



THURBER ENGINEERING LTD.

**FINAL
FOUNDATION INVESTIGATION AND DESIGN REPORT
REHABILITATION OF BRIDGE STRUCTURE No. 46-236
NEBSKWASHI RIVER BRIDGE HIGHWAY 129
CHAPLEAU TOWNSHIP
G.W.P. 5144-10-00
AGREEMENT NO.: 5015-E-0027**

GEOCRES NUMBER: 410-28

**SUBMITTED TO
MCINTOSH PERRY CONSULTING ENGINEERS**

Location:

Latitude: 47.819766°

Longitude: -83.398725°

**October 2018
THURBER FILE NO.: 13624**

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This section of the report presents the factual data obtained from a foundation investigation conducted by Thurber Engineering Ltd. (Thurber) for the proposed foundation work required for the rehabilitation of the Nebskwashi River Bridge which is located on Highway 129, within Chapleau Township. Thurber carried out the investigation as a subconsultant to McIntosh Perry Consulting Engineers (MPCE) as part of Change Proposal 1 for Agreement No. 5015-E-0027.

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 and reviewed in preparation of this report is as follows:

Report to Department of Highways Ontario on Soil Conditions and Foundations,
Proposed Nebskwashi River Bridge, Chapleau, Ontario (Geocres 41O00-005),
dated March 1965.

A copy of the historic boreholes have been included in Appendix B for information purposes only and have not been included in the description of the subsurface conditions within this report.

2 SITE DESCRIPTION

The Nebskwashi River Bridge (Structure No. 46-236) is located on Highway 129, approximately 1.0 km north of the north junction of Highway 101 and Highway 129. It is noted that for orientation purposes, Highway 129 within the project limits, will be described with an east-west 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 129 is a two-lane, rural, arterial, undivided highway. Based on the December 2016 drawing the roadway cross-section consists of two, 3.6 m wide lanes, and paved shoulders with a width of 1.1 m and 0.7 m on the WBL and EBL respectively. Guide rails are located on both sides of the highway for a short distance from the bridge.

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 borehole locations.

The field investigation for this site included two boreholes drilled on May 12, 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)	Borehole Depth below Existing Ground Surface (m)
17-1	West Abutment – eastbound lane	5 298 031.2	349 811.5	431.0	4.8
17-2	West Approach – eastbound lane	5 298 034.7	349 802.2	431.4	4.0

All boreholes were advanced through the roadway embankment with a track mounted CME 550 drill rig equipped with hollow stem augers and HW/NW casing. The subsurface stratigraphy encountered in the boreholes was recorded in the field by Thurber personnel. 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. All soil samples recovered from the boreholes were transported to Thurber's laboratory for further examination and testing.

The boreholes were backfilled with a low-permeability mixture of bentonite pellets and auger cuttings in general accordance with Ontario MOE Regulation 903. Boreholes were capped with granular auger 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 Thurber following completion of drilling.

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 testing was also carried out on selected samples to MTO and ASTM standards.

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 at the investigated locations. A stratigraphic profile 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.

The stratigraphy in the area of the west approach is generally characterized by the asphalt pavement structure and sand with gravel fill overlying native deposits varying from sand to silty sand with gravel, cobbles and boulders above inferred bedrock. Bedrock was confirmed at both abutments at elevations ranging from 424.4 to 427.7 in the original MTO investigation (Geocres 41O00-005).

4.2 Asphalt

The boreholes were advanced through the Highway 129 pavement structure and the thickness of the asphalt was found to be 100 mm in both boreholes.

4.3 Granular Fill

Fill consisting predominantly of sand with gravel was encountered below the asphalt in both boreholes. Occasional cobbles and boulders were noted within this layer in Borehole 17-1. This layer has a thickness ranging from 0.7 m to 1.4 m (base elevation of 429.5 m to 430.7 m). The SPT 'N' values ranged from 21 blows per 300 mm of penetration to 100 blows for 225 mm of penetration; indicating a compact to very dense condition.

The moisture content of the samples tested ranged from 1% to 2%. The results of grain size analysis conducted on one sample of this material are summarized in Table 4-1 and illustrated on Figure C1 in Appendix C.

Table 4-1: Gradation Results for Granular Fill

Soil Particle	%
Gravel	29
Sand	63
Silt and Clay	8

4.4 Sand (SP) with Gravel

A native layer of sand with gravel was encountered directly below the fill in both boreholes. Frequent cobbles and boulders were observed in this unit in both boreholes. The surface of this deposit ranged in elevation from 429.5 m to 430.7 m. This layer has a thickness ranging from 2.1 m to 2.2 m. The SPT 'N' values ranged from 3 to blows per 300 mm of penetration to 100 blows for 275 mm of penetration; indicating a very loose to very dense condition. The refusal blow counts may represent the presence of cobbles and boulders

The moisture content for the samples tested ranged from 1% to 11%. The results of grain size analysis conducted on one sample of this material are summarized in Table 4-2 and illustrated on Figure C2 in Appendix C.

Table 4-2: Gradation Results for Sand (SP) with Gravel

Soil Particle	%
Gravel	43
Sand	49
Silt & Clay	8

4.5 Silty Sand (SM) with Gravel

A native layer of silty sand with gravel was encountered in both boreholes below the sand with gravel deposit. Frequent cobbles and boulders were also noted in this layer in both boreholes and wood pieces were present within Borehole 17-01. The surface of this deposit ranged in elevation from 427.5 m to 428.4 m. This layer has a thickness ranging from 1.0 m to 1.2 m. The SPT 'N' values ranged from 24 blows for 300 mm of penetration to 100 blows for 150 mm of penetration; indicating a compact to very dense condition. Both boreholes were terminated within this layer.

The moisture content for the samples tested ranged from 5% to 19%. The results of grain size analysis conducted on two samples of this material are summarized in Table 4-3 and illustrated on Figure C3 in Appendix C.

Table 4-3: Gradation Results for Silty Sand (SM) with Gravel

Soil Particle	%	
Gravel	21 to 24	
Sand	46 to 60	
Silt	30	16
Clay	3	

4.6 Bedrock

Bedrock coring was not required as part of the current assignment. Both boreholes were advanced to refusal on inferred bedrock at elevation ranging from 427.4 to 426.2 m. The historic MTO report (Geocres No. 41O00-005) cored bedrock for Boreholes 2 and 4 located near the west abutment and encountered a bedrock surface at elevation 427.2 to 424.4 m

4.7 Groundwater

The groundwater level was measured in the open Borehole 17-02 during drilling and was noted to be at elevation 427.7 m. This observation is considered a short-term reading 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 embankments and native soils, it is expected that the groundwater level will respond rapidly to the water level changes in the Nebskwashi River which was noted to be near elevation 425.9 m at the time of the investigation.

5 MISCELLANEOUS

Thurber obtained utility clearances prior to drilling and the borehole locations were positioned relative to existing site features and proposed foundations. Thurber personnel 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 Ms. Katya Edney, P.Eng. 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, 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 from Part 1 of this report for the proposed rehabilitation of the Nebskwashi River Bridge located on Highway 129, near Chapleau, Ontario. Geotechnical assessment and recommendations are provided to assist the project team with the design of a temporary protection system for construction staging at the west abutment.

