



**THURBER** ENGINEERING LTD.

**FOUNDATION INVESTIGATION REPORT  
WHITEFISH RIVER BRIDGE REHABILITATION  
HIGHWAY 588, LYBSTER TOWNSHIP  
DISTRICT OF THUNDER BAY, ONTARIO**

**G.W.P. 479-00-00, Site No. 48W-76**

**Geocres Number: 52A-171**

**Report to**

**McCormick Rankin**

**A member of MMM Group**

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## TABLE OF CONTENTS

### PART 1      FACTUAL INFORMATION

1	INTRODUCTION.....	1
2	SITE DESCRIPTION.....	2
3	SITE INVESTIGATION AND FIELD TESTING .....	2
4	LABORATORY TESTING .....	3
5	DESCRIPTION OF SUBSURFACE CONDITIONS .....	3
5.1	Asphalt and Concrete.....	4
5.2	Sand and Gravel Fill .....	4
5.3	Silty Sand.....	5
5.4	Clayey Silt .....	5
5.5	Silt to Sandy Silt .....	6
5.6	Silty Sand and Gravel .....	6
5.7	Bedrock.....	6
5.8	Groundwater Levels.....	7
5.9	Previous Investigation (Reference 1).....	8
6	MISCELLANEOUS.....	9

### Appendices

Appendix A	Record of Borehole Sheets
Appendix B	Laboratory Test Results
Appendix C	Record of Borehole Sheets, Soil Profile and Laboratory Test Results from previous investigation
Appendix D	Site Photographs
Appendix E	Drawing titled “Borehole Locations and Soil Strata”

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**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 588 over Whitefish River located approximately 45 km southwest of Thunder Bay, between Nolalu and Silver Mountain in Lybster Township, in the District of Thunder Bay, Ontario.

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

Thurber carried out the investigation as a sub-consultant to McCormick Rankin, 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 report. The title of the previous report is listed as follows:

- Soils Investigation, Whitefish River Bridge, W.P. 490-64-02, Thunder Bay District, Thunder Bay, Ontario. Prepared by Morton, Dodds & Partners, April 1975. Geocres No. 52A-63 (Reference 1).

## **2 SITE DESCRIPTION**

The Whitefish River bridge is located on Highway 588 approximately 45 km southwest of Thunder Bay, between Nolalu and Silver Mountain in Lybster Township, in the District of Thunder Bay, Ontario. The bridge is approximately 55 m south of Pakka Rd. and 115 m north of Rintala Loop.

At present, the highway crosses Whitefish River on a single-span structure supported on concrete abutments. The bridge span is 18.3 m and the width is 10.7 m. The existing approach embankments are approximately 4 m in height. Rock fill, cobbles and boulders are present at the abutments. Photographs of the site are provided in Appendix D.

The Whitefish River flows easterly and meanders at the highway crossing. At the site, the width of the River varies from 7.6 m to 15.2 m. The lands immediately surrounding the bridge site are forested. The ground surface throughout this area has a rolling topography.

The site lies at the boundary between the Animikie Basin and the Wawa Subprovince of the Superior Province of the Canadian Shield. The local area is underlain by metasedimentary rocks of the Gunflint Formation and Archean granitic rock. The native soils overlying bedrock generally consist of clayey till ground moraine.

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

The site investigation and field testing for this project were carried out during the period of October 3 to 6, 2011 and consisted of drilling and sampling four boreholes (numbered WFR-01 to WFR-04) through the highway embankment at the abutments and approaches. Boreholes WFR-02 and WFR-03 were drilled near the abutments and terminated at 10.6 m and 12.1 m depth (Elev. 326.2 and 325.1), respectively. Boreholes WFR-01 and WFR-04 were drilled through the approach embankments and terminated at 6.3 m and 7.4 m depth (Elev. 330.8 and 329.4), respectively.

Bedrock was proved in Boreholes WFR-02 and WFR-03 by NQ size diamond coring advanced 2.9 m and 3.6 m into bedrock. Boreholes WFR-01 and WFR-04 were terminated upon auger refusal on probable bedrock.

The approximate locations of the boreholes are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix E.

The borehole locations were marked in the field and utility clearances were obtained prior to drilling.

The drilling was carried out using a CME 75 truck-mounted drill rig. Wash boring methods with NW-casing were used to advance Boreholes WFR-02 and WFR-03. Hollow stem augers were used to advance Boreholes WFR-01 and WFR-04. Samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). NQ coring methods were used to recover core samples from the bedrock.

The drilling and sampling operations were supervised on a full time basis by a member of Thurber's technical staff. The supervisor logged the boreholes and processed the recovered soil and rock samples for transport to Thurber's laboratory for further examination and testing.

All rock cores were logged, and the Total Core Recovery (TCR), Rock Quality Designation (RQD) and the Fracture Indices (FI) were determined.

Two standpipe piezometers consisting of 19 mm PVC pipe with slotted screen and enclosed in filter sand were installed at this site to permit longer term groundwater level monitoring. The piezometers were subsequently decommissioned in general accordance with MOE Regulation 903. Boreholes without piezometers were backfilled in general accordance with Regulation 903. The installation and completion details of the boreholes and piezometers are summarized in Table 3.1.

**Table 3.1 – Borehole and Piezometer Completion Details**

Location	Borehole	Piezometer Tip Depth/ Elevation (m)	Completion Details
East Abutment/ Approach	WFR-01	None installed	Borehole backfilled with bentonite and auger cuttings to 0.6 m, sand from 0.6 m to 0.1 m then asphalt to surface.
	WFR-02	10.6/326.2	Sand from 10.6 m to 5.5 m, bentonite from 5.5 m to surface.
West Abutment/ Approach	WFR-03	12.1/325.1	Sand from 12.1 m to 5.5 m, bentonite from 5.5 m to surface.
	WFR-04	None installed	Borehole backfilled with bentonite and auger cuttings to 0.6 m, sand from 0.6 m to 0.15 m then 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.

Point load tests were carried out on selected samples of intact bedrock to assist in evaluation of the compressive strength of the bedrock. Results of point load tests on the rock core samples are included on the Record of Borehole sheets in Appendix A.

#### **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 subsurface stratigraphy encountered at this site consists of an asphalt surface and concrete approach slab on embankment fill comprising sand and gravel, underlain by native clayey silt, then a layer of silt to silty sand and gravel overlying granite bedrock. Locally at the west abutment, silty sand was encountered in place of the clayey silt. More detailed descriptions of the individual strata are presented below.

### 5.1 Asphalt and Concrete

In Boreholes WFR-01 and WFR-04 drilled on the bridge approaches, a 75 mm to 150 mm thick layer of asphalt was encountered surficially. In Boreholes WFR-02 and WFR-03 drilled through the approach slab, a 75 mm to 125 mm thick layer of asphalt was encountered over 175 mm to 325 mm of concrete. Granular fill was encountered below the asphalt and concrete.

### 5.2 Sand and Gravel Fill

A layer of brown to dark brown sand and gravel fill containing some silt was contacted below the asphalt and concrete in all boreholes. A 300 mm thick layer of sandy silt was encountered within the fill in Borehole WFR-01, and the lower 800 mm of fill consisted of sand in Borehole WFR-04.

The thickness of the sand and gravel fill varied from 2.9 m to 4.3 m. The depth to the base of the granular fill ranged from 3.0 m to 4.7 m (Elev. 334.1 to 332.1).

SPT N-values recorded in the sand and gravel fill ranged from 18 to 88 blows per 0.3 m of penetration, indicating a compact to very dense relative density. Auger grinding was noted while advancing the borehole through the sand and gravel fill at 0.8 m depth in Borehole WFR-04.

The moisture content of samples of the sand and gravel fill generally ranged from 6% to 16%.

Grain size distribution curves for the sand and gravel fill are presented on the Record of Borehole sheets and on Figure B1 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	Sand and Gravel Fill Percentage (%)	Sand Fill Percentage (%)
Gravel	24 to 36	0
Sand	47 to 66	85
Silt and Clay	10 to 20	15

### 5.3 Silty Sand

Brown silty sand was encountered below the sand and gravel fill locally in Borehole WFR-03 drilled adjacent to the west abutment. The silty sand layer contains some gravel and clay.

The upper and lower boundaries of the silty sand were encountered at depths of 4.1 m and 7.3 m (Elev. 333.1 and 329.9), respectively. The thickness of the silty sand layer was 3.2 m.

SPT 'N' values recorded in the silty sand were 14 and 15 blows per 0.3 m of penetration, indicating a compact condition. Moisture contents were 16% and 18%.

