



THURBER ENGINEERING LTD.

**FINAL
FOUNDATION INVESTIGATION AND DESIGN REPORT
REHABILITATION OF BRIDGE STRUCTURE No. 43X-0155/B0
MOORE CREEK BRIDGE HIGHWAY 523
LYELL TOWNSHIP
W.P. 5274-14-01
AGREEMENT NO.: 5015-E-0043**

GEOCRES NUMBER: 31F-199

**SUBMITTED TO
MCINTOSH PERRY CONSULTING ENGINEERS**

Location:

Latitude: 45.488553°
Longitude: -77.973778°

April 2019
Thurber File: 16284

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual data obtained from a foundation investigation conducted by Thurber Engineering Ltd. (Thurber) for the proposed rehabilitation of the Moore Creek Bridge located on Highway 523, within Lyell Township. Thurber carried out the investigation as a subconsultant to McIntosh Perry Consulting Engineers (MPCE) as part of Agreement No. 5015-E-0043.

The purpose of this investigation was to explore the subsurface conditions at the site and, based on this data, provide a borehole location plan, record of boreholes, a stratigraphic profile, laboratory test results and a written description of the subsurface conditions. A base plan survey drawing was provided by MPCE for the preparation of this report.

An earlier foundation investigation report that has been obtained from the Geocres Library in preparation of this report is as follows:

Foundation Investigation Report, Sec. Hwy. #523 Line 'A' and Moore Ck., District of Nipissing, Twp. Of Lyell, District #10 (Bancroft), W.J. 61-F-21, W.P. 256-62 (Geocres 31F00-009), dated April 1965.

The historic boreholes were drilled prior to the re-alignment of Highway 523 and therefore do not reflect current conditions at the existing bridge. Furthermore, the position of the boreholes from the historical report relative to the boreholes completed as part of the current investigation are not known. Therefore, the historic boreholes have been included in Appendix A for information purposes only and have not been included in the description of the subsurface conditions within this report.

2 SITE DESCRIPTION

The existing structure (No. 43X-0155/B0) is located on Highway 523, approximately 1.8 km south of the junction of Highway 60 near Madawaska, Ontario. It is noted that for project orientation purposes, Highway 523 within the project limits, will be described with a north-south alignment. The location of the bridge is shown on the inset Key Plan on Drawing No. 1 in Appendix A.

Within the project limits, Highway 523 is a two-lane highway. Steel guide rails are located on both sides of the highway for a short distance from the bridge. The guide rails north of the bridge transition to a steel 3-cabled guide rail.

The existing bridge, as described in the RFP, is a 30 m single span bridge with a reinforced cast-in-place concrete deck constructed in 1986. The road width is reported to be 8.5 m with an overall width of 9.5 m.

The embankment slopes located adjacent to the abutment are inclined at approximately 1.25 to 1.5H:1V with the surface consisting of mainly rock fill with granular infill material. The north approach embankment extends out into the water approximately 300 m from the shoreline. Based on the survey data, the elevation of the center line of roadway was reported to be approximately 317.1 m and 317.8 m at the north and south abutments, respectively.

Historical Contract Drawings from 1984 indicate that the previous alignment of Highway 523 was west of the current bridge alignment. Adjacent to the west side of the bridge alignment are remnants of a platform used to support a bailey bridge along the original alignment of Highway 523. The topography adjacent to the creek at the site is rolling forested lands with frequent bedrock outcrops. The land in the vicinity of the bridge is mainly single-family dwellings and cottages with the exception of a camp ground which is present southwest of the bridge site. Traffic volumes are understood to be 530 AADT (2013)

Site photographs showing the general conditions at the site during the time of the field investigation are presented in Appendix D.

3 SITE INVESTIGATION AND FIELD TESTING

Thurber contacted Ontario One Call in advance of the field investigation to provide utility locate clearances in the vicinity of the intended boreholes.

The field investigation for this site included advancing three boreholes drilled from May 4, 2017 to May 13, 2017. The northing, easting and elevation of the boreholes are shown on the Borehole Location and Soil Strata Drawing No. 1 in Appendix A and are summarized in Table 3-1.

Table 3-1: Borehole Summary

Borehole No.	Drilled Location	Northing (m)	Easting (m)	Ground Surface Elevation (m)	Depth below Existing Ground Surface (m)
17-1A	North Abutment – southbound lane	5 039 799.3	189 583.6	317.1	13.0
17-1B	North Abutment – southbound lane	5 039 800.1	189 582.9	317.1	24.4
17-2	South Abutment – northbound lane	5 039 783.5	189 629.5	317.8	5.6

All boreholes were advanced through the roadway embankment with a truck mounted CME 75 drill rig equipped with HW/NW casing. The subsurface stratigraphy encountered in the boreholes was recorded in the field by Thurber personnel. Where possible split spoon samples were collected at regular depth intervals in the boreholes via the completion of Standard Penetration Tests (SPT), following the methods described in ASTM Standard D1586. Borehole 17-1B was advanced beyond the sampled depth of 21.7 m while completing a Dynamic Cone Penetration

Test (DCPT). All soil samples recovered from the boreholes were transported to Thurber's Ottawa geotechnical laboratory for further examination and testing.

All boreholes were backfilled with a low-permeability mixture of auger cuttings and bentonite pellets in general accordance with Ontario MOE Regulation 903. Boreholes advanced within paved areas were capped with cuttings followed by 150 mm of cold patch asphalt to reinstate the travelling surface.

The as-drilled locations and ground surface elevation of the boreholes were surveyed by MPCE in July 2017.

3.1 Laboratory Testing

Geotechnical laboratory testing consisted of natural moisture content determination and visual identification of all retained soil samples in accordance with the current MTO standards. Grain size distribution analyses testing was also carried out on selected samples to MTO and ASTM standards. Chemical analysis for determination of pH, resistivity, soluble sulphate and chloride concentrations was carried out on two soil samples.

The results of the geotechnical tests are summarized on the Record of Borehole sheets included in Appendix B and all laboratory results are presented on the figures included in Appendix C.

4 DESCRIPTION OF SUBSURFACE CONDITIONS

4.1 Overview / General

Reference is made to the Record of Borehole sheets in Appendix B for details of the soil stratigraphy encountered in the boreholes. A stratigraphic profile for the bridge area is presented on Drawing No. 1 in Appendix A for illustrative purposes. An overall description of the stratigraphy is given in the following paragraphs; however, the factual data presented in the Record of Boreholes governs any interpretation of the site conditions. It must be recognized that soil and groundwater conditions may vary between and beyond sampled locations.

The stratigraphy in the area of the boreholes through the embankment is generally characterized by the asphalt pavement structure with granular fill and rockfill embankment overlying native silty sand or silt above bedrock.

4.2 Asphalt

All three boreholes were advanced through the Highway 523 pavement structure and encountered asphalt ranging from 75 mm to 130 mm in thickness.

4.3 Fill

4.3.1 Sand Fill

A granular fill layer consisting predominantly of sand with silt and gravel to silty sand with gravel was encountered below the asphalt in boreholes on both sides of the bridge. Cobbles were noted within the granular fill in Borehole 17-2. This fill layer has a thickness ranging from 0.5 m to 2.5 m (base elevation of 315.2 m to 316.5 m). The SPT 'N' values ranged from 41 blows to greater

than 100 blows for 250 mm of penetration; indicating a dense to very dense condition. The higher blow counts could be attributed to the cobbles observed within the fill.

The results of a grain size analysis conducted on one sample of granular fill is summarized in Table 4-1 and illustrated on Figure C1 in Appendix C.

Table 4-1: Gradation Results for Granular Fill

Soil Particle	%
Gravel	39
Sand	51
Silt and Clay	10

4.3.2 Rock Fill

A layer consisting predominantly of rock fill was encountered beneath the granular fill in Boreholes 17-1 and 17-1B. Boreholes were advanced through the rockfill using casing and coring techniques. Sampling was attempted, however due to the nature of this material sample recovery was poor. The voids between rockfill pieces contained a granular material. Wood fragments were encountered in Borehole 17-1 at a depth near 3.0 m. The rockfill layer has a top elevation of 316.3 m to 316.5 m, and a thickness ranging from 6.7 m to 7.1 m. The SPT 'N' values varied from 13 blows to greater than 100 blows for 75 mm of penetration; indicating a compact to very dense condition. The lower N-values were obtained within the granular infill.

Rockfill pieces were cored and indicated particles with diameters ranging from 50 mm to 530 mm. Boulders estimated as large as 1.5 m in diameter were observed on the side slopes of the embankment in the area of the bridge.

4.3.3 Gravel Fill

A second granular fill layer consisting predominantly of gravel with sand was encountered below the rockfill within Boreholes 17-1 and 17-1B. This layer had a thickness ranging from 2.9 m to 3.2 m (bottom elevation of 306.4 m to 306.6 m). The SPT 'N' values typically ranged from 16 to 26 blows indicated a compact relative density. An N-value as high as 100 blows for 250 mm of penetration was encountered and may be attributed to boulders within this fill layer. Sample recovery was found to be very poor within this layer.

The moisture content of the granular fill samples tested ranged from 5% to 11%.

4.4 Silty Sand (SM) to Silt (ML)

A native layer of silty sand to silt was encountered below the fill layers in Boreholes 17-1 and 17-1B. A boulder was observed in this unit in Borehole 17-1, this boulder caused the termination of Borehole 17-1 within this layer. The surface of this deposit ranged in elevation from 306.4 m to 306.6 m and had a thickness of 10.4 m in Borehole 17-1B. The SPT 'N' values ranged from 4 to 25 blows per 0.3 m of penetration; indicating a loose to compact condition.

The moisture content for the samples tested ranged from 19% to 45%. The results of grain size analysis conducted on three samples of this material are summarized in Table 4-2 and are illustrated on Figure C2 in Appendix C.

