PROJECT NO. 161-17014

PROPOSED RANKIN BRIDGE REPLACEMENT

KOUCHIBOUGUAC NATIONAL PARK

Parks Canada Parcs Canada

Final Geotechnical Investigation Report

DECEMBER 14, 2017

WSP

PROPOSED RANKIN BRIDGE REPLACEMENT

KOUCHIBOUGUAC NATIONAL PARK

Parks Canada Parcs Canada

Final Geotechnical Investigation Report

Project No: 161-17014
Date: December 14, 2017

WSP Canada Inc.
1 Spectacle Lake Drive
Dartmouth, NS B3B 1X7

Phone: 902-835-9955
Fax: 902-835-1645
www.wspgroup.com

WSP

December 14, 2017

Jason Angel, M.Sc., P.Eng., PMP
Highway Engineering Services (East)/Services de genie routier (Est)
Parks Canada/ Parcs Canada
1869 Upper Water Street, Suite AH201 | 1869, rue Upper Water, pièce AH201
Halifax, Nova Scotia B3J 1S9 | Halifax (Nouvelle-Écosse) B3J 1S9
(By Email: jason.angel@pc.gc.ca)

Subject: **Final Geotechnical Investigation Report**
Proposed Rankin Bridge Replacement
Kouchibouguac National Park, New Brunswick

Dear Mr. Angel,

At your request WSP completed a geotechnical investigation for the proposed replacement of Rankin Bridge at Kouchibouguac National Park, in New Brunswick. The attached report details the findings of the investigation as well as design and construction recommendations.

We trust this report meets your present requirements. If you have any questions with the information in the report, please do not hesitate to contact us at your convenience. This report was prepared by WSP Canada Inc.

Yours truly,

Clayton J. Rogers, P.Eng
Manager, Geotechnical - Dartmouth

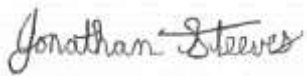
WSP Canada Inc.
1 Spectacle Lake Drive
Dartmouth, NS B3B 1X7

Phone: +1 902-835-9955
Fax: +1 902-835-1645
www.wspgroup.com

SIGNATURES

PREPARED BY

Taylor N. Elson
Engineer-in-Training, Geotechnical
Telephone: (902) 835-9955
Fax: (902) 835-1645
Email: taylor.elson@wspgroup.com



Jonathan K. Steeves. P.Eng.
Project Geotechnical Engineer
Telephone: (902) 835-9955
Fax: (902) 835-1645
Email: jonathan.steeves@wspgroup.com

REVIEWED BY

Clayton J. Rogers. P.Eng.
Manager, Geotechnical – Dartmouth
Telephone: (902) 835-9955
Fax: (902) 835-1645
Email: clayton.rogers@wspgroup.com

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1 INTRODUCTION AND BACKGROUND

At the request of Parks Canada, WSP Canada Inc. (WSP) has completed a geotechnical investigation for the proposed replacement of Rankin Bridge, in Kouchibouguac National Park, New Brunswick. The purpose of this investigation was to obtain information on subsurface soil and bedrock conditions at the site and provide geotechnical recommendations for earthworks, site preparation, geotechnical design and construction. Soil and bedrock samples were collected at various depths and submitted for analysis of properties such as moisture content, gradation, Atterberg limits and unconfined compressive strength (UCS) for bedrock.

Fieldwork for the subsurface investigation was conducted on December 5 and 6, 2016 and consisted of drilling four (4) boreholes at the approximate locations as shown on the attached Figure 1. This report presents the results of the field investigation and laboratory testing programs.

2 SITE DESCRIPTION

The site is located along Highway No.117 at the Kouchibouguac National Park, in New Brunswick. It is understood that Rankin Bridge has been identified by as being in relatively poor condition and in need of replacement.

The Rankin Brook Bridge was constructed in 1963 and has received rehabilitations in 2003 and 2015. The bridge is of monolithic rigid frame design with concrete T-beams monolithic with the deck and abutments. The span length is 14.56m (face to face of abutments) and the bridge is on a 33 degree +/- skew.

The bridge accommodates two traffic lanes and two shoulders with a curb-to-curb width of 9.14 m. There is a sidewalk supported off of the east side of the bridge intended for pedestrian and bicycle traffic. There is a 0.91m wide safety curb on each side with concrete panel railings. The overall structure width is 12.97m.

In 2015 the bridge was rehabilitated. Some of the rehabilitations included new steel traffic barriers, new concrete crash blocks, new deck drains and general structure repairs.

2.1 GEOLOGY

Available surficial geologic soil mapping of the area indicates that the site overlain by marine blanket, generally consisting of sand, clay, silt and minor gravel.

Geologic mapping of the proposed development area indicates that bedrock belongs to the Richibucto formation of the Pictou Group. This formation can generally be described as consisting of grey and minor greyish to brownish red sandstone, pebbly sandstone and intra-formational conglomerate, interstratified with red and minor grey very fine-grained sandstone, siltstone, mudstone and rare, lacustrine limestone.

2.2 TOPOGRAPHIC INFORMATION

Topography on the site can be characterized as relatively level along the road surface. Elevations ranged from 5.3 to 5.7 metres at the borehole locations.

3 INVESTIGATION PROCEDURE

3.1 BOREHOLE PROGRAM

The purpose of the geotechnical investigation was to develop an understanding of the subsurface soil, bedrock and groundwater conditions at the site and provide recommendations to assist in foundation design. The recommendations consider the field and laboratory test results discussed subsequently.

Subsurface investigation of the site was conducted on December 5 and 6, 2017 and included drilling four (4) boreholes (designated BH-01 – BH-04), at the locations shown on Figure 1. The boreholes were drilled using a track-mounted drill rig supplied by Lantech. All boreholes were terminated within bedrock.

During the borehole investigation soil samples were taken at 750-mm increments using a 50-mm outside diameter split-spoon sampler, driven in accordance with standard penetration resistance procedures (ASTM D1586). N-index values, described as the number of blows required to drive the sampler 305 mm (1 ft) into the soil were recorded for each sample location and are plotted on the borehole log. Diamond-bit core-drilling of bedrock was conducted using a 96 mm outside diameter HQ core barrel at select borehole locations.

Basic laboratory and visual examinations were carried out on select soil samples from the borehole investigation. Tests were performed in accordance with materials testing requirements and procedures outlined in ASTM testing manuals, as applicable. Laboratory testing was carried out by Stantec Inc.

An explanation of the symbols and terms used in this report are enclosed in Appendix A. Borehole logs and photo plate detailing the subsurface conditions are enclosed in Appendix B. Confirmatory laboratory index testing results are presented in Appendix C (laboratory testing services provided by Stantec Inc.).

3.2 LABORATORY TESTING

Basic laboratory testing and visual examinations were carried out on selected soil samples from the borehole investigation. Tests were performed in accordance with materials testing requirements and procedures outlined in the ASTM and CSA testing manuals, as applicable. All laboratory testing was carried out by Stantec Inc. at the request of WSP and laboratory results can be found in Appendix C.

4 SUBSURFACE CONDITIONS

In Summary, the subsurface conditions were found to be relatively similar in the subject boreholes. Generally, asphalt pavement overlying fill, glacial till and bedrock was encountered in the boreholes. The fill deposits extended to a depth of 3.5 to 3.7 metres below ground surface. Bedrock was encountered in all boreholes and generally consisted of weathered and fractured sandstone. Groundwater was observed in all the boreholes ranging in depth from 2.1 to 4.5 metres below ground surface. A summary of the subsurface conditions is provided in Table 4-1, below.

Table 4-1 – Summary of Subsurface Conditions

Borehole	Ground Surface Elevation* (metres)	Thickness of Asphalt (metres)	Thickness of Fill (metres)	Depth to Till (metres)	Depth to Bedrock (metres)	Depth to Groundwater (metres)	Bedrock Elevation* (metres)
BH-01	5.3	0.15	3.55	3.70	6.00	4.50	-0.7
BH-02	5.7	0.15	3.35	3.50	4.00	3.50	1.7
BH-03	5.3	0.15	3.35	3.50	5.30	2.10	0.0
BH-04	5.7	0.15	3.35	3.50	5.00	4.50	0.7

*Approximate ground surface elevations are referenced to WSP Topographic Survey Data (Collected: December, 2016).

4.1 ASPHALT

An asphalt layer was encountered at all borehole locations and extended to approximately 150 mm in total thickness.

4.2 SAND AND GRAVEL

A sand and gravel layer was encountered below asphalt layer in all boreholes locations, with a thickness ranging from 1,350 to 1,550 mm.

4.3 FILL

Fill deposits were encountered during the investigation beneath the sand and gravel layer. The fill material consisted of sand and clay, some silt, trace to some gravel. The material was generally in a dry to moist condition and red-brown in colour. Standard Penetration N-Values ranged from 5 to 20 blows per 305 mm, indicating a loose to compact relative density (note: higher N-Values may be the result of cobble sized particles.)

