

**FOUNDATION INVESTIGATION AND DESIGN REPORT
DETAIL DESIGN
BEATTY CREEK BRIDGE REPLACEMENT
HIGHWAY 534
G.W.P. 5200-03-00, SITE 44-016**

Geocres Number: 31L-120

Report to

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PART A: FOUNDATION INVESTIGATION REPORT

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted for the proposed replacement of the Beatty Creek bridge located on Highway 534 approximately 100 m west of the Highway 654 junction.

A preliminary foundation investigation was carried out for this project by Thurber in August to September 2006, and the factual data from that investigation has been incorporated into the current assignment.

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, borehole logs, stratigraphic profile and a written description of the subsurface conditions. A model of the subsurface conditions was developed to describe the geotechnical conditions influencing structure foundation design, embankment stability and settlement, and construction concerns.

Thurber carried out the investigation as a sub-consultant to McCormick Rankin Corporation, under the Ministry of Transportation Ontario (MTO) Agreement Number 5004-E-0056.

2 SITE DESCRIPTION

The bridge site lies on Highway 534 approximately 100 m west of Highway 654 and 1 km south of the Village of Nipissing. It lies in the Township of Nipissing, District of Parry Sound.

The general site area is located within the physiographic region known as the Canadian Shield, characterized by Pre-Cambrian bedrock typically occurring as rounded knobs and ridges where exposed. The bedrock is locally overlain by deposits of glacio-fluvial sands and gravels, and glacio-lacustrine soils. More recent organic deposits are present in poorly drained swamp environments.

The immediate area of the bridge is generally wooded, low-lying and wet. Photographs of the site are provided in Appendix C. At the site, Beatty Creek is a slow moving watercourse within a meandering channel typically ranging from 6 to 8 m wide. An abandoned meander with ponded

water exists in the southwest quadrant of the creek crossing. The site is prone to flooding during heavy rainfall events and spring snowmelt.

The existing bridge is a three span timber beam and deck structure supported on timber pile bents. The bridge has a total length of 13 m.

An abandoned road alignment, now a snowmobile trail, runs south of the current road alignment. A general store is present at the junction of Highway 654.

3 SITE INVESTIGATION AND FIELD TESTING

Thurber carried out site investigation and field testing for the detailed design phase of this project during the period July 23 to August 2, 2007. The fieldwork for the preliminary investigation was carried out from August 28 to September 8, 2006. In total, 18 boreholes were drilled and sampled at the locations of the proposed bridge, approaches and embankments.

The approximate locations of the boreholes are shown on the attached Borehole Locations and Soil Strata Drawings in Appendix E. The locations and depths of the boreholes were as follows:

Table 3.1 – Borehole Details

Location	Study Phase	Number of Boreholes	Borehole Numbers	Depth of Boreholes (m)
Proposed Bridge Abutments	Preliminary	4	06-B1 to 06-B4	41.8 to 47.8
	Detail	4	07-B1, 07-B2, 07-B4, 07-B5	15.8 to 45.5
Structure Approaches	Detail	2	07-B3, 07-B6	40.4 to 44.0
Existing and Proposed Embankments	Preliminary	2	06-B8, 06-B10	17.7 to 20.1
	Detail	3	07-B7 to 07-B9	38.7 to 44.5
Alternate Alignments	Preliminary	3	06-B6, 06-B7, 06-B9	12.6 to 42.5

The borehole depths in Table 3.1 include recovery of an approximate 3 m length of rock core at four locations.

Thurber positioned the boreholes in the field relative to the centreline of Highway 534 and the existing bridge structure. Several boreholes were repositioned from the programmed locations due to overhead wires, embankment slopes, and the creek channel. The coordinates and ground surface elevations at the boreholes were subsequently established by MRC. The coordinates and elevations of the boreholes are given on the Borehole Locations and Soil Strata Drawing and on the individual Record of Borehole Sheets in Appendix A.

A combination of hollow stem auger and rotary drilling techniques was used to advance the boreholes and samples were obtained using a split spoon sampler in conjunction with Standard Penetration Tests (SPT). The in situ strength of the cohesive soils was assessed using the MTO shear vane, and thin wall tube samples were recovered from the soft cohesive deposits. The boreholes were supplemented by dynamic cone penetration testing. Bedrock cores were recovered using NQ coring equipment.

A member of Thurber's engineering staff supervised the drilling and sampling operations on a full time basis. The inspector logged the soil and groundwater conditions encountered in the boreholes, and collected, labelled and arranged for transport of the samples to Thurber's laboratory.

Standpipe piezometers were installed in selected boreholes to monitor groundwater levels. The completion details of the piezometers are presented in Table C1 of Appendix C.

The boreholes without piezometers were grouted upon completion. Following water level measurements, the piezometers were decommissioned in accordance with the abandonment requirements of MOE Reg. 903.

4 LABORATORY TESTING

All recovered soil samples were subjected to visual identification and to natural moisture content determination. The results of this testing are shown on the Record of Borehole sheets in Appendix A.

Selected samples were subjected to gradation analysis (sieve and hydrometer) and Atterberg Limits testing. Thin wall tube samples were also selected for consolidation testing and unconfined compression tests. The results are shown on the Record of Borehole sheets in Appendix A and on the charts in Appendix B.

The rock core descriptions were confirmed in the laboratory and Point Load Tests were conducted to assess the compressive strength of the rock.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

5.1 General

Reference is made to the Record of Borehole sheets in Appendix A and to the Borehole Locations and Soil Strata Drawings in Appendix E. An overall description of the stratigraphy based on the conditions encountered in the boreholes is given in the following paragraphs. However, the factual data presented in the borehole logs takes precedence over this general description and interpretation of the site conditions.

The soil stratigraphy encountered at this site generally consists of existing road embankment fill and/or relatively thin layers of sand, silty sand, sandy silt and silt, underlain by a deposit of very soft to stiff silty clay to clayey silt. The upper clay deposit is underlain by a unit of sands and silts, and a deeper, thick layer of soft to very stiff silty clay to clayey silt. The lower clay deposit typically overlies sands and silts which mantle bedrock.

The thickness and gradation of the particular deposits vary with location. Further, the deposits have a layered structure and often contain discontinuous seams and layers of coarser or finer material within each generalized unit.

More detailed descriptions of the individual strata are presented below.

Three boreholes (BH06-B6, 06-B7 and 06-B9) were drilled on alternate alignments during the preliminary investigation. The Record of Borehole sheets for these boreholes are included in Appendix A for information purposes, however the data is not included in the discussion below.

5.2 Roadway Pavement and Embankment Fill

A 40 to 90 mm thick layer of asphalt, appearing to consist of chip seal surface treatment, was encountered in seven boreholes drilled on Highway 534.

The asphalt was underlain by granular fill (sand and gravel to sand, some gravel). Based on recorded SPT N-values ranging from 7 to 28 blows/0.3 m, the fill is typically loose to compact. One N-value of 49 blows/0.3 m (dense) was obtained east of the bridge (BH06-B10). Moisture contents varied from 2 to 22% dependent upon the relative silt content and position with respect to the water table. The depth of the granular fill ranged from 1.4 to 2.4 m (elevation 196.6 to 198.1 m).

A 0.6 m thick layer of sand and gravel fill was placed at the location of borehole 06-B02 as a levelling and support pad for drilling equipment.

5.3 Topsoil and Peat

A 150 to 200 mm thick layer of topsoil was encountered surficially in four boreholes drilled off of the road embankment. A 300 mm thick layer of peat was encountered at one other location (BH07-B8). The topsoil/peat thickness may vary between and beyond the borehole locations and the data is not intended for the purpose of estimating quantities.

5.4 Surficial Layers of Sand and Silt

Discontinuous layers of cohesionless sand, silty sand, sandy silt and silt were encountered at the ground surface or below fill, topsoil or a clay layer in all but two boreholes. The sand and silt layers were typically described as wet and grey, locally dry to moist and brown to dark brown.

SPT values of 1 to 16 blows/0.3 m were obtained in the sand/silt layers, indicating a very loose to compact condition. Natural moisture contents ranged from 5 to 43%,

The results of laboratory gradation tests carried out on six samples were as follows:

Gravel %	0
Sand %	2 to 94
Silt & Clay %	6 to 98

The grain size distribution curves for the samples tested are presented in Figures B1 and 07-B1 in Appendix B.

The sand and silt layers typically ranged in thickness from 0.3 to 3.2 m, locally 5.9 m in one borehole (BH07-B9) located near Highway 654. The depth to the base of these strata ranged from 0.5 to 6.1 m (elevation 194.2 to 196.6 m).

5.5 Upper Silty Clay to Clayey Silt

A thick deposit of silty clay, grading to clayey silt at the upper and lower boundaries of this unit at many locations, was encountered below the embankment fill and sand/silt strata at all locations. The clay was typically described as grey and wet.

SPT values obtained in the silty clay/clayey silt ranged from 0 to 14 blows/0.3 m. The undrained shear strength, assessed by in situ vane testing, ranged from 8 to 72 kPa, typically about 16 to 34 kPa. Undrained shear strengths of 10.8 and 8.5 kPa were determined by laboratory unconfined compression testing of two samples. Based on this data, the clay has a very soft to stiff consistency.

Natural moisture contents of 19 to 120% were measured in this unit. Values of less than about 30% probably reflect the presence of silt lenses within the cohesive deposit.

The results of laboratory tests carried out on 23 samples were as follows:

Gravel %	0
Sand %	0 to 4
Silt %	28 to 84
Clay %	15 to 71
Liquid Limit	30 to 87
Plastic Limit	16 to 42

The results of these tests indicate that the silty clay is a CL to CH soil (low to high plasticity).

The grain size distribution curves for the samples tested are shown in Figures B2 to B5 and 07-B2 to 07-B4, Appendix B. The Atterberg Limits are plotted on Figures B11 to B13, 07-B11 and 07-B12.

The results of consolidation testing conducted on samples of the silty clay to clayey silt are included in Appendix B and summarized in Table 5.1.

Table 5.1 – Consolidation Test Parameters

Borehole	Sample Depth (m)	Soil Type	w _o (%)	γ (kN/m ³)	e _o	p _o ' (kPa)	p _c ' (kPa)	OCR	C _c	C _r
06-B04	6.1-6.7	CH	93	14.6	2.61	85	90	1.1	2.49	0.18
06-B06	4.8-5.0	CH	97	14.5	2.67	40	80	2.0	1.89	0.16
07-B2	3.0-3.7	CL-ML	47	17.2	1.31	35	45	1.3	0.40	0.05
07-B4	9.1-9.8	CL-ML	28	19.3	0.79	100	120	1.2	0.16	0.01

Comparison of the existing and preconsolidation pressures (p_o' and p_c') derived from the test results indicate that the natural silty clay is lightly preconsolidated. The coefficient of consolidation, c_v, recorded during the test generally varied from 10⁻² to 10⁻⁴ cm²/s for the typical pressure range anticipated in the field. The compressibility characteristics will vary with depth in accordance with the moisture content and shear strength profiles.

The total thickness of the upper clay deposit, excluding the discontinuous layers of non-cohesive sand and silt contained within this unit, ranged from 5.9 to 11.9 m. The interpreted depth to the base of the clay layer ranged from 7.5 to 14.9 m (elevation 184.1 to 189.8 m).

5.6 Intermediate Sands and Silts

Various deposits of non-cohesive sand, silty sand, sandy silt and silt were encountered between the upper and lower cohesive units.

SPT N-values obtained in the sands and silts ranged from 1 to 25 blows/0.3 m, indicating a very loose to compact condition. A value of 36 blows/0.3 m was obtained at one location (BH07-9), indicating a localized dense zone.

The natural moisture content of recovered samples ranged from 11 to 31%, typically 16 to 25%.

The results of laboratory tests carried out on 20 samples were as follows:

Gravel %	0 to 7
Sand %	1 to 94
Silt %	4 to 96
Clay %	3 to 17

The grain size distribution curves for the samples tested are shown in Figures B6, B7 and 07-B5 to 07-B7, Appendix B.

The sands and silts deposits ranged in thickness from 1.5 to 13.9 m. The depth to the base of this unit was interpreted to range from 13.7 to 23.5 m (elevation 175.5 to 185.1 m).

5.7 Lower Clayey Silt to Silty Clay

A thick deposit of silty clay, grading to clayey silt at several locations, was encountered below the intermediate sand/silt strata. The clay was typically described as grey and wet.

SPT values obtained in the lower silty clay/clayey silt ranged from 1 to 30 blows/0.3 m. One value of 40 blows/0.3 m (hard) was obtained. The undrained shear strength, assessed by in situ vane testing, ranged from 20 to 96 kPa. Based on this data, the clay has a soft to stiff consistency.

Natural moisture contents of 23 to 61% were measured in this unit.

The results of laboratory tests carried out on 20 samples were as follows:

Gravel %	0
Sand %	0 to 9
Silt %	36 to 84
Clay %	15 to 62
Liquid Limit	25 to 48
Plastic Limit	14 to 26

The results of these tests indicate that the silty clay is a CL to CI soil (low to intermediate plasticity).

The grain size distribution curves for the samples tested are shown in Figures B8 to B10, 07-B8 and 07-B9, Appendix B. The Atterberg Limits are plotted on Figures B14, B15, 07-B13 and 07-B14.

The results of consolidation testing conducted on one sample of the silty clay are included in Appendix B and summarized in Table 5.2.

Table 5.2 – Consolidation Test Parameters

Borehole	Sample Depth (m)	Soil Type	w _o (%)	γ (kN/m ³)	e _o	p _o ' (kPa)	p _c ' (kPa)	OCR	C _c	C _r
07-B5	27.4-28.0	CL	47	17.2	1.30	240	240	1.0	0.60	0.09

Comparison of the existing and preconsolidation pressures (p_o' and p_c') derived from the test results indicate that the natural silty clay is normally consolidated. The coefficient of consolidation, c_v, recorded during the test generally varied from 10⁻² to 10⁻³ cm²/s for the typical pressure range anticipated in the field. The compressibility characteristics will vary with depth in accordance with the moisture content and shear strength profiles.

The total thickness of the lower cohesive deposit, excluding the discontinuous layers of non-cohesive sand and silt contained within this unit, ranged from 11.9 to 24.4 m. The interpreted depth to the base of the clay layer ranged from 21.3 to 39.6 m (elevation 157.8 to 164.3 m). Locally in one borehole located west of the bridge site (BH06-B8), the thickness was 3.1 m with a base at 16.8 m depth (elevation 181.2 m).

5.8 Basal Sands and Silts

Various deposits of non-cohesive sand, silty sand, sandy silt and silt were encountered below the lower silty clay to clayey silt unit. These deposits were described as grey and wet.

SPT N-values obtained in the basal sands and silts ranged from 6 blows/0.3 m to 100 blows/0.15 m, indicating a loose to very dense condition.

The natural moisture content of recovered samples ranged from 16 to 30%.

The results of laboratory tests carried out on four samples were as follows:

Gravel %	0
Sand %	13 to 39
Silt %	54 to 78
Clay %	3 to 13

The grain size distribution curves for the samples tested are shown in Figures B10 and 07-B10, Appendix B.

The sand and silt deposits ranged in thickness from 0.9 to 9.9 m. The depth to the base of this unit ranged from 38.3 to 45.3 m (elevation 153.5 to 159.5 m). Locally in one borehole located west of the bridge site (BH06-B8), auger refusal was encountered in this unit at 17.7 m depth (elevation 180.3 m).

5.9 Bedrock and/or Refusal

Bedrock or refusal was encountered at the depths and elevations listed in Table 5.3.

Table 5.3 – Depth to Bedrock and/or Refusal

Location	Borehole	Bedrock and/or Refusal		Comment
		Depth (m)	Elevation (m)	
West Approach	07-B3	44.0	155.1	Probable bedrock
West Abutment				
8 m North of North End	06-B1	43.6	153.5	Probable bedrock
2 m South of Centreline	07-B4	45.3	153.7	Probable bedrock
2 m South of South End	06-B3	44.6	154.4	Bedrock proven by coring
East Abutment				
3 m North of Centreline	06-B2	41.9	155.5	Bedrock proven by coring
2 m South of Centreline	07-B5	42.6	156.4	Bedrock proven by coring
2 m South of South End	06-B4	41.8	157.2	Probable bedrock
East Approach	07-B6	40.4	158.7	Probable bedrock
West of Beatty Creek	06-B8	17.7	180.3	Auger refusal
	07-B7	38.7	159.5	Probable bedrock
East of Beatty Creek	07-B8	41.1	157.1	Probable bedrock
	07-B9	44.5	155.8	Probable bedrock

The bedrock was proved in boreholes 06-B2, 06-B3 and 07-B5 by coring approximately 3.0 m. The bedrock consists of salmon and black granite of the Pre-Cambrian Canadian Shield. The rock is described as fresh, with black banding and occasional horizontal to vertical joints.

The total core recovery was 93 to 100%. With the exception of the second core run in borehole 06-B6, RQD values ranged from 80 to 100%, indicating an excellent rock quality. A lower RQD value of 60% was obtained in the second run from borehole 06-B6 where a vertical joint was encountered. The Fracture Index was generally 0 to 1, with isolated values of 2 to 5 fractures/0.3 m.

Based on Point Load Testing, the unconfined compressive strength of the bedrock was estimated to range from about 120 to 160 MPa. Based on these strength values and the classification system given in the Canadian Foundation Engineering Manual, the rock is classified as very strong.

5.10 Groundwater

The initial and final groundwater depths and elevations measured in the piezometers are shown in Table 5.4.

Table 5.4 – Groundwater Depths and Elevations

Location	Borehole	Tip Depth (m)	Date	Water Level (m)	
				Depth*	Elevation
West Abutment	06-B1	42.7	31-Aug-2006	1.5 ags	198.6
			08-Sep-2006	1.5 ags	198.6
			25-Sept-2006	1.5 ags	198.6
			29-Aug-2007	1.6 ags	198.7
			01-Oct-2007	1.6 ags	198.7
	07-B1	4.6	15-Aug-2007	0.6 ags	197.8
			29-Aug-2007	0.5 ags	197.7
			01-Oct-2007	0.3 ags	197.5
	07-B4	23.8	15-Aug-2007	0.3	198.7
			29-Aug-2007	0.4	198.6
			01-Oct-2007	0.7	198.3
East Abutment	06-B2	40.5	08-Sept-2006	0.4 ags	197.8
			25-Sept-2006	1.1 ags	198.5
			29-Aug-2007	1.2 ags	198.6
			01-Oct-2007	1.0 ags	198.4
	07-B5	9.0	15-Aug-2007	0.4	198.6
			29-Aug-2007	1.2	198.8
			01-Oct-2007	1.1	197.9
West of Beatty Creek	06-B8	16.8	06-Sept-2006	0.3 ags	198.3
			11-Sept-2006	0.3 ags	198.3
			25-Sept-2006	0.4 ags	198.4
	07-B7	7.6	15-Aug-2007	0.1 ags	198.3
			29-Aug-2007	0.3 ags	198.5
			01-Oct-2007	0.3 ags	198.5
East of Beatty Creek	07-B2	10.7	15-Aug-2007	1.0 ags	198.0
			29-Aug-2007	1.0 ags	198.0
			01-Oct-2007	1.1 ags	198.1
	07-B8	9.1	15-Aug-2007	0.2 ags	198.4
			29-Aug-2007	0.3 ags	198.5
			01-Oct-2007	0.2 ags	198.4
	06-B10	20.1	09-Sept-2006	1.1	198.4
			25-Sept-2006	1.1	198.4
			29-Aug-2007	0.9	198.6
			01-Oct-2007	1.0	198.5

* ags = above ground surface (artesian condition)

The above water levels reflect the piezometric head at the level of the piezometer tips at the time of the investigation. The measurements are short-term observations and seasonal fluctuations of the groundwater level are to be expected.

Shallow groundwater levels in the upper deposits will fluctuate with the water level in Beatty Creek. Higher levels should be expected after the spring snowmelt or after periods of heavy rainfall, and lower levels may be anticipated after dry periods. The water level in Beatty Creek was near elevation 197 m at the time of the investigation.

6 MISCELLANEOUS

McCormick Rankin Corporation determined the co-ordinates and ground elevations at the boreholes following completion of the site investigation.

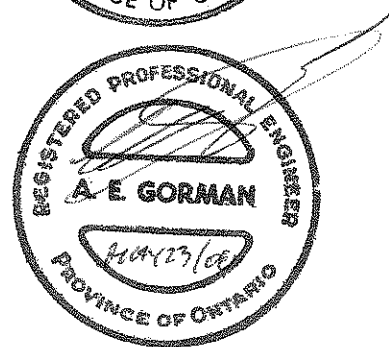
George Downing Estate Drilling Ltd. supplied and operated the drilling and sampling equipment. Full time supervision of the field activities, including obtaining utility clearances, was carried out by Mr. George Azzopardi and Mr. Stephane Loranger of Thurber.

Supervision of the field program, interpretation of the field data, and preparation of the report was performed by Mr. Murray Anderson, P.Eng. The report was reviewed by Mr. Alastair Gorman, P.Eng., and by Dr. P.K. Chatterji, Ph.D., a Designated Principal Contact for MTO Foundations Projects.

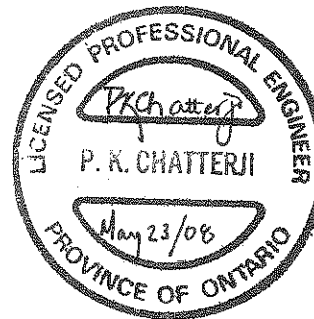
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This report presents interpretation of the geotechnical data in the factual report and presents geotechnical design recommendations to assist selection and design of the foundation system and approach embankments for the proposed bridge replacement.

The existing bridge is a three-span timber beam and deck structure supported on timber pile bents. The bridge has a total length of 13 m and width of about 8.5 m. It is proposed to replace the structure with a new one-span prestressed concrete girder bridge with a span of 14.7 m and width of 12.8 m.

The centreline of the new bridge will be shifted approximately 5.5 m north of the existing bridge centreline. The top of pavement at the centreline of the new bridge will be near elevation 199.9 m, approximately 0.9 m above road grade on the existing structure.

Bridge realignment will require widening and grade revision of the existing roadway embankment. Review of typical sections indicates that the embankment will be widened up to 10 m at the bridge approaches in addition to being raised by up to 1.0 m. The maximum total embankment height will be approximately 3.5 m. The new alignment will tie into existing grade approximately 200 m east and west of the structure.

Bridge and embankment construction will be carried out in two stages. Initially, the north side of the road embankment will be widened and raised, and the north half of the bridge will be constructed. Traffic will then be shifted to the new section of bridge, the remainder of the approach fill will be placed, and the south half of the bridge will be completed.

The discussion and recommendations presented in this report are based on our understanding of the project and on the factual data obtained in the course of the investigation.

8 STRUCTURE FOUNDATIONS

Foundation alternatives are presented in the following sections together with the corresponding geotechnical design parameters. A foundation scheme preferred from a foundations perspective is recommended.

A comparison of the technical advantages and disadvantages of alternative foundation schemes is presented in Table C2 of Appendix C. Initial consideration was given to spread footings on native soil or engineered fill, driven steel H-piles, and caissons (drilled shafts).

Based on the results of the exploratory boreholes drilled at the proposed abutment locations, the subsurface stratigraphy consists of existing road embankment fill and/or relatively thin layers of sand, silty sand, sandy silt and silt, underlain by a 5.9 to 11.9 m thick deposit of very soft to stiff, compressible silty clay to clayey silt. The upper clay deposit is underlain by a unit of sands and silts, and a second, 11.9 to 24.4 m thick layer of soft to very stiff silty clay to clayey silt. The lower clay deposit typically overlies sands and silts which mantle bedrock at depths of 41.8 to 45.3 m (elevation 153.5 to 157.2 m).

The immediate area of the bridge is low-lying, wet, and prone to flooding during heavy rainfall events and spring snowmelt. Groundwater levels measured in piezometers ranged from 0.1 to 1.6 m above the original ground surface (artesian condition, elevation 197.5 to 198.7 m), and 0.3 to 1.2 m below the existing road grade (elevation 197.9 to 198.8 m).

8.1 Spread Footings

8.1.1 Spread Footings on Native Soil

The native deposits at this site are considered unsuitable for support of spread footings due to the very low bearing resistance available and the potential for substantial immediate and long-term settlements. Excavation for footing construction may also be difficult in view of the high groundwater table. Accordingly spread footings founded on native soil are not recommended.

8.1.2 Spread Footings on Engineered Fill

Construction of spread footings on engineered fill is not recommended in view of the potential for substantial immediate and long-term settlements in the underlying native soils, and construction concerns related to excavation within very loose/soft soils below a high groundwater table. The native clay soils may experience significant consolidation settlement under small increases in surface loading imposed by engineered fill construction. Therefore engineered fill construction is not recommended.

8.2 Driven Steel Piles

The geotechnical conditions encountered at this site are considered suitable for driven steel H-pile foundations. The piles must be driven to bedrock and are expected to encounter refusal on bedrock near elevation 153.5 to 157.2 m.

Design of the piles should be carried out on the basis of the axial geotechnical resistances given in Table 8.1. The SLS condition will not govern design of piles bearing on bedrock.

Table 8.1 – Pile Geotechnical Resistance

Pile Section	ULS (Factored)	Estimated Pile Tip Elevation	
		W. Abutment	E. Abutment
HP 310 X 110	2,000 kN	153.5-154.4	155.5-157.2
HP 360 X 132	2,400 kN	153.5-154.4	155.5-157.2

The structural resistance of the pile must be checked by the structural designer.

The pile tip elevations are presented for estimating purposes only and may vary along the abutment locations. The actual pile tip elevations will be controlled as described in Section 8.2.1 Pile Installation.

The tips of all piles should be fitted with H-section rock points from an approved manufacturer such as Titus Steel (Standard H-point), Pruyn Points or approved equivalent. Rock points are recommended for setting the piles on bedrock and tip protection when penetrating dense gravely deposits, or if cobbles or boulders are encountered above the bedrock.

8.2.1 Pile Installation

Pile installation should be in accordance with Special Provision No. 903S01. The foundation drawing should include the note “Piles to be driven to bedrock”.

To facilitate pile installation, embankment fill through which piles will be driven must not contain oversize material, i.e. no particles exceeding 75 mm in size.

8.2.2 Downdrag

Downdrag forces will develop along the length of pile embedded in the silty clay deposits, the overlying fill and native soil, and the intermediate sands and silts due to increased approach embankment loads. For design purposes, an unfactored downdrag force of 750 kN per pile is recommended to evaluate the impact of downdrag.

In accordance with Section 6.8.4 of the CHBDC, the factored downdrag load should be added to the factored permanent loads to assess the effects of downdrag. A check should be performed to confirm that the factored permanent and downdrag loads do not exceed the factored below-ground structural resistance of the pile at the neutral plane. At this site, the neutral plane will be close to the lower clay boundary, near elevation 165.0 m. As per the CHBDC, live loads and downdrag loads are not combined.

The factored structural resistance of the pile (factored for structural design and below-ground design) to be used in the downdrag check are:

HP 310 X 110	2,800 kN
HP 360 X 132	3,400 kN

The piles should be driven after the embankment preload period, discussed in a subsequent section.

8.2.3 Lateral Resistance of Piles

For integral abutment design, the upper 3 m of pile length is expected to lie within very loose and very soft to firm deposits which may provide sufficient flexibility. The use of batter piles to resist lateral loads (for conventional abutments) is not recommended due to the depth to rock and the potential that bending stresses will be imposed on the pile as the surrounding soil consolidates.

The lateral resistance of the piles may be calculated using a value for the coefficient of horizontal subgrade reaction (k_s) and ultimate lateral resistance (p_{ult}) as follows:

$$\begin{aligned} k_s &= n_h \cdot z / D \quad (\text{kN/m}^3) \quad \text{for cohesionless soils} \\ &= 67 \cdot c_u / D \quad (\text{kN/m}^3) \quad \text{for cohesive soils} \\ p_{ult} &= 3 \cdot \gamma \cdot z \cdot K_p \quad (\text{kPa}) \end{aligned}$$

where	z	=	depth of embedment of pile in metres
	D	=	pile width in metres
	n_h	=	coefficient of horizontal subgrade reaction (Table 8.2)
	c_u	=	undrained shear strength (Table 8.2)
	γ	=	bulk unit weight (Table 8.2), use submerged unit weight below water table
	K_p	=	passive earth pressure coefficient (Table 8.2)

The above equations and recommended parameters may be used to analyze the interaction between a pile and the surrounding soil. The lateral pressures obtained from the analysis should not exceed the ultimate lateral resistance.

The spring constant, K , for analysis may be obtained by the expression, $K = k_s \times L \times D$ (kN/m), where k_s is the coefficient of horizontal subgrade reaction (kN/m³), D is the pile width (m) and L is the length (m) of the pile segment or element used in the analysis. The ultimate lateral resistance, P_{ult} , may be obtained from the expression, $P_{ult} = p_{ult} \times L \times D$.

