should be proof rolled in the presence of geotechnical

FINAL GEOTECHNICAL REPORT

May 2012

personnel. All soft areas revealed during proof rolling or subgrade inspections should be excavated to a maximum depth of 500 mm and replaced with compacted OPSS Granular B Type II.

6.2 FOUNDATIONS

The foundations for the proposed building may be supported on spread footings provided that the foundation preparation work described in Section 6.1 above is carried out. Spread footings should be placed on clean undisturbed sound bedrock.

Table 6.1 provides Geotechnical Bearing Resistances for shallow foundations on bedrock.

Table 6.1: Geotechnical Bearing Resistance for Foundations on Bedrock

Foundation Type	Footing Width (m)	Geotechnical Resistance, ULS, (kPa)
Strip Footing	1.0 to 3.0	4500
Square Footing	1.0 to 3.0	5500

The factored geotechnical bearing resistance at ultimate limit states (ULS) incorporates a resistance factor of 0.5. The settlement of foundations founded on bedrock is expected to be negligible and therefore, the geotechnical reaction at Serviceability Limit States (SLS) is not provided for footings on bedrock.

The design frost depth is 1.8 m. All exterior spread footings and footings for unheated structures should be protected from frost action by a minimum soil cover of 1.8 m or equivalent insulation. Perimeter footings should be protected by a minimum soil cover of 1.5 m or equivalent insulation. Perimeter footings and interior footings within 1.5 m of perimeter walls of heated structures should be protected by a minimum soil cover of 1.5 m or equivalent insulation. Where proposed footings have insufficient soil cover for frost protection, the use of insulation will be required.

The base of all footing excavations should be inspected by a geotechnical engineer prior to placing concrete to confirm the design pressures and to ensure that there is no disturbance of the founding soils.

Where construction is undertaken during winter conditions, all footing subgrades should be protected from freezing. Foundation walls and columns should be protected against heave due to soil adfreeze.

6.3 SEISMIC SITE CLASSIFICATION

Existing $V_{\rm S30}$ measurements around the study site were reviewed to determine the site class according to the 2006 Ontario Building Code. The measurements were obtained from the geological Survey of Canada Surficial Boreholes for the National Capital Area. The data is accessible through the Carleton University website called the Interactive Surface Geography Map for the City of Ottawa. The selected boreholes are illustrated in Drawing No. 3 in Appendix B and the corresponding shear wave velocity information is shown in Table 6.2. This Table provides the average shear wave velocity in top 30 m for the studied sites ($V_{\rm s30}$).

May 2012

Based on V_{s30} values, the recommended site classification for seismic site response for the building is Site Class A in accordance with Table 4.1.8.4.A of the 2006 Ontario Building Code. It is noted that Table 6.2 presents V_{s30} values from surface, the underside of the foundations will be near elevation 47.7 m which would result in a higher V_{s30} .

Borehole Name	Borehole ID	Bedrock Depth (m)	V _{s30} (m/sec)	Bedrock Velocity Range (m/sec)
а	UGE05680	1.83	1856	1466-2239
b	UGE00469	1.52	1902	1509-2288
С	UGE05646	1.25	1944	1549-2333

The location of the proposed building and known faults was evaluated. Drawing No. 4 in Appendix B shows the location of the nearest faults. The drawing indicates that the proposed building is not located on a fault.

6.4 GROUNDWATER CONTROL

The groundwater level within monitoring wells MW12-3 and MW 12-4 was measured at elevations of 50.7 m and 53.2 m respectively. The proposed below grade parking levels will be below the groundwater level. The design of the below grade parking levels should consider the groundwater level. The below grade levels could be designed to be waterproof or a subdrain system could be provided. The subdrains should be founded at least 400 mm below the underside of the floor slab and should be connected to a frost free outlet. If subdrains are proposed, the floor slab should be supported on a 400 mm thick layer of clear stone for drainage.

6.5 PIPE BEDDING AND BACKFILL

Bedding for utilities should be placed in accordance with the pipe design requirements. It is recommended that a minimum of 150 mm to 200 mm of OPSS Granular A be placed below the pipe invert as bedding material. Granular pipe backfill placed above the invert should consist of Granular A material. A minimum of 300 mm vertical and side cover should be provided. These materials should be compacted to at least 95% of SPMDD.

Backfill for service trenches in landscaped areas may consist of excavated material replaced and compacted in lifts. Where the service trenches extend below paved areas, the trench should be backfilled with OPSS Select Subgrade Material (SSM) from the top of the pipe cover to within 1.2 m of the proposed pavement surface, placed in lifts and compacted to at least 95% of SPMDD. The material used within the upper 1.2 m and below the subgrade line should be similar to that exposed in the trench walls to prevent differential frost heave, placed in lifts and compacted to at least 95% of SPMDD. Different abutting materials within this zone will require a 3 horizontal to 1 vertical frost taper in order to minimize the effects of differential frost heaving.

Excavations for catch basins and manholes should be backfilled with compacted granular material. A 3 horizontal to 1 vertical frost taper should be built within the upper 1.2 m. The joints between catch basin or manhole sections must be wrapped with non-woven geotextile.

FINAL GEOTECHNICAL REPORT

May 2012

It should be noted that reuse of the site generated material will be highly dependent on the material's moisture content at time of placement.

Backfill should be compacted in lifts not exceeding 300 mm.

6.6 TEMPORARY EXCAVATIONS AND BACKFILLING

6.6.1 Excavations in Soil

The shallow silty sand fill (maximum encountered thickness of 1.3 m) present at the site is considered a Type 3 soil in accordance with the Occupational Health and Safety Act (OHSA) and Regulations for Construction Projects. Temporary excavations in the overburden may be supported or should be sloped at 1 horizontal to 1 vertical from the base of the excavation and as per the requirements of OHSA. Alternatively, sheet piling or other support methods will be required. Excavations should be inspected regularly for signs of instability and flattened as required. The excavation support system should be designed to resist loads from traffic and foundations from adjacent structures.

6.6.2 Excavations in Bedrock

Drilling and blasting and hoe ramming techniques will be required to excavate bedrock. Temporary excavation in bedrock may be carried out at near vertical slopes, provided the trench sides are cleared of loose rock prior to workers entering the trench. If the bedrock is overly fractured such that the loose rock cannot be entirely removed, a temporary rock catchment system such as a wire mesh system should be used. The catchment system should be designed to contain and/or prevent loose rock particles from falling on workers within the excavation.

Bedrock excavation sidewalls adjacent to existing building foundations should be supported to ensure the stability of the existing buildings.

6.6.3 Groundwater

Groundwater was encountered during this geotechnical investigation within the depths of the anticipated excavations.

Though soils and bedrock permeability measurements were not included as part of this investigation, it is expected that dewatering of the excavations will be possible using conventional sump and pump techniques. It should be noted that groundwater elevations fluctuate seasonally. Dewatering of the excavation is not anticipated to cause settlement of soils due to groundwater lowering in the vicinity of the site.

6.6.4 Earth Pressures on Shoring Systems

Earth pressures will need to be considered in the design of shoring systems for temporary excavations during construction. Table 6.3 gives the coefficients of lateral earth pressure for shoring systems. These values are based on the assumption that a horizontal back slope will be utilized behind the shoring system.

Table 6.3: Lateral Earth Pressure Parameters

Parameter	Native Fill	OPSS Granular A	OPSS Granular B Type I
Unit Weight (kN/m³)	19	22.0	21.2
Angle of Internal Friction, Φ	32°	40°	35°
Coefficient of Passive Earth Pressure, K _p	3.25	4.60	3.69
Coefficient of at Rest Earth Pressure, K _o	0.47	0.36	0.43
Coefficient of Active Earth Pressure, K _a	0.31	0.22	0.27

Sliding resistance can be calculated using the following unfactored friction coefficients, outlined in Table 6.4.

Table 6.4: Unfactored Friction Coefficients

Condition	Unfactored Friction Coefficient
Between Concrete and Structural Fill	0.55
Between Concrete and Clean Bedrock	0.6

6.6.5 Rock Anchors

Rock anchors could be used to ensure stability of temporary shoring system and resist uplift forces. For the design of rock anchors extending into bedrock, the following design parameters may be considered for the rock mass.

- A rock to grout working bond stress of 1000 kPa may be used for holes grouted with nonshrink grout having a minimum compressive strength of 30 MPa.
- The minimum fixed anchor length (i.e. the length over which the rock to grout bond stress is developed) should be no less than 3 m.
- The unbounded length of anchor should be equal to the height of the rock cone and less half the bonded length.

