Geotechnical Investigation
Proposed Residential Development
2409 Carlsen Avenue
Ottawa, Ontario

Client:
2409 Carlsen Inc

Type of Document:
Final Report

Project Number:
OTT-24002375-A0

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Date Submitted:
January 24, 2025

Table of Contents:

Appendices:

Figures:

List of Tables:

Executive Summary

EXP Services Inc. (EXP) is pleased to present the results of the geotechnical investigation completed for the proposed residential development at the civic address of 2409 Carlsen Avenue in Ottawa, Ontario (Figure 1). Authorization to proceed with this investigation was provided by 2409 Carlsen Inc via an exp signed authorization.

Based on preliminary design drawing prepared by S.J. Lawrence Architect Incorporated Job No. SL-1126-24 titled Modular homes – 8 Plex and dated October 31, 2024, the project will comprise the construction of three (3) 115 to 152 square meter three (3) story buildings (Block 1, 2, and 3) with one level of basement in each following the demolition of the existing house and clearing of trees currently at the site. The site also includes a retaining wall along the north side of Block 1 and down the east side of Block 1 and 2.

The fieldwork for the geotechnical investigation was completed on January 8 and 9, 2025 and consists of two (2) boreholes (Borehole Nos. 1 and 2) drilled in the accessible areas of the site to cone refusal depths of 26.4 m and 24.5 m, respectively (Approximate Elevation 56.0 m to 51.4 m). The borehole locations are shown in Figure 2. The fieldwork was supervised on a full-time basis by a representative from EXP.

The investigation has revealed that the site is underlain by a surficial layer of fill between 0.4 m to 0.8 m thick, overlying native silty clay desiccated crust which extends to 3.7 m to 6.1 m depth (Elevation 74.4 m to 74.1 m) over un-desiccated grey silty clay extending beyond the maximum sampled depth. Cone refusal was likely met on boulders or on bedrock at a depth of 26.4 m and 24.5 m (approximate elevation 56.0 m and 51.4 m). The groundwater level at the site was established at depths of 3.2 m and 3.9 m below existing ground (Approximate Elevation 74.6 m to 76.6 m) on January 19, 2025.

Based on the borehole information and Table 4.1.8.4.A of the 2012 Ontario Building Code (OBC) as amended January 1, 2022, a preliminary site classification for seismic site response is estimated to be **Class D.** The subsurface soils are not susceptible to liquefaction during a seismic event. An MASW is recommended for the site to confirm the site class.

The proposed 1 m grade raise is considered acceptable from a geotechnical point of view.

Strip footings with widths of up to 1 m, and spread footing with length and width of up to 3 m by 3 m, founded at the design underside of footing elevation of 75.80 m or higher, in the native brown silty 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 ULS value includes a geotechnical resistance factor of 0.5. The recommended SLS and factored ULS values are valid for a maximum site grade raise of up to 1.0 m. If this is different, EXP should be contacted to review and provide updated SLS and factored ULS values for the footings.

A minimum of 1.5 m of earth cover should be provided to the exterior foundations of heated structures 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 and to 2.4 m if snow will be removed from the vicinity of the structure. When earth cover is less than the minimum required, an equivalent thermal combination of earth cover and rigid insulation or rigid insulation alone should be provided. EXP can provide additional comments in this regard, if required.

The lowest floor level of the proposed buildings may be designed as slab on grade. The existing topsoil and fill are not considered suitable to support the slab-on-grade and should be excavated down to the native silty clay within the floor slab footprint. The floor slab should be set on a bed of well-packed 19 mm clear stone at least 200 mm thick placed over the native silty clay. The clear stone would prevent the capillary rise of moisture from the sub-soil to the floor slab. As an alternative to clear stone, the floor slab may be set on a Granular A pad compacted to 98

percent standard Proctor maximum dry density (SPMDD) and overlain by a vapour barrier. Adequate saw cuts should be provided in the floor slab to control cracking.

A perimeter drainage system should be installed around the proposed buildings. Underfloor drains may be necessary depending on additional water level measurements, and the design grades for Block 3 which were not known at the time of preparation of this report.

The excavations may be undertaken by conventional excavation and shall be completed 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 and for open cut excavations, the side slopes of the excavation must be cut back at 1H:1V from the bottom of the excavation.

Seepage of the surface and subsurface water into the excavations above the groundwater level is anticipated and it should be possible to collect water entering the excavations at low points and to remove it by conventional pumping techniques.

It is anticipated that the majority of the material required for engineered fill and for backfilling purposes for this project would have to be imported and should preferably conform to the specifications provided in the main body of the report.

At the time of drilling, an existing dwelling was present on the site which limited the access of the drilling equipment. After the site is cleared and existing house, fences are demolished it is recommended that additional boreholes should be completed to confirm the subsurface condition on other parts of the site.

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

1. Introduction

EXP Services Inc. (EXP) is pleased to present the results of the geotechnical investigation completed for the proposed residential development at the civic address of 2409 Carlsen Avenue in Ottawa, Ontario (Figure 1). Authorization to proceed with this investigation was provided by 2409 Carlsen Inc. via exp signed authorization.

A Phase I Environmental site assessment was completed by EXP for this project site under a different report.

Based on preliminary design drawing prepared by S.J. Lawrence Architect Incorporated Job No. SL-1126-24 titled Modular homes – 8 Plex and dated October 31, 2024, the project will comprise the construction of three (3) 115 to 152 square meter three (3) story buildings (Block 1, 2, and 3) with one level of basement in each following the demolition of the existing house and clearing of trees currently at the site. The site also includes a retaining wall along the north side of Block 1 and down the east side of Block 1 and 2.

This geotechnical investigation was undertaken to:

a) Establish the subsurface soil conditions and groundwater levels at two (2) boreholes drilled in the accessible areas of the site,

b) Provide classification of the site for seismic design in accordance with requirements of the 2012 Ontario Building Code (OBC) as amended January 1, 2022, and assess the liquefication potential of the subsurface soils during a seismic event,

c) Discuss grade raise restrictions,

d) Provide the bearing pressure at Serviceability Limit State (SLS) and factored geotechnical resistance at Ultimate Limit State (ULS) of the most suitable type of foundation for the proposed buildings, as well as anticipated total and differential settlements,

e) Discuss lateral earth pressures against subsurface walls,

f) Comment on slab-on-grade construction and permanent drainage requirements,

g) Discuss excavation conditions and dewatering requirements during construction of the foundation for the proposed building,

h) Discuss pipe bedding requirements,

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

j) Discuss the subsurface concrete requirements and the corrosion potential of subsurface soils to buried metal structures/members, and

k) Comment on Tree Planting.

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

2. Site Description

The property is located in a suburban developed residential area of the City of Ottawa. The site is L-shaped, bounded by residential properties to the south, Heron Road on the north side, Carlsen Avenue on the west side, and Chasseur Avenue to the east.

At the time of the geotechnical investigation, the site was occupied by an existing abandoned residential dwelling, and landscaped areas with raised plant-beds and garden appurtenances as well as trees.

A topographic plan of survey of Part of Lot 1, Registered Plan 301, and Part of Lot 1, Registered Plan 559, City of Ottawa, prepared by Farley, Smith, and Denis Surveying Ltd. 2024 (FSD) completed for the site and dated March 13, 2024, was provided to EXP as reference material. A review of this plan revealed that the topography of the site is relatively flat, gradually sloping downward from east to west. The site slopes down from Chasseur Avenue from an approximate Elevation of 80.90 m to Carlsen Avenue at an approximate Elevation of 77.70 m.

3. Procedure

The fieldwork for the geotechnical investigation was completed on January 8 and 9, 2025 and consists of two (2) boreholes (Borehole Nos. 1 and 2) drilled to cone refusal depths of 26.4 m and 24.5 m. The borehole locations are shown in Figure 2. The fieldwork was supervised on a full-time basis by a representative from EXP.

Prior to the fieldwork, the locations of the boreholes were staked in the field and their locations cleared of any public and private underground services. The geodetic elevation of the ground surface at each borehole location was estimated from the topographic plan of survey of the site dated March 13, 2024, and prepared by FSD. Therefore, the borehole ground surface elevations should be considered as approximate.

The boreholes were drilled using a track-mounted drill rig equipped with hollow stem augers and operated by a drilling specialist subcontracted to EXP. Standard penetration tests (SPTs) were performed in all the boreholes at 0.75 m, 1.5 m, and 3.0 m depth intervals and the soil samples were retrieved by the split-spoon sampler. The undrained shear strength of the cohesive soil was measured by conducting penetrometer and in-situ vane tests. In Borehole No. 1, a Shelby tube sample was taken within the silty clay at a depth of 5.2 m. In Borehole No. 1 and 2, a dynamic cone penetration test (DCPT) was conducted from the sampling termination depth to a cone refusal depth of 26.4 m, and 24.5 m below ground surface, respectively.

