APPENDIX F

GEOTECHNICAL ASSESSMENT

Peto MacCallum Ltd.
CONSULTING ENGINEERS

GEOTECHNICAL INVESTIGATION
PROPOSED REPLACEMENT OF TEESWATER RIVER BRIDGE
PAISLEY, ONTARIO

for

B.M. ROSS AND ASSOCIATES LIMITED

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PML Ref.: 21KF009
Report: 1
September 2021

Peto MacCallum Ltd.
CONSULTING ENGINEERS

September 10, 2021

PML Ref.: 21KF009
Report: 1

Mr. Ryan Munn, P.Eng.
B.M. Ross and Associates Limited
62 North Street
Goderich, Ontario
N7A 2T4

Dear Mr. Munn

Geotechnical Investigation
Proposed Replacement of Teeswater River Bridge
Paisley, Ontario

Peto MacCallum Ltd (PML) is pleased to present the results of the Geotechnical investigation recently completed at the above noted project site. Authorization for the work was provided by Mr. A. Ross in an email dated February 3, 2021.

The County of Bruce is proposing to reconstruct the bridge on Queen Street in the Village of Paisley, crossing the Teeswater River. The bridge is located about 20 to 25 m west of the confluence of the Teeswater River and the Saugeen River. The general concept is to remove the existing three-span bridge and replace it with a two-span bridge. No investigation was carried out at the central pier in the Teeswater River as part of the current assignment. It is understood the elevation of the replacement bridge will be raised about 200 mm to provide additional freeboard and capacity during high-flow events. A temporary bridge over the Saugeen River, about 100 to 110 m east of the current bridge crossing is planned in order to remove the existing bridge and construct the replacement bridge.

A Geotechnical investigation has been requested to assess the subsurface conditions at the bridge abutments for both the proposed bridge and the temporary bridge, and based on this information, provide Geotechnical recommendations for bridge abutment foundations for both bridges.

A total of eight boreholes were advanced (one borehole for the abutment and one borehole for the approach at each abutment location). Competent soil was revealed at each abutment location for footing foundations. It is understood that a pile foundation may also be considered for both bridges and recommendations for pile capacity have also been provided.

It is noted that the boreholes encountered organic very loose silt/ firm clayey silt below the fill to 4.5 m in the assumed footprint of the new approach fill. In this regard, if a larger grade raise is proposed subexcavation of the surficial fill and organic silt/clayey silt may be required.

It is recommended that a sampled borehole be drilled from the existing bridge deck at the location of the new central pier to determine the soil stratigraphic profile including the extent of the river bed sediments to assess the scour potential and for foundation and cofferdam design.

Geoenvironmental requirements are also part of the project, and will be addressed under separate cover.

We trust the information in this report is sufficient for your present purpose. If you have any questions, please do not hesitate to call our office.

Sincerely

Peto MacCallum Ltd.

Geoffrey R. White, P.Eng.
Director
Manager, Geotechnical Services (Barrie Office)

GRW/BRG:tc

TABLE OF CONTENTS

1. INTRODUCTION

Peto MacCallum Ltd (PML) is pleased to present the results of the Geotechnical investigation recently completed at the above noted project site. Authorization for the work was provided by Mr. A. Ross in an email dated February 3, 2021.

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A Geotechnical investigation has been requested to assess the subsurface conditions at the bridge abutments for both the proposed bridge and the temporary bridge, and based on this information, provide Geotechnical recommendations for bridge abutment foundations for both bridges.

Geoenvironmental requirements are also part of the project, and will be addressed under separate cover.

Two previous Geotechnical reports conducted by others for the bridge were provided for our review.

The comments and recommendations provided in this report are based on the site conditions at the time of the investigation and are applicable only to the proposed works as addressed in the report. Any changes in the proposed plans will require review by PML to re-assess the validity of the report, and may require modified recommendations, additional investigation and/or analysis.

This report is subject to the Statement of Limitations that is included in Appendix A and must be read in conjunction with the report.

2. INVESTIGATION PROCEDURES

The field work for this project consisted of eight boreholes. Boreholes 1 to 4 drilled for the bridge replacement and Boreholes 5 to 8 for the temporary bridge. Boreholes 1 and 4 were advanced to 3.5 m depth for the approaches and Boreholes 2 and 3 were advanced to 25.0 m for the abutments. Similarly for the temporary bridge, Boreholes 5 and 8 were advanced to 3.7 m for the approaches and Boreholes 6 and 7 were drilled to 15.8 m depth for the abutments. The field work was carried out between April 13 to April 15 and May 31, 2021.

A previous investigation conducted in 1977 by others had one borehole advanced to 15.7 m near the south abutment. The Log of Borehole and the borehole location plan are provided in Appendix B.

A previous investigation conducted in 2005 by others showed two boreholes advanced to 9.4 m depth and 9.6 m depth. The version of the report supplied to PML only had Borehole 2. The Log of Borehole and the borehole location plan are provided in Appendix C.

PML laid out the boreholes in the field for this current investigation. The ground surface elevation at the borehole locations was obtained with a Sokkia SHC5000 Global Navigation Satellite System (GNSS). The vertical and horizontal accuracy of this unit are 0.1 and 0.5 m, respectively. All elevations in this report are geodetic and expressed in metres.

Co-ordination for clearances of underground utilities was provided by PML. The boreholes were drilled cognizant of the underground utilities.

Traffic control was provided in accordance with Ontario Traffic Manual, Book 7, where required.

The boreholes were advanced using continuous flight hollow stem augers, powered by truck mounted CME-75 drill rig, equipped with an automatic hammer, supplied and operated by a specialist drilling contractors, working under the full-time supervision of a member of PML's engineering staff.

The existing pavement component thicknesses were measured and samples of the granular material were collected.

Representative samples of the subgrade were recovered at frequent depth intervals for identification purposes using a conventional 51 mm OD split spoon sampler. The sampler excluded particles larger than 38 mm. Standard penetration tests were carried out simultaneously with the sampling operations to assess the strength characteristics of the subsoil. The ground water conditions in the boreholes were assessed during drilling by visual examination of the soil samples, the sampler, and drill rods as the samples were retrieved, and measurement of the water level in the open boreholes, if any.

The boreholes were backfilled in accordance with O.Reg. 903 and capped with cold mix asphalt, where required.

All recovered samples were returned to our laboratory for detailed examination and moisture content determinations. Grain size analyses were carried out on six samples of the major soil units. Atterberg Limits testing was also carried out on all six samples. The laboratory test results are provided on Figures 1 to 5, appended.

3. SUBSURFACE CONDITIONS

Reference is made to the appended Log of Borehole sheets for details of the subsurface conditions, including pavement component thicknesses, soil classifications and inferred stratigraphy and thicknesses, Standard Penetration N values (N Values – blows per 300 mm of penetration of the split spoon sampler), and ground water levels, and the results of laboratory water content determinations and Atterberg Limits testing.

Due to the soil sampling procedures and the limited size of samples, the depth/elevation demarcations on the borehole logs must be viewed as “transitional” zones, and cannot be construed as exact geologic boundaries between layers. PML should be retained to assist in defining the geological boundaries in the field during construction, if required.

3.1 Bridge Replacement (Boreholes 1 to 4)

3.1.1 Soil

The existing pavement component thicknesses encountered in Boreholes 1 to 4 on Queen Street are summarized in the following table. No distinguishable granular subbase was observed in the boreholes.

BOREHOLE	ASPHALT (mm)	GRANULAR BASE (mm)	GRANULAR SUBBASE (mm)	TOTAL THICKNESS (mm)
1	120	450	--	570
2	100	300	--	400
3	110	500	--	610
4	85	915	--	1000

Fill was contacted below the pavement in all four boreholes, extending to 1.4 to 3.0 m (elevation 215.1 to 219.4). The fill was variable and comprised sand and gravel, sandy gravel and sandy silt. The N values in the fill were 8 to 23, indicating variable compactive effort was applied when the fill was placed. The upper granular fill was moist, wet at depth, with moisture contents ranging from 4 to 21%. A lower 1.5 m thick organic silt fill was noted in Borehole 3 at 3.0 m depth (elevation 215.1) below the upper granular fill, and extended to 4.5 m depth (elevation 213.6). The N values were 1 to 6. A moisture content of 29% was measured on an organic fill sample.

An organic silt/clayey silt layer was observed below the fill in Boreholes 2 and 4. The 0.7 m thick layer extended to 2.9 m (elevation 218.1) in Borehole 2, and to the 3.5 m exploration depth (elevation 214.4) in Borehole 4. The layer comprised silt/clayey silt with trace sand and organics.

The soil was firm/ very loose with N values of 1 blow for 450 mm advancement of the split spoon sampler to 6. Moisture contents were 13 to 26%.

In Boreholes 1, 2 and 3, at 2.1 to 4.5 m (elevation 218.7 to 213.6), a 4.0 m thick clayey silt till deposit was revealed below the fill/organic silt, being penetrated at 7.0 and 8.5 m depth (elevation 214.0 and 209.6) in Boreholes 2 and 3, respectively. Borehole 1 terminated in the 1.4 m thick till unit at 3.5 m (elevation 217.3). N values in the till were typically greater than 30 (hard), locally 17 (very stiff). The till matrix consisted of clayey silt, some sand and trace gravel, with cobbles and boulders noted during drilling. A sample of the till was submitted for grain size analysis and the results are provided in Figure 1, attached. Atterberg limits testing results are shown on Figure 2, appended. The clayey silt till has a plastic limit of 12 and a liquid limit of 29. Moisture contents were typically 15% or less.

An upper 3.0 m thick silt unit was beneath the till deposit and extended to 10.0 and 11.5 m (elevation 206.6 and 211.0) in Boreholes 2 and 3, respectively. The unit comprised silt with trace to some clay, and trace sand. The N values in the material were 42 to greater than 50 indicating dense to very dense conditions. A grain size analysis was conducted on a sample of the material and the results are provided on Figure 3, attached. Moisture contents were 15 to 19%. Atterberg limits testing showed the soil to be non-plastic.

Underlying the upper silt, a 3.5 and 4.5 m thick clayey silt layer extended to 14.5 and 16.5 m (elevation 206.5 and 201.6) in Boreholes 2 and 3, respectively. A grain size analysis revealed the soil comprises clayey silt with trace sand (Figure 4). Atterberg limits results on Figure 5 indicated the clayey silt possessed a liquid limit of 31 and a plastic limit of 15. The soil was hard (N values much greater than 30) and typically about the plastic limit, with moisture contents around 20%.

A lower silt unit underlying the clayey silt was 7.0 m thick, and extended to 23.5 m (elevation 194.6) in Borehole 3. Borehole 2 was terminated in the 10.5 m thick silt unit that extended to the 25.0 m exploration depth, elevation 196.0. The silt was dense to very dense, with N values of 37 to 93, and wet, with moisture contents near 20%. The laboratory results of a grain size analysis conducted on a silt sample are presented in Figure 3, attached. The silt was non-plastic based on the Atterberg limits test.

A local 1.5 m thick silty sand layer was at the base of Borehole 3, below the lower silt extending to the 25.0 m exploration depth (elevation 193.1). The material was very dense (N value of 69) and wet (moisture content of 18%).

3.1.2 Ground Water

The first water strike (ground water first encountered during drilling), and the ground water/wet cave levels measured in the boreholes upon completion of augering are summarized in the table below, on a borehole-by-borehole basis.

BOREHOLE	FIRST STRIKE DURING DRILLING DEPTH (m) / ELEVATION	UPON COMPLETION OF AUGERING DEPTH (m) / ELEVATION
1	No Water to 3.5 / 217.3	No Water to 3.5 / 217.3
2	6.1 / 214.9	7.1 / 213.9
3	4.6 / 213.5	2.7 / 215.4
4	No Water to 3.5 / 214.4	No Water to 3.5 / 214.4

The river water level was at elevation 213.49 in November 2020 (based on a plan provided by the Client). Ground water levels will fluctuate seasonally, and in response to variations in precipitation.

3.1.3 Previous Boreholes

The Log of Borehole sheets from previous boreholes by others are in Appendix B and C. The logs show similar soil stratigraphy and conditions were encountered as the current boreholes. Minor variation in the soil stratigraphy depths was noted.

3.2 Temporary Bridge (Boreholes 5 to 8)

3.2.1 Soil

The parking lot pavement component thicknesses encountered in Boreholes 5, 6 and 8 are summarized in the following table. No distinguishable granular subbase was observed in the boreholes.

BOREHOLE	ASPHALT (mm)	GRANULAR BASE (mm)	GRANULAR SUBBASE (mm)	TOTAL THICKNESS (mm)
5	75	205	--	280
6	85	255	--	340
8	65	255	--	320

Fill was contacted below the pavement, locally at the surface of Borehole 7, extending to 2.2 to 2.9 m depth (elevation 214.1 to 218.6). The fill was variable and comprised sand to silty sand to sandy silt. The N values in the very loose to compact fill were 1 to 18, indicating variable compactive effort was applied when the fill was placed. The fill was moist, wet at depth, with moisture contents ranging from 14 to 23%.

An estimated 1.0 to 2.0 thick organic clayey silt layer was observed below the fill in all four boreholes, extending to 3.0 and 4.5 m (elevation 213.8 and 216.5) in Boreholes 6 and 7, and to the 3.7 m exploration depth, in Boreholes 5 and 8. The layer comprised clayey silt with trace sand, gravel and organics. The soil consistency was very soft to very stiff with N values of 1 to 17. Moisture contents were 14 to 29%.

A typically 2.0 m thick upper silt unit was beneath the organic clayey silt layer and extended to 6.1 and 7.5 m depth (elevation 210.7 and 213.5) in Boreholes 6 and 7, respectively. The unit comprised silt with trace to some clay and trace sand. The N values in the material were 7 to greater than 50 indicating loose to very dense conditions. Moisture contents were 6 to 23% (moist to wet).

