FOUNDATION INVESTIGATION REPORT
LITTLE GRAVEL RIVER BRIDGE REHABILITATION
HIGHWAY 17
DISTRICT OF THUNDER BAY, ONTARIO

G.W.P. 6067-09-00, Site No. 48C-17

Geocres Number: 42D-31

Report to

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the location of the bridge carrying Highway 17 over Little Gravel River located approximately 45 km west of Schreiber, in the District of Thunder Bay, Ontario.

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

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

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

- Department of Highways of Ontario, Foundation Investigation, Little Gravel River Crossing, T.C.H. No. 17, District No. 19. Project: J267, Geocres No. 58-F-269C, Prepared by Trow, Soderman and Associates, dated November 20, 1958. (Reference 1).

2 SITE DESCRIPTION

The Little Gravel River bridge is located on Highway 17 approximately 45 km west of Schreiber in the District of Thunder Bay, Ontario. The site is approximately 460 m west of the Community of Gravel River and 1.1 km west of Mountain Bay Drive.

At present, the highway crosses Little Gravel River on a single-span structure. The bridge span is 15.2 m and the width is 10.5 m. At the site, Little Gravel River flows southerly towards Lake Superior, which is located approximately 200 m south of the bridge. At the bridge location, the river is shallow and slow flowing. The depth of water in the river is reported to vary from 0.6 m to 0.9 m.

The lands surrounding the bridge site consist of some forested areas. A railway runs parallel to Highway 17, crossing Little Gravel River on a bridge approximately 35 m to the south. A commercial building and an accommodation facility are located approximately 150 m east of the bridge.

Photographs in Appendix D show the general nature of the site.

The site lies within the Canadian Shield, characterized by low, rounded hills of Pre-Cambrian bedrock mantled by varying thicknesses of native soils. During the present investigation, bedrock was not contacted within the depth of exploration. The native soils encountered consist of extensive deposits of silty clay and clayey silt.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out during the period of November 6 to 11, 2011 and consisted of drilling and sampling four boreholes (numbered LGR-01 to LGR-04) through the highway embankment in the area of the existing west and east abutments and approaches. Boreholes LGR-02 and LGR-03 were drilled near the abutments and Boreholes LGR-01 and LGR-04 were drilled though the approach embankments. The four boreholes were terminated at 27.4 m depth (elevations 160.0 to 160.1).

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

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

The drilling was carried out using a CME 75 truck-mounted drill rig. Wash boring methods with NW-casing were used to advance the boreholes. Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). In situ vane shear testing was carried out to assess the undrained shear strength of soft to firm cohesive deposits.

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.

Two standpipe piezometers consisting of 19 mm PVC pipe with slotted screen and enclosed in filter sand were installed at this site to permit longer term groundwater level monitoring. The piezometers were subsequently decommissioned in general accordance with MOE Regulation 903.

Boreholes without piezometers were backfilled in general accordance with Regulation 903. The installation and completion details of the boreholes and piezometers are summarized in Table 3.1.

Table 3.1 – Borehole and Piezometer Completion Details

Location	Borehole	Piezometer Tip Depth/ Elevation (m)	Completion Details
West Abutment/ Approach	LGR-01	None installed	Borehole backfilled with bentonite grout mixture to 1.8 m, concrete to 0.8 m, sand to 0.15 m, then asphalt to surface.
	LGR-02	27.4/160.1	Sand from 27.4 m to 25.3 m, bentonite grout from 25.3 m to 1.7 m, sand from 1.7 m to 0.15 m, then concrete to surface.
East Abutment/ Approach	LGR-03	27.4/160.1	Sand from 27.4 m to 25.1 m, bentonite grout from 25.1 m to 2.0 m, concrete from 2.0 m to 0.8 m, sand from 0.8 m to 0.15 m, then asphalt to surface.
	LGR-04	None installed	Borehole backfilled with bentonite grout to 1.8 m, auger cuttings to 0.15 m, then asphalt to surface.

4 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to grain size distribution analyses (sieve and hydrometer) and Atterberg Limits testing where appropriate. The results of this testing program are shown on the Record of Borehole sheets in Appendix A and on the figures contained in Appendix B.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendix A. Details of the encountered soil stratigraphy are presented in these sheets and on the "Borehole Locations and Soil Strata" drawing in Appendix E. 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. It must be recognized that soil conditions may vary between and beyond borehole locations.

In general terms, the stratigraphy encountered at this site consists of pavement structure overlying sand fill and native soils. The native soils contacted below the fill consist of an upper layer of silt overlying a thick deposit of very soft silty clay, underlain by loose to compact silt with clay layers.

More detailed descriptions of the individual strata are presented below.

5.1 Asphalt and Concrete

All boreholes were drilled through the pavement structure on Highway 17.

In Boreholes LGR-01 and LGR-04, a 115 mm thick layer of asphalt was encountered. In Boreholes LGR-02 and LGR-03, drilled through the approach slab, a 100 mm thick layer of asphalt was encountered over 330 mm and 225 mm of concrete. Granular fill was encountered below the asphalt and concrete.

5.2 Sand Fill

A layer of brown sand to gravelly sand fill containing trace to some silt and clay was contacted below the asphalt and concrete in all the boreholes. Wood fragments, possibly comprising remnants of a former timber crib abutment, were observed within the sand fill layer at 5.5 m depth (elevation 182.0) in Borehole LGR-02, drilled at the west abutment. Cobbles were encountered in the lower part of the fill in Borehole LGR-01. Cobbles and boulders may be present elsewhere in the fill.

The thickness of the sand fill was 3.7 m and 2.9 m in Boreholes LGR-01 and LGR-04 drilled at the approaches and 5.9 m and 6.1 m in Boreholes LGR-02 and LGR-03 drilled near the abutments. The depth to the base of the sand fill ranged from 3.0 m to 6.4 m (elevations 181.1 to 184.4).

SPT N-values recorded in the sand fill generally ranged from 11 to 41 blows per 0.3 m of penetration, indicating a compact to dense relative density. A very dense relative density was encountered in the upper 1.4 m to 2.0 m of sand fill in Boreholes LGR-01 and LGR-04, where the SPT-N values were 60 and 67 blows per 0.3 m of penetration. Locally in Borehole LGR-03, a SPT N-value of 4 blows per 0.3 m of penetration was measured near elevation 183.3, indicating a very loose to loose relative density.

The moisture content of samples of the sand fill generally ranged from 7% to 16%, with values of 21% and 29% measured in two samples from below the groundwater level.

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

Soil Particles	Sand Fill (%)
Gravel	7 to 22
Sand	72 to 82
Silt and Clay	6 to 11

5.3 Upper Silt

An upper layer of native silt was contacted below the fill in Boreholes LGR-01 and LGR-04, drilled at the approaches. The silt contained some clay and trace to some sand. In Borehole LGR-04, organics and wood fragments were observed in the silt immediately below the fill, and clay seams were encountered in the lower part of this unit.

The thickness of the upper silt layer was 1.2 m and 3.6 m in Boreholes LGR-01 and LGR-04, respectively. The depths to the base of the silt were 5.0 m and 6.6 m (Elev. 182.4 and 180.8).

SPT N-values recorded in the upper silt ranged from 0 to 5 blows per 0.3 m of penetration, indicating a loose to very loose condition.

The moisture content of samples of the upper silt ranged from 29% to 46%.

Grain size distribution curves for two samples of the upper silt are presented on the Record of Borehole sheets and on Figure B2 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	Silt (%)
Gravel	0
Sand	4 to 19
Silt	71 to 79
Clay	10 to 17

5.4 Silty Clay

Native grey silty clay was encountered below the fill in Boreholes LGR-02 and LGR-03 and below the silt layer in Boreholes LGR-01 and LGR-04 at depths of 5.0 to 6.6 m (Elev. 182.4 to 180.8). The silty clay contains silt seams, particularly near the upper and lower boundaries with the overlying and underlying silt deposits.

The thickness of the silty clay ranged from 10.5 m to 11.6 m. The depth to the base of the silty clay ranged from 16.6 m to 17.2 m (Elev. 170.3 to 170.8).

SPT N-values recorded in the silty clay ranged from 0 to 1 blows for 0.3 m of penetration, indicating a very soft consistency. A higher N-value of 6 blows for 0.3 m was obtained near the base of this deposit where silt layers were encountered within the clay. In-situ vane shear tests performed during drilling indicated undrained shear strengths ranging from 10 kPa to 28 kPa.

The moisture content of samples collected from the silty clay layer varies between 22% and 90%, typically between 47% and 65%.

Grain size distribution curves for selected samples of the silty clay are presented in Appendix B, Figures B3 and B4. Atterberg Limits test results are presented on Figures B6

and B7 of Appendix B. The results are also summarized on the Record of Borehole sheets included in Appendix A. The results shown on Figures B4 and B7 are for samples recovered near the boundaries of the clay unit and are believed to reflect the presence of silt seams/layers within the clay. The results of the laboratory tests are summarized as follows:

Soil Particles	Silty Clay (%)	Silty Clay with Silt Layers (%)
Gravel	0	0
Sand	0	0
Silt	17 to 41	53 to 74
Clay	59 to 83	26 to 47

Index Property		
Liquid Limit	53 to 61	28 to 35
Plastic Limit	22 to 24	16 to 18

The above results show that the silty clay is generally of high plasticity with a group symbol of CH. Locally near the upper boundary of the clay unit in Borehole LGR-01 and the lower boundary in Boreholes LGR-01, LGR-02 and LGR-04 where silt layers are present, low plasticity (CL) is indicated.

5.5 Lower Silt

A lower layer of grey silt containing seams and layers of silty clay was contacted below the silty clay at depths ranging from 16.6 m to 17.2 m (Elev. 170.3 to 170.8). All the boreholes were terminated within the lower silt layer at 27.4 m depth (Elev. 160.0 to 160.1).

SPT N-values recorded in the lower silt layer ranged from 5 to 20 blows per 0.3 m of penetration, indicating a loose to compact relative density. The moisture content ranged from 19% to 31%.

