"REVISED"

GEOTECHNICAL INVESTIGATION

GEOTECHNICAL INVESTIGATION/SLOPE STABILITY
PROPOSED SUBDIVISION
211 ELIZA STREET
ARTHUR, ONTARIO

CMT Project 19-519.R01(REVISED)

Prepared for:

Sarah Properties Limited

Revised Date: October 17, 2024
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October 17, 2024 19-519.R01(REVISED)

Sarah Properties Limited
836 Normandy Drive
Woodstock, Ontario
N4T 0E6

Attention: Mr. Walter Broos

Dear Sir:

Re: Geotechnical Investigation/Slope Stability
Proposed Subdivision
211 Eliza Street
Arthur, Ontario

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

This report has been revised to update the slope stability analysis with additional data. This report supersedes all previous versions of this 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 truly,

Marc Favaro, B.Sc.

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1.0 INTRODUCTION

The services of CMT Engineering Inc. (CMT Inc.) were retained by Mr. Walter Broos of Sarah Properties Limited, to conduct a geotechnical investigation and slope stability assessment for the proposed subdivision to be located at 211 Eliza Street in Arthur, Ontario. The location of the site is shown on Drawing 1.

This report has been revised to update the slope stability analysis with additional data. This report supersedes all previous versions of this report.

It is understood that the project will involve the construction of a new residential subdivision with associated roadways, underground utilities and stormwater management facilities.

The purpose of the geotechnical investigation was to assess the existing soil and groundwater conditions encountered in the boreholes and assess the characteristics of the slope around the creek area. 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; slope stability assessment; and a summary of the laboratory results.

2.0 EXISTING SITE CONDITIONS

The site of the proposed new residential subdivision is located on the east side of Eliza Street and currently comprises agricultural land which generally slopes down to the southwest, with over-steepened slopes along the creek that borders the east and south sides of the site. It is understood that the site has had at least one residence and associated barns at some point in the past, and as recent as 2015. The site is bounded by Eliza Street to the west, Wellington County Road 109 to the south, a residential subdivision to the north, and agricultural property to the east. It is understood that the residential property to the south (8014 Wellington Road 109) was recently acquired and will be part of this development as well.

3.0 FIELD AND LABORATORY PROCEDURES

The field investigation was conducted on November 22 and 25, 2019 and comprised the advancement of twelve boreholes (referenced as Boreholes 101 to 112), utilizing a Geoprobe 7822DT drillrig operated by employees of CMT Drilling Inc. Boreholes 101, 102 and 110 were advanced at the top of the slopes on the east and south extents of the site to support the slope assessment. Boreholes 103 to 109 and Boreholes 111 and 112 were advanced at random and widely spaced locations throughout the area of the proposed residential subdivision construction. Borehole 101 was advanced to an approximate depth of 9.75 m (32.00 ft) below the ground surface. Borehole 102 was advanced to an approximate depth of 5.49 m (18.00 ft) below the ground surface. Borehole 110 was advanced to an approximate depth of 9.14 m (30.00 ft) below the ground surface. Boreholes 103 to 109 and Boreholes 111 and 112 were advanced to approximate depths of 5.18 m (17.0 ft) below the existing ground surface.

Standard penetration testing and sampling was carried out in all boreholes using 38 mm inside diameter split spoon sampling equipment and an automatic hammer, in accordance with ASTM D 1586 "Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils". SPT soil sampling was generally conducted at 0.76 m (2.5 ft) intervals to 3.05 m (10.0 ft), and every 1.52 m (5.0 ft) thereafter, to borehole termination. Macro core (MC5) direct push sampling was conducted between the SPT soil samples conducted below 3.05 m (10.0 ft) depth. Technical staff from CMT Inc. observed the drilling operation and collected and logged the recovered soil samples. A small portion of each sample was placed in a sealed, marked jar for moisture content determinations.

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

- Borehole 101 - depth 1.52 m to 2.13 m (5.0 ft to 7.0 ft),
- Borehole 106 - depth 0.76 m to 1.37 m (2.5 ft to 4.5 ft),
- Borehole 110 - depth 3.66 m to 4.57 m (12.0 ft to 15.0 ft),
- Borehole 110 - depth 8.23 m to 9.14 m (27.0 ft to 30.0 ft), and
- Borehole 111 - depth 3.66 m to 4.57 m (12.0 ft to 15.0 ft).

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

The ground surface elevations of the boreholes were surveyed by CMT Inc. following the completion of drilling. An existing sanitary manhole located at the intersection of Eliza Street and John Street (southeast corner) was utilized as a benchmark, with a reported elevation of 457.80 m. The ground surface elevations at the boreholes ranged from approximately 455.20 m to 467.06 m. The locations of the boreholes are shown on Drawing 2.

4.0 SUBSOIL CONDITIONS

The following paragraphs have been simplified in terms of major soil strata for the purposes of geotechnical design. The soil boundaries indicated have been inferred from non-continuous samples and observations of sampling and drilling resistance, and typically represent transitions from one soil type to another rather than exact planes of geological change. Further, the subsurface conditions are anticipated to vary between and beyond the borehole locations.

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

4.1. Topsoil

Dark brown to black, silty, organic topsoil was encountered at the surface of all boreholes completed as part of this investigation. The topsoil was considered to be loose, with SPT N-values ranging from 2 to 7 blows per 0.30 m (average 3 blows per 0.30 m). The topsoil was considered to be moist, with moisture contents ranging from about 23.0% to 32.3% (average 25.9%). The thickness of the topsoil was observed to range from about 100 mm to 600 mm (average 360 mm) at the borehole locations. The thickness of the topsoil is anticipated to vary outside of the borehole locations. Materials noted as topsoil in this report were classified based on visual and textural evidence. Testing of organic content or for other nutrients was not carried out.

4.2. Clayey Silt Fill

Brown to mottled brown and grey clayey silt fill was encountered underlying the topsoil in Boreholes 111 and 112. The clayey silt fill was considered to be soft to stiff, with SPT N-values ranging from 2 to 9 blows per 0.30 m (average 6 blows per 0.30 m). The clayey silt fill was considered to be moist, with moisture contents ranging from about 22.4% to 26.6% (average 24.5%). The clayey silt fill ranged in thickness from 660 mm to 920 mm (average 790 mm) at the borehole locations. Boreholes 111 and 112 were advanced in the approximate area of the previous existing residence and barn, respectively. This fill may be a result of backfilling from the demolition of the previous structures.

4.3. Sandy Silt

Brown, sandy silt with trace clay was encountered underlying the topsoil in Boreholes 101, 102 and 107, underlying the clayey sandy silt in Boreholes 103, 106, 109 and 112, underlying the clayey silt fill in Borehole 111, as well as underlying the sand in Borehole 111. The sandy silt was considered to be loose to dense, with SPT N-values ranging from 5 to 43 blows per 0.30 m (average 23 blows per 0.30 m). The sandy silt was considered to be moist to saturated, with moisture contents ranging from about 7.2% to 23.4% (average 16.5%).

4.4. Clayey Sandy Silt/Clayey Sand and Silt

Brown to grey clayey sand and silt, or clayey sandy silt, with up to trace amounts of gravel was encountered underlying the topsoil in Boreholes 103, 104, 105, 106, 108, 109 and 110, underlying sandy silt in Boreholes 101, 102, 103, 107, 109 and 112, as well as underlying the clayey silt fill in Borehole 112. The clayey sandy silt/clayey sand and silt was considered to be soft to hard, with SPT N-values ranging from 2 to in excess of 100 blows per 0.30 m (average 37 blows per 0.30 m). The clayey sandy silt/clayey sand and silt was considered to be moist to saturated, with moisture contents ranging from about 7.6% to 21.7% (average 15.1%).

4.5. ***Clayey Silt***

Brown to grey clayey silt with trace sand and gravel was encountered underlying the clayey sandy silt/clayey sand and silt in Boreholes 101, 102, 103, 104, 105, 108, 109, 110 and 112, underlying the sandy silt in Borehole 106, as well as underlying the sand in Borehole 107. The clayey silt was considered to be very stiff to hard, with SPT N-values ranging from 18 to in excess of 100 blows per 0.30 m (average 47 blows per 0.30 m). The clayey silt was considered to be moist to saturated, with moisture contents ranging from about 6.9% to 27.7% (average 13.9%).

4.6. ***Sand***

Brown sand with trace silt, clay and gravel was encountered underlying the clayey sandy silt in Boreholes 107 and 109, as well as between sandy silt layers in Borehole 111. The sand was considered to be compact to dense, with SPT N-Values ranging from 18 to 34 blows per 0.30 m (average 26 blows per 0.30 m). The sand was considered to be moist to saturated, with moisture contents ranging from about 15.4% to 23.7% (average 19.3%).

4.7. ***Groundwater***

Accumulated groundwater and/or wet to saturated soil conditions were observed in the majority of the boreholes conducted as part of this investigation. The following table summarizes the borehole number, ground surface elevation, elevation of water accumulated in the borehole, cave elevation, elevation of wet to saturated soils, and the bottom of borehole elevation for each borehole:

Borehole No.	Ground Surface Elevation (m)	Approximate Elevation of Water in Open Borehole (m)	Cave Elevation (m)	Approximate Elevation of Wet to Saturated Soils (m)	Bottom of Borehole Elevation (m)
BH101	461.69	--	--	--	451.94
BH102	460.84	--	--	--	455.35
BH103	464.11	--	459.03	461.82 to 461.06	458.93
BH104	466.04	--	--	--	460.86
BH105	464.10	--	459.99	463.87 to 463.34	458.92
BH106	467.06	--	464.62	466.30 to 464.77	461.88

Borehole No.	**Ground Surface Elevation (m)**	**Approximate Elevation of Water in Open Borehole (m)**	**Cave Elevation (m)**	**Approximate Elevation of Wet to Saturated Soils (m)**	**Bottom of Borehole Elevation (m)**
BH107	455.20	451.85	451.54	453.68 to 452.61	450.02
BH108	464.57	--	--	--	459.39
BH109	461.72	459.59	458.37	459.43 to 456.54 (termination)	456.54
BH110	456.03	--	450.24	447.65 to 446.89 (termination)	446.89
BH111	460.26	458.13	457.44	458.74 to 455.08 (termination)	460.26
BH112	460.53	458.09	457.79	457.48 to 456.57	460.53

The above-noted measured elevations of water in the open boreholes are for reference only as they can be influenced by borehole cave and they generally are not considered a stabilized groundwater table. It should be noted that groundwater conditions (particularly perched water) are generally dependent on the amount of precipitation, control of surface water, as well as the time of year, and can fluctuate significantly in elevation and volume.

The relatively stiff and fine-grained clayey sandy silt/clayey sand and silt, as well as the clayey silt soils, have the potential to create perched water conditions in any overlying soils. It should be noted that groundwater conditions (particularly perched water) are generally dependent on the amount of precipitation, control of surface water, as well as the time of year, and can fluctuate significantly in elevation and volume.

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

5.0 DISCUSSION AND RECOMMENDATIONS

This section of the report provides an interpretation of the factual geotechnical data obtained during the investigation and is intended for the guidance of the owner and design engineer. Where comments are made on construction, they are provided only to highlight those aspects which could affect the design of the project. Contractors bidding on or undertaking the work should make their own independent interpretation of the factual subsurface information provided as it affects their proposed construction means and methods, equipment selection, scheduling, pricing, and the like.

It is understood that the project will involve the construction of a new residential subdivision with associated roadways, underground utilities and stormwater management facilities.

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 a summary of the estimated geotechnical reaction at the Serviceability Limit State (SLS) and the factored geotechnical resistance at the Ultimate Limit State (ULS) at the various elevations, including soil type:

BH No.	Ground Surface Elevation (m)	SLS kPa (psf)	ULS kPa (psf)	Estimated Highest Founding Elevations (m)	Depth Below Existing Grade to Founding Elevation (m)	Soil Type
101	461.69	150 (3,000) 250 (5,000)	225 (4,500) 375 (7,500)	461.09 to 459.40 459.40 to 451.94 (termination)	0.60 2.29	Sandy Silt, Clayey Sandy Silt
102	460.84	150 (3,000) 250 (5,000)	225 (4,500) 375 (7,500)	459.77 to 459.32 459.32 to 455.35 (termination)	1.07 1.52	Clayey Sandy Silt, Clayey Silt
103	464.11	150 (3,000) 250 (5,000)	225 (4,500) 375 (7,500)	463.35 to 460.68 460.68 to 458.93 (termination)	0.76 3.43	Clayey Sandy Silt, Clayey Silt
104	466.04	150 (3,000) 250 (5,000)	225 (4,500) 375 (7,500)	465.28 to 461.47 461.47 to 460.86 (termination)	0.76 4.57	Clayey Sandy Silt, Clayey Silt
105	464.10	150 (3,000) 250 (5,000)	225 (4,500) 375 (7,500)	463.34 to 461.81 461.81 to 458.92 (termination)	0.76 2.29	Clayey Sandy Silt, Clayey Silt
106	467.06	150 (3,000)	225 (4,500)	466.30 to 461.88 (termination)	0.76	Sandy Silt, Clayey Silt
107	455.20	150 (3,000) 250 (5,000)	225 (4,500) 375 (7,500)	453.68 to 451.24 451.24 to 450.02 (termination)	1.52 3.96	Sandy Silt, Clayey Silt
108	464.57	150 (3,000) 250 (5,000)	225 (4,500) 375 (7,500)	463.05 to 462.28 462.28 to 459.39 (termination)	1.52 2.29	Clayey Sandy Silt, Clayey Silt
109	461.72	150 (3,000)	225 (4,500)	460.20 to 456.54 (termination)	1.52	Clayey Sandy Silt
110	456.03	150 (3,000) 250 (5,000)	225 (4,500) 375 (7,500)	454.51 to 453.74 453.74 to 446.89 (termination)	1.52 2.29	Clayey Sandy Silt, Clayey Silt
111	460.26	150 (3,000) 250 (5,000)	225 (4,500) 375 (7,500)	458.74 to 457.97 457.97 to 455.99	1.52 2.29	Sandy Silt, Sand,

BH No.	Ground Surface Elevation (m)	SLS kPa (psf)	ULS kPa (psf)	Estimated Highest Founding Elevations (m)	Depth Below Existing Grade to Founding Elevation (m)	Soil Type
		150 (3,000)	225 (4,500)	455.99 to 455.08 (termination)	4.27	Sandy Silt
112	460.53	150 (3,000) 250 (5,000)	225 (4,500) 375 (7,500)	459.77 to 456.57 456.57 to 455.35 (termination)	0.76 3.96	Clayey Sandy Silt, Clayey Silt

Based on the bearing capacities and elevations provided in the table above, suitable founding elevations for conventional foundations designed with an estimated bearing capacity of 150 kPa (3,000 psf) at SLS and 225 kPa (4,500 psf) at ULS range throughout the site, however suitable founding soils are typically found below the existing topsoil, fill soils, as well as loose/soft upper native soils.

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 good quality granular structural fill placed on suitable subgrade soils and compacted in accordance with Section 5.4.5 of this report and constructed on approved competent native soil is estimated to be at least 150 kPa (3,000 psf) at SLS and 225 kPa (4,500 psf) at ULS. Alternatively, lean mix concrete fill could be utilized for this application.

Alternatively, footings could be stepped down to bear on approved undisturbed founding soils. Due to the presence of fill soils, it is imperative that the founding soils be assessed at the time of construction by qualified geotechnical personnel in order to confirm their founding suitability.

Footings founded on soil 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.

It is recommended that structural foundation drawings be cross-referenced with site servicing drawings to ensure that service pipes do not conflict with building foundations (including the zone of influence down and away from the footings).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 in order to provide protection against frost action.

It should be noted that the native soils that exist at or below founding elevations may be in a wet/saturated state and may be too wet to provide suitable bearing for foundations without drainage or construction of a mud mat or granular drainage layer. It is imperative that the subgrade soils be inspected and approved by competent geotechnical personnel to ensure that the founding soils are suitable for bearing. 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.

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 5.18 m to 9.75 m of strata. Based on the information gathered in the geotechnical field investigation, the site classification for seismic site response would be considered Site Class D (stiff soils) for structures founded on the native soils or structural fill at the recommended founding elevations provided in Section 5.1 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 estimated soil design parameters for existing native soils encountered on-site, as well as imported granular fill. It should be noted that earth pressure coefficients (K_a, K_p, K_o) provided are for flat ground surface conditions and will differ for areas with slopes or embankments. The estimated 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)**	**Cohesion (Undrained) (kPa)**
Imported Granular 'A'/ Granular 'B' (OPSS 1010)	2,100	34	0.28	3.54	0.44	0.45	0
Sandy Silt	1,750	30	0.33	3.00	0.50	0.38	0
Clayey Sandy Silt/	1,800	28	0.36	2.77	0.53	0.35	5

Soil Type	**Soil Density (kg/m^3)**	**Friction Angle (Degree)**	**Coefficient of Active Pressure**	**Coefficient of Passive Pressure**	**Coefficient of At-Rest Pressure**	**Coefficient of Friction (μ)**	**Cohesion (Undrained) (kPa)**
Clayey Silt and Sand							
Clayey Silt	1,850	28	0.36	2.77	0.53	0.35	10
Sand	1,800	32	0.31	3.25	0.47	0.41	0

5.4. Site Preparation

The site preparation for the proposed new residential subdivision is anticipated to include the removal of any potential remaining structures associated with the previously-existing residence and barns, removal of topsoil and vegetation, the subexcavation of all unsuitable fill and any native soils deemed not capable of supporting the design bearing capacity, removal or relocation of any existing services, followed by the placement of structural fill (as required) and site grading to achieve proposed grades.

5.4.1. Removal of Below-Grade Structures

It is understood that this site has had at least one residence and associated barns at some point in the past, and as recent as 2015. The buildings have since been removed, though there is a possibility that below-grade structures such as foundations, concrete slabs, and loose backfill may remain. Boreholes 111 and 112 were advanced in the area of the previously existing residence and barn respectively. The boreholes did not encounter any existing structures, however, 620 mm to 920 mm of fill was encountered below the topsoil. Below-grade structures may still remain outside of the sampled area and as such, any existing below-grade structures must be removed within the proposed building envelopes and driveways.

Provided any concrete from the former building foundations, 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 5.4.5 of this report. It is recommended that approved native soils or imported sand and gravel (OPSS 1010 Granular 'B' Type I or an approved alternative) be placed as structural fill to backfill the building demolition area.

5.4.2. Topsoil Stripping/Vegetation Removal

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

The volume of topsoil removed during the stripping process can be influenced by 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, generally loose/soft 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.

5.4.3. Fill/Unsuitable Soil Removal

All existing fill, as well as any native soil that has inadequate bearing capacity or has been disturbed by construction processes and is deemed unsuitable to support foundations or slab-on-grades, must be subexcavated from within the proposed building envelopes to expose approved competent subgrade soils. It would also be sound construction practice to subexcavate all existing unsuitable fill from the paved roadway and driveway areas; however, this may not be cost-effective. At a minimum, thorough inspection will be required at the time of construction to assess the existing fill to ensure there is no buried topsoil or other deleterious materials within the prepared subgrade. Remedial action will also be required to further consolidate the existing fill if it is decided to leave it in place. If the existing fill is left in place, provisions for the alterations to the design of the pavement structure should be included in the tender documents. Review of the subgrade and potential changes to the design of the pavement structure, as required, will be addressed at the time of construction.

Prior to reusing excavated material on-site as potential bulk fill in the driveways, thorough field inspection and approval by qualified geotechnical personnel would be required to ensure that existing fill materials do not comprise organics, topsoil or other deleterious materials.

5.4.4. Removal/Relocation of Existing Buried Piping

Any existing tile drains (field tiles or municipal tile drains) that may be located within the proposed building and driveway envelopes 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 5.4.5 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.

5.4.5. Site Grading

Following removal of any existing below-grade structures, the topsoil, vegetation, as well as the subexcavation of the relatively loose fill and any 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 subexcavated and replaced with approved fill materials.

