Geotechnical Investigation

Client:
Wigwamen Incorporated
23 Lesmill Road, Unit 106
Toronto, Ontario
M3B 3P6

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Project Name:
Proposed Housing Development
2040 Arrowsmith Drive
Ottawa, Ontario

Project Number:
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Prepared By:
EXP Services Inc.
100-2650 Queensview Drive
Ottawa, Ontario K2B 8H6
Canada

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Executive Summary

It is our understanding that the proposed development will consist of a six-story (with a partial seventh storey mechanical room) slab-on-grade residential building with no basement. The development will also include a surface parking lot with access roads and a landscaped green space. A retaining wall is proposed along the east property line and will partially surround the garbage bins. The preliminary design finished floor elevation for the proposed building will be Elevation 71.75 m. The preliminary design elevation of the surface of the parking lot will be Elevation 71.30 m and Elevation 71.00 m.

The borehole fieldwork for this investigation was undertaken on September 27 and 28, 2022 and consists of eight (8) boreholes (Borehole Nos. 1 and 3 to 9). Borehole No. 2 was not drilled. Borehole Nos. 1 and 3 to 5 are located in the vicinity of the proposed building and were advanced to termination and auger refusal depths of 10.1 m to 13.3 m below existing grade. Borehole Nos. 6 to 9 are located within the proposed parking lot and were advanced to termination depths of 3.6 m to 5.2 m below existing grade. Monitoring wells were installed in selected boreholes for long-term monitoring of groundwater levels. The fieldwork was supervised on a full-time basis by a representative from EXP.

The borehole information indicates the subsurface conditions at the site consist of a surficial topsoil layer and pavement structure underlain by fill and an extensive marine clay deposit followed by glacial till and shale bedrock. The groundwater level is at 2.0 m and 2.6 m depths (Elevation 69.4 m and Elevation 69.0 m).

The site may be classified as **Class C** for seismic site response in accordance with the 2012 Ontario Building Code (as amended May 2, 2019). The subsurface soils are not considered to be liquefiable during a seismic event.

Based on a review of the borehole information, a maximum grade raise at the site of 0.5 m is considered to be acceptable from a geotechnical perspective and will accommodate the anticipated site grade raise of up to 0.4 m.

The preliminary design finished floor elevation of the proposed building will be at Elevation 71.75 m. Based on a review of the borehole information, it is considered feasible to support the **proposed building** by spread and strip footings founded on top of the native undisturbed brown clay at a 0.7 m depth (Elevation 70.9 m and Elevation 70.7 m) at Borehole Nos. 1, 3 and 4 and at 0.8 m depth (Elevation 70.6 m) at Borehole No. 5 or by a raft foundation founded at a 1.5 m depth below the design finished floor elevation at a founding elevation of Elevation 70.25 m on the native undisturbed brown clay. The **proposed retaining wall** may be supported by a strip footing founded on the native undisturbed brown clay to a maximum 1.8 m depth below existing grade. The topsoil (surficial and buried) and the fill are not suitable to support the foundations of the proposed building and retaining wall.

For the **proposed building**, strip footings having a maximum width of 1.5 m and square pad footings having a maximum width and length of 4.0 m and founded on top of the native undisturbed brown clay at a 0.7 m depth (Elevation 70.9 m and Elevation 70.7 m) at Borehole Nos. 1, 3 and 4 and at 0.8 m depth (Elevation 70.6 m) at Borehole No. 5, may be designed for a bearing pressure at serviceability limit state (SLS) of 210 kPa and factored geotechnical resistance at ultimate limit state (ULS) of 315 kPa.

Alternatively, the **proposed building** may be supported by a raft foundation founded at a 1 .5 m depth below the design finished floor elevation at a founding elevation of Elevation 70.25 m on the native undisturbed brown clay and may be designed for a bearing pressure at SLS of 85 kPa and factored geotechnical resistance at ULS of 130 kPa.

For the proposed **retaining wall**, a strip footing having a maximum width of 1.5 m and founded at a 1.8 m depth below existing grade on the native undisturbed brown clay may be designed for a bearing pressure at serviceability limit state (SLS) of 150 kPa and factored geotechnical resistance at ultimate limit state (ULS) of 225 kPa.

The factored geotechnical resistance values at ULS includes a resistance factor of 0.5. The total and differential settlements of well designed and constructed footings and raft foundation placed in accordance with the above recommendations are expected to be less than 25 mm and 19 mm respectively. The SLS and factored ULS values are valid provided the site grade raise to a maximum of 0.5 m is respected.

The floor slab of the proposed building may be designed as a slab-on-grade in accordance with recommendations made in the attached geotechnical report.

All excavations must be undertaken in accordance with the Occupational Health and Safety Act (OHSA), Ontario Reg. 213/91. Based on the definitions provided in OHSA, the subsurface soils on site are considered to be Type 3 soil and as such must be cut back at 1H:1V from the bottom of the excavation. Within zones of seepage and below the groundwater level, the excavation side slopes are expected to slough and eventually stabilize at 2H:1V to 3H:1V from the bottom of the excavation. Seepage of the surface and subsurface water into open cut and shored excavations is anticipated and it should be possible to collect water entering the excavations at low points and to remove it by conventional pumping techniques. In areas of high infiltration and below the groundwater level, a higher seepage rate should be anticipated and may require high-capacity pumps to keep the excavation dry.

It is anticipated that the majority of the material required for backfilling purposes in the interior and exterior of the proposed building, backfill against the proposed retaining wall, for service trench backfill and for parking lot and access road(s) construction would have to be imported and should preferably conform to the Ontario Provincial Standard Specifications (OPSS) for Granular A, Granular B Type II material and Select Subgrade Material (SSM), as discussed in the attached geotechnical report.

The above and other related considerations are discussed in greater detail in the main body of this report.

1. Introduction

EXP Services Inc. (EXP) is pleased to present the results of the geotechnical investigation completed for the proposed 50-unit affordable housing development to be located at 2040 Arrowsmith Drive in, Ottawa, Ontario (Figure 1). Written authorization to proceed with this geotechnical investigation was provided by Angus D. Palmer via our signed work authorization dated August 16, 2022.

It is our understanding that the proposed development will consist of a six-story (with a partial seventh storey mechanical room) slab-on-grade residential building with no basement. The development will also include a surface parking lot with access roads and a landscaped green space. A retaining wall is proposed along the east property line and will partially surround the garbage bins. The preliminary design finished floor elevation for the proposed building will be Elevation 71.75 m. The preliminary design elevation of the surface of the parking lot will be Elevation 71.30 m and Elevation 71.00 m.

The geotechnical investigation was undertaken to:

a) Establish the subsurface soil and groundwater conditions at eight (8) boreholes located at the subject site,

b) Classify the site for seismic site response in accordance with the requirements of the 2012 Ontario Building Code (as amended May 2, 2019) and assess the potential for liquefaction of the subsurface soils during a seismic event,

c) Comment on grade-raise restrictions,

d) Make recommendations regarding the most suitable type of foundations, founding depth and bearing pressure at serviceability limit state (SLS) and factored geotechnical resistance at ultimate limit state (ULS) of the founding strata for the proposed building and retaining wall and comment on the anticipated total and differential settlements of the recommended foundation type,

e) Provide comment regarding slab-on-grade construction and the requirements for perimeter and underfloor drainage systems,

f) Provide lateral earth pressure coefficients (static and seismic conditions) for the proposed retaining wall,

g) Comment on excavation conditions and de-watering requirements during construction,

h) Make recommendation regarding pipe bedding requirements,

i) Discuss backfilling requirements and suitability of on-site soils for backfilling purposes,

j) Recommend pavement structure thicknesses for access roads and parking lot; and

k) Comment on subsurface concrete requirements and corrosion potential of subsurface soils to buried metal structures/members.

The comments and recommendations given in this report are based on the assumption that the above-described design concepts 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 site is located in a residential neighbourhood within the city of Ottawa and is bounded by low and high-rise residential buildings to the north, east, and west and by Regional Road No. 174 to the south. The site is currently occupied by a single-story building with a paved parking lot in the north half of the site and green space in the south half. A raised area consisting of a landscaped grassy soil berm is located along the southern and eastern portions of the site, adjacent to the highway on the south side in the south portion of the site and with a vegetable garden located on the soil berm in the northeast portion of the site.

Based on the ground surface elevations at the boreholes located on the site, Elevation 72.70 m to Elevation 71.45 m, the site is relatively flat with a raised soil berm area along the southern and eastern sides of the site. The boreholes were not located on the raised berm area.

3. Procedure

The borehole fieldwork for this investigation was undertaken on September 27 and 28, 2022 and consists of eight (8) boreholes (Borehole Nos. 1 and 3 to 9). Borehole No. 2 was not drilled. Borehole Nos. 1 and 3 to 5 are located in the vicinity of the proposed building and were advanced to termination and auger refusal depths of 10.1 m to 13.3 m below existing grade. Borehole Nos. 6 to 9 are located within the proposed parking lot and were advanced to termination depths of 3.6 m to 5.2 m below existing grade. The fieldwork was supervised on a full-time basis by a representative from EXP.

The borehole locations and geodetic elevations were established on site by EXP and are shown on the Borehole Location Plan, Figure 2.

The borehole locations were cleared of any private and public underground services, prior to the start of drilling operations. The boreholes were drilled using a CME-75 truck-mounted drill-rig equipped with continuous flight hollow stem augers and soil sampling and bedrock coring capabilities. Standard penetration tests (SPTs) were performed in all the boreholes at depth intervals ranging from a continuous basis to a 2.3 m depth interval with soil samples retrieved by the split-barrel sampler. The undrained shear strength of the cohesive soil was measured by conducting penetrometer and in-situ vane tests. The presence of the bedrock was confirmed in Borehole No. 1 by conventional rock coring techniques using the NQ-size core barrel. A record of wash water return, colour of wash water and any sudden drops of the core barrel/rods was kept during the coring operation.

Monitoring wells (50 mm diameter) were installed in Borehole Nos. 1, 5, 7, and 8 for long-term monitoring of groundwater levels. The monitoring wells were installed in accordance with EXP standard practice, and the installation configuration is documented on the respective borehole logs. The boreholes were backfilled upon completion of drilling and the installation of the monitoring wells.

Upon completion of the borehole fieldwork, the soil samples and rock cores were transported to the EXP Ottawa laboratory where they were visually examined in the laboratory by a geotechnical engineer. The soil samples were classified in accordance with the Unified Soil Classification System (USCS) and the modified Burmeister System (as per the 2006 Fourth Edition Canadian Foundation Engineering Manual (CFEM)). The rock cores were logged in accordance with Section 3.2 of the 2006 Canadian Foundation Engineering Manual (CFEM) Fourth Edition. A summary of the soil and bedrock laboratory testing program is shown in Table I.

Table I: Summary of Laboratory Testing Program

Type of Test	Number of Tests Completed
Soil Samples	
Moisture Content Determination	53
Unit Weight Determination	16
Grain Size Analysis	7
Atterberg Limit Determination	5
Corrosion Analysis (pH, sulphate, chloride and resistivity)	3
Bedrock Cores	
Uniaxial Compression Test and Unit Weight Determination	2

4. Subsurface Conditions and Groundwater Levels

A detailed description of the subsurface conditions and groundwater levels from the boreholes are given on the attached Borehole Logs, Figure Nos. 3 to 10. The borehole 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 locations 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 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.

It should be noted that the soil boundaries indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling operations. These boundaries are intended to reflect approximate transition zones for the purpose of geotechnical design and should not be interpreted as exact planes of geological change. The "Notes on Sample Descriptions" preceding the borehole logs form an integral part of this report and should be read in conjunction with this report.

A review of the borehole logs indicates the following subsurface conditions with depth and groundwater level measurements.

4.1 Topsoil

A 100 mm to 180 mm thick surficial topsoil layer was encountered in Borehole Nos. 1 and 6 to 9.

4.2 Pavement Structure

Borehole Nos. 3 to 5 are located within an existing paved area where the pavement structure consists of 65 mm and 100 mm thick asphaltic concrete underlain by 200 mm to 250 mm thick granular fill base layer. The moisture content of the granular fill is 3 percent and 4 percent.

The results from the grain-size analysis conducted on two (2) samples of the granular fill base layer are summarized in Table II. The grain-size distribution curves are shown in Figure 11 and 12.

Table II: Summary of Results from Grain-Size Analysis – Granular Fill Samples

Borehole (BH) No. – Sample (SS) No.	Depth (m)	Grain-Size Analysis (%)			Soil Classification (USCS)
		Gravel	Sand	Fines (Silt and Clay)	
BH 3 – AS1	0.1 – 0.2	36	53	11	Well Graded Sand with Silt and Gravel (SW-SM)
BH 4 – AS1	0.1 – 0.2	39	46	15	Silty Sand with Gravel (SM)

Based on a review of the results from the grain size analysis, the granular fill samples may be classified as a well graded sand with silt and gravel (SW-SM) and a silty sand with gravel (SM) in accordance with the Unified Soil Classification System (USCS).

4.3 Fill

The surficial topsoil and pavement structure are underlain by fill that extends to depths of 0.7 m to 2.4 m depths (Elevation 70.9 m to Elevation 70.0 m) with the deepest fill (1.2 m to 2.4 m depths) located in Borehole Nos. 6, 7 and 9. The fill consists of silty sand with gravel and contains asphalt pieces and rootlets. Based on the standard penetration test (SPT) N-values of 5 to 25, the fill is in a loose to compact state. The moisture content of the fill ranges from 4 percent to 39 percent. The unit weight of the fill is 17.8 kN/m^3 to 20.8 kN/m^3.

4.4 Buried Topsoil Layer

The fill in Borehole No. 8 is underlain by a 100 mm thick topsoil layer contacted at a 0.8 m depth (Elevation 70.8 m).