Grain size distribution curves for selected samples of the lower silt layer are presented on the Record of Borehole sheets and on Figure B5 of Appendix B. The curves for some samples are believed to reflect the presence of clay seams within the silt. The results of the laboratory tests are summarized as follows:

Soil Particles	Silt (%)
Gravel	0
Sand	0
Silt	69 to 88
Clay	12 to 31

Atterberg Limits test results for one sample exhibiting plasticity are presented in Figure B8 of Appendix B. The results were as follows:

Index Property	(%)
Liquid Limit	24
Plastic Limit	19

The above results show that zones of the lower silt exhibit slight plasticity with a group symbol of CL-ML.

5.6 Water Levels

Wash boring methods were used to advance the boreholes and therefore natural groundwater levels could not be monitored during drilling. Standpipe piezometers were installed in Boreholes LGR-02 and LGR-03 to monitor water levels after completion of drilling. The water levels measured in the piezometers are summarized in Table 5.1.

Table 5.1 – Water Level Measurements

Foundation Unit	Borehole	Date	Water Level (m)		Comments
			Depth	Elevation	
West abutment	LGR-02	November 9, 2011 November 30, 2011 May 29, 2012	3.0 2.2 2.2	184.5 185.3 185.3	In piezometer
East abutment	LGR-03	November 12, 2011 November 30, 2011 May 29, 2012	3.3 2.7 2.6	184.2 184.8 184.9	In piezometer

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

The groundwater levels will also be affected by the water level in the river. The preliminary GA drawing dated April 2013 indicates that the water level in the Little Gravel River was near Elevation 182.5 in October 2012.

5.7 Data from previous investigation, 1958 (Reference 1)

A foundation investigation was conducted at this site in 1958 for construction of the currently existing bridge (Reference 1). The borehole logs, borehole location plan and soil profiles prepared for the previous investigation are reproduced in Appendix C. The approximate locations of the previous boreholes (Boreholes 1 to 4) are included on the drawing in Appendix E.

In general, the subsurface conditions documented during the 1958 investigation are consistent with the conditions encountered during the current investigation, comprising the following:

- A surficial layer of loose sand and gravel fill. The fill was brown in colour and approximately 1.5 m to 2.0 m thick.
- Immediately underlying the fill, a native deposit of grey silt and silty sand was contacted in the four boreholes. The thickness of the native silt/silty sand varies from 2.6 m to 3.0 m, with the lower 1.5 m grading to clayey silt at one location. The silt and silty sand was in a loose state.
- A deposit of varved silty clay was found in all the boreholes below the native silt and silty sand. The thickness of the silty clay was approximately 10.7 m. The in-situ field vane tests conducted in the silty clay, indicated undrained shear strengths ranging from 14 kPa to 28 kPa, indicating a typically soft consistency.
- Light grey silt was contacted below the silty clay, extending to depths of 49.0 m to 50.3 m in two boreholes. The silt was in a compact to dense state. Thin layers of fine sand and clay were found within the silt layer, and a 7.6 m thick layer of silty clay was encountered near the base of this deposit in one borehole.
- A layer of dense gravel and boulders was encountered approximately 50.0 m below the ground surface in Boreholes 1 and 4.
- Water was encountered in the boreholes at depths ranging from 0.9 m to 1.5 m below ground surface, near elevations 183.9 to 185.1.

6 MISCELLANEOUS

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

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

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

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

Routine laboratory testing was carried out by Thurber Engineering Ltd.

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

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

Thurber Engineering Ltd.

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Appendix A

Record of Borehole Sheets

EXPLANATION OF ROCK LOGGING TERMS

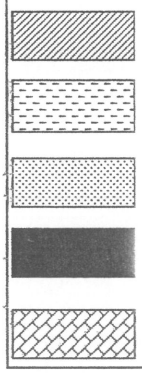
ROCK WEATHERING CLASSIFICATION

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

DISCONTINUITY SPACING

Bedding	**Bedding Plane Spacing**
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

Rock Strength	**Approximate Uniaxial Compressive Strength (MPa)**	**(psi)**	**Field Estimation of Hardness***
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.

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			

SYMBOLS AND TERMS USED ON TEST HOLE LOGS

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 naked eye

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

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

TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)		APPROX. SPT[(1)] "N" VALUE
Very Soft	< 10		< 2
Soft	10 to 25	(POCKET PEN)	2 to 4
Firm	25 to 50	(0.5-1)	4 to 8
Stiff	50 to 100	(1-2)	8 to 15
Very Stiff	100 to 200	(2-4)	15 to 30
Hard	> 200	(>4)	> 30

(1) Standard Penetration Test – the number of blows from a 63.5kg hammer falling through 0.76m to advance a 60 degree truncated cone 0.3m

TERMS DESCRIBING DENSITY(COHESIONLESS SOILS)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	< 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	> 50

HIERARCHY OF SOIL STRENGTH PREDICTION

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

LEGEND FOR TEST HOLE LOGS

- MC – Moisture Content (% by Weight) as determined by sample

▼	Water Level
C_{vane}	Shear Strength Determination by Field Insitu Vane
C_{pen}	Shear Strength Determination by Pocket Penetrometer
C_{lab}	Shear Strength Determination using a Laboratory Vane Apparatus
C_U	Undrained Shear Strength determined by Unconfined Compression Test
AS/GS/BS	Auger Sample/Grab Sample/ Block Sample
SS	Split-spoon
SC	Soil core
AED	Oedometer test
TXL	Triaxial test

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RECORD OF BOREHOLE No LGR-01 1 OF 3 METRIC

W.P. 6067-09-00 LOCATION Little Gravel River Bridge N 5 420 759.7 E 248 060.6 ORIGINATED BY SLL

HWY 17 BOREHOLE TYPE NW Casing COMPILED BY AN

DATUM Geodetic DATE 2011.11.08 - 2011.11.09 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
187.4											
0.0	**ASPHALT:** (115mm)										
0.1	Gravelly **SAND**, trace silt and clay Very Dense to Compact Brown Moist (FILL)		1	SS	60		187		○		
			2	SS	41		186		○		22 72 6 (SI+CL)
			3	SS	41		185		○		
	Occasional cobbles Wet		4	SS	26		184				
183.6											
3.8	**SILT**, some clay, trace sand Very Loose Grey		5	SS	1		183		○		
182.4											
5.0	Silty **CLAY**, with silt layers Very Soft Grey		6	SS	0		182		⊢○		0 0 74 26
							181	4.0 +			
			7	SS	0		180		○		
	Without silt layers							3.0 +			
			8	SS	0		179		○		
							178	3.0 +			

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 1197.GPJ 2012TEMPLATE(MTO).GDT 6/14/13

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RECORD OF BOREHOLE No LGR-01 2 OF 3 METRIC

W.P. 6067-09-00 LOCATION Little Gravel River Bridge N 5 420 759.7 E 248 060.6 ORIGINATED BY SLL

HWY 17 BOREHOLE TYPE NW Casing COMPILED BY AN

DATUM Geodetic DATE 2011.11.08 - 2011.11.09 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	Silty **CLAY** Very Soft Grey		9	SS	0		177				0 0 18 82
							176				
			10	SS	0						
							175				
			11	SS	0		174				
							173				
			12	SS	0						
							172				
	With silt layers		13	SS	1		171				
170.8											
16.6	**SILT**, some clay, with clay seams/layers Compact to Loose/Firm Grey Wet						170				
			14	SS	12						0 0 88 12
							169				
							168				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

ONTMT4S 1197.GPJ 2012TEMPLATE(MTO).GDT 6/14/13

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No LGR-01 3 OF 3 METRIC

W.P. 6067-09-00 LOCATION Little Gravel River Bridge N 5 420 759.7 E 248 060.6 ORIGINATED BY SLL

HWY 17 BOREHOLE TYPE NW Casing COMPILED BY AN

DATUM Geodetic DATE 2011.11.08 - 2011.11.09 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	SILT, some clay Loose Grey						167				
			15	SS	5				○		
							166				
							165				
							164				
			16	SS	5				○		0 0 72 28
							163				
							162				
							161				
160.0			17	SS	7				○		
27.4	END OF BOREHOLE AT 27.4m. BOREHOLE BACKFILLED WITH BENTONITE AND GROUT MIXTURE TO 1.8m, CONCRETE TO 0.8m, SAND TO 0.15m, THEN ASPHALT TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$15\frac{20}{10}5$ (%) STRAIN AT FAILURE

ONTMT4S 1197.GPJ 2012TEMPLATE(MTO).GDT 6/14/13

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No LGR-02 1 OF 3 METRIC

W.P. 6067-09-00 LOCATION Little Gravel River Bridge N 5 420 759.3 E 248 069.5 ORIGINATED BY SLL

HWY 17 BOREHOLE TYPE NW Casing COMPILED BY AN

DATUM Geodetic DATE 2011.11.07 - 2011.11.08 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
187.5											
0.0	**ASPHALT:** (100mm)										
0.1 / 187.2	**CONCRETE:** (330mm)										
0.3	**SAND**, trace to some silt and clay, trace gravel Compact to Dense Brown Moist (FILL)		1	SS	28		187		○		
			2	SS	30		186		○		
			3	SS	40		185		○		7 82 11 (SI+CL)
	Moist to Wet		4	SS	33		184		○		
	Grey Wet		5	SS	11		183		○		
	Wood fragments (possible timber) at 5.5m		6	SS	25		182		○		
181.2											
6.2	Silty **CLAY** Very Soft Grey		7	SS	1		181		○		
			8	SS	0		180		○		0 0 19 81
							179				
							178	3.0			

ONTMT4S 1197.GPJ 2012TEMPLATE(MTO).GDT 6/14/13

Continued Next Page

+ ^{3}, × ^{3} : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No LGR-02 2 OF 3 METRIC

W.P. 6067-09-00 LOCATION Little Gravel River Bridge N 5 420 759.3 E 248 069.5 ORIGINATED BY SLL