To ensure against the possibility of a rock mass failure, the following design parameters should be used:

- Submerged Unit weight of rock = 16 kN/m3
- A 90° (apex angle) failure cone with the apex located at the midpoint of the bonded length as shown on the sheet titled "Rock Anchor: Resistance to Rock Mass Failure" in Appendix E.

The bond stress used by the contractor for design should be confirmed by full scale testing of anchors.

6.6.6 Foundation Backfill

Backfill within the footprint of the proposed buildings should consist of OPSS Granular A compacted to 100% SPMDD. Exterior foundation backfill should consist of a material meeting the requirements of OPSS Select Subgrade Material (SSM).

FINAL GEOTECHNICAL REPORT

May 2012

Exterior foundation backfill shall be placed in lifts no thicker than 300 mm and compacted using suitable compaction equipment to at least 95% of SPMDD. Care should be taken immediately adjacent to the foundation walls to avoid over-compaction of the soil which could result in damage to the walls.

6.7 CEMENT TYPE AND CORROSION POTENTIAL

One representative groundwater sample was submitted to Paracel Laboratories Ltd. in Ottawa, Ontario, for pH, chloride, sulphate and resistivity testing. The test results are summarized in Table 6.5.

Table 6.5: pH, Sulphate, Chloride and Resistivity Analysis Results

Borehole No.	рН	Sulphate (µg/g)	Resistivity (0.01 ohm.m)	Chloride (µg/g)
MW12-4	6.9	179	1.83	1950

One concentration of soluble sulphate provides an indication of the degree of sulphate attack that is expected for concrete in contact with soil and groundwater at the site. The soluble sulphate is 179 μ g/g. Soluble sulphate concentrations less than 1000 μ g/g generally indicate that a low degree of sulphate attack is expected for concrete in contact with soil and groundwater. Type GU Portland Cement should therefore be suitable for use in concrete at this site.

The pH, resistivity and chloride concentration provide an indication of the degree of corrosiveness of the sub-surface environment. The soil pH was 6.9 which is within what is considered the normal range for soil pH of 5.5 to 9.0. The pH levels of the tested soil do not indicate a highly corrosive environment. The test results provided in the Table 6.5 can be used to aid in the selection of coatings and corrosion protection systems for buried steel objects.

6.8 PAVEMENT STRUCTURE RECOMMENDATIONS

It has been assumed that the parking areas will be used mostly by passenger vehicles and the access roads will be used by delivery trucks and fire vehicles.

The subgrade in paved areas should be prepared as described in Section 6.1 above. The following minimum pavement structures are recommended:

Table 6.6: Recommended Pavement Design

Table tier itteetiinienata ravenient Beelgii				
Material	Heavy Duty Parking Access Roads	Standard Duty Parking Area		
SP 12.5 Asphaltic Concrete	40 mm	50 mm		
SP 19 Asphaltic Concrete	50 mm	-		
Granular Base Course, OPSS Granular A	150 mm	150 mm		
Granular Subbase Course, OPSS Granular B Type II	400 mm	300 mm		

Stantec FINAL GEOTECHNICAL REPORT

May 2012

It is estimated that the service life prior to major rehabilitation for the above pavement structures is 20 years provided they are properly maintained. The pavement surface and the underlying subgrade should be graded to direct runoff water towards suitable drainage.

All granular materials should be tested and approved by a geotechnical engineer prior to delivery to the site. Both base and subbase materials should be compacted to at least 100% SPMDD. Asphalt should be compacted to at least 97% Marshal bulk density.

It is recommended that the lateral extent of the subbase and base layers not be terminated in a vertical fashion immediately behind the curb line. A taper with a grade of 5 horizontal to 1 vertical is recommended in the subgrade line to minimize differential frost heave problems under sidewalks.

6.9 VIBRATIONS MONITORING AND PRE-CONSTRUCTION SURVEYS

The required construction activities for the proposed building will generate some vibrations that will be perceptible to nearby residents. The vibrations are expected to be greatest during bedrock excavation by blasting/mechanical methods. It is recommended that pre-construction surveys of all structures be carried out in accordance with OPSS 120 "General Specifications for the Use of Explosives".

It is recommended that construction vibrations generally be limited to a maximum peak particle velocity as outlined in OPSS 120. Should there be structures in the area sensitive to vibrations, more stringent specifications should be developed by a vibration specialist. For instance, the particle velocity should be limited to 10 mm/sec if there is a historic building in the area. Vibration monitoring should be carried out prior to and throughout the construction period.

No blasting should be carried out within a distance of 200 m from any water storage reservoir, pumping station, water works transformer station or water storage tank without prior approval by the owner of the facility.

FINAL GEOTECHNICAL REPORT May 2012

6.10 CLOSURE

Use of this report is subject to the Statement of General Conditions provided in Appendix A. It is the responsibility of Richcraft, who is identified as "the Client" within the Statement of General Conditions, and its agents to review the conditions and to notify Stantec should any of these note be satisfied. The Statement of General Conditions addresses the following:

- Use of the report
- Basis of the report
- Standard of care
- Interpretation of site conditions
- Varying of unexpected site conditions
- Planning, design or construction

This report has been prepared by Kasgin Khaheshi Banab and reviewed by Chris McGrath.

Respectfully submitted,

STANTEC CONSULTING LIMITED

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Stantec FINAL GEOTECHNICAL REPORT May 2012

APPENDIX A

Statement of General Conditions

STATEMENT OF GENERAL CONDITIONS

<u>USE OF THIS REPORT</u>: This report has been prepared for the sole benefit of the Client or its agent and may not be used by any third party without the express written consent of Stantec Consulting Ltd. and the Client. Any use which a third party makes of this report is the responsibility of such third party.

<u>BASIS OF THE REPORT</u>: The information, opinions, and/or recommendations made in this report are in accordance with Stantec Consulting Ltd.'s present understanding of the site specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time of the investigation or study. If the proposed site specific project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Stantec Consulting Ltd. is requested by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

<u>STANDARD OF CARE</u>: Preparation of this report, and all associated work, was carried out in accordance with the normally accepted standard of care in the state or province of execution for the specific professional service provided to the Client. No other warranty is made.

<u>INTERPRETATION OF SITE CONDITIONS</u>: Soil, rock, or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Stantec Consulting Ltd. at the time of the work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behavior. Extrapolation of in situ conditions can only be made to some limited extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

<u>VARYING OR UNEXPECTED CONDITIONS</u>: Should any site or subsurface conditions be encountered that are different from those described in this report or encountered at the test locations, Stantec Consulting Ltd. must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Stantec Consulting Ltd. will not be responsible to any party for damages incurred as a result of failing to notify Stantec Consulting Ltd. that differing site or subsurface conditions are present upon becoming aware of such conditions.

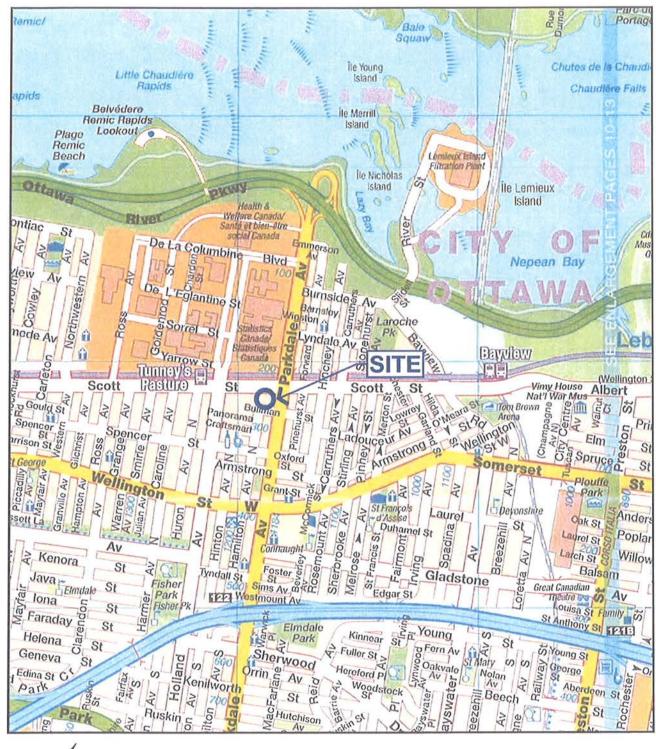
<u>PLANNING, DESIGN, OR CONSTRUCTION</u>: Development or design plans and specifications should be reviewed by Stantec Consulting Ltd., sufficiently ahead of initiating the next project stage (property acquisition, tender, construction, etc), to confirm that this report completely addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Site work relating to the recommendations included in this report should only be carried out in the presence of a qualified geotechnical engineer; Stantec Consulting Ltd. cannot be responsible for site work carried out without being present.

