Revised Report on
Preliminary Geotechnical Investigation
Proposed Buildings
1971-1975 St. Laurent Boulevard
Ottawa, ON

Prepared For:
Starlight Developments

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1. INTRODUCTION

DS Consultants Ltd. (DS) was retained by Starlight Developments to undertake a preliminary geotechnical investigation for the proposed development located at 1971-1975 St. Laurent Boulevard in Ottawa, Ontario.

It is understood that the project will consist of construction of three (3) high-rise buildings (Building A, Building B and Building C, each 17-Storeys) and a five (5) storey above grade parking structure. It is also understood that the proposed high-rise buildings will have one level of basement (P1 Basement) at about 3.8m below existing grade for mechanical/ electrical, resident lockers. The finish floor elevations at the P1 basement floor are not available to us at the time of writing this report.

The purpose of this geotechnical investigation was to determine the subsurface conditions at the borehole locations and from the findings at the boreholes make preliminary geotechnical recommendations for the following:

1. Foundations
2. Floor slabs and permanent drainage
3. Excavations and groundwater control
4. Earth pressures
5. Earthquake considerations
6. Pavements
7. Underground Services

Additional deep boreholes are required prior to the final design of the proposed buildings.

This report is provided on the basis of the terms of reference presented above and, on the assumption, that the design will be in accordance with applicable codes and standards. If there are any changes in the design features relevant to the geotechnical analyses, or if any questions arise concerning the geotechnical aspects of the codes and standards, this office should be contacted to review the design. It may then be necessary to carry out additional borings and reporting before the recommendations can cater to the changed design.

The site investigation and recommendations follow generally accepted practice for geotechnical consultants in Ontario. The format and contents are guided by client specific needs and economics and do not conform to generalized standards for services. Laboratory testing for most part follows ASTM or CSA Standards or modifications of these standards that have become standard practice.

This report has been prepared for Starlight Developments, its architect and designers. Use of this report by third party without DS consent is prohibited.

2. FIELD AND LABORATORY WORK

A total of ten (10) boreholes (BH21-2 to BH21-10 and BH21-12) see **Drawing 1** for borehole locations) were drilled to depths ranging from 11.6 to 17.7m below ground surface. Boreholes were drilled using solid stem and hollow stem continuous flight augers arranged by a drilling sub-contractor under the

direction and supervision of DS personnel. Samples were retrieved at regular intervals with a 50 mm O.D. split-barrel sampler driven with a hammer weighing 624 N and dropping 760 mm in accordance with the Standard Penetration Test (SPT) method. The samples were logged in the field and returned to the DS laboratory for detailed examination by the project engineer and for laboratory testing.

BH21-4 and BH21-8 were drilled to a depth of 13.4m without soil sampling to the depth of bedrock and rock coring started. Dynamic Cone Penetration (DCPT) tests were carried out in BH21-5 and BH21-12 below depths of 11.3m and 13.6m below ground surface.

As well as visual examination in the laboratory, all soil samples were tested for moisture contents. Grain size analyses of selected soil samples were conducted and the results are presented on individual logs and on **Drawing 12**.

Shale bedrock was cored in three (3) boreholes (BH21-3, BH21-4 and BH21-8 with HQ-2 double tube wireline equipment providing 63mm dia. rock core samples. The coring was carried out under the full-time supervision of a representative from DS who identified and described the rock samples, noting and recording the percentages of total and solid rock core recovery, RQD values, fracture index and the percentage and thicknesses of hard layers. Photographs of bedrock cores are presented in **Appendix A**.

Water level observations were made during and upon completion of drilling. Monitoring wells of 50mm diameter were installed in three (3) boreholes for the long-term groundwater level monitoring.

The surface elevations at the borehole locations were surveyed by DS using differential GPS system.

3. SUBSURFACE CONDITIONS

The borehole location plan is shown on **Drawing 1**. General notes on sample description are provided on **Drawing 1A**. The subsurface conditions in the boreholes are presented in the individual borehole logs presented on **Drawings 2 to 11**.

3.1 Soil and Bedrock Conditions

Pavement Structure/Topsoil/Fill Materials: Boreholes were drilled on the paved surface and encountered 50mm of asphalt overlying 150mm to 410mm granular base/subbase.

BH21-12 was drilled on grass area and encountered 130mm thick layer of surficial topsoil.

Fill material was found in all boreholes extending to depths ranging from 0.8 to 1.8m below ground surface. The fill material was consisted of clayey silt, sandy silt, silty sand and sand and gravel, with inclusions of rootlets and organics. The fill was found to be in a stiff to very stiff consistency/compact state with measured SPT 'N' values of ranging from 9 to 24 blows per 300 mm penetration.

Silty Clay to Clayey Silt: Silty Clay to Silty Clay was encountered in all boreholes and were found to extend to depths ranging from 3.1 to 4.6m below existing ground. These deposits were found to have generally firm to very stiff consistency with occasional hard layers, with measured SPT 'N' values ranging from 5 to 20 blows per 300mm penetration.

Grain size analyses of one silty clay samples (BH21-7/SS5) was conducted and the result is presented in the borehole log and on **Drawing 12**, with the following fractions:

Clay:	48%
Silt:	46%
Sand:	6%

Weak Silty Clay: The weak silty clay was found in all boreholes below depths ranging from 3.1 to 4.6m and was found to extend to depths ranging from 10.7 to 12.2m below ground surface. Weak silty clay found to have a very soft to soft consistency with occasional firm to stiff layers, with measured SPT 'N' values ranging from (Weight of Hammer WH, less than 1 blow) to 4 blows per 300mm penetration.

Undrained shear strength tests (vane test) were carried out in weak soft clay in BH21-3 at depths 7m and 7.3m, and an undrained shear strength C_u of 44 kPa and 47 kPa was noted.

Grain size analyses of four (4) weak silty clay samples (BH21-2/SS6, BH21-2/SS8, BH21-5/SS8 and BH21-6/SS9) were conducted and the results are presented in the borehole log and on **Drawing 12**, with the following fractions:

Clay:	34% to 55%
Silt:	44% to 63%
Sand:	1% to 5%

Atterberg Limits tests of four (4) silty clay samples (BH21-2/SS6, BH21-2/SS8, BH21-5/SS8 and BH21-6/SS9) were conducted. The results are shown on the borehole logs

Liquid limit (WL):	28% to 45%
Plastic limit (WP):	15% to 21%
Plasticity index (PI):	10 to 24

Clayey Silt Till: These deposits were encountered in boreholes BH21-2, BH21-6, BH21-9 and BH21-12 and extended to depths ranging from 11 to 13.7m below ground surface. This deposit was found to have very stiff to hard consistency with measured SPT 'N' values ranging from 12 to 32 blows per 300mm penetration.

Grain size analyses of two (2) clayey silt till samples (BH21-2/SS10 and BH21-6/SS11) were conducted and the results are presented in the borehole log and on **Drawing 12**, with the following fractions:

Clay:	11%
Silt:	30%
Sand:	43% to 46%
Gravel:	13% to 16%

Atterberg Limits tests of two (2) clayey silt samples (BH21-2/SS10 and BH21-6/SS11) were conducted. The results are shown on the borehole logs

Liquid limit (WL):	17% to 19%
Plastic limit (WP):	11% to 13%
Plasticity index (PI):	6

Clayey Silt Till/Shale Complex: Cohesive deposits of clayey silt till/shale complex were encountered in Boreholes BH21-2, BH21-3, BH21-6 and BH21-7. These deposits were found to have generally hard consistency with occasional very stiff layers with measured SPT 'N' values of more than 50 blows per 300mm. Occasional cobble and boulders should be expected in the till deposit. The clayey silt till/shale complex consists of clayey silt till mixed with highly weathered shale and contains properties of hard till and shale bedrock.

