Azure Group

A SOIL INVESTIGATION FOR PROPOSED HIGH RESIDENTIAL BUILDING

3-11 MCDONALD STREET, 17 SOPHIA STREET

AND

58 & 60 CLAPPERTON STREET

BARRIE, ONTARIO

PREPARED FOR: **BLACK CREEK GROUP**

123 FRONT STREET WEST, UNIT 1200

TORONTO, ONTARIO

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PROJECT NO. **2203 – 002**

DATE: **OCTOBER 18, 2022**

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ENCLOSURES

1. INTRODUCTION

Azure Group Inc. was retained by Black Creek Group (the Client) to prepare a geotechnical investigation for the proposed development (High Rise Building) at 3-11 McDonald Street, 17 Sophia Street East and 58-60 Clapperton Street, in Barrie, Ontario. (hereinafter referred to as the "Site"). The development will consider the construction of a twenty-one (21) storey mix use building with three (3) underground parking levels.

Geotechnical investigations were carried out in March 2021 for the properties at McDonald and Sophia Streets and in May 2022 for the properties at Clapperton Street. The geotechnical investigations were summarized in report number 2101-009 for the properties at McDonald Street and 17 Sophia Street East, and report number 2203-002 for the properties at 58-60 Clapperton Street.

Based on the materials encountered at the borehole locations, conventional **spread and strip footings** were recommended in 2021 and 2022 investigations to support the building loads. Furthermore, dewatering system was recommended during and after building construction.

Later, we have been informed by the Client that City of Barrie prohibits pumping groundwater into the City's sewer system. That is, the building should be constructed without drainage system.

To eliminate pumping the groundwater into the City sewer system, water tight footing is recommended (water tight raft foundation). Another option is supporting the building on piles. The former option of foundation (water tight raft foundation) was recommended by the Client. The Client instructed Azure Team to revise the geotechnical reports to consider the construction of water tight raft foundation.

This report has been prepared for Black Creek Group (the Client) specifically and solely for the proposed development of the Site based on the intended layout and the proposed facilities provided at the time of preparing this report. Third party use of this report is prohibited without written consent of Azure Group Inc.

2. PREVIOUS INVESTIGATION

The following investigations were carried out by Azure Team at the proposed properties for the construction of the high rise building:

- At 3-11 McDonald Street and 17 Sophia Street East. Azure Team Geotechnical Report No. 2101-009 dated March 17, 2021.
- At 58 and 60 Clapperton Street. Azure Team Geotechnical Report No. 2203-002 dated May 18, 2022.
- At 3-11 McDonald Street and 17 Sophia Street East several monitoring wells were installed by Azimuth Environmental Consulting Inc. Report No. AEC 21-056 dated March, 2021 .

The investigations revealed that the properties were covered with topsoil and fill, underlined by interlayered strata of sand, silty sand and sandy silt, and the groundwater was encountered at shallow depth.

3. SITE AND PROJECT DESCRIPTION

The proposed development covers the properties at 3-11 McDonald Street, 17 Sophia Street East and 58-60 Clapperton Street in Barrie, Ontario.

The topography of the properties at McDonald and Sophia Streets was uneven with an elevation difference of ±1.2 m at the borehole locations. The properties at 58-60 Clapperton Street are occupied by residential buildings with possible basement.

JCI provided us the elevation section of the proposed development. Based on this section, the proposed development will consider the construction of a twenty-one storey building with three (3) underground parking levels. The underground parking at level P3 will be constructed at depth of 10 m below ground floor elevation. The approximate thickness of the raft was also provided in JCI elevation section. However, the structural loads, underground utilities invert depths, etc., are not available at the time of preparing this report. Details of the Site is shown in Figure 1.

4. SCOPE OF WORK

The geotechnical scope of work included the following:

- Advancing five (5) boreholes "BH1 to BH5" at McDonald and Sophia Streets, and two (2) boreholes "BH101 & BH102" at Clapperton Street. The location of the boreholes is shown in Figure 1 attached to this report;
- Installed 50 mm diameter monitoring wells at Clapperton Street properties at the location of BH101 & BH102;
- Conduct field tests during drilling (Standard Penetration Tests "SPT") to obtain the number of blows "N" per 300 mm and pocket penetrometer tests on the extracted soil samples to obtain the undrained shear strength of the soil c_u;
- Conduct a limited laboratory tests on selected soil samples obtained from the boreholes for soil classification, and moisture content;
- Prepared a geotechnical report with comments and recommendations regarding:
    - Site preparation Site Grading, Cut and Fill);
    - Appropriate foundation depth, type, bearing capacity, settlement, and seismic classification;
    - Slab on grade;
    - General excavation and backfilling requirements;
    - Lateral earth pressure;
    - Temporary excavations in accordance with latest edition of the Occupational Health and Safety Act (OHSA), and Regulations 213/91,
    - Sewer bedding and cover;
    - Suitability of the existing materials for backfilling; and,
    - Pavement recommendations along the investigated area.

5. FIELD WORK

Prior to undertaking the drilling operation, the Site was cleared of buried underground utilities at the borehole locations. A private locating contractor was retained to identify the position of any privately owned electrical cables or piping that could be present but not identified by Ontario One Call (Public Utilities Locator).

The field work for the Site at McDonald and Sophia Streets was carried out in February/March 2021. The investigation at this Site consisted of drilling 5 boreholes "BH1 to BH5" to depths ranging between 16 m and ±20 m. The field work for the Site at Clapperton was Carried out in April/May 2022. Two boreholes "BH101 and BH102 were drilled to depth of ±20 m, using drilling mud. Monitoring wells were installed at the location of BH101 and BH102 to depths 8.81 m and 8.55 m respectively. The location of the boreholes and monitoring wells is shown on the attached Figure 1.

It should be noted that the boreholes intended to be advanced to a depth of 25 m below the grade encountered virtual refusal at depth of ±20 m below grade and as a result was terminated at these depths;
The surface elevation at the borehole locations was referenced to geodetic datum and was surveyed by Azure Team.

All boreholes were advanced using a track-mounted CME-55 drilling rig with 100 mm diameter continuous flight open/solid-stem auger under the full-time supervision of a geotechnical engineer from Azure Group.

The subsurface strata were sampled at regular intervals of 0.75 m depth for the first 3 m and at 1.5 m interval for the remaining depth, using a split-spoon sampler while performing the Standard Penetration Test (SPT) as detailed in the ASTM D1586. The number of blows of the 63.4 kg hammer required to drive the spoon 0.3 m (12 inches) into the soil was the SPT "N" value of the soil. The "N" value provides an approximate measure of the consistency of cohesive soils or the relative density in non-cohesive (cohesionless) soils.

The field test results were supplemented by laboratory analysis following completion of the drilling, the soil samples were taken to accredited laboratory for final visual assessment, classification and testing. The soil samples were tested and classified in general accordance with the Unified Soil Classification System (USCS), ASTM 2487.

The soil samples recovered during the investigation will be stored for a period of 30 days after which they will be discarded unless further instructions are received from Black Creek Group. All boreholes were backfilled with soil cuttings and bentonite.

6. SUBSURFACE CONDITIONS

The subsurface conditions encountered in the boreholes are shown on the borehole records provided in Figures 2 to 8. Figure 2 to 6 represents BH1 to BH5 (McDonalds and Sophia Streets Sites), and Figures 7 and 8 represents BH101 and BH102 (Clapperton Street Sites). The borehole records include soil stratification at the borehole locations with detailed soil descriptions and selected physical properties for each stratum encountered. Variations in the soil stratification may occur and should be expected between borehole locations and elsewhere on the site. Furthermore, since the internal diameter of the Spoon used in the Standard Penetration Test (SPT) is 38 mm which is less than the maximum size of the gravel (75 mm), the grain size test results and soil classification may not reflect the entire gravel size fraction.

In general, the subsurface conditions encountered at the borehole locations consisted of topsoil, fill, and native soils.

The following sections describe the materials encountered at the location of the boreholes.

6.1 TOPSOIL

Topsoil was encountered at the location of all boreholes. The thickness of the topsoil varies from 100 mm to 250 mm.

However, the thickness of the topsoil at the borehole locations may not represent the entire Site. Therefore, they should not be considered in estimating the total quantity of the topsoil. The topsoil encountered was dark brown in color indicating a considerable amount of roots and humus. Topsoil in general, is unstable and compressive under loads, therefore, it should not be used for engineering purposes.

6.2 Fill Soil

Fill soil was encountered below the topsoil. The fill consisted of loose to very loose dark brown silty sand, sandy silt and/or soft to very soft sandy clay/silty clay or a mixture of these materials trace gravel, concrete fragments, brick fragments and topsoil. The fill extended to an approximate depths ranging between ±1.0 m and ±2.0 m below the existing ground surface at the location of BH1 to BH5 and ±1.8 m to ±2.0 m at the location of BH101 and BH102.

Records of backfilling operation were not available at the time of our investigation. Therefore, we are of the opinion that the existing fill was not engineered and are not suitable for supporting the proposed building.

6.3 Native Soils

Layers of native sand/silty sand, sandy silt and silt trace gravel and clay were encountered below the fill at the location of all the boreholes. The native soils extend to a refusal depth of ±20.0 m below grade. Based on the "N" values obtained from the Standard Penetration Test "SPT", the relative density of the sandy soil immediately below the fill at the location of BH1 to BH5 was very loose to loose. The loose soil extended to an average depth of ±3.5 m below the existing ground surface. The relative density of the sandy soil below a depth of ±3.5 m increases gradually to very dense at the location of all boreholes except at the location of BH3. At BH3 loose to compact sandy soil was encountered at depths ranging between 12 and 13 m. The low relative density at these depths may be attributed to the hydrostatic uplift pressure (the uplift water pressure may cause quick conditions or soil piping in sandy soil).

To minimize the effect of uplift hydrostatic pressure during the drilling process below the ground water table, drilling mud was used at the location of BH101 and BH102.
The relative density of the sandy soil at the location of BH101 and BH102 was compact to very dense below the fill soils. A layer of hard/very dense clayey silt/silt was encountered at depths ranging between ±11.5 m and 13.5 m.

The drilling operation extended to termination depth of 16 m at the location of BH1 to BH4 and a refusal depth of 20 m at the location of BH5. At the location of BH101 and BH102, the native soil extended to a termination depth of ±19.0 m below the existing ground surface.

The moisture content of the native soil ranges between 7.6% to 17.4% with average of 12.9% at the location of BH1 to BH5 and 9.7% to 18.8% with average of 13.64% at the location of BH101 and BH102.

Grain size analysis was carried out on representative soil samples at the location of BH1 to BH5 indicated the following:

Gravel	Average 8.7% (Ranging between 0.4% and 28.0%)
Sand	Average 58.04 (Ranging between 45.7% and 70.1%)
Silt and Clay	Average 33.3% (Ranging between 10.9% and 53.9%)

At the location of BH101 and BH102 the grain size analysis indicated the following:

Gravel	Average 1.93% (Ranging between 0.4% and 4.4%)
Sand	Average 57.43 (Ranging between 46.6% and 64.1%)
Silt and Clay	Average 40.64% (Ranging between 35.5% and 52.3%)

Summary of the materials encountered at the location of the boreholes and grain size analysis of selected soil samples are provided in the Appendix B - Borehole logs (drawing 2 to 8) and Appendix C – Grain Size Distribution Graphs.

6.4 GROUNDWATER

In 2016 hydroglogical investigation, several monitoring wells were installed by others. The groundwater table in these wells were monitored in 2016 and 2017 by others and by Azure Team in 2021 and 2022. Monitoring results are summarized in Table 2.

In 2021 investigation (at McDonald and Sophia Streets) five boreholes BH1 to BH5 were drilled at various locations. Groundwater was encountered at depths ranging 5.5 m and 10.4 m with average of 7.7 m below the existing ground surface.

In 2022 investigation (at Clapperton Street), two monitoring wells were installed at the location of BH101 and BH102. Groundwater was not measured during or upon drilling completion since drilling mud was used during the drilling operation.

The groundwater table in monitoring wells BH101 and BH102, was measured in April 28, 2022 at depth of 5.33 m and 5.63 m (corresponding to elevations 228.33 m and 228.4 m) respectively.

It should be noted that the natural groundwater table is likely to vary throughout the year, depending on the amount of precipitation, runoff, evaporation, and percolation in the area. Summary of subsurface condition and groundwater table is provided in Table 1.