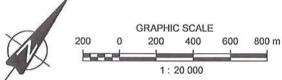


Stantec FINAL GEOTECHNICAL REPORTMay 2012

APPENDIX B

 $\label{eq:Key Plan} \text{Key Plan}$ Borehole Location Plan $\text{V}_{\text{S30}} \text{ Measurement Location Plan}$ Fault Location Plan





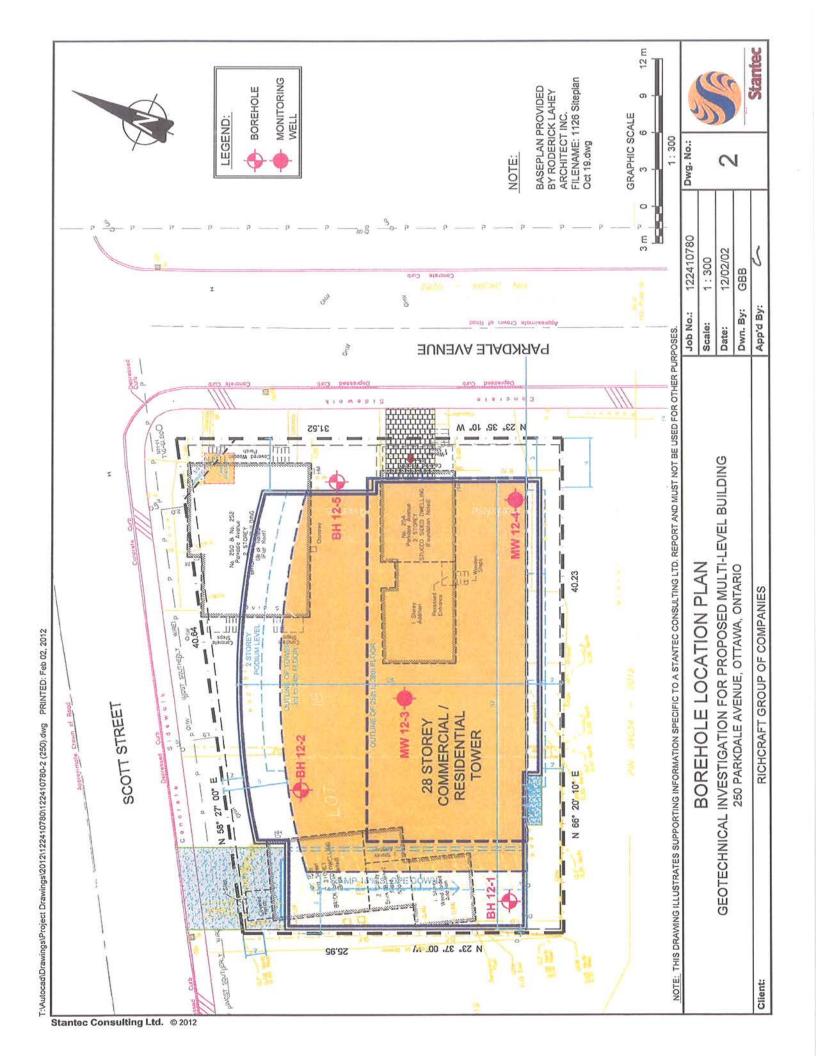
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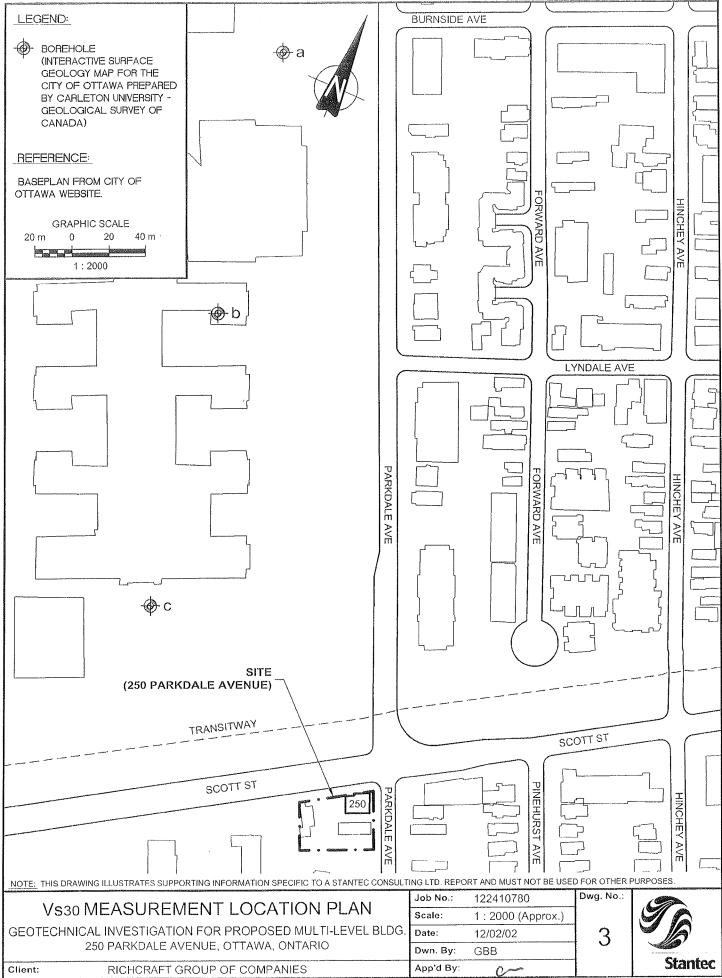
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GEOTECHN	IICAL INVESTIGATION FOR PROPOSED MULTI-LEVEL BDLG.	I
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Stantec FINAL GEOTECHNICAL REPORTMay 2012

APPENDIX C

Symbols and Terms Used on Borehole Records

Borehole Records

Field Core Logs

Bedrock Core Photos

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

Topsoil	- mixture of soil and humus capable of supporting vegetative growth
Peat	- mixture of visible and invisible fragments of decayed organic matter
Till	- unstratified glacial deposit which may range from clay to boulders
Fill	- material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

Desiccated	- having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
Fissured	- having cracks, and hence a blocky structure
Varved	- composed of regular alternating layers of silt and clay
Stratified	- composed of alternating successions of different soil types, e.g. silt and sand
Layer	- > 75 mm in thickness
Seam	- 2 mm to 75 mm in thickness
Parting	- < 2 mm in thickness

Terminology describing soil types:

The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488). The classification excludes particles larger than 76 mm (3 inches). The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):

Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present:

Trace, or occasional	Less than 10%
Some	10-20%
Frequent	> 20%

Terminology describing compactness of cohesionless soils:

The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test N-Value (also known as N-Index). A relationship between compactness condition and N-Value is shown in the following table.

Compactness Condition	SPT N-Value
Very Loose	<4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

Terminology describing consistency of cohesive soils:

The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests.

Consistancy	Undrained Shear Strength									
Consistency	kips/sq.ft.	kPa								
Very Soft	<0.25	<12.5								
Soft	0.25 - 0.5	12.5 - 25								
Firm	0.5 - 1.0	25 - 50								
Stiff	1.0 - 2.0	50 – 100								
Very Stiff	2.0 - 4.0	100 - 200								
Hard	>4.0	>200								



ROCK DESCRIPTION

Terminology describing rock quality:

remineregy accorning room quanty.												
RQD	Rock Mass Quality											
0-25	Very Poor											
25-50	Poor											
50-75	Fair											
75-90	Good											
90-100	Excellent											

Rock quality classification is based on a modified core recovery percentage (RQD) in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be due to close shearing, jointing, faulting, or weathering in the rock mass and are not counted. RQD was originally intended to be done on NW core; however, it can be used on different core sizes if the bulk of the fractures caused by drilling stresses are easily distinguishable from *in situ* fractures. The terminology describing rock mass quality based on RQD is subjective and is underlain by the presumption that sound strong rock is of higher engineering value than fractured weak rock.

Terminology describing rock mass:

Spacing (mm)	Joint Classification	Bedding, Laminations, Bands
> 6000	Extremely Wide	-
2000-6000	Very Wide	Very Thick
600-2000	Wide	Thick
200-600	Moderate	Medium
60-200	Close	Thin
20-60	Very Close	Very Thin
<20	Extremely Close	Laminated
<6	-	Thinly Laminated

Terminology describing rock strength:

Strength Classification	Unconfined Compressive Strength (MPa)
Extremely Weak	<1
Very Weak	1 – 5
Weak	5 – 25
Medium Strong	25 – 50
Strong	50 – 100
Very Strong	100 – 250
Extremely Strong	> 250

Terminology describing rock weathering:

Term	Description								
Fresh	No visible signs of rock weathering. Slight discolouration along major discontinuities								
Slightly Weathered	Discolouration indicates weathering of rock on discontinuity surfaces. All the rock material may be discoloured.								
Moderately Weathered	Less than half the rock is decomposed and/or disintegrated into soil.								
Highly Weathered	More than half the rock is decomposed and/or disintegrated into soil.								
Completely Weathered	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.								



STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.

















Fill







Boulders Cobbles Gravel







Asphalt

Concrete

Bedrock

Metamorphic

Bedrock

mentary Bedrock

SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)							
ST	Shelby tube or thin wall tube							
DP	Direct-Push sample (small diameter tube sampler hydraulically advanced)							
PS	Piston sample							
BS	Bulk sample							
WS	Wash sample							
HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond coring bits.							





measured in standpipe. piezometer, or well



inferred

RECOVERY

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock core, recovery is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

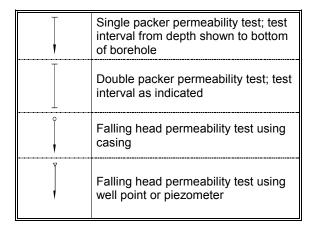
Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (64 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (305 mm) into the soil. For split spoon samples where insufficient penetration was achieved and N-values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N value corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to A size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (305 mm) into the soil. The DCPT is used as a probe to assess soil variability.

OTHER TESTS

S	Sieve analysis
Н	Hydrometer analysis
k	Laboratory permeability
γ	Unit weight
G₅	Specific gravity of soil particles
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure
	measurements
UU	Unconsolidated undrained triaxial
DS	Direct Shear
С	Consolidation
Q_u	Unconfined compression
	Point Load Index (Ip on Borehole Record equals
I_p	I _p (50) in which the index is corrected to a reference
	diameter of 50 mm)





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1 of 2 **Stantec** MONITORING WELL RECORD MW 12-3 CLIENT Richcraft Group of Companies MW 12-3 BOREHOLE No. LOCATION 250 Parkdale Ave.- Ottawa, ON 122410780 PROJECT No. DATES: BORING January 12, 2012 WATER LEVEL February 3, 2012 Geodetic DATUM _____ UNDRAINED SHEAR STRENGTH - kPa SAMPLES ELEVATION (m) 200 STRATA PLOT WATER LEVEL DEPTH (m) RECOVERY N-VALUE OR RQD SOIL DESCRIPTION TYPE WATER CONTENT & ATTERBERG LIMITS DYNAMIC PENETRATION TEST, BLOWS/0.3m STANDARD PENETRATION TEST, BLOWS/0.3m 60.32 \64 mm ASPHALT 60.3 1111 FILL: brown silty gravel with sand, some brick 111111111 1111 1111 BS 1 59.4 1111 LIMESTONE with shaly HQ 100% 61% 1 partings 3111 1111 1111 \Box -Grev 1111 -Fair to excellent rock mass 2 HQ 98% 88% quality 1111 -Close to wide spacing -Strong intact rock strength -Unweathered 3 -Fractured dip 0 to 20° See Field Core Log for detailed 1111 | 1111 | 1111 | 1111 $\Pi\Pi$ НО 100% 100% description of rock core $\Pi\Pi\Pi$ 4 1111 111111111 1111111111 1111 11115 НО 100% 94% 1111 1111 11111 1111 1111 ± 111 6 1 : : : : 1 | 1 : : : 1 | 1 : : : : : НО 99% 82% 11111111 1111 $\Box\Box\Box$ 7 1111 1111 111111111111111111111 \square 8 HQ 91% 85% 1111 1111 9 шин 1111 100% 100% HQ 11111111111111111 1111 1111

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DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD	
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-10~									10 20 30 40 50 60 70 80 90
10		LIMESTONE with shaly	H						
<u> </u>		partings		4	 	<u> </u>			
-11		-Grey	日	1					
111		-Good to excellent rock mass quality	E		HQ	8	98%	98%	
-		-Very close to wide spacing	H	1	````		70,0)) , ,	
-12-		-Strong intact rock strength -Unweathered	H	4					
14		-Fractured dip 0 to 20°	日	1					
		See Field Core Log for detailed				-			
12		description of rock core	田	1	HQ	9	100%	100%	
-13-			H	4 1					
			上	4	<u> </u>	<u> </u>			
]	1				
-14-							200/	2004	
			F		НQ	10	98%	98%	
			H		<u> </u>				
-15-			臣	4		-			<u></u>
			H						
					HQ	11	100%	89%	
-16-			H	4	`				<u> </u>
									-
-17-			上						
			日		HQ	12	97%	94%	
]			片	1 1					
-18-			臣	1					
			H	,					
			占		,				
-19-			F	1	НQ	13	100%	100%	
			片						
	41.3	End of borehole	- =	H	 	<u> </u>			
-20		Lild of potentie	<u></u>	Ш		<u> </u>		L	☐ Field Vane Test, kPa
	[☑ Inferred Groundwater Level							Remoulded Vane Test, kPa App'd

△ Pocket Penetrometer Test, kPa Date

STAN-GEO 122410780_PARKDALE_SCOTT.GPJ SMART.GDT 2/3/12

▼ Groundwater Level Measured in Standpipe

	§ St	antec	MONI	T (OF	NIS	G 1	WEL	LR	ECORD	M	W 12	2-4
		Richcraft Group of Co	=										MW 12-4
		250 Parkdale Ave O											
DA	ATES: BO	RING January 13, 201	12 WATE	ER L	EVE	L		Janu	ary 25		· — · · · · · · · · · · · · · · · · · ·		
	Ê			<u> </u>	,,		SA	MPLES		UNDRA 50	AINED SHEAR STRENG 100 1	STH - kPa 50	200
ОЕРТН (m)	ELEVATION (m)	CON DECCRIPTION	ON	STRATA PLOT	WATER LEVE		64	.R ≺	<u> </u>	ļ		 	
DEPT	EVAT	SOIL DESCRIPTI	ON	RAT/	ATER	TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD	WATER CONTENT &	ATTERBERG LIMITS	₩	₩ W _L
	ᇤ			,	W		Z	S.	żΟ	i	ION TEST, BLOWS/0.3m ATION TEST, BLOWS/0.3		*
										10 20 30	•		80 90
20 		Monitoring well instal	led									11111	
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1												11111	
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.]												111111	
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28-													
1													
29-													
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30 -						Ц	1						
			r Level							☐ Field Vane T		App'd	
		Groundwater Level M		andı	nine					B .	rometer Test kPa		

STAN-GEO 122410780_PARKDALE_SCOTT.GPJ SMART.GDT 2/3/12

9	န် St	antec 1	BO	RI	E H (OL.	E RI	ECO	ORD BH 12-5
CI	LIENT	Richcraft Group of Companies							BOREHOLE No. BH 12-5
LC	CATION	250 Parkdale Ave Ottawa, ON							PROJECT No. 122410780
DA	ATES: BO	RING January 12, 2012 WAT	ŒR L	EVE	L				DATUM Geodetic
	÷		1.			SA	MPLES		UNDRAINED SHEAR STRENGTH - kPa
(E)	ELEVATION (m)		STRATA PLOT	WATER LEVEL		T	≿		50 100 150 200
ОЕРТН (m)	VATIC	SOIL DESCRIPTION	RATA	ER L	TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR ROD	WP W WL WATER CONTENT & ATTERBERG LIMITS
ā	ELE		STR	WA	۴	N	REC(Ā Q 5 K	DYNAMIC PENETRATION TEST, BLOWS/0.3m
			+	\vdash					STANDARD PENETRATION TEST, BLOWS/0.3m
-0-	62.89 62.8	76 mm ASPHALT	ΓΧΧΧ		Т-	ļ		<u> </u>	10 20 30 40 50 60 70 80 90
	62.8	FILL: brown to dark brown silty	′ ₩					l t	
		gravel with sand, some rock	\otimes		. L				
-1-	61.7	fragments	\otimes		SS	1		50/	<u> </u>
-	01.7	End of borehole						152mm	
F :=		A was no five at one in famous							
- 2 -		Auger refusal on inferred bedrock							
-									
- 3 -									
					i				
- 4 -									
5									
F·					į			ļ	
-6-									
"									
F = 1									
7 -									
1									
- 8 -									
-									
- 9 -									
10				Ш	Ш_		<u> </u>	<u></u>	
		☐ Inferred Groundwater Level							☐ Field Vane Test, kPa ☐ Remoulded Vane Test, kPa App'd
		▼ Groundwater Level Measured in S	Stand	pipe					□ Remoulded Vane Test, kPa App'd Δ Pocket Penetrometer Test, kPa Date