HWY 17 BOREHOLE TYPE NW Casing COMPILED BY AN

DATUM Geodetic DATE 2011.11.07 - 2011.11.08 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	Silty **CLAY** Very Soft Grey		9	SS	0		177		○		
			10	SS	0		176		○		
							175	4.0 +			
	With thin silt seams (varved)		11	SS	0		174		○		
			12	SS	0		173		○		
							172	5.0 +			
			13	SS	0		171		○		0 0 53 47
170.3											
17.2	**SILT**, some clay, with clay seams Compact to Loose Grey		14	SS	18		170		○		
							169				
							168				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 1197.GPJ 2012TEMPLATE(MTO).GDT 6/14/13

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No LGR-03 1 OF 3 METRIC

W.P. 6067-09-00 LOCATION Little Gravel River Bridge N 5 420 738.0 E 248 085.5 ORIGINATED BY SLL

HWY 17 BOREHOLE TYPE NW Casing COMPILED BY AN

DATUM Geodetic DATE 2011.11.09 - 2011.11.11 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
187.5											
0.0	**ASPHALT:** (100mm)										
0.1											
187.2	**CONCRETE:** (225mm)										
0.3	**SAND**, trace to some gravel Compact Brown Moist (FILL)		1	SS	20		187		C		
			2	SS	24		186		C		
			3	SS	12		185		C		
	Wet		4	SS	12		184		O		
	Very Loose to Loose		5	SS	4		183				
	Compact		6	SS	19		182				
181.1											
6.4	Silty **CLAY**, with silt seams Very Soft Grey		7	SS	0		181		⊢—⊣ O		0 0 41 59
	Without silt seams		8	SS	0		180		O		
							179				
							178	3.0			

ONTMT4S 1197.GPJ 2012TEMPLATE(MTO).GDT 6/14/13

Continued Next Page

+ ³, × ³ : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No LGR-03 3 OF 3 METRIC

W.P. 6067-09-00 LOCATION Little Gravel River Bridge N 5 420 738.0 E 248 085.5 ORIGINATED BY SLL

HWY 17 BOREHOLE TYPE NW Casing COMPILED BY AN

DATUM Geodetic DATE 2011.11.09 - 2011.11.11 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SILT, some clay Compact Grey						167				
			15	SS	11				H C		0 0 77 23
							166				
							165				
							164				
			16	SS	13				○		0 0 79 21
							163				
							162				
							161				
160.1			17	SS	13				○		
27.4	END OF BOREHOLE AT 27.4m. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Nov.12/11 3.3 184.2 Nov.30/11 2.7 184.8 May 29/12 2.6 184.9										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

ONTMT4S 1197.GPJ 2012TEMPLATE(MTO).GDT 6/14/13

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No LGR-04 1 OF 3 METRIC

W.P. 6067-09-00 LOCATION Little Gravel River Bridge N 5 420 735.8 E 248 096.8 ORIGINATED BY SLL

HWY 17 BOREHOLE TYPE NW Casing COMPILED BY AN

DATUM Geodetic DATE 2011.11.06 - 2011.11.07 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
187.4											
0.0	**ASPHALT:** (115mm)										
0.1	**SAND**, trace to some gravel, trace silt Very Dense Brown Moist (FILL)		1	SS	67		187		○		
			2	SS	60		186		○		
	Compact Wet		3	SS	19		185		○		
184.4											
3.0	**SILT**, some clay, trace to some sand, occasional organics and wood fragments Loose to Very Loose Grey		4	SS	5		184		○		0 19 71 10
			5	SS	3		183		○		
	With silt seams		6	SS	0	▽	182		○		0 4 79 17
180.8							181				
6.6	Silty **CLAY**, with thin silt seams Very Soft Grey		7	SS	0		180		○		
			8	SS	0		179		○		
							178	3.0 2.0			

Continued Next Page

+ ^{3}, × ^{3} : Numbers refer to Sensitivity

15 $\frac{20}{10}$ 5 (%) STRAIN AT FAILURE

ONTMT4S 1197.GPJ 2012TEMPLATE(MTO).GDT 6/14/13

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No LGR-04 2 OF 3 METRIC

W.P. 6067-09-00 LOCATION Little Gravel River Bridge N 5 420 735.8 E 248 096.8 ORIGINATED BY SLL

HWY 17 BOREHOLE TYPE NW Casing COMPILED BY AN

DATUM Geodetic DATE 2011.11.06 - 2011.11.07 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **CLAY**, trace sand Very Soft Grey		9	SS	0		177				0 0 17 83
							176				
			10	SS	0						
							175	2.0			
			11	SS	0		174				
							173				
			12	SS	0						
							172	3.0			
	With silt layers		13	SS	6		171				0 0 54 46
170.3											
17.1	**SILT**, some clay, with clay seams/layers Compact to Loose Grey		14	SS	11		170				
							169				
							168				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No LGR-04 3 OF 3 METRIC

W.P. 6067-09-00 LOCATION Little Gravel River Bridge N 5 420 735.8 E 248 096.8 ORIGINATED BY SLL

HWY 17 BOREHOLE TYPE NW Casing COMPILED BY AN

DATUM Geodetic DATE 2011.11.06 - 2011.11.07 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	SILT, some clay Compact Grey						167				
			15	SS	7				○		
							166				
							165				
							164				
			16	SS	10				○		
							163				
							162				
							161				
160.0			17	SS	8				○		
27.4	END OF BOREHOLE AT 27.4m. BOREHOLE BACKFILLED WITH GROUT AND BENTONITE MIXTURE TO 1.8m, AUGER CUTTINGS TO 0.15m, THEN ASPHALT TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

ONTMT4S 1197.GPJ 2012TEMPLATE(MTO).GDT 6/14/13

Appendix B

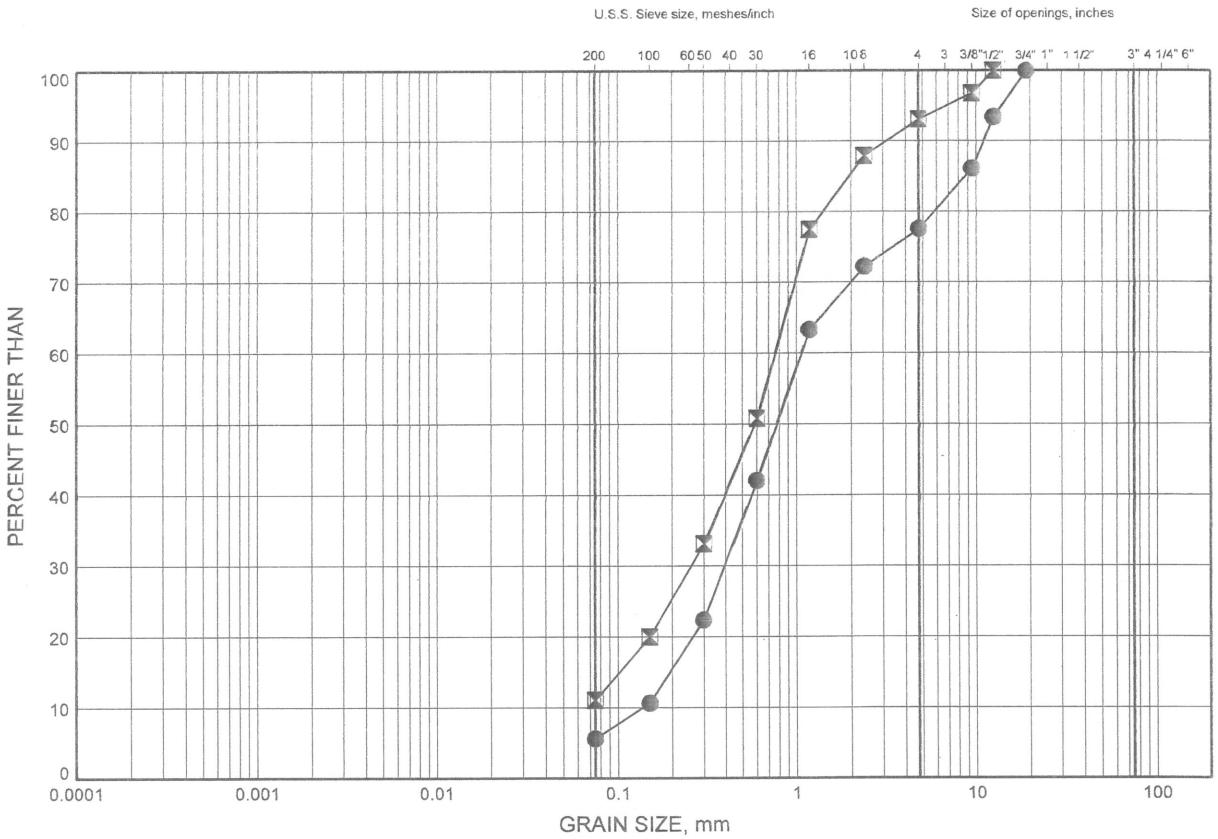
Laboratory Test Results

NWR 32 Rehabs

GRAIN SIZE DISTRIBUTION

FIGURE B1

GRAVELLY SAND FILL & SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	LGR-01	1.83	185.57
⧓	LGR-02	2.59	184.91

