

**FOUNDATION INVESTIGATION REPORT  
GRAVEL RIVER BRIDGE REPLACEMENT  
HIGHWAY 17  
THUNDER BAY DISTRICT, ONTARIO  
W.P. 6106-10-01, SITE #48C-18**

**Geocres Number: 42D-34**

**Report to**

**MMM GROUP LIMITED**

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

December 15, 2014  
File: 19-1351-197

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

## TABLE OF CONTENTS

1	INTRODUCTION .....	1
2	SITE DESCRIPTION .....	1
3	SITE INVESTIGATION AND FIELD TESTING.....	2
4	LABORATORY TESTING .....	3
5	DESCRIPTION OF SUBSURFACE CONDITIONS .....	3
5.1	Pavement and Concrete.....	3
5.2	Fill .....	4
5.3	Sand.....	4
5.4	Sand and Silt .....	4
5.5	Silt .....	5
5.6	Silty Clay .....	5
5.7	Lower Silt.....	6
5.8	Sand and Gravel .....	7
5.9	Bedrock .....	7
5.10	Water Levels .....	8
6	MISCELLANEOUS .....	9

## Appendices

Appendix A	Record of Borehole Sheets
Appendix B	Laboratory Test Results
Appendix C	Borehole Logs and Location Plan from Previous Investigation
Appendix D	Site Photographs
Appendix E	Borehole Locations and Soil Strata Drawing

**FOUNDATION INVESTIGATION REPORT  
GRAVEL RIVER BRIDGE REPLACEMENT  
HIGHWAY 17  
THUNDER BAY DISTRICT, ONTARIO  
W.P. 6106-10-01, SITE #48C-18**

**Geocres Number: 42D-34**

**PART 1: FACTUAL INFORMATION**

**1 INTRODUCTION**

This report presents the factual findings obtained from a foundation investigation conducted for the proposed replacement of the Gravel River Bridge on Highway 17, located in the District of Thunder Bay.

The purpose of the investigation was to explore the subsurface conditions at the site, and based on the data obtained, to provide a borehole location plan, record of borehole sheets, a 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 MMM Group Limited, under the Ministry of Transportation Ontario (MTO) Agreement Number 6010-E-0011.

A previous foundation investigation was carried out at this site prior to construction of the existing bridge (Foundation Investigation, Gravel River Crossing, T. C. H. No. 17, District No. 19; prepared by Trow Soderman and Associates; dated November 17 1958; Geocres No. 42D-2). The information presented in the above report was reviewed and incorporated in the current investigation, and the borehole logs and location plan are provided in Appendix C for information purposes.

**2 SITE DESCRIPTION**

The existing Gravel River Bridge is located on Highway 17 approximately 45 km (by road) west of Schreiber and 47 km (by road) east of Nipigon, Ontario. The Gravel River meanders southerly into Lake Superior. The bridge site is located at the apex of a horse-shoe shaped river bend and less than 1 km northeast of the river mouth along the lake shore.

The existing bridge is a two-span structure supported on concrete abutments and pier. Each span is approximately 26 m in length. The approach embankments are about 2.5 m high. A sheet pile wall extends south from the west abutment and a failed sheet pile wall is evident at the north end of the west abutment.

The area surrounding the bridge site is generally flat and heavily treed with occasional clearings for residential and commercial usage and gravel pits along the highway. The land to the south is characteristic of a river flood plain along the shoreline of Lake Superior. Photographs of the bridge and surrounding area are presented in Appendix D.

The site lies within the Canadian Shield, which is characterized by Pre-Cambrian igneous and metamorphic bedrock typically occurring as rounded knobs and ridges where exposed. According to Canadian Geological Survey (CGS) data, the bedrock at this site generally consists of massive to foliated granodiorite to granite of Wawa Subprovince. The bedrock is overlain by thick deposits of silt and clay (glaciolacustrine deposits) which underlie deltaic sands along the river channel.

### 3 SITE INVESTIGATION AND FIELD TESTING

The previous foundation investigation for the existing bridge consisted of advancing seven sampled boreholes (Boreholes 1 to 7) with dynamic cone penetration tests performed adjacent to each borehole location and/or at the bottom of borehole except for Borehole 3. Two boreholes (Boreholes 3 and 4) were drilled in the river and the remaining five on land. Bedrock was encountered in Boreholes 1, 3 and 6, and proved by coring a minimum of 1.8 m.

The current site investigation and field testing for this project were carried out during the period of May 8 to 13, 2014. A total of five sampled boreholes, identified as GRB-01 to GRB-05, were advanced to depths ranging from 9.8 to 46.3 m below the ground surface or the bridge deck surface. Dynamic cone penetration tests (DCPT) were conducted from the bottom of sampled boreholes GRB-02 to GRB-04 to depths ranging from 48.8 to 55.7 m below the ground surface. DCPT refusal was encountered in two boreholes. Details of the borehole locations, drilling depths and completion details are summarized in Table 3.1 below.

**Table 3.1 – Borehole Summary**

Location	Boreholes	Sampling/DCPT Depth (m)	Completion Details
West Approach	GRB-01	9.8	Borehole backfilled with bentonite holeplug to 0.1 m, then cold patch asphalt to ground surface.
West Abutment	GRB-02	43.3/55.7	Standpipe piezometer consisting of 19 mm diameter Schedule 40 PVC pipe with a 3.0 m slotted screen installed at 36.6 m, filter sand to 32.3 m, bentonite holeplug to 0.1 m, and then cold patch asphalt to ground surface.
Pier	GRB-03	46.3/52.6 (40.1/46.4)*	Borehole backfilled with sand and bentonite to river bottom.
East Abutment	GRB-04	40.2/48.8	Standpipe piezometer consisting of 19 mm diameter Schedule 40 PVC pipe with a 3.0 m slotted screen installed at 32.0 m, filter sand to 28.0 m, bentonite holeplug to 0.1 m, and then cold patch asphalt to ground surface.
East Approach	GRB-05	9.8	Borehole backfilled with bentonite holeplug to 0.2 m, then cold patch asphalt to ground surface.

Note: \* Sampling/DCPT depth below the river bottom.

The approximate locations of the boreholes are shown on the attached Borehole Locations and Soil

Strata Drawing included in Appendix E.

All boreholes were advanced using a CME75 truck-mounted drill rig in combination with NW casing and wash boring methods to advance the boreholes in the overburden. Samples of the overburden soils were obtained from the boreholes at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT).

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 samples for transport to Thurber's laboratory for further examination and testing.

Groundwater conditions in the open boreholes were observed during the drilling operations. Standpipe piezometers consisting of 19 mm PVC pipes with a 3.0 m slotted screen were installed in Boreholes GRB-02 and GRB-04. Following the final water level reading, the piezometers were decommissioned in general accordance with MOE Regulation 903.

#### **4 LABORATORY TESTING**

The recovered soil samples were subjected to visual identification (VI) and to natural moisture content determination. The results of this testing are shown on the Record of Borehole sheets included in Appendix A. Selected samples were also subjected to gradation analysis and Atterberg Limits testing (where applicable), and the results of this testing program are summarized on the Record of Borehole sheets in Appendix A and shown on the figures included in Appendix B.

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

Reference is made to the Record of Borehole sheets included in Appendix A. Details of the encountered stratigraphy are presented in this appendix and on the "Borehole Locations and Soil Strata" drawing in Appendix E. Borehole logs from the previous investigation (referenced hereafter as previous boreholes) were considered in the current investigation and are provided in Appendix C. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.

The subsurface stratigraphy encountered below the existing embankment fill at the site generally consists of a surficial layer of sand and silt overlying a layer of varved silty clay transitioning to clayey silt to silt which contains sand and clay seams and pockets. Bedrock was encountered in the previous boreholes beneath the deep silt deposit. More detailed descriptions of the individual strata are presented below.

##### **5.1 Pavement and Concrete**

Asphalt pavement was encountered in all boreholes drilled in the current investigation. The thickness of the asphalt ranged from 50 to 100 mm in the boreholes.

Concrete was encountered in Borehole GRB-03 advanced from the bridge deck. The thickness of the concrete was 190 mm.

## 5.2 Fill

Existing embankment fill was encountered below the asphalt pavement in Boreholes GRB-01 to GRB-05 except GRB-03. The brown fill is mainly composed of sand with trace to some gravel and trace silt. The thickness of the fill ranged from 4.0 to 5.6 m, with the base of the fill at Elev. 182.7 to 184.1.

SPT 'N' values recorded in the fill ranged from 8 to 57 blows per 0.3 m penetration, indicating a loose to very dense relative density. The 'N' values generally decreased with depth. An SPT 'N' value of 50 blows for 0.075 m penetration was recorded in Borehole GRB-01 at 2.3 m depth, indicating the presence of cobbles. Moisture contents of the fill ranged from 7 to 26% with typical values between 10 and 20%.

The results of grain size analyses conducted on fill samples are provided on the Record of Borehole sheets in Appendix A and illustrated in Figure B1 of Appendix B. The test results are summarized as follows:

Gravel	2 to 18%
Sand	74 to 92%
Silt & Clay	2 to 10%

## 5.3 Sand

A light brown to brown native sand layer was encountered at the river bottom in Borehole GRB-03 and below the fill in Borehole GRB-04 in the current study, and at the ground surface in the previous Borehole 7. The thickness of the sand layer ranged from 1.5 to 6.4 m with the base at Elev. 179.9 to 184.3.

SPT 'N' values recorded in the sand ranged from 2 to 5 blows per 0.3 m penetration at the river bottom, indicating a very loose to loose relative density. SPT 'N' values recorded in the sand encountered in the on-land boreholes ranged from 13 to 22 blows per 0.3 m penetration, indicating a compact relative density. Moisture contents of the sand ranged from 18 to 23%.

The results of one grain size analysis conducted on a sand sample are provided on the Record of Borehole sheets in Appendix A and illustrated in Figure B3 of Appendix B. The test results indicate that the sand contains 3% gravel, 91% sand and 6% silt and clay.

## 5.4 Sand and Silt

A layer of brown to grey sand and silt was encountered below the fill in Boreholes GRB-01, GRB-02 and GRB-05, below the sand in Boreholes GRB-03, GRB-04 and 7, and at the ground surface or river bottom in the previous boreholes 1 to 6. The layer was generally described as silty fine sand to fine sandy silt in boreholes 1 to 7.

The thickness of the layer ranged from 2.7 to 6.1 m in the current boreholes and from 4.9 to 10.7 m in the previous boreholes. The lower boundary of the sand and silt was encountered at Elev. 176.3 to 181.0 in the current boreholes and at Elev. 175.3 to 178.2 in the previous

boreholes. Borehole GRB-05 was terminated within the sand and silt at 9.8 m depth (Elev. 178.1).

SPT 'N' values recorded in the sand and silt ranged from 2 to 24 blows per 0.3 m penetration, indicating a very loose to compact relative density. Measured natural moisture contents ranged from 21 to 33% in the layer.

The results of grain size analyses conducted on samples of the sand and silt deposit are provided on the Record of Borehole sheets in Appendix A and plotted in Figure B2 of Appendix B. The test results are summarized as follows:

Gravel	0%
Sand	30 to 83%
Silt	16 to 65%
Clay	1 to 7%

### 5.5 Silt

A grey silt layer was encountered below the sand and silt in Boreholes GRB-01 and GRB-02. The thickness of the silt layer was 1.7 m with the base at Elev. 177.9 in Borehole GRB-02. Borehole GRB-01 was terminated within the silt at 9.8 m depth (Elev. 178.4).

SPT 'N' values recorded in the silt ranged from 6 to 8 blows per 0.3 m penetration, indicating a loose relative density. Moisture contents of the silt ranged from 27 to 30%.

The results of one grain size analysis conducted on a silt sample is provided on the Record of Borehole sheets in Appendix A and illustrated in Figure B4a of Appendix B. The test results indicate that the silt sample contains 95% silt and 5% clay.

### 5.6 Silty Clay

A layer of grey silty clay was encountered below the silt in Borehole GRB-02, below the sand and silt in Boreholes GRB-03, GRB-04 and all previous boreholes. The silty clay was described as varved in the previous boreholes. Where fully penetrated, the thickness of the layer ranged from 8.0 to 11.5 m with the lower boundary lying at depths of 14.7 to 23.2 m (Elev. 164.8 to 167.9). Borehole 7 was terminated within the silty clay at 14.6 m depth (Elev. 176.1).

SPT 'N' values recorded in the silty clay in the current boreholes ranged from 1 to 6 blows per 0.3 m penetration. Field vane shear tests (VST) measured undrained shear strengths ranging from 18 to 31 kPa. Based on the SPT and VST data, the consistency of the silty clay varies from soft to firm.