Table 8.2 – Parameters for Lateral Pile Resistance

Location	Elevation	Soil	n_h (kN/m ³)	c_u (kPa)	K_p	Unit Weight* (kN/m ³)
West Abutment	196 to 189	Clay	-	18	2.4	7
	189 to 176	Sand/Silt	2,500	-	3.0	10
	176 to 163	Clay	-	30	2.6	8
	163 to Rock	Sand/Silt	4,500	-	3.3	10
East Abutment	196 to 188	Clay	-	18	2.4	7
	188 to 180	Sand/Silt	2,500	-	3.0	10
	180 to 163	Clay	-	30	2.6	8
	163 to Rock	Sand/Silt	6,500	-	3.3	10

*Buoyant unit weight below the water table.

The total horizontal lateral resistance of a single pile should not exceed the following values:

Table 8.3 – Maximum Lateral Resistance of Piles

Pile	Maximum Lateral Resistance	
	Factored ULS	SLS
HP 310X110	80 kN	25 kN
HP360X132	80 kN	35 kN

The modulus of subgrade reaction may have to be reduced, based on the pile spacing. The reduction factors to be used for a pile group oriented perpendicular or parallel to the direction of loading are provided in Table 8.4. Intermediate values may be obtained by linear interpolation.

Table 8.4 – Subgrade Reaction Reduction Factors for Pile Spacing

Condition	Pile Spacing, Centre to Centre*	Reduction Factor
Pile group oriented <i>perpendicular</i> to direction of loading	4D	1.0
	1D	0.5
Pile group oriented <i>parallel</i> to direction of loading	8D	1.0
	6D	0.7
	4D	0.4
	3D	0.25

* where D is the width of pile

8.3 Caissons

The use of augered caissons is not recommended in view of the depth to suitable bearing material (bedrock at 42 to 45 m depth) and the anticipated difficulties constructing caissons at this site. Constructing caissons would require use of a liner socketed into rock and/or slurry methods to control groundwater, support the sidewalls of the shaft, and prevent heave in the base.

8.4 Recommended Foundation

From a geotechnical perspective, the recommended foundation system for both abutments at this site is steel H-piles driven to bedrock.

8.5 Abutment Type

From a geotechnical perspective, the subsurface conditions at this site are considered to be suitable for the construction of conventional, semi-integral or integral abutments. The recommended foundation system of H-piles makes integral abutments a feasible option.

8.6 Frost and Scour Protection

The depth of earth cover required to provide frost protection for pile caps at this site is 2.0 m. It is possible to reduce the thickness of earth cover by the substitution of synthetic insulation.

Scour and erosion protection must be provided for the pile caps, approach embankments and creek banks. Design of the scour and erosion protection measures must consider hydrologic and hydraulic concerns and should be carried out by specialists experienced in these fields.

9 EXCAVATION AND DEWATERING

The General Arrangement drawing indicates that excavation for construction of the bridge abutments and pile caps will extend to approximate elevation 195.8 m. The borehole data indicates that the excavation will take place within existing embankment fill, thin layers of silts and sands, and approximately 1.0 m into the underlying very soft to stiff silty clay/clayey silt. Water levels are expected to be essentially coincident with the creek level at the time of construction, typically about 1.5 m above the anticipated excavation depth.

All excavations must be carried out in accordance with the Occupational Health and Safety Act (OHSA) and in accordance with Special Provision 902S01. For the purposes of the OHSA, the native soils at this site may be classified as Type 3 soils above the water table and Type 4 soils below the water table. Excavation below the groundwater level is not recommended without prior dewatering. Provided dewatering is carried out as described below, temporary excavations may be sloped at 1H:1V or flatter.

The design of the groundwater control system is the responsibility of the Contractor. However, suitable systems that might be considered include the use of a sheeted excavation and pumping from filtered sumps.

The design must include measures to prevent stream flow from entering the excavation, and consider the maximum creek water level potentially occurring during construction.

The Contract Documents should alert the Contractor to the requirement to maintain a stable excavation and that any shoring system should be designed by a shoring specialist, taking

account of the need to control groundwater, support the excavation sidewalls and prevent basal instability within the excavation.

For construction staging, roadway protection should be supplied in accordance with Special Provision 105S19 and designed for Performance Level 2.

10 EMBANKMENTS

Construction of the embankments for road realignment and new bridge approaches will require placement of fill to widen the existing roadway embankment and raise roadway grades. Review of the typical sections indicates that the most significant widening will be required near the east approach where the embankment will be widened nearly 10 m and road grades will be raised by up to 1.0 m. The total embankment height will be approximately 3.5 m.

10.1 Embankment Settlement

Placement of the embankment fill is expected to result in immediate (elastic) and long-term consolidation settlement of the foundation soils consisting of thick deposits of clay. The magnitude and timing of the settlement will depend upon the proposed construction staging and will vary both across the width and along the length of the roadway embankment.

We understand that bridge and embankment construction will be carried out in the following stages:

Stage 1A - The north side of the road embankment will be widened and raised by placement of fill up to approximate finished grade. This configuration will be maintained over the winter months for a preload period of six months. Traffic will be maintained on the existing bridge and pavement.

Stage 1B - After the preload period, the north half of the bridge will be constructed (estimated duration of three months).

Stage 2 - Traffic will be shifted to the new section of bridge, the remainder of the approach fill will be placed over the existing embankment, and the south half of the bridge will be completed (estimated duration of three months).

Based on our understanding of the construction staging and embankment configuration, the total immediate and consolidation settlements, as well as the embankment settlement expected to occur after the preload period, were assessed using elastic methods and one-dimensional consolidation theory. The estimated maximum settlements in the area of highest fill (Sta. 19+100) at various points across the roadway section are summarized in Table 10.1.

The magnitude of the post-construction settlement computed for an 18-month preload option (two-year construction) is also presented in the table, in addition to the six-month preload analysis. The degree of post-construction maintenance required could be reduced by employment of an 18-month preload period.

Table 10.1 – Estimated Maximum Embankment Settlement

Condition	Estimated Maximum Settlement (mm) at Station 19+100					
	North Crest of New Embankment	New Left Edge of Pavement	New Centreline	Existing Left Edge of Pavement	New Right Edge of Pavement	Existing Right Edge of Pavement
Total Immediate (during construction)	75	75	50	40	40	25
Total Consolidation (long-term)	750	700	300	200	200	125
Settlement remaining after construction – 6 month preload	150	150	50	50	50	25
Settlement remaining after construction – 18 month preload	50	50	25	25	25	15

Regrading and placement of additional fill will be required to maintain road grades as consolidation progresses during the construction period. A graveled surface is recommended during construction to accommodate maintenance operations. It is difficult to predict the frequency of maintenance required, however for planning purposes it may be assumed that regrading will be required every two to three weeks for the first few months, decreasing to monthly thereafter.

The initial embankment should be overbuilt to accommodate the anticipated settlement and achieve the required platform width without placement of additional fill on the embankment slope as consolidation progresses. For a 2H:1V embankment slope and a maximum long-term settlement of 750 mm, an additional width of 1.5 m will be required.

Monitoring of the embankment settlement during the preload period is recommended to confirm the anticipated magnitude and rate of consolidation. An NSSP for installation of settlement pins is provided in Appendix D.

Primary consolidation is expected to occur over a period of 5 to 10 years with secondary consolidation continuing for years afterward. The requirement for post-construction maintenance, including placement of additional granular material, resurfacing and possibly jacking/grouting of the approach slabs, should be anticipated.

The existing timber bridge structure is presumably supported on timber piles founded in the clay deposits or intermediate sand/silt layers. Therefore, consolidation of the foundation soils under the embankment loads is likely to result in settlement of the pile foundations as well. The existing structure will be subjected to consolidation settlements during Stage 1A and Stage 1B of the construction period, for a total duration of 9 or 21 months depending on whether a 6-month or 18-month preload period is adopted.

The estimated settlements at the existing bridge abutments during the 9 and 21-month periods are as follows:

Table 10.2 – Estimated Settlement at Existing Bridge Abutments

Duration of Stage 1A + 1B	Estimated Settlement at Existing Bridge Abutment (mm)	
	North Side	South Side
9 months	100 to 125	50 to 60
21 months	125 to 150	60 to 75

Measures to re-establish the bridge level, by such means as jacking of the deck, must be designed to accommodate the anticipated magnitude of settlement (both total and rotational) and maintain serviceability of the bridge during the construction period.

10.2 Embankment Stability

Stability analyses were carried out for both earth fill and rockfill embankments under static and seismic loading conditions. For cohesive soils, short term (undrained) and long term (effective stress) conditions were assessed. Embankment slope inclinations of 2H:1V for earth fill and 1.25H:1V for rockfill were assumed. The input parameters and soil model used in the stability analyses, including soil stratigraphy, engineering properties, groundwater conditions, and embankment geometry, are shown on Figures C1 to C8 in Appendix C.

The results of the stability analyses indicate that the Factor of Safety (FS) for a maximum 3.5 m high embankment will exceed 1.3 for short-term conditions, be near 1.5 for long-term conditions, and exceed 1.0 for seismic conditions. Therefore, measures to improve the stability of widened or raised embankments should not be necessary.

10.3 Embankment Construction

Embankment construction should be carried out in accordance with OPSS 206 as amended by Special Provision “Amendment to OPSS 206, December 1993” dated November 2002.

In general, use of granular material meeting OPS Granular B Type I gradation specifications is recommended as new embankment fill to provide similar characteristics as the existing embankment fill. Standard slope inclinations of 2H:1V are suitable for embankment heights of up to 3.5 m in granular fill.

To reduce the embankment footprint and avoid placing fill in the creek channel, rockfill will be used at the immediate approaches to the bridge to permit an embankment slope inclination of 1.5H:1V. The longitudinal extent of rockfill will be defined by the designer based on space limitations. The top surface of the rockfill must be chinked with rock fragments and spalls, and a minimum 150 mm layer of Granular B Type II should be placed over the rockfill to prevent loss of subbase materials into the voids of the rockfill.

All topsoil and organic material should be stripped for the full width of the new embankment footprint. Prior to placement of new fill against the existing embankment slope, the existing earth slope should be benched in accordance with OPSD 208.010.

The soft, wet subgrade materials are highly susceptible to disturbance by construction traffic. Movement of heavy construction equipment on the exposed subgrade should be avoided to prevent disturbance of the embankment foundation soils. To achieve a stable trafficable base for fill placement and compaction, it may be necessary to increase the thickness of the initial fill lift and/or provide a geogrid over the exposed subgrade.

Earth fill embankment slopes must be provided with erosion protection in accordance with Special Provision SP 572S01.

11 BACKFILL TO ABUTMENTS

In the case of integral or semi-integral abutments, backfill to the abutment must be granular material. In the case of a conventional abutment, granular backfill is recommended but rock backfill can be permitted. A NSSP is required to limit rock fill used as abutment backfill to fragments no greater than 150 mm and to include adequate spalls to fill voids in the rock fill.

In all cases where the approach embankment consists of rock fill and granular backfill to the abutment wall is used, the granular backfill must consist of OPSS Granular “B” Type II.

The backfill to the abutment walls should be in accordance with OPSS 902 as amended by Special Provision 902S01. Granular backfill should be placed to the extents shown in OPSD 3101.150, and rock backfill should be placed to the extents shown in OPSD 3101.200.

All granular material should meet the specifications of Special Provision 110F13 “Amendment to OPSS 1010, March 1993”. Compaction equipment to be used adjacent to retaining structures should be restricted in accordance with SSP 105S10.

The design of the abutment should incorporate backfill and wall drains as shown in OPSD 3102.100 and OPSD 3190.100.

12 EARTH PRESSURE COEFFICIENTS (ABUTMENTS)

Earth pressures acting on the abutment walls may be assumed to be triangular and to be governed by the characteristics of the abutment backfill. For a fully drained condition, the pressures should be computed in accordance with the CHBDC but generally are given by the expression:

$$p_h = K(\gamma h + q)$$

Where:

p_h = horizontal pressure on the wall at depth h (kPa)

K = earth pressure coefficient (see below)

γ = unit weight of retained soil (see table below)

h = depth below top of fill where pressure is computed (m)

q = value of any surcharge (kPa)

Earth pressure coefficients for backfill to the abutment wall are dependent on the material used as backfill. Typical values are shown in Table 12.1.

Table 12.1 – Earth Pressure Coefficients (K)

Condition	Earth Pressure Coefficient (K)					
	OPSS Granular A or OPSS Granular B Type II $\phi = 35^\circ, \gamma = 22.8 \text{ kN/m}^3$		OPSS Granular B Type I $\phi = 32^\circ, \gamma = 21.2 \text{ kN/m}^3$		Rock Fill (Limited to 300 mm size) $\phi = 42^\circ, \gamma = 19 \text{ kN/m}^3$	
	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall(2H:1 V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall(2H:1 V)
Active (Unrestrained Wall)	0.27	0.40*	0.31	0.43*	0.20	0.30*
At rest (Restrained Wall)	0.43	-	0.47	-	0.33	-
Passive (Movement Towards Soil Mass)	3.7	-	3.3	-	5.0	-

* For wing walls.

In conventional design, the use of a material with a high friction angle and low active pressure coefficient (e.g. Granular A, Granular B Type II) might be preferred as it results in lower earth pressures acting on the wall. In the case of integral abutments, material with a lower passive pressure coefficient (e.g. Granular B Type I) might be preferred as it results in lower forces acting on the ballast wall as the wall moves toward the soil mass.

In accordance with Clause 6.9.3 of the CHBDC, a compaction surcharge should be added. The magnitude should be 12 kPa at the top of fill and decreasing to 0 kPa at a depth of 2.0 m for Granular B Type I or 1.7 m for Granular A or Granular B Type II.

13 SEISMIC CONSIDERATIONS

For design purposes, the site is treated as lying in Seismic Zone 1.

13.1 Seismic Design Parameters

The following seismic parameters should be used for design:

- Velocity Related Seismic Zone 0
- Zonal Velocity Ratio 0.00
- Acceleration Related Seismic Zone 0
- Zonal Acceleration Ratio 0.00
- Peak Horizontal Acceleration 0.04

The Soil Profile Type at this site has been classified as Type IV. Thus, according to Table 4.4.6.1 of the CHBDC, a Site Coefficient “S” of 2.0 should be used in seismic design.

13.2 Liquefaction Potential

The potential for liquefaction of the foundation soils has been assessed using the Seed and Idriss (1971) method¹. Using this method, it was determined that the foundation soils are not in danger of liquefaction.

13.3 Retaining Wall Dynamic Earth Pressures

In accordance with Clause 4.6.4 of the CHBDC, retaining structures should be designed using active (K_{AE}) and passive (K_{PE}) earth pressure coefficients that incorporate the effects of earthquake loading.

The seismic earth pressure coefficients to be used in design at this site are shown in Table 13.1.

Table 13.1 – Earth Pressure Coefficients (K) for Seismic Design

Condition	Earth Pressure Coefficient (K) for Earthquake Loading					
	OPSS Granular A or OPSS Granular B Type II $\phi = 35^\circ, \delta = 17^\circ$		OPSS Granular B Type I $\phi = 32^\circ, \delta = 16^\circ$		Rock Fill $\phi = 42^\circ; \delta = 21^\circ$	
	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)
Active*, K_{AE} (Unrestrained Wall)	0.27	0.40	0.31	0.43	0.20	0.29
At rest**, K_{OE} (Restrained Wall)	0.51	-	0.55	-	0.41	-
Passive*, K_{PE} (Movement Towards Soil Mass)	6.6	-	5.2	-	12.0	-

* After Mononobe and Okabe, passive case assumes a horizontal surface in front of the wall.

** After Woods

14 CONSTRUCTION CONCERNS

Potential construction concerns include, but are not necessarily limited to:

- The surficial soils at the site are generally very soft and wet with numerous roots and organics. These materials are highly susceptible to disturbance by construction traffic and particular

¹ Seed, H.B. and Idriss, I.M. 1971, “Simplified Procedure for Evaluating Soil Liquefaction Potential” *Journal of Soil Mechanics and Foundations Division*, ASCE, Vol. 101, No. SM9, September, pp. 1249 – 1273.

attention/measures will be required to provide a stable trafficable base for movement of heavy equipment.

- Regrading and placement of additional fill will be required to maintain road grades as consolidation of the foundation soil progresses during the construction period and following completion of construction. Jacking of the approach slabs and existing bridge may be required.
- Approach fill placement and compaction must be carefully controlled to prevent shear failure of the underlying low-strength silty clay. Stockpiling of materials on site should be avoided.
- Excavation adjacent to the creek and within the existing embankment for foundation construction will require shoring of the excavation walls and control of creek water and groundwater.
- Construction activities, particularly excavation, pile driving and fill placement, may impact on the existing bridge, roadway embankment and profile. Procedures must be adopted that minimize the potential for disturbance and settlement of the existing bridge, roadway or detour if traffic is to be maintained during construction.
- Erosion and sedimentation control while maintaining streamflow.
- Potential rising water levels and flooding of the site during construction.

15 CLOSURE

Engineering analysis and preparation of the foundation design report was conducted by Mr. Murray Anderson, P.Eng. The report was reviewed by Mr. Alastair Gorman, P.Eng., and by Dr. P.K. Chatterji, Ph.D., a Designated Principal Contact for MTO Foundations Projects.

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Appendix A

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

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

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



Water Level






C_{pen} Shear Strength Determination by Pocket Penetrometer

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

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$).
		CI	Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

EXPLANATION OF ROCK LOGGING TERMS

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

DISCONTINUITY SPACING		STRENGTH CLASSIFICATION			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength (MPa) (psi)	Field Estimation of Hardness*	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
		Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
		Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
		Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

TERMS	
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.

RECORD OF BOREHOLE No 07-B01

1 OF 2

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 307.8 E 303 697.8 ORIGINATED BY GA
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2007-01-08 - 2007-01-08 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT Y kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
197.2	Ground Surface													
0.0	TOPSOIL: (200mm)						+0.3*							*Artesian
0.2	SAND, some silt, trace clay Loose Grey Wet		1	SS	5		197							
196.4														
0.8	SILT, some clay to clayey, trace sand Soft to Firm Grey Wet		2	SS	4		196							
			3	SS	3									
194.9							195							
2.3	Silty CLAY Very Soft to Soft Grey Wet		4	SS	1									0 0 76 24
			1	TW			194							
							2.0 +							
			2	TW			193							
							3.0 +							
			3	TW			191							
							2.3 +							
							190							
189.3			5	SS	7									
7.9	SAND, fine grained, some silt Loose Grey Wet						189							
			6	SS	9		188							

Continued Next Page

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

RECORD OF BOREHOLE No 07-B01

2 OF 2

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 307.8 E 303 697.8 ORIGINATED BY GA
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2007-01-08 - 2007-01-08 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								20 40 60 80 100					
	Continued From Previous Page							20 40 60 80 100					
			7	SS	7		187						
							186						
185.5													
11.7	Sandy SILT, trace clay Compact to Very Loose Grey Wet		8	SS	12		185						0 33 64 3
							184						
			9	SS	3		183						
181.4			10	SS	7		182						0 38 59 3
15.8	END OF BOREHOLE AT 15.8m. BOREHOLE OPEN TO 15.8m AND WATER LEVEL AT 0.3m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 2007-08-15 0.62 above G.S. 197.8 2007-08-29 0.50 above G.S. 197.7 2007-10-01 0.32 above G.S. 197.5												

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

METRIC

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 07-B02

2 OF 2

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 349.2 E 303 706.4 ORIGINATED BY GA
 HWY 534 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 2007-02-08 - 2007-02-08 CHECKED BY MRA

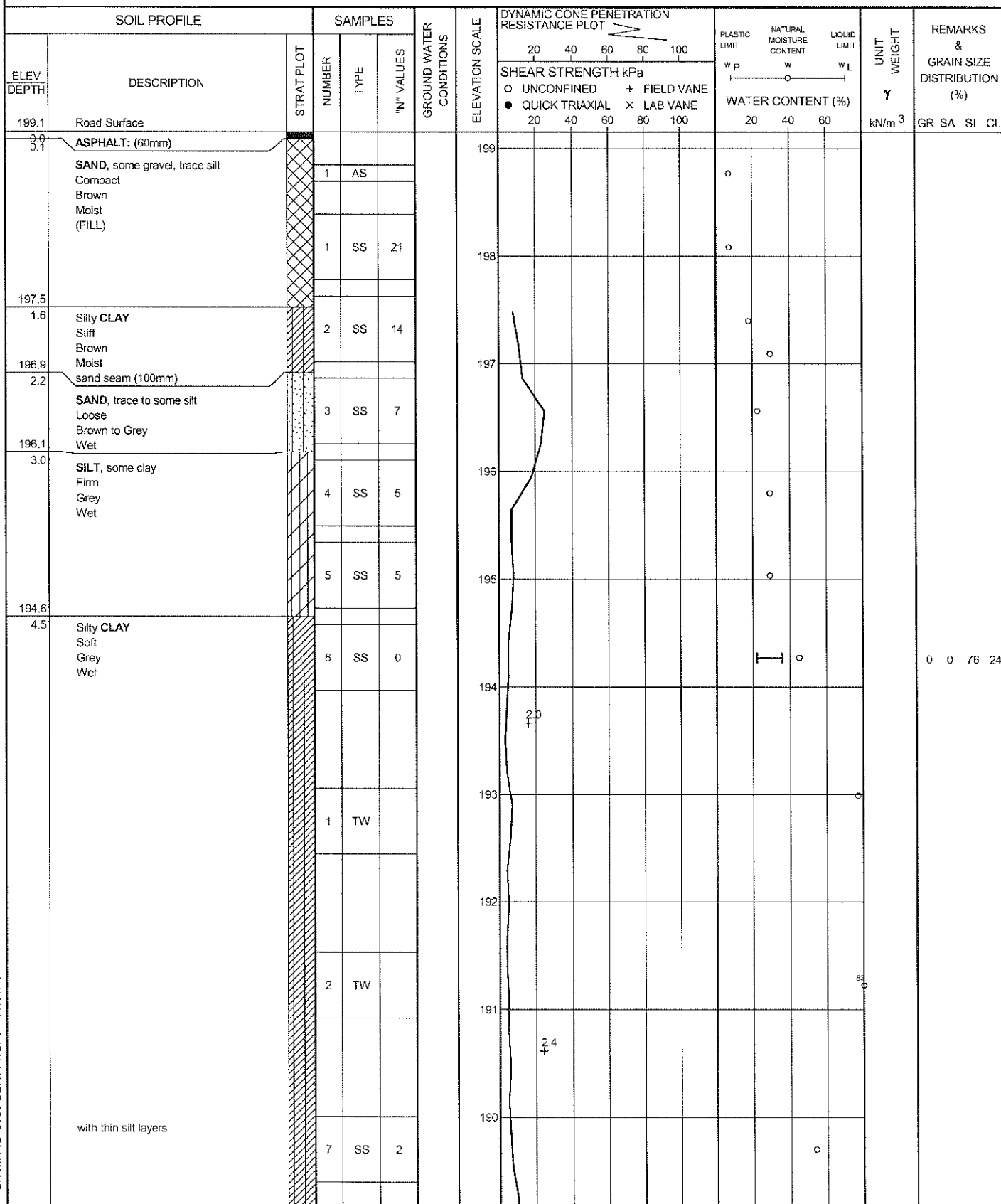
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								20 40 60 80 100	PLASTIC LIMIT w _p NATURAL MOISTURE CONTENT w LIQUID LIMIT w _L		WATER CONTENT (%) 20 40 60		
	Continued From Previous Page							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					
	Loose to Compact Grey Wet		7	SS	9		187						7 89 4 (SI+CL)
							186						
			8	SS	14		185						
							184						
183.7							183						0 5 86 9
13.3	SILT, trace sand, trace clay Loose Grey Wet		9	SS	7		182						
			10	SS	7								
181.2													
15.8	END OF BOREHOLE AT 15.8m. BOREHOLE OPEN TO 15.8m AND WATER LEVEL AT 1.4m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 2007-08-15 1.02 above G.S. 198.0 2007-08-29 1.00 above G.S. 198.0 2007-10-01 1.06 above G.S. 198.1												

RECORD OF BOREHOLE No 07-B03

1 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 285.1 E 303 705.0 ORIGINATED BY SLL
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2007-07-28 - 2007-07-29 CHECKED BY MRA



Continued Next Page

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

RECORD OF BOREHOLE No 07-B03

2 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 285.1 E 303 705.0 ORIGINATED BY SLL
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2007-07-28 - 2007-07-29 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE	WATER CONTENT (%)			GR SA SI CL
188.9							189					
10.2	SAND, some silt, trace clay Compact Grey Wet		8	SS	12		188					0 76 16 8
							187					
			9	SS	21		186					
185.7							185					
13.4	Clayey SILT, trace sand Soft Grey Wet		10	SS	3		184					0 14 81 5
185.1							183					
14.0	SILT, some sand, trace clay Loose Grey Wet		11	SS	8		182					
			12	SS	9		181					
181.3							180					
17.8	Silty CLAY, with silty sand seams Soft Grey Wet		13	SS	4							
180.5												
18.6	SILT, some sand, trace clay Loose Grey Wet											

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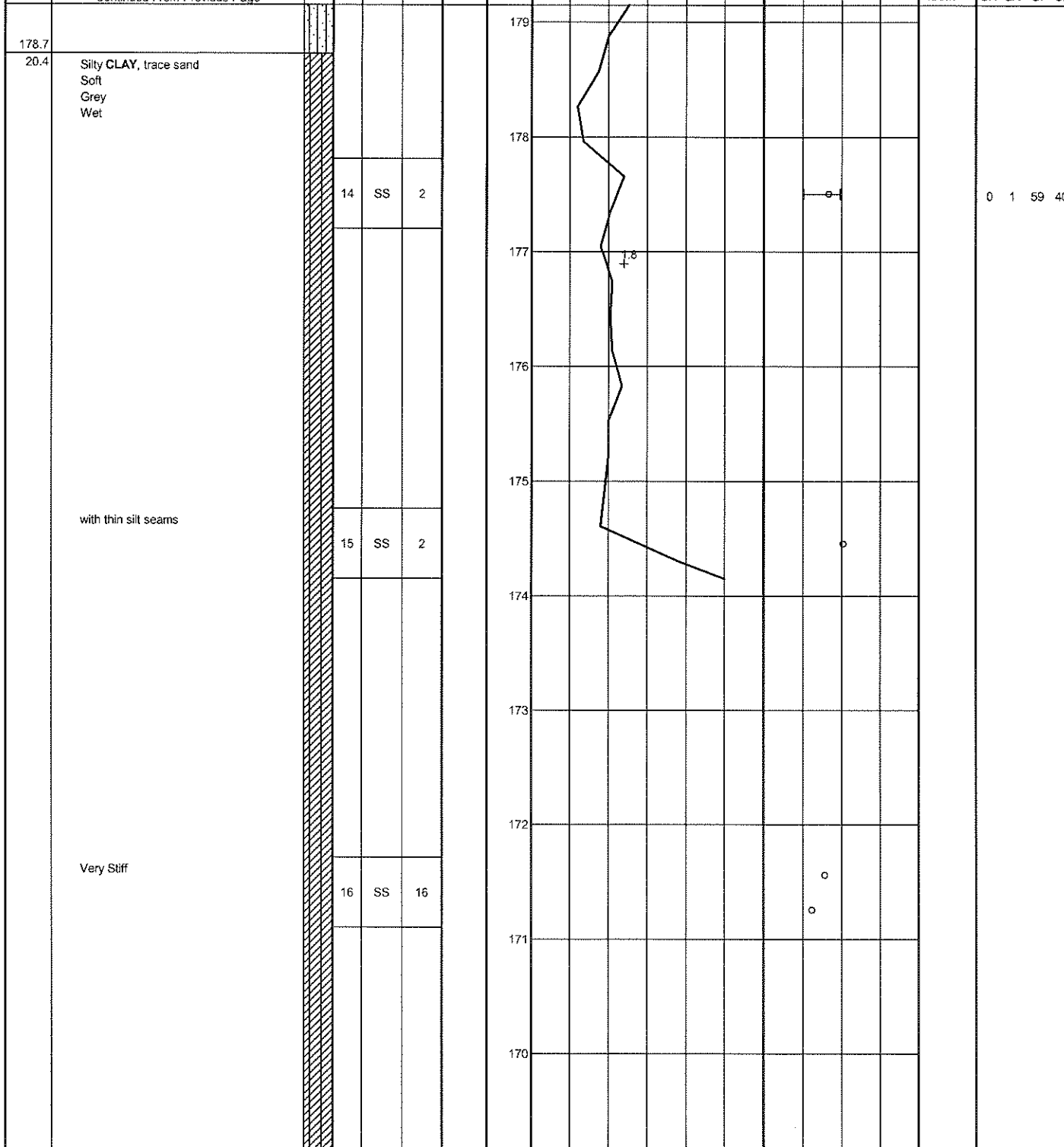
+³, X³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

METRIC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20				40
	Continued From Previous Page						SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100		WATER CONTENT (%) 20 40 60			



+³, ×³; Numbers refer to Sensitivity

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RECORD OF BOREHOLE No 07-B03

4 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 285.1 E 303 705.0 ORIGINATED BY SLL
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2007-07-28 - 2007-07-29 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	WATER CONTENT (%) 20 40 60			GR SA SI CL
	with thin silty sand seams		17	SS	15		169					
							168					
							167					
	Hard		18	SS	40		166					
							165					0 3 59 38
163.9							164					
35.2	SILT, some sand, trace clay, with sand seams Very Dense to Compact Grey Wet		19	SS	59		163					
							162					
							161					
							160					
			20	SS	18							0 18 78 4