Date April 2013

W.P. 6067-09-00

THURBER

Prep'd AN

Chkd. RPR

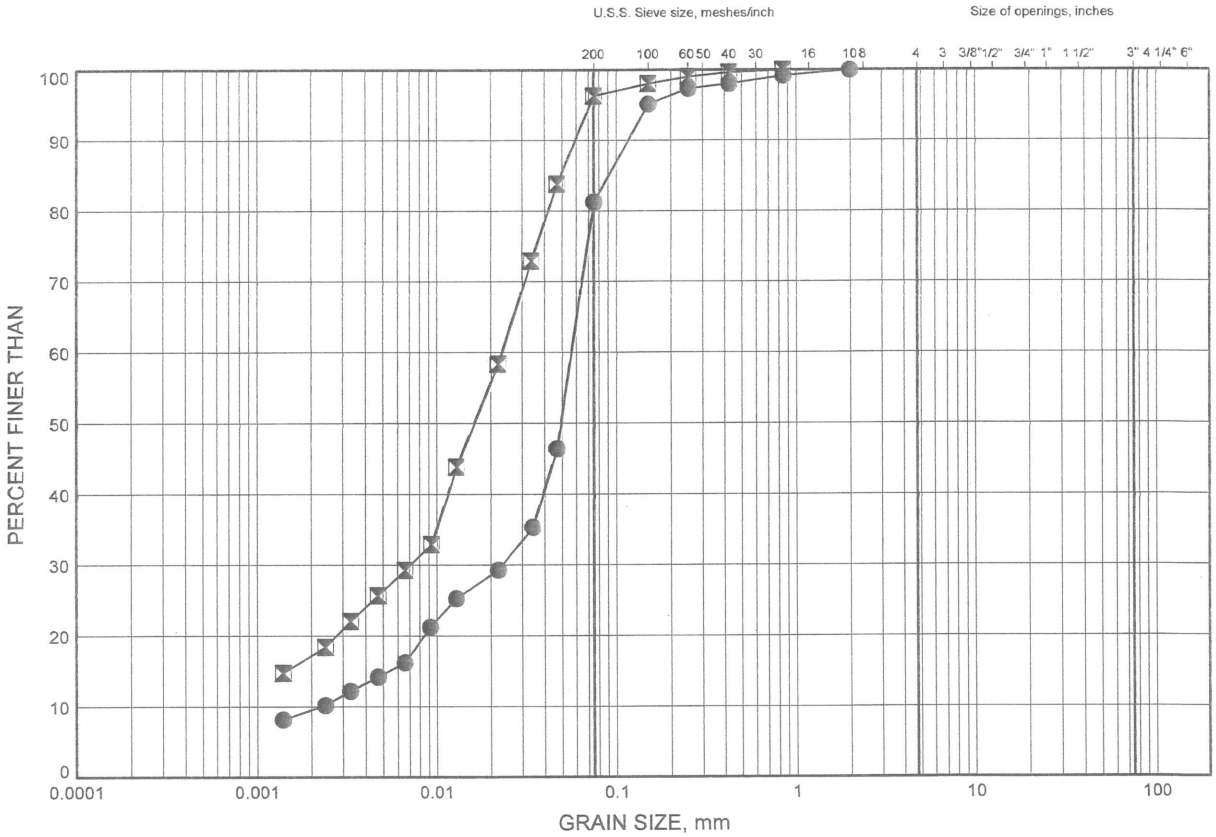
GRAIN SIZE DISTRIBUTION - THURBER 1197.GPJ 4/30/13

NWR 32 Rehabs

GRAIN SIZE DISTRIBUTION

FIGURE B2

UPPER SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	LGR-04	3.35	184.04
⊠	LGR-04	5.79	181.61

Date June 2013

W.P. 6067-09-00

THURBER

Prep'd AN

Chkd. RPR

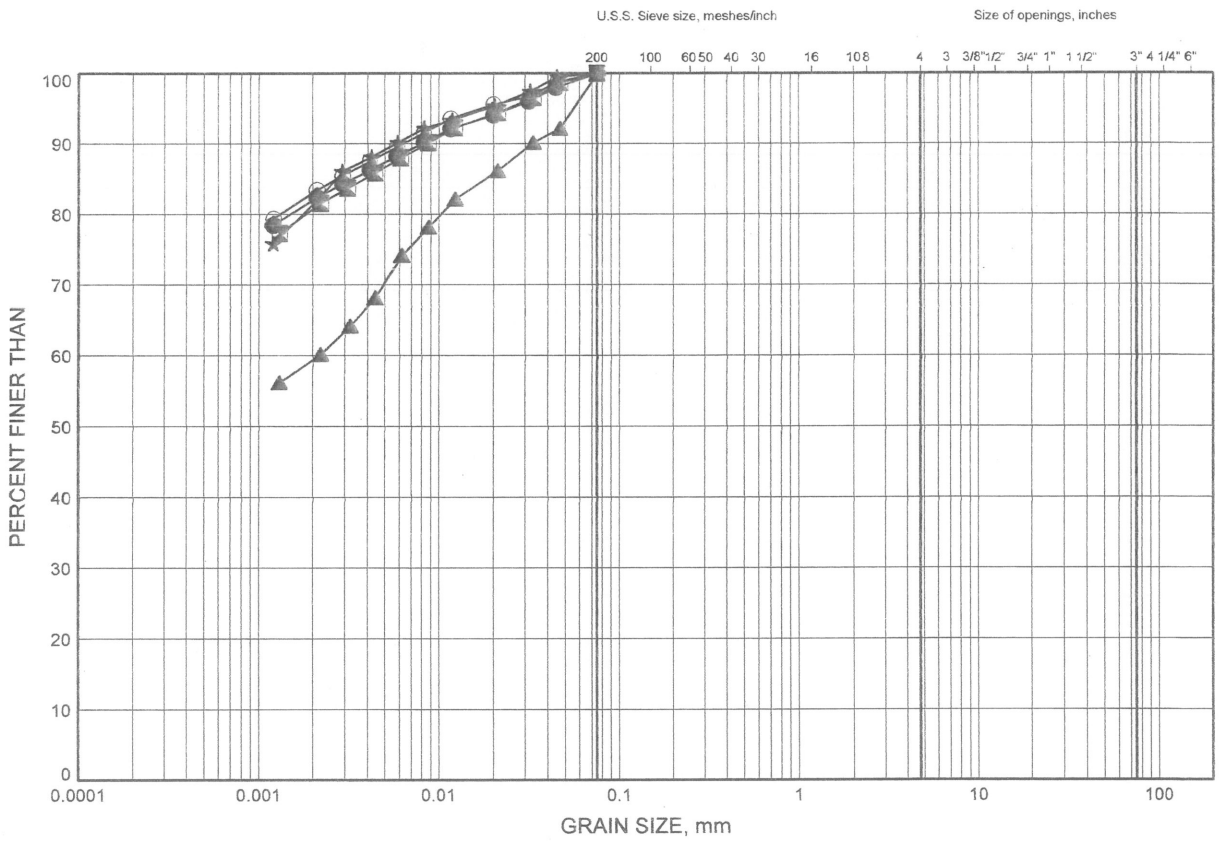
GRAIN SIZE DISTRIBUTION - THURBER 1197.GPJ 6/14/13

NWR 32 Rehabs

GRAIN SIZE DISTRIBUTION

FIGURE B3

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	LGR-01	10.36	177.03
⊠	LGR-02	8.84	178.66
▲	LGR-03	7.32	180.18
★	LGR-03	13.41	174.09
⊙	LGR-04	10.36	177.03

Date August 2013

W.P. 6067-09-00

THURBER

Prep'd AN

Chkd. RPR

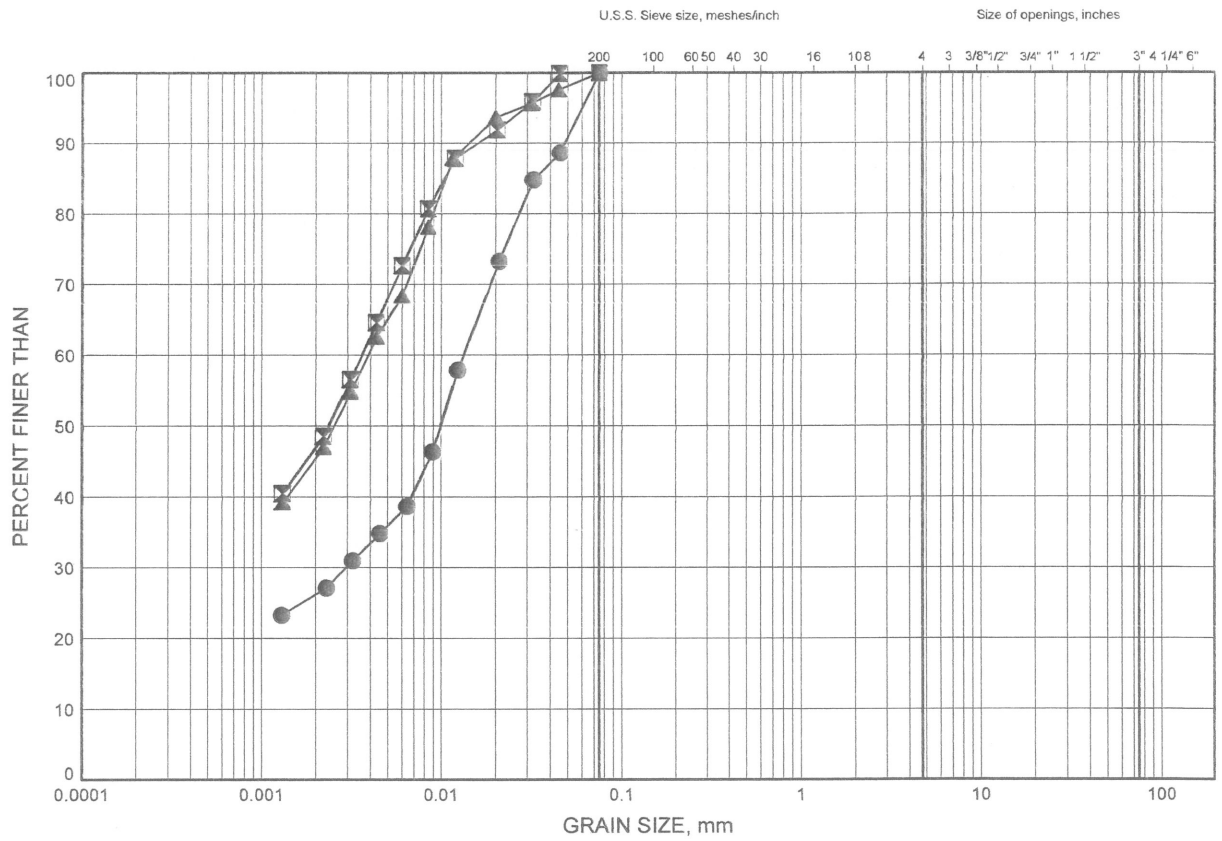
GRAIN SIZE DISTRIBUTION - THURBER 1197.GPJ 8/15/13

