

**FOUNDATION INVESTIGATION REPORT
JACKFISH RIVER BRIDGE REPLACEMENT
HIGHWAY 17, CORRIGAL AND PATIENCE TOWNSHIPS
THUNDER BAY UNORGANIZED DISTRICT
G.W.P. 465-00-00, STRUCTURE NO. 48C-8**

Geocres Number: 52H-18

**Report to
McCormick Rankin Corporation**

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a geotechnical investigation conducted at the location of an existing bridge carrying Highway 17 over Jackfish River in Corrigan and Patience Townships, Ontario.

The original purpose of the investigation was to explore the subsurface conditions pertinent to the design of roadway protection at the existing bridge abutments and strengthening of foundation of the existing pier, in anticipation of superstructure replacement. As the design progressed, it became apparent that a full structure replacement would be a better option which necessitated additional borehole geotechnical information, at the abutments. Based on discussions with MTO, the development of the subsurface model has been based on the following foundation report previously prepared for the existing bridge:

- Foundation Investigation Jackfish River Crossing, T.C.H. No. 17 near Nipigon, Ontario, W.P. 936-58, prepared by Trow Soderman and Associates, dated October 20, 1958. (Reference 1).

On the basis of the data obtained during the current and previous investigations, this report provides a borehole location plan, borehole logs, stratigraphic profile and 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 (MRC) under the Ministry of Transportation Ontario (MTO) Agreement Number 6010-E-0011.

2 SITE DESCRIPTION

The site is located on Highway 17 approximately 14.2 km east of Nipigon, Ontario. The bridge is approximately 3.4 km east of the unnamed road leading to Fire Hall Lake, north of Highway 17, in Corrigan and Patience Townships, Thunder Bay Unorganized District, Ontario.

At the bridge location, Highway 17 is a two-lane paved roadway. The existing Jackfish River bridge is a two-span structure supported on two abutments and a central pier. The total length of the bridge is 52.3 m and the width is 11.0 m.

The section of Highway 17 at the bridge site has a north-south orientation, however a construction north has been assumed for this site, with Nipigon to the west and Rossport to the east. All direction indications in this report are relative to the construction north. At the bridge site, Jackfish River flows from north to south and the existing river channel is approximately 35 m wide. The lands immediately surrounding the bridge site consist of undeveloped forested areas.

Photographs included in Appendix E show the general nature of the bridge site.

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 consists primarily of fluvial deposits of silty sand to sand and gravel. Silt and clay deposits were also encountered at this site. Granite bedrock was encountered at depth during the previous investigation conducted at this site.

3 SITE INVESTIGATION AND FIELD TESTING

The present site investigation and field testing for this project were carried out between February 9 and 20, 2011. A total of six sampled boreholes (numbered JFR-01 to JFR-06) were drilled to depths ranging from 5.5 m to 17.4 m (elevations 170.9 to 179.3). Dynamic Cone Penetration Tests (DCPTs) were also performed from the bottom of each borehole, except in Borehole JFR-04 where the DCPT was conducted adjacent to the borehole from a depth of 3.1 m. The DCPTs extended to depths ranging from 7.9 m to 19.2 m (elevations 169.1 to 177.8).

Boreholes JFR-01 and JFR-05 were drilled at the west and east approaches, respectively, while Borehole JFR-02 was drilled near the west abutment and Borehole JFR-04 was drilled near the east abutment. Boreholes JFR-03 and JFR-06 were drilled through the tremie concrete forming the existing pier. Foundation core samples were obtained from the tremie concrete at the pier.

The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawing in Appendix F. The coordinates and elevations of the boreholes are listed on the drawings and are presented 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.

Eight boreholes (1 to 5, 7, 8, and 10) and 2 DCPTs (6 and 9) were previously drilled at this site during the investigation conducted in 1958 (Reference 1). The results of this previous investigation

have been incorporated into this report. The logs for these boreholes and DCPTs are included in Appendix D. Boreholes 1, 2, 5, and 7 were drilled near the west abutment, while Boreholes 3, 4, 8, and 10 were drilled near the east abutment. The two DCPTs (6 and 9) were conducted in the river near the west and east river banks, respectively.

The approximate locations of the boreholes drilled during the 1958 investigation are shown on the Borehole Locations and Soil Strata Drawing included in Appendix F. The locations of these boreholes are approximate since borehole coordinates were not included in the 1958 investigation report.

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

Hollow stem augers were used to advance Boreholes JFR-01, JRF-02, JFR-04, and JFR-05. Portable, light-weight coring equipment was used to advance Boreholes JFR-03 and JFR-06 through the concrete pier foundation and then a portable tripod set-up was used to advance the boreholes below the tremie concrete. Soil 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 a mixture of bentonite and auger cuttings in general accordance with O.Reg. 903 upon completion.

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) and Atterberg Limits testing, where appropriate. The results of this testing program are summarized on the Record of Borehole sheets included in Appendix A and on the figures contained in Appendix B.

The concrete cores obtained from the pier foundation were tested for compressive strength. The laboratory test results of the concrete cores as well as photos of the concrete cores are included in Appendix C.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets included in Appendix A for details of the encountered soil stratigraphy. A stratigraphic profile and sections are presented on the Borehole Locations and Soil Strata Drawings included in Appendix F. 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.

Based on the six boreholes drilled during the current investigation as well as the eight boreholes drilled previously during the 1958 investigation, the stratigraphy encountered at this site generally consists of asphalt over sand fill overlying layers of native clayey silt to silty clay at the west abutment and layers of native silt, sand, and sand and gravel at the east abutment. A deposit of silty clay was also encountered locally at the east approach below the silt layer. The native soil layers are underlain by an extensive deposit of silty sand to sand. Below the silty sand/sand, a thin layer of sand and gravel was contacted overlying granite bedrock. A layer of organics was encountered surficially in five boreholes in 1958. More detailed descriptions of the individual strata are presented below.

5.1 Organics

A layer of organics was encountered at surface in Boreholes 1 to 5 and 7 drilled during the 1958 investigation. The thickness of the organics ranged from 150 mm to 1.6 m.

5.2 Asphalt and Concrete

Asphalt was encountered at surface in four of the boreholes drilled at this site during the current investigation (JFR-01, JFR-02, JFR-04, and JFR-05). The thickness of the asphalt ranged from 75 mm to 125 mm.

Two boreholes from the current investigation (Boreholes JFR-03 and JFR-06) were drilled through the tremie concrete surrounding the existing pier. The concrete was 4.9 m thick in both boreholes.

The concrete cores from Borehole JFR-03 were tested for compressive strength in accordance with CSA Standard A23.14C, "Obtaining and Testing Drilled Cores for Compressive Strength Testing" in a dry condition. Report of the laboratory test is included in Appendix C. Photographs of the concrete cores are presented in Appendix C.

5.3 Sand Fill

Granular fill consisting of brown sand containing trace gravel to gravelly, some silt to silty and trace clay was encountered below the asphalt pavement in the four boreholes (JFR-01, JFR-02, JFR-04, and JFR-05) from the current investigation that were drilled through the highway embankment.

The thickness of the granular fill ranged from 2.9 m to 4.5 m, with the lower boundary of the granular fill encountered at depths of 3.0 m to 4.6 m (Elevation 186.1 to 183.7). The granular fill was typically thicker in the boreholes drilled on the east side of Jackfish River.

SPT 'N' values recorded in the sand fill ranged from 12 blows for 0.3 m penetration to 50 blows for 0.025 m penetration, indicating a compact to very dense relative density. The

high SPT 'N' values in the upper part of the fill might be related to the frozen condition of the fill at the time of drilling.

Moisture contents of the granular fill typically ranged from 2% to 16%.

Three samples of the sand fill underwent laboratory grain size analysis testing, the results of which are summarized below. The results of these tests are also presented on the Record of Borehole sheets included in Appendix A and the grain size distribution curves for these three samples are presented on Figure B1, Appendix B.

Gravel %	3 to 20
Sand %	73 to 75
Silt & Clay %	7
Silt %	18
Clay %	6

5.4 Silty Clay to Clayey Silt

Silty clay to clayey silt was encountered in Boreholes (JFR-01, JFR02, 1 and 2) drilled at the west abutment and west approach as well as in Borehole JFR-05 drilled at the east approach. The silty clay to clayey silt layer was encountered below a thin layer of organics in Boreholes 1 and 2 at 0.15 m depth, and below the sand fill in Boreholes JFR-01 and JFR-02 at 3.0 m and 3.1 m depth (elevations 186.1 and 185.9). In Borehole JFR-05, the silty clay was encountered at 8.7 m depth (elevation 179.6), below a layer of silt. The silty clay to clayey silt was brown to grey and contained trace sand and occasional silt seams and organics.

The thickness of the silty clay to clayey silt ranged from 4.4 m to 7.1 m, in Boreholes JFR-01, JFR-02, 1 and 2 with the lower boundary of the silty clay to clayey silt encountered at depths of 4.6 m to 10.2 m (Elevation 181.6 to 178.8). The silty clay layer in Borehole JFR-05, drilled at the east approach, was 8.4 m thick. The depth to the base of the clay in Borehole JFR-05 was 17.1 m (elevation 171.2).

SPT 'N' values recorded in the silty clay to clayey silt ranged from 0 to 22 blows for 0.3 m penetration, indicating a consistency varying from very soft to very stiff. In general, the silty clay to clayey silt had a soft to stiff consistency at the west abutment and approach (Boreholes 1, 2, JFR-01 and JFR-02) and a very soft consistency at the east approach (Borehole JFR-05).

Samples of the silty clay to clayey silt generally had moisture contents ranging from 20% to 30%. The samples from Borehole JFR-05 had higher moisture contents, ranging from 37% to 45%.

Four samples of the silty clay to clayey silt from the current investigation underwent laboratory grain size analysis testing. The results of these tests are presented on the Record

of Borehole sheets included in Appendix A and the grain size distribution curves for these samples are plotted on Figure B2 of Appendix B. The results are summarized as follows:

Gravel %	0
Sand %	2 to 4
Silt %	57 to 78
Clay %	18 to 41

Three of these samples also underwent Atterberg Limits testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix A and the results of these tests are plotted on Figure B6.

Liquid Limit %	27 to 44
Plastic Limit %	16 to 22

These results indicate that the silty clay to clayey silt has a low to medium plasticity with group symbols of CL and CI.

5.5 Sand and Silty Sand

Layers of brown to grey sand and silty sand were encountered in the boreholes at depths and elevations indicated in Table 5.1. The sand and silty sand layers contained trace to some gravel, trace clay and occasional gravelly zones. The sand is described as clean in places. A layer of sand with decayed wood was encountered directly below the sand fill in Boreholes JFR-04, below the tremie concrete surrounding the pier in Borehole JRF-03 and below the organics in Borehole 4. The layer of sand with decayed wood is also presented in Table 5.1.

Table 5.1 – Depths and Elevations of Native Sand and Silty Sand

Foundation Unit	Borehole	Depth below existing ground surface/riverbed (m)	Elevation (m)	Thickness (m)	Soil
West Abutment	1	4.6 to 27.1 (borehole termination depth)	181.6 to 159.1	22.5	Silty sand
	2	4.7 to 15.8 (borehole termination depth)	180.5 to 169.4	11.1	Silty sand
	5	1.3 to 22.3 ⁽²⁾	178.9 to 157.9	21.0	Silty sand and sand
	7	1.6 to 13.8 ⁽²⁾	180.6 to 168.4	12.2	Silty sand and sand
Pier	JFR-03	4.9 to 5.8	178.6 to 177.7	0.9	Silty sand ⁽¹⁾
	JFR-06	4.9 to 5.5 (borehole termination depth)	178.6 to 178.0	0.6	Silty sand
East Abutment	JFR-04	4.6 to 8.7	184.0 to 179.9	4.1	Sand ⁽¹⁾
	3	9.2 to 15.9 (borehole termination depth)	175.4 to 168.7	6.7	Silty sand
	4	1.5 to 3.7	183.5 to 181.4	2.1	Sand ⁽¹⁾
		9.4 to 25.6 (borehole termination depth)	175.6 to 159.4	16.2	Silty sand
	8	5.7 to 22.2 ⁽²⁾	176.5 to 160.1	16.5	Silty sand
	10	5.2 to 13.7 ⁽²⁾	176.8 to 168.3	8.5	Silty sand
East Approach	JFR-05	17.1 to 17.4 (borehole termination depth)	171.2 to 170.9	0.3	Sand

⁽¹⁾ With decayed wood fragments

⁽²⁾ Depth from the riverbed

SPT ‘N’ values recorded during the current investigation and the 1958 investigation ranged from 0 to 60 blows for 0.3 m penetration indicating a relative density varying from very loose to very dense. In general, SPT ‘N’ values ranged from 10 to 35 blows for 0.3 m penetration, indicating a compact to dense relative density.

Moisture contents of the silty sand to sand samples from the current investigation ranged from 15% to 22%.

One sample from the current investigation of the silty sand to sand layer underwent laboratory grain size analysis testing. The results of this test are presented on the corresponding Record of Borehole sheets included in Appendix A and the grain size distribution curve for this sample is plotted on Figures B4 of Appendix B. The results of this test are summarized as follows:

	Silty Sand
Gravel %	12
Sand %	59
Silt and Clay %	29

5.6 Silt to Sandy Silt

Native silt to sandy silt was encountered below the clayey silt to silty clay at 8.7 m and 10.2 m depth (elevations 180.4 and 178.8) in Boreholes JFR-01 and JFR-02 and below the sand fill at 4.6 m (elevation 183.7) in Borehole JFR-05. A layer of sandy silt was also encountered in Borehole JFR-03 at 5.8 m depth (elevation 177.7). The silt to sandy silt was greenish grey to brown and contains trace clay and occasional sand layers.

The silt to sandy silt layer was fully penetrated in Borehole JFR-05 only and was found to be 4.1 m thick with the lower boundary of this layer encountered at a depth of 8.7 m (Elevation 179.6). Boreholes JFR-01 to JFR-03 were advanced 1.1 m to 4.1 m into the silt layer and terminated at depths ranging from 7.6 m to 14.3 m (Elevations 179.3 to 174.7). A layer of silt, 1.2 m thick, was also encountered below the silty sand layer in Borehole 4 with a lower boundary at Elevation 180.1 m.

Boreholes JFR-01 to JFR-03, drilled on the west side of the Jackfish River, revealed that the silt and sandy silt layers are in a compact to dense state, based on SPT 'N' values ranging from 12 to 66 blows per 0.3 m of penetration. SPT 'N' values measured in Borehole JFR-05 were 1 and 3 blows per 0.3 m of penetration, indicating a very loose relative density.

Moisture contents of the silt to sandy silt ranged from 16 % to 38%. In general, higher moisture contents were measured in silt/sandy silt samples collected from the east side of the river.

Three samples of the silt to sandy silt from the current investigation underwent laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the corresponding Record of Borehole sheets included in Appendix A. The grain size distribution curves for these samples are plotted on Figure B3, Appendix B.

Gravel %	0
Sand %	8 to 27
Silt %	69 to 83
Clay %	4 to 9

5.7 Upper Sand and Gravel

A layer of sand and gravel was encountered in the boreholes drilled near the east river bank and east abutment (Boreholes 3, 4, 8, and 10 from the 1958 investigation and Borehole JFR-04 from the current investigation). The sand and gravel layer was encountered at the

surface of the river bed in Boreholes 8 and 10, below a thin layer of organics in Borehole 3 and below sand layer in Boreholes JFR-04 and 4.

The sand and gravel is grey to red and fine to coarse grained with occasional silty zones. Pieces of decayed wood were encountered in the sand and gravel in Borehole 8.

In Borehole 3, wood in the form of logs was encountered in the sand and gravel layer.

In Boreholes 3, 4, 8, and 10 the thickness of the sand and gravel layer ranged from 4.6 m to 7.7 m, with the lower boundary of the sand and gravel encountered at depths of 5.2 m to 9.4 m (Elevation 176.8 to 175.4). The sand and gravel layer was not fully penetrated in Borehole JFR-04, which was terminated at a depth of 11.3 m (Elevation 177.3), 2.6 m into the sand and gravel layer.

SPT 'N' values recorded in the sand and gravel ranged from 2 to 43 blows for 0.3 m penetration, indicating a variable density ranging from very loose to dense. In general, SPT 'N' values were greater than 12 (compact) and increased with depth.

Moisture contents of the sand and gravel samples from the current investigation ranged from 8% to 9%.

One sample of the sand and gravel from the current investigation underwent laboratory grain size analysis testing. The results of this test are presented on the corresponding Record of Borehole sheets included in Appendix A and the grain size distribution curve for this sample is plotted on Figure B5 of Appendix B. The results of this test are summarized as follows:

Gravel %	38
Sand %	43
Silt & Clay %	19

5.8 Lower Sand and Gravel

A thin layer of sand and gravel was encountered at depth in Boreholes 1, 4, 5, and 8. Occasional cobbles and boulders were noted within this layer.