A 19 mm diameter standpipe (with 1.5 m slotted section) was installed in Borehole Nos. 1 and 2 for long-term monitoring of the groundwater level. The standpipes were installed in accordance with EXP standard practice, and the installation configuration is documented on the respective borehole log. The boreholes were backfilled upon completion of drilling and the installation of the standpipes.

All soil samples were visually examined in the field for textural classification, logged, preserved in plastic bags and identified accordingly. On completion of the fieldwork, all the soil samples were transported to the EXP laboratory located in the City of Ottawa where they were visually examined by a geotechnical engineer and the borehole logs were prepared. The main constituents of the soils are classified in accordance with the Unified Soil Classification System (USCS) using the soil group name and symbol and by the modified Burmister soil classification method for the minor constituents of the soil using adjectives and modifiers such as trace and some.

The engineer also assigned the laboratory testing which consisted of performing the following tests on the soil samples:

Natural Moisture Content Determination.....19 tests

Grain Size Analysis.....4 tests

Atterberg Limits.....3 tests

Chemical Analysis (pH, sulphate, chloride and electrical resistivity).....2 tests

4. Subsurface Soil and Groundwater Conditions

A detailed description of the subsurface soil and groundwater conditions encountered in the boreholes are given on the borehole logs, Figures 3 and 4. 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 may also result in changes in the conditions interpreted to exist at the locations where sampling was conducted.

The boreholes were drilled to provide representation of subsurface conditions as part of a geotechnical exploration program and are not intended to provide evidence of environmental conditions.

It should be noted that the soil boundaries indicated on the borehole logs 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 forms 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 soil conditions with depth and groundwater level measurements.

4.1 Driveway Pavement

An existing driveway with an asphalt thickness of 70 mm and a granular layer of rounded sand and gravel approximately 300 mm thick was contacted at the location of Borehole No. 1.

The results from the grain size analysis on one sample of granular fill is shown in Table I and the grain size distribution curve is shown in Figure 5.

Table I: Summary of Results from Grain-Size Analysis - Granular Fill Sample

Borehole (BH) No. – Sample (SS) No.	Depth (m)	Grain-Size Analysis (%)				Soil Classification
		Gravel	Sand	Silt	*Clay	
BH1 – GS1	0.1 – 0.3	28	53	14	5	Silty sand (SM), gravelly, trace clay
Note *Clay content is projected from sieve analysis curve						

Based on a review of the results of the grain-size analysis, the granular fill at the site can be classified as silty sand (SM), gravelly, trace clay

4.2 Fill

Borehole No.2 contained a layer of heterogeneous fill that extends from the surface to a depth 0.8 m (Approximate Elevation 79.7 m). The fill contains topsoil, silty sand, and asphalt, brick, and concrete pieces. The fill is compact as indicated by the standard penetration test (SPT) N value of 14 blows for 300 mm penetration of the split spoon sampler and has a natural moisture content of 16 percent.

4.3 Silty Clay

The pavement and fill in both boreholes is underlain by a native silty clay deposit extending beyond the maximum sampled depths of 15.5 m and 10.0 m (i.e. Elevation 62.3 m and 70.5 m) in Borehole Nos. 1 and 2, respectively. The upper portion of silty clay is desiccated, brown in colour and has an undrained shear strength ranging from 120 kPa to 220 kPa indicating a very stiff to hard consistency. The upper silty clay crust extends to 3.7 m depth (i.e. Elevation 74.1 m) at Borehole No. 1 and 6.1 m depth (i.e. Elevation 74.4 m) at Borehole No. 2. The silty clay crust is underlain by lower grey silty clay with an undrained shear strength of 34 kPa to 65 kPa indicating a firm to stiff consistency. The sensitivity values of the silty clay deposit ranged from 18 to over 30 indicating a sensitive clay.

The natural moisture content of the silty clay deposit is 30 to 65 percent.

The results from the grain-size analysis and Atterberg limit determination conducted on one (1) sample of the brown silty clay crust (BH1 SS3) and two (2) samples of un-desiccated grey silty clay (BH1 SS6 and BH2 SS7) are summarized in Table II. The grain-size distribution curves are shown in Figure 6 to 8.

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

Borehole (BH) No. – Sample (SS) No.	Depth (m)	Grain-Size Analysis (%)				Atterberg Limits (%)				
		Gravel	Sand	Silt	Clay	Moisture Content	Liquid Limit	Plastic Limit	Plasticity Index	Soil Classification (USCS)
BH1 – SS3	1.5 – 2.1	0	1	19	80	37	71	20	51	Clay (Highly Plastic) (CH), some silt, trace sand
BH1 – SS6	7.6 – 8.2	0	6	56	38	36	31	16	15	Clay (Medium Plasticity) (CI), silty, trace sand
BH2 – SS7	6.1 – 6.7	0	3	31	66	56	61	21	40	Clay (Highly Plastic) (CH), silty, trace, sand

Based on a review of the results of the grain-size analysis and Atterberg limits, the silty clay deposit at the site can be classified as clay of medium to high plasticity (CI to CH) some silt to silty, trace sand.

4.4 Inferred Boulders or Bedrock

A Dynamic Cone Penetration Test (DCPT) was conducted at Borehole No. 1 from 15.5 m depth to cone refusal depth met at 26.4 m below ground surface (i.e. Elevation 51.4 m). A DCPT test was also conducted at Borehole No. 2 from 10.0 m depth to cone refusal met at 24.5 m depth below ground surface (i.e. Elevation 56.0 m). It is not known if refusal was met on boulders or the bedrock.

4.5 Groundwater Level

Groundwater levels were measured in the standpipes installed in Borehole Nos. 1 and 2, on January 19, 2025, and the results are summarized in Table III.

Table III: Summary of Groundwater Level Measurements

Borehole No. (BH)	Approximate Ground Surface Elevation (m)	Date of Measurement (Elapsed Time in Days from Date of Installation)	Groundwater Depth Below Ground Surface (Elevation), m
BH1	77.8	January 19, 2025 (10 days)	3.2 (74.6)
BH2	80.5	January 19, 2025 (11 days)	3.9 (76.6)

A review of Table III indicates the groundwater table at the site ranges from 3.2 m to 3.9 m depth (i.e. Elevation 76.6 m to 74.6 m).

Groundwater levels were determined in the standpipes installed within the boreholes at the time and under the conditions stated in the scope of services. Note that fluctuations in the level of groundwater may occur due to

seasonal variations 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. Seismic Site Classification and Liquefaction Potential of Soils

5.1 Site Classification for Seismic Site Response

Based on the borehole information and Table 4.1.8.4.A in the 2012 Ontario Building Code (as amended January 1, 2020), a preliminary site classification for seismic site response is **Class D**. It is recommended that a Multichannel Analysis of Surface Waves (MASW) test be completed at the site to confirm the seismic site classification.

5.2 Liquefaction Potential of Soils

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

6. Grade Raise Restrictions

The site is underlain by a deep deposit of silty clay that is prone to consolidation settlement if overstressed by loads imposed on it by site grade raise, foundations and by the permanent lowering of the groundwater level following construction. Overstressing of the silty clay will result in its consolidation and subsequent settlement of foundations, which may exceed tolerable limits of the structure resulting in cracking of the structure.

Based on the design drawings issued for coordination for the project Modular Homes – 8 Plex, 2409 Carlsen Avenue Drawings A4 and A4.1 Revision #6 dated October 31, 2024, the design finished floor of the proposed Block 1 is Elevation 78.96 m. The design average top of grade is Elevation 78.31 m. The design finished floor of the proposed Block 2 is Elevation 79.16 m. The design average top of grade is Elevation 78.42 m. Average design grades for Block 3 were not available at the time of this report.

Based on the existing grade of Elevation 77.90 m at the front of Block 1, to Elevation 78.5 m at the back of Block 1, and 77.9 m to 78.3 m front to back for Block 2, a maximum grade raise of 1.0 m can be approximated throughout the building footprint for each building. This is assumed to apply to Block 3 as well. From a geotechnical standpoint, a grade raise of up to 1 m is considered acceptable for the proposed development.

If any changes are made to the above design grades, EXP should be contacted to review the acceptability of the proposed grade raise from a geotechnical point of view and provide updated bearing pressure value at serviceability limit state (SLS) and factored geotechnical resistance value at ultimate limit state (ULS) for the footings of the proposed new building.