### 5.4 Clayey Silt

Native brown to grey clayey silt containing trace to some sand and trace gravel was encountered below the embankment fill in Boreholes WFR-01, WFR-02 and WFR-04. Seams of sand and silty clay were observed within this unit in Borehole WFR-04.

The thickness of the clayey silt layer ranged from 2.3 to 2.8 m. The depth to the base of the clayey silt ranged from 5.8 m to 7.5 m (Elev. 331.3 to 329.3).

SPT N-values recorded in the clayey silt varied significantly with location. N-values of 27 and 29 blows per 0.3 m of penetration (very stiff consistency) were recorded in Borehole WFR-01, N-values of 14 and 0 blows for 0.3 m of penetration (stiff to very soft consistency) were obtained in Borehole WFR-02, and N-values of 5 and 7 blows for 0.3 m of penetration were measured in Borehole WFR-04 (firm consistency).

The moisture content of samples collected from the clayey silt layer typically varied between 20% and 26%. A moisture content of 44% was measured in Borehole WFR-04 near elevation 331.4.

Grain size distribution curves for selected clayey silt samples are presented in Appendix B, Figure B2. The results are also summarized on the Record of Borehole sheets included in Appendix A. The results of the laboratory tests are summarized as follows:

Soil Particles	Clayey Silt Percentage (%)
Gravel	0 to 4
Sand	6 to 32
Silt	34 to 77
Clay	16 to 34

### 5.5 Silt to Sandy Silt

A layer of brown silt to sandy silt with some gravel was encountered below the clayey silt in Boreholes WFR-01 and WFR-02 drilled at the east approach and abutment. The inferred thickness of the silt layer was 0.5 and 0.2 m in Boreholes WFR-01 and WFR-02, respectively.

Borehole WFR-01 was terminated at 6.3 m depth (Elev. 330.8) upon auger refusal on probable bedrock at the base of the silt layer. Bedrock was contacted below the sandy silt layer at 7.7 m depth (Elev. 329.1) in Borehole WFR-02.

Based on observation of auger grinding, the silt is considered to be very dense. Moisture contents of 8% and 14% were measured.

### 5.6 Silty Sand and Gravel

A layer of grey to brown, silty sand and gravel was encountered below the silty sand and clayey silt in Boreholes WFR-03 and WFR-04. The thickness of the sand and gravel layer was 1.2 to 1.3 m.

Bedrock was contacted below the sand and gravel layer at 8.5 m depth (Elev. 328.7) in Borehole WFR-03. Borehole WFR-04 was terminated at 7.4 m depth (Elev. 329.4) upon auger refusal on probable bedrock at the base of this layer.

SPT 'N' values of 32 and 102 blows for 0.3 m penetration were recorded in the sand and gravel, indicating a dense to very dense condition. In Borehole WFR-04, an N-value of 50 blows for 0.075 m was recorded at the base of this layer on probable bedrock.

Moisture contents of 16% and 22% were measured in the sand and gravel.

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 B3 of Appendix B. The results are summarized as follows:

Soil Particles	Sand and Gravel Percentage (%)
Gravel	16 to 39
Sand	33 to 50
Silt & Clay	28 to 34

### 5.7 Bedrock

The soils described above are underlain by bedrock consisting of grey and white to grey and pink granite. Bedrock was proved by coring in Boreholes WFR-02 and WFR-03. Boreholes WFR-01 and WFR-04 were terminated upon auger refusal on probable bedrock.



Table 5.1 summarizes the depths and elevations to the top of bedrock and auger refusal encountered in the boreholes.

**Table 5.1 - Depths and Elevations of Top of Bedrock or Auger Refusal**

Location	Borehole	Top of Bedrock or Auger Refusal	
		Depth (m)	Elevation (m)
East Approach	WFR-01	6.3	330.8
East Abutment	WFR-02	7.7*	329.1
West Abutment	WFR-03	8.5*	328.7
West Approach	WFR-04	7.4	329.4

\*Bedrock proved by coring.

Total Core Recovery (TCR) in the bedrock was 90% to 100%. The RQD values ranged from 50% to 100%, indicating a fair to excellent rock quality. The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, ranged from 0 to 3.

The unconfined compressive strength of the rock interpreted from point load tests conducted on the recovered cores ranged from 133 MPa to 197 MPa, indicating a very strong rock.

## 5.8 Groundwater Levels

Groundwater levels were monitored during drilling in Boreholes WFR-01 and WFR-04. The sidewalls of Borehole WFR-01 caved below 4.0 m depth upon withdrawal of the augers, and groundwater was not observed above this level.

Water was added into the drill casing during wash-boring in Boreholes WFR-02 and WFR-03, and therefore natural groundwater levels were not measured during drilling. Standpipe piezometers were installed in Boreholes WFR-02 and WFR-03 to monitor water levels after completion of drilling. The water levels measured in the piezometers, and upon completion of drilling in Borehole WFR-04, are summarized in Table 5.2.

**Table 5.2 – Water Level Measurements**

Foundation Unit	Borehole	Date	Water Level (m)		Comments
			Depth	Elevation	
East Abutment	WFR-02	Oct. 5, 2011	4.4	332.4	In piezometer
		Nov. 30, 2011	5.5	331.3	
West Abutment	WFR -03	Nov. 30, 2011	5.6	331.6	In piezometer
West Approach	WFR-04	Oct. 4, 2011	6.1	330.7	In open borehole

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

The groundwater levels will also be affected by the water level in Whitefish River. River water levels of Elev. 331.5 in March 2011 and Elev. 332.0 in November 2011 are shown on drawings provided by McCormick Rankin.

### **5.9 Previous Investigation (Reference 1)**

A foundation investigation was conducted at this site in 1975 (Reference 1) for construction of the existing bridge. The borehole logs, laboratory testing, borehole location plan and soil profile prepared for the previous investigation are reproduced in Appendix C. The approximate locations of the previous boreholes (Boreholes 1, 1A, 1B, 2, 5, 6, 7 and 8, and Dynamic Cone Penetration Tests (DCPTs) 3 and 4) are included on the drawing in Appendix E.

The previous boreholes were drilled prior to placement of the existing embankment fill and commenced at the original ground surface. In general, the previous investigation indicated that the native soils consist of cohesionless sand to sand and gravel deposits, and the cohesive clayey silt layer encountered in the current boreholes was not documented. In addition, cobbles and boulders were more prevalent in the native soils than identified during the current investigation.

The subsurface conditions documented during the 1975 investigation are summarized as follows:

- A 500 to 600 mm thick layer of topsoil was encountered surficially in five of the boreholes.
- The underlying native soils generally consisted of brown sand containing some gravel, trace silt and numerous cobbles and boulders. The thickness of the sand varied from 1.5 m to 4.9 m. The sand varied from loose to dense.
- Locally in one borehole at the east approach, a 2.3 m thick layer of compact to dense silt was encountered within the sand and gravel.
- River deposits consisting of sand and gravel with numerous boulders were encountered in two boreholes drilled adjacent to the river. The river deposits were 1.6 m to 1.9 m thick.
- Granite bedrock was contacted below the native sand to sand and gravel layers at the following depths:

**Table 5.3 – Depths of Top of Bedrock or Auger/DCPT Refusal (Previous Investigation)**

Location	Borehole/DCPT	Top of Bedrock or Refusal	
		Depth(m)	Elevation**
West Side of River	1	5.2*	327.5
	1A	2.6	330.3
	1B	2.0	330.9
	2	5.5*	327.4
	5	2.7	330.1
	7	1.6*	329.8
East Side of River	3	4.3	331.3
	4	3.9	331.7
	6	5.8*	329.8
	8	1.9*	329.3

\* Bedrock proved by coring.

\*\* As the elevations (imperial) indicated on the previous borehole logs are not consistent with the current elevations, the bedrock elevations have been interpreted by adding a conversion factor of 30.5 m (100 ft) to the previously reported elevations (based on comparison of the existing road grades to the design grades shown on the original design drawings), and should be considered approximate.

- The observed groundwater level was generally at or within 0.8 m of the ground surface.

## 6 MISCELLANEOUS

Borehole locations were selected and established in the field by Thurber Engineering Ltd. MMM Group Limited surveyed the borehole locations and provided the co-ordinates and the ground surface elevations.

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

Eastern Ontario Diamond Drilling Ltd. from Hawkesbury, Ontario supplied a truck mounted CME 75 drill rig and conducted the drilling, sampling and in-situ testing operations.

The drilling and sampling operations were supervised in the field on a full time basis by Mr. Ryan Kromer, E.I.T. of Thurber Engineering Ltd.

Routine laboratory testing was carried out by Thurber Engineering Ltd.