Grain size analyses of one clayey silt till/shale complex sample (BH21-7/SS11) was conducted and the result is presented in **Drawing 12**, with the following fractions:

Clay: 13%
Sand: 39%
Silt: 27%
Gravel: 21%

Silty Sand Till/Sandy Silt Till: These deposits were encountered found in boreholes BH21-3 and BH21-12 and found to be in a dense to very dense state, with measured SPT 'N' values ranging from 35 to more than 50 blows per 300mm penetration.

Grain size analyses of one silty sand till sample (BH21-3/SS11) was conducted and the result is presented in the borehole log and on **Drawing 12**, with the following fractions:

Clay: 3%
Silt: 25%
Sand: 44%
Gravel: 28%

Silty Sand Till/Shale Complex: These deposits were encountered in BH21-10 and extended to the termination depth of the borehole. These deposits were found in a compact to very dense state with measured SPT 'N' values ranging from 22 to more than 50 blows per 300mm. Occasional cobble and boulders should be expected in the till deposit. The silty sand till/shale complex consists of silty sand till mixed with highly weathered shale and contains properties of very dense till and shale bedrock.

Grain size analyses of one silty sand till/shale complex sample (BH21-10/SS11) was conducted and the result is presented in **Drawing 12**, with the following fractions:

Clay: 8%
Sand: 45%
Silt: 24%
Gravel: 23%

Shale Bedrock: Shale bedrock was found in Boreholes BH21-2 to BH21-4, BH21-6 and BH21-8 at approximate depths varying from 12.4 to 13.8m below ground surface, corresponding to elevations varying from 64.3 to 66.8m. Dynamic Cone Penetration Testing (DCPT) and auger refusal was encountered in Boreholes BH21-5, BH21-7, BH21-9, BH21-10 and BH21-12 on possible bedrock at depths 13.1 to 14.3m below ground surface, as presented in **Table 1** below.

Table 1: Depth and Elevation of Shale Bedrock Surface

Borehole No.	Depth of Shale Bedrock Surface below Existing Ground (m)	Approximate Elevation of Shale Bedrock Surface (m)	Notes
BH21-2	12.4	66.8	Bedrock was augered
BH21-3	13.8	65.1	Bedrock was cored from 13.6m to 17.7m
BH21-4	13.8	65.1	Bedrock was cored from 13.8m to 16.7m
BH21-5	14.3	64.3	DCPT refusal on possible bedrock
BH21-6	13.9	64.9	Bedrock was augered
BH21-7	13.5	64.9	Auger refusal on possible bedrock
BH21-8	13.4	65.1	Bedrock was cored from 13.4m to 15.2m
BH21-9	13.1	65.8	Auger refusal on possible bedrock
BH21-10	11.6	66.9	Auger refusal on possible bedrock
BH21-12	13.6	65.6	DCPT refusal on possible bedrock

Because of the method of drilling and sampling, the surface elevations of the bedrock can be different than indicated on the borehole logs. With augering, the auger may penetrate some of the highly weathered shale and the coring may therefore begin below the bedrock surface. Commonly the overburden overlying the shale contains slabs of limestone which would give a false indication of the bedrock level. Similarly, the depth of weathering cannot be determined accurately due to the presence of limestone layers.

Total Core Recovery (TCR): The total core recovery indicates the total length of rock core recovered, expressed as a percentage of the actual length of the core run. The total core recovery in the coreholes ranged from 66 to 100%. Generally, less core recovery was experienced only near the surface of the rock, where the formation is slightly weathered and was almost full as depth increased.

Solid Core Recovery (SCR): The solid core recovery is the total length of solid, full diameter rock core that was recovered, expressed as a percentage of the length of the core run. Solid core recovery generally ranged from 33 to 92%, and also appears to generally improve with depth. Solid core recovery for R1 at BH21-4 was nil (0) but generally ranged from 33 to 92%, and also appears to generally improve with depth. The SCR index was generally influenced by the orientations of the fractures. SCR was low when fractures oblique to the borehole axis were intercepted.

Rock Quality Designation (RQD): The rock quality designation index is obtained by measuring the total length of recovered rock core pieces which are longer than 100mm and expressing their sum total length as a percentage of the length of the core run. RQD is a function of the frequency of joints, bedding plane partings and fractures in the rock cores. While the use of double tube core barrels provided reasonably good protection of the core during drilling and core retrieval, the fissile nature of the shale greatly influences the RQD values of the rock cores. Consequently, it is believed that the RQD values recorded underestimate the rock quality classification of the laminated fissile shale. The RQD value for R1 in BH21-

4 was found nil (0), but RQD values generally ranged from 33 to 90%. the rock quality is estimated to be generally "poor" to "good" quality.

Hard Layers: Based on the visual examination of the rock cores, an attempt was made to identify and record the thickness and percentages of the relatively harder siltstone and limestone layers. The percentage of the "hard layers" per core run ranges between 0 and 25%. The thickness of these layers varied but was generally between 60 to 150mm but generally less than 150mm, occasional layers of thickness more than 200 mm were also encountered in the coreholes. The thicker layers have been observed to be as much as 750 to 900 mm at other sites. The layers are actually lenses and they can vary significantly in thickness over short distance. Encountering such thick layers should be anticipated. It is also common to encounter closely spaced groupings of thin strong limestone/siltstone layers which individually may only be 12 to 25mm thick but collectively can be 1m in thickness.

Methane Gas: Methane gas is expected in the bedrock. Appropriate care and monitoring is essential in all confined bedrock excavations, particularly for caissons.

3.2 Groundwater Conditions

Monitoring wells of 50mm dia. Were installed in BH21-2, BH21-9 and BH21-10 and the groundwater measured on October 29, 2021, was found 3.8 to 6.3m below ground surface, corresponding to Elev. 72.9m to 75.0, as listed on **Table 2.**

Table 2: Summary of Groundwater Level Measurements

BH No.	Ground Surface Elevation (m)	Date of Observation	Groundwater Depth/Elevation (m)
BH21-2	79.2	October 29, 2021	6.3/72.9
BH21-9	78.9	October 29, 2021	3.8/75.0
BH21-10	78.5	October 29, 2021	5.0/73.5

It should be noted that the groundwater levels can vary and are subject to seasonal fluctuations in response to major weather events. Further monitoring of groundwater table is recommended.

4. FOUNDATIONS

It is understood that the project will consist of construction of three (3) high-rise buildings (Building A, Building B and Building C, each 17-Storeys) and a five (5) storey above grade parking structure. It is also understood that the proposed high-rise buildings will have one level basement (P1 Basement) at about 3.8m below existing grade for mechanical/ electrical, resident lockers. The finish floor elevations at the P1 basement floor are not available to us at the time of writing this report.

Weak soils of silty clay were found in the boreholes at depths ranging from 3.1 to 4.6m, extending to depths of 10.7 to 12.2m below the ground surface. These weak silty clay deposits will result in significant consolidation settlements with time when subjected to increased loading conditions from proposed structure. Therefore, conventional foundations such as spread and strip footings and/or raft

foundations are not suitable for supporting the structures due to the presence of weak silty clay deposits.

Based on the subsurface conditions at the site, deep foundations such as drilled caissons founded in shale bedrock can be adopted to support the proposed buildings (Building A, Building B, Building C and Parking Structure).

Caissons founded in sound shale bedrock at minimum 3.0m below the bedrock surface can be designed for a bearing capacity of 7.5 MPa at SLS (Serviceability Limit States), and for a factored geotechnical resistance of 11.0 MPa at ULS (Ultimate Limit States), provided that the bedrock be verified and witnessed by our office during construction and the caisson bases are proven to be clean. The bearing pressure values and the highest founding elevations are given in Table 3 below.