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 bridge. The discussions and recommendations presented in this report are based on the information provided by MPCE including the 30% Contract Drawings dated September 2017 and on the factual data obtained during the course of the investigation.

6.1 Proposed Structure

Placement of a 1.2 m thickness of expanded polystyrene (EPS) between the west abutment wingwalls was determined by MPCE to be required as part of the bridge rehabilitation to help reduce the unbalanced earth pressures which result from the unequal leg heights of the rigid frame Nebskwashi Bridge (Sheet 20 of the 30% Contract Drawings). It is understood that from a staging perspective, it is necessary to install a temporary roadway protection system to maintain a single lane of traffic during construction. At the time of preparation of this Foundation Investigation and Design Report, the general arrangement drawing (Sheet 9) shows a temporary roadway protection system west of the existing bridge structure installed along the highway centerline. The roadway protection is shown to be approximately 5 m in length.

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

Temporary protection systems 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 system is a function of the construction sequence and relative flexibility of the wall and these factors must be considered during its design.

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.

Driving of sheet piles as roadway protection at this site will be difficult due to the presence of cobbles and boulders in the fill and native soils. Furthermore, extraction of sheet piles after placement of EPS backfill is likely to disturb the EPS and is therefore not recommended. Drilled in soldier piles and lagging is considered a feasible option. All temporary protection systems should be left in place after and cut-off in accordance with OPSS 539 to limit disturbance to the newly placed EPS. The EPS should be protected from damage while cutting the temporary protection system and a suggested NSSP has been provided in Appendix E.

It is recommended that an NSSP be included in the tender documents to alert the Contractor to the potential for cobbles and boulders within the fill and of the difficulty of driving sheet piles.

Vibratory equipment should not be permitted at this site for installation of the temporary protection system.

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 walls and the EPS should be restricted in accordance with OPSS.PROV 501. If adequate drainage cannot be confirmed, the potential for 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), use submerged values below water table

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 vertical wall with horizontal back-slope are provided in Table 7-1.

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

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

The horizontal earth pressure of EPS should be taken as 10% of the vertical stress generated by the pavement structure/loading above the EPS.

For rigid structures, it is recommended that at-rest horizontal lateral earth pressures 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 coefficients for sloping ground should be used and these coefficients can be provided upon request.

Passive earth resistance in front of the abutments 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. A granular leveling pad should be placed prior to placement of the EPS blocks. The EPS will require a cover consisting of a cast-in-place or pre-cast concrete panels to further distribute the vertical forces on the top of the EPS and also to

prevent damage to the EPS. Furthermore, encapsulation of the EPS with heavy polyethylene to prevent degradation by petroleum hydrocarbons would be necessary. A minimum soil cover of 1.5 m is required along the embankment side slopes.

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 or embankment widening is anticipated and therefore negligible foundation settlement is expected to occur.

8 CONSTRUCTION CONSIDERATIONS

8.1 Excavations

It is anticipated that temporary excavations in the order of 2 m will be required for the removal of the existing material behind the west bridge abutment.

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 prior to excavating.

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

Subgrade preparation and placement of EPS and granular fills must be carried out in the dry. Based on the 30% Contract drawings, the depth of excavation is shown to be above the expected water table. Nevertheless, 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 proposed excavations.

Dewatering design and decisions regarding dewatering, must be carried out by the Contractor. The Contract Documents must alert the Contractor to this responsibility. The dewatering system is to be designed in accordance with OPSS.PROV 517 and SP517F01. It is not considered necessary that the design Engineer and design-checking Engineer have a minimum of 5 years experience in design systems of similar nature and scope to the required work, thus Designer Fill-in ***** in SP517F01 should be "No". A preconstruction survey is not required, thus Designer Fill-in ***** in this SP should be "N/A". Due to the shallow excavation depths being considered and the depth to groundwater at the site it is anticipated that conventional sump and pump techniques should be sufficient. It is anticipated that a Permit to take Water (PTTW) may not be required for an excavation depth limited to 2 m. If the excavation depth is increased or the excavation will be open for an extended period of time, further assessment of dewatering requirements and the need for a PTTW should be carried out by a specialist experienced in this field.

8.3 Erosion Control and Scour Protection

Slope protection and drainage measures will be required to ensure the long-term surficial stability of the 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 and boulders 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. Soldier piles/lagging are an option.
- Removal of temporary protection system will be difficult to prevent damage to the EPS.
- Seasonal fluctuations of the groundwater and river level are to be expected which may impact the construction. Dewatering in rockfill will be difficult.

The successful performance of the project will depend largely upon good workmanship and quality control during construction. Observation of the excavation and backfilling operations by qualified geotechnical personnel will be required during construction in accordance with SP109S12 to confirm that the foundation recommendations are correctly implemented, and material specifications are met.

10 CLOSURE

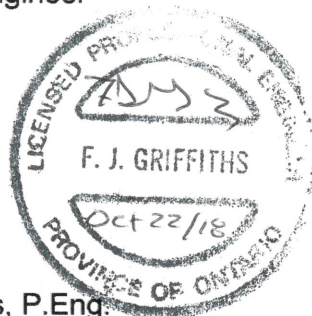
Engineering analysis and preparation of this report were completed Mr. Christopher Murray, P.Eng. and Mr. Stephen Peters, P.Eng. The report was reviewed by Dr. Fred Griffiths, P.Eng. and Dr. P.K. Chatterji, P.Eng., the Designated Principal Contact for MTO Foundations Projects.