Continued Next Page

+³, x³: Numbers refer to Sensitivity
 20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 07-B03

5 OF 5

METRIC



G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 285.1 E 303 705.0 ORIGINATED BY SLL
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2007-07-28 - 2007-07-29 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								20 40 60 80 100					
	Continued From Previous Page												

+³, X³: Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

METRIC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT 	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES						
199.0	Road Surface										

Depth (m)	Soil Description	Unit	Thickness (m)	Notes
0.0	ASPHALT: (50mm)			
0.9	SAND, some gravel Compact Brown Moist (FILL)	1 AS		
1.6		1 SS	15	
2.4		2 SS	19	
2.4	Silty SAND , trace clay, with rootlets Loose to Very Loose Dark Brown Wet	3 SS	3	
2.7		4 SS	6	
3.7	Clayey SILT , trace sand Firm Grey Wet	5 SS	5	
3.8		1 TW		
5.2	Silty CLAY Soft to Firm Grey Wet	2 TW		
6.8		6 SS	0	
9.6	SILT , some sand Loose	3 TW		

+ 3, X 3: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 07-B04

2 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 302.1 E 303 712.4 ORIGINATED BY SLI
 HWY 534 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 2007-01-08 - 2007-02-08 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE				
187.0	Grey Wet with thin clay seams		7	SS	6		189					
							188					
12.0	Silty SAND Compact Brown Wet		8	SS	14		187					
							186					
185.6	SILT, some clay, trace to some sand Soft Grey Wet		9	SS	1		185					
							184					
184.1	SILT, some sand, trace clay Loose Brown Wet		10	SS	4		183					
							182					
	Grey		11	SS	5		181					
							180					
180.6	Clayey SILT Very Stiff Grey Wet		12	SS	19							
180.3												
18.7	SILT, some sand, trace clay Compact Grey Wet											

Continued Next Page

+³, X³: Numbers refer to Sensitivity
 20
15
10
5
0
(%) STRAIN AT FAILURE

ONTM14S 5198-BEATTY.GPJ 15/11/07

RECORD OF BOREHOLE No 07-B04

3 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 302.1 E 303 712.4 ORIGINATED BY SLL
 HWY 534 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 2007-01-08 - 2007-02-08 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								20 40 60 80 100		w _P w w _L				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
	Continued From Previous Page						179							
							178							
			13	SS	12									
							177							
							176							
175.5							175							
23.5	Silty CLAY , with silty sand seams Soft Grey Wet		14	SS	3		174							
							173							
							172							
	Very Stiff		15	SS	22		171							
							170							

Continued Next Page

+³, X³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 07-B04

4 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 302.1 E 303 712.4 ORIGINATED BY SLL
 HWY 534 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 2007-01-08 - 2007-02-08 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE				
163.6			16	SS	30		169					0 1 67 32
35.4	SILT and SAND, trace clay Compact to Dense Grey Wet		17	SS	19		168					
			18	SS	23		167					
			19	SS	36		166					
							165					
							164					
							163					
							162					
							161					
							160					
												0 39 58 3

Continued Next Page

+³ X³: Numbers refer to
Sensitivity 20
15 10 5
(%) STRAIN AT FAILURE

METRIC

G.W.P.	5200-03-00	LOCATION	Beatty Creek Bridge N 5 105 302.1 E 303 712.4	ORIGINATED BY	SLI
HWY	534	BOREHOLE TYPE	Hollow Stem Augers	COMPILED BY	WM
DATUM	Geodetic	DATE	2007-01-08 - 2007-02-08	CHECKED BY	MRA

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ONTMT4S 5198-BEATTY.GPJ 15/11/07

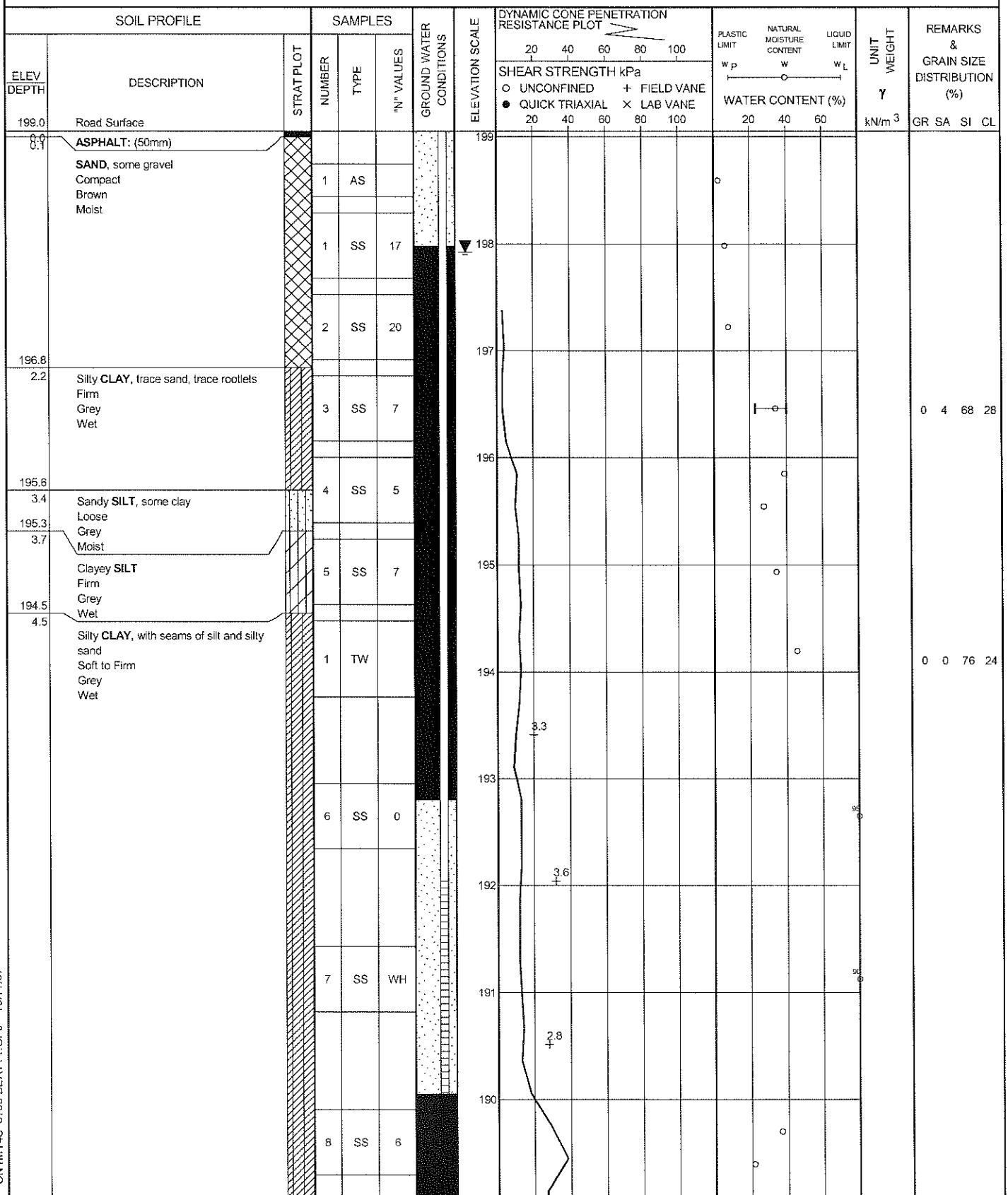
+³, X³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 07-B05

1 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 318.1 E 303 719.1 ORIGINATED BY SLL
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2007-07-25 - 2007-07-26 CHECKED BY MRA



Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 07-B05

2 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 318.1 E 303 719.1 ORIGINATED BY SLL
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2007-07-25 - 2007-07-26 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
	Continued From Previous Page							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE				
								WATER CONTENT (%) w _p w w _L				
							20 40 60 80 100	20 40 60				
187.1			9	SS	9							0 2 75 23
11.9	SAND, trace gravel, trace silt Compact Grey Wet		10	SS	12							
185.4												
13.6	Silty CLAY, with silt seams											
185.1												
13.9	Sandy SILT, trace to some clay Loose to Compact Grey Wet		11	SS	7							
			12	SS	25							0 27 70 3
			13	SS	4							
180.7												
18.3	Silty CLAY, with silty sand seams Firm to Stiff Grey Wet		14	SS	4							

Continued Next Page

+³, X³: Numbers refer to Sensitivity
 20
 15 10 5
 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 07-B05

3 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 318.1 E 303 719.1 ORIGINATED BY SLL
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2007-07-25 - 2007-07-26 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)	
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE							
Continued From Previous Page																
							179									
			15	SS	3		178									
							177	2.9								
							176									
			16	SS	4		175									
							174	3.2						0 0 57 43		
							173									
							172									
			2	TW			171	3.1						0 0 70 30		
							170									

Continued Next Page

+³ X³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

CONTMT4S 5198-BEATTY.GPJ 15/11/07

RECORD OF BOREHOLE No 07-B05

5 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 318.1 E 303 719.1 ORIGINATED BY SLL
HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
DATUM Geodetic DATE 2007-07-25 - 2007-07-26 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)	
								○ UNCONFINED + FIELD VANE										
								● QUICK TRIAXIAL x LAB VANE										
	Continued From Previous Page						20	40	60	80	100	20	40	60				
39.9	SAND, trace silt Very Dense Grey Wet																	
			20	SS	100/ .150								○					
156.4																		
42.6	Salmon and black, fresh, coarse grained, very strong GRANITE Horizontal joint at 43.2m Sub-vertical joints at 43.5m, 43.8m, 44.6m, 44.8m, 45.3m and 45.4m		1	RUN														
			2	RUN														
	with pink quartzite at 45.49m																	
153.5																		
45.5	END OF BOREHOLE AT 45.5m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 2007-08-15 0.43 198.57 2007-08-29 1.22 197.78 2007-10-01 1.14 197.86																	

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

ONTM4S 5198-BEATTY.GPJ 15/11/07

RECORD OF BOREHOLE No 07-B06

2 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 335.9 E 303 727.4 ORIGINATED BY SLL
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2007-07-27 - 2007-07-28 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
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188.3	SAND and SILT, with thin silt seams Compact Grey Wet		8	SS	25																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			

ONTMT4S 5198-BEATTY.GPJ 15/11/07

Continued Next Page

+³ ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 07-B06

3 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 335.9 E 303 727.4 ORIGINATED BY SLL
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2007-07-27 - 2007-07-28 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
								20 40 60 80 100				
								20 40 60 80 100				
Continued From Previous Page						20 40 60 80 100			20 40 60			
177.4			14	SS	4		179					
21.7	SILT, some sand Loose Grey Wet						178					
							177					
175.8							176					
23.3	Silty CLAY, trace sand, with thin silty sand and sand seams Firm to Stiff Grey Wet						175					
			15	SS	6		174					
							173					
							172					
			16	SS	10		171					
							170					

Continued Next Page

+³, X³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

METRIC

G.W.P. 5200-03-00	LOCATION	Beatty Creek Bridge N 5 105 335.9 E 303 727.4	ORIGINATED BY	SLL
HWY 534	BOREHOLE TYPE	Hollow Stem Augers/NW Casing	COMPILED BY	WM
DATUM Geodetic	DATE	2007-07-27 - 2007-07-28	CHECKED BY	MRA

[illegible]

+³, X³: Numbers refer to Sensitivity

ONTMT4S 5198-BEATTY.GPJ 15/11/07

RECORD OF BOREHOLE No 07-B06

5 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 335.9 E 303 727.4 ORIGINATED BY SLL
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2007-07-27 - 2007-07-28 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
	Continued From Previous Page						159											
158.7 40.4	END OF BOREHOLE AT 40.4m. AUGER REFUSAL ON PROBABLE BEDROCK AT 40.4m. BOREHOLE GROUTED WITH BENTONITE TO 0.5m, SAND TO 0.15m, AND ASPHALT PATCH TO SURFACE.																	

RECORD OF BOREHOLE No 07-B07

1 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 271.9 E 303 683.2 ORIGINATED BY SLL
 HWY 534 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 2007-07-27 - 2007-01-08 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								WATER CONTENT (%)	
198.2	Ground Surface							20	40	60	80	100	20	40	60		
0.0	TOPSOIL: (200mm)						+0.3*	20	40	60	80	100	20	40	60		*Artesian
0.2	Silty CLAY , occasional rootlets Stiff Brown Damp		1	SS	9												
			2	SS	8												
196.8																	
1.4	Sandy SILT Loose Grey Wet		3	SS	6												0 28 69 3
196.0																	
2.2	SILT , trace clay, trace to some sand Very Loose Grey Wet		4	SS	3												
195.2																	
3.0	Silty CLAY , trace sand Very Soft Grey Wet		5	SS	4												
			6	SS	1												
			1	TW													
			7	SS	2												0 1 28 71
189.1																	
9.1	SAND , fine to medium grained Compact Grey Wet		2	TW													

Continued Next Page

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

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RECORD OF BOREHOLE No 07-B07

2 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge, N 5 105 271.9 E 303 683.2 ORIGINATED BY SLL
 HWY 534 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 2007-07-27 - 2007-01-08 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE	WATER CONTENT (%)			GR SA SI CL
184.5			8	SS	17		188					
							187					
			9	SS	13		186					
							185					
13.7	Sandy SILT Loose to Compact Grey Wet		10	SS	10		184					
							183					
			11	SS	9		182					
							181					
			12	SS	14		180					
							179					
179.9												
18.3	Silty CLAY, trace sand Firm to Very Stiff Grey Wet		13	SS	5							

Continued Next Page

+³ X³ Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 07-B07

3 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 271.9 E 303 683.2 ORIGINATED BY SLL
 HWY 534 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 2007-07-27 - 2007-01-08 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE	WATER CONTENT (%) 20 40 60			GR SA SI CL
	occasional sand seams						178					
			14	SS	6		177			○		
							176	3.9 +				
							175					
			15	SS	5		174			○		
							173	4.0 +				
							172					
							171					
			16	SS	11		170			○		0 1 61 38
							169	3.6 +				

Continued Next Page

+³, X³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 07-B07

4 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 271.9 E 303 683.2 ORIGINATED BY SLL
 HWY 534 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 2007-07-27 - 2007-01-08 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE			WATER CONTENT (%)						
						20	40	60	80	100	20	40	60		
	Continued From Previous Page														
			17	SS	16										
			18	SS	14										
163.1															
35.1	Silty SAND, trace clay Dense Grey Wet														
			19	SS	31										
159.5															
38.7	END OF BOREHOLE AT 38.7m. AUGER REFUSAL ON PROBABLE BEDROCK AT 38.7m. BOREHOLE OPEN TO 38.7m AND WATER LEVEL AT 1.5m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.														

Continued Next Page

+³ ×³ : Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

METRIC

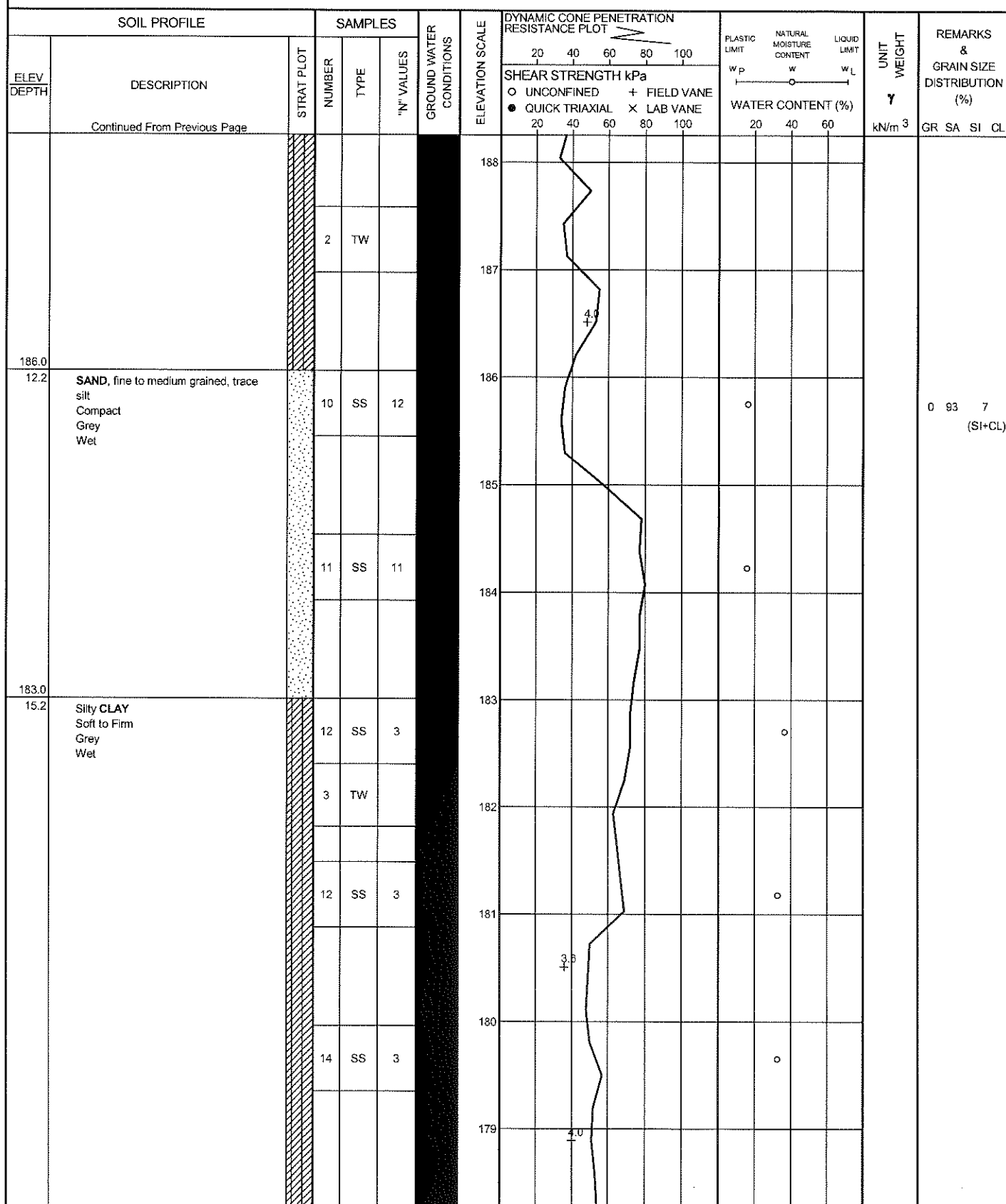
[illegible]

METRIC

+³, ×³: Numbers refer to Sensitivity

METRIC

CHECKED BY MRA



Continued Next Page

+³, ×³: Numbers refer to Sensitivity

ONTMT4S 5198-BEATTY.GPJ 15/11/07

RECORD OF BOREHOLE No 07-B08

3 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 376.1 E 303 735.3 ORIGINATED BY SLL
 HWY 534 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 2007-07-25 - 2007-07-26 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
								20 40 60 80 100				
								20 40 60 80 100				
Continued From Previous Page							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE			PLASTIC LIMIT w _p NATURAL MOISTURE CONTENT w LIQUID LIMIT w _L WATER CONTENT (%)		
176.9 21.3	Clayey SILT Soft Grey Wet		15	SS	3		178					
174.7 23.5	SAND, fine to medium grained Compact Grey Wet		16	SS	11		177					
170.8 27.4	Silty CLAY, trace sand Soft to Firm Grey Wet		17	SS	3		176					

Continued Next Page

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

RECORD OF BOREHOLE No 07-B08

4 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 376.1 E 303 735.3 ORIGINATED BY SLL
 HWY 534 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 2007-07-25 - 2007-07-26 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					PLASTIC LIMIT w _p NATURAL MOISTURE CONTENT w LIQUID LIMIT w _L
Continued From Previous Page													
167.7	SAND, fine to medium grained Compact Grey Wet		18	SS	14		168						
30.5							167						
							166						
165.3	Silty CLAY, trace sand Stiff Grey Wet		19	SS	9		165						
32.9							164						
							163						
							162						
			20	SS	20		161						
							160						
							159						
158.6	SAND, fine to medium grained, trace to some silt		21	SS	60/								
39.6													

Continued Next Page

+³, X³: Numbers refer to Sensitivity
 20
 15 10 5
 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 07-B08

5 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 376.1 E 303 735.3 ORIGINATED BY SLL
 HWY 534 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 2007-07-25 - 2007-07-26 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE					WATER CONTENT (%) w _p w w _L				
157.1	Continued From Previous Page Very Dense Grey Wet						158										
41.1	END OF BOREHOLE AT 41.1m. AUGER REFUSAL ON PROBABLE BEDROCK AT 41.1m. BOREHOLE OPEN TO 41.1m AND WATER LEVEL AT 1.1m ABOVE GROUND SURFACE UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 2007-08-15 0.16 above G.S. 198.36 2007-08-29 0.30 above G.S. 198.50 2007-10-01 0.15 above G.S. 198.35																

RECORD OF BOREHOLE No 07-B09

1 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 413.5 E 303 761.1 ORIGINATED BY SLL
 HWY 534 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 2007-07-23 - 2007-07-25 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	
200.3	Ground Surface											
0.0	TOPSOIL: (200mm)											
0.2	SAND, fine grained, some silt Loose Brown Wet		1	SS	8		200					
			2	SS	10		199					
	Grey		3	SS	6		198					0 85 15 (SI+CL)
			4	SS	7		197					
			5	SS	8		196					
196.6												
3.7	SILT, some clay Compact Grey Wet		6	SS	11		195					0 2 88 10
195.8												
4.5	Silty SAND Loose Grey Wet		7	SS	9		194					
							193					
194.2												
6.1	Silty CLAY, trace sand Firm to Stiff Grey Wet		8	SS	3		192					
							191					
			9	SS	3							
			10	SS	2							0 4 60 36

Continued Next Page




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

RECORD OF BOREHOLE No 07-B09

2 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 413.5 E 303 761.1 ORIGINATED BY SLL
HWY 534 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
DATUM Geodetic DATE 2007-07-23 - 2007-07-25 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE				
	Continued From Previous Page							20 40 60 80 100				
	with sand seams		11	SS	5							
			12	SS	8							
186.6												
13.7	SAND, fine grained, trace silt Dense Grey Wet		13	SS	36							
185.1												
15.2	Silty CLAY, occasional silt seams Firm to Stiff Grey Wet		14	SS	3							
			15	SS	4							
			16	SS	3							

Continued Next Page

+³, X³: Numbers refer to Sensitivity
20
15
10
(%) STRAIN AT FAILURE

METRIC

ELEV. DEPTH	SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES					
	Continued From Previous Page										kN/m³	GR SA SI C

Depth (m)	Description	No.	Soil Type	Notes
179.0 - 21.3	SILT , some clay, trace sand Firm Grey Wet	17	SS	7
		18	SS	4
173.5 - 26.8	Silty CLAY , occasional silt and sand seams Stiff Grey Wet	19	SS	5

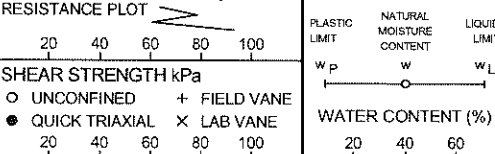


+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 07-B09

4 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 413.5 E 303 761.1 ORIGINATED BY SLL
 HWY 534 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 2007-07-23 - 2007-07-25 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
Continued From Previous Page														
			20	SS	16		170							
								169						
								168						
								167						
			21	SS	14			166						
								165						
								164						
			22	SS	12			163						
						162								
						161								
160.7														
39.6	SAND, fine grained, some silt Compact to Dense		23	SS	24									

Continued Next Page

+³, X³: Numbers refer to Sensitivity 20 15 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 07-B09

5 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 413.5 E 303 761.1 ORIGINATED BY SLL
 HWY 534 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 2007-07-23 - 2007-07-25 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
<div><div><div>20406080100</div><div>○ UNCONFINED + FIELD VANE</div><div>● QUICK TRIAXIAL X LAB VANE</div></div><div><div><div>PLASTIC LIMIT</div><div>NATURAL MOISTURE CONTENT</div><div>LIQUID LIMIT</div></div><div><div>W_P</div><div>W</div><div>W_L</div></div><div>WATER CONTENT (%)</div></div></div>												
	Continued From Previous Page						160					
							159					
							158					
			24	SS	35		157					
155.8							156					
44.5	END OF BOREHOLE AT 44.5m. AUGER REFUSAL ON PROBABLE BEDROCK AT 44.5m. BOREHOLE OPEN TO 44.5m AND WATER LEVEL AT 3.7m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE TO SURFACE.											

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**Record of Borehole Sheets
from Preliminary Investigation**

RECORD OF BOREHOLE No 06-B01

1 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 308.55 E 303 697.02 ORIGINATED BY GA
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2006.08.29 - 2006.08.30 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	
197.1	Ground Surface											
0.0	SAND , some silt, occasional rootlets Very Loose Dark Brown Dry		1	SS	2		+1.6*					*Artesian
196.6							197					
0.5	SILT , some clay to clayey, trace sand Very Soft Grey Wet		2	SS	2		196					
			3	SS	1		195					0 1 84 15
			4	SS	1		194					
194.1												
3.0	Silty CLAY , occasional black staining Very Soft Grey Wet (CL)		5	SS	1		193					
			6	SS	1		192					0 1 54 45
			1	TW			191	4.0				
189.6							190					
7.5	SAND , fine grained, some silt Loose Grey Wet		7	SS	6		189					
188.0							188					
9.1	SILT , some clay, trace sand Very Soft Grey Wet		8	SS	1							

Continued Next Page

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

METRIC

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	"N" VALUES		
							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE		
							20 40 60 80 100 WATER CONTENT (%) 20 40 60		
	Continued From Previous Page								

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		SHEAR STRENGTH kPa					WATER CONTENT (%)		
							○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL				× LAB VANE	
Continued From Previous Page														
186.4	SAND, trace silt, trace gravel Loose Grey Wet		9	SS	8						6 91 3 (SI+CL)			
10.7														
184.9	Sandy SILT, trace clay Compact to Loose Grey Wet Occasional clay seams		10	SS	15								0 35 60 5	
12.2														
			11	SS	5									
			12	SS	6									
			13	SS	4									

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 06-B01

3 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 308.55 E 303 697.02 ORIGINATED BY GA
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2006.08.29 - 2006.08.30 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE	WATER CONTENT (%)			
175.8	21.3 Clayey SILT Firm Grey Wet (CL) with clay seams and silty sand layers		14	SS	6		177					
172.7	24.4 SAND, fine grained, some silt Compact Grey Wet		15	SS	13		176					
169.8	27.3 Clayey SILT, trace to some sand Soft Grey Wet		16	SS	3		175					
							174					
							173					
							172					
							171					
							170					
							169					
							168					

Continued Next Page

+³, X³: Numbers refer to Sensitivity
 20
15 10 5
0 (%) STRAIN AT FAILURE

METRIC

Continued Next Page


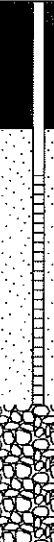
+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 06-B01

5 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 308.55 E 303 697.02 ORIGINATED BY GA
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2006.08.29 - 2006.08.30 CHECKED BY MA