This sand and gravel layer was fully penetrated in Boreholes 5 and 8 only and the layer is present just above the bedrock surface. In these two boreholes the sand and gravel layer was 0.8 m thick, with the lower boundary of the layer encountered at Elevations 157.2 and 159.3. Boreholes 1 and 4 were terminated at Elevations 159.0 and 159.4, respectively and penetrated 0.9 m to 2.3 m into the sand and gravel layer.

Coring techniques with an AX sized core barrel were used to advance the boreholes through the sand and gravel layer containing cobble and boulders.

5.9 Bedrock

Granite bedrock was proven by coring in two of the boreholes drilled during the 1958 investigation (Boreholes 5 and 8). Table 5.2 summarizes depths and elevations to the top of bedrock in these boreholes.

Table 5.2 – Depths and Elevations of Top of Bedrock

Foundation Unit	Borehole	Top of Bedrock	
		Depth (m) Below riverbed	Elevation (m)
West bank	5	23.1	157.2
East bank	8	23.0	159.3

Core recovery and RQD values for the granite bedrock were not recorded in the investigation report from 1958.

5.10 Water Levels

Water levels were observed upon completion of drilling operations in the open boreholes. The water levels measured in the open boreholes are summarized in Table 5.3.

Table 5.3 – Water Level Measurements

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
JFR-02	February 12, 2011	8.6	180.4	Open borehole
JFR-04	February 10, 2011	7.2	181.4	Open borehole
1	Fall 1958	2.0	184.0	A few days after drilling
2	Fall 1958	1.3	183.9	A few days after drilling
3	Fall 1958	1.6	183.1	A few days after drilling
4	Fall 1958	1.5	183.5	A few days after drilling

Based on the General Arrangement drawing dated June 2012, the water level in Jackfish River was at Elevation 182.8 m in February 2011 and the high water level has been identified at Elevation 183.3.

The water level of the Jackfish River during the 1958 investigation was at elevation 183.1.

The investigation conducted in 1958 reported that when the sand and gravel layer located immediately above the bedrock was reached, water quickly rose in the casing, denoting artesian pressure in the coarse deposit. The maximum levels recorded in Boreholes 5 and 8 were at elevations 185.4 and 185.5, respectively. This represented a maximum artesian

head of 2.3 m to 2.4 m of water above the existing river level at the time. No artesian pressures were observed in the soils above this deep sand/gravel layer.

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.

6 MISCELLANEOUS

The borehole locations were established in the field by Thurber Engineering. MRC provided plan drawings to obtain the co-ordinates and the ground surface elevations for the boreholes.

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 for the boreholes located on the highway at this site. Ohlmann Geotechnical Services (OGS) supplied portable drilling equipment and conducted the drilling, sampling and in-situ testing operations for the two boreholes drilled through the tremie grout of the existing pier.

The concrete core testing was conducted by Davroc Testing Laboratories Inc.

The field program was supervised on a full time basis by Mr. Ryan Kromer, E.I.T 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. Lindsey Blaine, E.I.T. The report was reviewed by Dr. P.K. Chatterji, P.Eng. a Designated Principal Contact for MTO Foundations Projects.

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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 ⁽¹⁾ '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

C_{pen}



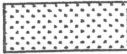


Shear Strength Determination by Pocket Penetrometer

- (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	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>	
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)

<u>DISCONTINUITY SPACING</u>		<u>STRENGTH CLASSIFICATION</u>		
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength (MPa)	Field Estimation of Hardness*
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	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	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m			
Very thinly bedded	20 to 60mm	Strong	50-100	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	Breaks under single blow of geological hammer.
<u>TERMS</u>				
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Weak	5.0 to 25.0	750 to 3,500
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Very Weak	1.0 to 5.0	150 to 750
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.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150
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 JFR-01

1 OF 2

METRIC

W.P. 465-00-00 LOCATION Jackfish River Bridge N 5 430 504.9 E 225 976.5 ORIGINATED BY RK
 HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2011.02.12 - 2011.02.12 CHECKED BY TJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
								WATER CONTENT (%)				
189.1							20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L		
0.0												
0.1	ASPHALT: (75mm)		1	AS			189					
	SAND, trace to some gravel, some silt Compact to very dense (frozen) Brown Moist (FILL)		1	SS	100/ 0.150		188					
			2	SS	100/ 0.150		187					
	Layer of organics (50mm)		3	SS	18		186					3 73 18 6
186.1							185					
3.0	Silty CLAY, silt seams, trace sand Very Stiff Greenish Grey to Grey		4	SS	17		184					
	Soft		5	SS	3		183					
							182					
183.0	Clayey SILT Firm Grey		6	SS	5		181					0 2 57 41
							180					
181.9	Silty CLAY, silt seams Very Stiff Grey		7	SS	22							
180.4	Sandy SILT Dense Grey Moist to Wet		8	SS	39							
179.3												
9.8	End of sampling at 9.8m and start											

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No JFR-01

2 OF 2

METRIC

W.P. 465-00-00 LOCATION Jackfish River Bridge N 5 430 504.9 E 225 976.5 ORIGINATED BY RK
 HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2011.02.12 - 2011.02.12 CHECKED BY TJH

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
	Continued From Previous Page									
177.8	DCPT					179				
11.3	END OF BOREHOLE AND DCPT AT 11.3m. BOREHOLE BACKFILLED WITH AUGER CUTTINGS TO 6.0m, HOLEPLUG AND AUGER CUTTINGS TO 3.0m, AUGER CUTTINGS TO 0.1m, THEN ASPHALT TO SURFACE.									

RECORD OF BOREHOLE No JFR-02

1 OF 2

METRIC

W.P. 465-00-00 LOCATION Jackfish River Bridge N 5 430 522.0 E 225 982.6 ORIGINATED BY RK
HWY 17 BOREHOLE TYPE Hollow Stem Augers/Casing COMPILED BY AN
DATUM Geodetic DATE 2011.02.12 - 2011.02.12 CHECKED BY TJH

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 ³	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		WATER CONTENT (%) w _p w w _L					
189.0 0.0 0.1	ASPHALT: (75mm) SAND, trace to some gravel Very Dense (frozen) Brown Moist (FILL)		1	AS											
				1	SS	100/ 0.275									
				2	SS	70									
186.3			3	SS	66										
2.7 185.9 3.1	Silty SAND Brown Moist (FILL) Layer of organics (50mm) Silty CLAY, silt seams, trace sand Very Stiff to Very Soft Greenish Grey		4	SS	18										
				5	SS	4									
			6	SS	0										
181.7 7.3	Clayey SILT, trace sand Firm to Very Stiff Grey Wet		7	SS	4										
				8	SS	18									

Continued Next Page

+³ ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No JFR-02

2 OF 2

METRIC

W.P. 465-00-00 LOCATION Jackfish River Bridge N 5 430 522.0 E 225 982.6 ORIGINATED BY RK
 HWY 17 BOREHOLE TYPE Hollow Stem Augers/Casing COMPILED BY AN
 DATUM Geodetic DATE 2011.02.12 - 2011.02.12 CHECKED BY TJH

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 ³	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	W _P W W _L				
Continued From Previous Page														
178.8	Clayey SILT, trace sand						179							
10.2	SILT, some sand to sandy Compact Grey to Brown Wet		9	SS	12		178							
							177							
			10	SS	20		176							
							175							
174.7			11	SS	13		174							
14.3	End of sampling at 14.3m and start DCPT						173							
							172							
							171							
170.5														
18.5	END OF BOREHOLE AND DCPT AT 18.5m. WATER LEVEL AT 8.6m UPON COMPLETION. BOREHOLE BACKFILLED WITH AUGER CUTTINGS TO 7.6m, HOLEPLUG AND AUGER CUTTINGS TO 3.0m, AUGER CUTTINGS TO 0.1m, THEN ASPHALT TO SURFACE.													

RECORD OF BOREHOLE No JFR-03

1 OF 1

METRIC

W.P. 465-00-00 LOCATION Jackfish River Bridge N 5 430 551.9 E 225 998.4 ORIGINATED BY RK
HWY 17 BOREHOLE TYPE Coring/Tripod - Wash Coring COMPILED BY MFA
DATUM Geodetic DATE 2011.02.17 - 2011.02.17 CHECKED BY TJH

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 ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE							
183.5							20 40 60 80 100				W _P W W _L				
0.0	CONCRETE (Cored through concrete surrounding the pier)		1	RUN											
			2	RUN											
			3	RUN											
			4	RUN											
			5	RUN											
178.6															
4.9	Silty SAND, some gravel, some clay, decayed wood fragments Compact Grey Wet		1	SS	10									12 59 29 (SI+CL)	
177.7															
5.8	Sandy SILT, trace silt and clay, occasional sand layers Compact to Very Dense Grey Wet		2	SS	24										
			3	SS	29										
			4	SS	66									0 27 69 4	
175.9															
7.6	End of sampling at 7.6m and start DCPT														
175.4															
8.1	END OF BOREHOLE AND DCPT AT 8.1m. BOREHOLE BACKFILLED WITH SILICA SAND TO 4.9m, THEN CEMENT TO SURFACE.														

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No JFR-04

1 OF 2

METRIC

W.P. 465-00-00 LOCATION Jackfish River Bridge N 5 430 583.1 E 226 007.3 ORIGINATED BY RK
HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2011.02.10 - 2011.02.10 CHECKED BY TJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	
188.6												
0.0	ASPHALT: (125mm)											
0.1	SAND, some gravel to gravelly, trace silt and clay Very Dense to Compact (frozen) Brown Moist (FILL)		1	AS								
			1	SS	100/ 0.225							
			2	SS	100/ 0.075							
			3	SS	21							
			4	SS	12							
	Start of DCPT at 3.1m.											
184.0												
4.6	SAND, fine to coarse, trace to some gravel Compact Brown Moist to Wet		5	SS	14							
			6	SS	14							
	Dark Brown to Black and Grey with decayed wood fragments											
			7	SS	100/ 0.100							
179.9												
8.7	SAND and GRAVEL, some silt and clay Compact Grey Wet		8	SS	20							

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No JFR-04

2 OF 2

METRIC

W.P. 465-00-00 LOCATION Jackfish River Bridge N 5 430 583.1 E 226 007.3 ORIGINATED BY RK
HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2011.02.10 - 2011.02.10 CHECKED BY TJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
								○ UNCONFINED + FIELD VANE							
	Continued From Previous Page						● QUICK TRIAXIAL × LAB VANE	WATER CONTENT (%)							
								20 40 60 80 100	20 40 60						
177.3	SAND and GRAVEL , some silt and clay Compact Grey Wet		9	SS	22										
11.3	END OF BOREHOLE AT 11.3m. WATER LEVEL AT 7.2m UPON COMPLETION. BOREHOLE BACKFILLED WITH AUGER CUTTINGS TO 0.10m, THEN ASPHALT TO SURFACE.														
172.8															
15.8	End of DCPT at 15.8m.														

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

RECORD OF BOREHOLE No JFR-05

1 OF 2

METRIC

W.P. 465-00-00 LOCATION Jackfish River Bridge N 5 430 603.8 E 226 009.3 ORIGINATED BY RK
HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2011.02.13 - 2011.02.13 CHECKED BY TJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
188.3								20 40 60 80 100						
0.0								20 40 60 80 100						
0.1	ASPHALT: (75mm)		1	AS			188							
	SAND, some gravel to gravelly, trace silt and clay Very Dense to Compact (frozen) Brown Moist (FILL)		1	SS	50/ 0.025									
			2	SS	100/ 0.150		187							
			3	SS	33		186							18 75 7 (SI+CL)
			4	SS	18		185							
							184							
183.7														
4.6	Sandy SILT Loose Greenish Grey Moist		5	SS	9		183							
182.7														
5.6	SILT, trace clay, trace sand Very Loose Dark Brown to Grey Moist		6	SS	3		182							0 8 83 9
							181							
			7	SS	1		180							
179.6														
8.7	Silty CLAY, trace sand, occasional organics Very Soft Grey		8	SS	0		179							

Continued Next Page

+ 3, X 3: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No JFR-05

2 OF 2

METRIC

W.P. 465-00-00 LOCATION Jackfish River Bridge N 5 430 603.8 E 226 009.3 ORIGINATED BY RK
 HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2011.02.13 - 2011.02.13 CHECKED BY TJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES								
Continued From Previous Page													
	Silty CLAY , trace sand Very Soft												
			9	SS	0								
			10	SS	0								0 3 63 33
			11	SS	0								
			12	SS	0								
171.2			13	SS	0								
17.1	SAND , some clay												
170.9	Grey												
17.4	Wet												
	End of sampling at 17.3m and start DCPT.												
169.1													
19.2	END OF BOREHOLE AND DCPT AT 19.2m. BOREHOLE BACKFILLED WITH AUGER CUTTINGS TO 0.10m, THEN ASPHALT TO SURFACE.												

RECORD OF BOREHOLE No JFR-06

1 OF 1

METRIC

W.P. 465-00-00 LOCATION Jackfish River Bridge N 5 430 554.2 E 225 991.7 ORIGINATED BY RK
 HWY 17 BOREHOLE TYPE Coring/Tripod - Wash Boring COMPILED BY MFA
 DATUM Geodetic DATE 2011.02.20 - 2011.02.20 CHECKED BY TJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
								○ UNCONFINED + FIELD VANE				
								● QUICK TRIAXIAL × LAB VANE				
183.5							20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L		
0.0	CONCRETE (Cored through concrete surrounding the pier)		1	RUN			183					
			2	RUN			182					
			3	RUN			181					
			4	RUN			180					
178.6							179					
4.9	Silty SAND, some gravel to gravelly Dense Dark Brown Wet		1	SS	32		178					
178.0							177					
5.5	End of sampling at 5.5m and start DCPT						176					
175.6							175					
7.9	END OF BOREHOLE AND DCPT AT 7.9m. BOREHOLE BACKFILLED WITH HOLEPLUG TO 4.9m, THEN CONCRETE TO SURFACE.						174					

+³ . X³ : Numbers refer to
Sensitivity

20
15
10

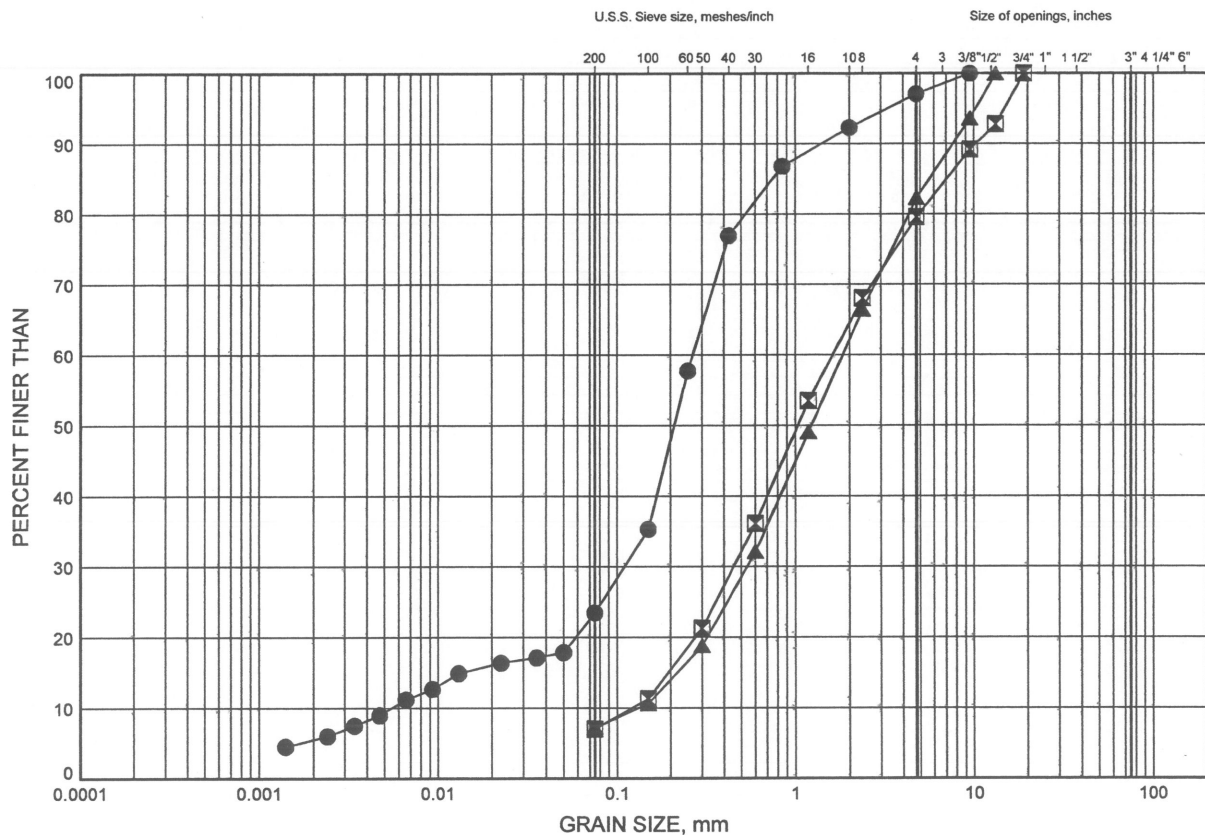
(%) STRAIN AT FAILURE

Appendix B
Laboratory Test Results
(Current Investigation)