Overall planning and supervision of the field program was conducted by Mr. Mark Farrant, P. Eng.

Interpretation of the data and preparation of the report was carried out by Ms. R. Palomeque Reyna, P.Eng. and Mr. Murray Anderson, P. Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

**Thurber Engineering Ltd.**

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## **Appendix A**

### **Record of Borehole Sheets**

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

### 1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

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

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

NOTE: Hierarchy of Soil Strength Prediction

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



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

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

### 5. LEGEND FOR RECORDS OF BOREHOLES

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

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


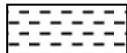



 Water Level  
 Shear Strength Determination by Pocket Penetrometer

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

# 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 <sub>L</sub> < 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 <sub>L</sub> < 30%).
		CI	Inorganic clays of medium plasticity, silty clays. (30% < W <sub>L</sub> < 50%).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS W <sub>L</sub> > 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	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

## EXPLANATION OF ROCK LOGGING TERMS

<u>ROCK WEATHERING CLASSIFICATION</u>		<u>SYMBOLS</u>			
<b>Fresh (FR)</b>	No visible signs of weathering.				
<b>Fresh Jointed (FJ)</b>	Weathering limited to the surface of major discontinuities.		CLAYSTONE		
<b>Slightly Weathered (SW)</b>	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE		
<b>Moderately Weathered (MW)</b>	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE		
<b>Highly Weathered (HW)</b>	Weathering extends throughout the rock mass and the rock is partly friable.		COAL		
<b>Completely Weathered (CW)</b>	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.		Bedrock (general)		
<u>DISCONTINUITY SPACING</u>		<u>STRENGTH CLASSIFICATION</u>			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength (MPa) (psi)	Field Estimation of Hardness*	
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.
<u>TERMS</u>		Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.				
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen				
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.				



# RECORD OF BOREHOLE No WFR-01

1 OF 1

METRIC

W.P. 479-00-00 LOCATION Whitefish River Bridge N 5 349 633.0 E 316 461.6 ORIGINATED BY RK  
 HWY 588 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2011.10.05 - 2011.10.05 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  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				GR	SA	SI	CL
								20	40	60	80	100	W <sub>P</sub>	W		W <sub>L</sub>			
337.1																			
0.0	<b>ASPHALT:</b> (75mm)  <b>SAND</b> and <b>GRAVEL</b> , some silt, trace clay Very Dense to Compact Brown Moist (FILL)  																		

ONTMT4S 1197.GPJ 2012TEMPLATE(MTO).GDT 8/30/13

# RECORD OF BOREHOLE No WFR-02

1 OF 2

METRIC

W.P. 479-00-00 LOCATION Whitefish River Bridge N 5 349 622.9 E 316 458.2 ORIGINATED BY RK  
 HWY 588 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2011.10.03 - 2011.10.03 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  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL      × LAB VANE				WATER CONTENT (%) w <sub>p</sub> w      w <sub>L</sub>				
336.8							20	40	60	80	100	20	40	60		
0.0	ASPHALT:(75mm)															
0.1	CONCRETE:(325mm)															
336.4																
0.4	SAND and GRAVEL, some silt Compact to Very Dense Dark Brown (FILL)		1	SS	18											
			2	SS	47											36 47 17 (SI+CL)
			3	SS	37											
			4	SS	53											
332.1																
4.7	Clayey SILT, some sand, trace gravel Stiff Brown		5	SS	14											
	Very Soft Brown to Grey		6	SS	0											4 19 61 16
329.3																
329.7	Sandy SILT, some gravel Very Dense Brown Auger grinding															
7.7	BEDROCK granite, grey and white to grey and pink, occasional sub-vertical and horizontal breaks		1	RUN												RUN #1 TCR=100% SCR=87% RQD=50% UCS=158MPa (Average)
			2	RUN												RUN #2 TCR=100% SCR=100% RQD=63% UCS=135MPa (Average)
			3	RUN												RUN #3 TCR=93% SCR=80%

Continued Next Page

+ 3, x 3: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No WFR-02

2 OF 2

METRIC

W.P. 479-00-00 LOCATION Whitefish River Bridge N 5 349 622.9 E 316 458.2 ORIGINATED BY RK  
 HWY 588 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2011.10.03 - 2011.10.03 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			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
326.2	Continued From Previous Page <b>BEDROCK</b> granite, grey, occasional sub-vertical and horizontal breaks															1 0	RQD=69% UCS=188MPa (Average)
10.6	END OF BOREHOLE AT 10.6m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen.  WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Oct. 05/11 4.4 332.4 Nov.30/11 5.5 331.3																

# RECORD OF BOREHOLE No WFR-03

1 OF 2

METRIC

W.P. 479-00-00 LOCATION Whitefish River Bridge N 5 349 607.2 E 316 436.7 ORIGINATED BY RK  
 HWY 588 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2011.10.05 - 2011.10.06 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  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)						
								20	40	60	80	100		W <sub>P</sub>	W	W <sub>L</sub>		
								○ UNCONFINED      + FIELD VANE										
								● QUICK TRIAXIAL      × LAB VANE										
337.2								20	40	60	80	100		20	40	60		
0.0	ASPHALT:(125mm)																	
336.9	CONCRETE:(175mm)																	
0.3	SAND and GRAVEL, some silt Dense to Very Dense Brown Wet (FILL)		1	SS	73		337							○				
			2	SS	48		336							○				
			3	SS	81		335							○				
			4	SS	50		334							○			24 66 10 (SI+CL)	
333.1	Silty SAND, some gravel, some clay Compact Brown Wet		5	SS	14		333							○				
			6	SS	15		332											
329.9	Silty SAND and GRAVEL, trace clay Very Dense Brown Grey		7	SS	102		330							○			16 50 24 10	
328.7	BEDROCK granite, grey and white to grey and pink, occasional vertical breaks		1	RUN			329										RUN #1 TCR=100% SCR=100% RQD=100% UCS=133MPa (Average)	
8.5			2	RUN			328										RUN #2 TCR=90% SCR=79% RQD=79% UCS=146MPa (Average)	

Continued Next Page

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

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No WFR-03

2 OF 2

METRIC

W.P. 479-00-00 LOCATION Whitefish River Bridge N 5 349 607.2 E 316 436.7 ORIGINATED BY RK  
 HWY 588 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN  
 DATUM Geodetic DATE 2011.10.05 - 2011.10.06 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 (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20	40	60	GR	SA	SI	CL
SHEAR STRENGTH kPa																		WATER CONTENT (%)						
	Continued From Previous Page		3	RUN																				
	BEDROCK granite, grey and white to grey and pink, mechanical and vertical breaks		4	RUN																				
325.1																								
12.1	END OF BOREHOLE AT 12.1m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen.  WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Nov.30/11 5.6 331.6																							

# RECORD OF BOREHOLE No WFR-04

1 OF 1

METRIC

W.P. 479-00-00 LOCATION Whitefish River Bridge N 5 349 596.1 E 316 435.0 ORIGINATED BY RK  
 HWY 588 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2011.10.04 - 2011.10.04 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			SHEAR STRENGTH kPa						
								20 40 60 80 100						
336.8														
0.0	ASPHALT:(150mm)													
0.2	SAND and GRAVEL, some silt Very Dense Dark Brown Moist (FILL) Auger grinding at 0.8m		1	SS	88									
			2	SS	36									
			3	SS	43									
	Layer of sand Compact		4	SS	23									
333.0														
3.8	Clayey SILT, some sand, occasional seams of sand and silty clay Firm Dark Grey  No recovery		5	SS	5									
			6	SS	7									
330.7														
6.1	Silty SAND and GRAVEL Dense Grey Wet Auger grinding at 6.7m		7	SS	32									
329.4			8	SS	50/									
7.4	END OF BOREHOLE AT 7.4m UPON AUGER REFUSAL ON PROBABLE BEDROCK. WATER LEVEL AT 6.1m. BOREHOLE BACKFILLED WITH BENTONITE AND AUGER CUTTINGS TO 0.6m, SAND TO 0.15m THEN ASPHALT TO SURFACE.				0.075									

