GEOTECHNICAL INVESTIGATION

PROPOSED RESIDENTIAL SUBDIVISION
SOUTH MILL STREET
GLEN ALLAN, ONTARIO
TOWNSHIP OF MAPLETON

CMT Project 18-462.R01

Prepared for:

Mr. Murray Martin
c/o GM BluePlan Engineering Ltd.

September 25, 2018

CMT ENGINEERING INC.

CMT Engineering Inc.

CONSULTING ENGINEERS

1011 Industrial Crescent, Unit 1
St. Clements, Ontario N0B 2M0
Tel: 519-699-5775
Fax: 519-699-4664
www.cmtinc.net

September 25, 2018 18-462.R01

Mr. Murray Martin
c/o GM BluePlan Engineering Ltd.
975 Wallace Avenue North
Listowel, Ontario
N4W 1M6

Attention: Mr. John Kerr, P.Eng.

Dear Sir,

Re: Proposed Residential Subdivision
South Mill Street, Glen Allan
Township of Mapleton, 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, M.Eng.

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1.0 INTRODUCTION

The services of CMT Engineering Inc. (CMT Inc.) were retained by Mr. John Kerr, P.Eng., of GM BluePlan Engineering Ltd., on behalf of Mr. Murray Martin, to conduct a geotechnical investigation for a proposed residential subdivision located at South Mill Street in Glen Allan, Ontario. The geotechnical investigation was carried out in conjunction with a hydrogeology study completed by GM BluePlan Engineering Ltd., which will be provided under separate cover. The location of the site is shown on Drawing 1.

It is understood that the project will involve the construction of a residential subdivision with eleven (11) residential blocks that will be serviced by individual wells and conventional septic systems, along with a storm water management facility and a new road (George Street).

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); dewatering considerations; site classification for seismic site response; recommendations for site grading, site servicing, excavations and backfilling, recommendations for slab-on-grade construction; pavement design/drainage; soil design properties; storm water infiltration, and a summary of the laboratory results.

2.0 EXISTING SITE CONDITIONS

The site is currently predominantly used for agricultural crop production; however, there are some areas of scrub brush and trees (typically in the unopened road allowances and along the fence lines). The proposed location of Block 6 (Borehole 1) at the western side of the site is located at the top of a hill, sloping downward on all sides. There is an existing storage building and a grain bin, as well as evidence of a former barn in the southwest portion of the property on proposed Blocks 10 and 11. Some pieces of red clay brick as well as pieces of porcelain were observed in the worked fields. The site is bounded by South Mill Street to the east, residential properties to the north, and agricultural properties to the south and west.

Based on a review of historical aerial photography, in 1930 there is evidence of an apparent pond (or excavation) located west and south of the existing west end of South Mill Street. A 1958 air photo revealed that the existing shed, which is currently located on the north side of South Mill Street at the west end of South Mill Street, had been constructed. A house and barn are also evident south of South Mill Street and west of the existing western road allowance on the property. There was no evidence of any significant change in a review of 1966 and 1976 air photos. In a review of 1990 aerial photography, it is apparent that the previously mentioned house and barn have been demolished, and there is a disturbed area visible at the location of the present depressed area that is located directly north of the existing grain bin. There is potential that the former house and barn may have been buried on-site.

3.0 FIELD AND LABORATORY PROCEDURES

Prior to the commencement of the field drilling program, ON1Call locates were organized by CMT Inc. to ensure that underground utilities would not be damaged.

The drilling field investigation was conducted on August 29 and 30, 2018, and comprised the advancement of six (6) boreholes (referenced as Boreholes 1 to 6), utilizing a Geoprobe 7822DT drillrig operated by employees of CMT Drilling Inc.

The borehole depths ranged from 5.79 m (19.0 ft) to 10.67 m (35.0 ft) below the existing ground surface elevations as directed by GM BluePlan. Soil sampling was undertaken utilizing the Standard Penetration Test (SPT), as well as Macro Core (MC5) systems for Boreholes 1 to 6. 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.

As requested, representative samples from the following boreholes and depths were submitted to our laboratory for grain size analyses:

- Borehole 1 - depth 0.76 m to 1.37 m (2.5 ft to 4.5 ft)
- Borehole 2 - depth 4.57 m to 5.18 m (15.0 ft to 17.0 ft)
- Borehole 3 - depth 3.20 m to 3.66 m (10.5 ft to 12.0 ft)
- Borehole 4 - depth 9.14 m to 10.67 m (30.0 ft to 35.0 ft)
- Borehole 5 - depth 5.18 m to 6.10 m (17.0 ft to 20.0 ft)
- Borehole 6 - depth 2.29 m to 2.90 m (7.5 ft to 9.5 ft)

CMT Inc. may be contacted for additional laboratory testing on bagged samples should it be required. Samples are normally kept for three months, unless other arrangements are made.

The borehole logs are provided in Appendix A and the resulting grain size analyses can be found in Appendix B.

As requested by GM BluePlan, Boreholes 2, 3, 4, and 5 were equipped with 38 mm diameter monitoring wells comprising a 3.0 m long prepack screen with a sand filter, then riser pipe backfilled with bentonite, a J-plug and then a locking monument style protective cover. The monitoring wells were installed according with the Ontario Water Resources Act, Regulation 903 (O.Reg. 903) by well technicians licensed by the Ministry of the Environment (MOE), working for a contractor also licensed by the MOE. The boreholes that were not instrumented with monitoring wells were backfilled with bentonite in accordance with O.Reg. 903. The monitoring wells are registered with the MOE in accordance with O.Reg. 903 and must be decommissioned in accordance with Reg. 903 when they are no longer required. CMT Drilling Inc. can provide the decommissioning services.

GM BluePlan Engineering Ltd. surveyed the ground surface elevations at the borehole locations. A nail in the hydro pole on the west side of South Mill Street was used as a benchmark with a reported elevation of 400.679 m above sea level. The ground surface elevations at the borehole locations ranged from 396.57 m to 401.025 m. The locations of the boreholes 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

Very loose to loose, dark brown, silty, organic topsoil was encountered at the surface of all the boreholes. The topsoil was considered moist. The topsoil ranged in thickness from 100 mm to 400 mm (average 180 mm) at the borehole locations. Given the variation in topsoil thicknesses at the borehole locations, and the undulating nature of the topography some variance in the topsoil thickness should be expected outside of the sampled areas. It would be expected that topsoil thicknesses would be thinner on the hill tops, with more significant accumulation expected in the low-lying areas.

4.2. Clayey Silt

Brown, clayey silt, with some sand and trace gravel, was encountered underlying the topsoil in all boreholes. The clayey silt immediately underlying the topsoil was observed to contain trace amounts of organic material from the root structures as well as rootlets. The clayey silt was considered to be soft to hard, with SPT N-values ranging from 3 to in excess of 100 blows per 0.3 m (average 28 blows per 0.3 m), and undrained shear strengths from pocket penetrometer measurements ranging from 200 kPa to 450 kPa (average 375 kPa). Typically, the soft to firm clayey silt was encountered directly underlying the topsoil. It is expected that this material has become loosened/soft from frost action and will require further inspection and remedial action (further compactive effort) at the time of construction, if it will be intended to be utilized during site grading. The clayey silt was considered drier than the plastic limit to about the plastic limit, with moisture contents ranging from 10.3% to 25.6% (average 16.3%).

4.3. Silt and Clay/Clay and Silt

Grey silt and clay or clay and silt, with trace to some sand and up to trace amounts of gravel, was encountered underlying the clayey silt in all boreholes, as well as underlying the silt in Borehole 3. Occasional wet sand seams were observed within the clay and silt deposit in Boreholes 2 and 3. The silt and clay/clay and silt was considered to be stiff to hard, with SPT N-values ranging from 13 to in excess of 70 blows per 0.3 m (average 34 blows per 0.3 m), and undrained shear strengths from pocket penetrometer measurements ranging from 100 kPa to 450 kPa (average 285 kPa). The silt and clay/clay and silt were considered drier than the plastic limit to wetter than the plastic limit, with moisture contents ranging from 8.7% to 26.8% (average 16.5%).

4.4. *Silt*

Grey silt with some sand and clay was encountered underlying the silt and clay/clay and silt in Boreholes 3, 4, and 5. Occasional wet sand seams were observed within the silt deposit in Borehole 3. The silt was considered compact to very dense, with SPT N-values ranging from 22 to in excess of 100 blows per 0.3m (average 74 blows per 0.3m). The silt was considered moist to wet with moisture contents ranging from 8.4% to 27.0% (average 16.2%).

4.5. *Groundwater*

Boreholes 2, 3, 4, and 5 were equipped with monitoring wells. The monitoring wells were installed and registered in accordance with the Ontario Water Resources Act, Regulation 903 (O.Reg. 903) by well technicians licensed by the Ministry of the Environment (MOE), working for a contractor also licensed by the MOE. The boreholes that were not instrumented with a monitoring well were backfilled with bentonite in accordance with O.Reg. 903.

CMT Engineering Inc. staff measured the water levels on October 3, 2018. The following table summarizes the borehole number, ground surface elevation, elevation of water in the monitoring well, cave elevation, zone of saturation and the bottom of borehole elevation for each borehole.

Borehole No.	**Ground Surface Elevation (m)**	**Measured Elevation of Water in Monitoring Well October 3/30, 2018 (m)**	**Cave Elevation (m)**	**Zone of Saturation Elevation (m)**	**Bottom of Borehole Elevation (m)**
1	405.48	--	402.28	--	399.69
2	403.13	400.71	--	399.47 to termination	397.34
3	402.27	398.87	--	398.46 to termination	395.56
4	399.00	389.53	--	--	388.33
5	399.70	393.99	--	393.65 to termination	392.99
6	396.57	--	390.02	--	389.86

No accumulated groundwater was observed in the boreholes that were not instrumented with a monitoring well (Boreholes 1 and 6).

It should be noted that the hard and/or fine-grained, less permeable clayey silt, clay and silt, and silt soils have the potential to create perched water conditions. 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. As such, provisions for site dewatering should be part of the site development and construction process. 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 involve the construction of a residential subdivision with eleven (11) residential blocks that will be serviced by individual wells and conventional septic systems, along with a storm water management facility and a new road (George Street).

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

Based on the information obtained from the boreholes, the following table provides the Serviceability Limit States (SLS) and Ultimate Limit States (ULS) pressures at the various elevations, including soil types:

Borehole No.	**Ground Surface Elevation (m)**	**SLS kPa (psf)**	**ULS kPa (psf)**	**Estimated Highest Founding Elevation (m)**	**Depth to Highest Founding Elevation (m)**	**Soil Type**
1	405.48	150 (3,000)	225 (4,500)	405.02 to 399.69 (termination)	0.46	Clayey Silt/Silt and Clay
2	403.13	150 (3,000)	225 (4,500)	402.37 to 397.34 (termination)	0.76	Clayey Silt/Clay and Silt
3	402.27	150 (3,000)	225 (4,500)	401.92 to 395.56 (termination)	0.35	Clayey Silt/Clay and Silt/Silt
4	399.00	150 (3,000) 250 (5,000)	225 (4,500) 375(7,500)	398.24 to 396.71 396.71 to 388.33 (termination)	0.76 2.29	Clayey Silt Clayey Silt/Clay and Silt/Silt
5	399.70	150 (3,000) 250 (5,000)	225 (4,500) 375(7,500)	399.24 to 397.41 397.41 to 392.99 (termination)	0.46 2.29	Clayey Silt Clayey Silt/Silt and Clay/Silt

Borehole No.	Ground Surface Elevation (m)	SLS kPa (psf)	ULS kPa (psf)	Estimated Highest Founding Elevation (m)	Depth to Highest Founding Elevation (m)	Soil Type
6	396.57	150 (3,000) 250 (5,000)	225 (4,500) 375(7,500)	395.81 to 395.05 395.05 to 389.86 (termination)	0.76 1.52	Clayey Silt Clayey Silt/Silt and Clay

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 150 kPa (3,000 psf) at SLS and 225 kPa (4,500 psf) at ULS range below elevations 395.81 m to 405.02 m for Boreholes 1 to 6. It should be noted that the above-referenced elevations of soils capable of supporting foundations designed with a bearing capacity of 150 kPa (3,000 psf) at SLS and 225 kPa (4,500 psf) at ULS corresponds with depths ranging from approximately 0.35 m to 0.76 m below the existing ground surface at the borehole locations.

Suitable founding elevations for conventional foundations designed with a minimum bearing capacity of 250 kPa (5,000 psf) at SLS and 375 kPa (7,500 psf) at ULS range below elevations 395.05 m to 397.41 m for Boreholes 4 to 6. Suitable founding elevations for conventional foundations designed with a minimum bearing capacity of 250 kPa (5,000 psf) at SLS and 375 kPa (7,500 psf) at ULS were not encountered in Boreholes 1 to 3. It should be noted that the above-referenced elevations of soils capable of supporting foundations designed with a bearing capacity of 250 kPa (5,000 psf) at SLS and 375 kPa (7,500 psf) at ULS corresponds with depths ranging from approximately 1.52 m to 2.29 m below the existing ground surface at the borehole locations.

Soils 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. Alternatively, the soft to firm clayey silt encountered directly underlying the topsoil could be subjected to further compactive effort and testing, provided the moisture content is suitable to achieve the specified compaction of 100% SPMDD.

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 structural fill placed and compacted in accordance with Section 5.4.4 of this report and constructed on approved competent native soils is estimated to be at least 150 kPa (3,000 psf) at SLS and 225 kPa (4,500 psf) at ULS. 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 are 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 sump pits.

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.

It should be noted that depending on the final grades, the native founding soils may be in a wet state; therefore, dewatering during construction may be required (see Section 5.8 of this report) along with the potential construction of a mud mat or granular drainage layer.

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 10.67 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 D (stiff soil) for structures founded on the native soils at the recommended founding elevations provided in Section 5.1 of this report or on or structural fill placed in accordance with section 5.4.4 of this report. The structural engineer responsible for the design of the structure should review the earthquake loads and effects.