NWR 32 Rehabs GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	JFR-01	2.59	186.51
◻	JFR-04	2.59	186.01
▲	JFR-05	2.59	185.71

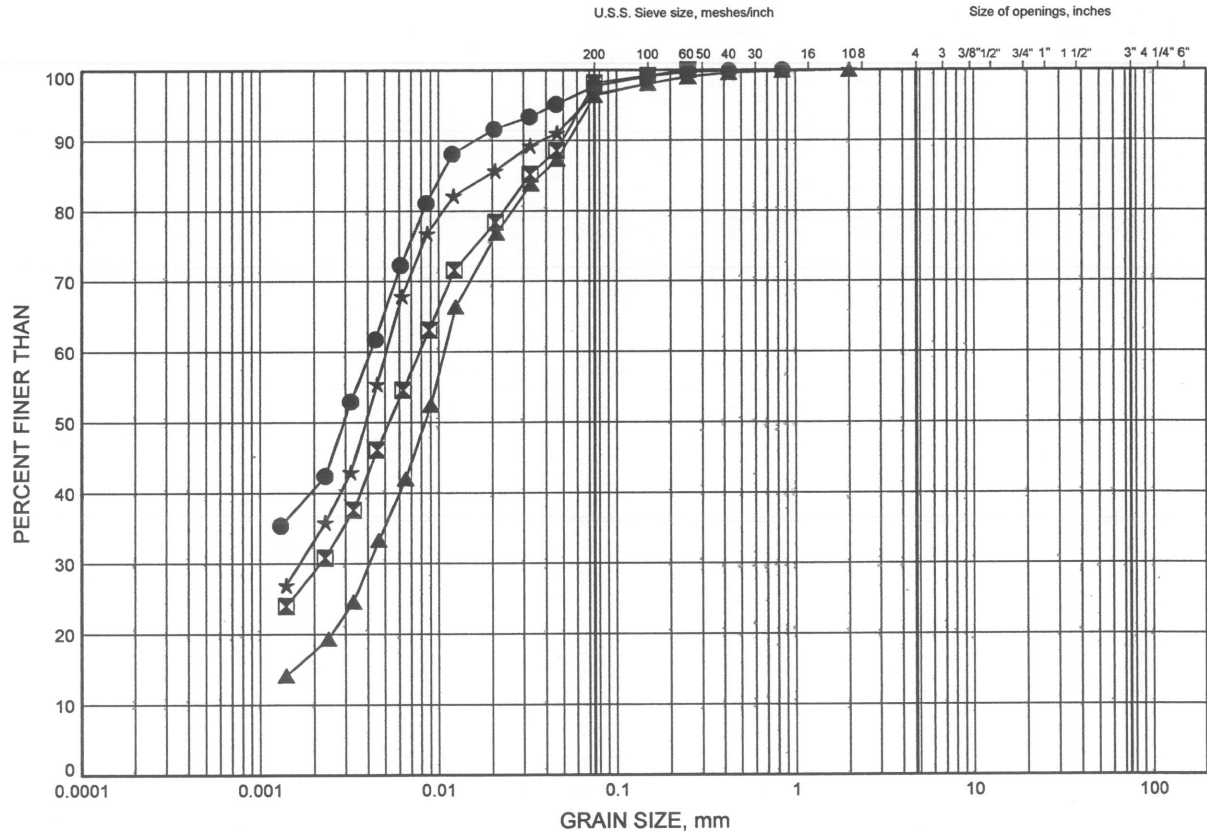


W.P.# .465-00-00.....
Prepared By .MFA.....
Checked By .MRA.....

NWR 32 Rehabs GRAIN SIZE DISTRIBUTION

FIGURE B2

SILTY CLAY TO CLAYEY SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	JFR-01	7.92	181.18
⊠	JFR-02	3.35	185.65
▲	JFR-02	9.45	179.55
★	JFR-05	12.50	175.80



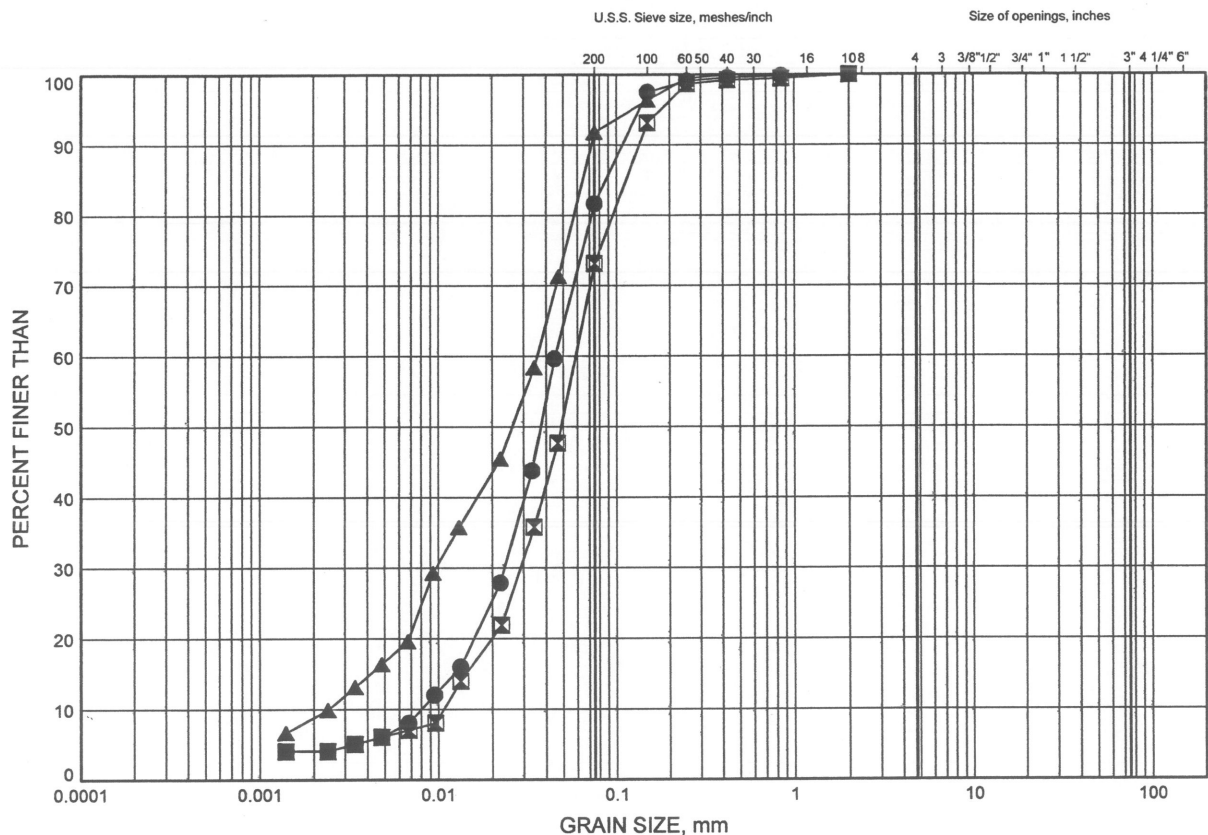
W.P.# 465-00-00
Prepared By MFA
Checked By MRA

NWR 32 Rehabs

GRAIN SIZE DISTRIBUTION

FIGURE B3

SILT TO SANDY SILT



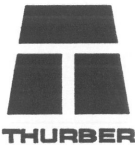
SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	JFR-02	14.02	174.98
■	JFR-03	7.32	176.18
▲	JFR-05	6.40	181.90

GRAIN SIZE DISTRIBUTION - THURBER 1197.GPJ 9/12/11

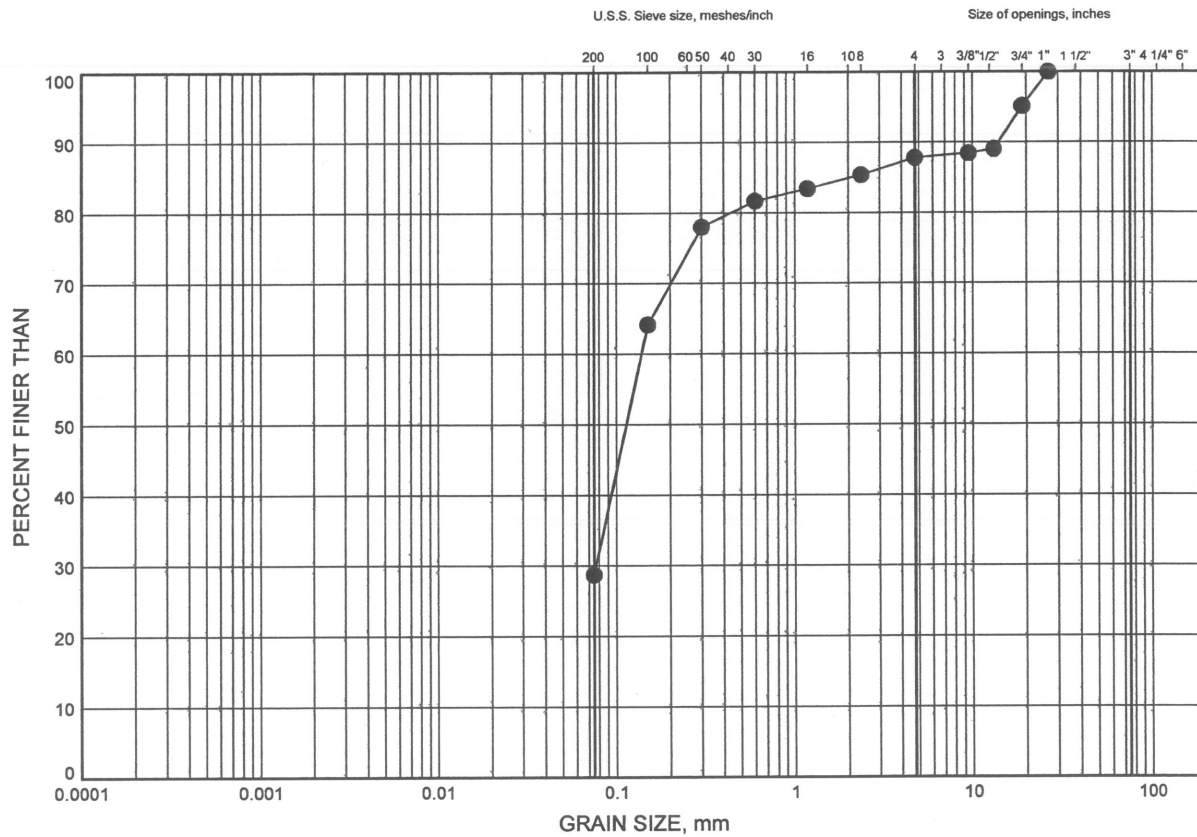
W.P.# 465-00-00
 Prepared By MFA
 Checked By MRA



NWR 32 Rehabs GRAIN SIZE DISTRIBUTION

FIGURE B4

SILTY SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	JFR-03	5.33	178.17

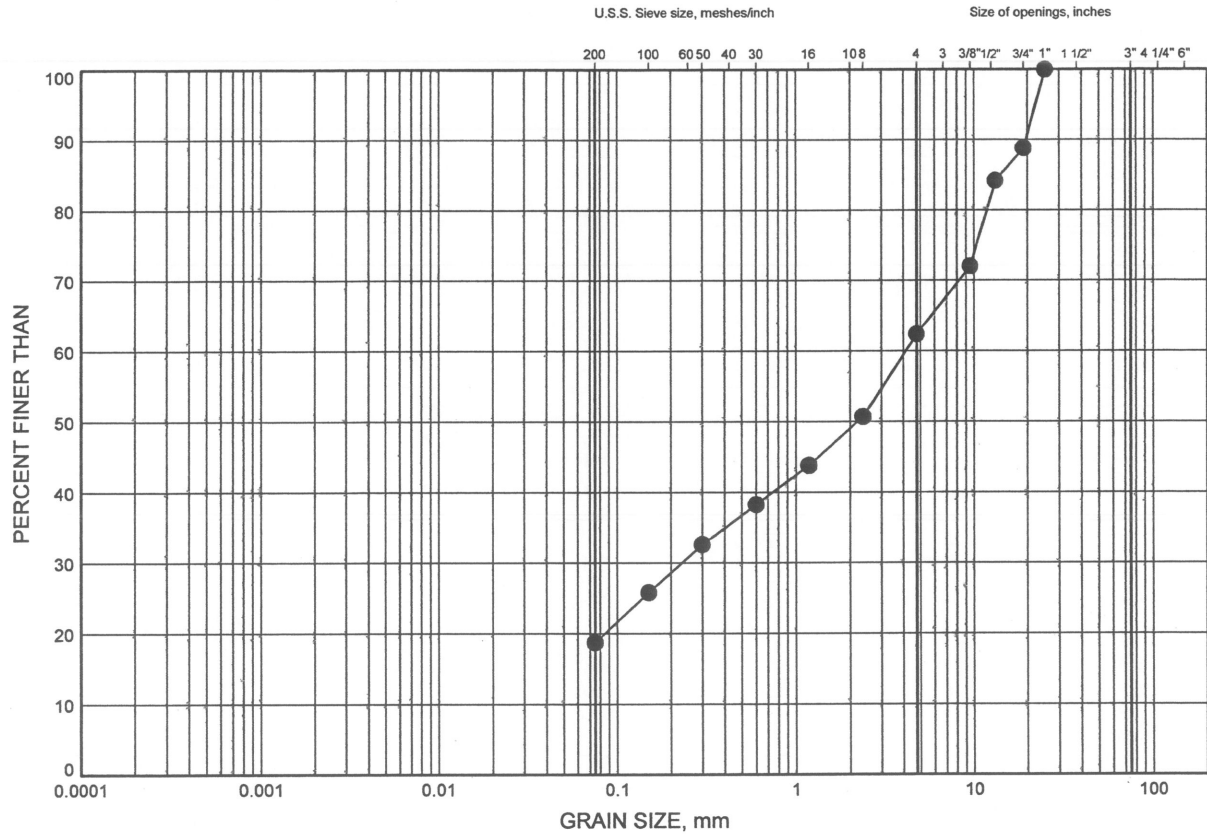


W.P.# .465-00-00.....
Prepared By .MFA.....
Checked By .MRA.....