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

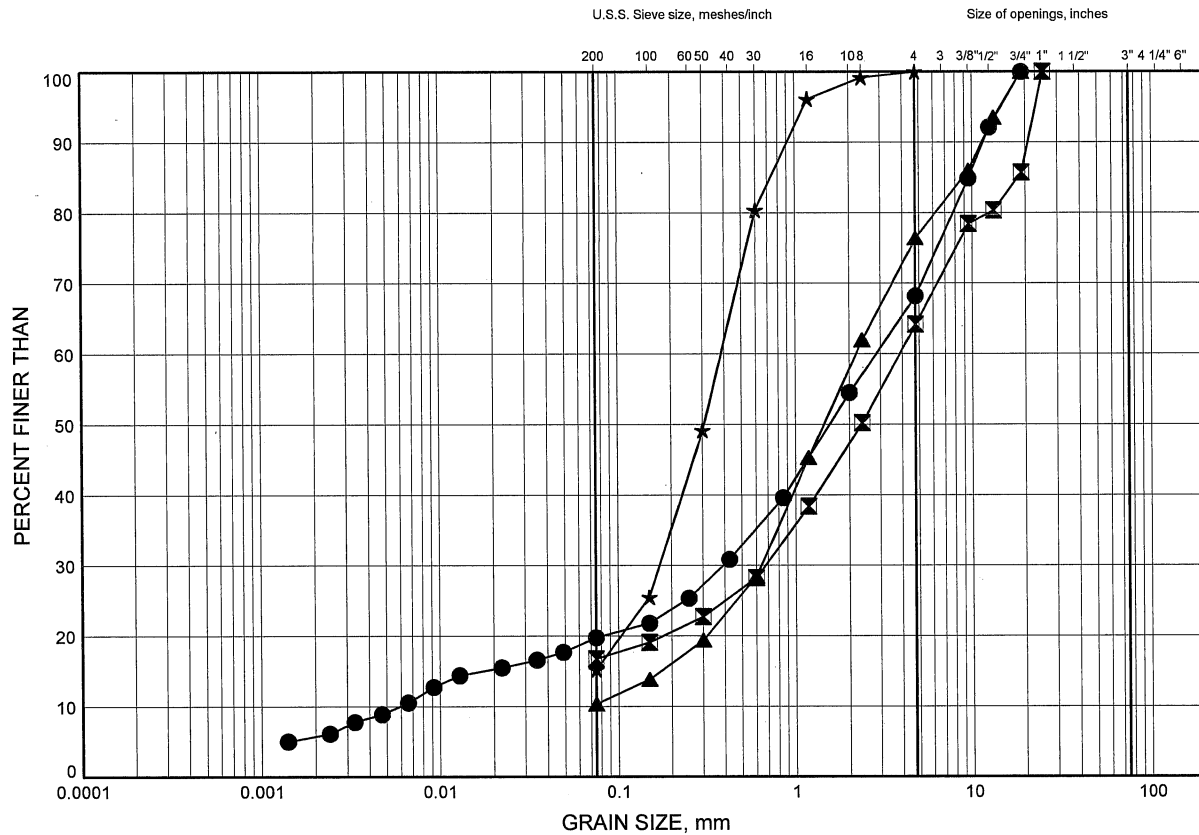
## **Appendix B**

### **Laboratory Test Results**

# Whitefish River Bridge GRAIN SIZE DISTRIBUTION

FIGURE B1

## SAND FILL and SAND & GRAVEL FILL



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	WFR-01	2.59	334.51
⊠	WFR-02	1.83	334.97
▲	WFR-03	3.35	333.84
★	WFR-04	3.35	333.44

Date June 2013  
W.P. 479-00-00



Prep'd AN  
Chkd. RPR



## FIGURE B2

PERCENT FINER THAN

GRAIN SIZE, mm

U.S.S. Sieve size, meshes/inch

Size of openings, inches

Grain Size (mm)	Sieve Size (U.S.S.)	Opening Size (inches)	Percent Finer Than (Circles)	Percent Finer Than (Triangles)	Percent Finer Than (Squares)
0.0015	-	-	13	30	-
0.0025	-	-	18	35	-
0.00375	-	-	26	38	23
0.005	-	-	34	41	27
0.0075	-	-	42	44	30
0.01	No. 20	0.0075	52	51	37
0.015	-	-	70	57	49
0.025	-	-	83	61	58
0.0375	-	-	91	63	67
0.05	No. 30	0.0375	94	64	72
0.075	No. 20	0.075	95	68	77
0.1	No. 150	0.1	96	77	82
0.15	-	-	97	85	88
0.25	-	-	98	95	95
0.375	-	-	99	98	98
0.5	No. 30	0.5	100	100	100

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

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	WFR-01	4.88	332.22
⊠	WFR-02	6.40	330.40
▲	WFR-04	5.49	331.31

GRAIN SIZE DISTRIBUTION - THURBER 1197.GPJ 6/11/13

Date June 2013  
W.P. 479-00-00

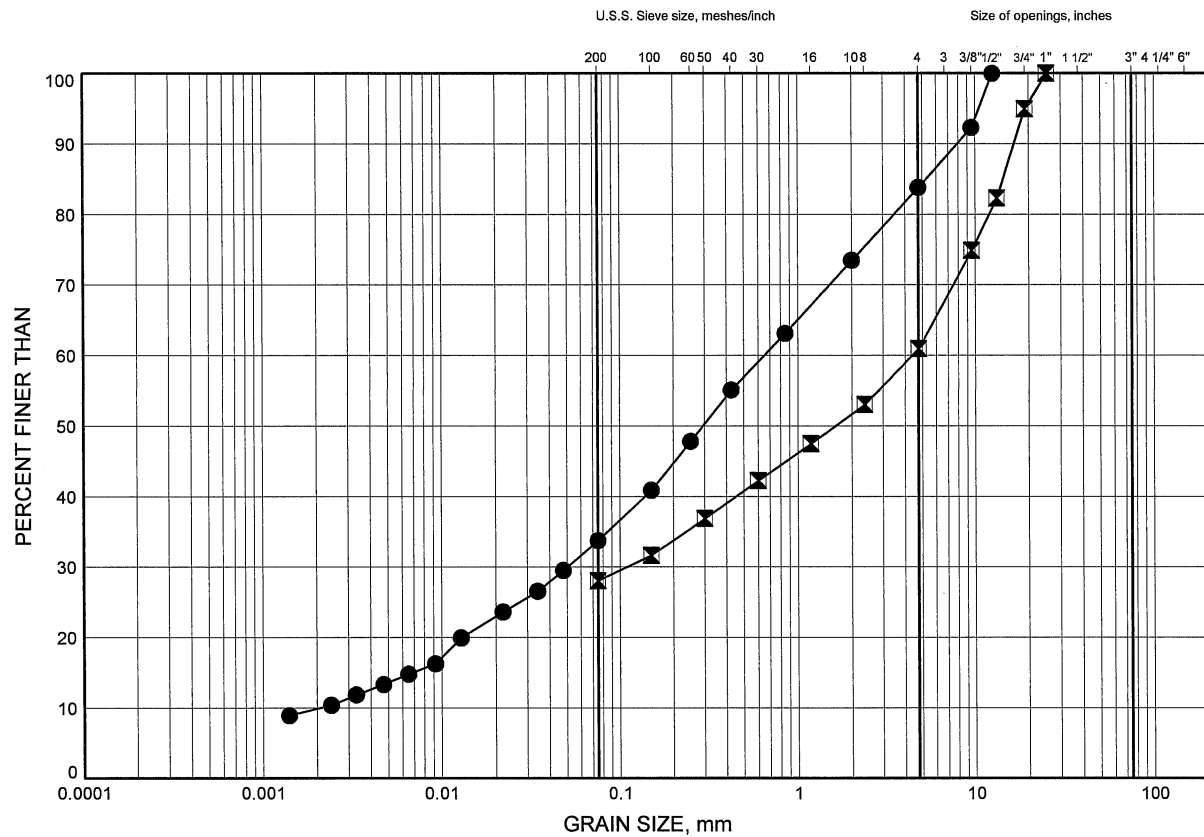


Prep'd ..... AN .....  
Chkd. .... RPR .....