7. Foundation Considerations

7.1 Buildings

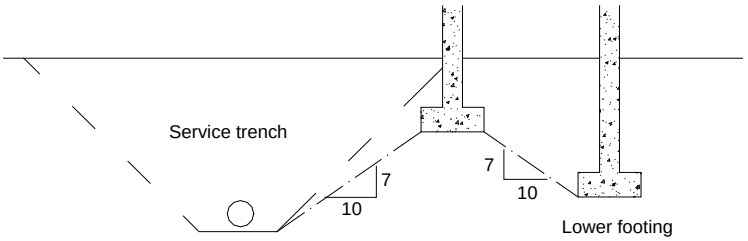
At the time of writing this report, the site plan includes three buildings (Block 1, 2, and 3). Block 1 has a design underside of footing Elevation of 75.81 m and design average top of grade of Elevation 78.31 m. Block 2 has a design underside of footing elevation of 76.01 m and design average top of grade of Elevation 78.42 m. Details for Block 3 were not available at the time of writing this report. The distance from underside of footing to top of foundation is 2.8 m for both Block 1 and 2, and the top of foundation is approximately 0.3 m above the proposed top of grade. Block 3 is assumed to follow the same design methodology and therefore the underside of footing would be at approximate Elevation 78.0 m.

The existing fill is not considered suitable to support the footings for the proposed buildings and must be excavated down to the native silty clay deposit.

Strip footings with widths of up to 1 m, and spread footing with length and width of up to 3 m by 3 m, may be founded at Elevation of 75.80 m or higher, in the native brown silty clay, and 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 ULS value includes a geotechnical resistance factor of 0.5. The recommended SLS and factored ULS values are valid for a maximum site grade raise of up to 1.0 m. If this is different, EXP should be contacted to review and provide updated SLS and factored ULS values for the footings.

The total and differential settlements of footings designed in accordance with the recommendations of this report and with careful attention to construction detail are expected to be less than 25 mm and 19 mm respectively.

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 footing beds should be examined by a geotechnical engineer to ensure that the founding soil is capable of supporting the bearing pressure at SLS and that the footings have been properly prepared.

It should be noted that the exposed silty clay subgrade surface is susceptible to disturbance due to movement of workers and construction traffic and the prevailing weather conditions during construction. To prevent disturbance to the silty clay subgrade, the approved footing beds should be covered or protected with a minimum 50 mm thick concrete mud slab.

A minimum of 1.5 m of earth cover should be provided to the exterior foundations of heated structures 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 and to 2.4 m if snow will be removed from the vicinity of the structure.

When earth cover is less than the minimum required, an equivalent thermal combination of earth cover and rigid insulation or rigid insulation alone should be provided. EXP can provide additional comments in this regard, if required.

The recommended bearing pressure at SLS and factored geotechnical resistances at ULS 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.

7.2 Retaining Walls

Retaining walls may be constructed with strip footings founded on the native clay soil, similar to the footings for the proposed buildings. The respective bearing pressure at SLS and factored geotechnical resistance at ULS are the same as those described in the above section.

The factored sliding resistance at ULS between the underside of the cast in place concrete footing and the native silty clay is 0.36, which includes a geotechnical resistance factor of 0.8.

7.3 Additional Investigation

It should be noted that an existing dwelling, fences and trees were present at the site during the time of the investigation which limited access for drilling. Therefore, an additional borehole investigation is recommended to be completed at the site once the site is cleared and structures demolished to confirm the subsurface condition in the remainder of the site.

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8. Lateral Earth Pressure

The lateral earth pressures of retaining walls and subsurface basement walls for the proposed building are presented in this section of the report.

8.1 Basement Walls

The subsurface basement walls should be backfilled with free draining material, such as Ontario Provincial Standard Specification (OPSS) Granular B Type II and equipped with a permanent drainage system to prevent the buildup of hydrostatic pressure behind the wall. The drainage system should have a suitable outlet to provide positive drainage.

The walls will be subjected to lateral static and dynamic (seismic) earth forces.

The expressions below assume free draining backfill material, a perimeter drainage system, level backfill surface behind the wall and vertical face on the back side of the wall.

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

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

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

K_0 = lateral earth pressure at rest coefficient, assumed to be 0.5 for Granular B Type II backfill material

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

h = depth of point of interest below top of backfill, m

q = surcharge load stress, kPa

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

$$\Delta_{Pe} = \gamma H^2 \frac{a_h}{g} F_b$$

where Δ_{Pe} = dynamic thrust in kN/m of wall

H = height of wall, m

γ = unit weight of backfill material = 22 kN/m^3

$\frac{a_h}{g}$ = earth pressure coefficient = 0.374 for the site address; 2020 NBC

F_b = thrust factor = 1.0

The dynamic thrust does not take into account the surcharge load. The resultant force of the lateral dynamic thrust acts approximately at 0.63H above the base of the wall.

All subsurface walls should be properly dampproofed.

8.2 Retaining Walls

The retaining walls 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 retaining walls should be backfilled with free draining material, such as OPSS Granular B Type II compacted to a minimum of 95% Standard Proctor maximum dry density (SPMDD) and equipped with a permanent drainage system to prevent the buildup of hydrostatic pressure behind the wall.

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 earthquake pressure on the retaining wall is assumed to be applied at a height of 0.6 H above the base of the wall where H is the height the wall. The total active pressure distribution can be separated into static component and dynamic components 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 active lateral earth pressure (dynamic and static) at depth z, (kPa).

z = depth below the top of the retaining wall

K_A = static lateral active earth pressure coefficient

K_{AE} = combined (static and dynamic) 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

As noted above, for the total 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.

Additional Comments

The estimated lateral earth pressure parameters are summarized in Table IV.

Table IV: 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 Lateral (static and seismic) Active Earth Pressure Coefficient, K_{AE} for a Yielding Wall (Retaining Wall)	0.46

For the calculation of the active dynamic (seismic) lateral earth pressure coefficients for retaining walls, the seismic coefficient in the horizontal direction, k_h, was taken as 0.5 times the PGA value of 0.374g. The calculated active dynamic (seismic) lateral earth pressure coefficients assume 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 coefficients values would be somewhat different.

The K_{AE} value calculations 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) and 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.

The static active condition for a retaining wall will be reached when the outward displacement of the wall is approximately 0.001 H to 0.004 H for granular soil backfill where 'H' is the height of the wall. For the seismic condition for a retaining wall the K_{AE} value is applicable for a wall designed to move by up to approximately 80 mm.

The final design of the retaining walls should be reviewed by this office.

9. Slab-on-Grade Construction and Permanent Drainage Systems

The lowest floor level of the proposed building may be designed as slab on grade. The existing topsoil and fill are not considered suitable to support the slab-on-grade and should be excavated down to the native silty clay within the floor slab footprint. The native subgrade should be inspected by a geotechnician from this office. Upon approval of the subgrade, the grades may be raised using a granular pad constructed of OPSS Granular B type II in maximum 300 mm thick lifts, and each lift compacted to 98% SPMDD.

The floor slab should be set on a bed of well-packed 19 mm clear stone at least 200 mm thick placed over the approved native silty clay or Granular B type II pad. The clear stone would prevent the capillary rise of moisture from the sub-soil to the floor slab. As an alternative to clear stone, the floor slab may be set on a 200 mm thick Granular A pad compacted to 98 percent standard Proctor maximum dry density (SPMDD) and overlain by a vapour barrier. Adequate saw cuts should be provided in the floor slab to control cracking.

A perimeter drainage system should be installed around the proposed new building. The perimeter drainage system may comprise of 150 mm diameter perforated pipe or equivalent covered at the top, sides and bottom with a minimum 150 mm thick layer of clear stone that is completely wrapped or covered with a non-woven geotextile such as Terrafix 270R or equivalent. The perimeter drainage system should be connected to a sump to provide positive drainage. The need for an underfloor drainage system will be assessed following review of the design elevations for Block 3, when they come available, and following additional boreholes including at Block 2 Location.

The ground floor should be set at least 150 mm above the surrounding exterior grades and the finished exterior grade should be sloped away from the building to prevent ponding of surface water close to the exterior walls of the proposed building.

10. Excavation and De-Watering Requirements

10.1 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.

10.2 Excavations

Excavations for the construction of the proposed building foundations are anticipated to extend a maximum of 3.0 m depth below existing ground surface. These excavations will extend through the fill and into the native silty clay and will be above the groundwater level.

The excavations may be undertaken by conventional excavation equipment.

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 and for open cut excavations, the side slopes of the excavation must be cut back at 1H:1V from the bottom of the excavation. For zones along the sidewalls of the excavation of persistent water seepage, the excavation side slopes are expected to slough and eventually stabilize at a slope of 2H:1V from the bottom of the excavation.