NWR 32 Rehabs GRAIN SIZE DISTRIBUTION

FIGURE B5

SAND & GRAVEL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	JFR-04	9.45	179.15

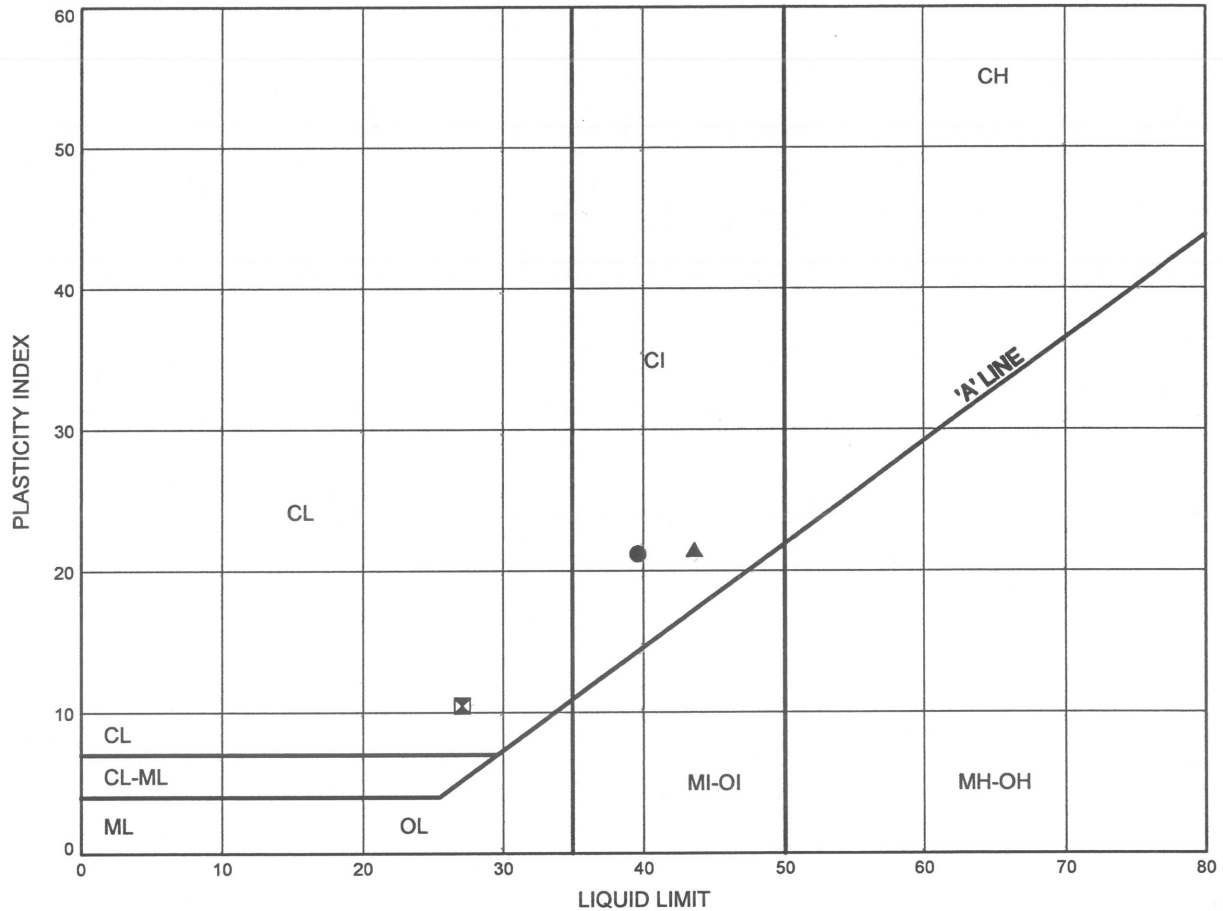


W.P.# .465-00-00.....
Prepared By .MFA.....
Checked By .MRA.....

NWR 32 Rehabs
ATTERBERG LIMITS TEST RESULTS

FIGURE B6

SILTY CLAY TO CLAYEY SILT



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	JFR-02	3.35	185.65
⊠	JFR-02	9.45	179.55
▲	JFR-05	12.50	175.80

Appendix C
Laboratory Test Results of Concrete Cores and Core Photos
(current investigation)

File: L11-0165AVS

Thurber Engineering Ltd.
2010 Winston Park Dr., Suite 103
Oakville, Ontario

November 14, 2011

Attn: Mr. Weiss Mehdawi, M.Eng., P.Eng.

Dear Sir;

Concrete Core Testing
Project No.: 19-1351-197

Further to receipt of four (4) 75 mm diameter nominal size concrete core samples in our laboratory on November 11, 2011, Davroc Testing Laboratories Inc., is pleased to report the results of our tests.

As per your request, each core was trimmed, end ground and tested for compressive strength in accordance with CSA Standard A23.2-14C, "Obtaining and Testing Drilled Cores for Compressive Strength Testing," in a dry condition.

The results of our core tests are shown on the attached Core Test Report form.

We trust this provides you with the information you require at this time. Should you require any further information, please do not hesitate to contact the undersigned.

Your very truly,
Davroc Testing Laboratories Inc.



Fabio Fregonese, C.E.T.
Manager Materials Testing Services



Sal Fasullo, C.E.T.
Vice President

SF/ff
11-0165-12

CONCRETE CORE TEST REPORT

File No. L11-0165CC
Client Project Number: 13-1351-197
Davroc Sample No.:2421

Core No.	1	2	3	4
Location	Bore Hole JFR 03			
Nominal Size of Coarse Aggregate (mm)	20	20	20	20
Date Cast	Not Given	Not Given	Not Given	Not Given
Date Cored	Not Given	Not Given	Not Given	Not Given
Date Tested	November 11, 2011	November 11, 2011	November 11, 2011	November 11, 2011
Ground Height -(mm)	148.5	149.5	150.0	149.5
Average Diameter (mm)	75.0	75.0	75.0	75.0
Corrected Compressive Strength (MPa)	31.8	39.0	30.3	31.6
Mode of Failure	Satisfactory	Satisfactory	Satisfactory	Satisfactory
*Direction of Loading	Not Given	Not Given	Not Given	Not Given
** Moisture Condition at Time of Test	Dry	Dry	Dry	Dry
Concrete Compaction	Satisfactory	Satisfactory	Satisfactory	Satisfactory

Remarks: None

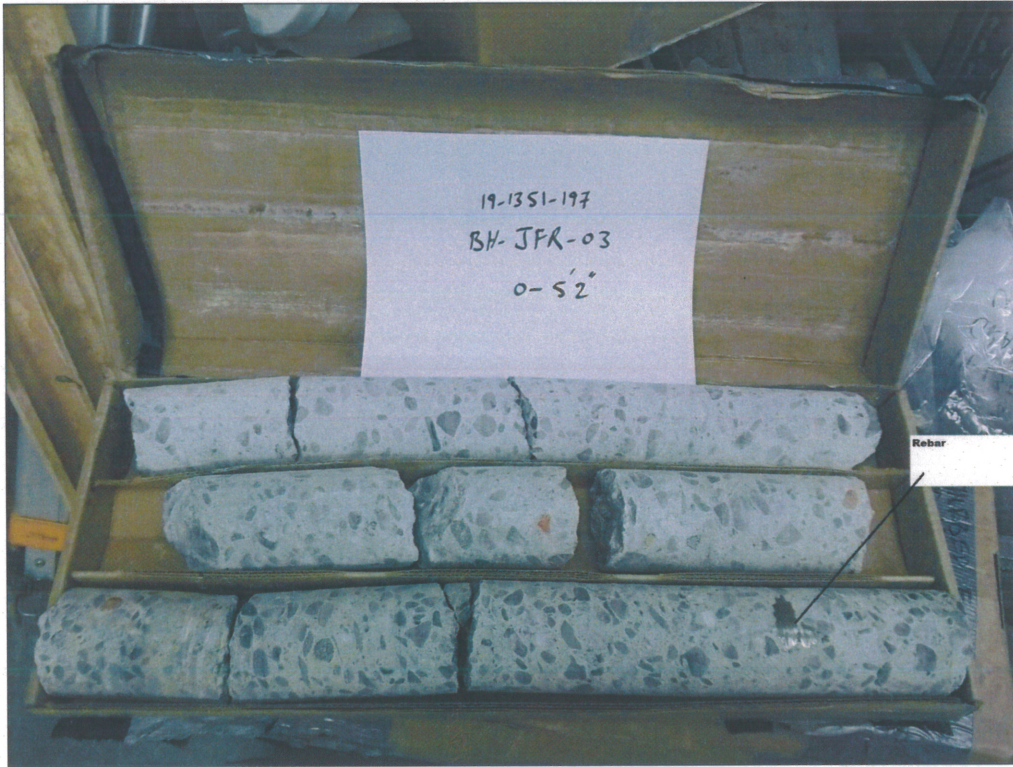
Date: November 11, 2011

Signed:

Sal Fasullo, C.E.T.

*Relative to direction of compaction of concrete when placed.

** Moisture conditioning as per clause 5.3.2 of the Test Method CSA A23.2-14C



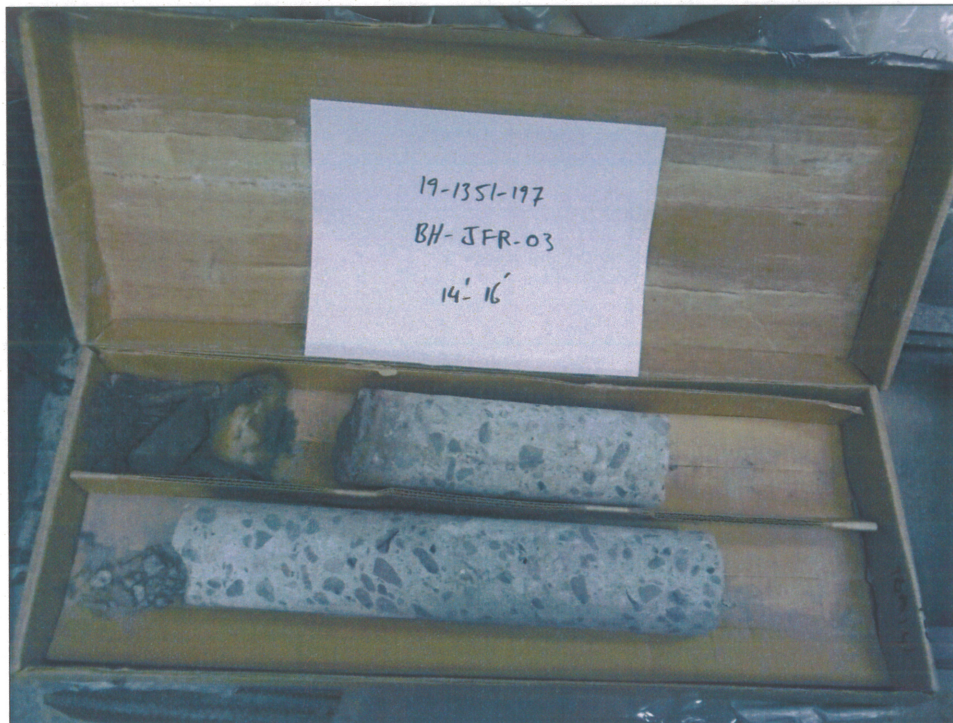
Photograph 1C – Concrete cores, Borehole JFR-03, 0.0 m to 1.6 m depth



Photograph 2C – Concrete cores, Borehole JFR-03, 1.6 m to 3.0 m depth



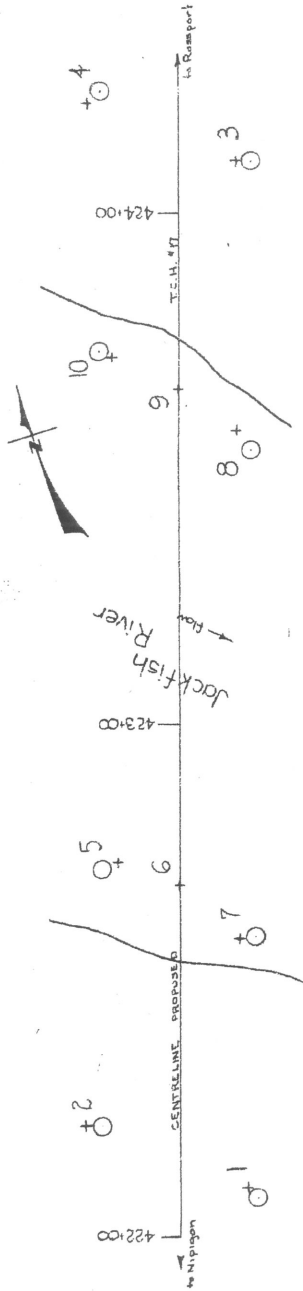
Photograph 3C – Concrete cores, Borehole JFR-03, 3.0 m to 4.2 m depth



Photograph 4C – Concrete cores, Borehole JFR-03, 4.2 m to 4.9 m depth

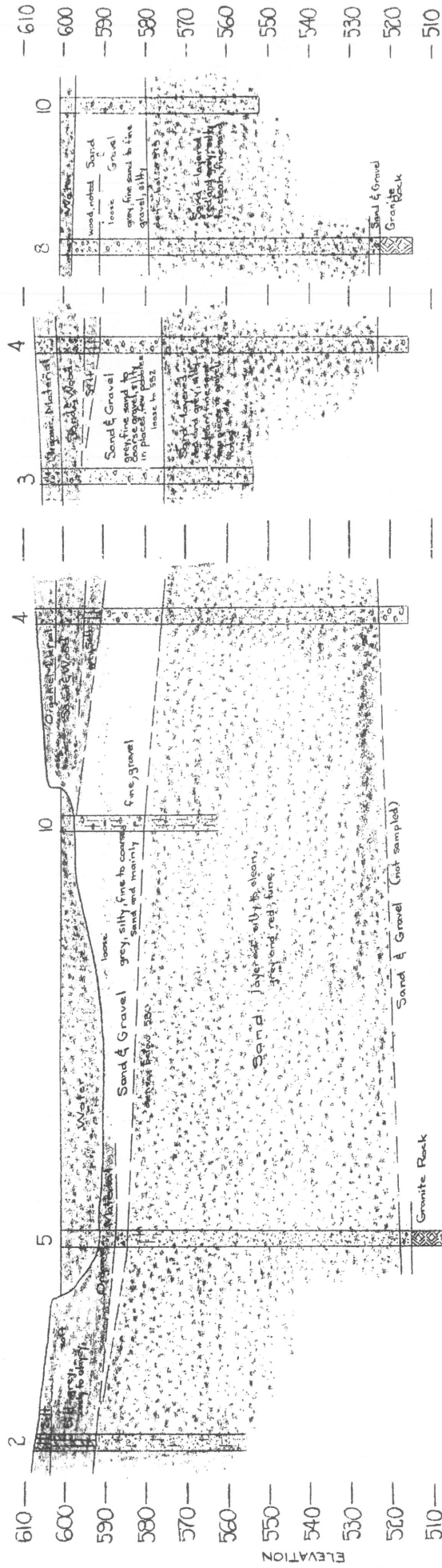
Appendix D
Record of Borehole Sheets
(Previous Investigation)

JACKFISH RIVER



Borehole Location Plan SCALE 1"=20'

Legend
Hole O
Cont. +



Projected Soil's Profile between Boreholes 2, 5, 10 & 4
SCALE 1"=20'

Soil Profile
SCALE 1"=20'

Soil Profile
SCALE 1"=20'

TROW SODERMAN AND ASSOCIATES

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

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

PROJECT Jackfish River Crossing, Hwy #17

LOCATION T.C.H. near Hapigon, Ont.

HOLE LOCATION See dwg. No. 1

HOLE ELEVATION AND DATUM 610.8

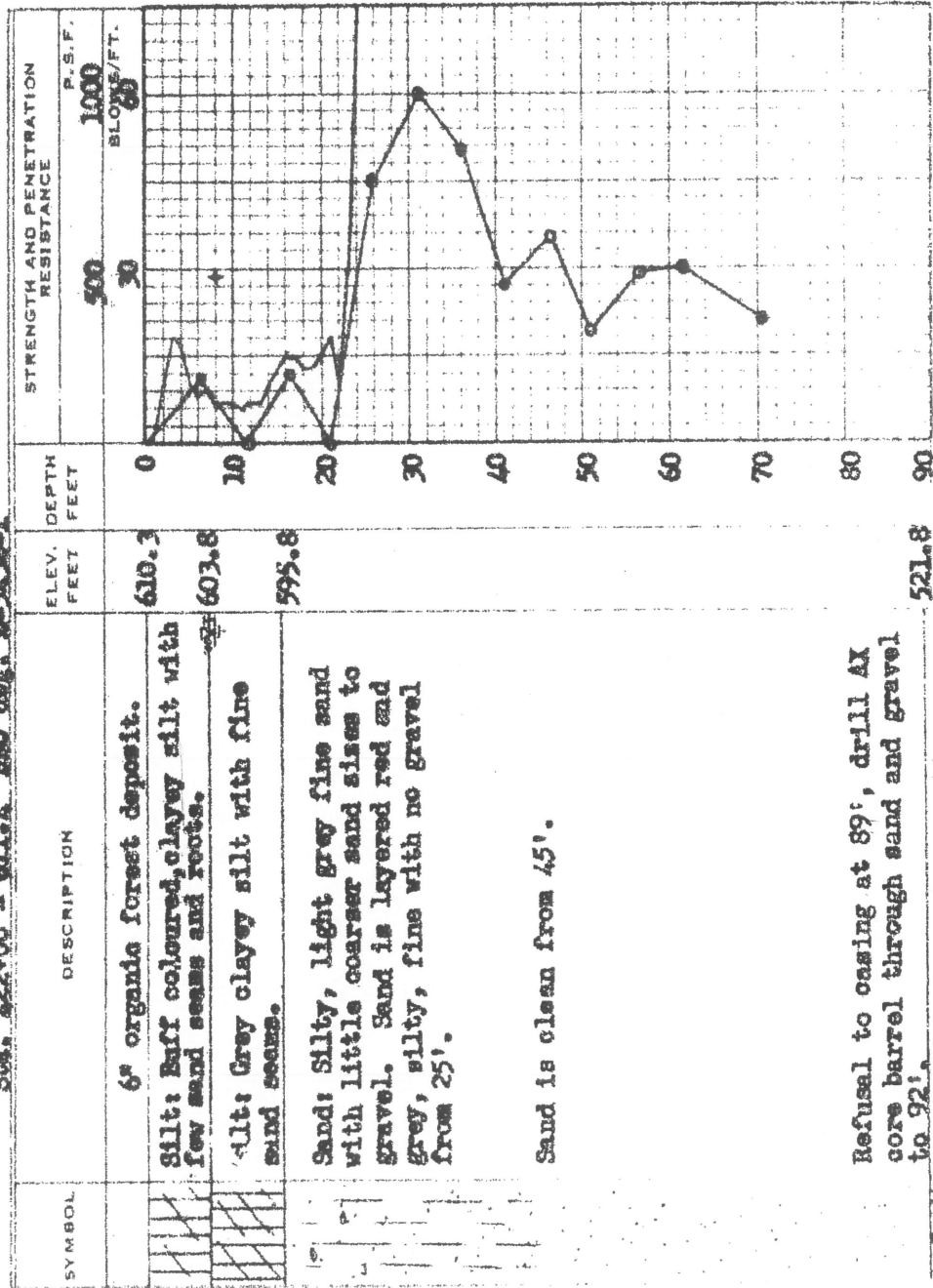
Sta. 422+00 = 611.4 HSD dwg. E-3432-1

BOREHOLE NO. 1

FIELD SUPERVISOR D.S.