4.5 Clay

The fill and buried topsoil layer is underlain by a marine clay contacted at 0.7 m to 2.4 m depths (Elevation 70.9 m to Elevation 70.0 m). The clay extends to depths of 9.4 m to 10.7 m (Elevation 62.0 m to Elevation 60.9 m) in Borehole Nos. 1, 4 and 5. The clay consists of an upper weathered desiccated brown clay crust that exhibits good strength underlain by a weaker non-desiccated grey clay.

4.5.1 Upper Brown Desiccated Clay Crust

The upper brown desiccated clay crust extends to approximate depths of 2.2 m to 4.3 m (Elevation 69.4 m to Elevation 68.4 m). The undrained shear strength of the clay ranges from 130 kPa to greater than 230 kPa indicating the clay has a very stiff to hard consistency. The sensitivity of the clay ranges from 5.3 to 7.7 indicating the clay is sensitive. The natural moisture content of the brown clay ranges from 39 percent to 63 percent. The natural unit weight of the clay is 16.9 kN/m^3 to 18.3 kN/m^3.

The results from the grain-size analysis and Atterberg limit determination conducted on three (3) selected samples of the upper brown clay are summarized in Table III. The grain-size distribution curves are shown in Figures 13 to 15.

Table III: Summary of Results from Grain-Size Analysis and Atterberg Limit Determination Brown Clay Samples

Borehole No. (BH) – Sample No. (SS)	Depth (m)	Grain-Size Analysis (%)			Atterberg Limits (%)				
		Gravel	Sand	Fines (Silt and Clay)	Moisture Content	Liquid Limit	Plastic Limit	Plasticity Index	Soil Classification (USCS)
BH 1 – SS3	2.3 – 2.9	0	0	100	63	69	30	39	Clay of High Plasticity (CH)
BH 5 – SS3	1.5 – 2.1	0	1	99	47	71	29	42	Clay of High Plasticity (CH)
BH 7 – SS3	1.5 – 2.1	0	1	99	44	67	32	35	Clay of High Plasticity (CH)

Based on a review of the results of the grain-size analysis and Atterberg limits, the upper brown clay may be classified as a clay of high plasticity (CH) in accordance with the USCS.

4.5.2 Grey Clay

The grey clay was contacted beneath the brown clay at approximate depths of 2.2 m to 4.3 m (Elevation 69.4 m to Elevation 68.4 m) and extends to depths of 9.4 m to 10.7 m (Elevation 62.0 m to Elevation 60.9 m) in Borehole Nos. 1, 4 and 5. Based on SPT N-values of 1 and 3 in Borehole Nos. 7and 9, the grey clay has a very soft to soft consistency. The undrained shear strength of the grey clay ranges from 38 kPa to 110 kPa indicating a firm to very stiff consistency. Locally in Borehole No. 3, a soft zone of the grey clay with undrained shear strength value of 24 kPa exists at a 7.0 m depth (Elevation 64.4 m). The sensitivity values of the clay range from 4.1 to 22.0 indicating the clay is sensitive to quick. The natural moisture of the grey clay is 34 percent to 75 percent. The natural unit weight of the grey clay is 16.3 kN/m^3 to 16.9 kN/m^3.

The results from the grain-size analysis and Atterberg limit determination conducted on two (2) selected samples of the grey clay are summarized in Table IV. The grain-size distribution curves are shown in Figures 16 and 17.

Table IV: Summary of Results from Grain-Size Analysis and Atterberg Limit Determination Grey Clay Samples

Borehole No. (BH) – Sample No. (SS)	Depth (m)	Grain-Size Analysis (%)			Atterberg Limits (%)				
		Gravel	Sand	Fines (Silt and Clay)	Moisture Content	Liquid Limit	Plastic Limit	Plasticity Index	Soil Classification (USCS)
BH 1 -SS6	7.6 – 8.2	0	3	97	46	38	22	16	Clay of Low Plasticity (CL)
BH 5 – SS7	7.6 – 8.2	0	3	97	44	34	20	14	Clay of Low Plasticity (CL)

Based on a review of the results of the grain-size analysis and Atterberg limits, the grey clay may be classified as a clay of low plasticity (CL) in accordance with the Unified USCS.

4.6 Glacial Till

The clay in Borehole Nos.4 and 5 is underlain by glacial till contacted at 9.4 m and 10.4 m depths (Elevation 62.0 m and Elevation 61.0 m). The glacial till consists of silty clayey sand and silty sand with gravel. The glacial till contains cobbles and boulders. The SPT N-values range from hammer weight to 42 indicating the glacial till is in a very loose to dense state. The natural moisture content of the glacial till ranges from 10 percent to 45 percent.

4.7 Shale Bedrock

Auger refusal was met on inferred cobbles, boulders or bedrock in Borehole Nos. 4 and 5 at 10.2 m and 12.9 m depths, respectively (Elevation 61.2 m to Elevation 58.5 m). Weathered shale bedrock was contacted in Borehole No. 1 at a 10.7 m depth (Elevation 60.9 m) and it was possible to auger into the weathered shale bedrock by approximately 1.1 m to the intact shale bedrock contacted below at an 11.8 m depth (Elevation 59.8 m). The presence of the bedrock was confirmed by coring a 1.5 m length of the bedrock to a borehole termination depth of 13.3 m (Elevation 58.3 m). Based on a review of the bedrock core and published geology map (Map P. 2716 - Paleozoic Geology of the Ottawa Area, Southern Ontario, Ministry of Natural Resources, 1984), the bedrock is shale of the Billings formation. Photographs of the bedrock core are shown in Figure 18.

A review of the recovered rock core indicates the total core recovery (TCR) is 100 percent. The rock quality designation (RQD) value is 87 percent indicating the bedrock is of good quality.

Two (2) uniaxial compressive strength tests were completed on the rock cores indicating a compressive strength of 38.0 MPa in both tests. The unit weight was also determined to be 25.6 kN/m^3 and 26.0 kN/m^3. Based on the uniaxial compressive strength test result, the bedrock may be classified as being medium strong (R3) in accordance with the 2006 Fourth Edition of the Canadian Foundation Engineering Manual (CFEM).

4.8 Groundwater Level Measurements

A summary of the groundwater level measurements taken in Borehole Nos. 1, 5 and 8 equipped with monitoring wells is shown in Table V.

Table V: Summary of Groundwater Level Measurements

Borehole No. (BH)	Ground Surface Elevation (m)	Date of Measurement (Elapsed Time in Days from Date of Installation)	Groundwater Depth Below Ground Surface (Elevation), m
BH 1	71.57	Oct 27, 2022 (30 days)	2.6 (69.0)
BH 5	71.36	Oct 27, 2022 (29 days)	2.0 (69.4)
BH8	71.63	Oct 27, 2022 (29 days)	2.6 (69.0)

The groundwater level is at 2.0 m and 2.6 m depths (Elevation 69.4 m and Elevation 69.0 m).

Groundwater levels were determined in the boreholes at the times and under the conditions stated in the scope of services. Note that fluctuations in the level of groundwater may occur due to a 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. Site Classification for Seismic Site Response and Liquefaction Potential of Soils

5.1 Site Classification for Seismic Site Response

The subsurface conditions identified in the boreholes were examined in relation to Table 4.1.8.4.A of the 2012 Ontario Building Code (OBC) as amended May 2, 2019. Based on the borehole information, the site classification for seismic site response is considered to be **Site Class C**.

5.2 Liquefaction Potential of Soils

The subsurface soils are not considered to be liquefiable during a seismic event.

6. Grade Raise Restrictions

The preliminary design elevation for the floor slab of the proposed building will be Elevation 71.75 m and the surface of the parking lot will be at Elevation 71.30 m and Elevation 71.00 m. The ground surface elevations at the boreholes located in the vicinity of the proposed building range from Elevation 71.57 m to Elevation 71.36 m. Therefore, the site grade raise in the vicinity of the proposed building will be up to 0.4 m. The ground surface elevation of the boreholes located within the proposed parking lot range from Elevation 72.70 m to Elevation 71.45 m. Therefore, there will be no site grade raise within the proposed parking lot area; the area will be a cut area.

Based on a review of the borehole information, a maximum grade raise at the site of 0.5 m is considered to be acceptable from a geotechnical perspective and will accommodate the anticipated site grade raise of up to 0.4 m.

If the design grade raise exceeds the maximum permissible grade raise of 0.5 m, EXP should be contacted to review the acceptability of the proposed new grade raise and to provide updated bearing pressure at serviceability limit state (SLS) and factored geotechnical resistance at ultimate limit state (ULS) for the building foundations.

7. Site Grading

Once the existing building has been demolished, all construction debris, topsoil (surficial and buried) and fill should be excavated and removed down to the native clay soil.

The **existing soil berm** currently present on-site will likely require removal and disposal off-site as part of the proposed new development. The disposal of this material should be in accordance with Section 11. 1 of this report (Excess Soil Management).

Site grading within the **proposed building footprint** should consist of the removal of all existing fill, surficial and buried topsoil layers and organic stained soils down to the native undisturbed brown clay. The native subgrade should be examined by a geotechnician. Any loose/soft areas identified during the subgrade examination in the floor slab area should be excavated, removed and replaced with Ontario Provincial Standard Specification (OPSS) Granular B Type II material compacted to 98 percent standard Proctor maximum dry density (SPMDD). Once the subgrade has been approved, the grades may be raised to the design underside of the floor slab elevation by the construction of an engineered fill pad. The engineered fill pad should consist of Ontario Provincial Standard Specification (OPSS) Granular B Type II with each lift compacted to 98 percent standard Proctor maximum dry density (SPMDD).

The preliminary design elevation of the surface of the **proposed parking lot and access road area** will be Elevation 71.30 m and Elevation 71.00 m. Borehole Nos. 6 to 9 are located within the footprint of the proposed parking lot/access road area and the existing ground surface elevations of these boreholes ranges from Elevation 71.45 m to Elevation 72.70 m. Therefore, the proposed parking lot/access road area will be in a cut area, where approximately the existing grade will be lowered or cut by 0.2 m to 0.7 m to achieve the preliminary design elevation of the surface of the parking lot. At Borehole No. 9, the existing grade will be lowered by approximately 1.4 m to 1.7 m to achieve the preliminary design elevation of the surface of the proposed parking lot. It is also understood that an existing sanitary sewer easement crosses the proposed parking lot area as shown in Figure 2. It is anticipated that within the limits of the existing sanitary sewer easement, the depth of the existing fill will likely be deeper than encountered in the boreholes located outside of the sewer easement and is expected to extend to the invert depth of the sanitary sewer which is not known at the time of this geotechnical investigation. Boreholes were not undertaken within the sewer easement due to conflict with the sanitary sewer. The contractor should construct the new parking lot and access roads in such a manner as to not damage the sanitary sewer located in the easement that crosses the footprint of the new parking lot and access roads.

Site grading within the **proposed parking lot and access road area** should consist of the removal of the existing soils down to the design subgrade level where the subgrade is anticipated to consist of the existing fill and native clay. The existing fill subgrade should be proofrolled in the presence of a geotechnician. Any loose/soft areas identified during the proofrolling process should be excavated, removed and replaced with Ontario Provincial Standard Specification (OPSS) Granular B Type II or OPSS Select Subgrade Material (SSM) compacted to 95 percent standard Proctor maximum dry density (SPMDD). Alternatively, portions of the excavated and removed existing fill that is free of debris, cobbles, boulders and topsoil, may be reused to raise the site grades in sub-excavated areas to the design subgrade level. The suitability of re-using the existing fill to raise the grades in the sub-excavated areas will have to be further assessed at time of construction by examining the fill material and conducting additional tests on the material.

8. Foundation Considerations

The preliminary design finished floor elevation of the proposed building will be at Elevation 71.75 m. Based on a review of the borehole information, it is considered feasible to support the **proposed building** by spread and strip footings founded on top of the native undisturbed brown clay at a 0.7 m depth (Elevation 70.9 m and Elevation 70.7 m) at Borehole Nos. 1, 3 and 4 and at 0.8 m depth (Elevation 70.6 m) at Borehole No. 5 or by a raft foundation founded at a 1.5 m depth below the design finished floor elevation at a founding elevation of Elevation 70.25 m on the native undisturbed brown clay. The **proposed retaining wall** may be supported by a strip footing founded on the native undisturbed brown clay to a maximum 1.8 m depth below existing grade. The topsoil (surficial and buried) and the fill are not suitable to support the foundations of the proposed building and retaining wall.

For the **proposed building**, strip footings having a maximum width of 1.5 m and square pad footings having a maximum width and length of 4.0 m and founded on top of the native undisturbed brown clay at a 0.7 m depth (Elevation 70.9 m and Elevation 70.7 m) at Borehole Nos. 1, 3 and 4 and at 0.8 m depth (Elevation 70.6 m) at Borehole No. 5, may be designed for a bearing pressure at serviceability limit state (SLS) of 210 kPa and factored geotechnical resistance at ultimate limit state (ULS) of 315 kPa.

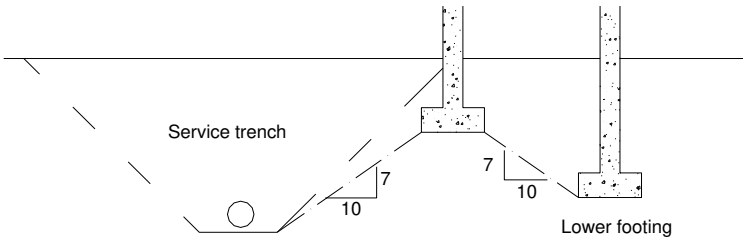
Alternatively, the **proposed building** may be supported by a raft foundation founded at a 1 .5 m depth below the design finished floor elevation at a founding elevation of Elevation 70.25 m on the native undisturbed brown clay and may be designed for a bearing pressure at SLS of 85 kPa and factored geotechnical resistance at ULS of 130 kPa.

