

**FOUNDATION INVESTIGATION REPORT  
JACKPINE RIVER BRIDGE REHABILITATION  
HIGHWAY 17, PATIENCE TOWNSHIP  
THUNDER BAY UNORGANIZED DISTRICT  
G.W.P. 465-00-00, STRUCTURE NO. 48C-15**

**Geocres Number: 42D-29**

**Report to  
McCormick Rankin Corporation**

Thurber Engineering Ltd.  
2010 Winston Park Drive, Suite 103  
Oakville, Ontario  
L6H 5R7  
Phone: (905) 829 8666  
Fax: (905) 829 1166

February 12, 2013  
File: 19-1351-197

H:\19\1351\197 NWR 32 Rehabs\Reports & Memos\Jackpine\Jackpine River Bridge FINAL FIR.doc

## TABLE OF CONTENTS

### PART 1      FACTUAL INFORMATION

1	INTRODUCTION .....	1
2	SITE DESCRIPTION .....	1
3	SITE INVESTIGATION AND FIELD TESTING .....	2
4	LABORATORY TESTING .....	3
5	DESCRIPTION OF SUBSURFACE CONDITIONS .....	3
5.1	Asphalt .....	3
5.2	Granular Fill .....	3
5.3	Sand and Gravel .....	4
5.4	Sand .....	5
5.5	Water Levels .....	5
6	MISCELLANEOUS .....	6

### Appendices

Appendix A	Record of Borehole Sheets (present investigation)
Appendix B	Laboratory Test Results (present investigation)
Appendix C	Record of Borehole Sheets and Borehole Location Plan (previous investigation)
Appendix D	Site Photographs
Appendix E	Drawing titled "Borehole Locations and Soil Strata"

**FOUNDATION INVESTIGATION REPORT  
JACKPINE RIVER BRIDGE REHABILITATION  
HIGHWAY 17, PATIENCE TOWNSHIP  
THUNDER BAY UNORGANIZED DISTRICT  
G.W.P. 465-00-00, STRUCTURE NO. 48C-15**

**Geocres Number: 42D-29**

**PART 1: FACTUAL INFORMATION**

**1 INTRODUCTION**

This report presents the factual findings obtained from a foundation investigation conducted at the location of the bridge carrying Highway 17 over Jackpine River in Patience Township, Ontario.

The purpose of the investigation was to explore the subsurface conditions at the bridge site and, based on the data obtained, to provide a borehole location plan, borehole logs, stratigraphic profile, cross-sections, laboratory test results and a written description of the subsurface conditions.

Thurber carried out the investigation as a sub-consultant to McCormick Rankin Corporation under the Ministry of Transportation Ontario (MTO) Agreement Number 6010-E-0011.

In the preparation of this report and in addition to the boreholes drilled under the current assignment, reference has been made to information on subsurface conditions contained in a previous foundation report. The title of this report is listed as follows:

- Foundation Investigation for Jackpine River Crossing, T.C.H. No. 17, District No. 19, W.P. 944-58, prepared by Trow Soderman and Associates, Dated November 21, 1958. (Reference 1).

**2 SITE DESCRIPTION**

The site is located on Highway 17 approximately 24 Km east of Nipigon, Ontario. The bridge is approximately 550 m east of Karma Road in Patience Township, Thunder Bay Unorganized District, Ontario.

At the bridge location, Highway 17 is a two-lane paved roadway. The existing Jackpine River Bridge is a single-span structure with a total length of 24.4 m supported on two abutments. The abutments are supported on spread footings founded on native soils. The width of the bridge is 11.4 m.



At the site, the Jackpine River flows from north to south.

The lands immediately surrounding the bridge site consist of forested areas. A steep exposed scarp is observed on the north side of the bridge. The river channel is lined with cobbles and boulders, more noticeable along the edges of the channel. Rock fill protection is also observed surficially at the abutments.

Photographs in Appendix D show the general nature of the surrounding land.

The site lies within the Canadian Shield, characterized by low, rounded hills of Pre-Cambrian bedrock mantled by varying thicknesses of overburden. At this site, the overburden primarily consists of glaciofluvial outwash deposits: gravel and sand.

### **3 SITE INVESTIGATION AND FIELD TESTING**

The site investigation and field testing for this project were carried out on February 5 to 8, 25 and 26, 2011. A total of four sampled boreholes (numbered JPR-01 to JPR-04) were drilled to depths ranging from 12.7 m to 18.3 m (elevations 189.6 to 184.7). Dynamic Cone Penetration Tests (DCPTs) were also performed from the bottom of Boreholes JPR-01, JPR-03 and JPR-04 extending to depths ranging from 12.8 m to 22.4 m.

Two DCPTs were also performed from 3.1 m to 5.4 m depth and from 3.1 m to 12.0 m depth adjacent to Boreholes JPR-02 and JPR-03, respectively. The DCPTs were conducted to supplement the data/information collected from the boreholes.

The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawing in Appendix E. The coordinates and elevations of the boreholes are given on the drawings and on the individual Record of Borehole Sheets in Appendix A. The co-ordinates and ground surface elevations of the boreholes were obtained from plan drawings provided by MRC.

Boreholes JPR-02 and JPR-03 were drilled just behind the approach slab at the abutments. Boreholes JPR-01 and JPR-04 were drilled through the west and east approach embankments.

Records of Boreholes 1 to 4 drilled during the previous investigation, (Reference 1) and the associated Borehole Location Plan are included in Appendix C.

Prior to commencement of the current drilling program, utility clearances were obtained for all borehole locations.

Hollow stem augers and wash-boring with casing were used to advance the boreholes. Coring techniques were required at various depths in Borehole JPR-02 to advance the boreholes through zones of cobbles and boulders present in the native sand and gravel deposits. Samples were obtained at selected intervals using a 50 mm diameter split spoon sampler in conjunction with Standard Penetration Testing (SPT).

A member of Thurber's technical staff supervised the drilling and sampling operations on a full time basis. The supervisor logged the boreholes, visually examined the recovered samples, and prepared the samples for transport back to Thurber's laboratory for further examination and testing.

Groundwater conditions were observed in the open boreholes throughout the drilling operations. The boreholes were backfilled with auger cuttings to 0.05 m, then cold patch asphalt to surface.

#### **4 LABORATORY TESTING**

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 analyses (sieve and hydrometer). The results of this testing program are shown on the Record of Borehole sheets in Appendix A and on the figures contained in Appendix B.

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

Reference is made to the Record of Borehole sheets in Appendix A for details of the encountered soil stratigraphy. A stratigraphic profile is presented on the Borehole Locations and Soil Strata Drawing in Appendix E, for illustrative purposes. Overall descriptions of the stratigraphy are given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions. It must be recognized that soil conditions may vary between and beyond borehole locations.

In general terms, the soil stratigraphy encountered at this site consists of asphalt over gravelly sand to sand and gravel fill overlying native deposits of sand and gravel to sand. Auger grinding noted at various depths and the occasional use of coring techniques to advance the boreholes, indicate the presence of cobbles and boulders within the native cohesionless deposits. More detailed descriptions of the individual strata are presented below.

Boreholes 1 to 4 drilled in 1958, revealed native medium to coarse gravel with stones and boulders up to 0.9 m in diameter over sand.

##### **5.1 Asphalt**

Asphalt was encountered at surface in all the boreholes. The thickness of the asphalt ranged from 90 mm to 150 mm.

##### **5.2 Granular Fill**

Granular embankment fill consisting of brown gravelly sand and sand and gravel containing trace silt and clay was encountered below the asphalt at the approach.

The thickness of the granular fill ranged from 3.3 m to 4.2 m.

The depth to the base of the granular fill ranged from 3.4 m to 4.3 m (Elevations 199.9 to 198.0).