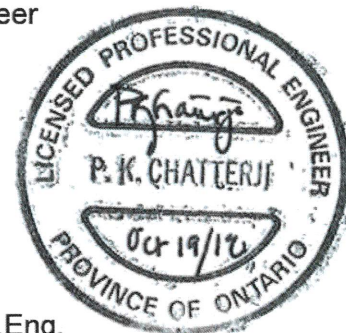
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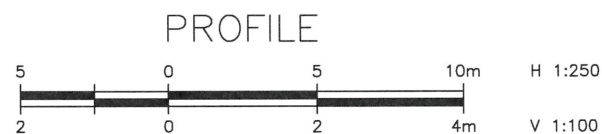
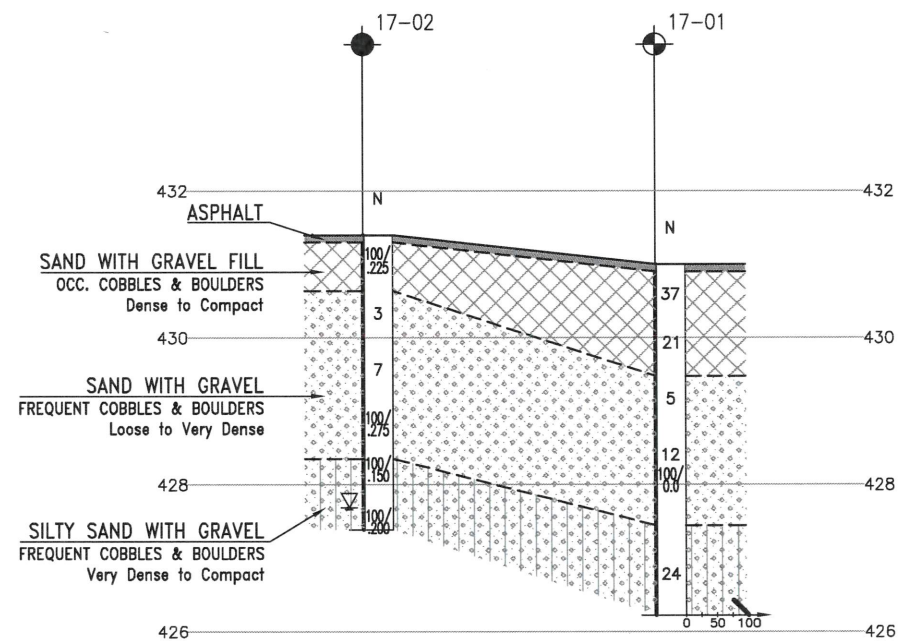
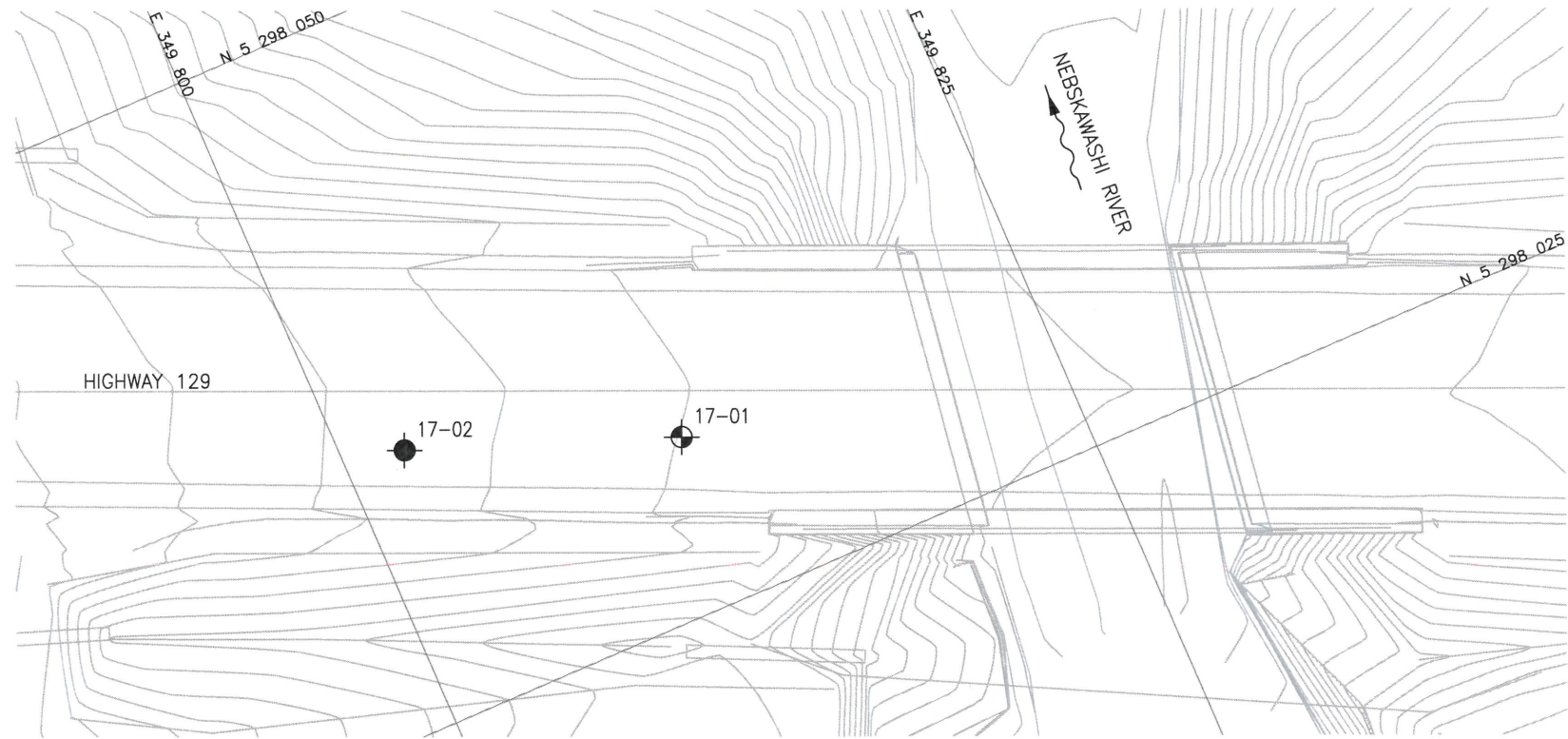


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APPENDIX A
BOREHOLE LOCATIONS AND SOIL STRATA DRAWINGS



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



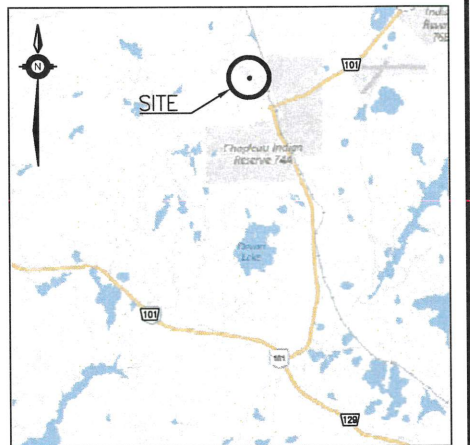
CONT No
GWP No 5144-10-00

HIGHWAY 129
NEBSKAWASHI RIVER
BRIDGE REHABILITATION
BOREHOLE LOCATIONS AND SOIL STRATA

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
17-01	431.0	5 298 031.2	349 811.5
17-02	431.4	5 298 034.7	349 802.2

-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.