Base heave type failure is not expected in excavations that extend into the native silty clay to a maximum 3.0 m depth below existing grade.

The silty clay stratum at the site is susceptible to disturbance due to the movement of construction equipment and personnel on its surface. It is therefore recommended that the excavation at the site should be undertaken by equipment that does not need to 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.

10.3 De-Watering Requirements

Seepage of the surface and subsurface water into the 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. High-capacity pumps may be required to keep the excavation dry in zones of persistent seepage where more permeable soil may exist along the side walls of the excavation.

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.

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.

11. Pipe Bedding Requirements

It is recommended that 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).

The pipe subgrade material is anticipated to consist of very stiff to hard silty clay. In this case, it is recommended the pipe bedding consist of 150 mm thick of OPSS 1010 Granular A bedding material. The bedding material should be compacted to at least 98 percent SPMDD.

The bedding thickness may be further increased in areas where the silty clay subgrade becomes disturbed or below the water table. Trench base stabilization techniques, such as removal of loose/soft material, placement of crushed stone sub-bedding (Granular B Type II) that is completely wrapped in a non-woven geotextile, may also be used if trench base disturbance becomes a problem in wet or soft areas.

The trench backfill should be placed in 300 mm thick lifts and each lift compacted to 95 percent SPMDD.

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

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

The material to be excavated from the site will comprise of topsoil, fill, and native silty clay. Portions of the fill may be re-used as backfill material in the landscaped areas. The excavated soils are not considered suitable for use under structural elements and for structural backfilling purposes and therefore must be disposed of off-site or used in landscaped areas.

It is anticipated that the majority of the material required for engineered fill and for backfilling purposes for this project would have to be imported and should preferably conform to the following specification:

- Engineered fill under slab-on-grade - OPSS 1010 Granular B Type II placed in maximum 300 mm thick lifts and each lift compacted to 98 percent SPMDD.
- Backfill in footing trenches and against foundation walls – OPSS 1010 Granular B Type II placed in 300 mm thick lifts and each lift compacted to 98 percent of the SPMDD inside the building and 95 percent SPMDD outside the building respectively.
- Bedding for underground services – OPSS 1010 Granular A placed in maximum 300 mm thick lifts and each lift compacted to 98 percent SPMDD.
- Trench backfill and subgrade fill under sidewalks – OPSS Select Subgrade Material (SSM) or approved on-site material excavated above the water table placed in 300 mm thick lifts and each lift compacted to 95 percent SPMDD.

13. Subsurface Concrete and Steel Requirements

Chemical tests limited to pH, sulphate, chloride, and resistivity determination were performed on two (2) samples of the native silty clay soil. The laboratory certificate of analysis is attached in Appendix A and the results are summarized in Table V.

Table V: Results of pH, Sulphate, Chloride, and Resistivity Tests on Soil Samples

Borehole No. (Sample No.)	Depth (m)	Soil Type	pH	Sulphate (%)	Chloride (%)	Resistivity (Ohm*cm)
BH1 – SS4	2.3 - 2.9	Native Silty Clay	7.91	0.0051	0.0022	6060
BH2 – SS5	3.0 – 3.6	Native Silty Clay	7.43	0.0071	0.0073	2720

Based on a review of the sulphate test results, the concentration of sulphate in the native silty clay has a negligible potential of sulphate attack on subsurface concrete. The chloride concentration of less than 0.01% has a negligible affect on the subsurface concrete. The concrete should be designed in accordance with CSA A.23.1-19.

Based on a review of the resistivity test result, the native silty clay sample is considered to be mildly corrosive to bare steel as per the National Association of Corrosion Engineers (NACE). Appropriate measures should be undertaken to protect buried steel elements from corrosion.

14. Tree Planting Restrictions

Based on the results of the Atterberg limits of the clayey soils and comparison of the results with the City of Ottawa 2005 Clay Soils Policy and 2017 Tree Planting in Sensitive Marine Clay Soils Guidelines (2017 Tree Planting Guidelines), the clayey soils at this site are considered to have a high potential for soil volume change. Therefore, the tree planting should be carried out in accordance with the 2005 City of Ottawa Clay Soils Policy 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 tree planting restrictions and setbacks for the proposed development are in accordance with the applicable City of Ottawa guidelines.

15. Additional Investigation

It should be noted that an existing dwelling, fences and trees were present at the site during the time of the investigation which limited access for drilling. Therefore, an additional borehole investigation is recommended to be completed at the site once the site is cleared and structures demolished to confirm the subsurface condition in the remainder of the site.

16. 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 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 is satisfactory for your purposes. Should you have any questions, please contact this office.

Sincerely,

Matthew Zammit, M.A.Sc., P.Eng.
Geotechnical Engineer
Earth and Environment

Ismail Taki, M.Eng, P.Eng.
Senior Manager, Eastern Ontario
Earth and Environment

Figures

LEGEND

APPROXIMATE PROPERTY BOUNDARY

ORIGINAL SHEET SIZE = 11" X 8.5"

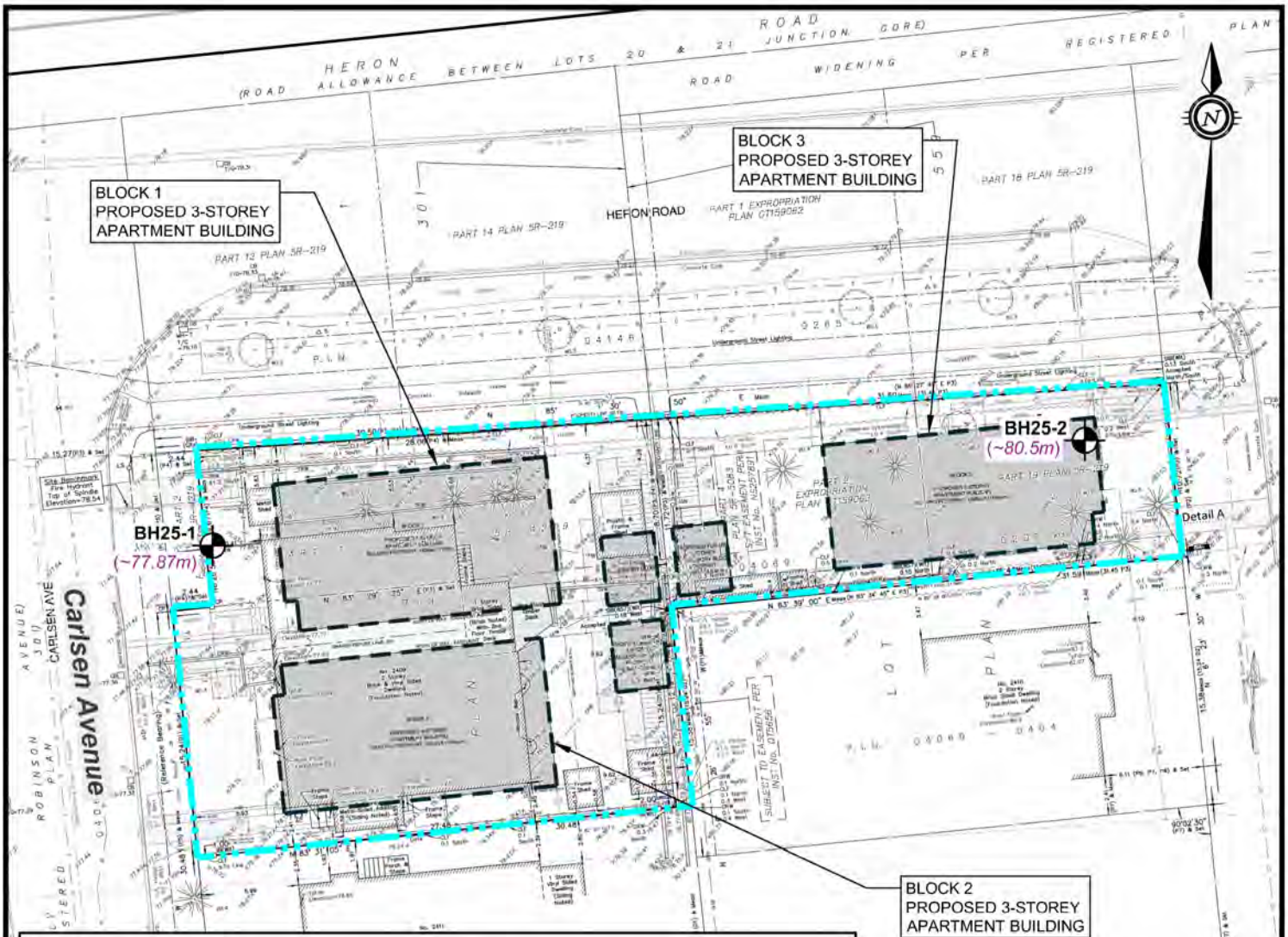
0 100m 200m 400m

HORIZONTAL 1:10,000

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 2025	CLIENT: 2409 CARLSEN INC.		project no. OTT-24002375-A0
DESIGN: MZ / CHECKED: IT	PROPERTY ADDRESS: 2409 CARLSEN AVENUE, OTTAWA, ONTARIO		scale 1:10,000
DRAWN BY: AS	PROJECT: PROPOSED RESIDENTIAL DEVELOPMENT	TITLE: SITE LOCATION PLAN	FIG 1