SPT 'N' values recorded in the gravelly sand and sand and gravel fill ranged from 17 blows for 0.3 m penetration to 70 blows for 0.05 m penetration, indicating a compact to very dense condition

Cobbles and boulders are likely present within the fill, which may account for some high blow counts and grinding of the drill augers.

Moisture contents of the granular fill ranged from 2% to 11%.

Grain size distribution curves for three samples of the granular fill are presented on Figures B1 and B2, Appendix B. These results are also presented on the Record of Borehole sheets in Appendix A and are summarized as follows:

Gravel %	22 to 42
Sand %	51 to 71
Silt & Clay %	5 to 7

### 5.3 Sand and Gravel

Native brown sand and gravel was encountered below the granular fill in Boreholes JPR-01, JPR-02, and JPR-04 at depths ranging from 3.4 m to 4.0 m (elevations 198.0 to 199.9). The sand and gravel layer contains trace silt and clay with occasional cobbles and boulders. The thickness of the sand and gravel layer ranged from 3.3 m to 4.9 m.

Two isolated layers of sand and gravel were encountered within a sand deposit in Borehole JPR-03 at 9.1 m depth and 15.0 m depth (elevations 193.8 and 188.0). The thicknesses of these layers were 0.7 m and 1.3 m.

The depth to the base of the sand and gravel layer varied from 7.3 m to 8.7 m (elevations 193.6 to 195.7) in Boreholes JPR-01, JPR-02, and JPR-04

SPT 'N' values recorded in this layer ranged from 11 blows for 0.3 m penetration to 100 blows for 0.1 m penetration, indicating a compact to very dense condition. In Borehole JPR-02, coring techniques were required to advance the borehole from 5.9 m to 7.1 m depth due to the presence of cobbles and boulders. Grinding of the drill augers was noted at various depths during borehole advancement through the sand and gravel layer, also indicating presence of cobbles and boulders.

Moisture contents in this layer ranged from 5% to 13%.

The results of grain size distribution analyses conducted on samples of the sand and gravel are presented on the Record of Borehole sheets in Appendix A and on Figure B4 of Appendix B. The results are summarized as follows:

Gravel %	35 to 38
Sand %	56 to 59
Silt & Clay %	6

#### 5.4 Sand

Native sand was encountered below the sand and gravel layer in Boreholes JPR-01, JPR-02, and JPR-04 and directly below the embankment fill in Borehole JPR-03. The sand is brown to reddish brown, typically medium to coarse grained, and contains trace gravel to gravelly, trace silt and clay and occasional cobbles. In Borehole JPR-03, layers of sand and gravel were encountered within the sand. The thickness of the sand layer ranges from 5.5 m to 8.1 m in Boreholes JPR-01, JPR-02 and JPR-04. The thickness of the sand layer including the interlayers of sand and gravel in Borehole JPR-03 is 14.0.

All boreholes were terminated upon refusal in the sand layer at depths ranging from 12.8 m to 18.3 m (elevations 184.7 to 189.6).

SPT 'N' values recorded in the sand ranged from 11 blows for 0.3 m penetration to 100 blows for 0.28 m penetration, indicating a compact to very dense condition.

Grinding of the drill augers was noted at various depths in Borehole JPR-03, drilled at the east abutment, indicating presence of cobbles and boulders.

Moisture contents of the sand samples ranged from 6% to 23%.

The results of grain size distribution analyses conducted on samples of the sand are presented on the Record of Borehole sheets in Appendix A and on Figure B3 of Appendix B. The results are summarized as follows:

Gravel %	2 to 18
Sand %	76 to 96
Silt & Clay %	2 to 7

#### 5.5 Water Levels

Water levels were observed in the boreholes during and upon completion of drilling.

Water levels were measured at depths ranging from 5.9 m to 7.4 m (elevations 195.8 to 196.1) in Boreholes JPR-01, JPR-03 and JPR-04.

The water level in Jackpine River was at elevation 197.1 m in January 2011 (from preliminary General Arrangement drawing).

Fluctuations of the groundwater level and river level are to be expected and subject to seasonal conditions. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

The groundwater level is expected to fluctuate in conjunction with variations in the river water level.

## 6 MISCELLANEOUS

The borehole locations were established in the field by Thurber Engineering. The coordinates and ground surface elevations at the boreholes were subsequently determined by MMM Group Limited survey personnel.

Thurber obtained utility clearances for the borehole locations prior to drilling.

Eastern Ontario Diamond Drilling Ltd. supplied a truck-mounted drill rig and conducted the drilling, sampling and in-situ testing operations.

The field program was supervised on a full time basis by Mr. Ryan Kromer, E.I.T and Rory McAllister of Thurber Engineering Ltd. Overall supervision of the field program was provided by Mr. Alastair E. Gorman, P.Eng. and Mr. Tony Harte, M.Sc.

Interpretation of the data and preparation of the report was carried out by Ms. Rocío Palomeque Reyna, P.Eng. and Ms. Lindsey Blaine, E.I.T. The report was reviewed by Dr. P.K. Chatterji, P.Eng. a Designated Principal Contact for MTO Foundations Projects.

### Thurber Engineering Ltd.

Lindsey Blaine, E.I.T.  
Project Manager

Rocío Palomeque Reyna, P.Eng.  
Geotechnical Engineer



P.K. Chatterji, P.Eng., Ph.D.  
Review Principal



**Appendix A**  
**Record of Borehole Sheets**  
**(Current Investigation)**

# 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

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

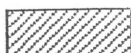
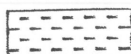



 Water Level  
 Shear Strength Determination by Pocket Penetrometer

- (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.

# UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	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	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and 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. ( $W_L < 30\%$ ).
		CI	Inorganic clays of medium plasticity, silty clays. ( $30\% < W_L < 50\%$ ).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
	HIGHLY ORGANIC SOILS		Pt
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

## EXPLANATION OF ROCK LOGGING TERMS

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

DISCONTINUITY SPACING		STRENGTH CLASSIFICATION			
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				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
		Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
		Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
		Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

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 0.1m 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 JPR-01

1 OF 2

METRIC

W.P. 465-00-00 LOCATION Jackpine River Bridge N 5 426 927.1 E 231 718.2 ORIGINATED BY RK  
HWY 17 BOREHOLE TYPE Hollow Stem Augers/Casing COMPILED BY AN  
DATUM Geodetic DATE 2011.02.08 - 2011.02.08 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
202.0												
0.0	ASPHALT: (100mm)											
0.1	SAND and GRAVEL, trace silt and clay Very Dense to Compact Brown Moist (FILL)		1	AS								
			1	SS	100							
	Auger grinding at 1.5m		2	SS	62/ 0.075							
			3	SS	26							
	Auger grinding at 3.1m		4	SS	17							
198.0	Auger grinding at 4.0m											
4.0	SAND and GRAVEL, trace silt and clay Compact to Very Dense Brown Wet		5	SS	100/ 0.100							
	Layer of cobbles from 5.1m to 5.7m											
	Auger grinding at 5.5m		6	SS	31							
194.7												
7.3	SAND, medium to coarse grained, some gravel, trace silt and clay Compact to Very Dense Brown Wet		7	SS	34							
			8	SS	63							

Continued Next Page

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

ONTMT4S 1197.GPJ 11/15/11

# RECORD OF BOREHOLE No JPR-01

2 OF 2

METRIC

W.P. 465-00-00 LOCATION Jackpine River Bridge N 5 426 927.1 E 231 718.2 ORIGINATED BY RK  
 HWY 17 BOREHOLE TYPE Hollow Stem Augers/Casing COMPILED BY AN  
 DATUM Geodetic DATE 2011.02.08 - 2011.02.08 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>		
	Continued From Previous Page																
	SAND, medium to coarse grained, some gravel, trace silt and clay Dense to Very Dense Brown Wet		9	SS	42		192										
							191										
			10	SS	100		190										
189.2	Start DCPT at 12.7m																
12.8	END OF BOREHOLE AND DCPT AT 12.8m UPON AUGER REFUSAL. BOREHOLE OPEN AND WATER LEVEL AT 5.9m UPON COMPLETION. BOREHOLE BACKFILLED WITH AUGER CUTTINGS TO 0.05m, THEN ASPHALT TO SURFACE.																

