GEOTECHNICAL INVESTIGATION

TWO 12-STOREY APARTMENT BUILDINGS
1242, 1250, 1260 GORDON STREET
GUELPH, ONTARIO

CMT Project 18-099.R01

Prepared For:

XCG Consulting Limited

April 25, 2018

CMT ENGINEERING INC.

CMT Engineering Inc.

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April 25, 2018 18-099.R01

XCG Consulting Limited
820 Trillium Drive
Kitchener, Ontario
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Attention: Mr. Kristian Peter, B.Sc. (Eng.), P.Eng., QP_{ESA}

Dear Kristian,

Re: Geotechnical Investigation
Two 12-Storey Apartment Buildings
1242, 1250, 1260 Gordon Street
Guelph, Ontario

As requested, CMT Engineering Inc. conducted a geotechnical investigation at the above-referenced site, and we are pleased to present the enclosed report.

We trust that this information meets your present requirements and we thank you for allowing us to undertake this project. Should you have any questions, please do not hesitate to contact our office.

Yours very truly,

Shawn Wheatley, B.Sc

TABLE OF CONTENTS

1.0 INTRODUCTION

The services of CMT Engineering Inc. (CMT Inc.) were retained by Mr. Kristian Peter, P.Eng. of XCG Consulting Limited (XCG) to conduct a geotechnical investigation for the proposed residential development at 1242, 1250, and 1260 Gordon Street, Guelph, Ontario. The location of site is shown on Drawing 1.

It is understood that the project will comprise the construction of construction of two 12-storey apartment buildings; one with two levels of underground parking and one with one level of underground parking.

The purpose of the geotechnical investigation was to assess the existing soil and groundwater conditions encountered in the boreholes. Included in the assessment are the soil classification and groundwater observations, as well as comments and recommendations regarding geotechnical resistance (bearing capacity); serviceability limit states (anticipated settlement); recommended founding elevations; site classification for seismic site response; dewatering considerations; recommendations for site grading, site servicing, excavations and backfilling; recommendations for slab-on-grade construction; pavement design/drainage; soil design properties; and a summary of the laboratory test results.

2.0 EXISTING SITE CONDITIONS

The site currently comprises three (3) houses with various treed areas. The site slopes down slightly towards Gordon Street to the southwest. The site is bounded by Gordon Street to the southwest, residential properties to the northwest and southeast, and vacant treed land to the northeast. The location of the site is shown on Drawing 1.

3.0 FIELD AND LABORATORY PROCEDURES

Prior to the commencement of the field drilling program, locates were organized by CMT Inc. to ensure that underground utilities would not be damaged.

The drilling field investigation was conducted on April 17, 18, and 19, 2018 and comprised the advancement of ten (10) boreholes (referenced as Borehole 1 to Borehole 10), utilizing a Geoprobe 7822DT drillrig operated by employees of CMT Drilling Inc. The boreholes were advanced to depths ranging from 7.62 m (25.0 ft) to 9.75 m (32.0 ft) below the existing ground surface elevations.

Boreholes 1 to 6 were advanced in the area of the proposed apartment building with two storeys of underground parking. Boreholes 7 to 10 were advanced in the area of the proposed apartment building with one storey of underground parking.

Soil sampling was undertaken utilizing the Standard Penetration Test (SPT), as well as Macro Core (MC5) systems for Boreholes 1 to 10. Standard Penetration Testing (SPT) was generally conducted at 0.76 m (2.5 ft) intervals to a depth of 3.66 m (12.0 ft), after which SPT sampling was conducted at 1.5 m (5.0 ft) intervals to borehole termination. MC5 continuous sampling was conducted between the 1.5 m (5.0 ft) SPT sampling intervals. Technical staff from CMT Inc. observed the drilling operation and collected and logged the recovered soil samples. A small portion of each sample was placed in a sealed, marked jar for moisture content determinations.

Representative samples from the following boreholes and depths were submitted to our laboratory for grain size analyses:

- Borehole 2 – depth 7.62 m to 9.14 m
- Borehole 5 – depth 1.52 m to 2.13 m
- Borehole 8 – depth 1.52 m to 2.13 m

The borehole logs are provided in Appendix A, and the grain size analyses are provided in Appendix B.

The geotechnical investigation was completed in conjunction with an environmental assessment by XCG Consulting Limited. The environmental investigation involved the analyzing of soils sampled from Borehole 3.

CMT Inc. surveyed the ground surface elevations at the borehole locations on April 5, 2018. The top of the manhole cover on Gordon Street across from house number 1260 was utilized as a temporary benchmark with a reported elevation of 336.21 m. The ground surface elevations at the borehole locations ranged from 338.04 m to 342.45 m. The locations of the boreholes and the temporary benchmark are shown on Drawing 2.

4.0 SUBSOIL CONDITIONS

The soils encountered in the boreholes are described briefly below and a more detailed stratigraphic description is provided on the borehole logs in Appendix A.

4.1. Topsoil

Dark brown, very loose to loose, silty, organic topsoil was encountered at the surface of all boreholes, with the exception of Borehole 8 which was located within an exposed driveway and hence had no topsoil cover. Where present, the topsoil ranged in thickness from approximately 190 mm to 250 mm (average 225 mm). The topsoil was considered moist to wet.

4.2. ***Sand and Silt***

Dark to light brown sand and silt, with some gravel and trace clay was encountered underlying the topsoil in Boreholes 1 to 7, 9 and 10, at the surface of Borehole 8, and underlying the sand in Boreholes 6 and 7. The sand and silt was considered very loose to dense, with SPT N-values ranging from of 1 to 82 blows per 0.30 m. The sand and silt was considered moist to wet, with moisture contents ranging from 7.5% to 22.4% (average 11.7%). The sand and silt was typically dark brown, loose to very loose and wet in the upper portions directly underlying topsoil, with trace organic content as well as rootlets.

4.3. ***Sand***

Brown sand, with up to trace amounts of silt and gravel, was encountered underlying the sand and silt in Boreholes 6, 7, and 9. The sand was considered compact to dense, with SPT N-values ranging from 10 to 45 blows per 0.30 m (average 27 blows per 0.30 m). The sand was considered moist to wet, with moisture contents ranging from 6.0% to 18.4% (average 12.8%).

4.4. ***Silt and Sand Till***

Light brown to grey, silt and sand till, with some gravel and trace clay, was encountered underlying the sand and silt in Boreholes 1 to 8, and Borehole 10, and underlying the sand in Borehole 9. The silt and sand till was considered very dense, with SPT N-values ranging from 57 to over 100 blows per 0.30 m (average 94 blows per 0.30 m). The silt and sand till was considered moist, with moisture contents ranging from 5.0% to 10.4% (average 7.0%).

4.5. ***Groundwater***

Accumulated groundwater was observed in Borehole 9, at an elevation of 335.98 m, corresponding to a depth of 3.17 m below ground surface. Accumulated groundwater was not observed in any of the other boreholes conducted as part of this investigation, though some wet soil conditions were observed within the upper sand and silt, as well as the sand soils. The very dense, relatively fine-grained silt and sand till has the potential to create perched water conditions in the overlying soils. It should be noted that groundwater conditions (particularly perched water) are generally dependent on the amount of precipitation, control of surface water, as well as the time of year, and can fluctuate significantly in elevation and volume.

Recommendations with respect to dewatering conditions are provided in Section 5.8 of this report.

5.0 DISCUSSION AND RECOMMENDATIONS

It is understood that the project will comprise the construction of construction of two 12-storey apartment buildings; one with two levels of underground parking and one with one level of underground parking.

Utilizing the information gathered during the geotechnical investigation and assuming that the borehole information is representative of the subsoil conditions throughout the site, the following comments and recommendations are provided.

5.1. Serviceability and Ultimate Limit Pressure

The following table provides the estimated highest founding elevation on the existing soils

Borehole No.	Ground Surface Elevation (m)	SLS kPa (psf)	ULS kPa (psf)	Estimated Highest Founding Elevation (m)	Soil Type
1	340.87	500 (10,000)	750 (15,000)	338.53 to 331.12 (termination)	Sand and Silt/ Silt and Sand Till
2	341.25	150 (3,000)	225 (4,500)	340.49 to 337.85	Sand and silt
		500 (10,000)	750 (15,000)	337.85 to 332.11 (termination)	Silt and Sand Till
3	340.76	150 (3,000)	225 (4,500)	338.17 to 337.71	Sand and Silt
		500 (10,000)	750 (15,000)	337.71 to 331.62 (termination)	Sand and Silt/ Silt and Sand Till
4	342.45	150 (3,000)	225 (4,500)	340.93 to 340.14	Sand and Silt
		500 (10,000)	750 (15,000)	340.14 to 333.31 (termination)	Silt and Sand Till
5	341.62	150 (3,000)	225 (4,500)	340.86 to 338.11	Sand and Silt
		500 (10,000)	750 (15,000)	338.11 to 332.48 (termination)	Silt and Sand Till
6	340.48	150 (3,000)	225 (4,500)	339.72 to 335.60	Sand and Silt/Sand
		500 (10,000)	750 (15,000)	335.60 to 331.34 (termination)	Silt and Sand Till
7	339.88	150 (3,000)	225 (4,500)	339.12 to 335.31	Sand and Silt/Sand
		500 (10,000)	750 (15,000)	335.31 to 332.26 (termination)	Silt and Sand Till
8	338.04	150 (3,000)	225 (4,500)	337.28 to 335.75	Sand and Silt
		500 (10,000)	750 (15,000)	335.75 to 330.42 (termination)	Silt and Sand Till
9	339.15	150 (3,000)	225 (4,500)	337.63 to 334.58	Sand
		500 (10,000)	750 (15,000)	334.58 to 330.92 (termination)	Silt and Sand Till
10	338.50	150 (3,000)	225 (4,500)	337.74 to 336.04	Sand and Silt
		500 (10,000)	750 (15,000)	336.04 to 330.88 (termination)	Silt and Sand Till

Based on the bearing capacities and elevations provided in the table above, suitable founding elevations for conventional foundations designed with a minimum bearing capacity of 500 kPa (10,000 psf) at SLS and 750 kPa (15,000 psf) at ULS range below elevations 334.58 m to 340.14 m for Boreholes 1 to 10. It should be noted that the above-referenced elevations of soils capable of supporting foundations designed with a bearing capacity of 500 kPa (10,000 psf) at SLS and 750 kPa (15,000 psf) at ULS corresponds with depths ranging from approximately 2.29 m to 4.88 m below the existing ground surface at the borehole locations.

Soil capable of supporting foundations are generally encountered below the topsoil and upper zone of soft, native soils containing organics and rootlets at the borehole locations, Therefore, the topsoil and relatively soft native soils must be subexcavated in the areas of the proposed structures. The founding soil must be assessed at the time of construction by qualified geotechnical personnel in order to confirm their founding suitability.

Should footings be designed to be constructed at elevations higher than the elevations indicated in the table above, then structural fill will be required in order to achieve the design grades for the proposed foundations. The serviceability limit pressure for granular structural fill placed and compacted in accordance with Section 5.4.5 of this report and constructed on approved competent native soils is estimated to be at least 150 kPa (3,000 psf). Alternatively, footings could be stepped down to bear on approved undisturbed founding soils.

Footings may be placed at a higher elevation relative to another footing provided that the slope between the outside face of the footings is separated by a minimum slope of 10 horizontal to 7 vertical (10H:7V) with an imaginary line projected from the underside of the footings. This must be taken into account for any deep structures such as elevator pits, sump pits and/or pump chambers.

With respect to the Serviceability Limit State (SLS), the total and differential footing settlements are not expected to exceed the generally acceptable limits of 25 mm (1") and 19 mm (3/4") respectively.

All exterior footings must be provided with a minimum of 1.2 m of soil cover or equivalent thermal insulation (sufficient thermal insulation is required to protect all footings and slab-on-grades during construction until such a time that the structure is heated) in order to provide protection from frost action.

At the time of investigation, the proposed founding elevations were not available. CMT Inc. would be pleased to review design drawings when they become available and provide further recommendations with respect to bearing and foundation elevations.

5.2. ***Seismic Site Classification***

The site classification for seismic response in Table 4.1.8.4 of the 2012 Ontario Building Code relates to the average properties of the upper 30 m of strata. The information obtained in the geotechnical field investigation was gathered from the upper 9.75 m of strata. Based on the information gathered in the geotechnical field investigation, the site classification for seismic site response would be considered Site Class C (stiff soils) for structures founded on the native soils at the recommended founding elevations provided in Section 5.1 of this report. For foundations constructed on structural fill, placed in accordance with Section 5.5 of this report, the site classification for seismic site response would be considered Site Class D (stiff soil). The structural engineer responsible for the design of the structure should review the earthquake loads and effects.

5.3. ***Soil Design Parameters***

The following soil design parameters can be utilized for shoring and/or foundation design calculations:

Soil Type	**Soil Density (kg/m^3)**	**Friction Angle (Degree)**	**Coefficient of Active Pressure (K_a)**	**Coefficient of Passive Pressure (K_p)**	**Coefficient of At-Rest Pressure (K_o)**	**Coefficient of Friction (μ)**
Imported Gran 'A'/Gran 'B' (OPSS 1010)	2,100	34 °	0.28	3.54	0.44	0.45
Sand and Silt	1,800	32°	0.31	3.25	0.47	0.41
Sand	1,850	32°	0.29	3.46	0.45	0.37
Silt and Sand Till	1,900	34°	0.28	3.54	0.44	0.45

5.4. ***Site Preparation***

The site preparation for the proposed new residential development will include the demolition of the existing residential dwellings on the property, topsoil stripping, vegetation grubbing, the removal or relocation of any existing services, the subexcavation of all unsuitable native soils deemed not capable of supporting the design bearing capacity, followed by the placement of structural fill (as required) and site grading to achieve proposed grades.

5.4.1. ***Building Demolition***

Currently, three (3) residential dwellings exist on the property, which are to be removed. All above-grade structures as well as all foundations, concrete slabs, and loose backfill must be removed within the proposed building envelopes, driveways, and surface parking lot areas.

