



**THURBER** ENGINEERING LTD.

**FOUNDATION INVESTIGATION AND DESIGN REPORT  
BERRY CREEK BRIDGE REHABILITATION  
HIGHWAY 71, TOWNSHIP OF SIOUX NARROWS-NESTOR FALLS  
DISTRICT OF KENORA, ONTARIO  
W.P. No. 6818-14-02, SITE No. 41S-003**

**LATITUDE: 49.437732°, LONGITUDE: -94.000920°**

**GEOCRES Number: 52E-072**

**Report**

**to**

**McIntosh Perry**

Date: December 13, 2018  
File: 18879



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**PART 1: FACTUAL INFORMATION**

**1. INTRODUCTION**

This report presents the factual data obtained during a foundation investigation carried out by Thurber Engineering Ltd. (Thurber) for the proposed rehabilitation of the Berry Creek Bridge on Highway 71, located in the Township of Sioux Narrows-Nestor Falls, District of Kenora, Ontario.

The purpose of this investigation was to explore the subsurface conditions at the bridge location and, based on the data obtained, to provide a borehole location plan, stratigraphic profile, records of boreholes, laboratory test results, and a written description of the subsurface conditions.

Thurber was retained to carry out the foundation investigation by McIntosh Perry who are completing the detailed design of the bridge rehabilitation under the Ministry of Transportation Ontario (MTO) Agreement Number 6017-E-0001.

**2. SITE DESCRIPTION**

The Berry Creek bridge is located on Highway 71 approximately 7.5 km northeast of Sioux Narrows in the Township of Sioux Narrows-Nestor Falls, District of Kenora, Ontario. The existing bridge carries Highway 71 over Berry Creek in a generally south to north direction. Berry Creek flows westerly to Lake of the Woods.

The existing bridge consists of a three-span, two lane structure with a total length of 57.9 m and width of 11.3 m. The centre span length between the piers is 24.4 m and the span lengths at the abutments are 16.8 m. The bridge piers are designed to be supported on tremie-filled sheet pile caissons bearing on rock, and the abutment foundation design comprises steel H-piles driven to bedrock.



The Ontario Structure Inspection Manual (OSIM) report from June 2015 indicates that the structure is in overall good condition, with some scaling, spalling and cracking of concrete components.

Based on the General Arrangement drawing for the existing bridge, road grades on the bridge generally vary from Elev. 328.8 to 329.9 m. On the draft General Arrangement drawing for the current rehabilitation, the water level in Berry Creek is reported as Elev. 322.6 m in September 2017.

Photographs of the bridge and surrounding area are presented in Appendix A. Sand, gravel, and rock fill were observed at the surface at both the north and south abutments, extending to the pier locations. The existing approach embankments appear to be stable. The general area of the bridge consists of rock outcrops, forests, swamps and lakes.

The geology of the area generally consists of a sandy till ground moraine with cobbles and boulders, overlying Precambrian bedrock. Glacio-lacustrine deposits comprising varved clays and fine sands occupy low valley areas, and organic deposits have developed in depressions. Based on local geological maps the bedrock in the area is identified as metavolcanic.

### **3. INVESTIGATION PROCEDURES**

The site investigation and field testing program for this project was carried out between July 15 and 17, 2018, and consisted of drilling, sampling and coring of two boreholes, designated Boreholes BC-01 and BC-02, to depths of 11.5 and 13.6 m. Boreholes BC-01 and BC-02 were drilled from the existing road adjacent to the south and north abutments, respectively.

The borehole locations and depths are summarized in Table 3.1. The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata drawing in Appendix F. The locations were established in the field relative to site features, and the ground elevations at the boreholes have been interpreted from topographic and cross-section drawings provided by McIntosh Perry. An accuracy of 0.1 m is inferred.

**Table 3.1 – Borehole Details**

<b>Foundation Unit</b>	<b>Borehole No.</b>	<b>Ground Elevation (m)</b>	<b>Borehole Depth (m)</b>
South Abutment	BC-01	330.1	11.5
North Abutment	BC-02	329.8	13.6



A truck mounted drill rig was used to advance the boreholes using NW casing and wash boring techniques. Soil samples were obtained in the boreholes at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). HQ coring equipment was used to penetrate rock fill encountered in the south approach fill. Bedrock core samples were recovered in both boreholes using an NQ size diamond drill core barrel.

The field investigation was supervised on a full-time basis by a member of Thurber's technical staff who marked/staked the boreholes in the field, arranged for the clearance of subsurface utilities, directed the drilling, sampling and in-situ testing operations, logged the boreholes and processed the recovered soil samples for transport to Thurber's laboratory for further examination and testing. All rock cores were logged, and the Total Core Recovery (TCR), Rock Quality Designation (RQD) and the Fracture Indices (FI) were determined.

Groundwater conditions were observed throughout the drilling operations and in the open boreholes upon completion of drilling. The boreholes were backfilled upon completion in general accordance with Ontario Regulation 903 as amended.