+<sup>3</sup> . X<sup>3</sup> : Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No JPR-02

1 OF 2

METRIC

W.P. 465-00-00 LOCATION Jackpine River Bridge N 5 426 922.8 E 231 734.8 ORIGINATED BY RDM  
 HWY 17 BOREHOLE TYPE Hollow Stem Augers/Casing COMPILED BY AN  
 DATUM Geodetic DATE 2011.02.25 - 2011.02.26 CHECKED BY RPR

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
202.3														
0.0	ASPHALT: (150mm)													
0.2	SAND and GRAVEL, trace silt and clay Dense to Very Dense Brown Damp (FILL)		1	SS	75/ 0.075		202							
			2	SS	70/ 0.050									
			3	SS	50		201							
			4	SS	44		200							
			5	SS	75		199							
198.5														
3.8	SAND and GRAVEL, trace silt and clay Dense Brown Moist		6	SS	41		198							
	Cored through boulders and cobbles from 5.9m to 7.1m Boulder (380mm)						197							
	Wet						196							
							195							
							194							
193.6														
8.7	SAND, some gravel, trace silt and clay Compact Reddish Brown Wet		8	SS	29		193							

Continued Next Page

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

20  
15 5  
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No JPR-02

2 OF 2

METRIC

W.P. 465-00-00 LOCATION Jackpine River Bridge N 5 426 922.8 E 231 734.8 ORIGINATED BY RDM  
HWY 17 BOREHOLE TYPE Hollow Stem Augers/Casing COMPILED BY AN  
DATUM Geodetic DATE 2011.02.25 - 2011.02.26 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
	SAND, some gravel, trace silt and clay Compact to Very Dense Brown Wet		9	SS	81		192							
							191							
			10	SS	11		190							
							189							
			11	SS	31		188							
							187							
			12	SS	56		186							
185.6	Cored from 16.6m to 16.8m													
16.8	END OF BOREHOLE AT 16.8m UPON AUGER REFUSAL. BOREHOLE BACKFILLED WITH AUGER CUTTINGS TO 0.05m, THEN ASPHALT TO SURFACE.													

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

# RECORD OF BOREHOLE No JPR-03

1 OF 3

METRIC

W.P. 465-00-00 LOCATION Jackpine River Bridge N 5 426 897.2 E 231 769.3 ORIGINATED BY RK  
 HWY 17 BOREHOLE TYPE Hollow Stem Augers/Casing COMPILED BY AN  
 DATUM Geodetic DATE 2011.02.05 - 2011.02.06 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60		
203.0												
0.0	ASPHALT: (90mm)											
0.1	Gravelly SAND, trace silt and clay Compact to Very Dense Brown Moist (FILL) Auger grinding at 0.9m, 1.4m and 3.8m		1	AS								
			1	SS	70							
			2	SS	51/ 0.125							
			3	SS	22							
			4	SS	18							
	Cobbles at 3.8m											
198.7												
4.3	SAND, trace gravel to gravelly, trace silt and clay, occasional cobbles Compact to Very Dense Brown Moist to Wet		5	SS	28							
	Auger grinding at 5.8m											
	Wet DCPT refusal at 6.3m		6	SS	63							
	Auger grinding at 7.0m and 8.5m											
			7	SS	34							
193.8												
9.1	SAND and GRAVEL Compact Brown		8	SS	11							
193.2	Wet											
9.8												

Continued Next Page

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

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No JPR-03

2 OF 3

METRIC

W.P. 465-00-00 LOCATION Jackpine River Bridge N 5 426 897.2 E 231 769.3 ORIGINATED BY RK  
 HWY 17 BOREHOLE TYPE Hollow Stem Augers/Casing COMPILED BY AN  
 DATUM Geodetic DATE 2011.02.05 - 2011.02.06 CHECKED BY RPR

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
	Continued From Previous Page													
	SAND, some gravel to gravelly, trace silt and clay, occasional cobbles Very Dense Brown Wet		9	SS	61									
	DCPT refusal at 12.0m		10	SS	57									
	Compact		11	SS	13									
188.0														
15.0	SAND and GRAVEL, trace silt and clay Very Dense Brown Wet		12	SS	66									38 56 6 (SI+CL)
186.7														
16.3	SAND, some gravel Very Dense Brown Wet		13	SS	100/ 0.28									
184.7														
18.3	End of sampling at 18.3m and start DCPT													

Continued Next Page

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

ONTMT4S 1197.GPJ 11/15/11

# RECORD OF BOREHOLE No JPR-03

3 OF 3

METRIC

W.P. 465-00-00 LOCATION Jackpine River Bridge N 5 426 897.2 E 231 769.3 ORIGINATED BY RK  
 HWY 17 BOREHOLE TYPE Hollow Stem Augers/Casing COMPILED BY AN  
 DATUM Geodetic DATE 2011.02.05 - 2011.02.06 CHECKED BY RPR

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES								
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100					
180.6							183						
							182						
							181						
22.4	END OF BOREHOLE AND DCPT AT 22.4m UPON AUGER REFUSAL. WATER LEVEL AT 7.2m UPON COMPLETION. BOREHOLE BACKFILLED WITH SAND AND AUGER CUTTINGS TO 0.05m, THEN ASPHALT TO SURFACE.												

RECORD OF BOREHOLE No JPR-04

1 OF 2

METRIC

W.P. 465-00-00 LOCATION Jackpine River Bridge N 5 426 892.8 E 231 785.8 ORIGINATED BY RK  
HWY 17 BOREHOLE TYPE Hollow Stem Augers/Casing COMPILED BY AN  
DATUM Geodetic DATE 2011.02.07 - 2011.02.07 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	
203.3												
0.0	ASPHALT: (90mm)											
0.1	Gravelly SAND, trace silt and clay Compact Brown Moist (FILL)		1	SS	116/ 0.23		203					
			2	SS	40		202					
			3	SS	34		201					
			4	SS	18		200					
199.9	SAND and GRAVEL, occasional cobbles Compact to Very Dense Brown Moist Auger grinding at 4.0m and 5.5m		5	SS	24		199					
3.4			6	SS	103		198	150				
	Auger grinding at 6.7m						197					
			7	SS	40		196					
195.7	SAND, medium grained, trace to some gravel, trace silt and clay Compact to Very Dense Brown Wet		8	SS	18		195					
7.6							194					

Continued Next Page

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

20  
15 5  
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No JPR-04

2 OF 2

METRIC

W.P. 465-00-00 LOCATION Jackpine River Bridge N 5 426 892.8 E 231 785.8 ORIGINATED BY RK  
HWY 17 BOREHOLE TYPE Hollow Stem Augers/Casing COMPILED BY AN  
DATUM Geodetic DATE 2011.02.07 - 2011.02.07 CHECKED BY RPR