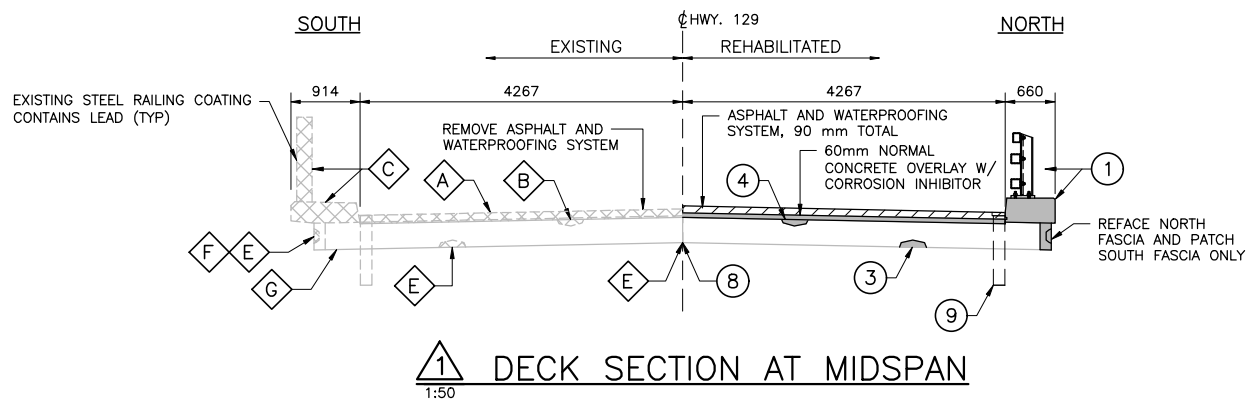
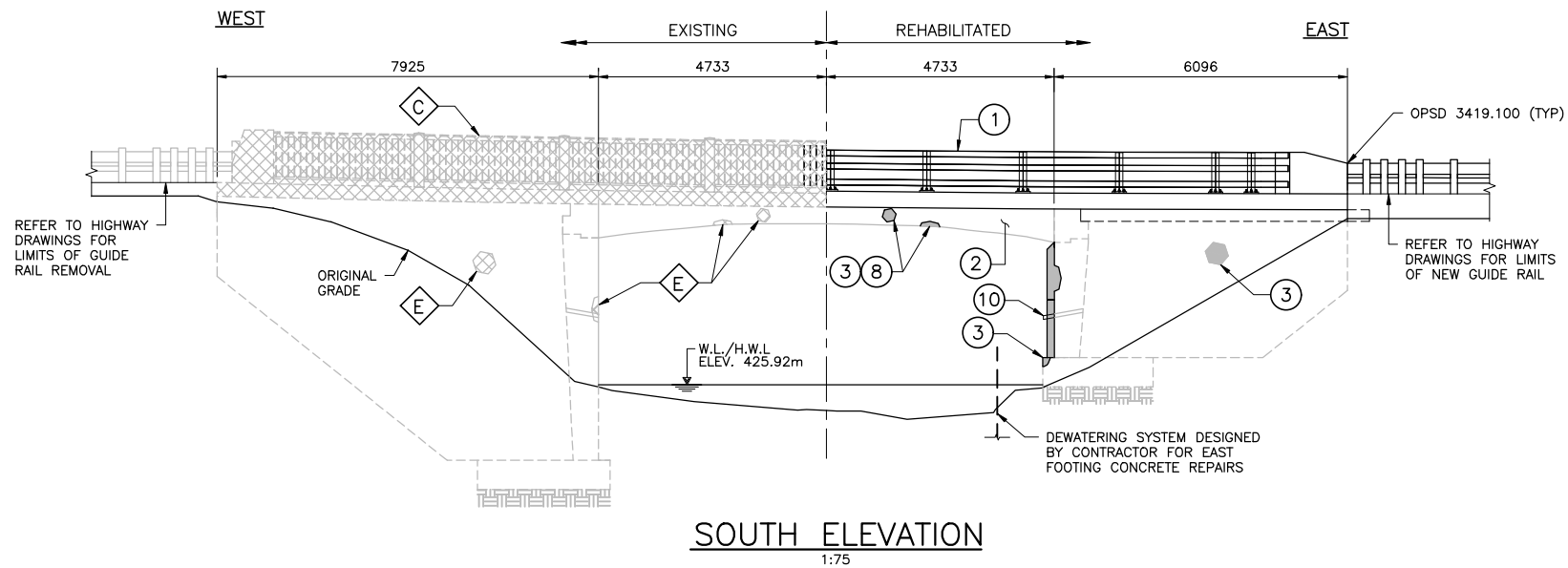
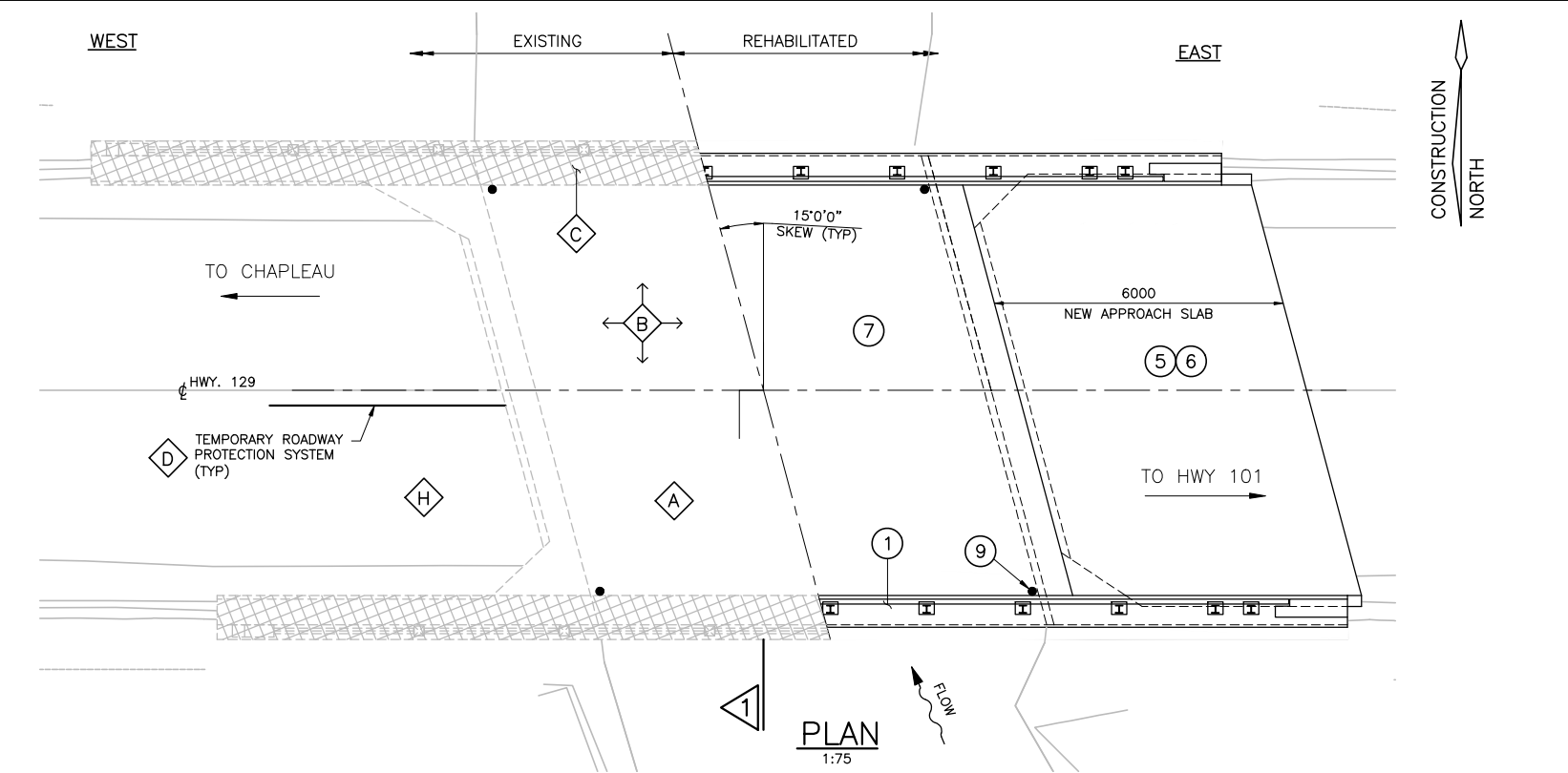
GEOCRES No. 410-28

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	SBP	CHK	PKC
DRAWN	AN	CHK	SBP
CODE	LOAD	DATE	OCT 2018
SITE	STRUCT	DWG	1

CAD FILE LOCATION AND NAME: S16-7040_BR-01_001CA.dwg
MODIFIED: 9/29/2017 4:49:29 PM BY: D3MMS
DATE PLOTTED: 10/2/2017 8:04:50 PM BY: DEREK SMMS