All excavations must be inspected and then backfilled as required according to the procedures outlined in Section 5.4.5 of this report. It is recommended that good quality imported sand and gravel (OPSS 1010 Type II or Type III Granular 'B' or an approved alternative) be placed as structural fill as required. Provided any concrete from former building foundations and slab-on-grades, as well as any other concrete on-site (if encountered) is reduced to a maximum size of 100 mm, and all reinforcing steel and any deleterious materials are removed, the reduced concrete material may be combined with imported granular fill to be utilized as fill on-site. The reuse of this material will be subject to approval from qualified geotechnical personnel.

5.4.2. ***Topsoil Stripping/Vegetation Removal***

All topsoil, vegetation, and trees (including tree root structures as well as any loose soils that are typically associated with root structures) must be removed from within the proposed building, parking lot, and driveway envelopes to expose approved competent subgrade soils. The topsoil may be used in landscaped areas where some settlement can be tolerated; otherwise it should be properly disposed of off-site.

5.4.3. ***Unsuitable Soil Removal***

The upper sand and silt soils underlying the topsoil contain organic material and root structures, and are typically loose to very loose, and as such would be considered unsuitable to support footings, slab-on-grades (including expansive sidewalk areas), driveways and parking lot pavement structure. Therefore, it is recommended that this material be subexcavated from these areas. These materials are considered highly frost-susceptible and present the opportunity for premature damage to the pavement structure due to frost heave during freeze/thaw cycles. Due to the inconsistency in the soil materials, it may be prudent to have qualified geotechnical personnel on-site during the site grading process in order to confirm the suitability of the soils for reuse.

5.4.4. Removal/Relocation of Existing Services

Any existing/abandoned underground services (if present) that may be located within the proposed building envelope and/or parking lot and driveway areas should be removed/relocated. If left in place, the location of existing services must be reviewed to ensure that they do not conflict with the proposed foundation location. All terminated pipes must be completely sealed with watertight mechanical covers, concrete or grout at termination points to prevent the migration of soils into pipe voids which can result in potential settlement. All existing trench backfill material associated with any underground services must be subexcavated and the subsequent excavation should be backfilled with approved soils placed in accordance with Section 5.4.5 of this report.

Based on the age and location of the existing buildings, it would be expected that the existing houses may have been previously serviced by an on-site sewage system which should include a septic tank and associated distribution piping. The presence and/or location of existing septic systems were not observed/confirmed as part of this geotechnical investigation. It is recommended that the previous owners be consulted if possible to determine if a septic system may exist and if so, where it may be located. There is the potential to follow any sewage pipes that exit the basement to assist in location a septic tank and distribution piping. Any existing septic system components (including septic tank, distribution piping and associated clear stone bedding) must be removed and disposed of properly off-site.

The presence of existing potable water wells was not observed/confirmed during the geotechnical investigation. Water piping that exits the basement could also be followed in order to try and locate any potential potable water wells that may be located on the property. A review of Ministry of the Environment (MOE) well records indicated that a former dug well (0.91 m diameter by 8.23 m deep) was decommissioned at 1250 Gordon Street on October 11, 2005. As such, there is the potential for potable water wells to exist at 1242 and 1260 Gordon Street as well. It is a requirement of the Ontario Water Resources Act, Regulation 903, that ay wells be decommissioned by an MOE licensed well contractor if they are no longer required. A well that has been constructed to provide drinking water (potable water) would require an MOE licensed well contractor with a Class 1 or Class 2 license to decommission the well in accordance with Reg. 903.

All existing backfill and any disturbed soils associated with the removal of any septic system and/or well components must be subexcavated and the subsequent excavation must be backfilled with approved soils placed in accordance with Section 5.4.5 of this report.

5.4.5. Site Grading

Following the stripping of topsoil and subexcavation of any fill and/or loose to very loose soils deemed unsuitable of supporting foundations, slab-on-grad and/or driveway and parking lot pavement structure, the exposed subgrade must be proof-rolled and any soft or unstable areas must be subexcavated and replaced with approved fill materials. Any fill materials required to achieve the design site grades should be placed according to the following procedures:

- Should the native subgrade soils at the design founding elevation in the proposed building envelope(s) comprise wet or saturated soils, then a granular drainage layer constructed in accordance with Section 9.14.4 of the current Ontario Building Code (OBC) may be required. Alternatively, a lean mix concrete mud mat may be poured overlying the subgrade soils to provide a stable base;

- Prior to placement of any structural fill, the subgrade for the proposed new buildings must be prepared large enough to accommodate a 1:1 slope commencing a distance of 1.0 m beyond the outside edge of the proposed foundation down to the competent native founding soils;

- Soils approved for use as structural fill must be placed in loose lifts not exceeding 0.3 m (12") in depth for granular soils (recommended fill materials) and 0.2 m (8") in depth for silts and clays, or the capacity of the compactor (whichever is less);

- Granular fill materials (OPSS 1010 Type II or Type III Granular 'B' recommended for this application) can be compacted utilizing adequate heavy vibratory smooth drum compaction equipment;

- Fine-grained silt and clay soils (if imported) must be compacted utilizing adequate heavy padfoot vibratory compaction equipment;

- Approved fill materials must be at suitable moisture contents to achieve the specified compaction;

- Approved structural fill materials that will support structures (including foundations, interior slab-on-grades, sidewalks and large expansive exterior slabs) must be compacted to 100% standard Proctor maximum dry density (SPMDD);

- Approved bulk fill (exterior foundation wall backfill in landscaped areas, bulk fill for roadway and driveways) must be compacted to a minimum 95% SPMDD;
- Granular 'B' subbase and Granular 'A' base materials for the roadway and driveways must be compacted to 100% SPMDD.

Based on the subsurface conditions observed in the boreholes, wet soils may be encountered, depending on the depth of excavation. As such, for soils excavated from the zone of saturation, significant air-drying along with working of the soils may be required in order to achieve the specified compaction of 100% SPMDD in the building envelope (including 1:1 as required) and 95% SPMDD for bulk fill for the parking lot and driveways. Utilizing the existing soils during site grading may be more achievable if work is completed during the generally drier summer months. It should be noted, however, that due to the nature of some of the soils, during hot dry weather, the addition of water might be required in order to achieve the specified compaction. Reuse of excavated soils on-site will be subject to approval from qualified geotechnical personnel.

5.5. Foundation Subgrade Preparation

The native sand and silt, sand, as well as the silt and sand till encountered in the boreholes are sensitive to change in moisture content and can become loose/soft if the subjected to additional water or precipitation as well as severe drying conditions. The native subgrade soils could also be easily disturbed if traveled on during construction. Once they become disturbed they are no longer considered adequate for the support of shallow foundations. To ensure and protect the integrity of the founding soils during construction operations, the following is recommended:

- During construction, the subgrade should be sloped to a sump (as required) located outside the building footprint (if feasible) in the excavation to promote surface drainage of rainwater or seepage and the collected water should be pumped out of the excavation. It is critical that all water be controlled (not allowed to pond) and that the subgrade and foundation preparation commence in dry conditions;
- Construction equipment travel and foot traffic on the founding soils should be minimized;
- If construction is to be undertaken during subzero weather conditions, the founding native soils and any potential fill materials must be maintained above freezing;

- Prior to pouring concrete for the footings, the footing area must be cleaned of all disturbed or caved materials;

- The foundation formwork and concrete should be installed as soon as practical following the excavation, inspection and approval of the founding soils. The longer that the excavated soils remains open to weather conditions and groundwater seepage, the greater the potential for construction problems to occur;

- If it is expected that the founding soils will be left open to exposure for an extended period of time, it is recommended that a 75 mm concrete mud slab be poured in order to protect the structural integrity of the founding soils.

5.6. Slab-on-Grade/Modulus of Subgrade Reaction

Prior to the placement of the granular base for the slab-on-grade construction, the subgrade should be proof-rolled. Any soft or weak zones should be subexcavated and backfilled with approved fill materials (see Section 5.7 of this report).

The following table provides the modulus of subgrade reaction (k) for the native soils encountered on-site:

Soil Type	Modulus of Subgrade Reaction (k)
Sand and Silt	54,000 kN/m^3 (200 lb/in^3)
Sand	68,000 kN/m^3 (250 lb/in^3)
Silt and Sand Till	81,000 kN/m^3 (300 lb/in^3)
Imported Sand and Gravel (OPSS 1010)	81,000 kN/m^3 (300 lb/in^3)

In dry conditions, the floor slab can be founded on a minimum thickness of 150 mm (6") of Granular 'A' (OPSS 1010) and compacted to 100% SPMDD. Alternatively (particularly in wet conditions), 150 mm (6") of 19 mm clear crushed stone (OPSS 1004) could be used instead of Granular 'A'. Compactive effort should be utilized to consolidate the clear stone.

It is recommended that areas of extensive exterior slab-on-grade (sidewalks, accessibility ramps and exterior stairs) be constructed with a Granular 'B' subbase (300 mm) and a Granular 'A' base (150 mm), as well as incorporating subdrains, to provide rapid drainage and reduce the effects of frost heaving. This is particularly critical at all barrier-free access points. Alternatively, a structural frost slab or thermal insulation could be designed and constructed at door entrances.

5.7. Excavations

All excavations must be carried out in accordance with Ontario Regulation 213/91 (Reg 213/91) of the Occupational Health and Safety Act and Regulations for Construction Projects.

Type 2 Soils - In general, the very dense silt and sand till soils encountered in the boreholes, in a drained state (not saturated), would be classified as Type 2 soils under Reg 213/91. Type 2 soils must be sloped from within 1.2 m of the bottom of the excavation at a minimum gradient of 1 horizontal to 1 vertical. Soils underlain by Type 3 or Type 4 soils that are exposed in the excavation must be treated accordingly as Type 3 or Type 4 soils (see below). Soils in a saturated condition (if encountered) must be treated as Type 4 soils, addressed below.

Type 3 Soils - In general, the compact sand and silt, as well as the sand soils encountered in the boreholes, in a drained state (not wet or saturated), would be classified as Type 3 soils under Reg 213/91. The Type 3 soils must be sloped from the bottom of the excavation at a minimum gradient of 1 horizontal to 1 vertical. All saturated soils encountered must be treated as Type 4 soils, as described below.

Type 4 Soils - In general, any wet to saturated soils would be classified as Type 4 soils under Reg 213/91. Type 4 soils must be sloped from the bottom of the excavation at a minimum gradient of 3 horizontal to 1 vertical.

If it is not practical to excavate according to the above requirements, then a trench support system (designed in accordance with the Ontario Health and Safety Act Regulations) may be utilized.

It should be noted that the native sand and silt, as well as the silt and sand till soils were observed to be very dense in places (N-values in excess of 50 blows). If excavations extend into these soils, it may prove difficult to excavate with conventional excavating equipment, impacting the production schedule. It is imperative that when very dense/hard soils are utilized for backfilling of service trenches, the material must be broken down (pulverized) to minimize voids and reduce the potential for settlement. It is not recommended that the very dense silt and sand till be utilized as structural fill, as it can be subject to excessive void space and potential settlement if not properly placed and compacted.

5.8. Construction Dewatering Considerations

Accumulated groundwater was observed in Borehole 9, at an elevation of 335.98 m, corresponding to a depth of 3.17 m below ground surface. Accumulated groundwater was not observed in any of the other boreholes conducted as part of this investigation, though some wet soil conditions were observed within the upper sand and silt, as well as the sand soils. The very dense, relatively fine-grained silt and sand till has the potential to create perched water conditions in the overlying soils. It should be noted that groundwater conditions (particularly perched water) are generally dependent on the amount of precipitation, control of surface water, as well as the time of year, and can fluctuate significantly in elevation and volume. As such, provisions for site dewatering should be part of the site development and construction process.

Seepage control requirements during construction will depend upon the area of work on the site, the depth of the excavations, the time of year, the amount of precipitation and the control of surface water. As required, seepage should generally be adequately controlled using conventional construction dewatering techniques such as pumping from sump pits. However, if heavy seepage occurs, it may be necessary to increase the number of pumps during construction.

Dewatering should be performed in accordance with OPSS 517 and the control of water must be in accordance with OPSS 518. It is the responsibility of the contractor to propose a suitable dewatering system based on the groundwater elevation at the time of construction. Collected water should discharge a sufficient distance away from the excavation to prevent re-entry. Sediment control measures must be installed at the discharge point of the dewatering system to avoid any potential adverse impacts on the environment.

5.9. Service Pipe Bedding

The native soils encountered in the geotechnical investigation are generally considered suitable for indirect support of the site service pipes. Should instability due to saturated soil conditions be encountered, it may be necessary to increase the thickness of the granular base and utilize 19 mm clear stone to create an adequate supporting base for the service pipes and/or manholes. Pipe embedment, cover and backfill for both flexible and rigid pipes should be in accordance with all current and applicable OPSD, OPSS and OBC standards and guidelines and as follows:

Flexible Pipes - The pipe bedding should be shaped to receive the bottom of the pipe. If necessary, pipe culvert frost treatment should be undertaken in accordance with OPSD-803.031. The trench excavations should be symmetrical with respect to the centreline of the pipe. The granular material placed under the haunches of the pipe must be compacted to 95% SPMDD prior to the continued placement and compaction of the embedment material. The homogeneous granular material used for embedment should be placed and compacted uniformly around the pipe. Should wet conditions be encountered at the base of the trench, then the pipe bedding should consist of 19 mm clear stone (meeting OPS Specifications) wrapped completely in a geotextile fabric such as Terrafix 270 or equivalent. The general contractor is responsible to protect service piping from damage by heavy equipment.

Rigid Pipes - In general, the pipe installation recommendations for rigid pipes are the same as those for flexible pipes, except that the minimum bedding depth below a rigid pipe should be 0.15*D* (where *D* is the pipe diameter). In no case should this dimension be less than 150 mm or greater than 300 mm.