5.3. *Soil Design Parameters*

The following table provides the soil design parameters for imported granular fill, as well as the native soils encountered on-site. The soil design parameters can be utilized for the design of perimeter shoring, foundations and retaining walls, as required:

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
Clayey Silt	1,900	28 °	0.36	2.77	0.53	0.35
Silt and Clay/ Clay and Silt	1,800	28 °	0.36	2.77	0.53	0.35
Silt	1,900	30 °	0.33	3.00	0.50	0.38

5.4. *Site Preparation*

The site preparation for the proposed new residential development will include topsoil stripping, vegetation grubbing, the subexcavation of all relatively loose/soft native soils deemed not capable of supporting the design bearing capacity (or remedial action which may include air drying and the application of further compactive effort), removal of potential foundations associated with former buildings (if encountered), the removal or relocation of any existing services (field tiles), followed by the placement of structural fill (as required) and site grading to achieve proposed grades.

5.4.1. *Topsoil Stripping/Vegetation Grubbing*

Due to the undulating topography and erosion, it should be expected that the thickness of topsoil may vary significantly throughout the site.

All existing topsoil, vegetation (including tree roots and all loose/disturbed soils associated with tree roots) must be removed from within the proposed building envelopes, driveways and road allowances 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.

Swelling and shrinkage factors of topsoil during site grading operations is generally relative to the insitu density and moisture content at the time of construction, as well as the type of equipment utilized and the compactive effort that the topsoil is subjected to during stockpiling and the subsequent placement during the final grading process. When topsoil is stripped and then placed in stockpiles with heavy earthmoving equipment such as motor scrapers or rock trucks and bulldozers, it tends to compact considerably in the stockpile. As previously indicated, the amount of compaction is generally relative to the weight of the equipment utilized, the number of passes that the equipment makes over the stockpiled topsoil, as well as the moisture content of the topsoil at the time of construction. Therefore, the swelling and shrinkage factors can vary significantly. Determination of swelling and shrinkage factors would require considerable laboratory testing throughout the construction process in order to provide an average that may be considered reasonable for quantity calculations. A frequently used practice to determine stripped quantities of topsoil would be to do a topographic survey prior to and following the stripping process. Due to the typical relatively loose insitu state of the topsoil, it should be expected that compacted volumes (when the topsoil is put back down) will be considerably less (again relative to the type and weight of equipment, the number of passes and the moisture content at the time of construction) than in the insitu state.

The volume of topsoil removed during the stripping process is also relative to the equipment utilized for the stripping process as well as the moisture conditions at the time of stripping. If an excavator with a smooth bucket is utilized for stripping, there would generally be less potential for topsoil to become intermixed with the underlying relatively loose subsoil and therefore less concern of over-excavation to remove all topsoil. If the topsoil is stripped with wheeled equipment or bulldozers, then there is an increased potential for the topsoil and subsoil to become intermixed, subsequently requiring additional excavation to remove all topsoil. This is further influenced by rutting which can occur during wet conditions.

It should also be noted that the clayey silt soils that were encountered directly underlying the topsoil are typically in a soft to firm state and are not considered suitable to support residential house foundations in their current state. As such, the clayey silt soils will require reworking with further compactive effort; otherwise these soils will require subexcavation to expose competent approved native mineral soils. This material will also be subjected to significant volume changes during the construction process.

There are numerous existing trees located throughout the site (typically around the fence lines). All trees, stumps and root masses must be subexcavated from within all building envelopes, driveways and road allowances. As previously noted, all relatively loose, disturbed soils and organic soils typically associated with any root masses must also be subexcavated.

5.4.2. Building Foundation Removal

It is expected that the existing storage building and grain bin on the site will be demolished/removed. A former house, barn and silos previously existed on the property, and were demolished prior to this investigation. At this time, it is uncertain if the former buildings were demolished and properly removed off site or if only the above grade portion of the buildings were removed. There is also the potential that the former buildings were simply buried on site (which would have been a typical practice at that time). As such, it would be recommended that provisions for removal of any existing foundations, building materials and any deleterious fill materials (including any associated foundation wall backfill) and subsequent replacement with imported granular fill (if required) be included in the tender documents. All existing foundation walls, footings, slab-on-grade and any other construction materials as well as all associated backfill material must be removed from all future building, septic, driveway, road and storm water management envelopes. Provided any concrete from the 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 or approved native soils to be utilized as fill on-site. The reuse of this material will be subject to approval from qualified geotechnical personnel. All excavations following demolition must be inspected and backfilled according to the procedures outlined in Section 5.4.4 of this report. It is recommended that approved native soils or imported sand and gravel (OPSS 1010 Granular 'B' or an approved alternative) be placed as structural fill to backfill the building demolition area(s). Thorough inspection of the former building areas will be required during construction.

5.4.3. __Removal/Relocation of Existing Services__

Any existing tile drains (field tiles or municipal tile drains) that may be located within the proposed building envelopes, driveways or road allowances must be completely removed to a minimum distance of 15.0 m (50.0 ft) outside of the construction envelopes. All drains that are terminated must be completely sealed with concrete or grout at termination points to prevent the migration of soils into pipe voids which may result in potential settlement. Ideally, depending on flow direction, any existing tile drains (if present) should be redirected and reconnected outside of the building envelopes in order to maintain flow and prevent subsurface accumulation of water. It may be prudent (if feasible) to incorporate existing field tiles into the storm sewer system or a separate collection system, to assist in systematically draining the subsurface soils in the subdivision. All existing trench backfill material associated with the drains must be subexcavated and the subsequent excavation must be backfilled with approved soils placed in accordance with Section 5.4.4 of this report. The location of existing field tiles is commonly identified by lines of buried topsoil within the subgrade soils and/or water boiling out of the ground following excavation. The field tiles are historically installed at 15.0 m (50.0 ft) intervals, however this can vary from site to site.

The monitoring wells that have been installed to determine static water levels can be decommissioned by an MOE licensed well contractor with a Class 1, Class 2 or Class 3 license in accordance with Reg. 903. CMT Drilling Inc. would be pleased to provide these services when the monitoring wells are no longer required.

5.4.4. ***Site Grading***

Currently, there are no design grades available. However, based on the existing grades and topography it is expected that significant cut and fill operations will be required to achieve the final design elevations across the site.

Following stripping of the topsoil, the removal of all trees roots (including all relatively loose soils associated with the tree roots) as well as the subexcavation of any relatively soft native soils deemed unsuitable of supporting the design bearing capacity, the exposed subgrade must be proof-rolled, and any soft or unstable areas must be further 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 a wet sand layer, as was observed in some of the boreholes, 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 or bulk fill, the subgrade for the proposed buildings, driveways and roads, 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 and pavement/concrete edge down to the approved competent 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 material) and 0.2 m (8") in depth for silts and clays, or the capacity of the compactor (whichever is less);

- Imported granular fill materials (OPSS 1010 Type I or Type III Granular 'B') can be compacted utilizing adequate heavy vibratory smooth drum or padfoot compaction equipment (compaction with padfoot equipment requires that structural fill be placed a minimum 0.3 m above the design footing grade in order to account for the disturbance of the founding soils from the pads on the compaction equipment);

- The native clayey silt, silt and clay/clay and silt as well as the silt soils must be compacted utilizing adequate heavy padfoot vibratory compaction equipment (compaction with padfoot equipment requires that structural fill be placed a minimum 0.3 m above the design footing grade in order to account for the disturbance of the founding soils from the pads on the compaction equipment);

- Approved fill materials must be at suitable moisture contents to achieve the specified compaction; the wet to saturated soils encountered in the boreholes would generally be considered difficult for use as structural fill as they would require extensive air-drying in order to achieve the specified density; soil moisture will also be dependent on weather conditions at the time of construction;

- Approved structural fill materials that will support structures (including residential house foundations, interior slab-on-grades, sidewalks, large expansive exterior slabs, decks and exterior stairs) must be compacted to a minimum of 98% standard Proctor maximum dry density (SPMDD);

- Approved bulk fill (exterior foundation wall backfill in landscaped areas, bulk fill for roadway (including sidewalk subgrade) and driveways) must be compacted to a minimum 95% SPMDD;

- Granular 'B' subbase and Granular 'A' base materials for the roads and driveways must be compacted to 100% SPMDD;

- It is recommended that compactive effort be applied to bulk fill in landscaped areas in order to reduce the effects of long term settlement.

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 98% SPMDD for structural fill 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. Reuse of excavated soils on-site will be subject to approval from qualified geotechnical personnel.

It should also be noted that the native soils encountered in the lower zone of Boreholes 4, 5 and 6 became very dense/hard with depth (SPT N-values in excess of 50 blows per 0.30 m) and may prove difficult to excavate with conventional excavating equipment. It is imperative that when the very dense/hard soils are utilized as fill, the material must be broken down (pulverized) to minimize void space and reduce the potential for settlement. Problems associated with compacting very dense/hard soils include the potential for long term settlement due to excessive void space caused by the generally blocky structure of the excavated soils. As such, the very dense, blocky material must **not** be used as structural fill. The contractor must have equipment on-site that can effectively break down (pulverize) the very dense excavated soil into workable sizes (as required). Backfilling utilizing this material must be performed in thin lifts with considerable compactive effort applied, thereby reducing the void space and minimizing long-term settlement. This process could be difficult and time-consuming.

5.5. ***Foundation Subgrade Preparation***

The native soils encountered in the boreholes are sensitive to change in moisture content and can become loose/soft if the soils are 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 or ditched to a sump located outside the building footprint 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;
- Should the native subgrade soils at the design founding elevation in the proposed building envelope(s) comprise saturated soils, as was observed in some of the boreholes, then a granular drainage layer, constructed in accordance with Section 9.14.4 of the current Ontario Building Code (OBC) may be required;
- 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 remain 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 soils should be proof-rolled. Any soft or weak zones, as well as any potential unsuitable fill in the subgrade (field tile trenches), should be subexcavated and backfilled with approved fill materials (see Section 5.4.4 of this report).

The following table provides the modulus of subgrade reaction (k) for imported granular fill, as well as the native soils encountered on-site:

Soil Type	Modulus of Subgrade Reaction (k)
Imported Sand and Gravel (OPSS 1010)	81,000 kN/m^3 (300 lb/in^3)
Clayey silt	41,000 kN/m^3 (150 lb/in^3)
Silt and Clay/Clay and Silt	41,000 kN/m^3 (150 lb/in^3)
Silt	41,000 kN/m^3 (150 lb/in^3)

Floor slabs can be founded on a minimum thickness of 100 mm (4") of coarse, clean granular material containing not more than 10% of material that will pass a 4 mm sieve in accordance with the current OBC. The clean granular material should be consolidated to prevent future settlement.

It is recommended that areas of extensive exterior slab-on-grade (sidewalks, accessibility ramps and exterior stairs) be constructed with a Granular 'B' subbase (450 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 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 hard or very dense native clayey silt, silt and clay/clay and silt in a drained state (not wet or saturated), would be classified as Type 2 soils under Reg 213/91. The Type 2 soils must be sloped to within 1.2 m of its bottom with a slope having 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 native silt 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 encountered in the boreholes, 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.

As previously noted, the native clayey silt, silt and clay/clay and silt, and silt soils encountered in the lower zone of Boreholes 4, 5 and 6 became very dense/hard with depth (SPT N-values in excess of 50 blows per 0.30 m) and may prove difficult to excavate with conventional excavating equipment, impacting the production schedule. It is imperative that when the very dense/hard soils are utilized as fill, the material must be broken down (pulverized) to minimize void space and reduce the potential for settlement.

5.8. *Construction Dewatering Considerations*

Wet to saturated soils were encountered in Boreholes 2, 3, 4, and 5 as described in Section 4.5 of this report. The relatively impermeable fine-grained, hard, clayey silt, silt and clay/clay and silt as well as the dense silt observed in the lower zone of the boreholes have the potential to create perched water conditions.

Seepage control requirements and groundwater conditions during construction are generally dependent on the amount of precipitation, control of surface water, the time of year, the area of work on the site, the depth of the excavations, and can fluctuate significantly in elevation and volume. As such, it is critical that provisions for site dewatering be part of the site development and construction process. 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 centre-line 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 $0.15D$ (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 dry buildings 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. Any surface discharge rainwater leaders must be constructed with solid piping that discharges with positive drainage at least 1.5 m away from the building foundations and/or beyond sidewalks to a drainage swale or appropriate storm drainage system.

The founding elevations for the proposed structures were not available at the time of preparation of this report. CMT Inc. can provide further recommendations for building drainage once the design drawings are completed and the founding elevations have been confirmed.

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, and deep structures such as sump pits within or below zones of saturation will require design of site-specific waterproofing systems constructed in accordance with the 2012 OBC. 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. 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).

It is expected that the new residences will have basements; therefore, an exterior perimeter weeping tile system comprising perforated drainage pipe with a factory installed filter sock, bedded in 19 mm clear crushed stone and wrapped in geotextile filter fabric such as Terrafix 270R (or equivalent), must be installed at an elevation that is below the proposed basement 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 in the interior basement as well to provide an outlet for any water that may collect in the subslab stone. 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.

In order to reduce the effects of surficial frost heave in areas that will be hard surfaced, it is recommended that the exterior foundation backfill consist of free-draining granular material such as approved on-site sand and gravel or imported Granular 'B' Type I or Type 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 concrete strength has not been achieved, the wall must be braced or laterally supported prior to backfilling. 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 driveways and parking lots; however, the wet soils may require air-drying in order to achieve the specified 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 (suited to soil type) 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 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 98% 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. ***Sensitivity of Subsoils***

The fine-grained clayey silt, silt and clay/clay and silt, as well as silt soils encountered in the boreholes are highly susceptible to strength losses and will prove difficult to place and compact if they are or become overly wet as a result of inclement weather or water seepage. If the soils are or become overly wet and disturbed, they may be unsuitable for reuse and require subexcavation. As such, the following recommendations are presented:

- perform the project during the drier summer months

- provide proper measures for adequate control of surface water and seepage during construction

- allow sufficient time between excavating and backfilling to provide for air-drying (as required)

- work the stockpiles as required to expedite air-drying

- use a smooth lipped bucket to reduce the disturbance while excavating to the subgrade elevation

- minimize construction traffic traveling over the subgrade soils

5.12. ***Pavement Design/Drainage***

All topsoil, vegetation (including tree roots and all loose/disturbed soils associated with tree roots) must be subexcavated from within the road allowance. It is recommended to either subexcavate any existing soft subgrade materials or provide further consolidation with vibratory compaction equipment in order to prepare a proper, stable subgrade.