#### **4. LABORATORY TESTING**

Routine laboratory testing was carried out at Thurber's laboratory. The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to grain size distribution analysis. Point Load Testing was carried out on selected rock cores for estimating the unconfined compressive strength of the intact rock. Results of the laboratory testing are summarized on the Record of Borehole sheets in Appendix B and presented on the figures included in Appendix C.

#### **5. DESCRIPTION OF SUBSURFACE CONDITIONS**

Reference is made to the Record of Borehole sheets included in Appendix B. Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets and on the Borehole Locations and Soil Strata Drawing included in Appendix F. A general description of the stratigraphy, based on the conditions encountered in the boreholes, is given in the following paragraphs. However, the factual data presented on the Record of Borehole sheets takes precedence over this general description and must be used for interpretation of the site conditions. It must be recognized and expected that soil conditions may vary between and beyond the borehole locations.

In general, the subsurface conditions encountered below the asphalt surface and concrete approach slab consisted of gravelly sand fill and rock fill overlying bedrock at the south abutment,



and gravelly sand fill overlying native sand and silt, which in turn was underlain by bedrock, at the north abutment. Descriptions of the individual strata are presented below.

## **5.1 Asphalt and Concrete**

An asphalt surface was encountered in both boreholes and was approximately 25 to 100 mm thick. The underlying approach slab was approximately 425 and 100 mm thick in Boreholes BC-01 and BC-02, respectively.

## **5.2 Embankment Fill**

Fill was encountered below the approach slab at both abutments. At the south approach (Borehole BC-01), the fill consisted of gravelly sand to a depth of 4.9 m (Elev. 325.2 m), containing a 0.7 m thick layer of rock fill between depths of 1.9 and 2.6 m, underlain by rock fill. At the north approach (Borehole BC-02), the fill consisted of gravelly sand to sand, trace gravel. Cobbles and boulders were locally present within the fill. The size of rock fragments recovered in core samples of the rock fill typically ranged from 50 to 425 mm.

The fill was underlain by bedrock at 8.5 m depth (Elev. 321.6 m) at the south approach, and by native sand and silt at 3.7 m depth (Elev. 326.1 m) at the north approach.

SPT 'N' values in the gravelly sand to sand fill generally ranged from 2 to 26 blows per 0.3 m penetration, indicating a very loose to compact condition. Higher blow counts of over 50 blows per 0.15 m of penetration were obtained in Borehole BC-01, likely indicating the presence of cobbles and boulders. Measure moisture contents in the gravelly sand to sand fill ranged from 8 to 20 percent.

The results of grain size distribution analyses conducted on samples of the gravelly sand to sand fill are provided on the Record of Borehole sheets in Appendix B, and illustrated in Figure C1 of Appendix C. The results are summarized as follows:

<b>Soil Particle</b>	<b>Percentage (%)</b>
Gravel	14 to 32
Sand	62 to 84
Silt and Clay	2 to 6



### 5.3 Sand and Silt

Sand and silt, containing trace clay and trace gravel, was encountered in Borehole BC-02 at a depth of 3.7 m (Elev. 326.1 m). The sand and silt layer was approximately 6.7 m thick and extended to bedrock at a depth of 10.4 m (Elev. 319.4 m).

SPT 'N' values recorded in the sand and silt ranged from 7 to 25 blows per 0.3 m penetration, indicating a loose to compact condition. Measured moisture contents in the sand and silt ranged from 19 to 20 percent.

The results of a grain size analysis conducted on a sample of the sand and silt are provided on the Record of Borehole sheets in Appendix B, and illustrated in Figure C2 of Appendix C. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	1
Sand	48
Silt	47
Clay	4

### 5.4 Bedrock

Bedrock was proven by coring in both boreholes. The table below summarizes the depths and elevations to the top of bedrock.

**Table 5.1 - Depths and Elevations of Top of Bedrock**

Borehole	Location	Top of Bedrock	
		Depth (m)	Elevation (m)
BC-01	South Abutment	8.5	321.6
BC-02	North Abutment	10.4	319.4

The bedrock recovered in the cores was described as slightly weathered, grey tuff with horizontal, sub-horizontal, and vertical fractures. Total Core Recovery (TCR) in the bedrock was 100 percent and the Solid Core Recovery (SCR) ranged from 85 to 100 percent. The Rock Quality Designation (RQD) determined from the recovered cores ranged from 38 to 78 percent, indicating poor to good rock quality.

Average unconfined compressive strengths (UCS) of the rock ranged between 158 and 316 MPa, indicating a rock strength classification of very strong to extremely strong. The estimated rock



strength values are interpreted from point load tests that were conducted on rock cores recovered from the boreholes.

## **5.5 Groundwater Conditions**

The groundwater conditions in the open boreholes were observed during and upon completion of drilling operations. Water was not observed in Borehole BC-01 during drilling. In Borehole BC-02, water was observed at 6.5 m depth (Elev. 323.3 m) upon completion and at 6.8 m depth (Elev. 323.0 m) the following morning.

The use of rotary coring techniques introduces water into the boreholes, which impacts the observation of groundwater levels. In general, the stabilized water level at the site is expected to be approximately coincident with the water level in Berry Creek, reported to be at Elev. 322.6 m in September 2017.