# Whitefish River Bridge GRAIN SIZE DISTRIBUTION

FIGURE B3

## SILTY SAND & GRAVEL



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	WFR-03	7.62	329.58
⊠	WFR-04	6.40	330.40

## **Appendix C**

### **Record of Borehole Sheets, Soil Profile and Laboratory Test Results From Previous Investigation**

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION MDP 75022

## RECORD OF BOREHOLE NO 1

W.P. 490-64-02 LOCATION Whitefish River Bridge Sta. 270+91 11'Rt. ORIGINATED BY DP  
 DIST. 19 HWY. 588 BORING DATE April 20, 1975 COMPILED BY RBD  
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger, Drill Casing, AXT CORE CHECKED BY RBD

SOIL PROFILE			SAMPLES			GROUND WATER	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$ $w_p$ — $w$ — $w_L$ WATER CONTENT % 10 20 30	UNIT WEIGHT $\gamma$	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100			
991.6	Ground Level					ELEV.								
990.1	TOPSOIL					991.6								
1.5	SAND					990								
	Compact, brown well-graded, some gravel, numerous cobbles and boulders; trace of silt		1	SS	12									
			2	WS		980								
974.5														
17.1	GRANITE BEDROCK													
969.6	sound		3	RC		970								
22.0	BOREHOLE TERMINATED													
	Rock Core Log					960								
	17.1 to 20.5 Granite-subhedral equigranular crystals of quartz, feldspar and amphiboles. One prominent joint set at 45° to axis. Closed periodic filling of weathered calcite.													
	20.5 to 22.0 same as above. Pegmatite intrusions of 1 to 4 inches.													
	RQD = 80% REC = 95%													

# RECORD OF BOREHOLE NO 1A

W.P. 490-64-02 LOCATION Whitefish River Bridge Sta. 270+91 26' R.O. ORIGINATED BY PH  
DIST. 19 HWY. 588 BORING DATE April 20, 1975 COMPILED BY RBD  
DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY RBD

SOIL PROFILE			SAMPLES			GROUND WATER	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
992.1	Ground Level					ELEV.										GR. SA. SI. CL.
990.6	TOPSOIL					992.1										
1.5	SAND Compact, brown bouldery					990										
983.6																
8.5	BOREHOLE TERMINATED Refusal to auger					980										

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION MDP 75022

# RECORD OF BOREHOLE NO 1B

W.P. 490-64-02 LOCATION Whitefish River Bridge Sta. 270+97 25' Rt ORIGINATED BY PH  
 DIST. 19 HWY. 588 BORING DATE April 20, 1975 COMPILED BY RBD  
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY RBD

SOIL PROFILE			SAMPLES			GROUND WATER	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
992.1	Ground Level					ELEV.										GR. SA. SI. CL.
990.6	TOPSOIL					990										
1.5	SAND															
985.6	compact, brown, bouldery		1	SS	12											
6.5	BOREHOLE TERMINATED Refusal to Auger					980										

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION MDP 75022

## RECORD OF BOREHOLE NO. 2

W.P. 490-64-02 LOCATION Whitefish River Bridge Sta. 271+15 22' R<sub>t</sub> ORIGINATED BY DP  
 DIST. 19 HWY. 588 BORING DATE April 22, 1975 COMPILED BY RBD  
 DATUM Geodetic BOREHOLE TYPE Hollow stem auger, Cased, BX Rock Core CHECKED BY RBD

SOIL PROFILE			SAMPLES			GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			UNIT WEIGHT $\gamma$	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
992.3	Ground Level															
990.3	SANDY TOPSOIL		1	SS	3	993.5								0		
2.0	SAND loose to dense, some gravel, numerous boulders		2	SS	15	990								0		
974.3																
18.0	GRANITE BEDROCK		4	RC												
971.3	sound															
21.0	BOREHOLE TERMINATED Rock Core Log Granite-equigran- ular, subhedral to anhedral cry- stals. Joints at about 1 ft.- spacing at 45° to core axis. RQD = 90%					970										

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION MDP 75022

## RECORD OF BOREHOLE No 3

W.P. 490-64-02 LOCATION Whitefish River Bridge Sta. 272+07 22' Rt ORIGINATED BY IK  
 DIST. 19 HWY. 588 BORING DATE April 22, 1975 COMPILED BY RBD  
 DATUM Geodetic BOREHOLE TYPE Cone Penetration CHECKED BY RBD

SOIL PROFILE			SAMPLES			GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$ $w_p$ — $w$ — $w_L$ WATER CONTENT %	UNIT WEIGHT $\gamma$	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES					
1001.0	Ground Level									
987.0						1000				
14.0	CONE PENETRATION TERMINATED					990				
						980				



ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION MDP 75022

## RECORD OF BOREHOLE NO 4

W.P. 490-64-02 LOCATION Whitefish River Bridge Sta. 272+63 16' L ORIGINATED BY TK  
 DIST. 19 HWY. 588 BORING DATE April 22, 1975 COMPILED BY RBD  
 DATUM Geodetic BOREHOLE TYPE Cone Penetration CHECKED BY RBD

SOIL PROFILE			SAMPLES			GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$ $w_p$ — $w$ — $w_L$ WATER CONTENT %	UNIT WEIGHT $\gamma$	REMARKS % GR. SA. SI. CL.
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES					
1001.0	Ground Level									
988.3										
12.7	CONE PENETRATION TERMINATED									

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION MDP 75022

## RECORD OF BOREHOLE NO 5

W.P. 490-64-02 LOCATION White Fish River Bridge Sta. 270+45 12' ORIGINATED BY DP  
 DIST. 19 HWY. 588 BORING DATE April 24, 1975 COMPILED BY RBD  
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY RBD

SOIL PROFILE			SAMPLES			GROUND WATER	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $W_L$ PLASTIC LIMIT $W_P$ WATER CONTENT $W$ $W_P - W - W_L$ WATER CONTENT % 20 40 60	UNIT WEIGHT $\gamma$	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100			
992.0	Ground Level					ELEV.								
	SAND - SILTY loose to dense, some gravel and boulders, clay seams.		1	SS	2	992.0								0, 18, 52, 30
			2	SS	12	990								
983.0			3	SS	100									36, 46, 14, 0
9.0	End of Borehole					980								

## RECORD OF BOREHOLE NO 6

W.P. 490-64-02 LOCATION Whitefish River Bridge Sta. 272+04 6' Lt ORIGINATED BY DP  
 DIST. 19 HWY. 588 BORING DATE April 24, 1975 COMPILED BY RBD  
 DATUM Geodetic BOREHOLE TYPE Hollow stem auger, cased, Ax rock core. CHECKED BY RBD

SOIL PROFILE			SAMPLES			GROUND WATER	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			UNIT WEIGHT $\gamma$	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
1001.0	Ground Level					ELEV.										
999.0	SANDY TOPSOIL					1000										
2.0	SAND		1	SS	6	998.5										8,85,7,0
995.5	loose, brown		2	SS	17											
5.5	SILT		3	SS	10											
	compact to dense		4	SS	50	990										0,0,86,14
	grey, trace gravel															
988.0	and clay															
13.0	SAND & GRAVEL															
	with boulders															
982.0			5	WS												
19.0	SOUND BEDROCK		6	RC												
980.1	BOREHOLE					980										
20.9	TERMINATED															
	Rock Core Log															
	19.0 to 20.9															
	Taconite silica															
	matrix with gre-															
	enallite spherules,															
	calcite filled															
	joints parallel															
	to core axis															
	RQD = 80%															
	REC = 80%															

Project No. MDP 75022 Date JUNE 28/75  
 Project WP490-64-02, Whitefish River  
 Location District 19, Hwy. 588, Thunder Bay  
 Hole Location Sta. 271+24, 11' Lt  
 Drilled by Diamond Drill  
 Datum Geodetic

Split Spoon

Wash or Auger Sample

Silty Tube

Core Sample

Sampler Pushed (pressure)

Water Table (definite, apparent)



Shear Strength

Unconfined Compression

Field Vane Test &amp; Sensitivity (S)

Torvane on Sample

2" Dia. Cone

Water Content % dry weight



Symbol	Description Classification	Elevation metres (feet)	Depth metres (feet)	Shear Strength				Sample Type & Number	Unit weight Recovery %	
				Water Content, % dry weight						
				Penetration Resistance, N. 350 ft lbs blows / ft						
		987.4			20	40	60	80		
	SAND and GRAVEL Numerous boulders (River deposits)								1	
		982.1	(5.3)							
	GRANITE BEDROCK Some weathering								2	Rec. 78%
	1st run		(9.1)						3	Rec. 65%
	2nd run	976.8	(10.6)							
	BOREHOLE TERMINATED									
	ROCK CORE LOG									
	5.3 to 9.1 feet									
	GRANITE - medium to coarse grained, jointing at 30° to core axis. Some quartz pyrite fil- ling. Core badly bro- ken.									
	9.1 to 10.6 feet									
	GRANITE - with pegmatite Rock fabric hard and fresh. Slightly weat- hered fracture faces.									