Table 1: Summary of Subsurface Conditions

BH No.	G.S.E. m	BH Depth m	Depth Soil Layers (m)		Monitoring Well Depth (m)	GWT March 21, 2021	
			Topsoil	Fill		Depth	Elev.
BH1	234.41	16/218.41	250 mm	1.1	-	5.5 m	228.91 m
BH2	234.43	16/218.43	250 mm	1.0	-	6.7 m	227.73 m
BH3	233.64	16/217.64	250 mm	1.5	-	10.4 m	223.24 m
BH4	233.61	16/217.61		1.5	-	7.0 m	226.61 m
BH5	233.76	20/213.76	250 mm	2.0	-	9.1 m	224.66 m
						GWT April 28, 2022	
BH101	233.66	18.9 m	50 mm	1.8 m	8.81 m	5.33 m	228.33 m
BH102	234.03	18.9 m	100 mm	2.0 m	8.55 m	5.63 m	228.40 m

G.S.E =Ground Surface Elevation
G.W.T = Ground Water Table

Summary of groundwater table in the Monitoring wells installed in 2016 and 2022 is summarized in Table 2.

Table 2: Groundwater Table in Monitoring Wells Installed in 2016 & 2022

BH & MW No.	G.S. Elev. (m)	Groundwater Table in MW installed in 2016, 2021 & 2022			
		Depth/Elevation (m)			
		Sep. 12, 2016	Mar. 21, 2017	Mar. 24, 2021	April 28, 2022
MW-1	233.38	7.07/226.31	5.52/227.86	-	-
MW-2	235.11	2.47/232.64	5.32/229.79	6.5/228.61	-

MW-3	234.32	7.90/226.42	6.42/227.9	7.27/227.15	-
MW-4	234.43	6.26/228.17	4.55/229.77	-	-
MW-4A	234.97	6.25/228.72	4.66/230.31	6.12/228.85	-
MW-A1	233.83	7.46/226.37	6.02/227.81	-	-
MW-A2	233.77	6.7/227.07	6.34/227.43	6.94/226.83	-
MW-B1	233.67	7.48/226.19	5.97/227.7		6.79/226.88
MW-B2	233.69	7.48/226.21	5.83/227.86		6.80/226.89
MW-C1	233.67	8.03/225.64	5.57/228.1		7.03/226.64
MW-C2	233.56	7.35/226.21	5.23/228.33		-
					May 2, 2022
MW-101	233.66		-	-	5.33/228.33
MW-102	234.03		-	-	5.63/228.4

7 DISCUSSION AND RECOMMENDATIONS

7.1 INTRODUCTION

Based on the information obtained from the investigation, the following comments are provided with respect to the proposed scope of development:

- The development considers the construction of a twenty-one (21) storey mix use building with three (3) underground levels;
- Taking into consideration that footing's thickness ranges between 1 to 2 m, and the depth of the elevator shafts is in the range ±1.6 m below the finished floor of the lower level of building (P3), the estimated depth of the underground excavation is ±12 m below the ground floor elevation;
- Loose to very loose sand/silty sand was encountered below the ground surface. The loose conditions extended to a depth of ±3.5 m. The compactness of the soil below the ±3.5 m, increases gradually to compact to very dense below a depth of ±4 m,
- The groundwater table in the monitoring wells was measured in April 28, 2022 at depth of 5.33 m and 5.63 m (corresponding to elevations 228.33 m and 228.4 m) respectively,
- Groundwater control (dewatering) will be required during construction only.
- To avoid dewatering after the construction of the building, the footings and underground walls will be constructed as water-tight structure.
- Shallow foundations (spread and continuous footings) and/or raft foundations may be constructed at various depths below ±4 m, and
- Temporary shoring may be required to maintain the stability of the excavation.

The following sections contain recommendations for building construction based on the materials encountered in the boreholes;

7.2 Site Preparation

There is a surface elevation difference of ±1.2 m throughout the properties at McDonald and Sophia Streets. Residential buildings with possible basement exist at the location of Clapperton Street. The following recommendations should be considered for the site preparation to achieve the final grades:

- The existing residential buildings at 58-60 Clapperton should be demolished and the basement (if any) should be backfilled to the existing ground surface;
- The trees, the topsoil, and the soft/loose soils should be removed from areas of the proposed development;
- The exposed ground surface should be inspected and thoroughly proof rolled in the presence of a qualified geotechnical engineer. The purpose of the proof-roll is to locate areas of unsuitably loose or soft subgrade and to uniformly compact the surface. In clayey soils, proof-rolling should be performed with a loaded tandem axle dump truck, rubber-tired loader, or other suitable piece of pneumatic-tired construction equipment. In granular soils, proof-rolling should be performed with a heavy (minimum 10 tones) self-propelled vibratory roller. The proof-rolling should consist of a minimum of six passes per unit area and should be tested to ensure that areas exhibiting more than 15 mm deflection or any soft, wet or deleterious materials identified at the time of proof rolling should be sub-excavated and replaced with a suitable and/or approved drier materials. The exposed surface after the proof rolling should be compacted to at least 100% of the materials Standard Proctor Maximum Dry Density (SPMDD);
- Following the subgrade preparation, fill materials may be placed on the exposed surface ;
- Materials placed to raise the final grade or backfilling the basement or replace the excavated materials during proof rolling should be placed in 150 mm thick lifts in the loose condition and uniformly compacted to minimum of 100% of the materials SPMDD,

- The filling and compacting should continue until the final elevation of the subgrade and/or foundation level is achieved,
- During the placement of structural fill, all frozen materials should be removed prior to placing additional layers of materials,
- Imported fill materials for use in the development on the site must meet all applicable municipal, provincial, and federal guidelines as well as regulations associated with environmental characterization of the materials. The materials should also be examined and approved by a qualified geotechnical engineer,
- We do not recommend construction to be carried out in wet or inclement weather,

7.3 FOUNDATION RECOMMENDATION

An elevation section of the proposed building development was provided to Azure Team by **JCI.** The detail shows that the elevation at P3 floor slab is 225.25 m (10 m below ground floor elevation).

Based on the available soil parameters obtained from the boreholes, conventional spread/strip footing foundations and/or raft footings supported on the native soils are considered suitable for the proposed building. Detail of foundation types is discussed in the following sections;

7.3.1 CONVENTIONAL SPREAD AND STRIP FOOTINGS

7.3.1.1 FOOTINGS ON NATIVE SOIL

- We anticipate that footings will be constructed on the existing dense native soil at various depths below 4.5 m,
- For foundations constructed on various depths of the existing native soil (below a depth of 4.5 m), the recommended factored Ultimate Limit State (ULS) and the Serviceability Limit State (SLS) to be used for the design of the proposed footings at various depths are summarized in Table 3.

Table 3: Recommended Bearing Capacities

Foundations Depth	ULS (kPa)	SLS (kPa)
±4.5 m	600	400
±7.5 m	750	500
>10 m	900	600

- The groundwater table should be lowered to a depth of not less than 1.2 m below the founding level of the foundation during construction,

7.3.1.2 FOOTING ON THE ENGINEERED FILL

Conventional spread and strip footings may also be constructed on the prepared engineered fill soil (Section 7.2) provided that the engineered fill constructed on the native soil.

For foundations constructed on the engineered fill, the recommended factored Ultimate Limit State (ULS) and the Serviceability Limit State (SLS) to be used for the design of the proposed footings are 225 kPa and 150 kPa respectively,

Foundation Notes

The following notes should be considered in the design and construction of the spread and strip footings:

- The above recommendations apply to the actual borehole locations. Variations in soil profile and properties may be present between the borehole locations. Should significant variations evident during construction, it may be necessary to re-evaluate the recommendations of this report,
- Footing excavations should be inspected and approved by **Azure Group geotechnical engineer** during construction. All soft/loose, wet frozen or disturbed material should be removed, and the exposed subgrade should be immediately covered with 50 mm of lean to minimize/eliminate soil disturbance,
- The ground water table in sandy soil should be lowered to a depth of not less 1.2 m below the founding level of the footings,
- For frost protection, footings should be constructed at a depth of not less than 1.5 m below the grade,
- Surface/rainwater should not be allowed in the excavated footings,
- The above bearing capacities must be reviewed by our office, once the finished floor elevation of the building has been established,

- The total and differential settlement for footings constructed on the native sandy soil and/or the engineered fill are expected to be less than 25 mm and 15 mm respectively,
- The minimum footing size, footing thickness, excavation size and other footing requirements should be designed in accordance with the requirements detailed in the latest edition of the Ontario Building Code "OBC",
- Footings constructed at different levels should be constructed so that the higher foundations are set behind a line sloping at an angle of 7V: 10 H and drawn from the near edge of the lower footing,
- For overturning considerations of spread or continuous foundations, the maximum soil pressure at the toe of the foundations should not exceed the maximum net allowable soil pressure.

7.3.1.3 RAFT FOUNDATION

Raft foundation is another option for the support of the proposed building loads. Raft foundation can be designed and constructed to provide suitable support for the underground level, which spreads the foundation loads over the entire structure footing footprint.

Raft foundation placed at depth where the building loads equal the weight of the excavated soil usually have adequate bearing capacity.

The provided drawing by JCI indicates that the recommended thickness of the raft is 1.5 m. The elevation at the top of the raft is 224.75 m. Dense to very dense sandy soils exists below this elevation.

A factored bearing resistance of 360 kPa at ULS and a gross bearing resistance of 240 kPa at SLS condition can be used in the design of raft foundation. The existing effective overburden pressure at foundation bearing elevation is included in the provided bearing resistance.

For an allowable bearing resistance of 240 kPa, we anticipate that the settlements and differential settlements to be less than 25 mm and 15 mm respectively. The computations have included the structural rigidity of the concrete raft.

A modulus of Subgrade reaction "Ks" of 15MPa/m may be considered for the design of raft foundation.

To eliminate the construction of drainage system below the underground finished floor slab, the raft and the underground walls **should be designed and constructed** as a water-tight structure. The construction of the water tight raft foundation should consider the following:

- 100 mm mud slab (concrete strength should be decided by the structural engineer),
- 250 mm water proof concrete slab below the raft (the strength and the materials to be used as waterproof should be decided by the structural engineer),
- The thickness of the raft footing as provide by JCI is 1.5 m,
- The raft foundation and the underground concrete walls should be constructed monolithically to prevent groundwater leak at the intersection of the raft and walls. Details of the joints and seal to be used at the intersection of the raft and the underground walls should be provided by the structural engineer,
- Details of waterproofing of the raft and walls should be provided by specialized consultant,
- Top of foundation is 500 mm below the finished slab of the underground parking (P3), and
- Clear stone is recommended below the finished slab of P3 and top of footing.

Notes:

- The raft should be designed sufficiently rigid to distribute uniformly the applied building loads over the entire building footprint,
- The groundwater table should be lowered to a depth of not less than 1.2 m below the underside of the foundation during construction.
- Mud slab should be applied without delay to prevent soil disturbance to the founding subgrade.
- The dewatering process should continue during construction of the building until the downward pressure from the structure is higher than the hydrostatic uplift pressure.

Therefore, the termination of the dewatering process should be decided by the structure engineer.

7.4 EARTHQUAKE CONSIDERATION

The 2012 Ontario Building Code (OBC) Subsection 4.1.8 stipulates that a structure should be designed to meet the requirements of the Earthquake Load Effects. The Site Classification for the Seismic Site Response (Table 4.1.8.4. A) is determined from the average Standard Penetration Resistance (N60) and the soil undrained shear strength (Su).

Based on the average soil conditions below the existing ground surface and as per 2012 OBC Table 4.1.8.4A, the site classification for seismic site response is considered as **Site Class C.** The site classification is only for design consideration. For the possibility of obtaining higher Site Class, e.g., Site Class **B**, Shear wave tests should be considered.