5.10. Perimeter Building Drainage, Foundation Wall Backfill and Trench Backfill

In order to assist in maintaining a dry building with respect to surface water seepage, it is recommended that exterior grades around the buildings be sloped down and away at a 2% gradient or more, for a distance of at least 1.5 m to 2.0 m (depending on side yard setbacks). Any surface discharge rainwater leaders must be constructed with solid piping that discharges with positive drainage at least 1.5 m away from building foundations and/or beyond sidewalks to a drainage swale or appropriate storm drainage system.

It should be noted that based on the observations in the boreholes, there is potential for perched water conditions. The construction of foundations, slabs-on-grade, elevator pits and sump pits within or below zones of saturation will require design of site-specific waterproofing and dewatering systems constructed in accordance with the 2012 OBC. It is recommended that a good quality sump pump be utilized and that the system be equipped with a battery back-up in the event of power failure, (keeping in mind that a battery back-up system does not typically have a long run time). If required, it would be recommended that a waterproofing supplier/specialist be consulted to recommend an appropriate product and installation requirements that would be suited to this site.

An exterior perimeter weeping tile system comprising perforated drainage pipe with a factory installed filter sock, bedded in 19 mm clear crushed stone (OPSS 1004) and wrapped in a geotextile filter fabric such as Terrafix 270R (or equivalent), must be installed at an elevation that is below the proposed slab-on-grade elevation and provided with positive drainage into a sump pit. The portion of the piping that connects the exterior weeping tile system into the sump pit must comprise solid piping to prevent exterior water from being introduced into the interior subslab stone. It may be prudent to install perforated drainage pipe on the interior as well to provide an outlet for any water that may collect in the subslab stone (particularly during the construction phase of the project). It is also recommended that a capped cleanout port(s) be extended up to the ground surface elevation to provide future access (if required). The rainwater leaders must not be connected to the perimeter weeping tile system. Foundation wall and slab-on-grade damp proofing and/or waterproofing must conform to current OBC regulations.

Depending on the groundwater conditions at the design founding elevations, it may be necessary to install a granular drainage layer to provide a suitable base for the foundations. This will depend on the bearing capacity required for the founding strata. If required, the granular drainage layer must conform to the requirements listed in Section 9.14.4 of the OBC 2012.

In order to reduce the effects of surficial frost heave, it is recommended that the exterior foundation backfill in areas that will be hard surfaced consist of free-draining granular material such as imported Granular 'B' Type I or III (OPSS 1010), with a maximum aggregate size not exceeding 100 mm, and that it extend a minimum lateral distance of 600 mm out from the foundation walls and/or beyond perimeter sidewalks and entranceway slabs. It is critical that particles greater than 100 mm in diameter are not in contact with the foundation wall to prevent point loading and overstressing. The backfill material used against the foundation walls must be placed so that the allowable lateral capacities of the foundation walls are not exceeded. Where only one side of a foundation wall will be backfilled and the height of the wall is such that lateral support is required, or where the required concrete strength has not been achieved, the wall must be braced or laterally supported prior to backfilling. The backfill material used against the foundation walls must be placed so that the allowable lateral capacities of the foundation walls are not exceeded. In situations where both sides of the wall are backfilled, the backfill should be placed in equal lifts, not exceeding 200 mm differential on each side during backfill operations and the backfill should be compacted to a minimum of 98% SPMDD.

The native mineral soils (non-organic), are generally considered suitable for reuse as trench backfill and bulk fill in the roadway and driveways; however, the wet to saturated soils will require significant air-drying in order to achieve the specified field compaction. Air-drying cannot typically be achieved during winter construction; therefore, depending on the time of year that construction takes place, it may be more feasible to utilize an imported granular fill for this project.

Backfilling operations should be carried out with the following minimum requirements:

- Adequate heavy smooth drum or padfoot vibratory compaction equipment should be used for the compaction and to break down any large blocky pieces of soil;

- Loose lift thicknesses should not exceed 0.3 m (12") for granular soils or 0.2 m (8") for clay and silt soils or the capacity of the compactor (whichever is less);

- The soils must be at suitable moisture contents to achieve compaction to a minimum 95% SPMDD in non-structural bulk fill areas; service trenches excavated within the zone of influence of footings for structures must be compacted to a minimum of 100% SPMDD;

- It is recommended that inspection and testing be carried out during construction to confirm backfill quality, thickness and to ensure that compaction requirements are achieved;

- Service trench backfill materials may consist of approved excavated soils with no particles greater than 100 mm and no topsoil or other deleterious materials;

- If construction operations are undertaken in the winter, strict consideration should be given to the condition of the backfill material to make certain that frozen material is not used.

5.11. ***Pavement Design/Drainage***

As previously indicated, any fill and all existing very loose or loose native soils must be subexcavated from within the proposed driveways and surface parking lot areas. Alternatively, prior to placement of the granular base, the loose native soils could be further consolidated. It would be expected that significant air-drying of this material will be required in order to achieve the design compaction. Any soft or unstable areas should be subexcavated and replaced with suitable drier materials. The subgrade should be graded smooth (free of depressions) and properly crowned to ensure positive drainage, with a minimum grade of 3% toward catch basins (if installed) or to the pavement edge (provided proper gravity drainage to a suitable outlet is provided). When service pipes are installed, pipe bedding and backfilling should be undertaken as indicated in Sections 5.9 and 5.10 of this report.

Rapid drainage of the pavement structure is critical to ensure long-term performance. The requirement for subdrains will be dependent on the composition of the prepared road subgrade soils. Should the subgrade soils comprise fine-grained, frost-susceptible soils, it is highly recommended to install subdrains (provided gravity drainage to a suitable outlet can be provided). It is recommended to install minimum 100 mm diameter perforated subdrains to collect and redirect water beneath the pavement surface. Subdrains should be designed and installed in accordance with OPSS 405 and OPSD 216.021. If Granular 'A' bedding (OPSS 1010) is utilized, the subdrains should be equipped with a factory installed filter sock. If 19 mm clear stone (OPSS 1004) is utilized as bedding for the subdrain, then the bedding must be wrapped completely with geotextile filter fabric such as Terrafix 270R (or equivalent) and a factory installed filter sock is not required. Installation of rigid subdrains allows for better grade control and less potential for damage during installation; however, it would be expected that there would be higher cost implications associated with the installation of rigid subdrains over flexible subdrains. Positive drainage through grade control of subdrains is critical, as improperly installed subdrains can turn drainage systems into reservoirs, which can fuel frost action. The subdrains will hasten the removal of water, thereby reducing the risk and effects of frost heaving and load transfer in saturated conditions. It is suggested that, at a minimum, subdrains be installed through all low areas in the parking lot and driveways, and ideally along the curb lines as well to prevent water from entering the granular subbase. The subdrains should be installed in a 0.3 m (1.0 ft) by 0.3 m (1.0 ft) trench in the subgrade and bedded approximately 50 mm (2") above the bottom of the trench. The subgrade must be prepared with positive drainage to the subdrains and the subdrains must be installed with positive drainage into a catch basin structure or other suitable outlet.

Should the subgrade soils comprise free-draining granular soils (minimum 1.0 m thick with positive drainage at the interface with any relatively impermeable soils), then the installation of subdrains may not be required.

The native subgrade soils are sensitive to change in moisture content and can become loose or soft if the soils are subject to inclement weather and seepage or severe drying. Furthermore, the subgrade soils could be easily disturbed if traveled on during construction. As such, where this material will be exposed, it is recommended that the granular subbase be placed immediately upon completion of the subgrade preparation to protect the integrity of the subgrade soils.

It is expected that the driveways and parking lots will experience light traffic (personal vehicles) and heavy traffic (moving trucks, delivery trucks, as well as maintenance and emergency vehicles). Based on the anticipated loading, the following pavement design is provided:

Material	**Recommended Thickness For New Pavement**	
	Light Traffic	Heavy Traffic
Asphaltic Concrete	HL3-40 mm (1.5") HL4 or HL8-50 mm (2.0")	HL3-40 mm (1.5") HL4 or HL8-60 mm (2.0")
Granular 'A' Base	150 mm (6.0")	150 mm (6.0")
Granular 'B' Subbase	300 mm (12.0")	450 mm (18.0")

Given the potential for wet subgrade conditions, site assessments may be required at the time of construction to determine what options can be undertaken to construct a stable driveway and parking lot base. These options may include subexcavation and increasing the thickness of the Granular 'B' subbase, the use of reinforcing geotextile and/or geogrid, or a combination of all. As such, it is recommended that provisions for subexcavation and disposal of wet soils, importing and placing additional Granular 'B' (OPSS 1010), as well as supply and placement of a reinforcing geotextile (Terrafix 200W or equivalent) and geogrid (Tensar BX1200 or equivalent) should be included in the tender documents.

Frost tapers must be constructed at any changes from light traffic to heavy traffic areas. If heavy traffic routes are not delineated by barriers or if it is anticipated that heavy equipment (such as loaders and dump trucks) will be utilized for snow removal, it would be recommended that the heavy traffic pavement structure be utilized throughout.

Construction joints in the surface asphalt must be offset a minimum of 150 mm to 300 mm (6" to 12") from construction joints in the binder asphalt so that longitudinal joints do not coincide.

Where new asphalt is joined into existing asphalt, it is recommended that the existing asphalt be sawcut in a straight line prior to being milled to a depth of 40 mm and a width of 150 mm as per OPSD 509.010. It is recommended that a tackcoat in conformance with OPSS 308 be applied to the edge and surface of all milled asphalt prior to placement of new asphalt.

The granular base and subbase materials must conform to the physical property and gradation requirements of OPSS 1010 and must be compacted to 100% SPMDD. Asphaltic concrete should be supplied, placed and compacted to a minimum 92.0% Marshall maximum relative density, in accordance with OPSS 1150 and OPSS 310.

The pavement should be designed to ensure that water will not pond on the pavement surface. If the surface asphalt is not placed within a reasonable time following placement of the binder asphalt, it is recommended that the catch basin lids are set at a lower elevation or apertures provided to allow surface water to drain into the catch basins and not accumulate around the catch basins. The strength of the pavement structure relies on all of the components to be in place in order to provide the design strength; therefore, it is strongly recommended that the surface asphalt be placed shortly after placement of the binder asphalt so as to avoid undue stress on the binder asphalt by not having the complete pavement structure in place.

It should be noted that, currently, asphalt mixes tend to be more flexible and, as such, there is a tendency for damage to occur from vehicles turning their steering wheels or applying excessive brake pressure. The damage can occur from both passenger vehicles as well as large vehicles. The condition is further intensified during hot weather. In high traffic/tight turning areas, it is recommended that rigid portland cement pavement be considered.

5.12 Chemical Analysis/Excess Soil Management

Generally if surplus soils are to be exported off-site, it will be necessary to perform chemical analysis of the soils. An environmental study was performed by XCG Consulting Limited, which should be referred to for the chemical analysis and excess soil management recommendations.

5.13 Storm Water Infiltration

As part of the geotechnical investigation, gradation analyses were performed on samples of the native silt and sand/sand and silt with trace to some gravel and clay. The following table provides the sample location (borehole number), sample depth, corresponding estimated coefficient of permeability (k) as well as soil type:

Borehole No.	**Depth (m)**	**Estimated Coefficient of Permeability (k) cm/s**	**Soil Type**
2	7.62 – 9.14	$<1.0 \times 10^{-6}$	silt and sand, some clay, trace gravel (ML)
5	1.52 - 2.13	6.25×10^{-6}	sand and silt, some gravel, trace clay (SM)
8	1.52 - 2.13	9.61×10^{-6}	sand and silt, some gravel, trace clay (SM)

Based on the grain size distribution curves and the estimated coefficient of permeability, as well as the generally dense to very dense nature, the native silt and sand/sand and silt encountered in the boreholes are not considered conducive to storm water infiltration.

The very dense glacial till soils encountered in the lower zone of boreholes have the potential to create perched water conditions which can result in wet to saturated zones as observed in the boreholes. Perched water conditions are generally dependent on the amount of precipitation, control of surface water, as well as the time of year, and can fluctuate significantly in elevation and volume.

We understand that the project layout and location of any potential infiltration galleries are not finalized yet. If infiltration galleries are to be included in the project design, once the location of the potential infiltration galleries is determined, additional sampling and/or laboratory testing may be required. Samples are generally stored for three months unless other arrangements are made.

5.14 __Radon__

According to information provided by Health Canada, radon is a radioactive gas that is naturally formed through the breakdown of uranium in soil, rock and water. When radon escapes the earth in the outdoors, it mixes with fresh air, resulting in concentrations that are too low to be of concern. However, when radon enters an enclosed space, such as a building, high concentration of radon can accumulate and become a health concern. Health Canada indicates that most homes have some level of radon in them. Unfortunately, it is not possible to predict before construction whether or not a new home will have high radon levels as radon can only be detected by radon measurement devices, which would be installed in a home, post construction. Section 9.13.4.1 Soil Gas Control of the current 2012 Ontario Building Code (OBC) states that *"Where methane or radon gases are known to be a problem, construction shall comply with the requirements for soil gas control in MMAH Supplementary Standard SB-9, Requirements for Soil Gas Control".*

6.0 SITE INSPECTIONS

Qualified geotechnical personnel should supervise excavation inspections as well as compaction testing for structural filling, site grading and site servicing. This will ensure that footings are founded in the proper strata and that proper material and techniques are used and the specified compaction is achieved. CMT Engineering Inc. would be pleased to review the design drawings and provide an inspection and testing program for the construction of the proposed development.

7.0 LIMITATIONS OF THE INVESTIGATION

This report is intended for the Client named herein and for their Client. The report should be read in its entirety, and no portion of this report may be used as a separate entity. 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.

The recommendations made in this report are in accordance with our present understanding of the project. We request that we be permitted to review our recommendations when the drawings and specifications are complete, or if the proposed construction should differ from that mentioned in this report.

It is important to emphasize that a soil investigation is, in fact, a random sampling of a site and the comments are based on the results obtained at the test locations only. It is therefore assumed that these results are representative of the subsoil conditions across the site. Should any conditions at the site be encountered which differ from those found at the test locations, we request that we be notified immediately in order to permit a reassessment of our recommendations.