Any fill materials required to achieve the design grades should be placed according to the following procedures:

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

- Prior to placement of any structural fill or bulk fill, the subgrade for the proposed building addition and driveways 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 edge (where feasible) 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 (not recommended for this application), or the capacity of the compactor (whichever is less);

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

- Fine-grained silt and clay soils (not recommended) must be compacted utilizing adequate heavy padfoot vibratory 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. Granular soils may require the addition of water in order to achieve the specified compaction;

- Approved structural fill materials that will support structures (including foundations, interior slab-on-grades, sidewalks and large expansive exterior slabs) must be compacted to 100% standard Proctor maximum dry density (SPMDD). The native clayey sandy silt/clayey silt/clayey silt and sand soils are not recommended for use as structural fill as they can be subject to excess void space and potential settlement if not properly placed and compacted;

- Approved bulk fill (foundation wall backfill, bulk fill under slab-on-grades that will not support footings or heavy point loading, bulk fill for driveways) must be compacted to a minimum 98% SPMDD. It would be expected that the native sand and sandy silt, and sand soils would be suitable for use as bulk fill; however, depending on the time of year and weather conditions when construction takes place, soils excavated at depth may require air-drying in order to achieve the specified density;

- Granular 'B' subbase and Granular 'A' base materials for the paved parking areas must be compacted to 100% SPMDD.

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

It should also be noted that the native soils encountered in the boreholes were observed to become 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 should the very dense/hard soils be 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 changes 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 to a sump (as required) located outside the building footprints (if feasible) in the excavation to promote surface drainage of rainwater or seepage and the collected water should be pumped out of the excavations. It is critical that all water be controlled (not allowed to pond) and that the subgrade and foundation preparations commence in dry conditions;

- Should the native subgrade soils at the design founding elevation in the proposed building envelopes comprise saturated soils, then a granular drainage layer, constructed in accordance with Section 9.14.4 of the current Ontario Building Code (OBC) may be required;

- 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 foundations, the founding soils 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 placed 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 any slab-on-grade construction, the subgrade soils should be proof-rolled. Any soft or weak zones, as well as the unsuitable fill in the subgrade, should be subexcavated and backfilled with approved fill materials (see Sections 5.4.5 and 5.10 of this report).

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

Soil Type	**Estimated Modulus of Subgrade Reaction (k)**
Imported Sand and Gravel (OPSS 1010)	81,000 kN/m^3 (300 lb/in^3)
Sandy Silt	41,000 kN/m^3 (150 lb/in^3)
Clayey Sandy Silt/ Clayey Silt and Sand	47,000 kN/m^3 (175 lb/in^3)
Clayey Silt	61,000 kN/m^3 (225 lb/in^3)
Sand	54,000 kN/m^3 (200 lb/in^3)

In dry conditions, floor slabs can be founded on a minimum thickness of 150 mm (6") of Granular 'A' (OPSS 1010) and compacted to 100% SPMDD. Alternatively, (particularly in wet conditions), 150 mm (6") of 19 mm clear crushed stone (OPSS 1004) could be used instead of Granular 'A'. Utilizing clear crushed stone for the slab-on-grade base can assist in providing a moisture barrier by reducing the potential for capillary rise of moisture from the subgrade soils. Compactive effort is required to consolidate the clear stone. The 19 mm clear crushed stone should meet the physical property and gradation requirements of OPSS 1004.

It is recommended that areas of extensive exterior slab-on-grade (sidewalks and accessibility ramps) be constructed with a Granular 'B' subbase (450 mm) and a Granular 'A' base (150 mm), as well as incorporating subdrains, to promote rapid drainage and reduce the effects of frost heaving. This is particularly critical at barrier-free access points. Alternatively, structural frost slabs could be designed and constructed, or sufficient thermal insulation could be provided, at all door entrances and areas of barrier-free access.

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

Type 3 Soils - In general, the native sandy silt, clayey sandy silt, clayey sand and silt, and sand soils encountered in the boreholes, as well as any existing fill materials (backfill of existing foundations and services) in a drained state (not 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. Soils underlain by Type 4 soils that are exposed in the excavation must be treated accordingly as Type 4 soils (see below). All saturated soils encountered must be treated as Type 4 soils, as described below.

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

If it is not practical to excavate according to the above requirements, then a trench support system (designed in accordance with the Ontario Health and Safety Act Regulations) may be utilized. When using a temporary trench support system consisting of trench boxes to reduce the lateral extent of the excavations, it should be noted that the support system is intended primarily to protect workers as opposed to controlling lateral soil movement. Any voids between the excavation walls and the support system should be immediately filled to reduce the potential for loss of ground and to provide support to existing adjacent utilities and roadways, and it is recommended that the excavation be carried out in short sections, with the support system installed immediately upon excavation completion.

5.8. Construction Dewatering Considerations

Some wet to saturated soils, as well as accumulated groundwater was observed in the boreholes conducted as part of this investigation. It should also be noted that the relatively fine-grained clayey silt soil typically encountered in the lower zone of the boreholes may have the potential to create perched water conditions. As such, it is critical that provisions for site dewatering be part of the site development and construction process.

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, and the depth of the excavations, and can fluctuate significantly in elevation and volume. As required, seepage should generally be adequately controlled using conventional construction dewatering techniques such as pumping from properly filtered sump pits. However, if heavy seepage occurs, it may be necessary to increase the number of pumps during construction. Some seepage and sloughing should be expected from the wet to saturated layers of sand, and sandy silt.

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 100% 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.

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

Any service pipes that are not provided with sufficient frost coverage must be protected with the necessary equivalent thermal insulation. The general contractor is responsible to protect existing and new service piping from damage by heavy equipment.

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

In order to assist in maintaining a dry building with respect to surface water seepage, it is recommended that exterior grades around the building be sloped down and away at a 2% gradient or more, for a distance of at least 1.5 m to 2.0 m (depending on side yard setbacks). Any surface discharge rainwater leaders must be constructed with solid piping that discharges with positive drainage at least 1.5 m away from 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 and dewatering systems constructed in accordance with the 2012 OBC. It is recommended that a good quality sump pump be utilized, and that the system be equipped with a battery backup in the event of power failure, (keeping in mind that a battery backup system does not typically have a long run time).

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

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

In order to reduce the effects of surficial frost heave 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 or 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 100% SPMDD.

The native mineral soils, as well as approved fill materials (non-organic) are generally considered suitable for reuse as trench backfill and bulk fill in the driveways; however, any wet soils encountered 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 (non-cohesive soil) or padfoot (cohesive soil) vibratory compaction equipment should be used for the compaction and to break down any large blocky pieces of soil;

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

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

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

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

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

5.11. Pavement Design/Drainage

All existing topsoil, vegetation (including tree root structures as well as any loose soils that are typically associated with root structures), fill, and any soils containing organics or other deleterious material, must be stripped/subexcavated from within the driveways and any other paved areas. It is recommended to either subexcavate any existing loose subgrade materials or provide further consolidation with vibratory compaction equipment in order to prepare a proper, stable subgrade. Prior to placement of the new 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 curb line. 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 and to help minimize frost heave. The requirement for subdrains will be dependent on the composition of the prepared roadway subgrade soils. Should the subgrade soils comprise fine-grained, frost-susceptible soils, then it is recommended to install subdrains, provided gravity drainage to a suitable outlet can be provided. It is recommended to install minimum 100 mm diameter perforated subdrains to collect and redirect water beneath the pavement surface. Subdrains should be designed and installed in accordance with OPSS 405 and OPSD 216.021. If Granular 'A' bedding (OPSS 1010) is utilized, the subdrains should be equipped with a factory installed filter sock. If 19 mm clear stone (OPSS 1004) is utilized as bedding for the subdrain, then the bedding must be wrapped completely with geotextile filter fabric such as Terrafix 270R (or equivalent) and a factory installed filter sock is not required. Installation of rigid subdrains allows for better grade control and less potential for damage during installation; however, it would be expected that there would be higher cost implications associated with the installation of rigid subdrains over flexible subdrains. Positive drainage through grade control of subdrains is critical, as improperly installed subdrains can turn drainage systems into reservoirs, which can fuel frost action. The subdrains will hasten the removal of water, thereby reducing the risk and effects of frost heaving and load transfer in saturated conditions. It is suggested that, at a minimum, subdrains be installed through all low areas of the parking lot and ideally along the edge of the pavement as well to prevent water from entering the subbase. The subdrains should be installed in a 0.3 m (1.0 ft) by 0.3 m (1.0 ft) trench in the subgrade and bedded approximately 50 mm (2") above the bottom of the trench. The subgrade must be prepared with positive drainage to the subdrains and the subdrains must be installed with positive drainage into a catch basin structure or other suitable outlet.

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

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

It is expected that the roadways will be subject to light traffic (personal vehicles) as well as heavy traffic (delivery trucks, maintenance and emergency vehicles). Based on the anticipated loading, the following pavement design is provided:

Material	**Recommended Thickness For New Pavement**	
	Light Duty	**Heavy Duty**
Asphaltic Concrete	HL3 - 40 mm (1.5") HL4 or HL8 - 50 mm (2.0")	HL3 - 50 mm (2.0") HL4 or HL8 - 60 mm (2.5")
Granular 'A' Base (OPSS 1010)	150 mm (6.0")	150 mm (6.0")
Granular 'B' Subbase (OPSS 1010)	400 mm (16.0")	450 mm (18.0")

Should wet to saturated conditions be encountered during construction, site assessments may be required at the time of construction to determine what options can be undertaken to construct a stable roadway base. These options may include subexcavation and increasing the thickness of the Granular 'B' subbase, the use of reinforcing geotextile and/or geogrid, or a combination of all. As such, it is recommended that provisions for subexcavation and disposal of wet soils, importing and placing additional Granular 'B' (OPSS 1010), as well as supply and placement of a reinforcing geotextile (Terrafix 270R or equivalent) and geogrid (Tensar BX1200 or equivalent) should be included in the tender documents.

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.

Frost tapers must be constructed at any changes from light traffic to heavy traffic areas within the roadways, parking areas and driveways. If it is anticipated that heavy equipment (such as loader and dump trucks) will be utilized for snow removal, it would be recommended that the heavy traffic pavement structure be utilized throughout all roadways.

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 80 mm and a width of 300 mm as per OPSD 509.010. It is recommended that a tackcoat in conformance with OPSS 308 be applied to the edge and surface of all milled asphalt prior to placement of new asphalt.

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

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

5.12. Excess Soil Management

5.12.1. 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.

*5.12.2 **TCLP Requirement***

If soils are transported to a landfill 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.

5.13. Stormwater Infiltration

As part of the geotechnical investigation completed at this site, gradation analyses were performed on representative samples of the native soils. The following table provides the sample location (borehole number), sample depth, corresponding estimated coefficient of permeability (k) as well as soil type:

Borehole No.	**Depth (m)**	**Estimated Coefficient of Permeability (k) cm/s**	**Soil Type**
101	1.52 – 2.13	<1.0 x 10^{-6}	clayey, sandy silt, trace gravel (ML)
106	0.76 – 1.37	1.7 x 10^{-4}	sandy silt, trace clay (ML)
110	3.66 – 4.57	<1.0 x 10^{-6}	clayey silt, trace sand and gravel (ML)
110	8.23 – 9.14	<1.0 x 10^{-6}	clayey sand and silt (ML)
111	3.66 – 4.27	1.1 x 10^{-2}	sand, trace silt, clay and gravel (ML)

5.14. Radon

According to information provided by Health Canada, radon is a radioactive gas that is naturally formed through the breakdown of uranium in soil, rock and water. When radon escapes the earth in the outdoors, it mixes with fresh air, resulting in concentrations that are too low to be of concern. However, when radon enters an enclosed space, such as a building, high concentration of radon can accumulate and become a health concern. Health Canada indicates that most buildings and homes have some level of radon in them. Unfortunately, it is not possible to predict before construction whether or not a new building will have high radon levels as radon can only be detected by radon measurement devices, which would be installed in a building, 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 SLOPE STABILITY ASSESSMENT

It is understood that the project will involve the construction of a new residential subdivision with associated roadways, underground utilities and stormwater management facilities. The Grand River Conservation Authority has regulated areas associated with slope and flooding hazards along the east and south sides of the subject property. Since the proposed construction would be at the top of the regulated slopes, a slope stability assessment was undertaken as part of this geotechnical investigation. The slopes were also assessed with respect to the *Grand River Conservation Authority: Policies for the Administration of the Prohibited Activities, Exemptions, and Permits Regulation, O.Reg 41/24, Dated May 24, 2024 (GRCA Policies Guideline).*

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.

6.1. ***Existing Slope Assessment***

In order to assess the current stability of the existing slopes, a slope stability analysis was completed. A total of three (3) slope cross-sections were analyzed; one (1) cross section through the south facing slope (referenced as Cross-Section A-A) and two (2) cross-sections through the east facing slope (referenced as Cross-Section B-B and C-C). The cross-section locations are provided on Drawings 2, 3 and 4. Based on measurements obtained from a topographic survey provided by Van Harten Surveying Inc., the steepness of each slope section was estimated. The top and toe of the slopes were determined by calculating where the slope steepness is less than 6.7H:1.0V. The slope is considered where the slope steepness is greater than 6.7H:1.0V. Cross-Section A-A (south slope) generally extends over a horizontal distance of approximately 23.43 m (76.87 ft) with a change in elevation of approximately 5.42 m (17.78 ft). As such, the steepness of the overall slope was generally on the order of 4.32H:1.0V. Cross-section B-B (east slope) generally extends over a horizontal distance of approximately 20.60 m (67.59 ft) with a change in elevation of approximately 7.30 m (23.95 ft). As such, the steepness of the overall slope was generally on the order of 2.82H:1.0V. Cross-section C-C (east slope) generally extends over a horizontal distance of approximately 17.04 m (55.91 ft) with a change in elevation of approximately 9.23 m (30.28 ft). As such, the steepness of the overall slope was generally on the order of 1.85H:1.0V. The slope cross-sections are provided on Drawing 5.

CMT Inc. staff conducted on-site visual inspections of the existing slope conditions. In general, the south slope (A-A) was lightly vegetated with mainly grass and with several large trees throughout and low-lying vegetation over the remainder of the area. There were no observed signs of slope instability such as seepage, slumps, erosion features or tension cracks. However, the east facing slope (B-B and C-C) in the assessed area had very little vegetation and consisted of bare soil in sections. There were also signs of instability such as slumps and erosion gullys, however, no seepage or tension cracks were observed. The toe of each slope is located within the associated floodplain limit based on discussions with the GRCA. Based on Table 4.2 – Slope Rating Chart from *Technical Guide – River and Stream Systems: Erosion Hazard Limit, 2002 by the MNR*, both the south and east slopes were determined to have a total rating values of 28 and 56, respectively, and therefore the south slope is considered to have a slight potential for slope instability while the east slope is considered to have a moderate potential for slope instability (see Appendix C).

6.1.1. Slope Stability Assessment

The stability of each slope was assessed using Bishop's simplified method. With this method, the factor of safety of a slope is determined by comparing the moment of the weight of a soil wedge about the centre of a slip circle, with the resisting moment provided by the shear stresses along the slip surface.

Based on the information collected in the boreholes, the following table shows the estimated soil parameters that were used for the slope stability analysis:

Soil Type	Unit Weight (kN/m^3)	Friction Angle	Cohesion (kPa)
Sandy Silt	21.0	30°	0
Clayey Sandy Silt	21.0	28°	5
Clayey Silt	20.0	28°	10

The above parameters are estimated based on the information obtained from the boreholes and are assumed to be consistent throughout the site.

A Factor of Safety of 1.0 is considered to represent a potential failure condition. As per Table 4.3 of *Technical Guide – River and Stream Systems: Erosion Hazard Limit, 2002* by the MNR*,* the land use of the site would be classified as "Active" (habitable or occupied structures near slope). A Factor of Safety of 1.5 is considered to be adequate for this site with respect to shallow and deep-seated (global) failure surfaces.

The slope stability analyses were completed utilizing the SLIDE software package developed by Rocscience. Based on the analyses completed, a minimum Safety Factor of 3.171, 2.303 and 1.367 was determined for the existing slopes at Cross-Sections A-A, B-B and C-C, respectively. Based on the results of the analyses, the existing south slope (A-A) and the east slope in the area of Cross-Section B-B is considered to be stable, however the existing east slope in the area of cross-section C-C is considered to be unstable in its current configuration. As such, the top of existing **stable** slope for cross-sections A-A and B-B is also the top of the existing slope and has stable slope angles of approximately 4.32H:1.0V and 2.82H:1.0V respectively. The top of existing **stable** slope for Cross-Section C-C was determined by reducing the slope angle until the factor of safety from slope failure was greater than 1.5. The top of existing **stable** slope for Cross Section C-C was calculated to be approximately 5.78 m west of the top of existing slope, which corresponds to a stable slope angle of about 2.34H:1.0V.

The results of the slope stability analyses including the safety factors achieved for the existing slopes are provided in Drawings 6, 8, 10 and 11 (Cross-Section A-A (existing/stable), B-B (existing/stable), C-C (existing/unstable), and C-C (existing/stable)). The existing top of slope, toe of slope and top of **stable** slope locations are provided in Drawings 2, 3, and 4.

6.2. Flooding Hazards

The site was assessed with respect to the *Grand River Conservation Authority: Policies for the Administration of the Prohibited Activities, Exemptions, and Permits Regulation, O.Reg 41/24, Dated May 24, 2024 (GRCA Policies Guideline)*.

It is understood that there is a one-zone floodplain in the area of the site. Through discussions with the GRCA with respect to regulated floodplains, the floodplain elevations are reported to be 450.49 m at the south slope (Cross-Section A-A) and 455.01 m at the east slope (Cross-Sections B-B and C-C). The floodplains do come into contact with the property and the slopes, however, the proposed construction is outside of the floodplain area and the required 15.0 m floodplain setback, as shown below on Table 3 of the GRCA Policies Guideline. As such, there should be no concern of flooding hazards for the proposed construction. The floodplain limit and the 15.0 m floodplain setback are shown on Drawing 2, 3, and 4.

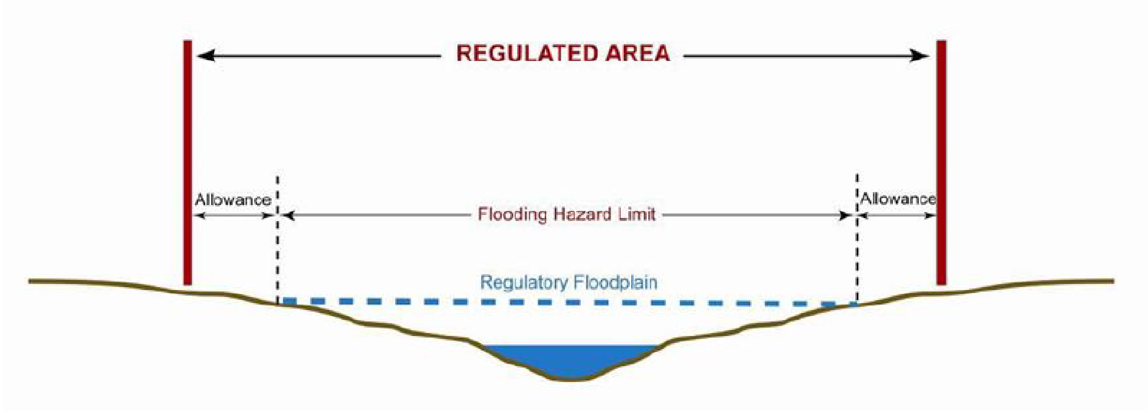


Figure 3. Riverine Flooding Hazard – Regulated Area for One Zone Policy Areas

6.3. Erosion Hazards

The slope throughout the site changes in classification from an "Erosion Hazard" to an "Other Valleyland" as defined by the GRCA policies guideline. The slope hazard areas are shown on Drawing 2, 3 and 4. The south slope in the area of Cross Section A-A has slope inclinations between 3.0:1.0 to 5.0:1.0. This slope would be classified as a an “Apparent Valley” and a Riverine Erosion Hazard. However, as you move east along the south facing slope, the slope becomes less steep with angles between 5.0H:1.0V and 6.7H:1.0V. This area would be considered an “Other Valleyland”. Eventually the slope becomes less steep than 6.7H:1.0V and would then be considered gently sloping lands, which do not classify as a regulated slope. As well, there is a portion of the east facing slope that is also considered an “Other Valleyland”, which exists to the west of the erosion hazard zone. As such, both sections of the slope will be discussed below.