Field vane shear tests (VST) conducted in the previous boreholes measured undrained shear strengths ranging from 17 to 85 kPa, indicating soft to stiff consistency. Sensitivity of the silty clay, calculated as a ratio of undisturbed strength to remoulded strength, ranged from 2 to 5, suggesting that the silty clay is low to medium sensitive.

The results of grain size analyses conducted on samples of the silty clay are provided on the Record of Borehole sheets in Appendix A, and illustrated in Figure B5 of Appendix B. The results are summarized as follows:

Gravel	0%
Sand	0%
Silt	18 to 43%
Clay	57 to 82%

The results of Atterberg Limits tests conducted on samples of the silty clay are provided on the Record of Borehole sheets in Appendix A and illustrated in Figure B6 of Appendix B. The results indicated that the deposit has plastic limits ranging from 17 to 25% and liquid limits ranging from 28 to 59%, suggesting low to high plasticity. Plasticity indices, the difference between the plastic limit and liquid limit, ranged from 11 to 34%.

Natural moisture content of the silty clay ranged from 44 to 62% in the previous boreholes and 29 to 61% in the current boreholes.

## 5.7 Lower Silt

A layer of grey silt was encountered below the silty clay in Boreholes GRB-02 to GRB-04, and in previous boreholes 1 to 6. The silt is locally clayey and contains seams of sand or clay throughout the layer. In Boreholes GRB-02 to GRB-04, sampling was terminated in the silt at depths of 40.2 to 46.3 m. Sampling in Boreholes 1 to 6 was terminated at depths of 18.9 to 33.9 m.

Dynamic cone penetration tests were carried out below the sampled portion of Boreholes GRB-02 to GRB-04. The DCPTs in Boreholes GRB-02 and GRB-03 were terminated upon refusal at depths of 55.7 and 52.6 m (Elev. 132.6 and 135.5). In previous Boreholes 1, 3 and 6, the lower boundary of the silt was encountered at depths of 47.5 to 54.3 m (Elev. 136.0 to 131.9). Based on these depths, the thickness of the silt deposit ranges from 31.1 to 35.3 m.

SPT 'N' values recorded in the silt layer ranged from 9 to 30 blows per 0.3 m penetration, indicating a loose to dense relative density, typically compact. Three consecutive SPT 'N' values of zero blows per 0.3 m penetration were encountered in Borehole GRB-02 at depths of 36.6 to 43.3 m, and an SPT 'N' value of 1 blow per 0.3 m penetration was encountered in Borehole GRB-04 at a depth of 36.6 m, both indicating presence of very loose zones. Natural moisture contents of the silt ranged from 20 to 33%.

The results of grain size analyses conducted on silt samples are provided on the Record of Borehole sheets in Appendix A, and plotted in Figures B4a and B4b of Appendix B. The results are summarized as follows:

	<u>Silt</u>	<u>Clayey Silt</u>
Gravel	0%	0%
Sand	0 to 8%	0 to 6%



Silt	87 to 94%	66 to 85%
Clay	5 to 11%	15 to 28%

## 5.8 Sand and Gravel

A layer of coarse sand and gravel was encountered below the silt layer and over the bedrock in the previous borehole 1. The layer was about 0.6 m thick with a lower boundary at 50.6 m depth (Elev. 135.4).

## 5.9 Bedrock

Bedrock was encountered below the sand and gravel in previous Borehole 1 and below the silt in Boreholes 3 and 6. Refusal to DCPT advance was encountered on probable bedrock in Boreholes GRB-02 and GRB-03 during the current investigation. Table 5.1 summarizes the depths and elevations to bedrock and probable bedrock determined in the boreholes.

**Table 5.1: Depths/Elevations of Bedrock and Probable Bedrock (DCPT Refusal)**

Location	Borehole	Bedrock / Probable Bedrock		Basis
		Depth (m)	Elevation	
West Abutment	GRB-02	55.7	132.6	Refusal to DCPT
	6	54.3	131.9	Proven by coring
Pier	GRB-03	46.4 *	135.5	Refusal to DCPT
	3	46.9 *	135.7	Proven by coring
East Abutment	1	50.6	135.4	Proven by coring

Note: \* Depth below the river bottom.

The bedrock in the previous boreholes was proven by coring. The bedrock recovered in the cores was described as reddish grey granite in Boreholes 1 and 3, and red shale or weathered slate in Borehole 6.

### 5.10 Water Levels

The water levels in the boreholes were measured upon completion. However, water was used during wash boring operations and therefore the measured water levels may not reflect prevailing groundwater levels at the site. Standpipe piezometers were installed in Boreholes GRB-02 and GRB-04 to monitor groundwater levels after drilling. The water levels measured in the open boreholes upon completion of drilling and in the piezometers are summarized in Table 5.2. The water level measurements in the previous boreholes are also provided.

**Table 5.2: Water Level Measurements**

Borehole	Date	Water Level (m)		Remark
		Depth	Elevation	
GRB-02	May 11, 2014	4.0	184.3	In piezometer
	May 13, 2014	2.3	186.0	
GRB-03	May 11, 2014	-	184.5	River level
GRB-04	May 11, 2014	4.4	183.6	In piezometer
	May 13, 2014	2.6	185.4	
1	October 1958	2.6	183.4	In open borehole
2		1.8	183.4	In open borehole
3 & 4		-	183.3	River level
5		0.9	185.0	In open borehole
6		2.4	183.7	In open borehole
7		5.6	185.1	In open borehole

The groundwater levels measured in the piezometers were up to 1.5 m above the river level at the time of the investigation, indicating the presence of artesian pressures in the underlying silt deposit. Artesian pressure with a head of 2.4 m above ground surface and a flow of about one litre per second was reported from the bedrock in previous Borehole 3.

The two-year high river level shown on the GA drawing is at Elev. 183.6. The river level was at Elev. 184.5 during the current study. The river and groundwater levels are expected to fluctuate seasonally and subject to precipitation patterns, and may vary from the levels presented above.

## 6 MISCELLANEOUS

The borehole locations were selected and established in the field by Thurber Engineering Ltd. relative to site features. The co-ordinates and ground surface elevations at the boreholes were inferred from the MMM Group Limited General Arrangement drawing.

Eastern Ontario Diamond Drilling Ltd. of Hawkesbury, Ontario supplied the drill rig and conducted the drilling, sampling and in-situ testing operations. A truck-mounted CME-75 drill rig was used for the duration of the investigation.

Belanger Construction carried out lane closure and flagging on the highway during the field work.

The drilling and sampling operations were supervised in the field by Ms. Eckie Siu of Thurber on a full-time basis. Mr. Mark E. Farrant, P.Eng., provided overall supervision and direction of the field operations.

Interpretation of the data and preparation of the report was carried out by Mr. Keli Shi, P.Eng. The report was reviewed by Mr. Murray Anderson, P.Eng. and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations projects.

### THURBER ENGINEERING LTD.

Keli Shi, P.Eng.  
Geotechnical Engineer



Murray R. Anderson, P.Eng.  
Associate, Senior Foundation Engineer



Dr. P.K. Chatterji, P.Eng.  
Review Principal



## **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 $W_L < 50\%$	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


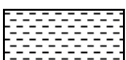

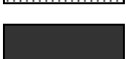

### ROCK WEATHERING CLASSIFICATION

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

### DISCONTINUITY SPACING

<b>Bedding</b>	<b>Bedding Plane Spacing</b>
Very thickly bedded	Greater than 2m
Thickly bedded	0.6 to 2m
Medium bedded	0.2 to 0.6m
Thinly bedded	60mm to 0.2m
Very thinly bedded	20 to 60mm
Laminated	6 to 20mm
Thinly Laminated	Less than 6mm

### SYMBOLS

	CLAYSTONE
	SILTSTONE
	SANDSTONE
	COAL
	BEDROCK

### STRENGTH CLASSIFICATION

<b>Rock Strength</b>	<b>Approximate Uniaxial Compressive Strength</b>		<b>Field Estimation of Hardness*</b>
	<b>(MPa)</b>	<b>(psi)</b>	
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

### TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length
Solid Core Recovery:(SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run
Rock Quality Designation:(RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a % 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 GRB-01

1 OF 2

METRIC

WP# 6106-10-01 LOCATION Gravel River Bridge N 5 420 511.4 E 248 442.4 ORIGINATED BY ES  
 HWY 17 BOREHOLE TYPE NW Casing & Wash Boring COMPILED BY AN  
 DATUM Geodetic DATE 2014.05.13 - 2014.05.13 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								<div><div><div>20406080100</div><div></div></div></div> <div>○ UNCONFINED + FIELD VANE</div> <div>● QUICK TRIAXIAL × LAB VANE</div>					
								<div><div><div>PLASTIC LIMIT</div><div>NATURAL MOISTURE CONTENT</div><div>LIQUID LIMIT</div></div><div><div>w<sub>P</sub></div><div>w</div><div>w<sub>L</sub></div></div></div> <div>WATER CONTENT (%)</div>					
188.2	GROUND SURFACE												
0.0	ASPHALT: (50mm)												
	SAND, trace gravel, trace silt Dense to Compact Brown Moist (FILL)			GS			188						
			1	SS	34		187						5 90 5 (SI+CL)
			2	SS	33		186						
	Occasional cobbles		3	SS	50/ 0.075		185						
			4	SS	19		184						
184.1							183						
4.1	SAND and SILT, trace clay Loose to Compact Grey Wet		5	SS	8		182						0 60 33 7
			6	SS	19		181						
181.0							180						
7.2	SILT, trace sand Loose Grey Moist to Wet		7	SS	8		179						
			8	SS	8								
178.4													
9.8	END OF BOREHOLE AT 9.8m.												

Continued Next Page

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



# RECORD OF BOREHOLE No GRB-01

2 OF 2

METRIC

WP# 6106-10-01 LOCATION Gravel River Bridge N 5 420 511.4 E 248 442.4 ORIGINATED BY ES  
 HWY 17 BOREHOLE TYPE NW Casing & Wash Boring COMPILED BY AN  
 DATUM Geodetic DATE 2014.05.13 - 2014.05.13 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	W P	W	W L	WATER CONTENT (%)		
	Continued From Previous Page BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.1m, THEN ASPHALT TO SURFACE.													

# RECORD OF BOREHOLE No GRB-02

1 OF 6

METRIC

WP# 6106-10-01 LOCATION Gravel River Bridge N 5 420 504.0 E 248 450.8 ORIGINATED BY ES  
HWY 17 BOREHOLE TYPE NW Casing & Wash Boring COMPILED BY AN  
DATUM Geodetic DATE 2014.05.08 - 2014.05.09 CHECKED BY MEF

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
188.3	GROUND SURFACE													
0.0	ASPHALT: (50mm)													
	SAND, trace gravel, trace silt Very Dense to Compact Brown Moist (FILL)			GS										
			1	SS	56									
			2	SS	57									
			3	SS	51									
			4	SS	21									
			5	SS	10									
182.7														
5.6	SAND and SILT, trace clay Compact to Loose Grey Wet													
			6	SS	12									
			7	SS	3									
179.6														
8.7	SILT, trace clay Loose Grey Moist to Wet													
			8	SS	6									

Continued Next Page

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

# RECORD OF BOREHOLE No GRB-02

2 OF 6

METRIC

WP# 6106-10-01 LOCATION Gravel River Bridge N 5 420 504.0 E 248 450.8 ORIGINATED BY ES  
 HWY 17 BOREHOLE TYPE NW Casing & Wash Boring COMPILED BY AN  
 DATUM Geodetic DATE 2014.05.08 - 2014.05.09 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	WATER CONTENT (%) 20 40 60			
177.9							178					
10.4	Silty CLAY Soft to Firm Grey Moist		9	SS	3							
							177	+				
			10	SS	3		176					
							175	+				
			11	SS	1		174					0 0 18 82
							173	+				
			12	SS	1		172					
							171	+				
			13	SS	1		170					
							169	+				
	Occasional sand seams		14	SS	2							

Continued Next Page

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

# RECORD OF BOREHOLE No GRB-02

3 OF 6

METRIC

WP# 6106-10-01 LOCATION Gravel River Bridge N 5 420 504.0 E 248 450.8 ORIGINATED BY ES  
 HWY 17 BOREHOLE TYPE NW Casing & Wash Boring COMPILED BY AN  
 DATUM Geodetic DATE 2014.05.08 - 2014.05.09 CHECKED BY MEF

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								
							20	40	60	80	100					
	Continued From Previous Page															
167.9							168									
20.4	SILT, trace clay Compact to Very Loose Grey Moist to Wet		15	SS	14		167									0 0 91 9
							166									
							165									
							164									
	Occasional clay seams		16	SS	19		163									
							162									
							161									
			17	SS	15		160									
							159									