Laboratory grain size analysis of two (2) samples of the fill indicated a particle size distribution (gradation) of 1.1 to 10.5 percent gravel, 37.2 to 39.6 percent sand and a silt/clay content of 52.3 to 59.3 percent. Moisture contents for the fill samples ranged from 9.3 to 20.5 percent.

4.4 UNDISTURBED TILL

Till was encountered beneath the fill deposits in the subject boreholes. The till generally consisted of sand, some silt and clay, some gravel. This material was in a dry to saturated condition, red-brown in colour and generally compact to dense in relative density.

Laboratory grain size analysis of two (2) samples of the till indicated a particle size distribution (gradation) of 15.7 to 16.3 percent gravel, 61.7 to 62.0 percent sand and a silt/clay content of 21.7 to 22.5 percent. Moisture contents for the fill samples ranged from 13.4 to 16.7 percent.

4.5 BEDROCK

Geologic mapping of the proposed development area indicates that bedrock belongs to the Richibucto formation of the Pictou Group. This formation can generally be described as consisting of grey and minor greyish to brownish red sandstone, pebbly sandstone and intra-formational conglomerate, interstratified with red and minor grey very fine-grained sandstone, siltstone, mudstone and rare, lacustrine limestone.

Bedrock was encountered in all boreholes at depths ranging from 4.0 metres to 6.0 metres below ground surface. During the field investigation, bedrock was core-drilled at all boreholes. Generally, the bedrock has been observed to be highly fractured, weathered and of low-strength. The Rock Quality Designation (RQD) values of core samples ranged from 0 to 75%, indicating very poor to fair quality rock. Photographs of bedrock core samples are included in Appendix B.

Laboratory compressive strength testing of two (2) intact rock core samples indicated unconfined compressive strengths (UCS) ranging from 29 MPa to 41 MPa. Based on classification systems used in the Canadian Foundation Engineering Manual (4th Ed), Section 3.2.4.1, the sandstone bedrock is generally medium strong (Grade R3). Laboratory results are included in Appendix C.

4.6 GROUNDWATER

Groundwater was observed in all boreholes at depths ranging from 2.1 to 4.5 metres below the ground surface, during the investigation. Groundwater levels can be expected to fluctuate seasonally

5 DISCUSSION AND RECOMMENDATIONS

5.1 GENERAL

The site is located along Highway No.117 at the Kouchibouguac National Park, in New Brunswick. It is understood that Rankin Bridge has been identified by as being in relatively poor condition and in need of replacement. The Rankin Brook Bridge was constructed in 1963 and has received rehabilitations in 2003 and 2015. The bridge is of monolithic rigid frame design with concrete T-beams monolithic with the deck and abutments. The span length is 14.56m (face to face of abutments) and the bridge is on a 33 degree +/-skew. The bridge accommodates two traffic lanes and two shoulders with a curb-to-curb width of 9.14 m. There is a sidewalk supported off of the east side of the bridge intended for pedestrian and bicycle traffic. There is a 0.91m wide safety curb on each side with concrete panel railings. The overall structure width is 12.97m.

The following discussion and recommendations for the proposed new bridge are based on the observed subsurface conditions and assume that the proposed abutment locations are in general conformance with Figure 1. As previously noted, the subsurface conditions encountered at the site generally consist of an asphalt layer (100-mm in thickness) overlying fill deposits, glacial till and sandstone bedrock (at an elevation ranging from 1.7 to -0.7 metres, geodetic datum).

Due to the relatively shallow depths to bedrock (i.e. 4 to 6 metres below asphalt surface); the use of spread foundations and approach embankments will be most practical for this site. If piles are being considered for the site, drilled piles extending into and socketed in bedrock would be recommended. Design parameters can be provided for pile foundations if this method is chosen for design.

Some of the recommendations below are preliminary in nature and can be confirmed once specific design information is available.

5.2 GEOTECHNICAL DESIGN

5.2.1 OPTION 1: SHALLOW FOUNDATIONS

Subsurface conditions are satisfactory for use of concrete spread footing and approach embankments. Footings may be set directly on bedrock.

Bearing capacity estimates for Serviceability Limit State (SLS) and Ultimate Limit State (ULS) design are provided as follows, and are based on criteria in the Canadian Highway Bridge Design Code (CHBDC, 2014), Section 6.

For spread/strip footings founded on sandstone bedrock, as approved by the Geotechnical Engineer:

→ Ultimate Limit State Bearing Capacity (ULS): 750 kPa

The ULS includes a geotechnical resistance factor 0.5 in accordance with CHBDC.

Total and differential settlement at the allowable SLS design stresses are expected to be negligible for footings set on bedrock.

Assessment of the foundation bearing surface (footing subgrade) will be required to confirm the recommended bearing pressures noted above. The footing subgrade should be inspected by qualified

geotechnical personnel during bearing surface preparation; compaction and proof rolling of the bearing surface will likely be required prior to placing concrete.

Bearing capacity estimates generally assume that the foundation footing depth (D_f) is at least 1.2 metres, and that the confining soil weight is included in the estimates. Footings should be founded at a minimum depth of 1.2 metres below exterior grade elevation for frost protection.

If loosening/softening of the footing subgrade occurs due to water seepage, construction traffic, etc. removal and replacement with an approved granular material (i.e. NBDOT 75-mm minus, or equivalent) may be required

5.2.2 OPTION 2: DRIVEN STEEL H PILES

We understand that the proposed new bridge will be a 14.56 m single span bridge. If pile foundations are considered for the design, each abutment will be supported on steel 'H' piles, driven to practical refusal on bedrock. Practical refusal shall be defined by an accepted pile inspection method.

Rock points should be used for the expected site conditions, and care should be taken not to overdrive and damage the pile upon refusal. The Canadian Foundation Engineering Manual (4th Edition) recommends that hammer energy during installation be restricted to $6x10^6$ J multiplied by cross-sectional pile area.

Axial capacities of 'H' piles bearing on bedrock are governed by the pile's allowable capacity when considered as a fully supported structural column. The maximum capacity is estimated as one third of the yield strength of the pile material ($0.3f_y$), and capacity estimates for the preferred H-pile types are provided in the following Table 5.1.

Table 5-1 – Pile Capacities

Pile Size	Factored Pile Capacity, kPa (ULS)	Bearing Capacity, kPa (SLS)	Ultimate Geotechnical Resistance
HP310x79	1200 kN	900 kN	4800 kN
HP310x110	1600 kN	1200 kN	4800 kN

SLS capacity is based on a factor of safety of 3. Factors for ULS design were obtained from the Canadian Highway Bridge Design Code (CHBDC). Settlement of individual piles driven to refusal on bedrock is expected to be negligible.

For estimating purposes, it is assumed that 'H' piles will meet refusal near an elevation of -1.0 metres, geodetic datum. Actual pile lengths will be determined by driving resistance assessments and field testing during installation.

Where adjacent piles are driven parallel to one another, we recommend a minimum pile spacing of three (3) times the outside diameter of the piles to avoid group reduction effects and potential "following" during installation. This requirement can be reviewed if the need for smaller spacing arises during design or construction.

A protective driving shoe should be used to protect steel piles during hard driving in Stony Till soils with cobbles and/or boulders. The maximum cobble/boulder size was not determined during this investigation and shallow refusal of driven piles on cobbles or boulders is not anticipated. Where piles

are refused above design elevations, pile extraction and drilling to clear obstructions should be undertaken prior to re-driving.

5.2.3 LATERAL RESISTANACE OF PILES

A number of options are available for estimating the lateral resistance of piles. The simplest and usually conservative approach is to use passive pressure resistances as suggested in Section 18.4 of the Canadian Foundation Engineering Manual (4nd Edition). For vertical piles subjected to horizontal loads, an approximate and usually conservative approach is to assume that each pile can sustain an allowable horizontal load equal to the passive earth pressure acting on an equivalent wall with depth 6b and width 3b, where b is the pile diameter or face-to-face distance. A depth of 8b is recommended if piles are fixed at the top. The allowable resistance (SLS) is the maximum calculated resistance divided by 3. If the lateral resistance is not sufficient, the use of sand or concrete filled corrugated steel pipes or batter piles is recommended. Due to the similar soils encountered across the site, the soil parameters are consistent for both bridge abutments. Parameters for use are as follows:

Table 5-2 – Soil Parameters for Pile Lateral Resistance

ɣ	KP (ABUTMENTS)
20 kN/m^3	2.8

It is assumed that the top of the 'H' piles will be located within 3 m of the existing site grade. If not, we should be notified to revise the values of these parameters.