Seasonal fluctuations of the creek and groundwater levels should be expected. In particular, the groundwater and creek water levels may be at a higher elevation after periods of significant or prolonged precipitation, or after snowmelt.

## **6. MISCELLANEOUS**

Thurber obtained subsurface utility clearances prior to drilling. The northing and easting coordinates and ground surface elevations were estimated based on field measurements relative to the topographic plans provided by McIntosh Perry.

George Downing Estate Drilling Ltd. of Ottawa, Ontario supplied and operated the drilling, sampling and in-situ testing equipment for the field investigation. The field investigation was supervised on a full-time basis by Mr. Ryan McCourt, P.Geo. of Thurber. Overall supervision of the field program was provided by Mr. Mark Farrant, P.Eng. of Thurber.

Geotechnical laboratory testing was carried out in Thurber's geotechnical laboratory.

Interpretation of the field data and preparation of this report was carried out by Mr. Cory Zanatta, P.Eng. and Murray Anderson, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.





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**PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS**

**7. GENERAL**

This section of the report presents interpretation of the subsurface data in the factual report and presents foundation recommendations concerning the proposed rehabilitation of the Berry Creek Bridge located on Highway 71 in the Township of Sioux Narrows-Nestor Falls, District of Kenora.

The existing bridge consists of a three-span, two lane structure with a total length of 57.9 m and width of 11.3 m. The centre span length between the piers is 24.4 m and the span lengths at the abutments are 16.8 m. The bridge piers are designed to be supported on tremie-filled sheet pile caissons bearing on rock, and the abutment foundation design comprises steel H-piles driven to bedrock.

We understand that the proposed rehabilitation of the bridge will include conversion of the abutments to a semi-integral configuration. This section of the report addresses the foundation aspects of excavation and temporary roadway protection to accommodate the semi-integral conversion.

The discussions and recommendations presented in this report are based on the information provided by McIntosh Perry and on the factual data obtained during the investigation.

This foundation design report with the interpretation and recommendations are intended for the use of the McIntosh Perry and Ministry of Transportation of Ontario (MTO), and shall not be used or relied upon for any other purposes or by any other parties including the construction contractor. The contractor must make their own interpretation based on the factual data in the foundation investigation 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.

## **8. EXCAVATION AND TEMPORARY PROTECTION SYSTEMS**

It is understood that conversion of the abutments to a semi-integral design will require excavation to a depth in the order of 2.5 m within the approach embankments adjacent to the abutments. Temporary roadway protection will be required to maintain a single lane of traffic at all times during construction.

All excavation must be carried out in accordance with OPSS 902 and the Occupational Health and Safety Act (OHSA). For the purposes of assessing excavation slope requirements in compliance with the OHSA, the gravely sand to sand fill within the anticipated excavation depth is classified as a Type 3 soil. Rock fill, if encountered, should also be considered a Type 3 soil. The excavation is expected to remain above the water level in Berry Creek.

Roadway protection will be required to maintain traffic during abutment construction. Temporary protection systems should be designed and constructed in accordance with OPSS.PROV 539 and designed for Performance Level 2 (maximum 25 mm horizontal deflection) provided that the existing adjacent roadway can tolerate this magnitude of deflection.

Use of a soldier pile and lagging system may be considered for the roadway protection at this site. Rock fill has been identified in the fill at the south abutment, and may locally be present within the north approach fill. Driving of H-piles is expected to encounter refusal at varying depths in the rock fill as well as on possible cobbles and boulders in the granular fill. Predrilling, coring or other means may be required to penetrate the rock fill and achieve an adequate depth of embedment to develop the required lateral resistance for the protection system.

Driving or vibrating of steel sheet piles within the rock fill is not expected to be feasible, and the use of sheet piles is not recommended at the south abutment.

The soil parameters in Table 8.1 may apply for design of the temporary roadway protection system with horizontal backfill. 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 designing the shoring system.



**Table 8.1 –Soil Parameters for Temporary Protection System Design**

Soil Parameter	Existing Embankment Fill	Sand and Silt
Unit weight, $\gamma$	21 kN/m <sup>3</sup>	20 kN/m <sup>3</sup>
$K_a$	0.31	0.33
$K_p$	3.3	3.0

Partial removal of the protection systems and dewatering measures shall be in accordance with OPSS.PROV 539.

The selection and design of the temporary protection systems and dewatering procedures are the responsibility of the contractor. The roadway protection system should be designed by a licensed Professional Engineer experienced in design of shoring with consideration of adjacent traffic loads, construction operations, and any sloping retained surfaces.

## 9. ABUTMENT BACKFILL AND LATERAL EARTH PRESSURES

Backfill to the structure elements (new abutments) should consist of rock backfill or free-draining granular material conforming to OPS Granular A or B Type II specifications. Rock backfill must be restricted to a maximum dimension of 250 mm. The rock backfill and granular material should be placed to the extents shown in OPSD 3101.200 or 3121.150. Compaction should be carried out in accordance with OPSS.PROV 206 and OPSS.PROV 501.