Continued Next Page

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

20  
15  
10  
(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No GRB-02

4 OF 6

METRIC

WP# 6106-10-01 LOCATION Gravel River Bridge N 5 420 504.0 E 248 450.8 ORIGINATED BY ES  
 HWY 17 BOREHOLE TYPE NW Casing & Wash Boring COMPILED BY AN  
 DATUM Geodetic DATE 2014.05.08 - 2014.05.09 CHECKED BY MEF

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						
Continued From Previous Page														
	Occasional clay pockets		18	SS	15		158							0 0 81 19
							157							
							156							
	Occasional clay seams		19	SS	30		155							
							154							
							153							
							152							
							151							
			20	SS	0		150							
							149							

Continued Next Page

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

## METRIC

[illegible]

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

# RECORD OF BOREHOLE No GRB-02

6 OF 6

METRIC

WP# 6106-10-01 LOCATION Gravel River Bridge N 5 420 504.0 E 248 450.8 ORIGINATED BY ES  
 HWY 17 BOREHOLE TYPE NW Casing & Wash Boring COMPILED BY AN  
 DATUM Geodetic DATE 2014.05.08 - 2014.05.09 CHECKED BY MEF

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	WATER CONTENT (%)					
	Continued From Previous Page						138 137 136 135 134 133	20 40 60 80 100	20 40 60					
132.6														
55.7	END OF DCPT AT 55.7m UPON REFUSAL. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen.  WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) May 11/ 14 4.0 184.3 May 13/ 14 2.3 186.0													

ONTMT4S 1197.GPJ 2012TEMPLATE(MTO).GDT 11/19/14

# RECORD OF BOREHOLE No GRB-03

1 OF 6

METRIC

WP# 6106-10-01 LOCATION Gravel River Bridge N 5 420 500.7 E 248 481.2 ORIGINATED BY ES  
 HWY 17 BOREHOLE TYPE NW Casing & Wash Boring COMPILED BY AN  
 DATUM Geodetic DATE 2014.05.11 - 2014.05.12 CHECKED BY MEF

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				
188.1	GROUND SURFACE							20 40 60 80 100				
0.0	ASPHALT: (100mm)						188					
187.8	CONCRETE: (190mm), with rebar											
0.3	AIR											
							187					
							186					
							185					
184.5												
3.6	WATER						184					
							183					
							182					
181.9												
6.2	SAND, trace gravel, trace silt Very Loose to Loose Brown Wet		1	SS	4							
	Grey		2	SS	2		181					
			3	SS	5							
179.9							180					
8.2	SAND and SILT, trace clay Loose Grey Wet		4	SS	5							
			5	SS	7		179					

Continued Next Page

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



## METRIC

[illegible]

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

# RECORD OF BOREHOLE No GRB-03

3 OF 6

METRIC

WP# 6106-10-01 LOCATION Gravel River Bridge N 5 420 500.7 E 248 481.2 ORIGINATED BY ES  
 HWY 17 BOREHOLE TYPE NW Casing & Wash Boring COMPILED BY AN  
 DATUM Geodetic DATE 2014.05.11 - 2014.05.12 CHECKED BY MEF

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 (%)  GR   SA   SI   CL				
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										
Continued From Previous Page																		
167.8			12	SS	5		168											
20.3	SILT, trace clay to clayey, trace sand Compact Grey Wet       Occasional clay pockets																	
							167											
			13	SS	13										0   0   89   11			
							166											
			14	SS	19		165											
							164											
			15	SS	15		163											
							162											
						161												
		16	SS	20		160								0   0   79   21				
						159												

Continued Next Page

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

# RECORD OF BOREHOLE No GRB-03

4 OF 6

METRIC

WP# 6106-10-01 LOCATION Gravel River Bridge N 5 420 500.7 E 248 481.2 ORIGINATED BY ES  
 HWY 17 BOREHOLE TYPE NW Casing & Wash Boring COMPILED BY AN  
 DATUM Geodetic DATE 2014.05.11 - 2014.05.12 CHECKED BY MEF

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								
Continued From Previous Page							158									
	Occasional clay seams		17	SS	12		157									
							156									
							155									
				18	SS	18		154								
							153									
							152									
				19	SS	12		151								
							150									
						149										
			20	SS	19											

Continued Next Page

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

20  
15 10 5 0  
(%) STRAIN AT FAILURE

## METRIC

SOIL PROFILE				SAMPLES		GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT			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					PLASTIC LIMIT  w <sub>P</sub>	NATURAL MOISTURE CONTENT  w	LIQUID LIMIT  w <sub>L</sub>		
							○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL						× LAB VANE	WATER CONTENT (%)
	Continued From Previous Page						20	40	60	80	100	20	40	60		
141.8 46.3	End of borehole sampling at 46.3m Start DCPT		21	SS	19		148									0 8 87 5
			22	SS	9		147									
							146									
							145									
							144									
							143									
							142									
							141									
							140									
							139									

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

# RECORD OF BOREHOLE No GRB-03

6 OF 6

METRIC

WP# 6106-10-01 LOCATION Gravel River Bridge N 5 420 500.7 E 248 481.2 ORIGINATED BY ES  
 HWY 17 BOREHOLE TYPE NW Casing & Wash Boring COMPILED BY AN  
 DATUM Geodetic DATE 2014.05.11 - 2014.05.12 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	W P	W	W L	WATER CONTENT (%)		
	Continued From Previous Page						138							
							137							
							136							
135.5 52.6	END OF DCPT AT 52.6m UPON REFUSAL. BOREHOLE BACKFILLED WITH SAND AND BENTONITE TO RIVER BOTTOM.													

# RECORD OF BOREHOLE No GRB-04

1 OF 6

METRIC

WP# 6106-10-01 LOCATION Gravel River Bridge N 5 420 485.9 E 248 516.8 ORIGINATED BY ES  
HWY 17 BOREHOLE TYPE NW Casing & Wash Boring COMPILED BY AN  
DATUM Geodetic DATE 2014.05.10 - 2014.05.11 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
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>					
188.0	GROUND SURFACE																				
0.0 0.1	ASPHALT: (65mm)																				
	SAND, trace gravel, trace silt Dense to Loose Brown Moist (FILL)			GS								○					5	92	3 (SI+CL)		
			1	SS	42							○									
			2	SS	15							○									
			3	SS	19							○									
			4	SS	8							○						2	88	10 (SI+CL)	
183.9																					
4.1	SAND Compact Light Brown Moist		5	SS	22							○									
182.4																					
5.6	SAND and SILT, trace clay Compact Grey Wet		6	SS	10							○									
	Occasional sand seams		7	SS	12							○									
			8	SS	20							○						0	83	16	1

Continued Next Page

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

20  
15  
10  
(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No GRB-04

2 OF 6

METRIC

WP# 6106-10-01 LOCATION Gravel River Bridge N 5 420 485.9 E 248 516.8 ORIGINATED BY ES  
 HWY 17 BOREHOLE TYPE NW Casing & Wash Boring COMPILED BY AN  
 DATUM Geodetic DATE 2014.05.10 - 2014.05.11 CHECKED BY MEF

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					
	Continued From Previous Page							UNCONFINED + FIELD VANE QUICK TRIAXIAL X LAB VANE					
								20 40 60 80 100					
176.3			9	SS	11		177						
11.7	Silty <b>CLAY</b> Soft to Firm Grey Moist						176						
			10	SS	2		175						0 0 43 57
			11	SS	1		174						
			12	SS	1		173						
			13	SS	1		172						
			14	SS	1		171						
							170						
													0 0 29 71
							169						

Continued Next Page

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

20  
15  
10

(%) STRAIN AT FAILURE

## METRIC

[illegible]

(%) STRAIN AT FAILURE



RECORD OF BOREHOLE No GRB-04

4 OF 6

METRIC

WP# 6106-10-01 LOCATION Gravel River Bridge N 5 420 485.9 E 248 516.8 ORIGINATED BY ES  
HWY 17 BOREHOLE TYPE NW Casing & Wash Boring COMPILED BY AN  
DATUM Geodetic DATE 2014.05.10 - 2014.05.11 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	W P	W	W L			
	Continued From Previous Page													
	Occasional clay seams		18	SS	14		157							
							156							
							155							
				19	SS	22		154						
								153						
	Occasional clay seams		20	SS	1		151							
							150							
							149							
				21	SS	9								

Continued Next Page

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

20  
15  
10

(%) STRAIN AT FAILURE

## METRIC

[illegible]

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

## METRIC

[illegible]

# RECORD OF BOREHOLE No GRB-05

1 OF 2

METRIC

WP# 6106-10-01 LOCATION Gravel River Bridge N 5 420 486.9 E 248 531.6 ORIGINATED BY ES  
 HWY 17 BOREHOLE TYPE NW Casing COMPILED BY AN  
 DATUM Geodetic DATE 2014.05.13 - 2014.05.13 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				GR	SA	SI	CL
								○ UNCONFINED      + FIELD VANE	● QUICK TRIAXIAL      × LAB VANE										
187.9	GROUND SURFACE							20	40	60	80	100							
0.0	ASPHALT: (100mm)							20	40	60	80	100							
0.1	SAND, some gravel, trace silt Dense to Loose Brown Moist (FILL)			GS										○					
		1	SS	40										○					
		2	SS	34										○					18 74 8 (SI+CL)
		3	SS	9										○					
			4	SS	11									○					13 85 2 (SI+CL)
183.8																			
4.1	SAND and SILT, trace clay Loose to Compact Grey Wet		5	SS	6									○					
		6	SS	4											○				0 30 65 5
			7	SS	12									○					
			6	SS	24									○					0 59 37 4
178.1																			
9.8	END OF BOREHOLE AT 9.8m.																		

Continued Next Page

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

# RECORD OF BOREHOLE No GRB-05

2 OF 2

METRIC

WP# 6106-10-01 LOCATION Gravel River Bridge N 5 420 486.9 E 248 531.6 ORIGINATED BY ES  
 HWY 17 BOREHOLE TYPE NW Casing COMPILED BY AN  
 DATUM Geodetic DATE 2014.05.13 - 2014.05.13 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	W P	W	W L	WATER CONTENT (%)		
	Continued From Previous Page													
	BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.2m, THEN ASPHALT TO SURFACE.													

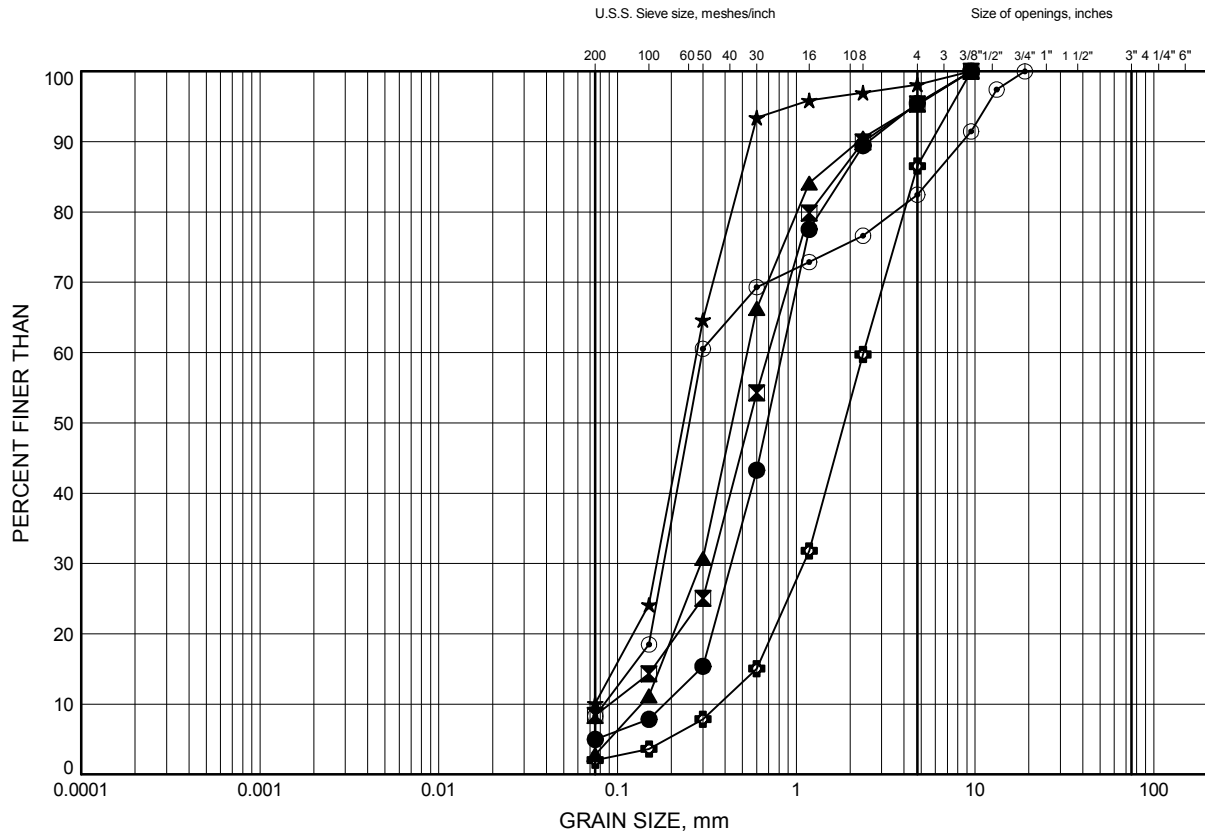
## **Appendix B**

### **Laboratory Test Results**

# Gravel River Bridge 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)
●	GRB-01	1.07	187.13
⊠	GRB-02	1.83	186.47
▲	GRB-04	0.38	187.62
★	GRB-04	3.35	184.65
⊙	GRB-05	1.83	186.07
⊕	GRB-05	3.35	184.55

Date ..October 2014.....  
WP# ..6106-10-00.....