Table 4-2: Gradation Results for Silty Sand (SM) to Silt (ML)

Soil Particle	%	
Gravel	0 to 3	
Sand	10 to 87	
Silt	66 to 89	10
Clay	1 to 2	

4.5 Silty Sand with Gravel

Underlying the silty sand layer, a native layer of silty sand with gravel was encountered in Borehole 17-1B. The surface of this deposit was found to be 296.2 m in elevation. This layer was inferred using a DCPT to have a thickness of 3.5 m. An SPT 'N' value of 9 blows was obtained from one split spoon within the layer indicating a loose condition.

The moisture content for the sample tested was 11%. Sample recovery was too poor for gradation analysis.

4.6 Bedrock

The overburden materials were underlain by very hard granite bedrock. Borehole 17-2 confirmed bedrock by coring 3.0 m as bedrock is shallow at the north abutment. The bedrock and inferred bedrock surface ranges from elevation 292.7 to 315.2 m as summarized in the table below:

Table 4-3 Summary of Bedrock Elevation

Location	Borehole No.	Depth Below Existing Ground Surface (m)	Top of Bedrock Elevation (m)
North Abutment	17-1B	24.4*	292.7*
South Abutment	17-2	2.6	315.2

Note: (*) inferred through use of a DCPT

The Total Core Recovery (TCR) was 100%, the Solid Core Recovery (SCR) ranged from 63 to 81% and the Rock Quality Designation (RQD) ranged from 54 to 72%. Based on the RQD value the bedrock is classified as fair to good quality.

4.7 Groundwater

Borehole 17-2 was noted to be dry on completion of drilling. A representative water level could not be taken in Boreholes 17-1 and 17-1B due to water remaining within the casing from coring.

The water level in Moore Creek was surveyed by MPCE in May 2017 at an elevation of 313.4 m at the time of Thurber's field investigation.

These observations are considered short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy and/or prolonged precipitation. Due

to the open nature of the rockfill approach embankments, it is expected that the groundwater level will respond rapidly to the water level changes in Moore Creek.

4.8 Results of Analytical Tests

Two samples of soil recovered from within the boreholes were selected and submitted for analytical testing including pH, conductivity, resistivity, chloride and sulphate. The results are summarized below and presented in the Certificate of Analysis included in Appendix C.

Table 4-4: Analytical Results Summary

Borehole	Sample	Depth (m)	pH	Conductivity (μS/cm)	Resistivity (Ohm-cm)	Chloride (μg/g)	Sulphate (μg/g)
17-1	SS7	11.0	5.3	388	2580	7	332
17-2	SS2	1.2	7.3	167	5990	23	46

5 MISCELLANEOUS

Thurber obtained utility clearances prior to drilling and positioned the borehole locations relative to existing site features. MPCE surveyed the borehole locations and ground surface elevations. George Downing Estate Drilling Ltd. of Hawkesbury, Ontario supplied and operated the drilling equipment to carry out the drilling, sampling, in-situ testing and borehole decommissioning. The drilling, and sampling operations in the field were supervised on a full time basis by Mr. Jeffery Morrison, E.I.T. of Thurber. Laboratory testing was carried out in Thurber's MTO-approved laboratory in Ottawa.

Overall project management and direction of the field program was provided by Mr. Stephen Peters, P.Eng. Interpretation of the field data and preparation of this report was completed by Mr. Christopher Murray, M.Sc., P.Eng.. The report was reviewed by Dr. Fred Griffiths, P.Eng. and Dr. P.K. Chatterji, P.Eng., the Designated Principal Contact for MTO Foundations Projects.



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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

6 GENERAL

This section of the report presents interpretation of the factual data in Part 1 of this report for the proposed rehabilitation of the Moore Creek Bridge located on Highway 523, near Madawaska, Ontario. Geotechnical assessment and recommendations are provided to assist the design team with the design of a temporary protection system for the rehabilitation of the abutments.

This foundation investigation and design report with the interpretation and recommendations are intended for the use of the Ministry of Transportation, and shall not be used or relied upon for any other purposes or by any other parties including the construction or design-build contractor. The construction or design-build contractor must make their own interpretation based on the factual data in Part 1 of the report. Where comments are made on construction, they are provided only in order to highlight those aspects which could affect the design of the project. Contractors must make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods and scheduling.

The following sections address the foundation aspects of the design and installation of a temporary protection system required for the rehabilitation of the abutments. The discussions and recommendations presented in this report are based on the information provided by MPCE and on the factual data obtained during the course of the investigation.

6.1 Rehabilitation of Existing Structure

The existing bridge, as described in the RFP, is a 30 m single span bridge with a reinforced cast-in-place concrete deck constructed in 1986. The road width is reported to be 8.5 m with an overall width of 9.5 m. The substructure consists of reinforced concrete abutments supported by spread footings constructed on bedrock at the east abutment and a rockfill pad at the west abutment.

At the time of preparation of this final Foundation Investigation and Design Report, the general arrangement drawing dated April 2018 indicates the proposed rehabilitation will include the removal and repair of deteriorated concrete from the deck, approach slab surface, wingwalls and abutment walls, as well as removing and reconstructing portions of the existing ballast walls and expansion joint.

6.2 Applicable Codes and Design Considerations

The geotechnical assessment presented below has been prepared based on the available data regarding the proposed foundations and existing ground conditions and in accordance with the Canadian Highway Bridge Design Code (CHBDC), version CSA S6-14.

7 GEOTECHNICAL RECOMMENDATIONS

7.1 Temporary Protection Systems

If temporary protection systems are required, they should be provided in accordance with OPSS.PROV 539 and designed for Performance Level 2 (maximum 25 mm horizontal deflection). The actual pressure distribution acting on the shoring systems is a function of the construction sequence and relative flexibility of the wall and these factors must be considered when design the shoring system.

Design of the temporary protection systems is the responsibility of the contractor. All protection systems should be designed by a Professional Engineer experienced in such designs. The design of the roadway protection system must incorporate traffic loading and surcharge loading due to the construction equipment and operations. The Contractor's selection of construction equipment and methodology must include assessment of the capability of the existing embankments to support the proposed construction equipment and any temporary fill.

Driving of sheet piles as roadway protection at this site will be difficult due to the presence of rockfill at the north abutment and cobbles within the fill overlying shallow bedrock at the south abutment. Drilled in soldier piles and lagging is another option. It is recommended that an NSSP be included in the tender documents to alert the Contractor of the stratigraphy and difficulty of driving sheet piles. Bracing of the shoring should be considered.

As a result of shallow bedrock encountered at the south abutment, an alternative staging option could be to widen the embankment to allow for an open cut or utilize a trench box.

7.2 Backfill and Lateral Earth Pressure

Backfill to the structure should be placed in accordance with OPSS 902. All backfill material should consist of Granular A or Granular B Type II meeting OPSS.PROV 1010 specifications. The backfill must be in accordance with OPSS 902 and placed to the extents shown on OPSD 3101.150.

The backfill should be compacted and compaction equipment to be used adjacent to the abutment walls should be restricted in accordance with OPSS.PROV 501. If adequate drainage cannot be confirmed, the potential of hydrostatic pressures should be considered.

Lateral earth pressures acting on structures should be computed in accordance with the CHBDC but, under fully drained conditions, is generally given by the expression:

$$P_h = K^*(\gamma h + q)$$

where:

P_h = horizontal pressure on the wall (kPa)

K = earth pressure coefficient

γ = unit weight of retained soil (kN/m³), to be adjusted for groundwater depth

h = depth below top of fill where pressure is computed (m)

q = value of any surcharge (kPa)

A lateral earth pressure due to backfill compaction should be added to the calculated lateral earth pressure in accordance with Clause 6.12.3 of the CHBDC. The recommended lateral earth pressure parameters for use in the design for a horizontal back-slope are provided in Table 7-1.

Table 7-1 Static Lateral Earth Pressure Coefficients, Horizontal Backslope

Parameter	OPSS Granular A & B Type II	OPSS Granular B Type I	Existing Granular Fill & Native Soils	Existing Rockfill
Soil Unit Weight, kN/m^3 , γ	22.8	21.2	20.0	18.0
Angle of Internal Friction, ϕ	35°	32°	30°	42°
Coefficient of at Rest Earth Pressure, K_o (Restrained Wall)	0.43	0.47	0.50	0.33
Coefficient of Active Earth Pressure, K_a (Unrestrained Wall)	0.27	0.31	0.33	0.20
Coefficient of Passive Earth Pressure, K_p	3.7	3.3	3.0	5.0

For rigid structures, it is recommended that at-rest horizontal lateral earth pressure parameters be used for design. Active pressures should be used for the design of unrestrained walls. The parameters in the table correspond to full mobilization of active and passive earth pressure and require certain relative movements between the wall and adjacent soil to produce these conditions. The values used in design can be assessed from Figure C6.16 of the Commentary to the CHBDC. Where ground surfaces are sloped behind the walls, the earth pressure coefficients must be revised.

Passive earth resistance in front of the walls should be ignored.

7.3 Embankment Design and Reinstatement

Embankment reconstruction should be carried out in accordance with OPSS.PROV 206. The embankment should be reinstated with side slopes of 2H:1V (or flatter) if constructed using Select Subgrade Material (SSM) or Granular B Type I. Alternatively, the embankments could be reconstructed using rockfill with side slopes reinstated at 1.5H:1V (or flatter). If granular material is used over rockfill then the surface of the rockfill must be chinked and a geotextile (Class II non-woven FOS 50 to 150 μm) should be used as a separation layer. Where newly placed embankment fill is placed against a sloping ground surface, benching of the existing slope should be carried out in accordance with OPSD 208.010.

It is understood that no grade raise is anticipated and therefore negligible foundation settlement is expected to occur.

7.4 Cement Type and Corrosion Potential

Two samples of the soil were submitted to Paracel Laboratories in Ottawa, Ontario for analysis of pH, water soluble sulphate and chloride concentrations, resistivity and conductivity. The analysis was completed to determine the potential for degradation of the concrete in the presence of soluble sulphates and the potential for corrosion of exposed steel used in foundations and buried infrastructure. The analysis results are summarized in the Table 4-4.