Prior to placement of the granular base, the subgrade must be proof-rolled, and 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 the drainage outlet or curbline/edge of asphalt (provided that collection and 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. Based on the frost susceptibility of the native soils it is strongly recommended to install minimum 100 mm diameter perforated subdrains to collect and redirect water beneath the pavement surface (provided positive drainage to a suitable outlet can be provided). 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 heave. 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 subdrains be along the curb lines. It is also recommended to install subdrains through any areas that cannot tolerate differential frost heave such as accessibility ramps/sidewalks. 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 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.

Should wet conditions be encountered during construction, site assessments may be required to determine what options can be undertaken to construct a modified pavement base. These options may include subexcavation of wet soils and increasing the thickness of the granular base, the use of reinforcing geotextiles, or a combination of both.

It is expected that the roads will experience mostly light residential traffic (personal vehicles) and some heavy traffic (delivery trucks, as well as maintenance and emergency vehicles). Based on the anticipated vehicle loading and frost susceptibility of the subgrade soils, the following pavement design is provided:

Material	**Recommended Thickness For New Pavement**
	Heavy Traffic
Asphaltic Concrete	HL3 - 40mm (1.5") HL4 or HL8 - 50 mm (2.0")
Granular 'A' Base (OPSS 1010)	150 mm (6.0")
Granular 'B' Subbase (OPSS 1010)	450 mm (18.0")

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.

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 be applied to the edge and surface of all milled asphalt prior to placement of new asphalt in conformance with OPSS 308.

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.

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 delivery trucks and the condition is further intensified during hot weather.

5.13. Excess Soil Management

5.13.1 Chemical Testing was NOT Undertaken

Generally, if surplus soils are to be exported off-site, it will be necessary to perform chemical analysis of the soils. Chemical analysis was not undertaken as part of this geotechnical investigation. Should chemical analysis tests be required, the required tests vary and will be dependent on the disposal site utilized by the general contractor.

Most commonly, the soils are tested for the following:

- F1-F4, VOC's, BTEX as per O. Reg. 153/04 as amended by R511
- SVOC as per O. Reg. 153/04 as amended by R511
- Metals/Inorganics as per O. Reg. 153/04 amended by R511

The chemical analysis results are then compared to Ontario Regulation 153/04 - as amended by O.Reg. 511 – April 15, 2011 Standards = [Suite] – ON-511-T1/T2-SOIL-RPI. Specifically, the results were compared in *T1-Soil-Res/Park/Inst/Ind/Com/Commu Property Use*, *T2-Soil-Res/Park/Inst. Property Use (Coarse)* and *T3-Soil-Res/Park/Inst. Property Use (Fine)*.

5.13.2 TCLP Requirement

If soils are transported to a land fill facility, additional chemical testing in accordance with Ontario Regulation 347, Schedule 4, as amended to Ontario Regulation 558/00, dated March 2001, Toxicity Characteristic Leaching Procedure (TCLP) will be required.

When transporting soils off-site, the following is recommended:

- All chemical analyses and environmental assessment reports must be fully disclosed to the receiving site owners/authorities, whom must agree to receive the material;
- An environmental consultant must confirm the land use at the receiving site is compatible to receive the material;
- An environmental consultant must monitor the transportation and placement of the materials to ensure that the material is placed appropriately at the pre-approved site;

- The excess materials may not be transported to a site that has previously had a Record of Site Condition (RSC) filed, unless the material meets the criteria outlined in the RSC.

It should be noted that landfill sites will generally only accept laboratory test results that have been completed within 30 days of exporting. Therefore, it is recommended that provisions for chemical analysis be included in the tender documents. It should also be noted that the laboratory testing generally takes five (5) working days to process with a regular turnaround time.

5.14. *Coefficient of Permeability/T-time*

As part of the geotechnical investigation, gradation analyses were performed on samples of the native clayey silt, the silt and clay/clay and silt, as well as the silt soils. The following table provides the sample location (monitoring well/borehole number), sample depth, corresponding estimated coefficient of permeability (k) and t-time as well as soil type:

Borehole No.	**Depth (m)**	**Estimated Coefficient of Permeability (k) cm/s**	**Estimated T-time (T) min/cm**	**Soil Type**
1	0.76 – 1.37	$< 1.0 \times 10^{-6}$	50	Clayey silt, some sand, trace gravel (ML)
2	4.57 – 5.18	$< 1.0 \times 10^{-6}$	> 50	Clay and silt, trace sand and gravel (CL)
3	3.20 – 3.66	$< 1.0 \times 10^{-6}$	50	Clay and silt, trace sand and gravel (ML)
4	9.14 – 10.67	$< 1.0 \times 10^{-6}$	35	Silt, some sand and clay (ML)
5	5.18 – 6.10	$< 1.0 \times 10^{-6}$	50	Silt and clay, trace sand (ML)
6	2.29 – 2.90	$< 1.0 \times 10^{-6}$	40	Clayey silt, some sand, trace gravel (ML)

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

The fine-grained, hard/very dense 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.

5.15. ***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.

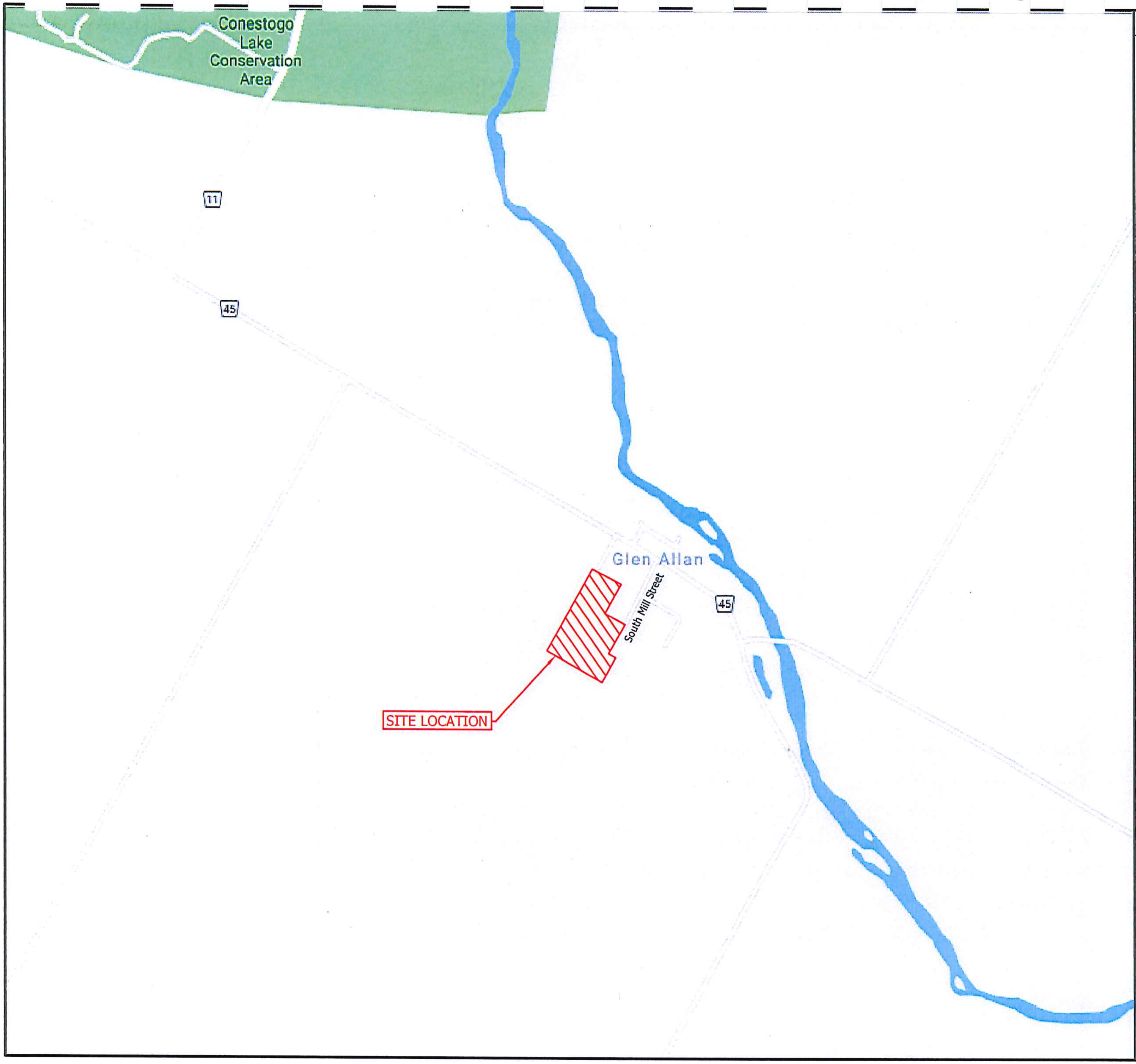
Prepared by:

Shawn Wheatley, M.Eng.

LICENSED PROFESSIONAL ENGINEER
Oct 11/18
R. KOOPMANS
PROVINCE OF ONTARIO

Reviewed by:

Robert Koopmans, P.Eng.
Consulting Engineer



NOTES:

Base map provided by Google Maps

NO.	DESCRIPTION	DATE

REVISIONS

CMT ENGINEERING INC.
1011 Industrial Crescent, Unit 1
St. Clements, Ontario N0B 2M0
Tel.: 519-699-5775
Fax: 519-699-4664
www.cmtinc.net

PROJECT:

Residential Subdivision
South Mill Street,
Glen Allan, Ontario

DRAWING TITLE:

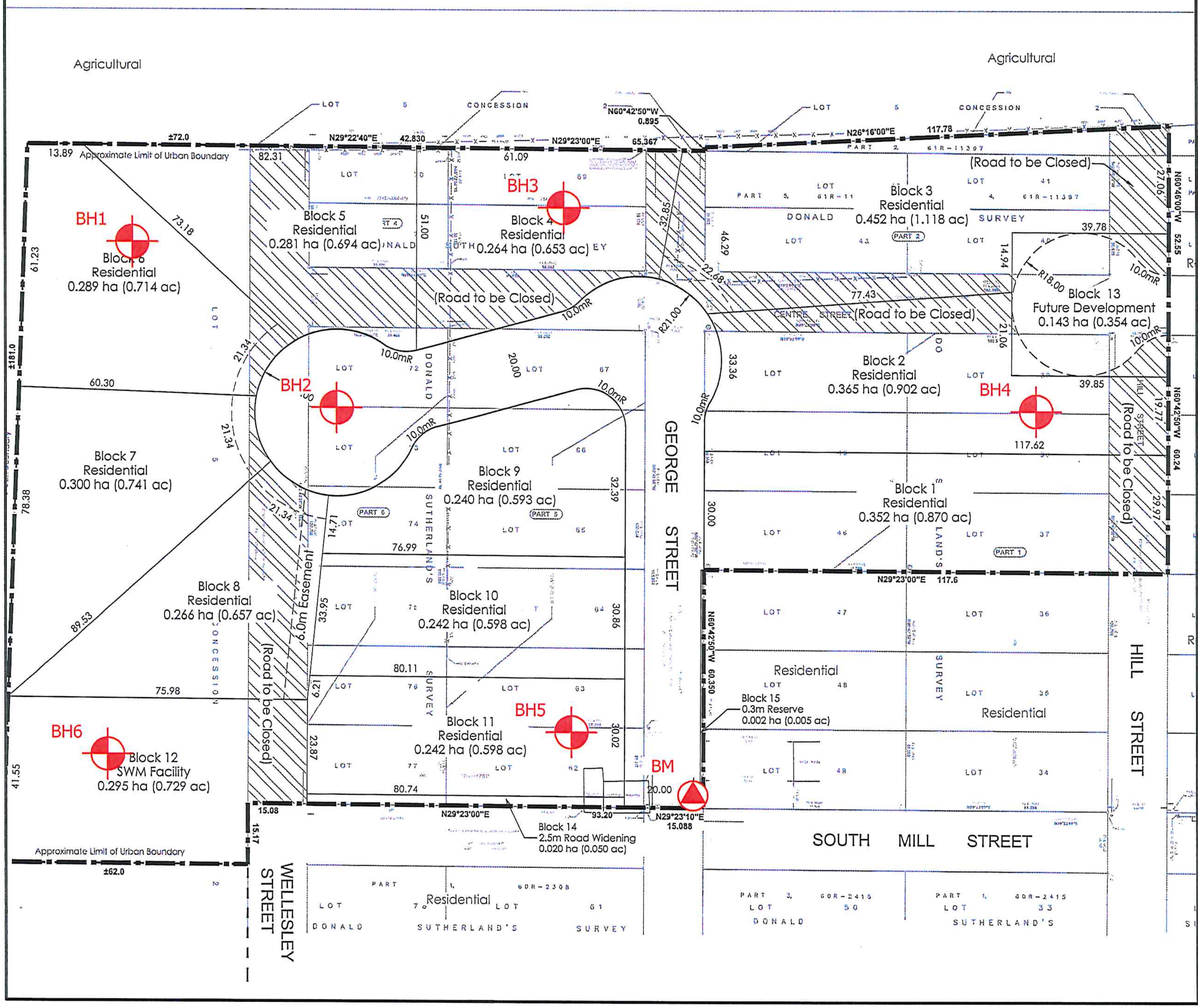
SITE LOCATION MAP

PROJECT NO.: 18-462

DATE: September 25, 2018

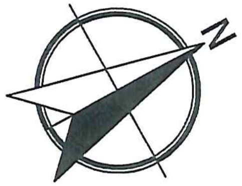
SCALE: N.T.S.

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 drawing is provided by MHCB Planning
3. Benchmark: Nail in Hydropole on west side of South Mill Street
Reported Elevation = 400.679



NO.	DESCRIPTION	DATE

REVISIONS

CMT ENGINEERING INC.
1011 Industrial Crescent, Unit 1
St. Clements, Ontario N0B 2M0
Tel.: 519-699-5775
Fax: 519-699-4664
www.cmtinc.net

PROJECT:

Residential Subdivision
South Mill Street,
Glen Allan, Ontario

DRAWING TITLE:

SITE PLAN SHOWING
BOREHOLE LOCATIONS

PROJECT NO.: 18-462

DATE: September 25, 2018

SCALE: N.T.S.