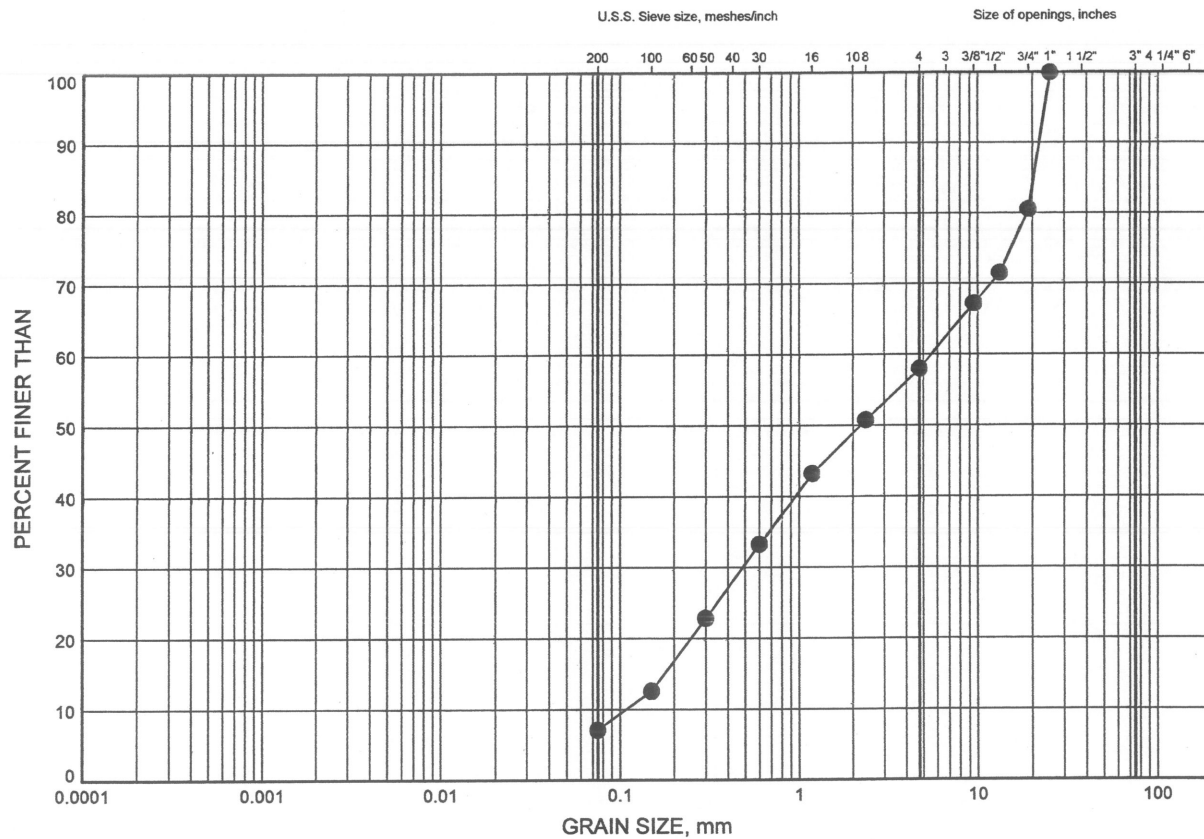
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
	Continued From Previous Page													
	SAND, trace gravel, trace silt and clay Compact to Very Dense Brown Wet		9	SS	16		193							
							192							
			10	SS	53		191							2 96 2 (SH+CL)
	End of sampling at 12.8m and start DCPT						190							
189.6														
13.7	END OF BOREHOLE AND DCPT AT 13.7m UPON AUGER REFUSAL. WATER LEVEL AT 7.4m UPON COMPLETION. BOREHOLE BACKFILLED WITH CUTTINGS TO 0.05m, THEN ASPHALT TO SURFACE.													

**Appendix B**  
**Laboratory Test Results**  
**(Current Investigation)**

# NWR 32 Rehabs GRAIN SIZE DISTRIBUTION

FIGURE B1

## SAND & GRAVEL FILL



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	JPR-02	2.59	199.74

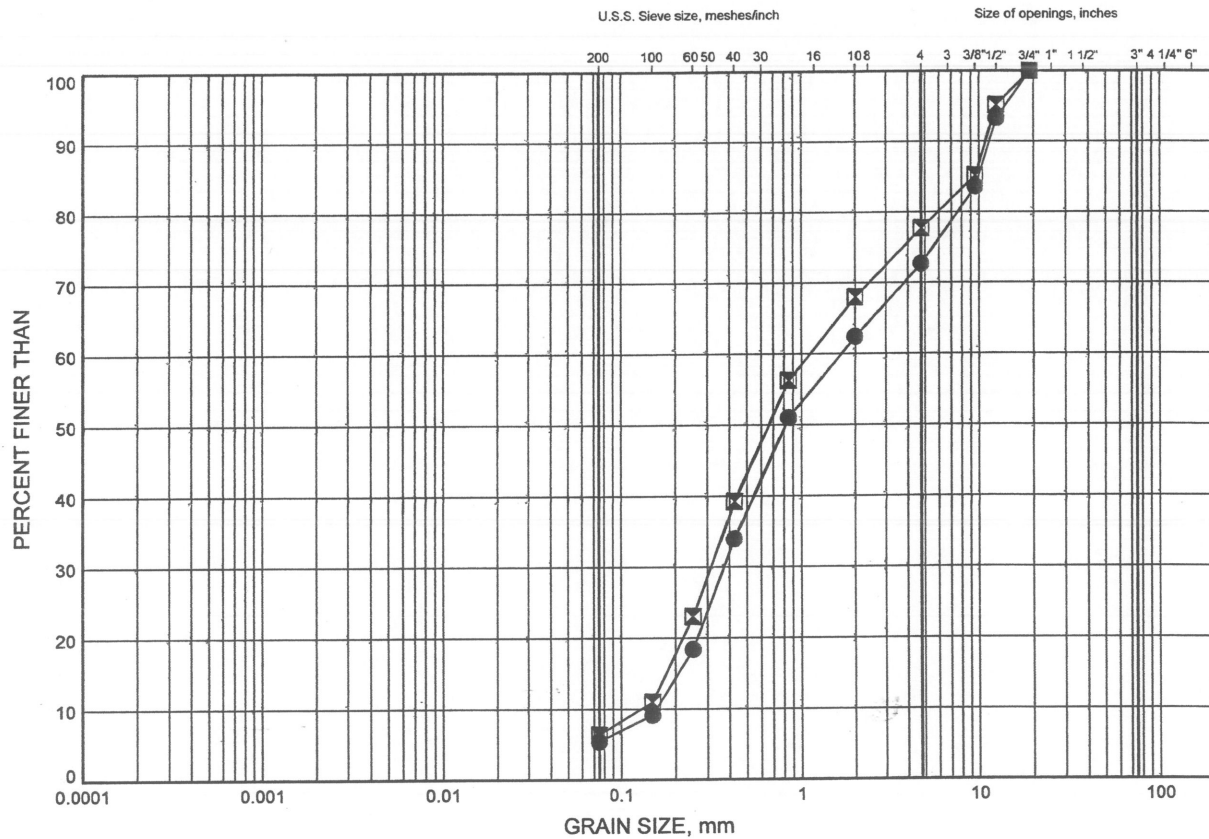


W.P.# 465-00-00.....  
Prepared By AN.....  
Checked By RPR.....