NWR 32 Rehabs

GRAIN SIZE DISTRIBUTION

FIGURE B4

SILTY CLAY WITH SILT SEAMS/LAYERS



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	LGR-01	5.79	181.61
⊠	LGR-02	16.76	170.73
▲	LGR-04	16.46	170.94

Date August 2013

W.P. 6067-09-00

THURBER

Prep'd AN

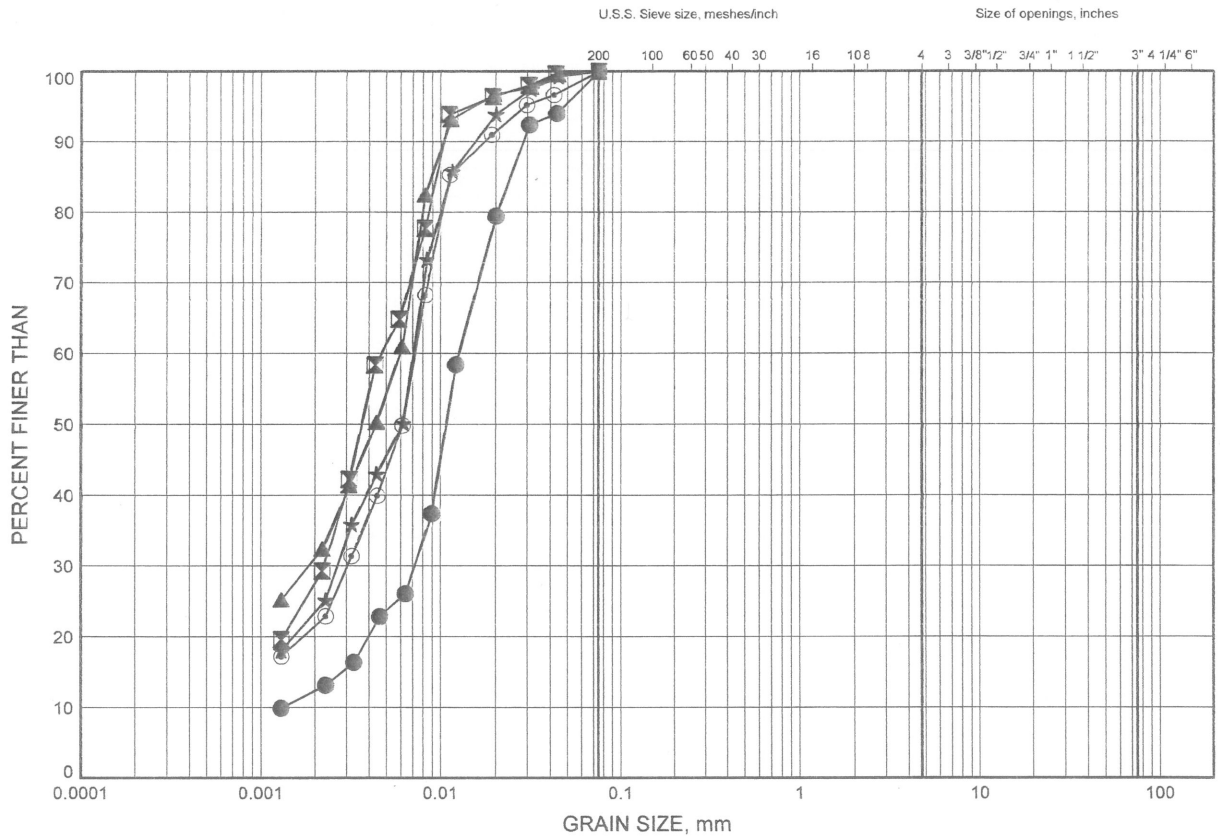
Chkd. RPR

NWR 32 Rehabs

GRAIN SIZE DISTRIBUTION

FIGURE B5

LOWER SILT WITH CLAY SEAMS



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	LGR-01	17.98	169.41
⊠	LGR-01	24.08	163.32
▲	LGR-02	27.13	160.37
★	LGR-03	21.03	166.47
⊙	LGR-03	24.08	163.42

Date June 2013

W.P. 6067-09-00

THURBER

Prep'd AN

Chkd. RPR

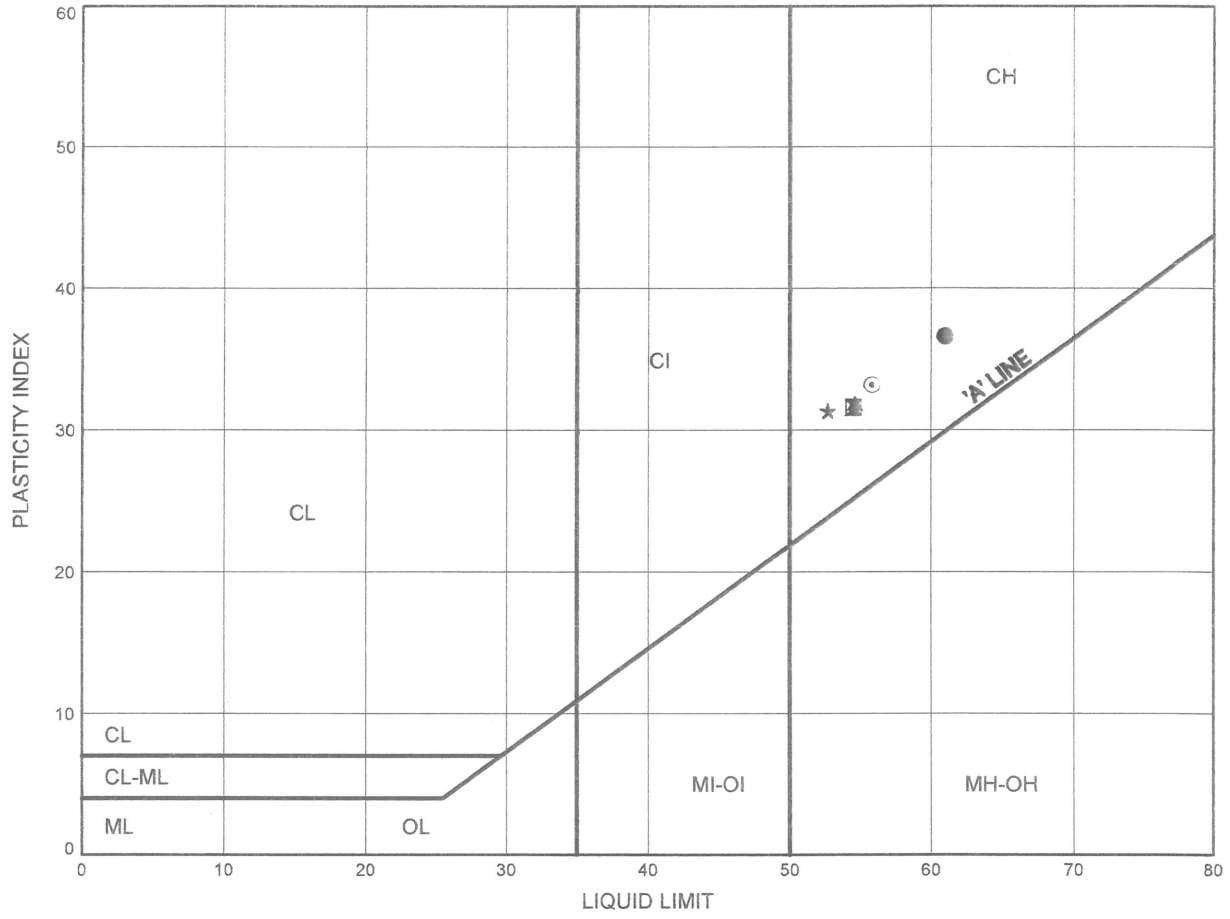
GRAIN SIZE DISTRIBUTION - THURBER 1197.GPJ 6/14/13

NWR 32 Rehabs

ATTERBERG LIMITS TEST RESULTS

FIGURE B6

SILTY CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	LGR-01	10.36	177.03
⊠	LGR-02	8.84	178.66
▲	LGR-03	7.32	180.18
★	LGR-03	13.41	174.09
⊙	LGR-04	10.36	177.03