The concentration of soluble sulphate provides an indication of the degree of sulphate attack that is expected for concrete in contact with soil and groundwater at the site. Soluble sulphate concentrations less than 1000 µg/g generally indicate that a low degree of sulphate attack is expected for concrete in contact with soil and groundwater. The class of concrete selected should consider the effects of road de-icing salts.

The pH, resistivity and chloride concentration provide an indication of the degree of corrosiveness of the sub-surface environment. The test results provided in the Table 4-4 may be used to aid in the selection of coatings and corrosion protection systems for buried steel objects. The effects of road de-icing salts should also be considered.

8 CONSTRUCTION CONSIDERATIONS

8.1 Excavations

All excavations must be conducted in accordance with the requirements of the Occupational Health & Safety Act & Regulations (OHSA) for Construction Projects. The fills and native soils above the water table at the site should be classified as Type 3 soils. All soils below the water table are considered to be Type 4 soils unless dewatering is carried out.

At locations where there are space restrictions or where a slope must be retained, the excavations will need to be carried out within a protection system as discussed in Section 7.1. Design of the temporary protection system is the responsibility of the Contractor.

8.2 Dewatering

Design of dewatering systems is the responsibility of the Contractor. The depth of excavation is not expected to extend below the creek level observed at the time of the investigation. The Contractor must be prepared to control the groundwater and surface water flow at the site to permit construction in a dry and stable excavation. Water from either surface flow and/or groundwater must be diverted away from any excavation at all times. Groundwater perched within the embankment fill and, surface runoff will tend to seep into, and accumulate in excavations.

Dewatering design and decisions regarding dewatering, must be carried out by the Contractor. However, it is anticipated that conventional sump and pump techniques should be sufficient for excavations in the upper Granular fill and rockfill.

Should excavations need to extend to below the creek level there will be significant challenges to maintaining dry conditions due to the presence of the rock fill at the north approach. The excavation would require full enclosure by shoring and the placement of a tremie concrete plug prior to dewatering.

8.3 Erosion Control and Scour Protection

Slope protection and drainage measures will be required to ensure the long-term surficial stability of the reinstated embankment slopes. Slope vegetation should be established as soon as possible after completion of the embankment fills in order to control surficial erosion in general accordance with OPSS.PROV 804. The contractor should provide silt fences and erosion control blankets, as required, throughout the duration of the construction to prevent silt/sediment from running off the site as per OPSS 805.

Scour and erosion protection should be confirmed to be adequate along the banks in the area of the bridge. Design of the scour and erosion protection measures must consider hydrologic and hydraulic concerns and should be carried out by specialists experienced in the field. Typically, rock protection should be provided over all earth surfaces subjected to flowing water in accordance with OPSS 511.

9 CONSTRUCTION CONCERNS

Potential construction concerns include, but are not necessarily limited to, the following:

- Cobbles, boulders and rockfill or other buried obstructions will be encountered in the existing approach embankments. An NSSP should be included in the contract alerting the Contractor to these conditions. Driving of sheet piles will be difficult.
- Seasonal fluctuations of the groundwater and creek level are to be expected which may impact the construction. Dewatering in rockfill below the water level will be difficult.
- The Contractor's selection of construction equipment and methodology must include assessment of the capability of the existing embankments to support the proposed construction equipment and any temporary fill.

The successful outcome of the project will depend largely upon good workmanship and quality control during construction.

10 CLOSURE

Engineering analysis and preparation of this report was completed by Mr. Stephen Peters, P.Eng and Mr. Christopher Murray, P.Eng.. The report was reviewed by Dr. Fred Griffiths, P.Eng. and Dr. P.K. Chatterji, P.Eng., the Designated Principal Contact for MTO Foundations Projects.



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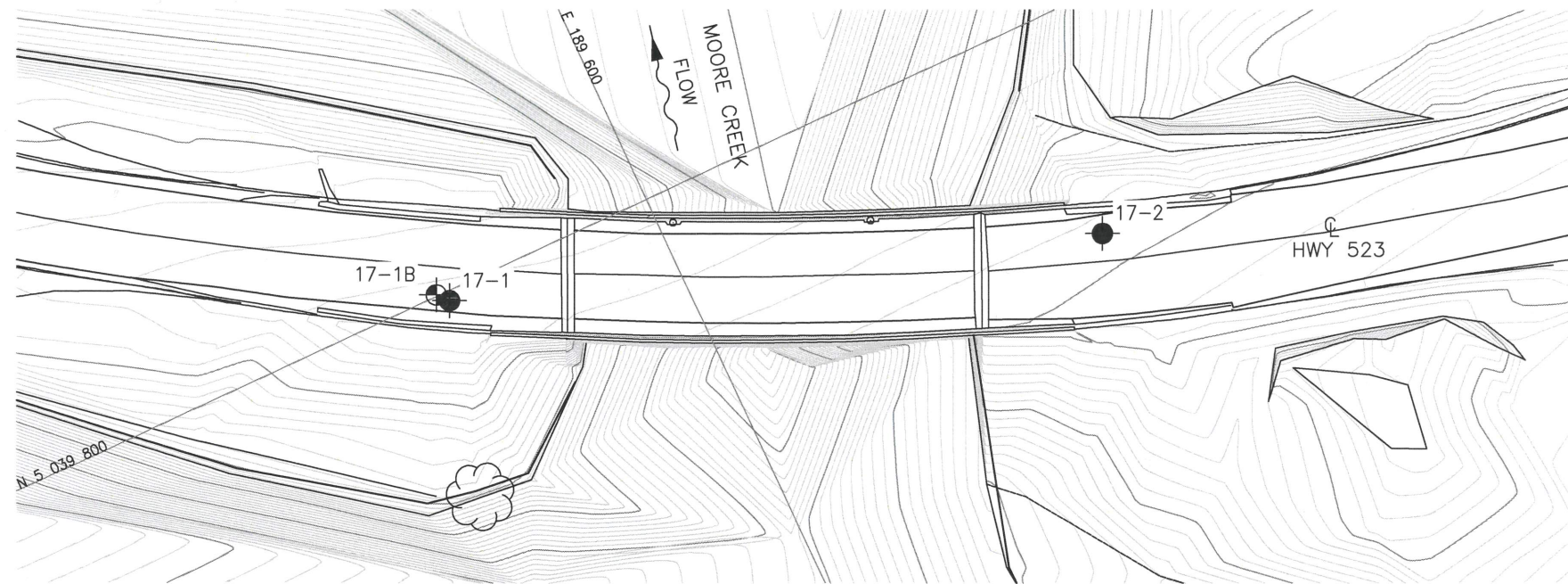


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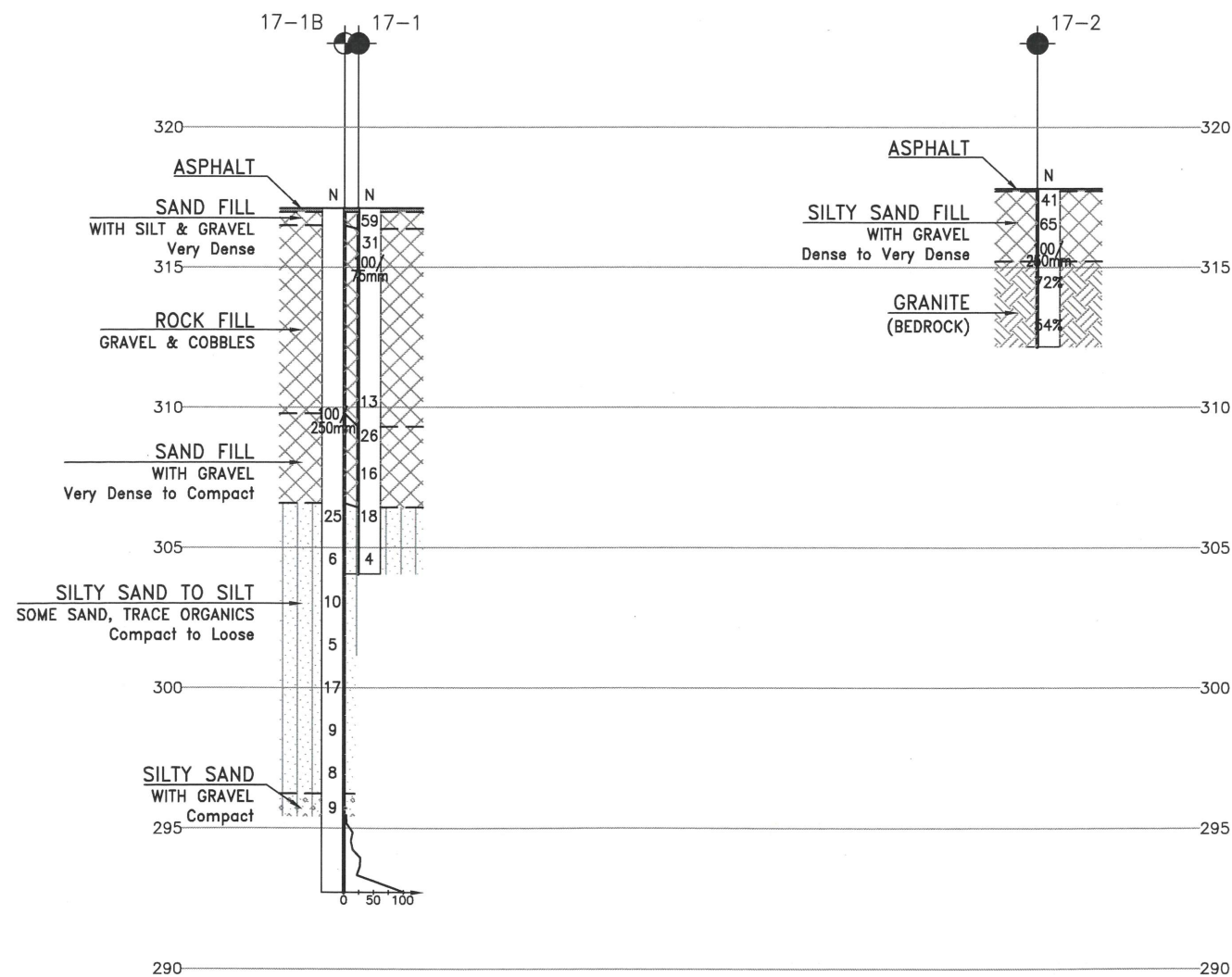


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APPENDIX A
DRAWINGS



PLAN
SCALE 1:500



PROFILE ALONG C HWY 523

SCALE 1:500
H 1:500
V 1:250

METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
WP No 5274-14-01

HIGHWAY 523
MOORE CREEK BRIDGE
REHABILITATION
BOREHOLE LOCATIONS AND SOIL STRATA

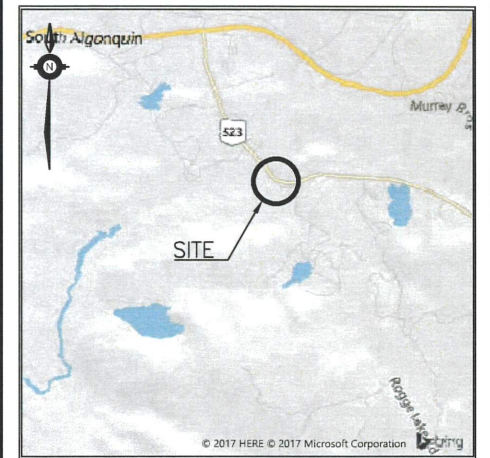


SHEET

McINTOSH PERRY



THURBER ENGINEERING LTD.