It should be noted that this report specifically addresses geotechnical aspects of the project and does not include any investigations or assessments relating to potential subsurface contamination. As such, there should be no assumptions or conclusions derived from this report with respect to potential soil or water contamination. Soil or water contamination is generally caused by the presence of xenobiotic (human-made) chemicals or other alteration processes in the natural soil and groundwater environment. If necessary, the investigation, assessment and rehabilitation of soil and water contaminants should be undertaken by qualified environmental specialists.

The samples obtained during the geotechnical investigation will be stored for a period of three months, after which time they will be disposed of unless alternative arrangements are made.

We trust that this report meets with your present requirements. Should you have any questions, please do not hesitate to contact our office.

Prepared by:

for

Shawn Wheatley, B.Sc

LICENSED PROFESSIONAL ENGINEER
May 1/18
R. KOOPMANS
PROVINCE OF ONTARIO

Reviewed by:

Robert Koopmans, P.Eng.
Consulting Engineer

NOTES:

Base map provided by Google Maps

N

NO.	DESCRIPTION	DATE

REVISIONS

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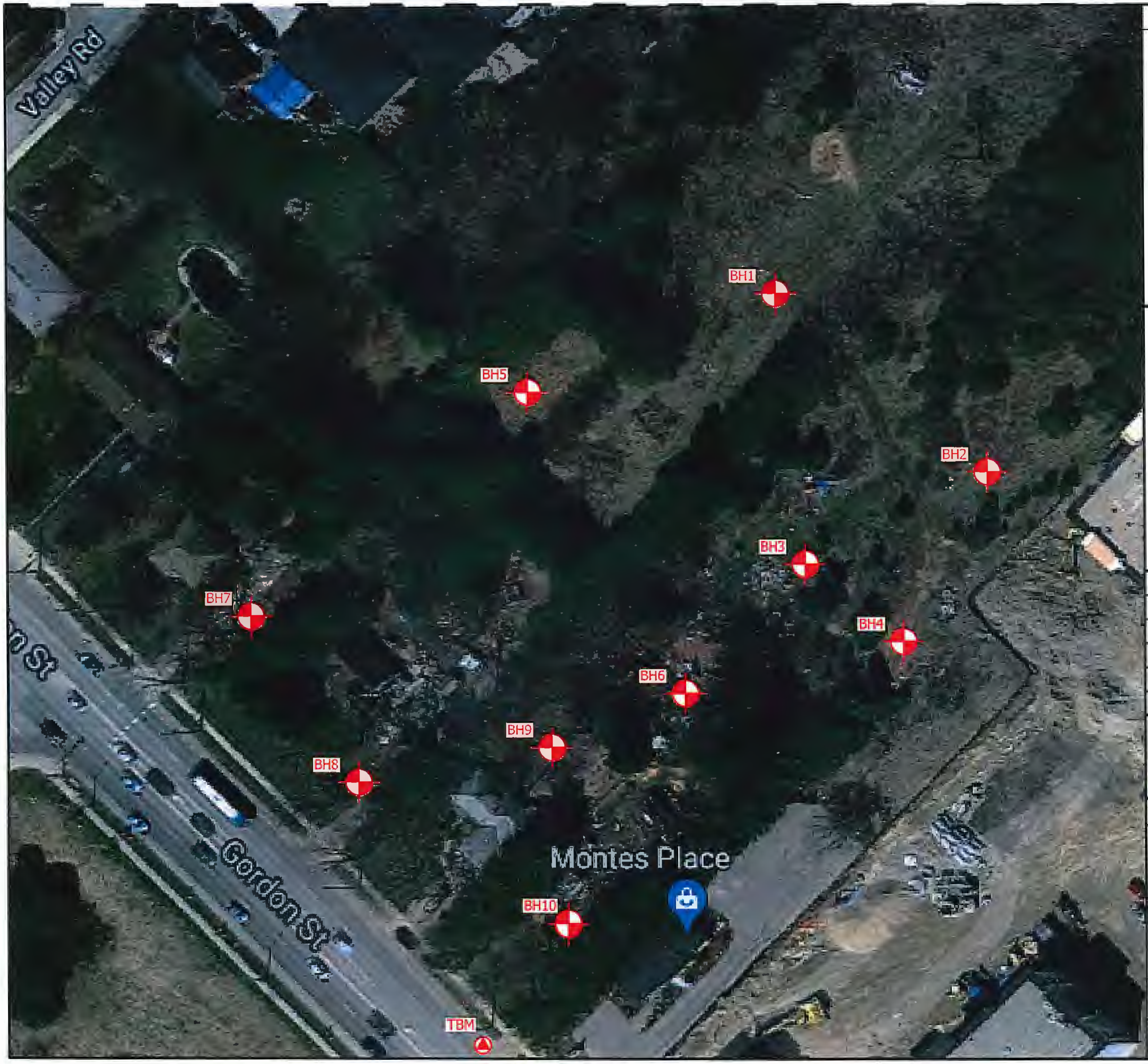
Fax: 519-699-4664
www.cmtinc.net

PROJECT:
Two 12 Storey Apartment Buildings
1242, 1250, and 1260 Gordon St.
Guelph, Ontario

DRAWING TITLE:
SITE LOCATION MAP

PROJECT NO.: 18-099
DATE: April 19, 2018
SCALE: N.T.S.
DRAWING NO. 1



NOTES:

1. This drawing is for information purposes only. Locations and sizes of existing and proposed structures are approximate only, and should not be used for construction.
2. Base image is provided by Google Maps
3. Temporary Benchmark: top of Manhole 'H', on Gordon Street across from House #1260 Reported elevation = 336.21 m

N

NO.	DESCRIPTION	DATE

REVISIONS

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PROJECT:
Two 12 Storey Apartment Buildings
1242, 1250, and 1260 Gordon St.
Guelph, Ontario

DRAWING TITLE:
SITE PLAN SHOWING
BOREHOLE LOCATIONS

PROJECT NO.: 18-099
DATE: April 19, 2018
SCALE: N.T.S.
DRAWING NO. 2

APPENDIX A

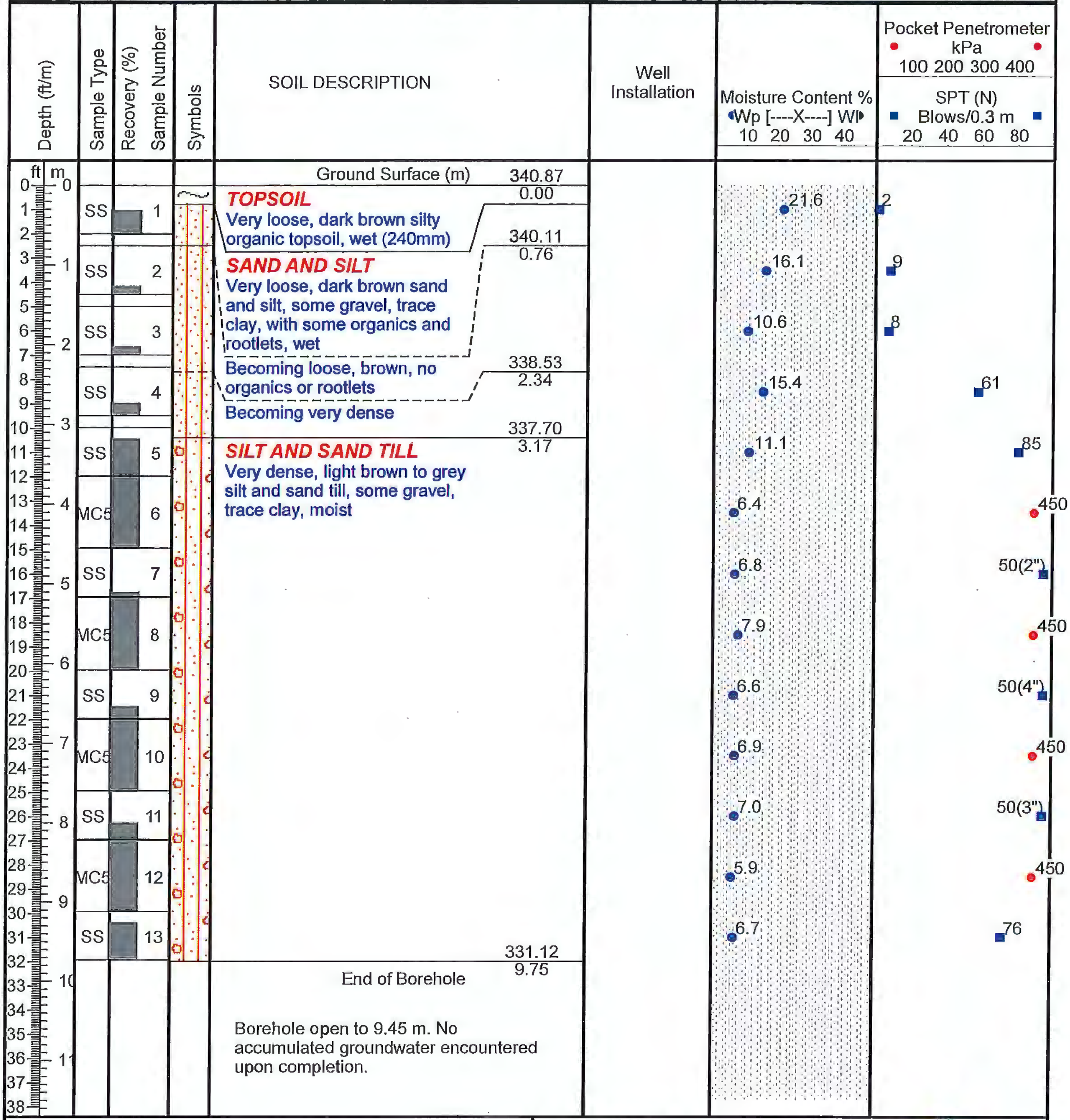
BOREHOLE LOGS

BOREHOLE 1

Date Drilled: April 18, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 340.87 m
Logged by: SW

Project No.: 18-099
Project: Two 12 Storey Appt. Buildings
Location: 1242, 1250, 1260 Gordon St
Guelph, ON



Ground Surface (m)	340.87	
TOPSOIL Very loose, dark brown silty organic topsoil, wet (240mm)	0.00	
SAND AND SILT Very loose, dark brown sand and silt, some gravel, trace clay, with some organics and rootlets, wet	340.11	0.76
Becoming loose, brown, no organics or rootlets	338.53	2.34
Becoming very dense		
SILT AND SAND TILL Very dense, light brown to grey silt and sand till, some gravel, trace clay, moist	337.70	3.17
End of Borehole	331.12	9.75

Sample Type	Sample Number	Moisture Content %	SPT (N) / Pocket Penetrometer
SS	1	21.6	2
SS	2	16.1	9
SS	3	10.6	8
SS	4	15.4	61
SS	5	11.1	85
MC5	6	6.4	450
SS	7	6.8	50(2")
MC5	8	7.9	450
SS	9	6.6	50(4")
MC5	10	6.9	450
SS	11	7.0	50(3")
MC5	12	5.9	450
SS	13	6.7	76

Borehole open to 9.45 m. No accumulated groundwater encountered upon completion.

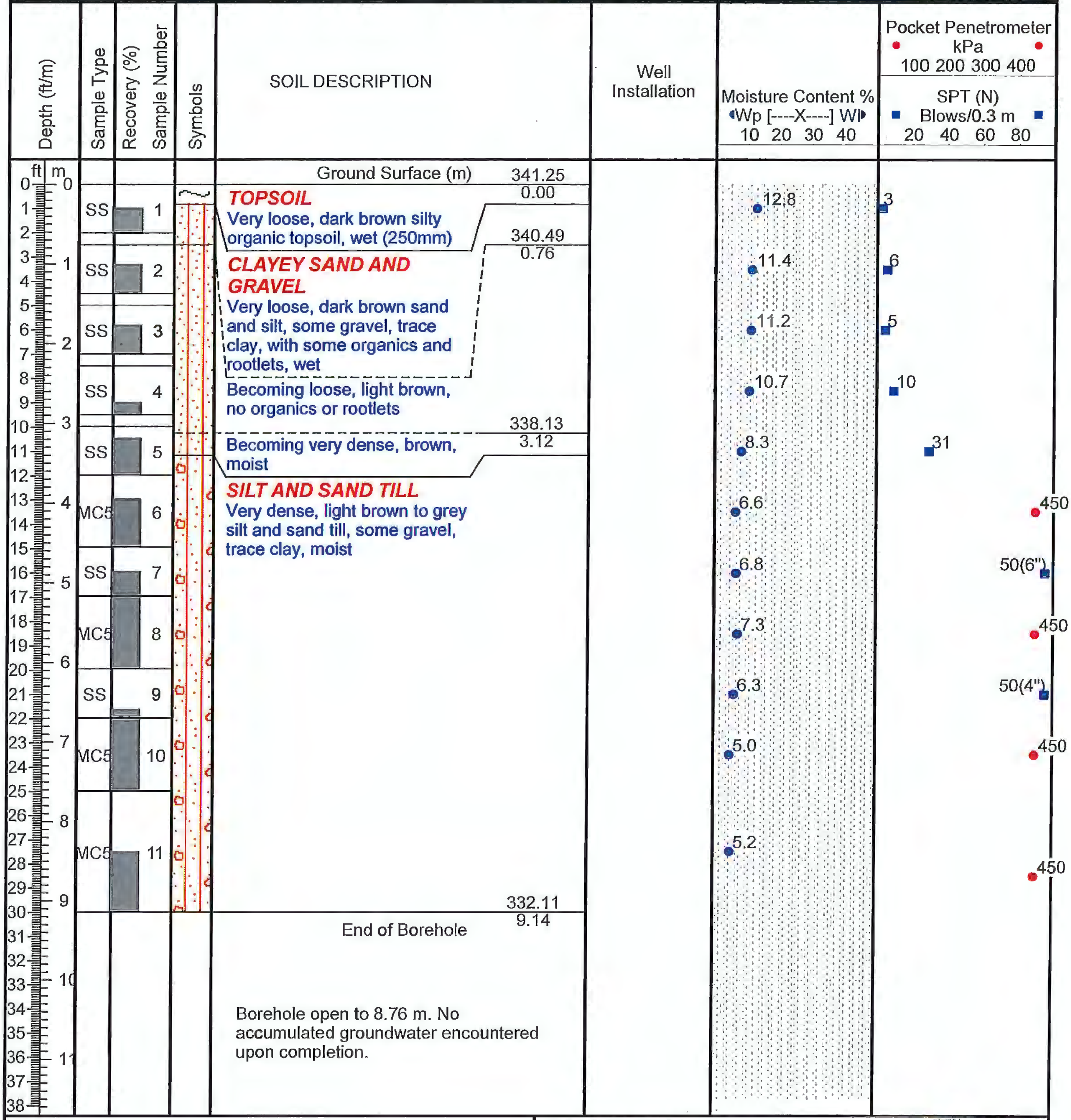
BOREHOLE 2

Page 1 of 1

Date Drilled: April 18, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 341.25 m
Logged by: SW

Project No.: 18-099
Project: Two 12 Storey Appt. Buildings
Location: 1242, 1250, 1260 Gordon St
Guelph, ON



SOIL DESCRIPTION	
Ground Surface (m)	341.25
	0.00
TOPSOIL Very loose, dark brown silty organic topsoil, wet (250mm)	
	340.49 0.76
CLAYEY SAND AND GRAVEL Very loose, dark brown sand and silt, some gravel, trace clay, with some organics and rootlets, wet	
Becoming loose, light brown, no organics or rootlets	
	338.13 3.12
Becoming very dense, brown, moist	
SILT AND SAND TILL Very dense, light brown to grey silt and sand till, some gravel, trace clay, moist	
	332.11 9.14
End of Borehole	

Borehole open to 8.76 m. No accumulated groundwater encountered upon completion.