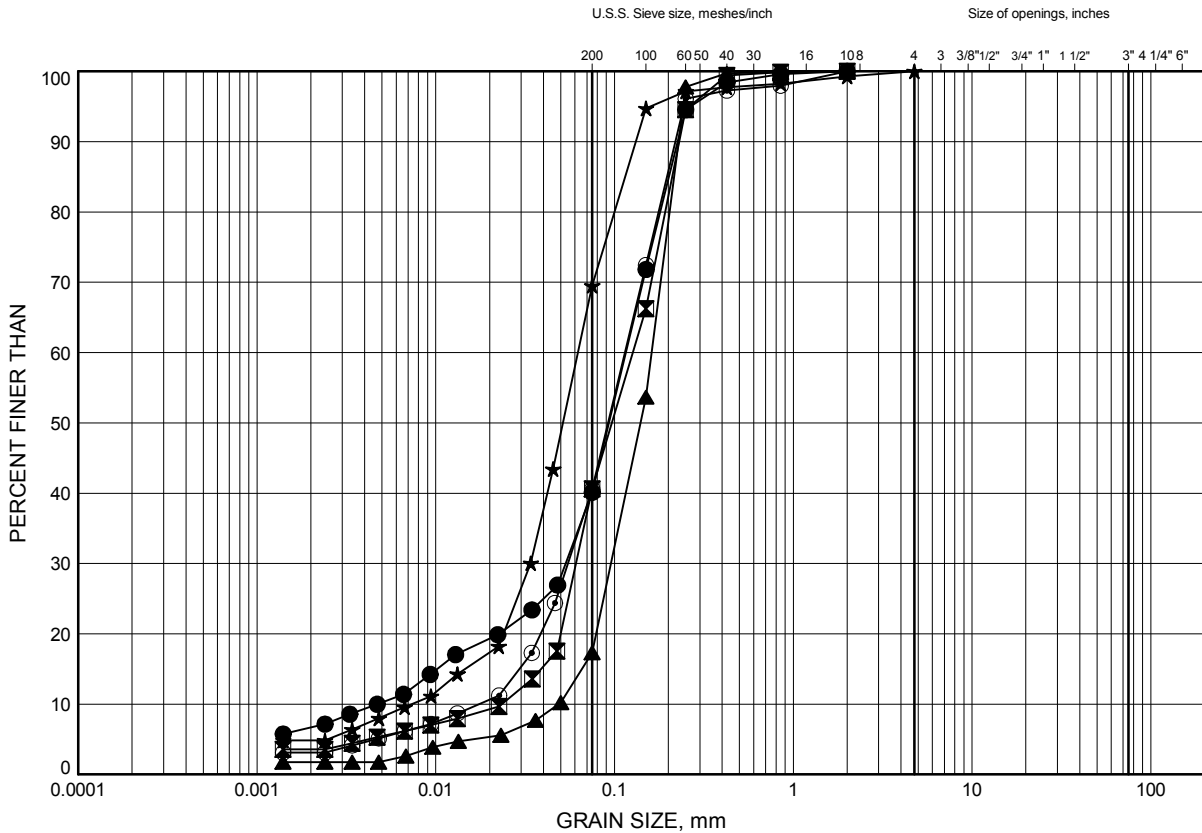


Prep'd .....AN.....  
Chkd. ....KS.....

# Gravel River Bridge GRAIN SIZE DISTRIBUTION

FIGURE B2

## SAND & SILT



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

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	GRB-01	4.88	183.32
⊠	GRB-02	6.40	181.90
▲	GRB-04	9.45	178.55
★	GRB-05	6.40	181.50
⊙	GRB-05	9.45	178.45

Date ..October 2014.....  
WP# ..6106-10-00.....



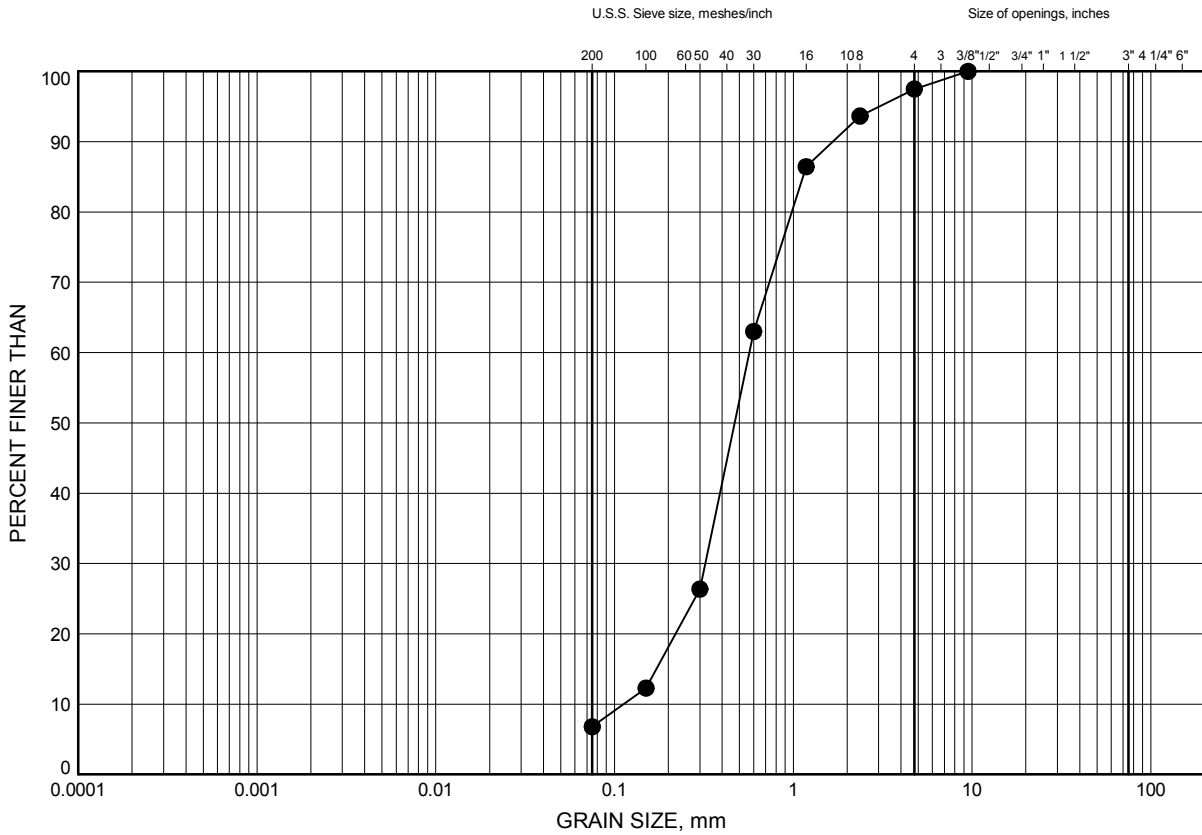
Prep'd .....AN.....  
Chkd. ....KS.....



# Gravel River Bridge GRAIN SIZE DISTRIBUTION

FIGURE B3

## SAND



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

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	GRB-03	7.16	180.94

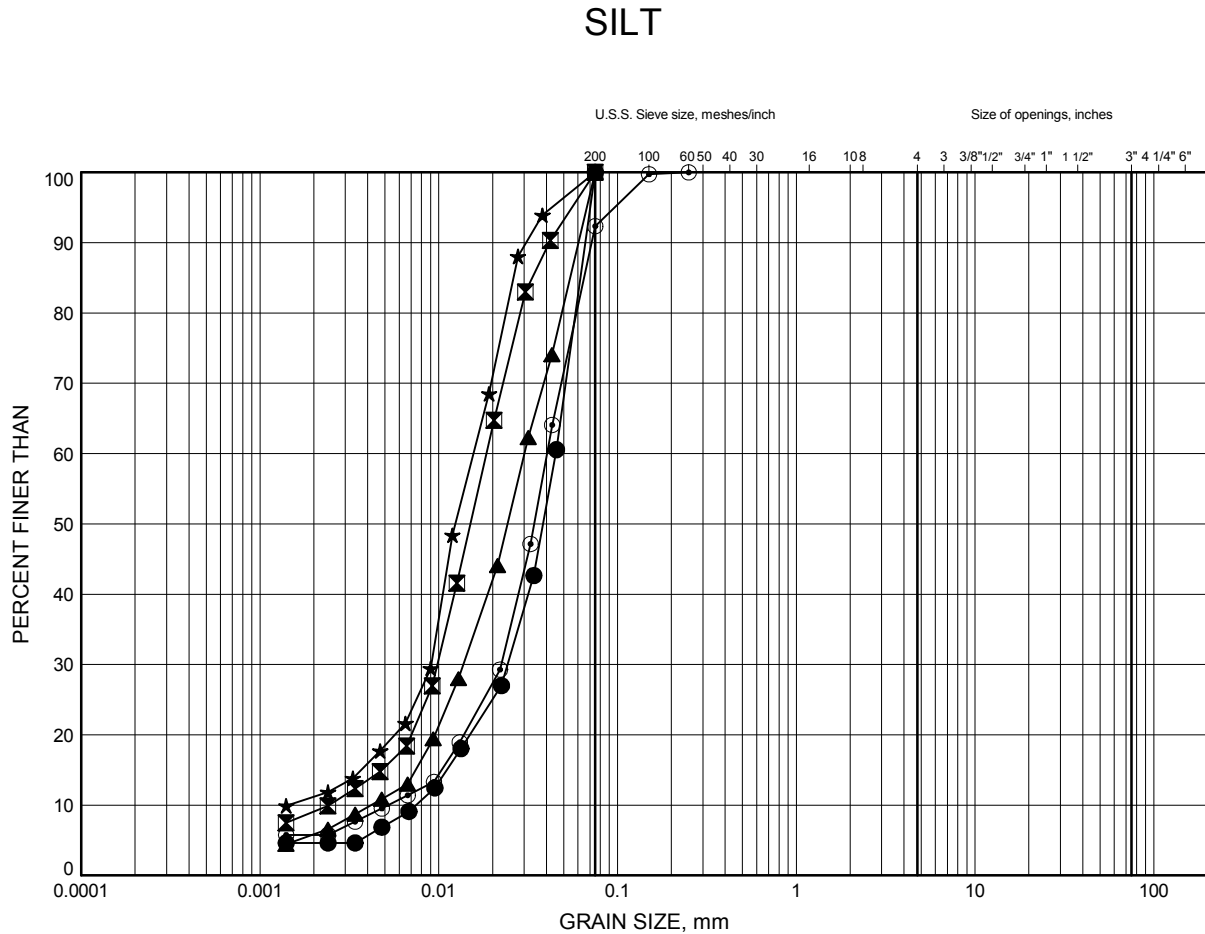
Date ..October 2014.....  
WP# ..6106-10-00.....



Prep'd .....AN.....  
Chkd. ....KS.....