# NWR 32 Rehabs GRAIN SIZE DISTRIBUTION

FIGURE B2

## GRAVELLY SAND FILL



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

### LEGEND

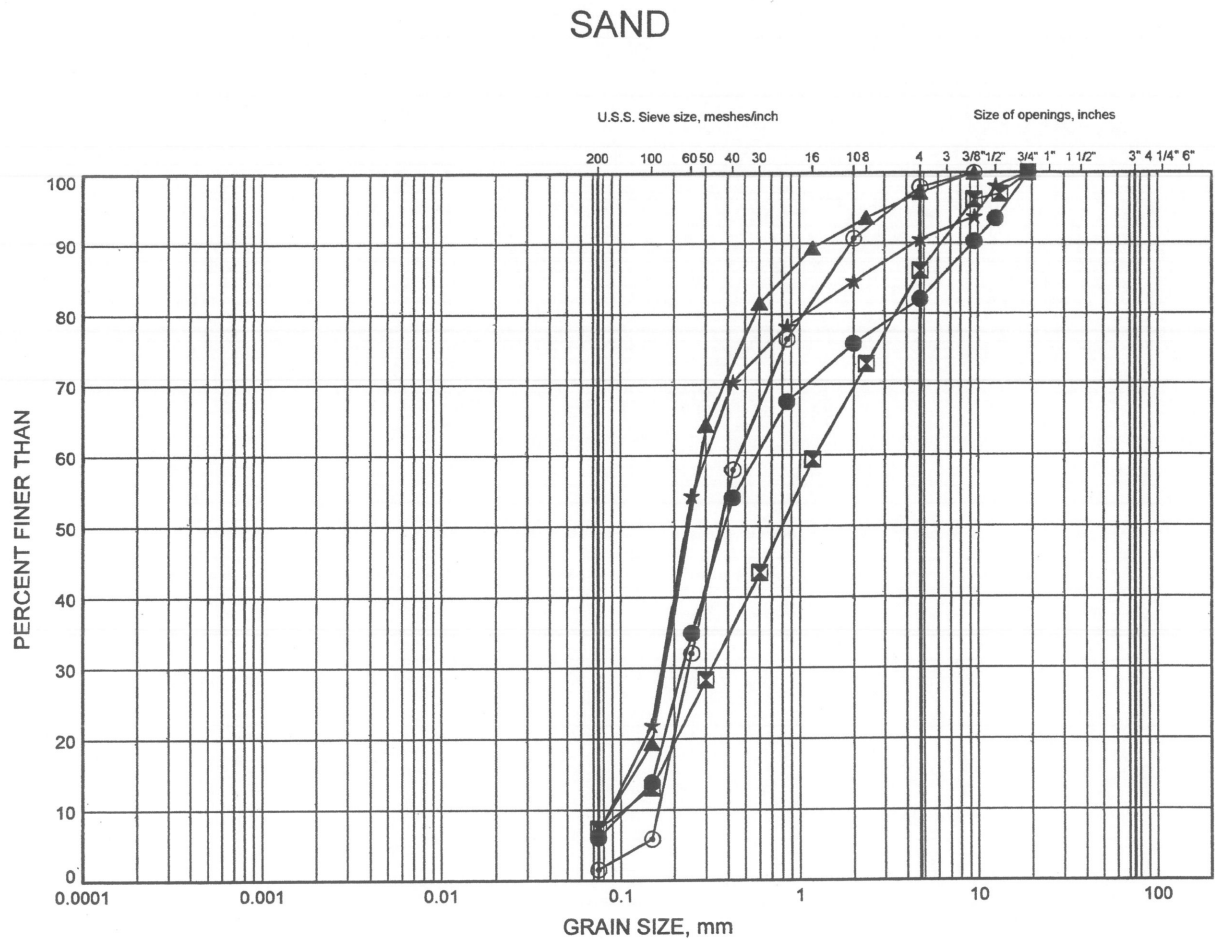
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	JPR-03	3.35	199.63
⊠	JPR-04	2.59	200.71



W.P.# 465-00-00  
Prepared By AN  
Checked By RPR

# NWR 32 Rehabs GRAIN SIZE DISTRIBUTION

FIGURE B3



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

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	JPR-01	9.45	192.56
⊠	JPR-02	9.45	192.88
▲	JPR-02	14.02	188.31
★	JPR-03	7.92	195.05
⊙	JPR-04	12.50	190.80

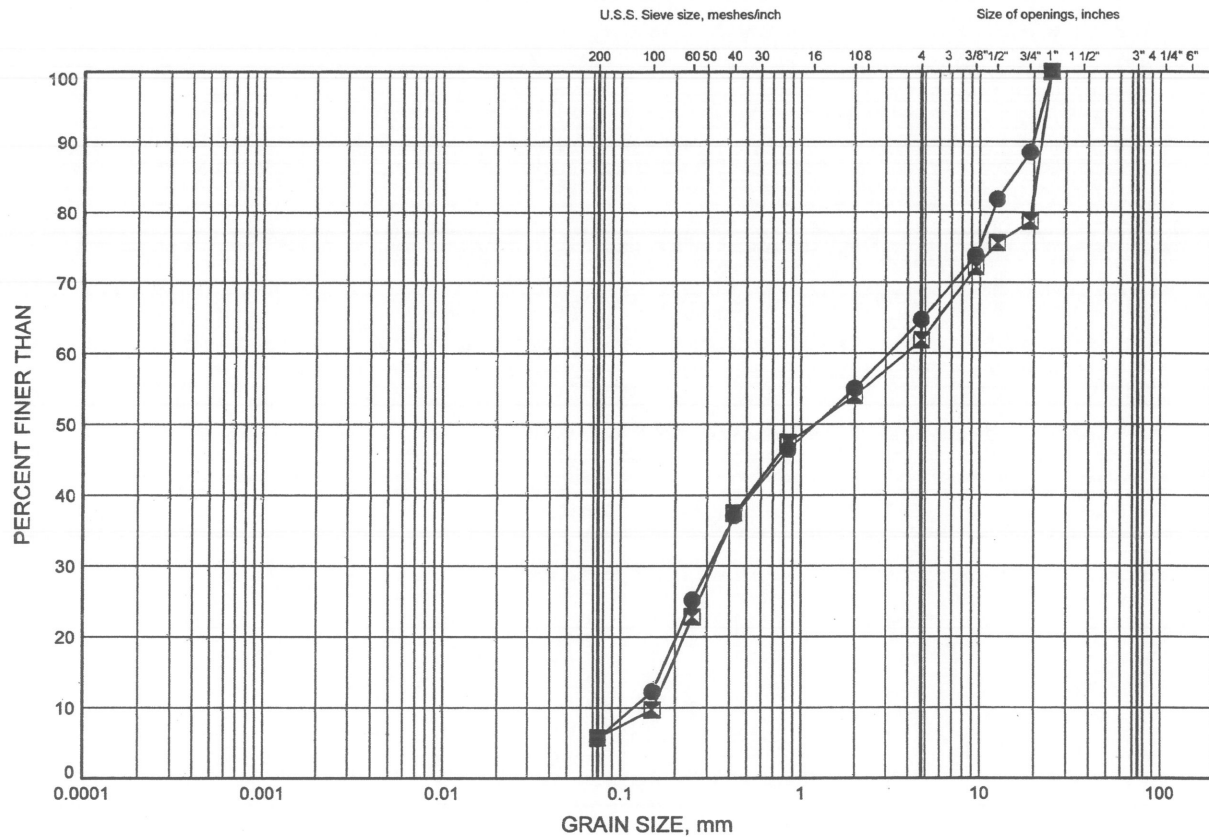


W.P.# .465-00-00.....  
Prepared By .AN.....  
Checked By .RPR.....

# NWR 32 Rehabs GRAIN SIZE DISTRIBUTION

FIGURE B4

## SAND & GRAVEL



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	JPR-01	6.40	195.61
⊠	JPR-03	15.54	187.43