5.2.4 MATERIAL DESIGN PARAMTERS FOR RETAINING WALLS

Recommended material design parameters for retaining walls are provided below, in Table 5-1. If conditions are different at time of construction we should be contacted immediately to re-evaluate the below design parameters.

Table 5-3 – Summary of Recommended Material Design Parameters

PARAMETER	BEDROCK	IMPORTANT SAND AND GRAVEL (NBDOT 75-MM MINUS, OR EQUIVALENT)
Total Unit Weight (kN/m^3)	25	21
Submerged Unit Weight (kN/m^3)	15	11
Angle of Internal Friction	38°	36°
Coefficient of Active Earth Pressure, Ka		0.26
Coefficient of Passive Earth Pressure, Kp		3.85
Friction Factor (Soil-Concrete Interface)	0.70	0.60

Retaining walls should be designed for anticipated surcharges from structures, vehicle loads, sloping backfill, etc. The above parameters assume the backfill behind the wall is horizontal. If inclined backfill is being constructed behind the wall, the Geotechnical Engineer should be contacted for appropriate revision of design parameters.

Compaction of backfill behind the retaining wall should be performed using a walk-behind vibratory plate roller or plate tamper rather than a large vibratory drum roller to avoid damage to the wall.

5.2.5 EARTHQUAKE DESIGN PARAMETERS

The subsurface conditions at the proposed site consist of sandstone bedrock at foundation design grades. According to clause 4.4.3.2 of the Canadian Highway Bridge Design Code (CHBDC, 2014), the soil profile designation for seismic analysis is Class “C” for soft rock. The applicable site coefficients are found in Table 4.2 to 4.9 of the same code.

The structural engineer should confirm the applicable site coefficients.

5.3 EARTHWORKS CONSTRUCTION

5.3.1 EXCAVATIONS AND RE-USE OF ON-SITE SOILS

We expect that any excavations above the water table will be reasonably straightforward. A 1:1 excavation slope should be feasible in the existing materials. We expect that steel sheet pile enclosures will be required to excavate any significant depth below the groundwater and river water levels (if required).

All temporary excavations must be carried out in accordance with the current Occupational Health and Safety Act (OHSA) requirements. All side slopes of excavations must be maintained within OHSA criteria, or they must be supported.

Any groundwater or surface water encountered must be diverted to avoid softening/loosening of the exposed subgrade. Measures to divert groundwater/surface water may include excavating subgrade to sump locations where water will be disposed of by pumping.

The footing subgrade should be inspected by qualified geotechnical personnel during bearing surface preparation; compaction and proof rolling of the bearing surface will likely be required prior to placing concrete.

5.3.2 STRUCTURAL FILL

Imported structural fill for the abutments should consist of a well-graded sand and gravel material, free of organics and have less than 10 % fines. The structural fill should consist of a 31.5-mm minus or 75-mm minus (or equivalent), as specified in the NBDOT Specifications.

The on-site soils will not be suitable for re-use as structural fill against the abutments but may be used in common areas for general site grading; materials must be approved by a Geotechnical Engineer prior to use. Saturated material is not suitable for re-use in structural applications and removal of oversize material (particle size greater than 200mm) will be required prior to re-use for backfilling. Proper construction methods during excavation, handling and stockpiling of the on-site materials will be required to prevent addition and excessive water content in the soil.

5.3.3 ABUTMENT BACKFILL

The abutment backfill should consist of a non-frost susceptible 31.5-mm minus or 75-mm minus (or equivalent), as specified in the NBDOT Specifications.

During fill placement, lift thickness should be compatible with type of compaction equipment and material used (i.e. gradation, particle size, etc.). Compaction of fill adjacent to the structure should be completed with hand operated compactors to prevent the build-up of significant “wedging” pressures

that may develop if large compactors are used. Generally, abutment backfill should be placed in compacted lifts not to exceed 200-mm and compacted to 98 percent of the material's Standard Proctor Maximum Dry Density (SPMDD) for structural applications (ASTM D698 procedure). Water and loose/soft soils should be removed prior to fill placement. Fill material, compaction equipment, lift thicknesses, etc. are to be evaluated for approval by the Geotechnical Engineer prior to fill placement.

5.3.4 GROUNDWATER CONTROL

During construction, surface runoff, groundwater and/or flood water from the Rankin Brook may be encountered. Controlling water at the site will minimize softening and loosening of the exposed subgrade.

If construction and excavation is being considered below the river level, a more aggressive water control measure (i.e. steel sheet pile enclosure) will likely be required to work in dry conditions below the river level.

Typical de-watering techniques for groundwater seepage may include grading excavations to sump locations to dispose of water by pumping. If necessary, soft/wet soils can be over excavated and replaced by an imported rock fill. Proper erosion and sedimentation control measures should be provided to limit site disturbance, as in accordance with provincial and municipal regulations.

5.3.5 EROSION AND SEDIMENT CONTROL

Erosion and sedimentation control measures (e.g. silt booms, silt fences, check dams, settling ponds, etc.) should be provided, as required, for the site as part of the detailed design activity in accordance with New Brunswick Environment requirements. Application of these control measures should be utilized to minimize soil erosion.

5.4 ASPHALT PAVEMENT REINSTATEMENT

Prior to the field drilling operations, a visual reconnaissance program was conducted along the bridge and the approach roadways. In general, the pavement is in excellent condition, it's understood Highway No. 117 was repaved in the summer of 2015. No severe areas of alligator cracking were evident in the investigated areas. The road crown is also in fair condition, and crossfall drainage does not appear to be an issue along the approach roadways or the bridge.

The project roadway is considered to be a relatively moderate volume road subject to all types of traffic, in particular transport truck traffic due to the peat farm industry in the near-by location. It is recommended that pavement reconstruction allow for both automobile and loaded truck loadings. Based on routine design methods and our assessment of the existing pavement profile and performance, the following minimum pavement structure is recommended.

Table 5-4 – Flexible Asphalt Pavement Design

MATERIAL	PAVEMENT STRUCTURE THICKNESS
Type C-HF Asphalt Pavement	50-mm
Type B-HF Asphalt Pavement	100-mm
31.5mm minus Gravel	150-mm
75-mm minus Gravel	400-mm

If soft/wet areas are encountered in the subgrade, additional gravels may be required. Soft areas, if any, would be determined during evaluation of finished subgrade, prior to placement of the pavement structure. The exposed subgrade should be compacted to 100 percent of the Standard Proctor Maximum Dry Density (SPMDD).

All granular material is to be compacted to 100 percent of the Standard Proctor Maximum Dry Density (SPMDD). Asphalt concrete pavement should be compacted to a minimum 92 percent of the Maximum Theoretical Bulk Density, as per NBDOT specifications. The pavement materials should be provided and constructed in accordance with the Municipal Specifications or other equivalent specifications.

6 CLOSURE

This report has been prepared for the sole benefit of Parks Canada and is not intended for use by others. This report may not be reproduced without the prior written permission of WSP and Parks Canada. Contractors undertaking work must draw their own interpretations of the factual investigation results provided in this report as it affects construction costs, procedures and scheduling.

As boreholes provide a localized representation of the total study area, subsurface conditions may vary between and/or beyond the borehole locations. If conditions encountered at the site vary significantly from the reported herein, we should be notified immediately so that our interpretations and recommendations can be reviewed and revised if necessary. The boreholes were backfilled and lightly compacted upon completion.

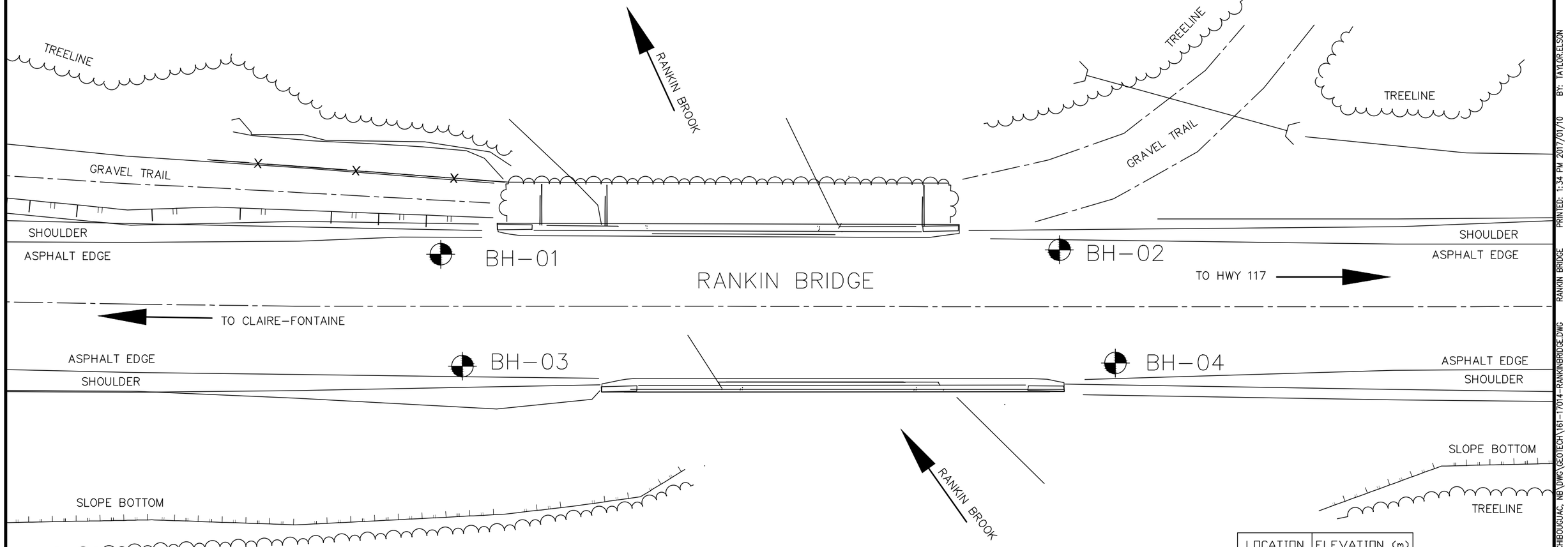
Since design details were not available at the time of preparing this report, the foundation and retaining wall design should be reviewed with us when more information is available. Inspections of testing of the subgrade conditions and pavement construction are recommended for QA/QC purposes.