MINISTRY OF TRANSPORTATION, ONTARIO

PR-D-707 88-05

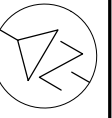


LEGEND:

- CONCRETE AND ASPHALT REMOVAL
- NEW CONCRETE
- NEW ASPHALT
- EXISTING TO REMAIN

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

DISTRICT OF SUDBURY
CONT. No. 2018-XXXX
WP No. 5167-12-01



HIGHWAY 129
NEBSKWASHI RIVER BRIDGE
BRIDGE REHABILITATION

SHEET

9

McINTOSH PERRY

SCOPE OF REHABILITATION WORK:

THE GENERAL SCOPE OF THE REHABILITATION WORK OUTLINED BELOW AND DESIGNATED ON THIS DRAWING SHALL BE CONSIDERED SIMILAR AT EACH SIDE OF THE CENTRELINE 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 ASPHALT AND WATERPROOFING FROM DECK.
- SCARIFY TOP 20mm± OF DECK AND REMOVE REMAINING DETERIORATED CONCRETE AND AREAS OF HIGH CORROSION POTENTIAL AS DIRECTED BY THE CONTRACT ADMINISTRATOR.
- REMOVE END BARRIER WALLS, STEEL RAILINGS & CURB.
- INSTALL TEMPORARY ROADWAY PROTECTION SYSTEM (WEST ONLY)
- REMOVE DETERIORATED CONCRETE FROM SOFFIT, FASCIA, ABUTMENT WALLS, WINGWALLS AND EXPOSED FOOTINGS.
- REPAIR ALL WIDE CRACKS WITH CRACK INJECTION
- REMOVE 150mm OF NORTH FASCIA FOR REFACING
- EXCAVATE FOR INSTALLATION OF LIGHT WEIGHT FILL BACKFILL AT WEST ABUTMENT ONLY

ALL AS SHOWN AND SPECIFIED IN CONTRACT DOCUMENTS. NOT INTENDED AS SEQUENCE OF REMOVALS

NEW CONSTRUCTION:

- CONSTRUCT NEW CURB AND INSTALL NEW STEEL BARRIER.
- REFACE NORTH FASCIA AND EAST ABUTMENT WALL.
- REPAIR DETERIORATED CONCRETE AREAS AT THE SOFFIT, FASCIAS, ABUTMENT WALLS, WINGWALLS AND EXPOSED FOOTINGS USING FORM & PUMP METHOD.
- PLACE 60mm NORMAL CONCRETE OVERLAY WITH CORROSION INHIBITOR
- INSTALL LIGHT WEIGHT FILL AT WEST ABUTMENT
- CONSTRUCT NEW APPROACH SLABS.
- WATERPROOF AND PAVE THE DECK AND APPROACH SLABS TO THE LIMITS SHOWN ON THE DRAWINGS.
- CARRY OUT CRACK INJECTION.
- COMPLETE DECK DRAIN MODIFICATION
- EXTEND EAST ABUTMENT WALL PIPE SUBDRAIN
- INSTALL LIGHT WEIGHT FILL BEHIND WEST ABUTMENT ONLY

ALL AS SHOWN AND SPECIFIED IN CONTRACT DOCUMENTS. NOT INTENDED AS SEQUENCE OF NEW CONSTRUCTION

LIST OF DRAWINGS:

- | | |
|-------|------------------------------------|
| R1-1 | GENERAL ARRANGEMENT |
| R1-2 | BOREHOLE LOCATIONS AND SOIL STRATA |
| R1-3 | CONSTRUCTION STAGING |
| R1-4 | REMOVALS I |
| R1-5 | REMOVALS II |
| R1-6 | RECONSTRUCTION I |
| R1-7 | RECONSTRUCTION II |
| R1-8 | REINFORCEMENT I |
| R1-9 | REINFORCEMENT II |
| R1-10 | TL4 - THREE TUBE RAILING |
| R1-11 | CONCRETE END WALL |
| R1-12 | APPROACH SLAB |
| R1-13 | MISCELLANEOUS AND STANDARD DETAILS |

GENERAL NOTES:

CLASS OF CONCRETE:

- ALL CONCRETE 30 MPa

CLEAR COVER TO REINFORCING STEEL

- DECK: TOP 70 ± 20mm
- BOTTOM 50 ± 10mm
- REMAINDER 70 ± 20mm UNLESS OTHERWISE NOTED

REINFORCING STEEL:

- REINFORCING STEEL SHALL BE GRADE 400W UNLESS OTHERWISE SPECIFIED.
- BAR MARKED WITH PREFIX 'S' DENOTES STAINLESS STEEL BARS.
- STAINLESS REINFORCING STEEL BARS SHALL BE TYPE 316LN OR DUPLEX 2205 AND HAVE A MINIMUM YIELD STRENGTH OF 500 MPa.
- UNLESS SHOWN OTHERWISE, TENSION LAP SPLICES SHALL BE CLASS B.
- BAR HOOKS SHALL HAVE STANDARD HOOK DIMENSIONS USING MINIMUM BEND DIAMETERS, WHILE STIRRUP 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:

- THE CONTRACTOR SHALL VERIFY ALL RELEVANT DIMENSIONS, ELEVATIONS, STATIONS AND DETAILS ON SITE AND REPORT ANY DISCREPANCIES TO THE CONTRACT ADMINISTRATOR 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.
- THE CONTRACTOR SHALL PROVIDE DEBRIS PLATFORM AND NECESSARY CONTAINMENT MEASURES TO COLLECT FALLING CONCRETE AND CONSTRUCTION DEBRIS SUCH THAT NO DEBRIS OR MATERIALS RESULTING FROM THE REMOVAL WORK FALL INTO THE WATERBODY BELOW THE BRIDGE.

APPLICABLE STANDARD DRAWINGS:

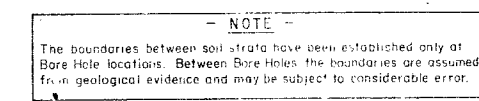
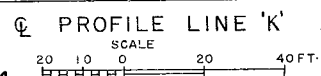
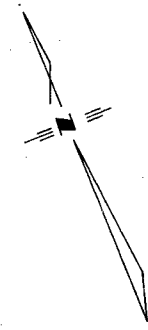
- OPSD 3370.100 - DECK, WATERPROOFING HOT APPLIED ASPHALT MEMBRANE WITH PROTECTION BOARD.
- OPSD 3370.101 - DECK, WATERPROOFING HOT APPLIED ASPHALT MEMBRANE AT ACTIVE CRACKS GREATER THAN 2mm WIDE AND CONSTRUCTION JOINTS.
- OPSD 3419.100 - BARRIERS AND RAILINGS, STEEL BEAM GUIDE RAIL AND CHANNEL ANCHORAGE
- OPSD 3941.200 - FIGURES IN CONCRETE, SITE NUMBER AND DATE LAYOUT
- OPSD 3950.100 - JOINTS CONCRETE EXPANSION AND CONSTRUCTION ON STRUCTURE

OCCUPATIONAL HEALTH AND SAFETY ACT - DESIGNATED SUBSTANCES:

DESIGNATED SUBSTANCE (ONTARIO REGULATION NUMBER)	LOCATION
ASBESTOS (R.R.O. 2005, REG 278)	DUCTS IN CURB
LEAD	STEEL RAILING COATING

DRAWING NOT TO BE SCALED
100mm ON ORIGINAL DRAWING

REVISIONS		DESCRIPTION	
DESIGN	AS	CHK	TT
DRAWN	DS	CHK	AS
CODE	CHBDC-14	LOAD	CL-625-ONT
DATE	SEP/17	SITE	46-236
STRUCT		SCHEME	
DWG	R1-1		



REF. NO. E-4534-1

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).