STAN-GEO 122410780_PARKDALE_SCOTT.GPJ SMART.GDT 2/3/12

Field Core Log



Richcraft Group of Companies Parkdale at Scott Contractor: Projects Client:

, 2012 page 1 of 3) 122410780 Project No.:

Bridgit Bocage Logger:

January 12,	MW 12-3 (p.	:
Date:	Borehole No.:	

				IL.		 	10			DISCO	DISCONTINUITIES	TIES			
GENERAL DESCRIPTION GENERAL DESCRIPTION GONERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	% RQD	ОТ НТЧЭО		GENERAL DESC (Rock Type/s, %, Colou	.RIPTION ır, Texture, etc.)	STRENGTH	ИІЯЭНТАЭМ	NO. OF SETS	TYPE/S	ИОІТАТИЗІЯО	SPACING	ROUGHNESS	ЭЯОТЯЭЧА	OCCASIONAL	DRILLING OBSERVATIONS
									В	ц	VC/M	RU		T	
HQ 1 100 61 1.35 Grey Limestone	61 1.35	1.35		Grey Limestor	Je		<u> </u>	~						Shale Partings	

									മ	ட	U	₩			
HQ 2 98 88 2.84 Grey Limestone	88 2.84	2.84		Grey Limestone			<u> </u>	7	В	>	Z/ C	GS	\dashv	T Shale Partings	
									(,			\dagger		
									n	L	/ vv	2			
HQ 3 100 100 4.37 Grey Limestone	100 4.37	4.37		Grey Limestone			<u> </u>	Н						Shale Partings	
									В	u	C/M	RU	_	F	****
HQ 4 100 94 5.89 Grey Limestone	94 5.89	5.89		Grey Limestone			_	2	В	^	C/M	RU		—	
STRENGTH (MPa)	STRENGTH (MPa)	STRENGTH (MPa)	ENGTH (MPa)	1 (MPa)		DISCONTINUITY TYPE	UITY I	PE		O,	ORIENTATION	NOIL			FILLING
EH = Extremely Strong = > 250 VW = Very Weak = 1-5			VW = Very Weak = 1.5	VW = Very Weak = 1.5	B	B = Bedding Joint	ij			: = Flat	$F = Flat = 0-20^{\circ}$			T = Tight, Hard	ס־
VS = Very Strong = 100-250 EW = Extremely Weak = < 1			EW = Extremely Weak = < 1	EW = Extremely Weak = < 1	11	J = Cross Joint			_	J = Dip	$\sin g = 2$	0-50		0 ≈ Oxidized	
					ц. Н	F = Fault				V = n - V	$V = n-Vertical = >50^{\circ}$	>500		SA = Slightly	SA = Slightly Altered, Clay Free
MS = Medium Strong = 25-50	ong = 25-50	-50			S	S = Shear Plane	a)							S = Sandy, Cla	S = Sandy, Clay Free
W = Weak = 5 - 25	15										ROUG	ROUGHNESS		Si = Sandy, Si	ty, Minor Clay
						SMISVOS	0141			₹U = Ro	RU = Rough Undulating	dulating		NC = Non-softening Clay	tening Clay
WEATHERING	EKING					SPA			-	P = Ro	RP = Rough Planar	, ,		SC = Swelling, Soft Clay	. Soft Clay
U = Unweathered = No Signs	= No Signs	รักร			\$	VW = Very Wide = >3m	le = >3r	٤	_ 0	21 - 17 72 - 17	ni = nought landidating SH = Smooth Undulating	id. Idulatir	ь	•	
S = Slightly = Oxidized	ized				⋛	W = Wide = 1-3 m	E		, 0	201	SD - Smooth Planar	in a con	۵		
M = Moderately = Discoloured	: Discoloured	ured			Ë (M = Moderate = 0.3-1 m	= 0.3-1	Ε	,		or = Sincour rianai 10 = Slickensided Undulating	d Undu	lating		
H = Highly = Friable C = Completely = Soil life	e control				< ر"	C = Close = 5-30 cm VC = Very Close = <5 cm	יובים ה≃<5 כ	ε.		.P = Slic	LP = Slickensided Planar	d Plana)		
C = COMPIETERY = 3011-11RE	COILTING				,	Y	,								

Field Core Log



Richcraft Group of Companies Parkdale at Scott Project: Client:

Contractor:

lary 12, 2012 Project No.:

122410780

12-3 (page 2 of 3) Bridgit Bocage Logger:

Jan	≶
·	 Q
ate:	orehole

	DRILLING OBSERVATIONS													FILLING			red, Clay Free	ree	Minor Clay	ing Clay	it clay				
	OCCASIONAL FEATURES		Shale Partings			Shale Partings								HIL	T = Tight, Hard	O = Oxidized	SA = Slightly Altered, Clay Free	S = Sandy, Clay Free	Si = Sandy, Silty, Minor Clay	NC = Non-softening Clay	SC = SWelling, SOIL CIAY				
	FILLING	Т	-		T			Ъ			⊢														
	ЗЯИТЯЗЧА																		ιΛΙ	6.0		<u>م</u>	4	ulaurig ar	
JITIES	ROUGHNESS	RP	RU		C/M RU/RP			C/M RM/RP			RU/RP			ATION		0-20	. >500		ROUGHNESS	RU = Rough Undulating	nar	SU = Smooth Undulating	SP = Smooth Planar	LO = Slickensided Offaur LP = Slickensided Planar	
DISCONTINUITIES	5PACING	C/M	U		C/M			C/M			VC/M RU/RP			ORIENTATION	= 0-20 ₀	ing = 2	ertical =		ROU	ugh Un	ugh Pla	ooth U	Doth Pi	kenside	
DISCO	ORIENTATION	ш	>		14-		· ·	ட			F				$F = Flat = 0-20^{\circ}$	$D = Dipping = 20-50^{\circ}$	= n-Ve			U = Ro	RP = Rough Planar	es i	SP = Smootn Planar 111 = Sliebengided 115	0 = Sir. P = Sir.	
	TYPE/S	В	В		В			В			В				L.L.		>			∝	<u>~</u> }	י ע	л <u>-</u>	3 3	
	NO. OF SETS		7		Н			<u></u>	н	L		m)E									٤		۰
	○ WEATHERING			n				>	•		⊃		TYF TYF						9	= >3m	Ε	0.3-1 r	cm	- <5 CH	
	STRENGTH										-			DISCONTINUITY TYPE	ng Join	Joint		Plane		SPACING	y Wide	5 = 1-3	erate =	= 5-30	Ciose
	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)		Grey Limestone			Grey Limestone			Grey Limestone			Grey Limestone		STRENGTH (MPa)	VW = Very Weak = 1-5 B = Bedding Joint	EW = Extremely Weak = < 1 J = Cross Joint	F = Fault	S = Shear Plane			VW = Very Wide = >3m	W = Wide = 1-3 m	M = Moderate = 0.3-1 m	C = Close = 5-30 cm	VC = Very Close = <5 cm
	OT HT930 54.		8.94		10.47				11.96		STRENG	0			_					g					
	% вор		82	85				100			66			g = > 25	0-250		= 25-50		9	o Signs		coloure	(A)	-ike	
КИ	% COKE RECOVI		66			91			100			100			/ Strong	ng = 10)-100	Strong	- 25	WEATHERING	red = N	xidized	ly = Dis	iable	-100 = /
	кои ио.		HQ 5			HQ 6		HQ 7			HQ 8		EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25 WEATHERING U = Unweathered = No Signs S = Slightly = Oxidized			derate	M = Nioderately = D H = Highly = Friable								
ı	7. 42 S. 89 DEPTH FROM				8.94			10.47			EH = EX	VS = Ve	S = Stro	MS = N	W = W		U=Un	S = Slig	M = Moderately = Discoloured	H=Hig	C = Completely = Soll-like				



Richcraft Group of Companies Parkdale at Scott

Contractor: Project: Client:

122410780 Project No.:

January 12, 2012 Date:

MW 12-3 (page 3 of 3) Borehole No.:

Bridgit Bocage Logger:

		I -		Т			Γ				 T
	DRILLING OBSERVATIONS	Lost water @ 39'3"	Water appeared at approx 41'		Lost water @ approx. 44'2"						EILLING T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free SI = Sandy, Clay Free SI = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay
	OCCASIONAL FEATURES										FILLING T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Fr S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay
	EITFING	Ţ		T			Τ				
	ая ит яачА										S B B In B In Ulating
JITIES	ВОПЕНИЕ22	RU		SU			SU			 	ORIENTATION F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50° RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating SP = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar
DISCONTINUITIES	SPACING	M/W		C/M			Σ				ORIENTATION t = 0-20° oping = 20-50° fertical = >50° ROUGHNES Ough Undulati ough Planar mooth Undulati ckensided Unc
DISCC	ИОІТАТИЗІЯО	ц		F			ш				P = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50° V = Rough Undulati RP = Rough Planar SU = Smooth Planar SP = Smooth Planar LU = Slickensided Unc
	TYPE/S	В		В			В				
	NO. OF SETS		н		Н			П]]
ć	WEATHERING		<u> </u>		<u> </u>			>			DISCONTINUITY TYPE Bedding Joint Cross Joint Fault Shear Plane SPACING SPACING Wide = 1-3 m Wide = 1-3 m Wide = 5-30 cm
	STRENGTH										ONTINUITY Jing Joint Joint r Plane SPACING ry Wide = 0. Werate = 0.
	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)		Grey Limestone		Grey Limestone			Grey Limestone			STRENGTH (MPa) O VW = Very Weak = 1-5 EW = Extremely Weak = < 1 F = Fault S = Shear Plane SPACING VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm
	OT HT430		13.46		14.96			16.46			STRENG 50 0
	ж вор		100		96			100			g = > 2: 00-250 (= 25-5 (= 25-5 scolouri
ЕВЛ	% СОВЕ ВЕСОЛ		100		100		100				emely Strong = Strong = 100-7 = 50-100 lium Strong = 7 = 5 - 25 WEATHERING athered = No 8 y = Oxidized = Friable
	.ои иоя		НД 9	НQ 10		HQ 11			EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25 W = Weak = 5 - 25 U = Unweathered = No Signs S = Slightly = Oxidized H = Highly = Friable		
V	DЕЬТН FRO <i>N</i>		11.96		13.46			14,96			EH = E: VS = V(S =



Richcraft Group of Companies Parkdale at Scott Contractor: Project: Client:

122410780 Date:

Project No.:

January 13, 2012 **Borehole No.:**

MW 12-4 (page 1 of 4) Bridgit Bocage Logger:

	DRILLING OBSERVATIONS		Shale Partings			Shale Partings			Shale Partings		Shale Partings	FILLING			ered, Clay Free	ree	IVIIIOI CIAY	oft Clav						
	OCCASIONAL FEATURES												T = Tight, Hard	O = Oxidized	SA = Slightly Altered, Clay Free	S = Sandy, Clay Free	SI = Sandy, Silty, Williof Clay	SC = Swelling, Soft Clav	ò					
	FILLING	-			⊥	Н		Н	F	⊢														
	<u> </u> ЗЯПТЯЗЧА																<u>က</u> ျ	ట్ల	ing)	SP = Smootn Planar LU = Slickensided Undulating	ıar		
JITIES	ВОПЕНИЕ22	RU			RU	RU		RU	RU	R		ATION		20-50	= >50 ₀		ROUGHNESS	RU = Rough Undulating	RP = Rough Plana! SU = Smooth Undulating	anar	ed Und	Slickensided Planar		
DISCONTINUITIES	ЭИІЭАЧЗ	VC/M			C/M	C/M		C/M	C/M	Μ/Μ		ORIENTATION	$F = Flat \approx 0.20^{\circ}$	$D = Dipping = 20-50^{\circ}$	$V = n$ -Vertical = $>50^{\circ}$		SO SO	ugh Ur	RP = Rougn Planar SU = Smooth Undu	SP = Smooth Planar	ckensid	kensid		
DISCO	ORIENTATION	Н			F	>		F	>	ı		Oi	= Flat	did = C	^-u = /			3U = RC	S = U:	P = Sm	U = Slic	LP = Slic		
	TYPE/S	В			В	В		В	В	В			_	_				· .	_ 0,	,		_		
	NO. OF SETS		Н			H		7 7			7		-	비							_	,	E	٤
	WEATHERING	Э				⊃			⊃		⊃	YT YTI	¥					NG NG	: = >3rr	E (1-5:0:=	= <5 CI		
	STRENGTH	STREN										DISCONTINUITY TYPE	= Bedding Joint	Joint		r Plane		SPACING	ry Wide	e = 1-3	nerate :	y Close		
	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)		Grey Limestone			Grey Limestone			Grey Limestone		Grey Limestone		ery Weak = 1-5	EW = Extremely Weak = < 1	F=Fault	S = Shear Plane			VW = Very Wide = >3m	W = W/de = 1-3 m		C = Close = 5-50 Cll VC = Very Close = <5 cm		
	DEPTH TO		1.42			2.92			4.42		0	STRENGTH (MPa)	0							_	0			
	% BOD		78		 	83			87		100		3 = > 25	0-250		= 25-50		희	o Signs		coloure	like		
КЯ	% COKE KECONE		100			91			100		97		/ Strong	ng = 10(-100	Strong	- 25	WEATHERING	red = N	xidized	ίγ = Uis.	lable / = Soil-		
	вли ио.		HQ 1			HQ 2			НО 3		HQ 4		tremel)	ry Stroi	ng = 50	ledium	eak = 5	WEA	U = Unweathered = No Signs	S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable	nıy = Fr npletely			
	DEPTH FROM		0.41 HC		1.42 Hc		2.92 H			4,42	EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25 WEATHERING U = Unweathered = No Signs		U = Unv	S = 511B1	M = M	н = rignly = rriable C = Completely = Soil-like								



Client:

Contractor: Project:

Richcraft Group of Companies Parkdale at Scott

Date:

Bridgit Bocage

122410780 Project No.:

MW 12-4 (page 2 of 4) January 13, 2012 **Borehole No.:**

Logger:

	DRILLING OBSERVATIONS		Shale Partings			Shale Partings			Shale Partings			Shale Partings	ING	EILLING T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay									
	OCCASIONAL FEATURES											-	III -	T = Tight, Hard	O = Oxidized	SA = Slightly Alte	S = Sandy, Clay Free	Si = Sandy, Silty,	NC = Non-sortening Clay	10			
	FITFING	T			1			⊢			-											50	
	<u> Э</u> ВИТЯЭЧА																	δl	ති	5	Σ Σ	lulating	ıar
JITIES	ВОПЕНИЕ22	RU			SU/SF			M/W SU/RU			SU/RU		ATION	.	20-50°	1 >50 ₀		ROUGHNESS	GENNESS Idulating Inar Indulatir Ianar			ed Und	Slickensided Planar
DISCONTINUITIES	SPACING	C/M			M/W			M/W			C/W		ORIENTATION	F = Flat = 0-20° D = Dipping = 20-50°		ertical	ROUG		RU = Rough Undulating RP = Rough Planar SU = Smooth Undulating			SP = Smooth Planar LU = Slickensided Undulating	kensid
DISCC	ИОІТАТИЗІЯО	ш			u.			ī			ц.		5	= Flat	o = Dip	/-u = /			3U = Ro	수 II 건 II I		.U = Slic	LP = Slic
	Z/39YT	В			В			В			В				_				ш.		, 0	, -1	7
	NO. OF SETS	H			H H		~		н		н		뜐							_		Ε	u.
į	МЕАТНЕВІИС	∃HTA∃W ⊃			ס				>			⊃	YT YTI	ıt.			a)		VW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m			. 0.3-1	= <5 cr
	ЗТВЕИСТН									•			DISCONTINUITY TYPE	ing Joir	Joint		. Plane		SPACING	ry Wide	e = 1-3	erate =	y Close
	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)		Grey Limestone			Grey Limestone			Grey Limestone			Grey Limestone			EW = Extremely Weak = < 1 J = Cross Joint	F = Fault	S = Shear Plane			VW = Very Wide = >3m	W = Wide = 1.3 m	M = Moderate = U.3 C = Closs = E 20 cm	$V = V \cos x = 3.50 \text{ cm}$ $V = V \cos x = 45 \text{ cm}$
	DEPTH TO		7.47			8.97			10.54			12.04	STRENG	Ö			_				-	g	
	ж вор		97		_	95	J		100			86		g = > 25	0-250		= 25-5(옑	lo Signs		scoloure	·like
ΥЯΞ	% COKE KECON		100			92			100			86		y Stron	ng = 10	0-100	Strong	- 25	THERIP	red = N	xidized	ily = Dis نماط ::	/= Soil-
	,ои ио,		HQ 5			НД 6			HQ 7			HQ 8		tremel	VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-5	MS = Medium Strong = 25-50 W = Weak = 5 - 25	WEATHERING WEATHERING U = Unweathered = No Signs	htly = C	S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable	nny = rr npletely			
	МОЯЭ НТӨЭО		5.92			7.47		8.97 Hi				10.54	EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25 W = Weak = 5 - 25 WEATHERING U = Unweathered = No Signs S = Slightly = Oxidized M = Madazatoly = Discoloured			¥ : Z	n = nigiliy = rijable C = Completely = Soil-like						