Table 3: Bearing Values and Founding Levels of Drilled Caissons

Building	Borehole No.	Material	Bearing Capacity at SLS (MPa)	Bearing Capacity at ULS (MPa)	Minimum Depth below Existing Ground (m)	Highest Elevation of Caisson Base (m)
Building A	BH21-2	Sound Shale	7.5	11.0	15.4	63.8
	BH21-3	Sound Shale	7.5	11.0	16.8	62.1
Building B	BH21-4	Sound Shale	7.5	11.0	16.8	62.1
	BH21-5	Sound Shale	7.5	11.0	17.3	61.3
	BH21-6	Sound Shale	7.5	11.0	16.9	61.9
Building C	BH21-7	Sound Shale	7.5	11.0	16.5	61.9
	BH21-8	Sound Shale	7.5	11.0	16.4	62.1
	BH21-9	Sound Shale	7.5	11.0	16.1	62.8
Proposed Parking Structure	BH21-10	Sound Shale	7.5	11.0	14.6	63.9
	BH21-12	Sound Shale	7.5	11.0	16.6	62.6

Variation in the bedrock surface elevations should be expected between the boreholes. Bedrock coring may be required for the caisson installation.

The presence of fill, weak soils and sandy soils below the groundwater table will make the construction of caissons difficult. An oversize liner will be required and must be sealed in the bedrock, in order to prevent water seepage and caving of the wet soils into the caisson hole.

Sealing of the liner in bedrock will be difficult where limestone or boulders layer are present at the surface above the shale and coring of the limestone layer or boulders will be required to advance the casing.

All foundations and pile caps exposed to seasonal freezing conditions must have at least 1.8m of soil cover or its thermal equivalent for frost protection.

Caissons designed to the specified bearing capacities at the serviceability limit states (SLS) are expected to settle less than 25 mm total and 19 mm differential.

Prior to placing concrete, all caisson bases must be inspected by qualified geotechnical personnel to confirm the design bearing value. The drilling contractor must provide evidences that the caisson bases are clean from any mud and water prior to pouring the concrete.

It should be noted that the recommended bearing capacities have been calculated by DS from the borehole information for the preliminary design stage only. Additional boreholes are required prior to the final design of the proposed buildings.

The investigation and comments are necessarily on-going as new information of the underground conditions becomes available. For example, more specific information is available with respect to conditions between boreholes when foundation construction is underway. The interpretation between boreholes and the recommendations of this report must therefore be checked through field inspections provided by DS to validate the information for use during the construction stage.

5. EARTH PRESSURES

The lateral earth pressures acting on basement walls may be calculated from the following expression:

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

where p = Lateral earth pressure in kPa acting at depth h

K = Earth pressure coefficient equal to 0.4 for vertical walls

and horizontal backfill.

γ = Unit weight of backfill, a value of 21 kN/m3 may be assumed

h = Depth to point of interest in metres

q = Equivalent value of surcharge on the ground surface in kPa

The above expression assumes that the perimeter drainage system prevents the buildup of any hydrostatic pressure behind the wall.

6. EXCAVATION AND GROUNDWATER CONTROL

Excavations in the overburden can be carried out with heavy hydraulic backhoe. No major problems with groundwater are anticipated for installation of the foundations. Some seepage from fill material should be expected which can be controlled by conventional methods pumping from collection sumps and ditches.

The proposed P1 basement floor level will be at or near the weak (soft to very soft) silty clay deposit. Due to the soft to firm consistency of the silty clay deposit, a construction mat consisting of a minimum 1.0m thick protective layer of 50 mm environmentally acceptable recycled crushed concrete or crusher

run limestone is recommended to cover the subgrade. Thicker construction mat may be required in some areas, depending on the type of construction machine expected in the areas.

It should be noted that the glacial till soils may contain boulders. Large obstructions in the fill material are anticipated. Provisions must be made in the excavation contract for the removal of boulders in the till and large obstructions in the fill material.

All excavations must be carried out in accordance with the most recent Occupational Health and Safety Act (OHSA). In accordance with OHSA, the fill material, firm to stiff clayey silt to silty clay and silty sand to sandy silt till can be classified as Type 3 soil above groundwater and Type 4 Soil below groundwater or in perched water. The very stiff to hard clayey soils can be classified as Type 2 Soil above the groundwater table and as Type 3 below the groundwater table. Soft to very soft silty clay can be classified as Type 4 Soil.

The native soils free from topsoil and organics can be used as general construction backfill, provided its moisture content is within 2 percent of the optimum moisture content. Loose lifts of soil, which are to be compacted, should not exceed 200 mm. Depending on the time of construction and weather, some excavated material may be too wet to compact and will require aeration prior to its use.

Imported granular fill, which can be compacted with hand held equipment, should be used in confined areas. The excavated soils are not considered to be free draining. Where free draining backfill is required, imported granular fill such as OPSS Granular B should be used.

It should be noted that the excavated soils are subject to moisture content increase during wet weather which would make these materials too wet for adequate compaction. Stockpiles should be compacted at the surface or be covered with tarpaulins to minimize moisture uptake.

7. FLOOR SLAB AND PERMANENT DRAINAGE

For the proposed parking structure without basement, the floor slab can be supported on grade provided all topsoil, fill, and surficially softened till are removed and the base thoroughly proof rolled. The fill required to raise the grade can consist of inorganic soil, placed in shallow lifts and compacted to 98 percent of Standard Proctor Maximum Dry Density (SPMDD).

For proposed buildings (Building A, B & C) with one level of basement, the floor slab can be supported on grade, provided the exposed soft to very soft silty clay subgrade is covered with a minimum 1.0m thick protective layer of 50 mm environmentally acceptable recycled crushed concrete or crusher run (as mentioned in **Section 6)**.

A moisture barrier consisting of at least 200 mm of 19 mm clear crushed stone should be installed under the floor slab.

For proposed buildings with a basement (Buildings A to C), the perimeter and underfloor drainage systems as shown on **Drawing 13** are recommended for the basement walls where open cut procedures are used.

For proposed slab on grade parking structure (ie without basement), if the floor slab is more than about 300 mm higher than the exterior grade then perimeter drainage is not considered to be necessary. If the floor is lower, then the perimeter drainage system shown on **Drawing 14** is recommended.

8. EARTHQUAKE CONSIDERATIONS

Based on the existing borehole information and according to Table 4.1.8.4.A of OBC 2012, the subject site for the proposed structures can be classified as "Class D" for seismic site response.

9. PAVEMENTS

The recommended pavement structures provided in **Table 4** are based upon subgrade soil properties determined as well as visual examination and textural classification of the soil samples. Consequently, the recommended pavement structures should be considered for preliminary design purposes only. A functional design life of eight to ten years has been used to establish the pavement recommendations. This represents the number of years to the first rehabilitation, assuming regular maintenance is carried out. If required, a more refined pavement structure design can be performed based on specific traffic data and design life requirements and will involve specific laboratory tests to determine frost susceptibility and strength characteristics of the subgrade soils, as well as specific data input from the client.

Table 4: Recommended Pavement Structure Thickness

Pavement Layer	Compaction Requirements	Light Duty Parking (Cars)	Heavy Duty Parking (Trucks & Fire Route)
Asphaltic Concrete	92.0 to 96.5% Maximum Relative Density (MRD)	40 mm HL 3 or SP 12.5 40 mm HL 8 or SP 19.0	40 mm HL 3 or SP 12.5 80 mm HL 8 or SP 19.0
OPSS Granular A Base (or 20mm Crusher Run Limestone)	100% SPMDD*	150 mm	150 mm
OPSS Granular B (or 50mm Crusher Run Limestone)	100% SPMDD	250 mm	350 mm

* Denotes Standard Proctor Maximum Dry Density, ASTM-D698

The subgrade must be compacted to 98% SPMDD for at least the upper 0.5m unless accepted by DS Consultants Ltd. Thicker lift of stone may be required to support the construction traffic as the existing subgrade is silty and it may puncture through the overlying granular. The long-term performance of the pavement structure is highly dependent upon the subgrade support conditions. Stringent construction control procedures should be maintained to ensure uniform subgrade moisture and density conditions are achieved. In addition, the need for adequate drainage cannot be over-emphasized. Water collected can cause differential frost heave leading to permanent cracking. The finished pavement surface and underlying subgrade should be free of depressions and undulations. As well, the finished pavement surface and the underlying subgrade surface should be sloped (preferably at a minimum grade of two

percent) to provide effective surface drainage toward catch basins. Surface water should not be allowed to pond adjacent to the outside edges of pavement areas. Subdrains should be installed to intercept excess subsurface moisture and prevent subgrade softening. This is particularly important in heavy-duty pavement areas.