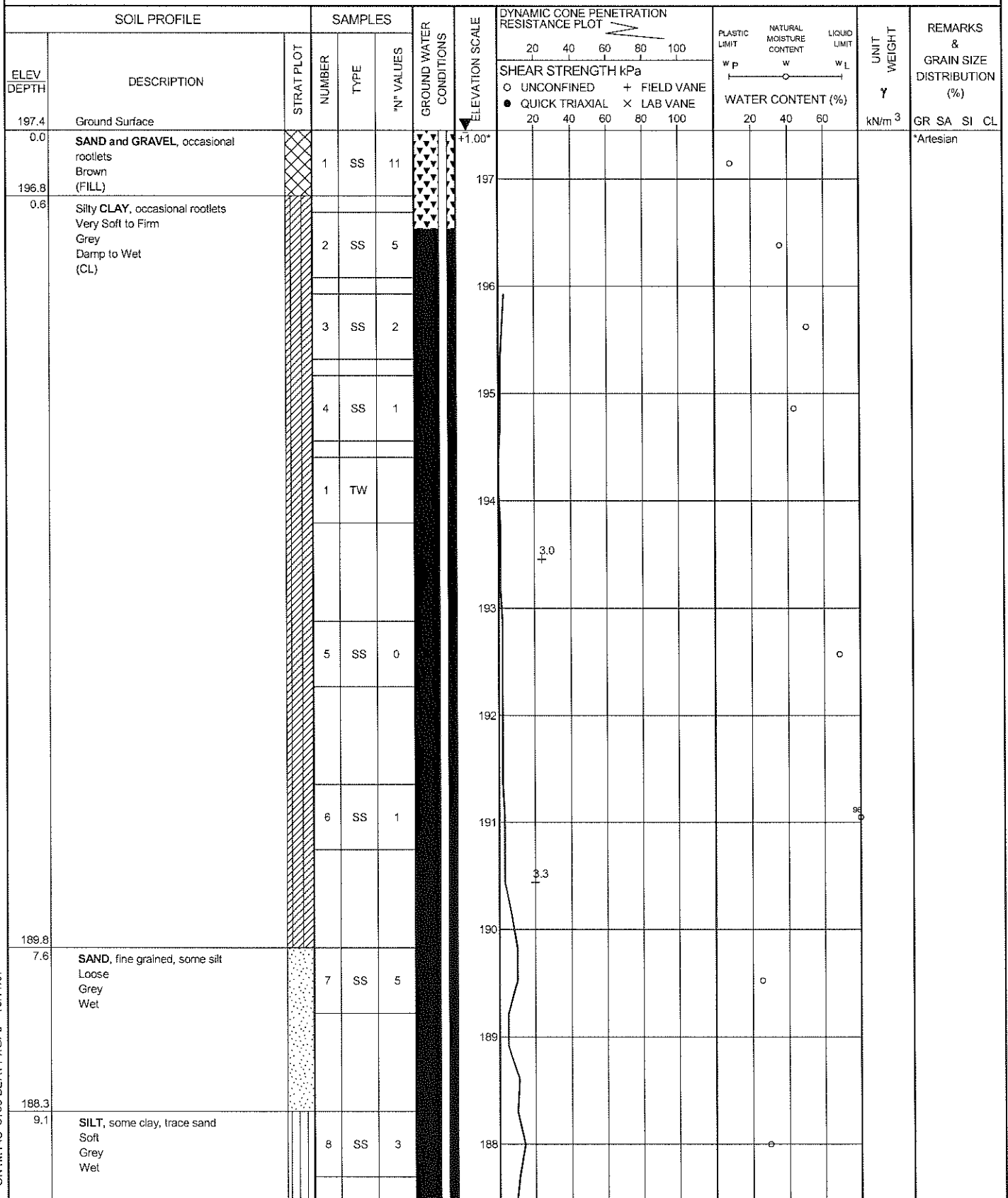
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
								20 40 60 80 100								
Continued From Previous Page								20 40 60 80 100				PLASTIC LIMIT W _P NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE				WATER CONTENT (%) 20 40 60				
153.5 43.6	Grey Wet (SW)						157									
							156									
							155									
			21	SS	24		154									
	END OF BOREHOLE AT 43.59 m. AUGER REFUSAL AT 43.59 m ON PROBABLE BEDROCK OR BOULDERS. BOREHOLE OPEN AND ARTESIAN FLOW TO 0.3 m ABOVE GROUND SURFACE. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 2006-08-30 1.2 above G.S. 198.3 2006-08-31 1.5 above G.S. 198.6 2006-09-06 1.5 above G.S. 198.6 2006-09-08 1.5 above G.S. 198.6 2006-09-11 1.5 above G.S. 198.6 2006-09-25 1.5 above G.S. 198.6 2007-08-29 1.6 above G.S. 198.7 2007-10-01 1.6 above G.S. 198.7															

RECORD OF BOREHOLE No 06-B02

1 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 320.69 E 303 714.37 ORIGINATED BY GA
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2006.09.06 - 2006.09.07 CHECKED BY MA



Continued Next Page

+³, ×³: Numbers refer to Sensitivity

20
15
10

METRIC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI C	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		SHEAR STRENGTH kPa					WATER CONTENT (%) w _p w w _L
							○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL			
186.7 10.7	SAND, fine to medium grained, trace silt Loose Grey Wet		9	SS	7							
185.2 12.2	Silty CLAY, trace sand Very Soft Grey to Reddish Brown Wet		10	SS	2							
184.0 13.4	SILT and SAND Loose Grey Wet		11	SS	8							
			12	SS	8							
179.1 18.3	SILT, some clay to clayey, trace sand Very Soft Grey Wet		13	SS	3							

+ ³, × ³: Numbers refer to Sensitivity

ONTMT4S 5198-BEATTY.GPJ 15/11/07

METRIC

CHECKED BY _____ MA

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 06-B02

4 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 320.69 E 303 714.37 ORIGINATED BY GA
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2006.09.06 - 2006.09.07 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	W _p	W	W _L			
Continued From Previous Page														
			17	SS	6									
			18	SS	1									
			19	SS	6									
157.8														
39.6	SAND, fine grained, trace silt Compact		20	SS	14									

Continued Next Page

+³, x³: Numbers refer to Sensitivity
 20
 15 10 5
 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 06-B02

5 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 320.69 E 303 714.37 ORIGINATED BY GA
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2006.09.06 - 2006.09.07 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page							20 40 60 80 100						
	Grey Wet							20 40 60 80 100						
155.5								20 40 60 80 100						
41.9	Salmon and black, fresh, coarse grained, very strong, GRANITE , with black banding							20 40 60 80 100						
	Horizontal joint at 42.62 m		1	RUN				20 40 60 80 100						
								20 40 60 80 100						
	Horizontal joints at 43.87, 44.12 and 44.42 m		2	RUN				20 40 60 80 100						
152.4								20 40 60 80 100						
45.0	END OF BOREHOLE AT 44.98 m. BOREHOLE OPEN AND WATER LEVEL AT SURFACE ON COMPLETION. ARTESIAN CONDITION DISSIPATED. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 2006-09-08 0.39 above G.S. 197.79 2006-09-11 0.41 above G.S. 197.81 2006-09-25 1.12 above G.S. 198.52 2007-08-29 1.16 above G.S. 198.56 2007-10-01 1.00 above G.S. 198.40													

+³ x³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 06-B03

1 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 301.00 E 303 716.81 ORIGINATED BY KH
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2006.08.29 - 2006.08.29 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	
199.0	Road Surface											
0.0	ASPHALT: (40 mm)		1	SS	23		199					
	SAND and GRAVEL, trace silt Compact to Loose Brown Moist (FILL)		2	SS	8		198					
	Silty		3	SS	20		197					
196.9												
2.1	Sandy SILT, occasional wood fiber Very Loose Grey Wet sand pocket at 2.69 m		4	SS	2		196					
196.0												
3.0	Clayey SILT, trace sand, trace organics Very Soft Grey Wet		5	SS	2		195					
194.7												
4.3	Silty CLAY Very Soft to Soft Grey to Greenish Grey Wet		6	SS	1		194					
			7	SS	1		193					
			8	SS	1		192					
							191					
189.8			9	SS	1		190					
9.2	Clayey SILT, trace sand Very Soft Grey Wet											

Continued Next Page

+ 3, x 3: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 06-B03

2 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 301.00 E 303 716.81 ORIGINATED BY KH
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2006.08.29 - 2006.08.29 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
	Continued From Previous Page											
187.4			10	SS	1		189					0 3 77 20
11.6	SAND, fine to medium grained, trace silt Very Loose Grey Wet		11	SS	3		188					
185.9							187					
13.1	Silty SAND, trace clay Very Loose Grey Wet		12	SS	1		186					
							185					
			13	SS	1		184					0 68 28 4
							183					
182.2							182					
16.8	Silty CLAY, trace sand Very Soft Grey Wet		14	SS	1		181					
							180					

Continued Next Page

+³ X³: Numbers refer to Sensitivity
 20
 15-10
 10 (%) STRAIN AT FAILURE

METRIC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE		"N" VALUES	SHEAR STRENGTH kPa	WATER CONTENT (%)		
	Continued From Previous Page									
			15	SS	1					0 1 69 30
			16	SS	1					
			17	SS	1					

+³, ×³: Numbers refer to Sensitivity

ONTMT4S 5198-BEATTY.GPJ 15/11/07

RECORD OF BOREHOLE No 06-B03

4 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 301.00 E 303 716.81 ORIGINATED BY KH
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2006.08.29 - 2006.08.29 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL × LAB VANE		
Continued From Previous Page							20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L		
			18	SS	1		169					0 1 58 41
							168					
							167					
							166					
			19	SS	1		165					
164.3							164					
34.7	SILT, some sand, some clay, occasional fine sand layers Compact Grey Wet						163					
			20	SS	22		162					0 13 74 13
							161					
161.2							160					
37.8	SAND, fine grained, some silt Compact Grey Wet		21	SS	17							

Continued Next Page

+³, X³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 06-B03

5 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 301.00 E 303 716.81 ORIGINATED BY KH
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2006.08.29 - 2006.08.29 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								20 40 60 80 100					
								20 40 60 80 100					
	Continued From Previous Page												
157.5	SILT, some sand Loose Grey Wet						159						
41.5							158						
							157						
			22	SS	9		156						
							155						
154.4	Salmon and black, fresh, coarse grained, very strong. GRANITE						154						
44.6			1	RUN			153						
			2	RUN			152						
			3	RUN									
151.2	END OF BOREHOLE AT 47.80 m. BOREHOLE BACKFILLED WITH BENTONITE AND SAND, WITH COLD PATCH AT SURFACE.												
47.8													

ONTM14S 5198-BEATTY.GPJ 15/11/07

RECORD OF BOREHOLE No 06-B04

1 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 316.00 E 303 723.57 ORIGINATED BY KH
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2006.08.30 - 2006.08.30 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
199.0	Road Surface											
0.0	ASPHALT: (90 mm)											
0.1	Gravelly SAND Compact to Loose Brown Moist (FILL)		1	SS	26		199					
			2	SS	7		198					
			3	SS	28		197					
196.6												
2.4	Sandy SILT, trace clay, trace gravel, occasional wood fragments Very Loose		4	SS	2		196					
196.0	Grey Wet											
3.0	Silty CLAY, trace gravel and organics to 4.11 m Very Soft to Soft Grey Wet		5	SS	2		195					
			6	SS	1		194					
			1	TW			193					0 0 33 67
			7	SS	1		192					0 0 37 63
							191					
			8	SS	1		190					

Continued Next Page

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

RECORD OF BOREHOLE No 06-B04

2 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 316.00 E 303 723.57 ORIGINATED BY KH
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2006.08.30 - 2006.08.30 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
	Continued From Previous Page							20 40 60 80 100	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	
			9	SS	2		189	○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE				
			10	SS	3		188					
			11	SS	1		187					
							186					
184.1							185					
14.9	SILT, trace sand, trace clay Very Loose Grey Wet		12	SS	2		184					
							183					
							182					
181.0							181					
18.0	Clayey SILT, trace sand, with layers of silt and silty clay Very Soft Grey Wet		13	SS	1		180					

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

ONTM14S 5198-BEATTY.GPJ 15/11/07

METRIC

ORIGINATED BY KH
COMPILED BY WM
CHECKED BY MA

Continued Next Page

+³, ×³; Numbers refer to Sensitivity

RECORD OF BOREHOLE No 06-B04

4 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 316.00 E 303 723.57 ORIGINATED BY KH
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2006.08.30 - 2006.08.30 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE	×						
	Continued From Previous Page		17	SS	1		169								0 8 61 31	
							168									
							167									
							166									
			18	SS	3		165								0 8 60 32	
							164									
							163									
162.4			19	SS	22		162									
36.6	SAND, fine grained, some silt Compact to Dense Grey Wet						161									
							160									
			20	SS	36											

Continued Next Page

+³, X³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 06-B04

5 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 316.00 E 303 723.57 ORIGINATED BY KH
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2006.08.30 - 2006.08.30 CHECKED BY MA

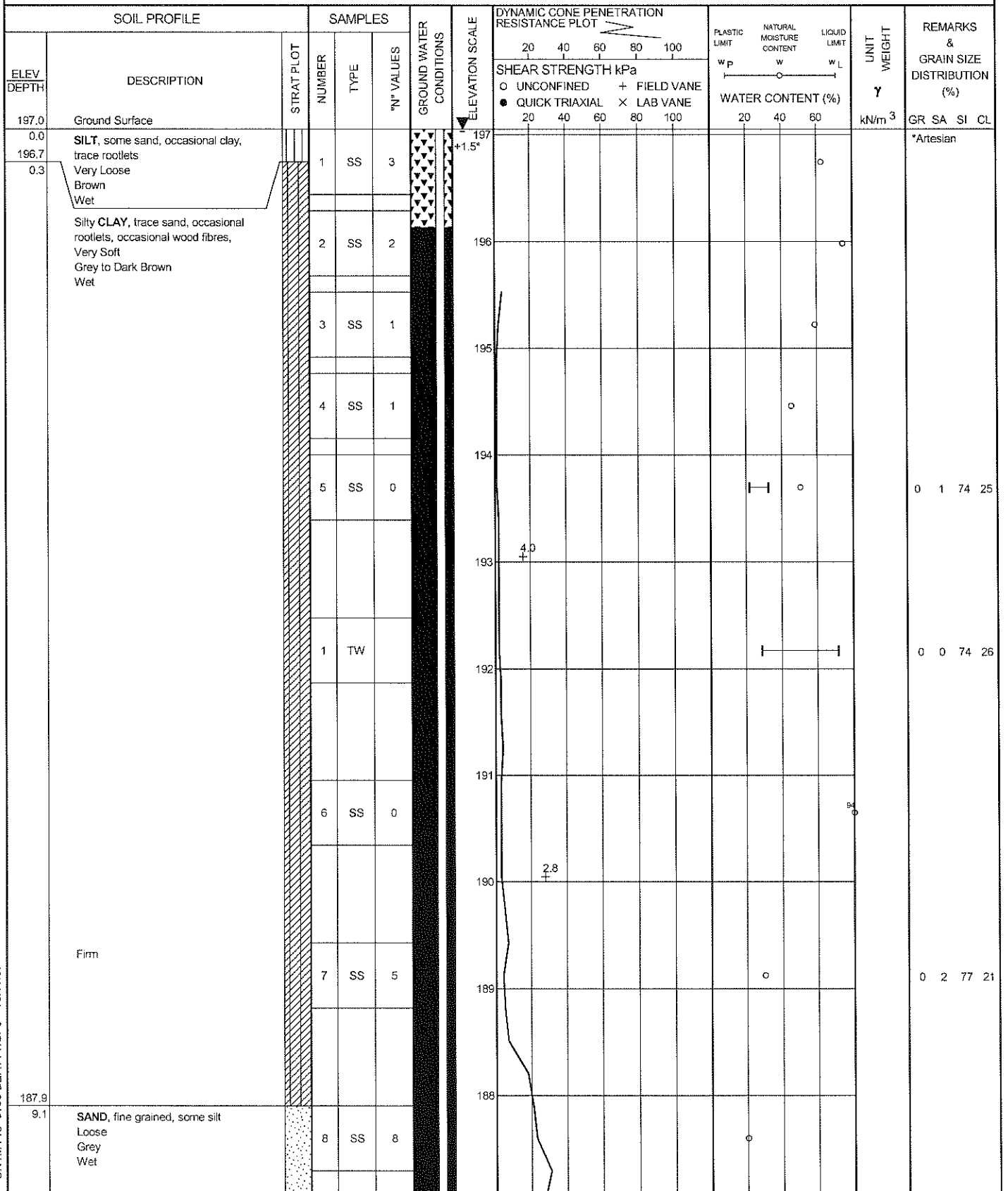
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page							20 40 60 80 100	20 40 60 80 100					
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL × LAB VANE						
														</

RECORD OF BOREHOLE No 06-B06

1 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 311.29 E 303 735.18 ORIGINATED BY GA
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2006.09.07 - 2006.09.08 CHECKED BY MA



Continued Next Page

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

RECORD OF BOREHOLE No 06-B06

2 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 311.29 E 303 735.18 ORIGINATED BY GA
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2006.09.07 - 2006.09.08 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
								20 40 60 80 100	PLASTIC LIMIT	NATURAL MOISTURE CONTENT		
Continued From Previous Page								w _p w w _L				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE			WATER CONTENT (%)	
								20 40 60 80 100	20 40 60			
186.3							187					
10.7	Silty CLAY Very Soft Grey to Reddish Brown Wet		9	SS	2		186	5.0				
							185					
			10	SS	1		184					
							183					
183.3							182					
13.7	SILT, some sand, trace clay Loose to Very Loose Grey Wet		11	SS	8		181					
							180					
			12	SS	5		179					
							178					
			13	SS	3							

Continued Next Page

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

METRIC

G.W.P.	5200-03-00	LOCATION	Beatty Creek Bridge N 5 105 311.29 E 303 735.18	ORIGINATED BY	GA
HWY	534	BOREHOLE TYPE	Hollow Stem Augers/NW Casing	COMPILED BY	WM
DATUM	Geodetic	DATE	2006.09.07 - 2006.09.08	CHECKED BY	MA

[illegible]

+³, X³: Numbers refer to Sensitivity

ONTMT4\$ 5198-BEATTY.GPJ 15/11/07

METRIC

ORIGINATED BY GA
COMPILED BY WM
CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		SHEAR STRENGTH kPa					
							20 40 60 80 100					
Continued From Previous Page						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w _p w w _L			
						WATER CONTENT (%) 20 40 60						
166.5	CLAY, silty, occasional sand seams Stiff Grey Wet		17	SS	9						0 1 61 38	
30.5												
			18	SS	10						0 10 55 35	
			19	SS	8							
	Occasional gravel seam											
157.4												
39.6	Salmon, black and dark grey, fresh, coarse grained, very strong, GRANITE									FI 0	Water at 0.6 m above G.S. in casing RUN 1# TCR=100%,	

+ ³, X ³: Numbers refer to Sensitivity

ONTMT4S 5198-BEATTY.GPJ 15/11/07

RECORD OF BOREHOLE No 06-B06

5 OF 5

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 311.29 E 303 735.18 ORIGINATED BY GA
HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
DATUM Geodetic DATE 2006.09.07 - 2006.09.08 CHECKED BY MA

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa							
	Continued From Previous Page						20 40 60 80 100								
							○ UNCONFINED + FIELD VANE								
							● QUICK TRIAXIAL × LAB VANE								
							WATER CONTENT (%)								
							20 40 60								
							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT								
							w _p w w _L								
154.5	Sub horizontal joint at 40.23 m Horizontal joint at 40.31 m		1	RUN		157								GR SA SI CL SCR=96%, RQD=93%, UCS=146MPa	
	Vertical joint from 41.00 to 41.61 m					156									RUN 2# TCR=100%, SCR=60%, RQD=60%, UCS=138MPa
	Broken zone from 41.00 to 41.30 m and 41.61 to 41.76 m		2	RUN		155									
42.5	END OF BOREHOLE AT 42.52 m. BOREHOLE OPEN AND WATER LEVEL AT 1.8 m ABOVE GROUND SURFACE UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.														
	WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 2006-09-11 1.4 above G.S. 2006-09-25 1.5 above G.S.														

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 06-B07

1 OF 2

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 093.88 E 303 642.56 ORIGINATED BY GA
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2006.08.28 - 2006.08.28 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	
197.9 0.0	Ground Surface SAND, some silt, trace organics Loose to Very Loose Brown Dry (SP) Grey Wet		1	SS	4							
196.4			2	SS	3		197					
1.5	SILT, some clay to clayey Very Soft Grey Wet (ML-NP)		3	SS	2		196					
			4	SS	1							0 0 82 18
194.9 3.0	Silty CLAY, trace sand Very Soft Grey Wet (CL)		5	SS	2		195					
			6	SS	1		194	4.0 +				
			7	SS	1		193					
			8	SS	4		192					
							191	3.0 +				
189.7 8.2	SAND, fine grained, trace to some silt Dense Grey Wet (SW)		9	SS	31		190				80	0 1 31 68
							189					
							188					

Continued Next Page

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

RECORD OF BOREHOLE No 06-B07

2 OF 2

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 093.68 E 303 642.56 ORIGINATED BY GA
HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
DATUM Geodetic DATE 2006.08.28 - 2006.08.28 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
	Continued From Previous Page							20 40 60 80 100								
			10	SS	31		187									
186.3																
11.6	GRAVEL, some sand, occasional granite fragments Very Dense Wet						186									
185.3			11	SS	130											
12.6	END OF BOREHOLE AT 12.65 m. AUGER REFUSAL AT 12.65 m ON PROBABLE BEDROCK OR BOULDERS. BOREHOLE OPEN AND ARTESIAN FLOW TO 0.3 m ABOVE GROUND SURFACE UPON COMPLETION. ARTESIAN CONDITION DISSIPATED AFTER 20 MIN. BOREHOLE BACKFILLED WITH HOLEPLUG AND CONCRETE AT SURFACE.															

+ ³ × ³; Numbers refer to
Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 06-B08

1 OF 2

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 196.21 E 303 667.23 ORIGINATED BY GA
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2006.09.05 - 2006.09.05 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)			
198.0	Ground Surface							20 40 60 80 100		W P W W L			GR SA SI CL
0.0	SAND, some silt, with rootlets and organics		1	SS	6		198 +1.5'						*Artesian
197.7													
0.3	SAND, fine to medium grained, trace silt, occasional iron oxide staining Loose Brown Dry to Wet		2	SS	5		197						
			3	SS	4		196						0 94 6 (SI+CL)
195.7													
2.3	Silty CLAY Very Soft to Soft Grey Wet		4	SS	2		195						
			5	SS	1								
							194	3.0					
			6	SS	1		193						
			7	SS	1		192						
													0 0 33 67
							191	3.3					
			8	SS	0		190						
188.9							189						
9.1	SAND, fine to medium grained, trace silt Loose to Compact Grey Wet		9	SS	9								

Continued Next Page

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

RECORD OF BOREHOLE No 06-B08

2 OF 2

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 196.21 E 303 667.23 ORIGINATED BY GA
HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
DATUM Geodetic DATE 2006.09.05 - 2006.09.05 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				
	Continued From Previous Page							20 40 60 80 100				
			10	SS	18							
			11	SS	7							
184.3												
13.7	Silty CLAY , trace sand, occasional silt seams Soft Grey Wet		12	SS	3			28				
			13	SS	3							
181.2												
16.8	SILT , trace sand, occasional sand seams Compact Grey Wet		14	SS	21							
180.3			15	SS	100							
17.7	END OF BOREHOLE AT 17.68 m. AUGER REFUSAL AT 17.68 m ON PROBABLE BEDROCK OR BOULDERS. BOREHOLE OPEN AND WATER LEVEL AT 1.52 m ON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 2006-09-06 0.30 above G.S. 2006-09-08 0.30 above G.S. 2006-09-11 0.31 above G.S. 2006-09-25 0.35 above G.S.											

ONTMT4S 5198-BEATTY.GPJ 15/11/07

+³. X³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 06-B09

1 OF 3

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 202.30 E 303 701.05 ORIGINATED BY GA
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2006.08.31 - 2006.08.31 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								20 40 60 80 100					
198.1	Ground Surface												
0.0	Silty SAND , occasional rootlets		1	SS	5								
197.6	Loose Dry												
0.5	Silty CLAY , trace sand, occasional iron oxide staining		2	SS	8								
196.7	Stiff Grey Damp												
1.4	Sandy SILT Compact Grey Wet		3	SS	12								
195.7													
2.4	Clayey SILT Soft to Very Soft Grey Wet		4	SS	5								
			5	SS	3								
194.0													
4.1	Silty CLAY Very Soft Grey Wet		6	SS	2								
			7	SS	1								
			8	SS	0								
189.0													
9.1	Sandy SILT , trace clay Loose Grey Wet		9	SS	8								

Continued Next Page

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

RECORD OF BOREHOLE No 06-B09

2 OF 3

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 202.30 E 303 701.05 ORIGINATED BY GA
HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
DATUM Geodetic DATE 2006.08.31 - 2006.08.31 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w _p w w _L		
	Continued From Previous Page							20 40 60 80 100							
187.4							188								
10.7	SAND, fine to coarse grained, trace silt Compact Grey Wet		10	SS	15		187								
185.9															
12.2	GRAVEL, some sand, trace silt, with granite fragments Compact Grey Wet		11	SS	17		186								
185.0															
13.1	SAND, fine to coarse grained, trace silt, trace gravel Loose Grey Wet		12	SS	8		185								
182.9							184								
15.2	SILT, some sand Compact Grey Wet		13	SS	12		183								
181.3							182								
16.8	SAND, fine to coarse grained, trace silt, trace gravel Compact Grey Wet		14	SS	14		181								
178.9							180								
19.2	SAND and GRAVEL Compact Grey Wet						179								

Continued Next Page

+³ ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 06-B09

3 OF 3

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 202.30 E 303 701.05 ORIGINATED BY GA
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2006.08.31 - 2006.08.31 CHECKED BY MA

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa		WATER CONTENT (%)			
	Continued From Previous Page		15	SS	22								
177.7													
20.4	END OF BOREHOLE AT 20.42 m. BOREHOLE OPEN TO 19.81 m AND WATER LEVEL AT 1.52 m ON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE.												

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

CONTMT4S 5198-BEATTY.GPJ 15/11/07

RECORD OF BOREHOLE No 06-B10

2 OF 3

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 376.19 E 303 758.13 ORIGINATED BY KH
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2006.08.31 - 2006.08.31 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
								WATER CONTENT (%)				
	Continued From Previous Page											
187.9			10	SS	1							
11.6	Silty SAND Compact Grey Wet		11	SS	10							0 66 34 (SI+CL)
186.4												
13.1	Clayey SILT Very Soft Grey Wet		12	SS	1							
184.6												
14.9	SILT, some sand to sandy, trace clay Very Loose Grey Wet		13	SS	1							
			14	SS	1							0 4 96 (SI+CL)
181.8												
17.7	SAND, fine grained, trace silt Very Loose Grey Wet											
			15	SS	3							

Continued Next Page

+³ x³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 06-B10

3 OF 3

METRIC

G.W.P. 5200-03-00 LOCATION Beatty Creek Bridge N 5 105 376.19 E 303 758.13 ORIGINATED BY KH
 HWY 534 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
 DATUM Geodetic DATE 2006.08.31 - 2006.08.31 CHECKED BY MA

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20 40 60 80 100	20 40 60 80 100	W _p W W _L			
179.4	Continued From Previous Page												
20.1	END OF BOREHOLE AT 20.12 m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 2006-08-06 1.11 198.39 2006-09-08 1.13 198.37 2006-09-11 1.09 198.41 2006-09-25 1.15 198.35 2007-08-29 0.91 198.59 2007-10-01 0.98 198.52					179							

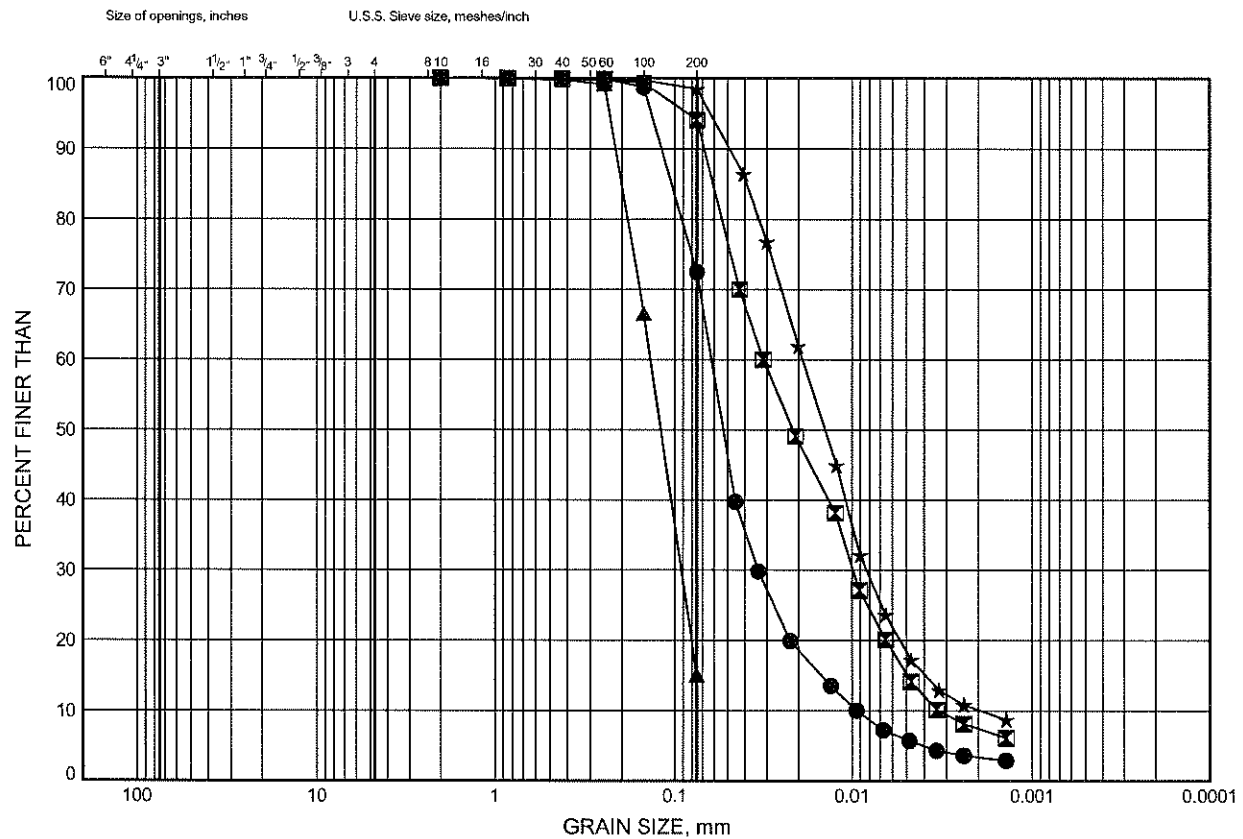
Appendix B

Laboratory Test Results

Beatty Creek Bridge Replacement GRAIN SIZE DISTRIBUTION

FIGURE 07-B1

SURFICIAL SANDS AND SILTS



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-B07	1.83	196.37
⊠	07-B08	2.59	195.61
▲	07-B09	1.83	198.47
★	07-B09	4.11	196.19