Beneath the upper silt, a typically 2.5 m thick clayey silt layer extended to 8.5 and 10.0 m (elevation 208.3 and 211.0) in Boreholes 6 and 7, respectively. A grain size analysis revealed the soil comprises clayey silt with trace sand (Figure 4). The soil was hard (N values much greater than 30) with moisture contents of 12 to 18%, typically about the plastic limit. Atterberg limits results indicated a liquid limit of 31 and a plastic limit of 17 as shown on Figure 5, attached.

A 5.6 and 7.3 m thick lower silt unit was beneath the clayey silt, extending to the 15.8 m exploration depth (elevation 201.0 and 205.2) in Boreholes 6 and 7, respectively. The silt was dense to very dense, with N values of 35 to greater than 50, and wet, with moisture contents near 20%.

3.2.2 Ground Water

The first water strike (ground water first encountered during drilling), and the ground water/wet cave levels measured in the boreholes upon completion of augering are summarized in the table below, on a borehole-by-borehole basis.

BOREHOLE	FIRST STRIKE DURING DRILLING DEPTH (m) / ELEVATION	UPON COMPLETION OF AUGERING DEPTH (m) / ELEVATION
5	2.6 / 214.4	2.7 / 214.3
6	3.0 / 213.8	3.0 / 213.8
7	2.1 / 218.9	1.8 / 219.2
8	3.0 / 217.8	2.9 / 217.9

The Saugeen River water level was not provided, however is assumed to be similar to but slightly lower than the Teeswater River water level at elevation 213.49 (November 2020), as the temporary bridge crossing is down stream from the main bridge.

Ground water levels will fluctuate seasonally, and in response to variations in precipitation.

4. GEOTECHNICAL ENGINEERING CONSIDERATIONS

4.1 General

The County of Bruce is proposing to reconstruct the bridge on Queen Street in the Village of Paisley, crossing the Teeswater River. The bridge is located about 20 to 25 m west of the confluence of the Teeswater River and the Saugeen River. The general concept is to remove the existing three-span bridge and replace it with a two-span bridge. No investigation was carried out at the central pier in the Teeswater River as part of the current assignment. It is understood the elevation of the replacement bridge will be raised 200 mm to provide additional freeboard and capacity during high-flow events. A temporary bridge over the Saugeen River, about 100 to 110 m east of the current bridge crossing is planned in order to remove and construct the replacement bridge.

Both sets of bridge abutments are planned to be founded on footings. A pile foundation may also be considered and pile capacity has also been provided for each abutment.

It is noted that a pier will be required for the replacement bridge on Queen Street. No investigation was carried out at this location to confirm subgrade conditions. The subsurface conditions in the abutment boreholes were fairly consistent and similar subsurface conditions are anticipated at the pier location below the river bed sediments. When the pier location is finalized, it is recommended that a sampled borehole be drilled from the existing bridge deck at the location of the new central pier to determine the soil stratigraphic profile including the extent of the river bed sediments to assess the scour potential and for foundation and cofferdam design.

4.2 Footings

The drawings provided indicate the footings for the replacement bridge are to be founded at elevation 211.2. The footing levels for the temporary bridge have not been finalize at his time but are anticipated to be at a similar depth, possibly higher and laterally further from the river.

The following tables summarize the recommended design bearing resistances for footings founded at various levels on the native soils:

BOREHOLE	DEPTH (m) / ELEVATION	ANTICIPATED SUBGRADE SOIL TYPE	GEOTECHNICAL BEARING RESISTANCE AT SLS (kPa)	FACTORED BEARING RESISTANCE AT ULS (kPa)
South Abutment Replacement Bridge				
2	9.8/211.2	Silt/Clayey Silt	400	600
North Abutment Replacement Bridge				
3	6.8/211.2	Clayey Silt Till/Silt	400	600
South Abutment Temporary Bridge				
7	5.5/215.5	Silt/Clayey Silt	500	750
	10.0/211.0	Silt	400	600
North Abutment Temporary Bridge				
6	3.5/213.25	Silt	100	150
	5.5/ 211.3	Silt/Clayey Silt	400	600

SLS = Serviceability Limit State
ULS = Ultimate Limit State

It is noted that the bearing resistance at the north abutment for the temporary bridge (Borehole 6) is lower than the other abutment areas. In this regard the value noted above can be take as a net value, with a gross value including the weigh of the existing soil (assuming the existing soil is removed at the time of construction) assuming a unit weight of 19 kN/m^3.

The bearing resistance at SLS is based on 25 mm of total settlement in the bearing stratum, with differential settlement of 75% of this value.

Footings subject to frost action must be provided with a minimum 1.4 m of earth cover or equivalent insulation. Scour protection must also be provided for the footings.

Prior to placement of structural concrete, all founding surfaces must be inspected by PML to verify the design bearing capacity is available, or to reassess the design parameters based on the actual conditions.

4.2.1 Seismic Considerations

Based on the N values in the stratigraphic revealed in the boreholes and in accordance with the Canadian Highway Bridge Design Code (CHBDC), December 2014, CSA-S6-14, Clause 4.4.3.2 – Table 4.1, Site Class D is applicable for both bridges.

Based on the type and relative density of the soil revealed in the boreholes, there is a very low potential for liquefaction of the shallow soils to occur (CHBDC Clause 4.6.6).

4.3 Piles

It is understood that a deep foundation comprised of 310 x 110 H-piles is also being considered and as such, bearing resistance for piles were also requested.

Pile caps are assumed to be set at about 3 to 4 m below existing grade at the respective abutment locations. The vertical axial resistances of a 310 X 110 H Pile driven a minimum 15 m below the pile cap in the dense to very dense/very stiff to hard soil is 750 kN at SLS and 900 kN at ULS.

It is noted that the boreholes for the temporary bridge were only drilled to about 15 m depth and it is assumed that the similar soil conditions are present below this depth, however conditions may vary. There should be allowance in the contract for this variation or further investigation is required.

A piled abutment foundation, although Geotechnically feasible, has many potential problematic design aspects that would require additional research and overall consideration, particularly when competent subsurface conditions exist for an economical spread footing design. The pile installation will require heavy driving effort to achieve the design pile capacity. The vibration will have severe consequences on adjacent building foundations (e.g., the existing Town Hall foundation directly abuts the west end of the existing north bridge abutment), the adjacent roadway fill, settlement sensitive underground services, utilities and sidewalks. There are also severe environmental considerations related to the high noise threshold related to pile driving equipment and detrimental air quality from the pile driving operations.

4.4 Abutment Wall Design

Abutment walls must be designed to resist the unbalanced lateral earth pressure imposed by the backfill adjacent to the abutment. The lateral earth and water pressure, P (kPa), may be computed using the equivalent fluid pressure method presented in Section 6.12 of the CHBDC, or employing the following equation:

$$P = K(\gamma h + q) + C_p + C_s$$

Where

P = total lateral pressure at depth h (m) below ground surface (kPa)
K = lateral earth pressure coefficient of compacted backfill
h = depth below grade (m) at which lateral pressure is calculated
γ = bulk unit weight of backfill
q = vertical stress at depth h due to surcharge loads (kPa)
C_p = compaction pressure (refer to clause 6.12.3 of CHBDC)
C_s = earth pressure induced by seismic events (refer to clause 4.6.5 of CHBDC)

In addition, there should be allowance for appropriate safety factors.

Free draining granular material should be used as backfill behind the abutments comprising OPSS Granular A or Granular B, placed in thin lifts compacted to a minimum 95% Standard Proctor maximum dry density (SPmdd). Site soils are not suitable for use as free draining backfill. Over compaction close to the abutment wall should be avoided as this could generate excessive pressure on the abutment wall.

The following parameters are recommended for design:

PARAMETERS	**OPSS GRANULAR A**	**OPSS GRANULAR B TYPE II OR TYPE II**
Angle of Internal Friction (degrees)	35°	30°
Unit Weight, γ (kN/m^3)	22.5±0.3	21.5±0.3
Rankin Active Earth Pressure Coefficient (K_a)	0.27	0.33
At Rest Earth Pressure Coefficient (K_o)	0.43	0.50
Rankin Passive Earth Pressure Coefficient (K_p)	3.69	3.00

A weeping tile system and/or weeping holes should be installed to minimize the build-up of hydrostatic pressure behind the abutments. The weeping tiles should be surrounded by a properly designed granular filter or geotextile to prevent migration of fines into the system. The drainage pipe should be placed on a positive grade and lead to a frost-free outlet.

4.5 Approach Fill

It is understood the elevation of the replacement bridge will be raised 200 mm to provide additional freeboard and capacity during high-flow events.

Based on the results of the preliminary investigation, the existing subsurface conditions at the new north and south bridge replacement approach fills will comprise a road pavement underlain by a loose to compact variable sand and gravel, sandy gravel and sandy silt fill underlain by very loose organic silt and firm clayey silt extending to about 4.5 m (elevation 213.6), and 2.9 m (elevation 218.8), at the north and south bridge replacement approaches respectively.

In general, approach fill embankments should be constructed in accordance with OPSS 206 and OPSD 200.01. Any side slopes of the approach embankments should be inclined no steeper than three horizontal to one vertical (3H:1V) for earth fill. Backfill adjacent to the structure should be carried out in conformance with OPSS for granular backfill.

Excavated inorganic site soil is generally considered to be acceptable for reuse in constructing bridge approaches, subject to moisture content control and Geotechnical field review and approval.

Side slopes should be protected from surface erosion by sodding or by seed and mulch as soon as possible following construction.

It is noted that the boreholes encountered organic very loose silt/firm clayey silt below the fill in the assumed footprint of the new approach fill. In this regard, if a larger grade raise is being considered at the bridge approach areas, subexcavation of the surficial fill and organic silt/clayey silt may be required due to the potential for gross and differential settlement.

If a larger grade raise is being considered and the removal of the very loose silt/firm clayey silt below the fill is not practical, it may be prudent to consider the use of light weight fill, cellular concrete, EPS Geofoam or conventional preloading to provide enhanced approach embankment performance while leaving the existing fill and organic silt/clayey silt in place. Additional recommendations for these options can be provided if required.

4.6 Excavation and Ground Water Control

Excavation for bridge foundations is expected to extend as much as 10.0 m below the ground surface, and will encounter the pavement and fill, organic silt/clayey silt, upper silt, clayey silt and the till deposit. More arduous digging can be expected in the hard and very dense soil. Cobbles and boulders should be expected in the till deposit.

As noted earlier, there are structures that are adjacent/very close to the bridge abutments. The foundation details of the existing bridge and adjacent structures are not known at this time, however considering the close proximity, the zones of influence of these structures likely coincide and some form of underpinning and/or shoring is anticipated. When foundation details are known Figure 6 should be utilized to assess requirements.

Subject to ground water control as discussed below and where adequate space permits, site soils are considered as Type 4 Soil requiring excavation sidewalls to be constructed at no steeper than 3H:1V from the base of the excavation in accordance with the Occupational Health and Safety Act, due to the organic silt/clayey silt soil.

Excavation side slopes should be continuously examined and reviewed for evidence of instability, particularly following periods of heavy rain or thawing. When required, remediation action must be taken to ensure the continued stability of the excavation slope and the safety of the workers.

It envisioned that shoring (a combination of soldier piles and lagging and steel sheet piling where the abutment excavations must be protected from the Teeswater river) will be required to support the excavations as space may not permit open cut. For design of temporary shoring for excavations, the following parameters may be assumed:

PARAMETER	FILL	SILT	CLAYEY SILT / TILL
Angle of Internal Friction, ϕ, (degrees)	28	30	Effective stress value - 31
Shear Strength, c, (kPa)	--	--	200
Bulk Unit Weight (kN/m³)	19	20	21
Rankin Active Earth Pressure Coefficient (K_a)	0.36	0.33	0.32
At Rest Earth Pressure Coefficient (K_o)	0.53	0.50	0.48
Rankin Passive Earth Pressure Coefficient (K_p)	2.77	3.00	3.12

Difficult driving conditions will be encountered in the till with the presence of cobbles and boulders. Shoring should be designed and installed by specialist in this field. Sump pumping/dewatering from within the shored excavation is still anticipated.

The construction staging, cofferdam and minor river diversion will likely be required for the central bridge pier. Details recommendations can be provided when construction plans are finalized and a supplementary investigation is carried out.

It is recommended the work be scheduled following periods of prolonged dry weather, and when the ground water table and river flow are usually at their lowest, in order to minimize the quantity of water to be handled.

Water taking in Ontario is governed by the Ontario Water Resources Act (OWRA) and the Water Taking and Transfer Regulation O.Reg. 387/040, Section 34 of the OWRA requires any one taking more than 50,000 L/d to notify the Ministry of Environment, Conservation and Parks (MECP). This requirement applies to all withdrawals, whether for consumption, temporary construction dewatering or permanent drainage improvements. Projects assessed to be taking more than 50,000 L/d but less than 400,000 L/d of ground water can obtain a permit/permission online via the Environmental Activity and Sector Registry (EASR) system. If it is assessed that more than 400,000 L/d is required, then a Category 3 Permit-to-Take-Water (PTTW) will be required.

Once design details, including river diversion and excavation plans, are finalized, the project should be reviewed to confirm the MECP requirements. As minimum, registering on the EASR system may be required.

4.7 Geotechnical Review and Construction Inspection and Testing

It is recommended that the final design drawings be submitted to PML for Geotechnical review for compatibility with site conditions and recommendations of this report.

Earthworks operations should be carried out under the supervision of PML to approve subgrade preparation, backfill materials, placement and compaction procedures and check the specified degree of compaction is achieved throughout.

Any piling installation operations should be reviewed on a full-time basis by qualified Geotechnical personnel to check that the required set and capacity are achieved, and to document founding elevation, alignment and plumbness.

The comments and recommendations provided in the report are based on information revealed in the boreholes. Conditions away from and between boreholes may vary. Geotechnical review during construction should be ongoing to confirm the subsurface conditions are substantially similar to those encountered in the boreholes, which may otherwise require modification to the original recommendations.