Notes

Project No. MDP 75022 Date JUNE 27/75  
 Project WP490-64-02, Whitefish River  
 Location District 19, Hwy #588, Thunder Bay  
 Hole Location Sta. 271+67, Centreline  
 Drilled by Diamond Drill  
 Datum Geodetic

Split Spoon

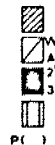
Wash or Auger Sample

Shallow Tube

Core Sample

Sampler Pushed (pressure)

Water Table (definite, apparent)



P ( )



Shear Strength

Unconfined Compression

Field Vane Test &amp; Sensitivity (S)

Torsion on Sample

2" Dia. Cone

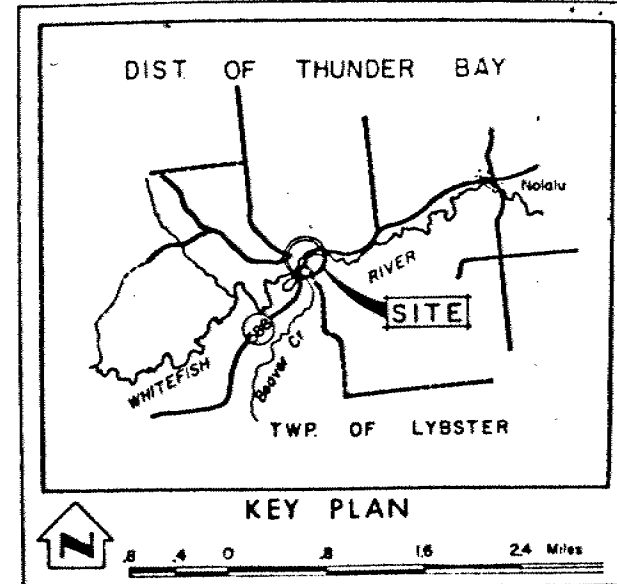
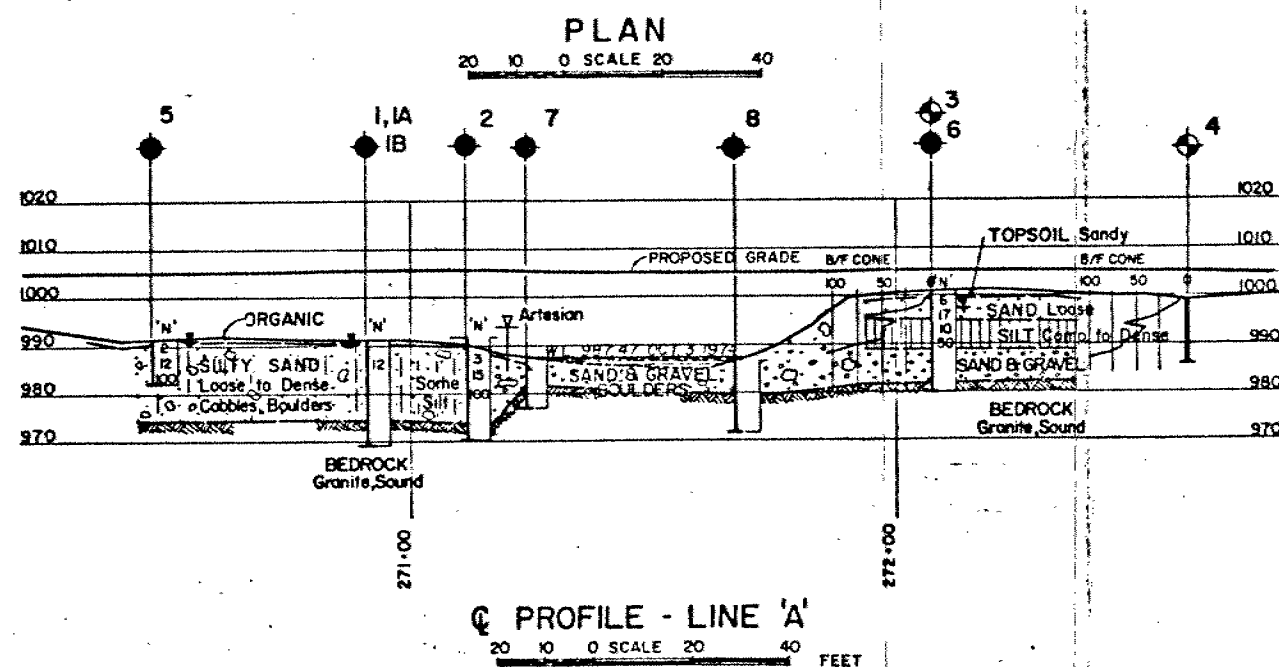
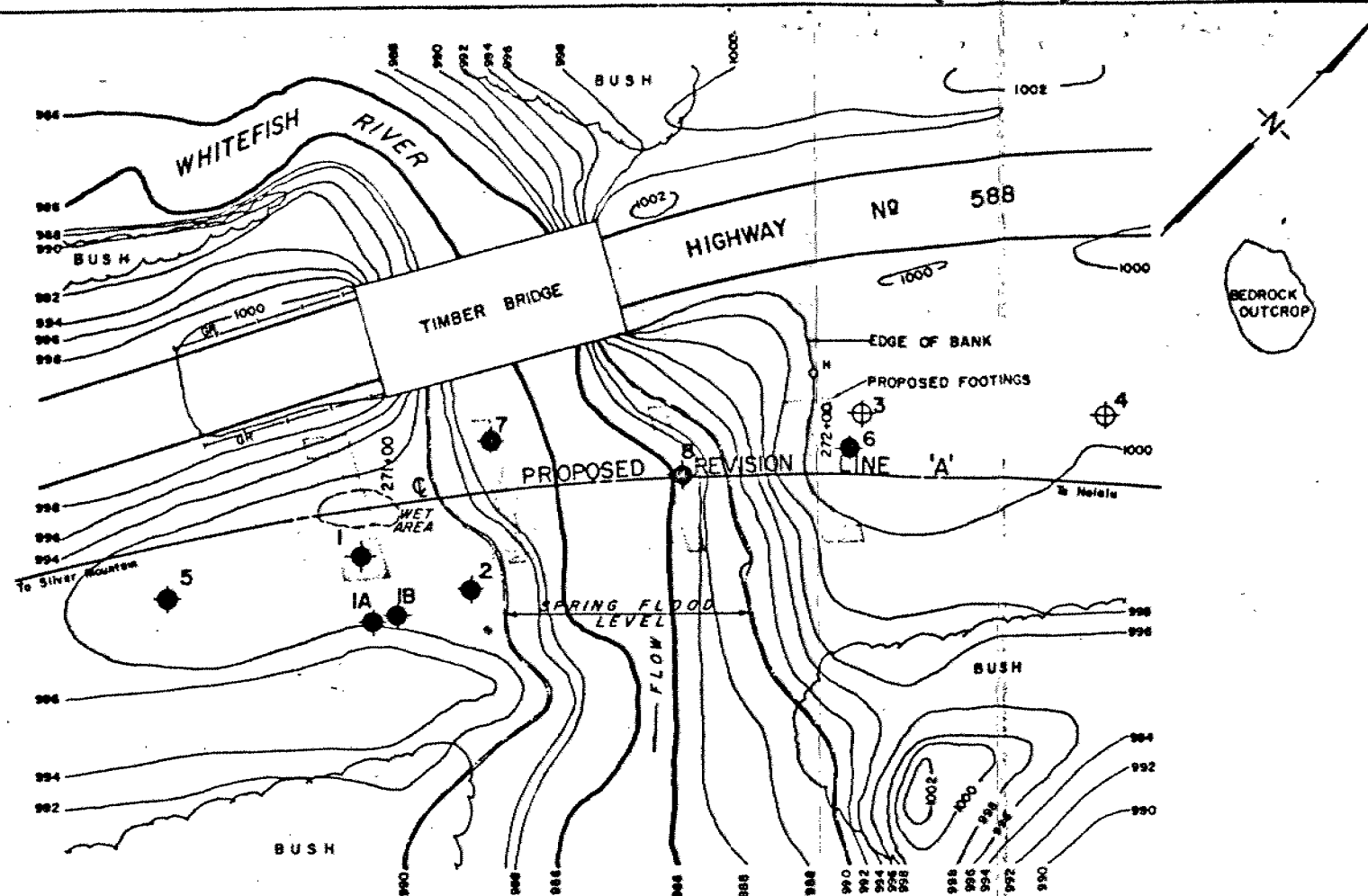
Water Content % dry weight



Symbol	Description Classification	Elevation metres (feet)	Depth metres (feet)	Shear Strength				Sample Type & Number	Unit weight Recovery %	
				Water Content, % dry weight						
				Penetration Resistance, N. 350 ft.lbs. blows / ft						
		986.6			20	40	60	80		
	SAND and GRAVEL Numerous boulders (River deposits)									1
	GRANITE BEDROCK Sound	980.5	(6.1)							2
										3
		972.5	(14.1)							
	BOREHOLE TERMINATED									
	<u>ROCK CORE LOG</u> 6.9 to 14.1 feet Granite - equigranular, medium grained. Jointed in one place at 10° to axis. Joints closed with very hard crystal- line filling  RQD = 75% Rec.= 80%									

Notes

Borehole



LEGEND			
◆	Bore Hole		
⊕	Dynamic Cone Penetration Resistance Test		
⊗	Bore Hole & Cone Test		
⬆	Water Levels established at time of field investigation, APRIL, 1975		
⬆	Head Encountered	ARTESIAN WATER	

NO.	ELEVATION	STATION	OFFSET
1	991.6	270+91	11' Rt
1A	992.1	270+91	26' Rt
1B	992.1	270+97	25' Rt
2	992.3	271+15	22' Rt
3	1001.0	272+07	14' Lt
4	1001.0	272+63	16' Lt
5	992.0	270+45	12' Rt
6	1001.0	272+04	6' Lt
7	987.4	271+24	11' Lt
8	986.6	271+67	0

**NOTE**  
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

**NOTE FOR CONTRACT DOCUMENT**  
The complete foundation investigation report for this structure may be examined at the Structural Office and Geotechnical Office, Downsview, and at the THUNDER BAY District Office.