DRAWING NO. 2

APPENDIX A

BOREHOLE LOGS

BOREHOLE 1

Page 1 of 1

Date Drilled: August 30, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 405.48 m
Logged by: SW

Project No.: 18-462
Project: Residential Subdivision
Location: South Mill Street,
Glen Allan, Ontario

Elevation (m) / Depth (m)	SOIL DESCRIPTION
405.48	Ground Surface (m)
0.00	**TOPSOIL** Loose, dark brown, silty, organic topsoil, moist (170 mm)
405.02 0.46	**CLAYEY SILT** Firm, brown clayey silt, some sand, trace gravel, with trace organics and rootlets, drier than the plastic limit Becoming very stiff, no organics or rootlets
403.19 2.29	Becoming hard, cobbles present
402.43 3.05	About the plastic limit Becoming very stiff
401.82 3.66	**SILT AND CLAY** Very stiff, grey silt and clay, trace sand and gravel, about the plastic limit
399.69 5.79	End of Borehole

Cave at 3.30 m below ground surface.
No accumulated groundwater encountered upon completion.

Sample Type	Sample Number	Moisture Content %	SPT (N) Blows/0.3 m	Pocket Penetrometer kPa
SS	1	15.5	6	375
SS	2	17.4	22	400
SS	3	12.2	29	400
SS	4	18.9	50(6")	250
SS	5	19.2	17	200
MC5	6	19.0		150
SS	7	20.2	21	150
SS	9	21.2	25	100

Moisture Content % Wp [----X----] Wl 10 20 30 40

Pocket Penetrometer kPa 100 200 300 400

SPT (N) Blows/0.3 m 20 40 60 80

Well Installation

CMT ENGINEERING INC.
1011 Industrial Crescent, Unit 1
St. Clements, Ontario N0B 2M0
phone 519-699-5775 fax 519-699-4664
www.cmtinc.net

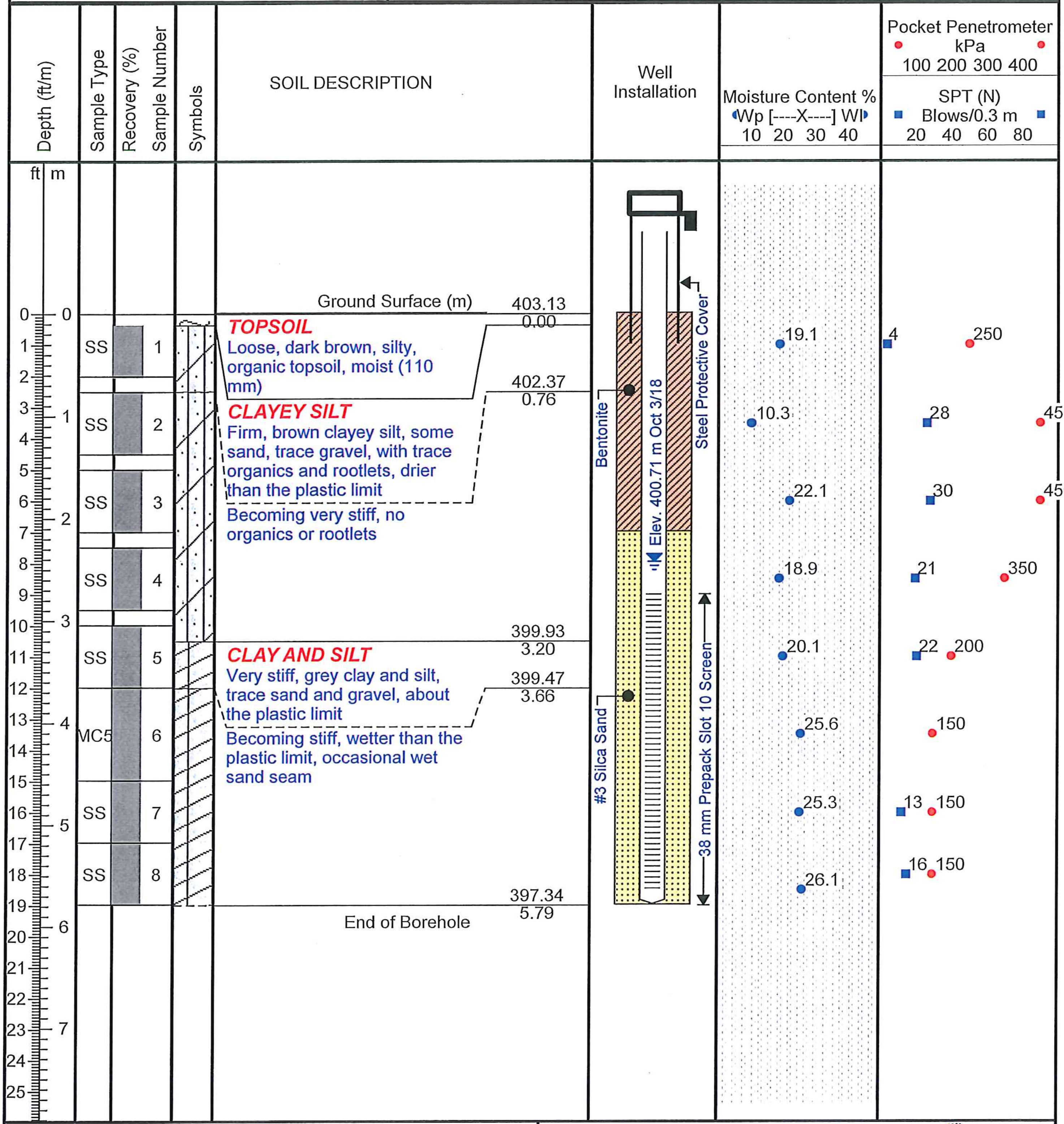
BOREHOLE 2

Page 1 of 1

Date Drilled: August 29, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 403.13 m
Logged by: SW

Project No.: 18-462
Project: Residential Subdivision
Location: South Mill Street,
Glen Allan, Ontario



Ground Surface (m) 403.13
0.00

TOPSOIL
Loose, dark brown, silty, organic topsoil, moist (110 mm)

402.37
0.76

CLAYEY SILT
Firm, brown clayey silt, some sand, trace gravel, with trace organics and rootlets, drier than the plastic limit

Becoming very stiff, no organics or rootlets

399.93
3.20

CLAY AND SILT
Very stiff, grey clay and silt, trace sand and gravel, about the plastic limit

399.47
3.66

Becoming stiff, wetter than the plastic limit, occasional wet sand seam

397.34
5.79

End of Borehole

SS	1	19.1	4	250
SS	2	10.3	28	450
SS	3	22.1	30	450
SS	4	18.9	21	350
SS	5	20.1	22	200
MC5	6	25.6		150
SS	7	25.3	13	150
SS	8	26.1	16	150

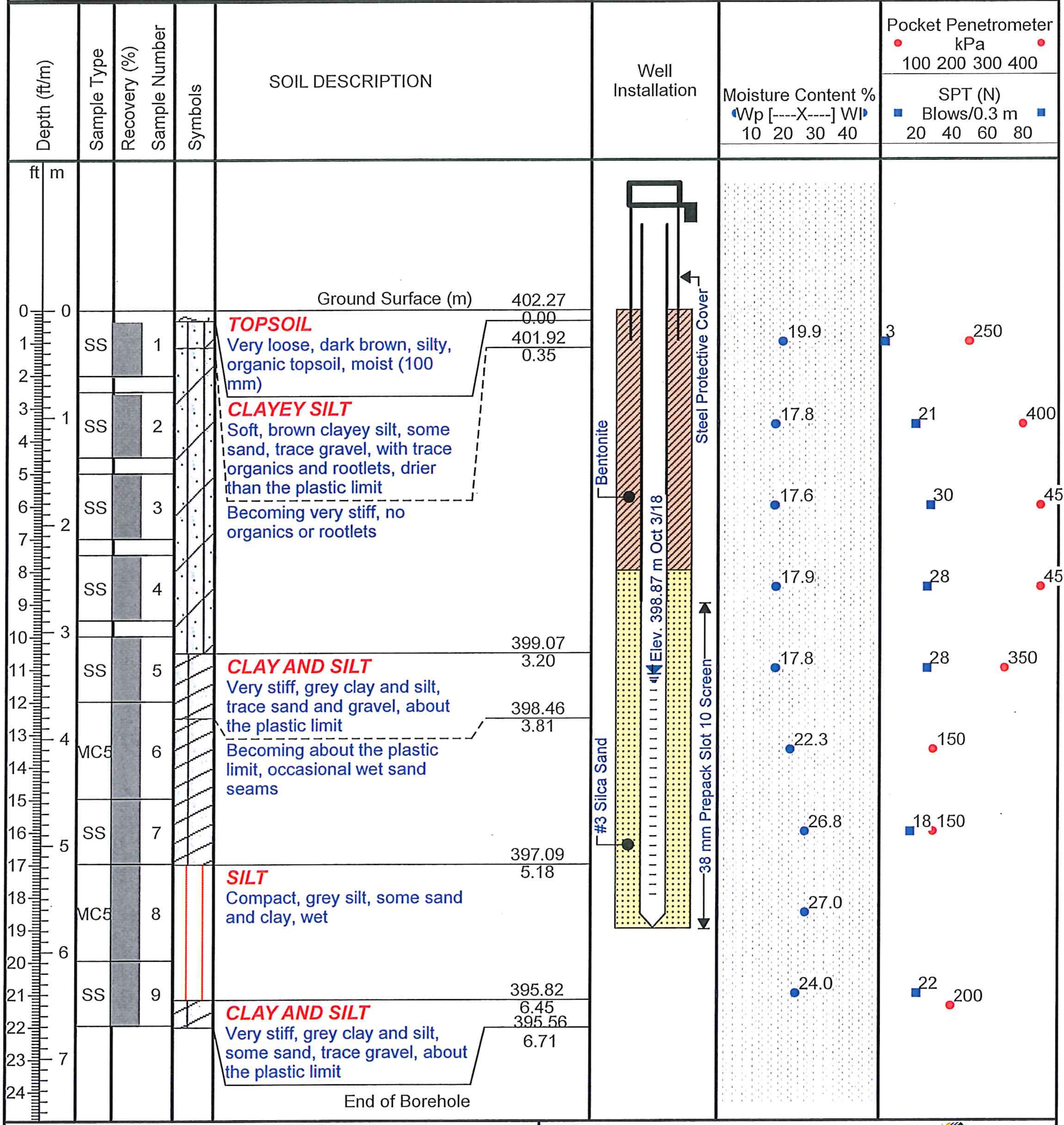
BOREHOLE 3

Page 1 of 1

Date Drilled: August 29, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 402.27 m
Logged by: SW

Project No.: 18-462
Project: Residential Subdivision
Location: South Mill Street,
Glen Allan, Ontario



Ground Surface (m) 402.27 / 0.00

TOPSOIL (401.92 / 0.35)
Very loose, dark brown, silty, organic topsoil, moist (100 mm)

CLAYEY SILT
Soft, brown clayey silt, some sand, trace gravel, with trace organics and rootlets, drier than the plastic limit

Becoming very stiff, no organics or rootlets

399.07 / 3.20

CLAY AND SILT (398.46 / 3.81)
Very stiff, grey clay and silt, trace sand and gravel, about the plastic limit

Becoming about the plastic limit, occasional wet sand seams

397.09 / 5.18

SILT
Compact, grey silt, some sand and clay, wet

395.82 / 6.45

CLAY AND SILT (395.56 / 6.71)
Very stiff, grey clay and silt, some sand, trace gravel, about the plastic limit

End of Borehole

Sample Type	Sample Number	Moisture Content %	SPT (N) Blows/0.3 m	Pocket Penetrometer kPa
SS	1	19.9	3	250
SS	2	17.8	21	400
SS	3	17.6	30	450
SS	4	17.9	28	450
SS	5	17.8	28	350
MC5	6	22.3		150
SS	7	26.8	18	150
MC5	8	27.0		
SS	9	24.0	22	200

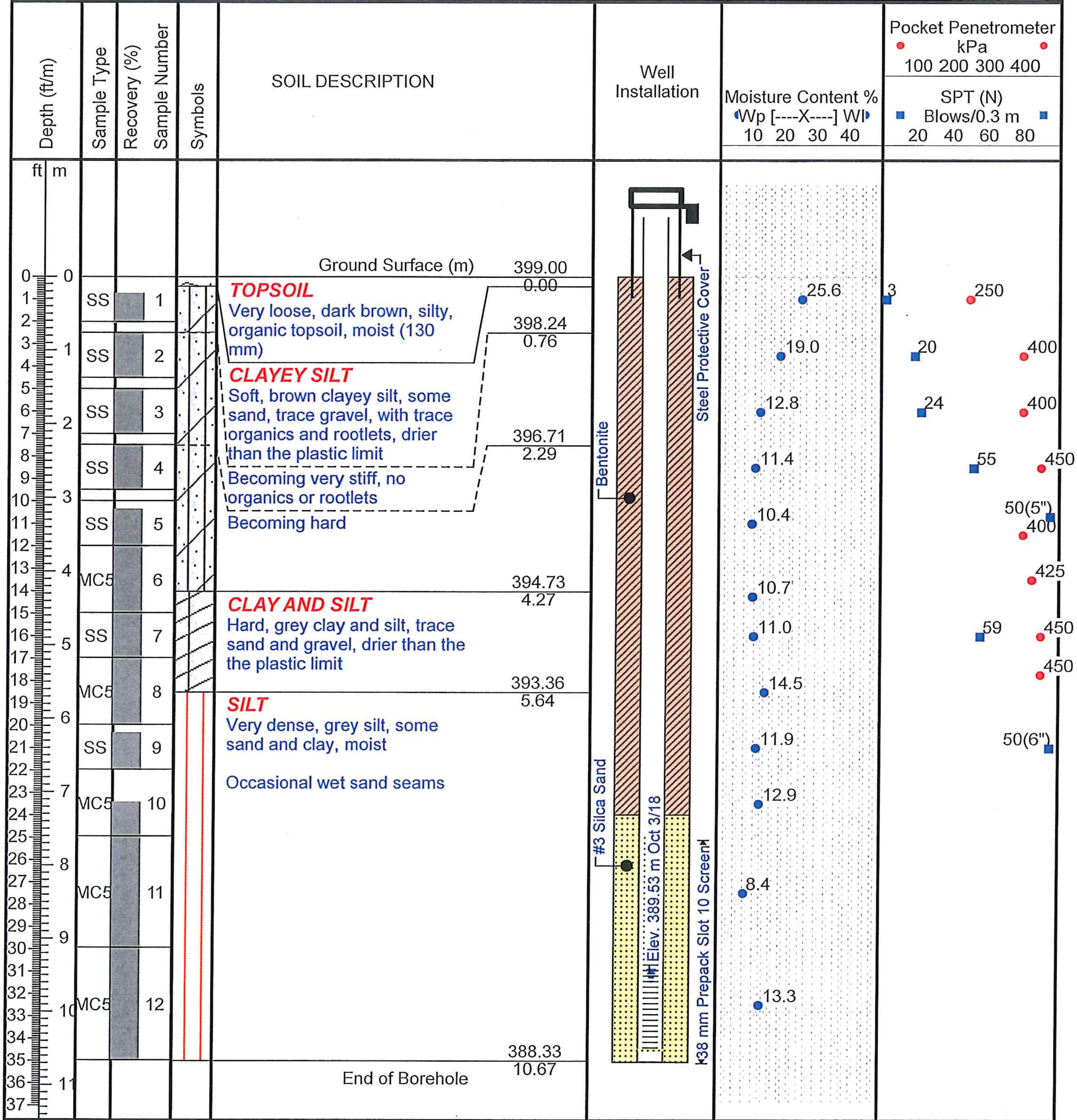
BOREHOLE 4

Page 1 of 1

Date Drilled: August 29, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 399.00 m
Logged by: SW

