Theberge Homes.

Preliminary Geotechnical Investigation

Type of Document
Final

Project Name
Proposed Residential Development
1158 Second Line Road, Ottawa, Ontario

Project Number
OTT-00245054-A0

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Date Submitted
April 12, 2018

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Executive Summary

A preliminary geotechnical investigation was undertaken at the site of the proposed residential development to be located at the property registered by the street address of 1158 Second Line Road, Ottawa, Ontario. This work was authorized by Mr. Joey Theberge of Theberge Homes. on February 5, 2018.

Preliminary plans call for the development of the site with ten (10) blocks of two-storey residential townhouses with basements. Preliminary grading plans call for the proposed underside of footings to be at Elevations 99.45 m to 102 m and the finished grades to be at Elevations 101.15 m to 104.0 m, resulting in up to 1 m of fill and up to 2 m of cut at the site.

The fieldwork for the geotechnical investigation comprised of the excavation of nine (9) test pits to refusal depths ranging between 0.2 m to 1.4 m and the drilling of two boreholes to depths of 4.5 and 4.6 m below the existing ground surface. Due to the forested nature of the majority site, it was not possible to excavate test pits in the northern part of the site.

The investigation has revealed that the subsurface conditions comprise of topsoil, shallow deposit of fill, sandy silt and silty sand underlain by bedrock contacted at depths ranging between 0.2 m to 1.8 m, i.e. Elevations 100.4 m to 103.9 m. Wash boring and core drilling used to advance the two boreholes below refusal depths revealed that the bedrock underlying the site within the depth cored comprises of sandstone bedrock with seams of granite and limestone. Review of the available geological maps indicates that the bedrock underlying the site comprises likely of sandstone of the March Formation.

Groundwater measurements taken during drilling of the boreholes and excavation of test pits and in standpipes installed in the boreholes indicate that the groundwater table had not stabilized during the short period over which readings were collected or is below the maximum depth investigated.

Based on the results of the investigation and available proposed grading plan, the majority of the blocks will be founded in the bedrock. Footings designed to bear on the surface or in the bedrock below any weathered or fractured zones may be designed for a bearing pressure at Ultimate Limit State (ULS) of 250 kPa. Since the bedrock in most of the site is present at shallow depth, the presence of cap rock, weathered rock and fissures should be expected at founding levels. Therefore, it is imperative that the surface of the exposed bedrock at the underside of the footings be examined by a geotechnical engineer and any fractured bedrock zones or fissured removed/cleaned prior to casting of the footings.

The basement and garage floor slabs of the proposed structures may be constructed as slabs-on-grade set on a bed of 300 mm of clear stone. Perimeter drainage system is required for the proposed townhouse blocks.

Excavations at the site in the overburden may be undertaken as open-cut if they are cut back at 45 degrees. Excavation of the bedrock would require line drilling and blasting technique and may be undertaken with near vertical sides. Vibrations should be monitored during construction to prevent

damage to adjacent structures and services. A condition survey of all the structures and services situated within proximity of the site will be required prior to commencement of construction and during the excavation of the bedrock.

Seepage of surface and sub-surface water into the excavations should be anticipated. It should be possible to collect the water entering the excavation in perimeter ditches and to remove it by pumping from sumps.

The subject site has been classified as **Class C** for seismic site response in relation to Section 4.1.8.4 of the 2012 Ontario Building Code (OBC 2012). A higher site class for the site may be obtained if a shear-wave measurement is completed at the site.

The pavement structure for the subdivision roadways and driveways of the subdivision are presented in Table V of the report.

Due to the inaccessibility to the forested areas of the site, presence of shallow bedrock and variability of the bedrock elevations throughout the site, it is highly recommended that an additional borehole and test pits investigation should be undertaken once the site is cleared from trees and prior to finalizing the design and tendering of the project.

The above and other related considerations are discussed in greater detail in the report.

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1 Introduction

A preliminary geotechnical investigation was undertaken at the site of the proposed residential development to be located on the north side of Second Line Road at 1158 Second Line Road in the City of Ottawa, Ontario, Figure 1. This work was authorized by Mr. Joey Theberge of Theberge Homes. on February 5, 2018.

Preliminary grading plans prepared by EXP call for the development of the site with ten (10) blocks of residential townhouses with basements. The proposed underside of footings and finished grades at the site range from 99.45 m to 102 m and between 101.15 m to 104.0 m respectively. resulting in up to 1 m of fill and 2 m of cut at the site.

The investigation was undertaken to:

- Establish the subsurface soil/bedrock and groundwater conditions at the borehole and test pits locations;
- Classify the site for Seismic Site Response in accordance the requirements of the 2012 Ontario Building Code (OBC) and comment on the liquefaction potential of the subsurface soils;
- Comment on grade-raise restrictions;
- Make recommendations regarding the most suitable type of foundations, founding depth, Serviceability Limit State (SLS) bearing pressure and Ultimate Limit State (ULS) factored geotechnical resistance of the founding strata for the proposed residential blocks;
- Discuss slab-on-grade construction and permanent drainage requirements;
- Discuss excavations and dewatering requirements;
- Comment on backfilling requirements and suitability of on-site soils for backfilling purposes;
- Recommend pavement structures for the proposed subdivision roadways and driveways; and
- Comment on subsurface concrete requirement.

The comments and recommendations given in this report are preliminary in nature and based on the assumption that the above-described design concept will proceed into construction. If changes are made either in the design phase or during construction, this office must be retained to review these modifications. The result of this review may be a modification of our recommendations or it may require additional field or laboratory work to check whether the changes are acceptable from a geotechnical viewpoint.

2 Site Description

The subject site is currently occupied by a residential structure and has a total area of 0.8 hectares. It is located on the north side of Second Line Road approximately 240 m southwest from the Old Carp Road and Second Line Road intersection. It is legally described as CON 3 PT LOT 11 RP 5R-1715; PARTS 1 & 2. The property identification number is 045260207. At the time of the investigation, the property was 80% woodlot and 20% building/driveway. The site was undeveloped until the mid 1990s when a single family residential structure was constructed.

The site slopes in the northerly and easterly directions with ground surface elevations varying from Elevation 105.25 m to Elevation 100.5 m.

The subject site is bordered by residential developments on the north and south sides, by a hydro utility corridor to the east and by wetlands to the west.

3 Procedure

The fieldwork for the geotechnical investigations was completed on February 16 and 22, 2018 and comprised the excavation of nine (9) test pits, i.e. Test Pits Nos. 1 to 9 using a rubber-tired backhoe to refusal depths ranging between 0.2 m to 1.4 m and the drilling of two boreholes, i.e. Borehole Nos. 1 and 2 using a CME-55 track-mounted drill rig to a depth of 4.5 m and 4.6 m respectively. The fieldwork was supervised on a full-time basis by a representative of EXP. It should be noted that some areas of the site are heavily forested, which prevented access and the completion of test pits/boreholes in these areas of the site.

The borehole and test pits locations were laid out in the field by survey crews of Farley, Smith & Denis Surveying Ltd and EXP and are shown on Site Plan, Figure 2. The elevations of the boreholes and test pits refer to the geodetic datum.

Standard penetration tests were performed in the overburden in the boreholes at 0.75 m depth intervals and the soil samples retrieved by split-barrel sampler to refusal depth. Below the refusal depth, the two boreholes were cased and advanced further using washboring and core drilling techniques and NQ-size core barrel. During bedrock coring, a careful record of any sudden drops of the drill rods, colour of wash water and wash water return was kept. In the test pits, representative grab samples were collected from each soil stratigraphy encountered.

All the soil samples were visually examined in the field for textural classification, logged, preserved in plastic bags and identified. Similarly, the rock cores were logged, placed in core boxes and identified. On completion of the fieldwork, all the soil samples and rock cores were transported to the EXP laboratory in the City of Ottawa, Ontario where they were visually examined by a geotechnical engineer and borehole logs prepared. The engineer also assigned the laboratory testing, which consisted of performing natural moisture content on all soil samples and grain-size analysis tests on selected soil samples. In addition, unconfined compressive strength, pH and sulphate tests were completed on selected rock samples.

Water levels were measured in the open boreholes on completion of drilling operations. In addition, long-term groundwater monitoring installations consisting of 19 mm diameter polyvinyl chloride (PVC) pipes were installed in the two boreholes in accordance with EXP standard practice. The installation configuration is documented on the respective borehole logs. The test pits were backfilled upon completion of the fieldwork.

4 Site and Soil Description

The site under consideration is registered by the street address of 1158 Second Line Road and is situated between Goward Drive and Klondike Road in the City of Ottawa, Ontario. The site is rectangular and currently occupied by a single-storey bungalow. The site slopes in the northerly and easterly directions with ground surface elevations varying from Elevations 105.25 m to 100.5 m and is mainly covered with woodlots.

A detailed description of the geotechnical conditions encountered in the nine (9) test pits and two (2) boreholes are given on the borehole logs, Figures 3 to 13 inclusive. The borehole and test pit logs and related information depict subsurface conditions only at the specific locations and times indicated. Subsurface conditions and water levels at other locations may differ from conditions at the location where sampling was conducted. The passage of time also may result in changes in the conditions interpreted to exist at the locations where sampling was conducted. Boreholes and test pits were drilled to provide representation of subsurface conditions as part of a geotechnical exploration program and are not intended to provide evidence of potential environmental conditions.

A review of Figures 3 to 13 inclusive indicates the following site stratigraphy in descending order.

4.1 Topsoil

Organic topsoil layer ranging in thickness between 150 mm and 305 mm was encountered at the surface of all the boreholes and test pits.

The topsoil in Test Pit No. 6 extends to surface of the bedrock contacted at 0.2 m depth, i.e. Elevation 102.9 m.

4.2 Fill

The topsoil in Test Pit No. 2 is underlain by fill, which extends to refusal depth of 0.8 m below the existing ground surface, i.e. Elevation 103.9 m. The fill is heterogenous in nature comprising of brown sand and gravel. The upper 400 mm of fill material frozen at time of investigation. The moisture content of the fill is 9 percent.

4.3 Sandy Silt (ML)

The topsoil in Borehole No. 1 is underlain by brown sandy silt, which extends to the surface of the bedrock contacted at 1.2 m depth below the existing ground surface i.e. Elevation 101.9 m. The sandy silt is very loose and has a natural moisture content of 23 percent.