Date November 2007
Project 5200-03-00

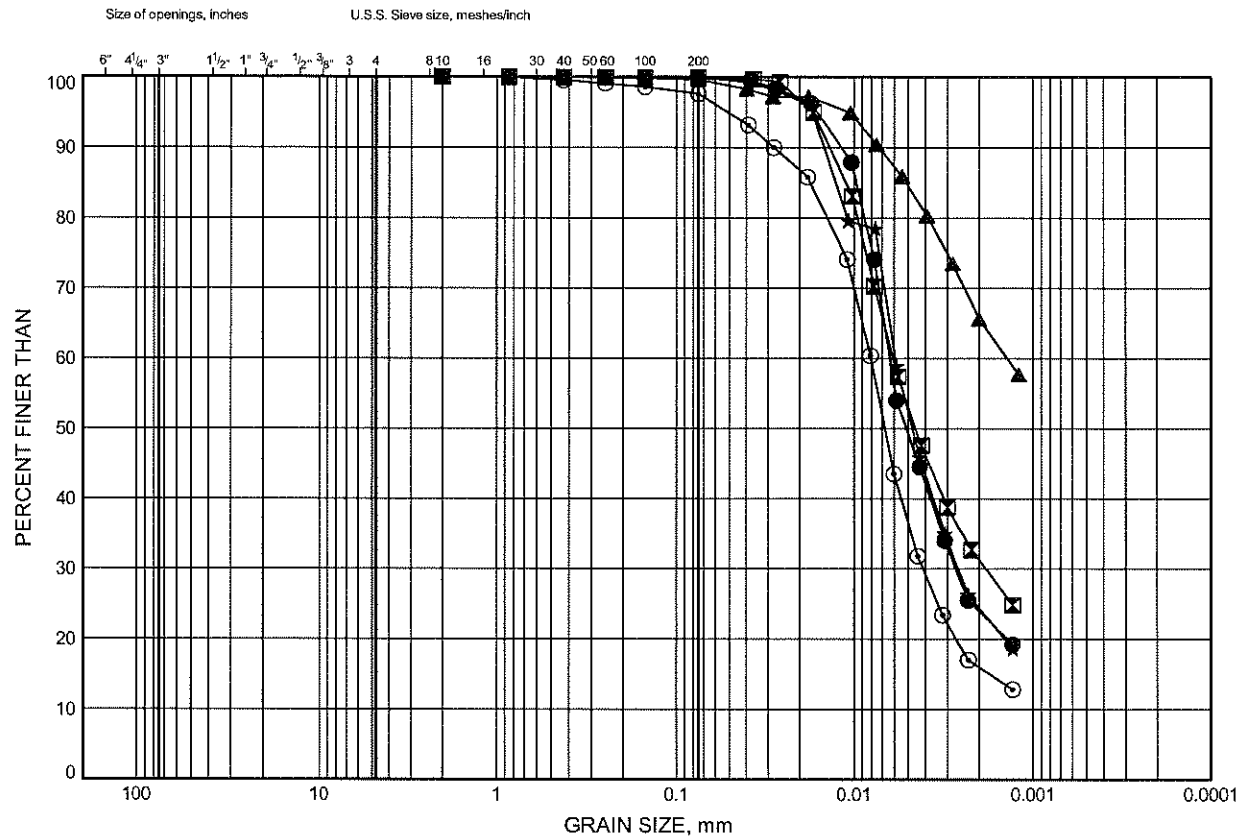


Prep'd MFA
Chkd. MRA

Beatty Creek Bridge Replacement GRAIN SIZE DISTRIBUTION

FIGURE 07-B2

UPPER SILTY CLAY TO CLAYEY SILT



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-B01	2.59	194.61
⊠	07-B02	3.39	193.61
▲	07-B02	6.40	190.60
★	07-B03	4.88	194.22
⊙	07-B04	4.11	194.89

Date November 2007
Project 5200-03-00

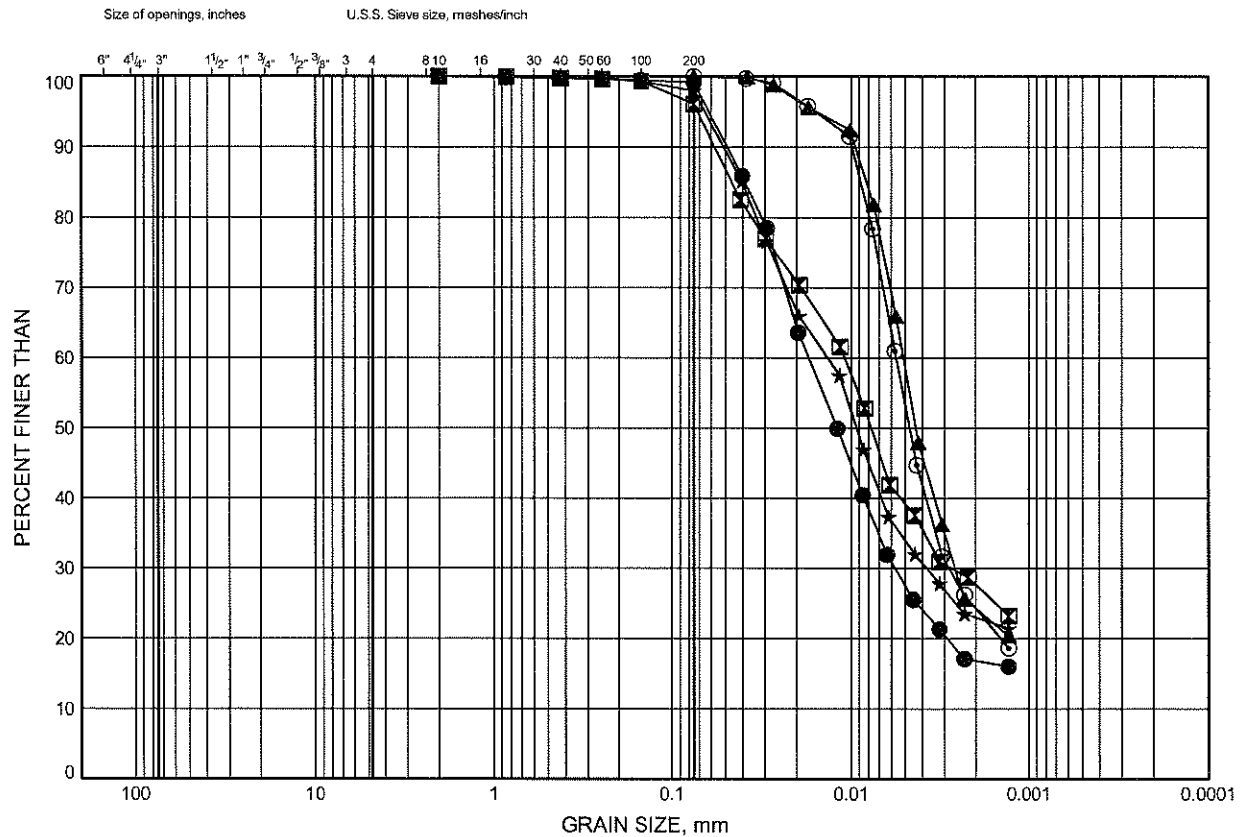


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Chkd. MRA

Beatty Creek Bridge Replacement GRAIN SIZE DISTRIBUTION

FIGURE 07-B3

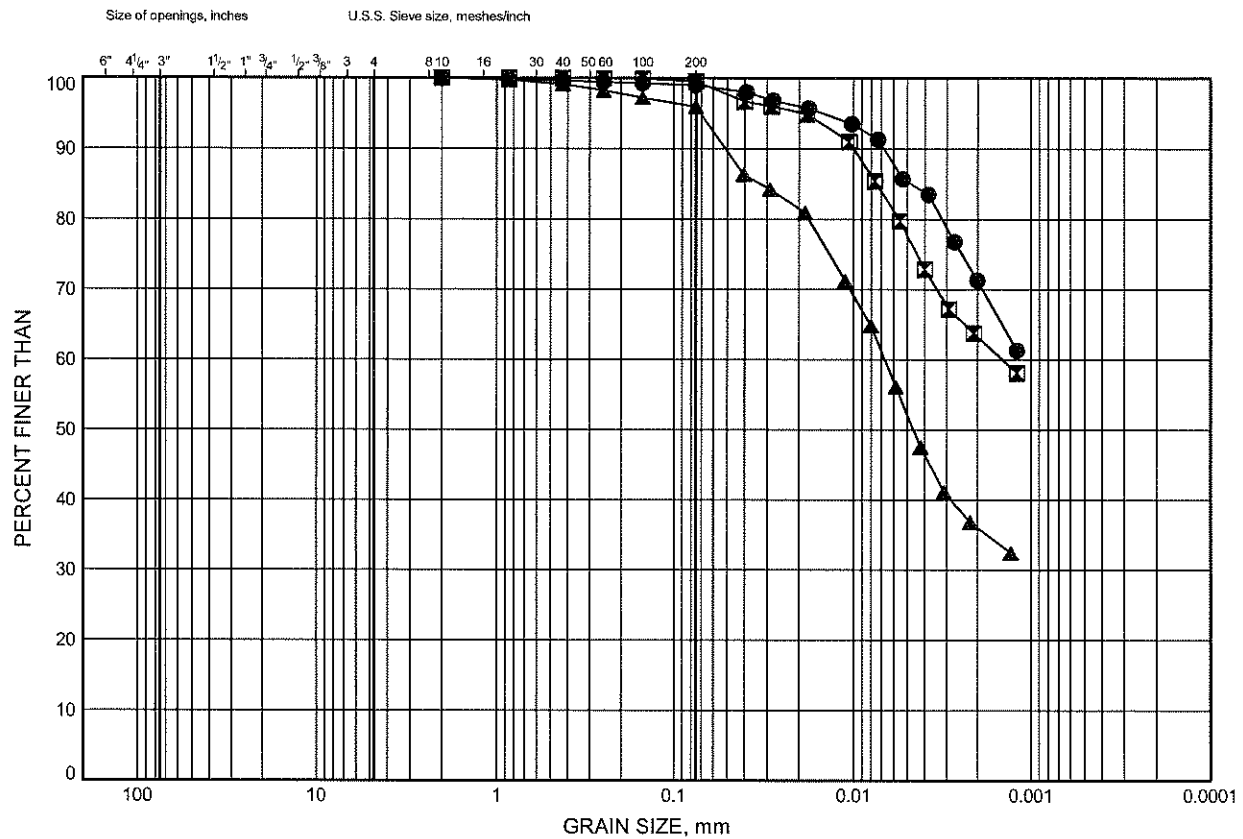
UPPER SILTY CLAY TO CLAYEY SILT



Beatty Creek Bridge Replacement GRAIN SIZE DISTRIBUTION

FIGURE 07-B4

UPPER SILTY CLAY TO CLAYEY SILT

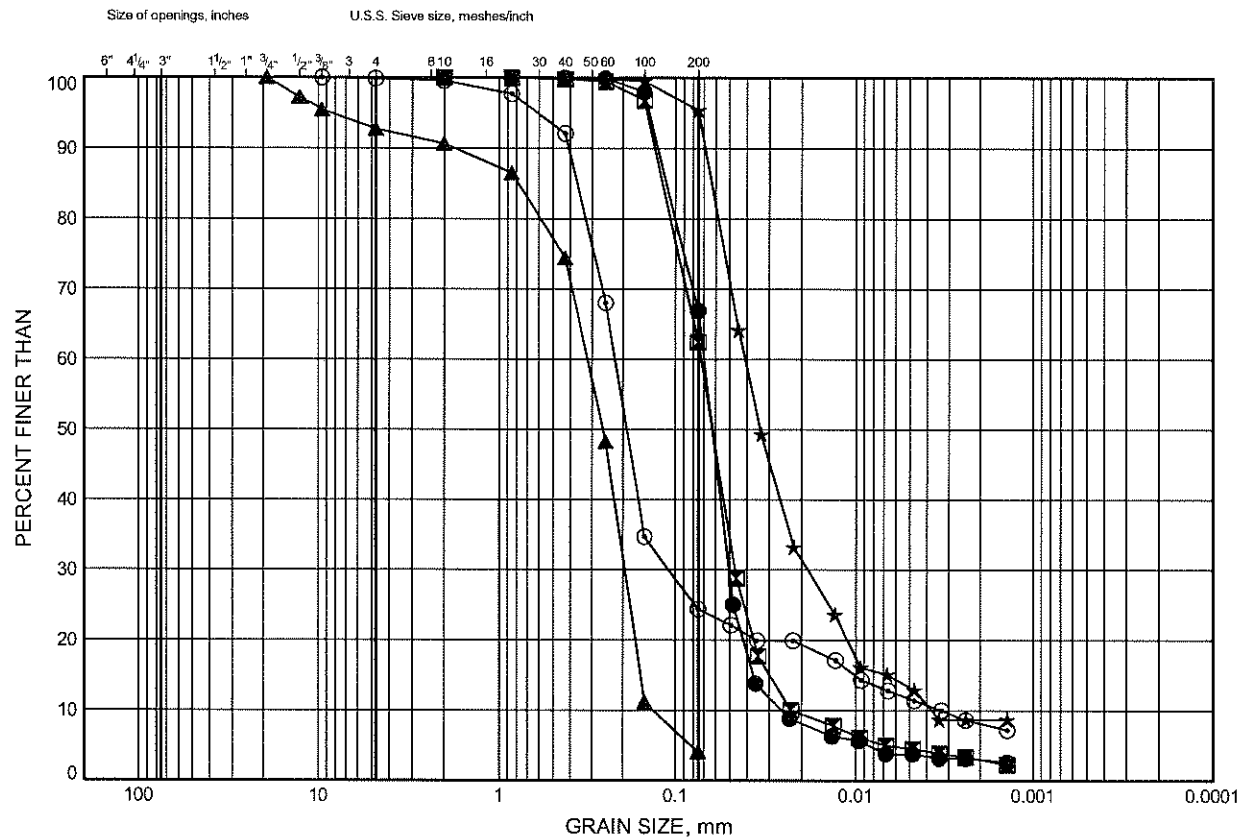


Beatty Creek Bridge Replacement

GRAIN SIZE DISTRIBUTION

FIGURE 07-B5

INTERMEDIATE SAND TO SILT



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-B01	12.50	184.70
⊠	07-B01	15.54	181.66
▲	07-B02	10.97	186.03
★	07-B02	14.02	182.98
⊙	07-B03	10.97	188.13

Date November 2007
Project 5200-03-00

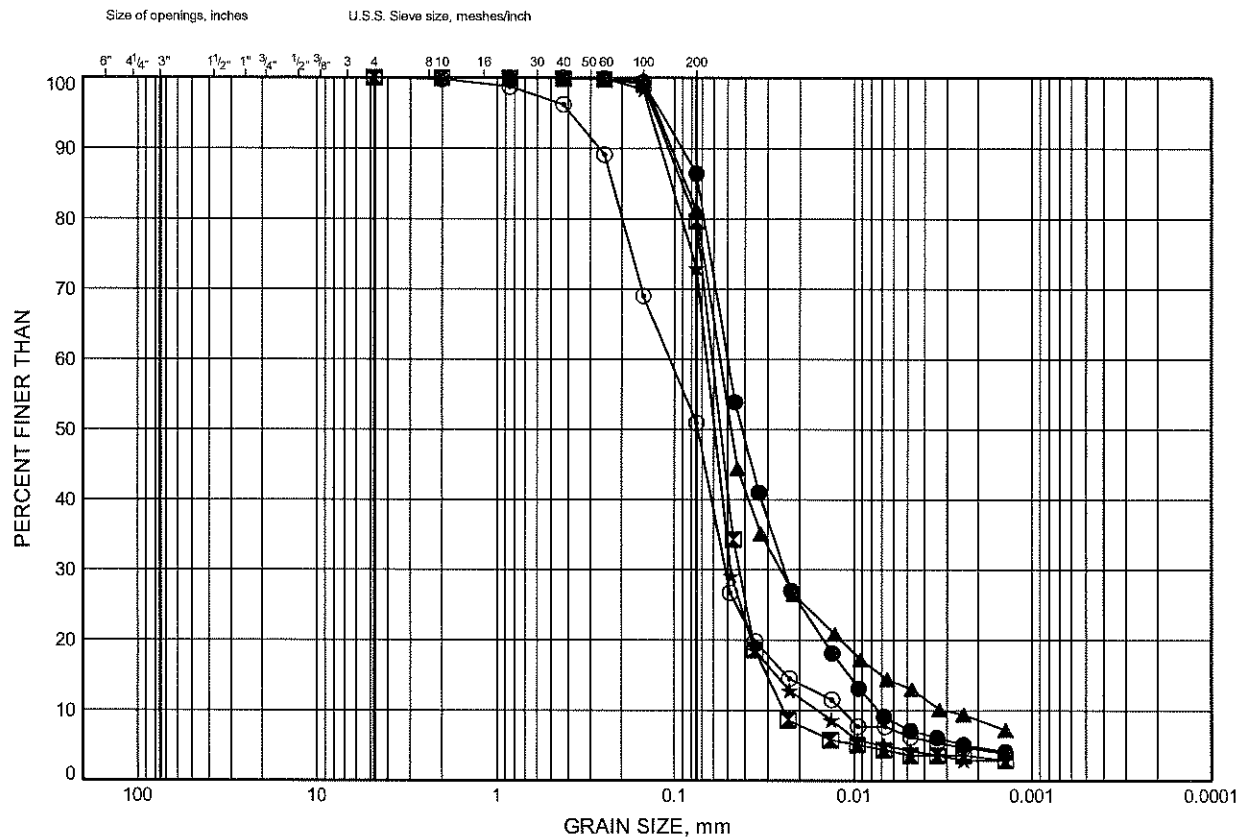


Prep'd MFA
Chkd. MRA

Beatty Creek Bridge Replacement GRAIN SIZE DISTRIBUTION

FIGURE 07-B6

INTERMEDIATE SAND TO SILT



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-B03	14.17	184.93
⊠	07-B04	17.07	181.93
▲	07-B04	18.82	180.18
★	07-B05	15.54	183.46
⊙	07-B06	10.97	188.13

Date November 2007
Project 5200-03-00

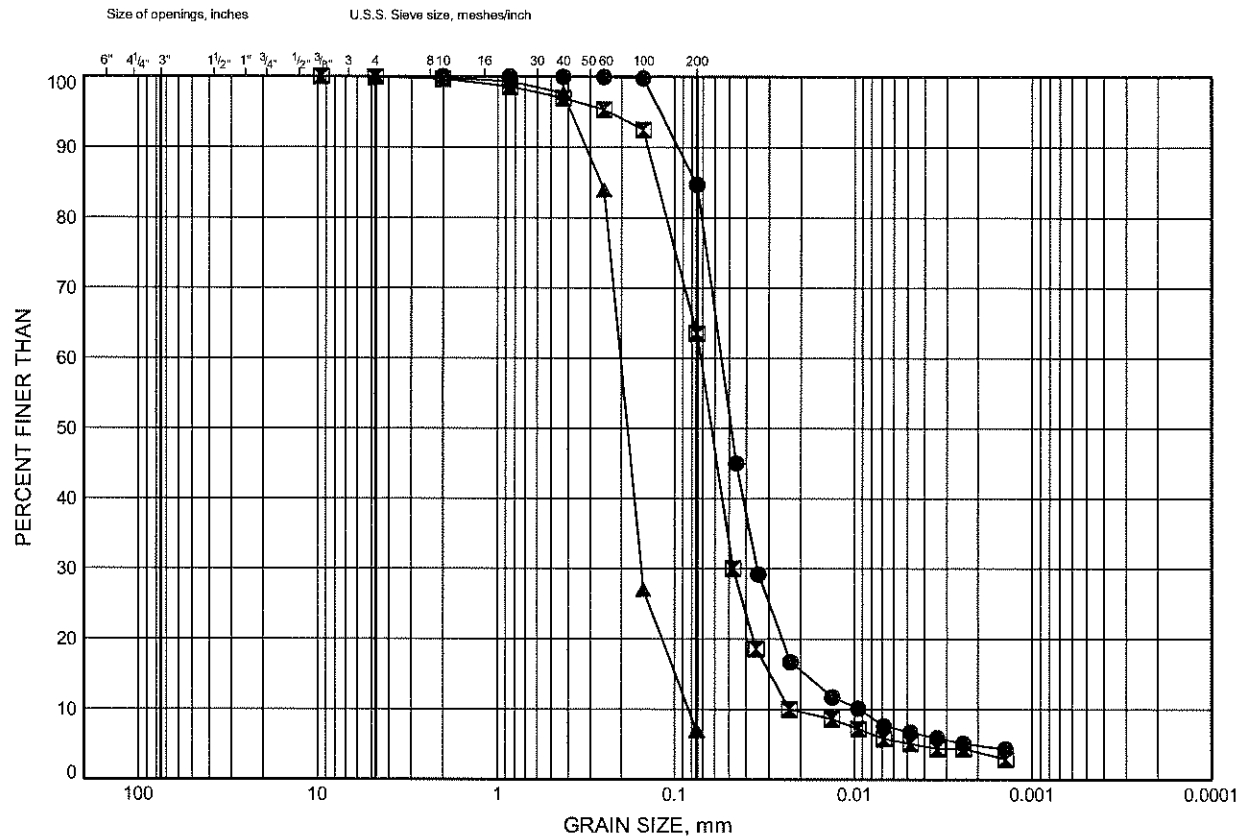


Prep'd MFA
Chkd. MRA

Beatty Creek Bridge Replacement GRAIN SIZE DISTRIBUTION

FIGURE 07-B7

INTERMEDIATE SAND TO SILT



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-B06	17.07	182.03
⊠	07-B07	15.54	182.66
▲	07-B08	12.50	185.70

Date November 2007
Project 5200-03-00



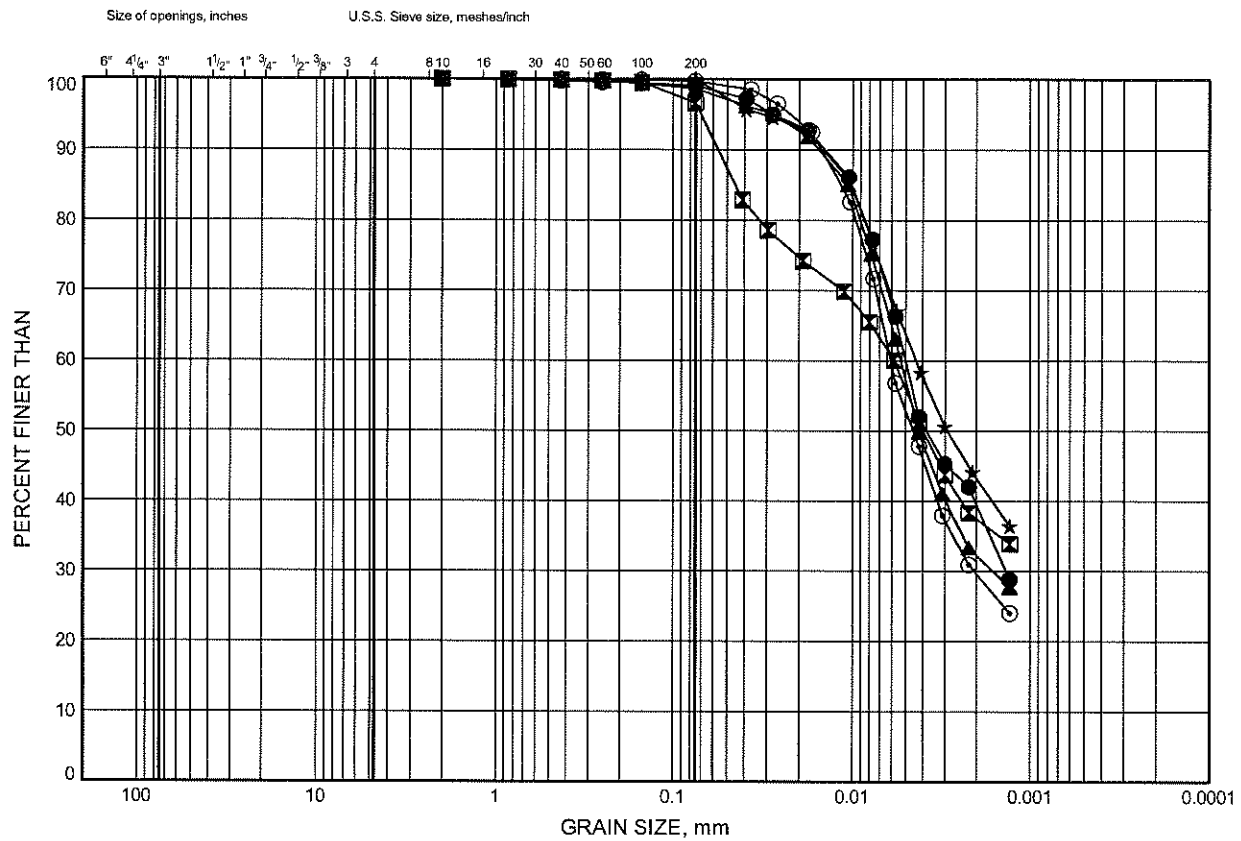
Prep'd MFA
Chkd. MRA

Beatty Creek Bridge Replacement

GRAIN SIZE DISTRIBUTION

FIGURE 07-B8

LOWER SILTY CLAY TO CLAYEY SILT



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-B03	21.64	177.46
⊠	07-B03	33.83	165.27
▲	07-B04	30.78	168.22
★	07-B05	24.69	174.31
⊙	07-B05	27.74	171.26

Date November 2007
Project 5200-03-00

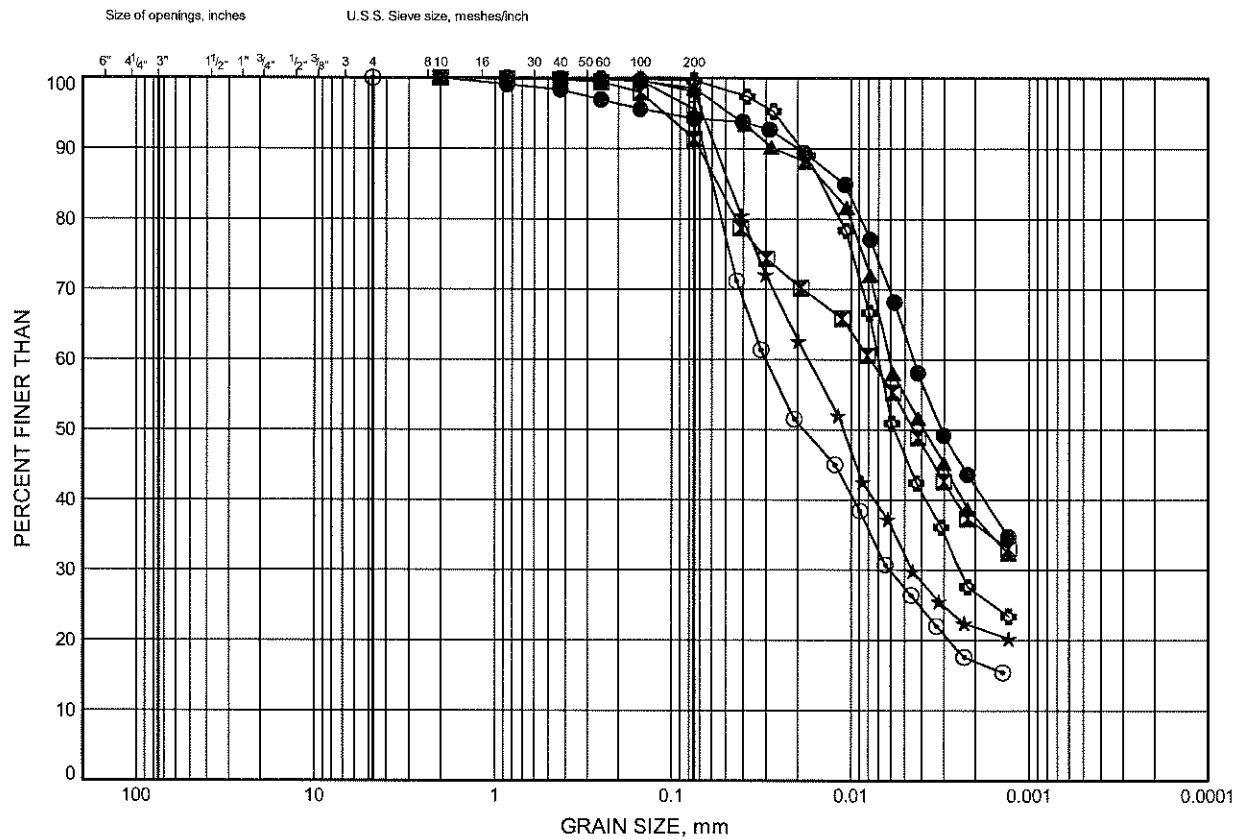


Prep'd MFA
Chkd. MRA

Beatty Creek Bridge Replacement GRAIN SIZE DISTRIBUTION

FIGURE 07-B9

LOWER SILTY CLAY TO CLAYEY SILT



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-B06	24.69	174.41
⊠	07-B06	36.88	162.22
▲	07-B07	27.74	170.46
★	07-B08	33.83	164.37
⊙	07-B09	21.64	178.66
⊕	07-B09	27.74	172.56