DRILLER E.S.

PREP. D.S.



CONSISTENCY	SAMPLE	NATURAL UNIT WT. P.C.F.
MOIST. CONTENT - % DRY WT.		
	MSL1	
	MSL2	
	MSL3	
	MSL4	
	MSL5	
	MSL6	
	MSL7	
	MSL8	
	MSL9	
	MSL10	
	MSL11	
	MSL12	
	MSL13	

PROJECT NO. C108/1259

TROW SODERMAN AND ASSOCIATES

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

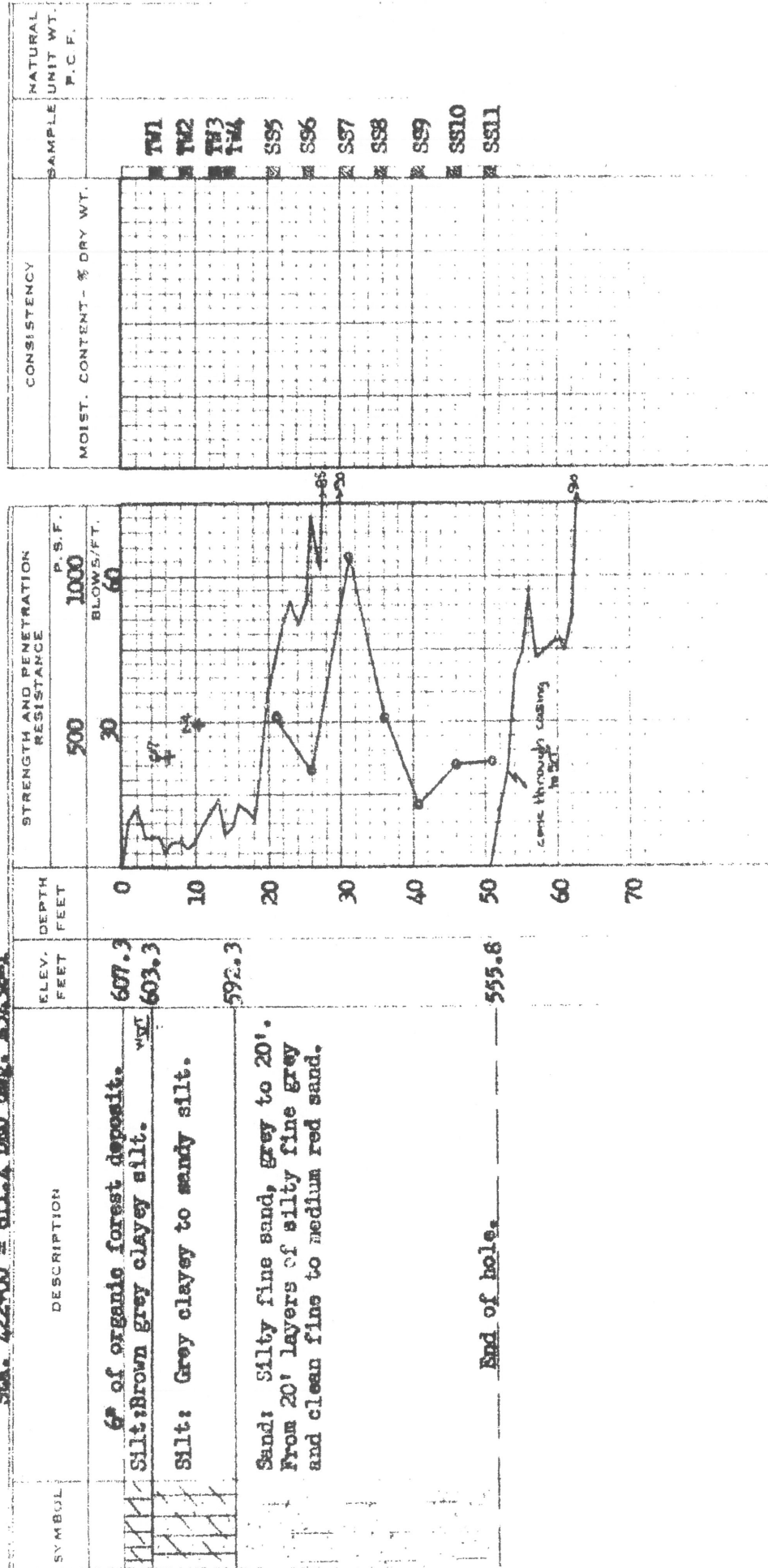
PROJECT Jackfish River Crossing, Hwy #17,
LOCATION T.C.R. near Nipigon, Ont.
HOLE LOCATION See dug No. 1
HOLE ELEVATION AND DATUM 607.3
Sta. 422+00 = 611.4 DEO dug. E3432-1

BOREHOLE NO. 2
FIELD SUPERVISOR D.S.
DRILLER E.S.
PREP. D.S.

DRAWING NO. 4

LEGEND

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



TROW SODERMAN AND ASSOCIATES

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

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

BOREHOLE NO. 3
FIELD SUPERVISOR D.S.
DRILLER E.S.
PREP. D.S.

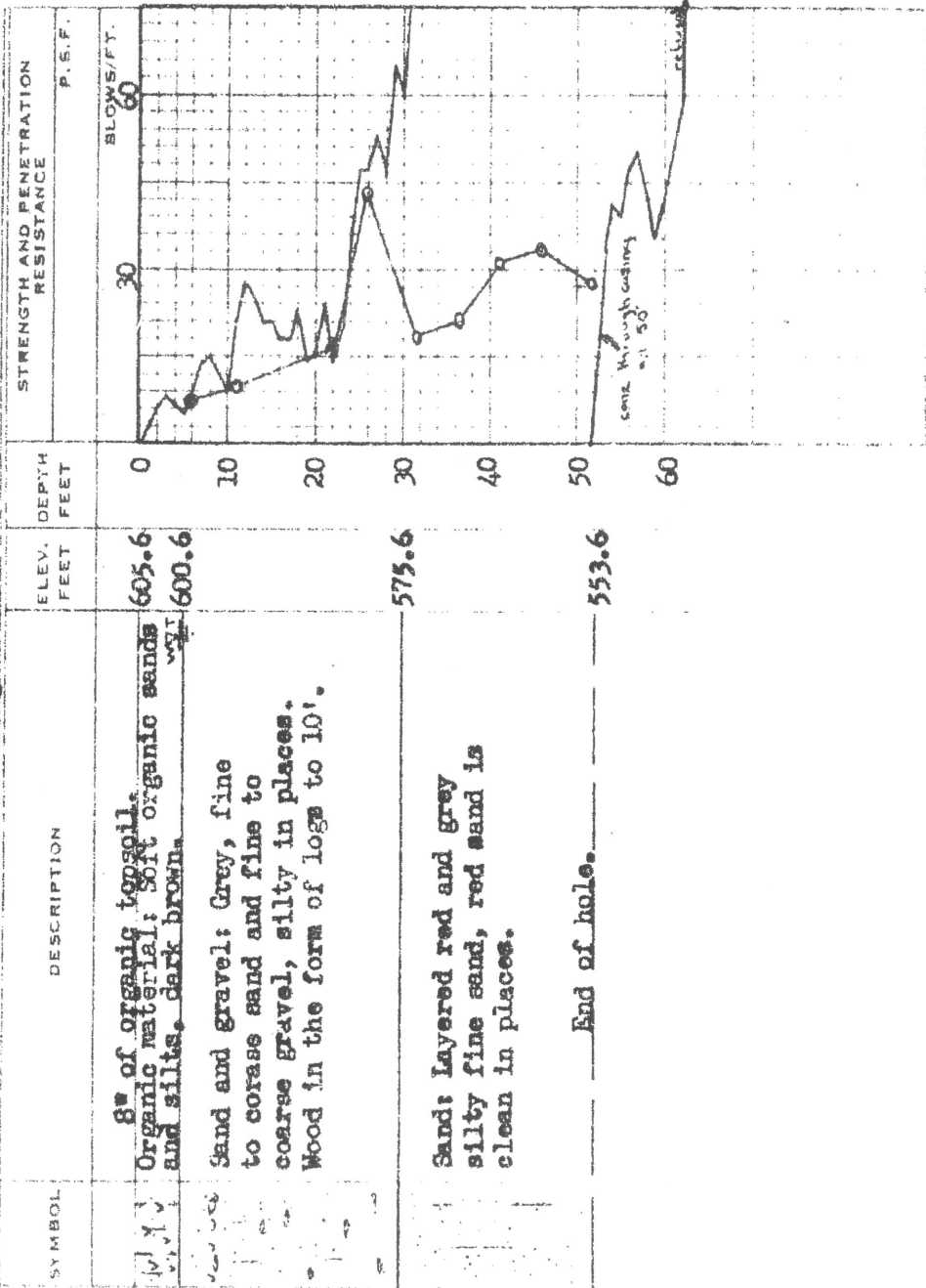
PROJECT Jackfish River Crossing, Hwy #17,

LOCATION T.C.H. near Nipigon, Ont.

HOLE LOCATION See dwg No. 1

HOLE ELEVATION AND D/TUM 605.6

Sta. 424+00 = 604.8 DHO dwg. E0432-1



CONSISTENCY	SAMPLE	NATURAL UNIT WT. P.C.F.
MOIST. CONTENT - % DRY WT.		
	SS1	
	SS2	
	SS3	
	SS4	
	SS5	
	SS6	
	SS7	
	SS8	
	SS9	
	SS10	

DRAWING NO.

TROW SODERMAN AND ASSOCIATES

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

LEGEND

- 1" 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
- LIQUIDITY LIMIT
- PLASTIC LIMIT

PROJECT Jackfish River Crossing Hwy #17,

LOCATION T.C.R. near Nipigon, Ont.

HOLE LOCATION See dwg. No. 1

HOLE ELEVATION AND DATUM 607.0

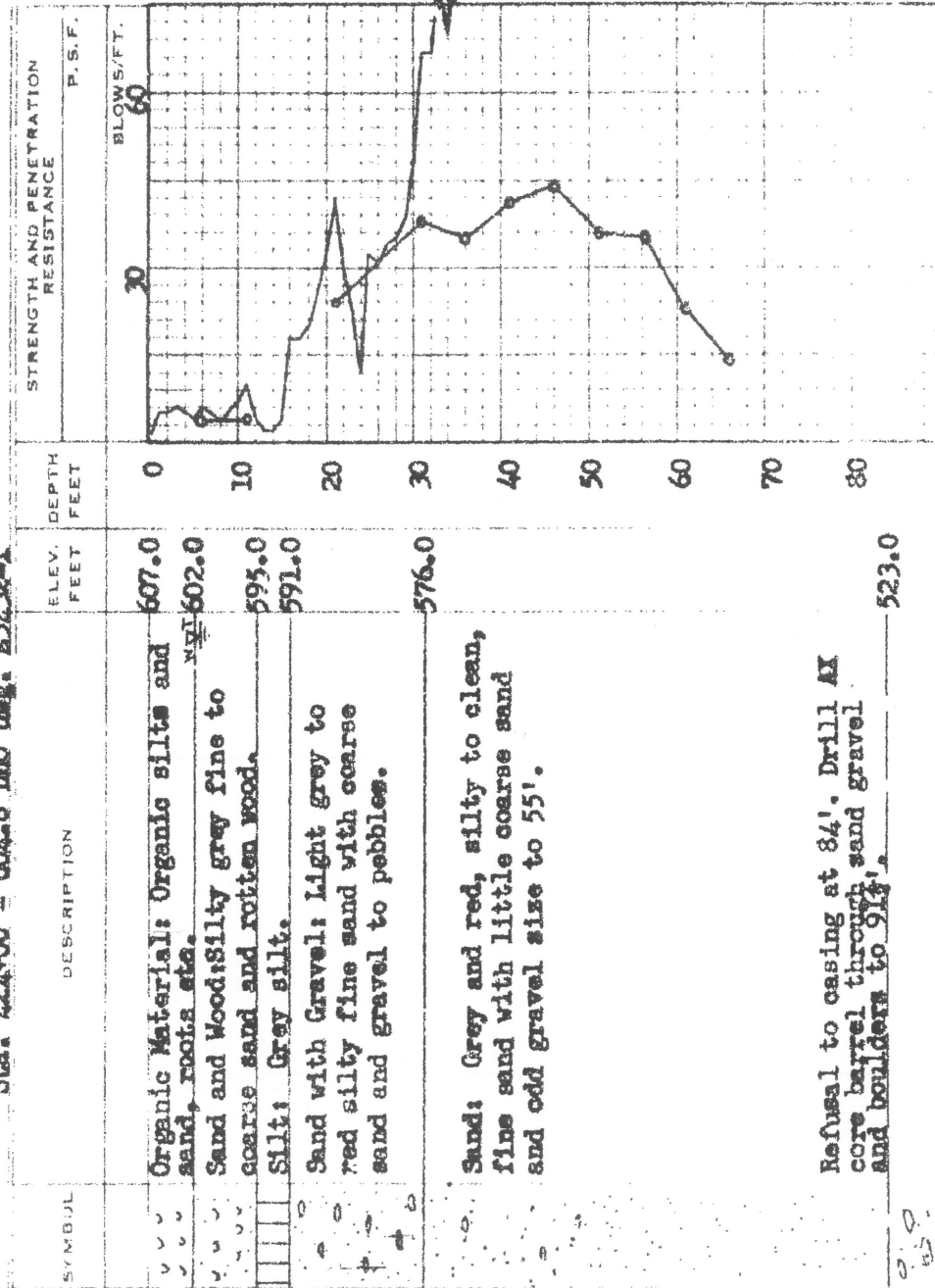
BOREHOLE NO. 4

FIELD SUPERVISOR D.S.

DRILLER E.S.

PREP. D.S.

Sta. 424+00 = 604.8 BHO dwg. E3432-1



Refusal to casing at 84'. Drill AX core barrel through sand gravel and boulders to 91'.