5. CLOSURE

We trust this report is complete within our terms of reference, and the information presented is sufficient for your present purposes. If you have any questions, or when we may be of further assistance, please do not hesitate to call our office.

Sincerely

Peto MacCallum Ltd.

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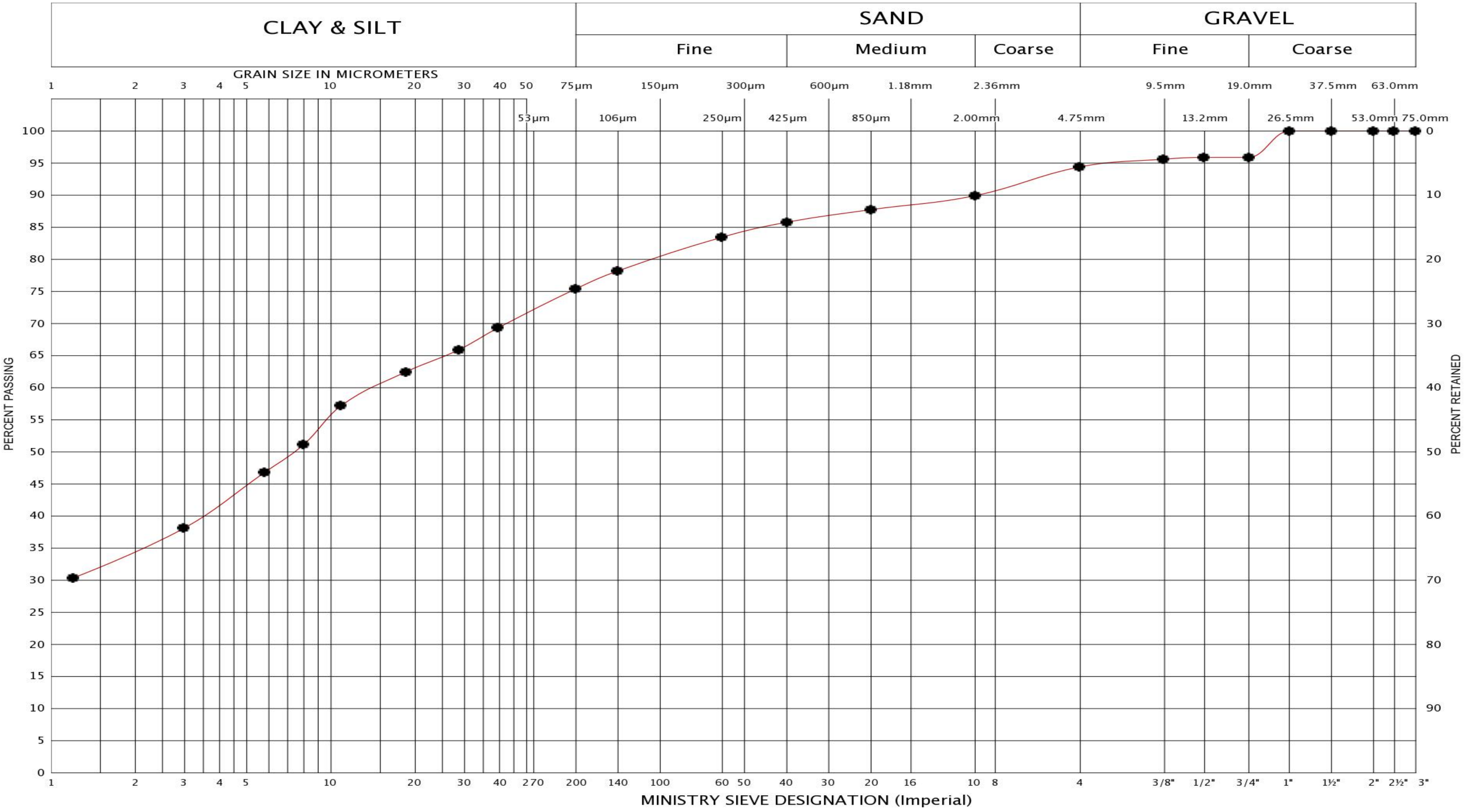
GRW/BRG:tc

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND	**BH**	2
	SAMPLE	5
	SYMBOL	●

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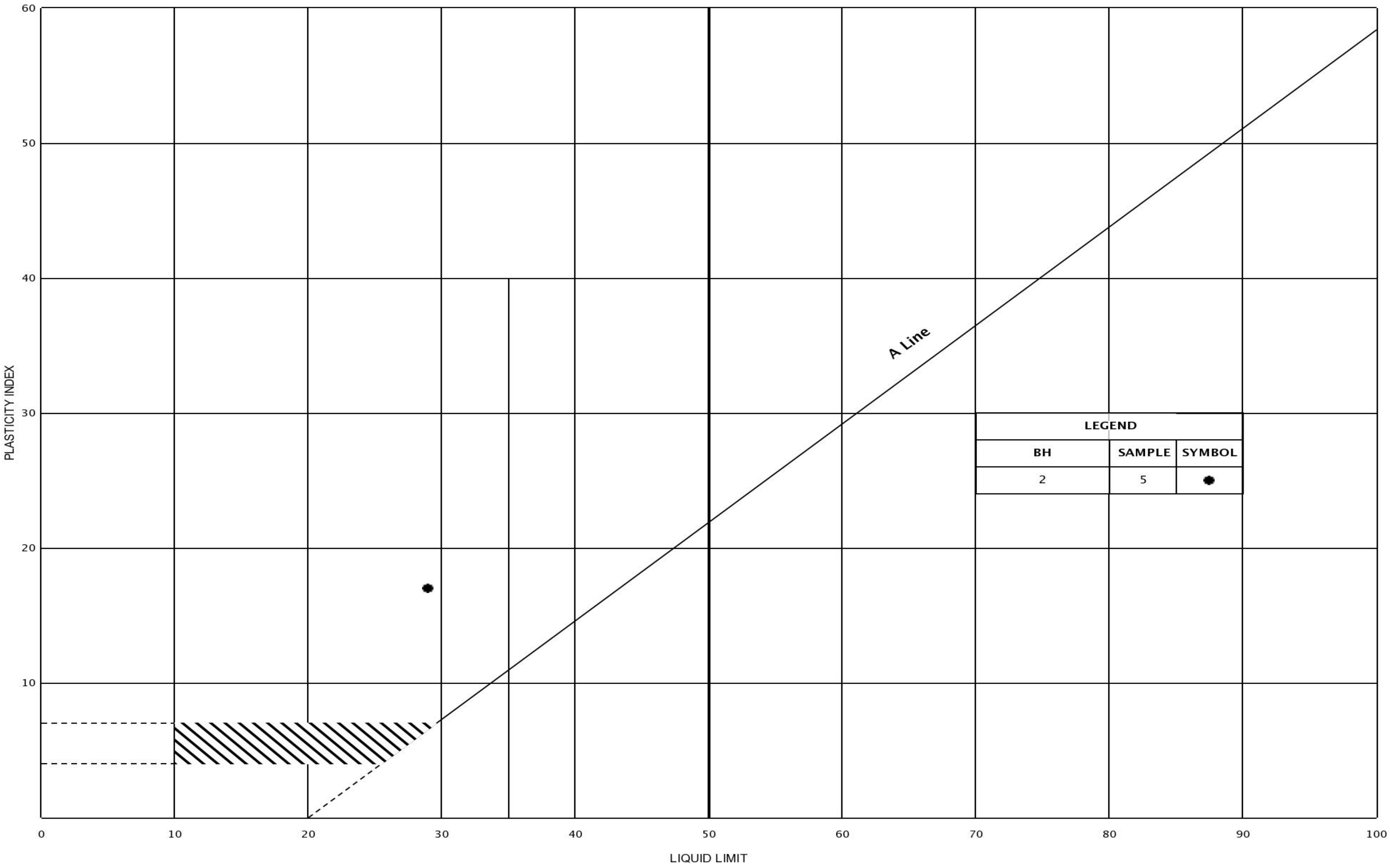
GRAIN SIZE DISTRIBUTION

TILL: Clayey Silt, Some Sand, Trace Gravel

FIG No.: 1

Project No.: 21KF009



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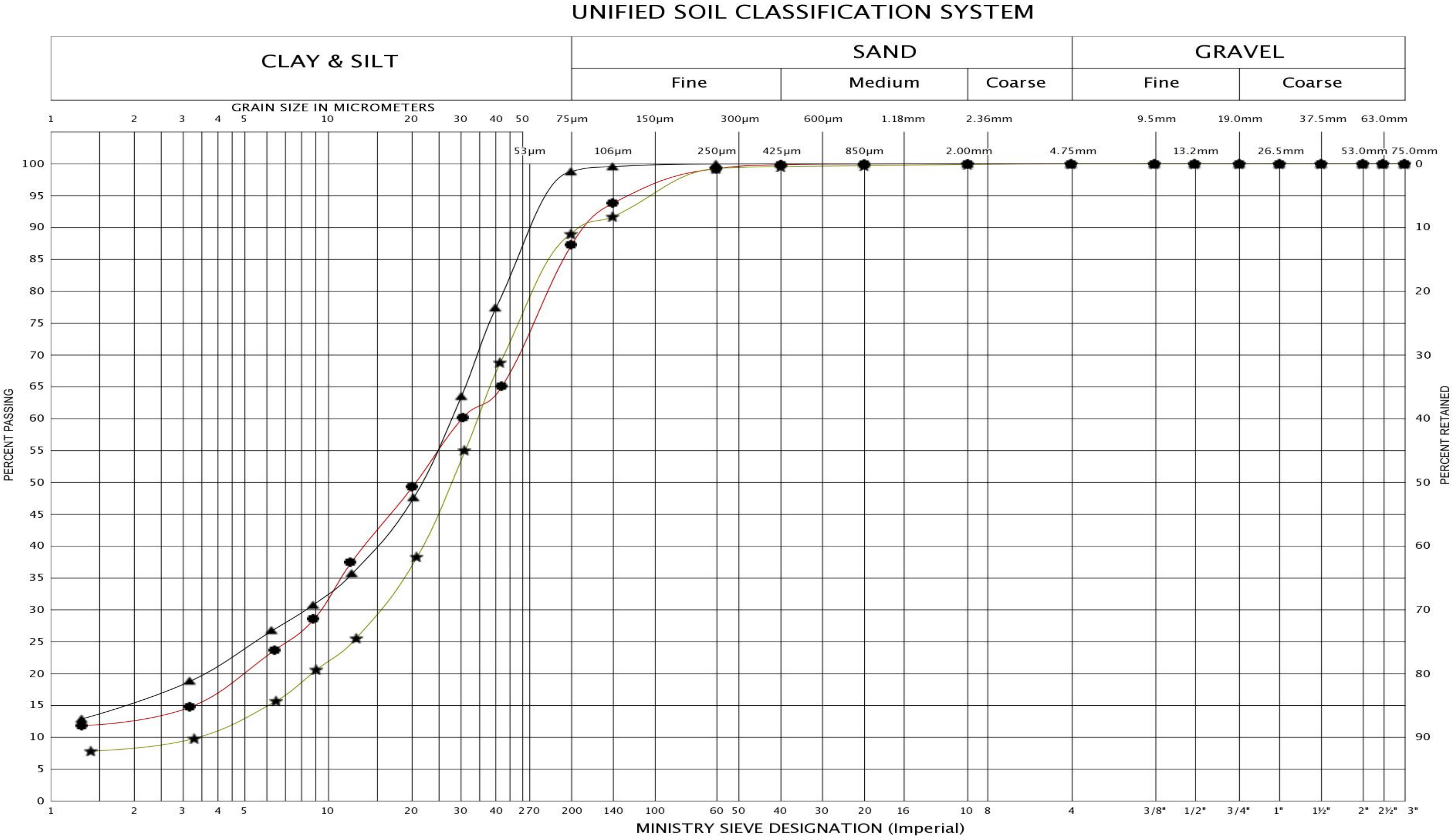
PLASTICITY CHART