Earth pressures acting on the structure may be assumed to impose a triangular distribution governed by the characteristics of the backfill. For a fully drained condition, the pressures should be computed in accordance with the CHBDC 2014 but generally are given by the expression:

$$p_h = K (\gamma h + q)$$

where

$$p_h = \text{horizontal pressure on the wall at depth } h \text{ (kPa)}$$

$$K = \text{earth pressure coefficient (see table below)}$$

$$\gamma = \text{bulk unit weight of retained soil (see table below)}$$

$$h = \text{depth below top of fill where pressure is computed (m)}$$

$$q = \text{value of any surcharge (kPa)}$$



The earth pressure coefficients are dependent on the material used as backfill. Recommended unfactored values are shown in Table 9.1. The at-rest coefficients should be employed for restrained walls. Active pressures should be used for any wingwalls or unrestrained walls.

**Table 9.1 – Lateral Earth Pressure Coefficients**

Loading Condition	Earth Pressure Coefficient (K)			
	OPSS Granular A or Granular B Type II $\phi = 35^\circ, \gamma = 22.8 \text{ kN/m}^3$		Rock Backfill $\phi = 42^\circ, \gamma = 19 \text{ kN/m}^3$	
	Horizontal Backfill	Sloping Backfill (2H:1V)	Horizontal Backfill	Sloping Backfill (2H:1V)
Active (Unrestrained Wall)	0.27	0.39*	0.20	0.25*
At-rest (Restrained Wall)	0.43	-	0.33	-
Passive	3.7	-	5.0	-

\* For wing walls.

The parameters in the table correspond to full mobilization of active and passive earth pressures, and require certain relative movements between the wall and adjacent soil to produce these conditions. The values to be used in design can be assessed from Figure C6.16 of the Commentary to the CHBDC 2014.

In accordance with Clause 6.12.3 of the CHBDC, a compaction surcharge should be added. The magnitude should be 12 kPa at the top of fill and decreasing to 0 kPa at a depth of 2.0 m for rock backfill, Granular A or Granular B Type II.

The design of the abutment walls must incorporate measures such as weep holes and/or subdrains to permit drainage of the backfill and avoid the potential build-up of hydrostatic pressures behind the walls.

## 10. EMBANKMENT RESTORATION

In general, the existing approach embankments comprise rock fill, sand and gravel and appear to be performing satisfactorily without evidence of instability. Where required, it is recommended that rock fill be used as embankment reconstruction material. After completion of the rehabilitation, the existing embankments should be restored to the existing inclination, but no steeper than 1.25H:1V, in accordance with OPSS.PROV 206.

Embankment slopes comprising exposed granular material must be provided with erosion protection in accordance with OPSS.PROV 804. Typically, rock protection should be provided



over all surfaces with which lake water is likely to be in contact. Rock fill or a vegetation cover should be established on all other exposed earth surfaces to protect against surficial erosion.

The embankment slopes should be regularly inspected and any areas of material loss potentially impacting the highway platform should be repaired with rock fill.

## **11. CONSTRUCTION CONCERNS**

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

- Rock fill is present within the existing approach embankments, and cobbles or boulders may be encountered in the granular fill. Equipment capable of excavating the rock fill and handling large boulders will be required for excavation. The rock fill thickness and rock size will vary with location.
- Driving of soldier piles for installation of roadway protections systems may be difficult within the existing approach fill, and predrilling, coring or other means may be required to advance the piles to adequate depth. Use of sheet piles is not recommended.

Suggested wording for an NSSP alerting the Contractor to these concerns is provided in Appendix E



## 12. CLOSURE

Engineering analysis and preparation of this report was carried out by Mr. Cory Zanatta, P.Eng and Mr. Murray Anderson, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

### Thurber Engineering Ltd.



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P.K. Chatterji, P.Eng.  
Review Principal, Designated MTO Contact



## **Appendix A**

### **Site Photographs**





## Berry Creek Bridge Rehabilitation Site Photographs



Photograph # 1 – Berry Creek Bridge, looking south (July 2018)

**Berry Creek Bridge Rehabilitation**  
Site Photographs



Photograph # 2 – Underside of Bridge, looking south (July 2018)



**Berry Creek Bridge Rehabilitation**  
Site Photographs



Photograph # 3 – Underside of Bridge, looking North (July 2018)

**Berry Creek Bridge Rehabilitation**  
Site Photographs



Photograph # 4 – Rock Fill at West Abutment (July 2018)



## **Appendix B**

### **Record of Borehole Sheets**

## SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

### 1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

### 2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

### 3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT <sup>(1)</sup> 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

- 1) Laboratory Triaxial Testing
- 2) Field Insitu Vane Testing
- 3) Laboratory Vane Testing
- 4) SPT value
- 5) Pocket Penetrometer


### 4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

### 5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample	TP Thin Wall Piston Sample	
	PH Sampler Advanced by Hydraulic Pressure	PM Sampler Advanced by Manual Pressure	
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

 Water Level  
 Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value      Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT      Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.