Sample Type	Sample Number	Moisture Content %	SPT (N)	Pocket Penetrometer kPa
SS	1	12.8	3	
SS	2	11.4	6	
SS	3	11.2	5	
SS	4	10.7	10	
SS	5	8.3	31	
MC5	6	6.6		450
SS	7	6.8	50(6")	
MC5	8	7.3		450
SS	9	6.3	50(4")	
MC5	10	5.0		450
MC5	11	5.2		450

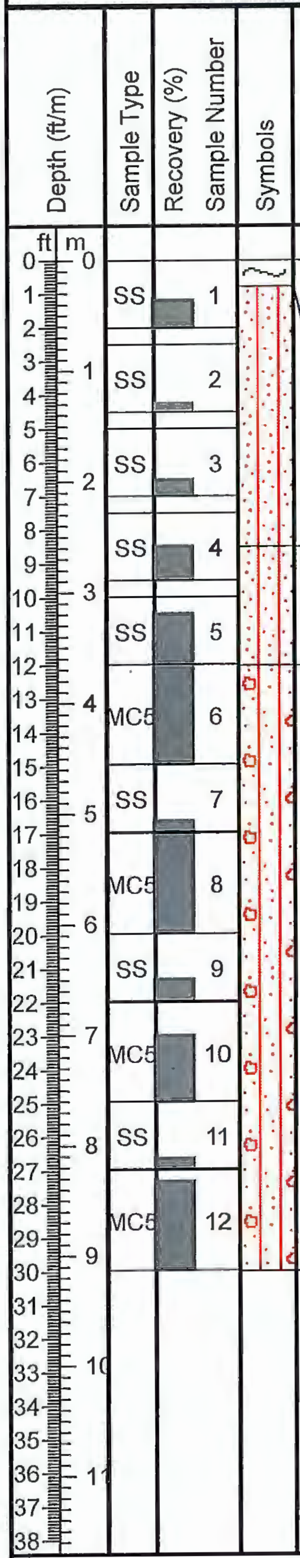
BOREHOLE 3

Page 1 of 1

Date Drilled: April 17, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 340.76 m
Logged by: SW

Project No.: 18-099
Project: Two 12 Storey Appt. Buildings
Location: 1242, 1250, 1260 Gordon St
Guelph, ON



SOIL DESCRIPTION

Ground Surface (m) 340.76

0.00
TOPSOIL
Loose, dark brown silty organic topsoil, moist (240mm)

SAND AND SILT
Loose, dark brown sand and silt, some gravel, trace clay, wet

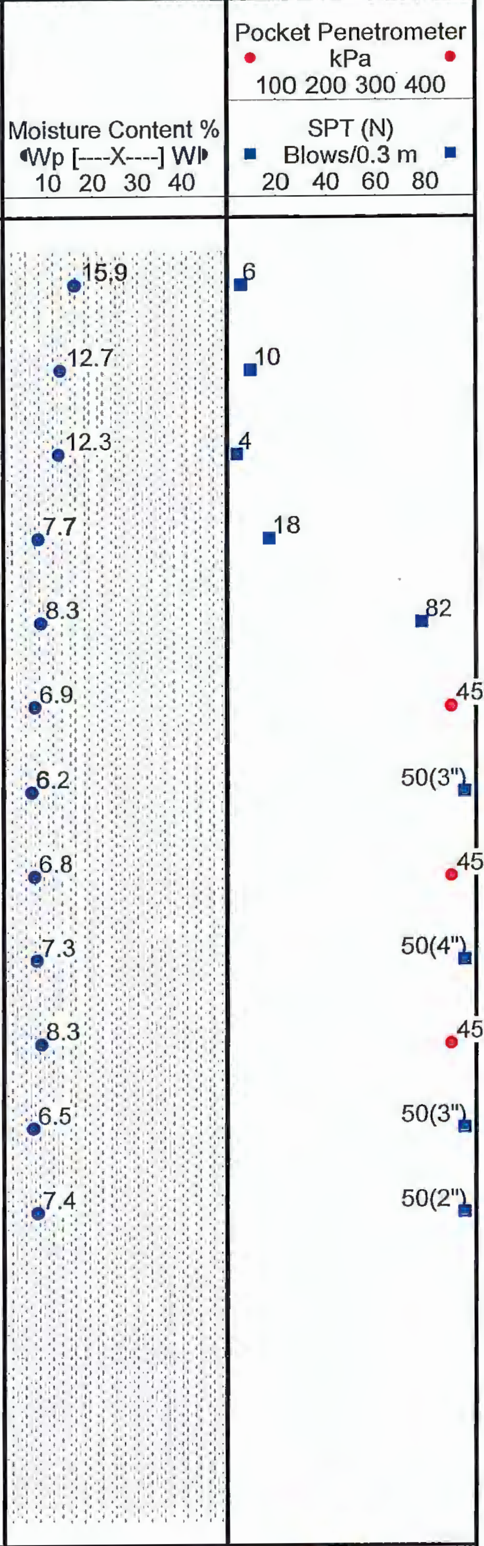
338.17
2.59
Becoming very dense, brown

337.10
3.66
SILT AND SAND TILL
Very dense, light brown to grey silt and sand till, some gravel, trace clay, moist

331.62
9.14
End of Borehole

Cave at 8.05 m. No accumulated groundwater encountered upon completion.

Well Installation



Sample Type	Sample Number	Moisture Content %	Pocket Penetrometer kPa	SPT (N) Blows/0.3 m
SS	1	15.9		6
SS	2	12.7		10
SS	3	12.3		4
SS	4	7.7		18
SS	5	8.3		82
MC5	6	6.9	450	
SS	7	6.2		50(3")
MC5	8	6.8	450	
SS	9	7.3		50(4")
MC5	10	8.3	450	
SS	11	6.5		50(3")
MC5	12	7.4		50(2")

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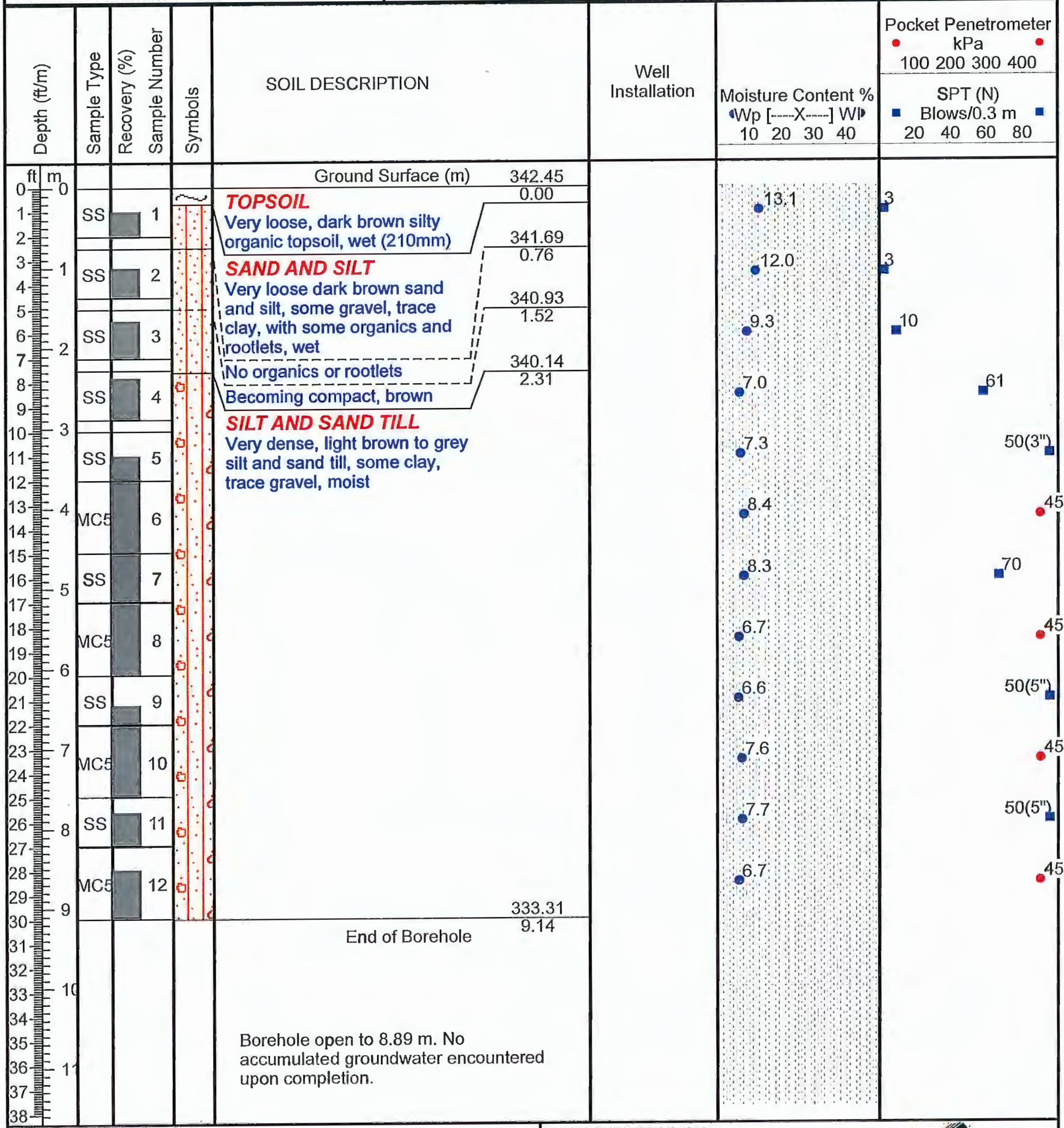
BOREHOLE 4

Page 1 of 1

Date Drilled: April 18, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 342.45 m
Logged by: SW

Project No.: 18-099
Project: Two 12 Storey Appt. Buildings
Location: 1242, 1250, 1260 Gordon St
Guelph, ON



Ground Surface (m) 342.45

TOPSOIL 0.00
Very loose, dark brown silty organic topsoil, wet (210mm)

341.69
0.76
SAND AND SILT
Very loose dark brown sand and silt, some gravel, trace clay, with some organics and rootlets, wet

340.93
1.52
No organics or rootlets

340.14
2.31
Becoming compact, brown

SILT AND SAND TILL
Very dense, light brown to grey silt and sand till, some clay, trace gravel, moist

333.31
9.14
End of Borehole

Borehole open to 8.89 m. No accumulated groundwater encountered upon completion.