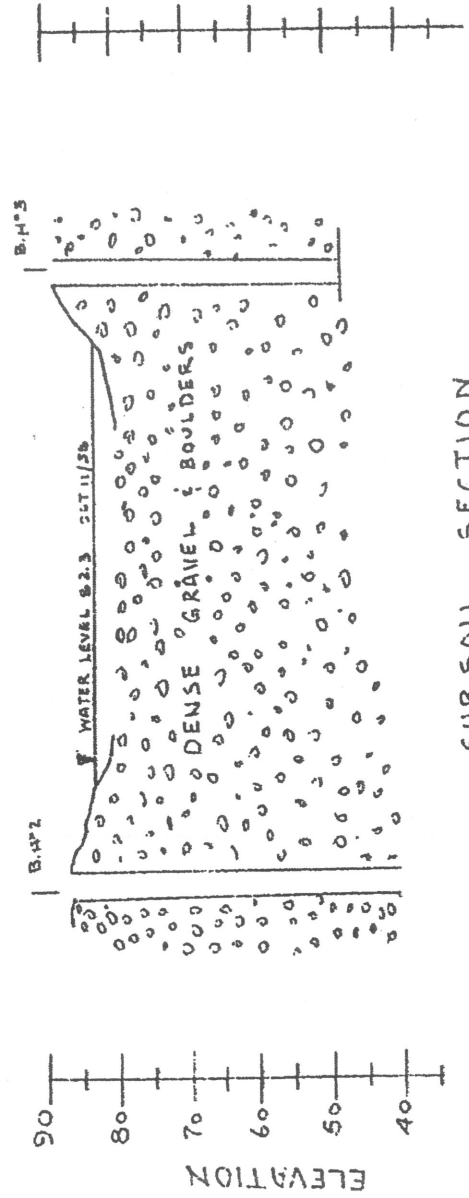
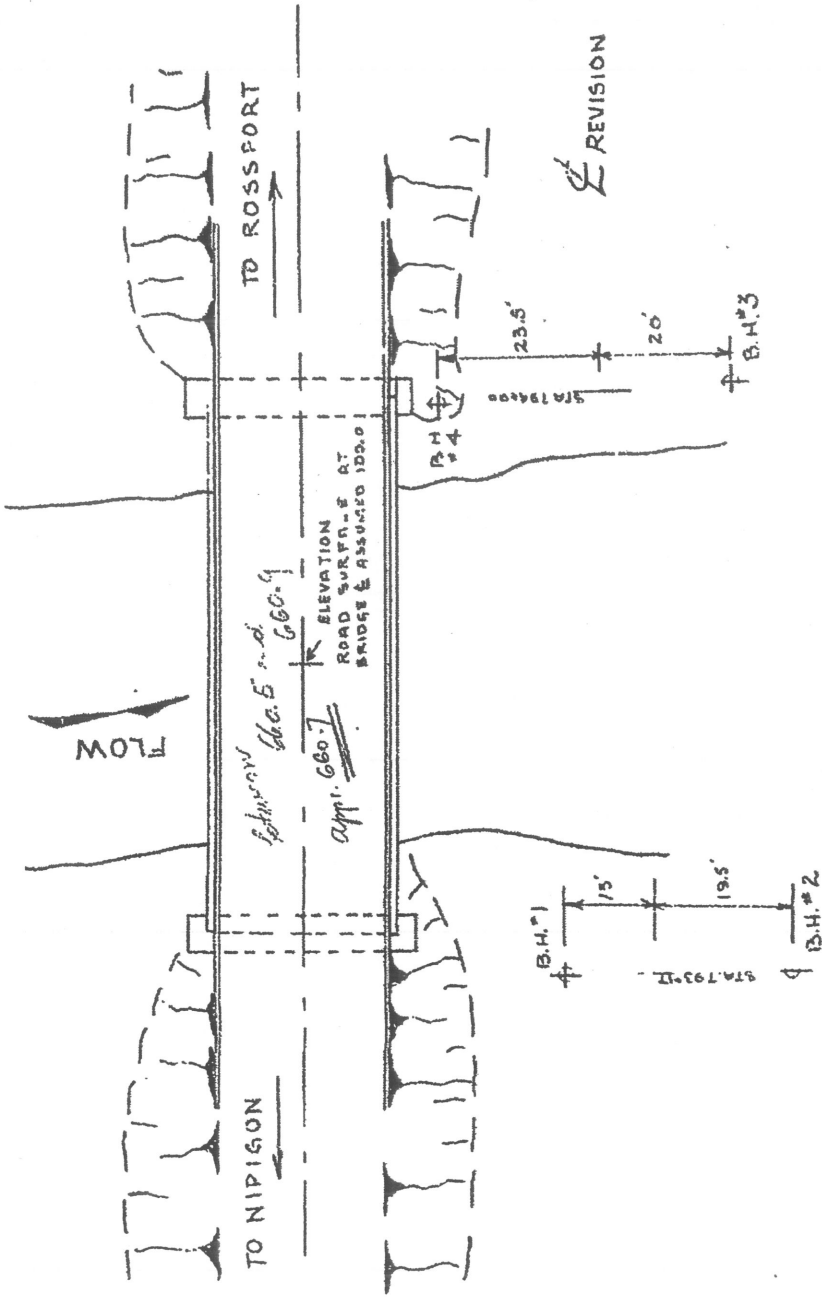
W.P.# 465-00-00.....  
Prepared By AN.....  
Checked By RPR.....

**Appendix C**

**Record of Borehole Sheets and Borehole Location Plan  
(Previous Investigation)**

JAI  
BOR

L.S.S.



PROJECT NO. J266

## TROW, SODERMAN AND ASSOCIATES

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

DRAWING NO. 2

## LEGEND

2" DIA. SPLIT TUBE

2" SHELLEY TUBE

2" SPLIT TUBE

2" DIA. CONE

CASING

2" SHELLEY

1/2 UNCONFINED COMPRESSION (QU)

VANE TEST (C) AND SENSITIVITY (S)

NATURAL MOISTURE AND

LIQUIDITY INDEX

LIQUID LIMIT

PLASTIC LIMIT

BOREHOLE NO. 1  
FIELD SUPERVISOR K.P.  
DRILLER R.J.  
PREP. L.S.

PROJECT Jackpine River Crossing

LOCATION T.C.H. #17, District 19

HOLE LOCATION As on plan

HOLE ELEVATION AND DATUM 88.1 Road surface at  
centre of existing bridge assumed el. 100.0

SYMBOL	DESCRIPTION	KLEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE		NATURAL UNIT WT P.C.F.
					BLOWS/FT.	
	Ground surface.	88.1	0			
	Glossely packed medium to coarse gravel with well rounded stones and boulders up to 3 ft in diameter.	W.L. 82.3	10			
	Unable to sample. Hole advance by diamond drilling using BX, AX and KX casing. Some sand noted below 30 ft depth.		20			
			30			
			40			
			50			
			60			
	End of borehole.	34.1				

## TROW SODERMAN AND ASSOCIATES

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

DNWEL

- 2" DIA. SPLIT TUBE  
2" SHELBY TUBE  
2" SPLIT TUBE  
2" DIA. CONE

Jackpine River Crossing

LOCATION T.C.H. #17, District 19

As on plan.

87.8 Road surface at centre of existing bridge assumed 100.0

BOREHOLE NO. 2  
FIELD SUPERVISOR K.P.

DESCRIPTION	ELEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE P.S.F.	BLOWS FT.
Ground surface.	87.8	0		
Closely packed medium to coarse gravel with well rounded stones and boulders up to 3 ft in diameter.	M.I. V 82.3	10		
		20		
		30		
		40		
End of borehole.	36.1	50		

Jacqueline Oliver Crossing  
T.C.R. #17, District 19

... 1941. As on 21st

centre of existing bridge assumed

BOREHOLE NO. 3  
FIELD SUPERVISOR K.P.  
CALLER E.J.  
L.S.

1.5" DIA. SPLIT TUBE  
 2" SHELBY TUBE  
 1" SPLIT TUBE  
 1" DIA. CONE  
 CASING  
 2" SHELBY  
 1-2 UNCONFINED COM-  
 PANE TEST (C) AND  
 NATURAL MOISTURE  
 LIQUIDITY INDEX  
 LIQUIDITY LIMIT  
 PLASTIC LIMIT

STRENGTH AND PENETRATION  
RESISTANCE

[illegible]

THE UNIVERSITY OF CHICAGO

Existing ground surface.

88-0

W.L.V. 82.3

Closely packed medium to coarse gravel with well rounded stones and boulders up to 3 ft in diameter.

42.0

Dense medium sand with  
fine to coarse gravel.  
Occasional boulder.

23.0

end of hole.

DRAWING NO.