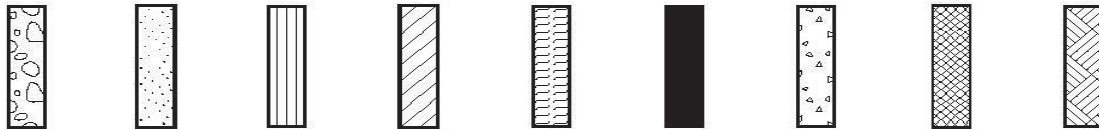
DYNAMIC CONE PENETRATION TEST (DCPT):

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 17-01

1 OF 1

METRIC

GWP# 5144-10-00 LOCATION Hwy 129 - Nebskwashi River Bridge N 5 298 031.2 E 349 811.5 ORIGINATED BY KE
 HWY 129 BOREHOLE TYPE HSA / NW Casing COMPILED BY CM
 DATUM Geodetic DATE 12.05.2017 - 12.05.2017 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					
								WATER CONTENT (%)					
431.0													
0.0													
0.1	100mm ASPHALT												
	SAND with Gravel FILL Occasional Cobbles and Boulders Dense to Compact Grey to Brown		1	SS	37								29 63 8 (SI+CL)
			2	SS	21		430						
429.5													
1.5	SAND (SP) with Gravel Frequent Cobbles and Boulders Loose to Compact Brown		3	SS	5		429						
			4	SS	12								
	- Auger Refusal at 2.9 m - 700 mm Boulder at 2.9 m		5	SS	100/ 0mm		428						
427.5													
3.6	Silty SAND (SM) with Gravel, trace Organics/Wood Frequent Cobbles and Boulders Compact Grey		6	SS	24		427						21 46 30 3
426.5													
4.5	End of Sampled Borehole												
426.2	DCPT from 4.5 m to 4.8 m												
4.8	Inferred Silty SAND with Gravel End of DCPT on Inferred Bedrock												

ONTMT4S 13624 - 101 AND 129 - NEBSKWASHI.GPJ 2012TEMPLATE(MTO).GDT 29/10/18

RECORD OF BOREHOLE No 17-02

1 OF 1

METRIC

GWP# 5144-10-00 LOCATION Hwy 129 - Nebskwashi River Bridge N 5 298 034.7 E 349 802.2 ORIGINATED BY KE
 HWY 129 BOREHOLE TYPE HSA COMPILED BY CM
 DATUM Geodetic DATE 12.05.2017 - 12.05.2017 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					
								WATER CONTENT (%)					
431.4													
0.0													
0.1	100mm ASPHALT		1	SS	100/ 225mm		431						
430.7	SAND with Gravel FILL Very Dense Grey to Brown												
0.8	SAND (SP) with Gravel Frequent Cobbles and Boulders Dense to Loose Brown		2	SS	3		430						43 49 8 (SI+CL)
			3	SS	7								
			4	SS	100/ 275mm		429						
428.4													
3.0	Silty SAND (SM) with Gravel Frequent Cobbles and Boulders Dense to Compact Brown		5	SS	100/ 150mm		428						24 60 16 (SI+CL)
427.4			6	SS	100/ 200mm								
4.0	End of Borehole on Inferred Bedrock Groundwater at 3.7 m BGS (Elev. 427.7 m) on completion												

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

GEOCON

OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T7722 BORING # 2 DATUM GEODETIC CASING BX
 BORING DATE FEB 6TH 65 REPORT DATE FEB 23RD 65 COMPILED BY BER CHECKED BY SSO
 SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS. ENERGY)

SAMPLE CONDITION

☒ DISTURBED
☐ FAIR
☐ GOOD
☐ LOST

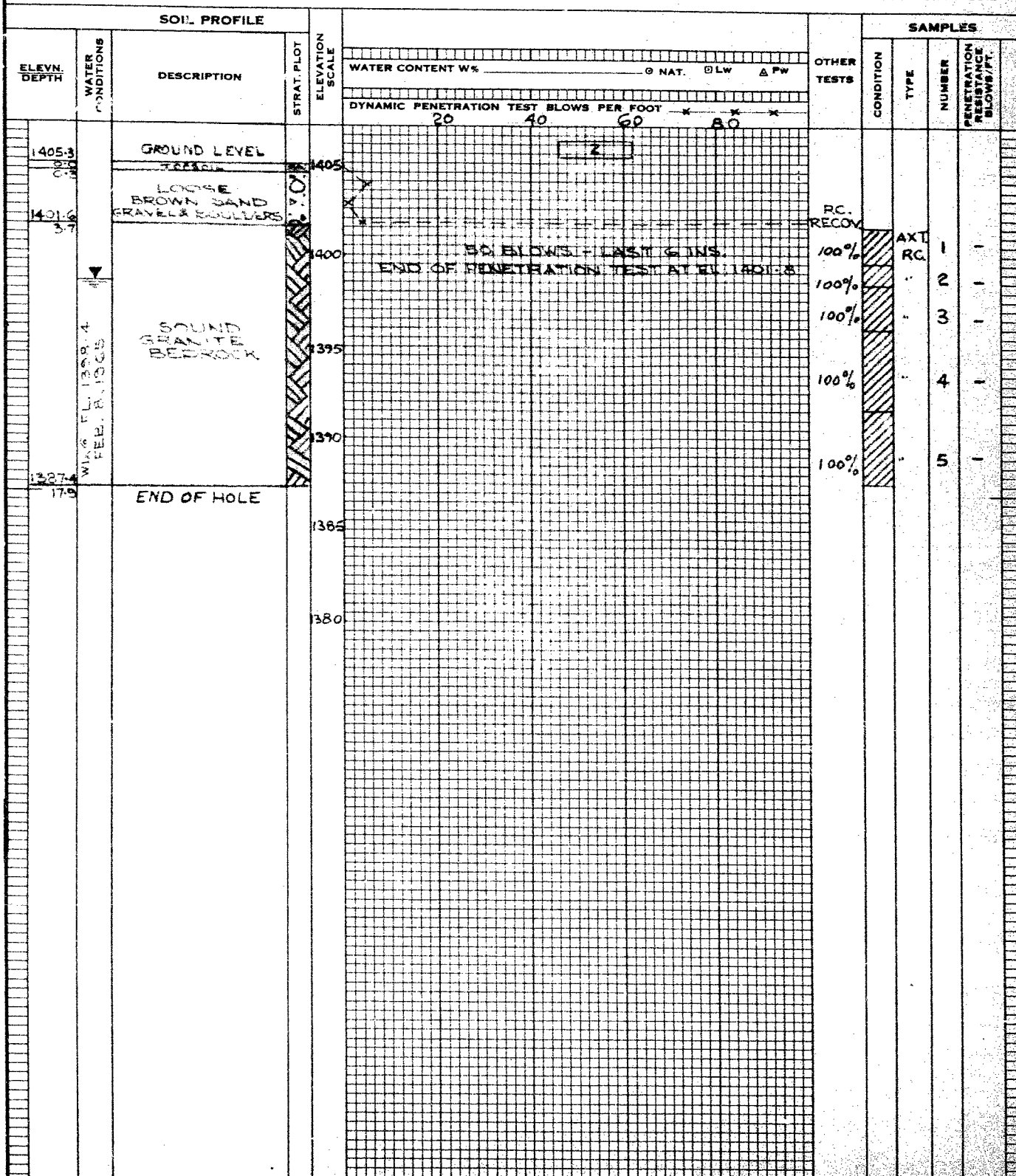
SAMPLE TYPES

A.S. - AUGER SAMPLE
 S.T. - SLOTTED TUBE
 W.S. - WASHED SAMPLE
 D.O. - DRIVE-OPEN
 D.F. - DRIVE-FOOT VALVE
 C.S. - CHUNK SAMPLE