Stantec

Clients

Contractor: Projects

Richcraft Group of Companies

Parkdale at Scott

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DEPTH FROM

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12.04 HQ 9 100

Project No.: Date:

lanuary 13, 2012 122410780

MW 12-4 (page 3 of 4)

Bridgit Bocage Logger:

Borehole No.:

	DRILLING OBSERVATIONS									FILLING			ered, Clay Free	ree	Minor Clay	oft Clay	•
	OCCASIONAL FEATURES		Shale Partings		Shale Partings		Shale Partings	Shale Partings			T = Tight, Hard	O = Oxidized	SA = Slightly Altered, Clay Free	S = Sandy, Clay F	Si = Sandy, Silty, Minor Clay	NC = Non-softening Clay SC = Swelling, Soft Clay	i .
	EIFFING	Т		Τ		Τ		Τ									
	<u> </u> ЗЯПТЯЗЧА														δI	8	
JITIES	ВОПЕНИЕЗЗ	RU		M/W RP/RU		RU		RU		ATION		20-50	= >500		ROUGHNESS	ndulatir	š
DISCONTINUITIES	SPACING	M/W		M/W		VC/M		VC/M		ORIENTATION	$F = Flat = 0.20^{0}$	$D = Dipping = 20-50^{\circ}$	ertical		ROU	RU = Rough Undulating	2 - 1.00
DISCC	NOITATNJIRO	ட		F		ц		Ŀ		J	F = Flat	D = Dip	\-u = \			3U = Ro	2
	TYPE/S	В		В		В		В			_	_					-
	NO. OF SETS		н		Н		Т		⊣	PE							=
	МЕАТНЕВІИС		<u></u>		ם		_		<u> </u>	DISCONTINUITY TYPE	nt					<u>ING</u>	e = >3r
	ЗТВЕИСТН									NITNO	ding Joi	s Joint		ır Plane		SPACING	ery Wid
	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)		Grey Limestone		Grey Limestone		Grey Limestone		Grey Limestone		ery Weak = 1-5	EW = Extremely Weak = < 1 J = Cross Joint		S = Shear Plane			VW = Very Wide = >3m
	OE HTG		13.54		15.06		16.64		18.16	STRENGTH (MPa)	250			20			S

89

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보 11

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98

86

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94

97

НД 12

16.64

MS = Medium Strong = 25-50

EH = Extremely Strong = > 250

VS = Very Strong = 100-250

S = Strong = 50-100

W = Weak = 5 - 25

U = Unweathered = No SignsWEATHERING

S = Slightly = Oxidized

M = Moderately = Discoloured C = Completely = Soil-like H = Highly = Friable

M = Moderate = 0.3-1 m VC = Very Close = <5 cm VW = Very Wide = >3m C = Close = 5-30 cm W = Wide = 1-3 m

SU = Smooth Undulating SP = Smooth Planar RP = Rough Planar

LU = Slickensided Undulating LP = Slickensided Planar

 $V: \{0.1224 \mid active \mid 1.224.107XX \mid 1.224.10780 \mid Report \ 2_Scott \mid Core \mid og \ and \ photos \mid field_core_logs_Version 2.XISX \mid 1.224.107XX \mid 1.224.10780 \mid Report \ 2_Scott \mid Core \mid og \ and \ photos \mid field_core_logs_Version 2.XISX \mid 1.224.107XX \mid 1.224.10780 \mid Report \ 2_Scott \mid Core \mid og \ and \ botos \mid field_core_logs_Version 2.XISX \mid 1.224.107XX \mid 1.224.10780 \mid Report \ 2_Scott \mid Core \mid og \ and \ botos \mid field_core_logs_Version 2.XISX \mid 1.224.107XX \mid 1.224.10780 \mid Report \ 2_Scott \mid Core \mid og \ and \ botos \mid field_core_logs_Version 2.XISX \mid 1.224.107XX \mid 1.224.10780 \mid Report \ 2_Scott \mid Core \mid og \ and \ botos \mid field_core_logs_Version 2.XISX \mid 1.224.107XX \mid 1.224.10780 \mid Report \ 2_Scott \mid Core \mid og \ and \$



Contractor: Project: Client:

Richcraft Group of Companies Parkdale at Scott

Date:

January 13, 2012 122410780 Project No.:

MW 12-4 (page 4 of 4) Bridgit Bocage Borehole No.:

Logger:

Г	S		T		
	DRILLING OBSERVATIONS				FILLING rd Altered, Clay Free lay Free lity, Minor Clay ftening Clay 5, Soft Clay
	OCCASIONAL FEATURES	Shale Partings			FILLING T = Tight, Hard O = Oxidized SA = Slightly Altered, Clay Free S = Sandy, Clay Free Si = Sandy, Silty, Minor Clay NC = Non-softening Clay SC = Swelling, Soft Clay
	FILLING	F			
	Э ЯОТЯЭ4А				S e e ulatine
JITIES	ВОПСНИЕ2S	N.			ORIENTATION F = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50° ROUGHNESS RU = Rough Undulating RP = Rough Planar SU = Smooth Planar LU = Slickensided Undulating LP = Slickensided Planar
DISCONTINUITIES	SPACING	3			P = Flat = 0-20° D = Dipping = 20-50° V = n-Vertical = >50° V = Nough Undulatii RP = Rough Planar SU = Smooth Undulati CU = Slickensided Unculation
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	TYPE/S	В			
	NO. OF SETS	7			H E c
į	WEATHERING	n		:	ITY TY! It IG IG IG IG IG IG IG IG IG
	ЗТВЕИСТН				DISCONTINUITY TYPE Bedding Joint Cross Joint Fault Shear Plane = Very Wide = >3m Noderate = 0.3-1 m Close = 5-30 cm = Very Close = <5 cm
	PTION Texture, etc.)	ne			B = Bedding Joint J = Cross Joint J = Cross Joint F = Fault S = Shear Plane SPACING WW = Very Wide = >3m W = Wide = 1-3 m M = Moderate = 0.3-1 m C = Close = 5-30 cm VC = Very Close = <5 cm
	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	Grey Limestone			STRENGTH (MPa) O VW = Very Weak = 1-5 EW = Extremely Weak = < 1
	От нтчэс	19.71			STRENG
	% ВОД	100			5-5c gns
ЕВЛ	% COBE BECOVI	100			emely Strong = Strong = 100-7 (= 50-100 Illum Strong = 7 (= 5 - 25 WEATHERING athered = No 9 P = Oxidized P = Oxidized P = Friable Etable
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ı	ОЕРТН FROM	18.16			EH = Extremely Strong = > 250 VS = Very Strong = 100-250 S = Strong = 50-100 MS = Medium Strong = 25-50 W = Weak = 5 - 25 U = Unweathered = No Signs S = Slightly = Oxidized M = Moderately = Discoloured H = Highly = Friable C = Completely = Soil-like