4

MOIST	CONTENT, % DRY WT.	CONSISTENCY	SAMPLE UNIT WT.	NATURAL	P.C.F.
1	10.0	1	100	1	1
2	10.0	2	100	2	2
3	10.0	3	100	3	3
4	10.0	4	100	4	4
5	10.0	5	100	5	5
6	10.0	6	100	6	6
7	10.0	7	100	7	7
8	10.0	8	100	8	8
9	10.0	9	100	9	9
10	10.0	10	100	10	10
11	10.0	11	100	11	11
12	10.0	12	100	12	12
13	10.0	13	100	13	13
14	10.0	14	100	14	14
15	10.0	15	100	15	15
16	10.0	16	100	16	16
17	10.0	17	100	17	17
18	10.0	18	100	18	18
19	10.0	19	100	19	19
20	10.0	20	100	20	20
21	10.0	21	100	21	21
22	10.0	22	100	22	22
23	10.0	23	100	23	23
24	10.0	24	100	24	24
25	10.0	25	100	25	25
26	10.0	26	100	26	26
27	10.0	27	100	27	27
28	10.0	28	100	28	28
29	10.0	29	100	29	29
30	10.0	30	100	30	30
31	10.0	31	100	31	31
32	10.0	32	100	32	32
33	10.0	33	100	33	33
34	10.0	34	100	34	34
35	10.0	35	100	35	35
36	10.0	36	100	36	36
37	10.0	37	100	37	37
38	10.0	38	100	38	38
39	10.0	39	100	39	39
40	10.0	40	100	40	40
41	10.0	41	100	41	41
42	10.0	42	100	42	42
43	10.0	43	100	43	43
44	10.0	44	100	44	44
45	10.0	45	100	45	45
46	10.0	46	100	46	46
47	10.0	47	100	47	47
48	10.0	48	100	48	48
49	10.0	49	100	49	49
50	10.0	50	100	50	50
51	10.0	51	100	51	51
52	10.0	52	100	52	52
53	10.0	53	100	53	53
54	10.0	54	100	54	54
55	10.0	55	100	55	55
56	10.0	56	100	56	56
57	10.0	57	100	57	57
58	10.0	58	100	58	58
59	10.0	59	100	59	59
60	10.0	60	100	60	60
61	10.0	61	100	61	61
62	10.0	62	100	62	62
63	10.0	63	100	63	63
64	10.0	64	100	64	64
65	10.0	65	100	65	65
66	10.0	66	100	66	66
67	10.0	67	100	67	67
68	10.0	68	100	68	68
69	10.0	69	100	69	69
70	10.0	70	100	70	70

PROJECT NO. J266

# TROW SODERMAN AND ASSOCIATES

SOIL INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT Jackpine River Crossing

LOCATION T.C.H. #17, District 19

DATE LOCATION As on plan

HOLE SEE ATTACHED MAP 96.8 Road surface at centre of existing bridge assumed 100.0

BOREHOLE NO. 4  
FIELD SUPERVISOR K.P.  
DRILLER H.J.  
PREP L.S.

DRAWING NO. 5

## LEGEND

2" DIA. SPLIT TUBE

2" SHELBY TUBE

2" SPLIT TUBE

2" DIA. CONE

CASING

2" SHELBY

1/2 UNCONFINED COMPRESSION (QU)

VANE TEST (C) AND SENSITIVITY (S)

NATURAL MOISTURE AND

LIQUIDITY INDEX

LIQUID LIMIT

PLASTIC LIMIT

CONSISTENCY  
MOIST. CONTENT % DRY WT.  
NATURAL  
SAMPLE UNIT WT.  
P C F.

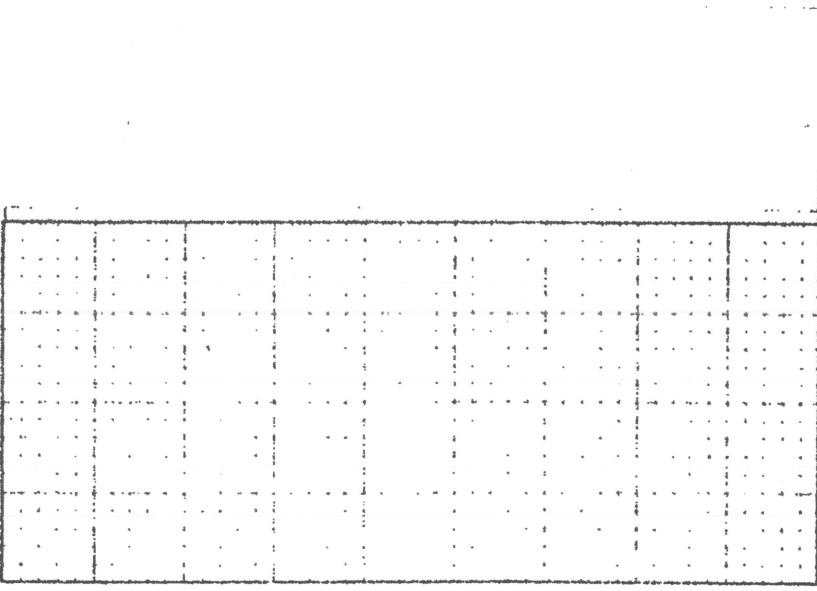
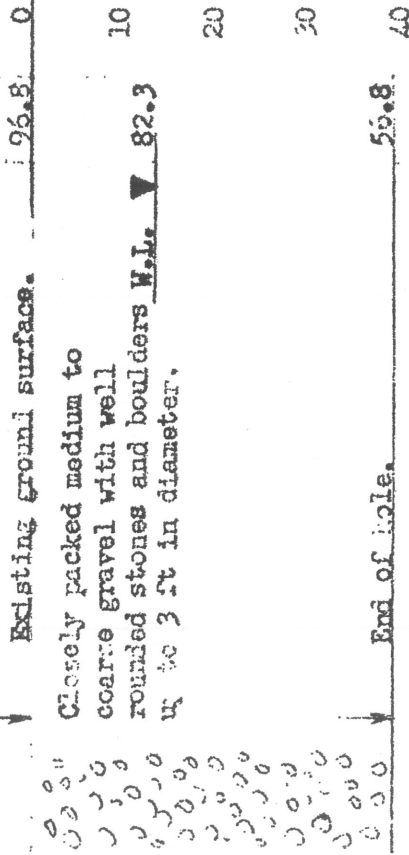
STRENGTH AND PENETRATION  
RESISTANCE  
P.S.F.

BLOWS/FT.

Existing ground surface.

Closely packed medium to coarse gravel with well rounded stones and boulders 1/2" to 3" in diameter.

End of hole.