For the proposed **retaining wall**, a strip footing having a maximum width of 1.5 m and founded at a 1.8 m depth below existing grade on the native undisturbed brown clay may be designed for a bearing pressure at serviceability limit state (SLS) of 150 kPa and factored geotechnical resistance at ultimate limit state (ULS) of 225 kPa.

The factored geotechnical resistance values at ULS includes a resistance factor of 0.5. The total and differential settlements of well designed and constructed footings and raft foundation placed in accordance with the above recommendations are expected to be less than 25 mm and 19 mm respectively. The SLS and factored ULS values are valid provided the site grade raise to a maximum of 0.5 m is respected.

If the founding depth for the proposed footings or raft foundation for the proposed building and retaining wall will be at a deeper depth than indicated above, EXP should be contacted to provide updated SLS and factored ULS values for the foundations.

Footings at different elevations should be located such that the higher footings are set below a line drawn up at 10 horizontal to 7 vertical (10H:7V) from the near edge of the lower footing. This concept should also be applied to service excavation, etc. to ensure that undermining is not a problem.



FOOTINGS NEAR SERVICE TRENCHES OR AT DIFFERENT ELEVATIONS

All the footing beds and subgrade for the raft foundation should be examined by a geotechnical engineer to ensure that the founding surfaces are capable of supporting the design bearing pressure and that the footing beds/ subgrade for the raft foundation have been properly prepared.

For footings and raft foundation founded directly on the native undisturbed brown clay and to prevent disturbance to the subgrade, the approved footing beds and subgrade for the raft foundation should be protected by covering the subgrade with a 50 mm thick concrete mud slab following examination and approval of the founding soil subgrade.

A minimum of 1.5 m of earth cover should be provided to the footings and raft foundation to protect them from damage due to frost penetration. The frost cover should be increased to 2.1 m for unheated structures if snow will not be removed from their vicinity. If snow will be removed from the vicinity of the unheated structures, the frost cover should be increased to 2.4 m. Rigid insulation thermally equivalent to the required soil cover may be used instead of the soil cover. Alternatively, a combination of rigid insulation and soil cover may be used to achieve the required frost protection for the footings and raft foundation. Once the final site grades and founding depth (elevation) of the foundations have been finalized, EXP can provide details regarding the thickness and horizontal length of the rigid insulation required in conjunction with the soil cover.

The recommended factored geotechnical resistance at ULS and bearing pressure at SLS 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 when foundation construction is underway. The interpretation between boreholes 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.

8.1 Sliding Resistance of Footings

The unfactored ULS coefficient between the concrete of the footing and the very stiff to hard brown clay is 0.50. As indicated in the 2006 Canadian Foundation Engineering Manual, Fourth Edition (CFEM), a geotechnical resistance factor of 0.8 should be applied to the unfactored ULS value to determine the factored ULS value.

8.2 Vertical Modulus of Subgrade Reaction

For the raft foundation founded on the very stiff to hard clay at the above noted design elevation, the vertical modulus of subgrade reaction is estimated to be 10 MPa/m.

9. Floor Slab and Drainage Requirements

The preliminary design elevation of the floor slab for the proposed building will be at Elevation 71.75 m. The floor slab for the proposed building may be designed and constructed as a slab-on-grade placed on a 200 mm thick 19 mm sized clear stone bed placed on a minimum 300 mm thick engineered fill pad set on the approved native clay subgrade that is constructed in accordance with Section 7 of this report. The clear stone would minimize the capillary rise of moisture from the sub-soil to the floor slab. As an alternative to the clear stone layer, the floor slab may be cast on a 200 mm thick bed of OPSS Granular A overlain by a vapour barrier. Adequate saw cuts should be provided in the floor slabs to control cracking.

It is recommended that a perimeter drainage system should be provided around the proposed building. Based on the preliminary design finished floor elevation of Elevation 71.75 m and the groundwater level at Elevation 69.4 m and Elevation 69.0 m, an underfloor drainage system is not required for the proposed building.

The floor slab should be set at a minimum of 150 mm higher than the surrounding final exterior grade.

The final exterior grade surrounding the proposed building should be sloped away from the proposed building to prevent ponding of surface water close to the exterior walls of the proposed building.

10. Lateral Earth Pressure Against Retaining Walls

The backfill behind the proposed retaining wall should consist of free-draining material, such as OPSS Granular B Type II material, and should be equipped with a permanent drainage system to prevent the build-up of hydrostatic pressure behind the wall. The drainage system should be positively (suitably) outletted away from the retaining wall.

The proposed retaining wall will be subjected to lateral static earth as well as lateral dynamic earth forces during a seismic event. Seismic loading will result in an increase in active lateral earth pressure on the wall. The seismic lateral earth pressure coefficient given below is based on the peak horizontal ground acceleration (PGA) of 0.32g applicable for the site.

The expression below assumes the retaining wall is backfilled with free draining material, such as OPSS Granular B Type II and equipped with a permanent drainage system to prevent the buildup of hydrostatic pressure behind the wall.

The total lateral active pressure distribution can be separated into a static component and a dynamic component and may be determined as follows (Mononobe and Matsuo, 1929):

$$\sigma_{AE}(z) = K_A \gamma z + (K_{AE} - K_A)\gamma(H - z) + q$$

Where $\sigma_{AE}(z)$ = the total combined lateral active earth pressure (dynamic and static) at depth z, (kPa).

z = depth below the top of the retaining wall (m)

K_A = static lateral active earth pressure coefficient

K_{AE} = combined (static and dynamic) lateral active earth pressure coefficient

γ = unit weight of the backfill soil (kN/m^3)

H = total height of the wall (m)

q = surcharge such as traffic and compaction pressure, where applicable (kPa)

For the total lateral active earth pressure, the seismic (dynamic) pressure distribution is an inverted triangle with maximum pressure at the top of the wall and a minimum at the bottom of the wall. Therefore, the resultant of the static and seismic (dynamic) pressures on the retaining wall is assumed to be applied at depths ranging between 0.67z from the top of the backfill behind the wall and 0.67 (H-z) from the bottom of the wall, respectively.

The lateral earth pressure parameters are summarized in Table VI. The estimated lateral earth pressure parameters assume the back face of the wall is vertical, there is no friction between the concrete of the wall and the backfill soil behind the wall, no hydrostatic pressure build-up behind the wall, the ground surface of the backfill behind the wall is level or flat and the ground surface of the backfill behind the wall is at the same level as the top of the retaining wall.

Table VI: Lateral Earth Pressure Parameters

Soil Type	OPSS Granular B Type II
Unit Weight of Soil (γ); kN/m^3	22
Angle of Internal Friction (ϕ'); degrees	30^o
Coefficient of Static Active Lateral Earth Pressure Coefficient, K_A	0.33
Combined Coefficient (Static and Dynamic) Active Lateral Earth Pressure, K_{AE}	0.42

For the calculation of the active dynamic (seismic) lateral earth pressure coefficient, the seismic coefficient in the horizontal direction, k_h, was taken as 0.5 times the PGA value of 0.32g. The calculated active dynamic (seismic) lateral earth pressure coefficient assumes the seismic coefficient in the vertical direction, k_v, is zero. If vertical acceleration is taken into consideration, the computed active and dynamic (seismic) lateral earth pressure coefficient value would be somewhat different.

As per the City of Ottawa requirement, a global stability check must be performed on retaining walls that are greater than 1.0 m in height.

11. Excavation and De-Watering Requirements

11.1 Excess Soil Management

Ontario Regulation 406/19 specifies protocols that are required for the management and disposal of excess soils. As set forth in the regulation, specific analytical testing protocols need to be implemented and followed based on the volume of soil to be managed and the requirements of the receiving site. The testing protocols are specific as to whether the soils are stockpiled or in situ. In either scenario, the testing protocols are far more onerous than have been historically carried out as part of standard industry practices. These decisions should be factored in and accounted for prior to the initiation of the project-defined scope of work. EXP would be pleased to assist with the implementation of a soil management and testing program that would satisfy the requirements of Ontario Regulation 406/19.

11.2 Excavation

Excavations for the construction of footings for the proposed building, retaining wall, installation of underground services and construction of the parking lot and access roads are anticipated to extend to a maximum depth of 3.0 m below the existing grade and are anticipated to extend through the fill, topsoil (surficial and buried layers) and into the native clay and are anticipated to be approximately 0.4 m to 1.0 m below the groundwater level.

Excavations maybe undertaken by conventional heavy equipment capable of removing debris within the fill.

Open cut excavation within the subsurface soils should comply with the most recent Occupational Health and Safety Act (OHSA), Ontario Regulations 213/91 (August 1, 1991). Based on the definitions contained in OHSA, the subsurface soils at the site are classified as Type 3 soil and as such the excavation sidewalls must be cut back at 1H:1V from the bottom of the excavation. Below the groundwater table, the excavation side slopes are expected to slough and will eventually stabilize at a slope of 2H:1V to 3H:1V.

If side slopes noted above for the construction of the proposed building and retaining wall cannot be achieved due to space restrictions on site, such as the proximity of open cut excavations to the property limits or existing infrastructure, the excavation for the new building and retaining wall construction would have to be undertaken within the confines of an engineered support system (shoring system). If space restrictions prevent open cut excavations, the underground services may be installed within the confines of a prefabricated support system (trench box) which is designed and installed in accordance with the above-noted regulations.

The need for a shoring system, the most appropriate type of shoring system and the design and installation of the shoring system should be determined by the contractors bidding on this project. The design of the shoring system should be undertaken by a professional engineer experienced in shoring design and the installation of the shoring system should be undertaken by a contractor experienced in the installation of shoring systems. The shoring system should be designed and installed in accordance with latest edition of Ontario Regulation 213/91 under the OHSA and the 2006 Fourth Edition of the Canadian Foundation Engineering Manual (CFEM). The shoring system as well as adjacent settlement sensitive structures (buildings) and infrastructure should be monitored for movement (deflection) on a periodic basis during construction operations.

Excavations that extend to a maximum 3.0 m depth below existing grade and terminate within the grey clay are not expected to experience a base-heave type failure.

The native clay is susceptible to disturbance due to movement of construction equipment and personnel on its surface. It is therefore recommended that the excavation at the site should be undertaken by construction equipment that does not travel on the excavated surface, such as a gradall or mechanical shovel.

Many geologic materials deteriorate rapidly upon exposure to meteorological elements. Unless otherwise specifically indicated in this report, walls and floors of excavations must be protected from moisture, desiccation, and frost action throughout the course of construction.

11.3 De-Watering Requirements

Seepage of the surface and subsurface water into the excavations is anticipated. However, it should be possible to collect any water entering the excavations in perimeter ditches and to remove it by pumping from sumps. In areas of high infiltration or in areas where more permeable soil layers may exist, a higher seepage rate should be anticipated and will require high-capacity pumps to keep the excavation dry.

For construction dewatering, an Environmental Activity and Sector Registry (EASR) approval may be obtained for water takings greater than 50 m^3 and less than 400 m^3 per day. If more than 400 m^3 per day of groundwater are generated for dewatering purposes, then a Category 3 Permit to Take Water (PTTW) must be obtained from the Ministry of the Environment, Conservation and Parks (MECP). A Category 3 PTTW would require a complete hydrogeological assessment and would take at least 90 days for the MECP to process once the application is submitted.

The excavations for the foundations for the proposed building at the founding elevations indicated in this report are anticipated to be above the groundwater level. In this case, groundwater removal from these excavations is anticipated to be minimal to not at all. Therefore, short-term groundwater removal during the construction of the foundations is not anticipated to negatively impact existing neighboring structures and infrastructure. Similarly, the recommended perimeter drainage system around the proposed building is also not anticipated to negatively impact adjacent structures and infrastructure over the long-term from a groundwater lowering perspective.

The installation of the underground municipal services will be below the groundwater level. Due to the impermeable nature of the clay, short-term excavations for the installation of the underground services are not anticipated to negatively impact existing neighboring structures and infrastructure from a groundwater lowering perspective. Since clay seals are recommended for granular backfilled service trenches in Section 12 of this report, the installation of the underground services is not anticipated to negatively impact existing adjacent structures and infrastructure over the long-term, from a groundwater lowering perspective.

Although this investigation has estimated the groundwater levels at the time of the fieldwork, and commented on dewatering and general construction problems, conditions may be present which are difficult to establish from standard boring and excavating techniques and which may affect the type and nature of dewatering procedures used by the contractor in practice. These conditions include local and seasonal fluctuations in the groundwater table, erratic changes in the soil profile, thin layers of soil with large or small permeabilities compared with the soil mass, etc. Only carefully controlled tests using pumped wells and observation wells will yield the quantitative data on groundwater volumes and pressures that are necessary to adequately engineer construction dewatering systems.

12. Pipe Bedding Requirements

The depth at which municipal services will be installed is anticipated to be a maximum of 3.0 m depth below existing grade. Based on this, the subgrade for the underground service pipes is expected to be the grey clay.

The bedding for the underground services including material specifications, thickness of cover material and compaction requirements conform to municipal requirements and/or Ontario Provincial Standard Specification and Drawings (OPSS and OPSD).

It is recommended that the pipe bedding be 300 mm thick and consist of OPSS Granular A. The bedding material should be placed along the sides and on top of the pipe to provide a minimum cover of 300 mm. The bedding should be compacted to at least 98 percent of the SPMDD.