7.5 EXCAVATION AND GROUNDWATER CONTROL

- It is anticipated that footings will be constructed at depths ±12 m below the existing ground surface,
- Groundwater was encountered at depths ranging between 5.33 m and 5.63 m below the existing grade,
- Building foundations will most likely be constructed below the encountered groundwater table,
- Temporary excavations for footings or underground services must be carried out in accordance with latest edition of the Occupational Health and Safety Act (OHSA),
- According to OHSA, if excavation is deeper than 1.2 m, the excavated sides should be sloped. The slope of the sides depends on the type of the excavation materials. Table 4 stipulates maximum slope excavation for various soil types,

Table 4- Soil Type and Slope Ratio

Soil Type	Base of Slope	Maximum Slope Identification
1	Within 1.2 meters of bottom of trench	1H: 1V
2	Within 1.2 meters of bottom of trench	1H: 1V
3	From bottom of trench	1H: 1V
4	From bottom of trench	3H: 1V

- Fill, native sandy soils were encountered at the location of all boreholes. Fill soil may be classified as Type 4. The native soil may be classified as Type 3,
- For foundations constructed below the groundwater table groundwater control is required. Dewatering the groundwater is discussed in **Section 7.9**.
- Excavation of side slopes should be protected from exposure to precipitation and associated ground surface run-off and should be inspected regularly for signs of instability. If localized instability is noted during excavation or if wet conditions are encountered, the side slopes should be flattened as required to maintain safe working conditions,
- Excavation of the overburden soil should be relatively straightforward using conventional equipment,
- It should be noted that the above recommendations are based on the actual boreholes locations. Should any contaminated materials be encountered beyond the location of the boreholes, it may be necessary to revise the above recommendations.

7.6 LATERAL EARTH PRESSURE

Walls and/or bracing supporting soil should be designed and constructed to resist lateral earth pressure imposed by the soil and hydrostatic pressure. For wall that are designed to allow rotation, active earth pressure may be used for design. For rigidly tied walls, the at-test earth pressure should be used for design. The lateral earth pressure, p, in kPa, acting on a unit element of the shoring system at any depth h, in meters, below the surface of the retained soil, may be estimated from the following equation:

$P = K [\gamma (h - h_w) + \gamma' h_w + q] + \gamma_w h_w$

The above equation considers the hydrostatic pressure in determining the lateral pressure on the wall if continuous wall drains are not provided.

A perimeter drainage system may be constructed to prevent the build-up of any hydrostatic pressure behind the wall. In this case, the following equation is recommended:

$Pa = K (\gamma h + q)$

Where:

γ = the soil unit weight

K = Lateral earth pressure coefficient

K_o = earth pressure coefficient at rest, if wall movement cannot be permitted

K_a = active earth pressure coefficient, if moderate wall movement can be permitted,

K_p = passive earth pressure coefficient

q = is the surcharge load adjacent to the shoring wall

ϕ = is the angle of internal friction of the soil

A summary of the soil parameters is provided in the following Table 5.

Table 5 – Recommended Soil Parameters

Soil Parameters	**ϕ**	**γ(kN/m3)**	**K_a**	**K_o**	**K_p**
Compact sand/silty sand	30	19	0.33	0.5	3.0
Dense sand/silty sand	33	21	0.30	0.45	3.33

7.7 SHORING THE EXCAVATED WALLS

If the underground excavation extends to the property boundaries, temporary shoring will be required. The following provides our recommendation for the design and construction of the temporary shoring:

If the underground excavation extends to the property boundaries, temporary shoring will be required. The following provides our recommendation for the design and construction of the temporary shoring:

1) The shoring system should be designed in accordance with the latest edition of the Canadian Foundation Engineering Manual (CFEM),
2) The design of the temporary shoring system must take into account the presence of underground utilities and services below the adjacent streets as well as proximity of the foundations of the existing structures of adjacent sites, both of which must be protected against lateral or downward movement. If services and/or foundations of adjacent structures are present within the active zone behind the shoring system, appropriate parameters must be considered to avoid any harmful movements,
3) Monitoring the horizontal movement at the top of the shoring is recommended. Monitoring recommendation is discussed in **Section 7.7.5**.
4) The temporary shoring may consist of caisson walls and/or soldier piles and a wooden lagging system. The latter is recommended for this project,
5) Groundwater and boulders may encounter during caisson and/or solider pile installation.

The following sections discuss the type of applicable shoring system;

7.7.1 CAISSON WALL

1) A caisson wall may be constructed to minimize the underground water seeping into the excavated area,
2) The caisson wall may be constructed by drilling individual caissons along all the excavated sides,
3) We recommend that the caissons extend 300 mm below the base of excavation,
4) We recommend that liners be used in sandy soil below the groundwater table and the caissons be advanced without removal of the soil for several meters below the groundwater table,
5) Soldier piles may be installed in some of the drilled holes as recommended by the shoring engineer,
6) The holes should be filled with concrete using Tremie pipe or equivalent method. The concrete strength must be specified by the shoring designer,
7) The walls of the excavation should be supported by either post-tensioned anchors or tiebacks drilled and grouted into the soil around the excavation by struts. Tiebacks and/or anchors are discussed in **section 7.7.3** of this report,
8) If permission to extend anchors into the adjacent properties subsoil is not granted, internal bracing, such as using struts and/or rakers, are other options for supporting the shoring,
9) If rakers are to be used to support the shoring system, they should be designed by the shoring consultant. The raker footings should be designed in accordance with the design principles for foundations subject to inclined loading. Raker foundation should be constructed at depth of not less than 0.50 m below the excavated surface of the underground level. The allowable bearing capacity of the raker foundation should be not more than 150 kPa at the depth of the building foundations. Footings and the foundation material of the rakers should be protected from freezing or deterioration. The rakers should be installed in trenches such that the lateral movement of the retaining wall is limited to an acceptable amount,
10) Similar lateral earth pressure and soil parameters recommended in Section 7.6, may be used for the design of the shoring system,
11) For the design of shoring system, a triangular pressure distribution envelope may be considered for the top third of the shoring system and rectangular pressure distribution envelope may be assumed for the lower two third,
12) The shoring system should be designed by a local design professional experienced in the type of system being proposed,
13) It should be noted that the caisson wall may not provide permanent waterproofing for the underground levels below the groundwater table. Furthermore, the wall should not be considered as a permanent basement wall unless special consideration was considered prior to its construction,

14) Permanent basement walls abutting the caissons wall and incorporating drainage measures should be considered in the construction to obtain relatively dry underground parking below the groundwater table, and
15) The underground wall and the drainage system should be constructed independent of the caisson walls. The underground parking wall and drainage system will be discussed in this report.

7.7.2 Soldier Piles and Wooden Lagging

1) Temporary shoring may also consist of soldier piles and wooden lagging,
2) The soldier piles should be installed in pre-augured holes extended below the deepest excavation. The depth below the deepest excavation must be specified by a shoring designer,
3) The shoring system should be supported by anchors, tie back, or rakers as discussed in the construction of the caisson walls (Section 7.7.3),
4) The soil parameters recommended in the design of the soldier piles and wooden lagging system can be found in Section 7.6 of this report,
5) The backfilled materials between the shoring system and the excavated sides should be free draining materials, in order to minimize the effect of hydrostatic pressure on the shoring system. Otherwise, the hydrostatic pressure should be added to the latseral earth pressure acting on the system,
6) We recommend the use of geotextile filter cloth on the exposed surface of the lagging boards to prevent/minimize the loss of the soil through the spaces between the boards.

7.7.3 Tiebacks or Anchors

1) The walls of the excavation should be supported by either post-tensioned anchors or tiebacks drilled and grouted into the soil around the excavation,
2) Liners should be used in constructing the anchors or tie backs in sandy soils,
3) The anchors/tie backs may extend to the adjacent properties and roads subsoil,
4) Permission will be required from the owners of the adjacent properties to install the anchors/tie backs,

5) The anchors/tie backs must extend to a length in the soil recommended by Canadian Foundation Manual. A minimum length of 2.5 m beyond the line of 45^{o} drawn from the base of the excavation is recommended,
6) The anchors/tie backs bond depends on the soil property, installation method and grouting properties. For gravity poured concrete, an allowable bond pressure of 40 kPa to 50 kPa is suggested for the compact to dense silty sand/sandy silt soils. A higher bond pressure may be obtained if a pressurized method of grout installation is used,
7) All anchors should be tested as indicated in Canadian Foundation Engineering Manual (CFEM). At least two (2) anchors in each level should be tested to 200% of the design load in accordance with the current edition of the CFEM in order to verify the capacity of the anchors/tie backs. The design of the working anchors/tie backs should then be modified based on the test results, where necessary. All remaining anchors should be installed following similar procedures and proof tested to 1.33 times the design load.

7.7.4 Lateral Earth Pressure on the Shoring

The recommendations and soil parameters provided in Section 7.6 of this report may be adopted in estimating the lateral earth pressure "P" acting on a unit element of the shoring system at any depth below the surface of the retained.

For the design of the shoring system, a rectangular pressure distribution envelope may be considered, and The shoring system should be designed by a local design professional experienced in the type of system being proposed.

7.7.5 Shoring System Movement (Vertical and Horizontal)

Vertical and horizontal movement of the shoring system are inevitable. The vertical movement will result from the vertical component of the inclined anchor or tie back and surface settlement. The horizontal movement will result from the lateral earth pressure and water pressure. The magnitude of these movements may be minimized/eliminated by proper construction practices. The vertical and horizontal movement will be in the range of 0.1H% to 0.25%H%. However, the actual shoring movement should be determined by the shoring consultant.

Monitoring the vertical and horizontal movement of the shoring system using inclinometer incorporated in the solider piles and/or using total station with targets attached on the soldier piles are recommended to ensure that the movements are within the acceptable range. Initial readings of these devices should be conducted prior to any excavation activities.

Based on our experience of monitoring the movement using either inclinometer and/or total station with targets, we recommend the measurements be carried out on weekly basis on the early stages of underground construction and then every other week until the completion of the underground levels and backfilling beyond the underground wall.

Monitoring records should be provided continuously to Azure Team and shoring consultant. We should also be informed immediately for any movement exceeding the recommended limit.

7.8 Elevator Pit

The elevator pit will be constructed at a depth of 1.6 m below the finished lower level (P3) of the underground parking. The top elevation of the elevator pit will be 223.65 m.

If spread footings are considered for supporting the building loads, we recommend that the pit be designed and constructed as a water-tight structure. The design should consider the hydrostatic pressure on the pit walls and the uplift pressure acting at the bottom of the pit.

If raft foundation is considered for supporting the building load, the elevator pit will be constructed as part of the raft footing.

7.9 Lowering the Groundwater Table

- Groundwater was encountered at depths ranging between 5.33 m and 5.63 m below the existing ground surface (corresponding to elevations 228.33 m & 228.40 m). The three underground levels of the proposed building will extend to a depth of ±12.0 m. i.e.; the footings will be constructed below the ground water table.

- Excavation below the groundwater table causes an uplift water pressure. The uplift water pressure may cause quick conditions in sandy soil (soil piping and disturbances), therefore, control of groundwater will be imperative during construction.
- To reduce the potential of the base instability during excavation in sandy soil, the groundwater table should be lowered to a depth of not less than 1.2 m below the bottom of the excavation. For this purpose, well point dewatering system is recommended to sufficiently lower the groundwater level,
- Lowering the groundwater table should be designed by specialized consultant and executed by specialized dewatering contractor,
- The dewatering process should continue during construction of the building until the downward pressure from the structure is higher than the hydrostatic uplift pressure. Therefore, the termination of the dewatering process should be decided by the structure engineer.
- For foundation constructed on clayey soil, swells along the footing that slope downwards toward a sump may be used. A sump pump may then be used to pump the accumulated,
- Lowering the groundwater table during underground construction should only be carried to a depth that will not adversely affect the adjacent structures.

7.10 Floor Slab on the Existing Grade (Existing Ground Surface)

The following recommendations are for floor slab constructed on the existing ground surface:

- Prior to any slab on grade construction, we recommend the stripping of the top 500 mm of the site soil,
- The subsurface of the exposed subgrade after the removal of the top 500 mm layer should be inspected and compacted to at least 98% of the material standard Proctor Maximum Dry Density “SPMDD”, and proof rolled with a loaded tandem truck. Proof rolling is discussed in Section 7.2.
- Materials placed to raise the final grade and compaction is discussed in Section 7.2,
- A moisture barrier (capillary moisture barrier) should be placed between the underside of the floor slab and exposed soil. It is recommended that the moisture barrier consist of a minimum 150 mm thick layer of Ontario Provincial Standard Specification (OPSS)

Granular "A" or 19 mm clear crushed stone compacted to a minimum of 98% of the Standard Proctor Maximum Dry Density (SPMDD),

- Subfloor drainage are not required provided that the slab-on-grade is constructed above the outside grade. Furthermore, the outside ground surface should be graded to direct run-off water away from the building.