REVISIONS	DATE	BY	DESCRIPTION
1	SEPT 75		BORE HOLES 7 & 8 ADDED

**MORTON DODDS & PARTNERS**

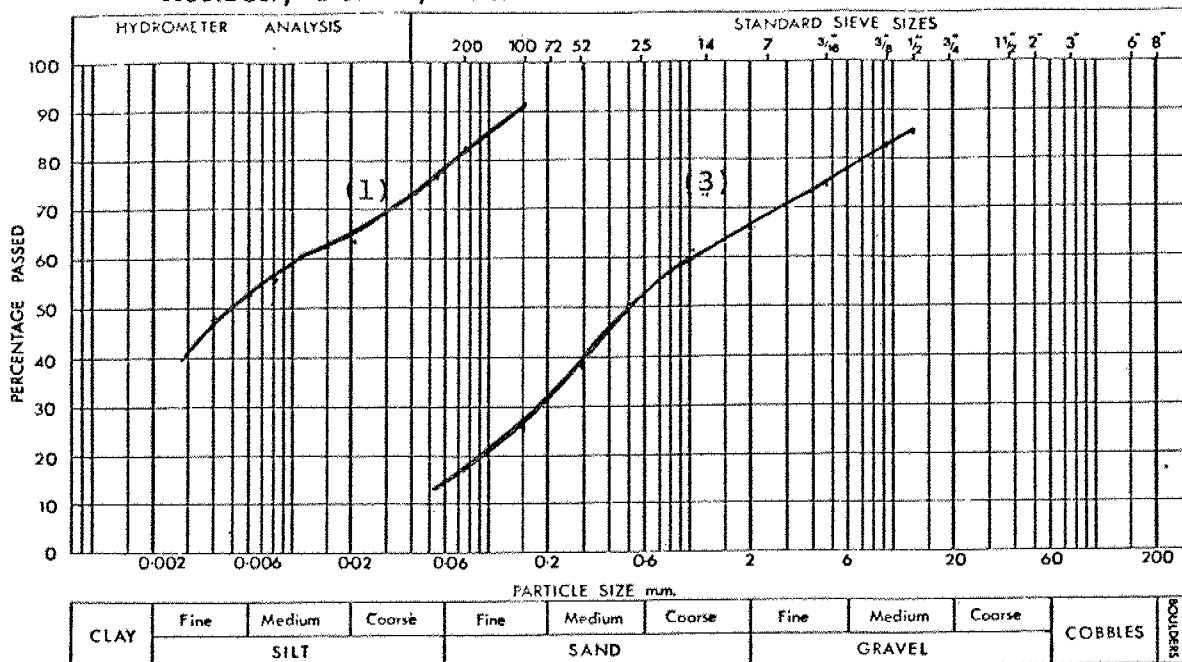
MINISTRY OF TRANSPORTATION AND COMMUNICATIONS—ONTARIO  
ENGINEERING SERVICES BRANCH—GEOTECHNICAL OFFICE—SOIL MECHANICS SECTION

**WHITEFISH RIVER**

HIGHWAY NO. 588 LINE 'A' REV. N DIST. NO. 19  
THUNDER BAY DISTRICT  
TWP. LYBSTER LOT 8 CON. 5

**BORE HOLE LOCATIONS & SOIL STRATA**

SUBNO	CHECKED	W.F. NO. 490-64-02	DRAWING NO.
DRAWN NO.	CHECKED RD.	W.O. NO.	4906402-A
DATE: April 28, 1975	SITE NO.		BRIDGE DRAWING NO.
APPROVED	CONT. NO.		