The bedding thickness may be further increased in areas where the subgrade becomes disturbed. Trench base stabilization techniques, such as the removal of loose/soft material, placement of additional sub-bedding, consisting of Ontario Provincial Standard Specification (OPSS) Granular B Type II completely wrapped in a non-woven geotextile, may be used if trench base disturbance becomes a problem in wet or soft/loose areas.

To minimize settlement of the pavement structure over services trenches, the trench backfill material within the frost zone, to 1.8 m depth below final grade, should match the existing material along the trench walls to minimize differential frost heaving of the subgrade soil, provided this material is compactible. Otherwise, frost tapers may be required.

If the backfill in the service trenches will consist of granular fill, clay seals should be installed in the service trenches at select intervals (spacing) as per City of Ottawa Drawing No. S8. The seals should be 1 m wide, extend over the entire trench width and from the bottom of the trench to the underside of the pavement structure. The clay should be compacted to 95 percent SPMDD. The purpose of the clay seals is to prevent the permanent lowering of the groundwater level.

The municipal services should be installed in short open trench sections that are excavated and backfilled the same day.

13. Backfilling Requirements and Suitability of On-Site Soils for Backfilling Purposes

The on-site soils to be excavated are topsoil (surficial and buried layers), fill, brown and grey clay. From a geotechnical perspective, portions of the existing fill (free of debris and topsoil) and the native brown clay from above the groundwater level may be re-used as fill material to raise the grades at the site to the design subgrade level in areas in the proposed parking lot, access roads and landscaped areas, subject to additional examination and testing during construction. These soils are susceptible to moisture absorption due to precipitation and therefore should be protected from the elements if stockpiled on site. The native grey clay below the groundwater table is expected to be too wet for re-use and for adequate compaction and should be discarded. The grey clay may, however, be used for general grading purposes in the landscape areas if left in the sun to dry or mixed with drier material. The existing topsoil (surficial and buried) is not considered suitable for use as backfill material.

It is anticipated that the majority of the material required for backfilling purposes in the interior and exterior of the proposed building, backfill against the proposed retaining wall and for service trench backfill would have to be imported and should preferably conform to the following specifications:

- Engineered fill and service trench backfill under the floor slab of the proposed building - OPSS 1010 Granular B Type II placed in 300 mm thick lifts and each lift compacted to 98 percent SPMDD,
- Backfill material for footing trenches and against foundation walls located outside the proposed building and for the retaining wall – OPSS 1010 Granular B Type II placed in 300 mm thick lifts and each lift compacted to 95 percent SPMDD,
- Trench backfill and subgrade fill should consist of OPSS Select Subgrade Material (SSM) for the parking lot and access roads, placed in 300 mm thick lifts and each lift compacted to 95 percent SPMDD; and
- Fill for landscaped areas should be clean fill free of debris, topsoil, cobbles and boulders placed in 300 mm thick lifts and each lift compacted to 92 percent SPMDD.

14. Access Roads and Parking Lot

Based on a comparison between the preliminary design elevation of the surface of the proposed parking lot and access roads and the existing ground surface elevations of Borehole Nos. 6 to 9 located within the footprint of the proposed parking lot and access roads, the subgrade for the pavement structures is anticipated to consist of the existing fill and clay. Pavement structure thicknesses required for the access roads and parking lots set on the anticipated approved subgrade materials were computed and are shown in Table VII. The pavement structures assume a functional design life of 15 to 20 years. The proposed functional design life represents the number of years to the first rehabilitation, assuming regular maintenance is carried out.

Table VII: Recommended Pavement Structure Thicknesses

Pavement Layer	Compaction Requirements	Computed Pavement Structure	
		Light Duty Traffic (Parking Lots - Cars Only)	Heavy Duty (Parking Lots and Access Roads – Garbage/Fire Trucks)
Asphaltic Concrete (PG 58-34)	92 percent to 97 percent MRD	65 mm HL3/SP12.5 mm/ Category B	40 mm HL3/SP12.5 Category B 50 mm HL8/SP 19 Category B
OPSS 1010 Granular A Base (crushed limestone)	100 percent SPMDD	150 mm	150 mm
OPSS 1010 Granular B Type II Sub-base	100 percent SPMDD	450 mm	600 mm

Notes:

1. SPMDD denotes standard Proctor maximum dry density, ASTM, D-698-12e2.
2. MRD denotes Maximum Relative Density, ASTM D2041.

The upper 300 mm of the subgrade fill must be compacted to 98 percent SPMDD.

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 may be required in addition to a woven geotextile.

Additional comments on the construction of the parking lot and access roads are as follows:

1. As part of the subgrade preparation, the proposed parking areas and access roads should be stripped of topsoil and other obviously unsuitable material down to the design elevation of the subgrade. The subgrade should be properly shaped, crowned, then proofrolled with a heavy vibratory roller in the full-time presence of a representative of this office. Any soft or spongy subgrade areas detected during proofrolling operations should be sub excavated and properly replaced with suitable approved backfill compacted to 95 percent SPMDD. The subgrade should be covered with geotextile prior to placing granular materials.
2. 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 that uniform subgrade moisture and density conditions are achieved. The need for adequate drainage cannot be over-emphasized. Subdrains should be installed on both sides of the access road(s). Subdrains must be installed in the proposed parking area at low points and should be continuous between catchbasins or open drainage ditches to intercept excess surface and subsurface moisture and to prevent subgrade softening. 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 subdrains 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 catchbasins/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 catchbasins/manholes to facilitate drainage of any water that may accumulate in the granular fill.

4. The most severe loading conditions on light-duty pavement areas and the subgrade may occur during construction. Consequently, special provisions such as restricted lanes, half-loads during paving, temporary construction roadways, etc., may be required, especially if construction is carried out during unfavorable weather.
5. 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.
6. Relatively weaker subgrade may develop over service trenches at subgrade level. These areas may require the use of thicker/coarser sub-base material and the use of a geotextile at the subgrade level. If this is the case, it is recommended that additional 150 mm of granular sub-base, OPSS Granular B Type II, should be provided in these areas, in addition to the use of a geotextile at the subgrade level.
7. The granular materials used for pavement construction should conform to Ontario Provincial Standard Specifications (OPSS 1010) for Granular A and Granular B Type II and should be compacted to 100 percent of the SPMDD.

The asphaltic concrete used and its placement should meet OPSS 1150 or 1151 requirements. It should be compacted from 92 percent to 97 percent of the MRD (ASTM D2041). Asphalt placement should be in accordance with OPSS 310 and OPSS 313.

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

15. Corrosion Potential

Chemical tests limited to pH, sulphate, chloride and resistivity were undertaken on three (3) selected samples of the clay. A summary of the results is shown in Table VIII. The laboratory certificate of analysis is shown in Appendix A.

Table VIII: Corrosion Test Results on Soil Samples

Borehole – Sample No.	Depth (m)	Soil Type	pH	Sulphate (%)	Chloride (%)	Resistivity (ohm-cm)
BH 3 – SS3	2.3 – 2.9	Brown Clay	6.54	0.0474	0.507	107
BH 4 – SS4	3.8 – 4.4	Grey Clay	6.97	0.0378	0.2600	197
BH 6 – SS3	1.5 – 2.1	Brown Clay	7.61	0.0055	0.0169	2160

The results indicate the soils have a negligible sulphate attack on subsurface concrete. The concrete should be designed in accordance with CSA A.23.1-19.

The results of the resistivity tests indicate that the brown clay is mildly to very corrosive and the grey clay is very corrosive to bare steel as per the National Association of Corrosion Engineers (NACE). Appropriate measures should be taken to protect the bare buried steel from corrosion.

16. Tree Planting Restriction

The site is underlain by marine clay. The results of the Atterberg limits and grain size analysis of the native upper brown clay portion of the marine clay deposit were compared with the document titled, *Tree Planting in Sensitive Marine Clay Soils – 2017 City of Ottawa Guidelines (2017 Guidelines)* and indicate the upper brown clay has a high potential for soil volume change. For soils that have a high potential for soil volume change, the 2017 Guidelines indicate that the tree to foundation setback distance and tree planting restrictions should be in accordance with the 2005 City of Ottawa Clay Soils Policy which is derived from the 2005 report titled, *Trees and Foundations Strategy in Areas of Sensitive Marine Clay in the City of Ottawa*.

A landscape architect should be consulted to ensure the setbacks and tree planting restrictions are in accordance with the 2005 City of Ottawa Clay Soils Policy.

17. General Comments

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

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

Sincerely,

EXP Services Inc.

Susan M. Potyondy, P.Eng.
Senior Project Manager
Earth & Environment
Eastern Region

Ismail M. Taki, M.Eng., P.Eng.
Senior Manager
Earth & Environment
Eastern Region

Figures

0 100m 200m 400m

HORIZONTAL 1:10,000

exp Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6
www.exp.com

DESIGN	DW
DRAWN	DW
DATE	NOVEMBER 2022
FILE NO	OTT-22017777-B0

GEOTECHNICAL INVESTIGATION
2040 ARROWSMITH DRIVE, OTTAWA, ONTARIO

SITE PLAN

SCALE 1:10,000

SKETCH NO FIG 1

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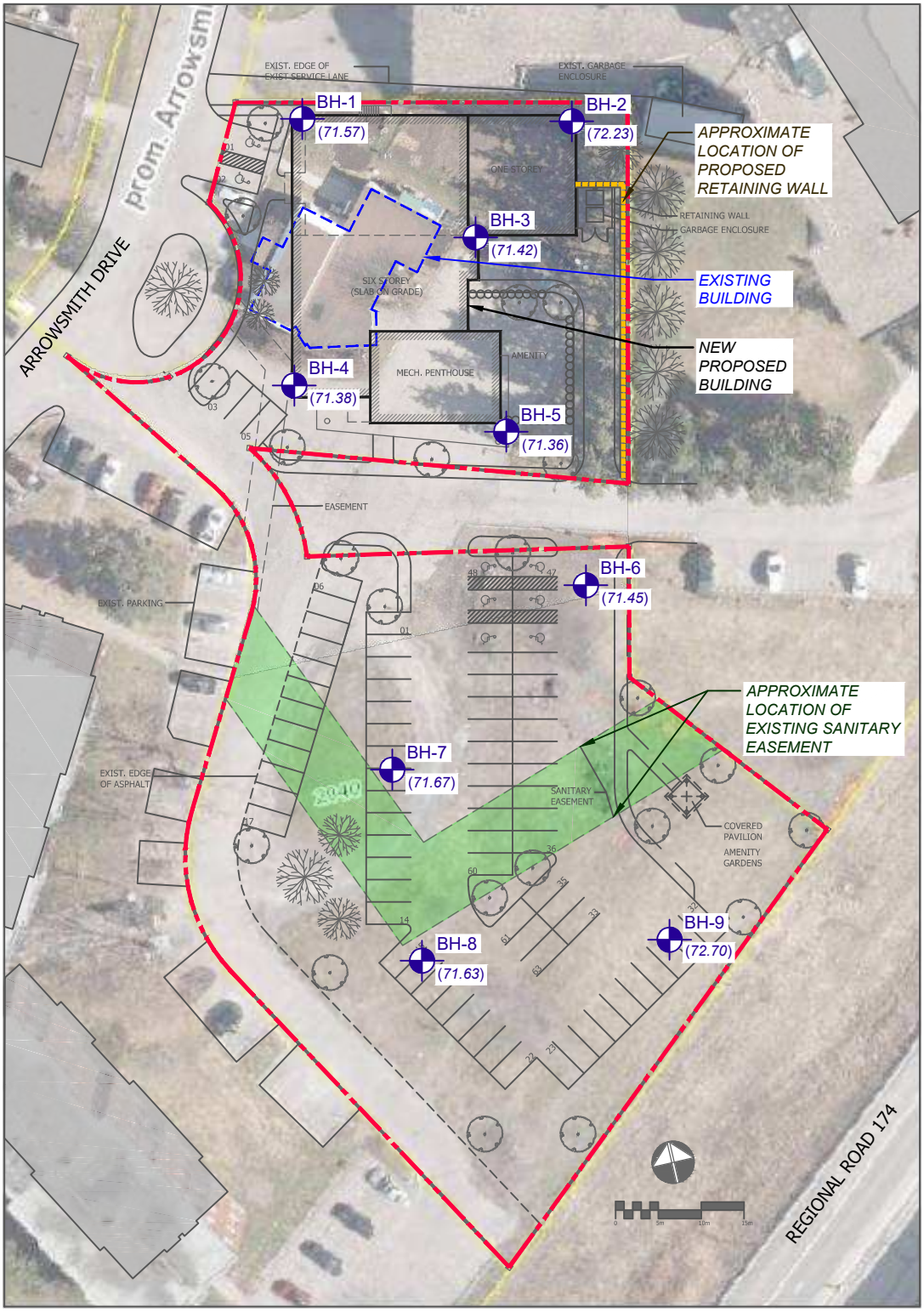

GENERAL NOTES:

1. THE BOUNDARIES, ROCK, AND SOIL TYPES HAVE BEEN ESTABLISHED ONLY AT BOREHOLE LOCATIONS. BETWEEN BOREHOLES THEY ARE ASSUMED AND MAY BE SUBJECT TO CONSIDERABLE ERROR.
2. SOIL SAMPLES AND ROCK CORES WILL BE RETAINED IN STORAGE FOR THREE MONTHS AND THEN DESTROYED UNLESS THE CLIENT ADVISES THAT AN EXTENDED TIME PERIOD IS REQUIRED.
3. TOPSOIL AND ASPHALT QUANTITIES SHOULD NOT BE ESTABLISHED FROM THE INFORMATION PROVIDED AT THE BOREHOLE LOCATIONS.
4. 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.