Date November 2007
Project 5200-03-00

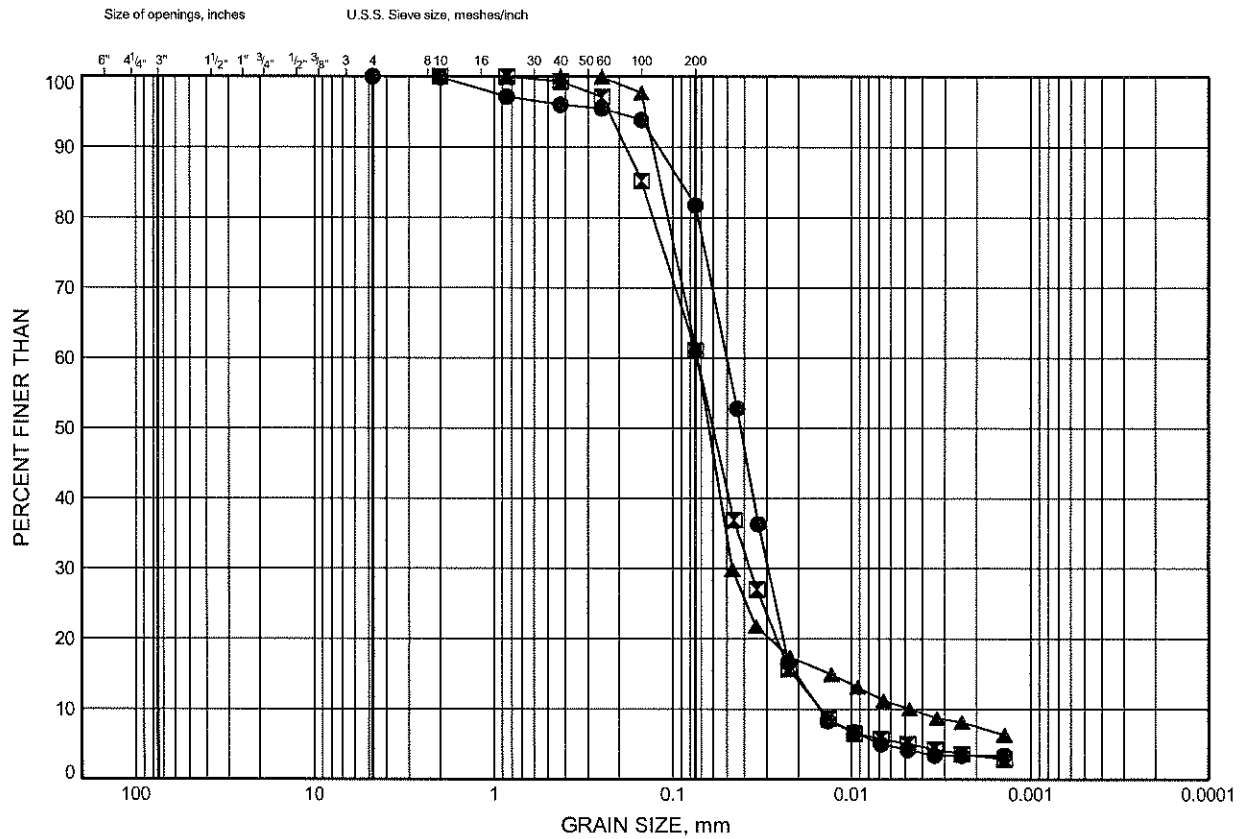


Prep'd MFA
Chkd. MRA

Beatty Creek Bridge Replacement GRAIN SIZE DISTRIBUTION

FIGURE 07-B10

LOWER SILT AND SAND



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-B03	39.93	159.17
⊠	07-B04	39.93	159.07
▲	07-B05	35.51	163.49

Date November 2007
Project 5200-03-00

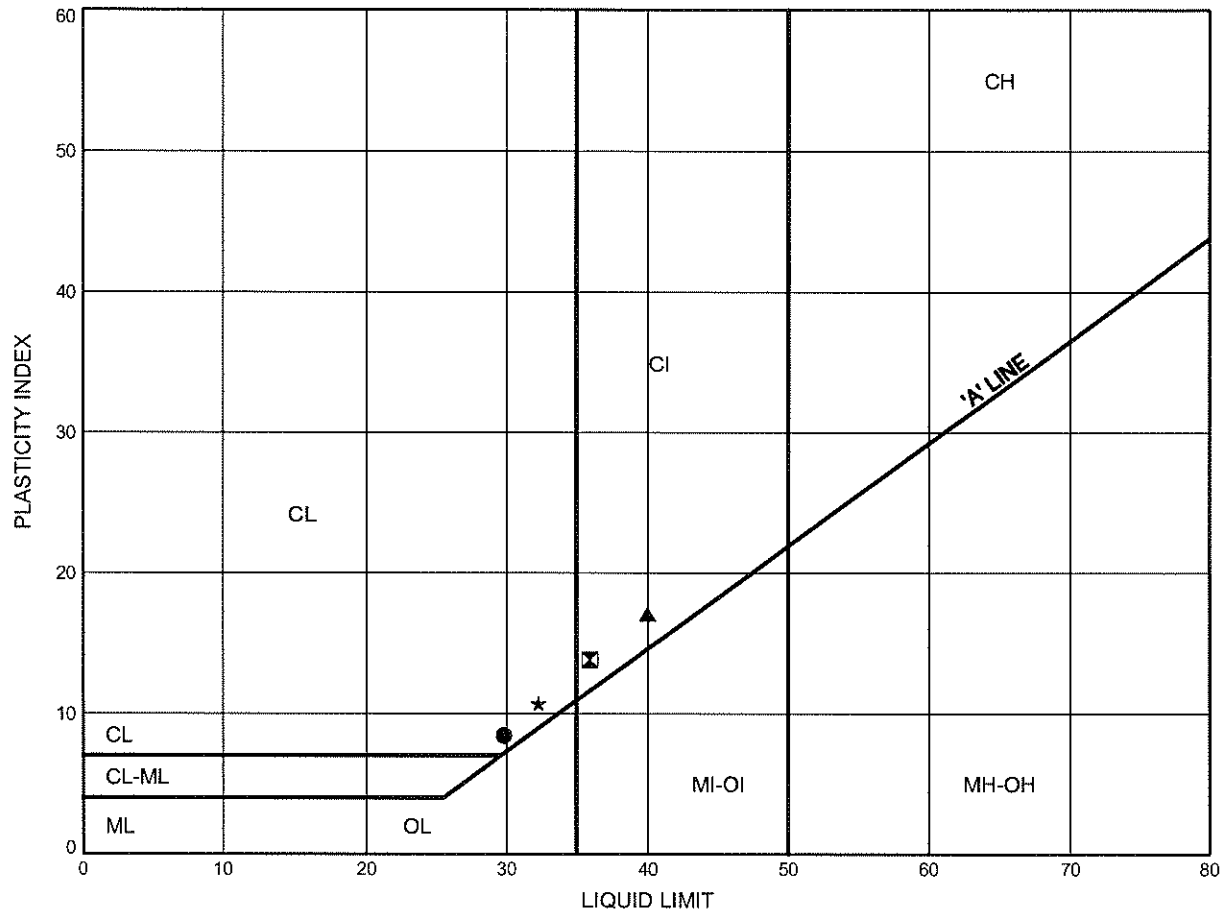


Prep'd MFA
Chkd. MRA

Beatty Creek Bridge Replacement
ATTERBERG LIMITS TEST RESULTS

FIGURE 07-B11

UPPER SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-B02	3.39	193.61
⊠	07-B03	4.88	194.22
▲	07-B05	2.59	196.41
★	07-B06	4.88	194.22

Date November 2007
 Project 5200-03-00

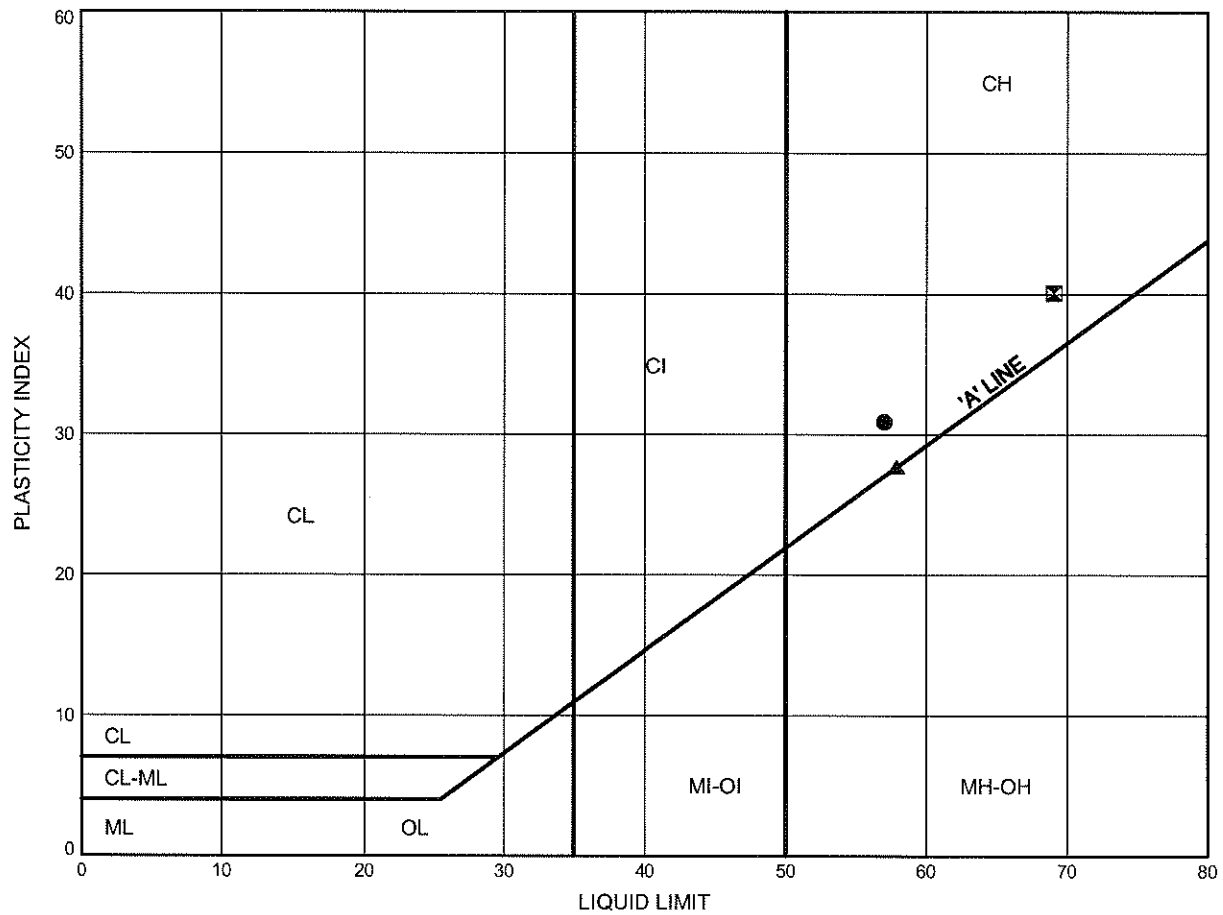


Prep'd MFA
 Chkd. MRA

Beatty Creek Bridge Replacement
ATTERBERG LIMITS TEST RESULTS

FIGURE 07-B12

UPPER SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-B07	7.92	190.28
⊠	07-B08	6.40	191.80
▲	07-B09	9.45	190.85

Date November 2007
 Project 5200-03-00

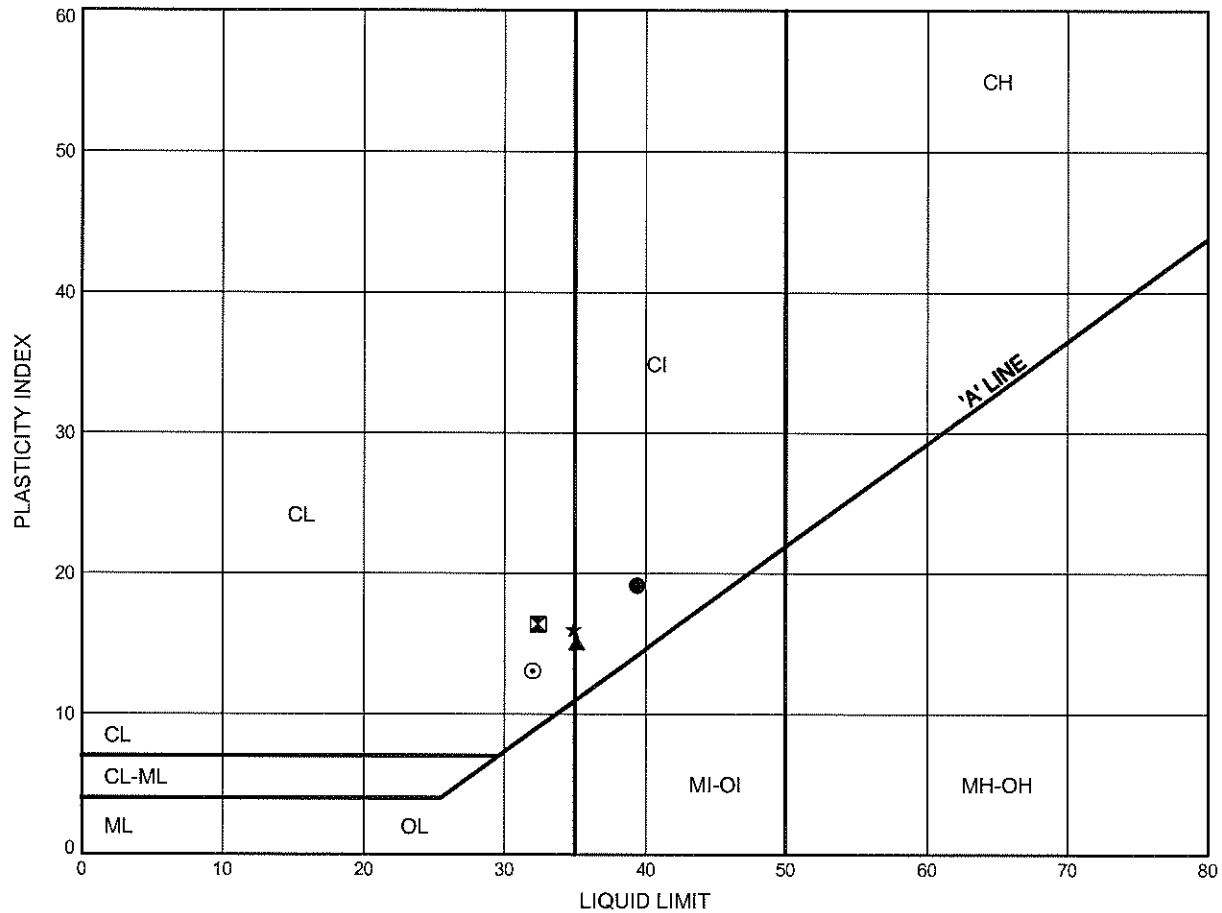


Prep'd MFA
 Chkd. MRA

Beatty Creek Bridge Replacement
ATTERBERG LIMITS TEST RESULTS

FIGURE 07-B13

LOWER SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-B03	21.64	177.46
⊠	07-B03	33.83	165.27
▲	07-B04	30.78	168.22
★	07-B05	24.69	174.31
⊙	07-B05	27.74	171.26

Date November 2007
 Project 5200-03-00

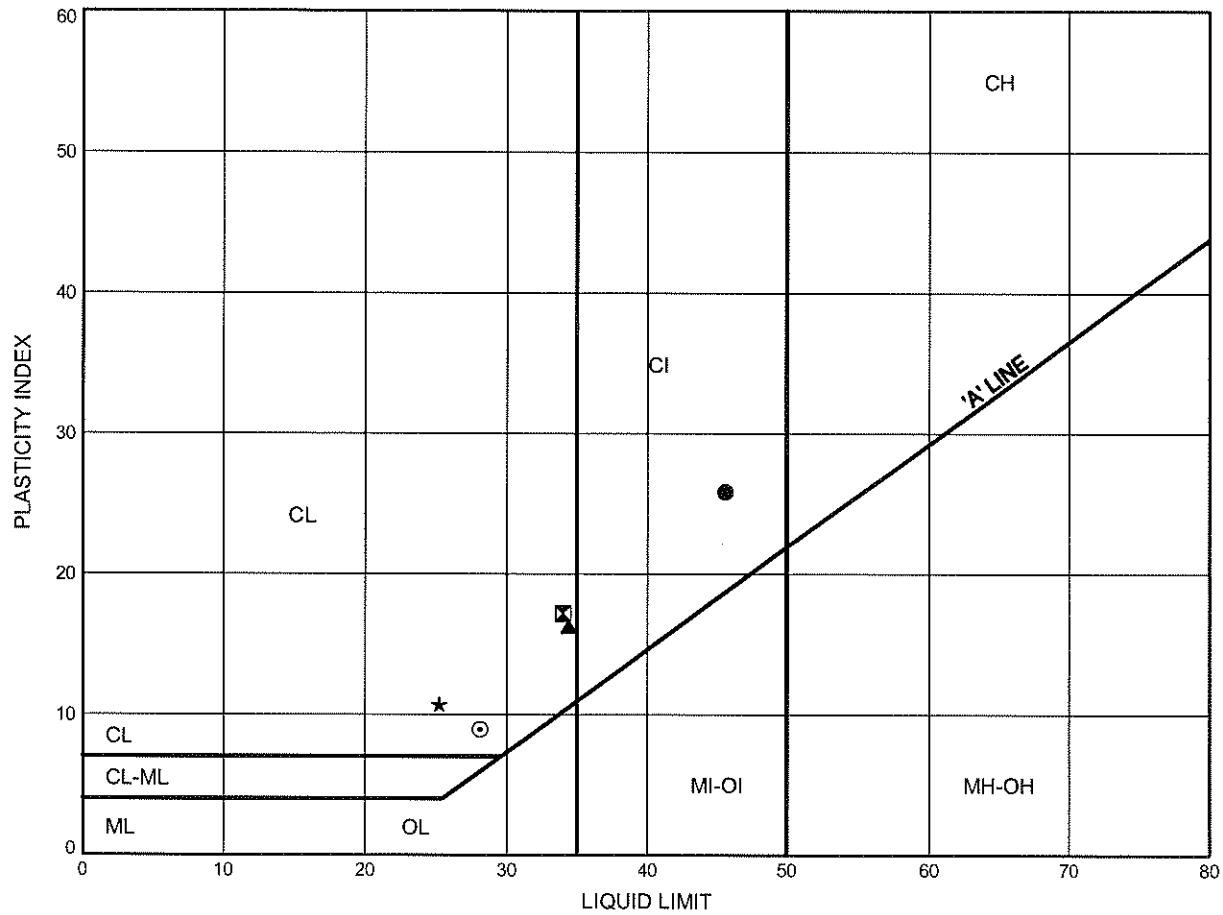


Prep'd MFA
 Chkd. MRA

Beatty Creek Bridge Replacement
ATTERBERG LIMITS TEST RESULTS

FIGURE 07-B14

LOWER SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-B06	24.69	174.41
⊠	07-B06	36.88	162.22
▲	07-B07	27.74	170.46
★	07-B08	33.83	164.37
⊙	07-B09	27.74	172.56

Date November 2007
 Project 5200-03-00



Prep'd MFA
 Chkd. MRA

Consolidation Test Report

CLIENT: **McCormick Rankin Corporation**

FILE NUMBER: 18-45-1 / 19-1351-98

PROJECT: Mindemoya and Beatty Creek

REPORT DATE: 15-Nov-07

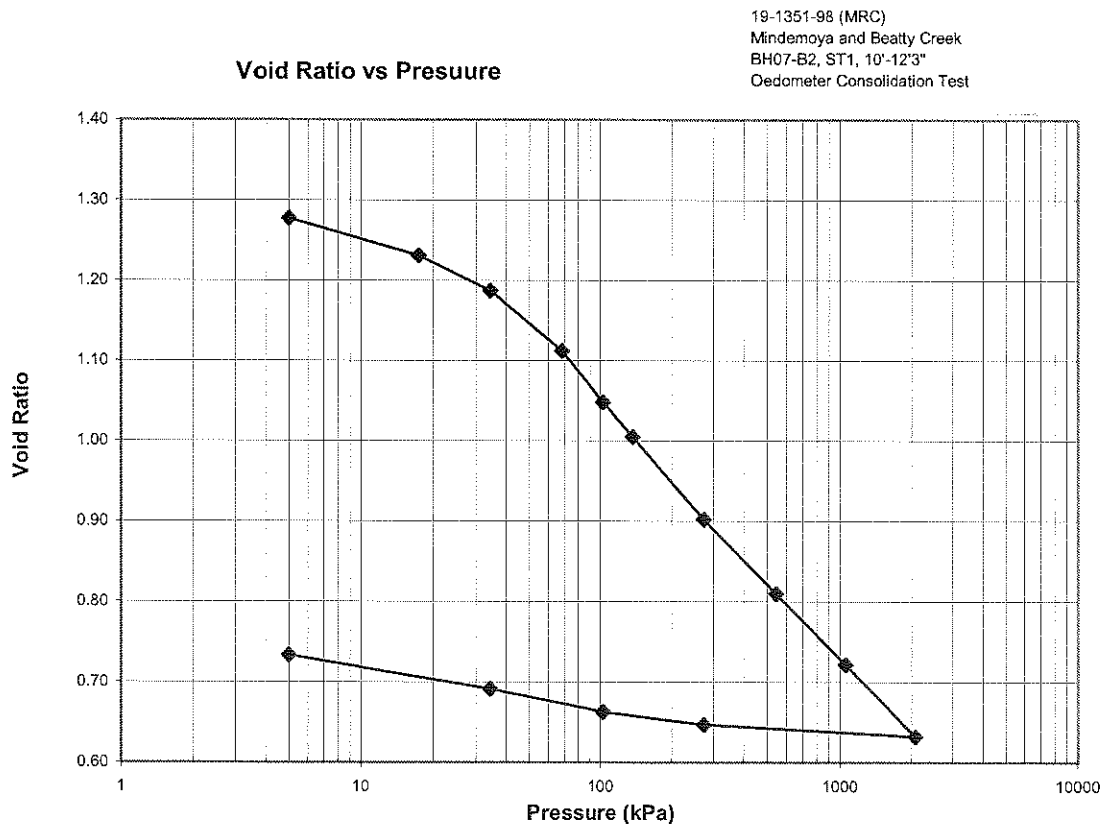
TEST DATES: September 5, 2007 - September 18, 2007

SAMPLE: BH07-B2, ST1, 10'-12'3"
 Silty Clay, grey, low plastic, (CL-ML), Lab Vane: 10 - 17 kPa (Soft)
 Grain Size: 32 % Clay & 68 % Silt

PROCEDURE: Tested in accordance with Standard Test Method for One-Dimensional Consolidation
 Properties of Soils, ASTM D 2435-04, method B

	<u>Start of Test</u>	<u>End of Test</u>
Wet Dens. (kg/m ³)	1754.3	2041.0
Dry Dens. (kg/m ³)	1192.0	1572.0
Moisture Cont. (%)	47.2	29.9
Void Ratio	1.307	0.749
Saturation (%)	99.2	

Note: A Specific Gravity of 2.75 was assumed for the void ratio and saturation calculations



TEST DONE BY: WM/EA
 REVIEWED BY: JPL

Consolidation Test Report

Mindemoya and Beatty Creek
18-45-1 / 19-1351-98

BH07-B2, ST1, 10'-12'3"

TRIMMING: The Specimen was manually trimmed to the size of consolidation ring, then mounted in a fixed ring consolidometer

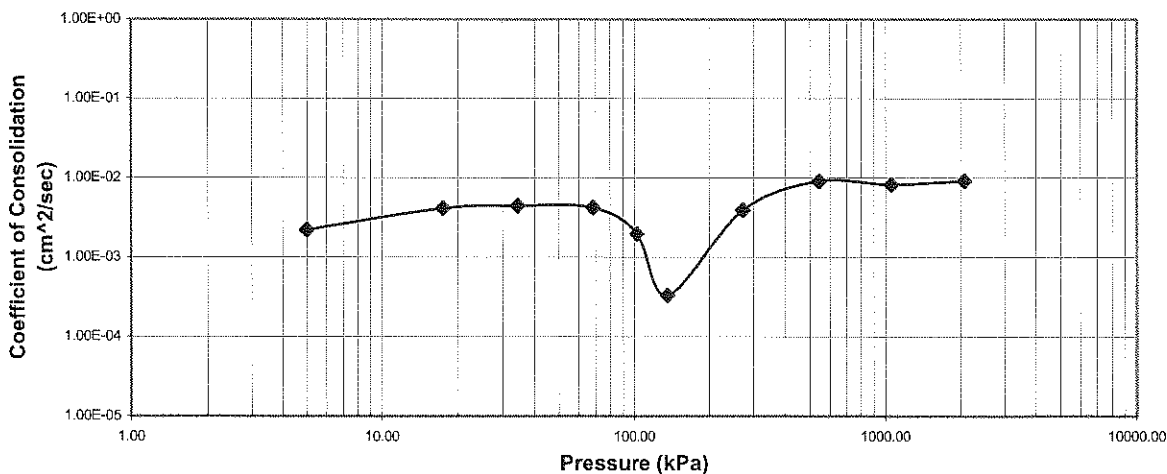
LOADING: A seating load of 5 kPa was applied and the consolidometer was flooded with distilled water. Sample was monitored to ensure no swelling effect occurred before the start of the test. Subsequent loads were applied and the duration of each load step was 24 hrs.

CALCULATIONS: Coefficients of Consolidation were calculated by the square root time method.