Additional comments on the construction of parking areas are as follows:

1. As part of the subgrade preparation, proposed parking areas should be stripped of topsoil and any objectionable material. The top 0.3m of fill material must be sub- excavated and properly replaced with suitable approved backfill material compacted to 98% SPMDD.
2. The locations and extent of sub-drainage required within the paved areas should be reviewed by this office in conjunction with the proposed lot grading. Assuming that satisfactory cross falls in the order of two percent have been provided, subdrains extending from and between catch basins may be satisfactory. In the event that shallower cross falls are considered, a more extensive system of sub-drainage may be necessary and should be reviewed by DS.
3. The most severe loading conditions on light-duty pavement areas and the subgrade may occur during construction. Consequently, special provisions such as restricted access lanes, half-loads during paving, etc., may be required, especially if construction is carried out during unfavorable weather.
4. It is recommended that DS be retained to review the final pavement structure designs and drainage plans prior to construction to ensure that they are consistent with the recommendations of this report.

10. UNDERGROUND UTILITIES

Excavations for the installation of services may be carried out to a greater depth. No major problems with groundwater are anticipated for the installation of services up to a depth of 5m. All excavations must be carried out in accordance with the Occupational Health and Safety Act.

Granular B material should be used as backfill for trenches located under slab on grade or paved areas. Compaction of the granular soils should be carried out with vibratory compactors and loose lifts not exceeding about 200 mm. Trench backfill should be compacted to at least 95 percent (SPMDD) to within 0.6 m of the top of the subgrade and then to 98 percent (SPMDD) to the subgrade level.

Class B bedding should be suitable to support the pipes/tanks. Depending on the pipe/tank depth, if soft to very soft clay is encountered at the invert elevation, a Geoweb reinforced base should be constructed at the trench base and then conventional Class B type bedding can be used on top of Geoweb.

The recommended minimum thickness of Class B bedding below the invert of the pipes is 150 mm. The thickness of the bedding may, however, need to be increased depending on the pipe diameter or in accordance with local standards or if wet or weak subgrade conditions are encountered, especially when the soil at the trench base level consists of soft to very soft clay soils.

The bedding material should conform to the City of Ottawa bedding stone gradation requirements. Where the bedding falls below the anticipated water table, the bedding stone must be surrounded with a geotextile filter cloth.

11. GENERAL COMMENTS AND LIMITATIONS OF REPORT

DS Consultants Ltd. (DS) should be retained for a general review of the final design and specifications to verify that this report has been properly interpreted and implemented. If not accorded the privilege of making this review, DS will assume no responsibility for interpretation of the recommendations in the report.

This report is intended solely for the Client named. The material in it reflects our best judgment in light of the information available to DS at the time of preparation. Unless otherwise agreed in writing by DS, it shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. No portion of this report may be used as a separate entity, it is written to be read in its entirety.

The conclusions and recommendations given in this report are based on information determined at the test hole locations. The information contained herein in no way reflects on the environment aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the test holes may differ from those encountered at the test hole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the test hole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of test holes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. DS accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report. We accept no responsibility for any decisions made or actions taken as a result of this report unless we are specifically advised of and participate in such action, in which case our responsibility will be as agreed to at that time.

We trust that the information contained in this report is satisfactory. Should you have any questions, please do not hesitate to contact this office.

DS CONSULTANTS LTD

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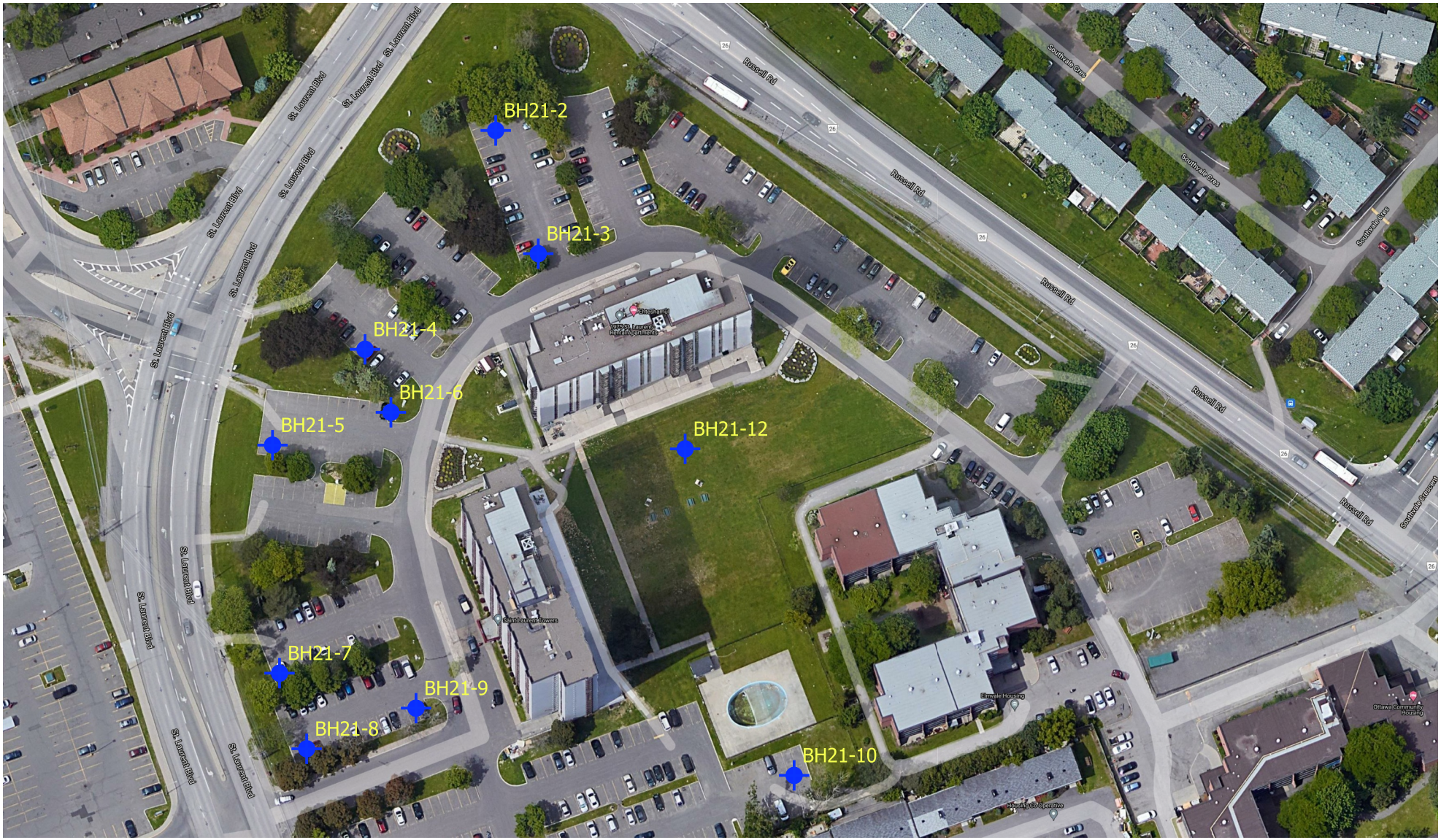
Drawings



Legend

Borehole Locations

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Project: Geotechnical Investigation -1971-1975 St. Laurent Boulevard, Ottawa, ON

Title: **Borehole Location Plan**

N

Client: Starlight Developments

Size:	Approved By:	Drawn By:	Date:
8.5 x 11	NE	SG	November 09, 2021
Rev: 0	Scale: As Shown	Project No.: 21-332-100	Drawing No.: 1

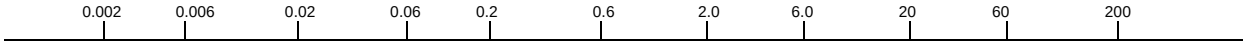
Image/Map Source: *Google Satellite Image*

Drawing 1A: Notes On Sample Descriptions

1. All sample descriptions included in this report generally follow the Unified Soil Classification. Laboratory grain size analyses provided by DSCL also follow the same system. Different classification systems may be used by others, such as the system by the International Society for Soil Mechanics and Foundation Engineering (ISSMFE). Please note that, with the exception of those samples where a grain size analysis and/or Atterberg Limits testing have been made, all samples are classified visually. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.