We trust this report meets your present requirements. If you have any questions with the information contained in the report, please do not hesitate to contact us at your convenience.

Yours truly,

WSP Canada Inc.

Clayton J. Rogers. P.Eng
Manager, Geotechnical - Dartmouth



LOCATION	ELEVATION (m)
BH-01	5.3
BH-02	5.7
BH-03	5.3
BH-04	5.7

*APPROXIMATE ELEVATIONS FROM WSP TOPOGRAPHICAL SURVEY DATED DECEMBER, 2016

LEGEND:

BH-01 - BOREHOLE LOCATION

WSP Canada Inc.
1 Spectacle Lake Drive
Dartmouth, Nova Scotia, Canada B3B 1X7
T 902-835-9955 F 902-835-1645 www.wspgroup.com

PROJECT:

KOUCHIBOUGUAC NATIONAL PARK DATA COLLECTION
GEOTECHINCAL INVESTIGATION

TITLE:

RANKIN BRIDGE
SITE PLAN SHOWING APPROXIMATE BOREHOLE LOCATIONS

PROJECT NO: 161-17014

SCALE: 1:250

DRAWN BY: T. ELSON

CHECKED BY: C. ROGERS

DATE: (YYYY/MM/DD) 2017/01/10

WSP REF. NO.: ---- N:\MONCTON\2016\161-17014- PARKS CAN, KOUCHIBOUGUAC, NB\DWG\GEOTECH\161-17014-RANKINBRIDGE.DWG PRINTED: 1:34 PM 2017/01/10 BY: TAYLOR.ELSON

Appendix A

BOREHOLE EXPLANATION FORM

BOREHOLE LOG EXPLANATION FORM

This explanatory section provides the background to assist in the use of the borehole logs. Each of the headings used on the borehole log, is briefly explained.

DEPTH

This column gives the depth of interpreted geologic contacts in metres below ground surface.

STRATIGRAPHIC DESCRIPTION

This column gives a description of the soil based on a tactile examination of the samples and/or laboratory test results. Each stratum is described according to the following classification and terminology.

Soil Classification*		Terminology	Proportion
Clay	<0.002 mm		
Silt	0.002 to 0.06 mm	"trace" (e.g. trace sand)	<10%
Sand	0.06 to 2 mm	"some" (e.g. some sand)	10% - 20%
Gravel	2 to 60 mm	adjective (e.g. sandy)	20% - 35%
Cobbles	60 to 200 mm	"and" (e.g. and sand)	35% - 50%
Boulders	>200 mm	noun (e.g. sand)	>50%

* Extension of MIT Classification system unless otherwise noted.

The use of the geologic term "till" implies that both disseminated coarser grained (sand, gravel, cobbles or boulders) particles and finer grained (silt and clay) particles may occur within the described matrix.

The compactness of cohesionless soils and the consistency of cohesive soils are defined by the following:

COHESIONLESS SOIL		COHESIVE SOIL	
Compactness	Standard Penetration Resistance "N", Blows / 0.3 m	Consistency	Standard Penetration Resistance "N", Blows / 0.3 m
Very Loose	0 to 4	Very Soft	0 to 2
Loose	4 to 10	Soft	2 to 4
Compact	10 to 30	Firm	4 to 8
Dense	30 to 50	Stiff	8 to 15
Very Dense	Over 50	Very Stiff	15 to 30
		Hard	Over 30

The moisture conditions of cohesionless and cohesive soils are defined as follows.

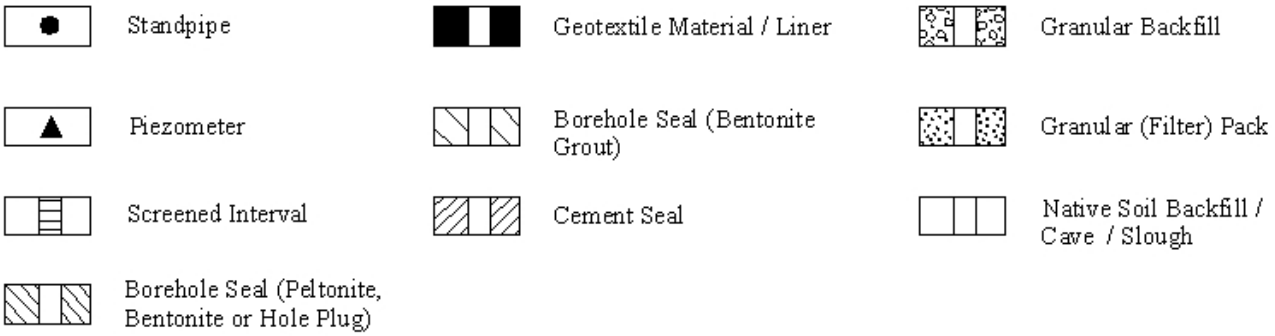
COHESIONLESS SOILS	COHESIVE SOILS		
Dry	DTPL	-	Drier Than Plastic Limit
Moist	APL	-	About Plastic Limit
Wet	WTPL	-	Wetter Than Plastic Limit
Saturated	MWTPL	-	Much Wetter Than Plastic Limit

STRATIGRAPHY

Symbols may be used to pictorially identify the interpreted stratigraphy of the soil and rock strata.

MONITOR DETAILS

This column shows the position and designation of standpipe and/or piezometer ground water monitors installed in the borehole. Also the water level may be shown for the date indicated.



Where monitors are placed in separate boreholes, these are shown individually in the "Monitor Details" column. Otherwise, monitors are in the same borehole. For further data regarding seals, screens, etc., the reader is referred to the summary of monitor details table.

SAMPLE

These columns describe the sample type and number, the "N" value, the water content, the percentage recovery, and Rock Quality Designation (RQD), of each sample obtained from the borehole where applicable. The information is recorded at the approximate depth at which the sample was obtained. The legend for sample type is explained below.

SS	=	Split Spoon	GS	=	Grab Sample
ST	=	Thin Walled Shelby Tube	CS	=	Channel Sample
AS	=	Auger Flight Sample	WS	=	Wash Sample
CC	=	Continuous Core	RC	=	Rock Core

$$\% \text{ Recovery} = \frac{\text{Length of Core Recovered Per Run}}{\text{Total Length of Run}} \times 100$$

Where rock drilling was carried out, the term RQD (Rock Quality Designation) is used. The RQD is an indirect measure of the number of fractures and soundness of the rock mass. It is obtained from the rock cores by summing the length of core recovered, counting only those pieces of sound core that are 100 mm or more in length. The RQD value is expressed as a percentage and is the ratio of the summed core lengths to the total length of core run. The classification based on the RQD value is given below.

RQD Classification	RQD (%)
Very poor quality	< 25
Poor quality	25 - 50
Fair quality	50 - 75
Good quality	75 - 90
Excellent quality	90 - 100

TEST DATA

The central section of the log provides graphs which are used to plot selected field and laboratory test results at the depth at which they were carried out. The plotting scales are shown at the head of the column.

Dynamic Penetration Resistance - The number of blows required to advance a 51 mm diameter, 60º steel cone fitted to the end of 45 mm OD drill rods, 0.3 m into the subsoil. The cone is driven with a 63.5 kg hammer over a fall of 750 mm.