Filename: E:\OTT\OTT-24002375-A0\60 Execution\65 Drawings\Geotechnical\OTT-24002375-A0_Geo_2409-Carlsen-Ave.dwg
Last Saved: Jan 24, 2025 11:54 AM Last Plotted: Jan 24, 2025 11:56 AM Plotted by: SeverA



GENERAL NOTES:

1. THE BOUNDARIES 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 WILL BE RETAINED IN STORAGE FOR THREE MONTHS AND THEN DESTROYED UNLESS THE CLIENT ADVISES THAT AN EXTENDED TIME PERIOD IS REQUIRED.
3. ASPHALT AND TOPSOIL 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.
6. BASE SITE PLAN PRODUCED BY: *S. J. LAWRENCE ARCHITECT INC.*, JOB NO.: SL-1126-24, DATED: 2024.10.31

BASE SURVEY PLAN PRODUCED BY *FARLEY, SMITH & DENIS SURVEYING LTD.*; PART OF LOT 1, REGISTERED PLAN 301 AND PART OF LOT 1, REGISTERED PLAN 559, CITY OF OTTAWA; DATED: MARCH 13, 2024.

LEGEND

PROPERTY BOUNDARY

BH25-1 (~77.87m) — BOREHOLE NO. AND LOCATION; APPROXIMATE GROUND SURFACE SPOT ELEVATION (m), BASED ON THE SURVEY

PROPOSED NEW BUILDINGS FOOTPRINT

ORIGINAL SHEET SIZE = 8.5" X 11"

0 4m 8m 16m

HORIZONTAL 1:400

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

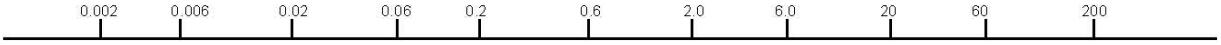
DATE: JANUARY 2025	CLIENT:	2409 CARLSEN INC.	project no.: OTT-24002375-A0
DESIGN: MZ / CHECKED: IT	PROPERTY ADDRESS:	2409 CARLSEN AVENUE, OTTAWA, ONTARIO	
	PROJECT:	PROPOSED RESIDENTIAL DEVELOPMENT	scale: 1:400
DRAWN BY: AS	TITLE:	BOREHOLE LOCATION PLAN	FIG 2

Notes On Sample Descriptions

1. All sample descriptions included in this report follow the Canadian Foundations Engineering Manual soil classification system. This system follows the standard proposed by the International Societv for Soil Mechanics and Foundation Engineering. Laboratory grain size analyses provided by **exp** Services Inc. also follow the same system. Different classification systems may be used by others; one such system is the Unified Soil Classification. Please note that, with the exception of those samples where a grain size analysis has been made, all samples are classified visually. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.

ISSMFE SOIL CLASSIFICATION

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



EQUIVALENT GRAIN DIAMETER IN MILLIMETRES

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

UNIFIED SOIL CLASSIFICATION

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

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

Log of Borehole BH25-01

Project No: OTT-24002375-A0

Project: Proposed Residential Development

Location: 2409 Carlsen Avenue, Ottawa, Ontario

Figure No. 3

Page. 1 of 3

Date Drilled: 'January 9, 2025

Drill Type: CME-55LC Rubber Track Mounted Drill Rig

Datum: Approximate 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	Approximate 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 ~ 70 mm thick	77.8	0				
		GRANULAR FILL ~300 mm thick	77.7					
		Silty sand and gravel, rounded, brown, moist, (dense)	77.4					
		SILTY CLAY DESICCATED CRUST High plasticity, trace sand, brown, moist, (very stiff to hard)			31		SS1	
		pink colour at 1.5 m depth		1	15; >215 kPa		SS2	
					11; 190 kPa		SS3	
				2	7		SS4	
			74.6	3	180 kPa; s = 6			
		SILTY CLAY Medium plasticity, trace sand, grey to dark grey, wet, (firm to stiff)	74.1	4	2		SS5	
					65 kPa; s = 18			
				5			ST-1	
		dark grey below 6.1 m depth		6	41 kPa			
				7				
				8	Hammer Weight		SS6	
				9	34 kPa			
				10				

Continued Next Page

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 19 mm standpipe was installed as shown
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-24002375-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
Jan. 19, 2025	3.2	

CORE DRILLING RECORD

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

LOG OF BOREHOLE OTT-24002375-A0 2409 CARLSEN AVE BH LOGS.GPJ TROW OTTAWA.GDT 1/29/25

Log of Borehole BH25-01

Project No: OTT-24002375-A0

Project: Proposed Residential Development

Figure No. 3

GWL	SYMBOL	SOIL DESCRIPTION	Approximate 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
		SILTY CLAY Medium plasticity, trace sand, grey to dark grey, wet, (firm to stiff) *(continued)*	67.8	10	20 40 60 80 Shear Strength kPa 50 100 150 200	250 500 750 Natural Moisture Content % Atterberg Limits (% Dry Weight) 20 40 60		
				11	Hammer Weight		SS7	
				12	38 kPa			
				13				
				14	Hammer Weight		SS8	
				15	36 kPa			
		Dynamic Cone Penetration Test Completed from 15.5 m depth to cone refusal at 26.4 m depth	62.3	16				
				17				
				18				
				19				
				20				
				21				
				22				

Continued Next Page

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 19 mm standpipe was installed as shown
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-24002375-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
Jan. 19, 2025	3.2	

CORE DRILLING RECORD

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

Log of Borehole BH25-01

Project No: OTT-24002375-A0

Project: Proposed Residential Development

Figure No. 3

GWL	SYMBOL	SOIL DESCRIPTION	Approximate 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
		Dynamic Cone Penetration Test Completed from 15.5 m depth to cone refusal at 26.4 m depth *(continued)*	55.8	22	20 40 60 80 / 50 100 150 200	250 500 750 / 20 40 60		
				23				
				24				
				25				
				26				
		Cone Refusal at 26.4 m Depth	51.4					

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 19 mm standpipe was installed as shown
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-24002375-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
Jan. 19, 2025	3.2	

CORE DRILLING RECORD

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

Log of Borehole BH25-02

Project No: OTT-24002375-A0

Project: Proposed Residential Development

Location: 2409 Carlsen Avenue, Ottawa, Ontario

Figure No. 4

Page. 1 of 3

Date Drilled: 'January 8, 2025

Drill Type: CME-55LC Rubber Track Mounted Drill Rig

Datum: Approximate 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	Approximate 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
		FILL Topsoil with silty sand, asphalt, brick, and concrete pieces, brown, moist, (compact)	80.5	0	14		SS1	
			79.7					
		SILTY CLAY DESICCATED CRUST Brown, moist, (very stiff to hard)		1	11		SS2	
				2	12, >215 kPa		SS3	
				3	10		SS4	
					8		SS5	
▽			76.6	4	220 kPa, s = 5.5			
				5	4		SS6	
				6	120 kPa, s = 8			
		SILTY CLAY High plasticity, trace sand, grey to dark grey, wet, (firm)	74.4		1		SS7	
				7	38 kPa			
		dark grey below 7.6 m depth		8	Hammer Weight		SS8	
					38 kPa			
				9	Hammer Weight		SS9	
			70.5	10				

Continued Next Page

NOTES:
1. Borehole data requires interpretation by EXP before use by others
2. A 19 mm standpipe was installed as shown
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-24002375-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
Jan. 19, 2025	3.9	