Project No.: 18-462
Project: Residential Subdivision
Location: South Mill Street,
Glen Allan, Ontario



TOPSOIL
Very loose, dark brown, silty, organic topsoil, moist (130 mm)

CLAYEY SILT
Soft, brown clayey silt, some sand, trace gravel, with trace organics and rootlets, drier than the plastic limit

Becoming very stiff, no organics or rootlets

Becoming hard

CLAY AND SILT
Hard, grey clay and silt, trace sand and gravel, drier than the the plastic limit

SILT
Very dense, grey silt, some sand and clay, moist

Occasional wet sand seams

End of Borehole

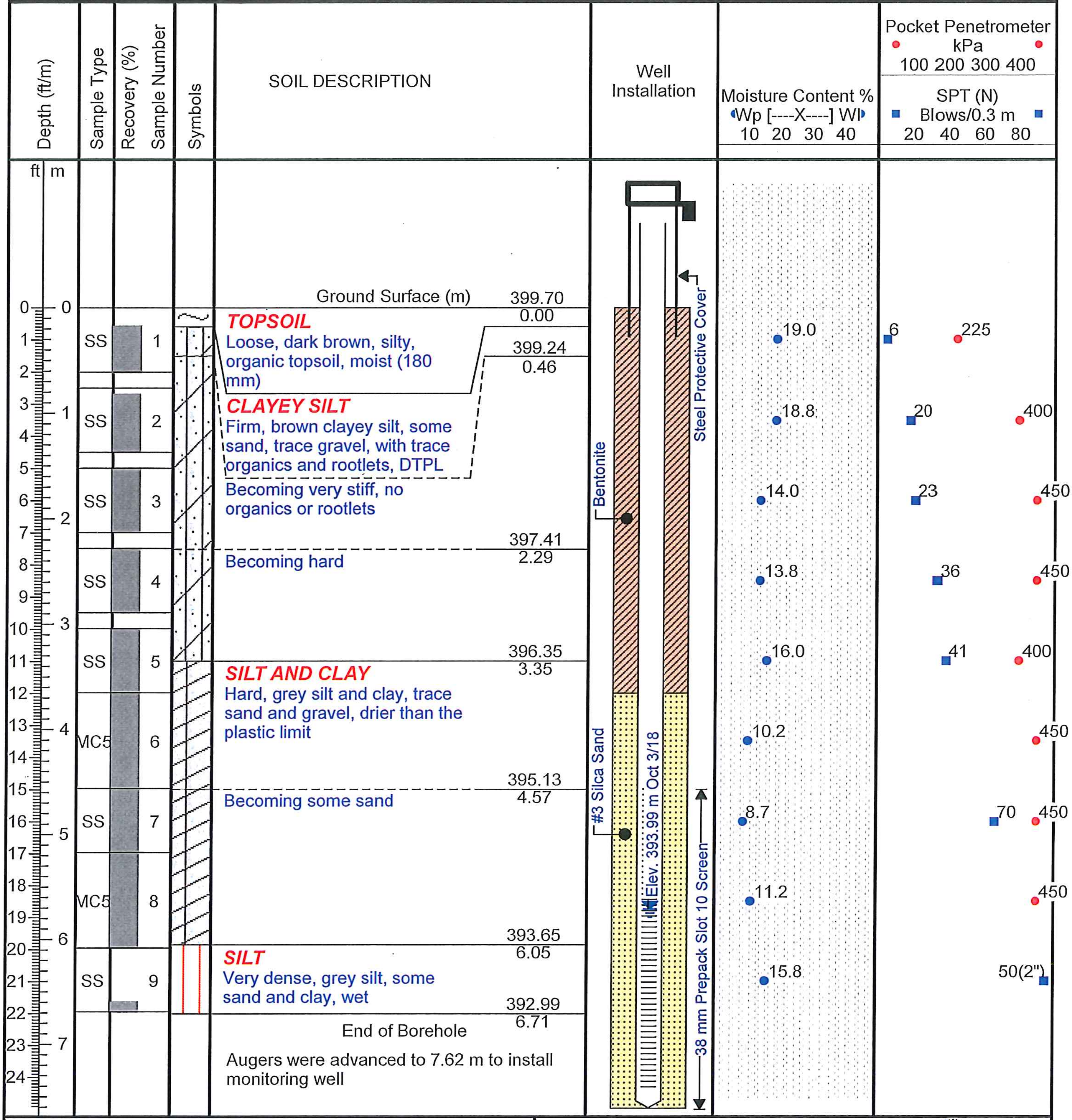
CMT ENGINEERING INC.
1011 Industrial Crescent, Unit 1
St. Clements, Ontario N0B 2M0
phone 519-699-5775 fax 519-699-4664
www.cmtinc.net

BOREHOLE 5

Date Drilled: August 29, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 399.70 m
Logged by: SW

Project No.: 18-462
Project: Residential Subdivision
Location: South Mill Street,
Glen Allan, Ontario



SOIL DESCRIPTION

Ground Surface (m) 399.70 / 0.00

TOPSOIL
Loose, dark brown, silty, organic topsoil, moist (180 mm)

399.24 / 0.46

CLAYEY SILT
Firm, brown clayey silt, some sand, trace gravel, with trace organics and rootlets, DTPL

Becoming very stiff, no organics or rootlets

397.41 / 2.29

Becoming hard

396.35 / 3.35

SILT AND CLAY
Hard, grey silt and clay, trace sand and gravel, drier than the plastic limit

395.13 / 4.57

Becoming some sand

393.65 / 6.05

SILT
Very dense, grey silt, some sand and clay, wet

392.99 / 6.71

End of Borehole

Augers were advanced to 7.62 m to install monitoring well

Sample Type	Sample Number	Moisture Content %	SPT (N) Blows/0.3 m	Pocket Penetrometer kPa
SS	1	19.0	6	225
SS	2	18.8	20	400
SS	3	14.0	23	450
SS	4	13.8	36	450
SS	5	16.0	41	400
MC5	6	10.2		450
SS	7	8.7	70	450
MC5	8	11.2		450
SS	9	15.8	50(2")	

BOREHOLE 6

Page 1 of 1

Date Drilled: August 30, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 396.57 m
Logged by: SW

Project No.: 18-462
Project: Residential Subdivision
Location: South Mill Street,
Glen Allan, Ontario

SOIL DESCRIPTION	Elevation (m) / Depth (m)
Ground Surface (m)	396.57 0.00
TOPSOIL Loose, dark brown, silty, organic topsoil, moist (400 mm)	396.17 0.40
CLAYEY SILT Soft, dark brown clayey silt, some sand, trace gravel, with trace organics and rootlets, drier than the plastic limit	395.81 0.76
Becoming very stiff, no organics or rootlets	395.05 1.52
Becoming hard	
SILT AND CLAY Hard, grey silt and clay, trace sand and gravel, drier than the plastic limit	393.52 3.05
End of Borehole	389.86 6.71

Depth (ft)	Sample Type	Sample Number	Moisture Content %	SPT (N) Blows/0.3 m	Pocket Penetrometer kPa
1	SS	1	21.9	3	
3.5	SS	2	12.5	17	450
6	SS	3	12.4	35	
8.5	SS	4	10.9	36	450
11	SS	5	10.2	56	450
13.5	MC5	6	10.2		
16	SS	7	11.4	49	450
18.5	MC5	8	9.3		350
21	SS	9	13.8	32	

Well Installation

Moisture Content % Wp [----X----] Wl (10 20 30 40)

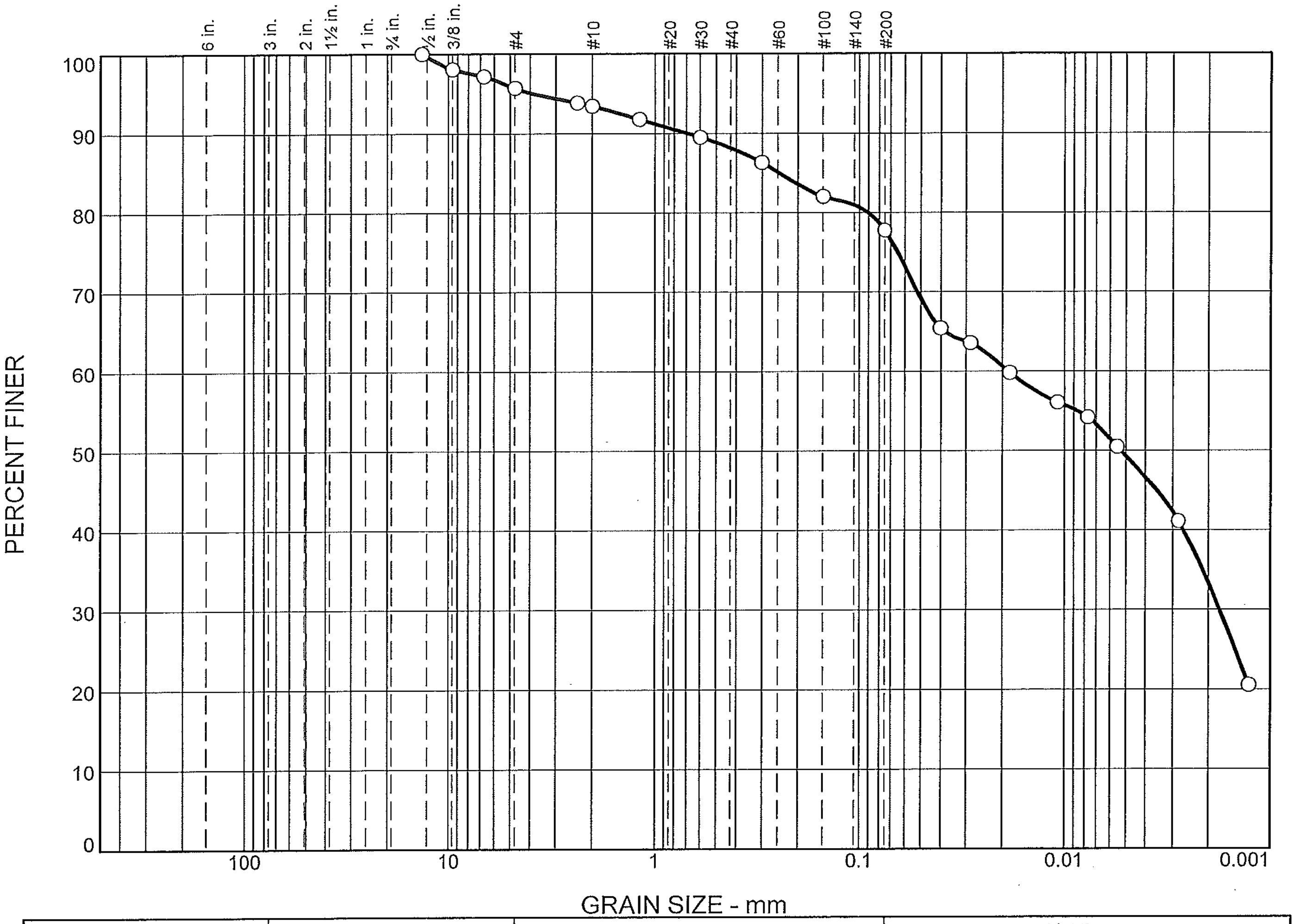
Cave at 6.55 m below ground surface.
No accumulated groundwater encountered upon completion.

CMT ENGINEERING INC.
1011 Industrial Crescent, Unit 1
St. Clements, Ontario N0B 2M0
phone 519-699-5775 fax 519-699-4664
www.cmtinc.net

APPENDIX B

GRAIN SIZE ANALYSES

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	4.3	2.3	5.2	10.5	44.3	33.4

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH1	5	0.76-1.37m	clayey silt, some sand, trace gravel	ML
				Tested by MS of CMT Engineering Inc., September 6, 2018	
				Coefficient of Permeability k < 1.0 x 10-6 cm/s	
				T = 50 min/cm	

CMT Engineering Inc.