ISSMFE SOIL CLASSIFICATION

CLAY	SILT			SAND			GRAVEL			COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE		



EQUIVALENT GRAIN DIAMETER IN MILLIMETRES

CLAY (PLASTIC) TO	FINE	MEDIUM	CRS.	FINE	COARSE
SILT (NONPLASTIC)	SAND			GRAVEL	

UNIFIED SOIL CLASSIFICATION

2. Fill: Where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc., none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional preliminary geotechnical site investigation.

3. Till: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

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Geotechnical ◆ Environmental ◆ Materials ◆ Hydrogeology

LOG OF BOREHOLE BH21-2

PROJECT: Geotechnical Investigation
CLIENT: Starlight Developments
PROJECT LOCATION: 1971-1975 St. Laurant Blvd., Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 5041400.53 E 920941.05

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200mm
Date: Oct-06-2021

REF. NO.: 21-332-100
ENCL NO.: 2

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS / 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
79.2 / 0.0	**ASPHALT:** 50mm						79					
78.8 / 0.4	**GRANULAR BASE:** sand and gravel (330mm)		1	SS	15							
1	**FILL:** clayey silt, trace organics, trace gravel, brown, moist, stiff to very stiff		2	SS	11		78					
77.7 / 1.5												
2	**CLAYEY SILT TO SILTY CLAY:** trace sand, brown, moist, stiff to very stiff grey below 2.3m		3	SS	20		77					
			4	SS	12							
3 76.1 / 3.1	**SILTY CLAY:** trace sand, grey, moist, firm to stiff		5	SS	8		76					
4							75					
5			6	SS	5		74					0 5 58 37
6	soft below 6m		7	SS	3	▽	73					
						W. L. 72.9 m Oct 29, 2021						
7							72					
8			8	SS	2							0 1 44 55
9	firm at 9.1m		9	SS	5		71					
10							70					
68.5 / 10.7							69					
11 68.2 / 11.0	**CLAYEY SILT TILL:** trace sand, trace gravel, occasional cobble, grey, moist, stiff		10	SS	12		68					16 43 30 11
12	**CLAYEY SILT TILL/SHALE COMPLEX:** sandy, some gravel, grey, moist, stiff											
66.8 / 12.4	seams of sandy silt till at 12.2m		11	SS	50/ 130mm		67					
66.6 / 12.6	**SHALE BEDROCK:** grey, weathered											
	END OF BOREHOLE:											

Notes:
1) 50mm dia. monitoring well installed upon completion.
2) Water Level Readings:

Date:	Water Level(mbgl):
Oct. 29, 2021	6.29

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

DS SOIL LOG 21-332-100-OCT 19, 2021 DCPT.GPJ DS.GDT 21-11-8

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LOG OF BOREHOLE BH21-3

PROJECT: Geotechnical Investigation
CLIENT: Starlight Developments
PROJECT LOCATION: 1971-1975 St. Laurant Blvd., Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 5041369.43 E 920954.14

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200mm
Date: Oct-14-2021

REF. NO.: 21-332-100
ENCL NO.: 3

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
78.9												
78.8	**ASPHALT:** 50mm											
78.5	**GRANULAR BASE:** sand and gravel (300mm)		1	SS	11		78					
78.1 0.8	**FILL:** clayey silt, trace organics, trace gravel, grey, moist, stiff		2	SS	8							
1	**SILTY CLAY TO CLAYEY SILT:** trace sand, grey, very moist, stiff to very stiff		3	SS	15		77					
2			4	SS	12							
3			5	SS	8		76					
74.3 4							75					
4.6 5	**SILTY CLAY:** trace sand, grey, moist, very soft to firm		6	SS	4		74					
6			7	SS	WH		73					
7				VANE			72	2.0, 1.7				
				VANE								
8			8	SS	WH		71					
9	firm to stiff below 9.1m		9	SS	6		70					
10			10	SS	11		69					
11							68					
66.7 12							67					
12.2	**SILTY SAND TILL:** trace clay, some gravel, grey, wet, dense		11	SS	35							28 44 25 3
13							66					
65.5												
65.4	**CLAYEY SILT TILL/SHALE**		12	SS	50/							
13.6 64.9 14	**COMPLEX:** grey, very moist, hard				75mm		65					
14.0	**SHALE BEDROCK:** TCR=83%, SCR=33%, RQD=33% Hard layer=0%		RC1	RC								
15	TCR=95%, SCR=91%, RQD=90% Hard layer=5%, Maximum hard layer thickness=25mm						64					
63.4 15.5												
16	TCR=100%, SCR=65%, RQD=65% Hard layer=0%		RC2	RC			63					
17			RC3	RC			62					
61.2 17.7	**END OF BOREHOLE:** Notes: 1) WH-weight of hammer 2) Water at depth of 9.1m during drilling.											

DS SOIL LOG 21-332-100-OCT 19, 2021 DCPT.GPJ DS.GDT 21-11-8

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

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LOG OF BOREHOLE BH21-4

PROJECT: Geotechnical Investigation
CLIENT: Starlight Developments
PROJECT LOCATION: 1971-1975 St. Laurant Blvd., Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 5041342.17 E 920911.48

DRILLING DATA
Method: Solid Stem Auger
Diameter: 150mm
Date: Oct-15-2021

REF. NO.: 21-332-100
ENCL NO.: 4

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"							GR SA SI CL
78.9												
0.0	Straight Augered to 13.8m without soil sampling						78					
							77					
							76					
							75					
							74					
							73					
							72					
							71					
							70					
							69					
							68					
							67					
							66					
65.1												
64.9	**SHALE BEDROCK:**		1	RC			65					
14.0	TCR=66%, SCR=0%, RQD=0% Hard layer=0% TCR=98%, SCR=51%, RQD=51% Hard layer=8%, Maximum hard layer thickness=25mm		2	RC			64					
63.5												
15.4	TCR=95%, SCR=90%, RQD=90% Hard layer=5%, Maximum hard layer thickness=25mm		3	RC			63					
62.4												
16.5	**END OF BOREHOLE:**											

DS SOIL LOG 21-332-100-OCT 19, 2021 DCPT.GPJ DS.GDT 21-11-8

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

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LOG OF BOREHOLE BH21-5

PROJECT: Geotechnical Investigation
CLIENT: Starlight Developments
PROJECT LOCATION: 1971-1975 St. Laurant Blvd., Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 5041316.25 E 920889.54

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200mm
Date: Oct-13-2021

REF. NO.: 21-332-100
ENCL NO.: 5

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION
78.6							
78.6 / 0.0	**ASPHALT:** 50mm						
78.2 / 0.4	**GRANULAR BASE:** sand and gravel (300mm)		1	SS	24		
77.8 / 0.8	**FILL:** clayey silt, trace organcis, brown, moist, very stiff		2	SS	20		
77.1 / 1.5	**FILL:** sand and gravel, trace organics, dark brown, moist, compact		3	SS	16		
	SILTY CLAY TO CLAYEY SILT: trace sand, brown, very moist, firm to very stiff		4	SS	11		
	grey below 2.3m		5	SS	6		
74.0 / 4.6	**SILTY CLAY:** trace sand, grey, moist, soft to very soft		6	SS	3		
	wet below 6.1m		7	SS	2		
			8	SS	2		
			9	SS	WH		
	trace gravel at 10.7m		10	SS	2		
67.3 / 11.3	DCPT carried out below 11.3m						
64.3 / 14.3	**END OF BOREHOLE:** Notes: 1) Cone refusal at 14.3m on possible bedrock. 2) WH-weight of hammer						