## EXPLANATION OF ROCK LOGGING TERMS

<u>ROCK WEATHERING CLASSIFICATION</u>		<u>SYMBOLS</u>	
<b>Fresh (FR)</b>	No visible signs of weathering.		
<b>Fresh Jointed (FJ)</b>	Weathering limited to the surface of major discontinuities.		CLAYSTONE
<b>Slightly Weathered (SW)</b>	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE
<b>Moderately Weathered (MW)</b>	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE
<b>Highly Weathered (HW)</b>	Weathering extends throughout the rock mass and the rock is partly friable.		COAL
<b>Completely Weathered (CW)</b>	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.		Bedrock (general)

<u>DISCONTINUITY SPACING</u>		<u>STRENGTH CLASSIFICATION</u>			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Very thinly bedded	20 to 60mm				
Laminated	6 to 20mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Thinly Laminated	Less than 6mm				
<u>TERMS</u>		Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.				
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen				
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.				

# RECORD OF BOREHOLE No BC-01

1 OF 2

METRIC

W.P. 6818-14-01 LOCATION Berry Creek Bridge, MTM Zone 16: N 5 478 207.0 E 232 199.1 ORIGINATED BY BRM  
DIST Kenora HWY 71 BOREHOLE TYPE HW/NW Casing COMPILED BY MP  
DATUM Geodetic DATE 2018.07.17 - 2018.07.17 LATITUDE 49.437403 LONGITUDE -94.001100 CHECKED BY GRL

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 <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			WATER CONTENT (%)					
								20   40   60   80   100	W <sub>P</sub> W      W <sub>L</sub>							
						○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL      × LAB VANE										
330.1	GROUND SURFACE						20   40   60   80   100	20   40   60								
8.9	ASPHALT (25mm)															
329.6	CONCRETE (425mm)															
0.5	Gravelly SAND, with cobbles and boulders Compact Brown Moist to Wet (FILL)		1	SS	19							○		32   62   6 (SI+CL)		
			2	SS	50/ 0.150									No recovery		
			3	SS	50/ 0.100							○				
328.2																
1.9	ROCK FILL 300mm diameter															
327.5																
2.6	Gravelly SAND, with cobbles and boulders Compact Grey Moist to Wet (FILL)		4	SS	16											
			5	SS	26											
			6	SS	11							○				
325.2																
4.9	ROCK FILL 50mm to 425mm diameter															

Continued Next Page

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



RECORD OF BOREHOLE No BC-01

2 OF 2

METRIC

W.P. 6818-14-01 LOCATION Berry Creek Bridge, MTM Zone 16: N 5 478 207.0 E 232 199.1 ORIGINATED BY BRM  
DIST Kenora HWY 71 BOREHOLE TYPE HW/NW Casing COMPILED BY MP  
DATUM Geodetic DATE 2018.07.17 - 2018.07.17 LATITUDE 49.437403 LONGITUDE -94.001100 CHECKED BY GRL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
								20	40	60	80					
	Continued From Previous Page															
	Sub vertical fracture (100mm) at 9.9m, at 10.4m, (75mm) at 10.5m, (100mm) at 10.7m and (125mm) at 10.8m		2	RUN			320									RUN #2 TCR=100% SCR=85% RQD=39% UCS=316MPa (Average)
	Sub horizontal fractures at 10.1m, 10.2m, 10.3m, 10.5m, 10.9m and 11.0m						319									
318.6																
11.5	END OF BOREHOLE AT 11.5m. BOREHOLE DRY UPON COMPLETION. BOREHOLE SIDEWALLS CAVED BELOW 2.9m, THEN BACKFILLED WITH BENTONITE HOLEPLUG TO 0.6m, SAND TO 0.2m, THEN ASPHALT TO SURFACE.															

# RECORD OF BOREHOLE No BC-02

1 OF 2

METRIC

W.P. 6818-14-01 LOCATION Berry Creek Bridge, MTM Zone 16: N 5 478 266.5 E 232 224.1 ORIGINATED BY BRM  
DIST Kenora HWY 71 BOREHOLE TYPE HW/NW Casing COMPILED BY MP  
DATUM Geodetic DATE 2018.07.15 - 2018.07.15 LATITUDE 49.437941 LONGITUDE -94.000767 CHECKED BY GRL

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 <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE				WATER CONTENT (%) w <sub>p</sub> w      w <sub>L</sub>					GR	SA	SI	CL			
329.8	GROUND SURFACE						329								31	65	4	(SI+CL)					
0.0	ASPHALT (100mm)																						
0.1	CONCRETE (100mm)																						
0.2	Gravelly SAND to SAND, some gravel, trace silt Very Loose to Compact Brown Moist to Wet (FILL)		1	SS	13																		
			2	SS	2																		
		3	SS	15																			
		4	SS	21				327															
		5	SS	9																			
326.1									326												14	84	2
3.7	SAND and SILT, trace clay, trace gravel Compact to Loose Brown Wet	6	SS	25		325																	
							324																
		7	SS	24		323																	
		8	SS	10		322									1	48	47	4					
		9	SS	7		321																	
						320																	

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

## METRIC

[illegible]