KEYPLAN
LEGEND

- Borehole
- Borehole and Cone
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- Water Level
- Head Artesian Water
- Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
17-1	317.1	5 039 799.3	189 583.6
17-1B	317.1	5 039 800.1	189 582.9
17-2	317.8	5 039 783.5	189 629.5

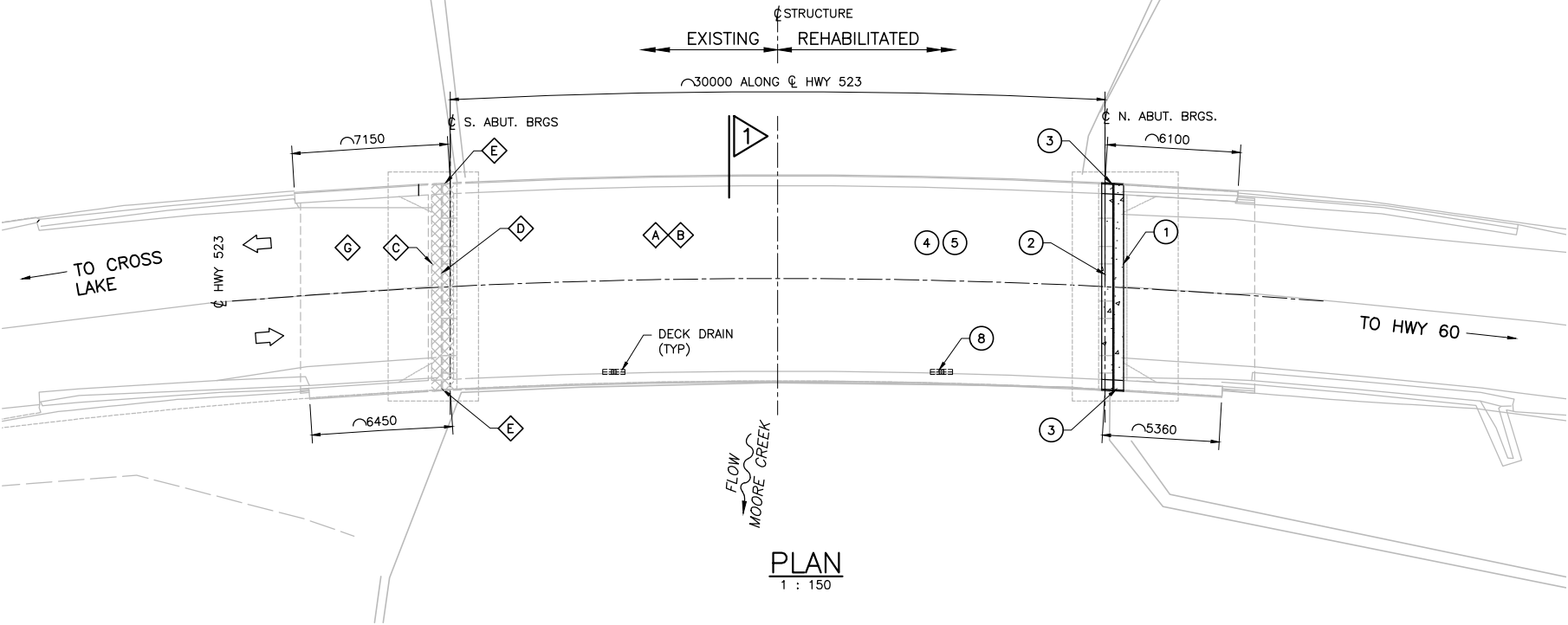
-NOTES-

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

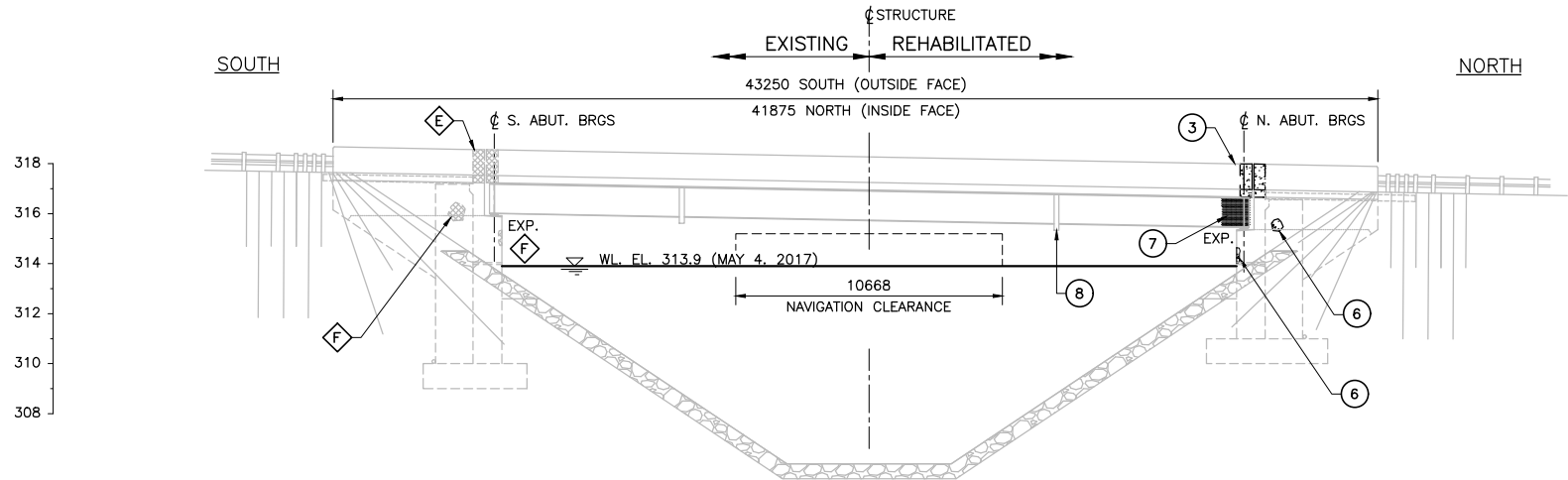
GEORES No. 31F-199



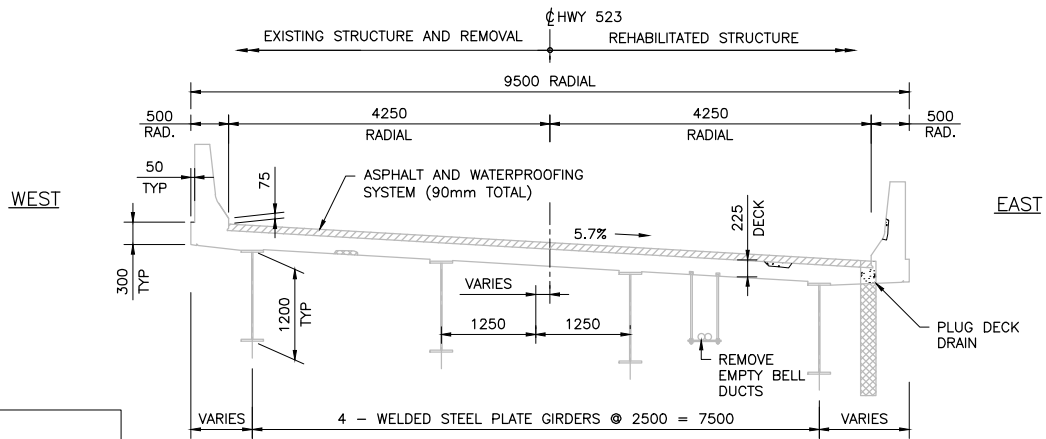
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PLAN
1 : 150

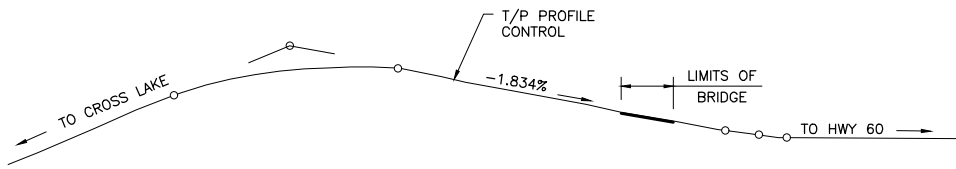


ELEVATION
1 : 150



BENCHMARK:

302 BM 314.683 SPK/W N ROOT 2x300 Ø BIRCH



PROFILE OF HWY 523
N.T.S.