Grain-size analysis performed on one selected soil sample from this deposit revealed a soil composition of 0 percent gravel, 55 percent sand and 45 percent silt and clay (Figure No. 14).

4.4 Silty Sand (SM)

The topsoil in Test Pit Nos. TP-01, TP-03 to TP-05 and TP-07 to TP-09 and in Borehole No. 2 is underlain by brown silty sand deposit containing frequent cobbles/boulders. This shallow deposit extended to the surface of the bedrock where refusal to augers or to backhoe bucket was encountered at depths ranging between 0.3 m to 1.8 m below the existing ground surface, i.e. Elevation 103.90 m to 100.5 m

Grain-size analysis completed on two soil samples from this deposit are presented in Figure Nos. 15 and 16 and summarized in Table I below:

Table I: Summary of Lab Test Results on Silty Gravel with Sand Samples

Test Pit No.	Sample Depth (m)	Observed Cobbles/ Boulders (%)	Grain-Size Analyse (sampled soil matrix)			Moisture Content (%)
			Gravel (%)	Sand (%)	Silt and Clay (%)	
TP1/S1	0.3 to 1.2	5 to 10	3	52	45	23
TP7/S1	0.3 to 1.0	N/E	-	50	50	19

NOTES: Not Encountered (N/E)

4.4 Refusal to Auger/Backhoe Refusal

Refusal to auger or to backhoe bucket was met in all boreholes/test pits at depths ranging between 0.2 m to 1.8 m below the existing ground surface (Elevations 102.9 to 100.4 m) as summarized in Table II.

Table II: Summary of Refusal Depth and Elevation in Boreholes and Test Pits

Borehole or Test Pit No.	Ground Surface Elevation (m)	Refusal Depth (m)	Refusal Elevation (m)
BH 1	103.12	1.2	101.92
BH 2	102.23	1.7	100.50
TP1	103.22	1.4	101.82
TP2	104.70	0.8	103.90
TP3	101.83	0.3	101.53
TP4	101.50	0.5	101.00
TP5	100.76	0.3	100.46
TP6	103.11	0.2	102.91
TP7	102.72	1.0	101.72
TP8	101.96	0.3	101.66
TP9	101.06	0.3	100.76

A review of the Table II indicates that the bedrock at the site slopes in the northerly and easterly directions with elevation differences of up to 3.4 m

4.5 Bedrock

Refusal to augers and to backhoe excavation was met in all test pits and boreholes. Washboring and core drilling techniques used to advance further in Borehole Nos. 1 and 2 revealed that refusal was met on bedrock. Review of available geological maps indicates that bedrock underlying the site likely consists of interbedded sandstone and sandy dolomite of the March formation.

A total Core Recovery (TCR) and Rock Quality Designation (RQD) of 73 to 100 percent and 14 to 91 percent respectively were obtained when core drilling the bedrock. On this basis, the bedrock quality within the depth investigated may be classified as very poor to excellent. Review of the recovered cores indicates that the bedrock at the location of Borehole No. 2 is fractured in the upper 1.3 m depth and comprise of sandstone interbedded with limestone and granite.

A total of four (4) rock samples were selected for unconfined compressive strength testing and the test results are presented in Table III. A review of the test results indicates a bedrock with compressive strength ranging between 138 MPa and 173 MPa. Based on these values, the rock can be classified with respect to intact strength as “very strong”, (Canadian Foundation Engineering Manual, 4th edition, 2006). The unit weight of the bedrock ranged between 2562 kN/m^3 and 2668 kN/m^3.

Table III: Results of Unconfined Compression Tests on Rock Samples

Borehole No. RUN No.	Depth (m)	Compressive Strength (MPa)	Unit Weight of Bedrock (KN/m^3)
BH 1- Run 1	1.3 – 1.4	173	2562
BH 1 – Run 2	1.2 – 1.4	141	2611
BH 2 – Run 1	2.2 – 2.4	138	2585
BH 2 – Run 2	3.8 – 4.0	167	2668

Photographs of the recovered bedrock cores are presented in Figures Nos. 17 to 20.

4.6 Groundwater Table

Water level observations were made in the boreholes and test pits upon completion of the field work and in standpipes installed in Borehole Nos. 1 and 2 and the results are presented on the respective borehole and test pits logs. A review of the results revealed that the groundwater table is likely below the maximum depth investigated or has not stabilized during the period over which readings were collected. Therefore, it is recommended that another set of groundwater measurements should be undertaken in the spring and as part of the detailed geotechnical investigation at the site.

Water levels observations were made in the exploratory boreholes at the times and under the conditions stated in the scope of services. These data were reviewed and EXP's interpretation of them discussed in the text of the report. Note that fluctuations in the level of the groundwater may occur due to seasonal variation such as precipitation, snowmelt, rainfall activities, and other factors not evident at the time of measurement and therefore may be at a higher level during wet weather periods.

5 Grade Raise

The investigation has revealed that the site contains a shallow deposit of sandy silt to silty sand soils ranging in thickness between 0.2 m and 1.8 m underlain by sandstone bedrock.

Based on the geotechnical findings, the proposed grade raise of up to 2 m is considered acceptable from a geotechnical point of view.

6 Foundation Considerations

The investigation has revealed that the geotechnical conditions at the site are well suited to construction of two-storey townhome blocks with one basement level on bedrock.

Review of the available grading plan and results of the boreholes and test pits investigation indicates that all the proposed residential blocks will be founded at the surface or in the bedrock. Therefore, excavation of the bedrock to varying depths for the construction of the footings is expected throughout the site.

Since the residential blocks are expected to be founded on bedrock, factored geotechnical resistance at ULS will govern the design. Footings design to bear on the surface or in the bedrock below any weathered or fractured zones may be designed for a bearing pressure at ULS of 250 KPa. Since the bedrock in most of the site is present at shallow depth, the presence of cap rock, weathered rock and fissures should be expected in the surface of the bedrock. Therefore, it is imperative that the surface of the exposed bedrock at the underside of the footings be examined by a geotechnical engineer and any fractured bedrock zones or fissured removed/cleaned prior to casting of the footings. Filling of the cleaned fissures with concrete and addition of rebar across any large fissures may be required and can be best established in the field by qualified geotechnical engineers or senior technicians.

A minimum of 1.2 m of earth cover should be provided to the footings of a heated structure founded on bedrock to protect them from damage due to frost penetration. The frost cover should be increased to 1.5 m for unheated structures.

All footing beds should be examined by a geotechnical engineer to ensure that the founding surfaces can support the design bearing pressure and that the footing beds have been properly prepared as described above.

The recommended bearing pressures have been calculated by EXP from the borehole information for the design stage only. The investigation and comments are necessarily on-going as new information of underground conditions becomes available. For example, more specific information is available with respect to conditions between boreholes and test pits when foundation construction is underway. The interpretation between boreholes and test pits and the recommendations of this report must therefore be checked through field monitoring provided by an experienced geotechnical engineer to validate the information for use during the construction stage.

7 Floor Slabs and Drainage Requirements

The basement and garage floor slabs of the proposed two-storey townhouse blocks may be constructed as slab-on-grade provided they are set on beds of well compacted 19 mm clear stone at least 300 mm thick placed on bedrock or on well compacted engineered fill. The clear stone would prevent the capillary rise of moisture to the floor slab. Adequate saw cuts should be provided in the floor slab to control cracking.

It is anticipated that perimeter drains would be required for the proposed residential blocks with basement. The perimeter drains may consist of 100 mm diameter perforated pipe wrapped with filter cloth (sock) and set on the footings and surrounded with 150 mm of 19 mm clear stone and properly outletted. The subsurface walls should be adequately damp proofed.

The finished exterior grade should be sloped away from the buildings to prevent surface ponding of water close to the exterior walls.

8 Pipe Bedding Requirement

It is recommended that the bedding for the underground services including material specification, thickness of cover material and compaction requirements conform to the local requirements of the municipality and/or Ontario provincial Standard Specification and Drawings (OPSS and OPSD).

For guidance, the pipe bedding may consist of 150 mm of OPSS 1010 Granular A for services founded on bedrock. The bedding material should be also placed along the sides and on top of the pipes to provide a minimum cover of 300 mm. The bedding, spring line and cover should be compacted to at least 95 percent the Standard Proctor Maximum Dry Density (SPMDD).

9 Lateral Earth Pressure against Basement Walls

The subsurface walls should be backfilled with free draining material, such as OPSS 1010 for Granular B, Type II and equipped with a perimeter drainage system to prevent the buildup of hydrostatic pressure behind the walls. The walls will be subjected to lateral static and dynamic (seismic) earth forces.

For design purposes, the lateral static earth thrust against the subsurface walls may be computed from the following equation:

$$P = K_0 H (q + \tfrac{1}{2} \gamma H)$$

where P = lateral earth thrust acting on the subsurface wall; kN/m

K_0 = lateral earth pressure coefficient for 'at rest' condition for Granular B Type II backfill material = 0.5

γ = unit weight of free draining granular backfill; Granular B = 22 kN/m^3

H = Height of backfill adjacent to foundation wall, m

q = surcharge load, kPa

The lateral seismic thrust may be computed from the equation given below:

$$\Delta P_E = 0.32 \gamma H^2$$

where ΔP_E = resultant thrust due to seismic activity; kN/m

γ = unit weight of free draining granular backfill; Granular B Type II = 22 kN/m^3

H = height of backfill behind wall, (m)

The ΔPE value does not take into account the surcharge load. The resultant load should be assumed to act at 0.6 H from the bottom of the wall.

10 Excavations

Excavations for the construction of the residential blocks and underground services is expected to require the removal of significant amount of the bedrock throughout the site.

Excavations at the site must comply with the latest version of Ontario Occupational Health and Safety Act, Ontario Regulations 213/91 (January 11, 2014), i.e. excavation in the overburden should be cut back at a slope of 1H to 1V.

Excavation of the bedrock may be undertaken with near vertical sides and would require the use of line drilling and blasting techniques. To prevent any damage to the surrounding structures and services, the blasting operations would have to be carefully planned and closely monitored. It is recommended that the blasting contractor should retain the services of a blast specialist to provide him with a blasting plan. The contractor should have a licensed blaster on site always during the blasting and a vibration engineer on retainer. A condition survey of all the structures near the site should be undertaken prior to commencement of the excavation work. Vibration monitoring should be carried out during blasting operations. Vibrations should be monitored at property boundaries and should be limited so that there will be no damage to the existing structures or services.