Date August 2013

W.P. 6067-09-00

THURBER

Prep'd AN

Chkd. RPR

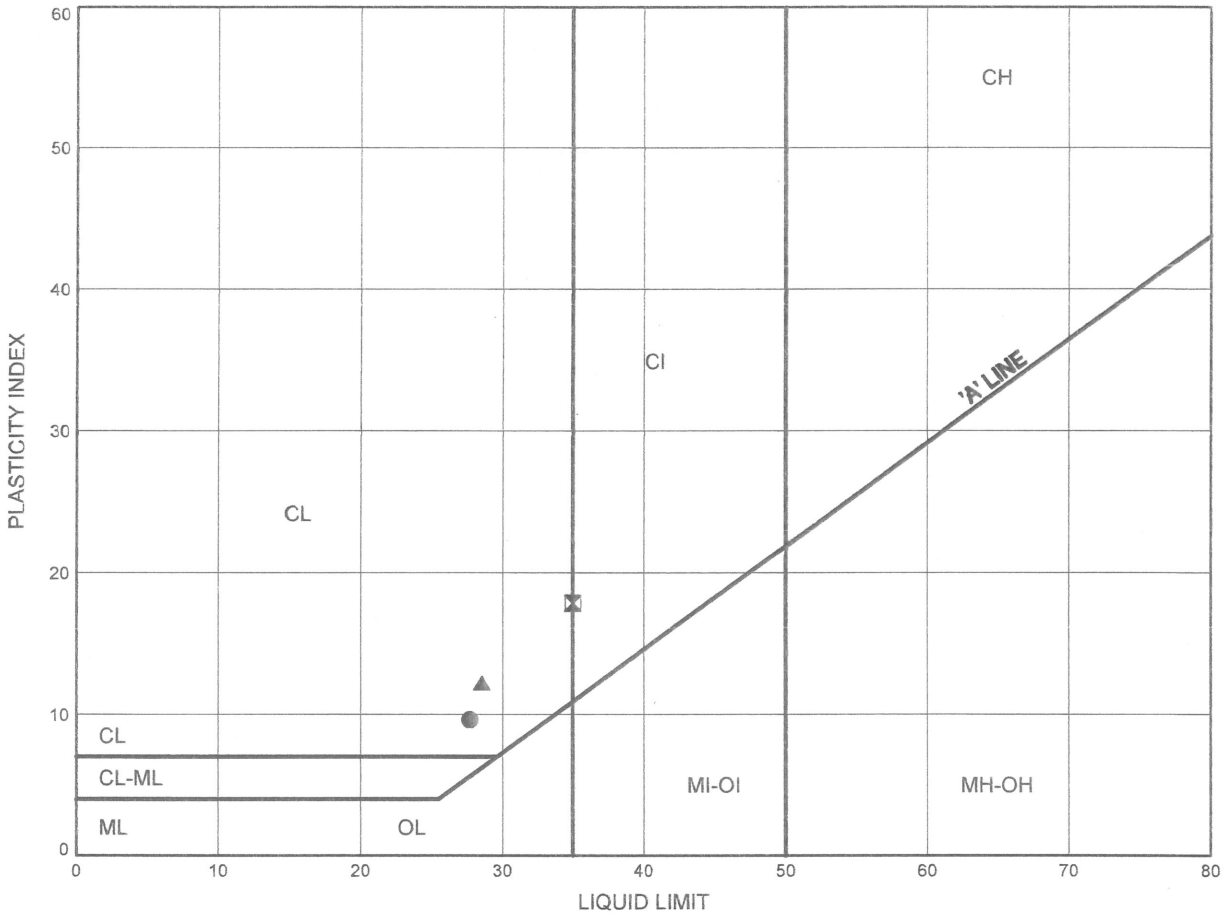
THURBALT 1197.GPJ 8/15/13

NWR 32 Rehabs

ATTERBERG LIMITS TEST RESULTS

FIGURE B7

SILTY CLAY WITH SILT SEAMS/LAYERS



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	LGR-01	5.79	181.61
⊠	LGR-02	16.76	170.73
▲	LGR-04	16.46	170.94

Date August 2013

W.P. 6067-09-00

THURBER

Prep'd AN

Chkd. RPR

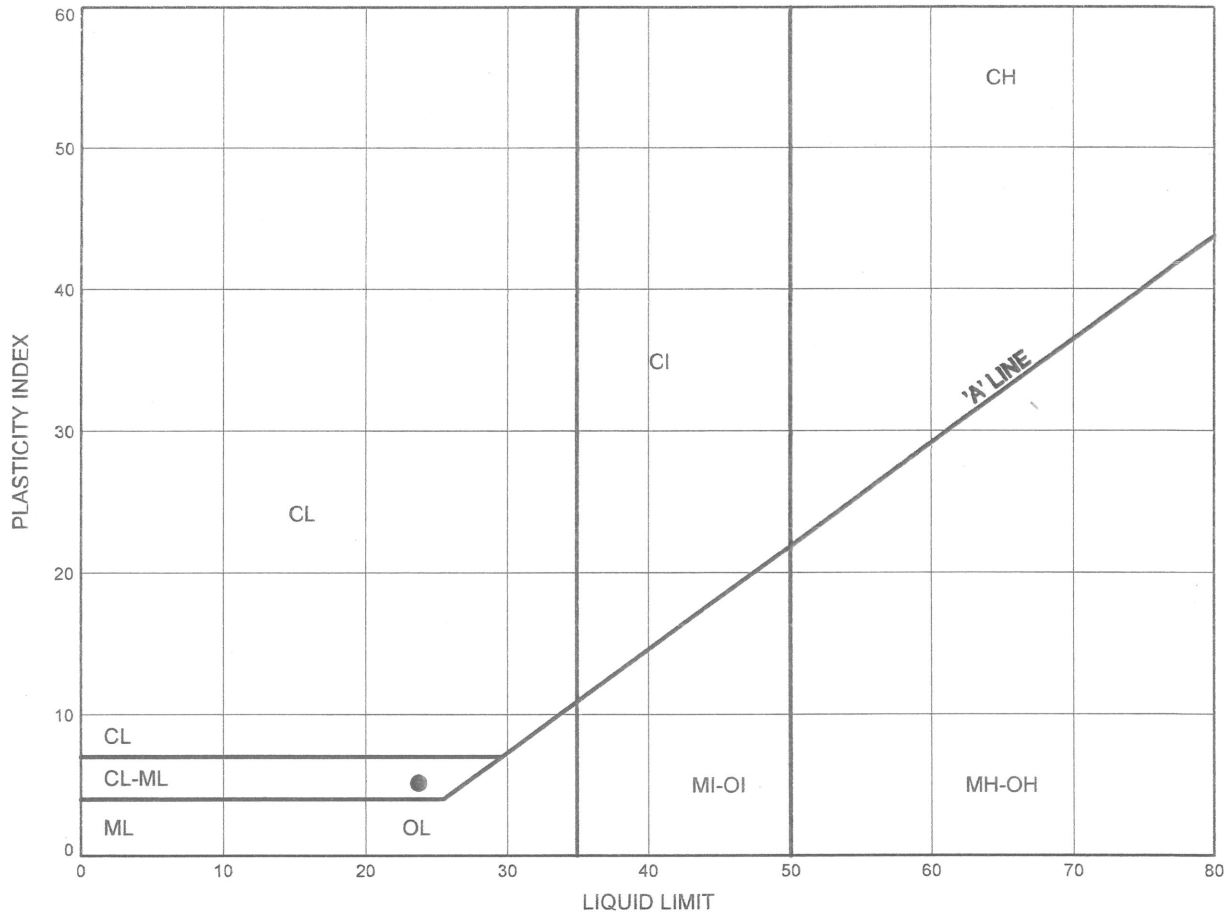
THURBALT 1197.GPJ 8/15/13

NWR 32 Rehabs

ATTERBERG LIMITS TEST RESULTS

FIGURE B8

LOWER SILT



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	LGR-03	21.03	166.47

Date June 2013

W.P. 6067-09-00

THURBER

Prep'd AN

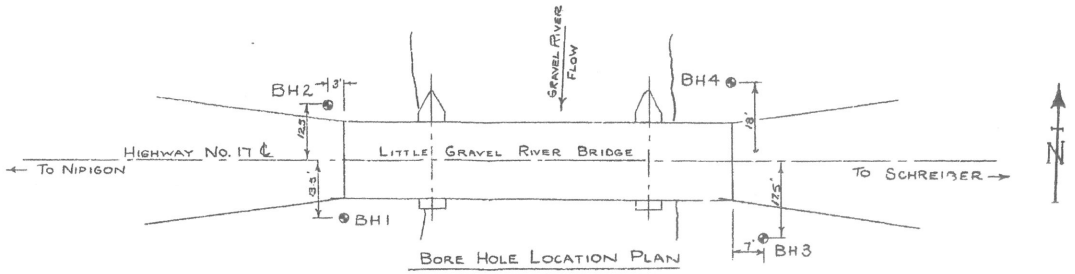
Chkd. RPR

THURBALT 1197.GPJ 6/14/13

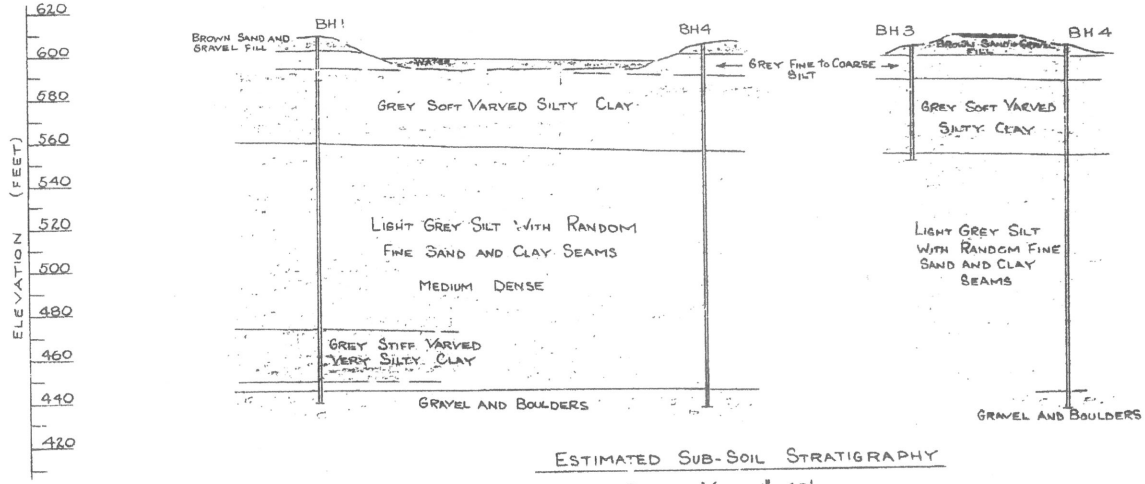
Appendix C

Record of Borehole Sheets, Borehole Locations and Soil Profile From Previous Investigation

Drawing No. 1
Job No. C108/J267



BORE HOLE LOCATION PLAN
SCALE 1"=20'



ESTIMATED SUB-SOIL STRATIGRAPHY
SCALE: VERT. 1"=40'
HORIZ. 1"=20'

LITTLE GRAVEL RIVER

BORE HOLE LOCATION AND SUB-SOIL STRATIGRAPHY

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

Nov. 1958

PROJECT NO. C108/J267

DRAWING NO. 2

TROW SODERMAN AND ASSOCIATES

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

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

BOREHOLE NO. 1
FIELD SUPERVISOR K.P.
DRILLER H.U.
PREP. K.P.