LEGEND:

- CONCRETE AND ASPHALT REMOVAL
- NEW ASPHALT
- NEW CONCRETE

SCOPE OF REHABILITATION WORK:

THE GENERAL SCOPE OF THE REHABILITATION WORK OUTLINED BELOW AND DESIGNATED ON THIS DRAWING SHALL BE CONSIDERED SIMILAR ON EACH SIDE OF THE CENTERLINE OF THE BRIDGE, UNLESS NOTED OTHERWISE. THIS IS NOT MEANT TO BE AN EXHAUSTIVE LIST OR INDICATE THE ORDER IN WHICH OPERATIONS SHOULD TAKE PLACE.

REMOVALS:

- REMOVE EXISTING ASPHALT AND WATERPROOFING FROM DECK.
- REMOVE DELAMINATED AND DETERIORATED CONCRETE FROM DECK AND APPROACH SLAB SURFACES.
- REMOVE PORTIONS OF TOP OF EXIST. BALLAST WALLS AND EXPANSION JOINT ASSEMBLIES.
- REMOVE EXPANSION JOINT CONCRETE DAMS AND JOINT ASSEMBLY.
- REMOVE PORTION OF EXIST. BARRIER WALLS.
- REMOVE DETERIORATED CONCRETE FROM DECK SOFFIT, WINGWALLS, ABUTMENT WALLS AND INTERIOR & EXTERIOR FASCIA OF BARRIER WALLS.
- REMOVE EXISTING ASPHALT FROM APPROACH SLAB.
- REMOVE EMPTY BELL DUCTS UNDER THE BRIDGE.
- OTHER AS SHOWN AND/OR SPECIFIED IN THE CONTRACT
- NOT INTENDED SEQUENCE OF REMOVALS.

NEW CONSTRUCTION:

- RECONSTRUCT PORTION OF TOP OF BALLAST WALLS.
- RECONSTRUCT EXPANSION JOINT CONCRETE DAMS AND INSTALL EXPANSION JOINT ASSEMBLY.
- RECONSTRUCT PORTIONS OF BARRIER WALLS.
- REPAIR DETERIORATED AREAS ON TOP OF DECK AND APPROACH SLAB.
- WATERPROOF AND PAVE THE DECK AND APPROACH SLABS TO THE LIMITS SHOWN ON THE DRAWINGS.
- REPAIR DETERIORATED AREAS AT DECK SOFFIT, WINGWALLS, ABUTMENT WALLS, AND INTERIOR & EXTERIOR FASCIA OF BARRIER WALLS. APPLY CONCRETE SEALER TO EAST WINGWALLS.
- COATING ENDS OF EXISTING GIRDERS.
- PLUG DECK DRAIN HOLES WITH CONCRETE.
- OTHER AS SHOWN AND/OR SPECIFIED IN THE CONTRACT
- NOT INTENDED SEQUENCE OF NEW CONSTRUCTION.

METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

HWY 523
CONT. No. 2019-5006
WP No. 5274-14-00



MOORE CREEK BRIDGE
REHABILITATION
GENERAL ARRANGEMENT

SHEET
01

McINTOSH PERRY

GENERAL NOTES:

- CLASS OF CONCRETE: 30 MPa
CLEAR COVER TO REINFORCING STEEL:
-DECK TOP 70 ± 20
-DECK BOTTOM 40 ± 10
-REMAINDER 70 ± 20
UNLESS OTHERWISE NOTED
- REINFORCING STEEL:**
 - REINFORCING STEEL SHALL BE GRADE 400W.
 - UNLESS SHOWN OTHERWISE, TENSION LAP SPLICES FOR REINFORCING STEEL BARS SHALL BE CLASS B.
 - STAINLESS REINFORCING STEEL SHALL BE TYPE 316LN OR DUPLEX 2205 AND HAVE A MINIMUM YIELD STRENGTH OF 500 MPa, UNLESS OTHERWISE SPECIFIED,
 - BAR MARKS WITH PREFIX 'S' DENOTE STAINLESS STEEL BARS.
 - BAR HOOKS SHALL HAVE STANDARD HOOK DIMENSIONS USING MINIMUM BEND DIAMETERS, WHILE STIRRUPS AND TIES SHALL HAVE MINIMUM HOOK DIMENSIONS. ALL HOOKS SHALL BE IN ACCORDANCE WITH THE STRUCTURAL STANDARD DRAWING SS12-1, UNLESS INDICATED OTHERWISE.

CONSTRUCTION NOTES:

- CONTRACTOR SHALL OBTAIN LOCATES PRIOR TO PROCEEDING WITH CONSTRUCTION OPERATIONS.
- INFORMATION OF EXISTING STRUCTURE SHOWN WAS TAKEN FROM THE ORIGINAL DESIGN DRAWINGS. THE CONTRACTOR SHALL VERIFY ALL RELEVANT DIMENSIONS, ELEVATIONS, STATIONS AND DETAILS ON SITE AND REPORT ANY DISCREPANCIES TO THE DESIGN ENGINEER PRIOR TO PROCEEDING WITH REHABILITATION WORK.
- TYPICAL AREAS OF REPAIRS ARE INDICATED ON THE DRAWINGS WHERE REPAIR LIMITS ARE NOT SHOWN, LIMITS SHALL BE INDICATED BY THE CONTRACT ADMINISTRATOR.
- SAWCUT IN CONCRETE, WHERE DESIGNATED SHALL BE 25mm DEEP OR TO THE FIRST LAYER OF REINFORCING STEEL, WHICHEVER IS LESS. SAWCUT SURFACES AGAINST WHICH NEW CONCRETE WILL BE PLACED SHALL BE ROUGHENED.
- THE CONTRACTOR SHALL PROVIDE DEBRIS PLATFORMS AND NECESSARY CONTAINMENT MEASURES TO COLLECT FALLING CONCRETE AND CONSTRUCTION DEBRIS AND ENSURE THAT NO DEBRIS OR MATERIALS RESULTING FROM THE REMOVAL WORK FALLS ON WATERWAYS AND OTHER AREAS BELOW THE BRIDGES.

LIST OF ABBREVIATIONS:

T/CONC. DENOTES TOP OF CONCRETE
EL. DENOTES ELEVATION
BRGS DENOTES BEARINGS
ABUT. DENOTES ABUTMENT
TYP DENOTES TYPICAL
WP DENOTES WORKING POINT
STA. DENOTES STATION
NTS DENOTES NOT TO SCALE
T/FTG DENOTES TOP OF FOOTING

DRAWING LIST:

R1-1 GENERAL ARRANGEMENT
R1-2 CONSTRUCTION STAGING
R1-3 REMOVALS
R1-4 REPAIRS - DIMENSIONS
R1-5 REPAIRS - REINFORCEMENT
R1-6 STRIP SEAL EXPANSION JOINT - ASSEMBLY FOR BARRIER WALLS
R1-7 STRIP SEAL EXPANSION JOINT - TYPE 'C' DETAILS
R1-8 MISCELLANEOUS & STANDARD DETAILS

REVISIONS	DATE	BY	REV	DESCRIPTION
DESIGN	DS	CHK	TT	CODE CHBDC-14 LOAD CL-625-ONT DATE APR/18
DRAWN	HCG	CHK	DS	SITE 43X-0155/B0 STRUCT SCHEME DWG R1-01

APPENDIX B
RECORD OF BOREHOLE SHEETS



SYMBOLS, ABBREVIATIONS AND TERMS USED ON TEST HOLE RECORDS

TERMINOLOGY DESCRIBING COMMON SOIL GENESIS

Topsoil	mixture of soil and humus capable of supporting vegetative growth
Peat	mixture of fragments of decayed organic matter
Till	unstratified glacial deposit which may include particles ranging in sizes from clay to boulder
Fill	material below the surface identified as placed by humans (excluding buried services)

TERMINOLOGY DESCRIBING SOIL STRUCTURE:

Desiccated	having visible signs of weathering by oxidization of clay materials, shrinkage cracks, etc.
Fissured	having cracks, and hence a blocky structure
Varved	composed of alternating layers of silt and clay
Stratified	composed of alternating successions of different soil types, e.g. silt and sand
Layer	> 75 mm in thickness
Seam	2 mm to 75 mm in thickness
Parting	< 2 mm in thickness

RECOVERY:

For soil samples, the recovery is recorded as the length of the soil sample recovered.

N-VALUE:

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 63.5 kg hammer falling 0.76 m, required to drive a 50 mm O.D. split spoon sampler 0.3 m into undisturbed soil. For samples where insufficient penetration was achieved and N-value cannot be presented, the number of blows are reported over the sampler penetration in millimetres (e.g. 50/75).

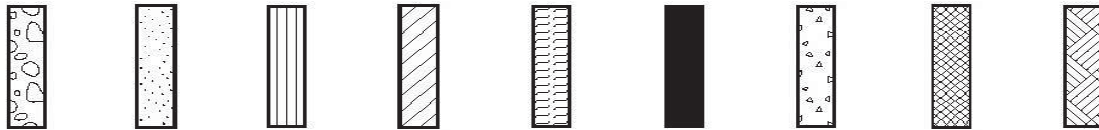
DYNAMIC CONE PENETRATION TEST (DCPT):

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to an "A" size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone 0.3 m into the soil. The DCPT is used as a probe to assess soil variability.



STRATA PLOT:

Strata plots symbolize the soil and bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders
Cobbles
Gravel Sand Silt Clay Organics Asphalt Concrete Fill Bedrock

TEXTURING CLASSIFICATION OF SOILS

Classification	Particle Size
Boulders	Greater than 200 mm
Cobbles	75 – 200 mm
Gravel	4.75 – 75 mm
Sand	0.075 – 4.75 mm
Silt	0.002 – 0.075 mm
Clay	Less than 0.002 mm

TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

Descriptive Term	Undrained Shear Strength (kPa)
Very Soft	12 or less
Soft	12 – 25
Firm	25 – 50
Stiff	50 – 100
Very Stiff	100 – 200
Hard	Greater than 200

NOTE: Clay sensitivity is defined as the ratio of the undisturbed strength over the remolded strength.