Water inflow into the excavation should be expected. However, it should be possible to adequately handle this inflow by collecting the water in perimeter ditches and pumping from properly filtered sumps. It is possible that additional localized sumps may be required in areas where the seepage is more extensive.

11 Seismic Site Classification

11.1 Liquefaction Potential

The investigation has revealed that the residential blocks will be founded on bedrock.

Based on the results of the investigation, there is no liquefaction potential of the subsurface soil during a seismic event.

11.2 Seismic Classification

Based on the subsurface conditions, the site is classified as **Class C for seismic site response** in accordance with Section 4.1.8.4 of the 2012 Ontario Building Code (ONBC 2012).

A higher site class will likely be obtained if a shear-wave velocity testing is completed at the site.

12 Backfilling Requirements and Suitability of On-Site Soils for Backfilling Purposes

The material to be excavated from the site will comprise of small quantity of heterogenous fill, sandy silt and silty sand trace clay. The fill and silty sand/sandy silt, may be re-used in backfilling of the service trenches located outside the buildings or for general grading purposes in the landscaped areas. However, these soils are susceptible to moisture absorption when exposed to the elements and will become too wet for adequate compaction and therefore must be protected from the elements if stockpiled on-site for re-use.

It is anticipated that majority of the material required for backfilling purposes will need to be imported and should preferably conform to the following specifications:

- Engineering fill under basement floor – OPSS 1010 Granular B Type II placed in 300 mm thick lifts and compacted to 98 percent of the SPMDD;
- Backfilling against exterior basement walls – OPSS 1010 Granular B Type II, placed in 300 mm thick lifts and compacted to 95 percent of the SPMDD;
- Trench backfill and fill placement to subgrade level for pavement – OPSS 1010 Select Subgrade Material (SSM), free of organics, debris and with a natural moisture content within 2 percent of the optimum moisture content. It should be placed in 300 mm thick lifts compacted to minimum 95 percent of the SPMDD.

Consideration may be given to crushing of the bedrock to provide granular material to raise the grades on the site. This feasibility of this option should be solely established and decided by the contractor undertaken the work.

13 Subdivision Roads and Driveways

The subgrade at the site is expected to be bedrock or engineered fill comprising of material conforming to OPSS 1010 Select Subgrade Material (SSM). Pavement structure thicknesses required for the subdivision streets and driveways were computed and are shown on Table IV. The thicknesses are based upon an estimate of the subgrade soil properties determined from visual examination, textural classification of the soil samples and functional design life of 18 to 20 years. The proposed functional design life represents the number of years to the first rehabilitation, assuming regular maintenance is carried out.

Table IV: Recommended Pavement Structure Thicknesses

Pavement Layer	Compaction Requirements	Driveways	Subdivision Roadways	
			Bedrock Subgrade	Overburden Engineered Fill (SSM)
Asphaltic Concrete (PG 58-34)	92 to 97 % MRD	50 mm HL3	40 mm – SP12.5 50 mm – SP19	40 mm – SP12.5 50 mm – SP19
Granular A Base (crushed limestone)	100% SPMDD*	150 mm	150 mm	150 mm
Granular B Sub-base, Type II	100% SPMDD*	300 mm	300 mm	450 mm

SPMDD* Standard Proctor Maximum Dry Density, ASTM-D698
MRD denotes Maximum Relative Density, ASTM D2041
Asphaltic Concrete in accordance with OPSS 1150/ 1151

The foregoing design assumes that construction is carried out during dry periods and that the subgrade is stable under the load of construction equipment. If construction is carried out during wet weather, and heaving or rolling of the subgrade is experienced, additional thickness of granular material and/or geotextile may be required in areas of overburden subgrade.

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

1. As part of the subgrade preparation for the areas to be paved, the subdivision roadways should be stripped of topsoil and other obviously unsuitable material down to subgrade level. Removal of the bedrock is expected as part of the preparation of the subgrade. Fill required to raise the grades to design elevations should conform to OPSS 1010 Select Subgrade Material (SSM) and should be placed in 300 mm lifts and each lift compacted to 95 percent of the SPMDD. The use of the blast/shattered bedrock to raise the grades in the roadways fill may be feasible provided

that the bedrock is broken to a maximum size of 300 mm and contains sufficient fines to prevent areas with voids surfaces and to ensure proper compaction.

2. The long-term performance of the pavement structure is highly dependent upon the subgrade support conditions. As a minimum, subdrains stubs should be installed at the catchbasin. This will ensure no water collects in the granular course, which could result in pavement failure during the spring thaw. The location and extent of sub drainage required within the paved areas should be reviewed by this office in conjunction with the proposed site grading.

3. To minimize the problems of differential movement between the pavement and catch basins/manhole due to frost action, the backfill around the structures should consist of free-draining granular preferably conforming to OPSS Granular B, Type II material. Weep holes should be provided in the catch basins/manholes to facilitate drainage of any water that may accumulate in the granular fill.

4. The finished pavement surface should be free of depressions and should be sloped (preferably at a minimum cross fall of 2 percent) to provide effective surface drainage towards catch basins. Surface water should not be allowed to pond adjacent to the outside edges of paved areas.

5. Transition zone should be provided in areas where subgrade changes from overburden to bedrock. EXP can provide additional recommendation in areas where this case arises;

6. The granular materials used for pavement construction should conform to OPSS 1010 for Granular A and Granular B, Type II and should be compacted to 100 percent of the SPMDD (ASTM D698-12 e2). The asphaltic concrete used, and its placement should meet OPSS 1150/1151 and 310/313 requirements. It should be compacted to 92 to 97 percent of the maximum relative density in accordance with ASTM D2041.

It is recommended that EXP be retained to review the final pavement structure design and drainage plans prior to construction to ensure that they are consistent with the recommendations of this report.

14 Subsurface Concrete Requirements

Chemical tests limited to pH and sulphate content were performed on two selected rock samples. The test results are given on Table No. V.

Table V: Results of Chemical Testing on Bedrock Samples

Borehole No.	Material	Depth (m)	pH	Sulphate (%)
Threshold Values			**<5**	**>0.1**
BH 1 – Run 1	Bedrock	1.44 – 1.52	7.58	0.003
BH 2 – Run 1	Bedrock	2.11 – 2.21	7.95	0.0024

A review of Table No. V indicates that the on-site rock contains less than 0.1 percent of water-soluble sulphates. These concentrations of sulphates are considered to have negligible potential of attack on subsurface concrete. In such cases, national Standard of Canada CAN/CSA-A23. 1-14 permits the use of General Use (GU) Portland cement in subsurface concrete. However, the concrete should be dense, well compacted and cured and should be designed to meet the requirement of CSA-A23. 1-14.

The certificate of the laboratory test results, which was performed by AGAT Laboratories in Mississauga, is attached in Appendix B.

15 General Comments

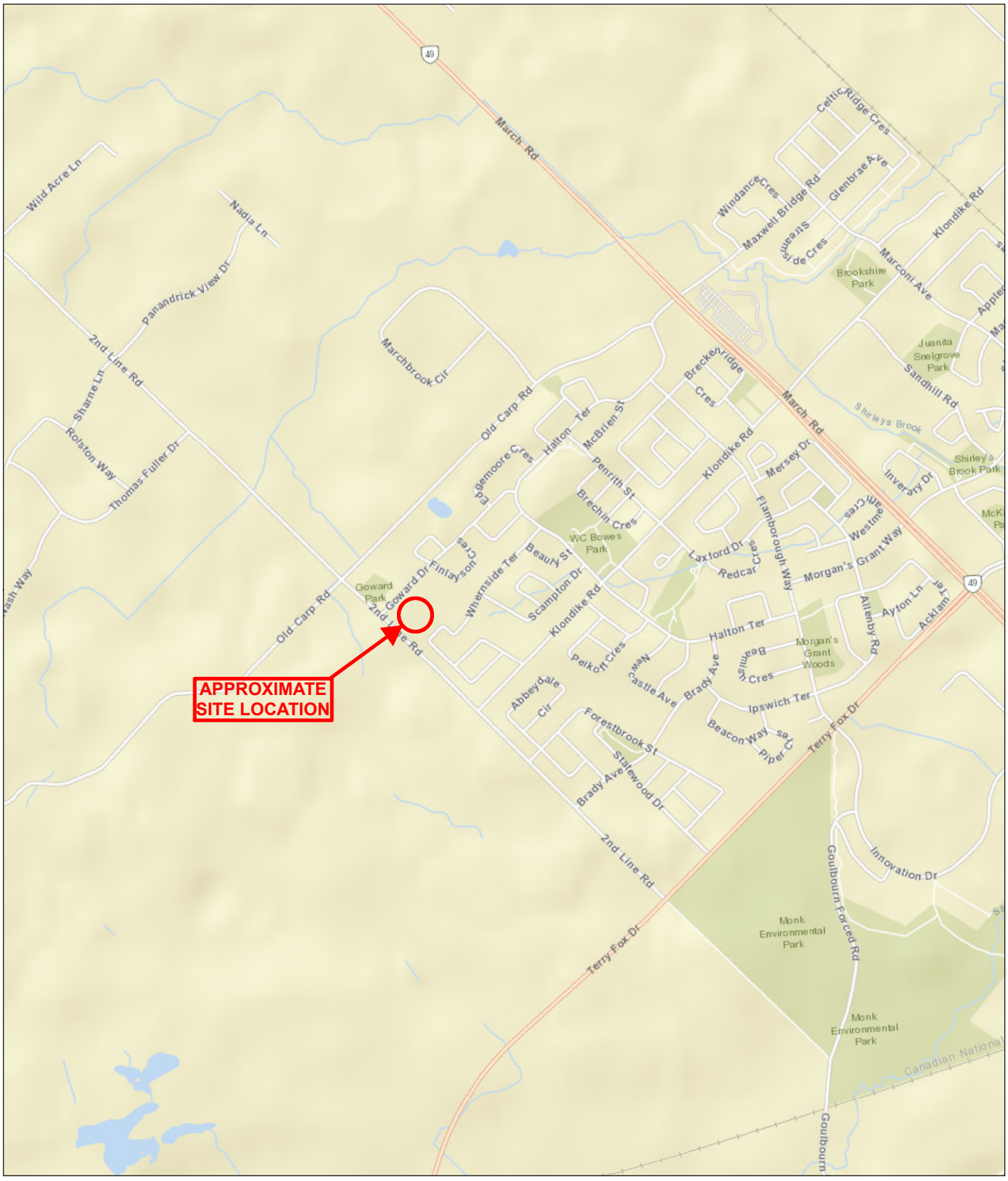
The comments given in this report are intended only for the guidance of the design engineers. The number of boreholes and test pits required to determine the localized underground conditions between boreholes and test pits affecting construction costs, techniques, sequencing, equipment, scheduling, etc., would be much greater than has been carried out for design purposes. Contractors bidding on or undertaking the works should in this light, decide on their own investigations, as well as their own interpretation of the factual borehole and test pit results to draw their own conclusions as to how the subsurface conditions may affect them.