The erosion allowance of the existing watercourse was determined from the Ministry of Natural Resources Technical Guide for River and Stream Systems: Erosion Hazard Limit. From Table 3 of the above-mentioned Technical Guide, the recommended erosion over a period of 100 years on the slope would be 5.0 m to 8.0 m, since there is evidence of active erosion within the river bank area and the native soils consist of stiff/hard, cohesive clays or clayey silts. A conservative estimate of 8.0 m of erosion over 100 years, or 0.08 m/year was used for this assessment and was applied to the edge of the existing river bank, as shown below in Table 6 of the GRCA Policies Guideline.

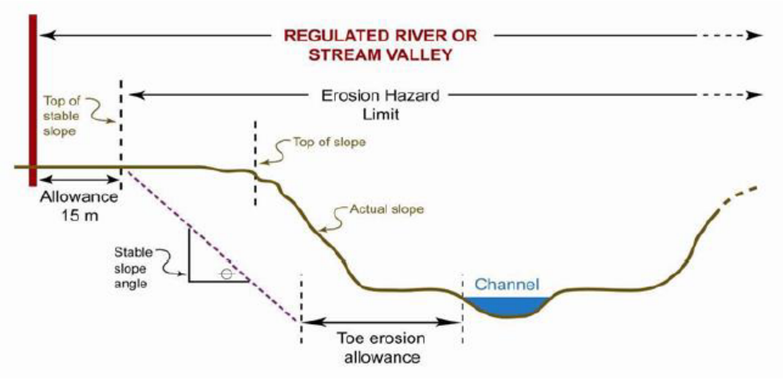


Figure 6. Riverine Erosion Hazard – Regulated Area for Apparent Oversteepened Valleys with Active Toe Erosion

Based on the analysis completed for the slopes in the proposed long-term (100 year) condition (proposed loading and applying 8.0 m of erosion at the edge of the existing river bank) the factors of safety for Cross Sections A-A and B-B remain unchanged at 3.171 and 2.303, respectively, due to the fact that the long term (100 year) erosion does not contact the toe of the slope. However, when applying the long term (100 year) erosion at the edge of the river bank at Cross Section C-C, the proposed erosion contacts the toe of the slope making it unstable. The long term (100 year) stable slope angle at Cross Section C-C was determined by applying the proposed loading and 8.0 m of erosion from the existing bank of the river and then reducing the slope angle until the factor of safety from slope failure was greater than 1.5. Based on the analysis completed, the top of long term (100 year) **stable** slope for Cross-Section C-C was calculated to be approximately 13.28 m west of the top of existing slope, which corresponds to a stable slope angle of about 2.36H:1.0V.

The results of the long term (100-year) slope stability analyses including the safety factors achieved for the slopes are provided in Drawings 7, 9 and 12 (Cross-Section A-A, B-B and C-C). The long term (100-year) top of **stable** slope location for both slopes is provided in Drawings 2, 3, 4 and 5.

6.3.1. Erosion Hazard Policy

As per Sections 8.2.2 to 8.2.11 of the GRCA Policies, a minimum setback of 6.0 m from the riverine erosion hazard to the proposed construction is required for emergency erosion control access. This setback is shown on Drawing 2, 3, 4, and 5. It is understood that all development is to be outside of the riverine erosion hazard including the 6.0 m development setback. Should any development encroach on the erosion hazard or the setback, the development must comply with Sections 8.2.2 to 8.2.11 of the GRCA Policies Guideline.

6.3.2. Other Valleyland Policy

Any development within the area of the slopes that are classified as Other Valleylands must utilize the following policies:

8.3.2. - ***Development*** *in Other Valleylands and the associated allowance may be permitted in accordance with the policies in Sections 7.1.2-7.1.3 - General Policies, and where it can be demonstrated through a site-specific geotechnical or engineering assessment that*:

a) the proposed development is not subject to a Riverine Erosion Hazard or a Riverine Flooding Hazard,

The area classified as Other Valleyland on the south facing slope is not subject to an erosion hazard. The area classified as Other Valleyland on the east slope is partially subject to an erosion hazard, however, all development should be outside of the erosion hazard within this area.

b) there is no impact on existing and future slope stability and bank stabilization, or erosion protection works are not required,

Based on the results of the slope stability analysis, the proposed developments have a negligible effect on existing and future slope stability.

c) *the potential of increased loading forces is addressed through appropriate structural design*,

The proposed developments were conservatively modelled with a 75 kPa surcharge loading at the surface in the slope stability analysis.

d) access into and through the valley for preventative actions or maintenance or during an emergency will not be prevented,

Access to and through the valley will not be impeded as a result of the proposed development.

e) the potential for surficial erosion is addressed by a drainage plan where applicable,

Drainage and grading plans are to be completed by others (as required). CMT Inc. recommends continuing to use the best drainage practices (collect and divert runoff to catch basins, use of splash pads in vegetated areas, drainage system behind retaining walls, drainage system at the development founding elevation etc.).

As such, the proposed development would be considered safe from any other valleyland hazards associated with this site and complies with the GRCA Policy Guidelines.

From a geotechnical perspective, there should be no concern for the proposed development to meet the above requirements; however, proposed site plans, drainage plans and grading plans for the proposed development should be submitted to the GRCA to address the additional requirements of the above-mentioned policy. Grading and drainage plans should address the control of surface water over soft and hard landscaped areas, while pavement and rooftops drainage should be directed to swales, catch basins, storm sewers and/or on-site infiltration galleries. It should be understood that the GRCA will make the final determination on the approval of the proposed development.

CMT Inc. would be pleased to review design drawings when they become available and make any additional comments or recommendations for the proposed development with respect to the *Grand River Conservation Authority: Policies for the Administration of the Prohibited Activities, Exemptions, and Permits Regulation, O.Reg 41/24, Dated May 24, 2024 (GRCA Policies Guideline).*

7.0 SITE INSPECTION

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.

8.0 LIMITATIONS OF THE INVESTIGATION

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.

This report is intended solely for the client named. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the reliability of such third parties. The factual data, interpretation, and recommendations in this report pertain to a specific project as described in this report and are not applicable to any other project or site location. If the project is modified in concept, location or elevation, deviates from the assumptions stated herein, CMT Inc. should be given an opportunity to confirm that the recommendations are still valid. The subject geotechnical exploration and this report address only the geotechnical aspects of the proposed project; potential environmental impacts or related issues are beyond the defined scope of this work and have not been addressed.

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:

Marc Favaro, B.Sc.
Project Leader

LICENSED PROFESSIONAL ENGINEER
10/18/2024
N. J. CHORTOS
100210851
PROVINCE OF ONTARIO

Reviewed by:

Nathan Chortos, P.Eng.
Senior Engineer

tb

NOTES:

1. BASE MAP PROVIDED BY GOOGLE EARTH

N

NO.	DESCRIPTION	DATE

REVISIONS

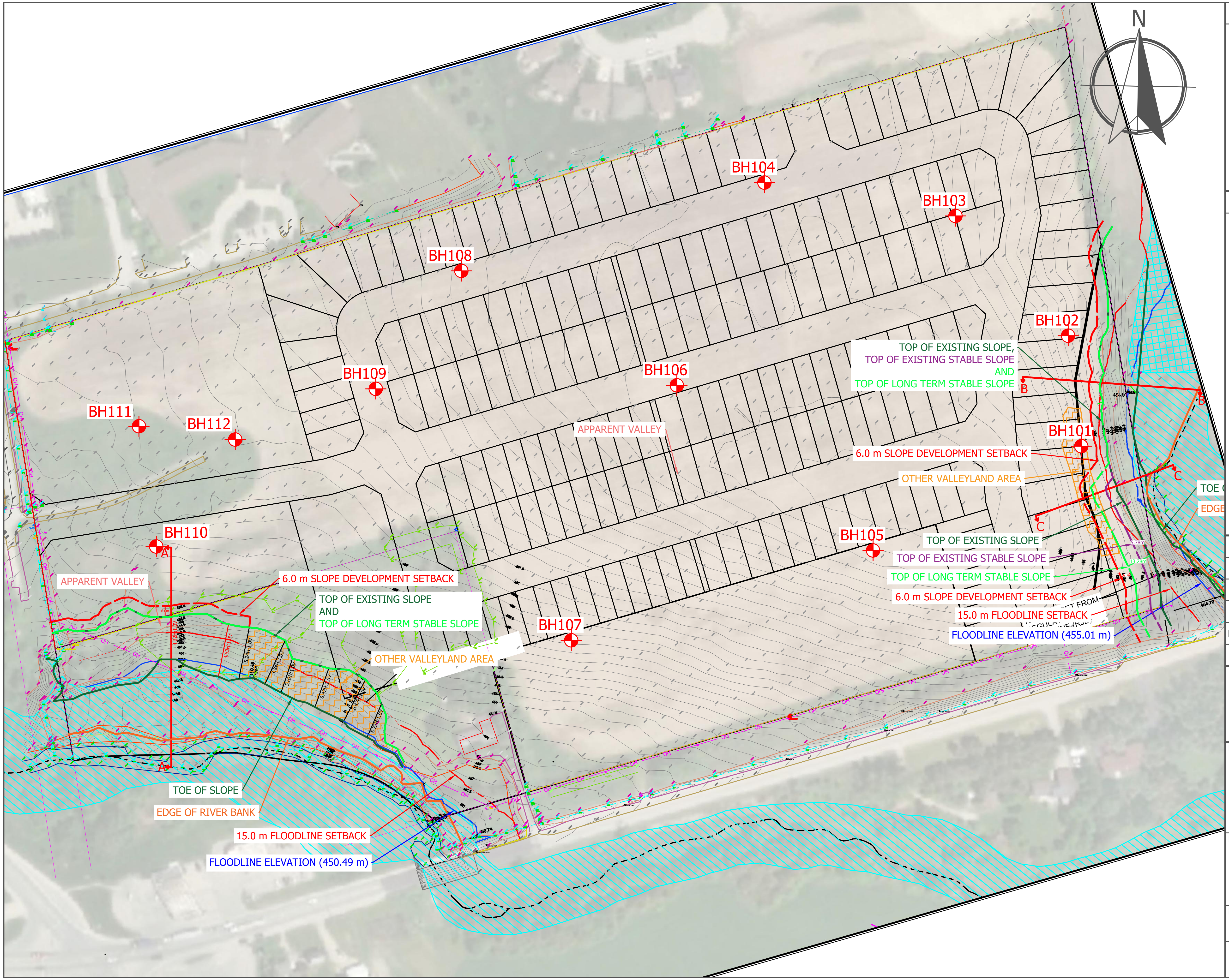
CMT ENGINEERING INC.
1011 Industrial Crescent, Unit 1
St. Clements, Ontario N0B 2M0
Tel.: 519-699-5775
Fax: 519-699-4664
www.cmtinc.net

PROJECT:
Geotechnical Investigation/
Slope Stability Study
211 Eliza Street,
Arthur, Ontario

DRAWING TITLE:

SITE LOCATION MAP

PROJECT NO.: 19-519
DATE: October 18, 2024
SCALE: N.T.S.
DRAWING NO. 1



NOTES:

1. BASEMAP AND SURVEY DETAILS PROVIDED BY VAN HARTEN LAND SURVEYORS - DATED JUNE 13, 2024

LEGEND:

↘A	CMT CROSS SECTION
—	EDGE OF RIVERBANK
—	TOP/TOE OF EXISTING SLOPE
- - -	TOP OF EXISTING STABLE SLOPE
- - -	TOP OF LONG TERM STABLE SLOPE
- - -	6.0 m SLOPE DEVELOPMENT SETBACK
—	FLOODLINE LIMIT
—	15.0 m FLOODLINE SETBACK
▨	OTHER VALLEYLAND

NO.	DESCRIPTION	DATE

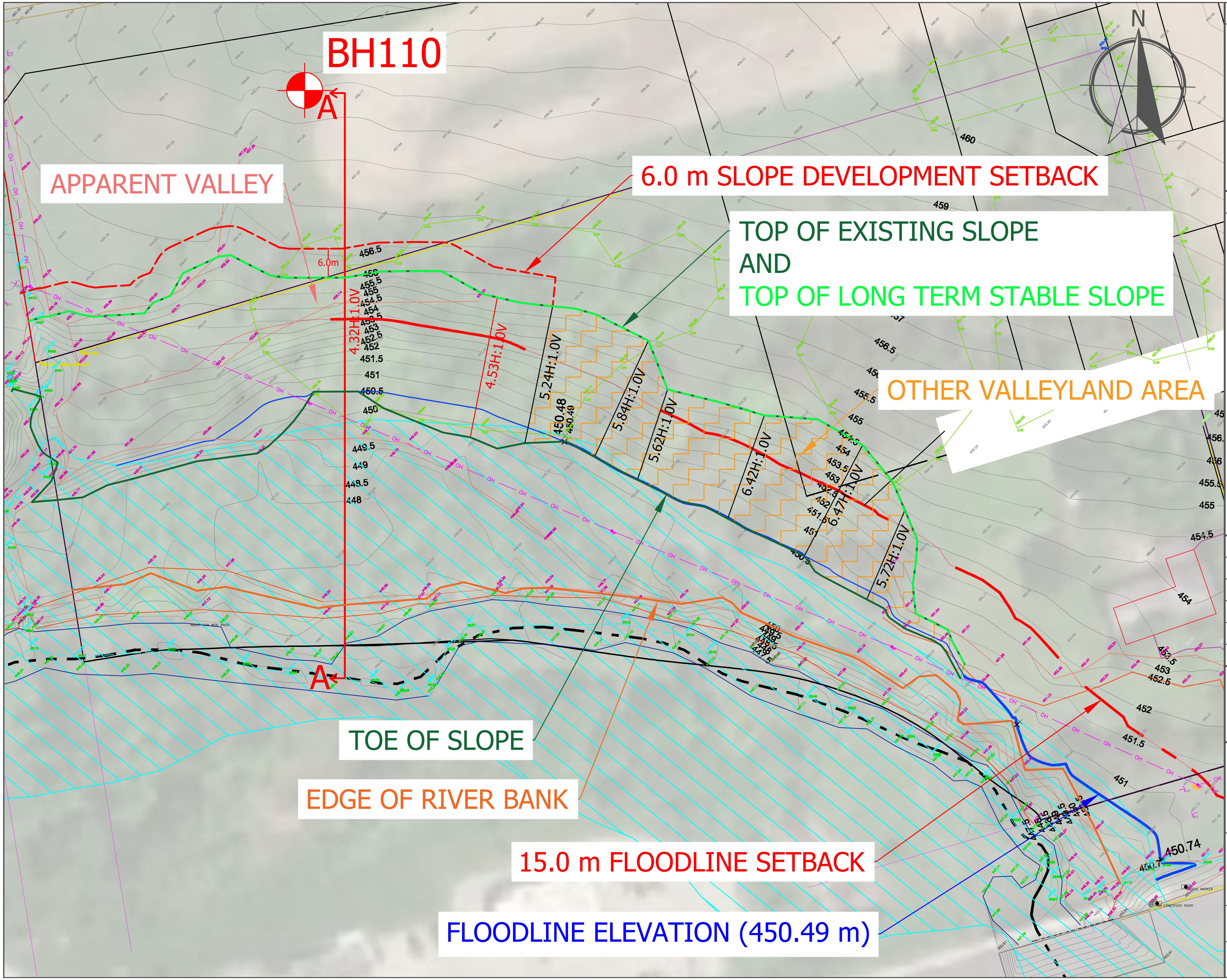
REVISIONS

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:
Geotechnical Investigation/
Slope Stability Study
211 Eliza Street,
Arthur, Ontario

DRAWING TITLE:
AERIAL VIEW SHOWING
BOREHOLE AND SLOPE
CROSS-SECTION LOCATIONS

PROJECT NO.:	DATE:
19-519	October 18, 2024
SCALE:	DRAWING NO.
1:2000	2



NOTES:

1. BASEMAP AND SURVEY DETAILS PROVIDED BY VAN HARTEN LAND SURVEYORS - DATED JUNE 13, 2024

LEGEND:

- ↘A CMT CROSS SECTION
- EDGE OF RIVERBANK
- TOP/TOE OF EXISTING SLOPE
- TOP OF EXISTING STABLE SLOPE
- TOP OF LONG TERM STABLE SLOPE
- 6.0 m SLOPE DEVELOPMENT SETBACK
- FLOODLINE LIMIT
- 15.0 m FLOODLINE SETBACK
- ▨ OTHER VALLEYLAND

NO.	DESCRIPTION	DATE

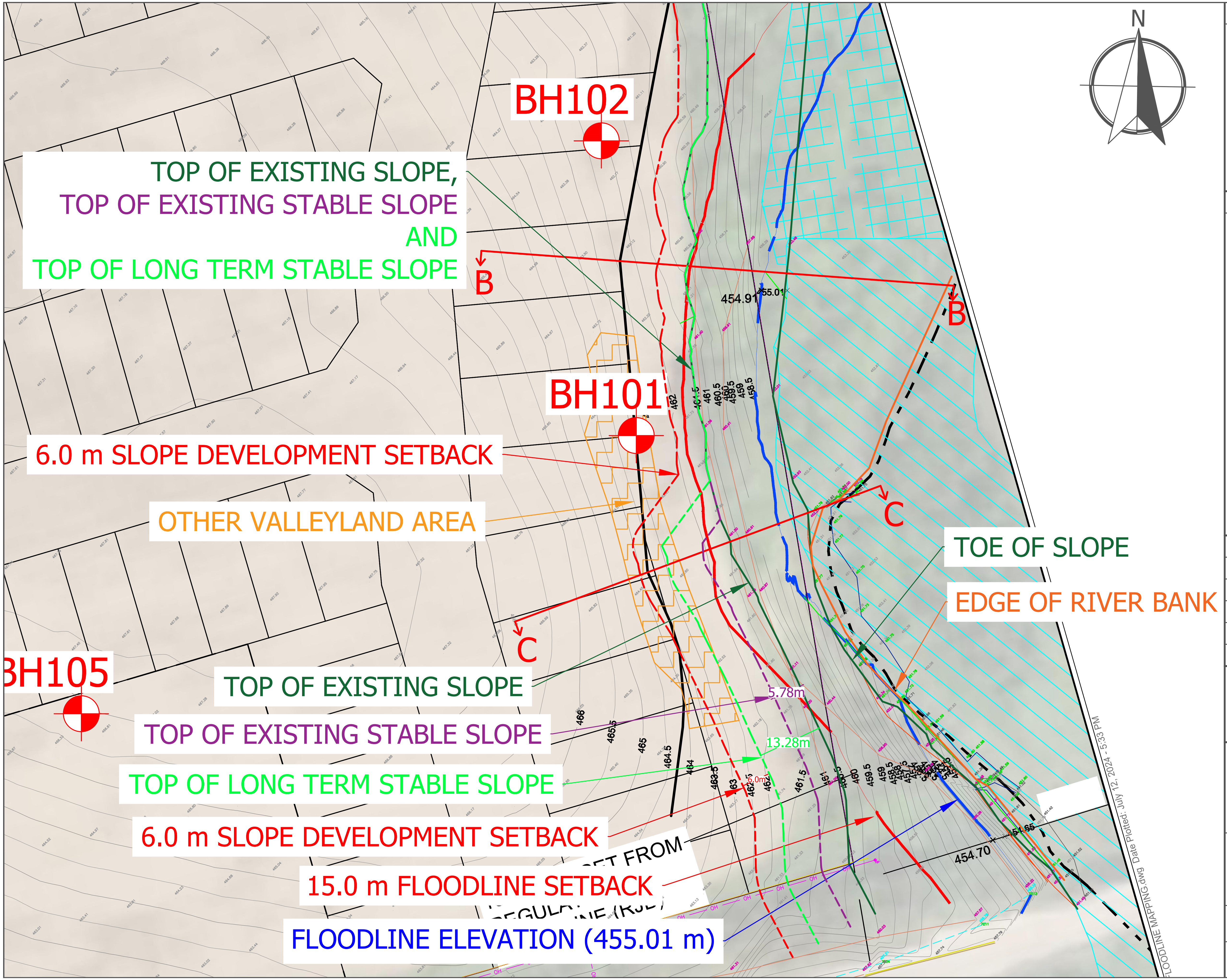
REVISIONS

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:
Geotechnical Investigation/
Slope Stability Study
211 Eliza Street,
Arthur, Ontario