**Appendix D**  
**Site Photographs**



**Photograph 1** – Highway 17 and Jackpine River Bridge crossing



**Photograph 2** – North side of the bridge



**Photograph 3 – View of north elevation**



**Photograph 4** – View of south elevation



**Photograph 5** – South side of the bridge



**Photograph 6**– Northwest view of the embankment



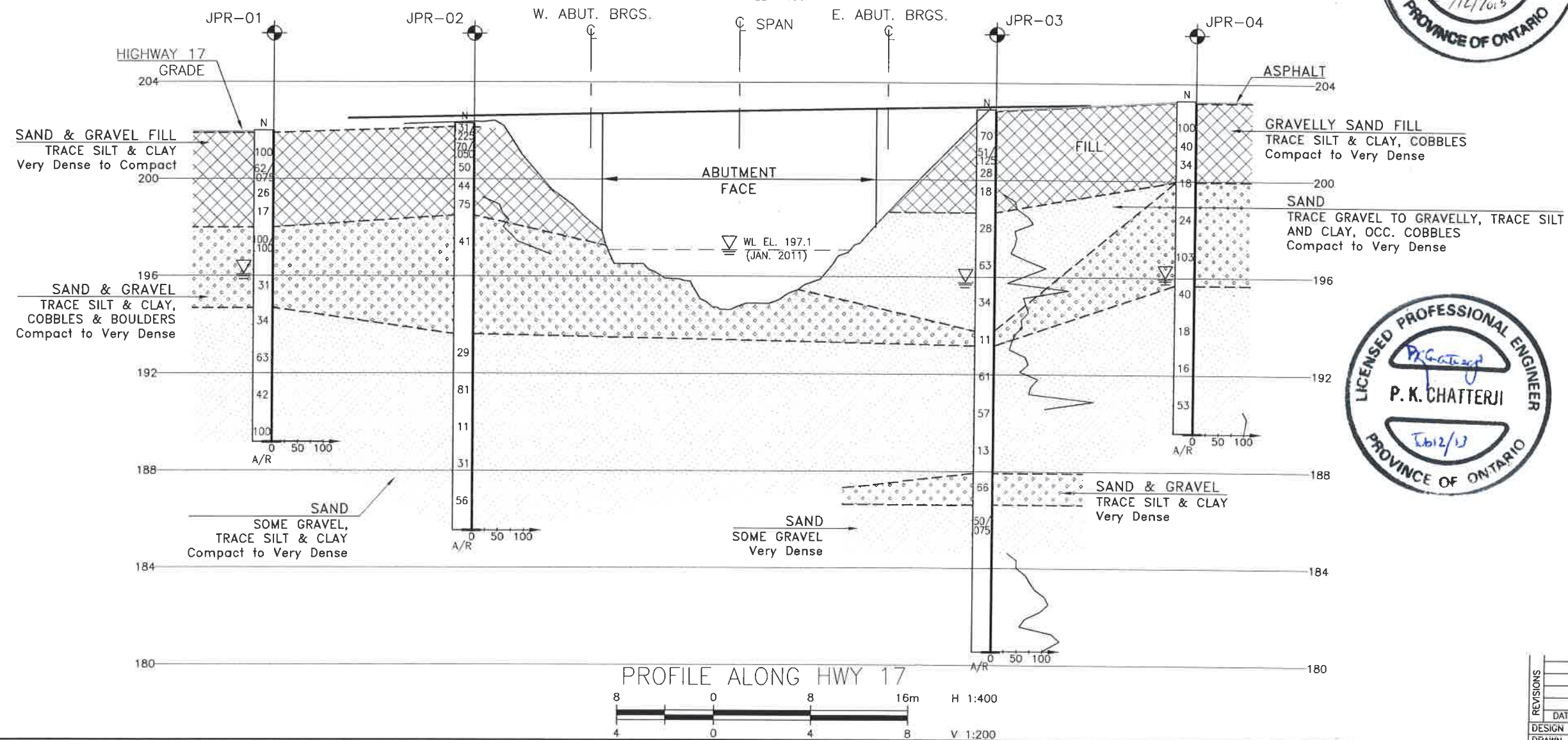
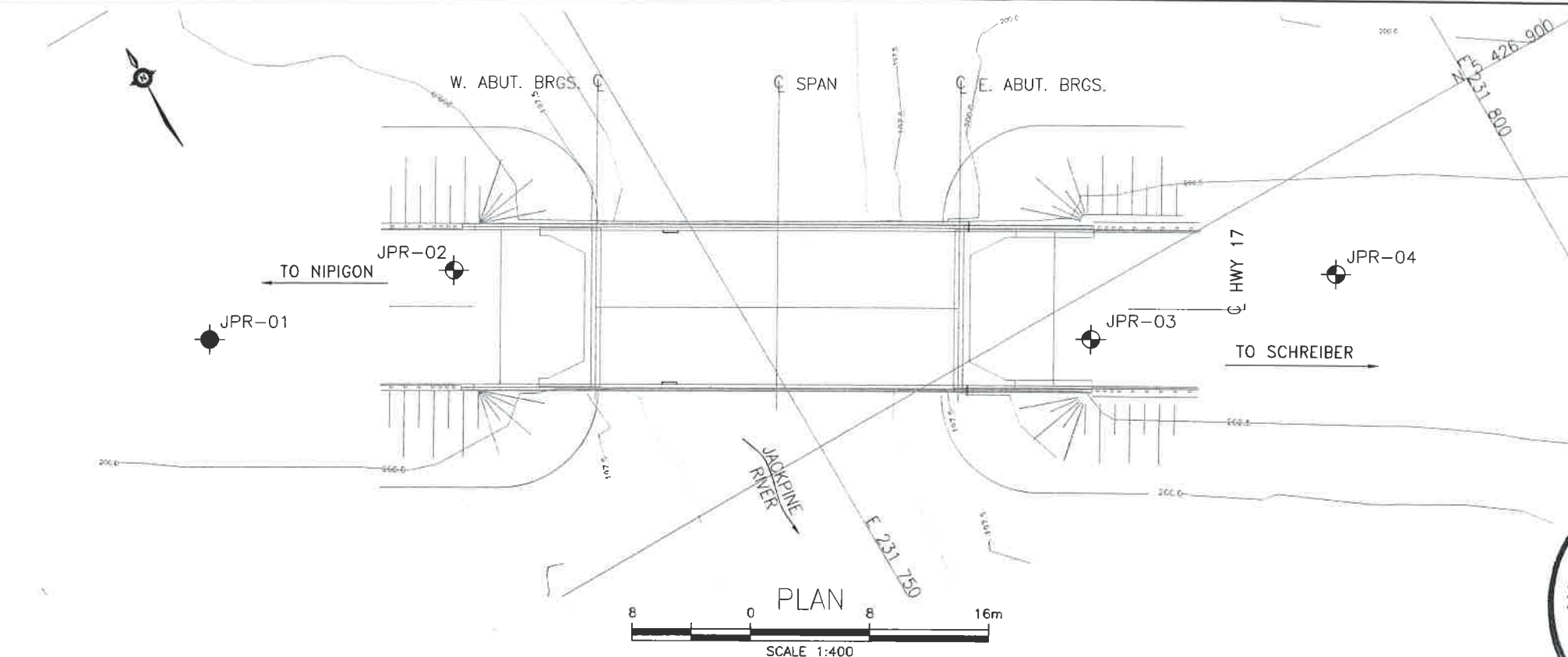
**Photograph 7–** Southeast view of the embankment



**Photograph 8—** Southwest view of the embankment

**Appendix E**

**Drawing titled "Borehole Locations and Soil Strata"**



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

CONT No  
WP No 6070-09-01

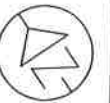
HIGHWAY 17  
JACKPINE RIVER BRIDGE  
BOREHOLE LOCATIONS AND SOIL STRATA



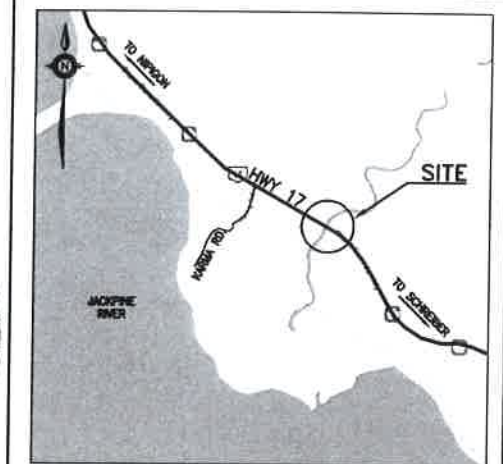
McCORMICK RANKIN  
A member of MMM GROUP



THURBER ENGINEERING LTD.



SHEET  
17



### 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
W	Water Level
HA	Head Artesian Water
P	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
JPR-01	202.0	5 426 927.1	231 718.2
JPR-02	202.3	5 426 922.8	231 734.8
JPR-03	203.0	5 426 897.2	231 769.3
JPR-04	203.3	5 426 892.8	231 785.8

### 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. 42D-29**

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	RPR	CHK	RPR
DRAWN	AN	CHK	SITE
			STRUCT
			DWG 2
			DATE JAN. 2013