The information contained in this report is not intended to reflect on environmental aspects of the soils. Should specific information be required, including for example, the presence of pollutants, contaminants or other hazards in the soil, additional testing may be required.

Due to the inaccessibility of the forested areas of the site, presence of shallow bedrock and variability of the bedrock elevations throughout the site, it is highly recommended that an additional boreholes and test pits investigation should be undertaken at the site once the site is cleared from trees and prior to finalizing the design and tendering of the project.

We trust that this information is satisfactory for your purposes. Should you have any questions, please contact this office.

Figures

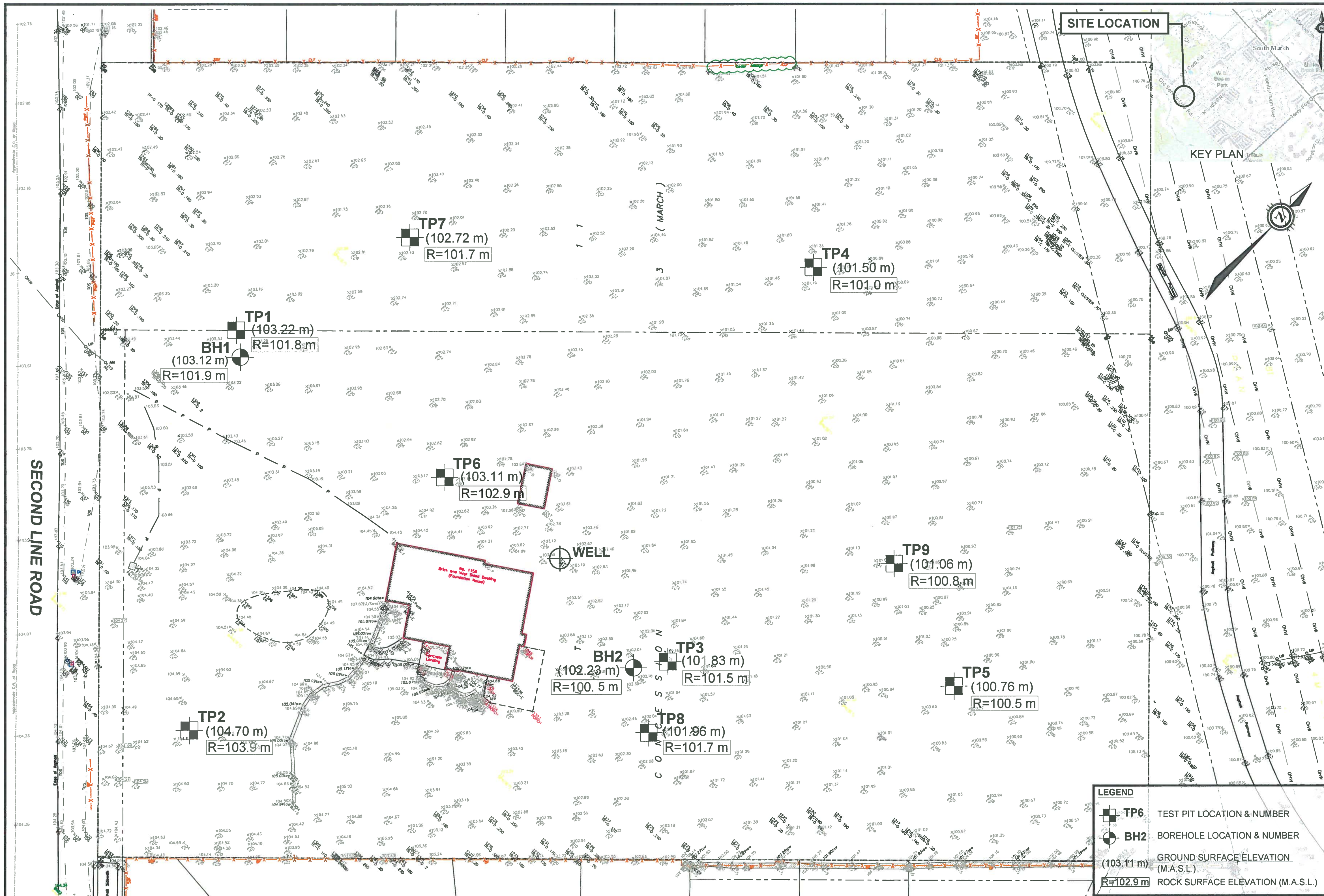


EXP Services Inc.
100-2650 Queensview Drive
Ottawa, Ontario
K2B 8H6
T - (613) - 688-1899
F - (613) - 225-7337

PROJECT TITLE:
Geotechnical Investigation
Proposed Residential Development
1158 Second Line Road
Ottawa, ON

DRAWING TITLE:
Key Plan

PROJECT No.: OTT-00245054-A0	DWN: ML
SCALE: AS SHOWN	CHKD: MM
DATE: MARCH 2018	FIG. No.: 1



NOTES :

1. THE BOUNDARIES AND SOIL TYPES HAVE BEEN ESTABLISHED ONLY AT TEST PIT AND BOREHOLE LOCATIONS. BETWEEN TEST PITS AND BOREHOLES THEY ARE ASSUMED AND MAY BE SUBJECT TO CONSIDERABLE ERROR.
2. SOIL SAMPLES AND ROCK WILL BE RETAINED IN STORAGE FOR THREE MONTHS AND THEN DESTROYED UNLESS THE CLIENT ADVISES THAT AN EXTENDED TIME PERIOD IS REQUIRED.
3. TOPSOIL QUANTITIES SHOULD NOT BE ESTABLISHED FROM THE INFORMATION PROVIDED AT THE TEST PIT AND BOREHOLE LOCATIONS.
4. TEST PIT AND BOREHOLE ELEVATIONS SHOULD NOT BE USED TO DESIGN BUILDING(S) OR FLOOR SLABS OR PARKING LOT(S) GRADES.
5. THIS DRAWING FORMS PART OF THE REPORT PROJECT NUMBER AS REFERENCED AND SHOULD BE USED ONLY IN CONJUNCTION WITH THIS REPORT.
6. BASE PLAN OBTAINED FROM *FARLEY, SMITH & DENIS SURVEYING LTD. 2018* DATED FEBRUARY 28TH, 2018

SCALE: 0 3m 6m 12m — HORIZONTAL 1:300

REVIEWED BY

CLIENT: THEBERGE HOMES
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• BUILDINGS • EARTH & ENVIRONMENT • ENERGY • INDUSTRIAL • INFRASTRUCTURE • SUSTAINABILITY •

BASEPLAN	
DESIGN	
CHECKED	I.T.
CAD	J.R.
PROJ. MAN	I.T.
APPROVED	

PROJECT: GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT
1154 SECOND LINE ROAD, OTTAWA, ONTARIO

TITLE: SITE PLAN
BOREHOLE AND TESTPIT LOCATION PLAN

PROJ NO. OTT-00245054-A0

SURVEY

DATE: MARCH 2018

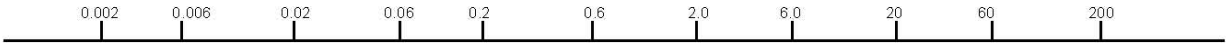
DRAWING NO: Fig : 2

Notes On Sample Descriptions

1. All sample descriptions included in this report follow the Canadian Foundations Engineering Manual soil classification system. This system follows the standard proposed by the International Societv for Soil Mechanics and Foundation Engineering. Laboratory grain size analyses provided by **exp** Services Inc. also follow the same system. Different classification systems may be used by others; one such system is the Unified Soil Classification. Please note that, with the exception of those samples where a grain size analysis has 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 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.

Log of Borehole BH 1

Project No: OTT-00245054-A0

Project: Geotechnical investigation. Proposed Townhouse Residential Development

Location: 1158 Second Line Road, City of Ottawa, ON

Figure No. 3

Page. 1 of 1

Date Drilled: 'February 22, 2018

Drill Type: CME-55 Track Mounted Drill Rig

Datum: Geodetic

Logged by: A. N. Checked by: I.T.

Split Spoon Sample ⊠
Auger Sample ◧
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits ⊢○⊣
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~ 250 mm	103.12	0	20 40 60 80 / 50 100 150 200 kPa	250 500 750 / 20 40 60		
		SANDY SILT (ML) Brown, wet, (very loose)	102.9		4	×		
▽			102.22	1	7	×		
		SANDSTONE BEDROCK Horizontally fractured, interbedded with limestone and granite (fair to excellent quality)	101.9				Run 1	
				2			Run 2	
				3			Run 3	
				4				
			98.6					
		Borehole Terminated at 4.5 m Depth						

LOG OF BOREHOLE LOGS OF TEST PIT - 245054. 2018.GPJ TROW OTTAWA.GDT 4/17/18

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 19 mm slotted standpipe was installed upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00245054-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
Completion	0.9	4.5
8days	dry	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	1.2 - 1.5	100	60
2	1.5 - 3	100	66
3	3 - 4.5	100	91

Log of Borehole BH 2

Project No: OTT-00245054-A0

Project: Geotechnical investigation. Proposed Townhouse Residential Development

Location: 1158 Second Line Road, City of Ottawa, ON

Figure No. 4

Page. 1 of 1

Date Drilled: 'February 22, 2018

Drill Type: CME-55 Track Mounted Drill Rig

Datum: Geodetic

Logged by: A. N. Checked by: I.T.