# Gravel River Bridge GRAIN SIZE DISTRIBUTION

FIGURE B4a



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

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	GRB-02	9.45	178.85
⊠	GRB-02	21.64	166.66
▲	GRB-02	42.98	145.32
★	GRB-03	21.64	166.46
⊙	GRB-03	46.02	142.08

Date October 2014  
WP# 6106-10-00

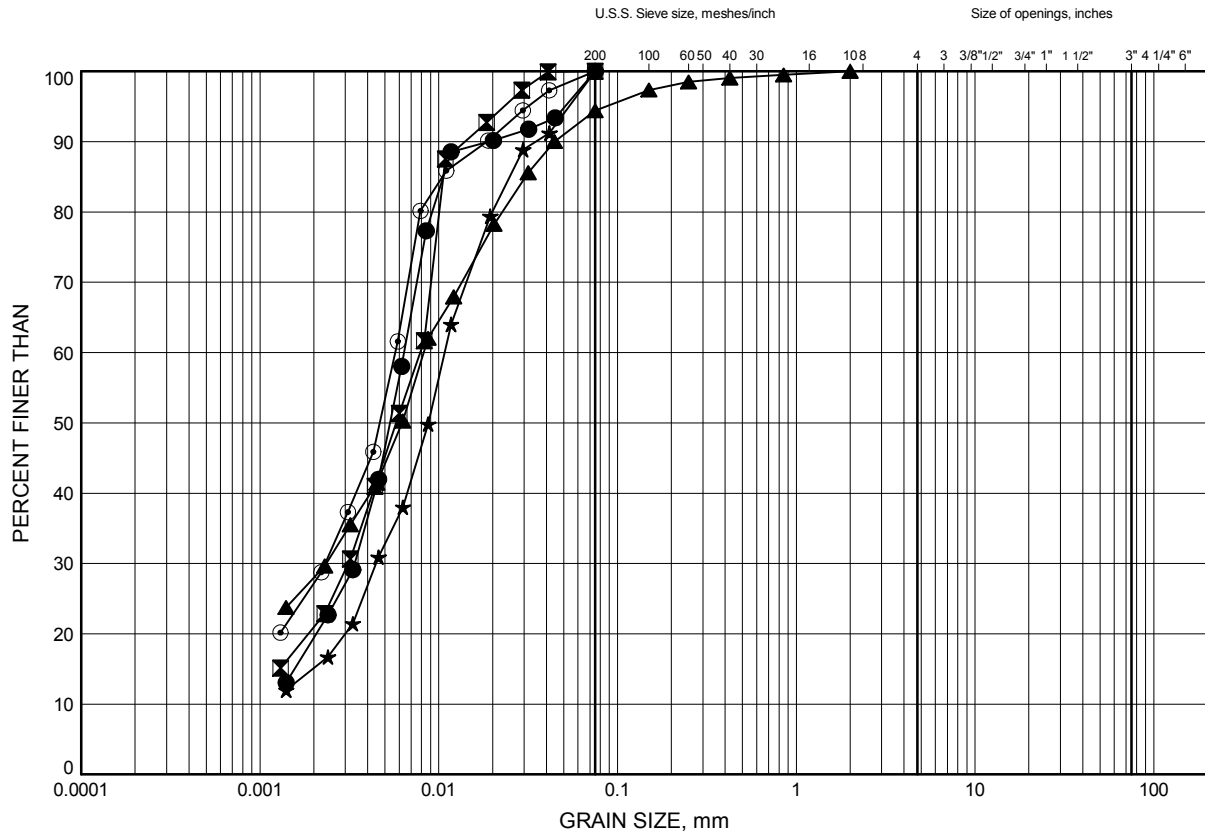


Prep'd AN  
Chkd. KS

# Gravel River Bridge GRAIN SIZE DISTRIBUTION

FIGURE B4b

SILT, CLAYEY



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

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	GRB-02	30.78	157.52
⊠	GRB-03	27.74	160.36
▲	GRB-03	36.88	151.22
★	GRB-04	24.69	163.31
⊙	GRB-04	33.83	154.17

Date ..October 2014.....  
WP# ..6106-10-00.....

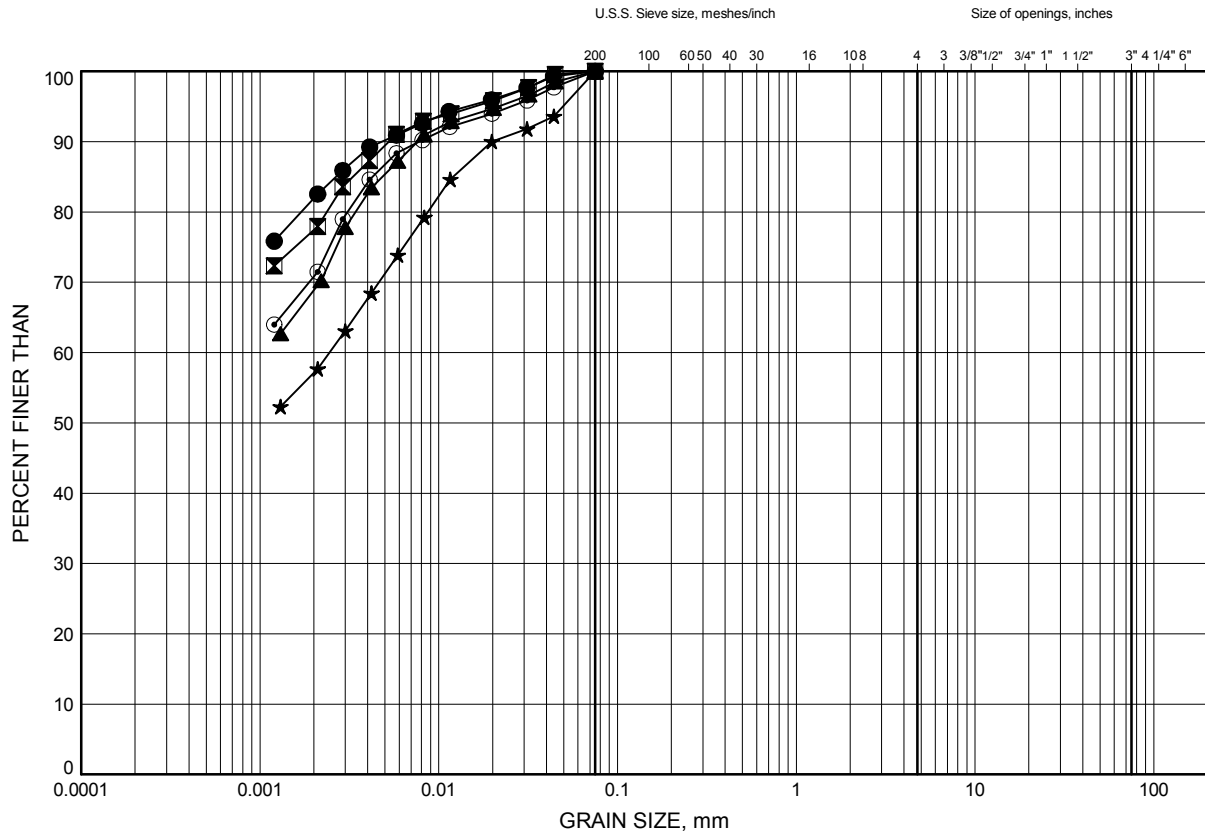


Prep'd ..AN.....  
Chkd. ..KS.....

# Gravel River Bridge GRAIN SIZE DISTRIBUTION

FIGURE B5

## SILTY CLAY



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

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	GRB-02	14.02	174.28
⊠	GRB-03	12.50	175.60
▲	GRB-03	15.54	172.56
★	GRB-04	12.50	175.50
⊙	GRB-04	18.59	169.41

Date October 2014  
WP# 6106-10-00

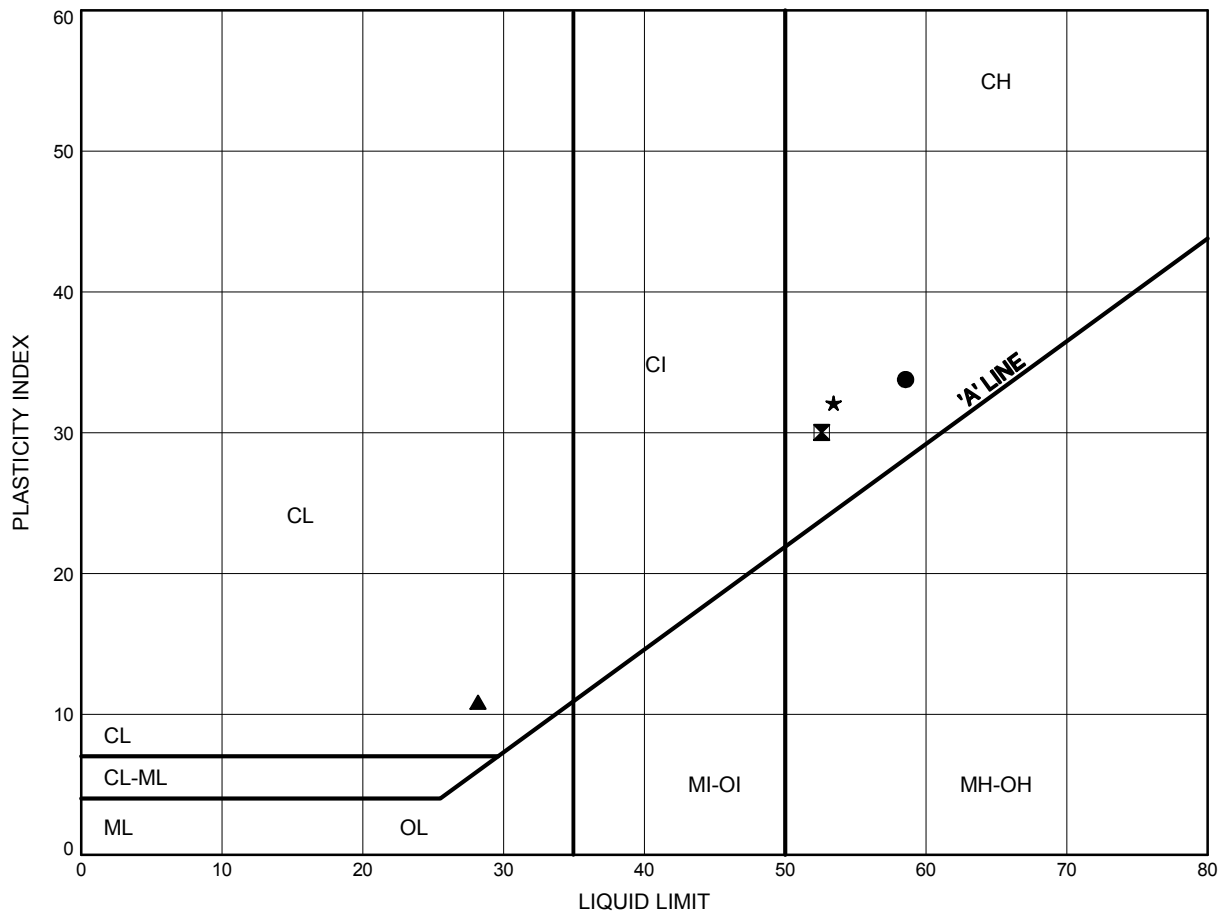


Prep'd AN  
Chkd. KS

Gravel River Bridge  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE B6

**SILTY CLAY**



**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	GRB-02	14.02	174.28
⊠	GRB-03	12.50	175.60
▲	GRB-04	12.50	175.50
★	GRB-04	18.59	169.41