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity



## **Appendix C**

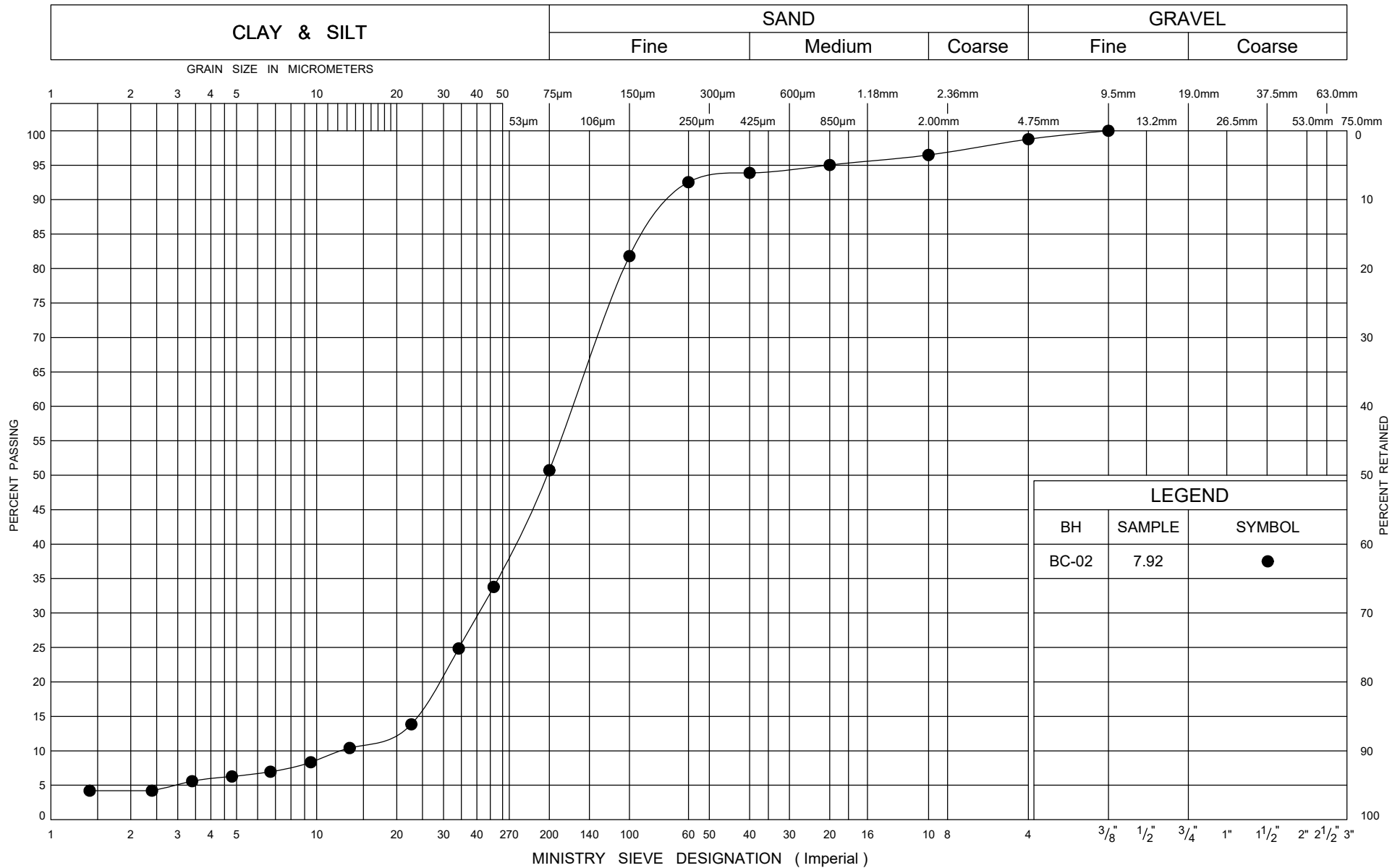
### **Geotechnical Laboratory Test Results**



## FIG No C1

W P 6818-14-01

Berry Creek Bridge



Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION SAND and SILT

FIG No C2

W P 6818-14-01

Berry Creek Bridge



# ASTM D5731-08

Date Drilled:	17-Jul-18
Date Tested:	26-Jul-18
Tester:	KF
Reviewed by:	CZ

[illegible]