Split Spoon Sample ⊠ | Auger Sample ◧ | SPT (N) Value ○ | Dynamic Cone Test —— | Shelby Tube ■ | Shear Strength by Vane Test +S

Combustible Vapour Reading □ | Natural Moisture Content × | Atterberg Limits ⊢○⊣ | Undrained Triaxial at % Strain at Failure ⊕ | Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic m	Depth
		TOPSOIL ~ 150 mm	102.23	0
		SILTY SAND (SM) Occasional boulders, brown , moist to wet (loose to very dense)	102.1	
		SANDSTONE BEDROCK Fractured in the upper levels, Horizontally fractured, interbedded with limestone and granite (very poor to good quality)	100.5	2
		Borehole Terminated at 4.6 m Depth	97.6	4

Standard Penetration Test N Value: 20 40 60 80

Shear Strength kPa: 50 100 150 200

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % Atterberg Limits (% Dry Weight): 20 40 60

50/100 mm

9

50/125 mm

SAMPLES: Run 1, Run 2

Natural Unit Wt. kN/m³

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 19 mm slotted standpipe was installed upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00245054-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
Completion	Dry	4.6
8 days	dry	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	1.8 - 3.1	73	14
2	3.1 - 4.6	100	80

LOG OF BOREHOLE LOGS OF TEST PIT - 245054. 2018.GPJ TROW OTTAWA.GDT 4/17/18

Log of Test Pit TP-01

Project No: OTT-00245054-A0

Project: Geotechnical investigation. Proposed Townhouse Residential Development

Location: 1158 Second Line Road, City of Ottawa, ON

Figure No. 5

Page. 1 of 1

Date Drilled: 'February 16, 2018

Drill Type: Rubber Tired Backhoe

Datum: Geodetic

Logged by: A. N. Checked by: I.T.

Split Spoon Sample	⊠	Combustible Vapour Reading	□
Auger Sample	◧	Natural Moisture Content	×
SPT (N) Value	○	Atterberg Limits	⊢○
Dynamic Cone Test	——	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■	Shear Strength by Penetrometer Test	▲
Shear Strength by Vane Test	+ S		

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic m	Depth
		TOPSOIL ~ 250 mm	103.22	0
		SILTY SAND (SM) Trace clay, rootlets present, brown to grey, moist	103.0	
		Refusal on Bedrock Surface at 1.4 m Depth	101.8	1
		NOTE A step bedrock refusal encountered at 1.9 m depth along the north side of the test pit.		

Standard Penetration Test N Value: 20 40 60 80

Shear Strength: 50 100 150 200 kPa

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % Atterberg Limits (% Dry Weight): 20 40 60

SAMPLES

Natural Unit Wt. kN/m³

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Test Pit backfilled with excavated material upon completion.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00245054-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
Completion	Dry	1.4

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE LOGS OF TEST PIT - 245054, 2018.GPJ TROW OTTAWA.GDT 4/15/18

Log of Test Pit TP-02

Project No: OTT-00245054-A0

Project: Geotechnical investigation. Proposed Townhouse Residential Development

Location: 1158 Second Line Road, City of Ottawa, ON

Figure No. 6

Page. 1 of 1

Date Drilled: 'February 16, 2018

Drill Type: Rubber Tired Backhoe

Datum: Geodetic

Logged by: A. N. Checked by: I.T.

Split Spoon Sample ⊠
Auger Sample ◧
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits ⊢—○
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic m	Depth	Standard Penetration Test N Value (20 40 60 80) / Shear Strength kPa (50 100 150 200)	Combustible Vapour Reading (ppm) (250 500 750) / Natural Moisture Content % Atterberg Limits (% Dry Weight) (20 40 60)	SAMPLES	Natural Unit Wt. kN/m³
		Topsoil	104.7	0				
		FILL Sand and gravel, brown, moist Frozen upper 400 mm.	104.5			×		
			103.9					
		Refusal on Bedrock Surface at 0.8 m Depth						

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Test Pit backfilled with excavated material upon completion.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00245054-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
Completion	Dry	0.8

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE LOGS OF TEST PIT - 245054, 2018.GPJ TROW OTTAWA.GDT 4/17/18

Log of Test Pit TP-03

Project No: OTT-00245054-A0

Project: Geotechnical investigation. Proposed Townhouse Residential Development

Location: 1158 Second Line Road, City of Ottawa, ON

Figure No. 7

Page. 1 of 1

Date Drilled: 'February 16, 2018

Drill Type: Rubber Tired Backhoe

Datum: Geodetic

Logged by: A. N. Checked by: I.T.

Split Spoon Sample	⊠	Combustible Vapour Reading	□
Auger Sample	◧	Natural Moisture Content	×
SPT (N) Value	○	Atterberg Limits	⊢○
Dynamic Cone Test	——	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■	Shear Strength by Penetrometer Test	▲
Shear Strength by Vane Test	+ S		

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic m	Depth 0	Standard Penetration Test N Value 20 40 60 80 / Shear Strength kPa 50 100 150 200	Combustible Vapour Reading (ppm) 250 500 750 / Natural Moisture Content % Atterberg Limits (% Dry Weight) 20 40 60	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~ 150 mm	101.83					
		SILTY SAND (SM) Brown, moist	101.7			×		
		Refusal on Bedrock Surface at 0.3 m Depth	101.5					

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Test Pit backfilled with excavated material upon completion.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00245054-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
Completion	Dry	0.3

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE LOGS OF TEST PIT - 245054, 2018.GPJ TROW OTTAWA.GDT 4/15/18

Log of Test Pit TP-04

Project No: OTT-00245054-A0

Project: Geotechnical investigation. Proposed Townhouse Residential Development

Location: 1158 Second Line Road, City of Ottawa, ON

Figure No. 8

Page. 1 of 1

Date Drilled: 'February 16, 2018

Drill Type: Rubber Tired Backhoe

Datum: Geodetic

Logged by: A. N. Checked by: I.T.

Split Spoon Sample ⊠
Auger Sample ◧
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits ⊢—○
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic m	Depth 0	Standard Penetration Test N Value 20 40 60 80 / Shear Strength 50 100 150 200 kPa	Combustible Vapour Reading (ppm) 250 500 750 / Natural Moisture Content % Atterberg Limits (% Dry Weight) 20 40 60	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~ 150 mm	101.5					
		SILTY SAND (SM) Brown, moist	101.4			×		
		Refusal on Bedrock Surface at 0.5 m Depth	101.0					

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Test Pit backfilled with excavated material upon completion.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00245054-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
Completion	Dry	0.5

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE LOGS OF TEST PIT - 245054, 2018.GPJ TROW OTTAWA.GDT 4/15/18

Log of Test Pit TP-05

Project No: OTT-00245054-A0

Project: Geotechnical investigation. Proposed Townhouse Residential Development

Location: 1158 Second Line Road, City of Ottawa, ON

Figure No. 9

Page. 1 of 1

Date Drilled: 'February 16, 2018

Drill Type: Rubber Tired Backhoe

Datum: Geodetic

Logged by: A. N. Checked by: I.T.

Split Spoon Sample	⊠	Combustible Vapour Reading	□
Auger Sample	◧	Natural Moisture Content	×
SPT (N) Value	○	Atterberg Limits	⊢○
Dynamic Cone Test	——	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■	Shear Strength by Penetrometer Test	▲
Shear Strength by Vane Test	+ S		

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic m	Depth 0	Standard Penetration Test N Value 20 40 60 80 / Shear Strength 50 100 150 200 kPa	Combustible Vapour Reading (ppm) 250 500 750 / Natural Moisture Content % Atterberg Limits (% Dry Weight) 20 40 60	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~ 150 mm	100.76					
		SILTY SAND (SM) Brown, moist	100.6			×		
		Refusal on Bedrock Surface at 0.3 m Depth	100.5					

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Test Pit backfilled with excavated material upon completion.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00245054-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
Completion	Dry	0.3

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE LOGS OF TEST PIT - 245054, 2018.GPJ TROW OTTAWA.GDT 4/15/18

Log of Test Pit TP-06

Project No: OTT-00245054-A0

Project: Geotechnical investigation. Proposed Townhouse Residential Development

Location: 1158 Second Line Road, City of Ottawa, ON

Figure No. 10

Page. 1 of 1

Date Drilled: 'February 16, 2018

Drill Type: Rubber Tired Backhoe

Datum: Geodetic

Logged by: A. N. Checked by: I.T.

Split Spoon Sample ⊠
Auger Sample ◧
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits |—⊖
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic m	Depth 0	Standard Penetration Test N Value 20 40 60 80 / Shear Strength 50 100 150 200 kPa	Combustible Vapour Reading (ppm) 250 500 750 / Natural Moisture Content % Atterberg Limits (% Dry Weight) 20 40 60	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~ 200 mm	103.11					
			102.9					
		Refusal on Bedrock Surface at 0.2 m Depth						

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Test Pit backfilled with excavated material upon completion.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00245054-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
Completion	Dry	0.2

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE LOGS OF TEST PIT - 245054, 2018.GPJ TROW OTTAWA.GDT 4/15/18

Log of Test Pit TP-07

Project No: OTT-00245054-A0

Project: Geotechnical investigation. Proposed Townhouse Residential Development

Location: 1158 Second Line Road, City of Ottawa, ON

Figure No. 11

Page. 1 of 1

Date Drilled: 'February 16, 2018

Drill Type: Rubber Tired Backhoe

Datum: Geodetic

Logged by: A. N. Checked by: I.T.

Split Spoon Sample	⊠	Combustible Vapour Reading	□
Auger Sample	◧	Natural Moisture Content	×
SPT (N) Value	○	Atterberg Limits	⊢○
Dynamic Cone Test	——	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■	Shear Strength by Penetrometer Test	▲
Shear Strength by Vane Test	+ S		

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic m	Depth
		TOPSOIL ~ 305 mm	102.72	0
		SILTY SAND (SM) Brown, moist	102.4	
		Refusal on Bedrock Surface at 1 m Depth	101.7	1

Standard Penetration Test N Value: 20 40 60 80

Shear Strength kPa: 50 100 150 200

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % Atterberg Limits (% Dry Weight): 20 40 60

SAMPLES

Natural Unit Wt. kN/m³

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Test Pit backfilled with excavated material upon completion.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00245054-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
Completion	Dry	1.0

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE LOGS OF TEST PIT - 245054, 2018.GPJ TROW OTTAWA.GDT 4/15/18

Log of Test Pit TP-08

Project No: OTT-00245054-A0

Project: Geotechnical investigation. Proposed Townhouse Residential Development

Location: 1158 Second Line Road, City of Ottawa, ON

Figure No. 12

Page. 1 of 1

Date Drilled: 'February 16, 2018

Drill Type: Rubber Tired Backhoe

Datum: Geodetic

Logged by: A. N. Checked by: I.T.