Pressure (kPa)	Corr. Hgt (mm)	Avg. Hgt. (mm)	T90 (min)	Cv (cm ² /sec)	Void Ratio	mv (m ² /kN)	k (cm/s)
0.00	19.850	19.850			1.307		
5.00	19.596	19.723	6.25	2.20E-03	1.278	1.61E-03	3.47E-07
17.50	19.197	19.396	3.24	4.10E-03	1.231	1.13E-03	4.52E-07
34.46	18.818	19.007	2.89	4.42E-03	1.187	9.59E-04	4.15E-07
68.42	18.171	18.494	2.89	4.18E-03	1.112	8.07E-04	3.31E-07
102.82	17.620	17.896	5.76	1.96E-03	1.048	5.51E-04	1.06E-07
136.78	17.249	17.434	32.49	3.31E-04	1.005	3.26E-04	1.06E-08
273.12	16.366	16.807	2.56	3.90E-03	0.902	1.47E-04	5.64E-08
545.39	15.569	15.968	1.00	9.01E-03	0.809	7.45E-05	6.57E-08
1057.63	14.812	15.191	1.00	8.15E-03	0.721	3.79E-05	3.03E-08
2080.12	14.043	14.428	0.81	9.08E-03	0.632	3.57E-06	3.18E-09
273.12	14.171	14.492			0.647		
102.82	14.308	14.240			0.663		
34.46	14.554	14.431			0.691		
5.00	14.916	14.735			0.734		

Coefficient of Consolidation vs Pressure

19-1351-98 (MRC)
Mindemoya and Beatty Creek
BH07-B2, ST1, 10'-12'3"
Oedometer Consolidation Test



Notes: C_v and k calculated using t_{90} values

TEST DONE BY: WM/EA
REVIEWED BY: JPL

Consolidation Test Report

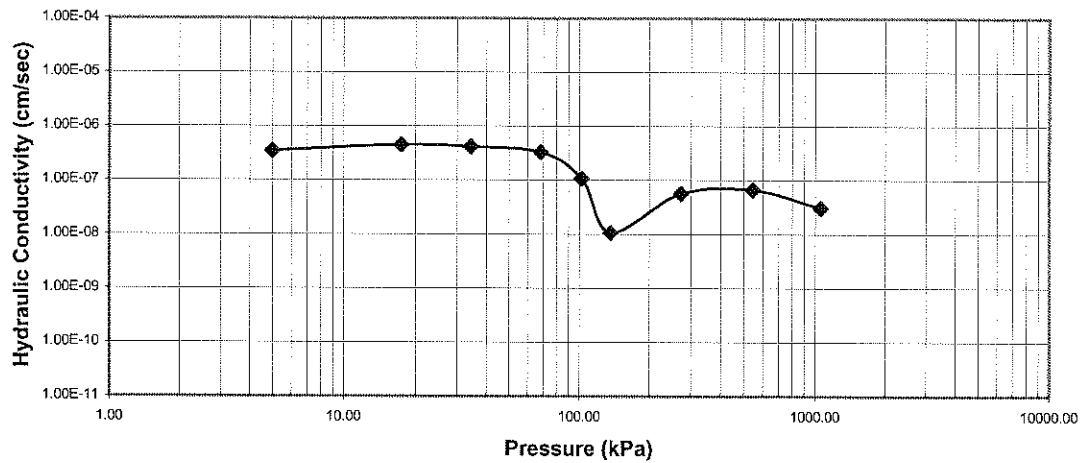
Mindemoya and Beatty Creek

18-45-1 / 19-1351-98

BH07-B2, ST1, 10'-12'3"

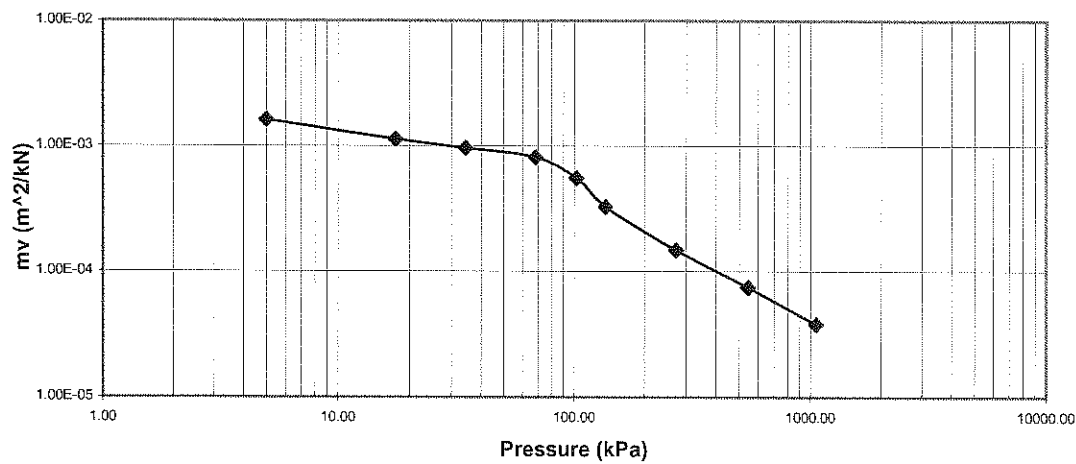
Hydraulic Conductivity vs Pressure

19-1351-98 (MRC)
Mindemoya and Beatty Creek
BH07-B2, ST1, 10'-12'3"
Oedometer Consolidation Test



mv vs Pressure

19-1351-98 (MRC)
Mindemoya and Beatty Creek
BH07-B2, ST1, 10'-12'3"
Oedometer Consolidation Test



TEST DONE BY: WM/EA

REVIEWED BY: JPL

Consolidation Test Report

CLIENT: **McCormick Rankin Corporation**

FILE NUMBER: 18-45-1 / 19-1351-98

PROJECT: Mindemoya and Beatty Creek

REPORT DATE: 9-Oct-07

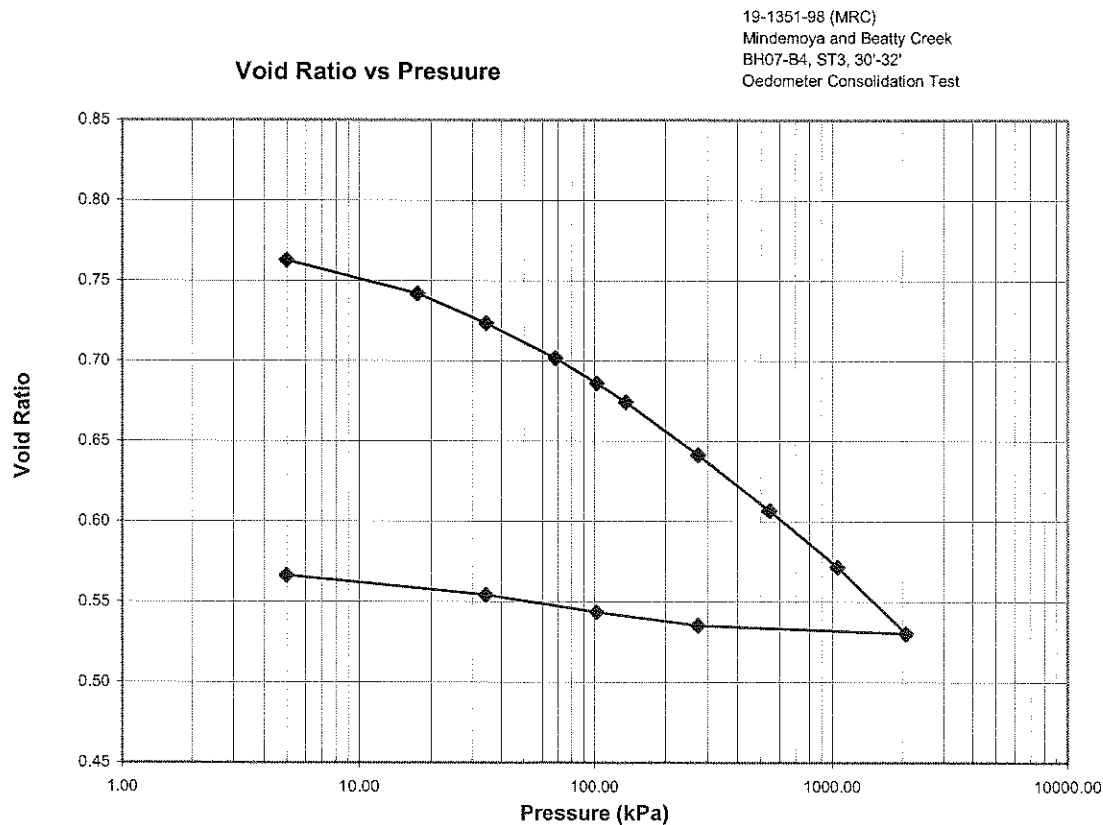
TEST DATES: August 21, 2007 - September 3, 2007

SAMPLE: BH07-B4, ST3, 30'-32'
 Silty Clay, dark grey, low plastic, (CL-ML), Lab Vane: 15 kPa (Soft)
 Grain Size: 20 % Clay & 80 % Silt

PROCEDURE: Tested in accordance with Standard Test Method for One-Dimensional Consolidation Properties of Soils, ASTM D 2435-04, method B

	<u>Start of Test</u>	<u>End of Test</u>
Wet Dens. (kg/m ³)	1964.0	2135.2
Dry Dens. (kg/m ³)	1536.0	1742.0
Moisture Cont. (%)	27.9	22.6
Void Ratio	0.790	0.579
Saturation (%)	97.0	

Note: A Specific Gravity of 2.75 was assumed for the void ratio and saturation calculations



TEST DONE BY: WM/EA
 REVIEWED BY: JPL

Consolidation Test Report

Mindemoya and Beatty Creek
18-45-1 / 19-1351-98

BH07-B4, ST3, 30'-32'

TRIMMING: The Specimen was manually trimmed to the size of consolidation ring, then mounted in a fixed ring consolidometer

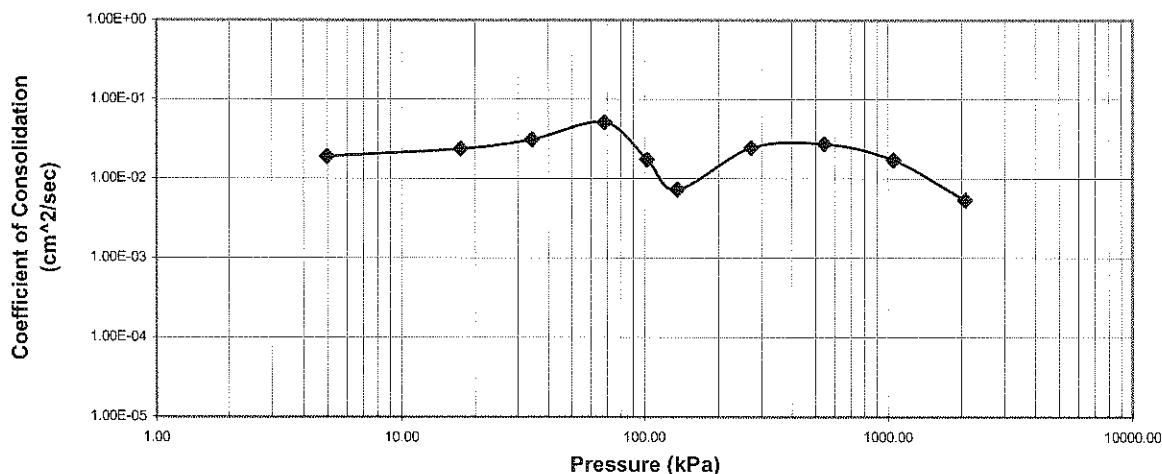
LOADING: A seating load of 5 kPa was applied and the consolidometer was flooded with distilled water. Sample was monitored to ensure no swelling effect occurred before the start of the test. Subsequent loads were applied and the duration of each load step was 24 hrs.

CALCULATIONS: Coefficients of Consolidation were calculated by the square root time method.

Pressure (kPa)	Corr. Hgt (mm)	Avg. Hgt. (mm)	T90 (min)	Cv (cm ² /sec)	Void Ratio	mv (m ² /kN)	k (cm/s)
0.00	19.850	19.850			0.790		
5.00	19.542	19.696	0.72	1.90E-02	0.763	9.25E-04	1.72E-06
17.50	19.313	19.427	0.56	2.37E-02	0.742	6.12E-04	1.42E-06
34.46	19.107	19.210	0.42	3.09E-02	0.723	3.57E-04	1.08E-06
68.42	18.866	18.986	0.25	5.09E-02	0.702	2.56E-04	1.28E-06
102.82	18.691	18.779	0.72	1.72E-02	0.686	1.91E-04	3.22E-07
136.78	18.563	18.627	1.69	7.25E-03	0.674	1.35E-04	9.58E-08
273.12	18.198	18.380	0.49	2.44E-02	0.641	7.14E-05	1.71E-07
545.39	17.812	18.005	0.42	2.71E-02	0.607	3.84E-05	1.02E-07
1057.63	17.422	17.617	0.64	1.71E-02	0.571	2.25E-05	3.77E-08
2080.12	16.966	17.194	1.96	5.33E-03	0.530	1.53E-06	8.01E-10
273.12	17.021	16.994			0.535		
102.82	17.113	17.067			0.543		
34.46	17.232	17.173			0.554		
5.00	17.366	17.299			0.566		

Coefficient of Consolidation vs Pressure

19-1351-98 (MRC)
Mindemoya and Beatty Creek
BH07-B4, ST3, 30'-32'
Oedometer Consolidation Test



Notes: Cv and k calculated using t_{90} values

TEST DONE BY: WM/EA
REVIEWED BY: JPL

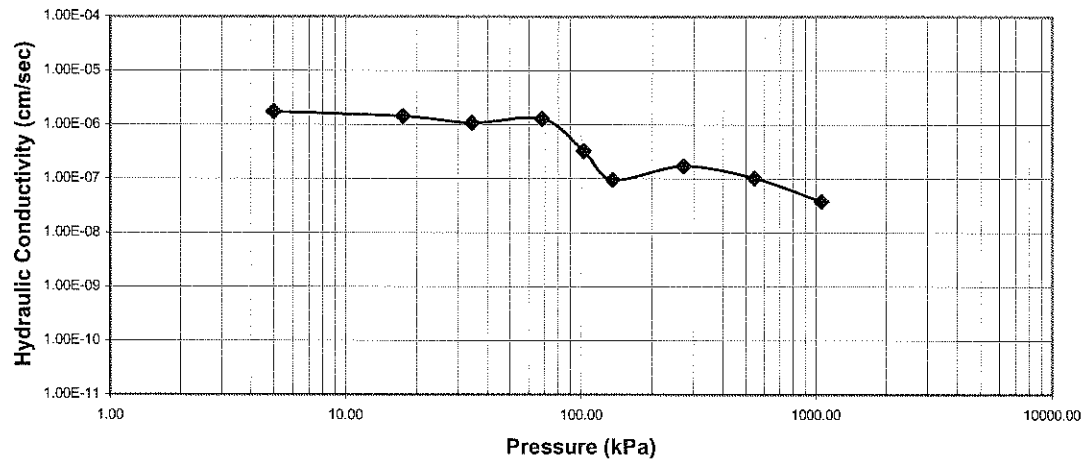
Consolidation Test Report

Mindemoya and Beatty Creek
18-45-1 / 19-1351-98

BH07-B4, ST3, 30'-32'

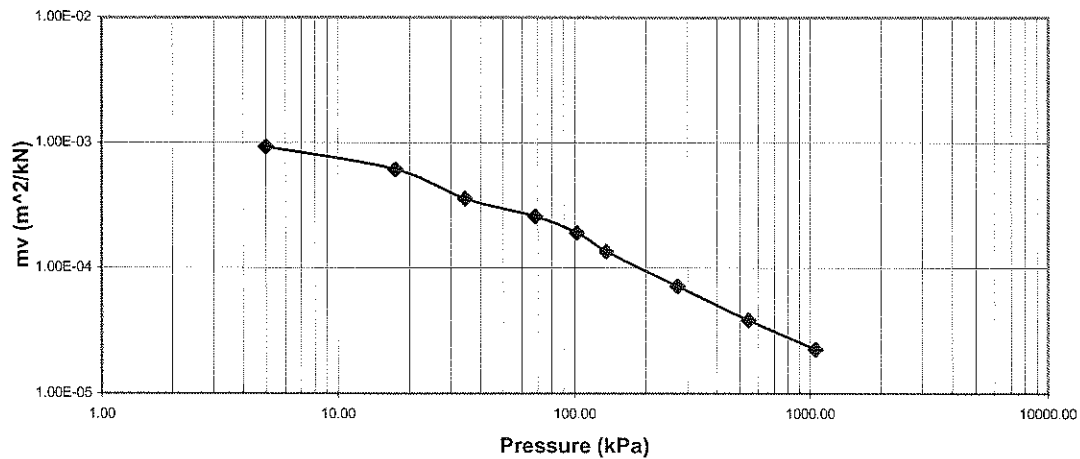
Hydraulic Conductivity vs Pressure

19-1351-98 (MRC)
Mindemoya and Beatty Creek
BH07-B4, ST3, 30'-32'
Oedometer Consolidation Test



mv vs Pressure

19-1351-98 (MRC)
Mindemoya and Beatty Creek
BH07-B4, ST3, 30'-32'
Oedometer Consolidation Test



TEST DONE BY: WM/EA
REVIEWED BY: JPL

Consolidation Test Report

CLIENT: **McCormick Rankin Corporation**

FILE NUMBER: 18-45-1 /19-1351-98

PROJECT: Mindemoya and Beatty Creek

REPORT DATE: 5-Oct-07

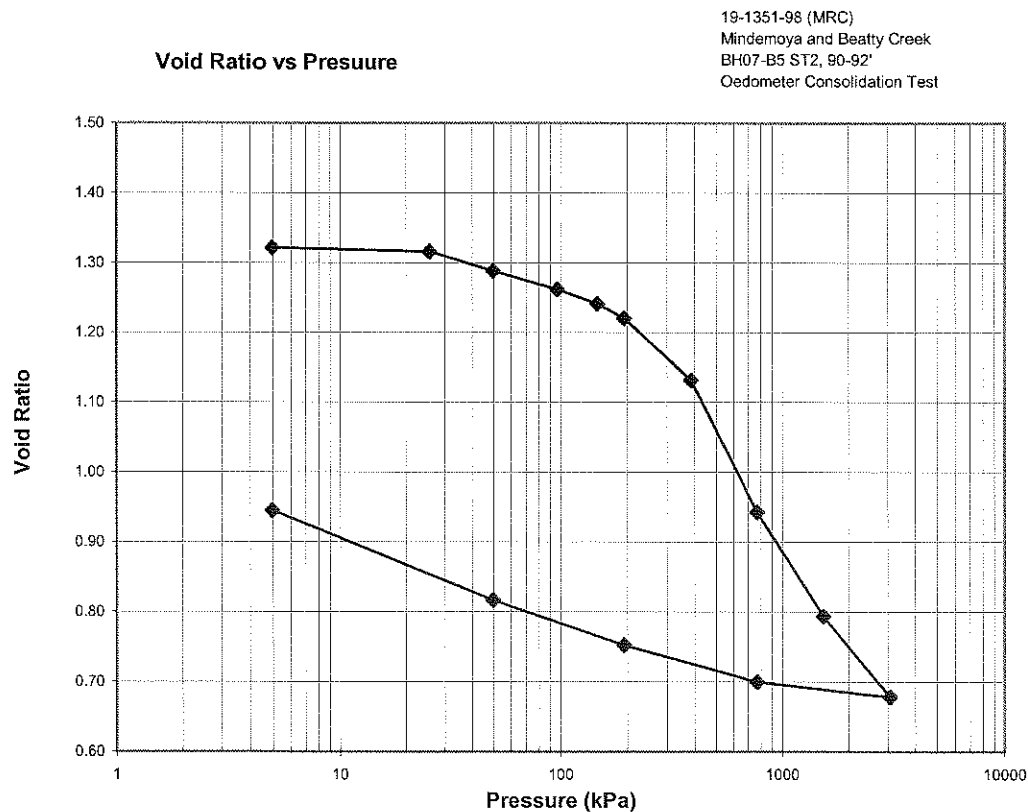
TEST DATES: September 17, 2007 - September 30, 2007

SAMPLE: BH07-B5 ST2, 90'-92'
 Silty Clay, grey, plastic, (CL), Lab Vane: 16 - 27 kPa (soft to firm)
 Grain Size: 30 % Clay & 70 % Silt

PROCEDURE: Tested in accordance with Standard Test Method for One-Dimensional Consolidation Properties of Soils, ASTM D 2435-04, method B

	<u>Start of Test</u>	<u>End of Test</u>
Wet Dens. (kg/m ³)	1749.5	1910.6
Dry Dens. (kg/m ³)	1193.8	1409.1
Moisture Cont. (%)	46.5	35.6
Void Ratio	1.304	0.952
Saturation (%)	98.2	

Note: A Specific Gravity of 2.75 was assumed for the void ratio and saturation calculations



TEST DONE BY: EA
 REVIEWED BY: JPL

Consolidation Test Report

Mindemoya and Beatty Creek
18-45-1 /19-1351-98

BH07-B5 ST2, 90'-92'

TRIMMING: The Specimen was manually trimmed to the size of consolidation ring, then mounted in a fixed ring consolidometer

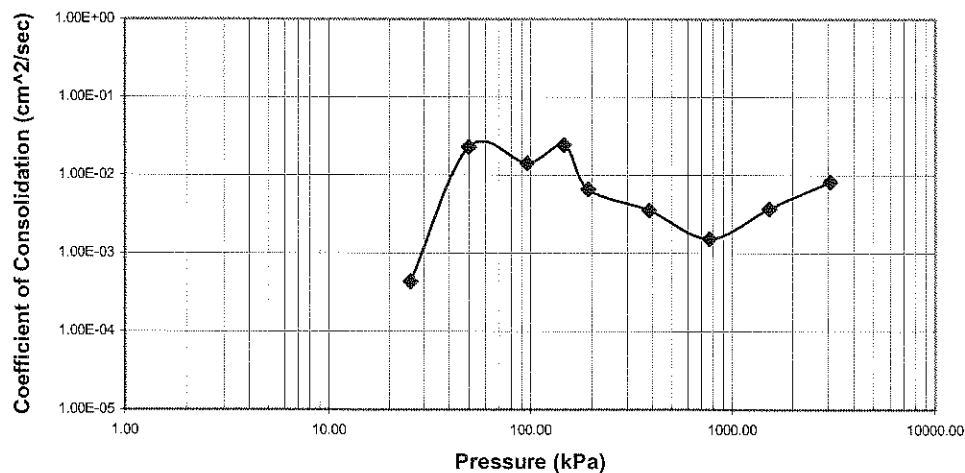
LOADING: A seating load of 4.97 kPa was applied and the consolidometer was flooded with distilled water. Sample was monitored to ensure no swelling effect occurred before the start of the test. Subsequent loads were applied and the duration of each load step was 24 hours.

CALCULATIONS: Coefficients of Consolidation were calculated by the square root time method.

Pressure (kPa)	Corr. Hgt (mm)	Avg. Hgt. (mm)	T90 (min)	Cv (cm ² /sec)	Void Ratio	mv (m ² /kN)	k (cm/s)
0.00	25.350	25.350			1.304		
4.97	25.550	25.450			1.321	1.09E-04	
25.67	25.492	25.521	53.30	4.32E-04	1.316	5.02E-04	2.12E-08
49.86	25.180	25.336	1.00	2.27E-02	1.288	2.46E-04	5.46E-07
96.65	24.884	25.032	1.56	1.42E-02	1.262	1.80E-04	2.50E-07
146.46	24.653	24.768	0.90	2.41E-02	1.241	1.88E-04	4.45E-07
193.24	24.426	24.540	3.24	6.57E-03	1.221	2.02E-04	1.30E-07
385.77	23.426	23.926	5.76	3.51E-03	1.131	2.13E-04	7.35E-08
770.72	21.310	22.368	11.56	1.53E-03	0.942	8.37E-05	1.25E-08
1540.91	19.650	20.480	4.00	3.70E-03	0.794	3.26E-05	1.18E-08
3081.80	18.356	19.003	1.56	8.18E-03	0.678	4.07E-06	3.26E-09
770.72	18.598	18.477			0.700		
193.24	19.184	18.891			0.752		
49.86	19.905	19.544			0.816		
4.97	21.338	20.622			0.945		

Coefficient of Consolidation vs Pressure

19-1351-98 (MRC)
Mindemoya and Beatty Creek
BH07-B5 ST2, 90'-92'
Oedometer Consolidation Test



Notes: Cv and k calculated using t_{90} values

TEST DONE BY: EA
REVIEWED BY: JPL

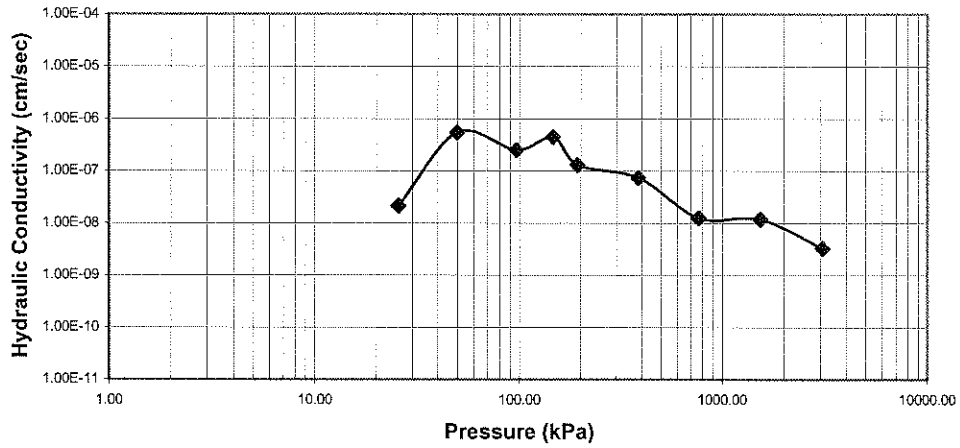
Consolidation Test Report

Mindemoya and Beatty Creek
18-45-1 /19-1351-98

BH07-B5 ST2, 90'-92'

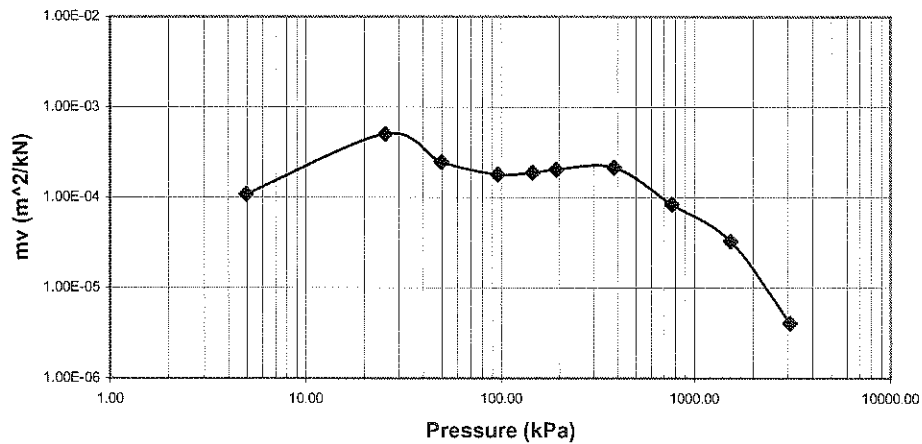
Hydraulic Conductivity vs Pressure

19-1351-98 (MRC)
Mindemoya and Beatty Creek
BH07-B5 ST2, 90'-92'
Oedometer Consolidation Test



mv vs Pressure

19-1351-98 (MRC)
Mindemoya and Beatty Creek
BH07-B5 ST2, 90'-92'
Oedometer Consolidation Test



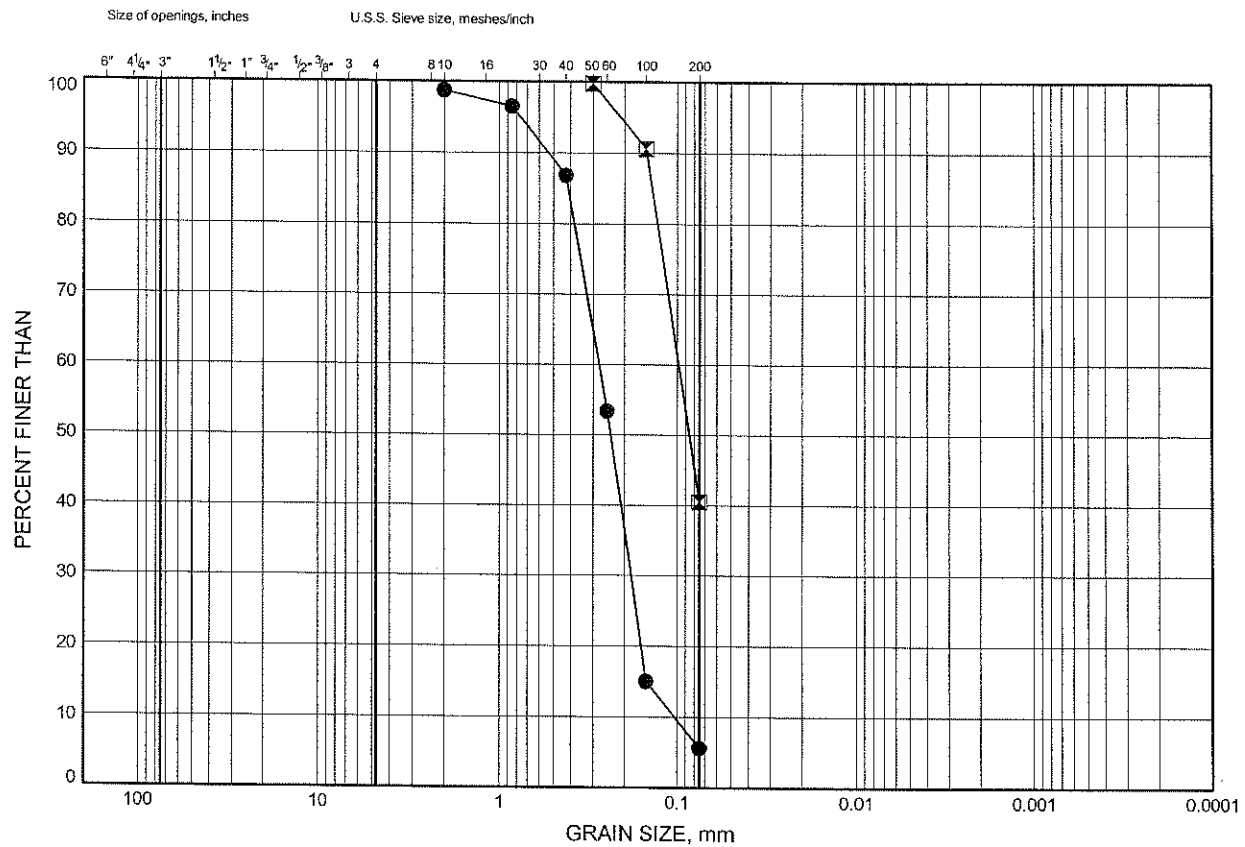
TEST DONE BY: EA
REVIEWED BY: JPL

**Laboratory Test Results
from Preliminary Investigation**

Beatty Creek Bridge Replacement GRAIN SIZE DISTRIBUTION

FIGURE B1

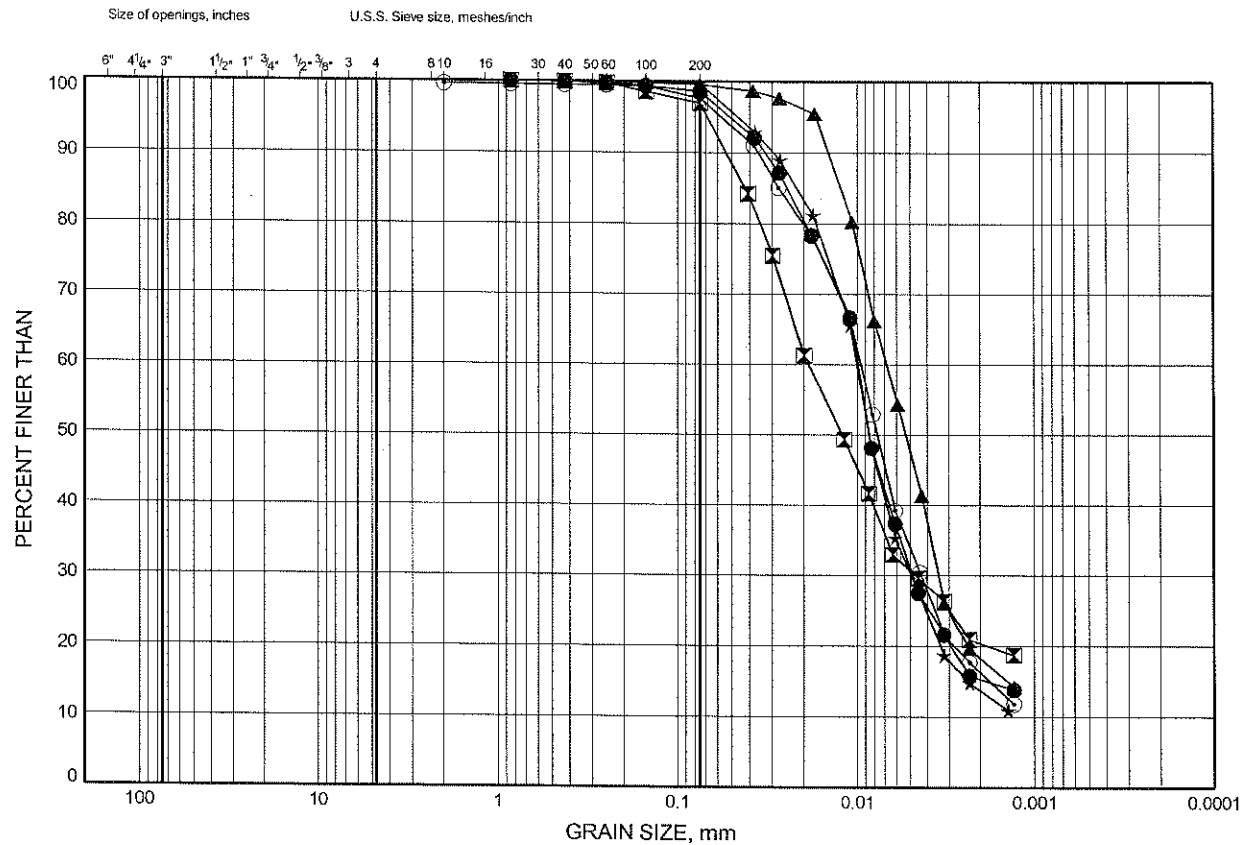
Surficial Sand to Silty Sand



Beatty Creek Bridge Replacement GRAIN SIZE DISTRIBUTION

FIGURE B2

Upper Clayey Silt

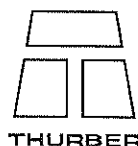


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-B01	1.83	195.27
⊠	06-B03	10.67	188.33
▲	06-B07	2.59	195.31
★	06-B09	2.59	195.51
⊙	06-B10	4.88	194.62