7.11 Suitability of Site Material for Reuse

The fill and native soils are considered suitable for backfilling the trenches provided that the moisture content is within the optimum content of 2%, and these activities are not undertaken in wet or freezing conditions. However, these materials are not suitable for reuse as new base/subbase materials below the pavement. Deleterious material, if any, should be removed prior to reuse on site. The use of these materials is subject to a geotechnical engineer approval.

7.11.1 Recommendation for Sewer Bedding and Trench Backfilling

- Pipe bedding and backfill material specifications and compaction criteria for water and sewer services should be in accordance with the pipe designer's recommendations and/or local municipal requirements,
- The subgrade of the sewer should consist of sound native soil, or properly compacted fill materials free of organic and/or deleterious materials. If the bottom of the trench at the required pipe grade is found to be unstable or include organics materials, the unsuitable materials should be removed and replaced with approved materials prior to any pipe installation,
- The exposed trench bottom shall be compacted to a minimum of 95% of the materials Standard Proctor Maximum Dry Density (SPMDD). OPSS Granular B is recommended for the backfilling the excavated trench. The backfilling operation should be carried out in lifts not exceeding 150 mm in the loose state compacted to 98% of the materials SPMDD,
- Sandy layer of minimum thickness of 50 mm should be placed below the sewers as a leveling pad. The leveling pad will make the pipe foundation more rigid, reduce the detrimental effect of differential settlement and provide working platform to facilitate the

construction off the sewers. The levelling pad should spread the full width of the trench bottom,

- After preparation of the trench base, a pipe bedding of a minimum thickness of 150 mm shall be placed using crushed stone or crushed gravel, meeting OPSS Granular "A" material compacted to 98% of the materials SPMDD,
- All trench excavations shall be backfilled immediately after the sewers are laid. The backfilling operation should be carried out on both sides of the sewer and shall be manually compacted simultaneously. At no time shall the levels of each side differ by more than 100 mm un-compacted. Approved granular materials should be used for backfilling. The granular materials should extend to a minimum of 300 mm above the top of pipe. Backfill materials shall be placed in uniform layers not exceeding 150 mm in thickness for the full width of the trench and compacted manually,
- Backfilling above the 300 mm should be placed in uniform thickness of 150 mm compacted to 98% of the materials SPMDD to eliminate the possibility of settlement, pipe misalignment, or damage to the joints,

  Granular materials may be used as backfill materials. The site materials encountered below the topsoil or the ground surface may also be used provided that the materials are free from organics and other deleterious materials,
- Backfill materials shall be placed to a minimum of 900 mm above the crown of the sewer before any power operated tractor or rolling equipment are used for compaction.
- To eliminate pipe floatation when the trench is deluged with water, we recommend to backfill the trench to a thickness of not less than 1.2 m immediately after pipe insallation.
- Water lines installed outside of heated areas should be provided with a minimum of 1.5-meter soil cover or equivalent for frost protection,
- In normal sewer construction, the problem of road settlement largely occurs adjacent to manholes or catch basin. In areas which are inaccessible to heavy compaction equipment, additional compactive effort with smaller equipment is warranted,
- In the event that the sewer and/or water main are located below the groundwater, the excavated trench should be dewatered and any loose/soft, saturated soil that exist at the bottom of the trench should be removed. To minimize the potential for instability of the

base and sidewalls of the trenches in sandy soil excavation, an external groundwater control system (e.g., well point system) will be required to sufficiently lower the groundwater table before the excavation is carried out. The proposed groundwater control system should be designed, installed and operated by specialist consultant, and

- Fill materials imported to the site must meet all applicable municipal, provincial, and federal guidelines and regulations associated with environmental characterization of the material. The materials preparation and compaction of bedding layer, the pipe installation should be in accordance with the current revision of OPSS 1010, OPSS 401, OPSS 501, OPSS410, OPSD 902.032, OPSD 803.030 and OPSD 803.031.

7.11.2 Foundation Walls Backfilling

All foundations and foundations trenches should be backfilled with granular materials. The backfilled materials should be compacted in 150 mm thick loose lifts to a minimum pf 98% of the materials SPMDD using plate vibrator compactor. The backfilling process should be carried out on both sides of the walls simultaneously.

7.12 Winter Construction

When construction is undertaken during periods of inclement weather, or when freeze-thaw affects are a concern, the backfilling procedures should consider the following comments:

- The preferred backfill material during periods of inclement weather is OPPS Granular B Type 1,
- Areas of intended backfill should be clearly identified in the field prior to commencing the work,
- Fill placement should be inspected by qualified field personnel under the supervision of a geotechnical engineer,
- Imported materials that contain ice, snow, or any frozen materials should not be accepted for use,
- Overnight frost penetration into the existing subgrade or the fill layer should be prevented by using insulation blankets. Alternatively, the frozen fill can be removed prior to placing subsequent lifts. Approaches such as breaking the frost in-situ is not considered acceptable, and

- During periods of cold, where ambient temperature is -5° or less, placement of engineered fill should stop and the existing fill materials should be protected from freezing.

7.13 Pavement Design for Asphalt Concrete

Flexible asphalt pavement is recommended for the parking areas and site access roads. Flexible pavement consists of a prepared roadbed (subgrade) underlying layers of subbase, base, and surface courses (pavement structure). Prior to pavement structure construction, we recommend the pavement subgrade should be prepared as noted below:

Pavement Subgrade: pavement subgrade can consist of the engineered fill or the native soils encountered at the site. The topsoil and the underlying fill soil to a depth of not less than 500 mm below the existing ground surface should be removed. Any soft, lose or unstable materials should also be removed. The exposed surface should be compacted to at least 98% of the SPMDD and proof-rolled with a loaded tandem truck as discussed in section 6.2.
Sub-grade up-fill should be compacted to at least 98% of the SPMDD, at or below the optimum moisture content (OMC) in lifts not exceeding 150 mm in thickness. Any materials that has moisture content higher than 3% of its OMC should be dried out.

Granular sub-base: the granular sub-base is the portion of the flexible pavement structure between the roadbed (subgrade) and the base course, and is used to increase the structural capacity, raise pavement layers above the frost line, or provide a levelling course for the placement of base layers. Granular "B" may be used for sub-base construction. The sub-base layer should be placed on prepared subgrade.

Granular Base: the granular base is the portion of the pavement structure immediately beneath the surface course. It is constructed with high quality aggregates. The base materials consist of 100% aggregate materials. These materials consist of durable particles of gravel and sand or crushed rock, crushed gravel and sand. Recycled aggregates may also be used for base construction. Geotechnical engineer should be consulted prior the use of the recycled materials.

The production, gradation and placement of granular materials (base and sub-base) shall be in accordance with applicable OPSS requirements. The granular base and sub-base layers should be compacted to at least 100% of the SPMDD.

In the extreme cases, such as during the wet season, the top 600 mm of the subgrade may have to be replaced by compacted granular material in order to compensate for the inadequate strength of the wet sub-grade.

Pavement Surface: the surface course of a flexible pavement structure consists of a mixture of mineral aggregates and bituminous materials placed as the upper course and usually constructed on a base course. The pavement surface must be constructed to a higher standard than other layers in the pavement structure. The materials most commonly used for pavement surfacing are the asphalt/bituminous mixtures. The recommended pavement structures are provided in Table 6.

Table 6: Pavement Structure for the Driveways and Parking Areas

Description	Heavy duty	Materials
Asphalt Surface Course (HL3)	40 mm	Hot Mix Asphalt
Asphalt Base Course (HL8)	60 mm	Hot Mix Asphalt
Granular Base	150 mm	19 mm CRL or Granular A
Granular Sub-Base Course	200 mm	50 mm Crushed Limestone or Granular B

CRL = Crusher Run Limestone

The recommended compaction level for each layer is provided in Table 7.

Table 7: Compaction Recommendation for Pavement Layers

Pavement Layer	Compaction Level
Asphalt Surface Course (HL3)	92.0 -96.5% MRD
Asphalt Base Course (HL8)	92.0 – 96.5% MRD
OPSS Granular “A” or 20 mm CRL (Granular Base)	100% SPMDD
OPSS Granular “B” Type II or 50 mm CRL (Granular Sub-base)	100% SPMDD

MRD = Marshall Relative Density

SPMDD = Standard Proctor Maximum Dry Density

Notes

1. The pavement surface and subgrade should be graded to direct run-off water away from the roadway, parking areas and associated infrastructure.
2. Construction trucks and equipment should be kept off the newly constructed parking area and driveways before the placement of asphalt layer.

The discussion and recommendations as presented represent the best judgment of the inspector based on the visual observations of the accessible property elements of the Site and adjacent properties observed. Should additional information become available, Azure Group Inc. requests that this information be brought to our attention so that we may reassess the conclusions presented herein.

Respectfully Submitted,

AZURE GROUP INC.

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8.0 LIMITATIONS OF REPORT

This report was prepared by Azure Group Inc. for the account of 2610818 Ontario Ltd. and for review by its designated agents and financial institutions and government agencies. The material in it reflects the judgement of Mr. Ahmed Al-Temimi, M.Sc., P.Eng. QP(ESA), in light of the information available to it at the time of preparation.

The report may not be relied upon by any other person or entity without the express written consent of Azure Group Inc. and the Client. Any use that a third party makes of this report, or any reliance on decisions made based on it, is the responsibility of such third parties. Azure Group Inc. accepts no responsibility for damages, if any, suffered by any party as a result of decisions made or actions based on this report.

One must understand that the mandate of Azure Group Inc. is to obtain readily available past and present information pertinent to the subject site for a Geotechnical Investigation only. No other warranty or representation, expressed or implied, as to the accuracy of the information is included or intended by this investigation. Azure Group Inc. makes no other representation whatsoever, including those concerning the legal significance of its findings or as to the other legal matters addressed incidentally in this report, including but not limited to, ownership of any property, or the application of any law to the facts set forth herein. With respect to regulatory compliance issues, regulatory statutes are subject to interpretation. These interpretations may change over time; thus the Client should review such issues with appropriate legal counsel.

It should be noted that the information supplied in this report is not be sufficient to obtain approval for disposal of excess soil or materials generated during construction. The geotechnical site characterization is a limited sampling of a site and it does not include any chemical testing. Some of the information presented in this report was provided through existing documents and by third parties. Although attempts were made, whenever possible, to obtain a minimum of two confirmatory sources of information, Azure Group Inc. in certain instances has been required to assume that this information provided is accurate. Due to the nature of the investigation and the

limited data available, Azure Group Inc. cannot warrant against undiscovered geotechnical liabilities. No other warranty or representation, either expressed or implied, is included or intended in this report.