Standard Penetration Resistance - Standard Penetration Test (SPT) "N" Value - The number of blows required to advance a 51 mm diameter standard split-spoon sampler 300 mm into the subsoil, driven by means of a 63.5 kg hammer falling freely a distance of 750 mm. In cases where the split spoon does not penetrate 300 mm, the number of blows over the distance of actual penetration in millimetres is shown as $\frac{xBlows}{mm}$

Water Content - The ratio of the mass of water to the mass of oven-dry solids in the soil expressed as a percentage.

W_P - Plastic Limit of a fine-grained soil expressed as a percentage as determined from the Atterberg Limit Test.

W_L - Liquid Limit of a fine-grained soil expressed as a percentage as determined from the Atterberg Limit Test.

REMARKS

The last column describes pertinent drilling details, field observations and/or provides an indication of other field or laboratory tests that were performed.

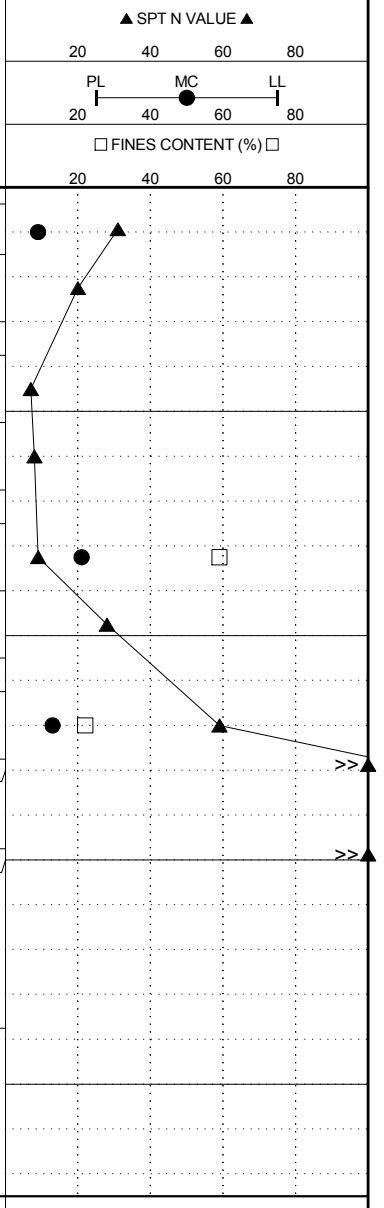
Appendix B

BOREHOLE LOGS AND PHOTOPLATE

BORING NUMBER BH-01

CLIENT Agence Parks Canada Agency
PROJECT NAME Kouchibouguac National Park - Data Collection
PROJECT NUMBER 161-17014
PROJECT LOCATION Kouchibouguac National Park, NB
DATE STARTED 5/12/16 **COMPLETED** 5/12/16
GROUND ELEVATION 5.3 m Geodetic **HOLE SIZE** 100mm
DRILLING CONTRACTOR Lantech Drilling Services Ltd.
GROUND WATER LEVELS:
DRILLING METHOD Track Mounted Drill Rig
AT TIME OF DRILLING 4.50 m / Elev 0.80 m
LOGGED BY T. Elson **CHECKED BY** C. Rogers
AT END OF DRILLING ---
NOTES Rankin Bridge
AFTER DRILLING ---

DEPTH (m)	GRAPHIC LOG	ELEVATION (m)	MATERIAL DESCRIPTION	WATER LEVEL	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	RECOVERY % (RQD)
		5.3	Asphalt (150mm in thickness)				
		5.15	FILL: sand and gravel, loose to compact, dry to moist, grey-brown.		SS 01	12-18-13 (31)	67
					SS 02	17-9-11-13 (20)	50
2		3.6	FILL: sand and clay, some silt, trace to some gravel, loose to compact, dry to moist, red-brown.		SS 03	16-4-3-4 (7)	67
					SS 04	6-4-4-4 (8)	17
					SS 05	2-3-6-9 (9)	75
4		1.6	TILL: sand, some silt and clay, some gravel, compact to dense, dry to saturated, red-brown.		SS 06	8-11-17-10 (28)	83
				▽	SS 07	31-40-19-37 (59)	100
					SS 08	50/0.10	100
6		-0.7	BEDROCK (Sandstone) - weathered and fractured, very poor to poor quality, medium strong to strong.		SS 09	50/0.10	100
					RC 01		100 (0)
8		-2.3	UCS = 41 MPa		RC 02		100 (59)
10		-3.8	End of borehole at 9.0 metres below ground surface in Bedrock (sandstone). Groundwater was encountered at 4.5 metres below ground surface at the time of the investigation. *Approximate elevations taken from available topographic information.				
12							

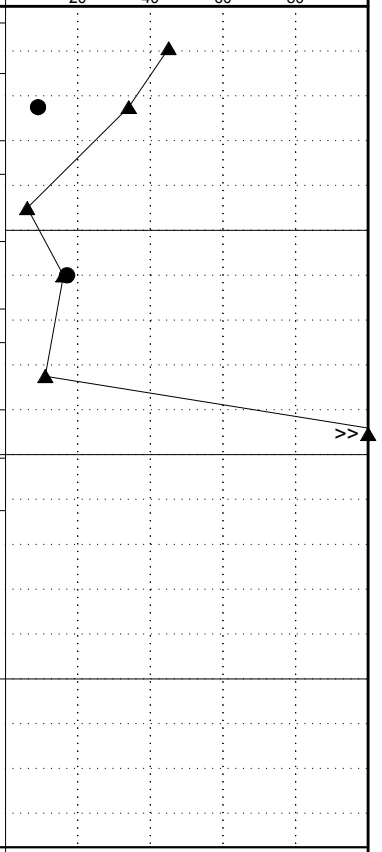


BORING NUMBER BH-02

CLIENT Agence Parks Canada Agency
PROJECT NAME Kouchibouguac National Park - Data Collection
PROJECT NUMBER 161-17014
PROJECT LOCATION Kouchibouguac National Park, NB
DATE STARTED 5/12/16 **COMPLETED** 5/12/16
GROUND ELEVATION 5.7 m Geodetic **HOLE SIZE** 100mm
DRILLING CONTRACTOR Lantech Drilling Services Ltd.
GROUND WATER LEVELS:
DRILLING METHOD Track Mounted Drill Rig
AT TIME OF DRILLING 3.50 m / Elev 2.20 m
LOGGED BY T. Elson **CHECKED BY** C. Rogers
AT END OF DRILLING ---
NOTES Rankin Bridge
AFTER DRILLING ---

DEPTH (m)	ELEVATION (m)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	RECOVERY % (RQD)
	5.7	Asphalt (150mm in thickness)			
	5.55	FILL: sand and gravel, loose to compact, dry to moist, grey-brown.	SS 01	37-24-21 (45)	67
			SS 02	18-18-16-14 (34)	58
2	4.2	FILL: sand and clay, some silt, trace to some gravel, loose to compact, dry to moist, red-brown.	SS 03	5-3-3-7 (6)	50
			SS 04	11-7-9-11 (16)	83
			SS 05	3-6-5-12 (11)	83
4	2.2	TILL: sand, some silt and clay, some gravel, compact to dense, dry to saturated, red-brown.	SS 06	13-14-50/0.13	70
	1.7	BEDROCK (Sandstone) - weathered and fractured, very poor to poor quality, medium strong to strong.	RC 01		100 (0)
6			RC 02		100 (50)
	-1.3	UCS = 29 MPa	RC 03		100 (50)
8	-1.9	End of borehole at 7.6 metres below ground surface in bedrock (sandstone). Groundwater was encountered at 3.5 metres below ground surface at the time of the investigation. *Approximate elevations taken from available topographic information.			
10					
12					

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ FINES CONTENT (%) ☐
20 40 60 80