## **Appendix D**

### **Photographs of Rock Core**

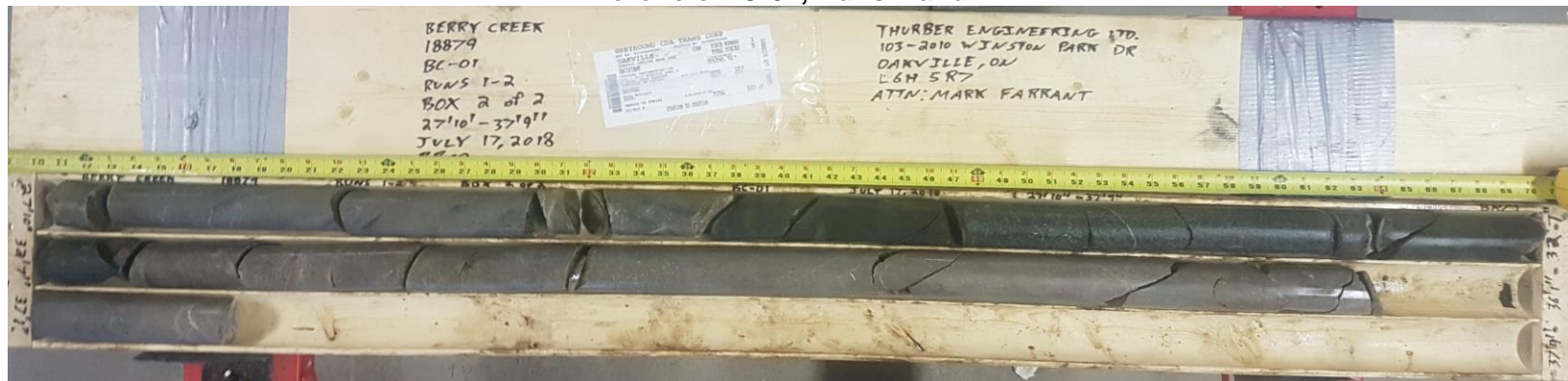


## Berry Creek Bridge Rehabilitation Photographs of Bedrock Core

**Borehole BC-01, Rock Fill**



**Borehole BC-01, Runs 1 and 2**



Berry Creek Bridge Rehabilitation  
Photographs of Bedrock Core

Borehole BC-02, Runs 1 and 2





## **Appendix E**

### **OPSS and OPSD References**



## **1. List of OPSS and OPSD Documents Referenced in this Report**

- OPSS.PROV 206 (Construction Specification for Grading)
- OPSS.PROV 501 (Construction Specification for Compacting)
- OPSS.PROV 539 (Construction Specification for Temporary Protection Systems)
- OPSS.PROV 804 (Construction Specification for Seed and Cover)
- OPSS.902 (Construction Specification for Excavating and Backfilling – Structures)
- OPSD 3101.150 (Walls, Abutment, Backfill, Minimum Granular Requirement)
- OPSD 3101.200 (Walls, Abutment, Backfill, Rock)

## **2. Suggested Text for NSSP on “Excavation and Installation of Roadway Protection”**

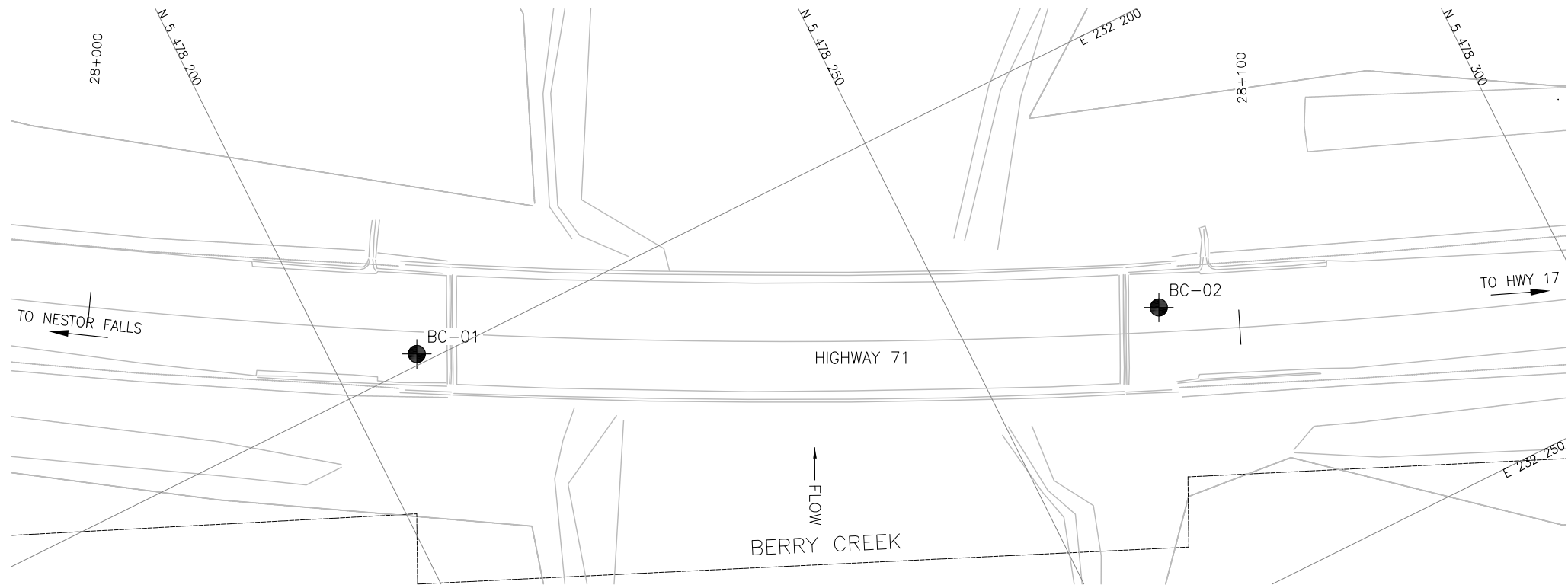
The Contractor is advised of the following site conditions:

- Rock fill is present within the existing approach embankments, and cobbles or boulders may be encountered in the granular fill. Equipment capable of excavating the rock fill and handling large boulders will be required for excavation. The rock fill thickness and rock size will vary with location.
- Driving of soldier piles for installation of roadway protections systems may be difficult within the existing approach fill, and predrilling, coring or other means may be required to advance the piles to adequate depth. Use of sheet piles is not recommended.