F.S. - FOIL SAMPLE
 S.O. - SLEEVE-OPEN
 S.F. - SLEEVE-FOOT VALVE
 T.O. - THIN WALLED OPEN
 R.C. - ROCK CORE

ABBREVIATIONS

V - IN-SITU VANE TEST
 M - MECHANICAL ANALYSIS
 U - UNCONFINED COMPRESSION
 QC - TRIAXIAL CONSOLIDATED UNDRAINED
 Q - TRIAXIAL UNDRAINED
 S - TRIAXIAL DRAINED
 γ - WET UNIT WEIGHT
 K - PERMEABILITY
 C - CONSOLIDATION
 WL - WATER LEVEL IN CASING
 WT - WATER TABLE IN SOIL



GEOCON

OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T7722 BORING # 4 DATUM GEODETIC CASING EXT
 BORING DATE FEB 13 1965 REPORT DATE FEB 23 1965 COMPILED BY BER CHECKED BY DBO
 SAMPLER HAMMER WT. — LBS. DROP — INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS. ENERGY)

SAMPLE CONDITION

 DISTURBED
 FAIR
 GOOD
 LOST

SAMPLE TYPES

A.S. - AUGER SAMPLE
 S.T. - SLOTTED TUBE
 W.S. - WASHED SAMPLE
 D.O. - DRIVE-OPEN
 D.F. - DRIVE-FOOT VALVE
 C.S. - CHUNK SAMPLE
 F.S. - FOIL SAMPLE
 S.O. - SLEEVE-OPEN
 S.F. - SLEEVE-FOOT VALVE
 T.O. - THIN WALLED OPEN
 R.C. - ROCK CORE

ABBREVIATIONS

V - IN-SITU VANE TEST
 M - MECHANICAL ANALYSIS
 U - UNCONFINED COMPRESSION
 OC - TRIAXIAL CONSOLIDATED UNDRAINED
 Q - TRIAXIAL UNDRAINED
 S - TRIAXIAL DRAINED
 T - WET UNIT WEIGHT
 K - PERMEABILITY
 C - CONSOLIDATION
 WL - WATER LEVEL IN CASING
 WT - WATER TABLE IN SOIL

SOIL PROFILE				SAMPLES					
ELEV. DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT. PLOT	ELEVATION SCALE	OTHER TESTS	CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOWS/FT.
1338.1		GROUND LEVEL		1400					
332.0		BROWN SAND SOME GRAVEL AND BOULDERS		375					
332.0		SOUND GRANITE BEDROCK		390					
332.0		END OF HOLE		385					