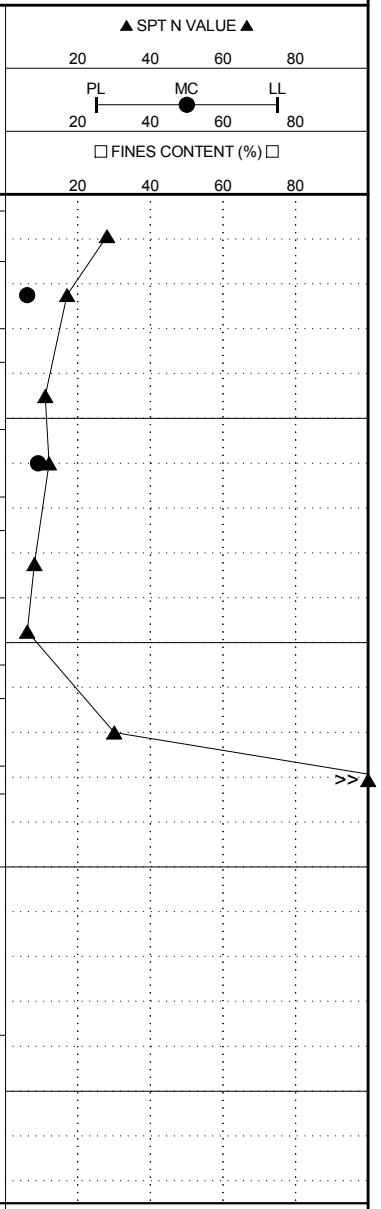


GEOTECH BH (N-VALUES) 161-17014 - PRELIM BH LOGS - RANKIN.GPJ GINT STD CANADA.GDT 1/10/17

BORING NUMBER BH-03

CLIENT Agence Parks Canada Agency
PROJECT NAME Kouchibouguac National Park - Data Collection
PROJECT NUMBER 161-17014
PROJECT LOCATION Kouchibouguac National Park, NB
DATE STARTED 6/12/16 **COMPLETED** 6/12/16
GROUND ELEVATION 5.3 m Geodetic **HOLE SIZE** 100mm
DRILLING CONTRACTOR Lantech Drilling Services Ltd.
GROUND WATER LEVELS:
DRILLING METHOD Track Mounted Drill Rig
▽ **AT TIME OF DRILLING** 2.10 m / Elev 3.20 m
LOGGED BY T. Elson **CHECKED BY** C. Rogers
AT END OF DRILLING ---
NOTES Rankin Bridge
AFTER DRILLING ---

DEPTH (m)	ELEVATION (m)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	RECOVERY % (RQD)
	5.3	Asphalt (150mm in thickness)			
	5.15	FILL: sand and gravel, loose to compact, dry to moist, grey-brown.	SS 01	13-16-12 (28)	67
			SS 02	13-10-7-7 (17)	50
	3.8	FILL: sand and clay, some silt, trace to some gravel, loose to compact, dry to moist, red-brown.	SS 03	6-6-5-6 (11)	50
2			SS 04	7-7-5-4 (12)	58
			SS 05	3-4-4-4 (8)	50
	1.8	TILL: sand, some silt and clay, some gravel, compact to dense, dry to saturated, red-brown.	SS 06	2-2-4-6 (6)	50
4			SS 07	8-8-22-29 (30)	100
			SS 08	38-50/0.10	100
	0	BEDROCK (Sandstone) - weathered and fractured, very poor to poor quality, medium strong to strong.	RC 01		100 (0)
6			RC 02		100 (30)
8			RC 03		100 (75)
	-3.8	End of borehole at 9.0 metres below ground surface in bedrock (sandstone).			
10		Groundwater was encountered at 2.1 metres below ground surface at the time of the investigation.			
		*Approximate elevations taken from available topographic information.			
12					

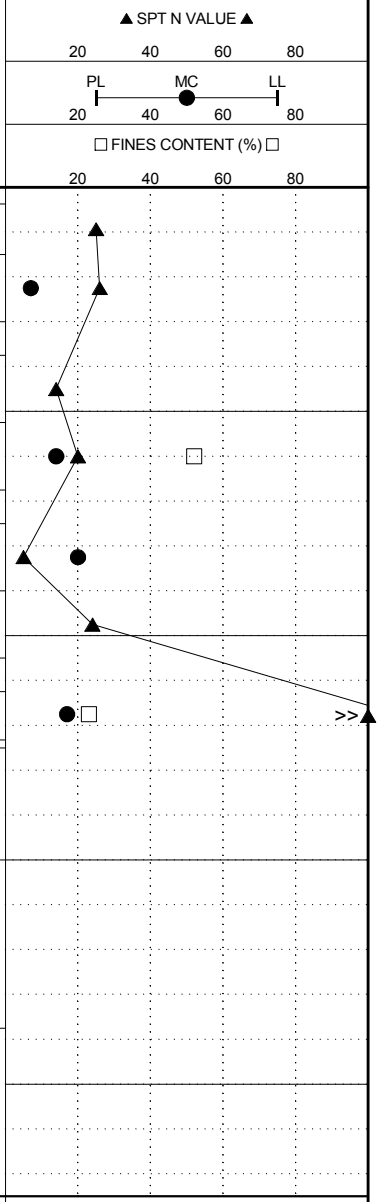


GEOTECH BH (N-VALUES) 161-17014 - PRELIM BH LOGS - RANKIN.GPJ GINT STD CANADA.GDT 1/10/17

BORING NUMBER BH-04

CLIENT Agence Parks Canada Agency
PROJECT NAME Kouchibouguac National Park - Data Collection
PROJECT NUMBER 161-17014
PROJECT LOCATION Kouchibouguac National Park, NB
DATE STARTED 6/12/16 **COMPLETED** 6/12/16
GROUND ELEVATION 5.7 m Geodetic **HOLE SIZE** 100mm
DRILLING CONTRACTOR Lantech Drilling Services Ltd.
GROUND WATER LEVELS:
DRILLING METHOD Track Mounted Drill Rig
▽ **AT TIME OF DRILLING** 4.50 m / Elev 1.20 m
LOGGED BY T. Elson **CHECKED BY** C. Rogers
AT END OF DRILLING ---
NOTES Rankin Bridge
AFTER DRILLING ---

DEPTH (m)	GRAPHIC LOG	ELEVATION (m)	MATERIAL DESCRIPTION	WATER LEVEL	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	RECOVERY % (RQD)
		5.7	Asphalt (150mm in thickness)				
		5.55	FILL: sand and gravel, loose to compact, dry to moist, grey-brown.		SS 01	16-12-13 (25)	67
					SS 02	9-10-16-16 (26)	75
		4.2	FILL: sand and clay, some silt, trace to some gravel, loose to compact, dry to moist, red-brown.		SS 03	8-6-8-12 (14)	83
2					SS 04	14-10-10-13 (20)	83
					SS 05	4-3-2-4 (5)	92
		2.2	TILL: sand, some silt and clay, some gravel, compact to dense, dry to saturated, red-brown.		SS 06	8-7-17-30 (24)	92
4				▽	SS 07	16-35-50/0.13	100
		0.7	BEDROCK (Sandstone) - weathered and fractured, very poor to poor quality, medium strong to strong.		RC 01		100 (0)
6					RC 02		100 (30)
8					RC 03		100 (67)
		-3.3	End of borehole at 9.0 metres below ground surface in bedrock (sandstone).				
10			Groundwater was encountered at 4.5 metres below ground surface at the time of the investigation.				
			*Approximate elevations taken from available topographic information.				
12							



GEOTECH BH (N-VALUES) 161-17014 - PRELIM BH LOGS - RANKIN.GPJ GINT STD CANADA.GDT 1/10/17

Photo 1: BH-01 / SS05

Photo 2: BH-01 / SS04

Photo 3: BH-03 / SS07

Photo 4: BH-04 / SS01

Photo 5: BH-01 / Rock Cores

Photo 6: BH-02 / Rock Cores

Photo 7: BH-03 / Rock Cores

Photo 8: BH-04 / Rock Cores

Appendix C

LABORATORY TEST RESULTS (STANTEC)