St. Clements, ON

Client: Mr. Murray Martin

Project: Residential Subdivision
South Mill Street, Glen Allan, Ontario

Project No.: 18-462 **Figure** 1

Particle Size Distribution Report

	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.4	0.4	0.6	2.9	37.1	58.6

SOIL DATA

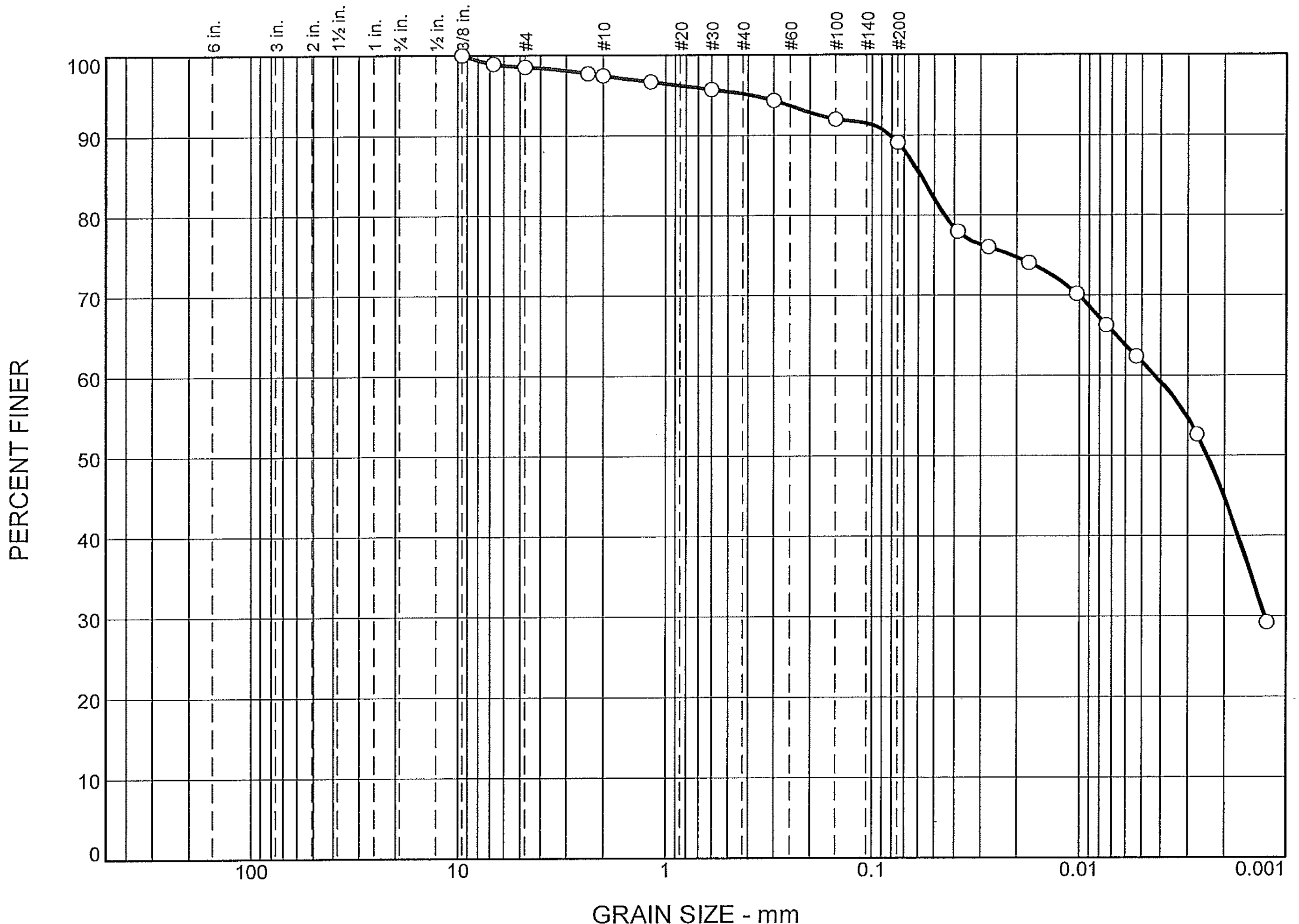
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH2	7	4.57-5.18m	clay and silt, trace sand and gravel	CL
				Tested by MS of CMT Engineering Inc., September 6, 2018	
				Coefficient of Permeability k < 1.0 x 10-6 cm/s	
				T = 50 min/cm	

CMT Engineering Inc.

St. Clements, ON

Client: Mr. Murray Martin
Project: Residential Subdivision
South Mill Street, Glen Allan, Ontario
Project No.: 18-462 **Figure** 2

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	1.4	1.1	2.3	6.1	44.3	44.8

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH3	3	3.05-3.66m	clay and silt, trace sand and gravel	ML
				Tested by MS of CMT Engineering Inc., September 6, 2018	
				Coefficient of Permeability k < 1.0 x 10-6 cm/s	
				T = 50 min/cm	

CMT Engineering Inc.

St. Clements, ON

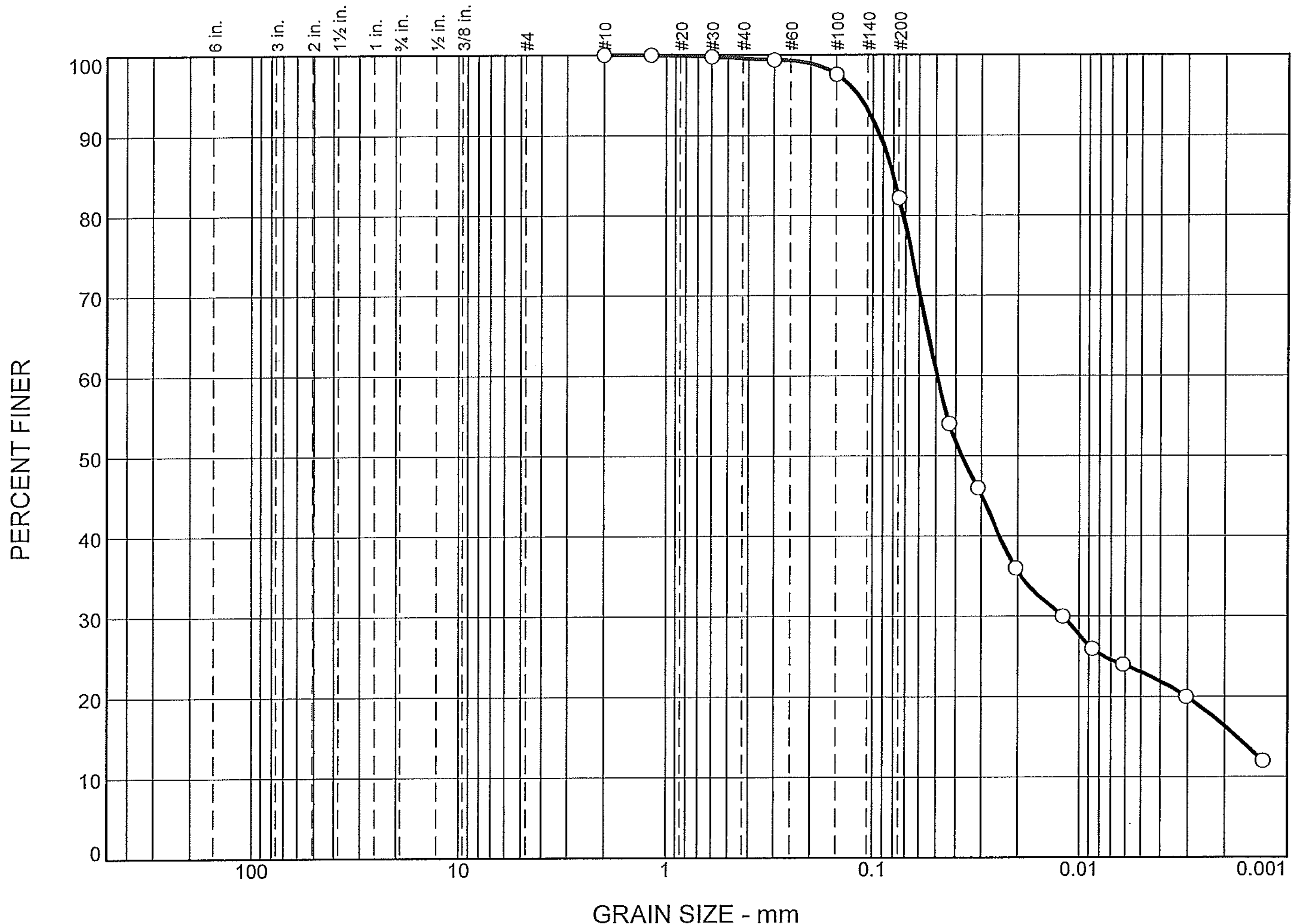
Client: Mr. Murray Martin

Project: Residential Subdivision
South Mill Street, Glen Allan, Ontario

Project No.: 18-462

Figure 3

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.4	17.4	65.9	16.3

SOIL DATA

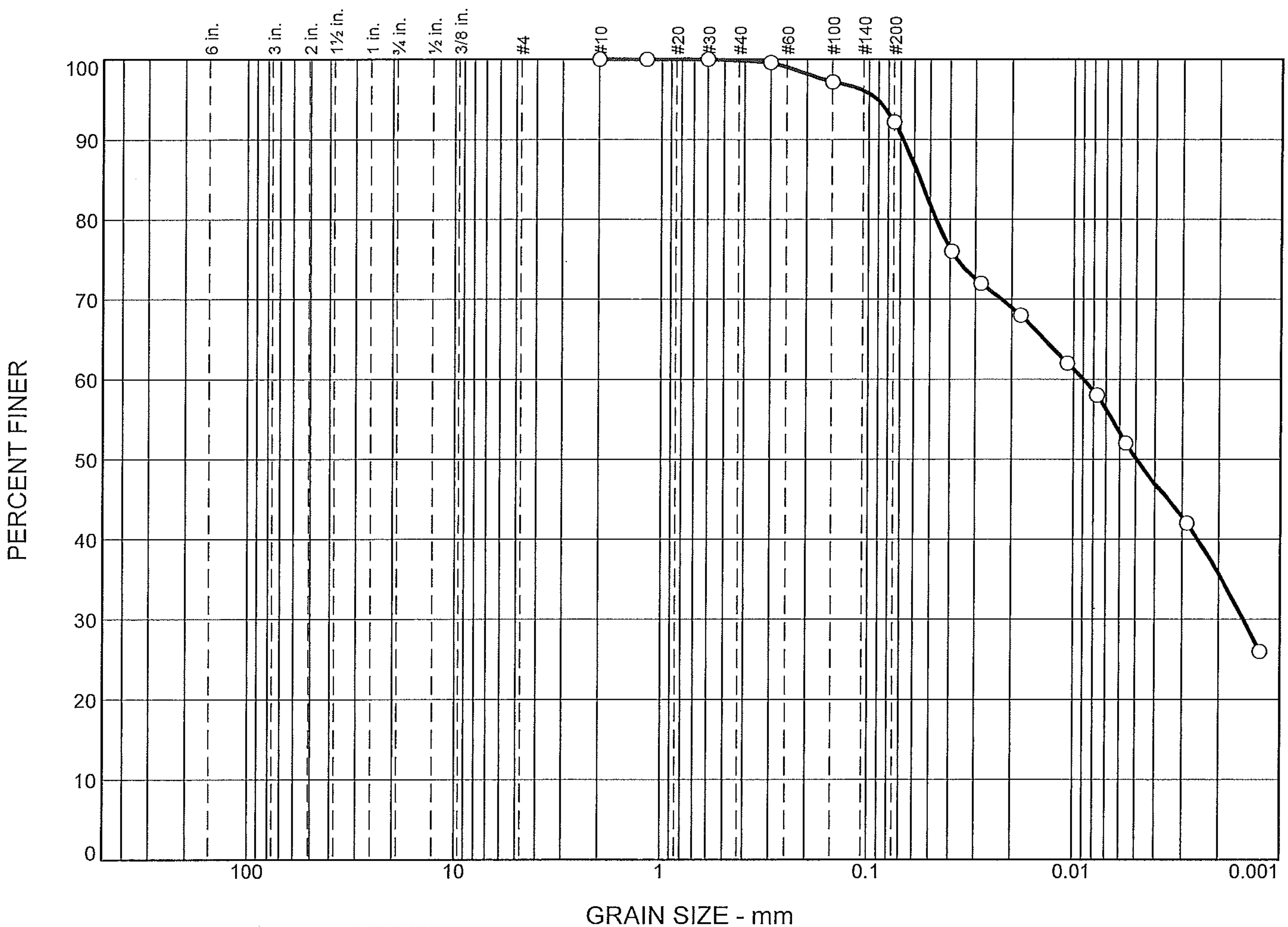
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH4	12	9.14-	silt, some sand and clay	ML
			10.67m	Tested by MS of CMT Engineering Inc., September 6, 2018	
				Coefficient of Permeability k < 1.0 x 10-6 cm/s	
				T = 50 min/cm	

CMT Engineering Inc.

St. Clements, ON

Client: Mr. Murray Martin
Project: Residential Subdivision
South Mill Street, Glen Allan, Ontario
Project No.: 18-462 **Figure** 4

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.1	7.7	56.5	35.7

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH5	8	5.18-6.10m	silt and clay. trace sand	ML
				Tested by MS of CMT Engineering Inc., September 6, 2018	
				Coefficient of Permeability k < 1.0 x 10-6 cm/s	
				T = 50 min/cm	

CMT Engineering Inc.