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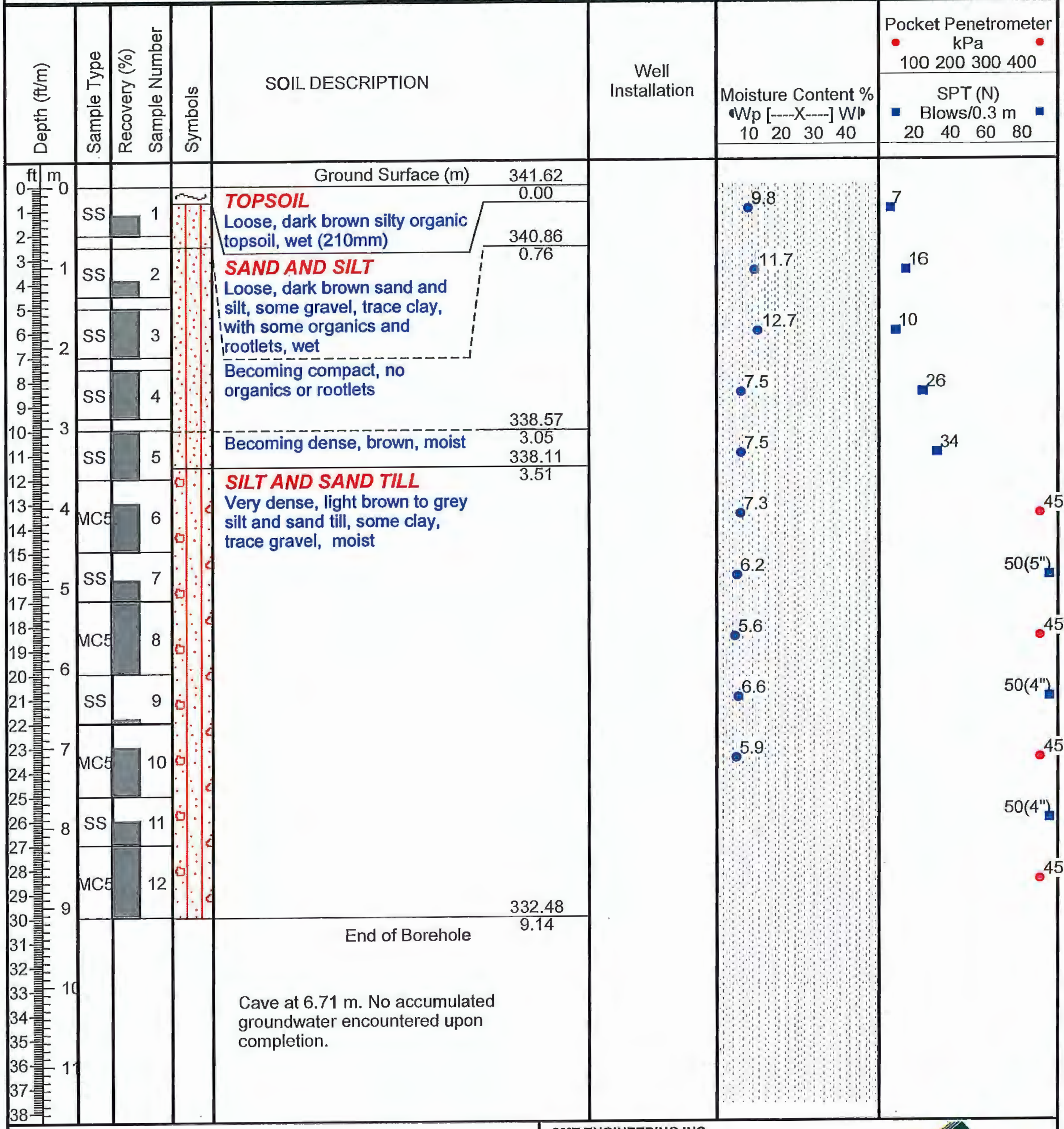
BOREHOLE 5

Page 1 of 1

Date Drilled: April 19, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 341.62 m
Logged by: SW

Project No.: 18-099
Project: Two 12 Storey Appt. Buildings
Location: 1242, 1250, 1260 Gordon St
Guelph, ON



Elevation / Depth (m)	Soil Description
341.62	Ground Surface (m)
0.00	***TOPSOIL*** Loose, dark brown silty organic topsoil, wet (210mm)
340.86 0.76	***SAND AND SILT*** Loose, dark brown sand and silt, some gravel, trace clay, with some organics and rootlets, wet Becoming compact, no organics or rootlets
338.57 3.05	Becoming dense, brown, moist
338.11 3.51	***SILT AND SAND TILL*** Very dense, light brown to grey silt and sand till, some clay, trace gravel, moist
332.48 9.14	End of Borehole

Cave at 6.71 m. No accumulated groundwater encountered upon completion.

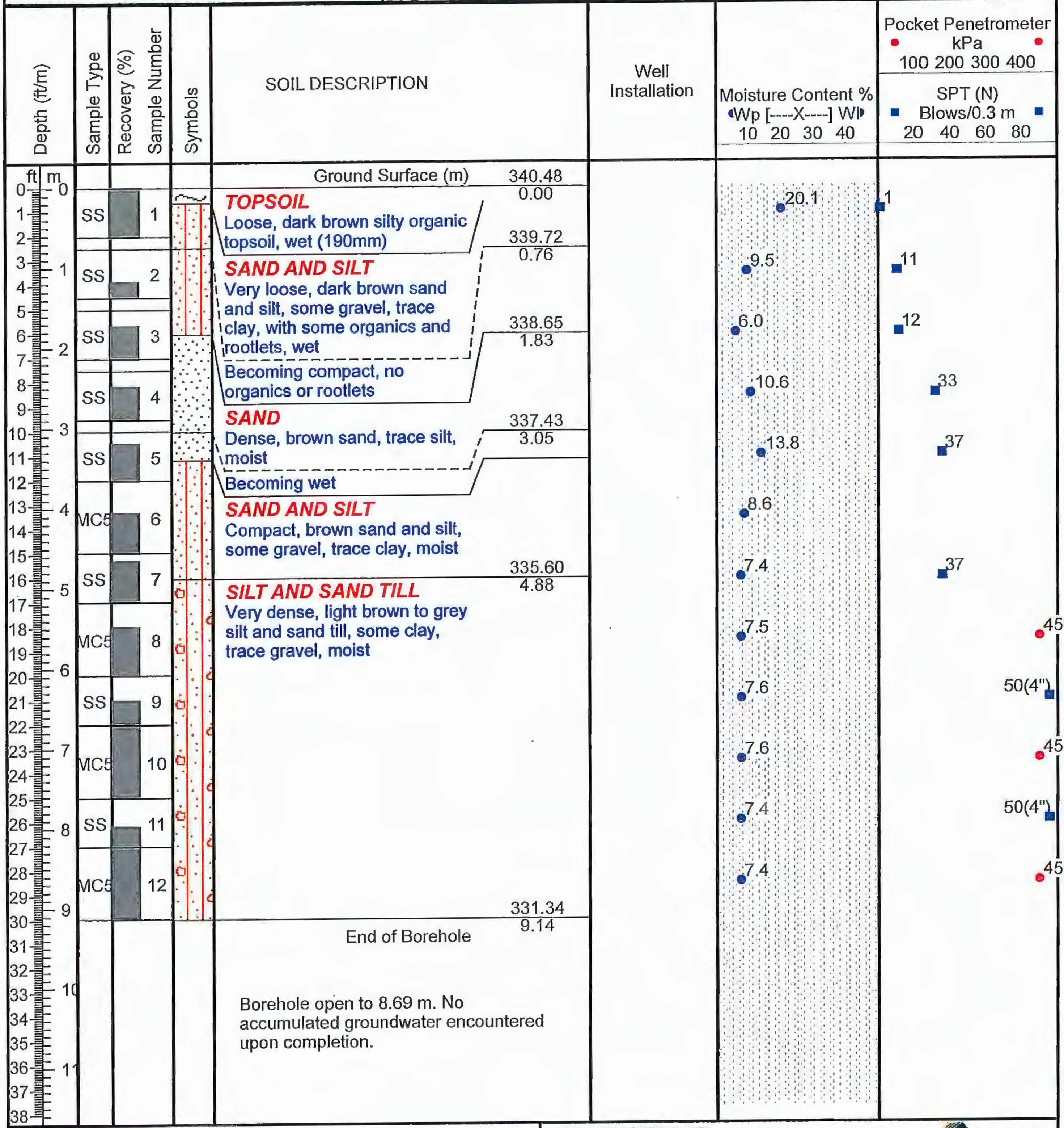
Sample Type	Sample Number	Moisture Content %	SPT (N)	Pocket Penetrometer kPa
SS	1	9.8	7	
SS	2	11.7	16	
SS	3	12.7	10	
SS	4	7.5	26	
SS	5	7.5	34	
MC5	6	7.3		450
SS	7	6.2	50(5")	
MC5	8	5.6		450
SS	9	6.6	50(4")	
MC5	10	5.9		450
SS	11		50(4")	
MC5	12			450

BOREHOLE 6

Date Drilled: April 19, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 340.48 m
Logged by: SW

Project No.: 18-099
Project: Two 12 Storey Appt. Buildings
Location: 1242, 1250, 1260 Gordon St
Guelph, ON



Ground Surface (m)	340.48	
	0.00	**TOPSOIL** Loose, dark brown silty organic topsoil, wet (190mm)
	339.72 0.76	**SAND AND SILT** Very loose, dark brown sand and silt, some gravel, trace clay, with some organics and rootlets, wet
	338.65 1.83	Becoming compact, no organics or rootlets
	337.43 3.05	**SAND** Dense, brown sand, trace silt, moist
		Becoming wet
		SAND AND SILT Compact, brown sand and silt, some gravel, trace clay, moist
	335.60 4.88	**SILT AND SAND TILL** Very dense, light brown to grey silt and sand till, some clay, trace gravel, moist
	331.34 9.14	End of Borehole

Borehole open to 8.69 m. No accumulated groundwater encountered upon completion.

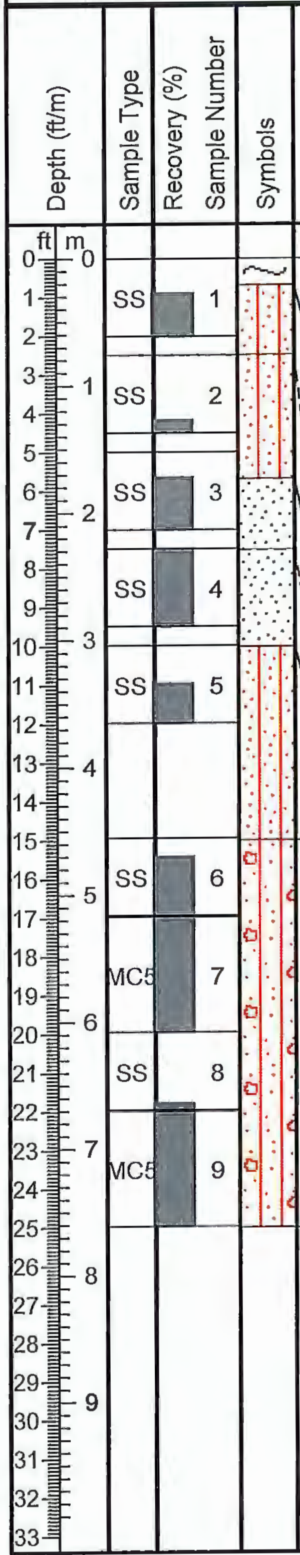
BOREHOLE 7

Page 1 of 1

Date Drilled: April 19, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 339.88 m
Logged by: SW

Project No.: 18-099
Project: Two 12 Storey Appt. Buildings
Location: 1242, 1250, 1260 Gordon St
Guelph, ON

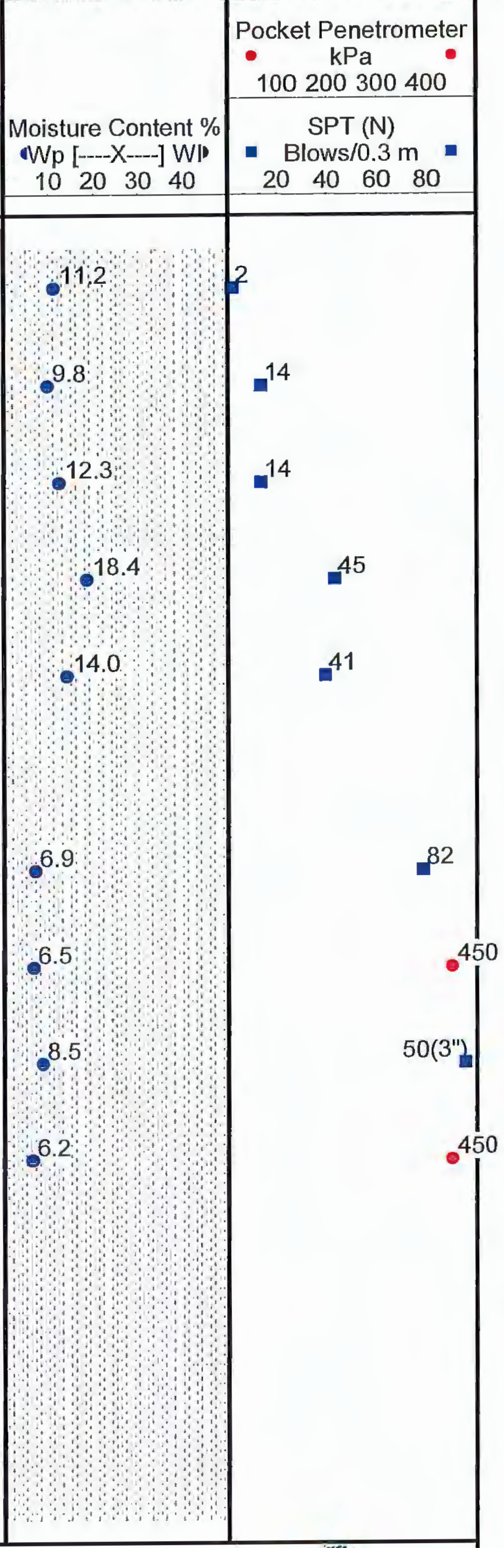


SOIL DESCRIPTION

Ground Surface (m)	339.88	
		0.00
TOPSOIL Loose, dark brown silty organic topsoil, wet (210mm)	339.12	0.76
SAND AND SILT Very loose, dark brown sand and silt, some gravel, trace clay, with some organics and rootlets, wet	338.15	1.73
Becoming compact, no organics or rootlets	337.59	2.29
SAND Dense, brown sand, trace gravel, moist	336.83	3.05
Becoming trace silt and clay, wet		
SAND AND SILT Compact, brown, sand and silt, some gravel, trace clay, moist	335.31	4.57
SILT AND SAND TILL Very dense, light brown to grey silt and sand till, some clay, trace gravel, moist	332.26	7.62
End of Borehole		

Borehole open to 6.91 m. No accumulated groundwater encountered upon completion.