DRAWING TITLE:
AERIAL VIEW SHOWING
SOUTH SLOPE

PROJECT NO.:	DATE:
19-519	October 18, 2024
SCALE:	DRAWING NO.
1:750	3



NOTES:

1. BASEMAP AND SURVEY DETAILS PROVIDED BY VAN HARTEN LAND SURVEYORS - DATED JUNE 13, 2024

LEGEND:

A CMT CROSS SECTION
EDGE OF RIVERBANK
TOP/TOE OF EXISTING SLOPE
TOP OF EXISTING STABLE SLOPE
TOP OF LONG TERM STABLE SLOPE
6.0 m SLOPE DEVELOPMENT SETBACK
FLOODLINE LIMIT
15.0 m FLOODLINE SETBACK
OTHER VALLEYLAND

NO.	DESCRIPTION	DATE

REVISIONS

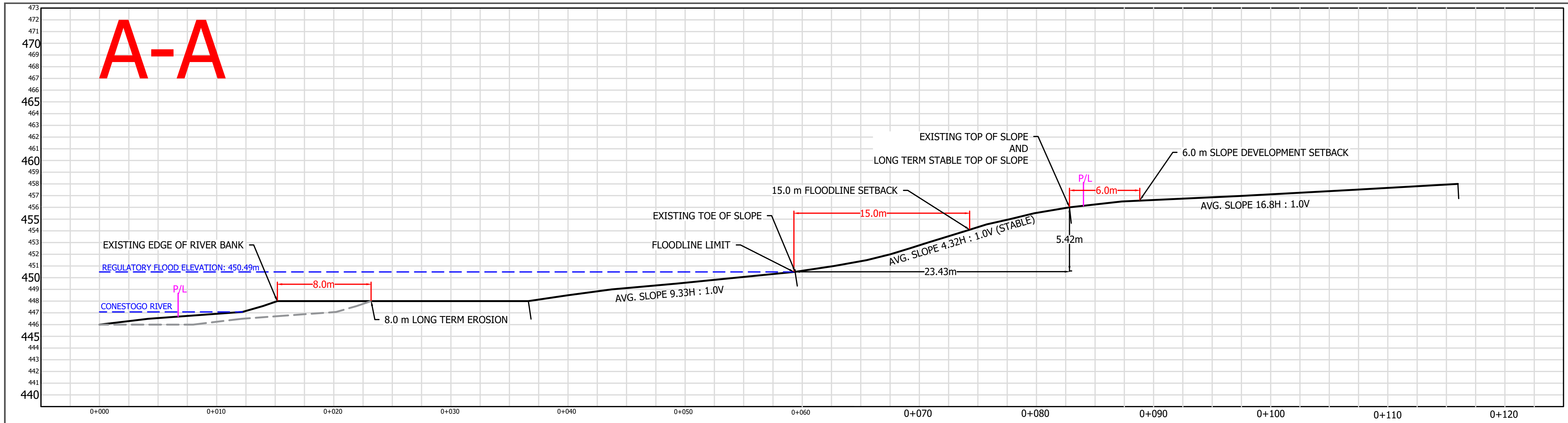
CMT ENGINEERING INC.
1011 Industrial Crescent, Unit 1
St. Clements, Ontario N0B 2M0
Tel.: 519-699-5775
Fax: 519-699-4664
www.cmtinc.net

PROJECT:
Geotechnical Investigation/
Slope Stability Study
211 Eliza Street,
Arthur, Ontario

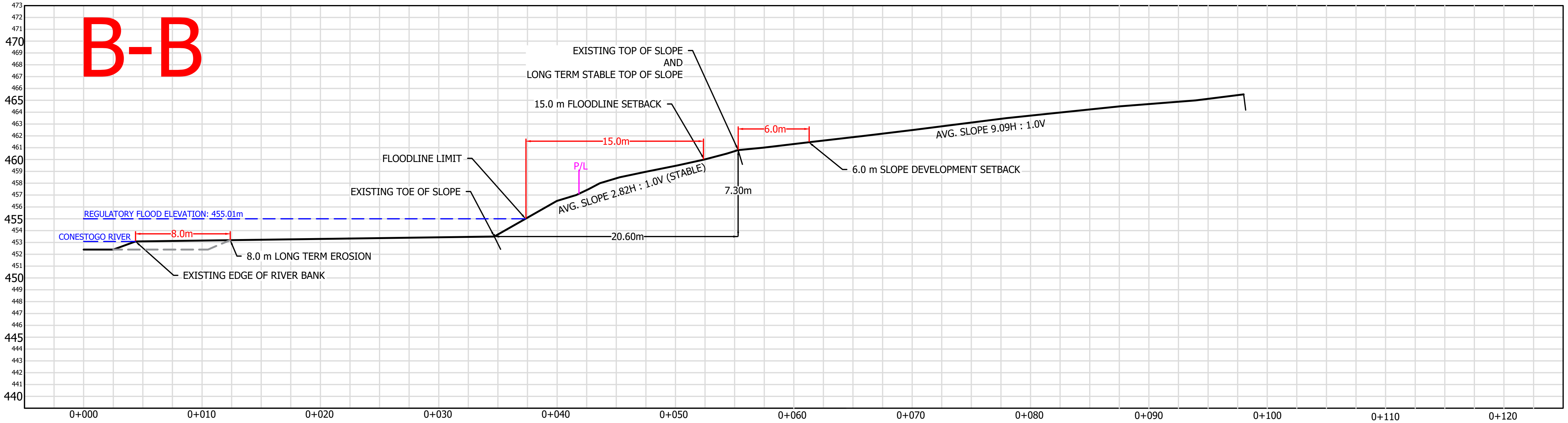
DRAWING TITLE:
AERIAL VIEW SHOWING
EAST SLOPE

PROJECT NO.:	DATE:
19-519	October 18, 2024
SCALE:	DRAWING NO.
1:750	4

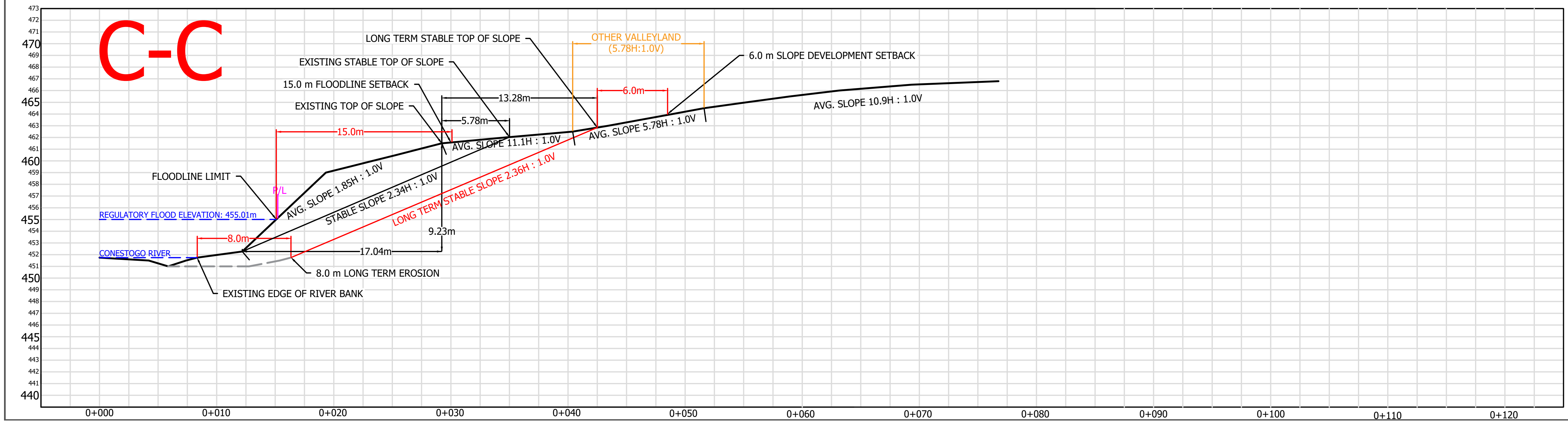
A-A



B-B



C-C



NOTES:

1. SLOPE CROSS-SECTION AS PER TOPOGRAPHIC SURVEY COMPLETED BY VAN HARTEN LAND SURVEYORS - DATED JUNE 13, 2024

NO.	DESCRIPTION	DATE

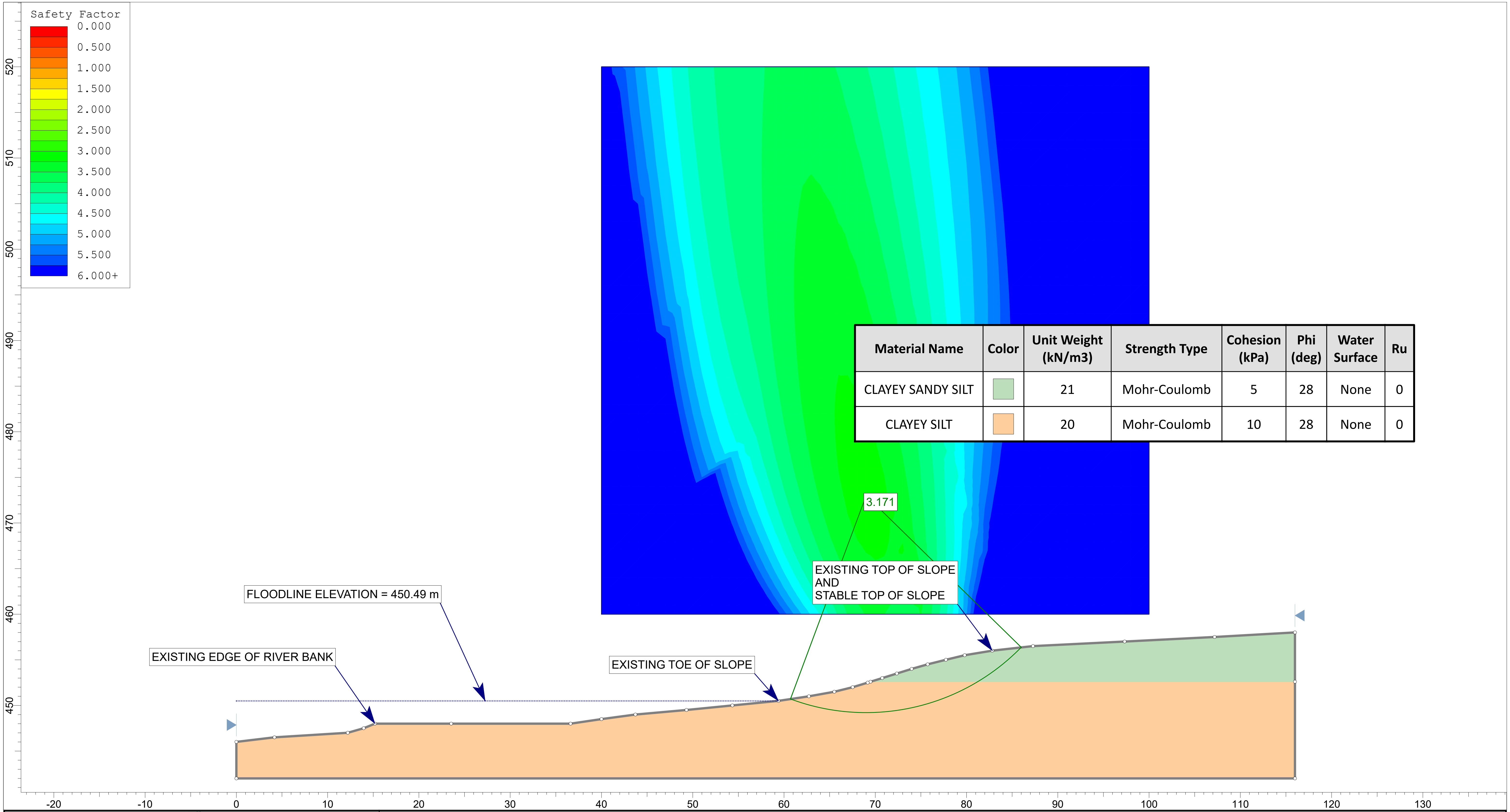
REVISIONS

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:
Geotechnical Investigation/
Slope Stability Study
211 Eliza Sreeet,
Arthur, Ontario

DRAWING TITLE:
SLOPE CROSS SECTIONS
A-A, B-B, AND C-C

PROJECT NO.: 19-519
DATE: October 18, 2024
SCALE: 1:400
DRAWING NO. 5

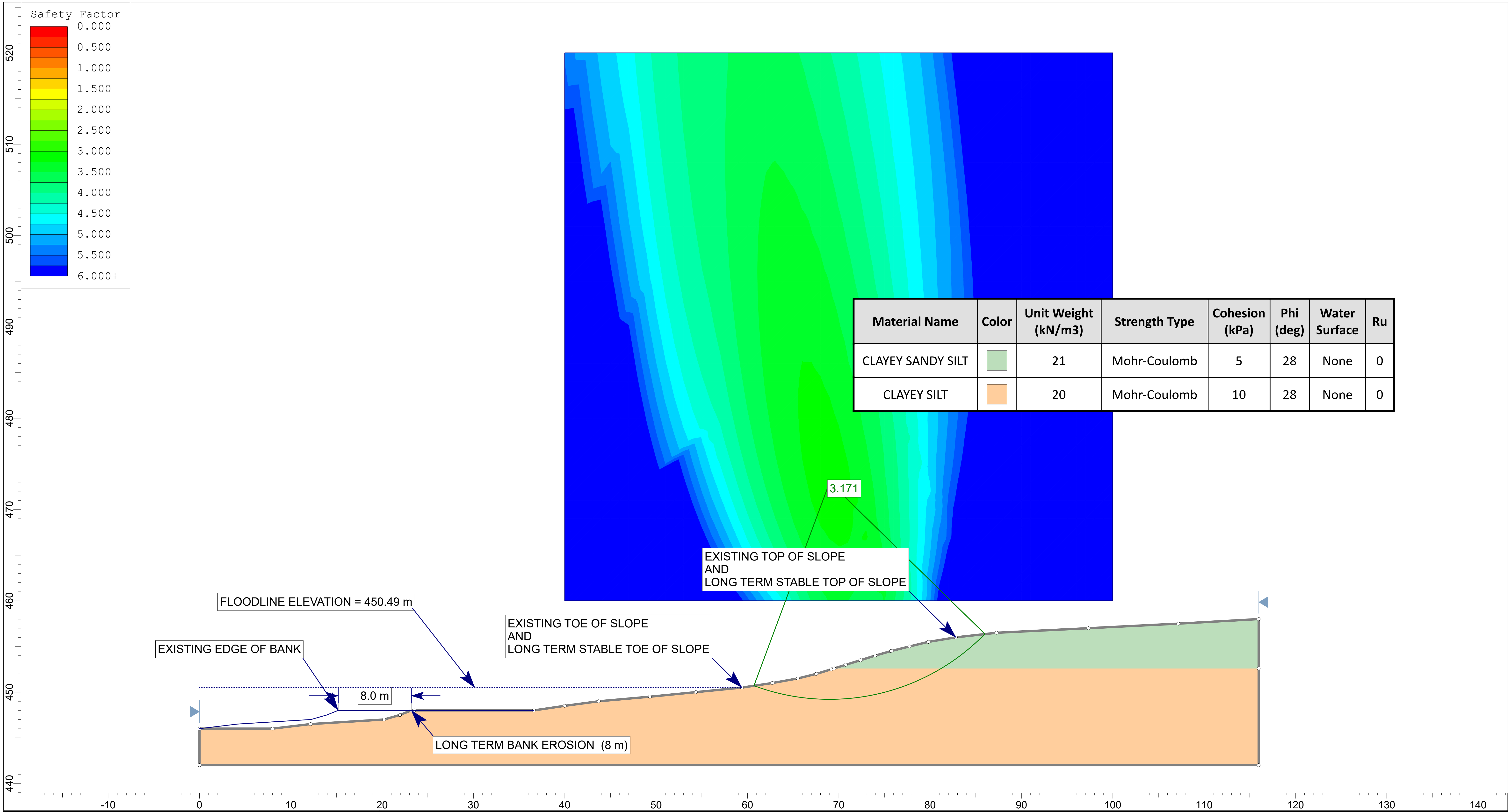


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
CLAYEY SANDY SILT	🟩	21	Mohr-Coulomb	5	28	None	0
CLAYEY SILT	🟧	20	Mohr-Coulomb	10	28	None	0

Project
DRAWING 6 - SLOPE CROSS SECTION A-A
SHOWING MINIMUM FACTORS OF SAFETY (LESS THAN 1.5) FOR EXISTING SLOPE

Location
211 Eliza Street, Arthur, ON

Drawn By	MF	*Scale*	1:400	*Company*	CMT ENGINEERING INC
Date	October 18, 2024			*Job Number*	19-519



EXISTING TOP OF SLOPE
AND
LONG TERM STABLE TOP OF SLOPE

FLOODLINE ELEVATION = 450.49 m

EXISTING TOE OF SLOPE
AND
LONG TERM STABLE TOE OF SLOPE

EXISTING EDGE OF BANK

LONG TERM BANK EROSION (8 m)

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
CLAYEY SANDY SILT	🟩	21	Mohr-Coulomb	5	28	None	0
CLAYEY SILT	🟧	20	Mohr-Coulomb	10	28	None	0

CMT ENGINEERING INC

Project
DRAWING 7 - SLOPE CROSS SECTION A-A
SHOWING MINIMUM FACTORS OF SAFETY (LESS THAN 1.5) FOR LONG TERM CONDITIONS WITH PROPOSED LOADING