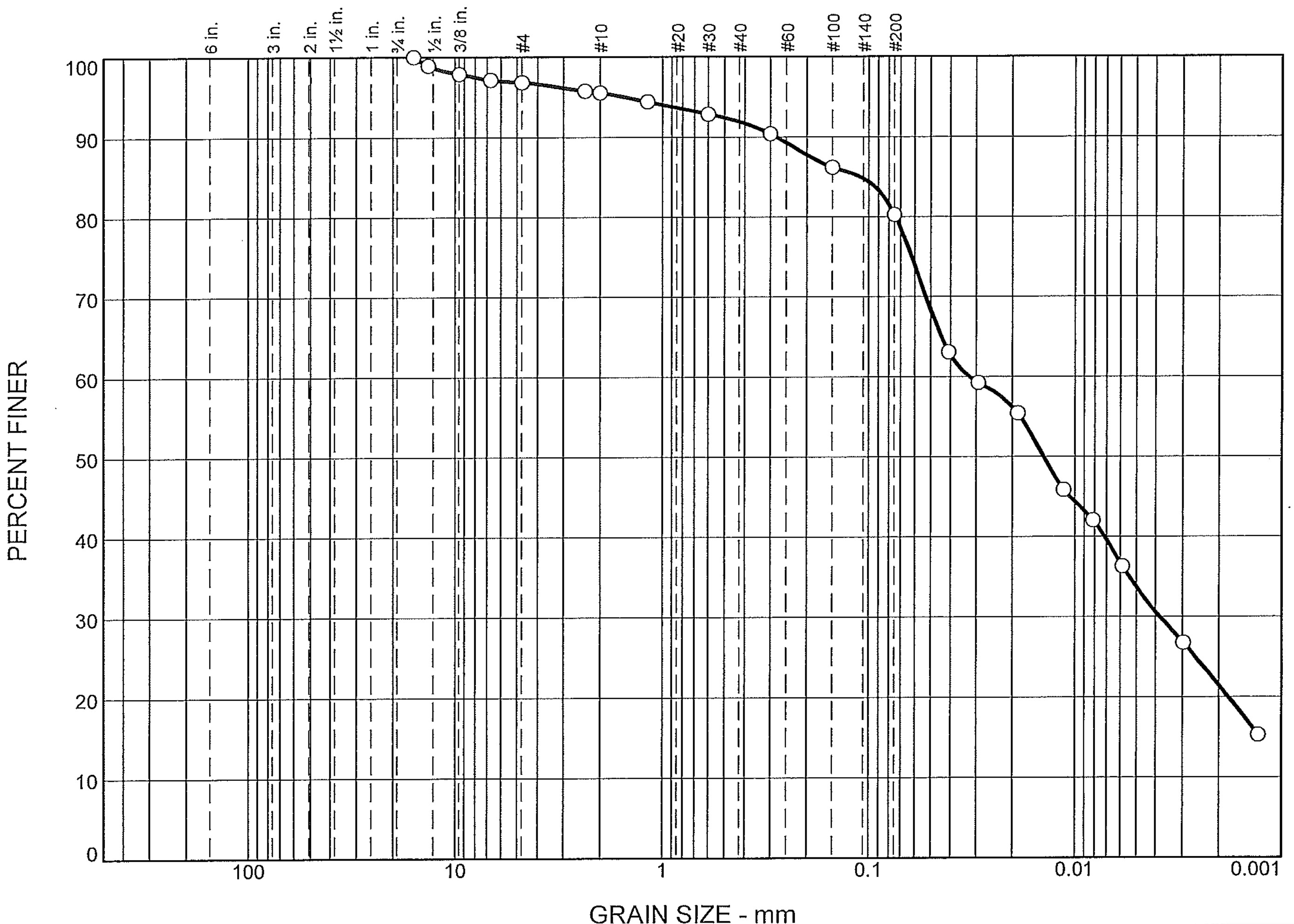
St. Clements, ON

Client: Mr. Murray Martin

Project: Residential Subdivision
South Mill Street, Glen Allan, Ontario

Project No.: 18-462 **Figure** 5

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	3.1	1.3	3.7	11.6	58.8	21.5

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH6	4	2.29-2.90m	Clayey Silt, some sand, trace gravel	ML
				Tested by MS of CMT Engineering Inc., September 6, 2018	
				Coefficient of Permeability k < 1.0 x 10-6 cm/s	
				T = 50 min/cm	

CMT Engineering Inc.

St. Clements, ON

Client: Mr. Murray Martin

Project: Residential Subdivision
South Mill Street, Glen Allan, Ontario

Project No.: 18-462 **Figure** 6

APPENDIX C

WELL RECORDS

Ontario
Ministry of the Environment and Climate Change

Measurements recorded in: ☐ Metric ☐ Imperial

Well Tag No. *(Place Sticker and/or Print Below)*
A249002

Well Record

Regulation 903 Ontario Water Resources Act

Page ____ of ____

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
Murray	Martin		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. *(inc. area code)*
58 Hill St	Wallenstein	ON	N0B2S0	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
Hill St. S.			

County/District/Municipality	City/Town/Village	Province	Postal Code
	Glen Allan	**Ontario**	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	17	523408	4833629		

Overburden and Bedrock Materials/Abandonment Sealing Record *(see instructions on the back of this form)*

General Colour	Most Common Material	Other Materials	General Description	Depth ([✓ m]/ft) From	To
Black	topsoil			0	0.1
Brown	silt	clay		0.1	5.1
Brown	silt	sand		5.1	5.7

Annular Space

Depth Set at ([✓ m]/ft) From	To	Type of Sealant Used *(Material and Type)*	Volume Placed ([✓ m³]/ft³)
0	2.4	3/8 holeplug	<1
2.4	5.7	#2 sand	<1

Method of Construction

☐ Cable Tool
☐ Rotary (Conventional)
☐ Rotary (Reverse)
☐ Boring
☐ Air percussion
☐ Other, *specify* ____
☐ Diamond
☐ Jetting
☑ Driving
☐ Digging

Well Use

☐ Public
☐ Domestic
☐ Livestock
☐ Irrigation
☐ Industrial
☐ Other, *specify* ____
☐ Commercial
☐ Municipal
☐ Test Hole
☐ Cooling & Air Conditioning
☐ Not used
☐ Dewatering
☑ Monitoring

Construction Record - Casing

Inside Diameter ([✓ cm]/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth ([✓ m]/ft) From	To
3.8	Plastic		0	2.7

Construction Record - Screen

Outside Diameter ([✓ cm]/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth ([✓ m]/ft) From	To
4	Plastic	10	2.7	5.7

Status of Well

☐ Water Supply
☐ Replacement Well
☐ Test Hole
☐ Recharge Well
☐ Dewatering Well
☑ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, *specify* ____
☐ Other, *specify* ____

Water Details

Water found at Depth	Kind of Water
____ (m/ft) ☐ Gas	☐ Fresh ☐ Untested ☐ Other, *specify* ____
____ (m/ft) ☐ Gas	☐ Fresh ☐ Untested ☐ Other, *specify* ____
____ (m/ft) ☐ Gas	☐ Fresh ☐ Untested ☐ Other, *specify* ____

Hole Diameter

Depth ([✓ m]/ft) From	To	Diameter ([✓ cm]/in)
0	5.7	10

Results of Well Yield Testing

After test of well yield, water was:
☐ Clear and sand free
☐ Other, *specify* ____

If pumping discontinued, give reason:

Pump intake set at *(m/ft)*

Pumping rate *(l/min / GPM)*

Duration of pumping
____ hrs + ____ min

Final water level end of pumping *(m/ft)*

If flowing give rate *(l/min / GPM)*

Recommended pump depth *(m/ft)*

Recommended pump rate *(l/min / GPM)*

Well production *(l/min / GPM)*

Disinfected?
☐ Yes ☐ No

Draw Down Time *(min)*	Water Level *(m/ft)*	Recovery Time *(min)*	Water Level *(m/ft)*
Static Level			
1		1	
2		2	
3		3	
4		4	
5		5	
10		10	
15		15	
20		20	
25		25	
30		30	
40		40	
50		50	
60		60	

Map of Well Location

Please provide a map below following instructions on the back.

SEE ATTACHED MAP
FOR MW2

Comments:

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
CMT Drilling Inc	7366

Business Address (Street Number/Name)	Municipality
1011 Industrial Cres	Waterloo

Province	Postal Code	Business E-mail Address
ON	N0B2N0	cmtinc.net

Bus.Telephone No. *(inc. area code)*	Name of Well Technician (Last Name, First Name)
5196495715	

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
37111	Black, Chris	2018[illegible]

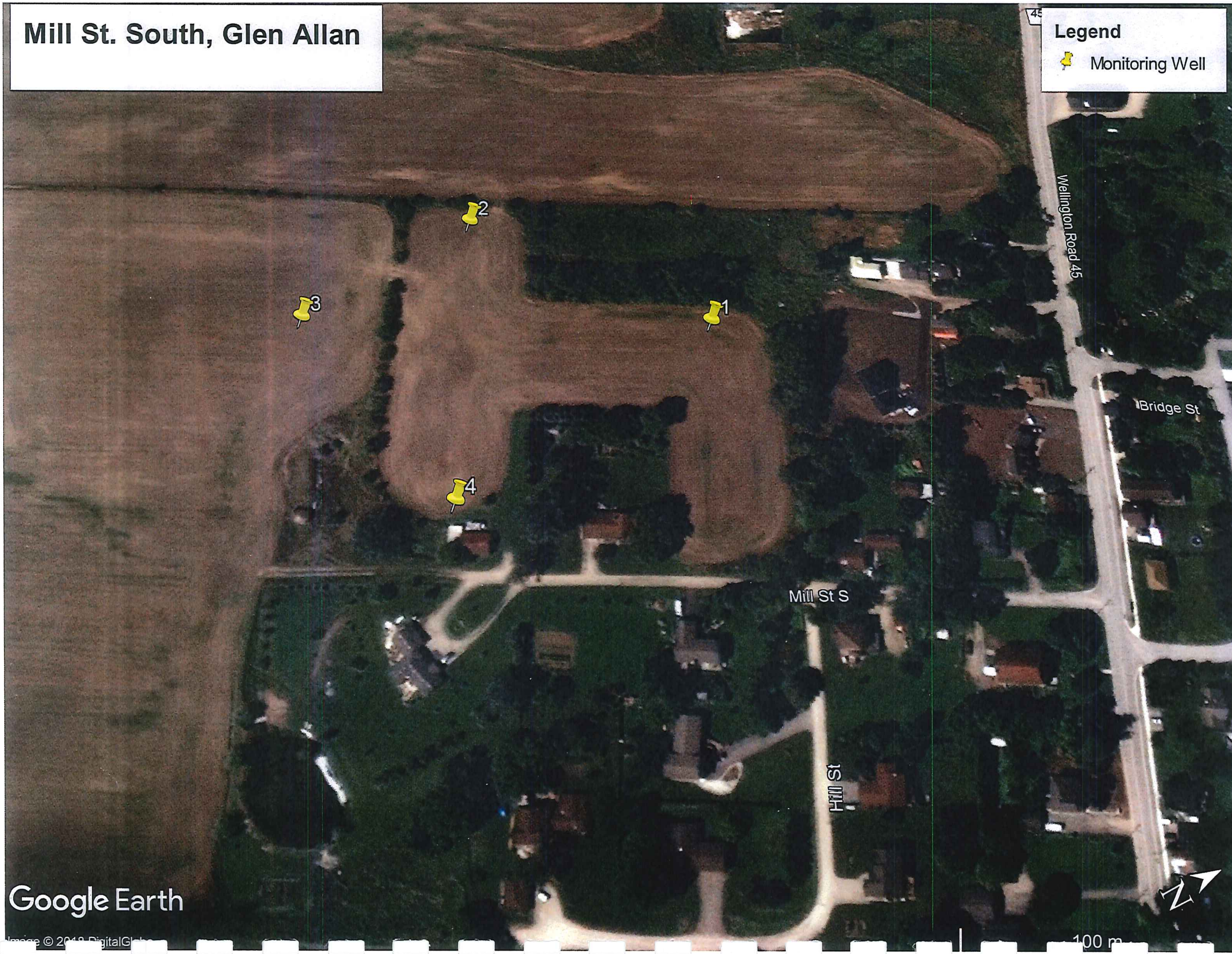
Well owner's information package delivered	Date Package Delivered
☐ Yes ☐ No	Y Y Y Y M M D D
	Date Work Completed
	2018[illegible]

Ministry Use Only
Audit No. Z288452
Received

0506E (2014/11)

Contractor's Copy

Mill St. South, Glen Allan



Ontario Ministry of the Environment and Climate Change

Measurements recorded in: ☑ Metric ☐ Imperial

Well Tag No. *(Place Sticker and/or Print Below)*
A249003

Well Record

Regulation 903 Ontario Water Resources Act

Page 1 of 1

Well Owner's Information

First Name: MURRAY	Last Name / Organization: MARTIN	E-mail Address:	☐ Well Constructed by Well Owner

Mailing Address (Street Number/Name): 58 HILL ST
Municipality: WALLENSTEIN
Province: ON
Postal Code: N0B2S0
Telephone No. *(inc. area code)*:

Well Location

Address of Well Location (Street Number/Name): HILL ST S
Township:
Lot:
Concession:
County/District/Municipality:
City/Town/Village: GLEN ALLAN
Province: **Ontario**
Postal Code:
UTM Coordinates: NAD 83 Zone 17 Easting 523422 Northing 4833546
Municipal Plan and Sublot Number:
Other:

Overburden and Bedrock Materials/Abandonment Sealing Record *(see instructions on the back of this form)*

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
BLACK	TOPSOIL			0	0.1
BROWN	SILT	CLAY		0.1	4.5
BROWN	SILT	SAND		4.5	6.1

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0	2.1	3/8 HOLEPLUG	<1
2.1	6.1	#2 SAND	<1

Results of Well Yield Testing

After test of well yield, water was:
☐ Clear and sand free
☐ Other, specify

If pumping discontinued, give reason:

Pump intake set at (m/ft)

Pumping rate (l/min / GPM)

Duration of pumping ___ hrs + ___ min

Final water level end of pumping (m/ft)

If flowing give rate (l/min / GPM)

Recommended pump depth (m/ft)

Recommended pump rate (l/min / GPM)

Well production (l/min / GPM)

Disinfected? ☐ Yes ☐ No

Draw Down Time (min)	Water Level (m/ft)	Recovery Time (min)	Water Level (m/ft)
Static Level			
1		1	
2		2	
3		3	
4		4	
5		5	
10		10	
15		15	
20		20	
25		25	
30		30	
40		40	
50		50	
60		60	

Method of Construction

☐ Cable Tool
☐ Rotary (Conventional)
☐ Rotary (Reverse)
☐ Boring
☐ Air percussion
☐ Other, specify
☐ Diamond
☐ Jetting
☑ Driving
☐ Digging

Well Use

☐ Public
☐ Domestic
☐ Livestock
☐ Irrigation
☐ Industrial
☐ Other, specify
☐ Commercial
☐ Municipal
☐ Test Hole
☐ Cooling & Air Conditioning
☐ Not used
☐ Dewatering
☑ Monitoring

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	To
3.8	PLASTIC		0	3

Status of Well

☐ Water Supply
☐ Replacement Well
☐ Test Hole
☐ Recharge Well
☐ Dewatering Well
☑ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, specify
☐ Other, specify

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	To
4	PLASTIC	10	3	6.1

Map of Well Location

Please provide a map below following instructions on the back.