SAMPLE TYPES

SS	Split spoon samples
ST	Shelby tube or thin wall tube
DP	Direct push sample
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ etc.	Rock core sample obtained with the use of standard size diamond coring equipment

TERMS DESCRIBING CONSISTENCY (COHESIONLESS SOILS ONLY)

Descriptive Term	SPT "N" Value
Very Loose	Less than 4
Loose	4 – 10
Compact	10 – 30
Dense	30 – 50
Very Dense	Greater than 50

MODIFIED UNIFIED SOIL CLASSIFICATION

Major Divisions		Group Symbol	Typical Description
COARSE GRAINED SOIL	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILT AND CLAY SOILS $W_L < 35\%$	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		OL	Organic silts and organic silty-clays of low plasticity.
	SILT AND CLAY SOILS $35\% < W_L < 50\%$	MI	Inorganic compressible fine sandy silt with clay of medium plasticity, clayey silts.
		CI	Inorganic clays of medium plasticity, silty clays.
		OI	Organic silty clays of medium plasticity.
	SILT AND CLAY SOILS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy of silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other organic soils.

Note - W_L = Liquid Limit



EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock materials.
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structures are preserved.

TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1 m in length or larger, as a percentage of total core length
Unconfined Compressive Strength: (UCS)	Axial stress required to break the specimen.
Fracture Index: (FI)	Frequency of natural fractures per 0.3 m of core run.

DISCONTINUITY SPACING

Bedding	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 to 2 m
Medium bedded	0.2 to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 to 60 mm
Laminated	6 to 20 mm
Thinly laminated	Less than 6 mm

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)
Extremely Strong	Greater than 250
Very Strong	100 – 250
Strong	50 – 100
Medium Strong	25 – 50
Weak	5 – 25
Very Weak	1 – 5
Extremely Weak	0.25 – 1

RECORD OF BOREHOLE No 17-1

1 OF 2

METRIC

WP# 5274-14-01 LOCATION Lat: 45.488605°, Long: -77.973999°
Moore Creek Bridge, MTM z9: N 5 039 799.3 E 189 583.6 ORIGINATED BY JM
HWY 523 BOREHOLE TYPE NW Casing COMPILED BY DJP
DATUM Geodetic DATE 2017.05.11 - 2017.05.11 CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				
												W P W L				
317.1							20 40 60 80 100									
0.0	130 mm ASPHALT															
0.1	SAND with Silt and Gravel Very Dense Brown		1	SS	59											
316.3	FILL															
0.7	ROCK FILL - Cobbles/Gravel from 0.7 m to 1.2 m		2	SS	31											
	- Cobbles/Gravel from 1.5 m to 2.0 m															
			3	SS	100/ 75mm											
	- Cobbles/Gravel from 2.7 m to 6.6 m															
	- Wood fragments plugging casing around 3.0 m															
	- 175 mm Boulder at 5.1 m															
	- 150 mm Boulder at 5.4 m															
	- Cobbles from 6.6 m to 7.8 m		4	SS	13											
309.3	GRAVEL with Sand Compact Grey to Brown FILL		5	SS	26											
7.8																
			6	SS	16											

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 17-1

2 OF 2

METRIC

WP# 5274-14-01 LOCATION Lat: 45.488605°, Long: -77.973999°
Moore Creek Bridge, MTM z9: N 5 039 799.3 E 189 583.6 ORIGINATED BY JM
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SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page							20 40 60 80 100						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
						20 40 60 80 100				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W P W W L WATER CONTENT (%) 20 40 60				
306.4	GRAVEL with Sand Compact Grey to Brown FILL						307							
10.7	Silty SAND (SM) to SILT (ML) some Sand, trace Organics near surface Compact to Loose Brown		7	SS	18		306							
							305							
304.0	- 150 mm Boulder at 12.8 m		8	SS	4									
13.0	Boulder at 12.8 m caused casing to shear apart, Borehole abandoned at 13.0 m, Offset 1 m to Borehole 17-1B													

+³, ×³: Numbers refer to
Sensitivity 20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 17-1B

1 OF 3

METRIC

WP# 5274-14-01 LOCATION Lat: 45.488612°, Long: -77.974008°
Moore Creek Bridge, MTM z9: N 5 039 800.1 E 189 582.9 ORIGINATED BY JM
HWY 523 BOREHOLE TYPE HW Casing / NW Casing COMPILED BY DJP
DATUM Geodetic DATE 2017.05.12 - 2017.05.13 CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
							20	40	60	80	100	20	40	60			
317.1																	
0.0	130 mm ASPHALT						317										
0.1	SAND with Silt and Gravel																
316.5	Very Dense																
0.6	Brown																
	FILL																
	ROCK FILL																
	Frequent Cobbles						316										
							315										
							314										
							313										
							312										
							311										
	- 530 mm Boulder at 6.4 m						310										
309.8																	
7.3	GRAVEL with Sand																
	Very Dense																
	Brown																
	FILL		1	SS	100/												
					250mm												
	- 200 mm Boulder at 8.0 m						309										
							308										

Continued Next Page

+³, ×³: Numbers refer to Sensitivity
20
15
10
(%) STRAIN AT FAILURE

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 17-1B

3 OF 3

METRIC

WP# 5274-14-01 LOCATION Lat: 45.488612°, Long: -77.974008°
Moore Creek Bridge, MTM z9: N 5 039 800.1 E 189 582.9 ORIGINATED BY JM
HWY 523 BOREHOLE TYPE HW Casing / NW Casing COMPILED BY DJP
DATUM Geodetic DATE 2017.05.12 - 2017.05.13 CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
								20 40 60 80 100	PLASTIC LIMIT	NATURAL MOISTURE CONTENT		
	Continued From Previous Page											
296.2	Silty SAND (SM) to SILT (ML) some Sand, trace Organics near surface Compact to Loose Brown to Grey		8	SS	8		297					
20.9	Silty SAND with Gravel Loose Grey		9	SS	9		296					
295.4												
21.7	End of Sampled Borehole, Start of DCPT Inferred Silty SAND with Gravel						295					
							294					
292.7							293					
24.4	End of DCPT at 24.4 m on Probable Bedrock											

+³, ×³: Numbers refer to Sensitivity
20
15 10 5 0
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 17-2

1 OF 1

METRIC

WP# 5274-14-01 LOCATION Lat: 45.488471°, Long: -77.973408°
Moore Creek Bridge, MTM z9: N 5 039 783.5 E 189 629.5 ORIGINATED BY JM
HWY 523 BOREHOLE TYPE NW Casing / NQ Coring COMPILED BY DJP
DATUM Geodetic DATE 2017.05.04 - 2017.05.04 CHECKED BY SP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				W P W W L																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				WATER CONTENT (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
317.8								20	40	60	80	100																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			

DOUBLE LINE 16284 MOORE CREEK BRIDGE.GPJ 2012TEMPLATE(MTO).GDT 3/4/19

Borehole 17-2
Core Box 1 of 2
Elevation 94.3 m to 92.1 m



Borehole 17-2
Core Box 2 of 2
Elevation 92.1 m to 91.2 m



Foundation Investigation
Moore Creek Bridge
Structure No. 43-155
Lyell Township, Ontario

WP: 5274-14-01
Project No.: 16284

ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL. THE DRIVING ENERGY BEING 350 FOOT POUNDS 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:-

<u>CONSISTENCY</u>	<u>'N' BLOWS / FT.</u>	<u>c LB. / SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T.	SLOTTED TUBE SAMPLE		
	P.H. SAMPLE ADVANCED HYDRAULICALLY		
	P.M. SAMPLE ADVANCED MANUALLY		

SOIL TESTS

Qu	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Qcu	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL	S	SENSITIVITY

ABBREVIATIONS USED IN THIS REPORT

SOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_P	PLASTIC LIMIT
I_P	PLASTICITY INDEX
s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE = $\frac{-\Delta e}{(1+e)\Delta\sigma}$
C_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX = $\frac{\Delta e}{\Delta \log_{10} \sigma}$
T_v	TIME FACTOR = $\frac{C_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_f	SENSITIVITY

GENERAL

π	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e a$ OR $\ln a$	NATURAL LOGARITHM OF a
$\log_{10} a$ OR $\log a$	LOGARITHM OF a TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
σ'	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_o	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION
JOB 65-f-22
W.P. 256-62
DATUM 1010.7

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

LOCATION Moore Crk & Sec Hwy 523 Revised Line "A" Ch23/50
BORING DATE Feb1-7, 1965 27'-0" Lt.
BOREHOLE TYPE Washboring - BK Casing.

ORIGINATED BY W.W.K.
COMPILED BY W.W.K.
CHECKED BY K.G.S.

SOIL PROFILE		STRAT. PLT	SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — WL			BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION		NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	SHEAR STRENGTH P.S.F.	PLASTIC LIMIT — WP	WATER CONTENT — W	WATER CONTENT %		
1010.7	Ice level					1010							
1008.6	Ice												
1005.9	Water												
1005.9	Muck		1	SS	3								
4.8			2	SS	9	1000							
	Sandy silt to silty sand.		3	SS	10								
			4	SS	5	990							
	Loose to very dense.		5	SS	11	980							
			6	SS	23	970							
			7	SS	20	960							
			8	SS	51	950							
949.2													
61.8	End of borehole.					940							

DEPARTMENT OF HIGHWAYS - ONTARIO

RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

MATERIALS & TESTING DIVISION

JOB 65-F-22

LOCATION Moore Crk & Sec Hwy 523 Revised Line "A" Ch24/20-

ORIGINATED BY W.W.K.

W.P. 256-62

BORING DATE Feb. 7th, 1965


10'-0" Lt.

COMPILED BY W.W.K.

DATUM 1011.0

BOREHOLE TYPE Washboring - BX Casing.

CHECKED BY K.G.S.


SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT			LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F.			WATER CONTENT % 20 40 60				
1011.0	Ice level					1010								
1008.8	Ice													
1008.0	Water													
1006.4	Muck		1	SS	3									
4.6			2	SS	7	1000								
			3	SS	10									
	Sandy silt to silty sand.		4	SS	17		990							
	Loose to very dense.		5	SS	14		980							
		6	SS	12		970								
		7	SS	39		960								
		8	SS	59		950								
944.5														
66.5	End of borehole.					940								

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION
JOB 65-F-22
W.P. 256-62
DATUM 1011.5

RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

LOCATION Moore Crk & Sec Hwy 523 Revised Line "A" Ch24.50 on 6
BORING DATE Feb. 8&9, 1965
BOREHOLE TYPE Washboring - BX Casin.
ORIGINATED BY W.W.K.
COMPILED BY W.W.K.
CHECKED BY K.G.S.

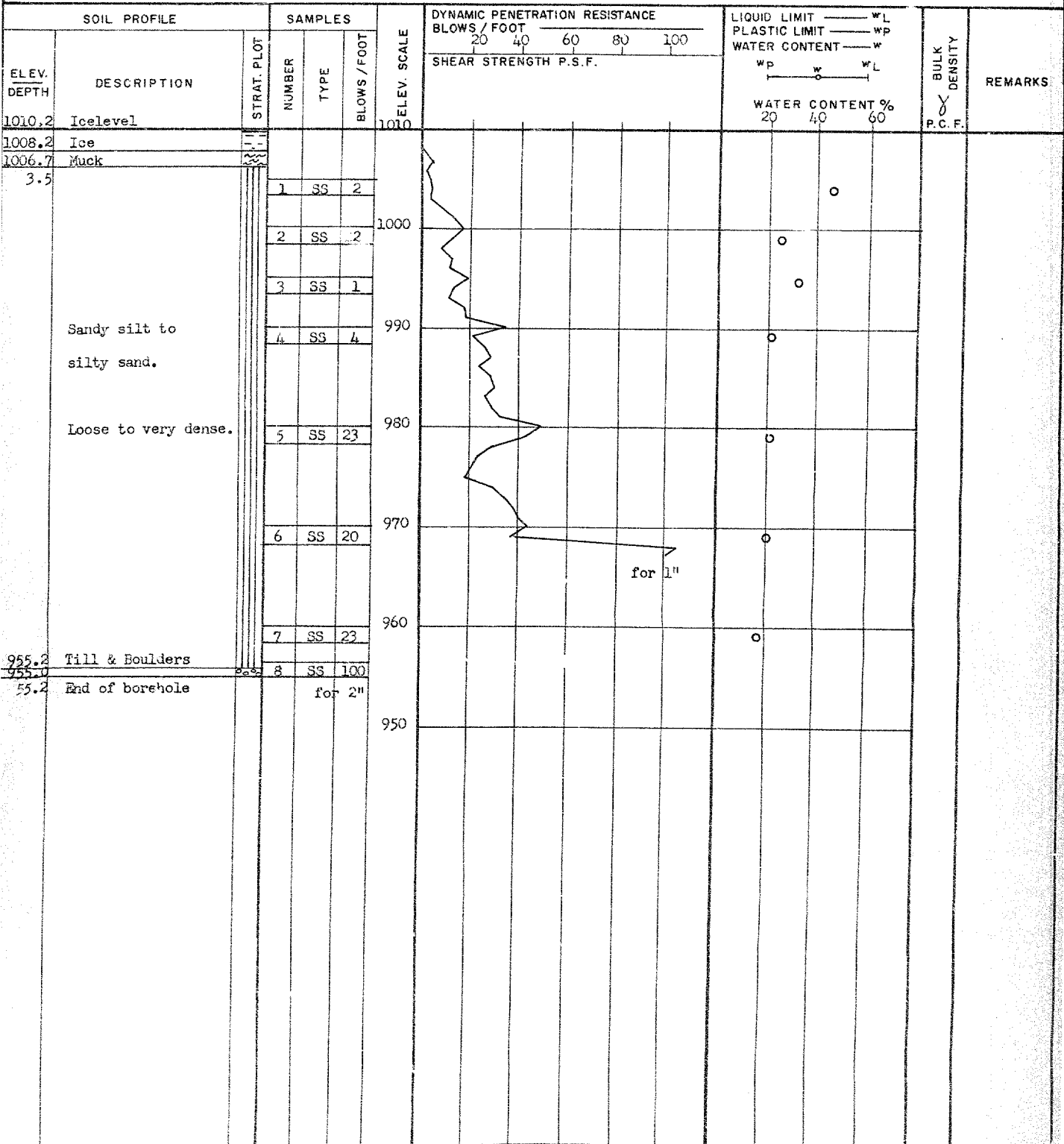
SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W		BULK DENSITY P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		BLOWS / FOOT	SHEAR STRENGTH P.S.F.		Wp — W — WL 20 40 60			
1011.5	Icelevel					1010						
1009.2	Ice											
1008.2	Water											
1006.7	Muck		1	SS	13							
4.8	Sandy silt to silty sand.		2	SS	2		1000					
			3	SS	6							
			4	SS	10		990					
			5	SS	12		980					
	Loose to very dense.	6	SS	17		970						
		7	SS	17		960						
		8	SS	57		950						
950.0	End of borehole.											
61.8						940						

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 4

FOUNDATION SECTION

JOB 65-F-22 LOCATION Moore Crk & Sec Hwy 523 Revised Line "A" Ch24/72 on E ORIGINATED BY W.W.K.
W.P. 256-62 BORING DATE Feb. 9&10, 1965 COMPILED BY W.W.K.
DATUM 1010.2 BOREHOLE TYPE Washboring - BX Casing CHECKED BY K.G.S.



MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 5

FOUNDATION SECTION

JOB 65-F-22LOCATION Moore Crk & Sec Hwy 523 Revised Line "A" Ch 25/00 on EORIGINATED BY W.W.K.W.P. 256-62BORING DATE Feb. 11-24, 1965COMPILED BY W.W.K.DATUM 1007.5BOREHOLE TYPE Washboring BX CasingCHECKED BY K.G.S.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE				LIQUID LIMIT ——— w_L			BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	SHEAR STRENGTH P.S.F.				PLASTIC LIMIT ——— w_p	WATER CONTENT ——— w		
							20 40 60 80 100								
1007.5	Ice level														
1005.5	Ice														
1003.5	Water														
1002.5	Muck														
5.5	Sandy silt to silty sand. Loose to very dense. Frequent boulders.		1	SS	1	1000									
			2	SS	4										
			3	SS	11	990									
			4	SS	105										
					for 3"										
			5	SS	34	980									
			6	SS	78										
972.8															
34.7	Granite Bedrock					970									
966.3															
41.2	End of borehole.					960									

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 6

FOUNDATION SECTION

JOB 65-F-22LOCATION Moore Crk & Sec Hwy 523 Revised Line "A" Ch25/26 on EORIGINATED BY W.W.K.W.P. 256-62BORING DATE Feb. 24&25, 1965COMPILED BY W.W.K.DATUM 1007.5BOREHOLE TYPE Washboring BX Casing.CHECKED BY K.G.S.

SOIL PROFILE

SAMPLES

DYNAMIC PENETRATION RESISTANCE

BLOWS / FOOT

20 40 60 80 100

SHEAR STRENGTH P.S.F.

LIQUID LIMIT ——— WL

PLASTIC LIMIT ——— WP

WATER CONTENT ——— W

WP ——— W ——— WL
 ————
 20 40 60

WATER CONTENT %

20 40 60

BULK
DENSITY

REMARKS

Y
P.C.F.

ELEV.
DEPTH

DESCRIPTION

STRAT. PLOT

NUMBER

TYPE

BLOWS / FOOT

ELEV. SCALE

1000

990

980

1007.5 Ice level

1006.0 Ice

1004.5 Water

1004.5 Muck

3.0 Sandy silt to silty
sand.
Compact.
Frequent boulders.

995.4

12.1 Granite Bedrock

989.9

17.6 End of borehole.

1 SS 20

2 SS 16

o

o

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 7

FOUNDATION SECTION

JOB 65-F-22LOCATION Moore Crk & Sec Hwy 523 Revised Line "A" Ch 25+52 on EORIGINATED BY W.W.K.W.P. 256-62BORING DATE Feb. 24, 1965.COMPILED BY W.W.K.DATUM 1009.8BOREHOLE TYPE BX Casing RunCHECKED BY K.G.S.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE						LIQUID LIMIT ——— WL PLASTIC LIMIT ——— WP WATER CONTENT ——— W WP W WL —○— WATER CONTENT %			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.										
1009.8	Groundlevel																
0.0	Sandy silt to silty sand. Compact.																
1002.0	Frequent Boulders.																
7.8	Granite Bedrock					1000											
997.0																	
12.8	End of borehole.					990											

▼ WL
El 1007.5
Observed
in casing.

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

JOB 65-F-22

W. P. 256-62

DATUM 1025.3

LOCATION Moore Crk & Sec Hwy 523 Revised Line "A" Ch25/80 on E

BORING DATE Feb. 27, 1965

BOREHOLE TYPE EX Casing Run

FOUNDATION SECTION

ORIGINATED BY W.W.K.

COMPILED BY W.W.K.

CHECKED BY _____ K.G.S.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT ——— WL		BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	SHEAR STRENGTH P.S.F.	PLASTIC LIMIT ——— WP	WATER CONTENT ——— W		
1025.3	Groundlevel											
	Sandy silt to silty sand. Compact											
1021.1	Frequent boulders											
4.2	Granite Bedrock					1020						
1015.4												
9.9	End of borehole					1010						

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 9

FOUNDATION SECTION

JOB 65-F-22

LOCATION Moore Crk & Sec Hwy 523 Revised Line "A" Ch26+00 on C

ORIGINATED BY W.W.K.

W. P. 256-62

BORING DATE Feb. 27, 1965

COMPILED BY _____ W.W.K.

DATUM 1036.1

BOREHOLE TYPE BX Casing Run

CHECKED BY _____ K.G.S.