Location
211 Eliza Street, Arthur, ON

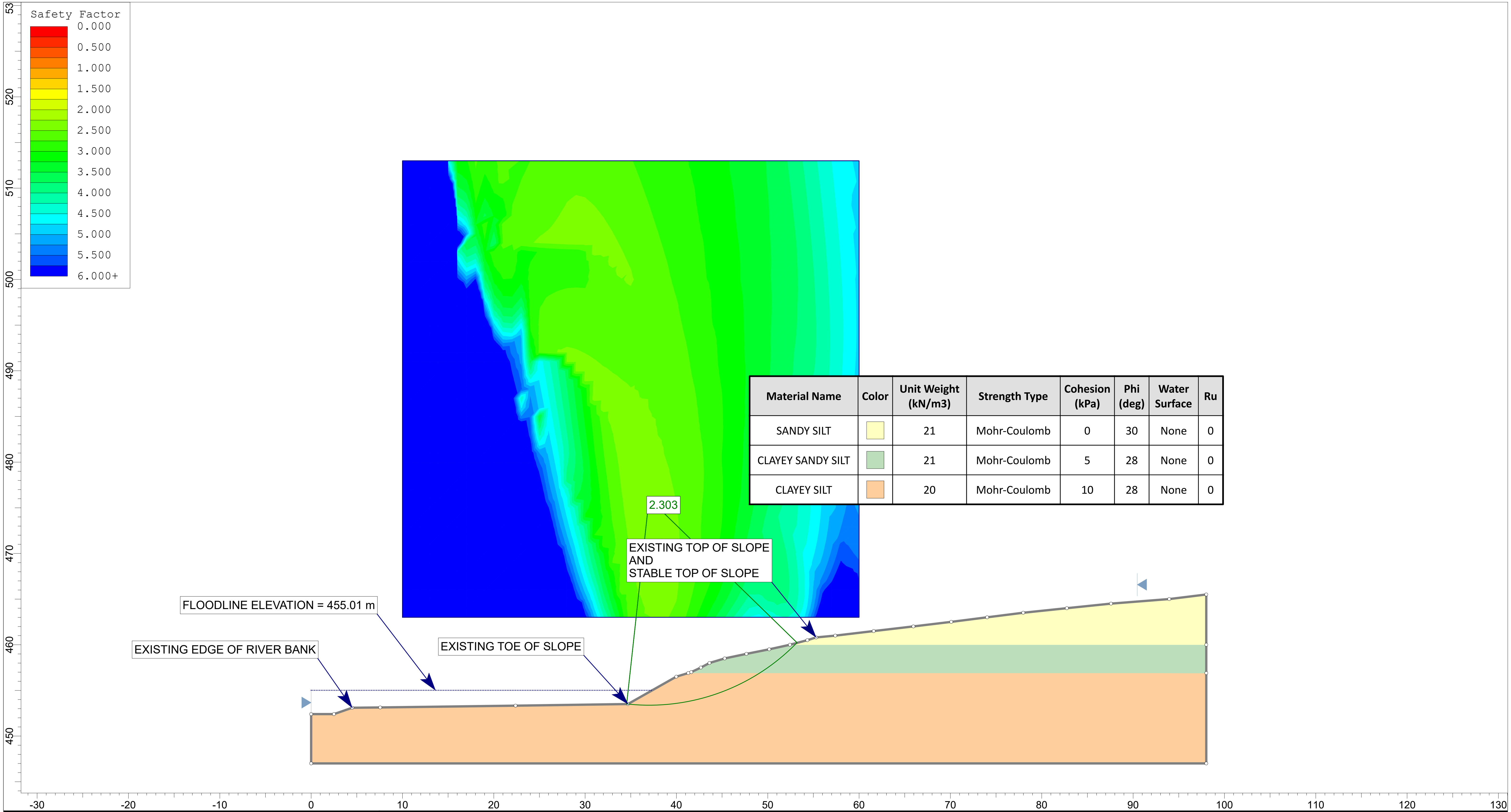
Drawn By
MF

Scale
1:400

Company
CMT ENGINEERING INC

Date
October 18, 2024

Job Number
19-519

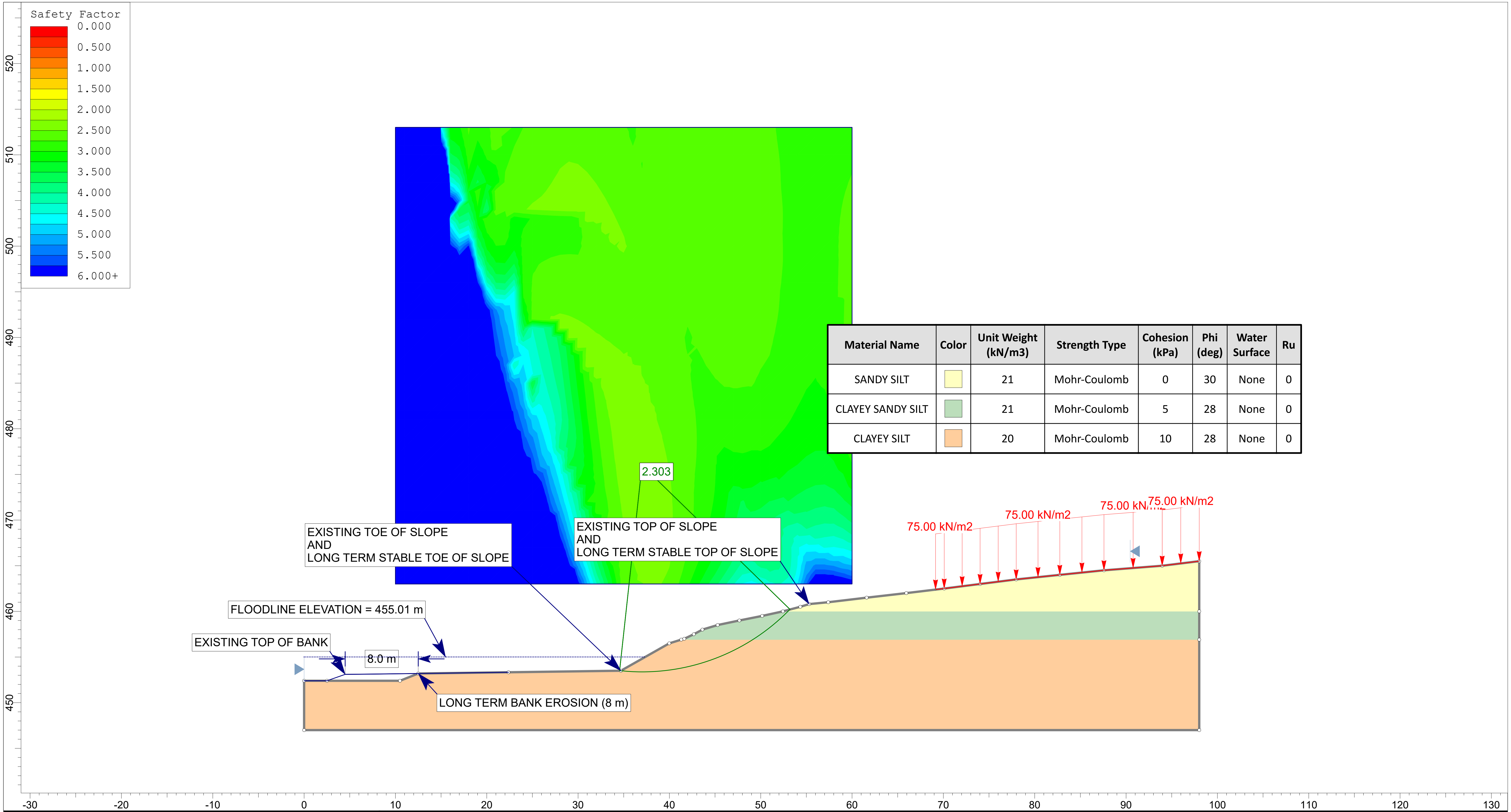


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
SANDY SILT	🟨	21	Mohr-Coulomb	0	30	None	0
CLAYEY SANDY SILT	🟩	21	Mohr-Coulomb	5	28	None	0
CLAYEY SILT	🟧	20	Mohr-Coulomb	10	28	None	0

Project
DRAWING 8 - SLOPE CROSS SECTION B-B
SHOWING MINIMUM FACTORS OF SAFETY (LESS THAN 1.5) FOR EXISTING SLOPE

Location
211 Eliza Street, Arthur, ON

Drawn By MF
Scale 1:400
Company CMT ENGINEERING INC
Date October 18, 2024
Job Number 19-519



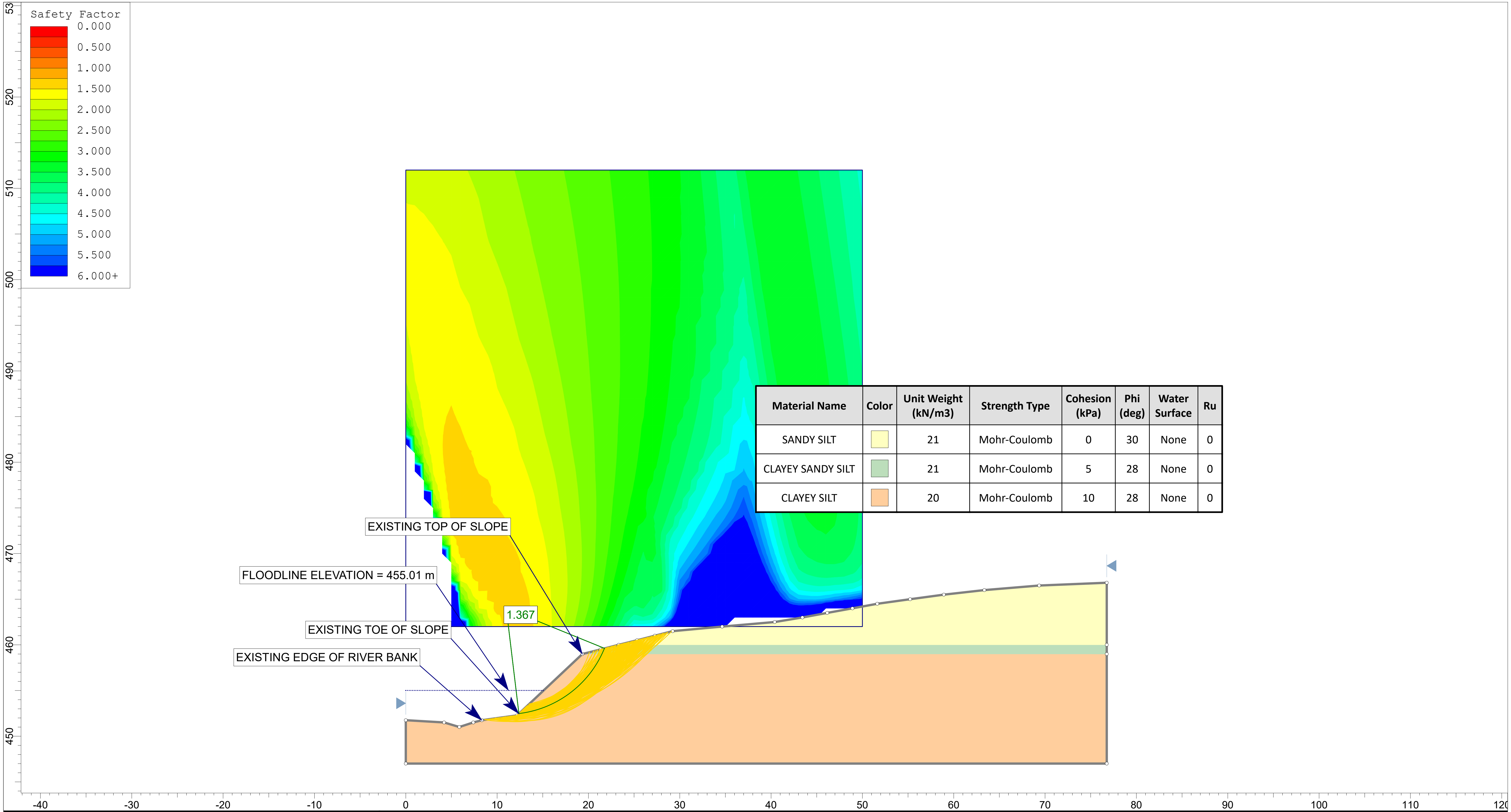
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
SANDY SILT	🟨	21	Mohr-Coulomb	0	30	None	0
CLAYEY SANDY SILT	🟩	21	Mohr-Coulomb	5	28	None	0
CLAYEY SILT	🟧	20	Mohr-Coulomb	10	28	None	0

CMT ENGINEERING INC.

Project
DRAWING 9 - SLOPE CROSS SECTION B-B
SHOWING MINIMUM FACTORS OF SAFETY (LESS THAN 1.5) FOR LONG TERM CONDITIONS WITH PROPOSED LOADING

Location
211 Eliza Street, Arthur, ON

Drawn By MF
Scale 1:400
Company CMT ENGINEERING INC
Date October 18, 2024
Job Number 19-519



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
SANDY SILT	🟨	21	Mohr-Coulomb	0	30	None	0
CLAYEY SANDY SILT	🟩	21	Mohr-Coulomb	5	28	None	0
CLAYEY SILT	🟧	20	Mohr-Coulomb	10	28	None	0

Project

DRAWING 10 - SLOPE CROSS SECTION C-C
SHOWING MINIMUM FACTORS OF SAFETY (LESS THAN 1.5) FOR EXISTING SLOPE

Location 211 Eliza Street, Arthur, ON

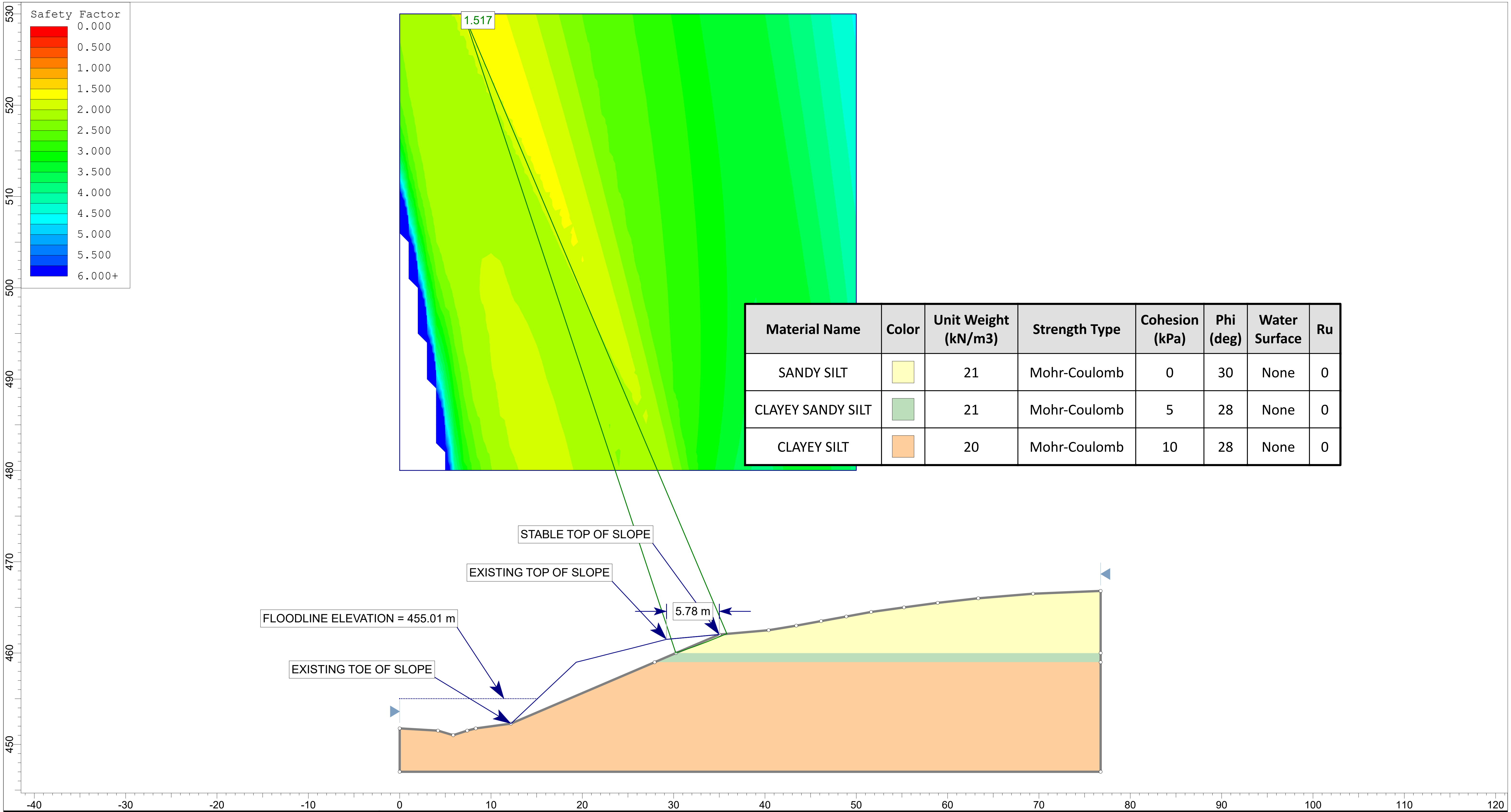
Drawn By MF

Scale 1:400

Company CMT ENGINEERING INC

Date October 18, 2024

Job Number 19-519



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
SANDY SILT	🟨	21	Mohr-Coulomb	0	30	None	0
CLAYEY SANDY SILT	🟩	21	Mohr-Coulomb	5	28	None	0
CLAYEY SILT	🟧	20	Mohr-Coulomb	10	28	None	0

CMT ENGINEERING INC

Project
DRAWING 11 - SLOPE CROSS SECTION C-C
SHOWING MINIMUM FACTORS OF SAFETY (LESS THAN 1.5) FOR EXISTING STABLE SLOPE ANGLE

Location 211 Eliza Street, Arthur, ON

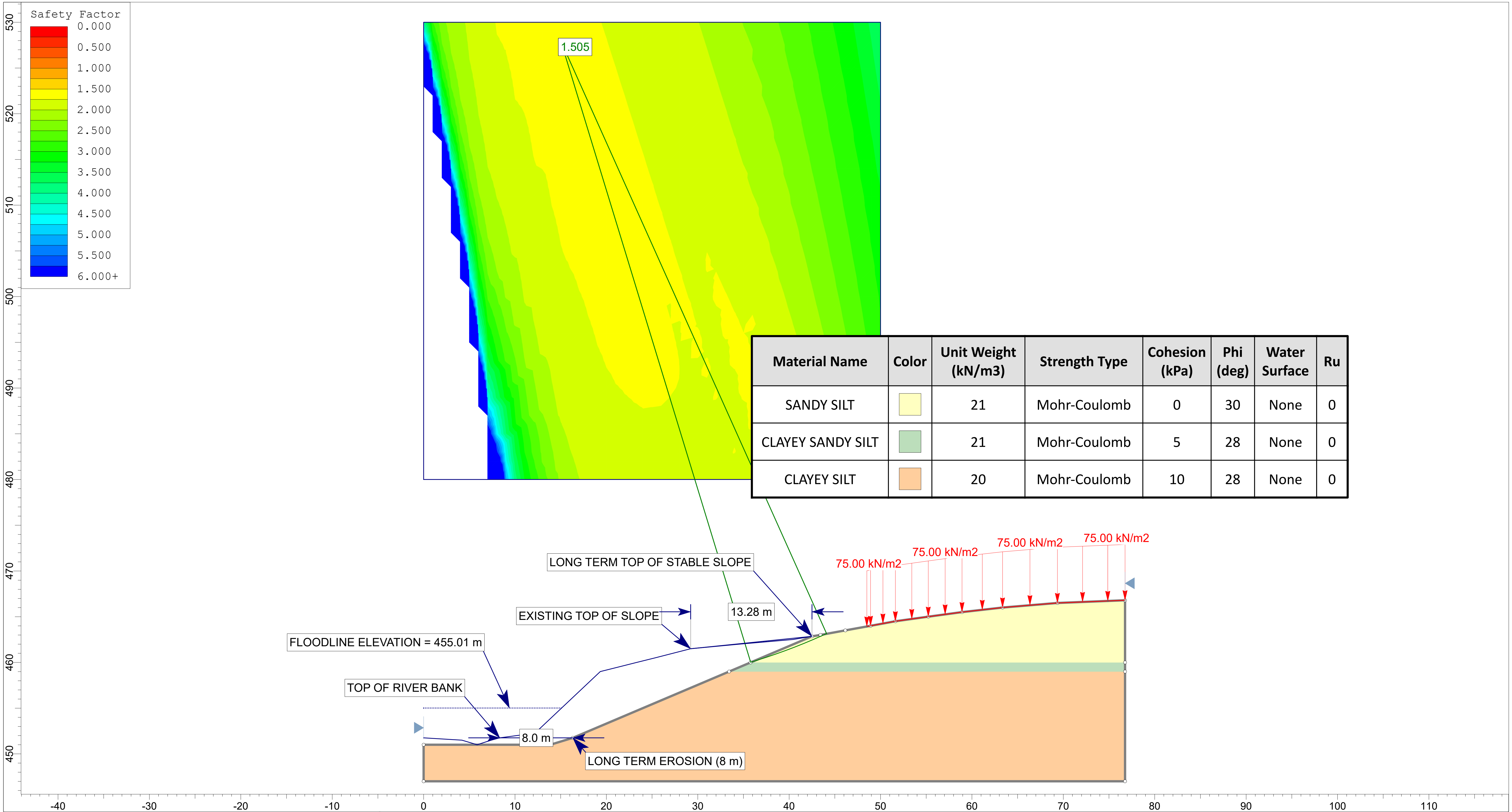
Drawn By MF

Scale 1:400

Company CMT ENGINEERING INC

Date October 18, 2024

Job Number 19-519



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Ru
SANDY SILT	🟨	21	Mohr-Coulomb	0	30	None	0
CLAYEY SANDY SILT	🟩	21	Mohr-Coulomb	5	28	None	0
CLAYEY SILT	🟧	20	Mohr-Coulomb	10	28	None	0

CMT ENGINEERING INC

Project
DRAWING 12 - SLOPE CROSS SECTION C-C
SHOWING MINIMUM FACTORS OF SAFETY (LESS THAN 1.5) FOR LONG TERM CONDITIONS WITH PROPOSED LOADING