APPENDIX A

FIGURES

0 0.0125 0.025 0.05 km

1:564

March 23, 2021

Subject Property Boundary

Spring 2015 Borehole/Monitoring Well Locations

June 2016 Borehole/Monitoring Well Locations

Monitoring Well Locations

February 2021 Azure Borehole Locations

April 2022 Azure Monitoring Well Locations

Title	Project	Project No.	Scale	Date	Drawing No.
Borehole Location Plan	Sophia and Clapperton Street, Barrie, ON	2203-002	As Shown	May 2022	1

APPENDIX B

BOREHOLE LOGS

AZURE GROUP **DRAWING NO. 2**

JOB NUMBER 2101-009 **BH1**

PROJECT LOCATION: 3-11 MCDONALD STREET & 17 SOPHIA STREET EAST, BARRIE, ONTARIO

Client: Black Creek Group

C_u = Shear Strength (kPa) | *G%= Gravel, S% = Sand, F% = Fines (Silt and Clay), M = Moisture Content*

Temperature: 5°C

Started/Date February 22, 2021 Time: 9.30 am Sheet 1 of 1
Finished/Date February 22, 2021 Time: 1:15 pm
Azure Rep: Sarah Shana Auger Type: 150 mm Open
G. S. El: 234.412 m G.W. Depth: 5.5 m G.W. Elevation: 228.912m Feb. 22, 2021 Time: 4 pm

Depth (m)	Elev. (m)	Soil Description	Type	No	N	C_u (kPa)	G.W.T	Remark
0	234.41	250 mm Topsoil						
		Fill: Loose to very loose silty sand,						
1.0	233.41	sandy silt, trace clay, gravel, bricks and organics (0.25 m to 1.1 m)						
		Loose to very loose SILTY SAND, SANDY SILT,	SS	1	5			
2.0	232.41	trace gravel and clay, moist (1.1 m to 3.4 m)						
			SS	2	4			
3.00	231.41							
		Dense to very dense brown SILTY SAND trace	SS	3	57			
4.00	230.41	gravel, moist						
			SS	4	56			
5.00	229.41	V. dense SANDY SILT below 4.5 m						
6.00	228.41	V. dense, grey SILTY SAND trace clay below 5.5 m	SS	5	80			
							5.5 m	
7.00	227.41							
			SS	6	80			
8.00	226.41	Very dense SAND/SILTY SAND below 7.5 m						G%= 6.7
								S%= 64.0
9.00	225.41		SS	7	80			F%=35.9
10.0	224.41	V. dense/hard CLAYEY SILT, SILT trace gravels below 9.0 m						
			SS	8	80			
11.0	223.41							G%=8.8
		V. dense grey SAND trace silt and gravels below						S%=55.3
12.0	222.41	10.5 m	SS	9	80			F%=35.9
13.0	221.41							G%= 8.8
		V. dense SAND/SILTY SAND below 12 m	SS	10	80			S%= 55.3
14.0	220.41							F%= 35.9
		V. dense SAND/SILTY SAND below 13.5 m						
15.0	219.41		SS	10	80			
		V. dense SAND/SILTY SAND below 15 m						

AZURE GROUP **DRAWING NO. 3**

JOB NUMBER 2101-009 **BH2**

PROJECT LOCATION: 3-11 MCDONALD STREET & 17 SOPHIA STREET EAST, BARRIE, ONTARIO

Client: Black Creek Group

C_u = Shear Strength (kPa) | *G = Gravel, S = Sand, F = Fines (Silt and Clay), M = Moisture Content*

Temperature: 5°C

Started/Date February 23, 2021 Time: 1.15 am Sheet 1 of 1
Finished/Date February 23, 2021 Time: 5:15 pm
Azure Rep: Sarah Shana Auger Type: 150 mm Open
G. S. Elevation: 234.434 m G.W. Depth: 6.7 m G.W. Elevation: 227. 73m Feb. 22, 2021 Time: 4 pm

Depth (m)	Elev. (m)	Soil Description	Type	No	N	C_u (kPa)	G.W.T	Remark
0	234.43	250 mm Topsoil						
		Fill: Loose to very loose silty sand,						
1.0	233.43	sandy silt, trace clay, gravel, bricks and organics (0.25 m to 1.0 m)						
		Loose to very loose SILTY SAND, SANDY SILT,	SS	1	8			
2.0	232.43	trace gravel and clay, moist (1.0 m to 3.0 m)						
			SS	2	6			
3.00	231.43							
		Dense brown SILTY SAND trace gravel, moist	SS	3	35			
4.00	230.43							
		V. dense SANDY SILT below 4.5 m	SS	4	57			
5.00	229.43							
		V. dense SAND/SILTY SAND trace clay below 5.5 m						
6.00	228.43		SS	5	80			
							6.7 m	
7.00	227.43							
			SS	6	28			
8.00	226.43	Compact SAND/SILTY SAND below 7.5 m						
9.00	225.43		SS	7	80			G%= 6.5
		V. dense/hard CLAYEY SILT, SILT trace gravels below 9.0 m						S%= 51.5
10.0	224.43							F%=42.0
			SS	8	80			
11.0	223.43	V. dense grey SAND trace silt and gravels below						
		10.5 m						G%=28.0
12.0	222.43		SS	9	80			S%=61.1
								F%=10.9
13.0	221.43	V. dense/hard grey CLAYEY SILT below 12 m						
			SS	10	80	>225		
14.0	220.43	V. dense/hard CLAYEY SILT/SILT below 13.5 m						
15.0	219.43		SS	10	80	>225		
		Hard/v. dense CLAYEY SILT/SILT below 15 m						

E.O.B

AZURE GROUP **DRAWING NO. 4**

JOB NUMBER 2101-009 **BH3**

PROJECT LOCATION: 3-11 MCDONALD STREET & 17 SOPHIA STREET EAST, BARRIE, ONTARIO

Client: Black Creek Group

C_u = Shear Strength (kPa) | *G = Gravel, S = Sand, F = Fines (Silt and Clay), M = Moisture Content*

Temperature: 5°C

Started/Date February 23, 2021 Time: 9.15 am Sheet 1 of 1
Finished/Date February 23, 2021 Time: 12:30 pm
Azure Rep.: Sarah Shana Auger Type: 150 mm Open
G.S Elev: 233.64 m G.W. Depth: 10.4 m G.W. Elev.: 223.24 m February 22, 2021 Time: 4 pm

Depth	Elev. (m)	Soil Description	Type	No	N	C_u (kPa)	G.W.T	Remark
0	233.64	250 mm Topsoil						
		Fill: Loose to very loose silty sand,						
1.0	232.64	sandy silt, trace clay, gravel, bricks and organics (0.25 m to 1.5 m)						
			SS	1	9			
2.0	231.64	Loose to very loose SILTY SAND, SANDY SILT,						
		trace gravel and clay, moist (1.5 m to 4.0 m)	SS	2	4			
3.00	230.64							
			SS	3	3			
4.00	229.64							
		Dense brown SILTY SAND trace gravel,	SS	4	40			
5.00	228.64	moist						
6.00	227.64	V. dense SANDY SILT below 4.5 m	SS	5	54			
7.00	226.64	V. dense SILTY SAND trace clay below 5.5 m						
			SS	6	54			
8.00	225.64	V. dense SANDY SILT/SILTY SAND below 7.5 m						
9.00	223.64		SS	7	77			
10.0	223.64	V. dense SANDY SILT/SILTY SAND trace						
		gravels below 9.0 m	SS	8	77		10.4 m	
11.0	223.64							
12.0	221.64	Loose grey SANDY SILT trace clay and	SS	9	8			G%= 0.4
		gravels below 12 m						S%= 45.7
13.0	220.64							F%=53.9
		Loose to compact SANDY SILT trace clay						
		below 13 m	SS	10	10			
14.0	219.64							
		Dense SAND/SILTY SAND below 14 m						
15.0	218.64		SS	11	47			

E.O.B

AZURE GROUP **DRAWING NO. 5**

JOB NUMBER 2101-009 **BH4**

PROJECT LOCATION: 3-11 MCDONALD STREET & 17 SOPHIA STREET EAST, BARRIE, ONTARIO

Client: Black Creek Group

C_u = Shear Strength (kPa) | *G = Gravel, S = Sand, F = Fines (Silt and Clay), M = Moisture Content*

Temperature: 5°C

Started/Date February 22, 2021 Time: 2.45 pm Sheet 1 of 1
Finished/Date February 22, 2021 Time: 5:45 pm
Azure Rep.: Sarah Shana Auger Type: 150 mm Open
G.S. Elev: 233.61 m G.W. Depth: 7.0 m G.W. Elev: 226.61 m February 22, 2021 Time: 4 pm

Depth (m)	Elev. (m)	Soil Description	Type	No	N	C_u (kPa)	G.W.T	Remark
0	233.61	250 mm Topsoil						
		Fill: Loose to very loose silty sand,						
1.0	232.61	sandy silt, trace clay, gravel, bricks and organics (0.25 m to 1.5 m)						
			SS	1	3			
2.0	231.61	Loose to very loose SILTY SAND, SANDY SILT,						
		trace gravel and clay, moist (1.5 m to 3.5 m)	SS	2	5			
3.00	230.61							
			SS	3	3			
4.00	229.61	Dense to v. dense brown SILTY SAND trace						
		gravel, moist	SS	4	57			
5.00	228.61							
		Dense grey SILTY SAND/SANDY SILT trace						
6.00	227.61	clay and boulder fragments below 5.5 m	SS	5	50			
7.00	226.61	Dense SANDY SILT/SILTY SAND below 7.5 m					7.0 m	
			SS	6	39			
8.00	225.61							
		V. dense SILTY SAND trace clay and gravels						
9.00	224.61	below 9.0 m	SS	7	80			G%= 6.9
								S%= 58.6
10.0	223.61	V. dense grey SILTY SAND/SANDY SILT trace						F%=34.5
		gravels below 10.5 m	SS	8	80			
11.0	222.61							
		Dense grey SANDY SILT trace clay below 12						
12.0	221.61	m		9	44			
13.0	220.61							
		V. dense SILTY SAND below 13.5 m	SS	10	56			
14.0	219.61							
15.0	218.61	V. dense SILTY SAND below 15 m	SS	11	58			

E.O.B

AZURE GROUP **DRAWING NO. 6**

JOB NUMBER 2101-009 **BH5**

PROJECT LOCATION: 3-11 MCDONALD STREET & 17 SOPHIA STREET EAST, BARRIE, ONTARIO

Client: Black Creek Group

C_u = Shear Strength (kPa) | ***G = Gravel, S = Sand, F = Fines (Silt and Clay), M = Moisture Content***

Started: February 22, 2021 Time: 9.00 pm Finished: February 24, 2021 Time: 2:00 pm

Azure Rep.: Sarah Shana Auger Type: 150 mm Open *Temperature: 5°C*

G. S. Elev: 233.76 m G.W. Depth: 9.1 m G.W. Elev: 225.23 m February 22, 2021 Time: 2 pm

Depth (m)	Elev. (m)	Soil Description	Type	No	N	C_u (kPa)	G.W.T	Remark
0	234.76	250 mm Topsoil						
		Fill: Loose to very loose silty sand,						
1.0	233.76	sandy silt, trace clay, gravel, bricks and organics (0.25 m to 2.0 m)						
			SS	1	5			
2.0	232.76							
		Loose to very loose SILTY SAND, SANDY SILT,	SS	2	6			
3.00	231.76	trace gravel and clay, moist (2.0 m to 3.7 m)						
			SS	3	8			
4.00	230.76	Compact brown SILTY SAND trace gravel, moist						
			SS	4	25			
5.00	229.76	Compact SANDY SILT below 4.5 m						
6.00	228.76	Compact SILTY SAND trace granular fragments	SS	5	26			
		below 5.5 m						
7.00	227.76							
		Compact grey SAND/SILTY SAND below 8.0 m	SS	6	26			
8.00	226 76							
9.00	225.76	Dense SILTY SAND, SANDY SILT trace gravels	SS	7	41		9.1 m	
		below 9.0 m						
10.0	224.76							
			SS	8	70			
11.0	223.76	V. dense grey SAND trace silt and gravels below 10.5 m						
12.0	222.76	Dense below 12 m	SS	9	47			
13.0	221.76							
		V. dense SAND/SILTY SAND below 13.5 m	SS	10	80			
14.0	220.76							
15.0	219.76		SS	11	80			
		V. dense SILT trace sand and gravel below 15 m						
16.0	218.76							
			SS	12	80			
17.0	217.76							
18.0	216.76		SS	12	80			
		V. dense SAND/SILT SAND trace clay and gravel						
19.0	215.76	below 18.5 m						
20.0	214.76		SS	14	80			

E.O.B

AZURE GROUP **DRAWING NO. 7**

JOB NUMBER 2203-002 **BH101**

PROJECT LOCATION: 58 & 60 Clapperton Street, BARRIE, ONTARIO

Client:

C_u = Shear Strength (kPa)	G%= Gravel, S% = Sand, F% = Fines (Silt and Clay), M = Moisture Content

Temperature: 5°C

Started/Date April 25, 2022 **Time: 9.30 am** **Sheet 1** **of 1**
Finished/Date April 26, 2022, **Time: 4:15 pm**
Azure Rep: Sarah Shana **Auger Type: 150 mm Open**
Ground Surface El: 233.66 m **G.W. Depth: 5.63 m** **G.W. Elevation: 228.03 m** **April 26, 2022** **Time: 4 pm**