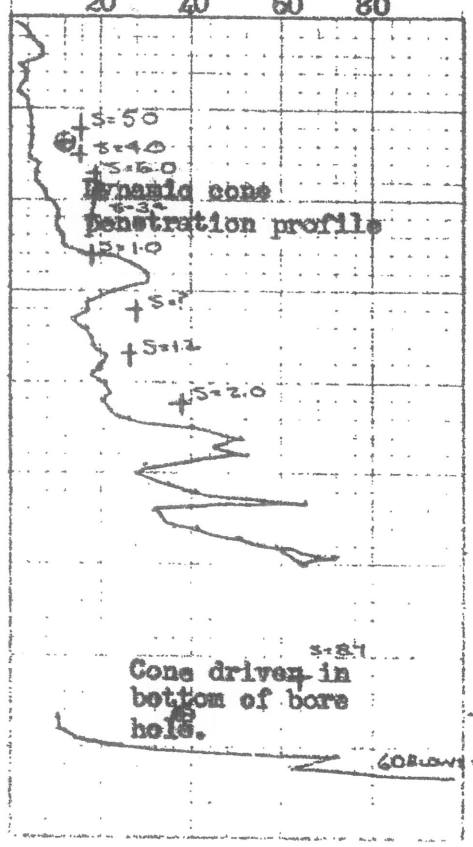
LEGEND
- 2" DIA. SPLIT TUBE
- 2" SHELBY TUBE
- 2" SPLIT TUBE
- 2" DIA. CONE
- CASING
- 2" SHELBY
- 1-2 UNCONFINED COMPRESSION (Qu)
- VANE TEST (C) AND SENSITIVITY (S)
- NATURAL MOISTURE AND LIQUIDITY INDEX
- LIQUID LIMIT
- PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	Ground surface.	609.8	0
	Brown sand and gravel.	603.3	
	Grey silty very fine sand.	594.8	
	Grey soft varved silty clay.	559.8	40
	Light grey fine to coarse silt with random thin clay seams.	474.8	120
	Grey stiff varved silty clay.		
	Light grey silt.	449.8	140
	End of hole.	444.8	160
	Boulders and gravel.	439.8	

Core AX from 165 to 170 ft. Recover boulder and gravel sizes.

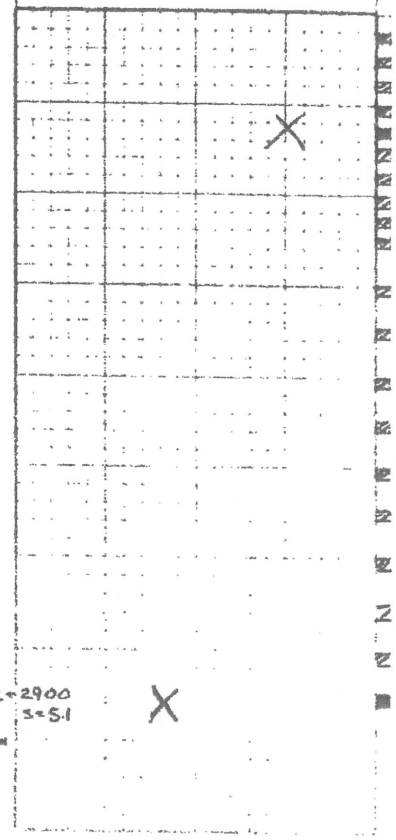
STRENGTH AND PENETRATION RESISTANCE P.S.F.

BLOWS/FT. 20 40 60 80



CONSISTENCY

MOIST. CONTENT - % DRY WT.



SAMPLE	NATURAL UNIT WT. P.C.F.
SS1	
SS2	
SS3	
SS4	
TW5	
SS6	
SS7	
SS8	
SS9	
SS10	
SS11	
SS12	
SS13	
SS14	
SS15	
SS16	
SS17	
SS18	
SS19	
TW20	

Ground water level = 0.5 ft in caved hole.

PROJECT NO. C108/J267

DRAWING NO. 3

TROW SODERMAN AND ASSOCIATES

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

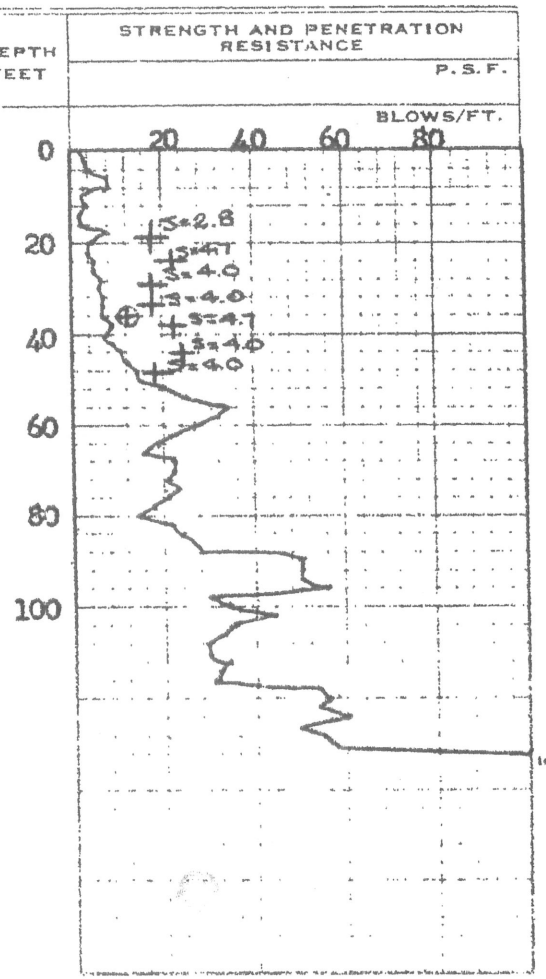
PROJECT Little Gravel River Bridge
LOCATION Highway No. 17
HOLE LOCATION See plan
HOLE ELEVATION AND DATUM 610.3

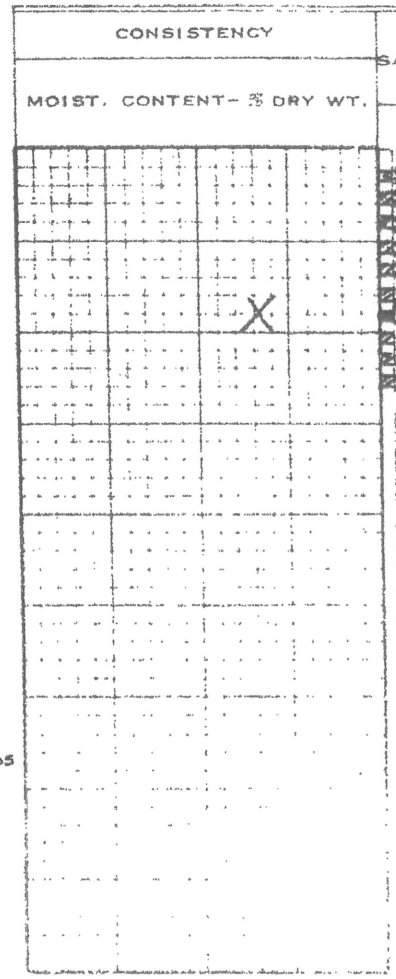
BOREHOLE NO. 2
FIELD SUPERVISOR K.P.
DRILLER H.U.
PREP. K.P.

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

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	↓ Ground surface.	610.3	0
	Sand and gravel fill.	605.3	
	Grey silty very fine sand.	595.3	
	Grey soft varved silty clay.		
		560.3	
	End of hole.	558.3	
	Light grey silt with random thin clay seams.		

Ground water level = 3 ft.





NATURAL UNIT WT. P.C.F.

PROJECT NO. C108/J267

DRAWING NO. 4

TROW SODERMAN AND ASSOCIATES

ITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT Little Gravel River
LOCATION Highway No. 17
HOLE LOCATION See plan
HOLE ELEVATION AND DATUM 609.2

BOREHOLE NO. 3
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 (Qu)
- VANE TEST (C) AND SENSITIVITY (S)
- NATURAL MOISTURE AND LIQUIDITY INDEX
- LIQUID LIMIT
- PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	Ground surface.	609.2	0
	Brown sand and gravel fill.	607.2	
	Grey silty fine sand.	599.2	
	Grey clayey silt.	594.2	20
	Grey medium stiff varved silty clay.	559.2	40
	End of hole.	557.2	
	Light grey silt.		60
			80
			100
			120

Ground water level = 3.5 ft.

STRENGTH AND PENETRATION RESISTANCE
P.S.F.
BLOWS/FT.
20 40 60 80

CONSISTENCY
MOIST. CONTENT - % DRY WT.

SAMPLE
SS1
SS2
SS3
SS4
SS5
TW-6
SS7
SS8
SS9
SS10

NATURAL UNIT WT. P.C.F.

PROJECT NO. C108/J267

DRAWING NO. 5

TROW SODERMAN AND ASSOCIATES

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT Little Gravel River
LOCATION Highway No. 17
HOLE LOCATION See plan
HOLE ELEVATION AND DATUM 608.4

BOREHOLE NO. 4
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 (Qu)
- VANE TEST (C) AND SENSITIVITY (S).
- NATURAL MOISTURE AND LIQUIDITY INDEX
- LIQUID LIMIT
- PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	Ground surface.	608.4	0
	Brown sand and gravel fill.	603.4	
	Grey medium to coarse silt.	593.4	
	Grey soft varved silty clay.	558.4	40
	Light grey fine to coarse silt with random fine sand and clay seams.		60
	Wash ahead from 100 - 161 ft.		120
		447.4	160
	End of hole. Gravel and boulders. 440.4		

Ground water level approx. 5 ft.

STRENGTH AND PENETRATION RESISTANCE

P.S.F. 1000 2000

BLOWS/FT. 20 40 60 80

Dynamic cone penetration profile

CONSISTENCY

MOIST. CONTENT - % DRY WT.