CORE DRILLING RECORD

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

LOG OF BOREHOLE OTT-24002375-A0 2409 CARLSEN AVE BH LOGS.GPJ TROW OTTAWA.GDT 1/29/25

Log of Borehole BH25-02

Project No: OTT-24002375-A0

Project: Proposed Residential Development

Figure No. 4

GWL	SYMBOL	SOIL DESCRIPTION	Approximate 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
		Dynamic Cone Penetration Test Push to resistance from 10 m depth to 23.5 m depth then strike to cone refusal at 24.5 m depth	70.5	10	20 40 60 80 Shear Strength 50 100 150 200 kPa	250 500 750 Natural Moisture Content % Atterberg Limits (% Dry Weight) 20 40 60		
				11				
				12				
				13				
				14				
				15				
				16				
				17				
				18				
				19				
				20				
				21				
				22				

Continued Next Page

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 19 mm standpipe was installed as shown
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-24002375-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
Jan. 19, 2025	3.9	

CORE DRILLING RECORD

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

Log of Borehole BH25-02

Project No: OTT-24002375-A0

Project: Proposed Residential Development

Figure No. 4

GWL	SYMBOL	SOIL DESCRIPTION	Approximate 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
		Dynamic Cone Penetration Test Push to resistance from 10 m depth to 23.5 m depth then strike to cone refusal at 24.5 m depth *(continued)*	58.5	22	20 40 60 80 / 50 100 150 200	250 500 750 / 20 40 60		
				23				
				24				
			56.0					
		Cone Refusal at 24.5 m Depth						

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 19 mm standpipe was installed as shown
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-24002375-A0

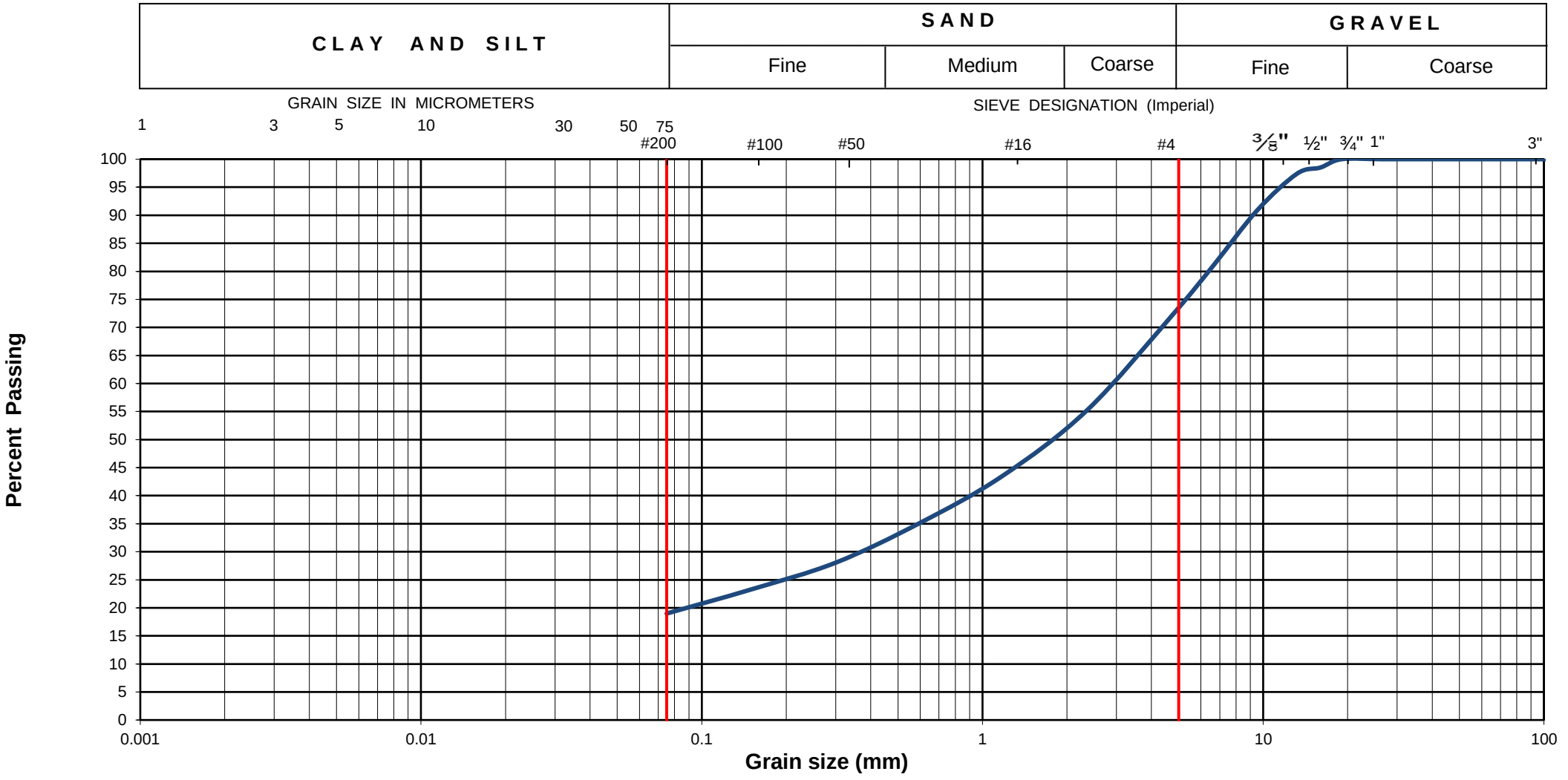
WATER LEVEL RECORDS		
Date	Water Level (m)	Hole Open To (m)
Jan. 19, 2025	3.9	

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

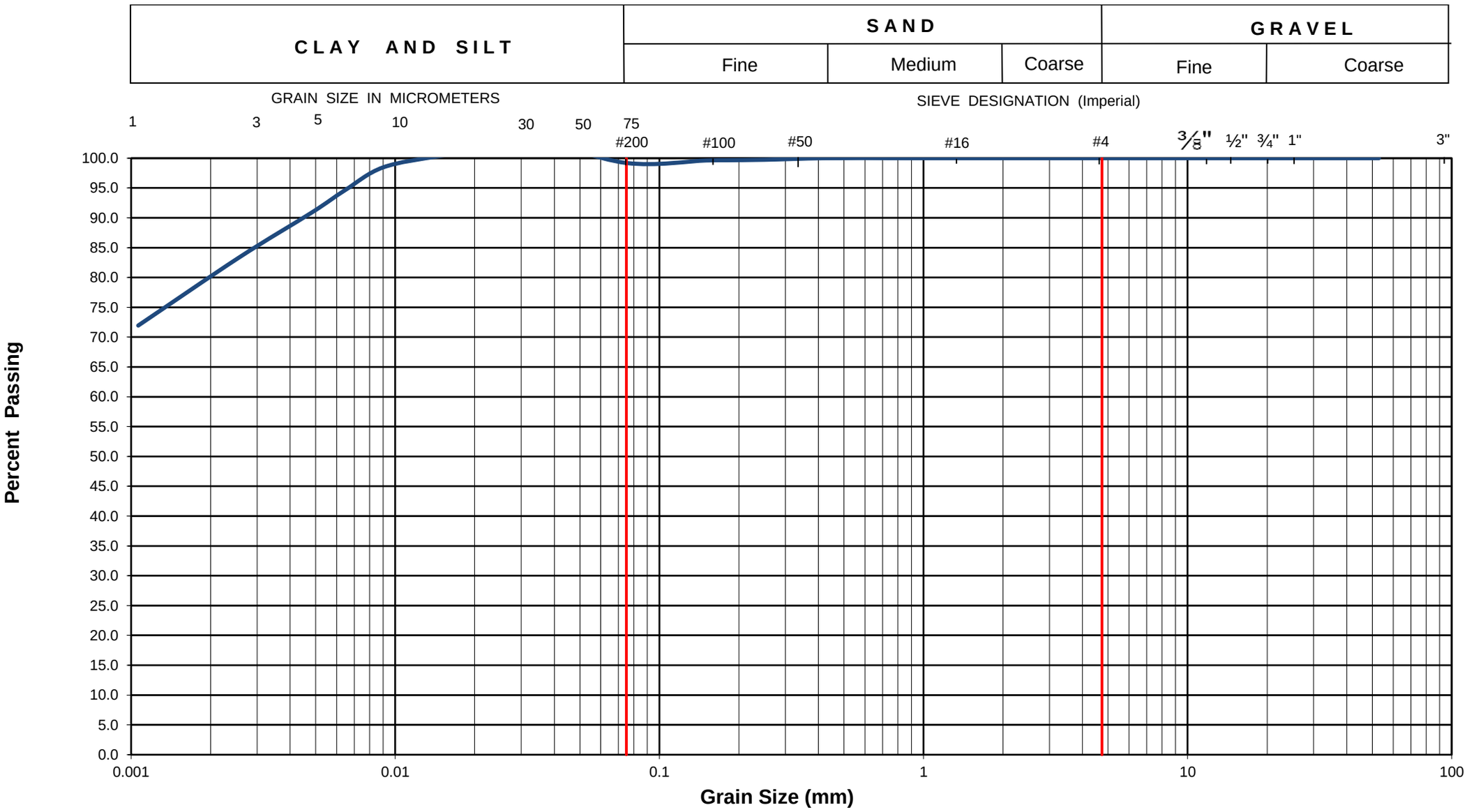


EXP Project No.:	**OTT-24002375-A0**	**Project Name :**	**Proposed Residential Development**						
Client :	**2409 Carlsen Inc.**	**Project Location :**	**2409 Carlsen Ave, Ottawa**						
Date Sampled :	**January 9, 2025**	**Borehole No:**	**BH1**	**Sample:**	**GS1**	**Depth (m) :**	**0.1 - 0.3**		
Sample Composition :		**Gravel (%)**	**28**	**Sand (%)**	**53**	**Silt & Clay (%)**	**19**	**Figure :**	**5**
Sample Description :	**GRANULAR FILL: Silty Sand (SM), Gravelly, Trace Clay**								