0.9

PROJECT NO. **CL08/J259**

TROW SODERMAN AND ASSOCIATES

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

DRAWING NO. **7**

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

PROJECT **Jackfish River Crossing Hwy #17,**

LOCATION **T.C.H. near Nipigon, Ont.**

HOLE LOCATION **See dwg. No. 1**

HOLE ELEVATION AND DATUM **602.1**

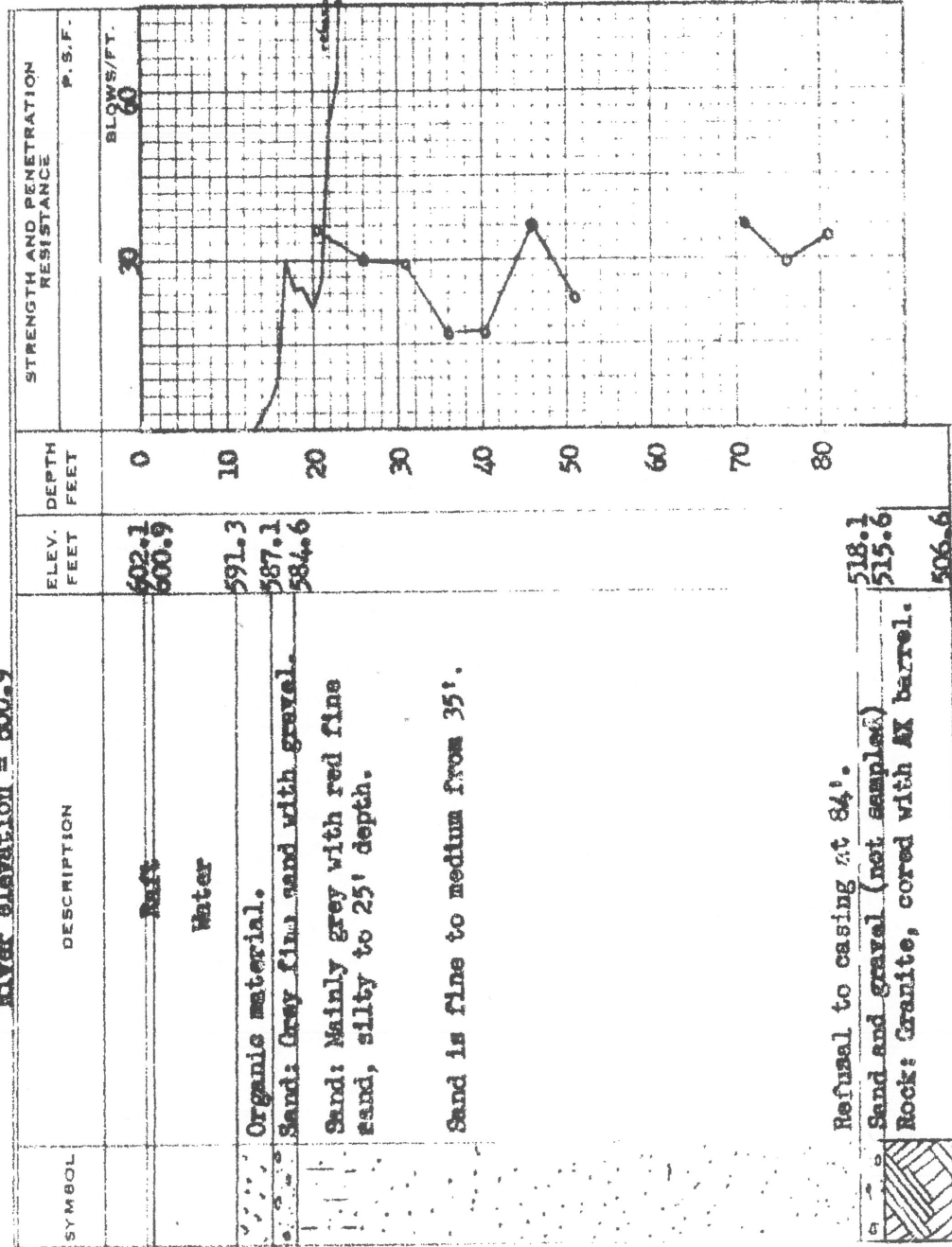
River elevation = 600.9

BOREHOLE NO. **5**

FIELD SUPERVISOR **D.S.**

DRILLER **H.J.**

PREP. **D.S.**



CONSISTENCY	SAMPLE	NATURAL UNIT WT. P.C.F.
MOIST. CONTENT- % DRY WT.		
	SS1	
	SS2	
	SS3	
	SS4	
	SS5	
	SS6	
	SS7	
	SS8	
	SS9	
	SS10	

PROJECT NO. 0108/J259

TROW SODERMAN AND ASSOCIATES

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

DRAWING NO. 8

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

PROJECT: Jackfish River Crossing Hwy #17

LOCATION: T.C.H. near Nipigon, Ont.

HOLE LOCATION: See dwg No. 1

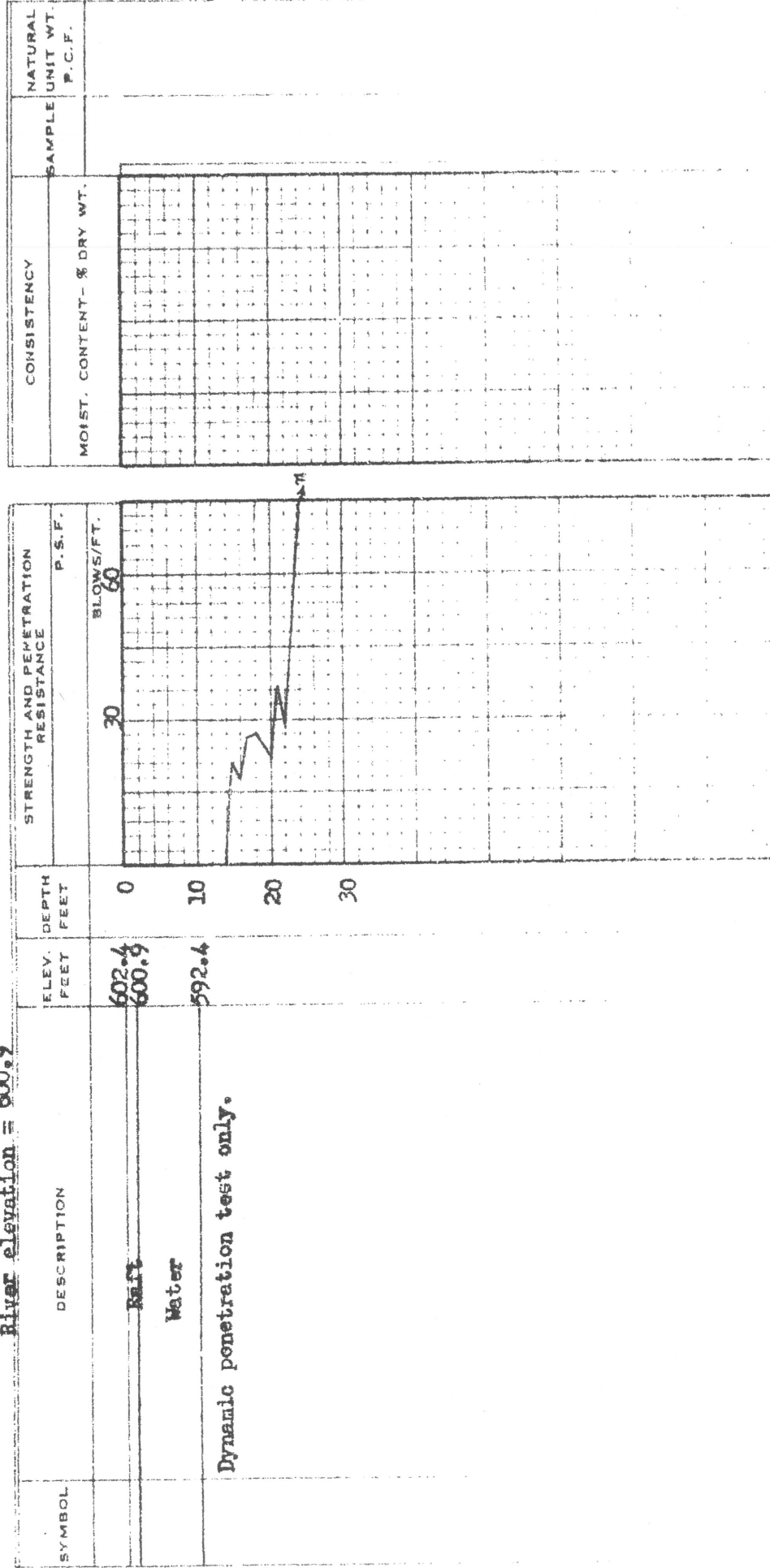
HOLE ELEVATION AND DATUM: 602.4
River elevation = 600.9

BOREHOLE NO. 6

FIELD SUPERVISOR D.S.

DRILLER H.J.

PREP. D.S.



PROJECT NO C108/J259

TROW SODERMAN AND ASSOCIATES

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

DRAWING NO. 9

LEGEND

- 2" DIA. SPLIT TUBE
- 2" SHELBY TUBE
- 2" SPLIT TUBE
- 2" DIA. CONE
- CASING
- 2" SHELBY
- 1/2 UNCONFINED COMPRESSION (QU)
- 1/2 SHELBY TUBE TEST (C) AND SENSITIVITY (S)
- NATURAL MOISTURE AND LIQUIDITY INDEX
- LIQUIDITY LIMIT
- PLASTIC LIMIT

PROJECT Jackfish River Crossing, Hwy #17

LOCATION T.C.H. near Wipigon, Ont.

HOLE LOCATION See dwg. No. 1

HOLE ELEVATION AND DATUM 602.4

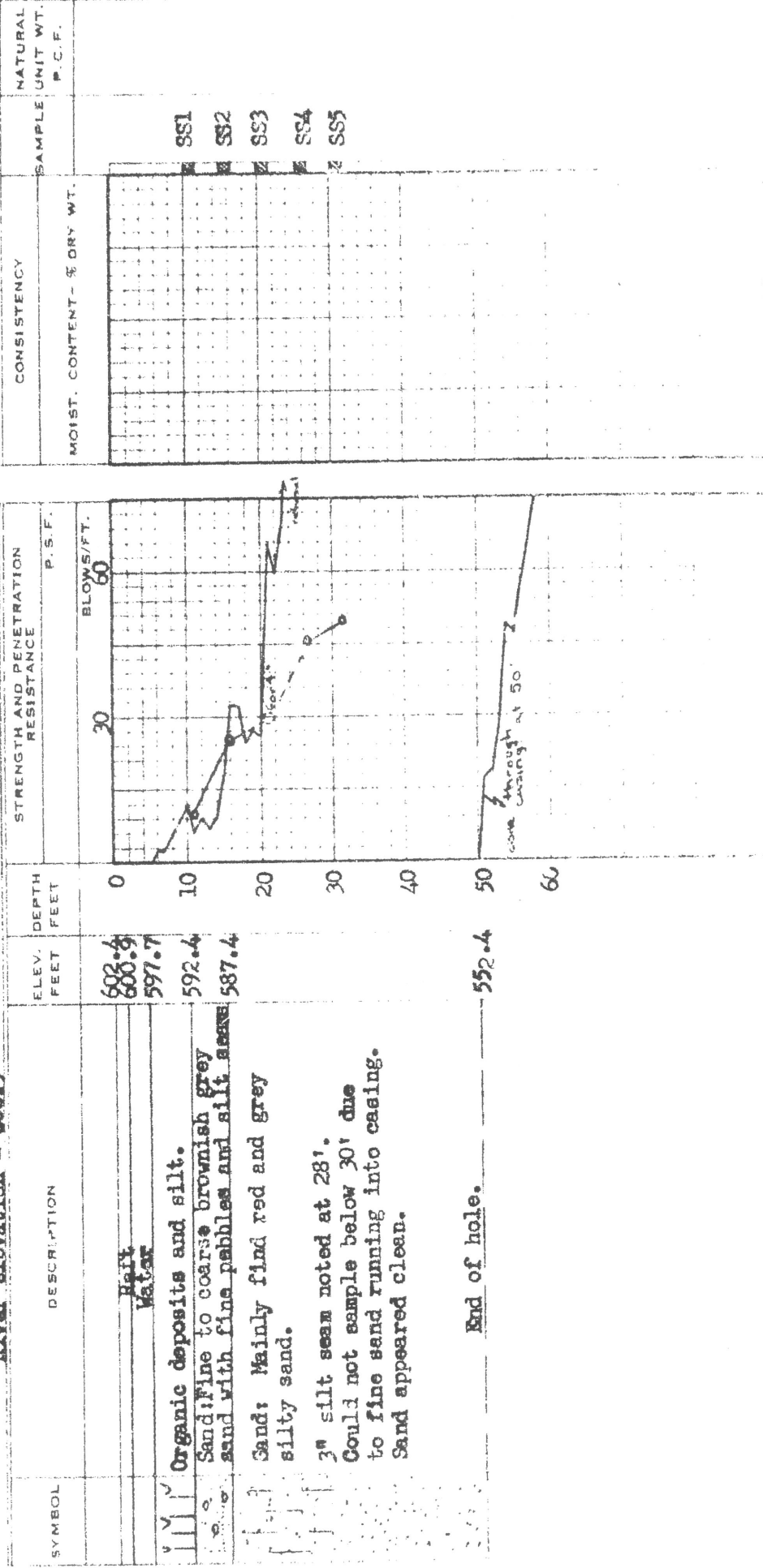
River elevation = 600.9

BOREHOLE NO. 7

FIELD SUPERVISOR D.S.

DRILLER H.J.

PREP D.S.



PROJECT NO. C108/J259

TROW SODERMAN AND ASSOCIATES

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

DRAWING NO.

10

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

PROJECT Jackfish River Crossing, Hwy #17

LOCATION T.C.H. near Rippon, Ont.

ROLL LOCATION See Dwg. No. 1

HOLE ELEVATION AND DATUM 602.2

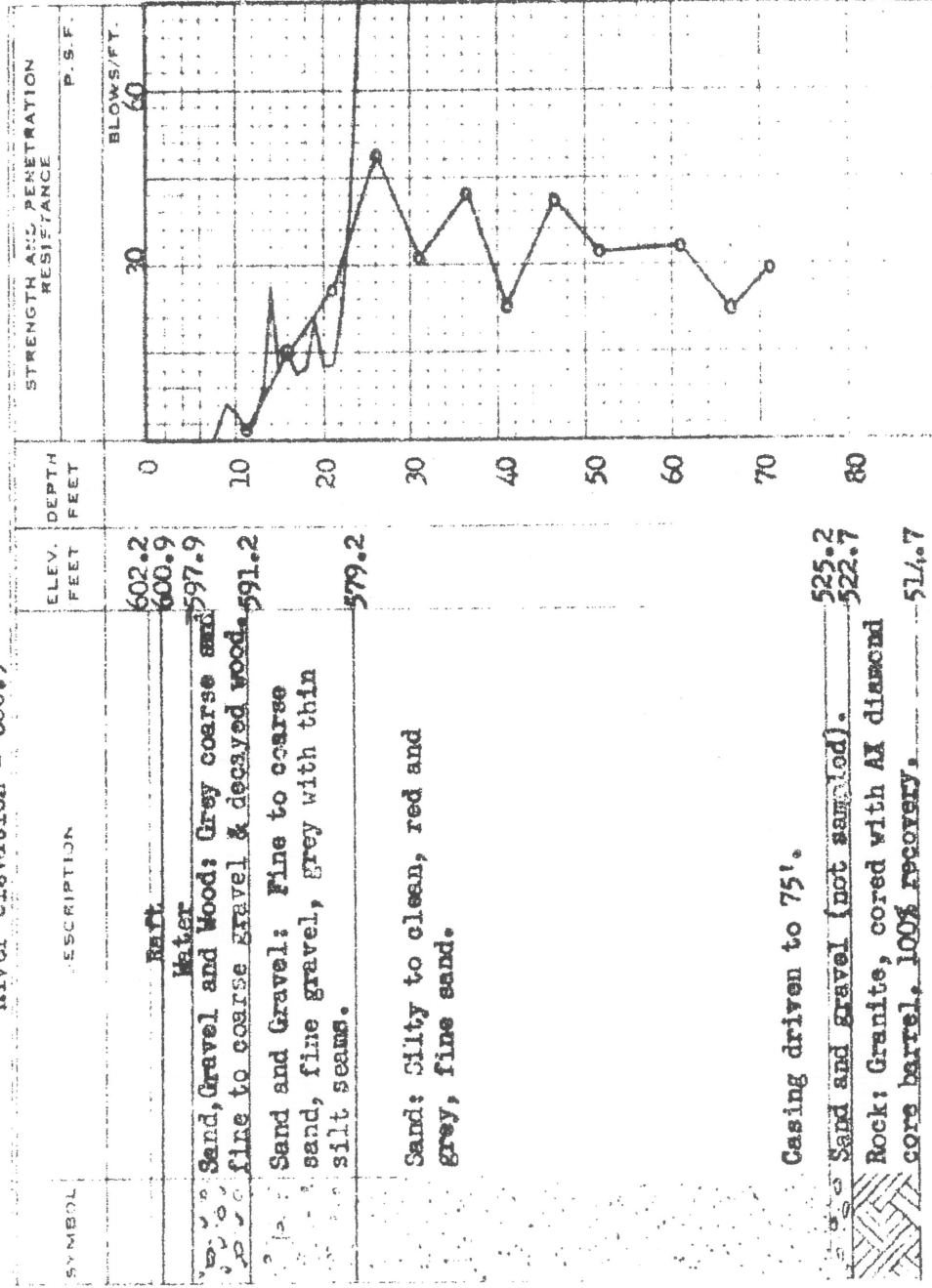
River elevation = 600.9

BOREHOLE NO. 8

FIELD SUPERVISOR D.S.

DRILLER H.J.

PREP. D.S.