Location
211 Eliza Street, Arthur, ON

Drawn By MF
Scale 1:400
Company CMT ENGINEERING INC

Date October 18, 2024
Job Number 19-519

APPENDIX A

BOREHOLE LOGS

BOREHOLE 101

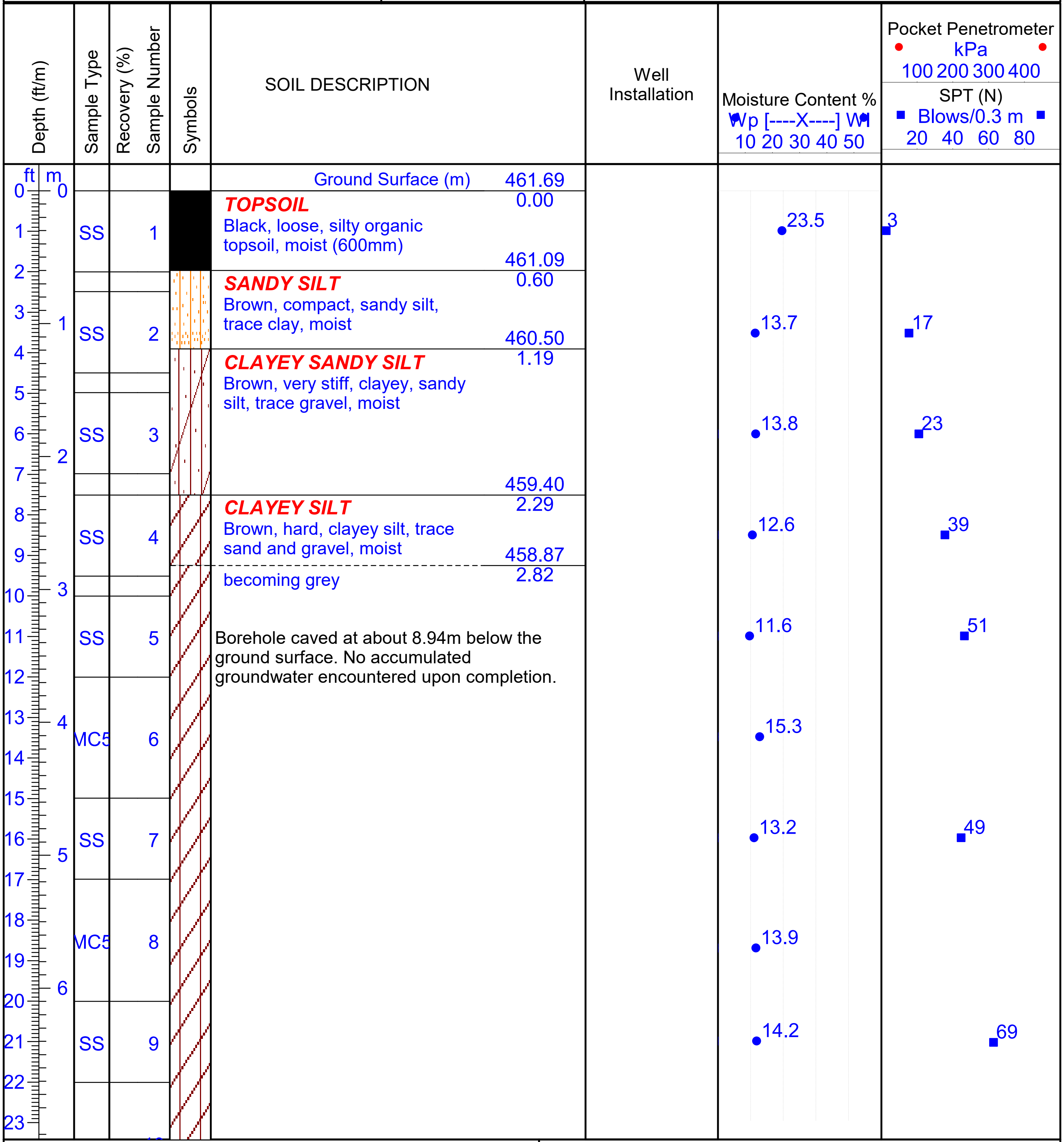
Page 1 of 2

Date Drilled: November 25, 2019
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT/MC5

Elevation: 461.69 m
Logged by: B.R.F.

Project No.: 19-519
Project: Geotechnical Investigation

Location: 211 Eliza Street, Arthur, ON



Elevation / Depth (m)	Soil Description
461.69	Ground Surface (m)
0.00	***TOPSOIL*** Black, loose, silty organic topsoil, moist (600mm)
461.09 0.60	***SANDY SILT*** Brown, compact, sandy silt, trace clay, moist
460.50 1.19	***CLAYEY SANDY SILT*** Brown, very stiff, clayey, sandy silt, trace gravel, moist
459.40 2.29	***CLAYEY SILT*** Brown, hard, clayey silt, trace sand and gravel, moist
458.87 2.82	becoming grey

Borehole caved at about 8.94m below the ground surface. No accumulated groundwater encountered upon completion.

Sample Type	Sample Number	Moisture Content %	SPT (N)
SS	1	23.5	3
SS	2	13.7	17
SS	3	13.8	23
SS	4	12.6	39
SS	5	11.6	51
MC5	6	15.3	
SS	7	13.2	49
MC5	8	13.9	
SS	9	14.2	69

BOREHOLE 101

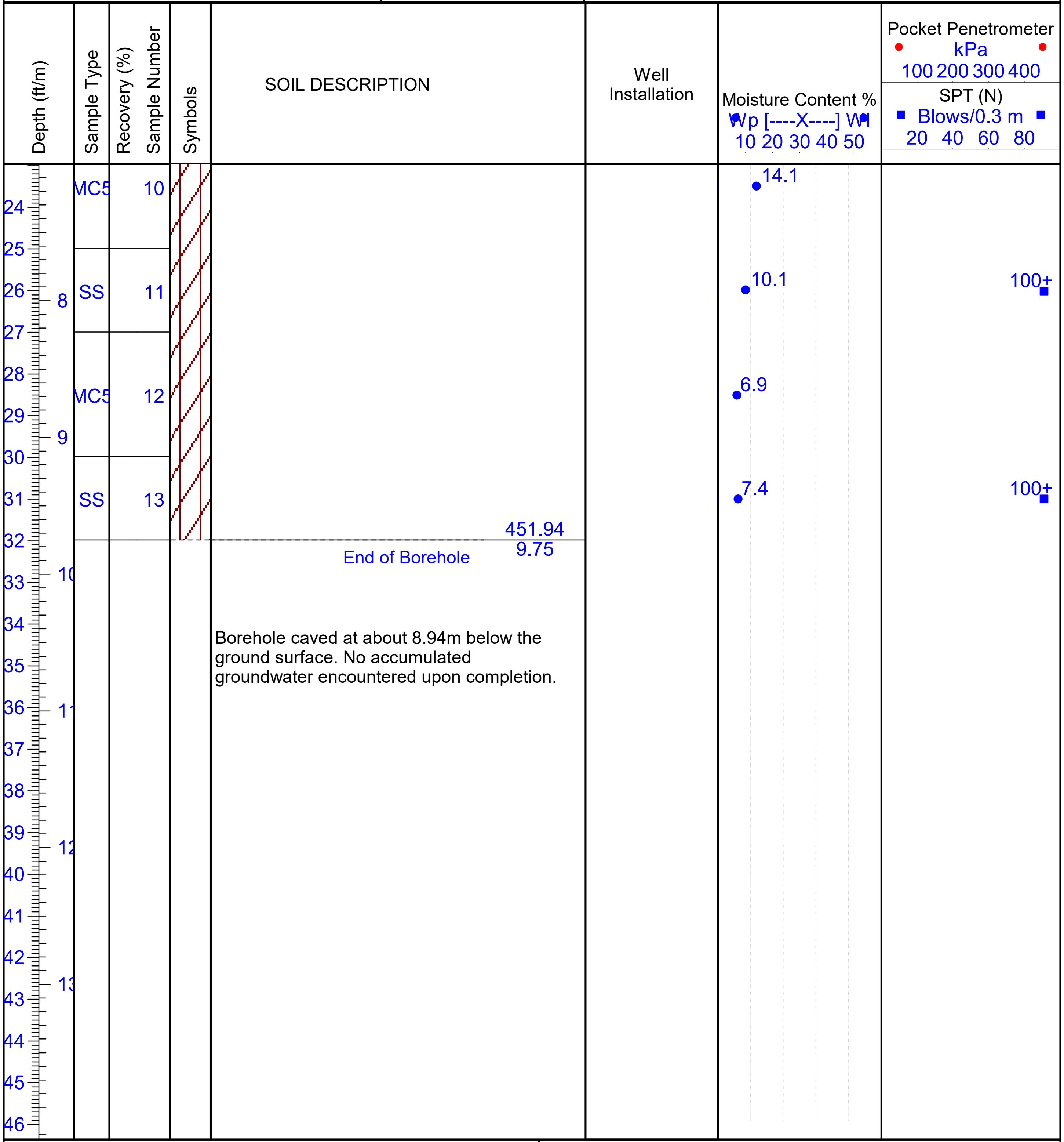
Page 2 of 2

Date Drilled: November 25, 2019
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT/MC5

Elevation: 461.69 m
Logged by: B.R.F.

Project No.: 19-519
Project: Geotechnical Investigation

Location: 211 Eliza Street, Arthur, ON



MC5	10	14.1	
SS	11	10.1	100+
MC5	12	6.9	
SS	13	7.4	100+

451.94
9.75

End of Borehole

Borehole caved at about 8.94m below the ground surface. No accumulated groundwater encountered upon completion.

BOREHOLE 102

Page 1 of 1

Date Drilled: November 25, 2019
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT/MC5

Elevation: 460.84 m
Logged by: B.R.F.

Project No.: 19-519
Project: Geotechnical Investigation

Location: 211 Eliza Street, Arthur, ON

SOIL DESCRIPTION	Elevation (m) / Depth (m)
Ground Surface (m)	460.84 0.00
TOPSOIL Black, loose, silty organic topsoil, moist (600mm)	460.24 0.60
SANDY SILT Brown, loose, sandy silt, trace clay, moist	459.77 1.07
CLAYEY SANDY SILT Brown, very stiff, clayey, sandy silt, trace gravel, moist	459.32 1.52
becoming hard	458.53 2.31
becoming clayey sand and silt, no gravel	457.49 3.35
becoming clayey sandy silt, trace gravel	
becoming grey	456.27 4.57
CLAYEY SILT Brown, hard, clayey silt, trace sand and gravel, moist MC5 refusal at 5.49m	455.35 5.49
End of Borehole	

Borehole open to about 5.49m below the ground surface. No accumulated groundwater encountered upon completion.

Sample Type	Sample Number	Moisture Content %	SPT (N) Blows/0.3 m
SS	1	23.0	7
SS	2	13.7	28
SS	3	12.6	55
SS	4	15.0	100+
SS	5	7.6	100+
MC5	6	12.5	
SS	7	12.4	54
MC5	8	9.2	

Depth (ft/m) · Recovery (%) · Symbols · Well Installation · Moisture Content % Wp [----X----] Wl 10 20 30 40 50 · Pocket Penetrometer kPa 100 200 300 400 · SPT (N) Blows/0.3 m 20 40 60 80

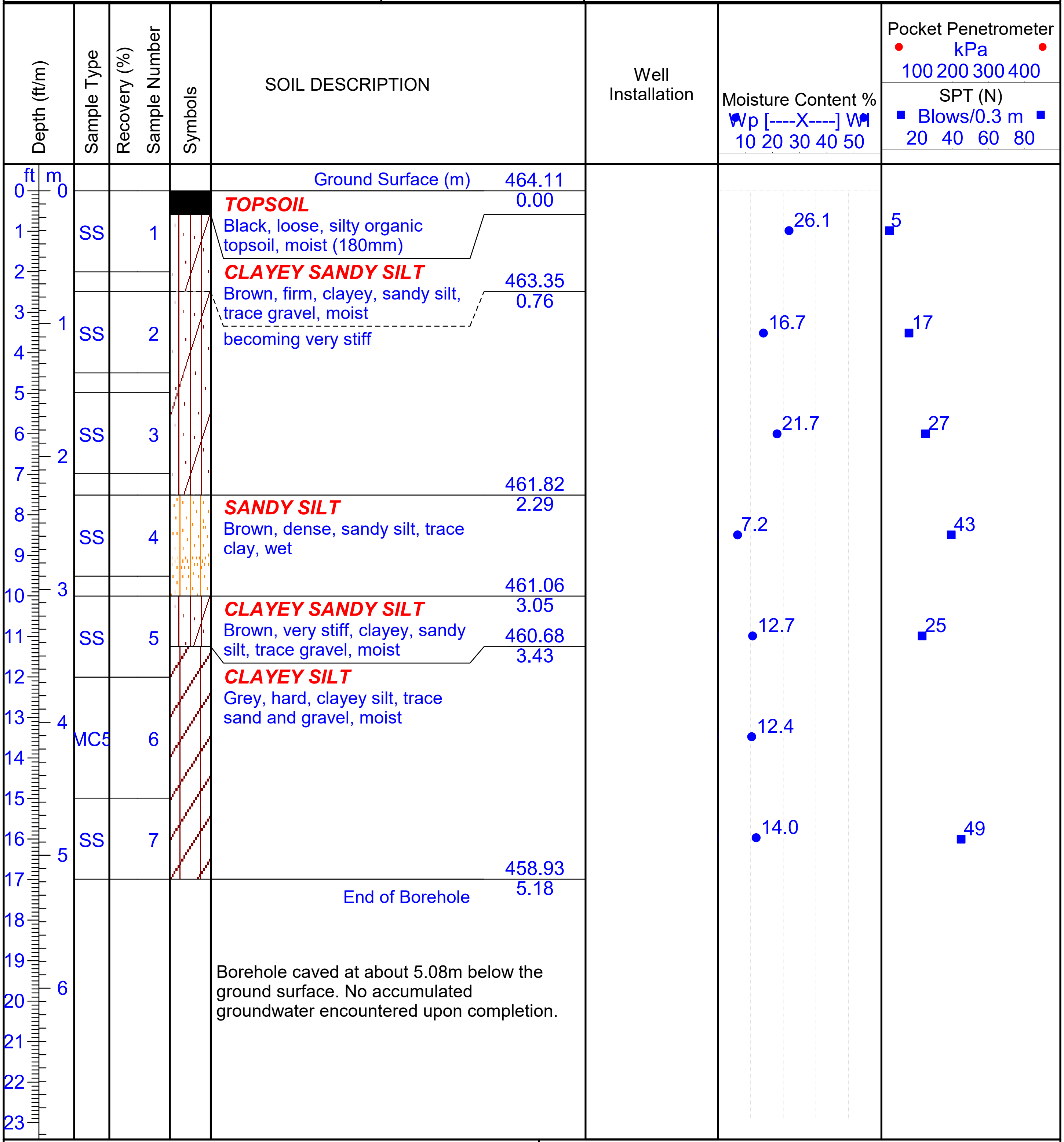
BOREHOLE 103

Date Drilled: November 25, 2019
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT/MC5

Elevation: 464.11 m
Logged by: B.R.F.

Project No.: 19-519
Project: Geotechnical Investigation

Location: 211 Eliza Street, Arthur, ON



Sample Type	Sample Number	Moisture Content %	SPT (N)
SS	1	26.1	5
SS	2	16.7	17
SS	3	21.7	27
SS	4	7.2	43
SS	5	12.7	25
MC5	6	12.4	
SS	7	14.0	49

SOIL DESCRIPTION

	Elevation (m) / Depth (m)
Ground Surface (m)	464.11
TOPSOIL Black, loose, silty organic topsoil, moist (180mm)	0.00
CLAYEY SANDY SILT Brown, firm, clayey, sandy silt, trace gravel, moist becoming very stiff	463.35 0.76
SANDY SILT Brown, dense, sandy silt, trace clay, wet	461.82 2.29
CLAYEY SANDY SILT Brown, very stiff, clayey, sandy silt, trace gravel, moist	461.06 3.05
CLAYEY SILT Grey, hard, clayey silt, trace sand and gravel, moist	460.68 3.43
End of Borehole	458.93 5.18

Borehole caved at about 5.08m below the ground surface. No accumulated groundwater encountered upon completion.

BOREHOLE 104

Page 1 of 1

Date Drilled: November 25, 2019
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT/MC5

Elevation: 466.04 m
Logged by: B.R.F.

Project No.: 19-519
Project: Geotechnical Investigation

Location: 211 Eliza Street, Arthur, ON

SOIL DESCRIPTION	Elevation (m)	Depth (m)
Ground Surface (m)	466.04	
TOPSOIL Black, loose, silty organic topsoil, moist (350mm)		0.00
CLAYEY SANDY SILT Brown, soft clayey, sandy silt, trace gravel, moist	465.69	0.35
becoming very stiff	465.28	0.76
becoming hard	463.75	2.29
CLAYEY SILT Grey, very stiff, clayey silt, trace sand and gravel, moist	462.99	3.05
becoming hard	461.47	4.57
End of Borehole	460.86	5.18

Sample Type	Sample Number	Moisture Content %	SPT (N) Blows/0.3 m
SS	1	17.2	4
SS	2	17.2	17
SS	3	15.9	26
SS	4	14.2	38
SS	5	14.5	18
MC5	6	16.2	
SS	7	13.2	43

Borehole open to about 5.18m below the ground surface. No accumulated groundwater encountered upon completion.

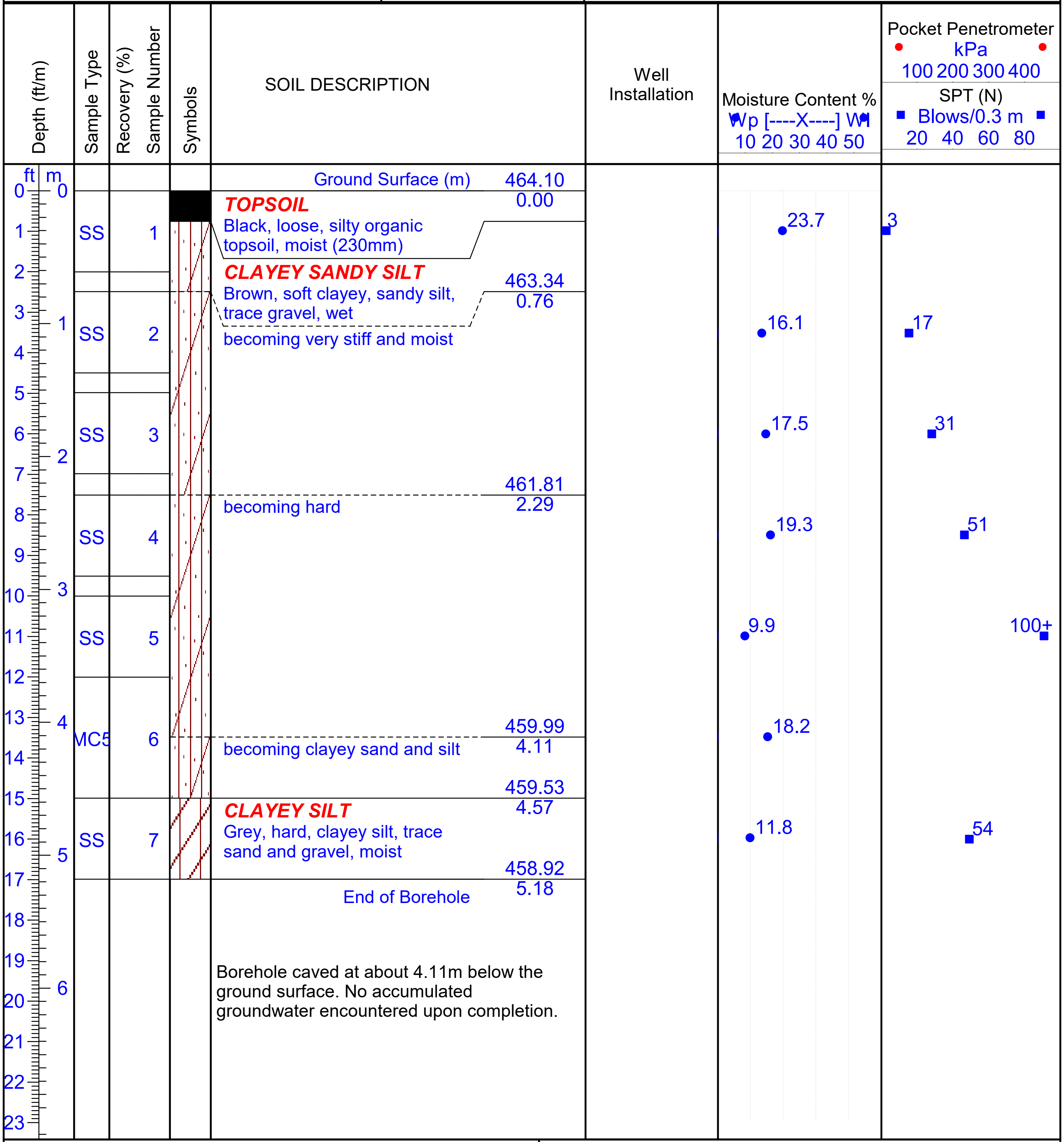
BOREHOLE 105

Date Drilled: November 25, 2019
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT/MC5

Elevation: 464.10 m
Logged by: B.R.F.