Well Installation



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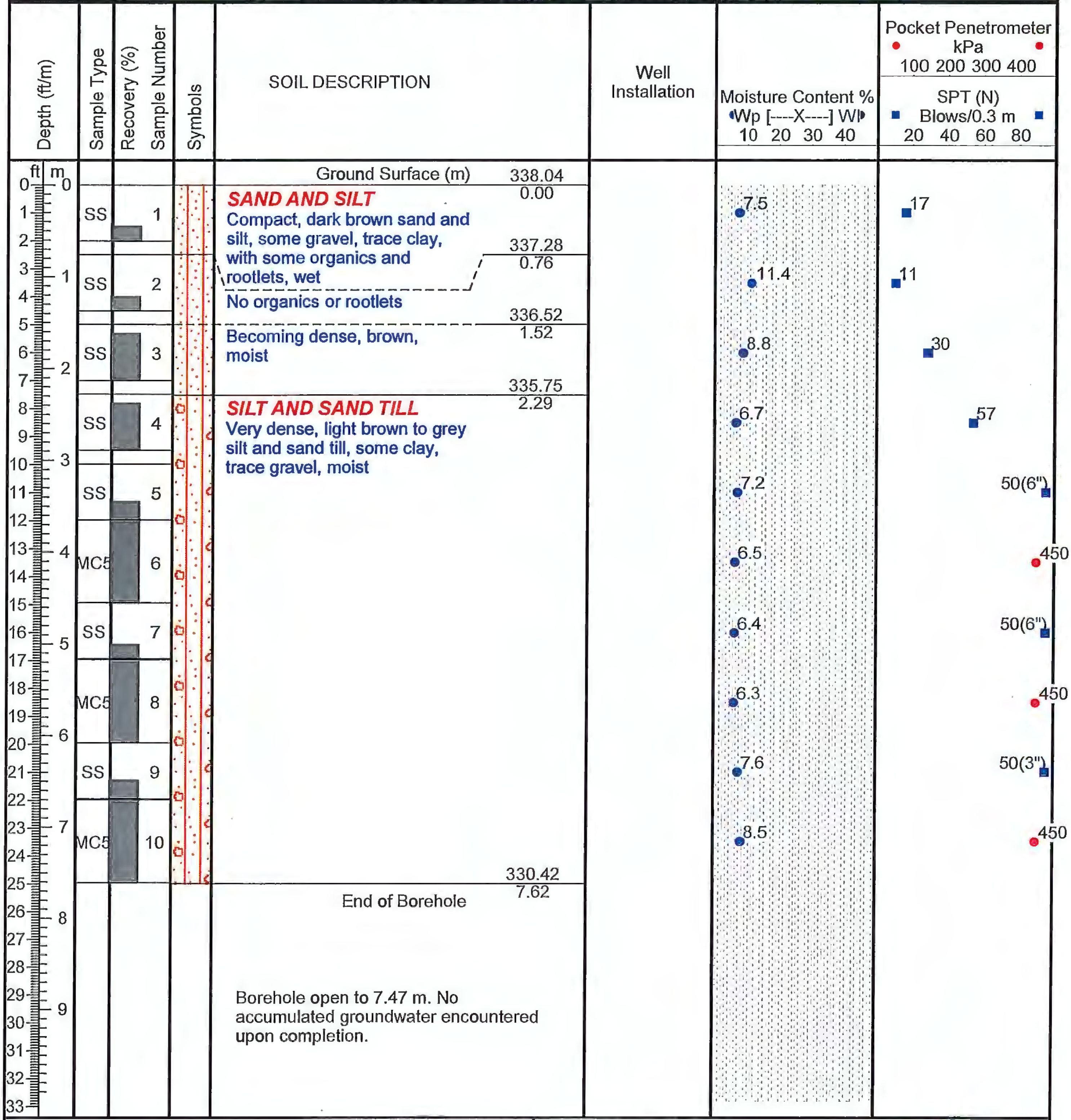
BOREHOLE 8

Page 1 of 1

Date Drilled: April 19, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 338.04 m
Logged by: SW

Project No.: 18-099
Project: Two 12 Storey Appt. Buildings
Location: 1242, 1250, 1260 Gordon St
Guelph, ON



Sample Type	Sample Number	Moisture Content %	SPT (N)	Pocket Penetrometer (kPa)
SS	1	7.5	17	
SS	2	11.4	11	
SS	3	8.8	30	
SS	4	6.7	57	
SS	5	7.2	50(6")	
MC5	6	6.5		450
SS	7	6.4	50(6")	
MC5	8	6.3		450
SS	9	7.6	50(3")	
MC5	10	8.5		450

Ground Surface (m) 338.04

338.04 / 0.00
SAND AND SILT
Compact, dark brown sand and silt, some gravel, trace clay, with some organics and rootlets, wet

337.28 / 0.76
No organics or rootlets

336.52 / 1.52
Becoming dense, brown, moist

335.75 / 2.29
SILT AND SAND TILL
Very dense, light brown to grey silt and sand till, some clay, trace gravel, moist

330.42 / 7.62
End of Borehole

Borehole open to 7.47 m. No accumulated groundwater encountered upon completion.

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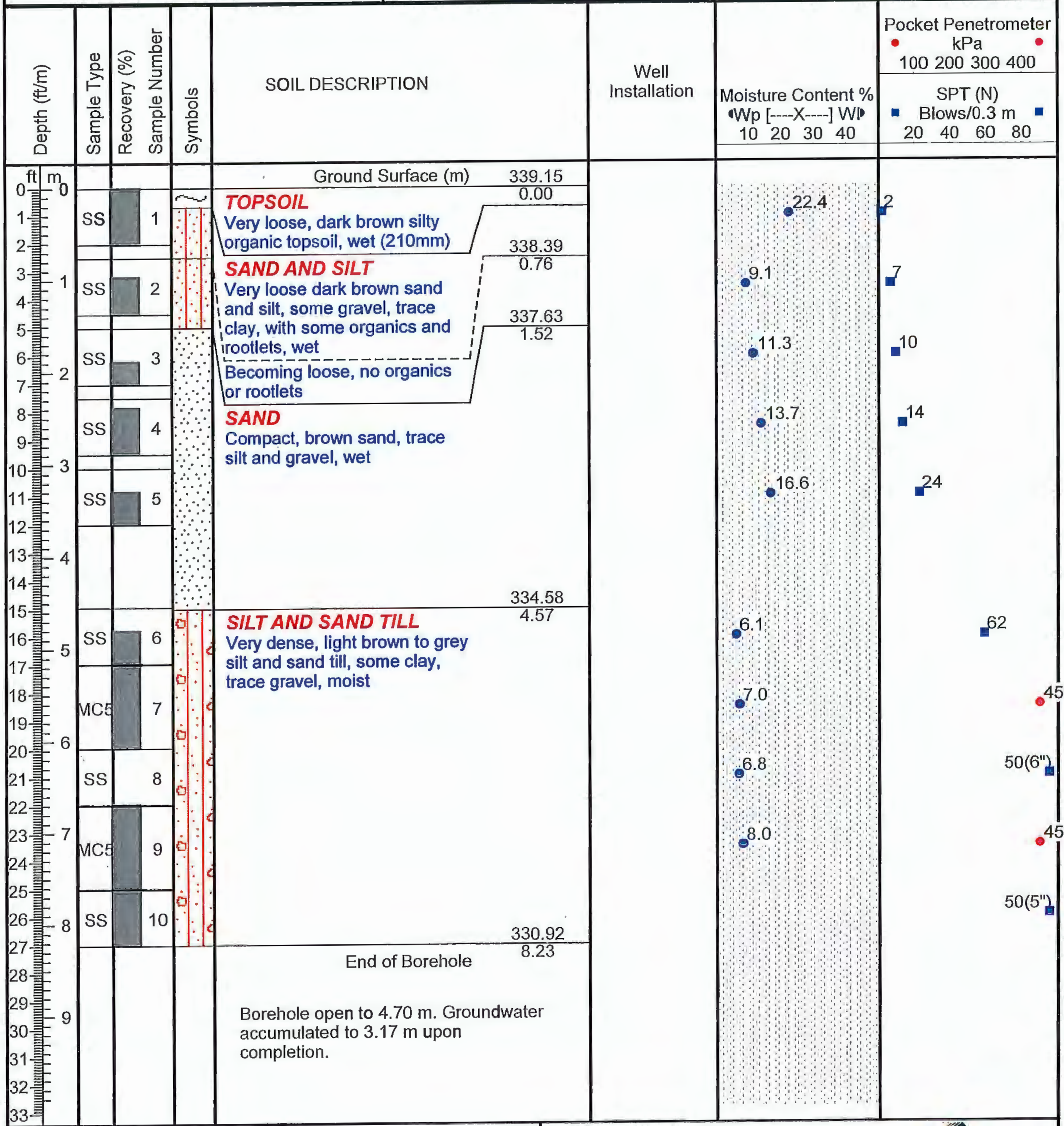
BOREHOLE 9

Page 1 of 1

Date Drilled: April 19, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 339.15 m
Logged by: SW

Project No.: 18-099
Project: Two 12 Storey Appt. Buildings
Location: 1242, 1250, 1260 Gordon St
Guelph, ON



Elevation (m)	Depth (m)	SOIL DESCRIPTION
339.15		Ground Surface (m)
	0.00	***TOPSOIL*** Very loose, dark brown silty organic topsoil, wet (210mm)
338.39	0.76	***SAND AND SILT*** Very loose dark brown sand and silt, some gravel, trace clay, with some organics and rootlets, wet Becoming loose, no organics or rootlets
337.63	1.52	***SAND*** Compact, brown sand, trace silt and gravel, wet
334.58	4.57	***SILT AND SAND TILL*** Very dense, light brown to grey silt and sand till, some clay, trace gravel, moist
330.92	8.23	End of Borehole

Sample Type	Sample Number	Moisture Content %	SPT (N) Blows/0.3 m	Pocket Penetrometer kPa
SS	1	22.4	2	
SS	2	9.1	7	
SS	3	11.3	10	
SS	4	13.7	14	
SS	5	16.6	24	
SS	6	6.1	62	
MC5	7	7.0		450
SS	8	6.8	50(6")	
MC5	9	8.0		450
SS	10		50(5")	

Borehole open to 4.70 m. Groundwater accumulated to 3.17 m upon completion.

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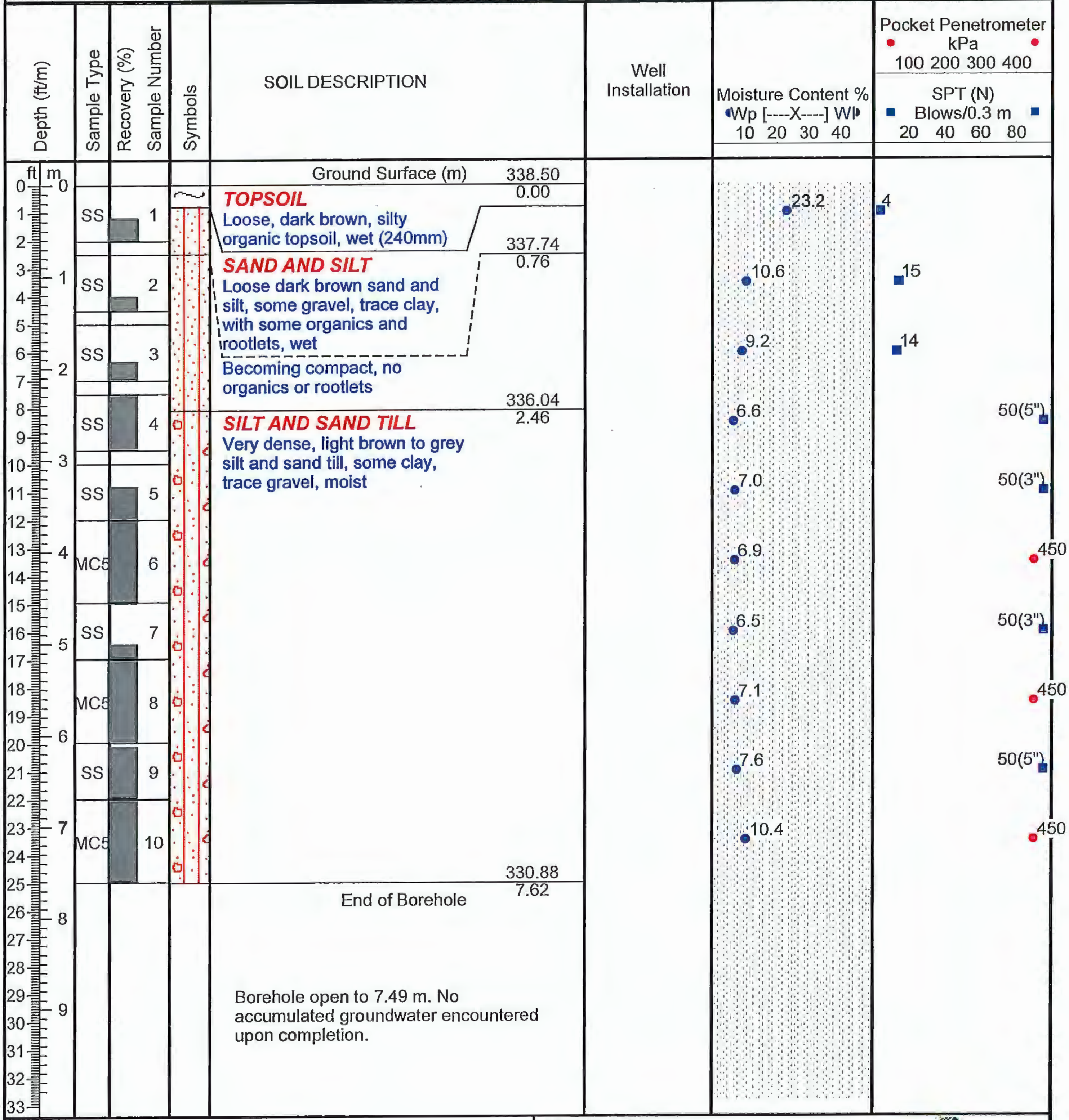
BOREHOLE 10

Date Drilled: April 17, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 338.50 m
Logged by: SW

Project No.: 18-099
Project: Two 12 Storey Appt. Buildings
Location: 1242, 1250, 1260 Gordon St
Guelph, ON



SOIL DESCRIPTION		
Ground Surface (m)	338.50	0.00
TOPSOIL Loose, dark brown, silty organic topsoil, wet (240mm)	337.74	0.76
SAND AND SILT Loose dark brown sand and silt, some gravel, trace clay, with some organics and rootlets, wet Becoming compact, no organics or rootlets	336.04	2.46
SILT AND SAND TILL Very dense, light brown to grey silt and sand till, some clay, trace gravel, moist	330.88	7.62
End of Borehole		

Sample Type	Sample Number	Moisture Content %	SPT (N) Blows/0.3 m	Pocket Penetrometer kPa
SS	1	23.2	4	
SS	2	10.6	15	
SS	3	9.2	14	
SS	4	6.6	50(5")	
SS	5	7.0	50(3")	
MC5	6	6.9		450
SS	7	6.5	50(3")	
MC5	8	7.1		450
SS	9	7.6	50(5")	
MC5	10	10.4		450

Borehole open to 7.49 m. No accumulated groundwater encountered upon completion.