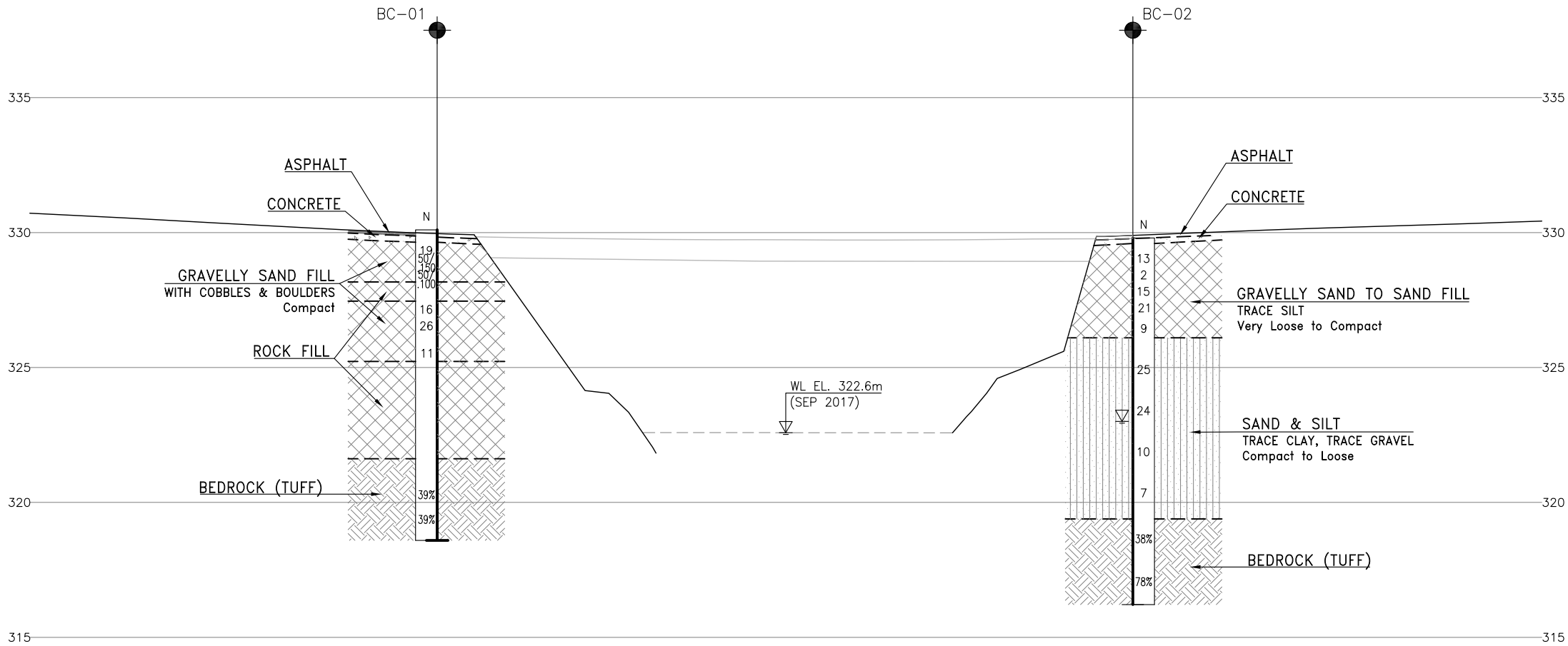


## **Appendix F**

### **Borehole Locations and Soil Strata Drawing**



PLAN  
SCALE 1:500



PROFILE ALONG  $\text{CL}$  HWY 71

SCALE 1:500  
SCALE 1:200

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



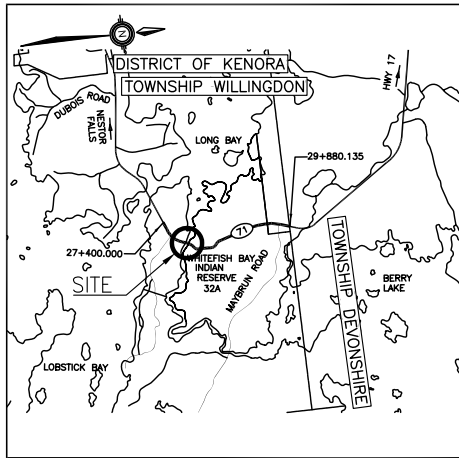
CONT No  
WP No 6818-14-01

HIGHWAY 71  
BERRY CREEK 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)
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
BC-01	330.1	5 478 207.0	232 199.1
BC-02	329.8	5 478 266.5	232 224.1

-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.
- Coordinate system is MTM NAD 83 Zone 16.

GEOCRES No. 52E-072

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	CZ	CHK MRA	CODE
DRAWN	MFA	CHK CZ	SITE
			LOAD
			DATE DEC 2018
			STRUCT
			DWG 1