TILL: Clayey Silt, Some Sand, Trace Gravel

FIG No.:	2
HWY.:	
Proj No.	21KF009



LEGEND	BH	2	2	3
	SAMPLE	11	20	12
	SYMBOL	▲	●	★

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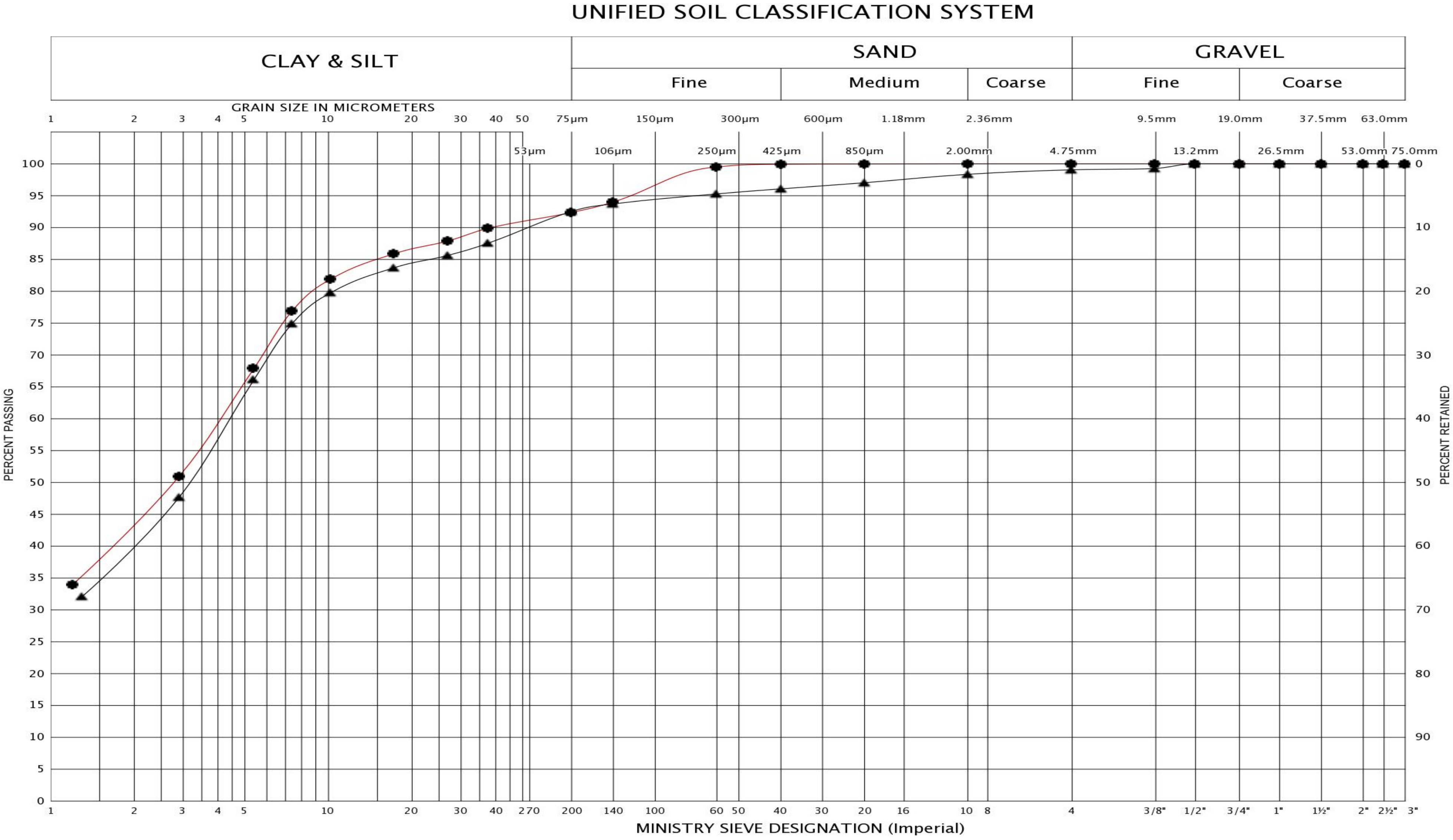
CONSULTING ENGINEERS

GRAIN SIZE DISTRIBUTION

SILT: Trace to Some Clay, Trace Sand (Non-Plastic)

FIG No.: 3

Project No.: 21KF009



LEGEND	**BH**	2	6
	SAMPLE	13	10
	SYMBOL	●	▲

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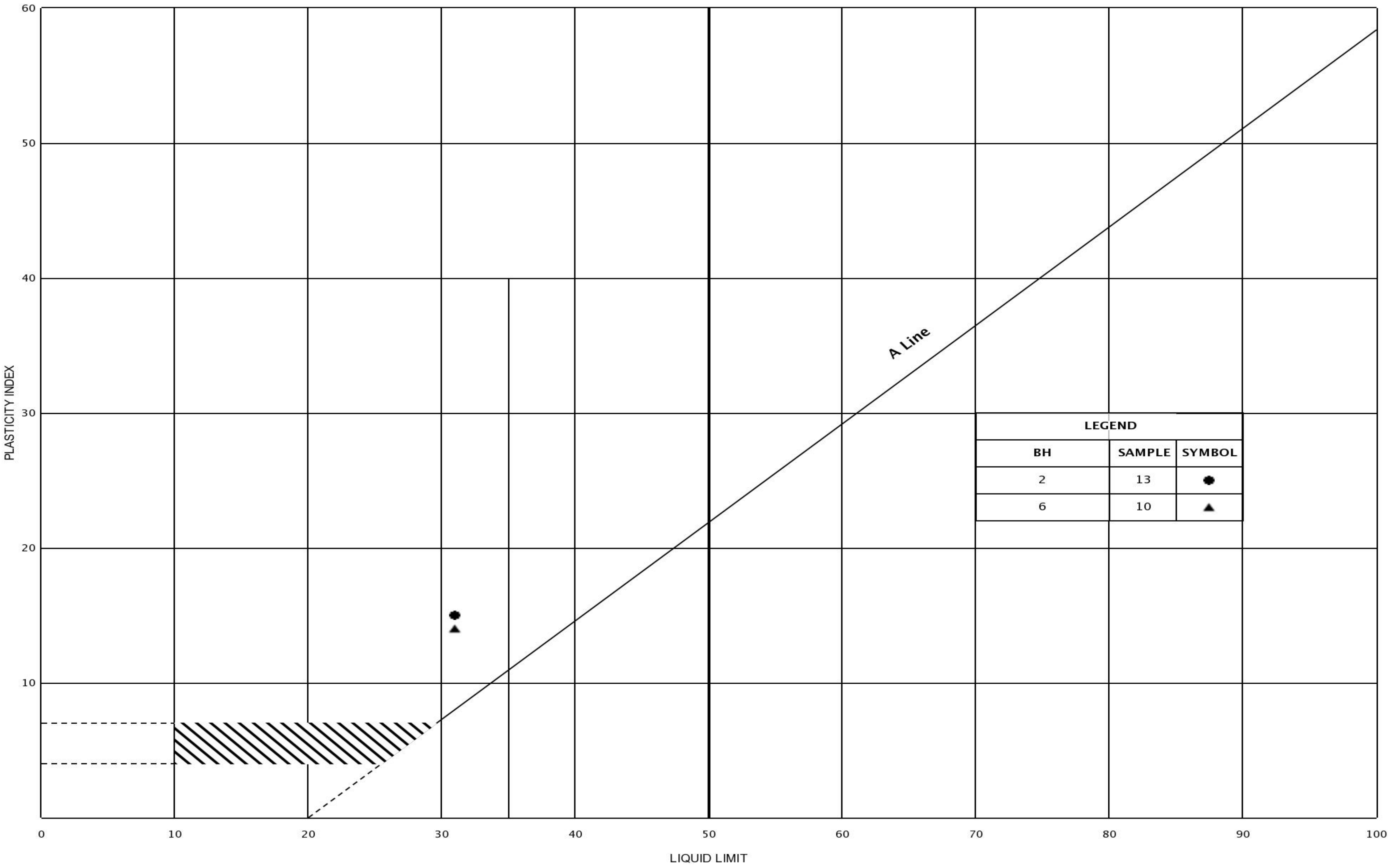
GRAIN SIZE DISTRIBUTION

CLAYEY SILT, Trace Sand

FIG No.: 4

Project No.: 21KF009



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PLASTICITY CHART

CLAYEY SILT, Trace Sand

FIG No.: 5

HWY.:

Proj No. 21KF009

STD – GEO–D REV 01/2004

NOTES

1. The need to underpin existing footings/utilities is dependent upon soil type, proximity of the existing facility to the face of the excavation, loads imposed on the foundation and permissible movements.

   ZONE A:
   Foundations of relatively heavy and/or settlement sensitive structures/utilities located in Zone A generally require underpinning.

   ZONE B:
   Foundations of structures located within Zone B generally do not require underpinning. Consideration should be given to underpinning of settlement sensitive utilities or heavy foundation units located in this zone.

   ZONE C:
   Utilities and foundations located within Zone C do not normally require underpinning.

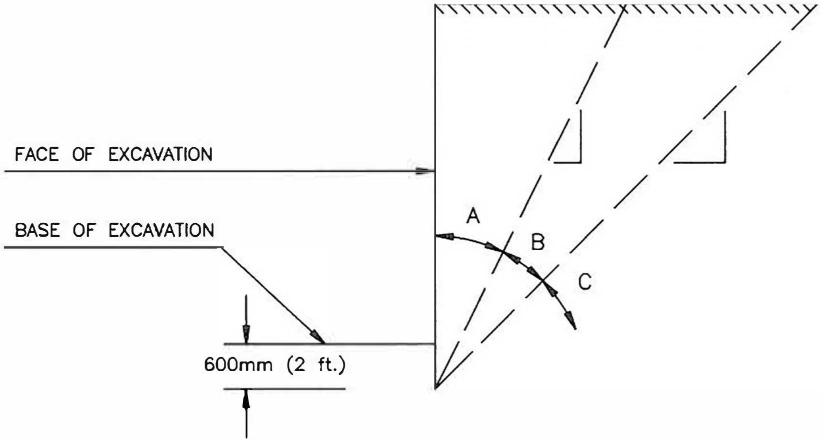
   Underpinning of foundations located in Zones A and B should extend at least into Zone C.

2. As an alternative to underpinning, it may be possible to control movement of existing utilities and foundations by supporting the face of the excavation with bracing/tiebacks or a rigid (caisson) wall. Horizontal and vertical earth pressures imposed on the excavation wall by non–underpinned foundations must be considered in the design of the support system.

3. A condition survey should be conducted prior to construction and appropriate monitoring (surface and insitu) carried out during construction to monitor any movement which may occur.

4. All work should be carried out in accordance with the Occupational Health and Safety Act and local regulations. Good quality workmanship and construction practices are to be employed.

5. This sheet is to be read in conjunction with text of report for this project. Additional comments and recommendations concerning these general guidelines will be provided if required.



STANDARD DRAWING

GENERAL RECOMMENDATIONS REGARDING UNDERPINNING OF FOUNDATIONS/UTILITIES
LOCATED CLOSE TO EXCAVATION

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DRAWN:	GRW	DATE	SCALE	JOB NO.	FIGURE NO.
CHECKED:	GRW	SEPT 2021	N.T.S.	21KF009	6
APPROVED:	BRG				

LIST OF ABBREVIATIONS

PENETRATION RESISTANCE

Standard Penetration Resistance N: - The number of blows required to advance a standard split spoon sampler 0.3 m into the subsoil. Driven by means of a 63.5 kg hammer falling freely a distance of 0.76 m.

Dynamic Penetration Resistance: - The number of blows required to advance a 51 mm, 60 degree cone, fitted to the end of drill rods, 0.3 m into the subsoil. The driving energy being 475 J per blow.

DESCRIPTION OF SOIL

The consistency of cohesive soils and the relative density or denseness of cohesionless soils are described in the following terms:

CONSISTENCY	N (blows/0.3 m)	c (kPa)	DENSENESS	N (blows/0.3 m)
Very Soft	0 - 2	0 - 12	Very Loose	0 - 4
Soft	2 - 4	12 - 25	Loose	4 - 10
Firm	4 - 8	25 - 50	Compact	10 - 30
Stiff	8 - 15	50 - 100	Dense	30 - 50
Very Stiff	15 - 30	100 - 200	Very Dense	> 50
Hard	> 30	> 200		

WTLL	Wetter Than Liquid Limit
WTPL	Wetter Than Plastic Limit
APL	About Plastic Limit
DTPL	Drier Than Plastic Limit

TYPE OF SAMPLE

SS	Split Spoon	ST	Slotted Tube Sample
WS	Washed Sample	TW	Thinwall Open
SB	Scraper Bucket Sample	TP	Thinwall Piston
AS	Auger Sample	OS	Oesterberg Sample
CS	Chunk Sample	FS	Foil Sample
GS	Grab Sample	RC	Rock Core

PH	Sample Advanced Hydraulically
PM	Sample Advanced Manually

SOIL TESTS

Qu	Unconfined Compression	LV	Laboratory Vane
Q	Undrained Triaxial	FV	Field Vane
Qcu	Consolidated Undrained Triaxial	C	Consolidation
Qd	Drained Triaxial		

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CONSULTING ENGINEERS

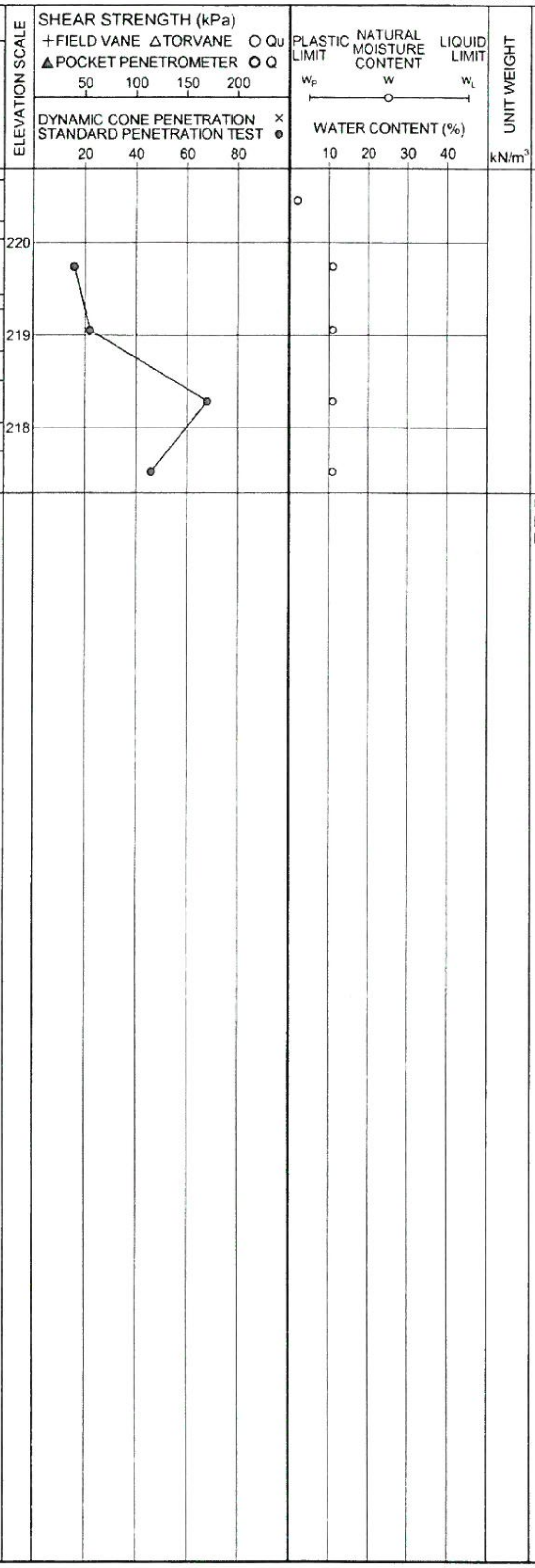
LOG OF BOREHOLE NO. 1

1 of 1

PROJECT Proposed Replacement of Teeswater River Bridge
LOCATION Paisley, Ontario
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE May 31, 2021
PML REF. 21KF009
ENGINEER G.W
TECHNICIAN D. van Esch