Project No.: 19-519
Project: Geotechnical Investigation

Location: 211 Eliza Street, Arthur, ON



Ground Surface (m) 464.10

0.00
TOPSOIL
Black, loose, silty organic topsoil, moist (230mm)

463.34
0.76
CLAYEY SANDY SILT
Brown, soft clayey, sandy silt, trace gravel, wet
becoming very stiff and moist

461.81
2.29
becoming hard

459.99
4.11
becoming clayey sand and silt

459.53
4.57
CLAYEY SILT
Grey, hard, clayey silt, trace sand and gravel, moist

458.92
5.18
End of Borehole

Borehole caved at about 4.11m below the ground surface. No accumulated groundwater encountered upon completion.

Sample Type	Sample Number	Moisture Content %	SPT (N)
SS	1	23.7	3
SS	2	16.1	17
SS	3	17.5	31
SS	4	19.3	51
SS	5	9.9	100+
MC5	6	18.2	
SS	7	11.8	54

BOREHOLE 106

Date Drilled: November 25, 2019
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT/MC5

Elevation: 467.06 m
Logged by: B.R.F.

Project No.: 19-519
Project: Geotechnical Investigation

Location: 211 Eliza Street, Arthur, ON

SOIL DESCRIPTION	Elevation (m) / Depth (m)
Ground Surface (m)	467.06 0.00
TOPSOIL Black, loose, silty organic topsoil, moist (280mm)	
CLAYEY SANDY SILT Brown, soft clayey, sandy silt, trace gravel, moist	466.30 0.76
SANDY SILT Brown, compact, sandy silt, trace clay, saturated	464.77 2.29
CLAYEY SILT Grey, very stiff, clayey silt, trace sand and gravel, moist	461.88 5.18
End of Borehole	

Sample Type	Sample Number	Moisture Content %	SPT (N) Blows/0.3 m
SS	1	14.3	3
SS	2	21.8	14
SS	3	20.6	27
SS	4	10.9	22
SS	5	15.2	22
MC5	6	14.7	
SS	7	16.3	21

Column headings: Depth (ft/m) · Sample Type · Recovery (%) · Sample Number · Symbols · SOIL DESCRIPTION · Well Installation · Moisture Content % Wp [----X----] Wl 10 20 30 40 50 · Pocket Penetrometer kPa 100 200 300 400 · SPT (N) Blows/0.3 m 20 40 60 80

Borehole caved at about 2.44m below the ground surface. No accumulated groundwater encountered upon completion.

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St. Clements, Ontario N0B 2M0
phone 519-699-5775 fax 519-699-4664
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BOREHOLE 107

Date Drilled: November 25, 2019
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT/MC5

Elevation: 455.20 m
Logged by: B.R.F.

Project No.: 19-519
Project: Geotechnical Investigation

Location: 211 Eliza Street, Arthur, ON

Sample Type	Recovery (%)	Sample Number	SOIL DESCRIPTION		Well Installation	Moisture Content % Wp [----X----] Wl 10 20 30 40 50	Pocket Penetrometer kPa 100 200 300 400 SPT (N) Blows/0.3 m 20 40 60 80
			Ground Surface (m)	455.20			
SS		1	***TOPSOIL*** Black, loose, silty organic topsoil, moist (380mm)	0.00		12.4	4
SS		2	***SANDY SILT*** Brown, loose sandy silt, trace clay, moist	454.82 0.38		19.2	5
SS		3	***CLAYEY SANDY SILT*** Brown, stiff, clayey sandy silt, trace gravel, wet	453.68 1.52		12.3	14
SS		4	becoming moist, hard to very stiff	452.61 2.59		12.7	100+
SS		5				10.4	19
MC5		6	***SAND*** Brown, compact, sand layer, trace silt, clay and gravel, moist	451.54 3.66		12.7	
SS		7	***CLAYEY SILT*** Grey, very stiff, clayey silt, trace sand and gravel, moist	451.24 3.96		16.9	30
			End of Borehole	450.02 5.18			

Borehole caved at about 3.66m below the ground surface. Accumulated groundwater encountered at about 3.35m below the ground surface (Elevation: 451.85m).

BOREHOLE 108

Date Drilled: November 25, 2019
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT/MC5

Elevation: 464.57 m
Logged by: B.R.F.

Project No.: 19-519
Project: Geotechnical Investigation

Location: 211 Eliza Street, Arthur, ON

SOIL DESCRIPTION	Elevation (m) / Depth (m)
Ground Surface (m)	464.57
TOPSOIL Black, loose, silty organic topsoil, moist (200mm)	0.00
CLAYEY SANDY SILT Brown, soft, clayey, sandy silt, trace gravel, moist	
becoming stiff	463.81 0.76
becoming very stiff	463.05 1.52
becoming hard	462.28 2.29
CLAYEY SILT Grey, hard, clayey silt, trace sand and gravel, moist	461.52 3.05
End of Borehole	459.39 5.18

Sample Type	Sample Number	Moisture Content %	SPT (N) Blows/0.3 m
SS	1	32.3	2
SS	2	18.1	9
SS	3	15.2	24
SS	4	12.7	55
SS	5	11.3	35
MC5	6	12.3	
SS	7	27.7	31

Borehole open to about 5.18m below the ground surface. No accumulated groundwater encountered upon completion.

BOREHOLE 109

Page 1 of 1

Date Drilled: November 25, 2019
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 461.72 m
Logged by: B.R.F.

Project No.: 19-519
Project: Geotechnical Investigation

Location: 211 Eliza Street, Arthur, ON

SOIL DESCRIPTION	Elevation (m)	Depth (m)
Ground Surface (m)	461.72	
TOPSOIL Black, loose, silty organic topsoil, moist (200mm)		0.00
CLAYEY SANDY SILT Brown, soft, clayey, sandy silt, trace gravel, moist	460.96	0.76
SANDY SILT Brown, loose, sandy silt, trace clay, moist	460.20	1.52
CLAYEY SANDY SILT Very stiff, brown clayey, sandy silt, trace gravel, moist	459.43	2.29
becoming hard clayey sand and silt, saturated	458.67	3.05
SAND Brown, compact, sand, trace silt, clay and gravel, saturated	458.24	3.48
CLAYEY SAND AND SILT Brown, very stiff, clayey sand and silt, saturated	457.05	4.67
CLAYEY SILT Grey, very stiff, clayey silt, trace sand and gravel, saturated	456.54	5.18
End of Borehole		

Sample Type	Sample Number	Moisture Content %	SPT (N) Blows/0.3 m
SS	1	23.1	2
SS	2	13.5	9
SS	3	14.5	28
SS	4	21.4	38
SS	5	23.7	18
SS	6	13.2	28

Column headings: Depth (ft/m); Sample Type; Recovery (%); Sample Number; Symbols; SOIL DESCRIPTION; Well Installation; Moisture Content % Wp [----X----] Wl 10 20 30 40 50; Pocket Penetrometer kPa 100 200 300 400; SPT (N) Blows/0.3 m 20 40 60 80

Borehole caved at about 3.35m below the ground surface. Accumulated groundwater encountered at about 2.13m below the ground surface (Elevation: 459.59m).

BOREHOLE 110

Page 1 of 2

Date Drilled: November 25, 2019
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT/MC5

Elevation: 456.03 m
Logged by: B.R.F.

Project No.: 19-519
Project: Geotechnical Investigation

Location: 211 Eliza Street, Arthur, ON

Depth (ft/m)	Sample Type	Recovery (%)	Sample Number	Symbols	SOIL DESCRIPTION	Well Installation	Moisture Content % Wp [----X----] Wl 10 20 30 40 50	Pocket Penetrometer kPa 100 200 300 400 SPT (N) Blows/0.3 m 20 40 60 80
ft 0 / m 0					Ground Surface (m) 456.03			
1	SS		1		**TOPSOIL** 0.00 Black, loose, silty organic topsoil, moist (600mm) 455.43		27.5	2
3 / 1	SS		2		**CLAYEY SANDY SILT** 0.60 Brown, soft, clayey, sandy silt, trace gravel, moist 454.51		17.0	2
6 / 2	SS		3		becoming stiff 1.52 453.74		16.2	10
8	SS		4		becoming very stiff 2.29 453.29		16.5	30
11 / 3	SS		5		**CLAYEY SILT** 2.74 Grey, hard, clayey silt, trace sand and gravel, moist		12.4	35
13 / 4	MC5		6				12.5	
16 / 5	SS		7				12.9	51
18	MC5		8				15.0	
21 / 6	SS		9				17.8	100+

Borehole caved at about 5.79m below the ground surface. No accumulated groundwater encountered upon completion.

Depth scale: ft 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23; m 0 1 2 3 4 5 6

BOREHOLE 110

Date Drilled: November 25, 2019
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT/MC5

Elevation: 456.03 m
Logged by: B.R.F.

Project No.: 19-519
Project: Geotechnical Investigation

Location: 211 Eliza Street, Arthur, ON

Depth (ft/m)	Sample Type	Recovery (%)	Sample Number	Symbols	SOIL DESCRIPTION	Elevation / Depth (m)	Well Installation	Moisture Content % Wp [----X----] Wl 10 20 30 40 50	Pocket Penetrometer kPa 100 200 300 400 SPT (N) Blows/0.3 m 20 40 60 80
24	MC5		10					18.0	
25–27 / 8	SS		11		moist to wet seams encountered	448.41 7.62		22.9	41
28–30 / 9	MC5		12		***CLAYEY SAND AND SILT*** Grey, hard, clayey, sand and silt, wet	447.65 8.38		21.6	
30					End of Borehole	446.89 9.14			

Depth scale: 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 (ft); 8 9 10 11 12 13 (m)

Borehole caved at about 5.79m below the ground surface. No accumulated groundwater encountered upon completion.

BOREHOLE 111

Page 1 of 1

Date Drilled: November 25, 2019
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT/MC5

Elevation: 460.26 m
Logged by: B.R.F.

Project No.: 19-519
Project: Geotechnical Investigation

Location: 211 Eliza Street, Arthur, ON

SOIL DESCRIPTION	Elevation (m) / Depth (m)
Ground Surface (m)	460.26
TOPSOIL Black, loose, silty organic topsoil, moist (600mm)	0.00
FILL Mottled brown and grey, stiff, clayey silt fill, moist (920mm)	459.66 0.60
SANDY SILT Brown, compact, sandy silt, trace clay, wet	458.74 1.52
SAND Brown, dense, sand, trace silt, clay and gravel, wet to saturated	457.97 2.29
SANDY SILT Brown, dense, sandy silt, trace clay, saturated sand seams encountered	457.21 3.05
SAND Brown, dense, sand, trace silt, clay and gravel, saturated	456.60 3.66
SANDY SILT Brown, compact, sandy silt, trace clay, saturated sand layer encountered at about 4.57m BGS (410mm)	455.99 4.27
End of Borehole	455.08 5.18

Sample Type	Sample Number	Moisture Content %	SPT (N) Blows/0.3 m
SS	1	27.6	3
SS	2	22.4	9
SS	3	16.1	16
SS	4	15.4	34
SS	5	18.3	43
MC5	6	18.9	
SS	7	19.5	14

Depth (ft/m): ft 0–23; m 0–6
Recovery (%)
Symbols
Well Installation
Moisture Content % Wp [----X----] Wl 10 20 30 40 50
Pocket Penetrometer kPa ● 100 200 300 400 ●
SPT (N) ■ Blows/0.3 m ■ 20 40 60 80

Borehole caved at about 2.82m below the ground surface. Accumulated groundwater encountered at about 2.13m below the ground surface (Elevation: 458.13m).

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BOREHOLE 112

Page 1 of 1

Date Drilled: November 25, 2019
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 460.53 m
Logged by: B.R.F.

Project No.: 19-519
Project: Geotechnical Investigation

Location: 211 Eliza Street, Arthur, ON

SOIL DESCRIPTION	Elevation (m) / Depth (m)
Ground Surface (m)	460.53 0.00
TOPSOIL Black, loose, silty organic topsoil, moist (100mm)	
FILL Brown, soft, clayey silt fill, moist (660mm)	459.77 0.76
CLAYEY SANDY SILT Brown, very stiff, clayey, sandy silt, trace gravel, moist	
SANDY SILT Brown, dense, sandy silt, trace clay, moist	458.24 2.29
becoming compact and saturated	457.48 3.05
CLAYEY SANDY SILT Brown, hard, clayey, sandy silt, trace gravel, moist	456.57 3.96
CLAYEY SILT Grey, hard, clayey silt, trace sand and gravel, moist	455.96 4.57
End of Borehole	455.35 5.18

Sample Type	Sample Number	Moisture Content %	SPT (N) Blows/0.3 m
SS	1	26.6	2
SS	2	13.7	20
SS	3	14.5	25
SS	4	15.6	38
SS	5	23.4	17
SS	6	13.9	35

Borehole caved at about 2.74m below the ground surface. Accumulated groundwater encountered at about 2.44m below the ground surface (Elevation: 458.09m).

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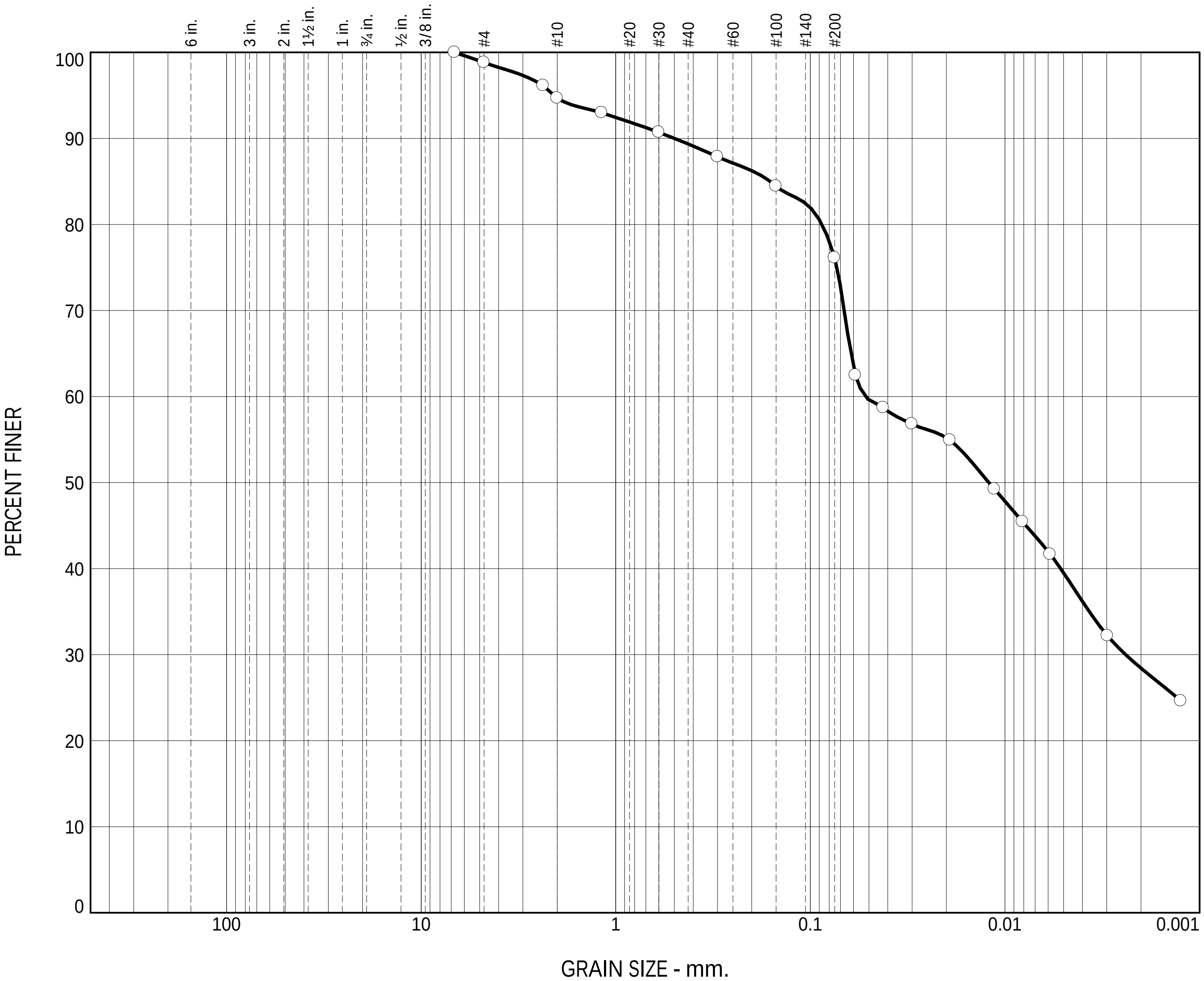
APPENDIX B

GRAIN SIZE ANALYSES

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	1.2	4.1	5.3	13.3	47.7	28.4

SOIL DATA

	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH101	3	1.52-2.13m	clayey, sandy silt, trace gravel Sampled by B.F. of CMT Engineering Inc., November 25, 2019 Tested by J.M. of CMT Engineering Inc., November 27, 2019 Estimated Coeficient of Permeability (k) < 1.0 x 10-6 cm/sec	ML

CMT Engineering Inc.