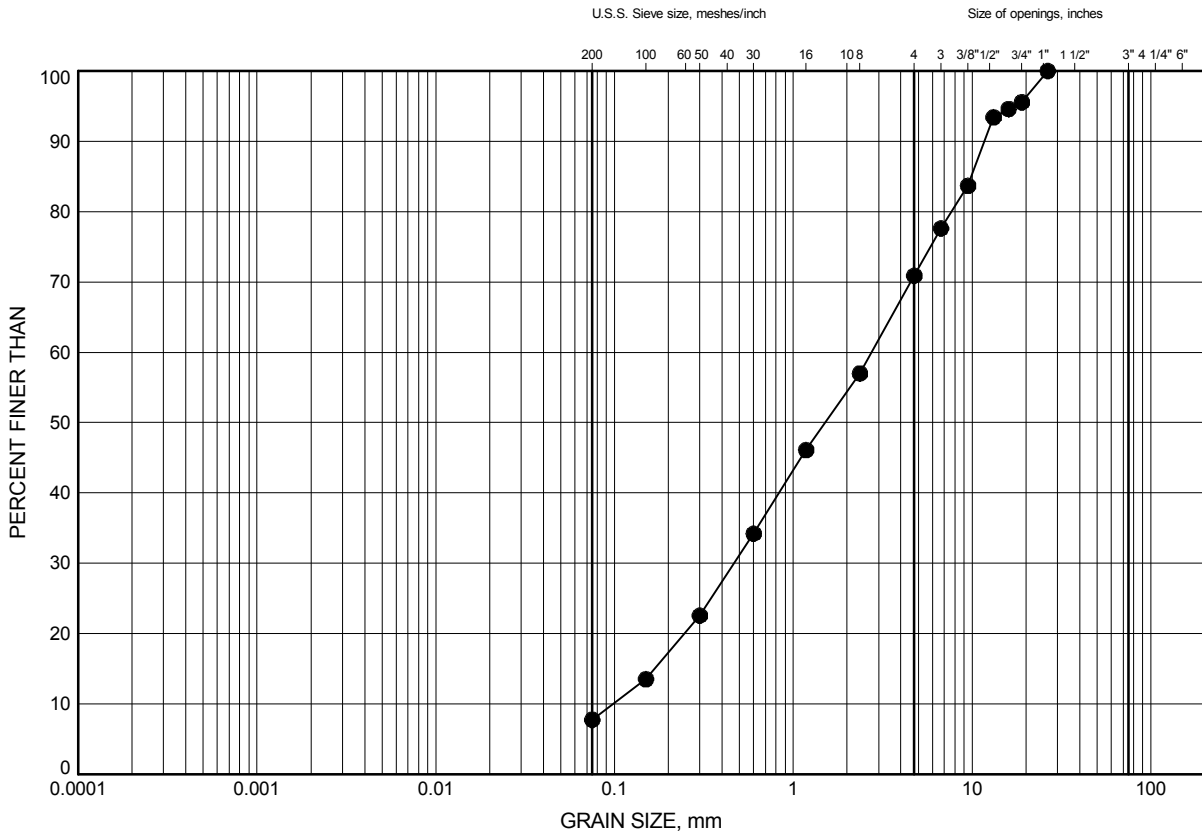
APPENDIX C
LABORATORY TEST RESULTS

Nebskwashi River Bridge

GRAIN SIZE DISTRIBUTION

FIGURE C1

Granular Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-01	0.41	430.61

Date July 2017
GWP# 5144-10-00



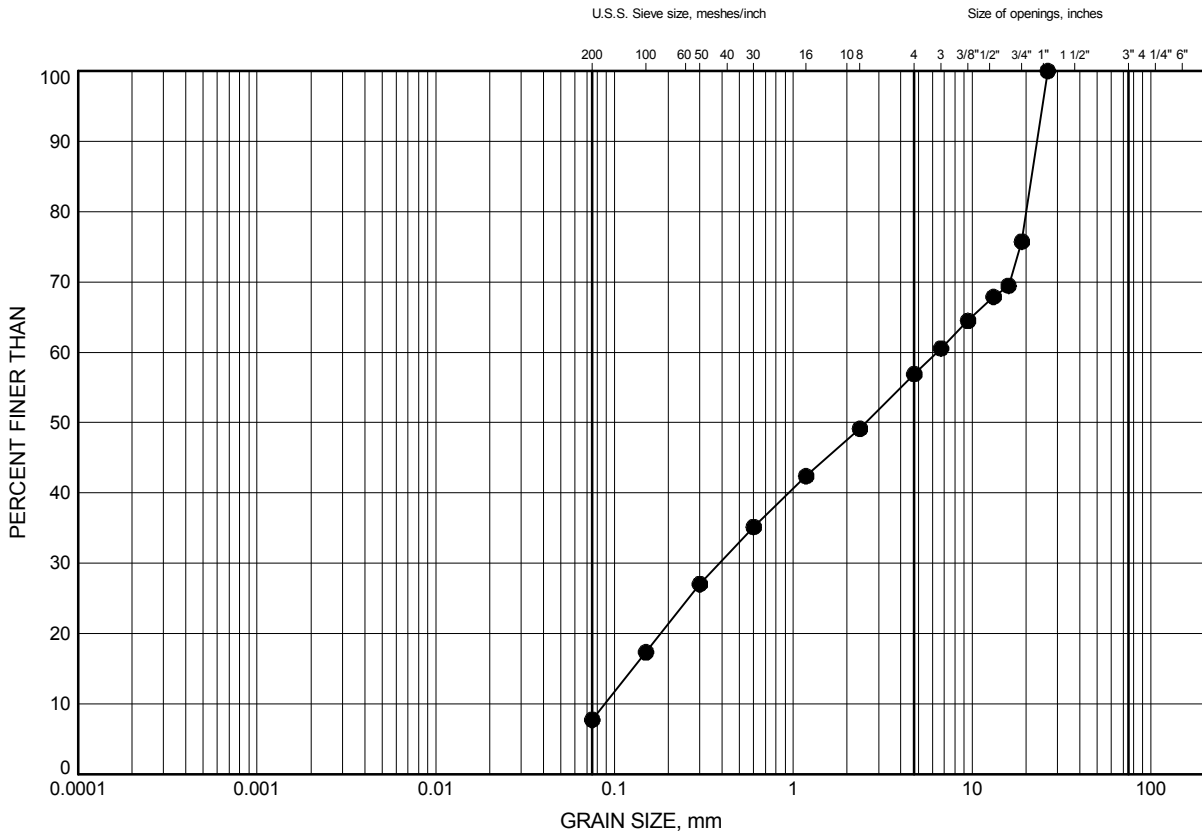
Prep'd DJP
Chkd. SP

Nebskwashi River Bridge

GRAIN SIZE DISTRIBUTION

FIGURE C2

Sand with Gravel



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-02	1.07	430.36

Date July 2017

GWP# 5144-10-00



Prep'd DJP

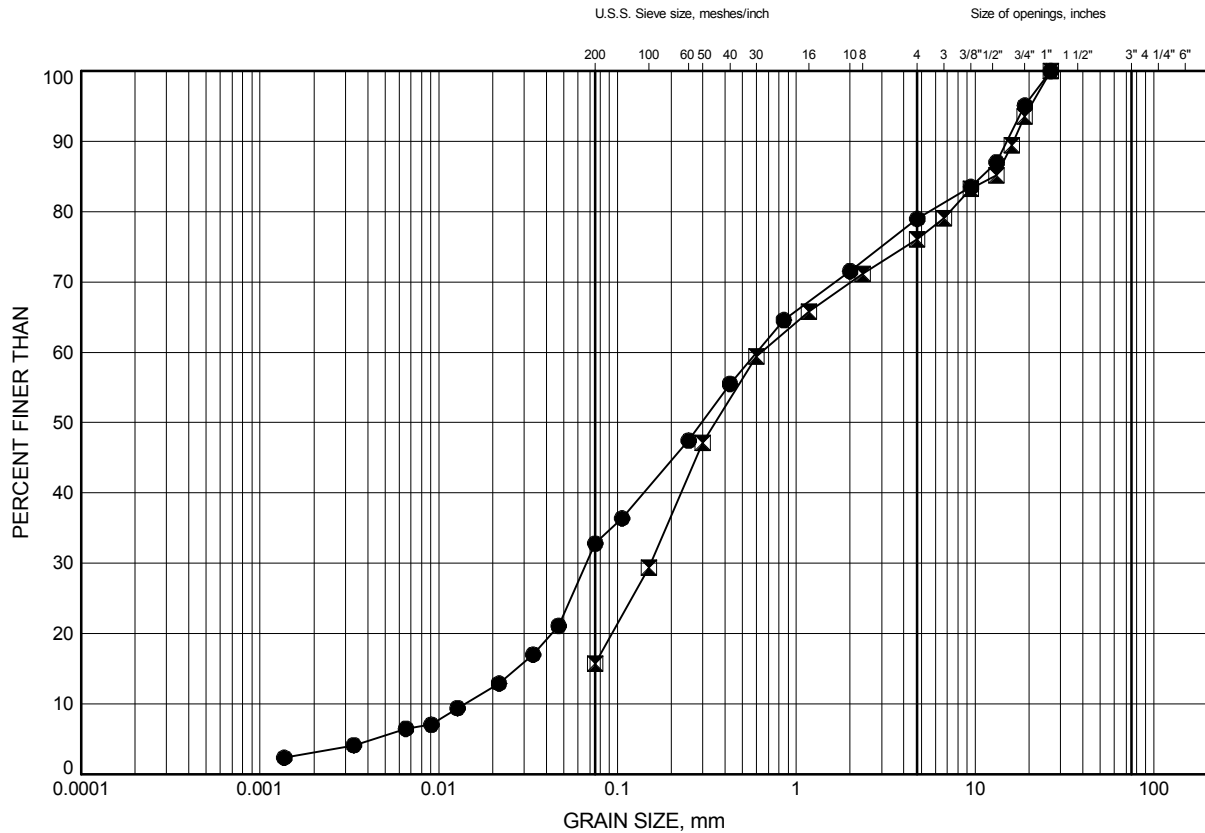
Chkd. SP

Nebskwashi River Bridge

GRAIN SIZE DISTRIBUTION

FIGURE C3

Silty Sand with Gravel



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-01	4.22	426.80
⊠	17-02	3.20	428.23

Date July 2017
GWP# 5144-10-00



Prep'd DJP
Chkd. SP

APPENDIX D
SELECTED PHOTOGRAPHS



Figure 1: As Drilled Boreholes at Bridge 46-236 looking East [taken May 5, 2017]



Figure 2: Looking towards West Abutment [taken May 5, 2017]

APPENDIX E
LIST OF REFERENCED SPECIFICATIONS

LIST OF REFERENCED SPECIFICATIONS

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
OPSS.PROV 517	Construction Specification for Dewatering
SP517F01	
SP109S12	

Suggested texted for a NSSP on "Protection of Expanded Polystyrene"

The expanded polystyrene must be protected from heat and physical damage during cutting of the temporary protection system.