STANTEC MATERIALS TESTING REPORT

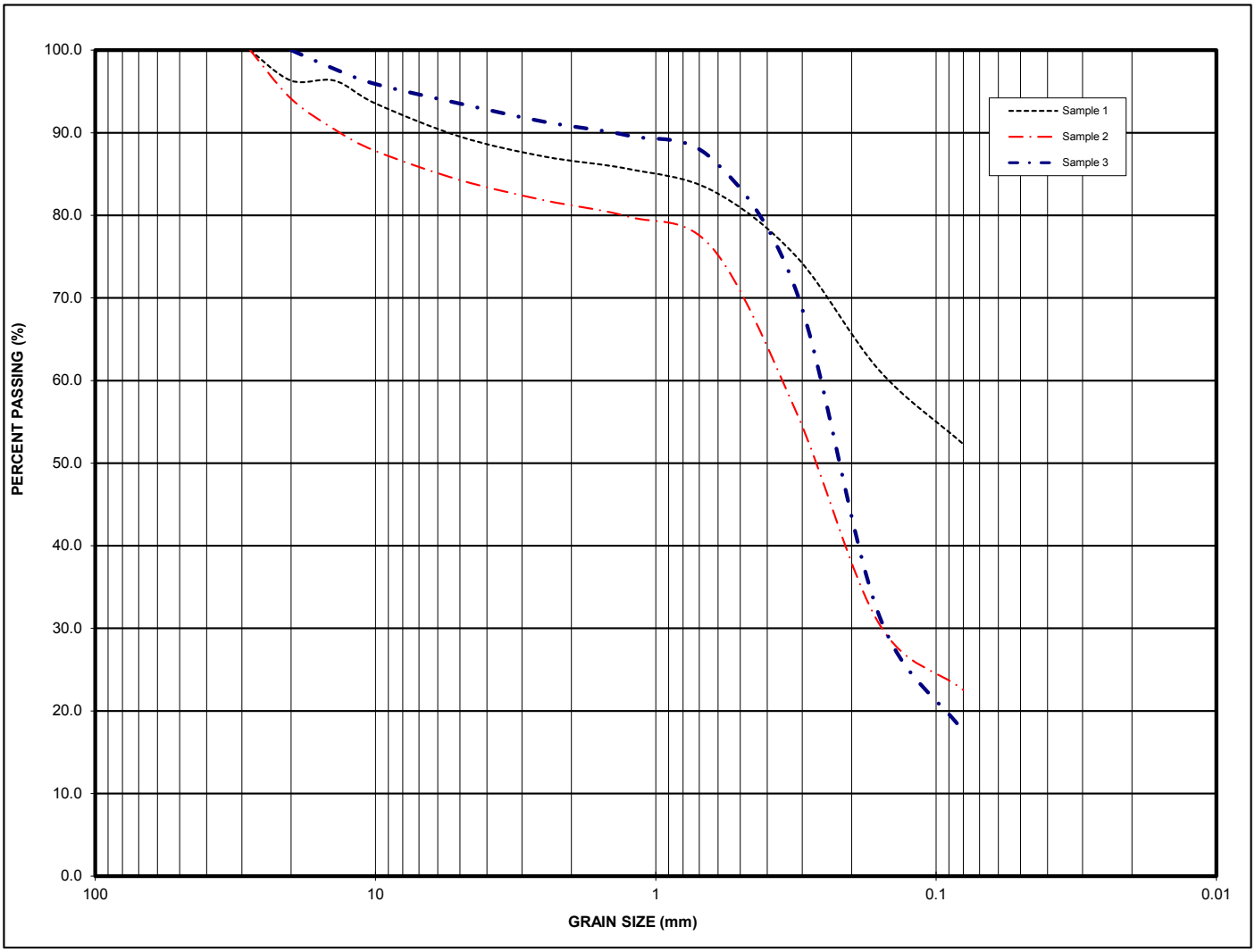
Project #: 121619399
Task#: 200.235

Client: WSP Canada Inc.
Project: WSP 161-17014, Kouchibouguac National Park
Source 1: BH04, SS04
Source 2: BH04, SS07
Source 3: BH06, SS08

Material Type: N/A
Date Received: 15-Dec-16
Date Tested: 19-Dec-16

GRADING				
SAMPLE #	1	2	3	
SIEVE (mm)	**% PASSING**	**% PASSING**	**% PASSING**	**SPEC**
80				-
56				-
40				-
28	100.0	100.0		-
20	96.3	94.1	100.0	-
14	96.3	90.4	97.7	-
10	93.5	87.8	95.9	-
5	89.5	84.3	93.5	-
2.5	87.1	81.8	91.3	-
1.25	85.6	79.8	89.6	-
0.630	83.0	76.1	86.8	-
0.315	75.0	56.1	70.8	-
0.160	61.3	30.6	31.6	-
0.080	52.3	22.5	17.5	-

PHYSICAL PROPERTY TESTS			
Sample Number	1	2	3
Gravel, %	10.5	15.7	6.5
Sand, %	37.2	61.7	76.0
Silt & Clay, %	52.3	22.5	17.5
Classification			
Natural Moisture Content, %			
Abrasion Loss, %			
Soundness Loss, %			
Micro Deval Loss, %			
Fine Absorption, %			
Flat & Elongated Particles,%			
Coarse Absorption, %			
Coarse Spec. Gravity, kg/m³			
Fractured Faces, %			
Liquid Limit, %			
Plastic Limit, %			
Plasticity Index, %		Non-Plastic	
Max. Dry Density: Standard			
Optimum Moisture Content %			



Technician R. Cameron

Reviewed By C.Mullins

STANTEC MATERIALS TESTING REPORT

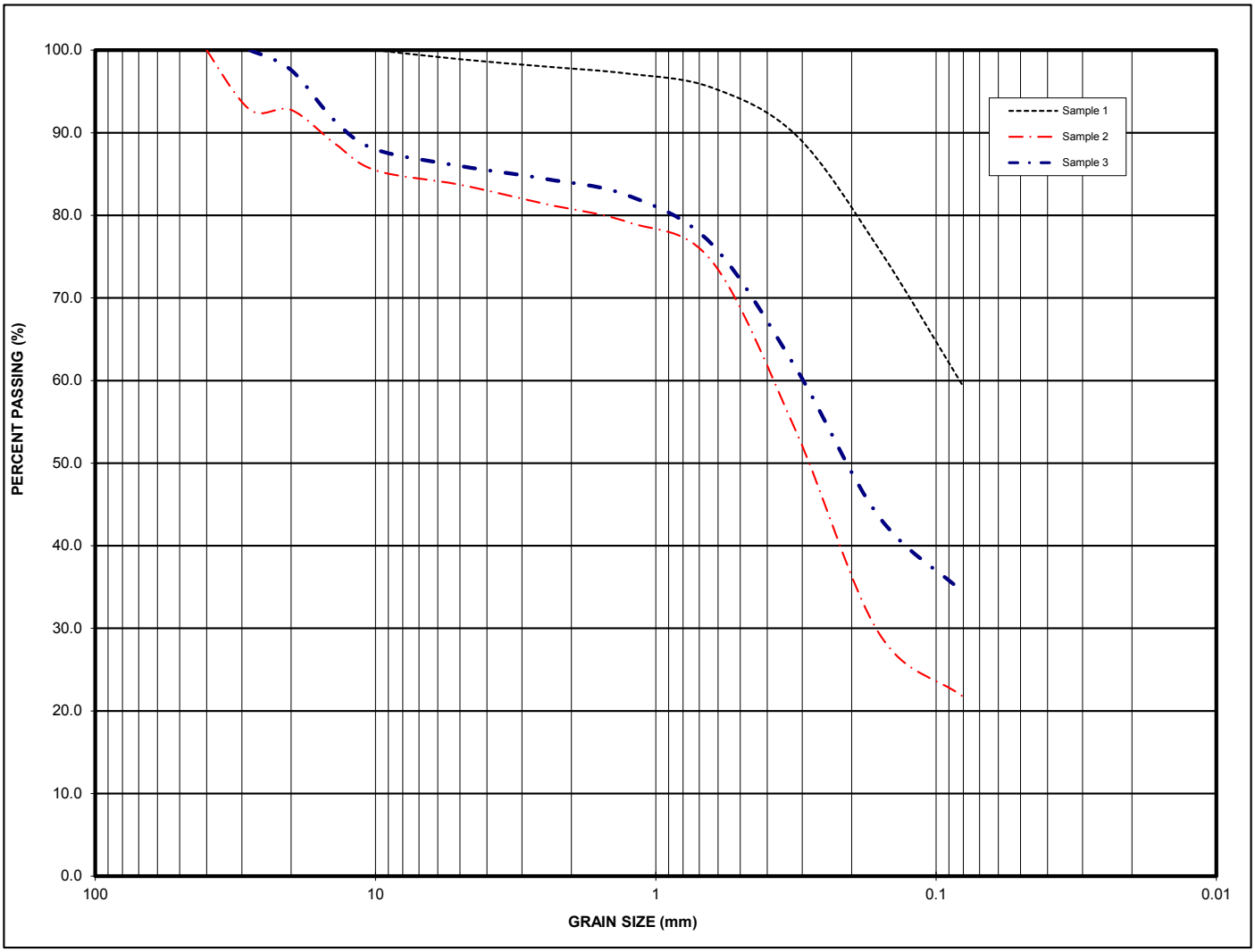
Project #: 121619399
Task#: 200.235

Client: WSP Canada Inc.
Project: WSP 161-17014, Kouchibouguac National Park
Source 1: BH01, SS05
Source 2: BH01, SS07
Source 3: BH09, SS04

Material Type: N/A
Date Received: 15-Dec-16
Date Tested: 19-Dec-16

GRADING				
SAMPLE #	1	2	3	
SIEVE (mm)	**% PASSING**	**% PASSING**	**% PASSING**	**SPEC**
80				-
56				-
40		100.0		-
28		92.8	100.0	-
20		92.8	97.6	-
14		88.7	91.5	-
10	100.0	85.4	88.0	-
5	98.9	83.7	86.0	-
2.5	98.0	81.4	84.4	-
1.25	97.1	79.2	82.4	-
0.630	95.5	74.4	76.5	-
0.315	89.7	53.7	61.4	-
0.160	75.9	29.4	43.5	-
0.080	59.3	21.7	34.4	-

PHYSICAL PROPERTY TESTS			
Sample Number	1	2	3
Gravel, %	1.1	16.3	14.0
Sand, %	39.6	62.0	51.6
Silt & Clay, %	59.3	21.7	34.4
Classification			
Natural Moisture Content, %			
Abrasion Loss, %			
Soundness Loss, %			
Micro Deval Loss, %			
Fine Absorption, %			
Flat & Elongated Particles,%			
Coarse Absorption, %			
Coarse Spec. Gravity, kg/m³			
Fractured Faces, %			
Liquid Limit, %			
Plastic Limit, %			
Plasticity Index, %			
Max. Dry Density: Standard			
Optimum Moisture Content %			



Technician J.Fiset

Reviewed By C.Mullins

Stantec

Project Name: WSP 161-17014, Kouchibouguac National Park **Project Number:** 121619399

Task: 200.235

Client: WSP Canada Inc.