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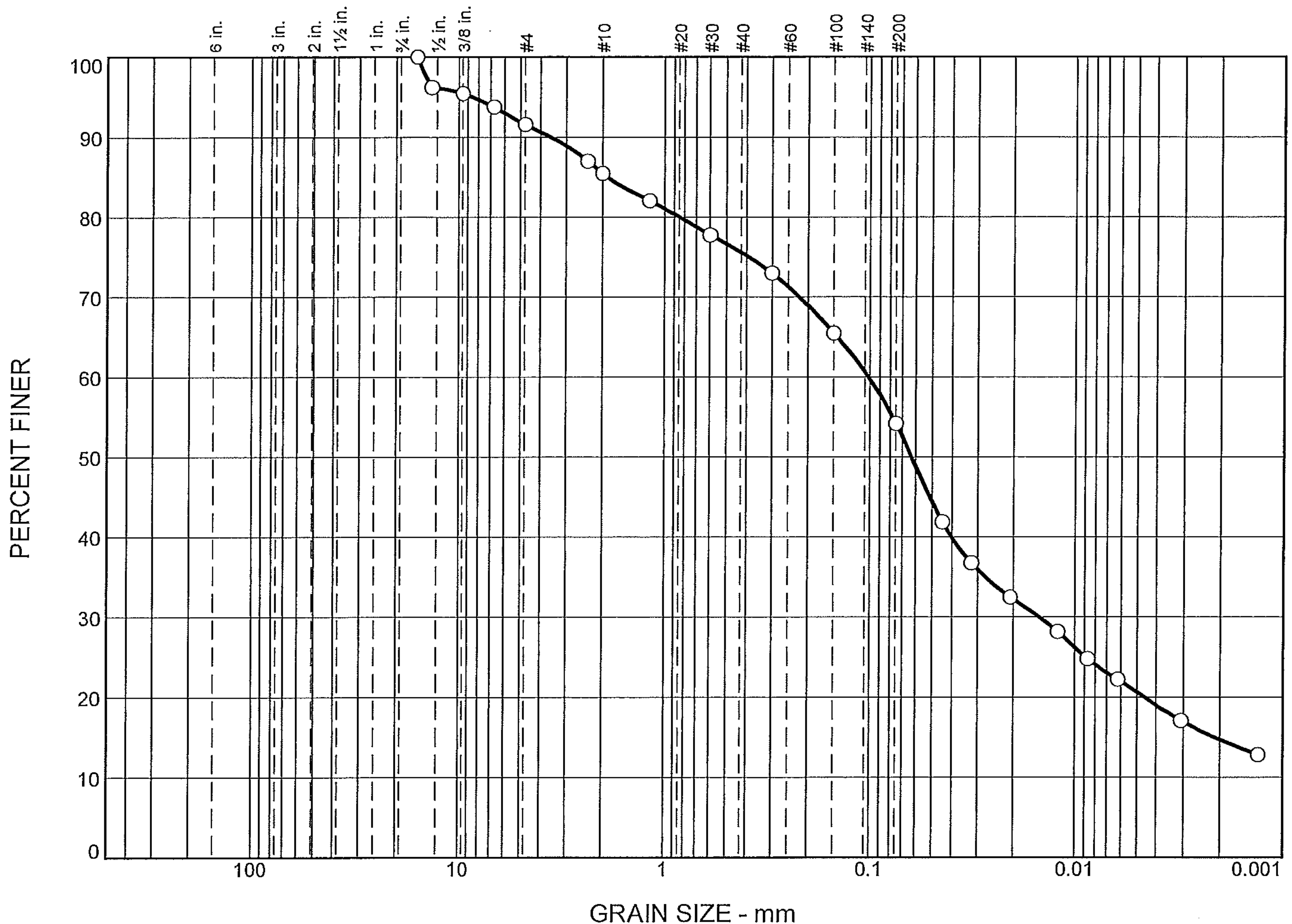
APPENDIX B

GRAIN SIZE ANALYSES

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	8.4	6.1	9.9	21.4	39.5	14.7

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH2	11	7.62-9.14m	silt and sand, some clay, trace gravel	ML
				Tested by MS of CMT Engineering Inc., April 23, 2018	
				Estimated coefficient of permeability k < 1.0x10^-6 cm/sec	

CMT Engineering Inc.

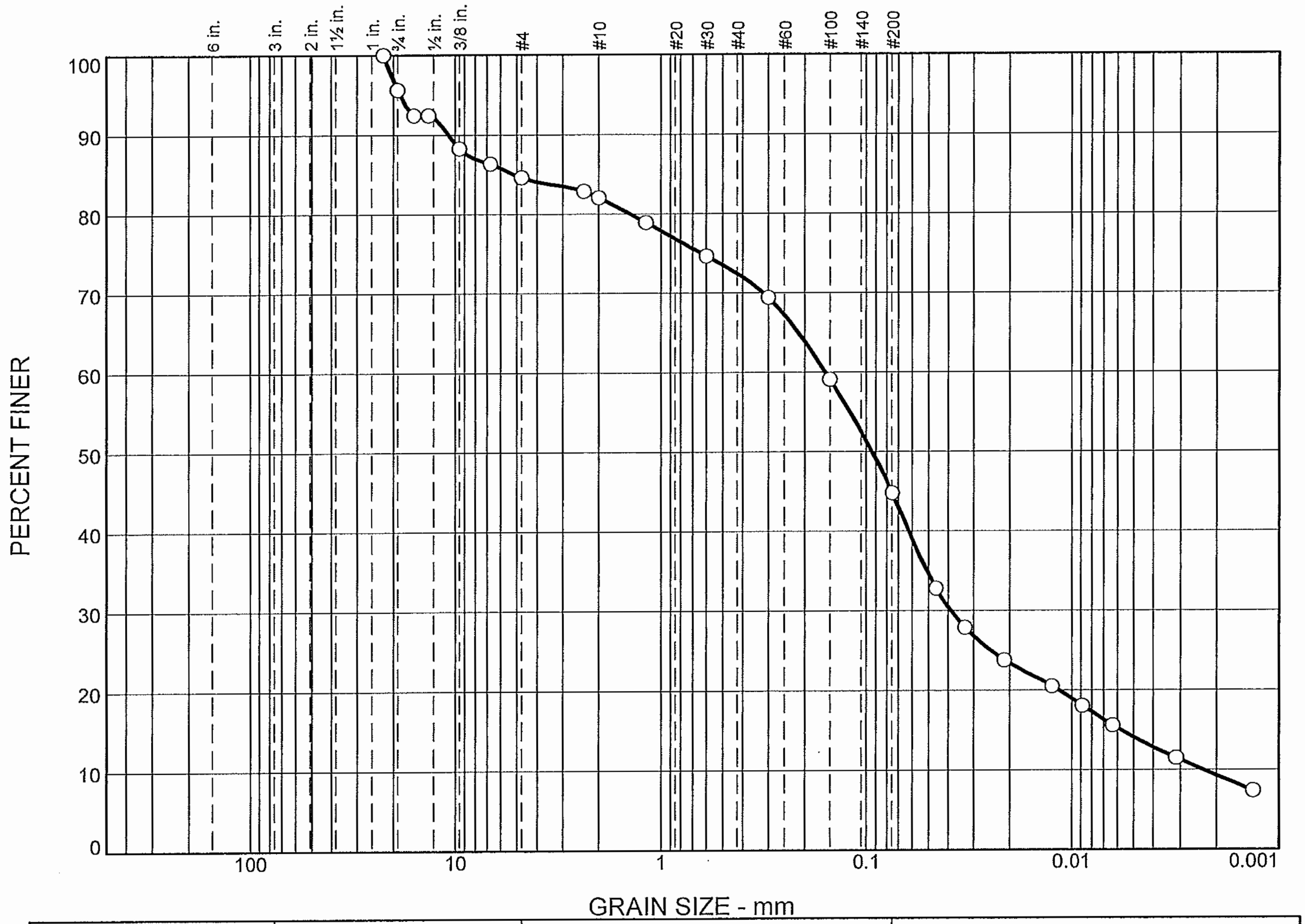
St. Clements, ON

Client: XCG Consulting Limited

Project: Two 12-Storey Apartment Buildings
1242, 1250 and 1260 Gordon Street, Guelph, Ontario

Project No.: 18-099 **Figure** 1

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	4.3	11.1	2.6	9.5	27.7	35.5	9.3

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH5	3	1.52-2.13m	sand and silt, some gravel, trace clay	SM
				Tested by MS of CMT Engineering Inc., April 23, 2018	
				Estimated coefficient of permeability k = 6.25x10^-6 cm/sec	

CMT Engineering Inc.

St. Clements, ON

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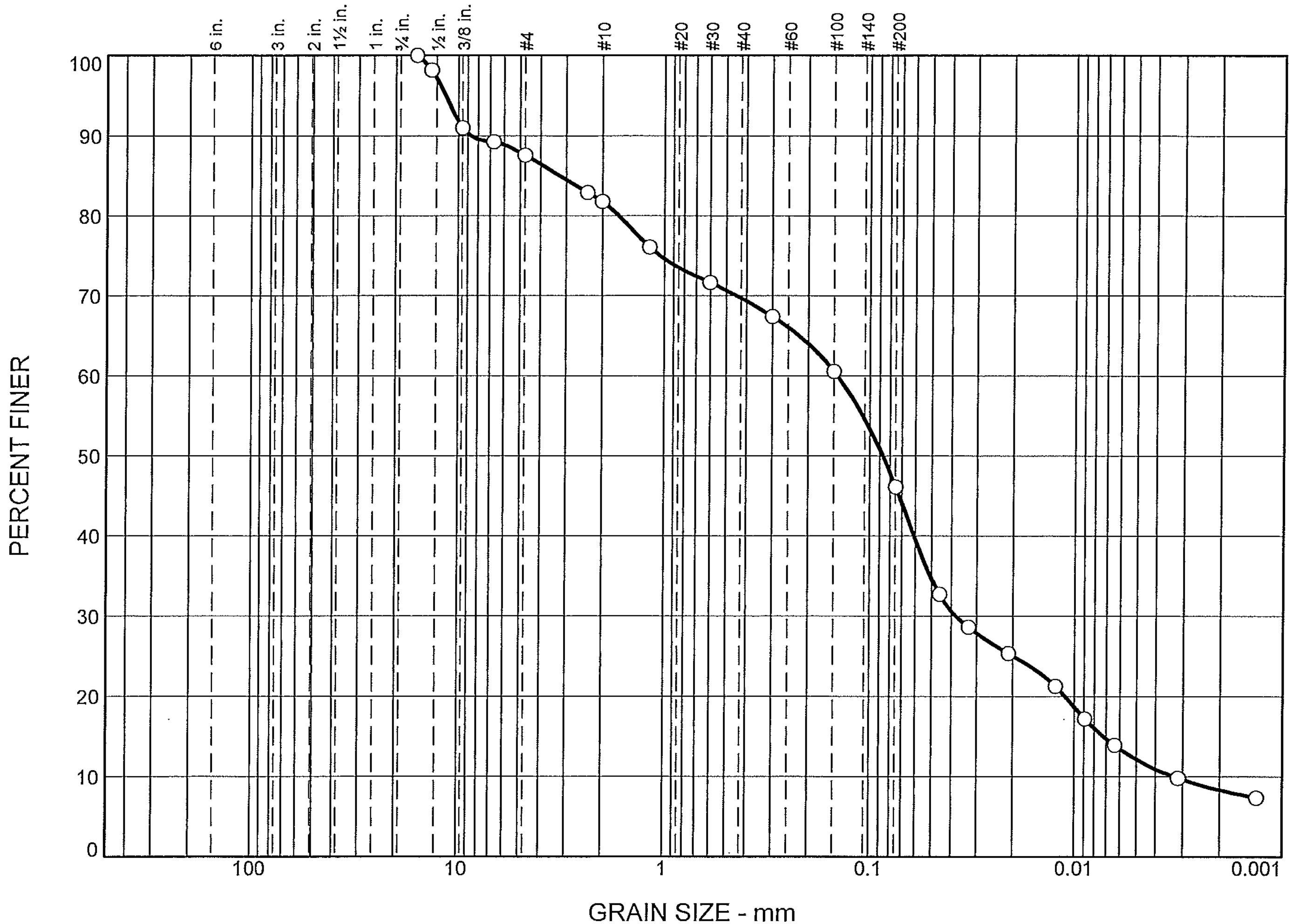
Project: Two 12-Storey Apartment Buildings
1242, 1250 and 1260 Gordon Street, Guelph, Ontario

Project No.: 18-099 **Figure** 2

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	12.4	5.8	12.1	23.6	37.8	8.3

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH8	3	1.52-2.13m	sand and silt, some gravel, trace clay	SM
				Tested by MS of CMT Engineering Inc., April 23, 2018	
				Estimated coefficient of permeability k < 9.61x10^-6 cm/sec	

CMT Engineering Inc.

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Client: XCG Consulting Limited

Project: Two 12-Storey Apartment Buildings
1242, 1250 and 1260 Gordon Street, Guelph, Ontario

Project No.: 18-099 **Figure** 3