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

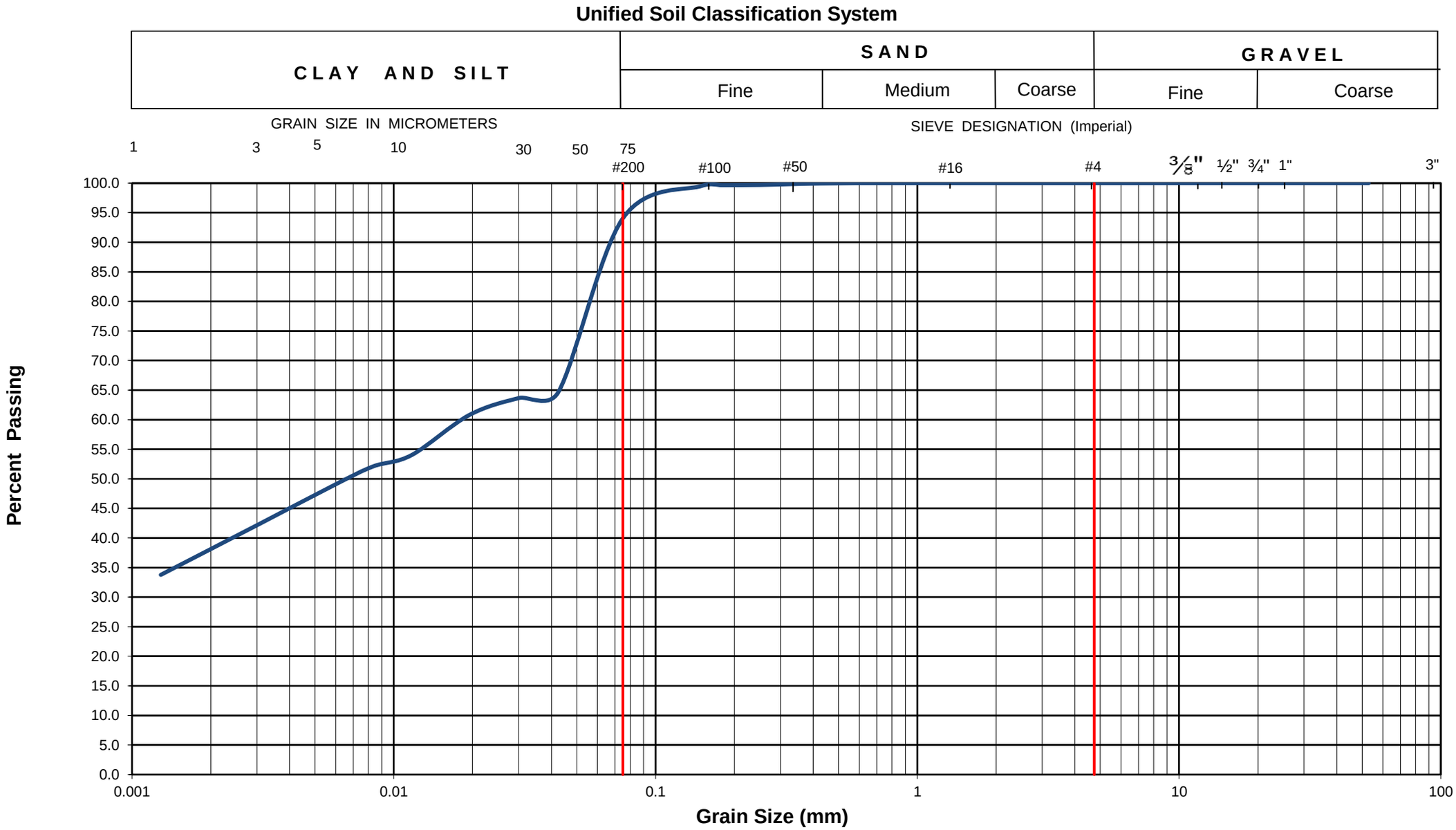
Unified Soil Classification System



EXP Project No.:	**OTT-24002375-A0**	**Project Name :**	**Proposed Residential Development**						
Client :	**2409 Carlsen Inc.**	**Project Location :**	**2409 Carlsen Ave, Ottawa**						
Date Sampled :	**January 9, 2025**	**Borehole No:**	**BH1**	**Sample No.:**	**SS3**			**Depth (m) :**	**1.5 - 2.1**
Sample Description :		**% Silt and Clay**	**99**	**% Sand**	**1**	**% Gravel**	**0**	**Figure :**	**6**
Sample Description :	**Clay (Highly Plastic) (CH), Some Silt, Trace Sand**								

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

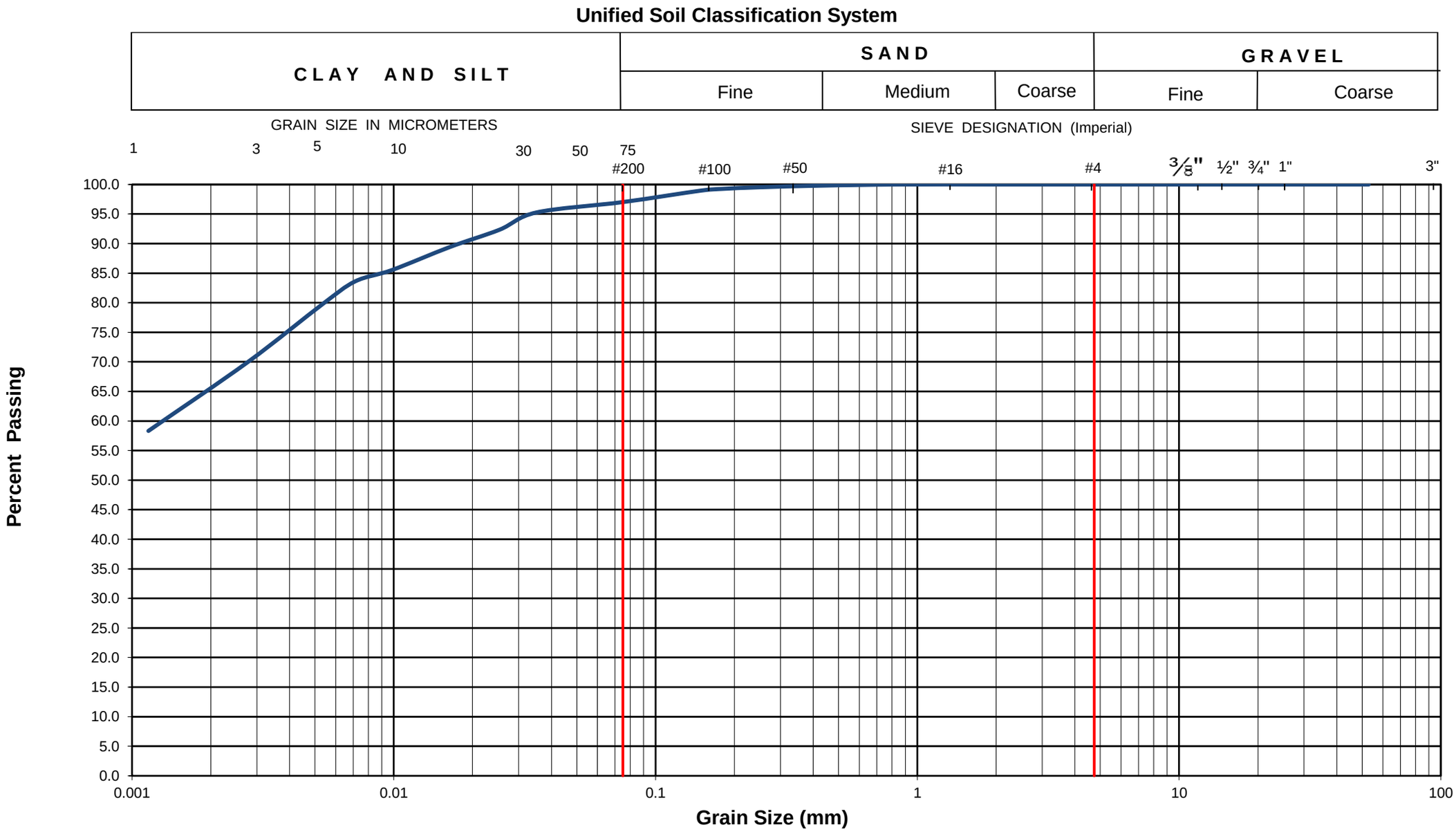
Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422