St. Clements, ON

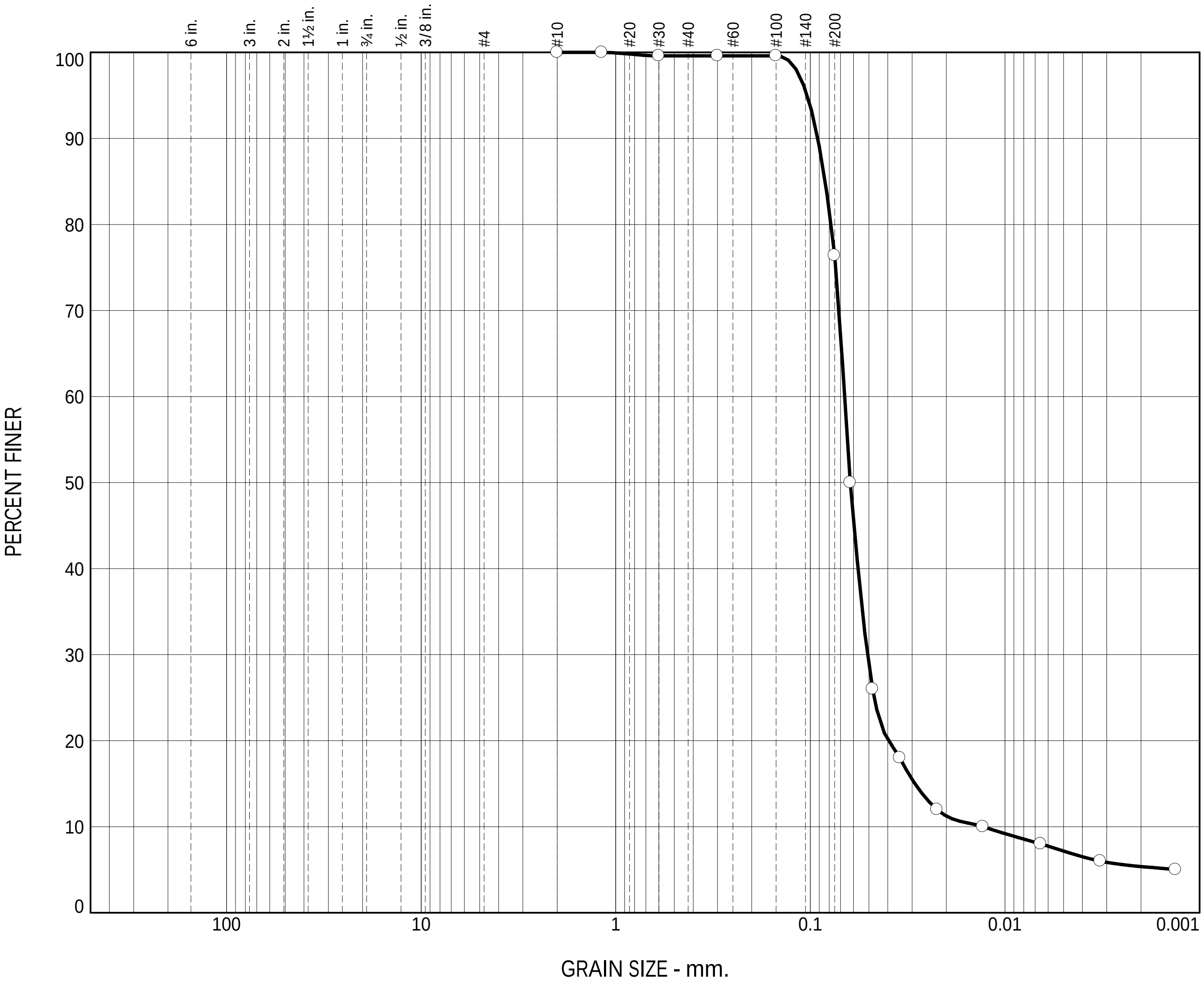
Client: R.J. Burnside and Associates

Project: Geotech - Slope Stability - Proposed Subdivision
211 Eliza Street, Arthur, Ontario

Project No.: 19-519

Figure 1

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	23.2	71.0	5.4

SOIL DATA

	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH106	2	0.76-1.37m	sandy silt, trace clay Sampled by B.F. of CMT Engineering Inc., November 22, 2019 Tested by J.M. of CMT Engineering Inc., November 27, 2019 Estimated Coeficient of Permeability (k) = 1.7 x 10-4 cm/sec	ML

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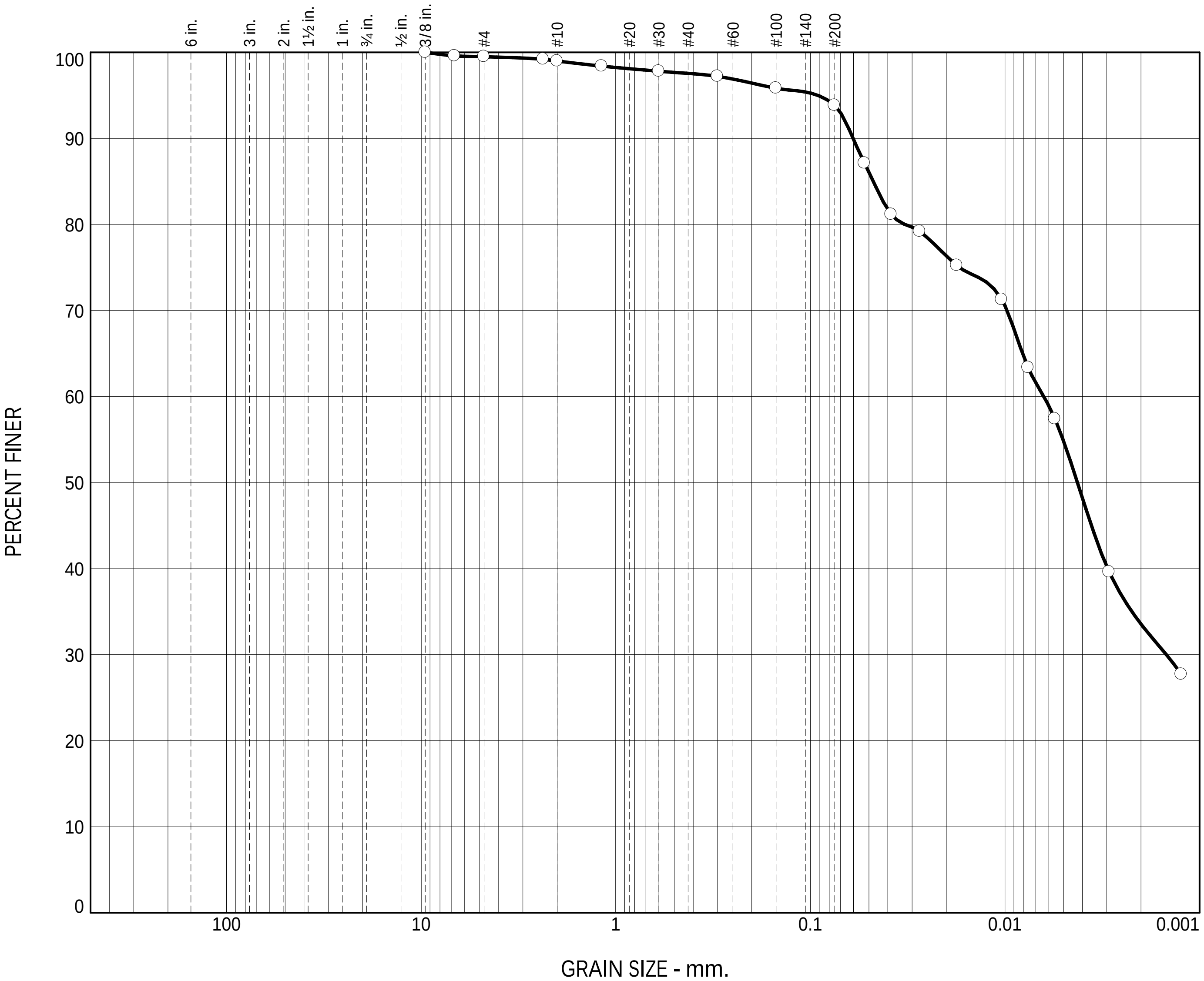
Project No.: 19-519

Figure 2

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.5	0.5	1.4	3.7	60.3	33.6

SOIL DATA

	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH110	6	3.66-4.57m	clayey silt, trace sand and gravel Sampled by B.F. of CMT Engineering Inc., November 22, 2019 Tested by J.M. of CMT Engineering Inc., November 27, 2019 Estimated Coeficient of Permeability (k) < 1.0 x 10-6 cm/sec	ML

CMT Engineering Inc.

St. Clements, ON

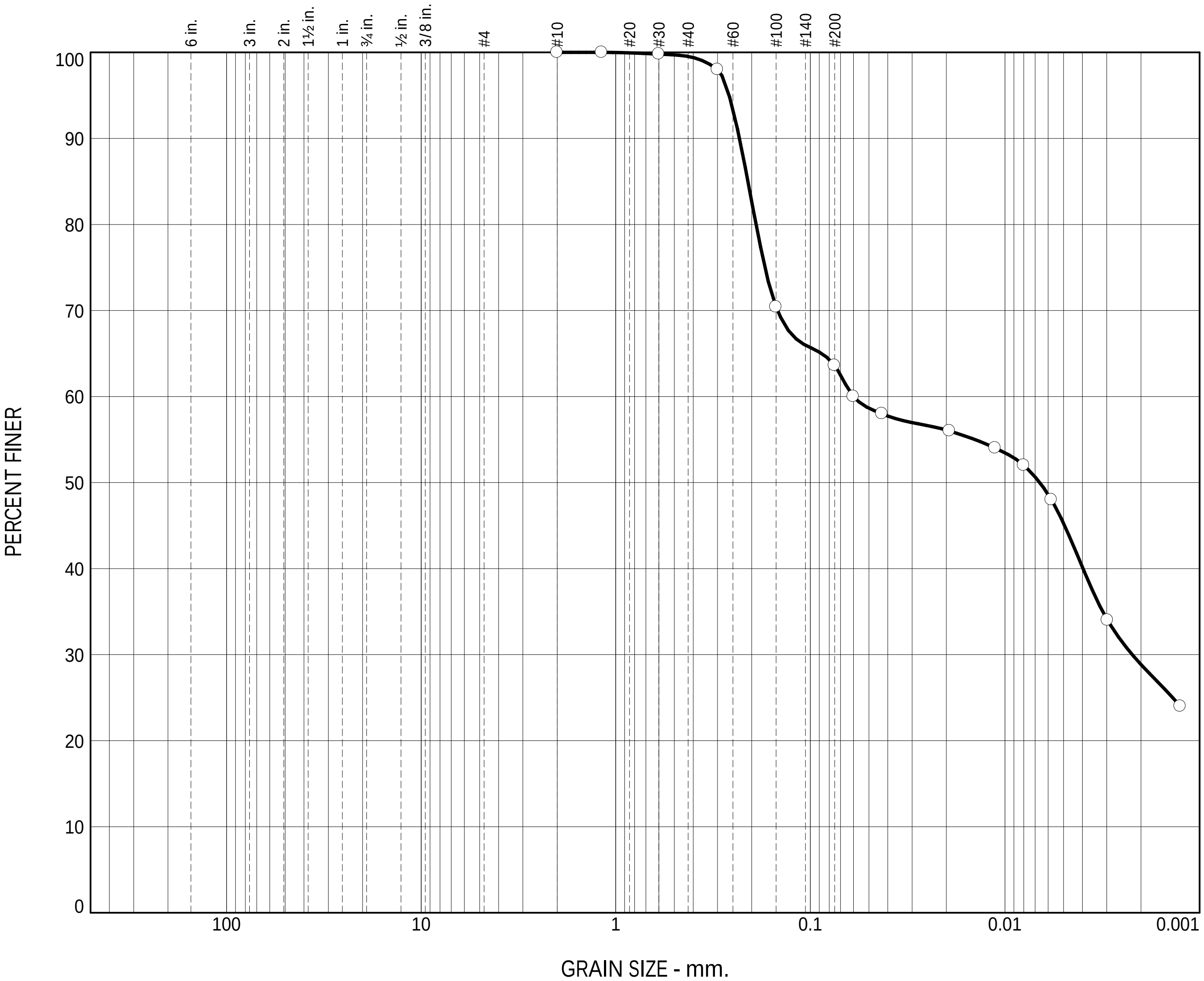
Client: R.J. Burnside and Associates

Project: Geotech - Slope Stability - Proposed Subdivision
211 Eliza Street, Arthur, Ontario

Project No.: 19-519

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	0.5	35.9	34.7	28.9

SOIL DATA

	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH110	12	8.23-9.14m	clayey sand and silt Sampled by B.F. of CMT Engineering Inc., November 22, 2019 Tested by J.M. of CMT Engineering Inc., November 27, 2019 Estimated Coefficient of Permeability (k) < 1.0 x10-6 cm/sec	ML

CMT Engineering Inc.

St. Clements, ON

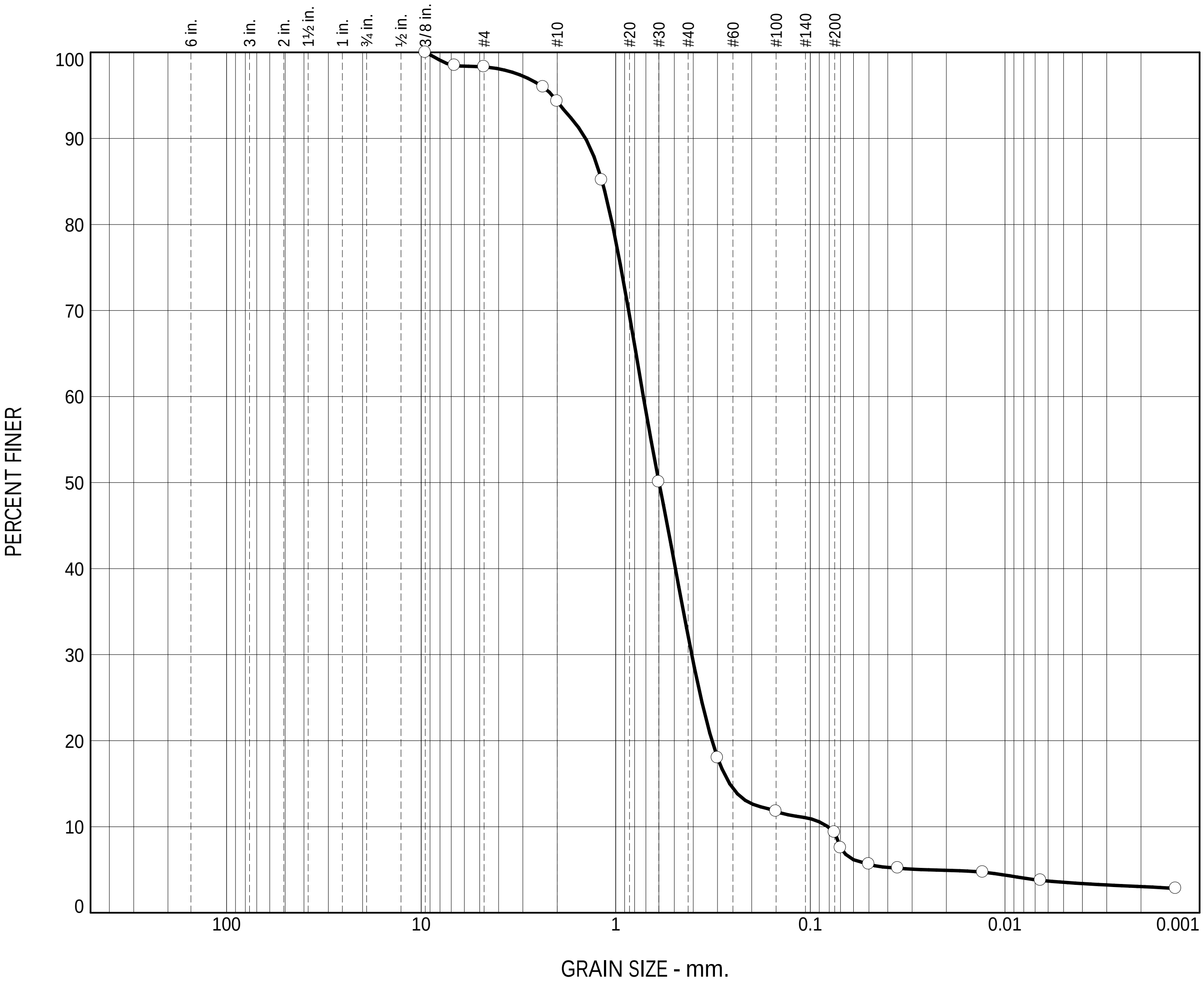
Client: R.J. Burnside and Associates

Project: Geotech - Slope Stability - Proposed Subdivision
211 Eliza Street, Arthur, Ontario

Project No.: 19-519

Figure 4

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	1.7	4.0	62.1	22.9	6.3	3.0

SOIL DATA

	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH111	6	3.66-4.27m	sand, trace silt, clay and gravel Sampled by B.F. of CMT Engineering Inc., November 22, 2019 Tested by J.M. of CMT Engineering Inc., November 27, 2019 Estimated Coeficient of Permeability (k) = 1.1 x 10-2 cm/sec	SW-SM

CMT Engineering Inc.

St. Clements, ON

Client: R.J. Burnside and Associates

Project: Geotech - Slope Stability - Proposed Subdivision
211 Eliza Street, Arthur, Ontario

Project No.: 19-519

Figure 5

APPENDIX C

SLOPE STABILITY RATING CHARTS

TABLE 4.2 - SLOPE STABILITY RATING CHART (SOUTH SLOPE)

Site Location 211 Eliza Street, Arthur, ON

Project No. 19-519

Property Owner Lambert Altena

Inspection Date Nov. 25, 2019

Inspected By BRF

Weather Cloudy, -5ºC

1. SLOPE INCLINATION		
degrees	**horiz:vert**	
a) 18 or less	3:1 or flatter	[✓ 0]
b) 18 - 26	2:1 to more than 3:1	6
c) more than 26	steeper than 2:1	16
2. SOIL STRATIGRAPHY		
a) shale, limestone, granite (bedrock)		0
b) sand, gravel		6
c) glacial till		9
d) clay, silt		[✓ 12]
e) fill		16
f) leda clay		24
3. SEEPAGE FROM SLOPE FACE		
a) none or near bottom only		[✓ 0]
b) near mid-slope only		6
c) near crest only or from several levels		12
4. SLOPE HEIGHT		
a) 2.0 m or less		0
b) 2.1 m to 5.0 m		2
c) 5.1 m to 10.0 m		[✓ 4]
d) more than 10.0 m		8
5. VEGETATION COVER ON SLOPE FACE		
a) well-vegetated, heavy shrubs or forested with mature trees		0
b) light vegetation; mostly grass, weeds, occasional trees, shrubs		[✓ 4]
c) no vegetation, bare		8
6. TABLE LAND DRAINAGE		
a) table land flat, no apparent drainage over slope		0
b) minor drainage over slope, no active erosion		[✓ 2]
c) drainage over slope, active erosion, gullies		4
7. PROXIMITY OF WATERCOURSE TO SLOPE TOE		
a) 15 metres or more from slope toe		0
b) less than 15 metres from slope toe		[✓ 6]
8. PREVIOUS LANDSLIDE ACTIVITY		
a) no		[✓ 0]
b) yes		6
SLOPE STABILITY RATING VALUES INVESTIGATION RATING SUMMARY	**TOTAL**	**28**

SUMMARY OF RATING VALUES AND RESULTING INVESTIGATION REQUIREMENTS

1. Low potential	< 24	- site inspection only, confirmation report letter
2. Slight potential	[✓ 25-35]	- site inspection and surveying, preliminary study, detailed report
3. Moderate potential	>35	- boreholes, piezometers, lab tests, surveying, detailed report

NOTES:

a) Choose only one from each category; compare total rating value with above requirements.

b) If there is a water body (stream, creek, river, pond, bay, lake) at the slope toe, the potential for toe erosion and undercutting should be evaluated in detail and protection provided if required.

Reference: Technical Guide - River and Stream Systems: Erosion Hazard Limit, Ontario Ministry of Natural Resources, 2002.

TABLE 4.2 - SLOPE STABILITY RATING CHART (EAST SLOPE)

Site Location 211 Eliza Street, Arthur, ON

Project No. 19-519

Property Owner Lambert Altena

Inspection Date Nov. 25, 2019

Inspected By BRF

Weather Cloudy, -5ºC

1. SLOPE INCLINATION		
degrees	**horiz:vert**	
a) 18 or less	3:1 or flatter	0
b) 18 - 26	2:1 to more than 3:1	6
c) more than 26	steeper than 2:1	[✓ 16]
2. SOIL STRATIGRAPHY		
a) shale, limestone, granite (bedrock)		0
b) sand, gravel		6
c) glacial till		9
d) clay, silt		[✓ 12]
e) fill		16
f) leda clay		24
3. SEEPAGE FROM SLOPE FACE		
a) none or near bottom only		[✓ 0]
b) near mid-slope only		6
c) near crest only or from several levels		12
4. SLOPE HEIGHT		
a) 2.0 m or less		0
b) 2.1 m to 5.0 m		2
c) 5.1 m to 10.0 m		[✓ 4]
d) more than 10.0 m		8
5. VEGETATION COVER ON SLOPE FACE		
a) well-vegetated, heavy shrubs or forested with mature trees		0
b) light vegetation; mostly grass, weeds, occasional trees, shrubs		4
c) no vegetation, bare		[✓ 8]
6. TABLE LAND DRAINAGE		
a) table land flat, no apparent drainage over slope		0
b) minor drainage over slope, no active erosion		2
c) drainage over slope, active erosion, gullies		[✓ 4]
7. PROXIMITY OF WATERCOURSE TO SLOPE TOE		
a) 15 metres or more from slope toe		0
b) less than 15 metres from slope toe		[✓ 6]
8. PREVIOUS LANDSLIDE ACTIVITY		
a) no		0
b) yes		[✓ 6]
SLOPE STABILITY RATING VALUES INVESTIGATION RATING SUMMARY	**TOTAL**	**56**

SUMMARY OF RATING VALUES AND RESULTING INVESTIGATION REQUIREMENTS

1. Low potential	< 24	- site inspection only, confirmation report letter
2. Slight potential	25-35	- site inspection and surveying, preliminary study, detailed report
3. Moderate potential	[✓ >35]	- boreholes, piezometers, lab tests, surveying, detailed report

NOTES:

a) Choose only one from each category; compare total rating value with above requirements.

b) If there is a water body (stream, creek, river, pond, bay, lake) at the slope toe, the potential for toe erosion and undercutting should be evaluated in detail and protection provided if required.

Reference: Technical Guide - River and Stream Systems: Erosion Hazard Limit, Ontario Ministry of Natural Resources, 2002.