Project Name: Parkdale Development

Rockcore Photographs



Rock Core Photo No.: 1 Borehole: MW 12-3 Depth: 0.89 – 3.40 m



Rock Core Photo No.: 2 Borehole: MW 12-3 Depth: 3.40 – 5.28 m



Project Name: Parkdale Development

Rockcore Photographs



Rock Core Photo No.: 3 Borehole: MW 12-3 Depth: 5.28 – 7.42 m



Rock Core Photo No.: 4 Borehole: MW 12-3 Depth: 7.42 – 10.17 m



Project Name: Parkdale Development

Rockcore Photographs



Rock Core Photo No.: 5 Borehole: MW 12-3 Depth: 10.17 – 13.08 m



Rock Core Photo No.: 6 Borehole: MW 12-3 Depth: 13.08 – 15.44 m



Project Name: Parkdale Development

Rockcore Photographs



Rock Core Photo No.: 7 Borehole: MW 12-3 Depth: 15.44 – 16.46 m



Rock Core Photo No.: 8 Borehole: MW 12-4 Depth: 0.41 – 2.92 m



Project Name: Parkdale Development

Rockcore Photographs



Rock Core Photo No.: 9 Borehole: MW 12-4 Depth: 2.92 – 5.92 m



Rock Core Photo No.: 10 Borehole: MW 12-4 Depth: 5.92 – 8.97 m



Project Name: Parkdale Development

Rockcore Photographs



Rock Core Photo No.: 11 Borehole: MW 12-4 Depth: 8.97 – 12.04 m



Rock Core Photo No.: 12 Borehole: MW 12-4 Depth: 12.04 – 15.06 m



Project Name: Parkdale Development

Rockcore Photographs



Rock Core Photo No.: 13 Borehole: MW 12-4 Depth: 15.06 – 17.88 m

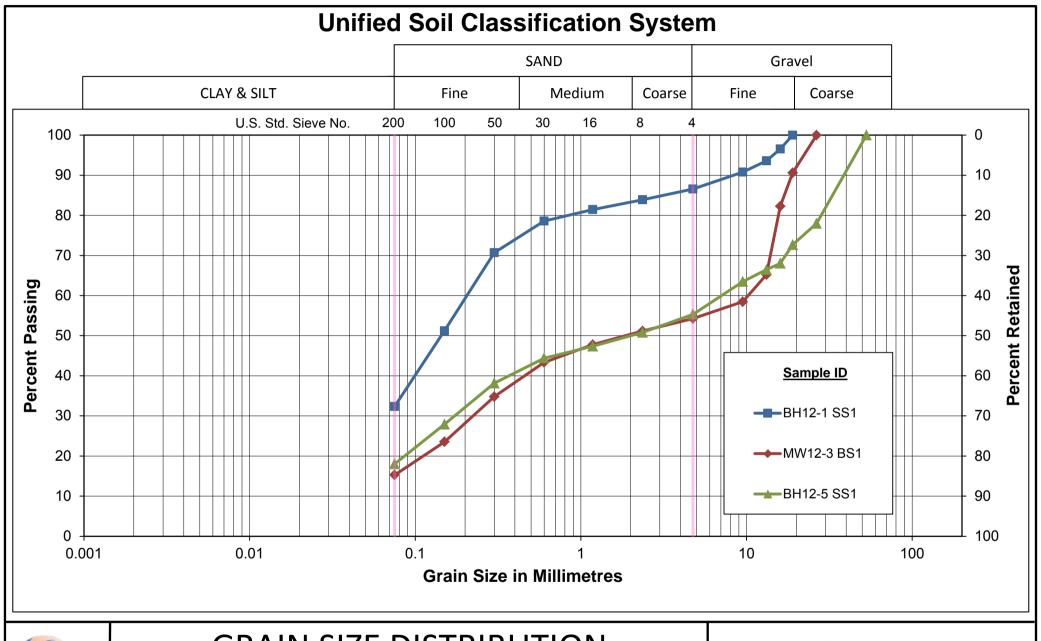


Rock Core Photo No.: 14 | Borehole: MW 12-4 | Depth: 17.88 – 19.71 m

Stantec FINAL GEOTECHNICAL REPORT May 2012

APPENDIX D

Laboratory Test Results





GRAIN SIZE DISTRIBUTION
FILL

Figure No. 1

Project No. 122410780



2781 Lancaster Rd. Suite 200 Ottawa, Ontario K1J 1A7 Tel: (613) 738-0708

Fax: (613) 738-0721

ASTM-D7012

Compressive Strength and Elastic Moduli of Intact Rock Core Speciments under Varying States of Stress and Temperatures. Method C: Unconfined Compressive of Intact Rock Core Speciments.

D4543/ Preparation

Client: Richcraft Group of Companies Inc.

Project: Parkdale Development

Date Drilled: January 9 to 12, 2012

Cored By: Bridgit Bocage

Project No.: 122410780 Date Rec'd: 13-Jan-12

Date Tested: 24-Jan-12

Tested By: Denis Rodriguez

Sample Location	MW12-3 HQ-4 4.4 to 5.9 M	MW12-3 HQ-7 8.9 to 10.5 M	MW12-3 HQ-9 12 to 13.5 M	MW12-3 HQ-11 15 to 16.5 M
Physical Description	As per Geo-tech Report	As per Geo-tech Report	As per Geo-tech Report	As per Geo-tech Report
Average Diameter (mm) (<47.0)	63.00	63.00	63.00	63.00
Specimen Length (mm)	154.00	152.00	146.00	153.00
L/D Ratio (2.0-2.5)	2.44	2.41	2.32	2.43
Failure Load (lbs)	121087	128881	92745	54076
Compressive Strength (Mpa)	172.8	183.9	132.3	77.2
Straightness by Procedure S1 (<0.02inch)	<0.02	<0.02	<0.02	<0.02
Flatness by Procedure FP2 (<0.001inch)	<0.001	<0.001	<0.001	<0.001
Parallelism by Procedure FP2 (<0.25°)	0.075	0.079	0.154	0.058
Perpendicularity by Procedure P2 (<0.0043)	<0.0043	<0.0043	<0.0043	<0.0043
Moisture Condition	As-Received	As-Received	As-Received	As-Received
Description of Break D7012/11.1.13	Well formed cone @ one end and vertical cracking	Vertical cracking	Vertical cracking	Vertical cracking

Reviewed by: Brian Prust

Date: January 26/2012



2781 Lancaster Rd. Suite 200 Ottawa, Ontario K1J 1A7 Tel: (613) 738-0708 Fax: (613) 738-0721

Stantec

ASTM-D7012

Compressive Strength and Elastic Moduli of Intact Rock Core Speciments under Varying States of Stress and Temperatures. Method C: Unconfined Compressive of Intact Rock Core Speciments.

D4543/ Preparation

Client: Richcraft Group of Companies Inc.	Project No.: 122410780
Project: Parkdale Development	Date Rec'd: 13-Jan-12
Date Drilled: January 9 to 12, 2012	Date Tested: 24-Jan-12
Cored By: Bridgit Bocage	Tested By: Denis Rodriguez

Sample Location	MW12-4 HQ-4 4.4 to	MW12-4 HQ-7 9.0 to 10.5 M	MW12-4 HQ-10 13.5 to 15.0 M	MW12-4 HQ-13 18.2 to 19.7 M
Physical Description	As per Geo-tech Report	As per Geo-tech Report	As per Geo-tech Report	As per Geo-tech Report
Average Diameter (mm) (<47.0)	63.00	63.00	63.00	63.00
Specimen Length (mm)	152.00	154.00	150.00	151.00
L/D Ratio (2.0-2.5)	2.41	2.44	2.38	2.40
Failure Load (lbs)	114177	98397	96497	95178
Compressive Strength (Mpa)	162.9	140.4	137.7	135.8
Straightness by Procedure S1 (<0.02inch)	<0.02	<0.02	<0.02	<0.02
Flatness by Procedure FP2 (<0.001inch)	<0.001	<0.001	<0.001	<0.001
Parallelism by Procedure FP2 (<0.25°)	-0.064	0.052	0.127	-0.039
Perpendicularity by Procedure P2 (<0.0043)	<0.0043	<0.0043	<0.0043	<0.0043
Moisture Condition	As-Received	As-Received	As-Received	As-Received
Description of Break D7012/11.1.13	Vertical cracking	Well formed cone @ one end with vertical cracking	Vertical cracking	Vertical cracking

Reviewed by: Brian Orwast

Date: January 26/2012

Stantec FINAL GEOTECHNICAL REPORT May 2012

APPENDIX E

Rock Anchor: Resistance to Rock Mass Failure

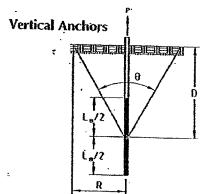
Rock Anchor

Resistance to Rock Mass Failure

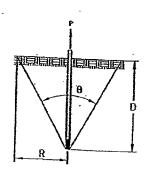
Required Safety Factor for Resistance to Rock Mass Failure: $W_R/P \ge 2.0$

Design Considerations:

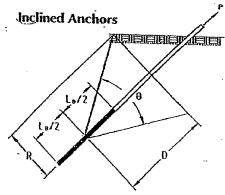
1. Use 60° or 90° apex angle as per recommendations in the geotechnical report



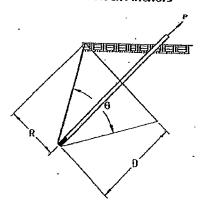
Grouted Rock Anchors



Mechanical Rock Anchors



Grouted Rock Anchors



Mechanical Rock Anchors

P = Resultant of maximum axial anchor forces

D = Height of rock cone R = Radius of rock cone

 θ = Appex angle L_B = Bond length

Y_R = Submerged unit weight of bedrock

 W_R = Weight of rock cone ($W_R = \frac{1}{3}\pi R^2D \gamma_R$)