Depth (m)	Elev. (m)	Soil Description	Type	No	N	C_u (kPa)	G.W.T	Remark
0	233.7	100 mm Topsoil	SS	1	4			
		Fill: Loose to very loose silty sand, trace clay, gravel, bricks and						
0.75	233.0	organics (0.1 m to 2.0 m)	SS	2	3			
1.5	232.2	Loose to compact SILTY SAND, trace clay, moist (1.8 m to 3.4 m)	SS	3	12			
2.25	231.5		SS	4	19			G%= 1.8
								S%=59.6
3.0	230.7		SS	5	47			F%=38.6
4.6	229.1	Dense brown SILTY SAND trace clay and gravel, below 4.0 m, moist	SS	6	45			
							5.63 m	
6.00	227.7	V. dense, grey SILTY SAND trace clay below 6.5 m	SS	7	42			G%=4.4
								S%=59.4
7.60	226.1		SS	8	53			F%=36.2
		Very dense SAND/SILTY SAND						
9.20	224.5	V. dense grey SAND trace silt and gravels	SS	9	63			
10.7	223.0		SS	10	75			
		Hard CLAYEY SILT/SILTY CLAY, SILT trace gravels below 11.5 m						
12.2	221.5		SS	11	>80			
		V. dense SAND/SILTY SAND						
13.7	220.0		SS	12	>80			
		V. dense SAND and gravel below 13.5 m						
15.2	218.5		SS	13	>80	>225		
16.8	216.9		SS	14	>80	>225		
18.3	213.9		SS	15	>80			
19.8	213.9	V. dense SAND and gravel	SS	16	>80			
	213.9	E.O.B						

AZURE GROUP **DRAWING NO. 8**

JOB NUMBER 2203-002 **BH102**

PROJECT LOCATION: 58 & 60 Clapperton Street, BARRIE, ONTARIO

Client:

C_u = Shear Strength (kPa)	G%= Gravel, S% = Sand, F% = Fines (Silt and Clay), M = Moisture Content

Temperature: 5°C

Started/Date April 25, 2022 Time: 9.30 am Sheet 1 of 1
Finished/Date April 26, 2022 Time: 4:15 pm
Azure Rep: Sarah Shana Auger Type: 150 mm Open
Ground Surface El: 234.03 m G.W. Depth: 5.63 m G.W. Elevation: 228.4 m April 26, 2022 Time: 4 pm

Depth (m)	Elev. (m)	Soil Description	Type	No	N	C_u (kPa)	G.W.T	Remark
0	234.0	100 mm Topsoil	SS	1	4			
		Fill: Loose to very loose silty sand, trace clay, gravel, bricks and						
0.75	233.3	organics (0.1 m to 2.0 m)	SS	2	3			
1.5	232.5	Loose to compact SILTY SAND, trace clay, moist	SS	3	12			
2.25	231.8		SS	4	19			
3.0	231.0		SS	5	47			
		Dense brown SILTY SAND trace clay and gravel, below 4.0 m, moist						
4.6	229.4		SS	6	45			G%=1.1
								S%=46.6
6.00	228.0	V. dense, grey SILTY SAND trace clay and gravel	SS	7	>80		5.63 m	F%=52.3
7.60	226.4		SS	8	>80			
8.00	226.0	V. dense, grey SILTY SAND trace clay and gravel	SS	9	>80			
9.20	224.8	V. dense, grey SILTY SAND trace clay and gravel	SS	10	>80			G%=0.4
								S%=64.1
10.7	233.3	Very dense SAND/SILTY SAND	SS	11	>80			F%=35.5
12.2	221.8	V. dense grey SAND trace silt and gravels	SS	12	>80			
13.7	220.32	V. dense SILTY SAND trace clay and gravel	SS	13	>80			
15.2	218.8	V. dense SILTY SAND trace clay and gravel	SS	14	>80			
16.8	217.2	V. dense SAND/SILTY SAND	SS	15	>80			
18.3	215.7	V. dense SAND/SILTY SAND	SS	16	>80			
18.9	215.1	V. dense SAND and GRAVEL	SS	18	>80			
18.9		E.O.B						

APPENDIX C

GRAIN SIZE DISTRIBUTION GRAPHS

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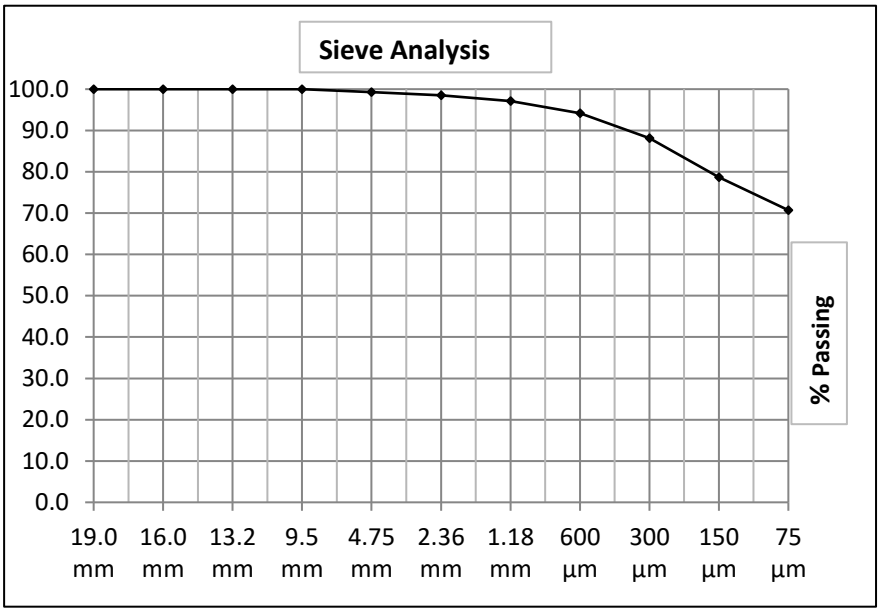
PARTICLE SIZE DISTRIBUTION GRAPH
LABORATORY TEST REPORT

Client:	Azure Group	Date Sampledd:	2021-02-24, 25
Project Name:	Sophia St. E, Barrie	Laboratory No.:	20316
Project Number:	CCC-213999-00	Sampled By:	S.S.
Location:	Sophia St. E, Barrie	Date Tested:	2021-02-26
Source:	BH 1 - SS 5 (25'-27')	Tested By:	H.F.

Aggregate Mix Properties	
Seive Size	% Passing
26.5mm	100.0
19.0mm	100.0
16.0mm	100.0
13.2mm	100.0
9.5mm	100.0
4.75mm	99.3
2.36mm	98.5
1.18mm	97.1
600µm	94.2
300µm	88.1
150µm	78.7
75µm	70.7



Comments: **Moisture content 15.3 %.**

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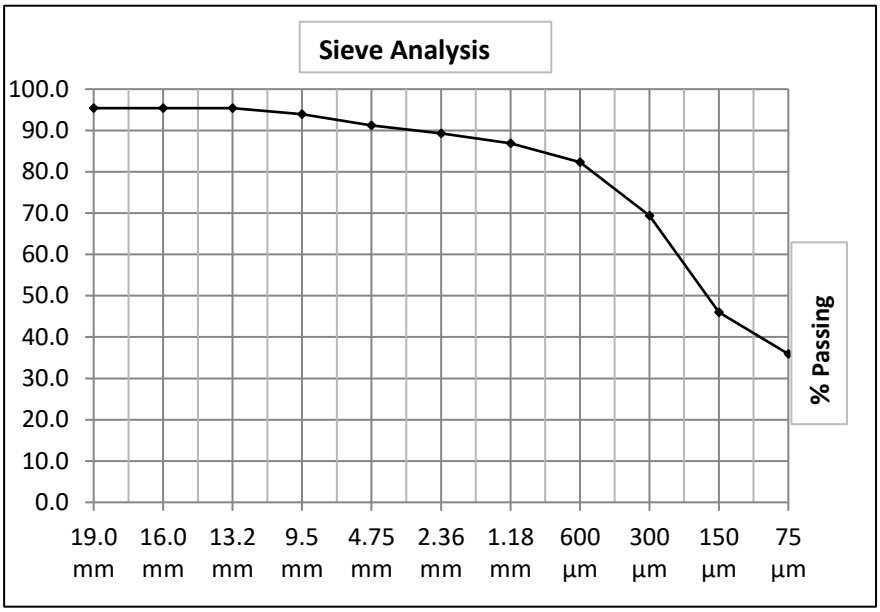
PARTICLE SIZE DISTRIBUTION GRAPH
LABORATORY TEST REPORT

Client:	Azure Group	Date Sampledd:	2021-02-24, 25
Project Name:	Sophia St. E, Barrie	Laboratory No.:	20316
Project Number:	CCC-213999-00	Sampled By:	S.S.
Location:	Sophia St. E, Barrie	Date Tested:	2021-02-26
Source:	BH 1 - SS 7 (35'-37')	Tested By:	H.F.

Aggregate Mix Properties	
Seive Size	% Passing
26.5mm	100.0
19.0mm	95.4
16.0mm	95.4
13.2mm	95.4
9.5mm	93.9
4.75mm	91.2
2.36mm	89.3
1.18mm	86.9
600µm	82.3
300µm	69.4
150µm	46.0
75µm	35.9



Comments: **Moisture content 12.3 %.**

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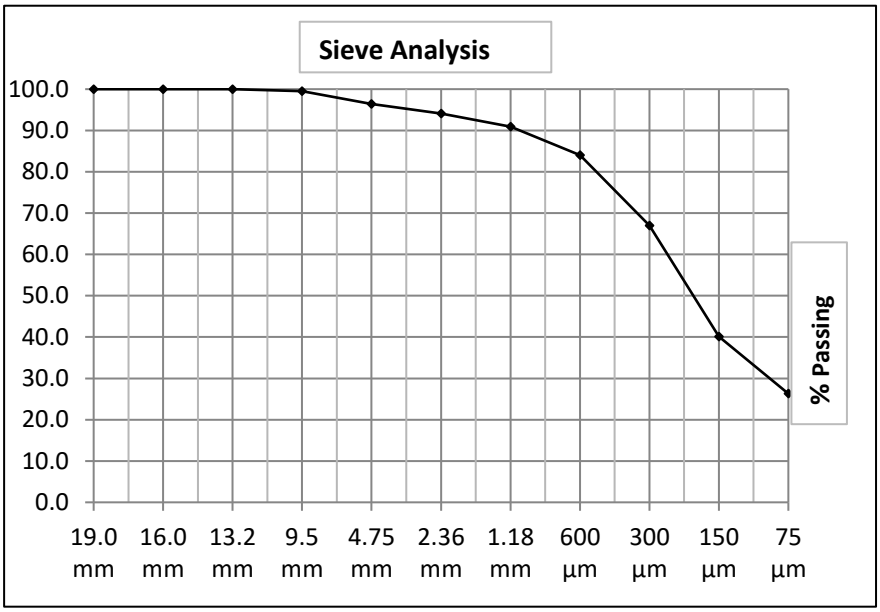
PARTICLE SIZE DISTRIBUTION GRAPH
LABORATORY TEST REPORT

Client:	Azure Group	Date Sampledd:	2021-02-24, 25
Project Name:	Sophia St. E, Barrie	Laboratory No.:	20316
Project Number:	CCC-213999-00	Sampled By:	S.S.
Location:	Sophia St. E, Barrie	Date Tested:	2021-02-26
Source:	BH 1 - SS 8 (40'-42')	Tested By:	H.F.