LEGEND

- SITE BOUNDARIES
- BH-1 — BOREHOLE NUMBER AND LOCATION
- (71.57) — GROUND SURFACE ELEVATION (m)

0 5m 10m 30m

HORIZONTAL 1:750

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

DATE JANUARY 2023	GEOTECHNICAL INVESTIGATION 2040 ARROWSMITH DRIVE, OTTAWA, ONTARIO	project no. OTT-22017777-A0
DESIGN SP / DW; CHECKED IT		scale 1:750
DRAWN BY AS	BOREHOLE LOCATION PLAN	FIG 2

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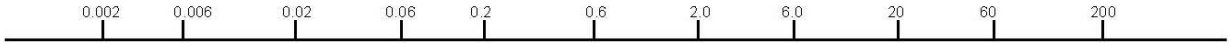
Notes On Sample Descriptions

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-22017777-A0

Project: Proposed Housing Development

Location: 2040 Arrowsmith Drive, Ottawa, Ontario

Figure No. 3

Page. 1 of 2

Date Drilled: 9/27/22

Drill Type: CME-75 Truck Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. 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 Elevation 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~150 mm thick	71.57	0				
		FILL	71.4					
		Silty sand with gravel and clay, brown and grey, moist, (compact)	70.9					
		CLAY (DESICCATED CRUST) Trace sand, light brownish grey, moist, (very stiff)		1				
				2				
			69.0	3				
		CLAY Low to high plasticity, trace sand, grey, moist (firm to stiff)	68.97					
				4				
				5				
				6				
				7				
				8				
				9				
				10				

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

14
7
160 kPa
s = 5.3
5
50 kPa
s = 10.0
Hammer Weight
50 kPa
s = 10.0
Hammer Weight
53 kPa
s = 22.0
Hammer Weight
50 kPa
s = 21.0
Hammer Weight

SS1
SS2 17.8
SS3 16.9
SS4
SS5
SS6
SS7

Continued Next Page

NOTES:
1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well was installed upon completion.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22017777-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
Oct. 27, 2022	2.6	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	11.8 - 13.3	100	87

LOG OF BOREHOLE BOREHOLE LOGS - OTT-22017777-A0 ARROWSMITH.GPJ TROW OTTAWA.GDT 11/17/22

Log of Borehole BH-1

Project No: OTT-22017777-A0

Project: Proposed Housing Development

Figure No. 3

Page. 2 of 2

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation 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
		CLAY Low to high plasticity, trace sand, grey, moist (firm to stiff) *(continued)*	61.57	10	20 40 60 80 Shear Strength kPa 38 kPa 100 150 200 s = 7.9	250 500 750 Natural Moisture Content % Atterberg Limits (% Dry Weight) 20 40 60		
		WEATHERED SHALE BEDROCK Dark grey shale rock fragments.	60.9	11	50 / 0 mm		SS8	
		SHALE BEDROCK Dark grey, good quality.	59.8	12			RUN1	
		Borehole Terminated at 13.3 m Depth	58.3	13				

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well was installed upon completion.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22017777-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
Oct. 27, 2022	2.6	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	11.8 - 13.3	100	87

LOG OF BOREHOLE BOREHOLE LOGS - OTT-22017777-A0 ARROWSMITH.GPJ TROW OTTAWA.GDT 11/17/22

Log of Borehole BH-3

Project No: OTT-22017777-A0

Project: Proposed Housing Development

Location: 2040 Arrowsmith Drive, Ottawa, Ontario

Figure No. 4

Page. 1 of 2

Date Drilled: 9/27/22

Drill Type: CME-75 Truck Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. 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 Elevation m	Depth
		ASPHALT ~100 mm thick	71.42	0
		GRANULAR FILL ~200 mm thick	71.3	
		Sand with silt and gravel, dark brown, moist	71.1	
		FILL	70.7	
		Silty sand with some clay, light brown, moist (loose)		1
		CLAY (DESICCATED CRUST)		
		Light brownish grey, moist (very stiff to hard)		2
			68.4	3
		CLAY		
		Grey, moist, (soft to stiff)		4
				5
				6
				7
				8
				9
				10

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

5
7
>250 kPa
7
60 kPa
s = 8.0
Hammer Weight
43 kPa
s = 9.0
Hammer Weight
24 kPa
s = 6.7
Hammer Weight
43 kPa
s = 12.0
Hammer Weight
77 kPa
s = 16.0

AS1
SS1
SS2 17.2
SS3 16.9
SS4
SS5
SS6
SS7

Continued Next Page

NOTES:
1. Borehole data requires interpretation by EXP before use by others
2. The borehole was backfilled with soil cuttings upon completion.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22017777-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
completion	dry	7.9

CORE DRILLING RECORD

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

LOG OF BOREHOLE BOREHOLE LOGS - OTT-22017777-A0 ARROWSMITH.GPJ TROW OTTAWA.GDT 11/17/22

Log of Borehole BH-3

Project No: OTT-22017777-A0

Project: Proposed Housing Development

Figure No. 4

Page. 2 of 2

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation 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
					20 40 60 80 / 50 100 150 200	250 500 750 / 20 40 60		
			61.42	0				
		Borehole Terminated at 10.1 m Depth	61.3	10				

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. The borehole was backfilled with soil cuttings upon completion.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22017777-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
completion	dry	7.9

CORE DRILLING RECORD

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

LOG OF BOREHOLE BOREHOLE LOGS - OTT-22017777-A0 ARROWSMITH.GPJ TROW OTTAWA.GDT 11/17/22

Log of Borehole BH-4

Project No: OTT-22017777-A0

Project: Proposed Housing Development

Location: 2040 Arrowsmith Drive, Ottawa, Ontario

Figure No. 5

Page. 1 of 2

Date Drilled: 9/27/22

Drill Type: CME-75 Truck Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. 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 Elevation 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
		ASPHALT ~65 mm thick	71.38	0			AS1	
		GRANULAR FILL ~215 mm thick Silty sand with gravel, brown, moist	71.3 71.1				SS1	
		FILL Silty sand, brown, moist, (loose)	70.7		7			
		CLAY (DESICCATED CRUST) Brown, moist, (hard)		1	5		SS2	17.7
					>250 kPa			
		CLAY Grey, wet (firm to stiff)	69.4	2				
					3		SS3	16.8
		with reddish-brown banding from 2.3 m to 2.9 m depth		3	62 kPa s = 8.6			
					Hammer Weight		SS4	
				5	53 kPa s = 8.8			
				6				
					Hammer Weight		SS5	
				7	43 kPa s = 7.2			
					Hammer Weight		SS6	
				8	48 kPa s = 10.0			
				9				
		GLACIAL TILL Silty clayey sand with gravel, grey, wet, (very loose)	62.0		Hammer Weight		SS7	
				10				

Continued Next Page

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. The borehole was backfilled with soil cuttings upon completion.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22017777-A0

WATER LEVEL RECORDS		
Date	Water Level (m)	Hole Open To (m)
completion	8.4	9.8

CORE DRILLING RECORD			
Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE BOREHOLE LOGS - OTT-22017777-A0 ARROWSMITH.GPJ TROW OTTAWA.GDT 11/17/22

Log of Borehole BH-4

Project No: OTT-22017777-A0

Project: Proposed Housing Development

Figure No. 5

Page. 2 of 2

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation 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
			61.38		20 40 60 80 / 50 100 150 200	250 500 750 / 20 40 60		
		61.2		10				
		Auger Refusal at 10.2 m Depth						

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. The borehole was backfilled with soil cuttings upon completion.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22017777-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
completion	8.4	9.8

CORE DRILLING RECORD

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

LOG OF BOREHOLE BOREHOLE LOGS - OTT-22017777-A0 ARROWSMITH.GPJ TROW OTTAWA.GDT 11/17/22

Log of Borehole BH-5

Project No: OTT-22017777-A0

Project: Proposed Housing Development

Location: 2040 Arrowsmith Drive, Ottawa, Ontario

Figure No. 6

Page. 1 of 2

Date Drilled: 9/28/22

Drill Type: CME-75 Truck Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. 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 Elevation 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
		ASPHALT ~100 mm thick	71.36	0			AS1	
		GRANULAR FILL ~250 mm thick	71.3					
		Sand and gravel, brown, moist	71.0		10		SS1	
		FILL	70.6					
		Silty sand, brown, moist (compact)		1	5		SS2	18.0
		CLAY (DESICCATED CRUST)						
		High plasticity, trace sand, brown, moist (very stiff)					SS3	
▽			69.39	2	130 kPa, s = 7.6			
		CLAY	68.6	3	Hammer Weight		SS4	16.3
		Low plasticity, trace sand, grey, wet (firm to stiff)		4	100 kPa, s = 8.3			
				5	Hammer Weight		SS5	
					53 kPa, s = 11			
				6	Hammer Weight		SS6	
				7	53 kPa, s = 11			
				8	Hammer Weight		SS7	
					48 kPa, s = 10			
		- with sand seams from 9.1 m to 9.8 m depth.		9	Hammer Weight		SS8	
				10				

Continued Next Page

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well was installed upon completion.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22017777-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
completion	6.1	11.9
Oct. 27, 2022	2.0	

CORE DRILLING RECORD

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

LOG OF BOREHOLE BOREHOLE LOGS - OTT-22017777-A0 ARROWSMITH.GPJ TROW OTTAWA.GDT 11/17/22

Log of Borehole BH-5

Project No: OTT-22017777-A0

Project: Proposed Housing Development

Figure No. 6

Page. 2 of 2

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation 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
			61.36		20 40 60 80 / 50 72 kPa 100 150 200	250 500 750 / 20 40 60		
		GLACIAL TILL Silty sand with gravel, boulders and cobbles, dark grey, moist (compact to dense)	61.0	10	s = 8.6			
				11	26	×	SS9	
				12	42	×	SS10	
		Auger Refusal at 12.9 m Depth	58.5					

LOG OF BOREHOLE BOREHOLE LOGS - OTT-22017777-A0 ARROWSMITH.GPJ TROW OTTAWA.GDT 11/17/22

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well was installed upon completion.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22017777-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
completion	6.1	11.9
Oct. 27, 2022	2.0	

CORE DRILLING RECORD

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

Log of Borehole BH-6

Project No: OTT-22017777-A0

Project: Proposed Housing Development

Location: 2040 Arrowsmith Drive, Ottawa, Ontario

Figure No. 7

Page. 1 of 1

Date Drilled: 9/28/22

Drill Type: CME-75 Truck Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. 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 Elevation m	Depth
		TOPSOIL ~180 mm thick	71.45	0
		FILL Silty sand with gravel and clay, rootlets, brown and grey, moist (compact)	71.3	
		CLAY (DESICCATED CRUST) Brown, moist, (very stiff)	70.3	1
				2
		CLAY Grey, wet, (very stiff)	68.8	3
			67.4	4
		Borehole Terminated at 4.1 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

	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
0	11				SS1	
1	25				SS2	18.3
2	5	150, s = 6.8			SS3	17.4
3	3				SS4	
4		110, s = 4.1				

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. The borehole was backfilled with soil cuttings upon completion.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22017777-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
completion	dry	2.8

CORE DRILLING RECORD

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

LOG OF BOREHOLE BOREHOLE LOGS - OTT-22017777-A0 ARROWSMITH.GPJ TROW OTTAWA.GDT 11/17/22

Log of Borehole BH-7

Project No: OTT-22017777-A0

Project: Proposed Housing Development

Location: 2040 Arrowsmith Drive, Ottawa, Ontario

Figure No. 8

Page. 1 of 1

Date Drilled: 9/27/22

Drill Type: CME-75 Truck Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. 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 Elevation 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 ~150 mm thick	71.67	0	11	×	SS1	
		FILL Silty sand with gravel and clay, brown and dark brown, moist (compact)	71.5	1	14	×	SS2	
			70.0	2	6	×	SS3	18.2
		CLAY (DESICCATED CRUST) High plasticity, trace sand, brown, moist (hard)			200 kPa s = 7.4			
			68.6	3	1	×	SS4	16.5
		CLAY Grey, wet (very soft)	68.1					
		Borehole Terminated at 3.6 m Depth						

NOTES:
1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well was installed upon completion.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22017777-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
completion	dry	3.1

CORE DRILLING RECORD

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

LOG OF BOREHOLE BOREHOLE LOGS - OTT-22017777-A0 ARROWSMITH.GPJ TROW OTTAWA.GDT 11/17/22

Log of Borehole BH-8

Project No: OTT-22017777-A0

Project: Proposed Housing Development

Location: 2040 Arrowsmith Drive, Ottawa, Ontario

Figure No. 9

Page. 1 of 1

Date Drilled: 9/28/22

Drill Type: CME-75 Truck Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. 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 I—○
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth
		TOPSOIL ~150 mm thick	71.63	0
		FILL	71.4	
		Silty sand with gravel and clay, brown and grey, moist (compact)	70.8	
		TOPSOIL LAYER ~100 mm thick	70.7	
		CLAY (DESICCATED CRUST)		1
		Brown, moist, (very stiff)		
			69.4	2
▽		**CLAY**		
		Grey, wet (stiff)	68.99	3
				4
			66.8	
		Borehole Terminated at 4.8 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

Sample	Natural Unit Wt. kN/m³	Standard Penetration Test N Value	Shear Strength kPa	Combustible Vapour Reading (ppm)	Natural Moisture Content % / Atterberg Limits (% Dry Weight)
SS1		11		×	×
SS2		14		×	×
SS3	17.4	8	132 kPa ▲	×	×
SS4	17.2	4		×	×
			70 kPa + s = 9.3		
SS5		2		×	×
			53 kPa + s = 22.0		

NOTES:
1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well was installed upon completion.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22017777-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
completion	dry	-
Oct. 27, 2022	2.6	