Date October 2014  
 WP# 6106-10-00

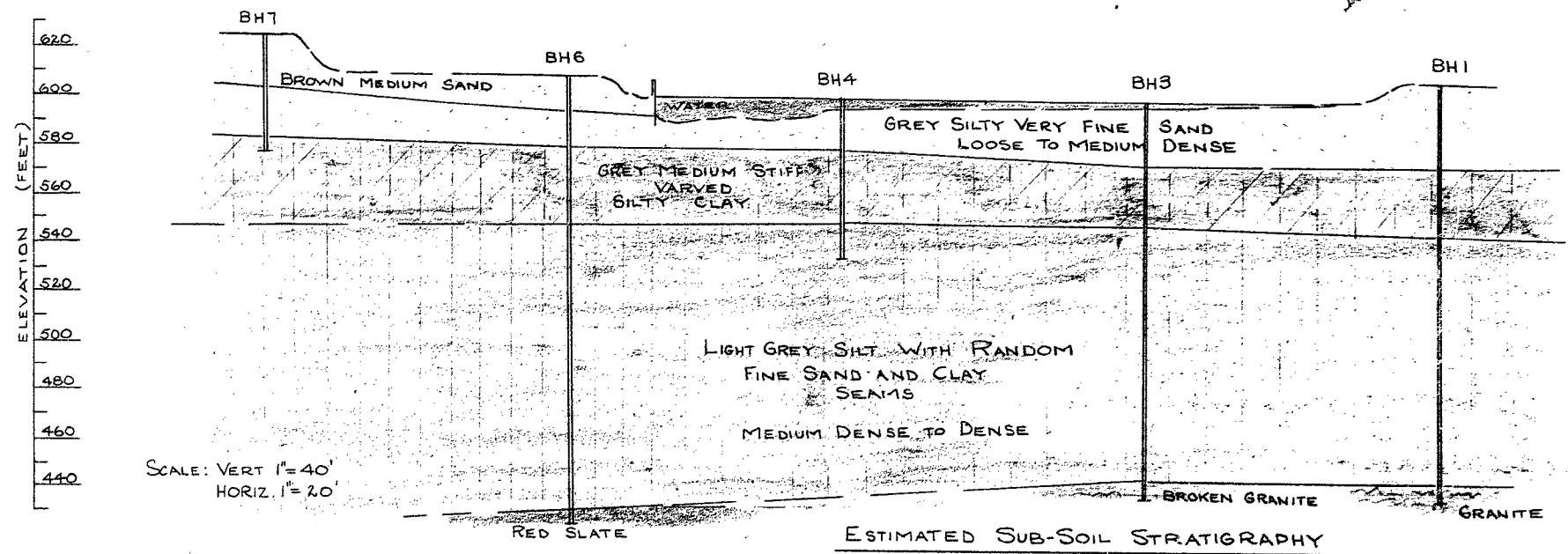
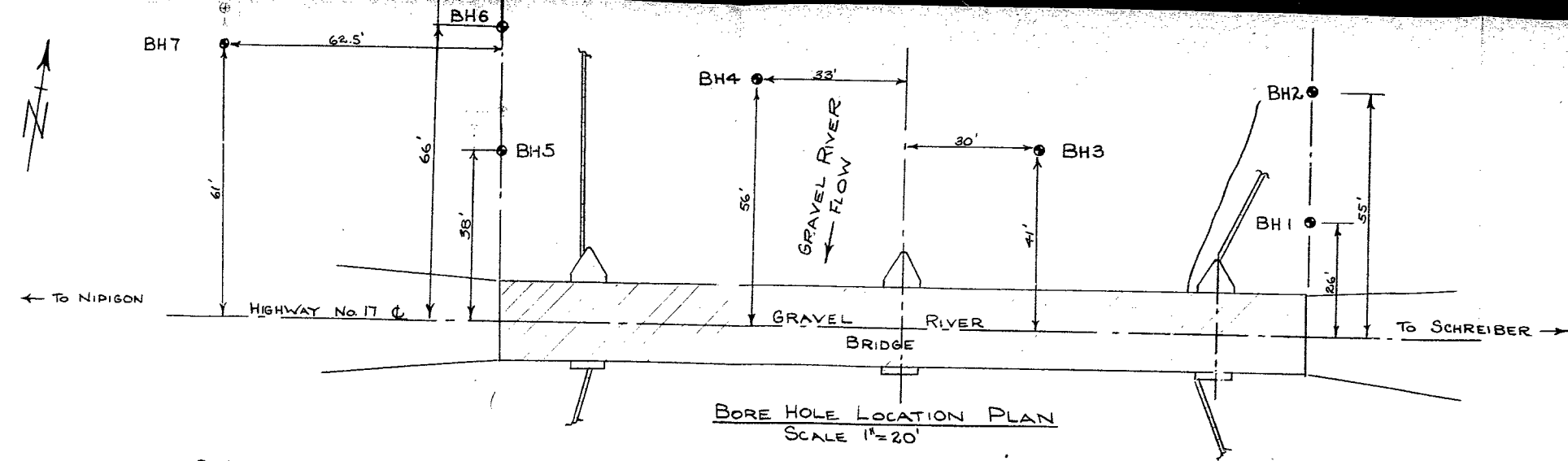


Prep'd AN  
 Chkd. KS

## **Appendix C**

### **Borehole Logs and Location Plan from Previous Investigation**

DRAWING No. 1  
 JOB No. C108/J268



# GRAVEL RIVER

BORE HOLE LOCATION  
 AND  
SUB-SOIL STRATIGRAPHY

SCALE: AS SHOWN  
 DWN. BY: K.P.  
 CHKD. BY: L.G.S.

OCT. 1958

## TROW SODERMAN AND ASSOCIATES

## SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT Gravel River Bridge  
LOCATION Highway No. 17  
HOLE LOCATION See plan  
HOLE ELEVATION AND DATUM 610.2

BOREHOLE NO. 1  
FIELD SUPERVISOR D.S.  
DRILLER E.S.  
PREP. K.P.

DRAWING NO.. 2

LEGEND

- 2 11 DIA. SPLIT TUBE  
2 11 SHELBY TUBE  
2 11 SPLIT TUBE  
2 11 DIA. CONE  
CASING  
2 11 SHELBY  
1/2 UNCONFINED COMPRESSION [Qu]  
VANE TEST [C] AND SENSITIVITY [S]  
NATURAL MOISTURE AND  
LIQUIDITY INDEX  
LIQUID LIMIT  
PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE	
				1000	2000
				P. S. F. BLOWS, FT.	
↓	Ground surface.	610.2	0	20	40
	Grey loose to medium dense silty very fine sand.	575.2	20	Dynamic cone penetration profile	
	Grey medium stiff varved silty clay.	548.2	40	$S = 3.8$ $S = 2.6$ $S = 2.6$ $S = 2.6$ $S = 2.8$	
	Light grey silt with random thin fine sand and clay seams.	446.2	60	Cone driven in bottom of borehole	
	End of hole.	438.7	160		

CONSISTENCY				SAMPLE		NATURAL UNIT WT P.C.F.
MOIST. CONTENT - % DRY WT						
					SS1	
					SS2	
					SS3	
					SS4	
					SS5	
					SS6	
					SS7	
					SS8	
					SS9	
					SS10	
					SS11	
					SS12	
					SS13	
					SS14	
					SS15	
					SS16	
					SS17	
					SS18	
					SS19	

Coarse sand and gravel 164 - 166 feet.  
166 - 171½ recovered 90% NX core,  
reddish grey granite.

Ground water level 8.5 ft.



TROW SODERMAN AND ASSOCIATES

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

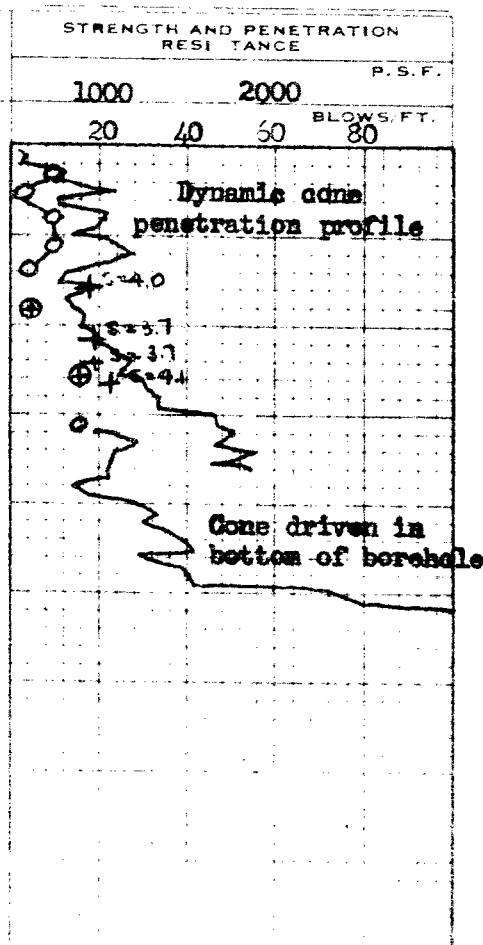
PROJECT Gravel River Bridge  
LOCATION Highway No. 17  
HOLE LOCATION See Plan  
HOLE ELEVATION AND DATUM 607.7

BOREHOLE NO. 2  
FIELD SUPERVISOR K.P.  
DRILLER E.S.  
PREP. K.P.

LEGEND

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

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	Ground surface.	607.7	0
	Grey fine to very fine sand with some silt.	577.7	20
	Grey medium stiff varved silty clay.	549.7	40
	End of hole. Grey silt.	525.7	60
	Ground water level 6 ft.		



CONSISTENCY	SAMPLE	NATURAL UNIT WT. P.C.F.
MOIST. CONTENT - % DRY WT.		
20 40 60		
	SS1	
	SS2	
	SS3	
	SS4	
	SS5	
	SS6	
	SS7	
	SS8	
	SS9	
	SS10	111.1
	SS11	110.9

## TROW SODERMAN AND ASSOCIATES

## SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT Gravel River Bridge  
LOCATION Highway No. 17  
HOLE LOCATION See plan  
HOLE ELEVATION AND DATUM

BOREHOLE NO. 3  
FIELD SUPERVISOR D.S.  
DRILLER H.J.  
PREP. K.P.

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

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE	
				1000	2000
				P.S.F. BLOWS/FT.	
	† River surface. River depth 2'	601.3	0	20	40 60 80
	Grey loose to medium dense silty very fine to medium sand.	599.3			
		575.3	20		
	Grey medium stiff varged silty clay.		40		
		549.3	60		
	Light grey silt with random fine sand and clay seams.		80		
			100		
			120		
			140		
		445.3	160		
	End of hole. Red and grey granite.	437.3	160		
	Cored AX 156'-164', recovery 100%.		180		

Cored AX 156'-164', recovery 100%.

Artesian flow 16 gpm at 8 foot head encountered at 165'

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

PROJECT NO.

0108/ J268

## TROW SODERMAN AND ASSOCIATES

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT Gravel River Bridge

LOCATION Highway No. 17

HOLE LOCATION See plan

HOLE ELEVATION AND DATUM 601.3

BOREHOLE NO. 4

FIELD SUPERVISOR K.P.

DRILLER H.J.

PREP. K.P.

DRAWING NO.

5

## LEGEND

2" DIA. SPLIT TUBE

2" SHELBY TUBE

2" SPLIT TUBE

2" DIA. CONE

CASING

2" SHELBY

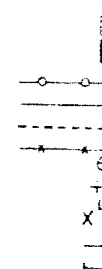
1/2 UNCONFINED COMPRESSION ( $Q_u$ )VANE TEST ( $C$ ) AND SENSITIVITY ( $S$ )

NATURAL MOISTURE AND

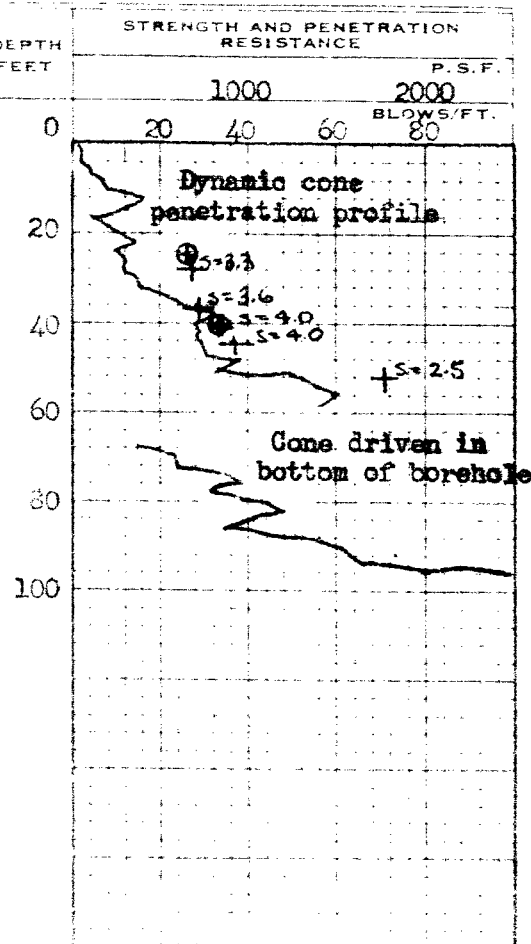
LIQUIDITY INDEX

LIQUID LIMIT

PLASTIC LIMIT



SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	River surface. River depth=4'	601.3	0
		597.3	
	Grey loose median dense silty very fine sand.	581.3	20
	Grey medium stiff varved silty clay.	549.3	40
	Grey silt with random layers of clay and fine sand.	535.3	60
	End of hole.		