Split Spoon Sample ⊠
Auger Sample ◧
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits ⊢—○
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic m	Depth 0	Standard Penetration Test N Value 20 40 60 80 / Shear Strength 50 100 150 200 kPa	Combustible Vapour Reading (ppm) 250 500 750 / Natural Moisture Content % Atterberg Limits (% Dry Weight) 20 40 60	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~ 150 mm	101.96					
		SILTY SAND (SM) Brown, moist	101.8			×		
		Refusal on Bedrock Surface at 0.3 m Depth	101.7					

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Test Pit backfilled with excavated material upon completion.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00245054-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
Completion	Dry	0.3

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE LOGS OF TEST PIT - 245054, 2018.GPJ TROW OTTAWA.GDT 4/15/18

Log of Test Pit TP-09

Project No: OTT-00245054-A0

Project: Geotechnical investigation. Proposed Townhouse Residential Development

Location: 1158 Second Line Road, City of Ottawa, ON

Figure No. 13

Page. 1 of 1

Date Drilled: 'February 16, 2018

Drill Type: Rubber Tired Backhoe

Datum: Geodetic

Logged by: A. N. Checked by: I.T.

Split Spoon Sample ⊠
Auger Sample ◧
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits ⊢—⊖
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic m	Depth 0	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~ 150 mm	101.06		20 40 60 80 / 50 100 150 200 kPa	250 500 750 / 20 40 60		
		SILTY SAND (SM) Brown, moist	100.9			×		
		Refusal on Bedrock Surface at 0.3 m Depth	100.8					

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Test Pit backfilled with excavated material upon completion.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00245054-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
Completion	Dry	0.3

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE LOGS OF TEST PIT - 245054, 2018.GPJ TROW OTTAWA.GDT 4/15/18

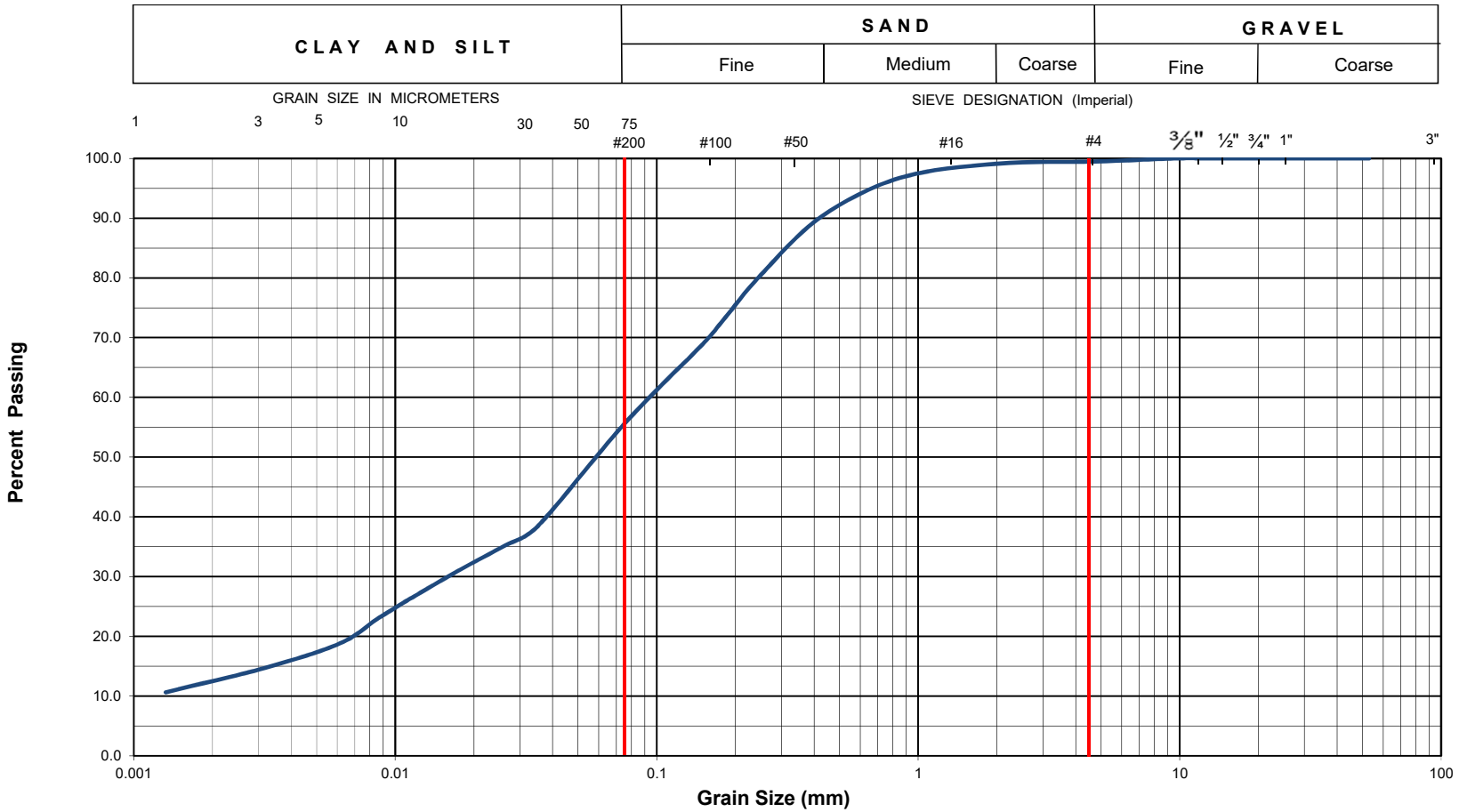
EXP Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6

Grain-Size Distribution Curve

Method of Test for Particle Size Analysis of Soil

ASTM C-136/ASTM D-422

Unified Soil Classification System



EXP Project No.:	**OTT-00245054-A0**	**Project Name :**	**Geotechnical Investigation. Proposed Residential Development**				
Client :	**Theberge Homes**	**Project Location :**	**1158 Second Line Road, Ottawa, ON**				
Date Sampled :	**February 22, 2018**	**Borehole No:**	**BH1**	**Sample No.:**	**SS2**	**Depth (m) :**	**0.8-1.4**
Sample Description :		**Sandy Silt (ML)**				**Figure :**	**14**

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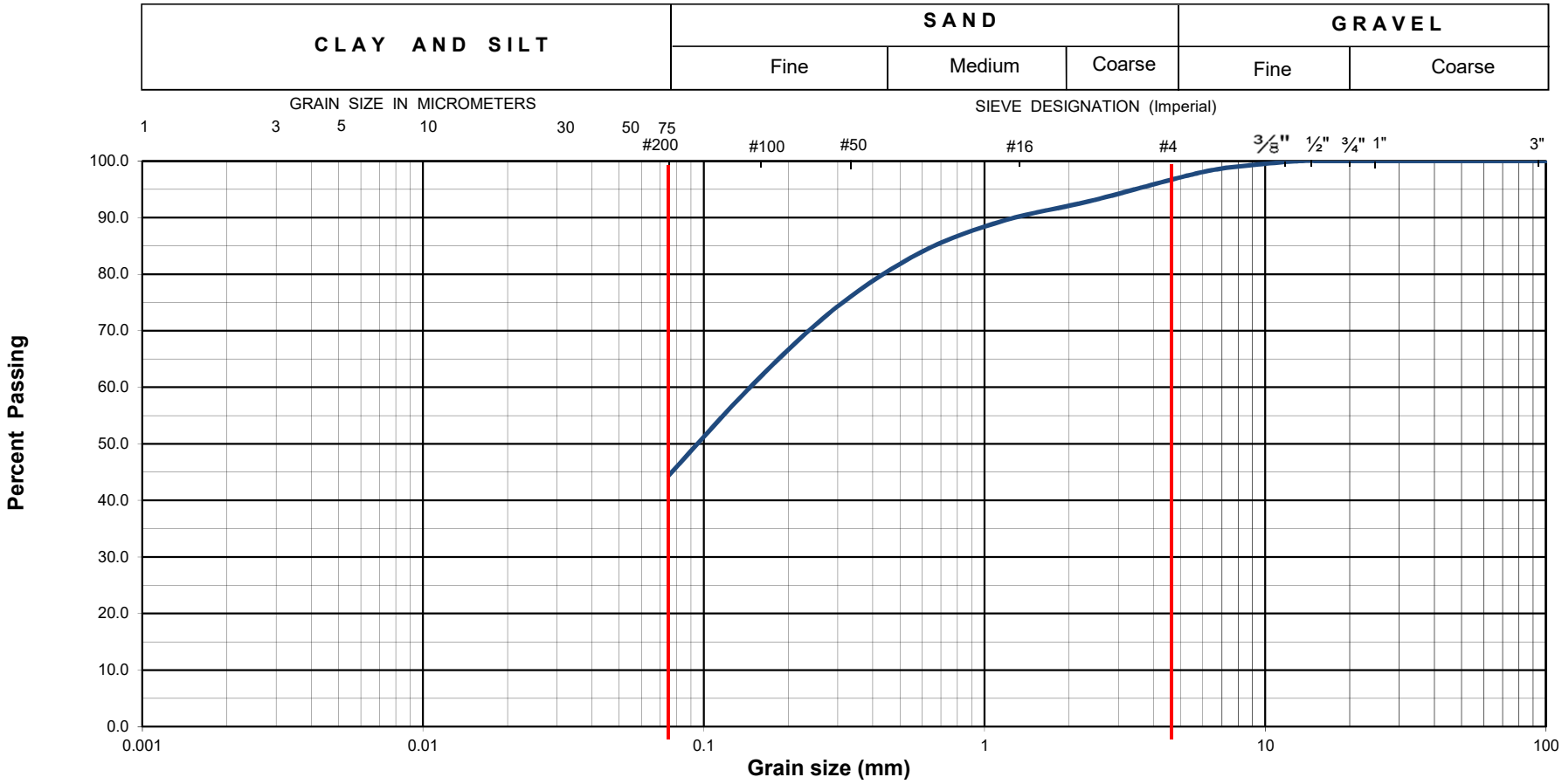
Ottawa, ON K2B 8H6