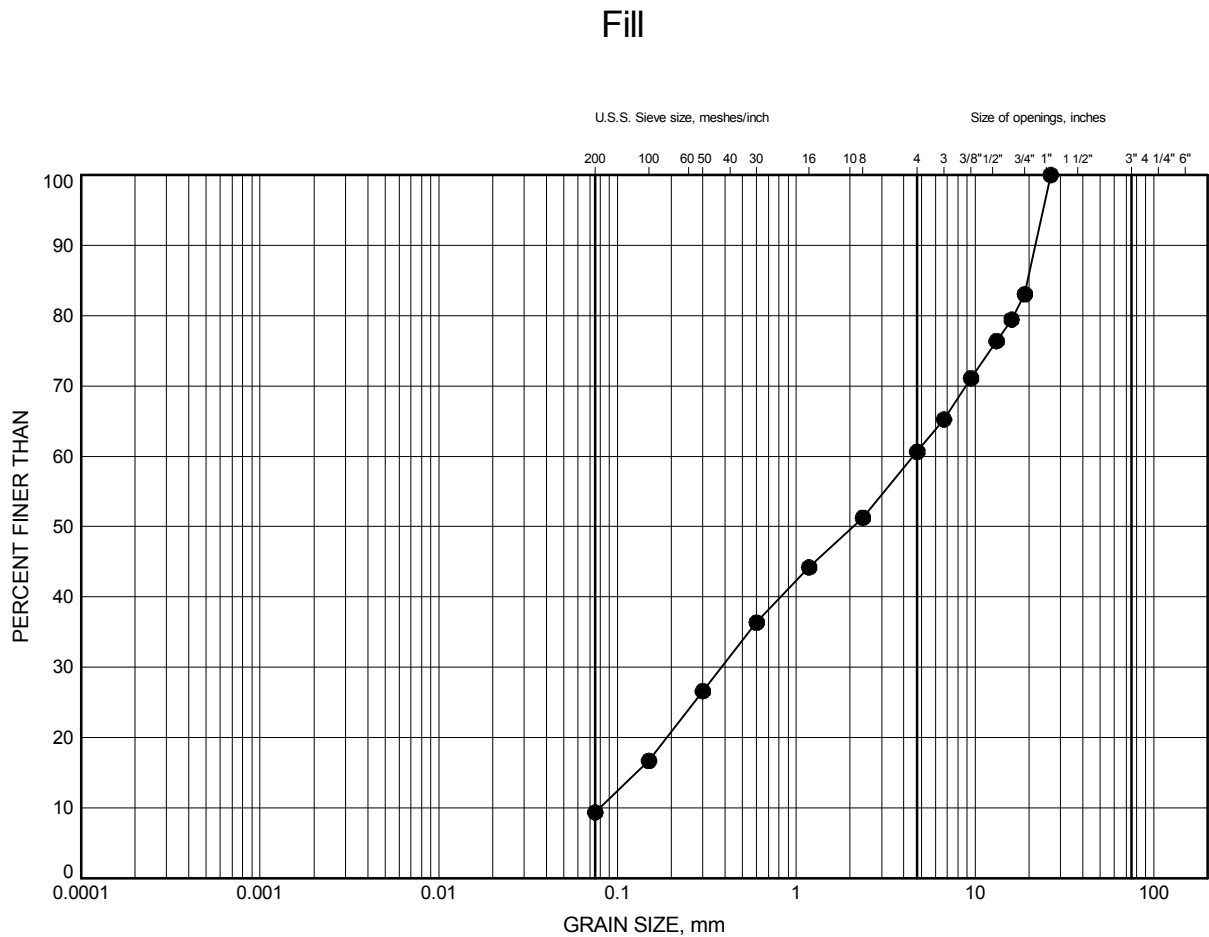
SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT ——— w _L PLASTIC LIMIT ——— w _p WATER CONTENT ——— w				BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.	w _p	w	w _L	WATER CONTENT %		
1036.1	Groundlevel												
1034.6	Topsoil												
1.5	Granite Bedrock												
1029.6						1030							
6.5	End of borehole.					1020							

APPENDIX C
LABORATORY TEST RESULTS

Moore Creek Bridge

GRAIN SIZE DISTRIBUTION

FIGURE C1



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-2	0.38	317.44

Date April 2019
 WP# 5274-14-01



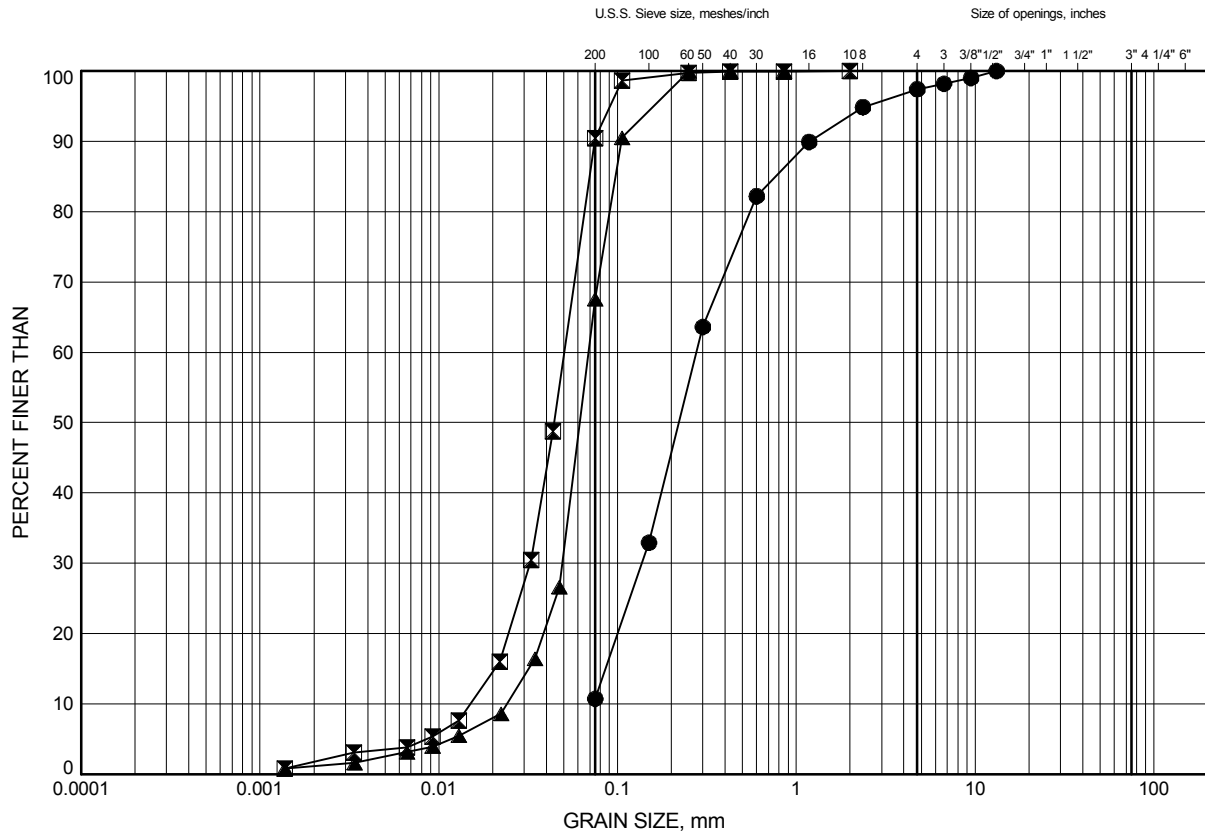
Prep'd CM
 Chkd. SP

Moore Creek Bridge

GRAIN SIZE DISTRIBUTION

FIGURE C2

Silty Sand to Silt some Sand



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-1B	10.97	306.10
◻	17-1B	15.54	301.53
▲	17-1B	18.59	298.48

Date April 2019
 WP# 5274-14-01



Prep'd CM
 Chkd. SP

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO: 16284

Report Date: 01-Jun-2017

Order Date: 26-May-2017

Project Description: Moores Creek Bridge

Client ID:	17-1, SS7, 35'-39'	17-2, SS2, 3'1"-5'1"	-	-
Sample Date:	12-May-17	04-May-17	-	-
Sample ID:	1721509-01	1721509-02	-	-
MDL/Units	Soil	Soil	-	-

Physical Characteristics

% Solids	0.1 % by Wt.	99.2	95.7	-	-
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General Inorganics

Conductivity	5 uS/cm	388	167	-	-
pH	0.05 pH Units	5.26	7.34	-	-
Resistivity	0.10 Ohm.m	25.8	59.9	-	-

Anions

Chloride	5 ug/g dry	7	23	-	-
Sulphate	5 ug/g dry	332	46	-	-

APPENDIX D
SELECTED PHOTOGRAPHS



Figure 1: Roadway Platform at Bridge 43X-0155/B0 looking South



Figure 2: Previous Bridge Alignment looking North from South Abutment



Figure 3: Looking towards South Abutment



Figure 4: Looking North from South Abutment

APPENDIX E

LIST OF REFERENCED SPECIFICATIONS

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OPSD 208.010	Benching of Earth Slopes
OPSD 3090.100	Foundation, Frost Penetration Depths for Northern Ontario
OPSD 3101.150	Walls, Abutment, Backfill Minimum Granular Requirements
OPSS.PROV 206	Construction Specification for Grading
OPSS.PROV 501	Construction Specification for Compacting
OPSS 511	Construction Specification for Rip-Rap, Rock Protection, and Granular Sheeting
OPSS.PROV 539	Construction Specification for Temporary Protection Systems
OPSS.PROV 804	Construction Specification for Seed and Cover
OPSS 805	Construction Specification for Temporary Erosion and Sediment Control Measures
OPSS 902	Construction Specification for Excavating and Backfilling-Structures
OPSS.PROV 1010	Material Specification for Aggregates-Base, Subbase, Select Subgrade, and Backfill Material

Suggested text for an NSSP on “Obstructions”

Obstructions such as cobbles and boulders may be encountered in the embankment and native soils during excavation and/or installation of traffic protection systems. Such obstructions may impede the work from reaching the design depth of installation. The Contractor shall be prepared to remove, drill through and/or penetrate these obstructions and extend the work to the design depths.