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH (kPa)
○ UNCONFINED + FIELD VANE & Sensitivity
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30

POCKET PEN. (Cu) (kPa)
NATURAL UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

43.2
0 1 47 52

Auger jammed due to soil cave-in

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES
+3, ×3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

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LOG OF BOREHOLE BH21-6

PROJECT: Geotechnical Investigation
CLIENT: Starlight Developments
PROJECT LOCATION: 1971-1975 St. Laurant Blvd., Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 5041326.6 E 920919.15

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200mm
Date: Oct-12-2021

REF. NO.: 21-332-100
ENCL NO.: 6

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	BLOWS 0.3 m "N"	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
78.8 / 0.0	**ASPHALT:** 50mm	1	SS	9	78	
78.4 / 0.4	**GRANULAR BASE:** sand and gravel (300mm)					
1	**FILL:** sandy silt, trace organics, trace gravel, brown to dark brown, moist, loose to compact	2	SS	16		
77.0 / 1.8	**SILTY CLAY TO CLAY SILT:** trace sand, brown, very moist, stiff grey below 2.3m	3	SS	10	77	
2		4	SS	12	76	
3		5	SS	41	75	
74.8 / 4.0	**SILTY CLAY:** trace sand, grey, moist, firm to very soft					
5		6	SS	4	74	
6		7	SS	3	73	
7		8	SS	3	72	
8					71	
9	very moist at 9.1m	9	SS	WH	70	0 3 63 34
10					69	
11	stiff at 11m	10	SS	9	68	
66.6 / 12.2	**CLAYEY SILT TILL:** sandy, trace gravel, dark grey, moist, stiff	11	SS	12	67	13 46 30 11
12					66	
65.1 / 13.9	**CLAYEY SILT TILL/SHALE COMPLEX:** dark grey, moist, hard	12	SS	60/ 130mm	65	
64.6 / 14.2	**SHALE BEDROCK:** grey, weathered	13	SS			
	END OF BOREHOLE: Notes: 1) Water level at 12.2 m during drilling. 2) WH-weight of hammer					

DYNAMIC CONE PENETRATION RESISTANCE PLOT
SHEAR STRENGTH (kPa)
○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE
PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
POCKET PEN. (Cu) (kPa)
NATURAL UNIT WT (kN/m³)

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

DS SOIL LOG 21-332-100-OCT 19, 2021 DCPT.GPJ DS.GDT 21-11-8

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LOG OF BOREHOLE BH21-7

PROJECT: Geotechnical Investigation
CLIENT: Starlight Developments
PROJECT LOCATION: 1971-1975 St. Laurant Blvd., Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 5041258.43 E 920895.21

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200mm
Date: Oct-12-2021

REF. NO.: 21-332-100
ENCL NO.: 7

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
78.4												
78.4	**ASPHALT:** 50mm											
78.3	**GRANULAR BASE:** sand and gravel (250mm)											
1	**FILL:** clayey silt, trace rootlets, trace gravel, brown, moist, stiff		1	SS	13		78					
			2	SS	11							
76.6	trace wood pieces at 0.8m		3	SS	18		77					
2 1.8	**SILTY CLAY TO CLAYEY SILT:** trace sand, brown, moist, firm to stiff		4	SS	11		76					
3	grey below 2.3m		5	SS	6		75					0 6 46 48
4 73.8							74					
4.6	**SILTY CLAY:** trace sand, grey, moist, soft to very soft		6	SS	3		73					
6			7	SS	3		72					
7			8	SS	WH		71					
8			9	SS	WH		70					
9			10	SS	WH		69					
10							68					
11							67					
12 66.2							66					
12.2	**CLAYEY SILT TILL/SHALE COMPLEX:** sandy, some gravel, grey to dark grey, moist, very stiff		11	SS	15							21 39 27 13
13 64.9							65					
13.5	**END OF BOREHOLE:**											

Notes:
1) Auger refusal at 13.5m on possible bedrock.
2) Sample could not reterive at 13.5m due to caved in to 11m
3) WH-Weight of Hammer

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

DS SOIL LOG 21-332-100-OCT 19, 2021 DCPT.GPJ DS.GDT 21-11-8

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LOG OF BOREHOLE BH21-8

PROJECT: Geotechnical Investigation
CLIENT: Starlight Developments
PROJECT LOCATION: 1971-1975 St. Laurant Blvd., Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 5041239.68 E 920903.41

DRILLING DATA
Method: Solid Stem Auger
Diameter: 150mm
Date: Oct-15-2021

REF. NO.: 21-332-100
ENCL NO.: 8

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" BLOWS / 0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
78.5												
0.0	Straight Augered to 13.4m without soil sampling						78					
							77					
							76					
							75					
							74					
							73					
							72					
							71					
							70					
							69					
							68					
							67					
							66					
65.1												
13.4	**SHALE BEDROCK:** TCR=86%, SCR=43%, RQD=43% Hard layer=13%, Maximum hard layer thickness=25mm		1	RC			65					
64.5												
14.0	TCR=93%, SCR=92%, RQD=89% Hard layer=6%, Maximum hard layer thickness=12mm		2	RC			64					
63.3												
15.2	**END OF BOREHOLE:**											

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

DS SOIL LOG 21-332-100-OCT 19, 2021 DCPT.GPJ DS.GDT 21-11-8

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LOG OF BOREHOLE BH21-9

PROJECT: Geotechnical Investigation
CLIENT: Starlight Developments
PROJECT LOCATION: 1971-1975 St. Laurant Blvd., Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 5041251.87 E 920930.59

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200mm
Date: Oct-08-2021

REF. NO.: 21-332-100
ENCL NO.: 9

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION
78.9							
78.8	**ASPHALT:** 50mm		1	SS	9		78
78.7	**GRANULAR BASE:** sand and gravel (150mm)						
78.1							
0.8	**FILL:** silty sand, trace organics, trace gravel, brown, moist, loose		2	SS	10		
77.4							77
1.5	**FILL:** clayey silt, trace organics, trace gravel, brown, moist, stiff		3	SS	8		
	SILTY CLAY TO CLAYEY SILT: trace sand, brown, moist, stiff grey below 2.3m		4	SS	8		76
75.8							
3.1	**SILTY CLAY:** trace sand, grey, moist, very soft		5	SS	4	▽	
						W. L. 75.0 m Oct 29, 2021	75
			6	SS	2		74
			7	SS	WH		73
							72
			8	SS	WH		71
			9	SS	WH		70
							69
			10	SS	WH		68
66.7							67
12.2	**CLAYEY SILT TILL:** trace sand, trace gravel, grey, moist, stiff		11	SS	13		
65.8							66
13.1	**END OF BOREHOLE:**						

Notes:
1) Augar refusal at 13.1m on possible bedrock.
2) Sample could not reterive at 13.1m due to caved in.
3) WH-Weight of Hammer
4) 50mm dia. monitoring well installed upon completion.
5) Water Level Readings:

Date: Water Level(mbgl):
Oct. 29, 2021 3.87

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH (kPa)
○ UNCONFINED + FIELD VANE & Sensitivity
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%)
10 20 30

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
+3, ×3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

DS SOIL LOG 21-332-100-OCT 19, 2021 DCPT.GPJ DS.GDT 21-11-8

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LOG OF BOREHOLE BH21-10

PROJECT: Geotechnical Investigation
CLIENT: Starlight Developments
PROJECT LOCATION: 1971-1975 St. Laurant Blvd., Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 5041241.24 E 921028.1