EXP Project No.:	**OTT-24002375-A0**	**Project Name :**	**Proposed Residential Development**						
Client :	**2409 Carlsen Inc.**	**Project Location :**	**2409 Carlsen Ave, Ottawa**						
Date Sampled :	**January 9, 2025**	**Borehole No:**	**BH1**		**Sample No.:**	**SS6**		**Depth (m) :**	**7.6 - 8.2**
Sample Description :		**% Silt and Clay**	**94**	**% Sand**	**6**	**% Gravel**	**0**	**Figure :**	**7**
Sample Description :	**Clay (Medium Plasticity) (Cl), Silty, Trace Sand**								

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-24002375-A0**	**Project Name :**	**Proposed Residential Development**						
Client :	**2409 Carlsen Inc.**	**Project Location :**	**2409 Carlsen Ave, Ottawa**						
Date Sampled :	**January 9, 2025**	**Borehole No:**	**BH2**	**Sample No.:**	**SS7**			**Depth (m) :**	**6.1 - 6.7**
Sample Description :		**% Silt and Clay**	**97**	**% Sand**	**3**	**% Gravel**	**0**	**Figure :**	**8**
Sample Description :		**Clay (Highly Plastic) (CH), Silty, Trace Sand**							

Appendix A:
Laboratory Certificate of Analysis

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-24002375-A0
AGAT WORK ORDER: 25Z238874
SOIL ANALYSIS REVIEWED BY: Nivine Basily, Inorganic Team Lead
DATE REPORTED: Jan 21, 2025
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 is available on request from AGAT Laboratories, in accordance with ISO/IEC 17025:2017, ISO/IEC 17025:2005 (Quebec), DR-12-PALA and/or NELAP Standards.*
- *This document is signed by an authorized signatory who meets the requirements of the MELCCFP, CALA, CCN and NELAP.*
- *For environmental samples in the Province of Quebec: The analysis is performed on and results apply to samples as received. A temperature above 6°C upon receipt, as indicated in the Sample Reception Notification (SRN), could indicate the integrity of the samples has been compromised if the delay between sampling and submission to the laboratory could not be minimized.*

AGAT Laboratories

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

Certificate of Analysis

AGAT WORK ORDER: 25Z238874

PROJECT: OTT-24002375-A0

CLIENT NAME: EXP SERVICES INC

ATTENTION TO: Matthew Zammit

SAMPLING SITE:2409 Carlsen Ave, Ottawa

SAMPLED BY:EXP

(Soil) Inorganic Chemistry

DATE RECEIVED: 2025-01-14 **DATE REPORTED: 2025-01-21**

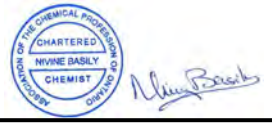
				BH1 SS4 7.	
		SAMPLE DESCRIPTION:		5'-9.5'	BH3 SS5 10'-12'
		SAMPLE TYPE:		Soil	Soil
		DATE SAMPLED:		2025-01-09	2025-01-08
Parameter	Unit	G / S	RDL	6460059	6460060
Chloride (2:1)	µg/g		2	22	73
Sulphate (2:1)	µg/g		2	51	71
pH (2:1)	pH Units		NA	7.91	7.43
Resistivity (2:1) (Calculated)	ohm.cm		1	6060	2720

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

6460059-6460060 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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CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: EXP SERVICES INC

AGAT WORK ORDER: 25Z238874

PROJECT: OTT-24002375-A0

ATTENTION TO: Matthew Zammit

SAMPLING SITE:2409 Carlsen Ave, Ottawa

SAMPLED BY:EXP

Soil Analysis

RPT Date: Jan 21, 2025			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)	6457460		86	87	1.2%	< 2	98%	70%	130%	96%	80%	120%	98%	70%	130%
Sulphate (2:1)	6457460		55	58	5.3%	< 2	104%	70%	130%	94%	80%	120%	93%	70%	130%
pH (2:1)	6460059	6460059	7.91	7.75	2.0%	NA	101%	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.

(Soil) Inorganic Chemistry									
pH (2:1)	6461329	8.25	8.38	1.5%	NA	96%	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.

Certified By:

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
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Method Summary

CLIENT NAME: EXP SERVICES INC

AGAT WORK ORDER: 25Z238874

PROJECT: OTT-24002375-A0

ATTENTION TO: Matthew Zammit

SAMPLING SITE:2409 Carlsen Ave, Ottawa

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

Have feedback? Scan here for a quick survey!

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Tel: 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
Contact: Matthew Zammit
Address: 2650 Queensview Drive, Suite 100
Ottawa, Ontario, K2B 8H6
Phone: 613-688-1899 Fax:
Reports to be sent to:
1. Email: matthew.zammit@exp.com
2. Email: ryan.digiuseppe@exp.com

Project Information:

Project: OTT-24002375-A0
Site Location: 2409 Carlsen Ave, Ottawa
Sampled By: EXP
AGAT Quote #: PO:
Please note: If quotation number is not provided, client will be billed full price for analysis.

Invoice Information:

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

Regulatory Requirements:

(Please check all applicable boxes)

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

☐ Regulation 406
Table ___ *Indicate One*
☐ Ind/Com ☐ Res/Park ☐ Agriculture

☐ 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 (RSC)**? ☐ Yes ☐ No

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

Legal Sample ☐

Sample Matrix Legend

GW	Ground Water	**SD**	Sediment
O	Oil	**SW**	Surface Water
P	Paint	**R**	Rock/Shale
S	Soil		

Laboratory Use Only

Work Order #: 25Z238874

Cooler Quantity: N/A - NO ICE / PACKS
Arrival Temperatures: 17.6 | 17.9 | 18.8
~~Depot~~ Temperatures: 4-2 | 4-3 | 3.2
Custody Seal Intact: ☐ Yes ☐ No ☑ N/A
Notes: B / I

Turnaround Time (TAT) Required:

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

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	Metals - ☐ CrVI, ☐ Hg, ☐ HWSB	BTEX, F1-F4 PHCs	VOC	PAHs	PCBs: Aroclors ☐	O. Reg 406: Regulation 406 Characterization Package	pH, Metals, BTEX, F1-F4	EC, SAR	Regulation 406 SPLP Rainwater Leach mSPLP: ☐ Metals ☐ VOCs ☐ SVOCs ☐ OC	O. Reg 558: Landfill Disposal Characterization TCLP: ☐ M&I ☐ VOCs ☐ ABNs ☐ B(a)P ☐ PCBs	Corrosivity: ☐ Moisture ☐ Sulphide	pH	Sulphates	Chlorides	Electro Resistivity			Potentially Hazardous or High Concentration (Y/N)
1. BH1 SS4 7.5'-9.5'	Jan 9	AM PM	1															☑	☑	☑	☑			
2. BH3 SS5 10'-12'	Jan 8	AM PM	1															☑	☑	☑	☑			
3.		AM PM																						
4.		AM PM																						
5.		AM PM																						
6.		AM PM																						
7.		AM PM																						
8.		AM PM																						
9.		AM PM																						
10.		AM PM																						
11.		AM PM																						

Samples Relinquished By (Print Name and Sign):	Date	Time	Samples Received By (Print Name and Sign):	Date	Time
			C. Cuthbertson	01/14/25	15h50
CC to Dave	01/15/25	15h00	TBP	Jan 16	8:45AM
					Page ___ of ___
					N°:

Pink Copy - Client | Yellow Copy - AGAT | White Copy - AGAT

Appendix B:
Legal Notification

Legal Notification

This report was prepared by EXP Services Inc. (EXP) for the account of 2409 Carlsen Inc.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. EXP accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this project.

Report Distribution

Jeremy Silburt - Jeremy@thebergehomes.com