SOIL PROFILE		SAMPLES			GROUND WATER OBSERVATIONS AND REMARKS
DEPTH ELEV (metres)	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GRAIN SIZE DISTRIBUTION (%) GR SA SI&CL
	SURFACE ELEVATION 220.80				
	PAVEMENT: 120 mm asphalt, over 450 mm granular base, moist	1	GS	-	
0.57 220.23	FILL: Compact, brown, sandy silt, some gravel, trace organics, moist	2	SS	16	
1.4 219.4	CLAYEY SILT: Very stiff, brown, clayey silt, APL	3	SS	22	
2.1 218.7	CLAYEY SILT TILL: Hard, brown to grey, clayey silt, trace sand, trace gravel, cobbles and boulders, APL	4	SS	68	
		5	SS	46	
3.5 217.3	BOREHOLE TERMINATED AT 3.5 m				Upon completion of augering No water No cave

0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0



NOTES

Peto MacCallum Ltd
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 2

1 of 2

PROJECT Proposed Replacement of Teeswater River Bridge
LOCATION Paisley, Ontario
BORING METHOD Continuous Flight Hollow Stem Augers
BORING DATE April 15, 2021
PML REF. 21KF009
ENGINEER G.W
TECHNICIAN D. van Esch

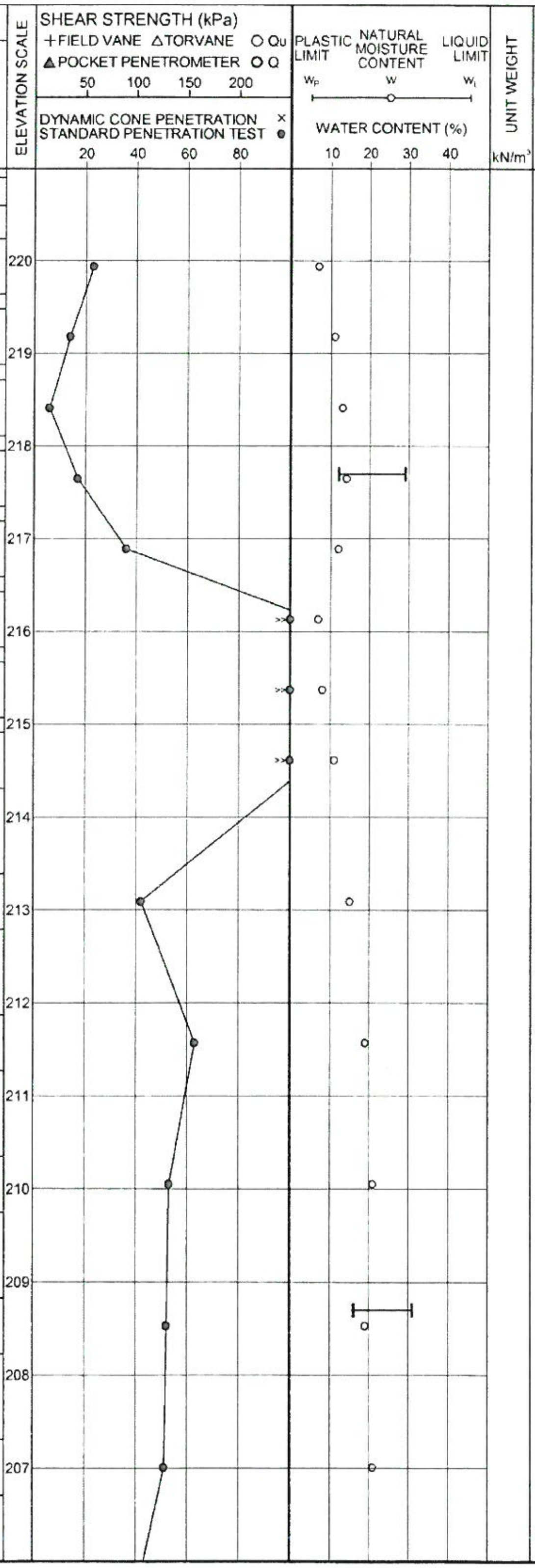
SOIL PROFILE

DEPTH ELEV (metres)	DESCRIPTION
	SURFACE ELEVATION 221.00
0.0	PAVEMENT: 100 mm asphalt, over 300 mm granular base, moist
0.40 220.60	FILL: Loose to compact, brown, sand and gravel, trace silt, moist
2.2 218.8	ORGANIC CLAYEY SILT: Firm, dark brown to black, clayey silt, trace organics, WTPL
2.9 218.1	CLAYEY SILT TILL: Very stiff to hard, brown to grey, clayey silt, some sand, trace gravel, cobbles and boulders, DTPL to ATPL
7.0 214.0	SILT: Dense to very dense, grey, silt, some clay, moist to wet
10.0 211.0	CLAYEY SILT: Hard, grey, clayey silt, trace sand, APL
14.5 206.5	SILT: Dense to very dense, grey, silt, trace to some sand and clay, wet

CONTINUED

SAMPLES

NUMBER	TYPE	"N" VALUES
1	GS	-
2	SS	23
3	SS	14
4	SS	6
5	SS	17
6	SS	36
7	SS	50/100mm
8	SS	50/50mm
9	SS	50/125mm
10	SS	42
11	SS	63
12	SS	53
13	SS	52
14	SS	51



GROUND WATER OBSERVATIONS AND REMARKS

GRAIN SIZE DISTRIBUTION (%)
GR SA SI&CL

▼ El. 214.9

NOTES

▼ GROUND WATER STRIKE

PML - BH LOG GEO/ENV WITH MWS 21KF009 BOREHOLE LOGS.GPJ ON_MOT.GDT 7/30/2021 4:56:06 PM

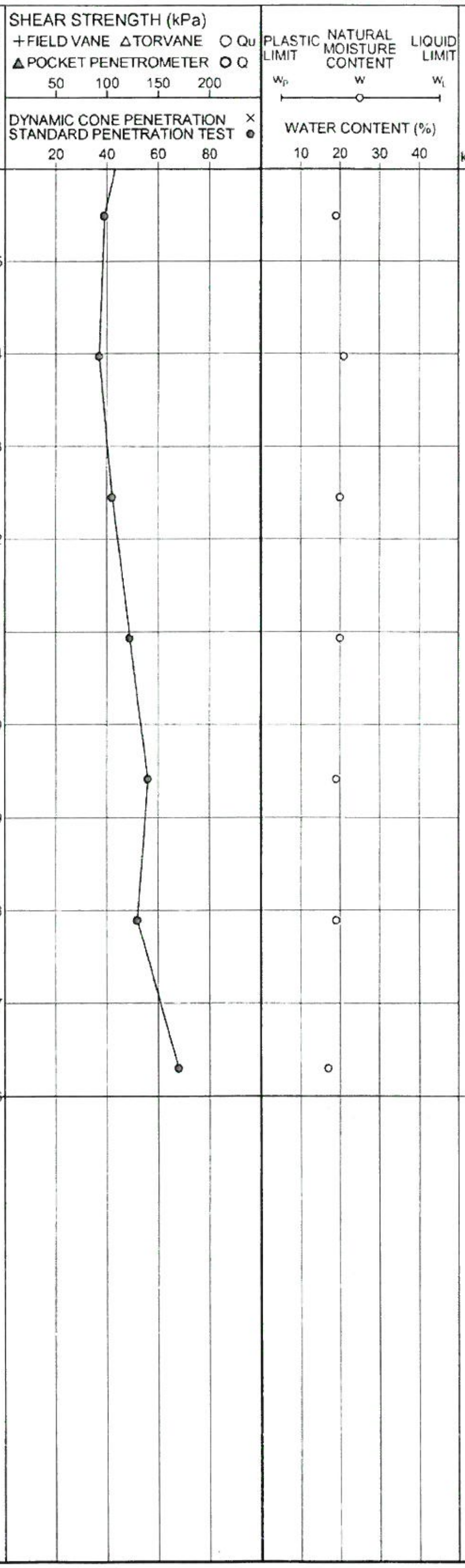
Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 2

2 of 2

PROJECT Proposed Replacement of Teeswater River Bridge
LOCATION Paisley, Ontario
BORING METHOD Continuous Flight Hollow Stem Augers
BORING DATE April 15, 2021
PML REF. 21KF009
ENGINEER G.W
TECHNICIAN D. van Esch

DEPTH / ELEV (metres)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	GROUND WATER OBSERVATIONS AND REMARKS
15.0	CONTINUED FROM PREVIOUS PAGE					
206.0	SILT: Dense to very dense, grey, silt, trace to some sand and clay, wet	15	SS	39		
					205	
		16	SS	37	204	
					203	
		17	SS	42		
					202	
		18	SS	49	201	
					200	
		19	SS	56		
					199	
		20	SS	52	198	
					197	
		21	SS	68		
25.0 196.0	BOREHOLE TERMINATED AT 25.0 m				196	Upon completion of augering Water at 7.1 m Cave at 7.3 m



GRAIN SIZE DISTRIBUTION (%) GR SA SI&CL

Depth scale: 15.0, 16.0, 17.0, 18.0, 19.0, 20.0, 21.0, 22.0, 23.0, 24.0, 25.0, 26.0, 27.0, 28.0, 29.0, 30.0

NOTES

▽ GROUND WATER STRIKE

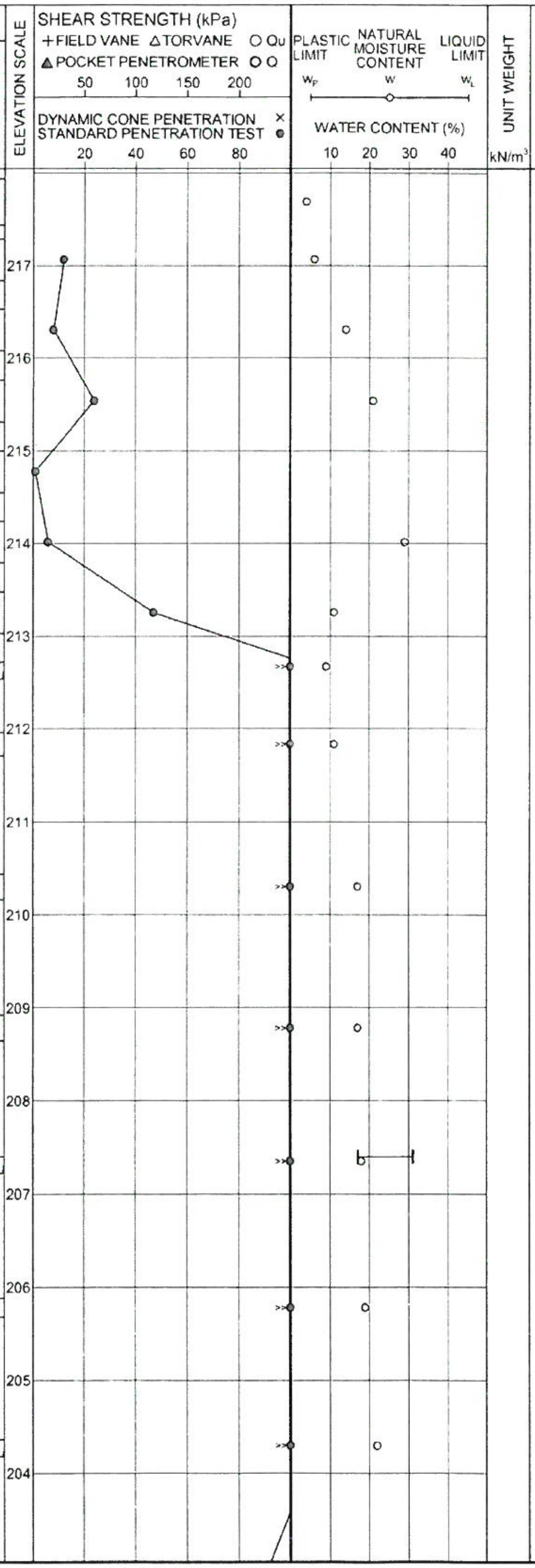
Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 3

1 of 2

PROJECT Proposed Replacement of Teeswater River Bridge
LOCATION Paisley, Ontario
BORING METHOD Continuous Flight Hollow Stem Augers
BORING DATE May 31, 2021
PML REF. 21KF009
ENGINEER G.W
TECHNICIAN D. van Esch

DEPTH / ELEV (metres)	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER OBSERVATIONS AND REMARKS
	SURFACE ELEVATION 218.05				
0.0	PAVEMENT: 110 mm asphalt, over 500 mm granular base, damp	1	GS	-	
0.61 / 217.44	FILL: Very loose to compact, brown, sandy gravel, trace silt, organic pockets, moist to wet	2	SS	12	
		3	SS	8	
		4	SS	24	
3.0 / 215.1	Becoming dark brown to black, organic silt	5	SS	1	
		6	SS	6	
4.5 / 213.6	CLAYEY SILT TILL: Hard, brown to grey, clayey silt, some sand, trace gravel, cobbles and boulders, DTPL to APL	7	SS	47	▼ El. 213.5
		8	SS	50/100mm	
		9	SS	85/250mm	
		10	SS	90/275mm	
8.5 / 209.6	SILT: Very dense, grey, silt, trace clay, trace sand, moist to wet	11	SS	70/275mm	
		12	SS	50/100mm	
11.5 / 206.6	CLAYEY SILT: Hard, grey, clayey silt, trace sand, APL	13	SS	100/200mm	
		14	SS	50/125mm	
15.0	CONTINUED				