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200mm
Date: Oct-06-2021

REF. NO.: 21-332-100
ENCL NO.: 10

(m) ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION
78.5						
78.4 / 0.1	**ASPHALT:** 50mm	1	SS	9		78
78.1 / 0.5	**GRANULAR BASE:** sand and gravel (410mm)					
77.7 / 0.8	**FILL:** clayey silt, trace organics, trace gravel, brown, moist, stiff	2	SS	14		77
77.0 / 1.5	**FILL:** silty sand, trace organics, trace clay, brown, moist, compact	3	SS	12		
	SILTY CLAY TO CLAYEY SILT: trace sand, grey, moist, firm to stiff	4	SS	9		76
		5	SS	5		75
73.9 / 4.6	**SILTY CLAY:** trace sand, grey, moist, very soft	6	SS	WH	▽ W. L. 73.5 m Oct 29, 2021	74
		7	SS	WH		72
		8	SS	WH		71
	wet silt seams at 10.7m	9	SS	WH		69
67.8 / 10.7	**SILTY SAND TILL/SHALE COMPLEX:** trace clay, some gravel, grey, moist, compact to very dense	10	SS	22		68
66.9 / 11.6		11	SS	70/100mm		67
	END OF BOREHOLE:					

Notes:
1) WH-Weight of hammer
2) Augar refusal at 11.3m on possible bedrock.
3) 50mm dia. monitoring well installed upon completion.
4) Water Level Readings:

Date:	Water Level(mbgl):
Oct. 29, 2021	5.0

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

SHEAR STRENGTH (kPa) (20 40 60 80 100)
○ UNCONFINED + FIELD VANE & Sensitivity
● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30)

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)	GR	SA	SI	CL
	23	45	24	8

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: + 3, × 3: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

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Geotechnical ◆ Environmental ◆ Materials ◆ Hydrogeology

LOG OF BOREHOLE BH21-12

PROJECT: Geotechnical Investigation
CLIENT: Starlight Developments
PROJECT LOCATION: 1971-1975 St. Laurant Blvd., Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 5041322.34 E 920994.76

DRILLING DATA
Method: Solid Stem Auger
Diameter: 150mm
Date: Oct-12-2021

REF. NO.: 21-332-100
ENCL NO.: 11

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION
79.2 / 0.0	**TOPSOIL:** 130mm						79
79.1 / 0.1	**FILL:** silty sand, trace rootlets, trace gravel, brown, moist, compact		1	SS	11		
78.4 / 0.8	**SILTY CLAY TO CLAYEY SILT:** trace sand, brown, moist, firm to stiff		2	SS	5		78
			3	SS	10		
	grey below 2.3m		4	SS	10		77
			5	SS	9		76
74.6 / 4.6	**SILTY CLAY:** trace sand, greyish brown, moist, firm to very soft		6	SS	6		75
	grey below 6.1m		7	SS	2		74
			8	SS	WH		73
			9	SS	4		72
68.5 / 10.7	**CLAYEY SILT TILL:** trace sand, trace gravel, grey, moist, stiff to hard		10	SS	10		71
			11	SS	32		70
66.4 / 13.1	**SILTY SAND TILL:** trace clay, trace gravel, grey, wet, very dense		12	SS	77/ 100mm		69
65.6 / 13.6	DCPT carried out below 13.1m						68
	END OF BOREHOLE:						67
	Notes: 1) Cone refusal at 13.6m on possible bedrock. 2) Water at depth of 9.1m during drilling. 3) WH-weight of hammer						66

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH (kPa)
○ UNCONFINED + FIELD VANE & Sensitivity
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%)
10 20 30

POCKET PEN. (Cu) (kPa)

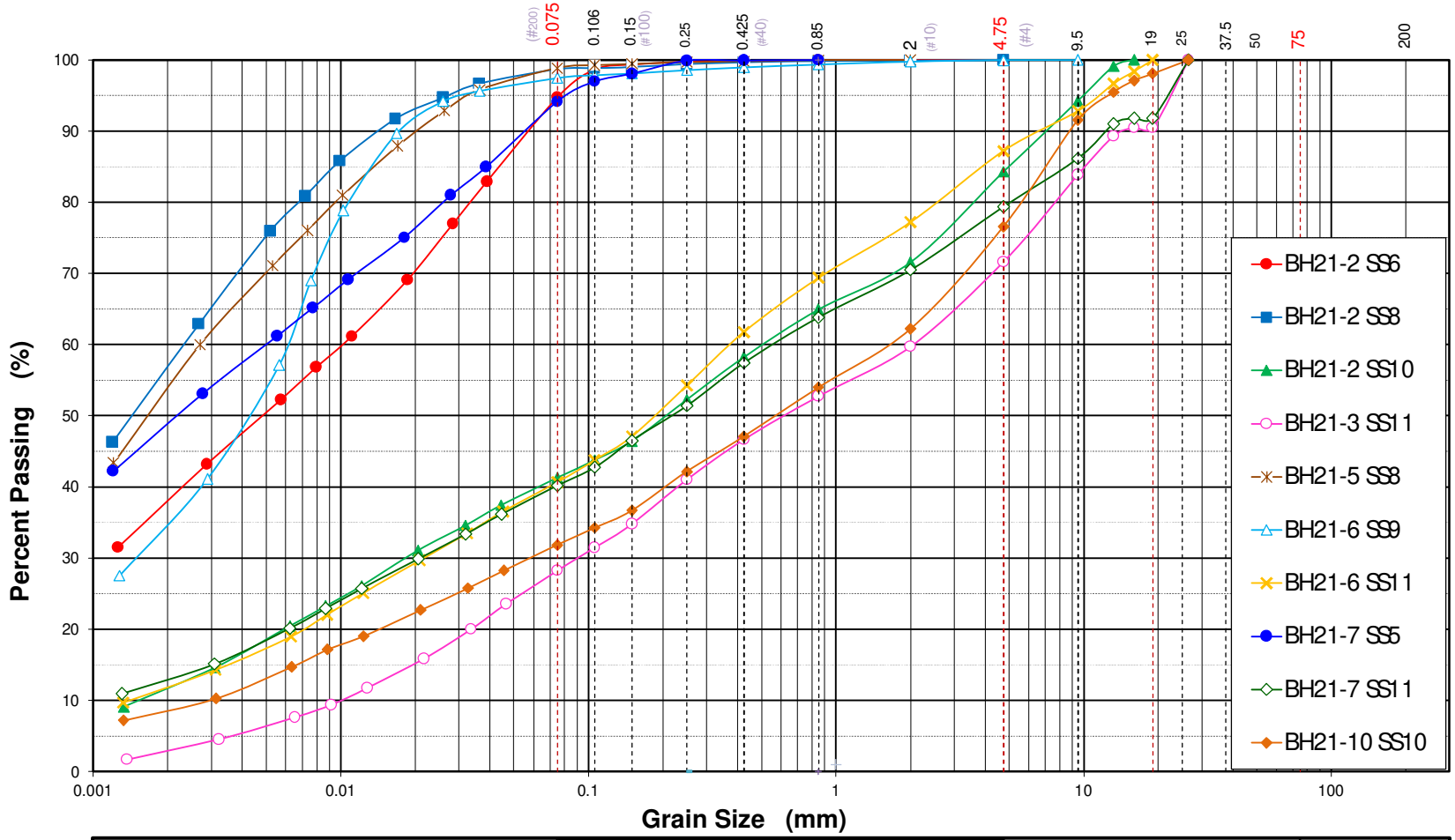
NATURAL UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES
+3, ×3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

Particle Size Distribution (ASTM-D421/D422)