CORE DRILLING RECORD

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

LOG OF BOREHOLE BOREHOLE LOGS - OTT-22017777-A0 ARROWSMITH.GPJ TROW OTTAWA.GDT 11/17/22

Log of Borehole BH-9

Project No: OTT-22017777-A0

Project: Proposed Housing Development

Location: 2040 Arrowsmith Drive, Ottawa, Ontario

Figure No. 10

Page. 1 of 1

Date Drilled: 9/28/22

Drill Type: CME-75 Truck Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. 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 Elevation 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 ~100 mm thick	72.7	0	9		SS1	
		72.6						
		FILL Silty sand with gravel and clay, some asphalt pieces, brown and grey, moist (loose to compact)		1	12		SS2	20.8
				2	16		SS3	17.8
		70.3						
		CLAY (DESICCATED CRUST) Brown, moist, (stiff to very stiff)		3	7		SS4	
					7		SS5	
				4	170 kPa s = 7.7			
		68.4						
		CLAY Grey, wet, (soft)		5	3		SS6	
		67.5						
		Borehole Terminated at 5.2 m Depth						

LOG OF BOREHOLE BOREHOLE LOGS - OTT-22017777-A0 ARROWSMITH.GPJ TROW OTTAWA.GDT 11/17/22

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. The borehole was backfilled with soil cuttings upon completion.
3. Field work was supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22017777-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
completion	dry	4.0

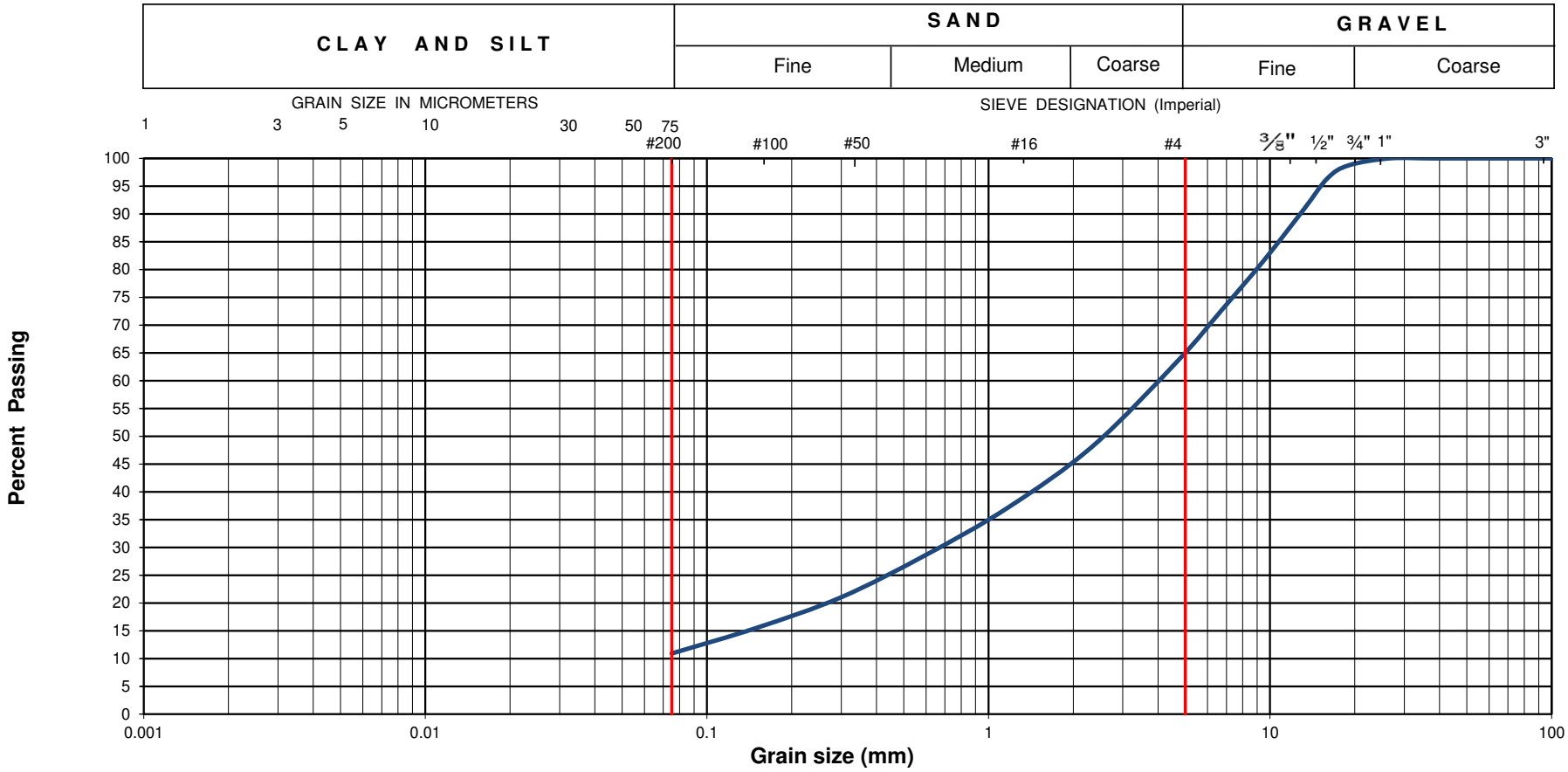
CORE DRILLING RECORD

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

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

Grain-Size Distribution Curve
Method of Test For Sieve Analysis of Aggregate
ASTM C-136

Unified Soil Classification System

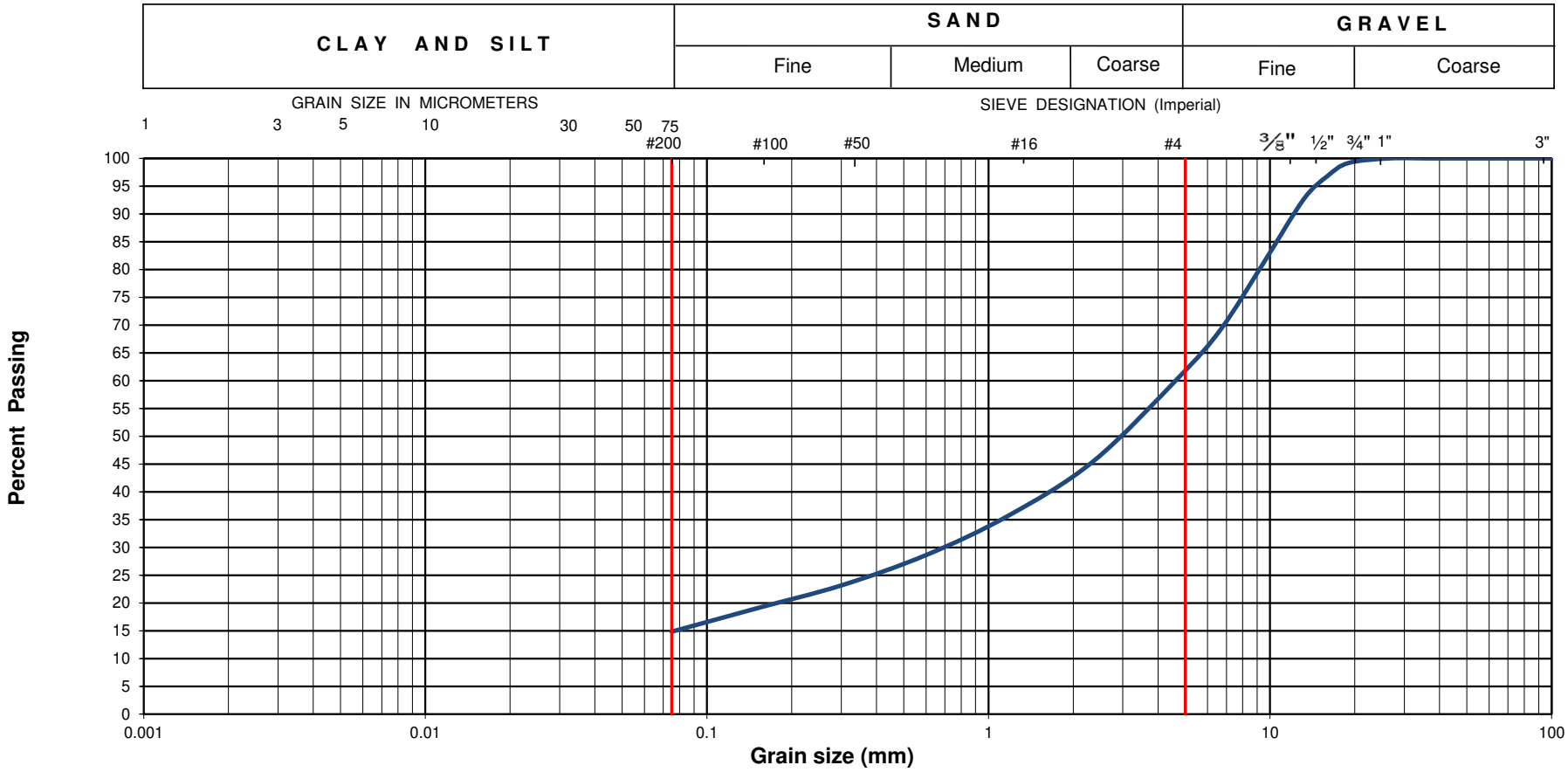


EXP Project No.:	**OTT-222017777-A0**	**Project Name :**	**Proposed Housing Development**						
Client :	**Wigwamen Incorporated**	**Project Location :**	**2040 Arrowsmith Drive, Ottawa, ON**						
Date Sampled :	**September 27, 2022**	**Borehole No:**	**BH3**	**Sample:**	**AS1**	**Depth (m) :**	**0.1-0.2**		
Sample Composition :		**Gravel (%)**	**36**	**Sand (%)**	**53**	**Silt & Clay (%)**	**11**	**Figure :**	**11**
Sample Description :	**FILL: Well Graded Sand with Silt & Gravel (SW-SM)**								

EXP Services Inc.
100-2650 Queensview Drive
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-222017777-A0**	**Project Name :**	**Proposed Housing Development**						
Client :	**Wigwamen Incorporated**	**Project Location :**	**2040 Arrowsmith Drive, Ottawa, ON**						
Date Sampled :	**September 27, 2022**	**Borehole No:**	**BH4**	**Sample:**	**AS1**	**Depth (m) :**	**0.1-0.2**		
Sample Composition :		**Gravel (%)**	**39**	**Sand (%)**	**46**	**Silt & Clay (%)**	**15**	**Figure :**	**12**
Sample Description :		**FILL: Silty Sand with Gravel (SM)**							

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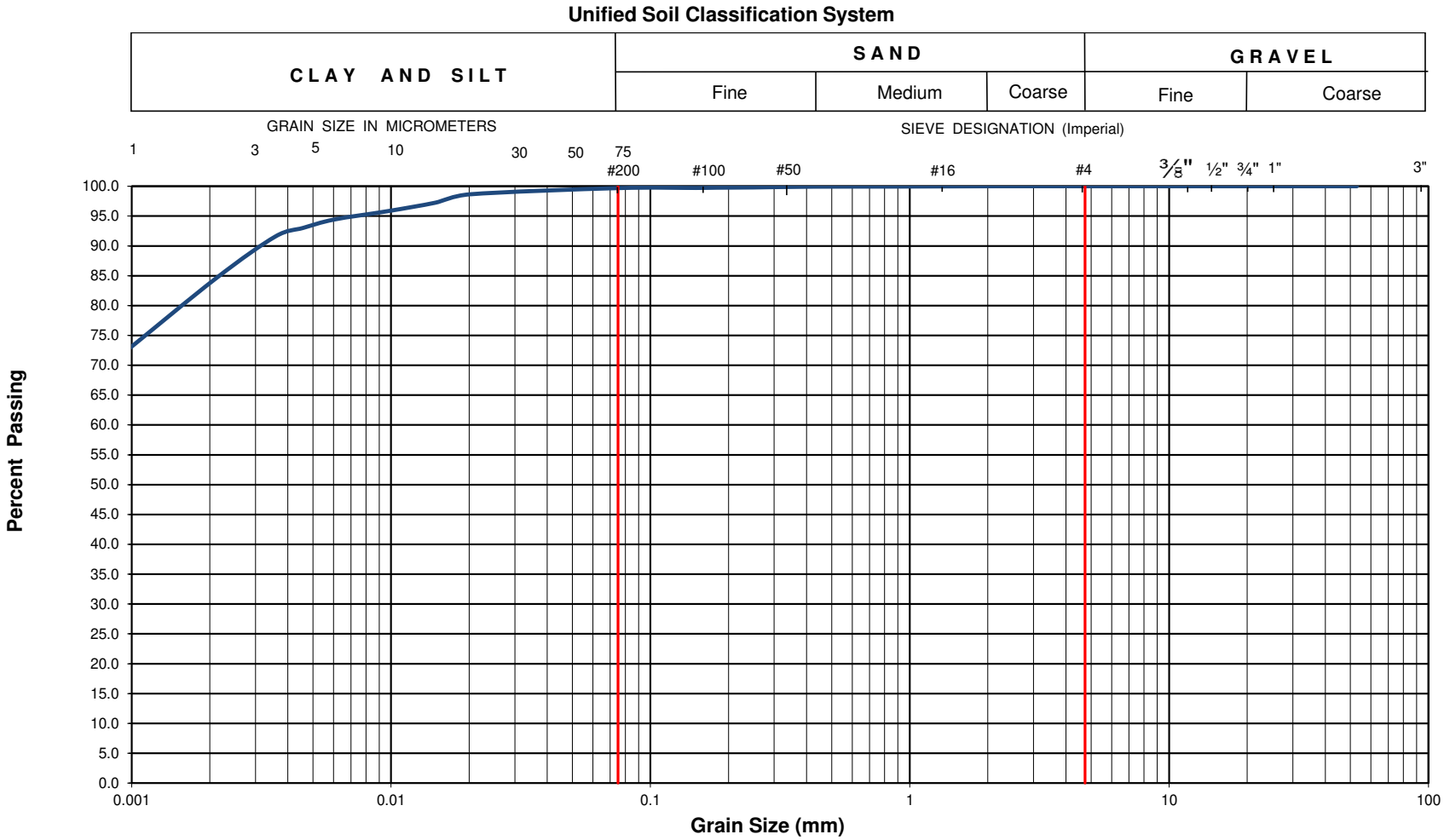
Ottawa, ON K2B 8H6

Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422



EXP Project No.:	**OTT-22017777-A0**	**Project Name :**	**Proposed Housing Development**						
Client :	**Wigwamen Incorporated**	**Project Location :**	**2040 Arrowsmith Drive, Ottawa, ON**						
Date Sampled :	**September 27, 2022**	**Borehole No:**	**1**	**Sample No.:**	**SS3**	**Depth (m) :**	**2.3-2.9**		
Sample Description :		**% Silt and Clay**	**100**	**% Sand**	**0**	**% Gravel**	**0**	**Figure :**	**13**
Sample Description :		**Brown Clay of High Plasticity (CH)**							

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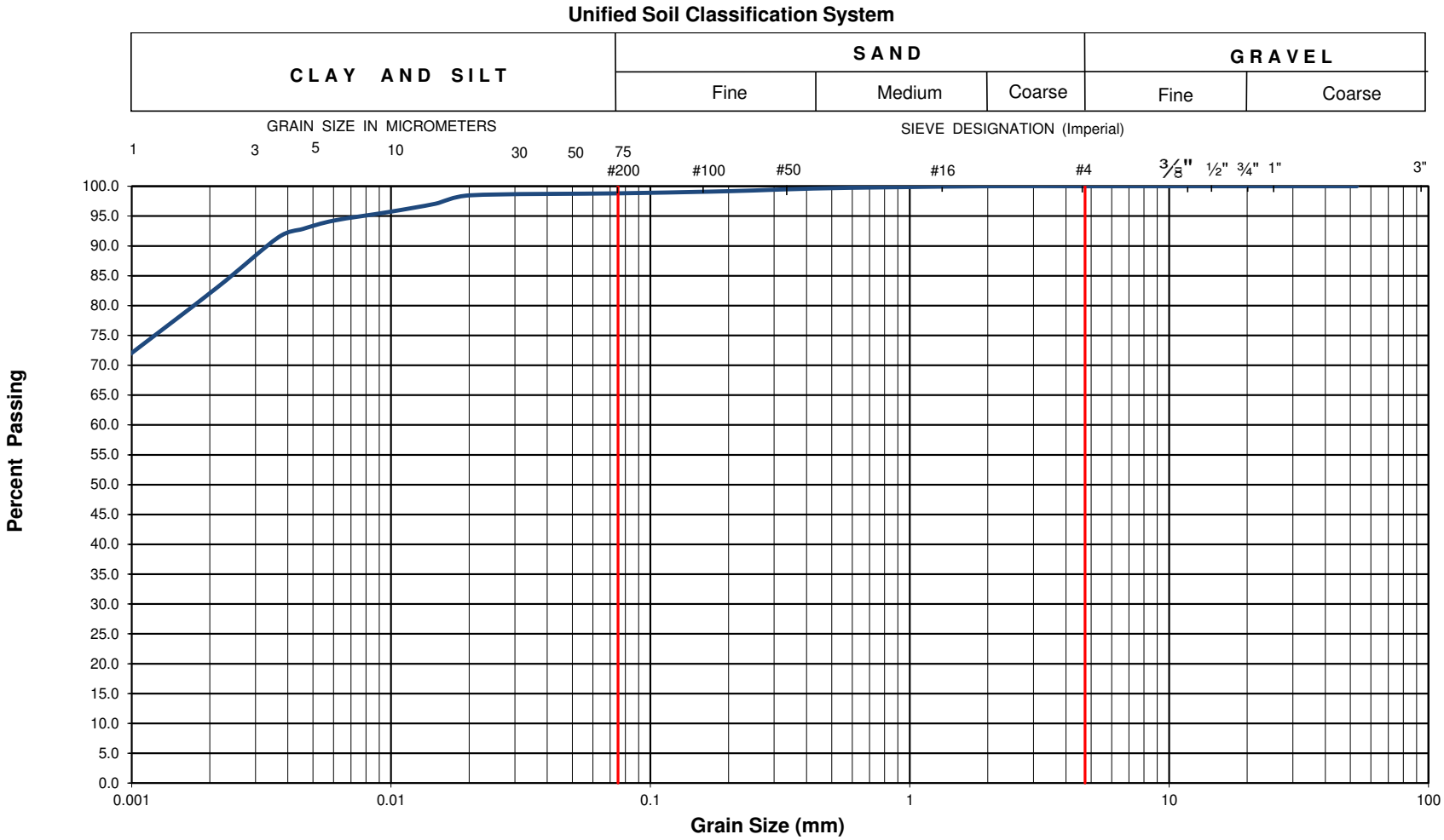
Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422



EXP Project No.:	**OTT-22017777-A0**	**Project Name :**	**Proposed Housing Development**						
Client :	**Wigwamen Incorporated**	**Project Location :**	**2040 Arrowsmith Drive, Ottawa, ON**						
Date Sampled :	**September 28, 2022**	**Borehole No:**	**5**		**Sample No.:**	**SS3**		**Depth (m) :**	**1.5-2.1**
Sample Description :		**% Silt and Clay**	**99**	**% Sand**	**1**	**% Gravel**	**0**	**Figure :**	**14**
Sample Description :		**Brown Clay of High Plasticity (CH)**							

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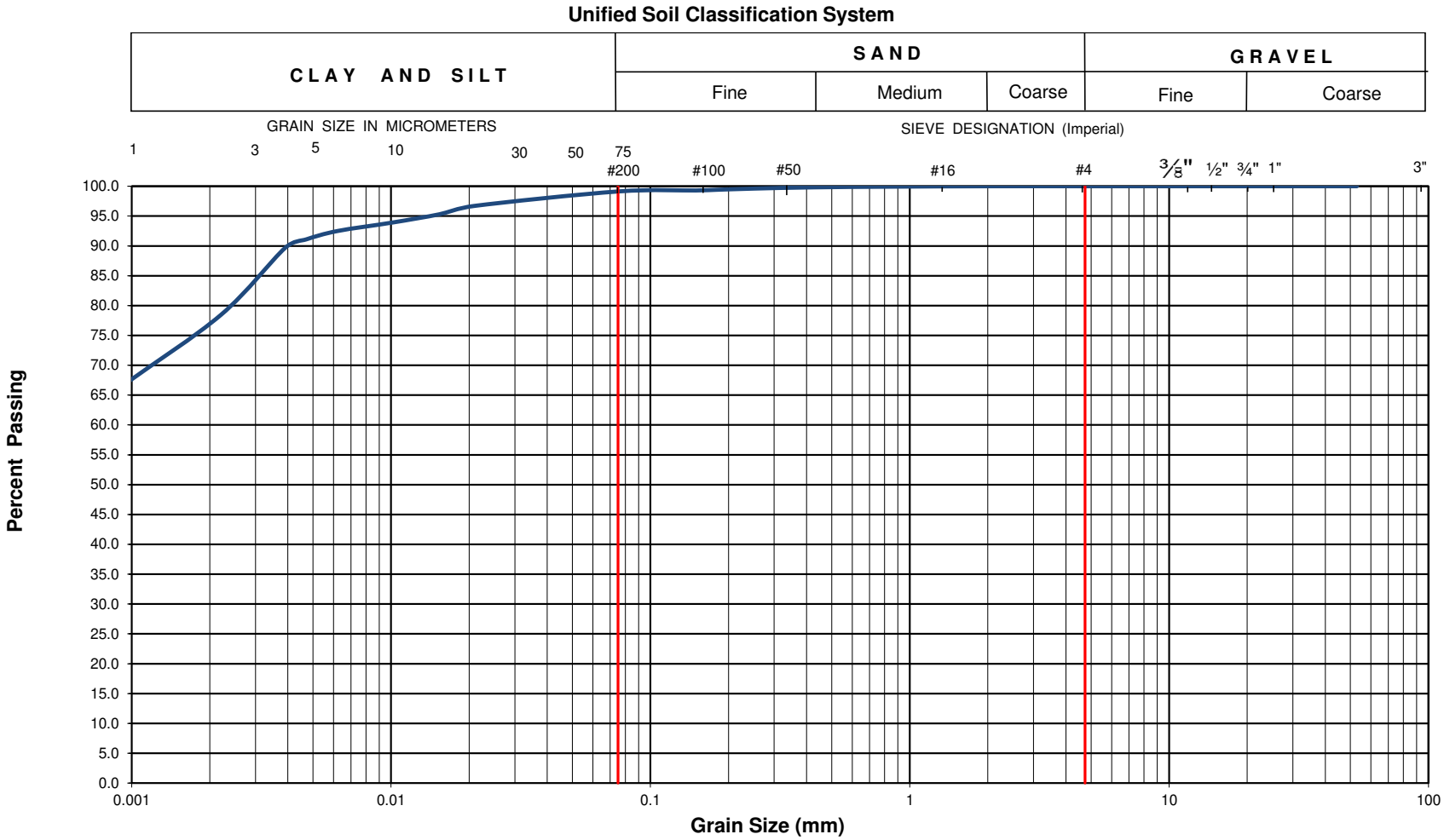
Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422



EXP Project No.:	**OTT-22017777-A0**	**Project Name :**	**Proposed Housing Development**						
Client :	**Wigwamen Incorporated**	**Project Location :**	**2040 Arrowsmith Drive, Ottawa, ON**						
Date Sampled :	**September 27, 2022**	**Borehole No:**	**7**		**Sample No.:**	**SS3**		**Depth (m) :**	**1.5-2.1**
Sample Description :		**% Silt and Clay**	**99**	**% Sand**	**1**	**% Gravel**	**0**	**Figure :**	**15**
Sample Description :		**Brown Clay of High Plasticity (CH)**							