Grain-Size Distribution Curve

Method of Test for Sieve Analysis of Aggregate

ASTM C-136

Unified Soil Classification System



EXP Project No.:	**OTT-00245054-A0**	**Project Name :**	**Geotechnical Investigation. Proposed Residential Development**				
Client :	**Theberge Homes**	**Project Location :**	**1158 Second Line Road, Ottawa, ON**				
Date Sampled :	**February 16, 2018**	**Test Pit No:**	**TP1**	**Sample:**	**SS1**	**Depth (m) :**	**0.3-1.2**
Sample Description :		**Silty Sand (SM)**				**Figure :**	**15**

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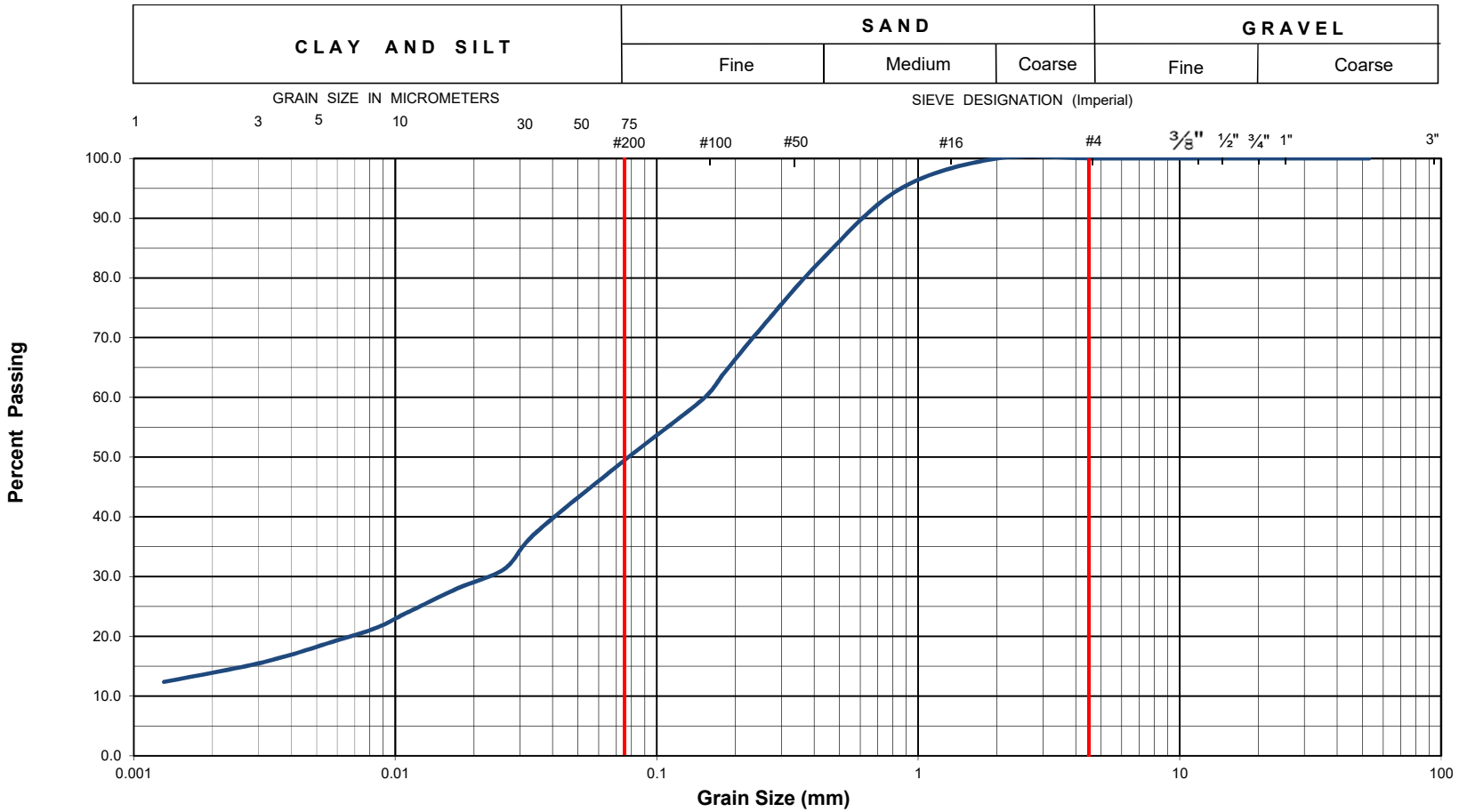
Grain-Size Distribution Curve

Method of Test for Particle Size Analysis of Soil

ASTM C-136/ASTM D-422

Unified Soil Classification System



EXP Project No.:	**OTT-00245054-A0**	**Project Name :**	**Geotechnical Investigation. Proposed Residential Development**		
Client :	**Theberge Homes**	**Project Location :**	**1158 Second Line Road, Ottawa, ON**		
Date Sampled :	**February 16, 2018**	**Test Pit No:**	**TP7**	**Sample No.:** **S1**	**Depth (m) :** **0.3-1.0**
Sample Description :		**Silty Sand with Clay (SM)**			**Figure :** **16**

DRY BEDROCK CORES

WET BEDROCK CORES

exp Services Inc.
t: +1.613.688.1899 | f: +1.613.225.7337
2650 Queensview Drive, Suite 100
Ottawa, ON K2B 8H6
Canada
www.exp.com

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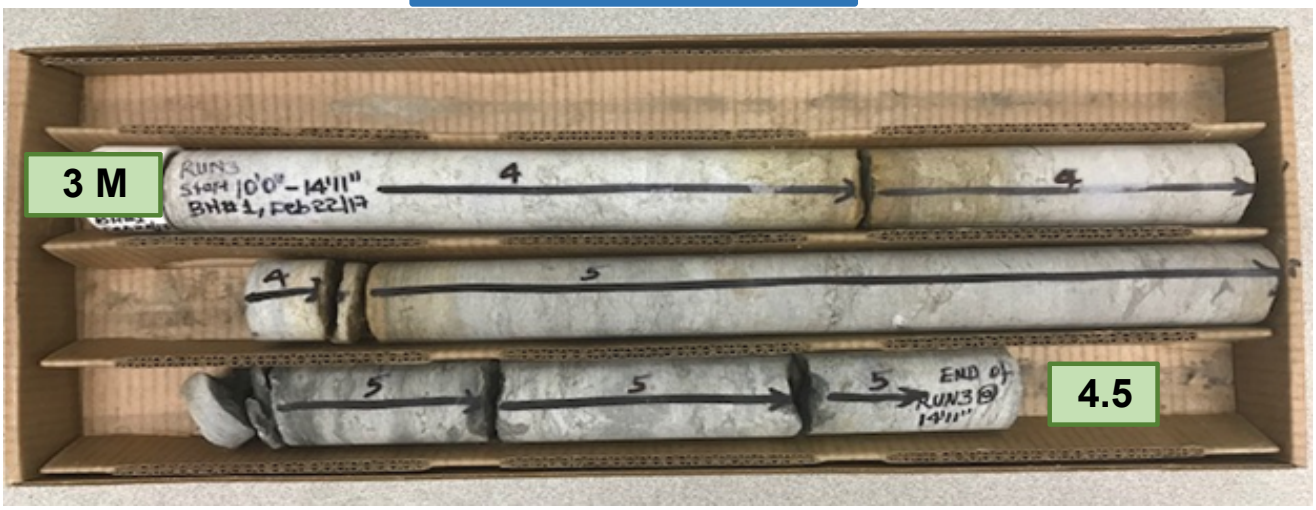
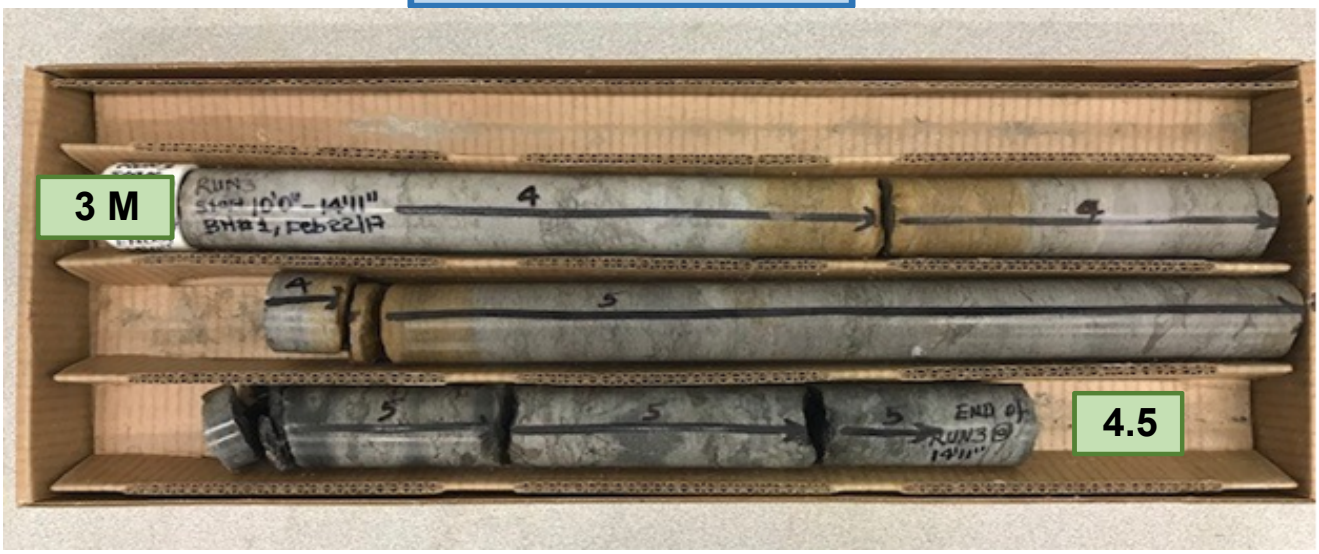
• INDUSTRIAL • INFRASTRUCTURE • SUSTAINABILITY •