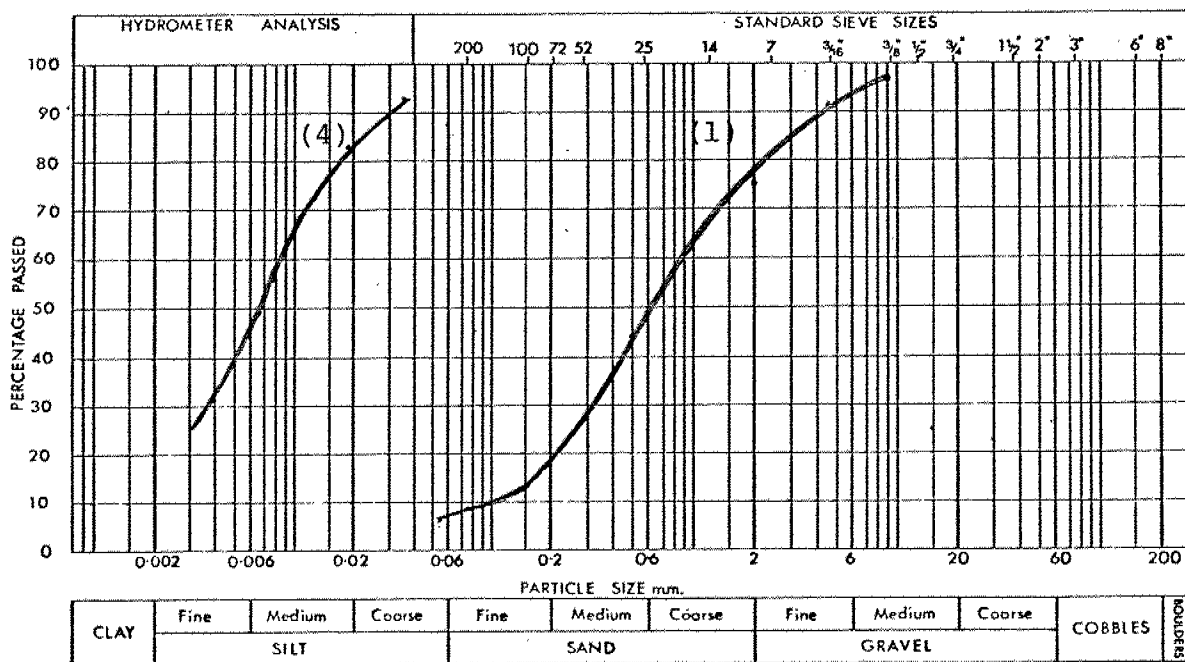


Boring No. 5 Sample No. 1, 3 Depth 2-1/2, 7-1/2 feet

Soil description \_\_\_\_\_ Sieving ☐ Wet

☒ Dry

Pretreatment loss \_\_\_\_\_ %



Boring No. 6 Sample No. 1, 4 Depth 2-1/2, 10 feet

Soil description \_\_\_\_\_ Sieving ☐ Wet

☒ Dry

Pretreatment loss \_\_\_\_\_ %

Drawing No. 9

PARTICLE SIZE  
DISTRIBUTION

## **Appendix D**

### **Site Photographs**





**Photograph 1** – Whitefish River Bridge, looking east



**Photograph 2** – Whitefish River Bridge, looking west



**Photograph 3** – North side of Whitefish River Bridge, west abutment

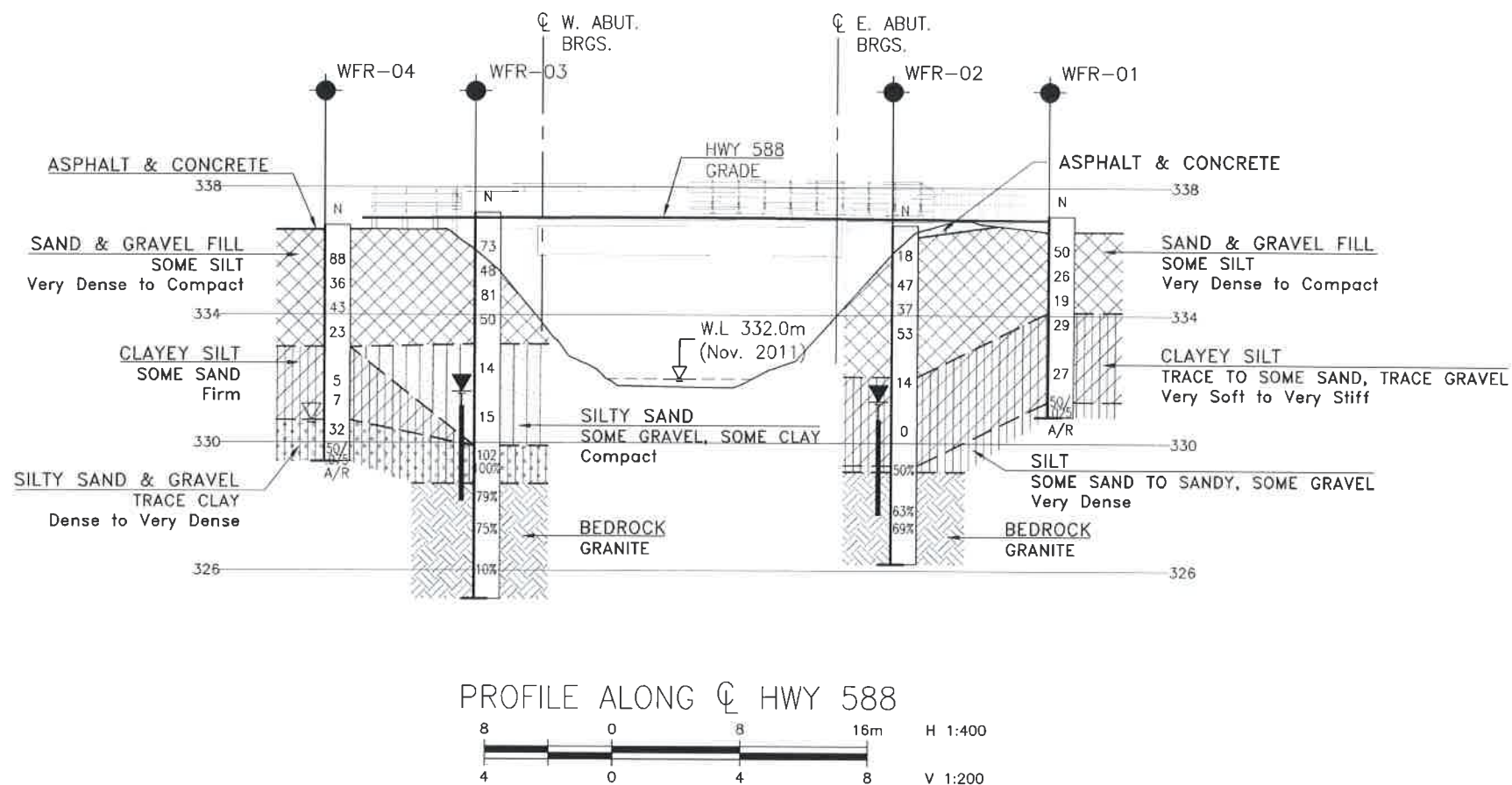
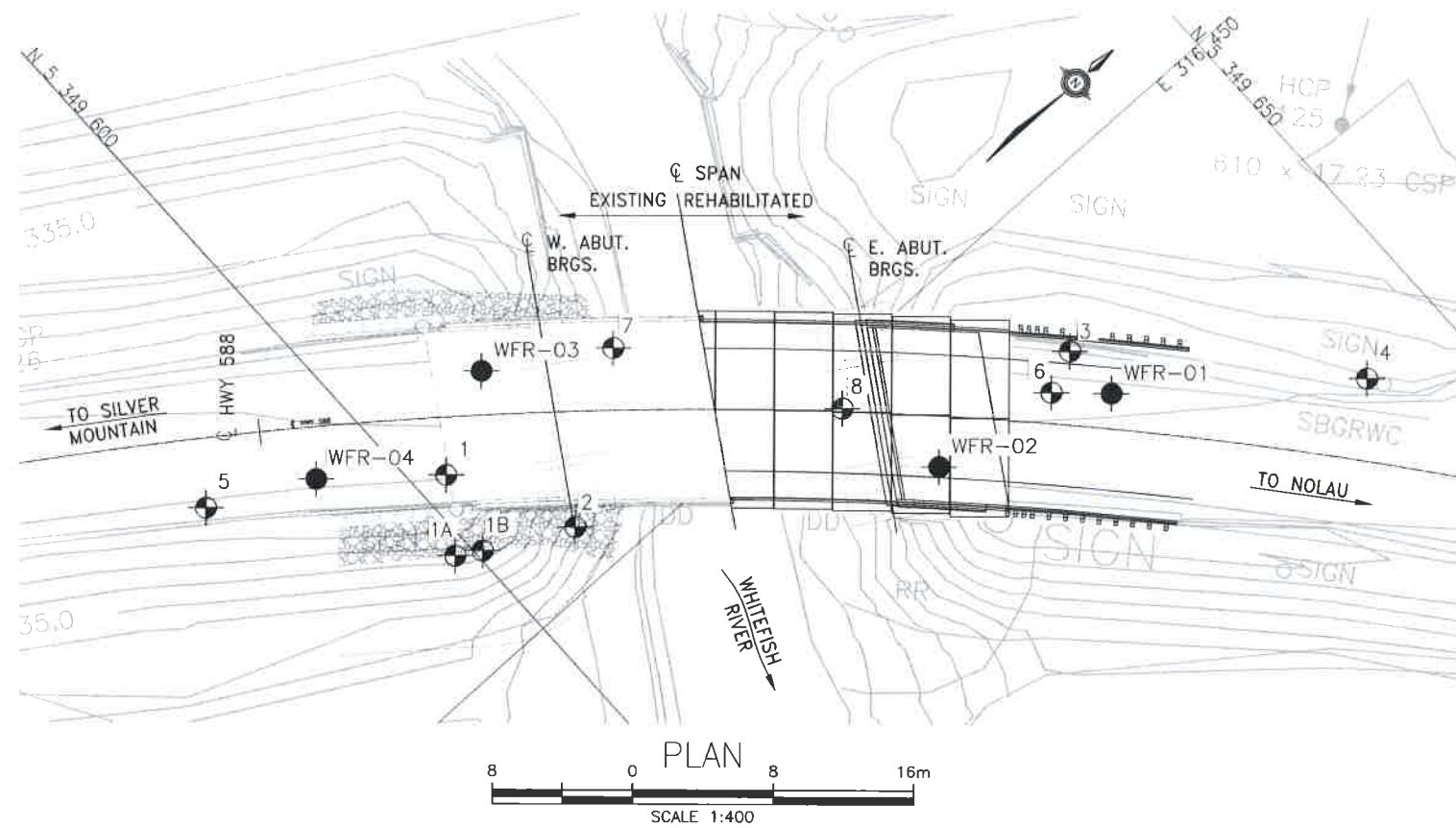


**Photograph 4** – North side of Whitefish River Bridge, east abutment

## **Appendix E**

**Drawing titled “Borehole Locations and Soil Strata”**

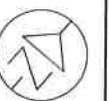




METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

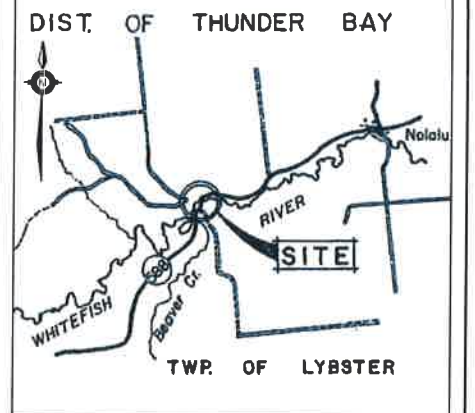


HWY 588  
CONT No  
WP No 479-00-01



HIGHWAY 588  
WHITEFISH RIVER BRIDGE  
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET  
S02



### LEGEND

- ◆ Borehole (Current Investigation)
- ◊ Borehole (Previous Investigation)
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- W Water Level During Drilling
- W Water Level in Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
WFR-01	337.1	5 349 633.0	316 461.6
WFR-02	336.8	5 349 622.9	316 458.2
WFR-03	337.2	5 349 607.2	316 436.7
WFR-04	336.8	5 349 596.1	316 435.0

### 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. 52A-171

DATE	BY	DESCRIPTION
DESIGN	RPR	CHK RPR
DRAWN	AN	CHK
SITE	48W-76	STRUCT
DWG	2	
DATE	OCT. 2013	