Silt and Clay		Sand			Gravel		Cobble +
Clay	Silt	Fine	Medium	Coarse	Fine	Coarse	

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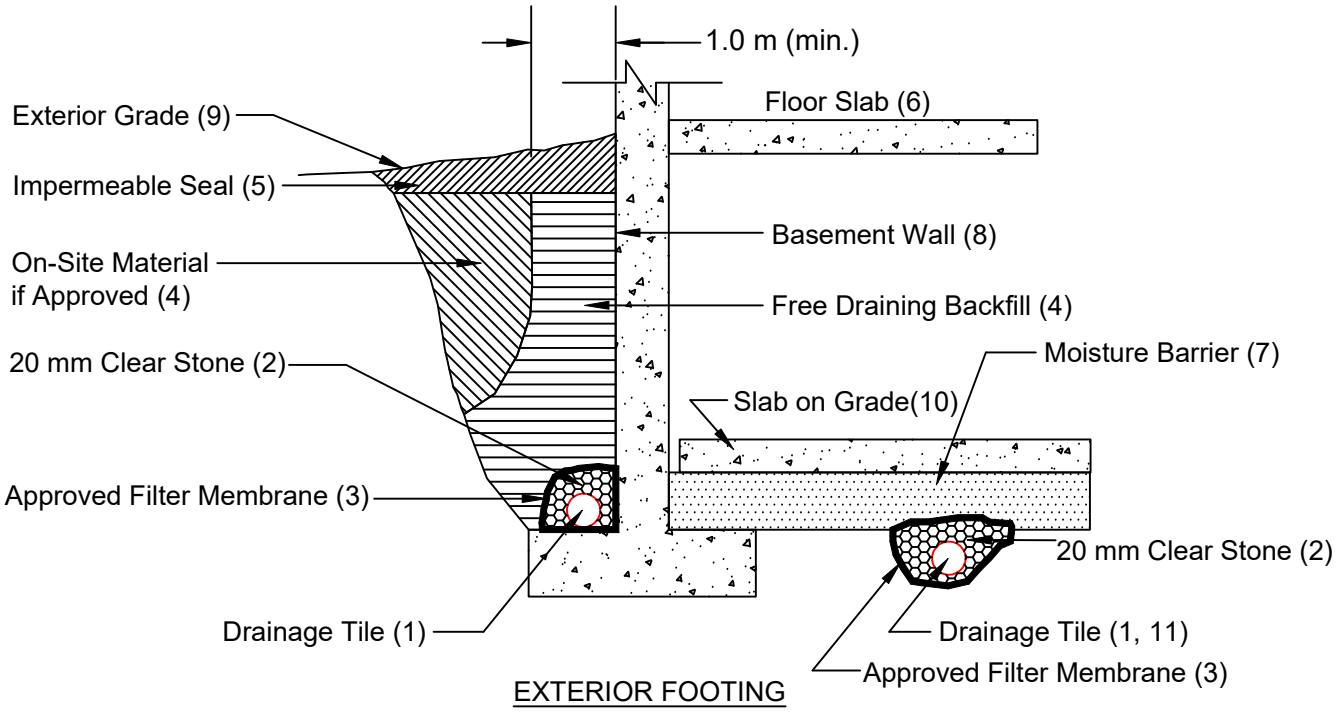
Vaughan, Ontario, L4H 0K8
Telephone: (905) 264-9393
www.dsconsultants.ca

Project	Geotechnical Investigation	Project No	21-332-100
Location	1971-1975 St. Laurant BLVD, Ottawa, ON.	Date	Oct-19-2021
Client	StarLight Developments	Dwg. No	12



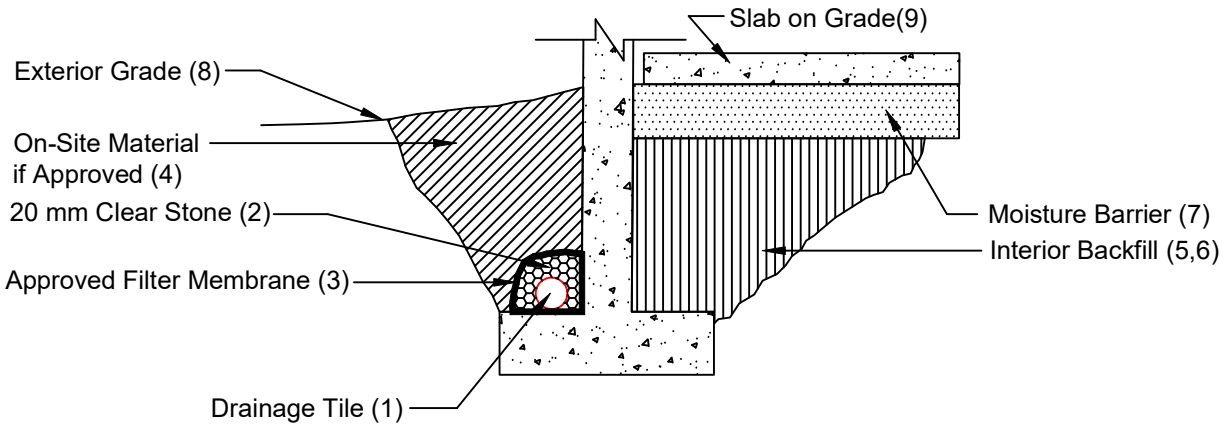
EXTERIOR FOOTING

Notes

1. Drainage tile to consist of 100 mm (4") diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet.
2. 20 mm (3/4") clear stone - 150 mm (6") top and side of drain. If drain is not on footing, place100 mm (4 inches) of stone below drain .
3. Wrap the clear stone with an approved filter membrane (Terrafix 270R or equivalent).
4. Free Draining backfill - OPSS Granular B or equivalent compacted to the specified density. Do not use heavy compaction equipment within 450 mm (18") of the wall. Use hand controlled light compaction equipment within 1.8 m (6') of wall. The minimum width of the Granular 'B' backfill must be 1.0 m.
5. Impermeable backfill seal - compacted clay, clayey silt or equivalent. If original soil is free-draining, seal may be omitted. Maximum thickness of seal to be 0.5 m.
6. Do not backfill until wall is supported by basement and floor slabs or adequate bracing.
7. Moisture barrier to be at least 200 mm (8") of compacted clear 20 mm (3/4") stone or equivalent free draining material. A vapour barrier may be required for specialty floors.
8. Basement wall to be damp proofed /water proofed.
9. Exterior grade to slope away from building.
10. Slab on grade should not be structurally connected to the wall or footing.
11. Underfloor drain invert to be at least 300 mm (12") below underside of floor slab.
12. Drainage tile placed in parallel rows 6 to 8 m (20 to 25') centers one way. Place drain on 100 mm (4") clear stone with 150 mm (6") of clear stone on top and sides. Enclose stone with filter fabric as noted in (3).
13. The entire subgrade to be sealed with approved filter fabric (Terrafix 270R or equivalent) if non-cohesive (sandy) soils below ground water table encountered.
14. Do not connect the underfloor drains to perimeter drains.
15. Review the geotechnical report for specific details.

DRAINAGE AND BACKFILL RECOMMENDATIONS
Basement with Underfloor Drainage

(not to scale)



EXTERIOR FOOTING

Notes

1. Drainage tile to consist of 100 mm (4") diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet.
2. 20 mm (3/4") clear stone - 150 mm (6") top and side of drain. If drain is not on footing, place100 mm (4 inches) of stone below drain .
3. Wrap the clear stone with an approved filter membrane (Terrafix 270R or equivalent).
4. The on-site material, if approved, can be used as backfill.
5. The interior fill may be any clean non-organic soil which can be compacted to the specified density in this confined space.
6. Do not use heavy compaction equipment within 450 mm (18") of the wall. Do not fill or compact within 1.8 m (6') of the wall unless fill is placed on both sides simultaneously.
7. Moisture barrier to be at least 200 mm (8") of compacted clear 20 mm (3/4") stone or equivalent free draining material. A vapour barrier may be required for specialty floors.
8. Exterior grade to slope away from building.
9. Slab on grade should not be structurally connected to the wall or footing.
10. Review the geotechnical report for specific details.

DRAINAGE AND BACKFILL RECOMMENDATIONS
Slab on Grade Construction Without Underfloor Drainage

(not to scale)

Appendix A
Photographs of Rock Cores

21-332-100

BH 21-3

R1: ~45’ ~46’
R2: ~46’ ~51’
R3: ~ 51’ ~54’ 7”

BH 21-4

R1: ~45’2” ~45’11”
R2: ~45’11” ~50’ 9”
R3: ~ 50’9” ~54’ 1”

BH 21-8

R1: ~43’11” ~45’9”
R2: ~45’9” ~49’ 9”