NOTES

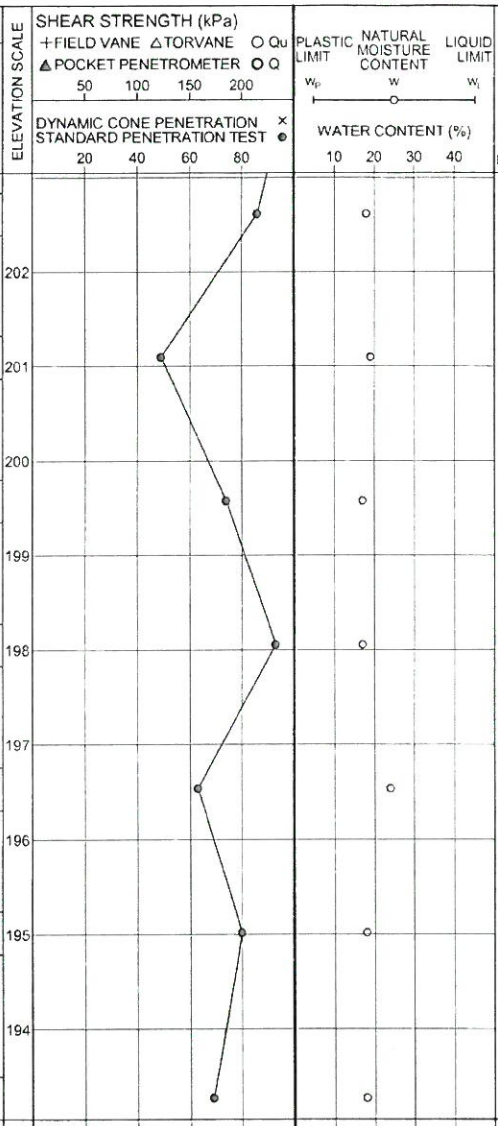
▼ GROUND WATER STRIKE

LOG OF BOREHOLE NO. 3

2 of 2

PROJECT Proposed Replacement of Teeswater River Bridge
LOCATION Paisley, Ontario
BORING METHOD Continuous Flight Hollow Stem Augers
BORING DATE May 31, 2021
PML REF. 21KF009
ENGINEER G.W
TECHNICIAN D. van Esch

SOIL PROFILE			SAMPLES				
DEPTH ELEV (metres)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	UNIT WEIGHT kN/m³	GROUND WATER OBSERVATIONS AND REMARKS GRAIN SIZE DISTRIBUTION (%) GR SA SI&CL
15.0	CONTINUED FROM PREVIOUS PAGE						
203.1	CLAYEY SILT: Hard, grey, clayey silt, trace sand, APL		15	SS	86		
16.5 201.6	SILT: Dense to very dense, grey, silt, trace to some sand and clay, wet		16	SS	49		
			17	SS	74		
			18	SS	93		
			19	SS	63		
			20	SS	80		
23.5 194.6	SILTY SAND: Very dense, grey, silty sand, wet		21	SS	69		
25.0 193.1	BOREHOLE TERMINATED AT 25.0 m						Upon completion of augering Water at 2.7 m Cave at 23.4 m



15.0
16.0
17.0
18.0
19.0
20.0
21.0
22.0
23.0
24.0
25.0
26.0
27.0
28.0
29.0
30.0

NOTES

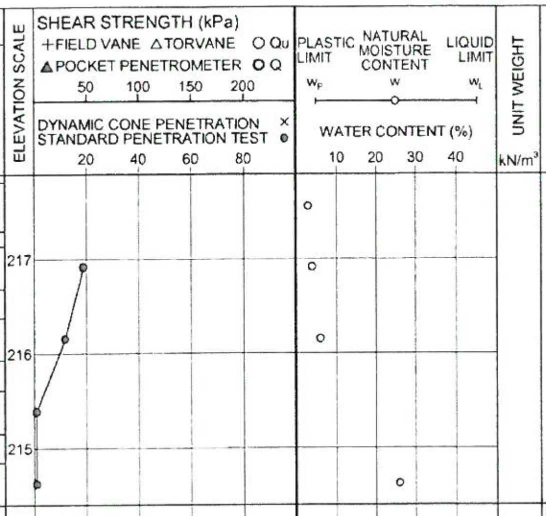
▼ GROUND WATER STRIKE

LOG OF BOREHOLE NO. 4

1 of 1

PROJECT Proposed Replacement of Teeswater River Bridge
LOCATION Paisley, Ontario
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE May 31, 2021
PML REF. 21KF009
ENGINEER G.W
TECHNICIAN D. van Esch

DEPTH ELEV (metres)	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	"N" VALUES	GROUND WATER OBSERVATIONS AND REMARKS
	SURFACE ELEVATION 217.90				
	PAVEMENT: 85 mm asphalt, over 915 mm granular base, moist	1	GS	-	
1.00 216.90	FILL: Compact, brown, sand and gravel, trace silt, moist	2	SS	19	
		3	SS	12	
2.1 215.8	ORGANIC SILT: Very loose, dark brown to black, silt, trace sand, trace organics, wet	4[1]	SS	1	
		5	SS	1	
3.5 214.4	BOREHOLE TERMINATED AT 3.5 m				Upon completion of augering No water No cave



GRAIN SIZE DISTRIBUTION (%)
GR SA SI&CL

Depth scale (metres): 0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0

NOTES

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CONSULTING ENGINEERS

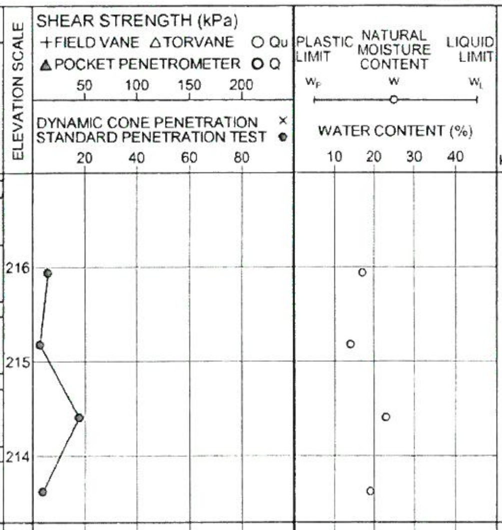
LOG OF BOREHOLE NO. 5

1 of 1

PROJECT Proposed Replacement of Teeswater River Bridge
LOCATION Paisley, Ontario
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE April 13, 2021
PML REF. 21KF009
ENGINEER G.W
TECHNICIAN D. van Esch

SURFACE ELEVATION 217.00

DEPTH ELEV (metres)	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GROUND WATER OBSERVATIONS AND REMARKS
0.28 216.72	PAVEMENT: 75 mm asphalt, over 205 mm granular base, moist	1	GS	-	
	FILL: Very loose to compact, brown to black sand, some silt, trace gravel, to sandy silt, occasional organic and brick fragments, moist to wet	2	SS	6	
		3	SS	3	
2.9 214.1		4	SS	18	El. 214.4
3.7 213.3	ORGANIC CLAYEY SILT: Soft, grey, clayey silt, trace sand, organics, WTPL	5	SS	4	
	BOREHOLE TERMINATED AT 3.7 m				Upon completion of augering Water at 2.7 m Cave at 2.9 m



UNIT WEIGHT kN/m³

GRAIN SIZE DISTRIBUTION (%) GR SA SI&CL

Depth scale (m): 0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0

NOTES

▽ GROUND WATER STRIKE

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 6

1 of 2

PROJECT Proposed Replacement of Teeswater River Bridge
LOCATION Paisley, Ontario
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE April 13, 2021

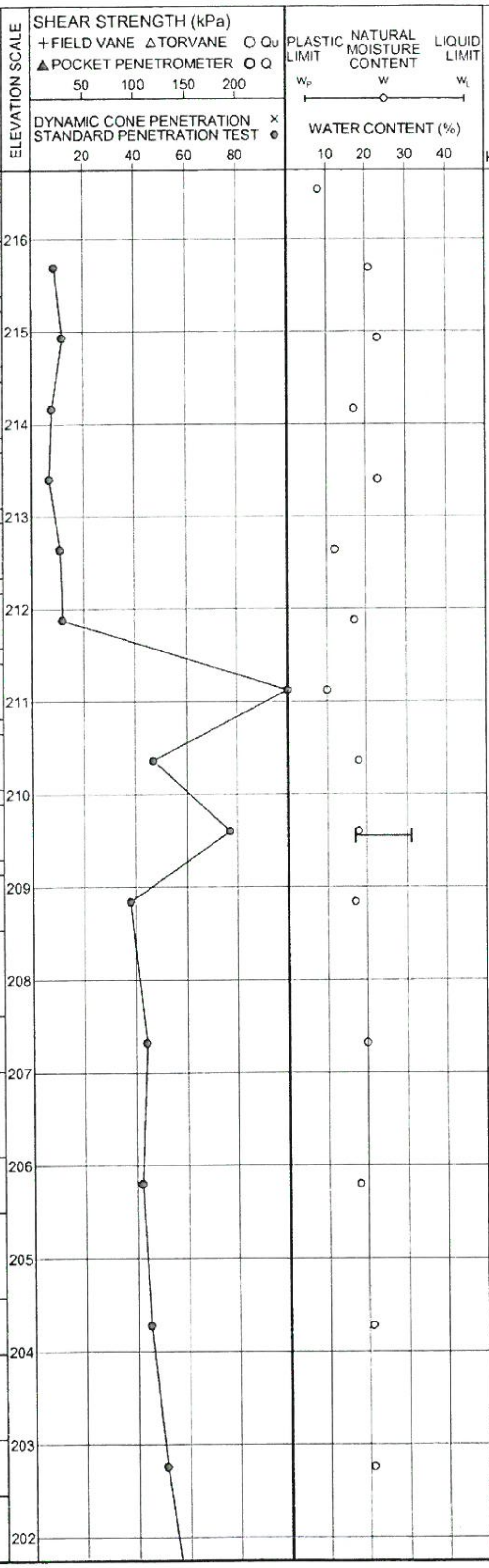
PML REF. 21KF009
ENGINEER G.W
TECHNICIAN D. van Esch

SOIL PROFILE

DEPTH ELEV (metres)	DESCRIPTION
	SURFACE ELEVATION 216.75
0.34 216.42	PAVEMENT: 85 mm asphalt, over 255 mm granular base, slight petroleum odour, moist
	FILL: Loose to compact, dark brown, silty sand, some gravel, occasional rootlets, moist
2.2 214.6	ORGANIC CLAYEY SILT: Firm, dark brown to black, organic clayey silt, WTPL
3.0 213.8	SILT: Loose to very dense, brown to grey, silt, trace to some clay, moist to wet
5.3 211.5	Sand layers, cobbles and boulders
6.1 210.7	CLAYEY SILT: Hard, grey, clayey silt, APL
8.5 208.3	SILT: Dense to very dense, grey, silt, trace to some sand and clay, wet
	CONTINUED

SAMPLES

NUMBER	TYPE	"N" VALUES
1	GS	-
2	SS	9
3	SS	12
4	SS	8
5	SS	7
6	SS	11
7	SS	12
8	SS	100
9	SS	47
10	SS	77
11	SS	38
12	SS	44
13	SS	42
14	SS	45
15	SS	51



GROUND WATER OBSERVATIONS AND REMARKS

GRAIN SIZE DISTRIBUTION (%)
GR SA SI&CL

▽ El. 213.8

NOTES

▽ GROUND WATER STRIKE

PML - BH LOG GEO/ENV WITH MWS 21KF009 BOREHOLE LOGS.GPJ ON_MOT.GDT 7/30/2021 4:56:10 PM

LOG OF BOREHOLE NO. 6

PROJECT Proposed Replacement of Teeswater River Bridge
LOCATION Paisley, Ontario
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE April 13, 2021

PML REF. 21KF009
ENGINEER G.W
TECHNICIAN D. van Esch

SOIL PROFILE			SAMPLES							
DEPTH ELEV (metres)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	SHEAR STRENGTH (kPa) + FIELD VANE △ TORVANE ○ Qu ▲ POCKET PENETROMETER ● Q 50 100 150 200 / DYNAMIC CONE PENETRATION × STANDARD PENETRATION TEST ● 20 40 60 80	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L / WATER CONTENT (%) 10 20 30 40	UNIT WEIGHT kN/m³	GROUND WATER OBSERVATIONS AND REMARKS / GRAIN SIZE DISTRIBUTION (%) GR SA SI&CL
15.0	CONTINUED FROM PREVIOUS PAGE									
201.8	SILT: Dense to very dense, grey, silt, trace to some sand and clay, wet		16	SS	59	201				
15.8 201.0	BOREHOLE TERMINATED AT 15.8 m									Upon completion of augering Water at 3.0 m No cave