CONSISTENCY	SAMPLE	NATURAL UNIT WT. P.C.F.
MOIST. CONTENT - % DRY WT.	SS1	
	SS2	
	SS3	
	SS4	
	SS5	
	SS6	
	SS7	
	SS8	
	SS9	
	SS10	
	SS11	
	SS12	

PROJECT NO C108/J259

TROW SODERMAN AND ASSOCIATES

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

DRAWING NO.

11

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

PROJECT Jackfish River Crossing, Hwy #17

LOCATION T.C.H. near Nipigon, Ont.

HOLE LOCATION See drg. No.1

HOLE ELEVATION AND DATUM 602.1

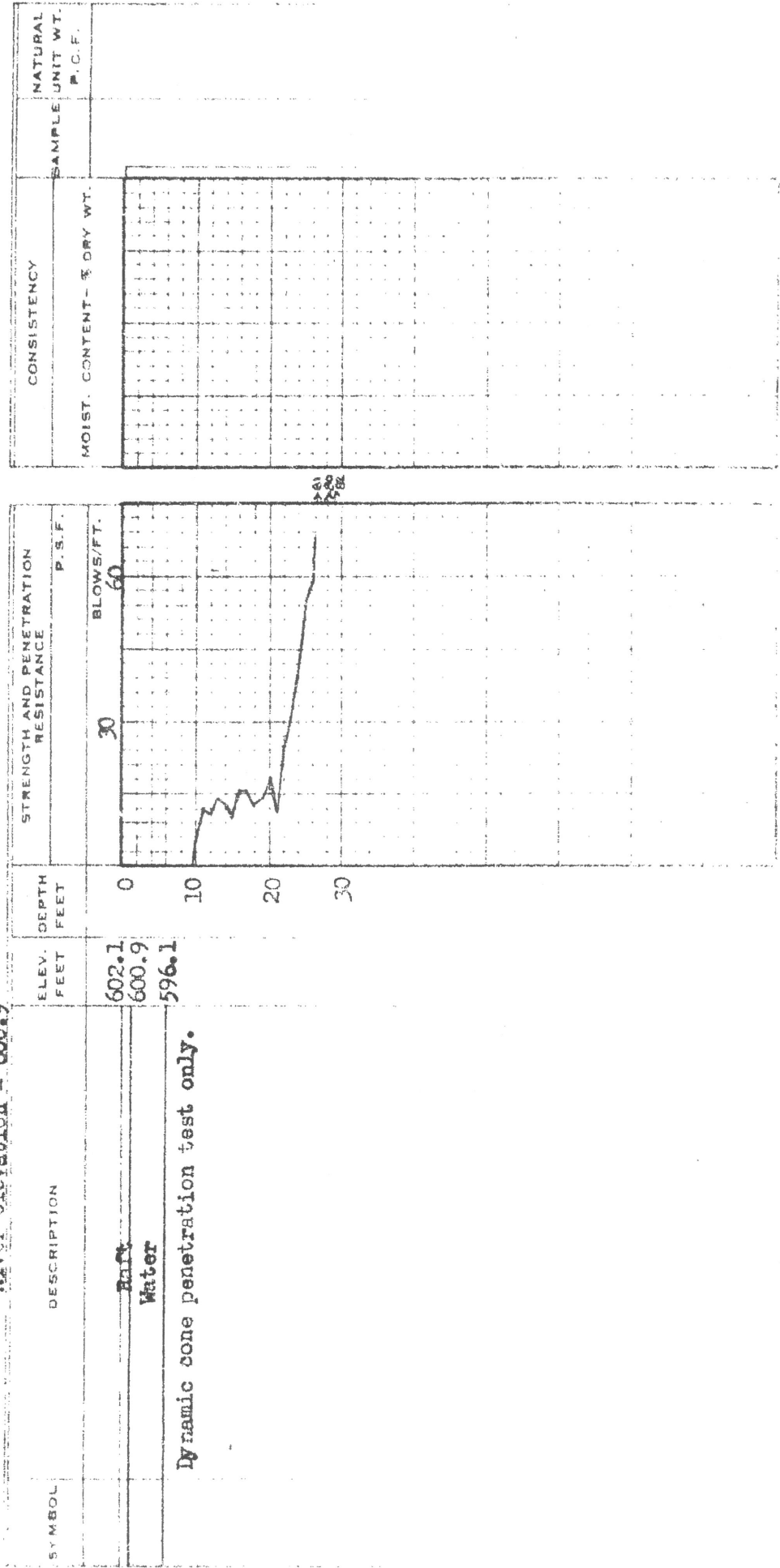
River elevation = 600.9

BOREHOLE NO. 9

FIELD SUPERVISOR D.C.

DRILLER H.J.

PREP. D.C.



TROW SODERMAN AND ASSOCIATES

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT Jackfish River Crossing, Hwy #17
LOCATION T.C.H. near Hinton, Ont.

HOLE LOCATION See Dwg. No. 1

HOLE ELEVATION AND DATUM 602.2

Water elevation = 600.9

BOREHOLE NO. 10
FIELD SUPERVISOR D.S.
DRILLER H.J.
PREP. D.S.

DRAWING NO.

LEGEND

2" DIA. SPLIT TUBE

2" SHELBY TUBE

2" SPLIT TUBE

2" DIA. CONE

CASING

2" SHELBY

1/2 UNCONFINED COMPRESSION (QU)

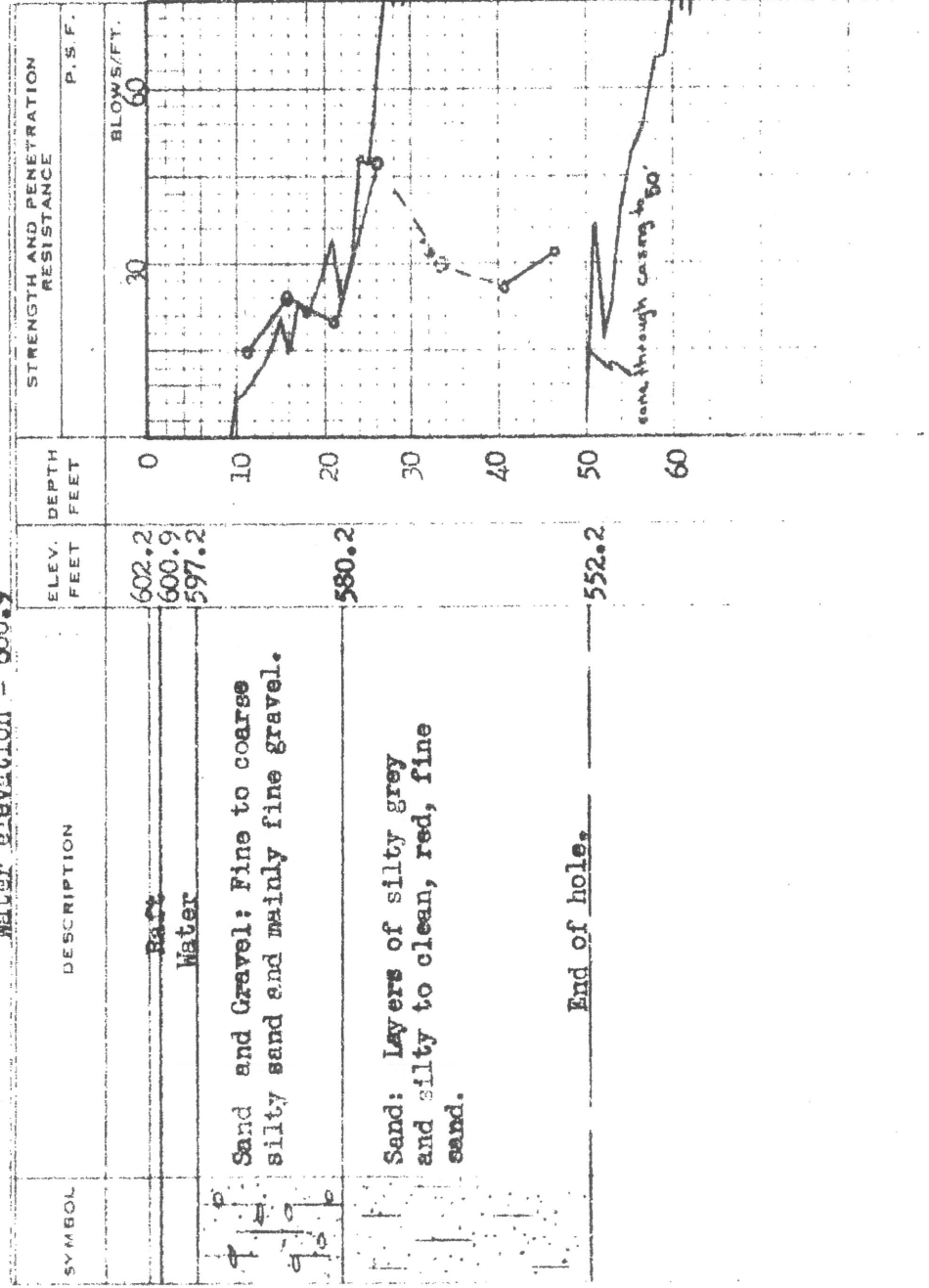
VANE TEST (C) AND SENSITIVITY (S)

NATURAL MOISTURE AND

LIQUIDITY INDEX

LIQUID LIMIT

PLASTIC LIMIT



CONSISTENCY	SAMPLE	NATURAL UNIT WT. P.C.F.
MOIST. CONTENT - % DRY WT.		
	SS1	
	SS2	
	SS3	
	SS4	
	SS5	
	SS6	
	SS7	

Appendix E
Site Photographs



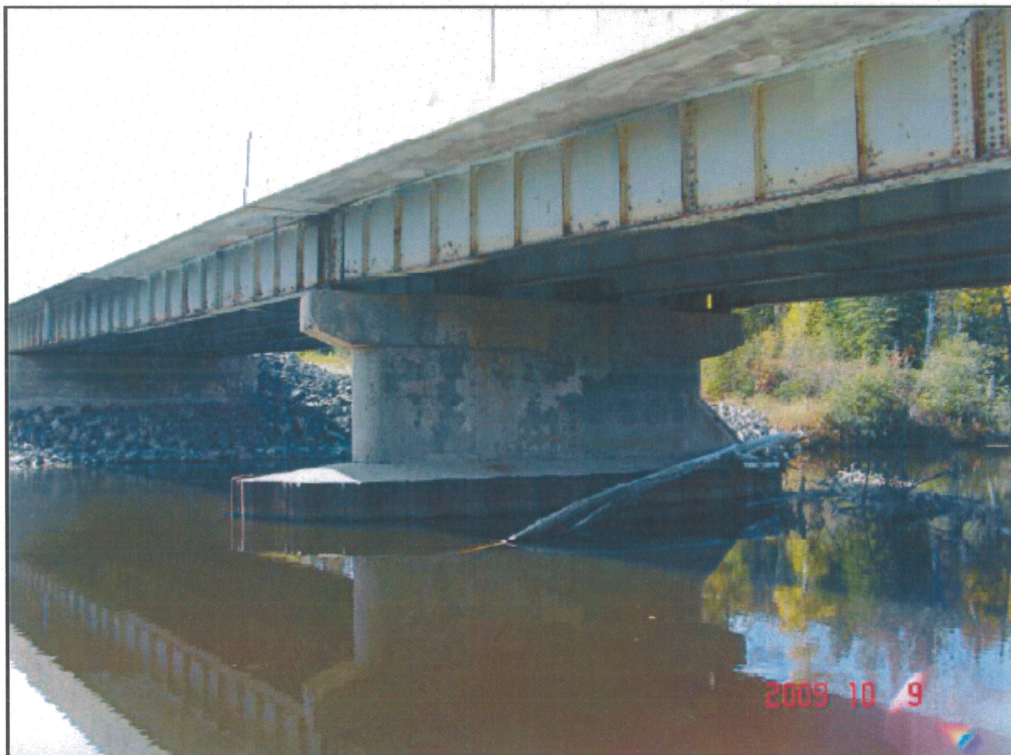
Photograph 1E – Highway 17 at Jackfish River bridge, looking west



Photograph 2E – Jackfish River bridge east abutment



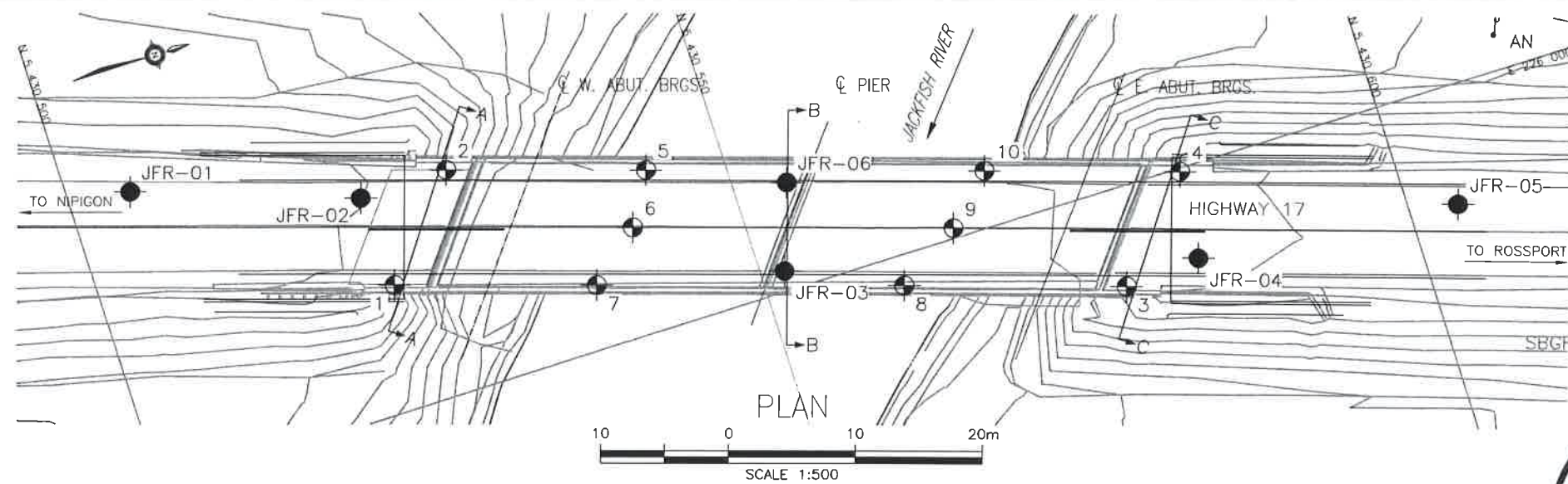
Photograph 3E – Jackfish River bridge west abutment



Photograph 4E – Jackfish River bridge pier

Appendix F

Drawing titled "Borehole Locations and Soil Strata"



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



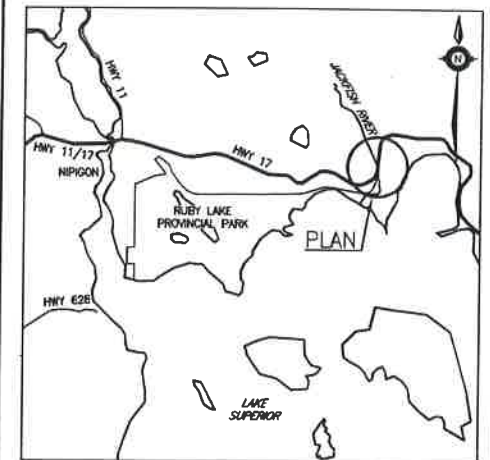
CONT No
WP No 465-00-01

HIGHWAY 17
JACKFISH RIVER
BRIDGE REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET
33

MRC MCCORMICK RANKIN
A member of **MMM GROUP**

THURBER ENGINEERING LTD.