Aggregate Mix Properties	
Seive Size	% Passing
26.5mm	100.0
19.0mm	100.0
16.0mm	100.0
13.2mm	100.0
9.5mm	99.5
4.75mm	96.4
2.36mm	94.1
1.18mm	90.9
600µm	84.0
300µm	67.0
150µm	40.1
75µm	26.3



Comments: **Moisture content 13.7 %.**

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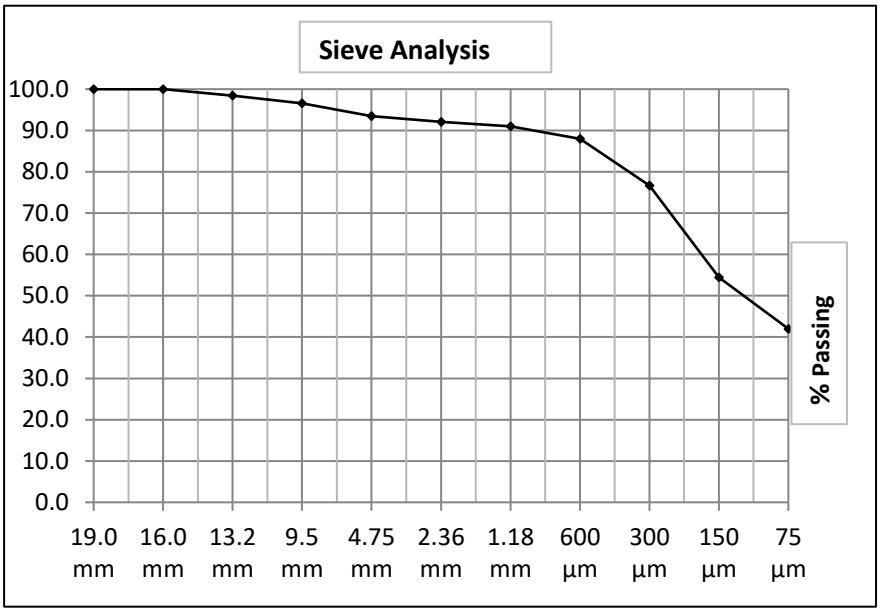
PARTICLE SIZE DISTRIBUTION GRAPH
LABORATORY TEST REPORT

Client:	Azure Group	Date Sampledd:	2021-02-24, 25
Project Name:	Sophia St. E, Barrie	Laboratory No.:	20316
Project Number:	CCC-213999-00	Sampled By:	S.S.
Location:	Sophia St. E, Barrie	Date Tested:	2021-02-26
Source:	BH 2 - SS 6 (30'-32')	Tested By:	H.F.

Aggregate Mix Properties	
Seive Size	% Passing
26.5mm	100.0
19.0mm	100.0
16.0mm	100.0
13.2mm	98.4
9.5mm	96.6
4.75mm	93.5
2.36mm	92.1
1.18mm	91.0
600µm	88.0
300µm	76.7
150µm	54.4
75µm	42.0



Comments: **Moisture content 11.5 %.**

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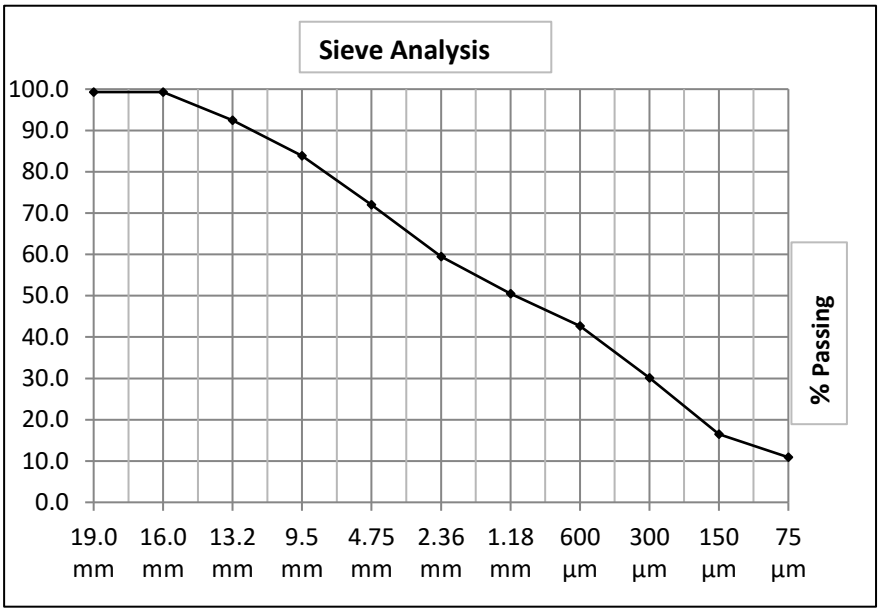
PARTICLE SIZE DISTRIBUTION GRAPH
LABORATORY TEST REPORT

Client:	Azure Group	Date Sampledd:	2021-02-24, 25
Project Name:	Sophia St. E, Barrie	Laboratory No.:	20316
Project Number:	CCC-213999-00	Sampled By:	S.S.
Location:	Sophia St. E, Barrie	Date Tested:	2021-02-26
Source:	BH 2 - SS 7 (35'-37')	Tested By:	H.F.

Aggregate Mix Properties	
Seive Size	% Passing
26.5mm	100.0
19.0mm	99.3
16.0mm	99.3
13.2mm	92.5
9.5mm	83.9
4.75mm	72.0
2.36mm	59.5
1.18mm	50.5
600µm	42.7
300µm	30.1
150µm	16.5
75µm	10.9



Comments: **Moisture content 7.6 %.**

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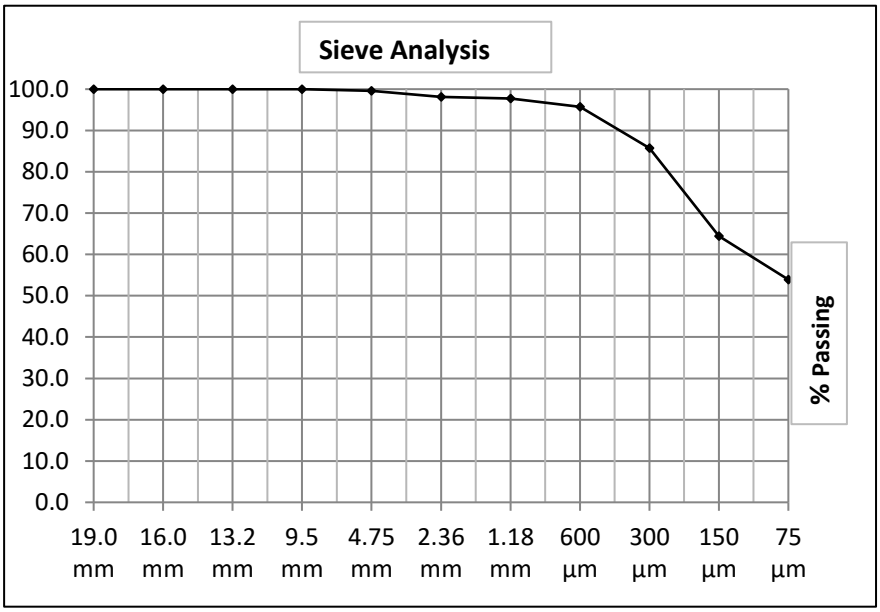
PARTICLE SIZE DISTRIBUTION GRAPH
LABORATORY TEST REPORT

Client:	Azure Group	Date Sampledd:	2021-02-24, 25
Project Name:	Sophia St. E, Barrie	Laboratory No.:	20316
Project Number:	CCC-213999-00	Sampled By:	S.S.
Location:	Sophia St. E, Barrie	Date Tested:	2021-02-26
Source:	BH 3 - SS 8	Tested By:	H.F.

Aggregate Mix Properties	
Seive Size	% Passing
26.5mm	100.0
19.0mm	100.0
16.0mm	100.0
13.2mm	100.0
9.5mm	100.0
4.75mm	99.6
2.36mm	98.1
1.18mm	97.7
600µm	95.7
300µm	85.7
150µm	64.4
75µm	53.9



Comments: **Moisture content 17.4 %.**

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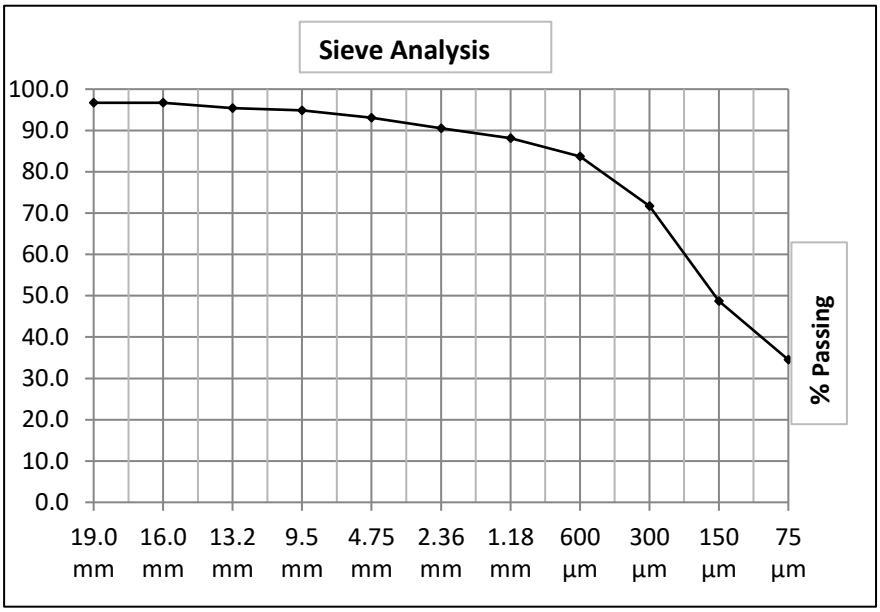
PARTICLE SIZE DISTRIBUTION GRAPH
LABORATORY TEST REPORT

Client:	Azure Group	Date Sampledd:	2021-02-24, 25
Project Name:	Sophia St. E, Barrie	Laboratory No.:	20316
Project Number:	CCC-213999-00	Sampled By:	S.S.
Location:	Sophia St. E, Barrie	Date Tested:	2021-02-26
Source:	BH 4 - SS 6 (30'-32')	Tested By:	H.F.

Aggregate Mix Properties	
Seive Size	% Passing
26.5mm	100.0
19.0mm	96.7
16.0mm	96.7
13.2mm	95.4
9.5mm	94.9
4.75mm	93.1
2.36mm	90.5
1.18mm	88.1
600µm	83.7
300µm	71.7
150µm	48.7
75µm	34.5



Comments: **Moisture content 12.0 %.**

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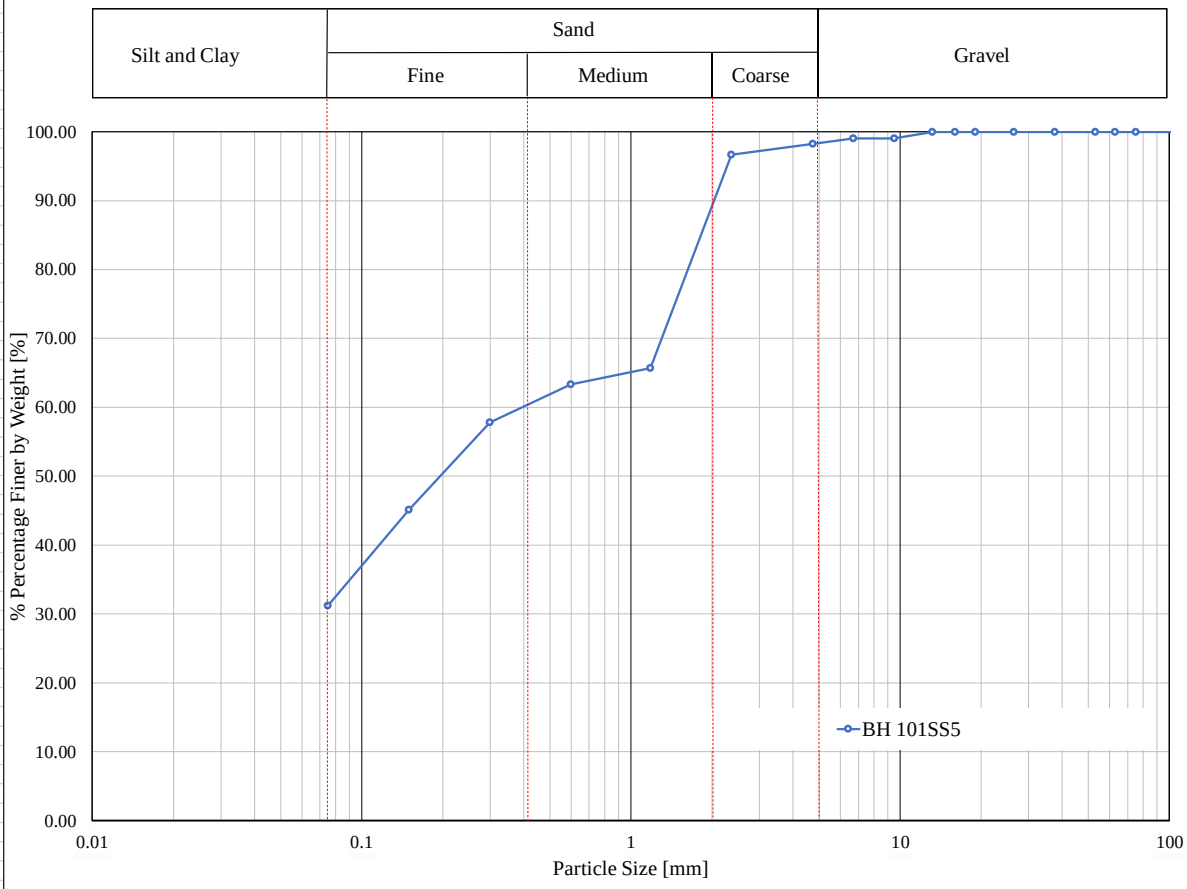
JOB NO. 2203-002 (CCC-213999-00)

DRAWING NO.