NOTES

▽ GROUND WATER STRIKE

LOG OF BOREHOLE NO. 7

1 of 2

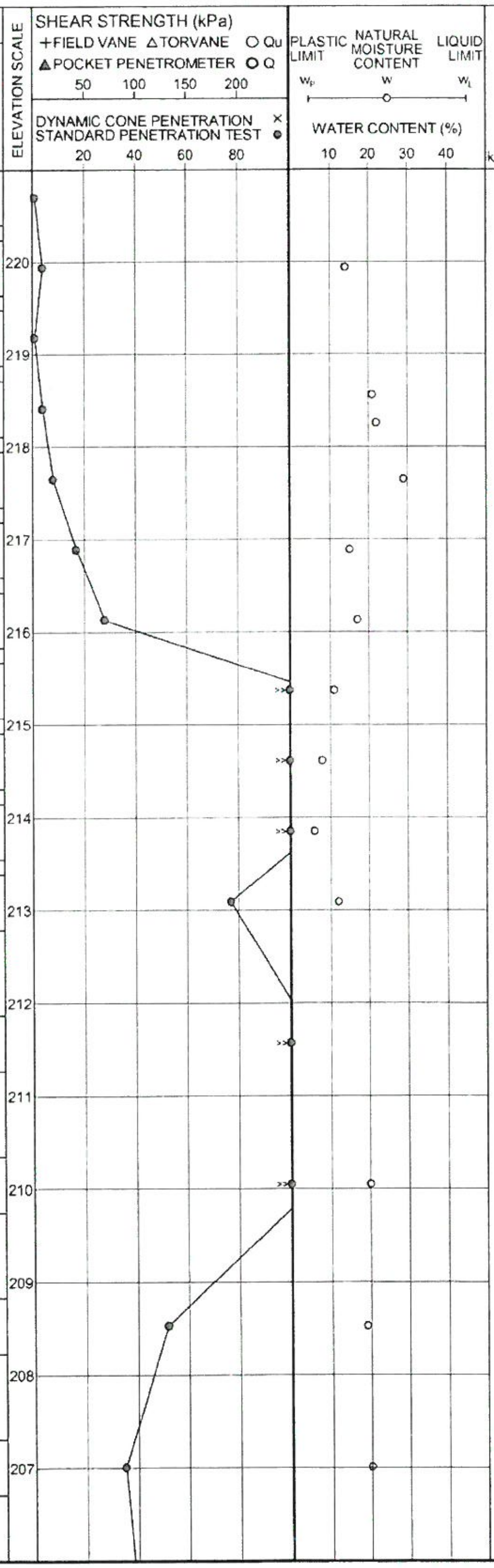
PROJECT Proposed Replacement of Teeswater River Bridge
LOCATION Paisley, Ontario
BORING METHOD Continuous Flight Hollow Stem Augers
BORING DATE April 14, 2021
PML REF. 21KF009
ENGINEER G.W
TECHNICIAN D. van Esch

SOIL PROFILE

DEPTH ELEV (metres)	DESCRIPTION
	SURFACE ELEVATION 221.00
0.0	FILL: Very loose to loose, brown, sand, some gravel, trace silt, occasional rootlets, brick and asphalt fragments, moist to wet
2.6 218.4	ORGANIC CLAYEY SILT: Firm to very stiff, dark brown, organic clayey silt, trace gravel, numerous wood fragments, WTPL
4.5 216.5	SILT: Compact to very dense, brown silt, trace clay, trace sand, moist
7.5 213.5	CLAYEY SILT: Hard, dark brown, clayey silt, trace gravel, APL
10.0 211.0	SILT: Very dense to dense, grey, silt, trace sand, trace clay, wet

SAMPLES

NUMBER	TYPE	"N" VALUES
1	SS	1
2	SS	4
3	SS	1
4a 4b	SS	4
5	SS	8
6	SS	17
7	SS	28
8	SS	50/100mm
9	SS	50/75mm
10	SS	50/50mm
11	SS	77
12	SS	50/75mm
13	SS	50/50mm
14	SS	52
15	SS	35



GROUND WATER OBSERVATIONS AND REMARKS

GRAIN SIZE DISTRIBUTION (%)
GR SA SI&CL

▼ El. 218.9

NOTES

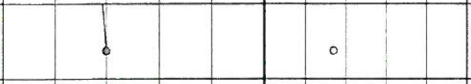
▼ GROUND WATER STRIKE

CONTINUED

LOG OF BOREHOLE NO. 7

PROJECT Proposed Replacement of Teeswater River Bridge
LOCATION Paisley, Ontario
BORING METHOD Continuous Flight Hollow Stem Augers
BORING DATE April 14, 2021
PML REF. 21KF009
ENGINEER G.W
TECHNICIAN D. van Esch

DEPTH ELEV (metres)	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	SHEAR STRENGTH (kPa) +FIELD VANE △TORVANE ○ Qu ▲POCKET PENETROMETER ● Q 50 100 150 200 DYNAMIC CONE PENETRATION × STANDARD PENETRATION TEST ● 20 40 60 80	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%) 10 20 30 40	UNIT WEIGHT kN/m³	GROUND WATER OBSERVATIONS AND REMARKS GRAIN SIZE DISTRIBUTION (%) GR SA SI&CL
15.0	CONTINUED FROM PREVIOUS PAGE									
206.0	SILT: Very dense to dense, grey, silt, trace sand, trace clay, wet		16	SS	40					
15.8 205.2	BOREHOLE TERMINATED AT 15.8 m									Upon completion of augering Water at 1.8 m Cave at 2.0 m



15.0
16.0
17.0
18.0
19.0
20.0
21.0
22.0
23.0
24.0
25.0
26.0
27.0
28.0
29.0
30.0

NOTES

▽ GROUND WATER STRIKE

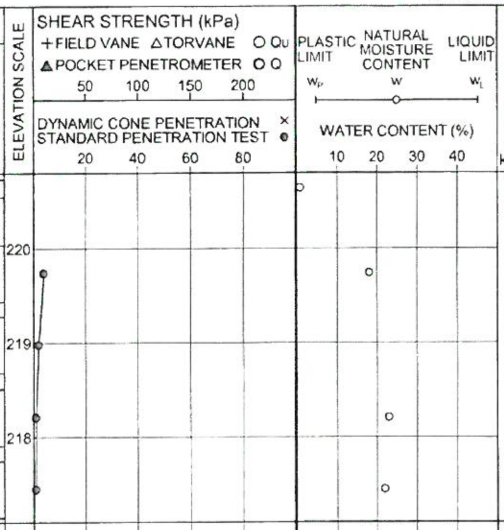
PML Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 8

1 of 1

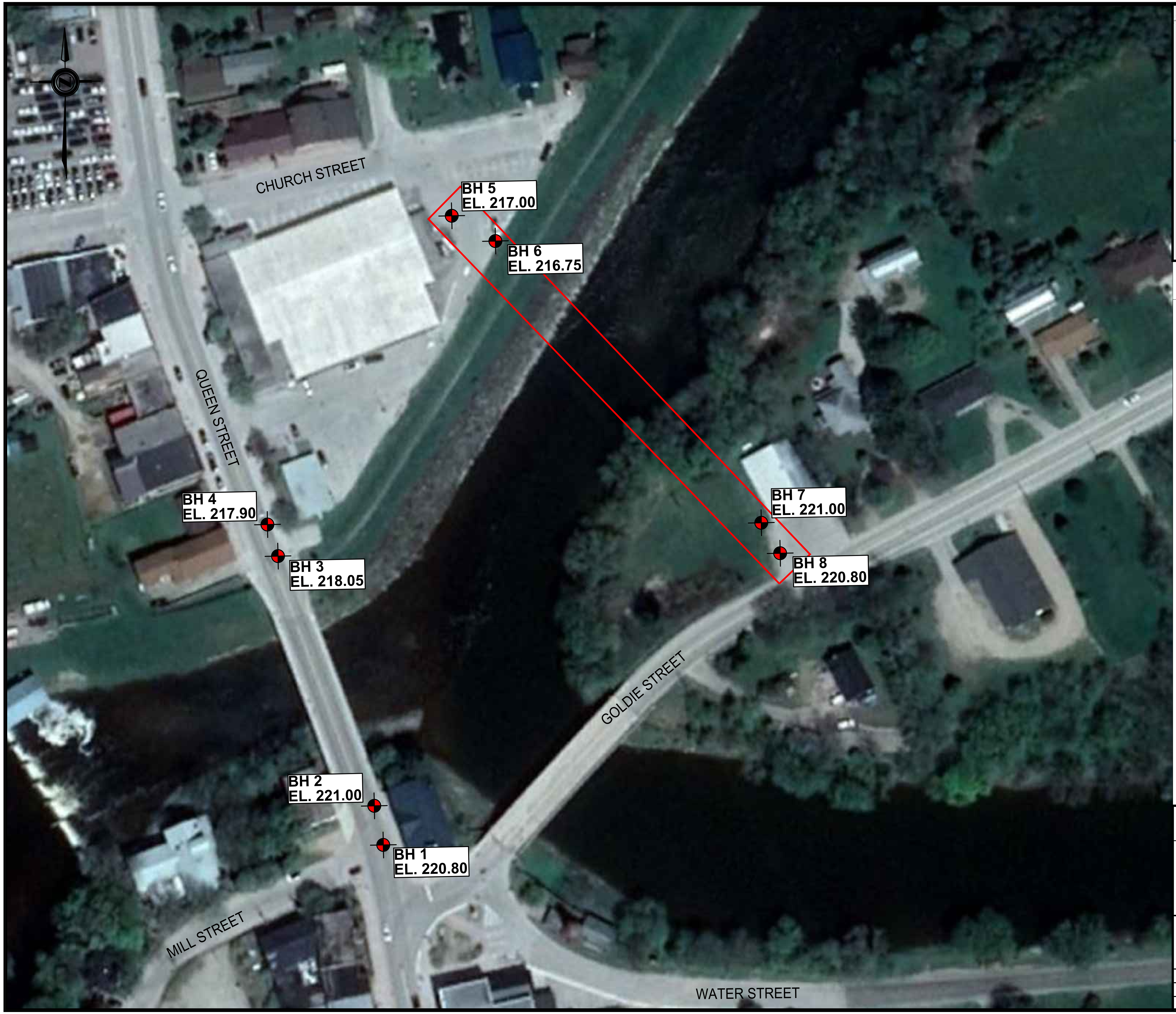
PROJECT Proposed Replacement of Teeswater River Bridge
LOCATION Paisley, Ontario
BORING METHOD Continuous Flight Hollow Stem Augers
BORING DATE April 14, 2021
PML REF. 21KF009
ENGINEER G.W
TECHNICIAN D. van Esch

DEPTH ELEV (metres)	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER OBSERVATIONS AND REMARKS
0.0	SURFACE ELEVATION 220.80				
0.32 220.48	PAVEMENT: 65 mm asphalt, over 255 mm granular base, moist	1	GS	-	
	FILL: Very loose, brown, silty sand to sandy silt, trace gravel, brick fragments, moist	2	SS	4	
2.2 218.6		3	SS	2	
	ORGANIC CLAYEY SILT: Very soft organic clayey silt, trace sand and gravel, numerous wood fragments, WTPL	4	SS	1	▽ El. 217.8
3.7 217.1		5	SS	1	
	BOREHOLE TERMINATED AT 3.7 m				Upon completion of augering Water at 2.9 m No cave



NOTES

▽ GROUND WATER STRIKE



KEY PLAN
PAISLEY, ONTARIO

LEGEND:

⌖ **BH 1** **EL. 220.80**	APPROXIMATE LOCATION OF BOREHOLE 1 SURFACE ELEVATION
▬	APPROXIMATE LOCATION OF TEMPORARY BRIDGE

REFERENCE:
PLAN PRODUCED FROM GOOGLE EARTH IMAGERY, DATED MAY 22, 2020.

BOREHOLE LOCATION PLAN

PROPOSED REPLACEMENT OF TEESWATER RIVER BRIDGE
PAISLEY, ONTARIO

PML Peto MacCallum Ltd.
CONSULTING ENGINEERS

		DATE	SCALE	PML REF.	DRAWING NO.
DRAWN	DvE	SEPT 2021	AS SHOWN	21KF009	1
CHECKED	GW				
APPROVED	BRG				

APPENDIX A

Statement of Limitations

STATEMENT OF LIMITATIONS

This report is prepared for and made available for the sole use of the client named. Peto MacCallum Ltd. (PML) hereby disclaims any liability or responsibility to any person or entity, other than those for whom this report is specifically issued, for any loss, damage, expenses, or penalties that may arise or result from the use of any information or recommendations contained in this report. The contents of this report may not be used or relied upon by any other person without the express written consent and authorization of PML.

This report shall not be relied upon for any purpose other than as agreed with the client named without the written consent of PML. It shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. A portion of this report may not be used as a separate entity: that is to say the report is to be read in its entirety at all times.

The report is based solely on the scope of services which are specifically referred to in this report. No physical or intrusive testing has been performed, except as specifically referenced in this report. This report is not a certification of compliance with past or present regulations, codes, guidelines and policies.

The scope of services carried out by PML is based on details of the proposed development and land use to address certain issues, purposes and objectives with respect to the specific site as identified by the client. Services not expressly set forth in writing are expressly excluded from the services provided by PML. In other words, PML has not performed any observations, investigations, study analysis, engineering evaluation or testing that is not specifically listed in the scope of services in this report. PML assumes no responsibility or duty to the client for any such services and shall not be liable for failing to discover any condition, whose discovery would require the performance of services not specifically referred to in this report.

STATEMENT OF LIMITATIONS
(continued)

The findings and comments made by PML in this report are based on the conditions observed at the time of PML's site reconnaissance. No assurances can be made and no assurances are given with respect to any potential changes in site conditions following the time of completion of PML's field work. Furthermore, regulations, codes and guidelines may change at any time subsequent to the date of this report and these changes may affect the validity of the findings and recommendations given in this report.

The results and conclusions with respect to site conditions are therefore in no way intended to be taken as a guarantee or representation, expressed or implied, that the site is free from any contaminants from past or current land use activities or that the conditions in all areas of the site and beneath or within structures are the same as those areas specifically sampled.

Any investigation, examination, measurements or sampling explorations at a particular location may not be representative of conditions between sampled locations. Soil, ground water, surface water, or building material conditions between and beyond the sampled locations may differ from those encountered at the sampling locations and conditions may become apparent during construction which could not be detected or anticipated at the time of the intrusive sampling investigation.

Budget estimates contained in this report are to be viewed as an engineering estimate of probable costs and provided solely for the purposes of assisting the client in its budgeting process. It is understood and agreed that PML will not in any way be held liable as a result of any budget figures provided by it.

The Client expressly waives its right to withhold PML's fees, either in whole or in part, or to make any claim or commence an action or bring any other proceedings, whether in contract, tort, or otherwise against PML in anyway connected with advice or information given by PML relating to the cost estimate or Environmental Remediation/Cleanup and Restoration or Soil and Ground Water Management Plan Cost Estimate.