Borehole No:	Total Core Depth	Project Name	Project No:
BH-1	Run 1: 1.2 m - 1.5 m Run 2: 1.5 m - 3 m	Proposed Residential Development 1158 Second Line Road, Ottawa, ON	OTT-00245054-A0
Date Cored Feb 22, 2018		ROCK CORE PHOTOGRAPHS	FIG 17

DRY BEDROCK CORES



WET BEDROCK CORES



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Borehole No:	Total Core Depth	Project Name:	Project No:
BH-1	Run 3: 3 m - 4.5 m	Proposed Residential Development 1158 Second Line Road, Ottawa, ON	OTT-00245054
Date Cored Feb 22, 2018		ROCK CORE PHOTOGRAPHS	FIG 18

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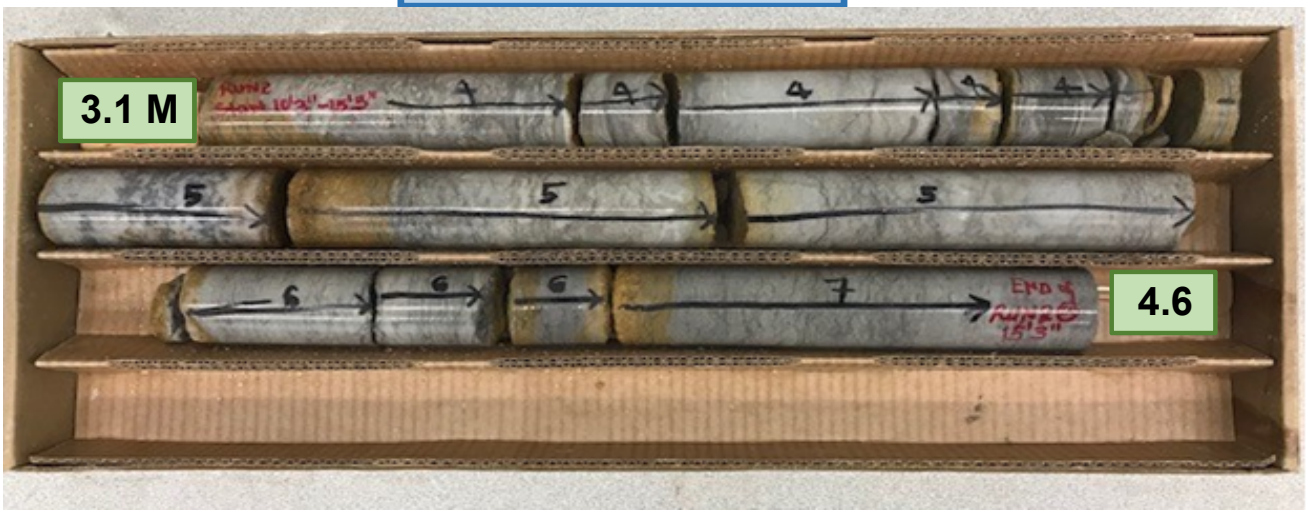
Borehole No.	Total Core Depth	Project Name	Project No:
BH-2	Run 1: 1.8 m - 3.1 m	Proposed Residential Development 1158 Second Line Road, Ottawa, ON	OTT-00245054-A0
Date Cored Feb 22, 2018		ROCK CORE PHOTOGRAPHS	FIG 19

DRY BEDROCK CORES

WET BEDROCK CORES



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Borehole No:	Total Core Depth	Project Name	Project No:
BH-2	Run 2: 3.1 m - 4.6 m	Proposed Residential Development 1158 Second Line Road, Ottawa, ON	OTT-00245054-A0
Date Cored Feb 22, 2018		ROCK CORE PHOTOGRAPHS	FIG 20

Appendix A: AGAT Laboratory Certificate

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: EXP SERVICES INC
2650 QUEENSVIEW DRIVE, UNIT 100
OTTAWA, ON K2B8H6
(613) 688-1899

ATTENTION TO: Raad Akrawi

PROJECT: OTT-245054

AGAT WORK ORDER: 18Z315065

SOIL ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Coordinator

DATE REPORTED: Mar 05, 2018

PAGES (INCLUDING COVER): 5

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 18Z315065

PROJECT: OTT-245054

CLIENT NAME: EXP SERVICES INC

ATTENTION TO: Raad Akrawi

SAMPLING SITE:1158 Second Line Rd.

SAMPLED BY:exp

Inorganic Chemistry (Soil)

DATE RECEIVED: 2018-02-27 **DATE REPORTED: 2018-03-05**

				BH1 Run 1	BH3 Run 1
		SAMPLE DESCRIPTION:		4'9"-5'	6'11"-7'3"
		SAMPLE TYPE:		Soil	Soil
		DATE SAMPLED:		2018-02-22	2018-02-22
Parameter	Unit	G / S	RDL	9089226	9089228
pH, 2:1 CaCl2 Extraction	pH Units		NA	7.58	7.95
Sulphate (2:1)	µg/g		2	30	24

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

9089226 Sulphate was determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil). pH was determined on the 0.01M CaCl2 extract prepared at 2:1 ratio.

Certified By: Amanjot Bhela

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: EXP SERVICES INC

AGAT WORK ORDER: 18Z315065

PROJECT: OTT-245054

ATTENTION TO: Raad Akrawi

SAMPLING SITE:1158 Second Line Rd.

SAMPLED BY:exp

Soil Analysis

RPT Date: Mar 05, 2018			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Inorganic Chemistry (Soil)															
pH, 2:1 CaCl2 Extraction	9089226	9089226	7.58	7.63	0.7%	NA	101%	80%	120%						
Sulphate (2:1)	9089226	9089226	30	30	0.0%	< 2	100%	70%	130%	109%	70%	130%	112%	70%	130%

Comments: NA signifies Not Applicable.

Certified By: Amanjot Bhela

AGAT Laboratories

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MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Method Summary

CLIENT NAME: EXP SERVICES INC

AGAT WORK ORDER: 18Z315065

PROJECT: OTT-245054

ATTENTION TO: Raad Akrawi

SAMPLING SITE:1158 Second Line Rd.

SAMPLED BY:exp

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
pH, 2:1 CaCl2 Extraction	INOR-93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Sulphate (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH

AGAT Laboratories

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
webearth.agatlabs.com

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Report Information:

Company: Exp Services
Contact: Raad Akrawi
Address: 100-2650 Queensview drive
Ottawa Ont K2B 8H6
Phone: 613-688-1899 Fax:
Reports to be sent to:
1. Email: Raad.Akrawi@exp.com
2. Email:

Project Information:

Project: OTT-245054
Site Location: 1158 Second line Rd
Sampled By: Exp
AGAT Quote #: PO:
Please note: If quotation number is not provided, client will be billed full price for analysis.

Invoice Information:

Bill To Same: Yes ☒ No ☐
Company:
Contact:
Address:
Email:

Regulatory Requirements:

☐ No Regulatory Requirement
(Please check all applicable boxes)

☐ Regulation 153/04
Table (Indicate One) ☐ Ind/Com ☐ Res/Park ☐ Agriculture
Soil Texture (Check One) ☐ Coarse ☐ Fine

☐ Sewer Use
☐ Sanitary ☐ Storm
Region (Indicate One)
☐ MISA

☐ Regulation 558
☐ CCME
☐ Prov. Water Quality Objectives (PWQO)
☐ Other
(Indicate One)

Is this submission for a Record of Site Condition? ☐ Yes ☐ No

Report Guideline on *Certificate of Analysis* ☐ Yes ☐ No

Laboratory Use Only

Work Order #: 1873150 65
Cooler Quantity: One on ice
Arrival Temperatures: 14.8 | 14.7 | 14.7 | 14.0 (NO ICE)
Custody Seal Intact: ☐ Yes ☐ No ☐ N/A
Notes:

Turnaround Time (TAT) Required:

Regular TAT ☒ 5 to 7 Business Days
Rush TAT (Rush Surcharges Apply)
☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day
OR Date Required (Rush Surcharges May Apply):
Please provide prior notification for rush TAT
**TAT is exclusive of weekends and statutory holidays*
For 'Same Day' analysis, please contact your AGAT CPM

Sample Matrix Legend

B	Biota
GW	Ground Water
O	Oil
P	Paint
S	Soil
SD	Sediment
SW	Surface Water

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI (Y/N)	O. Reg 153: Metals and Inorganics (☐ All Metals ☐ 153 Metals (excl. Hydrides) ☐ Hydride Metals ☐ 153 Metals (Incl. Hydrides))	ORPs: ☐ B-HWS ☐ Cl ☐ CN ☐ Cr^{6+} ☐ EC ☐ FOC ☐ Hg ☐ pH ☐ SAR	Full Metals Scan	Regulation/Custom Metals	Nutrients: ☐ TP ☐ NH_3 ☐ TKN ☐ NO_3 ☐ NO_2 ☐ NO_3+NO_2	Volatiles: ☐ VOC ☐ BTEX ☐ THM	PHCs F1 - F4	ABNs	PAHs	PCBs: ☐ Total ☐ Aroclors	Organochlorine Pesticides	TCLP: ☐ M&I ☐ VOCs ☐ ABNs ☐ B(a)P ☐ PCBs	Sewer Use	pH	Sulphides
BH 1 Run 1 4'9"-5'	Feb 22/18																		✓	✓
BH 3 Run 1 6'11"-7'3"	Feb 22/18																		✓	✓

Samples Relinquished By (Print Name and Sign): Ryan DiGiuseppe	Date: Feb 26/18	Time: 5:05	Samples Received By (Print Name and Sign): Bertha Tet /	Date: 27-Feb-18	Time: 8h00
Samples Relinquished By (Print Name and Sign): GSO FedEx 27-Feb-18	Date:	Time: 16h00	Samples Received By (Print Name and Sign):	Date:	Time:
Samples Relinquished By (Print Name and Sign):	Date:	Time:	Samples Received By (Print Name and Sign): Shanmin Tan Feb 28/18	Date: 9:07 am	Time:

Page 1 of
N°: T 063372

List of Distribution

Report Distributed To:

Theberge Homes - Mr. Joey Theberge
EXP Infrastructure Division - Mr. Bruce Thomas