SEE ATTACHED MAP FOR MW3

Water Details

Water found at Depth (m/ft) ☐ Gas | Kind of Water: ☐ Fresh ☐ Untested ☐ Other, specify
Water found at Depth (m/ft) ☐ Gas | Kind of Water: ☐ Fresh ☐ Untested ☐ Other, specify
Water found at Depth (m/ft) ☐ Gas | Kind of Water: ☐ Fresh ☐ Untested ☐ Other, specify

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	6.1	10

Well Contractor and Well Technician Information

Business Name of Well Contractor: Chit Drilling Inc
Well Contractor's Licence No.: 7366
Business Address (Street Number/Name): 1011 Industrial Cres
Municipality: [illegible]
Province: ON
Postal Code: N0B2M0
Business E-mail Address: Chitinc.net
Bus.Telephone No. (inc. area code): 5196495475
Name of Well Technician (Last Name, First Name): Chris Black
Well Technician's Licence No.: 3711
Signature of Technician and/or Contractor:
Date Submitted: 2018092[illegible]

Comments:

Well owner's information package delivered ☐ Yes ☐ No

Date Package Delivered: Y Y Y Y M M D D

Date Work Completed: 20180829

Ministry Use Only
Audit No. Z288449
Received

0506E (2014/11)

Contractor's Copy

Mill St. South, Glen Allan

Ontario Ministry of the Environment and Climate Change

Measurements recorded in: ☑ Metric ☐ Imperial

Well Tag No. *(Place Sticker and/or Print Below)*
A249035

Well Record

Regulation 903 Ontario Water Resources Act

Page 1 of 1

Well Owner's Information

First Name: Murray	Last Name / Organization: Martin	E-mail Address:	☐ Well Constructed by Well Owner
Mailing Address (Street Number/Name): 58 Hill st.	Municipality: Wallenstein	Province: ON	Postal Code: N0B2S0
Telephone No. *(inc. area code)*:			

Well Location

Address of Well Location (Street Number/Name): Mill st. S	Township:	Lot:	Concession:
County/District/Municipality:	City/Town/Village: Glen Allan	Province: **Ontario**	Postal Code:
UTM Coordinates NAD 83 Zone 17 Easting 523528 Northing 4833568	Municipal Plan and Sublot Number:	Other:	

Overburden and Bedrock Materials/Abandonment Sealing Record *(see instructions on the back of this form)*

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
Black	Topsoil			0	0.1
Brown	silt	Clay		0.1	6
Brown	silt	sand		6	6.7
Brown	silt			6.7	7.6

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used *(Material and Type)*	Volume Placed (m³/ft³)
0	3.6	3/8 HOLEPLUG	L1
3.6	7.6	#2 SAND	L1

Results of Well Yield Testing

After test of well yield, water was:
☐ Clear and sand free
☐ Other, *specify*

If pumping discontinued, give reason:

Pump intake set at *(m/ft)*

Pumping rate *(l/min / GPM)*

Duration of pumping ___ hrs + ___ min

Final water level end of pumping *(m/ft)*

If flowing give rate *(l/min / GPM)*

Recommended pump depth *(m/ft)*

Recommended pump rate *(l/min / GPM)*

Well production *(l/min / GPM)*

Disinfected? ☐ Yes ☐ No

Draw Down Time *(min)*	Water Level *(m/ft)*	Recovery Time *(min)*	Water Level *(m/ft)*
Static Level			
1		1	
2		2	
3		3	
4		4	
5		5	
10		10	
15		15	
20		20	
25		25	
30		30	
40		40	
50		50	
60		60	

Method of Construction

☐ Cable Tool
☑ Rotary (Conventional)
☐ Rotary (Reverse)
☐ Boring
☐ Air percussion
☐ Other, *specify*
☐ Diamond
☐ Jetting
☐ Driving
☐ Digging

Well Use

☐ Public
☐ Domestic
☐ Livestock
☐ Irrigation
☐ Industrial
☐ Other, *specify*
☐ Commercial
☐ Municipal
☐ Test Hole
☐ Cooling & Air Conditioning
☐ Not used
☐ Dewatering
☑ Monitoring

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	To
38	Plastic		0	4.5

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	To
4	Plastic	10	4.5	7.6

Status of Well

☐ Water Supply
☐ Replacement Well
☐ Test Hole
☐ Recharge Well
☐ Dewatering Well
☑ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, *specify*
☐ Other, *specify*

Water Details

Water found at Depth (m/ft) ☐ Gas | Kind of Water: ☐ Fresh ☐ Untested ☐ Other, *specify*
Water found at Depth (m/ft) ☐ Gas | Kind of Water: ☐ Fresh ☐ Untested ☐ Other, *specify*
Water found at Depth (m/ft) ☐ Gas | Kind of Water: ☐ Fresh ☐ Untested ☐ Other, *specify*

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	7.6	12

Map of Well Location

Please provide a map below following instructions on the back.

SEE ATTACHED MAP FOR MW4

Comments:

Well Contractor and Well Technician Information

Business Name of Well Contractor: CMT Drilling Inc	Well Contractor's Licence No.: 7316
Business Address (Street Number/Name): 1611 Industrial Cres	Municipality: Waterloo
Province: ON	Postal Code: N0B 2N0
Business E-mail Address: cmtinc.net	
Bus.Telephone No. *(inc. area code)*: 5196995775	Name of Well Technician (Last Name, First Name): Chris Black
Well Technician's Licence No.: 3711	Signature of Technician and/or Contractor:
Date Submitted: 20180820	

Well owner's information package delivered ☐ Yes ☐ No

Date Package Delivered: Y Y Y Y M M D D

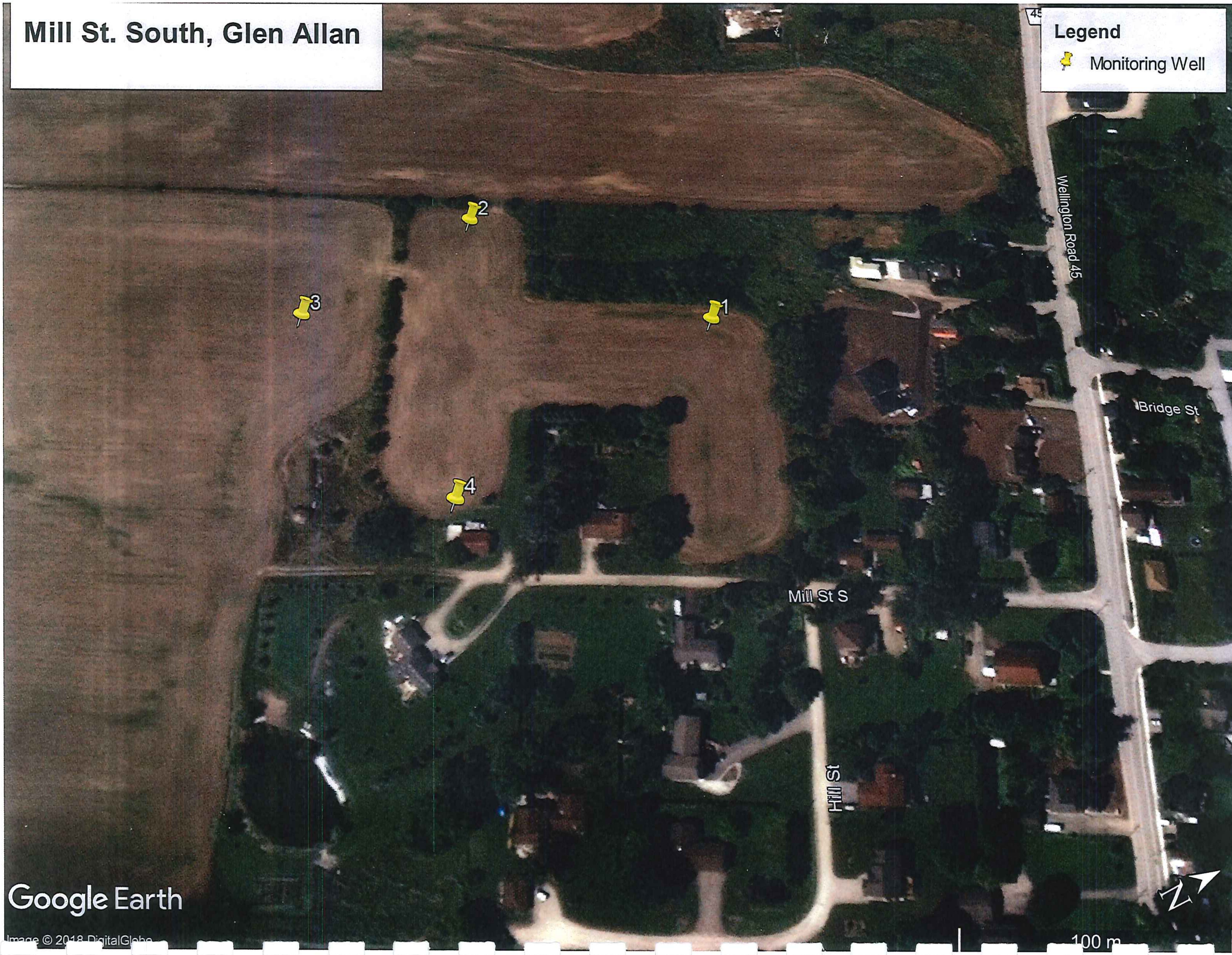
Date Work Completed: 20180830

Ministry Use Only
Audit No. Z288450
Received

0506E (2014/11)

Contractor's Copy

Mill St. South, Glen Allan



Ontario

Ministry of the Environment and Climate Change

Measurements recorded in: ☑ Metric ☐ Imperial

Well Tag No. *(Place Sticker and/or Print Below)*
A249033

Well Record

Regulation 903 Ontario Water Resources Act

Page 1 of 1

Well Owner's Information

First Name: MURRAY	Last Name / Organization: MARTIN	E-mail Address:	☐ Well Constructed by Well Owner
Mailing Address (Street Number/Name): 58 HILL ST.	Municipality: WALLENSTEIN	Province: ON	Postal Code: N0B2S0
Telephone No. *(inc. area code)*:			

Well Location

Address of Well Location (Street Number/Name): MILL ST S	Township:	Lot:	Concession:
County/District/Municipality:	City/Town/Village: GLEN ALLAN	Province: **Ontario**	Postal Code:
UTM Coordinates NAD 83 Zone: 17 Easting: 523500 Northing: 4833698	Municipal Plan and Sublot Number:	Other:	

Overburden and Bedrock Materials/Abandonment Sealing Record *(see instructions on the back of this form)*

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	To
BLACK	TOPSOIL			0	0.1
BROWN	SILT	CLAY		0.1	7.6
BROWN	SILT			7.6	10.9

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used *(Material and Type)*	Volume Placed (m³/ft³)
0	7.3	3/8 HOLEPLUG	<1
7.3	10.9	#2 SAND	<1

Method of Construction

☐ Cable Tool
☑ Rotary (Conventional)
☐ Rotary (Reverse)
☐ Boring
☐ Air percussion
☐ Other, *specify*
☐ Diamond
☐ Jetting
☐ Driving
☐ Digging

Well Use

☐ Public
☐ Domestic
☐ Livestock
☐ Irrigation
☐ Industrial
☐ Other, *specify*
☐ Commercial
☐ Municipal
☐ Test Hole
☐ Cooling & Air Conditioning
☐ Not used
☐ Dewatering
☑ Monitoring

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	To
38	PLASTIC		0	7.9

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	To
4	PLASTIC	10	79	109

Status of Well

☐ Water Supply
☐ Replacement Well
☐ Test Hole
☐ Recharge Well
☐ Dewatering Well
☑ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, *specify*
☐ Other, *specify*

Water Details

Water found at Depth (m/ft) ☐ Gas Kind of Water: ☐ Fresh ☐ Untested ☐ Other, *specify*
Water found at Depth (m/ft) ☐ Gas Kind of Water: ☐ Fresh ☐ Untested ☐ Other, *specify*
Water found at Depth (m/ft) ☐ Gas Kind of Water: ☐ Fresh ☐ Untested ☐ Other, *specify*

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	10.9	12

Well Contractor and Well Technician Information

Business Name of Well Contractor: CMT Drilling Inc.	Well Contractor's Licence No.: 7366
Business Address (Street Number/Name): 1011 Industrial Cres	Municipality: [illegible]
Province: ON	Postal Code: N0B2M0
Business E-mail Address: [illegible]	
Bus.Telephone No. *(inc. area code)*: 5196995775	Name of Well Technician (Last Name, First Name): Chris Black
Well Technician's Licence No.: 3711	Signature of Technician and/or Contractor:
Date Submitted: 20180821	

0506E (2014/11)

Contractor's Copy

Results of Well Yield Testing

After test of well yield, water was:
☐ Clear and sand free
☐ Other, *specify*

If pumping discontinued, give reason:

Pump intake set at (m/ft)

Pumping rate (l/min / GPM)

Duration of pumping ___ hrs + ___ min

Final water level end of pumping (m/ft)

If flowing give rate (l/min / GPM)

Recommended pump depth (m/ft)

Recommended pump rate (l/min / GPM)

Well production (l/min / GPM)

Disinfected? ☐ Yes ☐ No

Draw Down Time (min)	Water Level (m/ft)	Recovery Time (min)	Water Level (m/ft)
Static Level			
1		1	
2		2	
3		3	
4		4	
5		5	
10		10	
15		15	
20		20	
25		25	
30		30	
40		40	
50		50	
60		60	

Map of Well Location

Please provide a map below following instructions on the back.

SEE ATTACHED MAP FOR MW1

Comments:

Well owner's information package delivered ☐ Yes ☐ No

Date Package Delivered Y Y Y Y M M D D

Date Work Completed 20180820

Ministry Use Only

Audit No. Z288451

Received

Mill St. South, Glen Allan