APPENDIX B

1977 Log of Borehole and Borehole Location Plan by Others

LOG OF BOREHOLE ..1..................

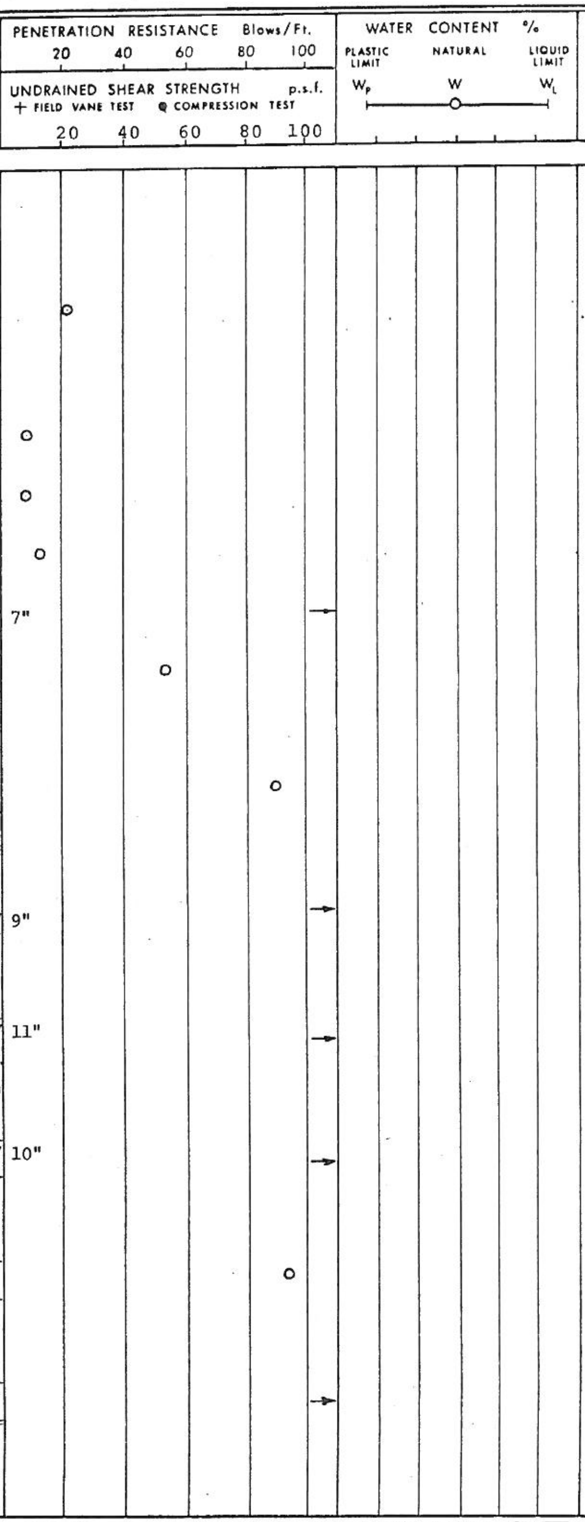
Our Reference No. ..77-2-L6....

Enclosure No. ...3.....

CLIENT: County of Bruce
PROJECT: Teeswater River Bridge
LOCATION: Queen Street, Paisley
DATUM ELEVATION: Cut X on Bridge, El. 720.98 feet

DRILLING DATA
Method: Auger
Diameter: Hollow-stem
Date: March 11, 1977

SUBSURFACE PROFILE					SAMPLES		
ELEVATION Ft.	DEPTH Ft.	DESCRIPTION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' Blows/Ft.
722.9	0.0	Ground Surface					
		1" Asphalt					
720		Sand and gravel. Fill.					
	4.0	Brown silty sand. Fill.			1	SS	22
715	8.0	Brown silty clay. Fill.					
	10.5	Loose brown silty fine sand. Fill.			2	SS	9
710					3	SS	9
					4	SS	13
705	16.0	Very stiff brown silty clay.			5	SS	100/ 7"
	18.5	Very dense grey laminated fine sand, silt and clayey silt.		▼	6	SS	53
700							
					7	SS	90
695							
					8	SS	100/ 9"
690							
					9	SS	100/ 11"
685	36.0	Very dense grey clayey silt, silt seams.					
					10	SS	100/ 10"
680							
					11	SS	93
675							
					12	SS	118
670	51.5	End of Borehole					



REMARKS

VERTICAL SCALE: 1 inch to ft.

DOMINION SOIL INVESTIGATION LIMITED

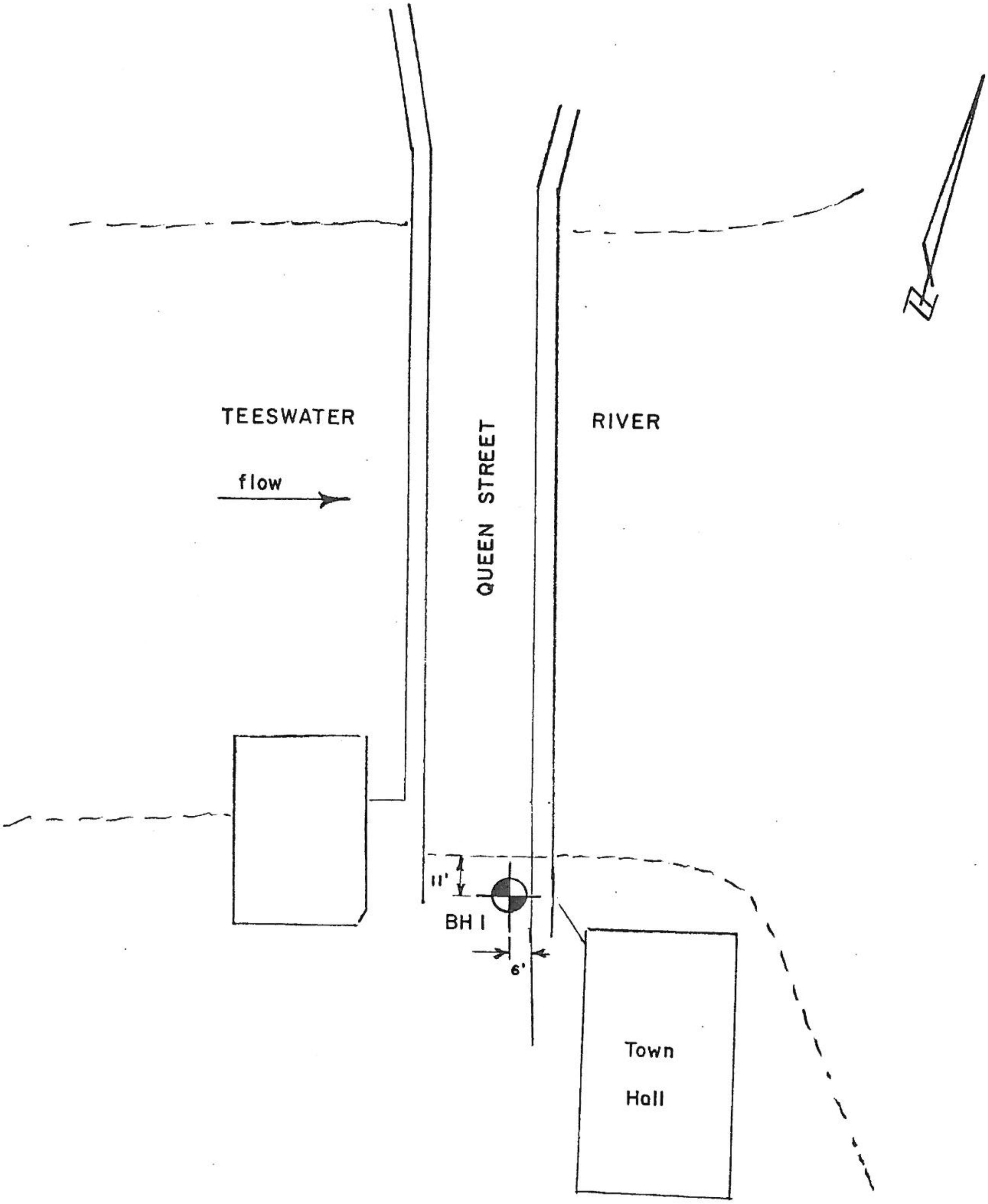
DRAWN:

CHECKED:

Our Ref. No. 77-2-L6

Enclosure No. 2

Prep. By



SITE PLAN
Scale 1" = 40'

DOMINION SOIL INVESTIGATION LIMITED

APPENDIX C

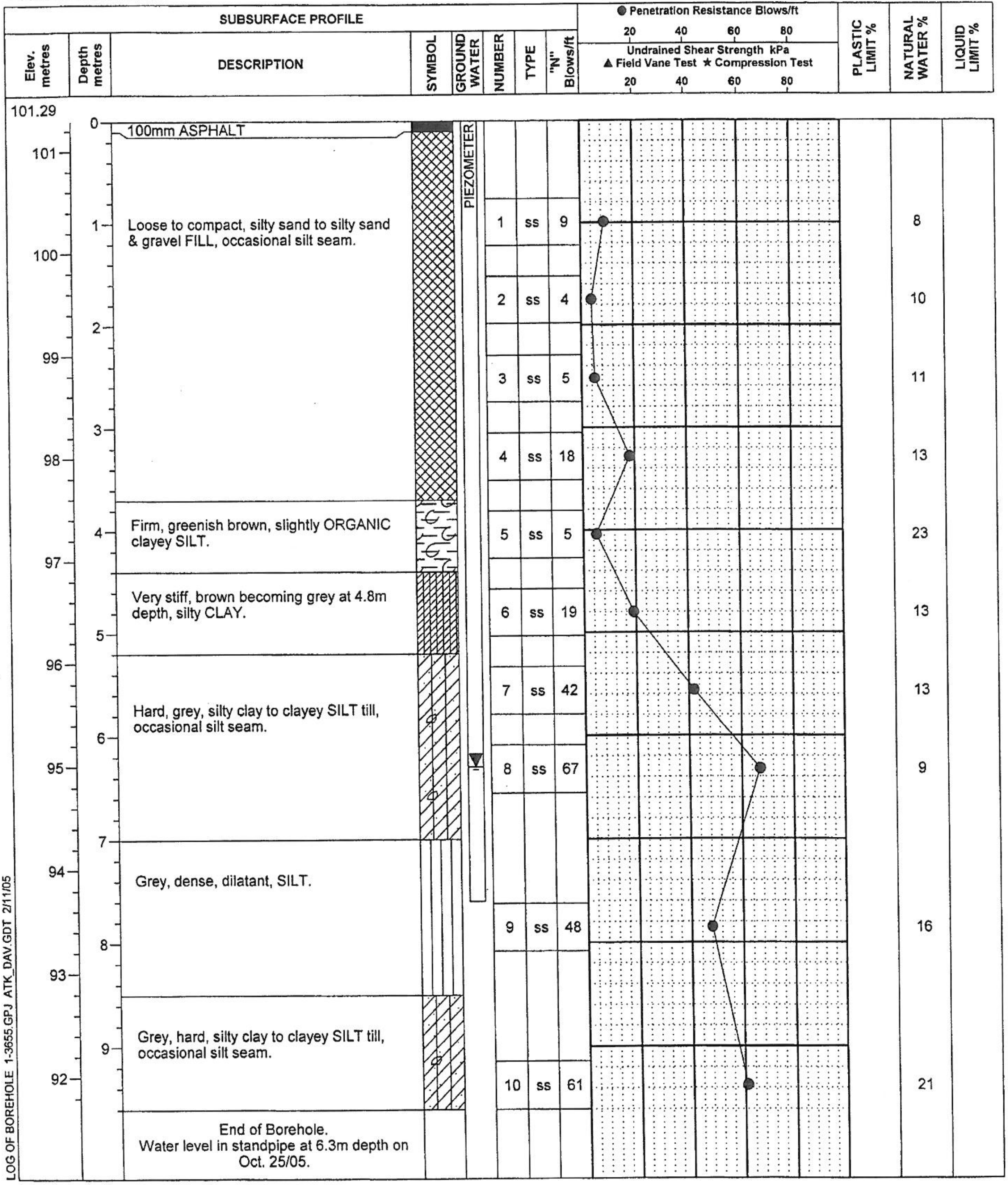
2005 Log of Borehole and Borehole Location Plan by Others

ATKINSON, DAVIES INC. *CONSULTING SOILS AND MATERIALS ENGINEERS*
12 - 60 Meg Drive, London ON N6E 3T6
PHONE (519) 685-6400 FAX (519) 685-0943

REF. NO.: 1-3655
CLIENT: B. M. Ross & Associates Limited
PROJECT: Teeswater River Bridge
LOCATION: Queen Street, Paisley, Ontario
DATUM ELEVATION:

LOG OF BOREHOLE NO. 2

Encl. No. 4 (Sheet 1 of 1)
DRILLING DATA: Marooka Drill Rig
METHOD: Solid Stem Augers
DIAMETER: 150mm
DATE: Oct 24, 2005



DESCRIPTION
100mm ASPHALT
Loose to compact, silty sand to silty sand & gravel FILL, occasional silt seam.
Firm, greenish brown, slightly ORGANIC clayey SILT.
Very stiff, brown becoming grey at 4.8m depth, silty CLAY.
Hard, grey, silty clay to clayey SILT till, occasional silt seam.
Grey, dense, dilatant, SILT.
Grey, hard, silty clay to clayey SILT till, occasional silt seam.
End of Borehole. Water level in standpipe at 6.3m depth on Oct. 25/05.

NUMBER	TYPE	"N" Blows/ft	NATURAL WATER %
1	ss	9	8
2	ss	4	10
3	ss	5	11
4	ss	18	13
5	ss	5	23
6	ss	19	13
7	ss	42	13
8	ss	67	9
9	ss	48	16
10	ss	61	21

Enclosure 2
Ref.: 1-3655