SAMPLE

SS1
SS2
TW3
SS4
SS5
SS6
SS7
SS8
SS9
SS10

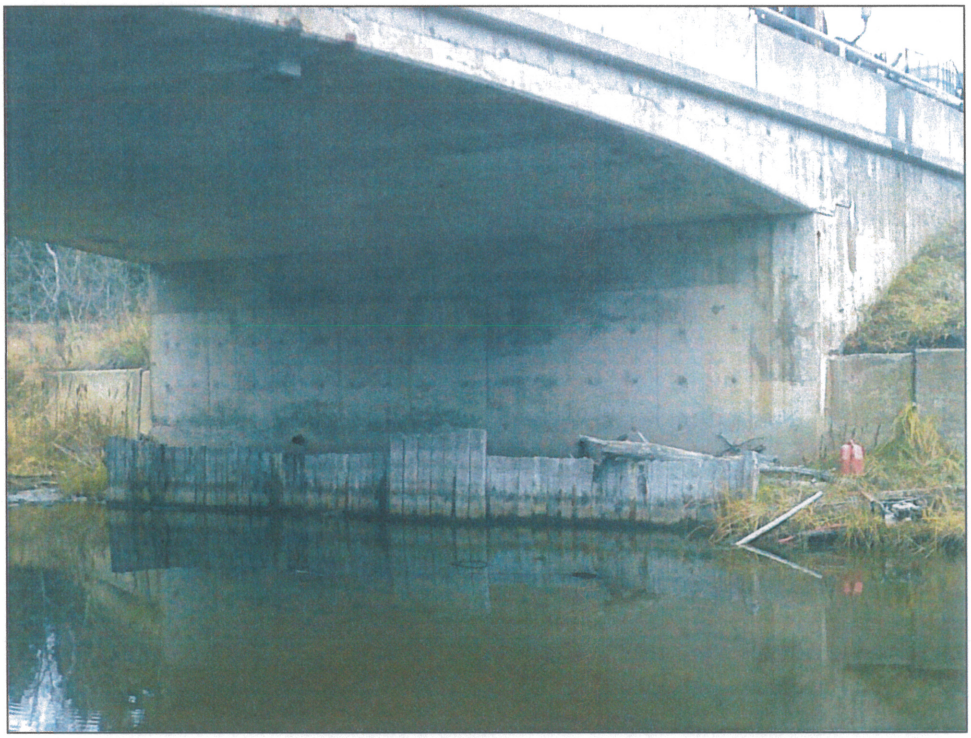
NATURAL UNIT WT. P.C.F.

Appendix D

Site Photographs

Photograph 1 – Little Gravel River Bridge, north side looking west

Photograph 2 – Little Gravel River Bridge, north side looking east



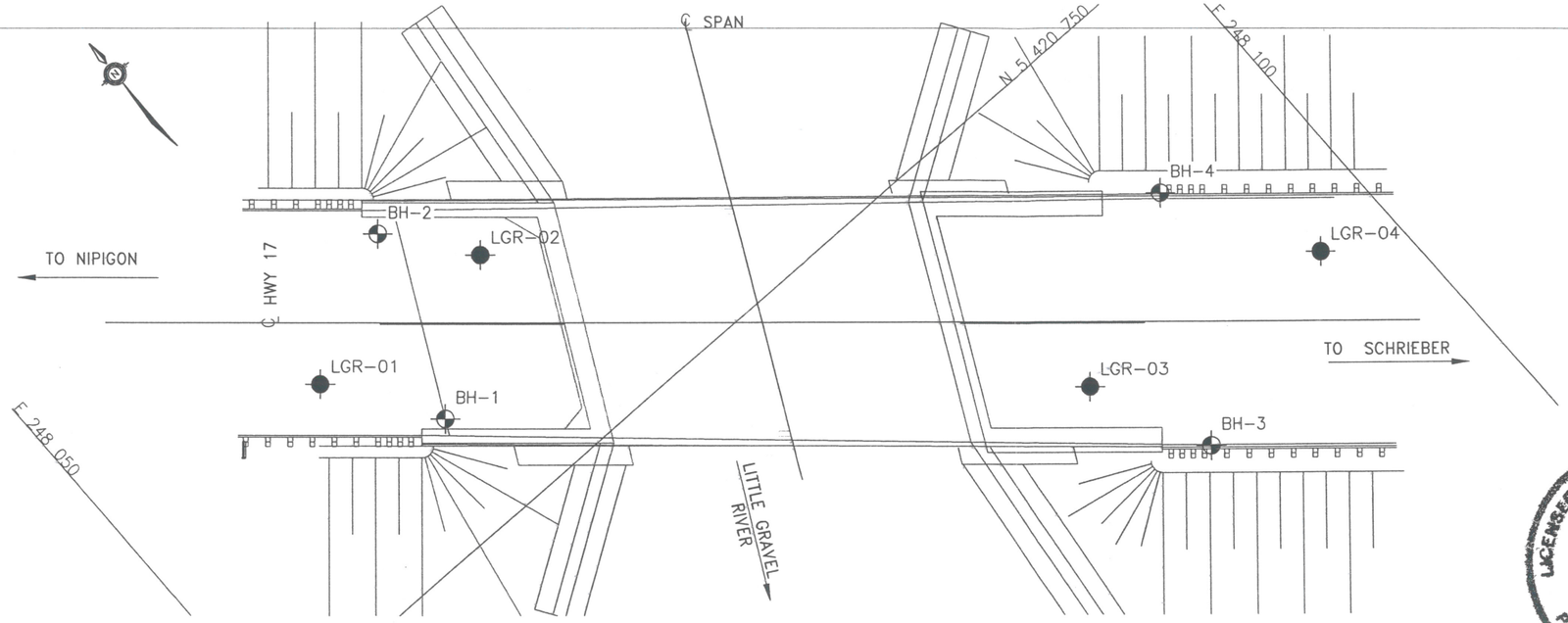
Photograph 3 – Little Gravel River Bridge, west abutment

Photograph 4 – Under Little Gravel River Bridge, looking south to railway bridge

Appendix E

Drawing titled "Borehole Locations and Soil Strata"

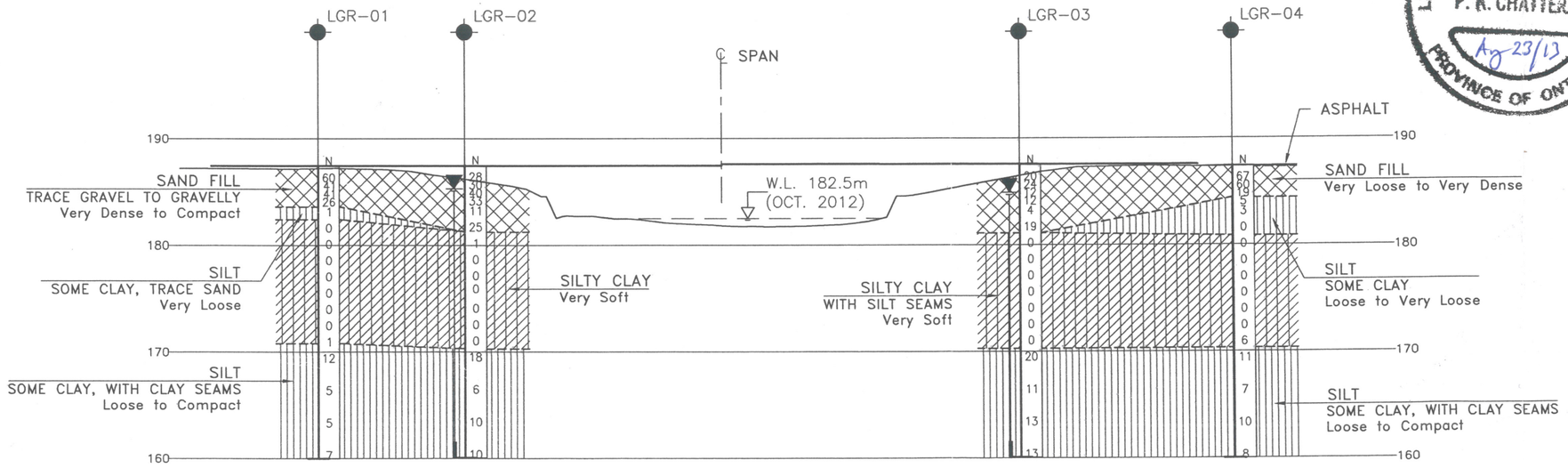
MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

5 0 5 10m

SCALE 1:250



PROFILE ALONG ℄ HWY 17

5 0 5 10m H 1:250

10 0 10 20 V 1:500

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

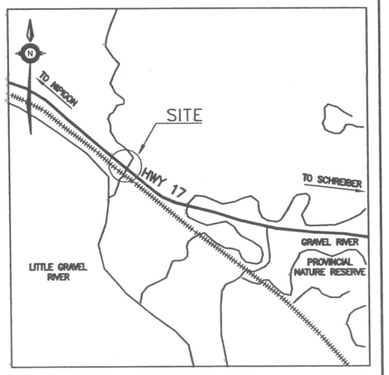
CONT No
WP No 6067-09-01

HIGHWAY 17
LITTLE GRAVEL RIVER BRIDGE
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET S02

McCORMICK RANKIN
A member of MMM GROUP

THURBER ENGINEERING LTD.



KEYPLAN

LICENSED PROFESSIONAL ENGINEER
M. R. ANDERSON
Aug 23/13
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Aug 23/13
PROVINCE OF ONTARIO

	LEGEND
●	Borehole (Current Investigation)
⊕	Borehole (Previous Investigation)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level During Drilling
▼	Water Level In Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
LGR-01	187.4	5 420 759.7	248 060.6
LGR-02	187.5	5 420 759.3	248 069.5
LGR-03	187.5	5 420 738.0	248 085.5
LGR-04	187.4	5 420 735.8	248 096.8
BH-1	185.9	5 420 755.0	248 063.7
BH-2	186.0	5 420 762.9	248 066.7
BH-3	185.7	5 420 732.7	248 087.7
BH-4	185.4	5 420 742.2	248 093.2

-NOTES-

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

GEOCRES No. 42D-31

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	RPR	CHK	RPR	CODE		LOAD	DATE MAY 2013
DRAWN	AN	CHK		SITE	48C-17	STRUCT	DWG 2

FILENAME: H:\Drafting\19\351\197\ted1197-LittleGravelRiverBridge(Plan&Profile).dwg
PLOTDATE: 8/14/2013 1:12 PM