CLIENT : Azure Group

LOCATION : 58-60 Clapperton Street, Barie

DATE : May 4, 2022



Sample	Percent Gravel [%]	Percent sand [%]	Percent Silt and Clay [%]	Moisture Content [%]
BH 101SS5 Brown Silty Sand	1.75%	59.64%	38.61%	12.39%

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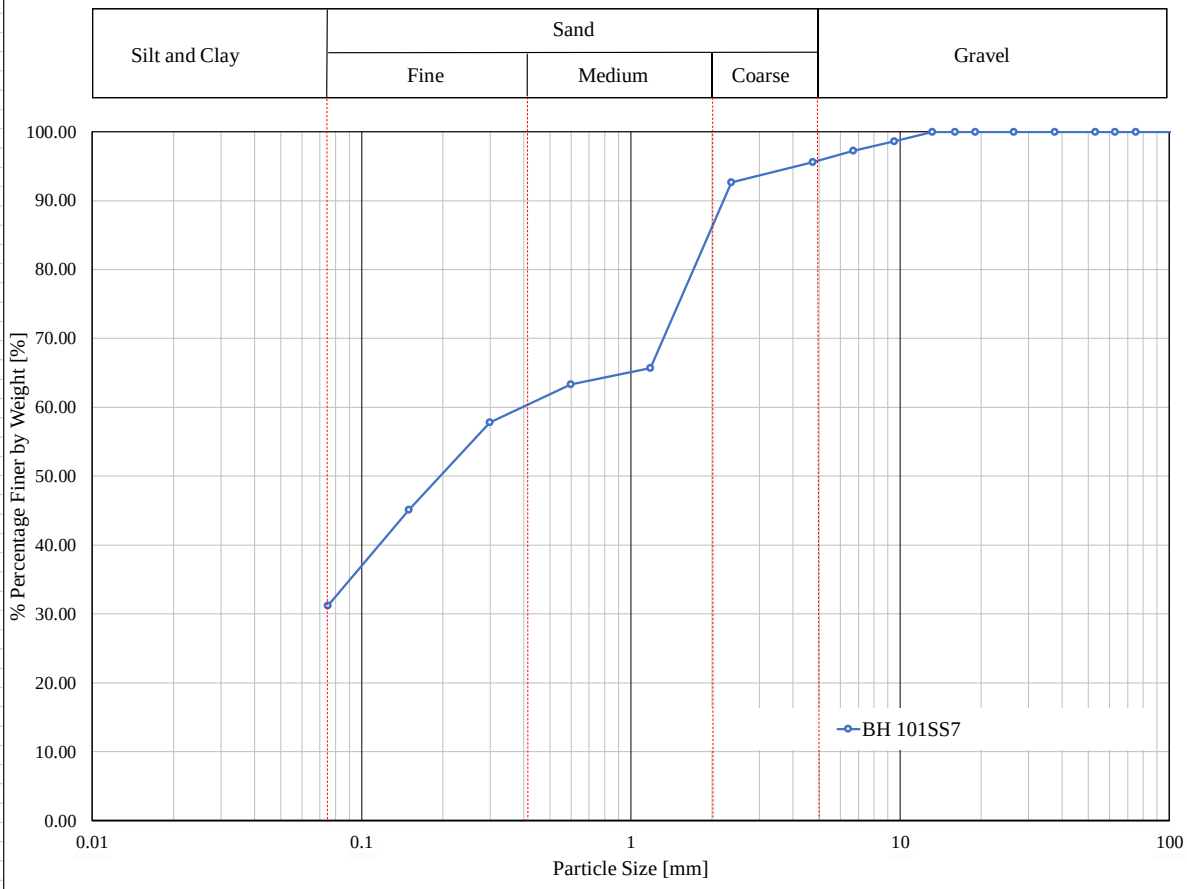
JOB NO. 2203-002 (CCC-213999-00)

DRAWING NO.

CLIENT : Azure Group

LOCATION : 58-60 Clapperton Street, Barrie

DATE : May 4, 2022



Sample	Percent Gravel [%]	Percent sand [%]	Percent Silt and Clay [%]	Moisture Content [%]
BH 101SS7 Brown Silty Sand	4.40%	59.40%	36.20%	9.71%

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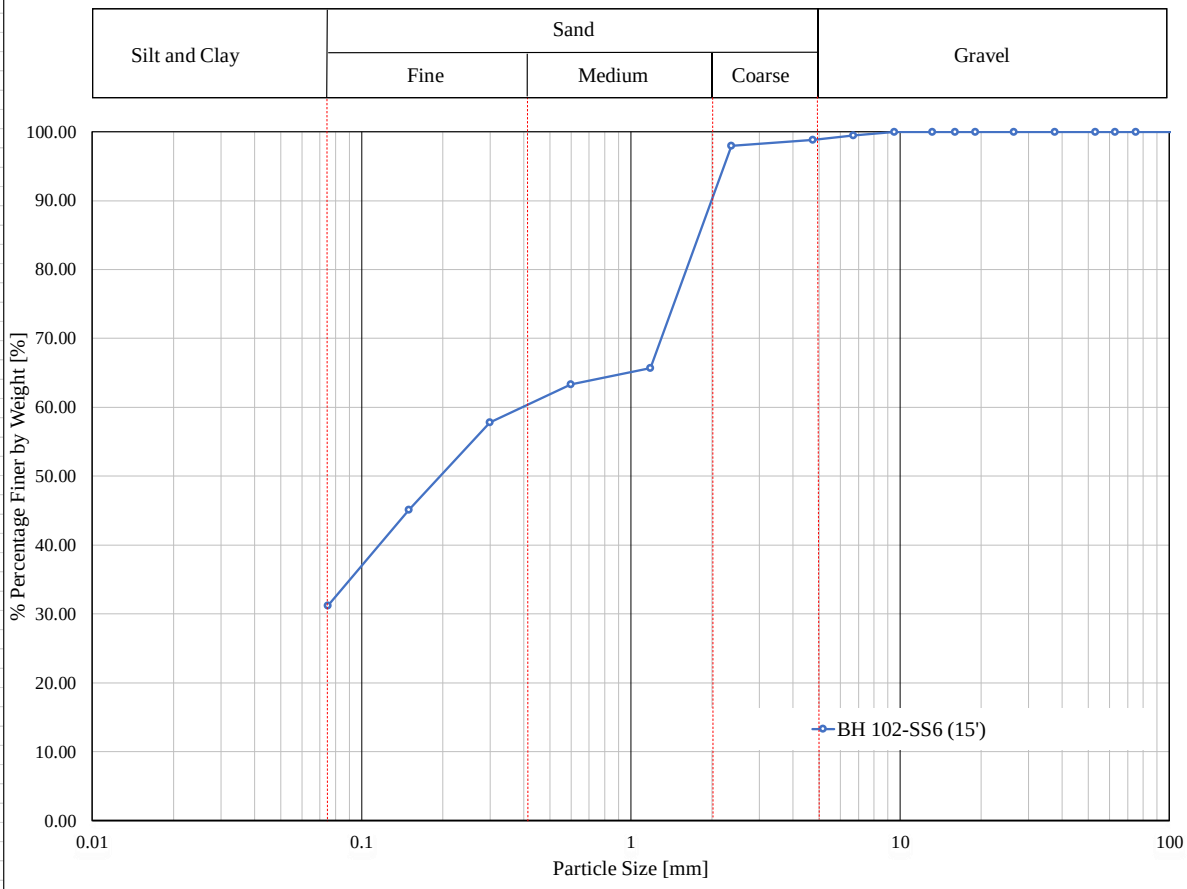
JOB NO. 2203-002 (CCC-213999-00)

DRAWING NO.

CLIENT : Azure Group

LOCATION : 17 Sophia Street, Barrie

DATE : May 4, 2022



Sample	Percent Gravel [%]	Percent sand [%]	Percent Silt and Clay [%]	Moisture Content [%]
BH 102-SS6 (15') Clayey Silty Sand	1.18%	46.55%	52.27%	18.83%

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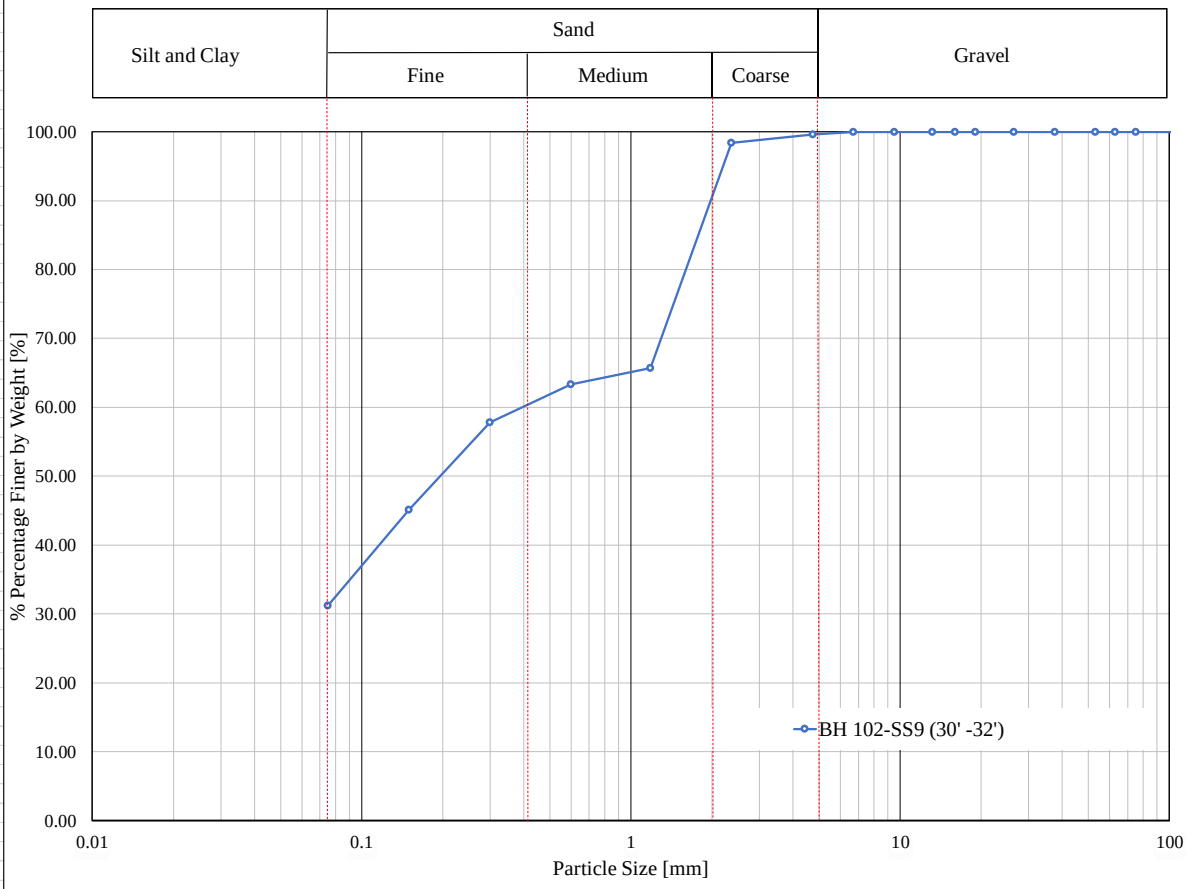
JOB NO. 2203-002 (CCC-213999-00)

DRAWING NO.

CLIENT : Azure Group

LOCATION : 17 Sophia Street, Barrie

DATE : May 4, 2022



Sample	Percent Gravel [%]	Percent sand [%]	Percent Silt and Clay [%]	Moisture Content [%]
BH 102-SS9 (30' -32') Sandy Clayey Silt	0.40%	64.12%	35.48%	13.66%

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