Sample Identification	Moisture Content, %		Sample Identification	Moisture Content, %
BH01 SS02	8.7			
BH01 SS05	20.5			
BH01 SS07	13.4			
BH02 SS02	8.9			
BH02 SS04	17.1			
BH03 SS02	5.5			
BH03 SS04	9.3			
BH04 SS02	7.3			
BH04 SS04	14.0			
BH04 SS05	20.2			
BH04 SS07	16.7			
BH05 SS04	20.4			
BH06 SS04	8.6			
BH06 SS08	23.7			
BH09 SS02	12.4			
BH09 SS04	16.4			

Reviewed By: C.Mullins **Date:** 24-Dec-16

Stantec Ltd.

ROCK CORE DIMENSIONAL and SHAPE TOLERANCES ASTM D 4543

Project Name	WSP 161-17014			Project Location	Kouchibouguac National Park			Project Number	121619399 200.235
Block	1	**Sample**	25'	**Area (mm²)**	3117	**L (mm)**	146.25	**D (mm)**	63.00

Axial Tolerance	Axial		End Surface Flatness				Perpendicularity Tolerance		
	Min	Max	D_1	D_2	D_3	D_4			
L_1	0.000	0.013	0.000	0.002	0.008	0.003	D_1 Δ	0.008	
L_2	0.000	0.005	0.008	0.009	0.000	0.010	D_2 Δ	0.007	
L_3	-0.003	0.002					D_3 Δ	0.008	
							D_4 Δ	0.007	
L_1 Δ	0.013								
L_2 Δ	0.005						L/D Ratio	2.3	
L_3 Δ	0.005						L/D Meets Spec		
Maximum Axial Deviation (in) 0.013							Δ Max	0.008	
							Δ Max / D	0.003	
Axial Deviation Meets Spec							Perpendicularity Meets Spec		

COMPRESSIVE STRENGTH of INTACT ROCK CORE ASTM D 7012

Load, kN	128.0	Compressive Strength, MPa	41	Unit Weight, g/cm³	2.166
Bedrock Type	Sandstone				
Remarks					
Tested By	JF	Date 16-Dec-16	Reviewed By	M.Bochmann	

Stantec Ltd.

ROCK CORE DIMENSIONAL and SHAPE TOLERANCES ASTM D 4543

Project Name	WSP 161-17014			Project Location	Kouchibouguac National Park			Project Number	121619399 200.235
Block	4	**Sample**	19'	**Area (mm²)**	3117	**L (mm)**	130.00	**D (mm)**	63.00

Axial Tolerance	Axial		End Surface Flatness				Perpendicularity Tolerance		
	Min	Max	D_1	D_2	D_3	D_4			
L_1	0.000	0.018	0.000	0.006	0.006	0.006	D_1 Δ	0.007	
L_2	0.000	0.026	0.007	0.000	0.008	-0.002	D_2 Δ	0.006	
L_3	0.000	0.022					D_3 Δ	0.002	
							D_4 Δ	0.008	
L_1 Δ	0.018								
L_2 Δ	0.026						L/D Ratio	2.1	
L_3 Δ	0.022						L/D Meets Spec		
Maximum Axial Deviation (in) 0.026							Δ Max	0.008	
							Δ Max / D	0.003	
Axial Deviation Out of Spec							Perpendicularity Meets Spec		

COMPRESSIVE STRENGTH of INTACT ROCK CORE ASTM D 7012

Load, kN	117.8	Compressive Strength, MPa	38	Unit Weight, g/cm³	2.151
Bedrock Type	Sandstone				
Remarks	Axial deviation out of spec due to undulations along side of core due to drill process				
Tested By	JF	Date 16-Dec-16	Reviewed By	M.Bochmann	

Stantec Ltd.

ROCK CORE DIMENSIONAL and SHAPE TOLERANCES ASTM D 4543

Project Name	WSP 161-17014			Project Location	Kouchibouguac National Park			Project Number	121619399 200.235
Block	6	**Sample**	38'	**Area (mm²)**	3093	**L (mm)**	128.50	**D (mm)**	62.75

Axial Tolerance	Axial		End Surface Flatness				Perpendicularity Tolerance		
	Min	Max	D_1	D_2	D_3	D_4			
L_1	0.000	0.022	0.000	-0.005	0.002	-0.005	D_1 Δ	0.005	
L_2	0.000	0.020	-0.005	0.004	-0.007	0.001	D_2 Δ	0.009	
L_3	0.000	0.016					D_3 Δ	0.009	
							D_4 Δ	0.006	
L_1 Δ	0.022								
L_2 Δ	0.020						L/D Ratio	2.0	
L_3 Δ	0.016						L/D Meets Spec		
Maximum Axial Deviation (in) 0.022							Δ Max	0.009	
							Δ Max / D	0.004	
Axial Deviation Out of Spec							Perpendicularity Meets Spec		

COMPRESSIVE STRENGTH of INTACT ROCK CORE ASTM D 7012

Load, kN	137.2	Compressive Strength, MPa	44	Unit Weight, g/cm³	2.411
Bedrock Type	Sandstone				
Remarks	Axial deviation out of spec due to undulations along side of core due to drill process				
Tested By	JF	Date 20-Dec-16	Reviewed By	M.Bochmann	

Stantec Ltd.

ROCK CORE DIMENSIONAL and SHAPE TOLERANCES ASTM D 4543

Project Name	WSP 161-17014			Project Location	Kouchibouguac National Park			Project Number	121619399 200.235
Block	7	**Sample**	33'	**Area (mm²)**	3142	**L (mm)**	143.75	**D (mm)**	63.25

Axial Tolerance	Axial		End Surface Flatness				Perpendicularity Tolerance		
	Min	Max	D_1	D_2	D_3	D_4			
L_1	-0.012	0.000	0.000	0.001	0.005	0.005	D_1 Δ	0.007	
L_2	-0.010	0.002	0.007	0.007	0.000	-0.003	D_2 Δ	0.006	
L_3	-0.002	0.000					D_3 Δ	0.005	
							D_4 Δ	0.008	
L_1 Δ	0.012								
L_2 Δ	0.012						L/D Ratio	2.3	
L_3 Δ	0.002						L/D Meets Spec		
Maximum Axial Deviation (in) 0.012							Δ Max	0.008	
							Δ Max / D	0.003	
Axial Deviation Meets Spec							Perpendicularity Meets Spec		

COMPRESSIVE STRENGTH of INTACT ROCK CORE ASTM D 7012

Load, kN	127.4	Compressive Strength, MPa	41	Unit Weight, g/cm³	2.397
Bedrock Type					
Remarks					
Tested By	JF	Date 20-Dec-16	Reviewed By	M.Bochmann	

Stantec Ltd.

ROCK CORE DIMENSIONAL and SHAPE TOLERANCES ASTM D 4543

Project Name	WSP 161-17014			Project Location	Kouchibouguac National Park			Project Number	121619399 200.235
Block	9	**Sample**	25'	**Area (mm²)**	3043	**L (mm)**	107.75	**D (mm)**	62.25

Axial Tolerance	Axial		End Surface Flatness				Perpendicularity Tolerance		
	Min	Max	D_1	D_2	D_3	D_4			
L_1	-0.015	0.016	0.000	-0.010	0.008	-0.003	D_1 Δ	0.004	
L_2	-0.058	0.002	-0.004	0.010	-0.012	0.003	D_2 Δ	0.020	
L_3	-0.040	0.000					D_3 Δ	0.020	
							D_4 Δ	0.006	
L_1 Δ	0.031								
L_2 Δ	0.060						L/D Ratio	1.7	
L_3 Δ	0.040						L/D Out of Spec		
Maximum Axial Deviation (in)							Δ Max	0.020	
0.06							Δ Max / D	0.008	
							Perpendicularity Out of Spec		
Axial Deviation Out of Spec									

COMPRESSIVE STRENGTH of INTACT ROCK CORE ASTM D 7012

Load, kN	88.8	Compressive Strength, MPa	29	Unit Weight, g/cm³	2.403
Bedrock Type	Sandstone				
Remarks	Axial deviation out of spec due to undulations along side of core due to drill process				
Tested By	JF	Date 20-Dec-16	Reviewed By	M.Bochmann	