CONSISTENCY	SAMPLE	NATURAL UNIT WT. P.C.F.
MOIST. CONTENT- % DRY WT.		
20 40 60		
	S81	
	S82	
	S83	
	S84	103.8
	S85	
	S86	
	S87	111.1
	S88	
	S89	
	S90	

## TROW SODERMAN AND ASSOCIATES

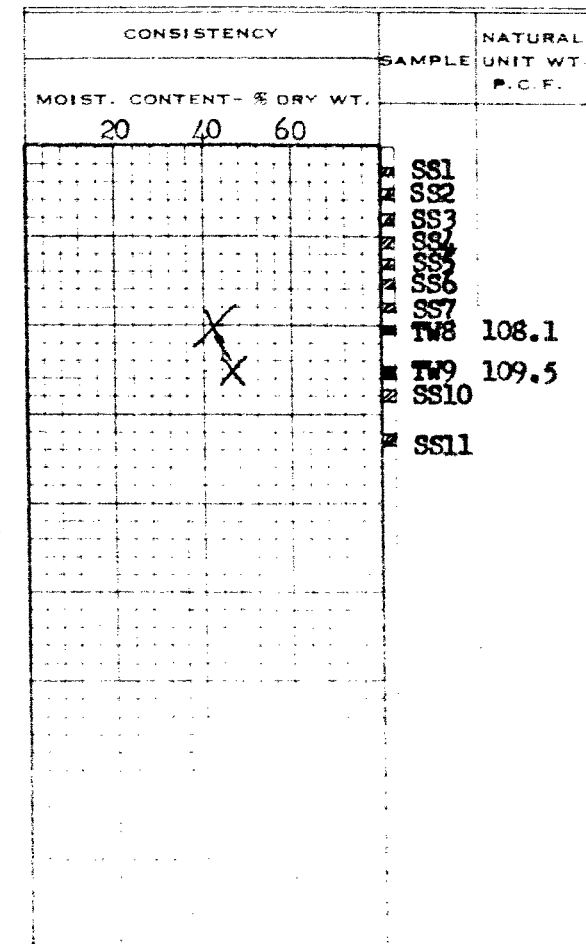
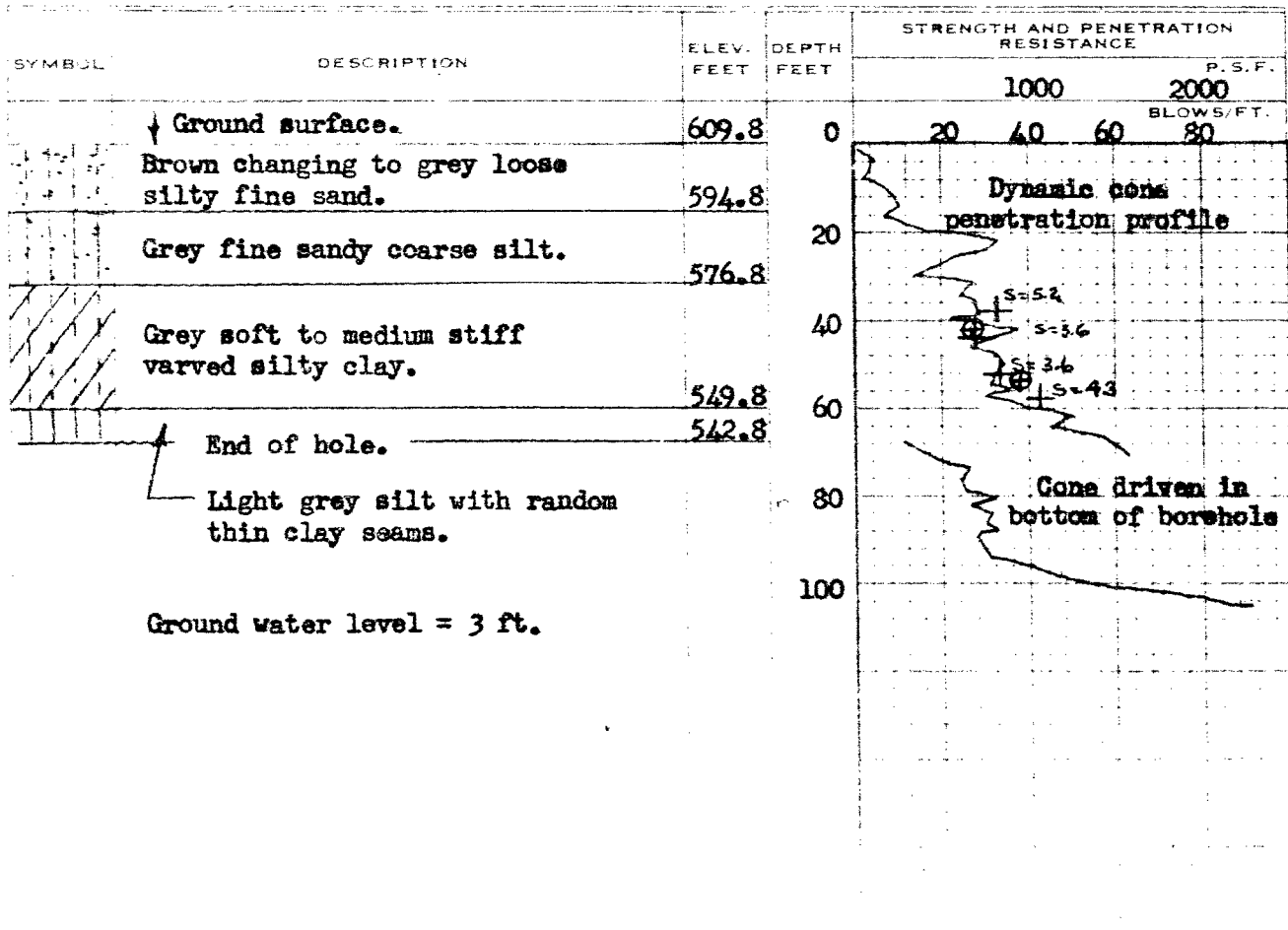
SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT **Gravel River Bridge**  
 LOCATION **Highway No. 17**  
 HOLE LOCATION **See plan**  
 HOLE ELEVATION AND DATUM **609.8**

BOREHOLE NO. **5**  
 FIELD SUPERVISOR **K.P.**  
 DRILLER **H.J.**  
 PREP. **K.P.**

## 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



## TROW SODERMAN AND ASSOCIATES

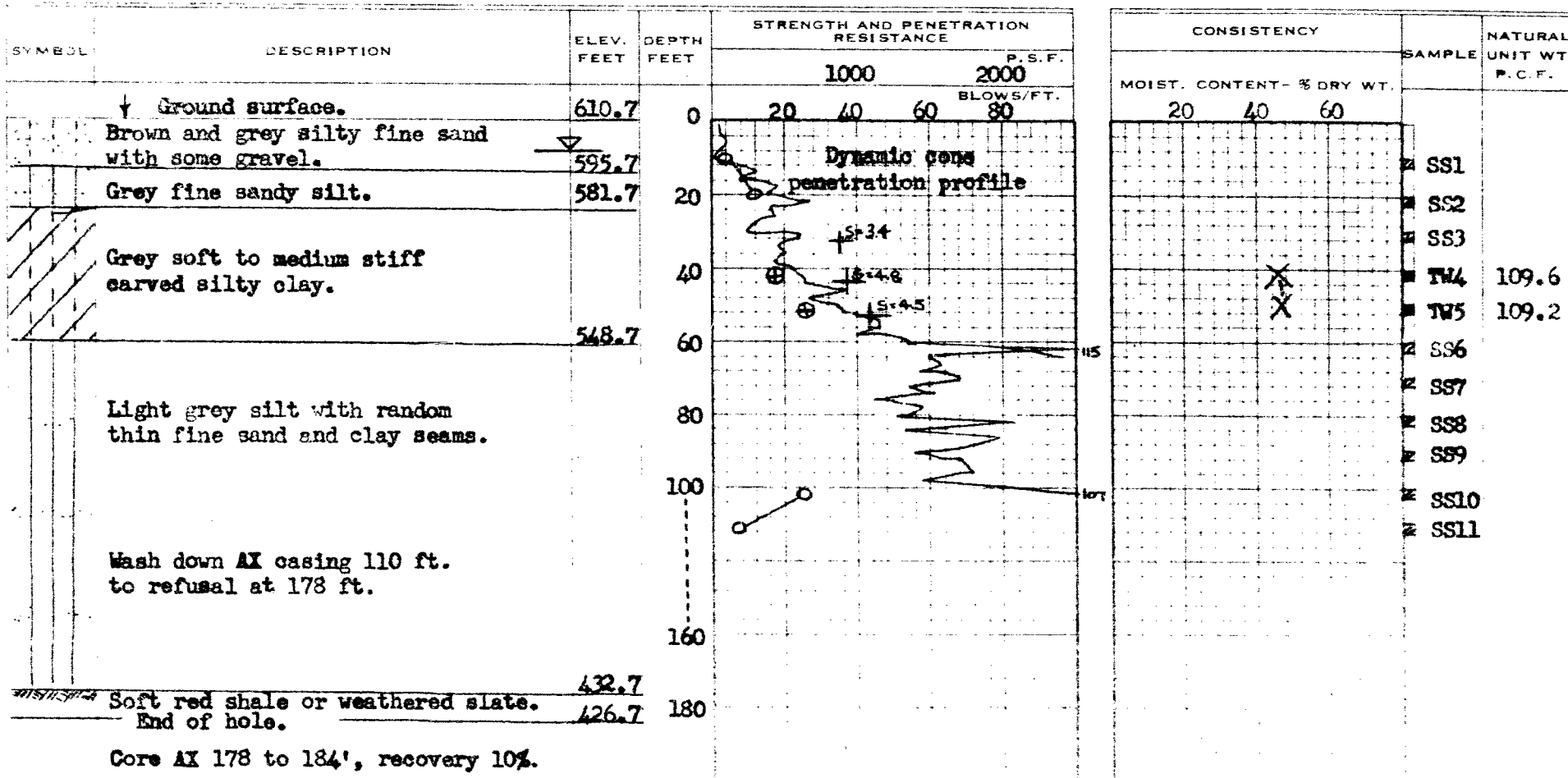
SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT **Gravel River Bridge**  
 LOCATION **Highway No. 17**  
 HOLE LOCATION **See plan**  
 HOLE ELEVATION AND DATUM **610.7**

BOREHOLE NO. **6**  
 FIELD SUPERVISOR **K.P.**  
 DRILLER **E.S.**  
 PREP. **K.P.**

## LEGEND

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



PROJECT NO C108/J268

TROW SODERMAN AND ASSOCIATES

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

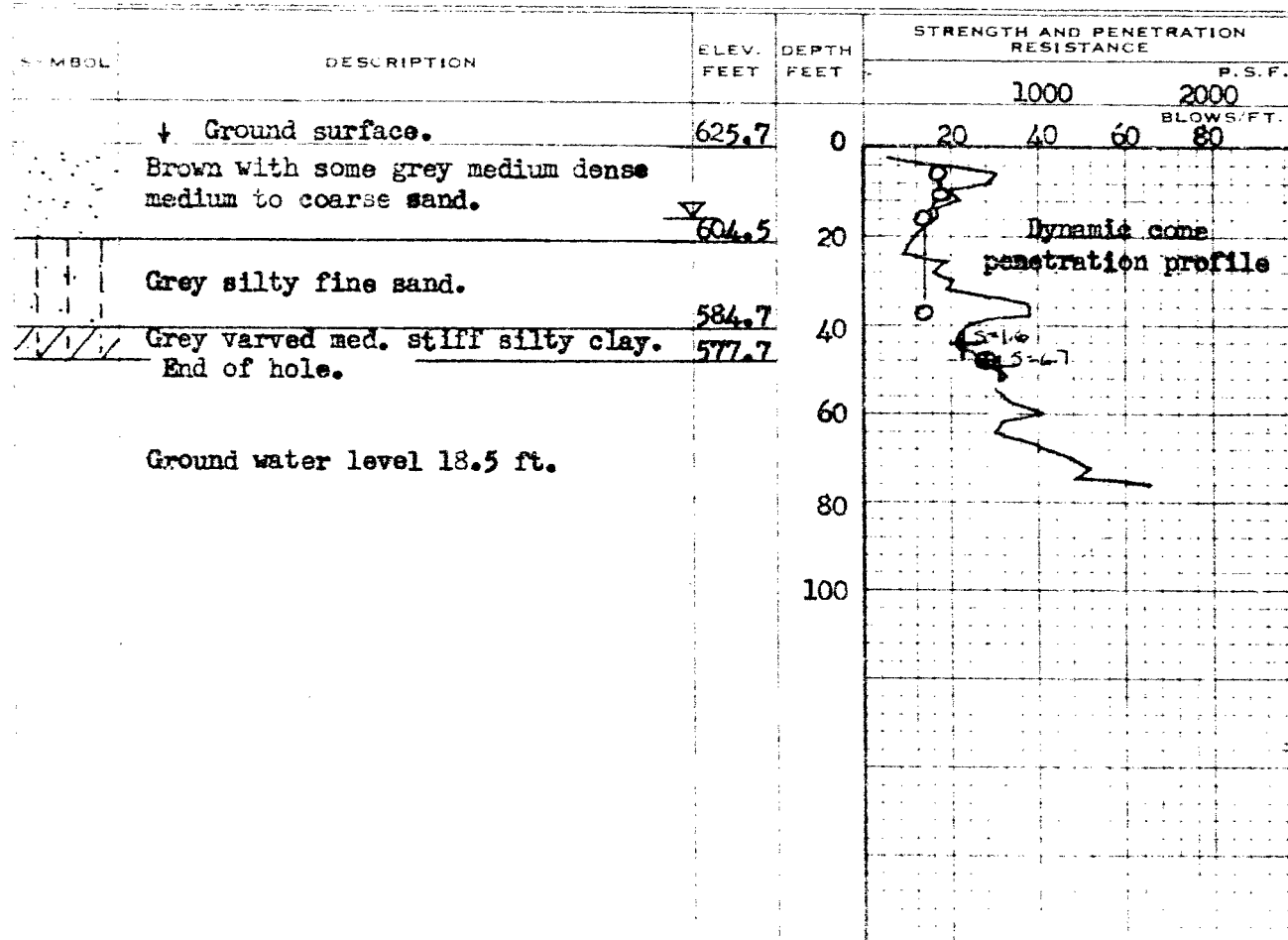
PROJECT Gravel River Bridge  
 LOCATION Highway No. 17  
 HOLE LOCATION See plan  
 HOLE ELEVATION AND DATUM 625.7

BOREHOLE NO. 7  
 FIELD SUPERVISOR K.P.  
 DRILLER H.J.  
 PREP. K.P.