LEGEND

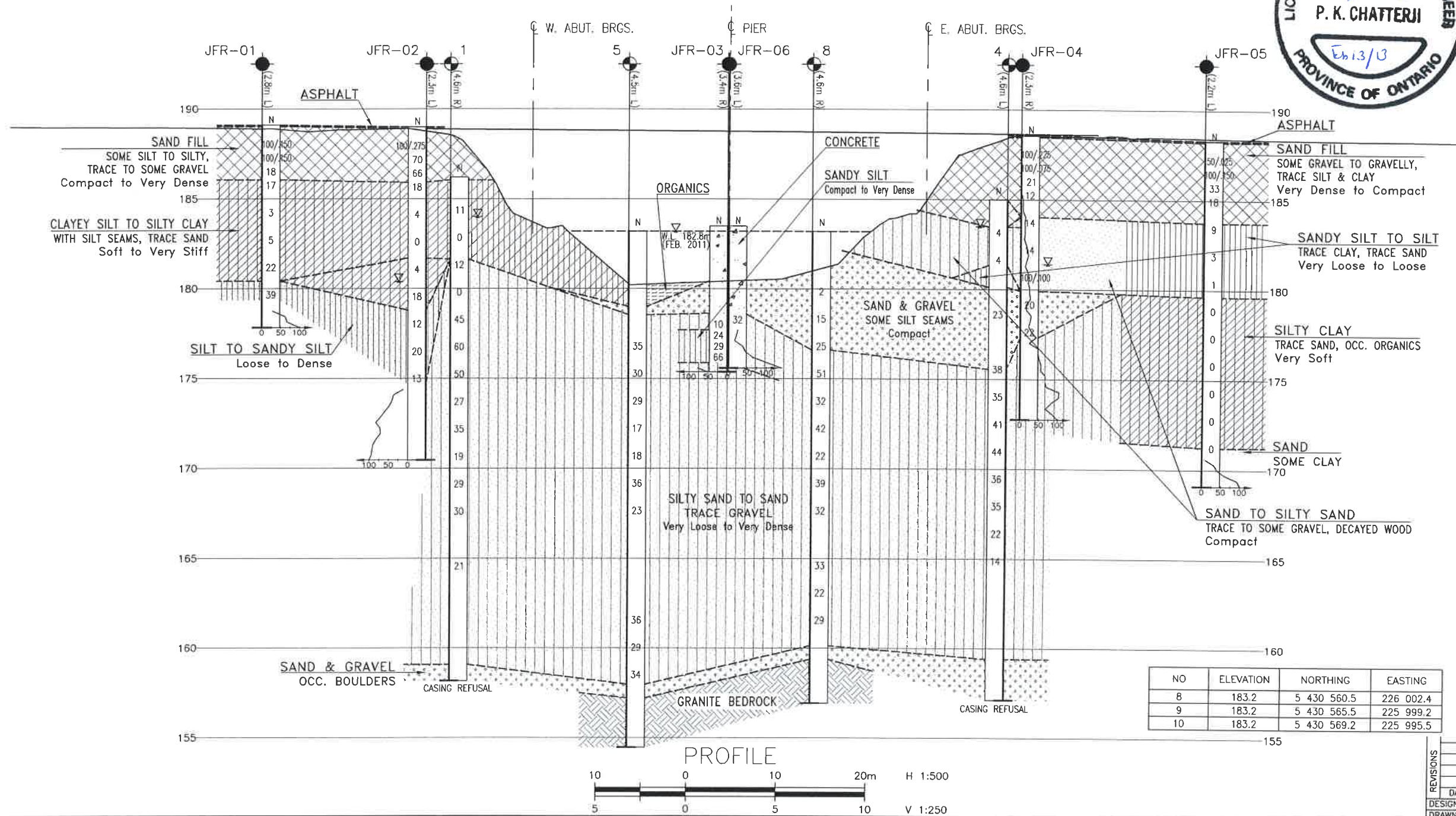
- ◆ Borehole (Current investigation by Thurber)
- ◆ Borehole (Previous investigation by others)
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- W Water Level
- W Head Artesian Water
- W Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
JFR-01	189.1	5 430 504.9	225 976.5
JFR-02	189.0	5 430 522.0	225 982.6
JFR-03	183.5	5 430 551.9	225 998.4
JFR-04	188.6	5 430 583.1	226 007.3
JFR-05	188.3	5 430 603.8	226 009.3
JFR-06	183.5	5 430 554.2	225 991.7
1	186.2	5 430 522.4	225 990.0
2	185.1	5 430 529.1	225 982.5
3	184.6	5 430 577.0	226 007.7
4	185.0	5 430 583.8	226 000.3
5	183.2	5 430 544.0	225 987.4
6	183.2	5 430 541.6	225 991.4
7	183.2	5 430 537.5	225 994.9

NOTES

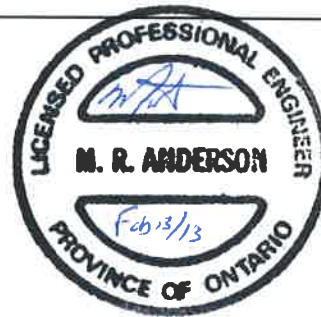
- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- Locations of Boreholes 1 to 10 are approximate

GEOCRES No. 52H-18



NO	ELEVATION	NORTHING	EASTING
8	183.2	5 430 560.5	226 002.4
9	183.2	5 430 565.5	225 999.2
10	183.2	5 430 569.2	225 995.5

DATE	BY	DESCRIPTION
DESIGN	LRB	CHK PKC CODE
DRAWN	MFA	CHK LRB SITE
LOAD	STRUCT	DATE JAN. 2013
DWG	2	

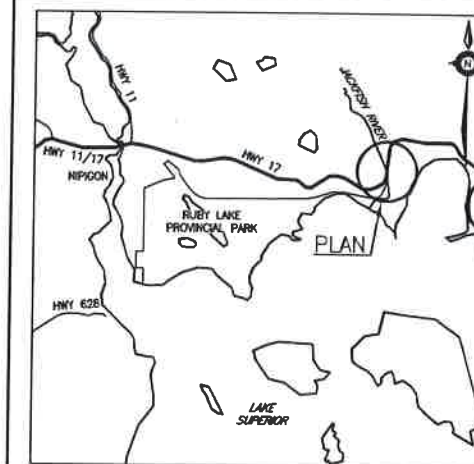


METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
WP No 465-00-01

HIGHWAY 17
JACKFISH RIVER
BRIDGE REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET
34



KEYPLAN

LEGEND

	Borehole (Current investigation by Thurber)
	Borehole (Previous investigation by others)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

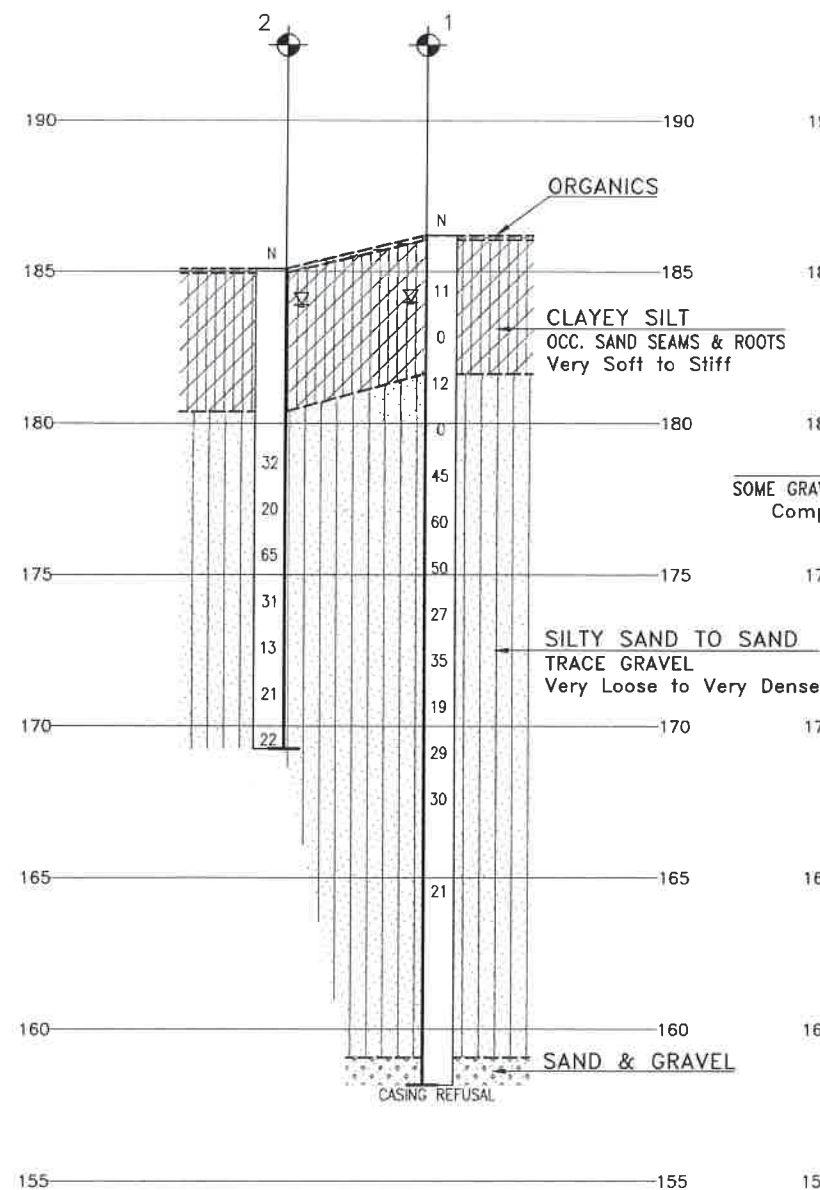
NO	ELEVATION	NORTHING	EASTING
JFR-01	189.1	5 430 504.9	225 976.5
JFR-02	189.0	5 430 522.0	225 982.6
JFR-03	183.5	5 430 551.9	225 998.4
JFR-04	188.6	5 430 583.1	226 007.3
JFR-05	188.3	5 430 603.8	226 009.3
JFR-06	183.5	5 430 554.2	225 991.7
1	186.2	5 430 522.4	225 990.0
2	185.1	5 430 529.1	225 982.5
3	184.6	5 430 577.0	226 007.7
4	185.0	5 430 583.8	226 000.3
5	183.2	5 430 544.0	225 987.4
6	183.2	5 430 541.6	225 991.4
7	183.2	5 430 537.5	225 994.9

NOTES

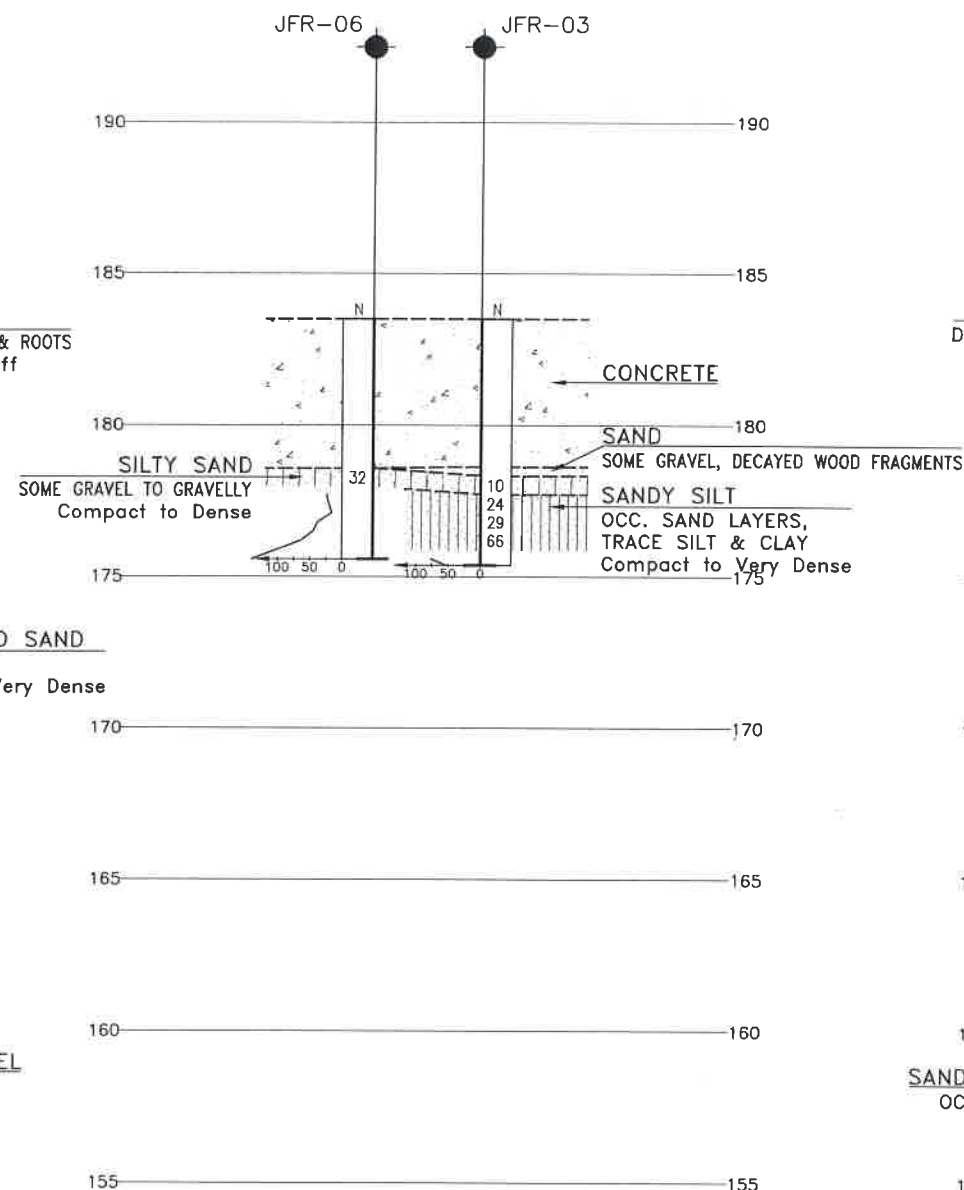
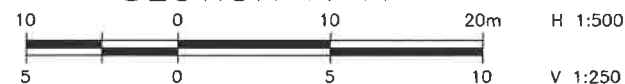
- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- Locations of Boreholes 1 to 10 are approximate

GEOCRES No. 52H-18

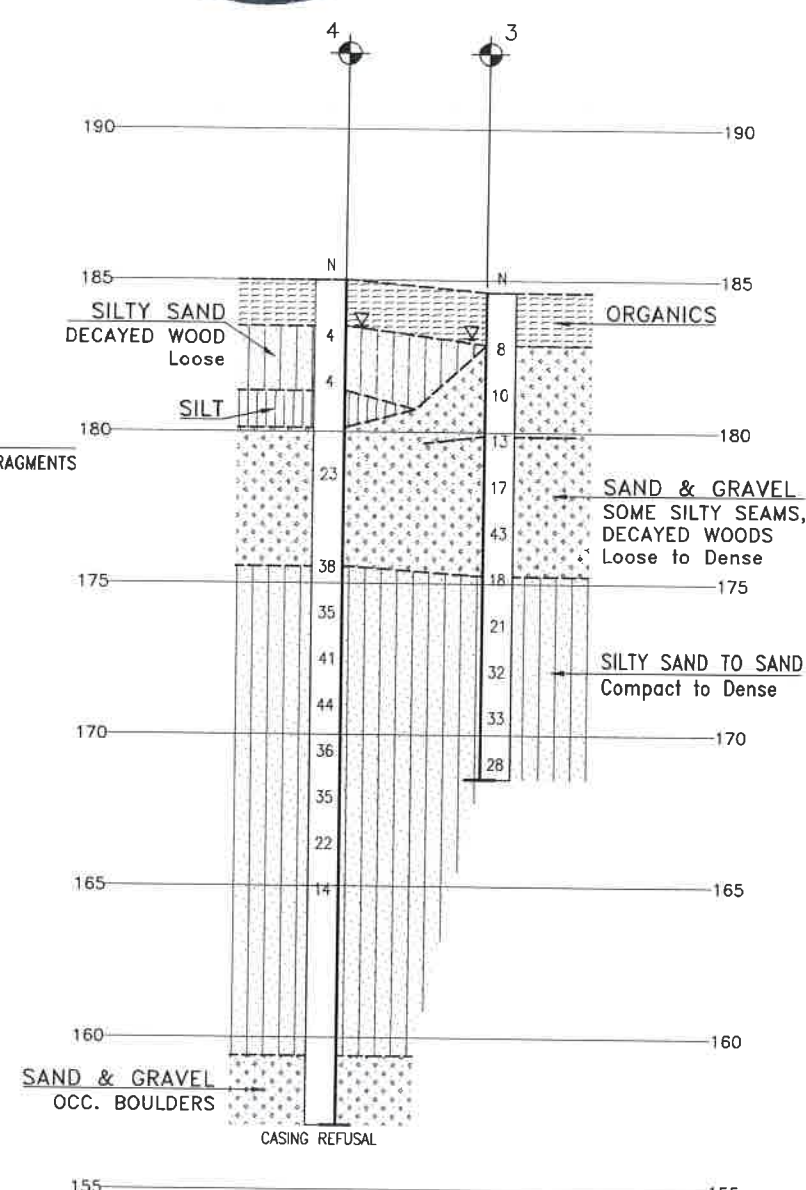
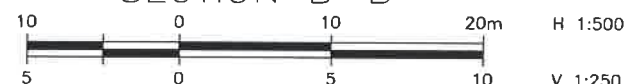
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NO	ELEVATION	NORTHING	EASTING
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9	183.2	5 430 565.5	225 999.2
10	183.2	5 430 569.2	225 995.5