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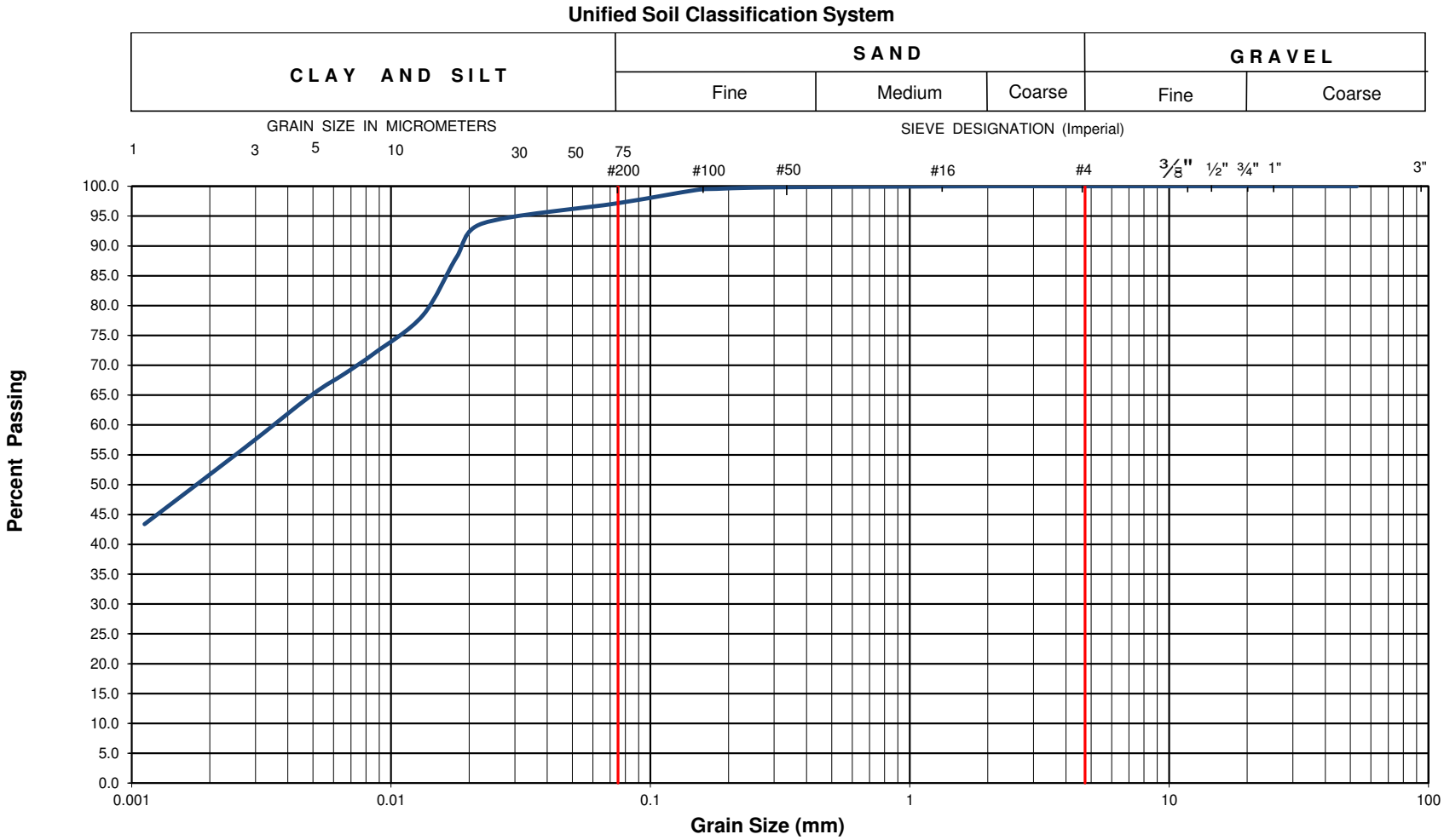
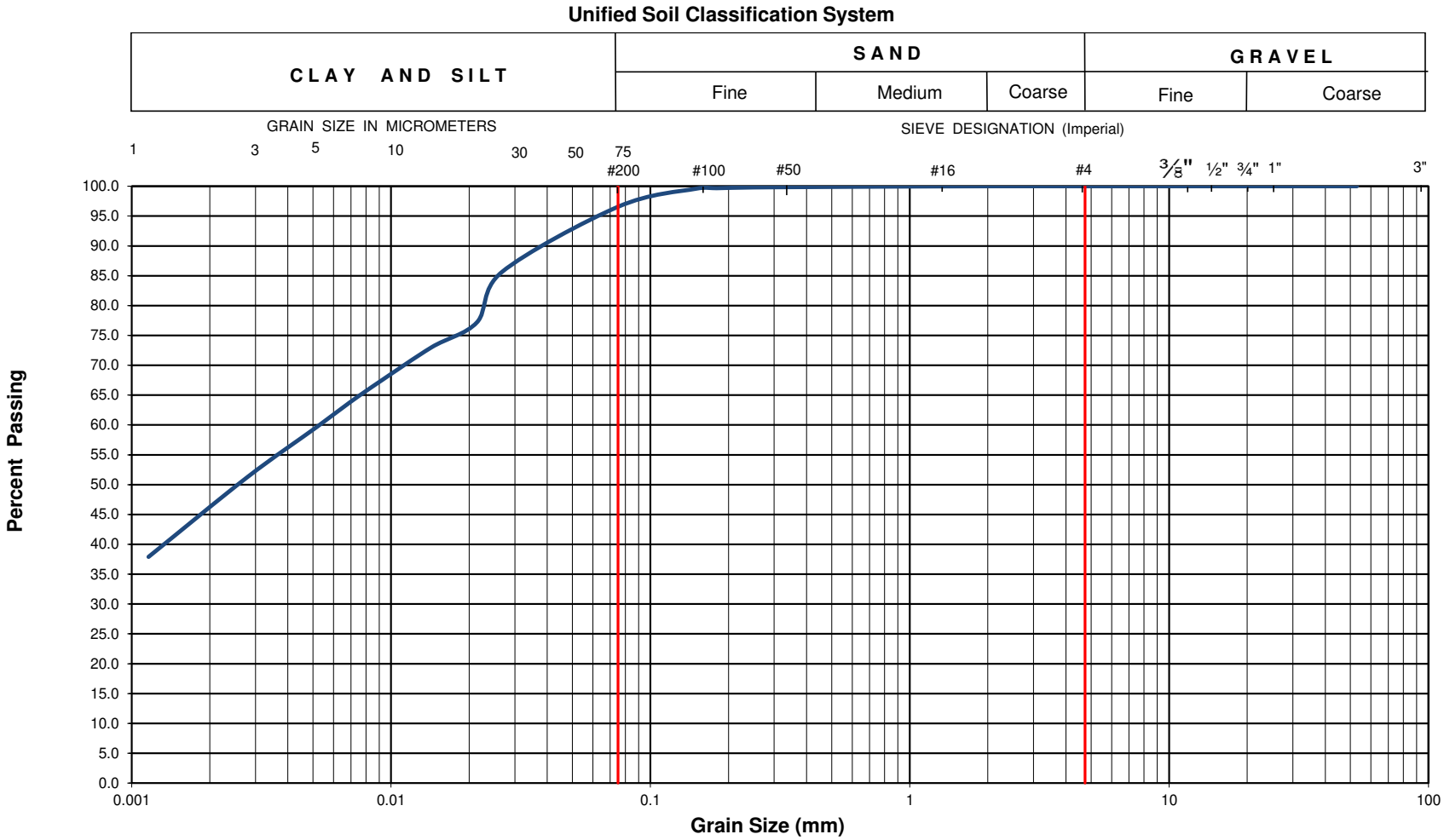
Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422



EXP Project No.:	**OTT-22017777-A0**	**Project Name :**	**Proposed Housing Development**						
Client :	**Wigwamen Incorporated**	**Project Location :**	**2040 Arrowsmith Drive, Ottawa, ON**						
Date Sampled :	**September 27, 2022**	**Borehole No:**	**1**	**Sample No.:**	**SS6**	**Depth (m) :**	**7.6-8.2**		
Sample Description :		**% Silt and Clay**	**97**	**% Sand**	**3**	**% Gravel**	**0**	**Figure :**	**16**
Sample Description :		**Grey Clay of Low Plasticity (CL)**							

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 D422



EXP Project No.:	**OTT-22017777-A0**	**Project Name :**	**Proposed Housing Development**						
Client :	**Wigwamen Incorporated**	**Project Location :**	**2040 Arrowsmith Drive, Ottawa, ON**						
Date Sampled :	**September 28, 2022**	**Borehole No:**	**5**		**Sample No.:**	**SS7**		**Depth (m) :**	**7.6-8.2**
Sample Description :		**% Silt and Clay**	**97**	**% Sand**	**3**	**% Gravel**	**0**	**Figure :**	**17**
Sample Description :		**Grey Clay of Low Plasticity (CL)**							

DRY BEDROCK CORES

WET BEDROCK CORES

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

borehole no.	Core Runs:	project	project no.
BH-1	Run 1: 11.8m - 13.3m	2040 Arrowsmith Drive, Ottawa, ON	OTT-22017777-A0
date cored		Rock Core Photographs	FIG. 18
Sep 27, 2022			

Appendix A – Certificate of Laboratory Analysis

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: **Matthew Zammit**

PROJECT: **OTT-22017777-AO**

AGAT WORK ORDER: **22Z954660**

SOIL ANALYSIS REVIEWED BY: **Jacky Zhu, Spectroscopy Technician**

DATE REPORTED: **Oct 17, 2022**

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

Disclaimer:

- *All work conducted herein has been done using accepted standard protocols, and generally accepted practices and methods. AGAT test methods may incorporate modifications from the specified reference methods to improve performance.*
- *All samples will be disposed of within 30 days after receipt unless a Long Term Storage Agreement is signed and returned. Some specialty analysis may be exempt, please contact your Client Project Manager for details.*
- *AGAT's liability in connection with any delay, performance or non-performance of these services is only to the Client and does not extend to any other third party. Unless expressly agreed otherwise in writing, AGAT's liability is limited to the actual cost of the specific analysis or analyses included in the services.*
- *This Certificate shall not be reproduced except in full, without the written approval of the laboratory.*
- *The test results reported herewith relate only to the samples as received by the laboratory.*
- *Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, warranties of merchantability, fitness for a particular purpose, or non-infringement. AGAT assumes no responsibility for any errors or omissions in the guidelines contained in this document.*
- *All reportable information as specified by ISO/IEC 17025:2017 is available from AGAT Laboratories upon request.*

AGAT Laboratories

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

Certificate of Analysis

AGAT WORK ORDER: 22Z954660

PROJECT: OTT-22017777-AO

CLIENT NAME: EXP SERVICES INC

ATTENTION TO: Matthew Zammit

SAMPLING SITE:2040 Arrowsmith Rd.

SAMPLED BY:EXP

(Soil) Inorganic Chemistry

DATE RECEIVED: 2022-10-06 **DATE REPORTED: 2022-10-17**

Parameter	Unit	G / S	RDL	SAMPLE DESCRIPTION: BH3 SS3 7. 5'-9.5'	SAMPLE TYPE: Soil	DATE SAMPLED: 2022-09-27	4391512
Chloride (2:1)	µg/g		2	5070			
Sulphate (2:1)	µg/g		2	474			
pH (2:1)	pH Units		NA	6.54			
Resistivity (2:1) (Calculated)	ohm.cm		1	107			

Parameter	Unit	G / S	RDL	SAMPLE DESCRIPTION: BH4 SS4 10'-12'	SAMPLE TYPE: Soil	DATE SAMPLED: 2022-09-28	4391513
Chloride (2:1)	µg/g		2	2600			
Sulphate (2:1)	µg/g		2	378			
pH (2:1)	pH Units		NA	6.97			
Resistivity (2:1) (Calculated)	ohm.cm		1	197			

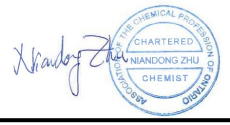
Parameter	Unit	G / S	RDL	SAMPLE DESCRIPTION: BH6 SS3 5'-7'	SAMPLE TYPE: Soil	DATE SAMPLED: 2022-09-28	4391514
Chloride (2:1)	µg/g		2	169			
Sulphate (2:1)	µg/g		2	55			
pH (2:1)	pH Units		NA	7.61			
Resistivity (2:1) (Calculated)	ohm.cm		1	2160			

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

4391512-4391514 EC, pH, Chloride and Sulphate were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil). Resistivity is a calculated parameter.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:



AGAT Laboratories

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

Quality Assurance

CLIENT NAME: EXP SERVICES INC

PROJECT: OTT-22017777-AO

SAMPLING SITE:2040 Arrowsmith Rd.

AGAT WORK ORDER: 22Z954660

ATTENTION TO: Matthew Zammit

SAMPLED BY:EXP

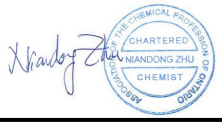
Soil Analysis

RPT Date: Oct 17, 2022			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
(Soil) Inorganic Chemistry															
Chloride (2:1)	4408295		20	20	0.0%	< 2	96%	70%	130%	103%	80%	120%	99%	70%	130%
Sulphate (2:1)	4408295		14	15	6.9%	< 2	102%	70%	130%	100%	80%	120%	102%	70%	130%
pH (2:1)	4391512	4391512	6.54	6.77	3.5%	NA	103%	80%	120%						

Comments: NA signifies Not Applicable.
pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document.

Duplicate NA: results are under 5X the RDL and will not be calculated.

Certified By:



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: 22Z954660

PROJECT: OTT-22017777-AO

ATTENTION TO: Matthew Zammit

SAMPLING SITE:2040 Arrowsmith Rd.

SAMPLED BY:EXP

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Chloride (2:1)	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	modified from EPA 9045D and MCKEAGUE 3.11	PH METER
Resistivity (2:1) (Calculated)	INOR-93-6036	McKeague 4.12, SM 2510 B,SSA #5 Part 3	CALCULATION

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 Inc. Ottawa
Contact: Matthew Zammit
Address: 2650 Queensview dr. Unit 100
Ottawa, ON, K2B 8H6
Phone: 613-688-1899 Fax:
Reports to be sent to:
1. Email: matthew.zammit@exp.com
2. Email:

Project Information:

Project: OTT-22017777-A0
Site Location: 2040 Arrowsmith rd.
Sampled By: EXP
AGAT ID #: 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:

(Please check all applicable boxes)

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

☐ Excess Soils R406
Table ___ *Indicate One*
☐ Regulation 558
☐ CCME

☐ Sewer Use
☐ Sanitary ☐ Storm
___ *Region*
☐ 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

Sample Matrix Legend

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

Laboratory Use Only

Work Order #: 22Z9546060
Cooler Quantity: 1 large n/a - one bag.
Arrival Temperatures: 23.6 | 23.8 | 23.5
L.T-> 2.9 | 3.6 | 4.8
Custody Seal Intact: ☐ Yes ☐ No ☐ N/A
Notes: Bagged Ice

Turnaround Time (TAT) Required:

Regular TAT *(Most Analysis)* ☑ 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 Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI, DOC Y/N	O. Reg 153: Metals & Inorganics	O. Reg 153: Metals - ☐ CrVI, ☐ Hg, ☐ HWSB	O. Reg 153: BTEX, F1-F4 PHCs	O. Reg 153: Analyze F4G if required ☐ Yes ☐ No	O. Reg 153: PAHs	O. Reg 153: Total PCBs ☐ Aroclor	O. Reg 153: VOC	O. Reg 558: Landfill Disposal Characterization TCLP: ☐ M&I ☐ VOCs ☐ ABNs ☐ B(a)P ☐ PCBs	O. Reg 406: Excess Soils SPLP Rainwater Leach SPLP: ☐ Metals ☐ VOCs ☐ SVOCs	O. Reg 406: Excess Soils Characterization Package	Salt - EC/SAR	pH	sulphate	chloride	resistivity	Potentially Hazardous or High Concentration (Y/N)
BH 3 SS3 7.5-9.5'	Sept.27	AM PM	1	S														✓	✓	✓	
BH 5 SS4 10-12'	Sept.28	AM PM	1	S														✓	✓	✓	
BH 6 SS3 5-7'	Sept.28	AM PM	1	S														✓	✓	✓	
		AM PM																			
		AM PM																			
		AM PM																			
		AM PM																			
		AM PM																			
		AM PM																			
		AM PM																			
		AM PM																			

Samples Relinquished By (Print Name and Sign): Jeff MacMillan Jeff MacMillan	Date Oct.6/22	Time	Samples Received By (Print Name and Sign): C. Griffith	Date OCT 06 2022	Time 16h10
Samples Relinquished By (Print Name and Sign): CC to Pino	Date OCT 07 2022	Time	Samples Received By (Print Name and Sign): Anthony Daoulas	Date	Time
Samples Relinquished By (Print Name and Sign):	Date	Time	Samples Received By (Print Name and Sign):	Date	Time

22 OCT 8 11:05 AM

Page 1 of 1

№: T114975

Legal Notification

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Angus Palmer; apalmer@wigwamen.com

Brenda Aviles; baviles@wigwamen.com

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Andrew Vrana; avrana@shs-inc.ca

Catherine Tusien; ctusien@shs-inc.ca

Christine Pacini; cpacini@shs-inc.ca