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



CONSISTENCY	SAMPLE	NATURAL UNIT WT. P.C.F.
MOIST. CONTENT - % DRY WT.		
20 40 60		
	SS1	
	SS2	
	SS3	
	SS4	
	SS5	
	SS6	
	SS7	
	SS8	
	SS9	
	SS10	
	SS11	
	SS12	
	SS13	
	SS14	
	SS15	
	SS16	
	SS17	
	SS18	
	SS19	
	SS20	
	SS21	
	SS22	
	SS23	
	SS24	
	SS25	
	SS26	
	SS27	
	SS28	
	SS29	
	SS30	
	SS31	
	SS32	
	SS33	
	SS34	
	SS35	
	SS36	
	SS37	
	SS38	
	SS39	
	SS40	
	SS41	
	SS42	
	SS43	
	SS44	
	SS45	
	SS46	
	SS47	
	SS48	
	SS49	
	SS50	
	SS51	
	SS52	
	SS53	
	SS54	
	SS55	
	SS56	
	SS57	
	SS58	
	SS59	
	SS60	
	SS61	
	SS62	
	SS63	
	SS64	
	SS65	
	SS66	
	SS67	
	SS68	
	SS69	
	SS70	
	SS71	
	SS72	
	SS73	
	SS74	
	SS75	
	SS76	
	SS77	
	SS78	
	SS79	
	SS80	
	SS81	
	SS82	
	SS83	
	SS84	
	SS85	
	SS86	
	SS87	
	SS88	
	SS89	
	SS90	
	SS91	
	SS92	
	SS93	
	SS94	
	SS95	
	SS96	
	SS97	
	SS98	
	SS99	
	SS100	

## **Appendix D**

### **Site Photographs**



**West Approach looking east**



**North Elevation looking east**





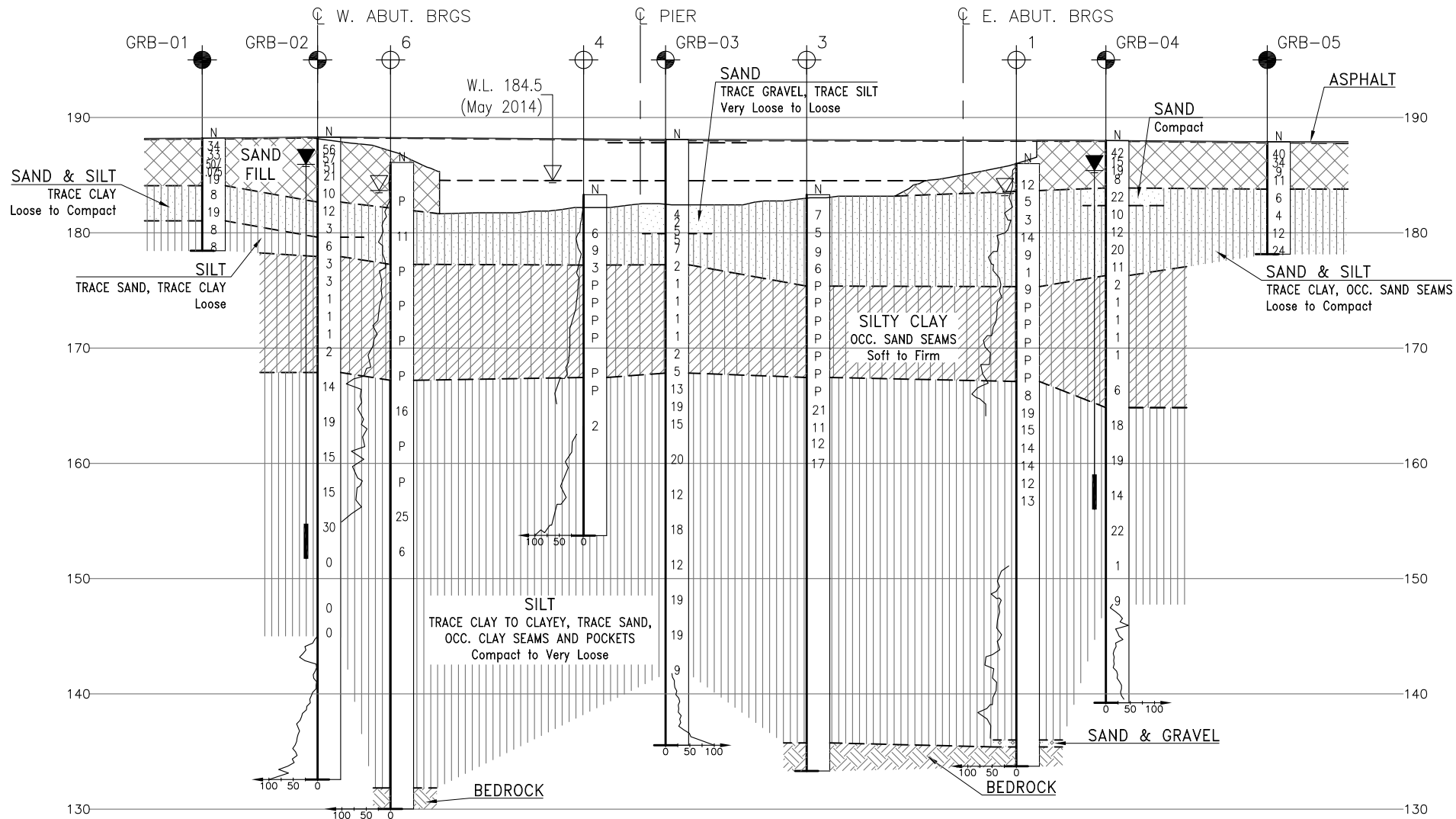
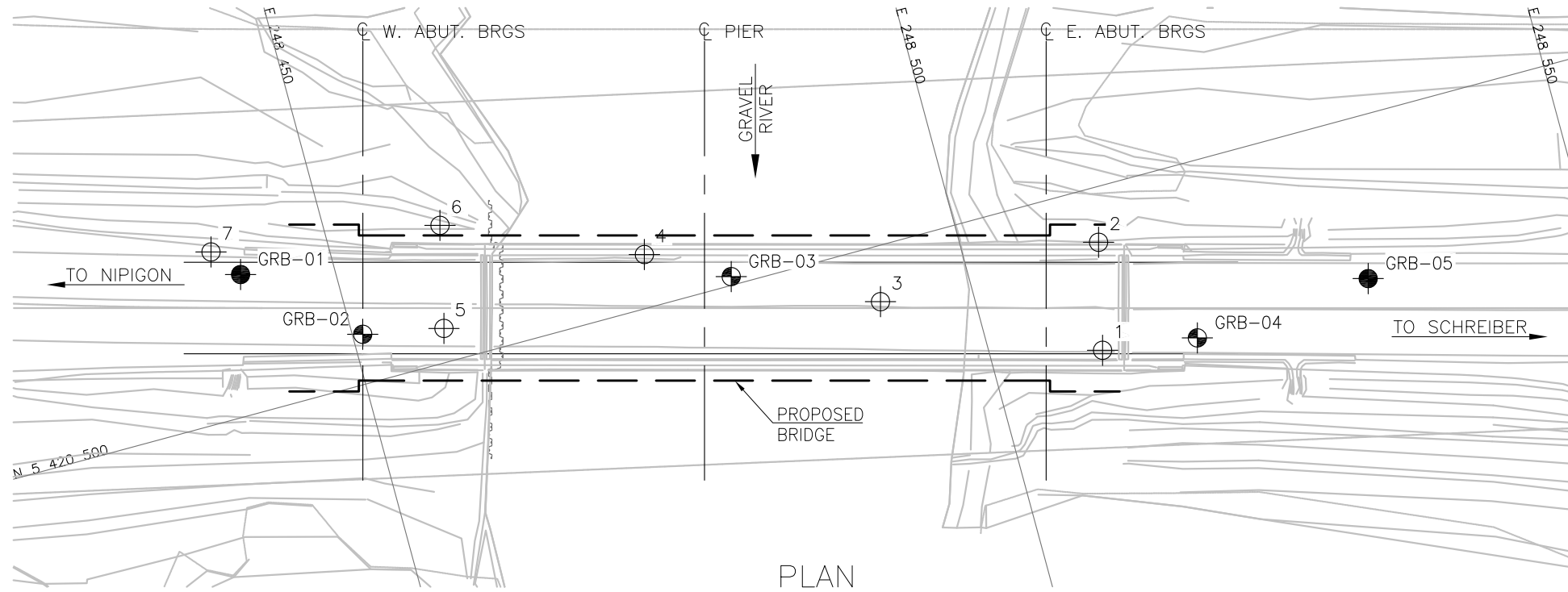
**West Abutment north side (failed sheet piling)**



**South Elevation looking east**

## **Appendix E**

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

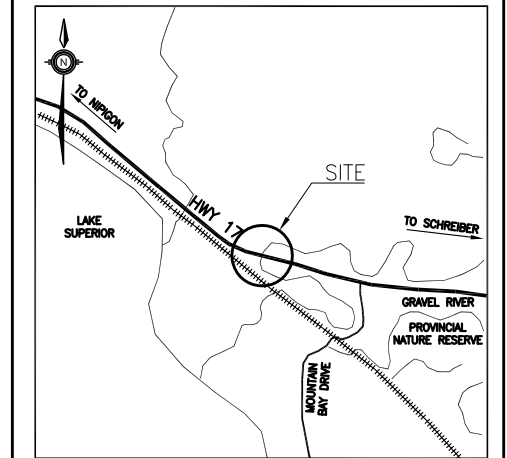


METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN



CONT No  
WP No 6106-10-01

HIGHWAY 17  
GRAVEL RIVER BRIDGE  
REPLACEMENT  
BOREHOLE LOCATIONS AND SOIL STRATA



KEYPLAN

LEGEND

	Borehole (Geocres 42D-2)
	Borehole (Current)
	Borehole and Cone (Current)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60' Cone, 475J/blow)
P	Pressure, Weight Of Hammer
	Water Level In Open Borehole
	Water Level In Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
1	186.0	5 420 486.9	248 509.0
2	185.2	5 420 495.6	248 511.0
3	183.3	5 420 495.5	248 492.5
4	183.3	5 420 504.3	248 474.8
5	185.9	5 420 502.7	248 457.4
6	186.1	5 420 511.0	248 459.3
7	190.7	5 420 513.8	248 440.6
GRB-01	188.2	5 420 511.4	248 442.4
GRB-02	188.3	5 420 504.0	248 450.8
GRB-03	188.1	5 420 500.7	248 481.2
GRB-04	188.0	5 420 485.9	248 516.8
GRB-05	187.9	5 420 486.9	248 531.6

-NOTES-

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

GEOCRES No. 42D-34

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	KS	CHK PKC	CODE
DRAWN	MFA	CHK KS	SITE 48C-18 STRUCT
DATE	DEC 2014	DATE	DEC 2014
DWG	1	DWG	1