Date December 2006

Project 5200-03-00



THURBER

Prep'd JHL

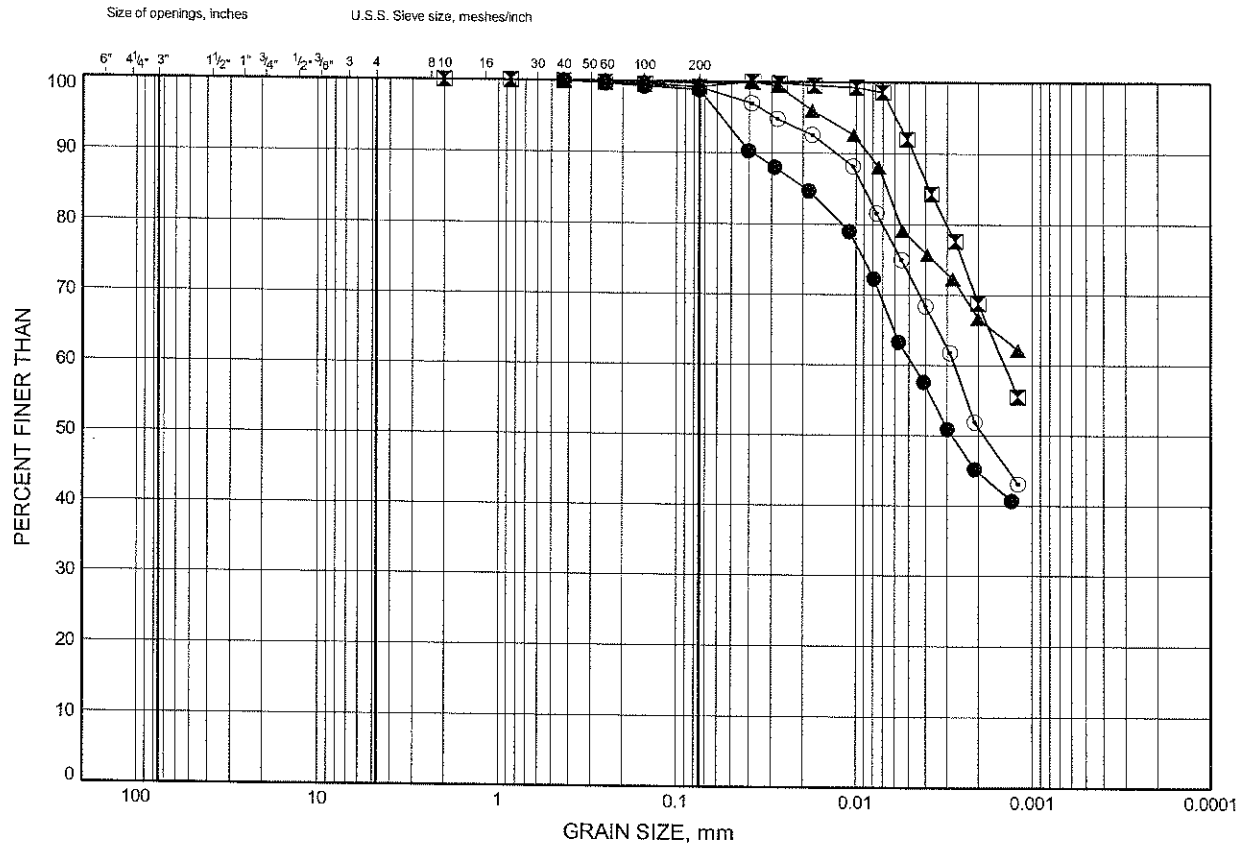
Chkd. MRA

Beatty Creek Bridge Replacement

GRAIN SIZE DISTRIBUTION

FIGURE B3

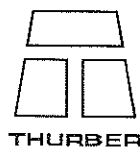
Upper Silty Clay



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-B01	4.88	192.22
⊠	06-B02	12.50	184.90
▲	06-B04	6.40	192.60
★	06-B04	7.62	191.38
⊙	06-B04	13.72	185.28

Date December 2006
Project 5200-03-00



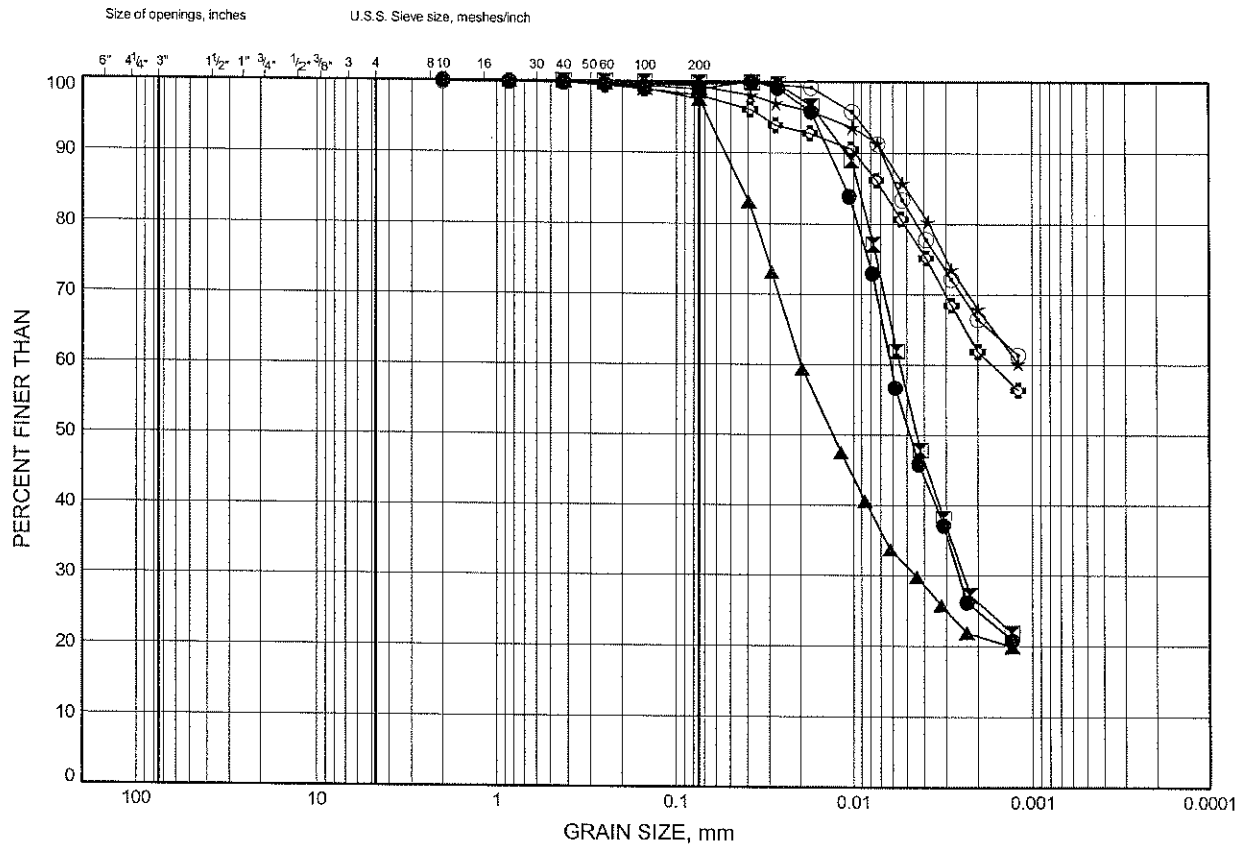
Prep'd JHL
Chkd. MRA

Beatty Creek Bridge Replacement

GRAIN SIZE DISTRIBUTION

FIGURE B4

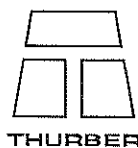
Upper Silty Clay



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-B06	3.35	193.65
⊠	06-B06	4.88	192.12
▲	06-B06	7.92	189.08
★	06-B07	7.92	189.98
⊙	06-B08	6.40	191.60
⊛	06-B08	15.54	182.46

Date December 2006
Project 5200-03-00

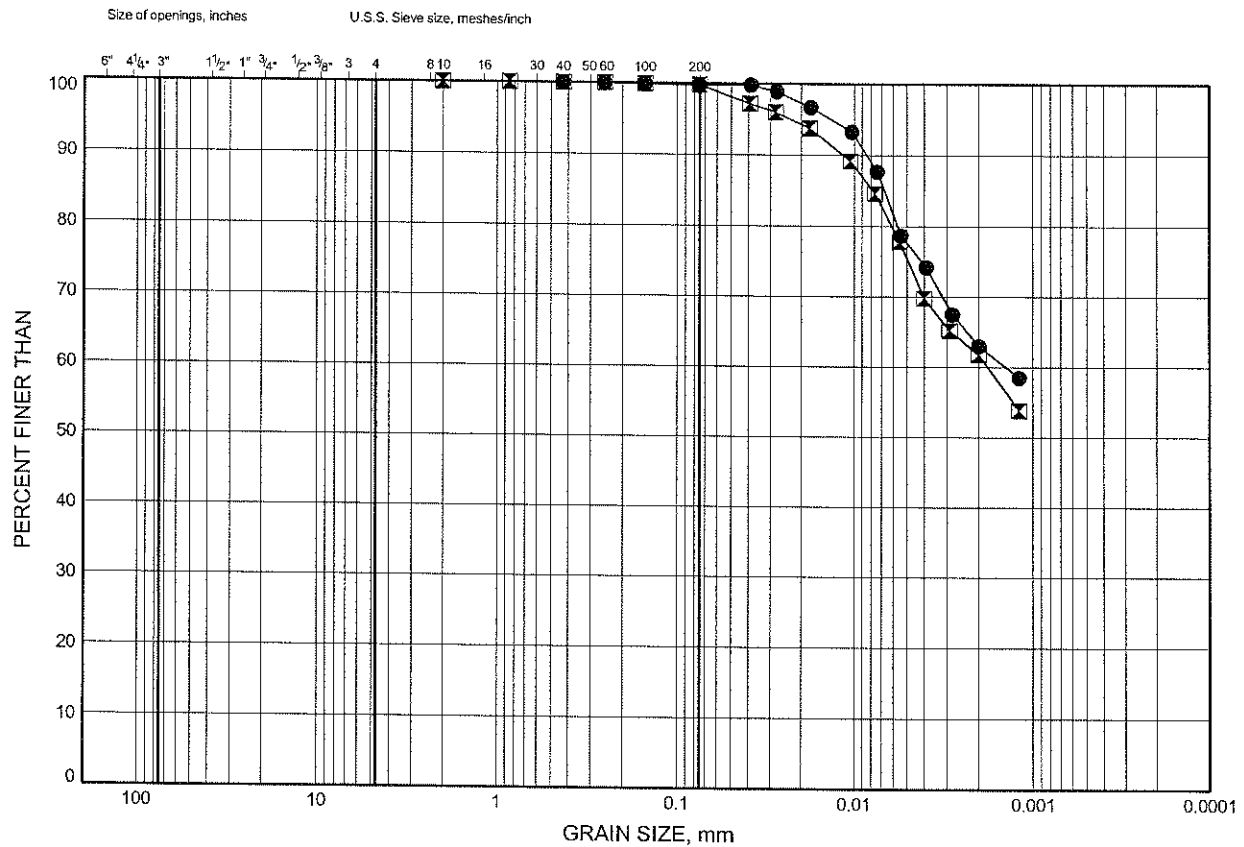


Prep'd JHL
Chkd. MRA

Beatty Creek Bridge Replacement GRAIN SIZE DISTRIBUTION

FIGURE B5

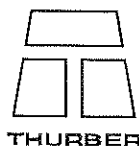
Upper Silty Clay



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-B09	6.40	191.70
⊠	06-B10	7.62	191.88

Date December 2006
Project 5200-03-00



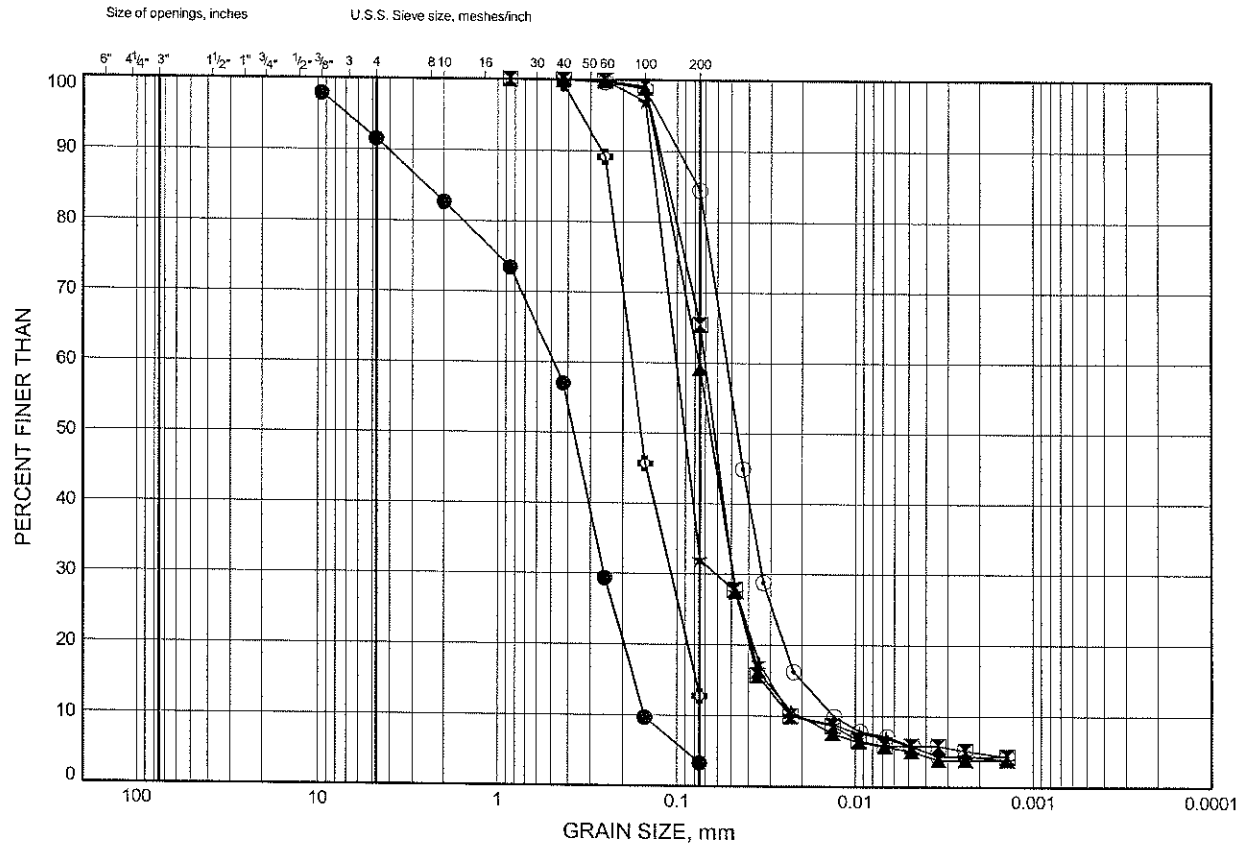
Prep'd JHL
Chkd. MRA

Beatty Creek Bridge Replacement

GRAIN SIZE DISTRIBUTION

FIGURE B6

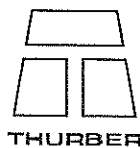
Intermediate Sand to Silt



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-B01	10.97	186.13
⊠	06-B01	15.54	181.56
▲	06-B02	15.54	181.86
★	06-B03	15.24	183.76
⊙	06-B06	14.02	182.98
⊕	06-B06	27.74	169.26

Date December 2006

Project 5200-03-00



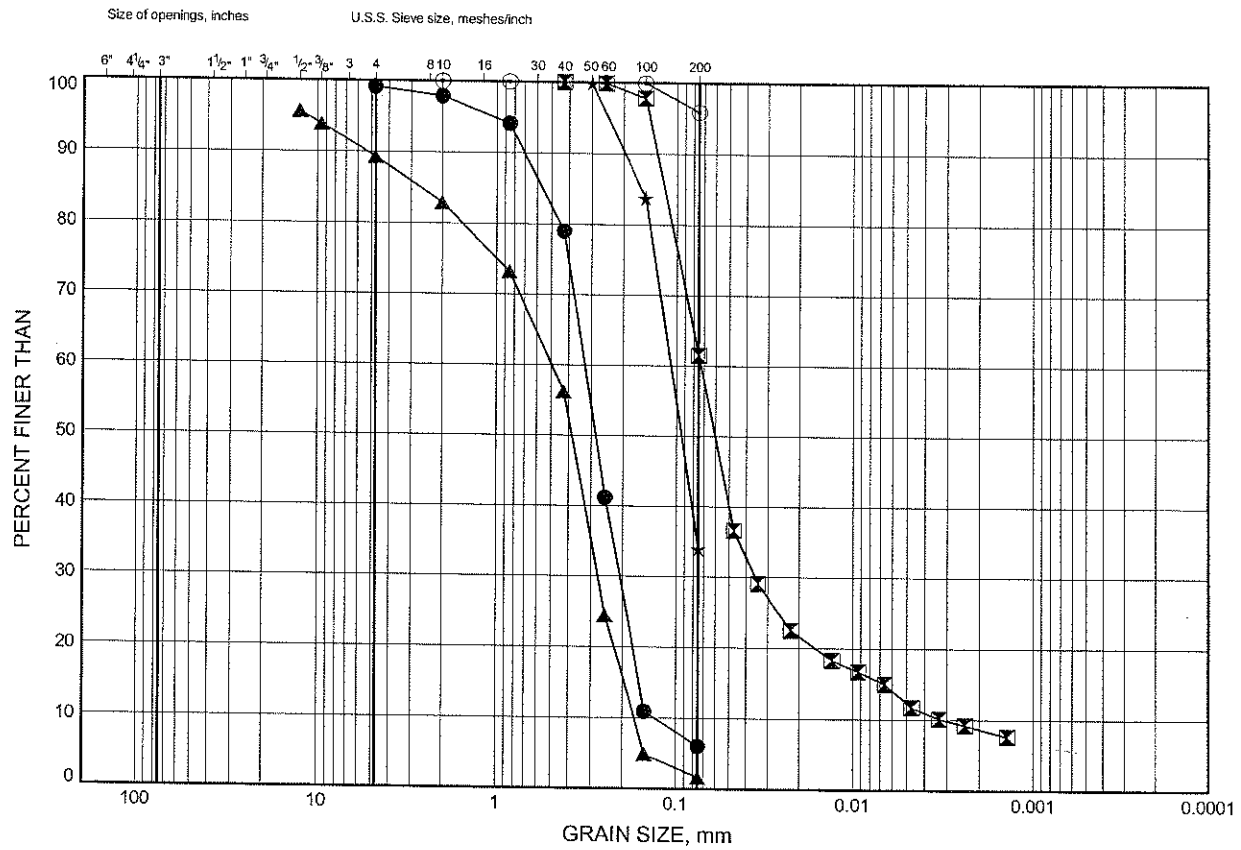
Prep'd JHL

Chkd. MRA

Beatty Creek Bridge Replacement GRAIN SIZE DISTRIBUTION

FIGURE B7

Intermediate Sand to Silt

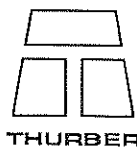


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-B08	10.97	187.03
⊠	06-B09	9.45	188.65
▲	06-B09	14.02	184.08
★	06-B10	12.19	187.31
⊙	06-B10	16.76	182.74

Date December 2006

Project 5200-03-00



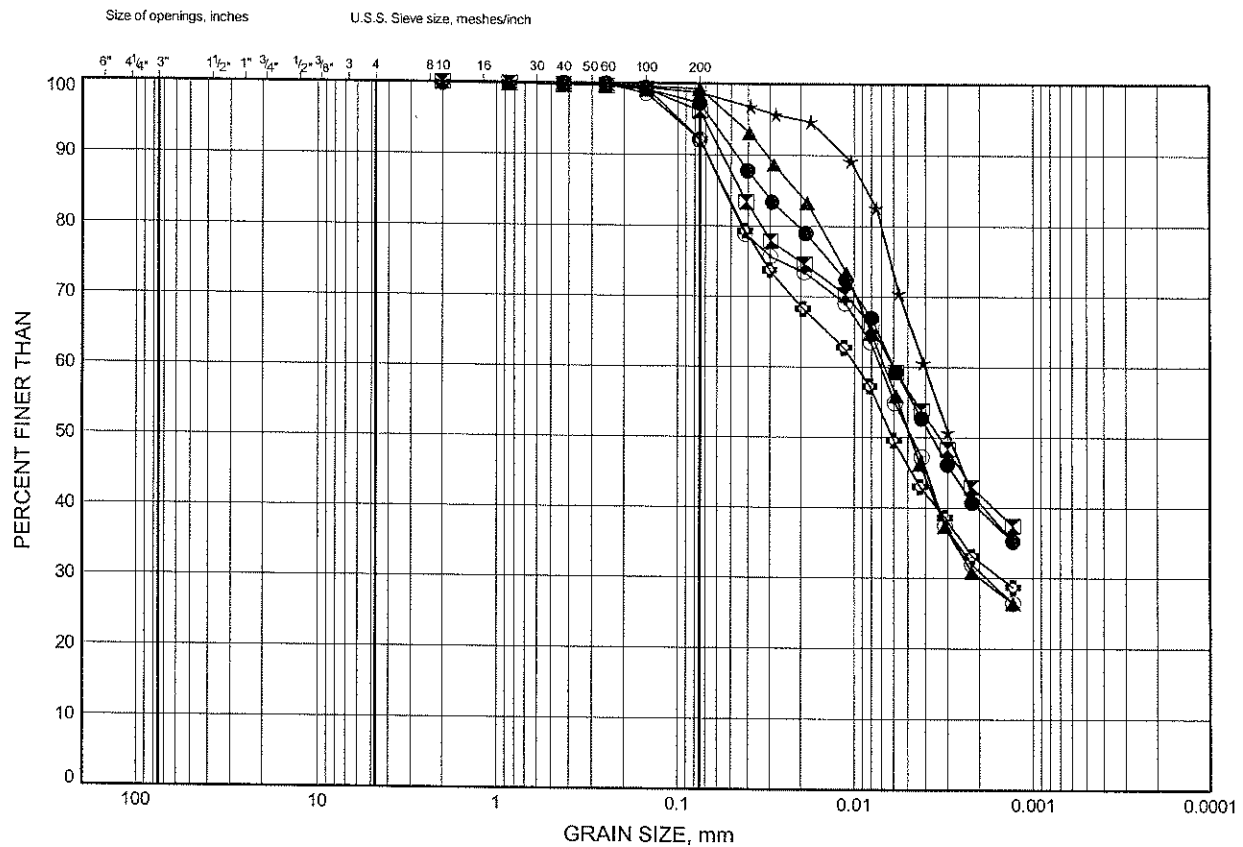
Prep'd JHL

Chkd. MRA

Beatty Creek Bridge Replacement GRAIN SIZE DISTRIBUTION

FIGURE B8

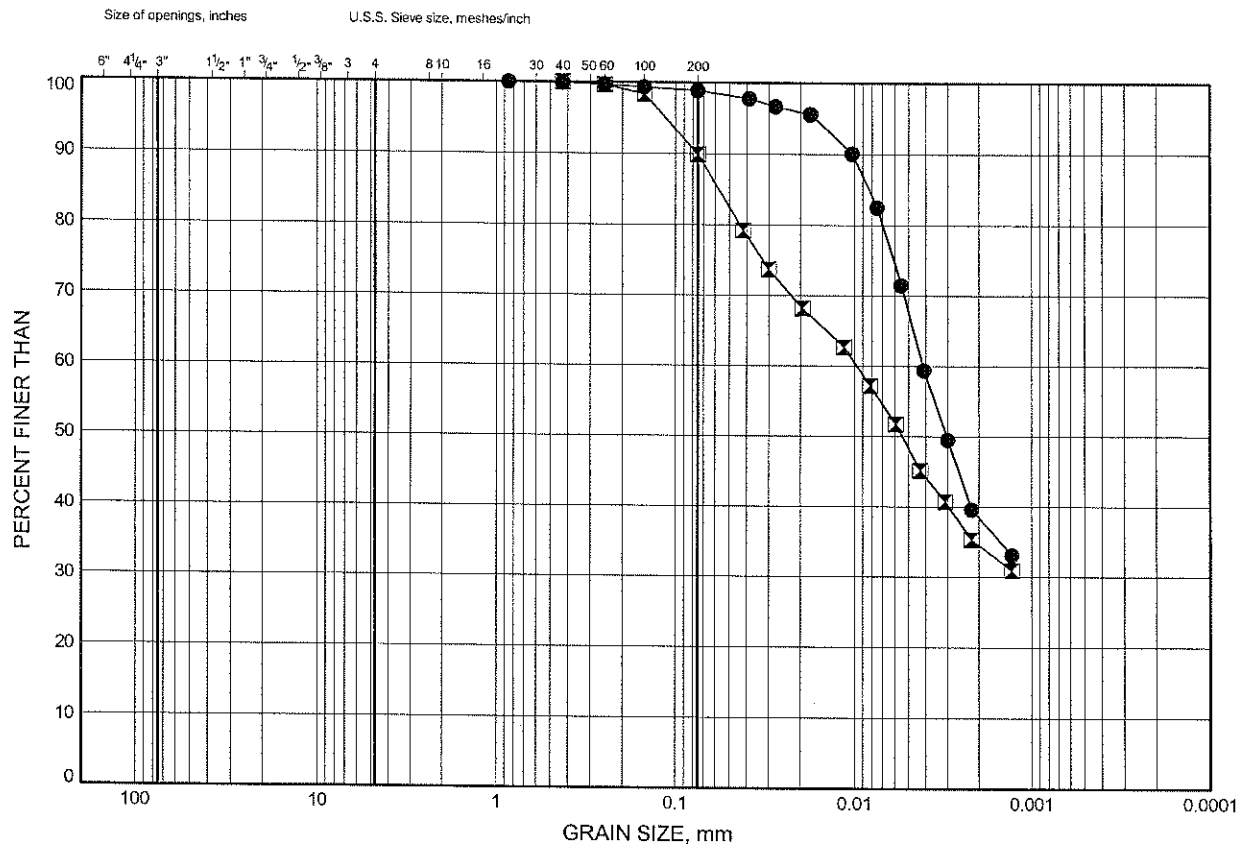
Lower Silty Clay



Beatty Creek Bridge Replacement GRAIN SIZE DISTRIBUTION

FIGURE B9

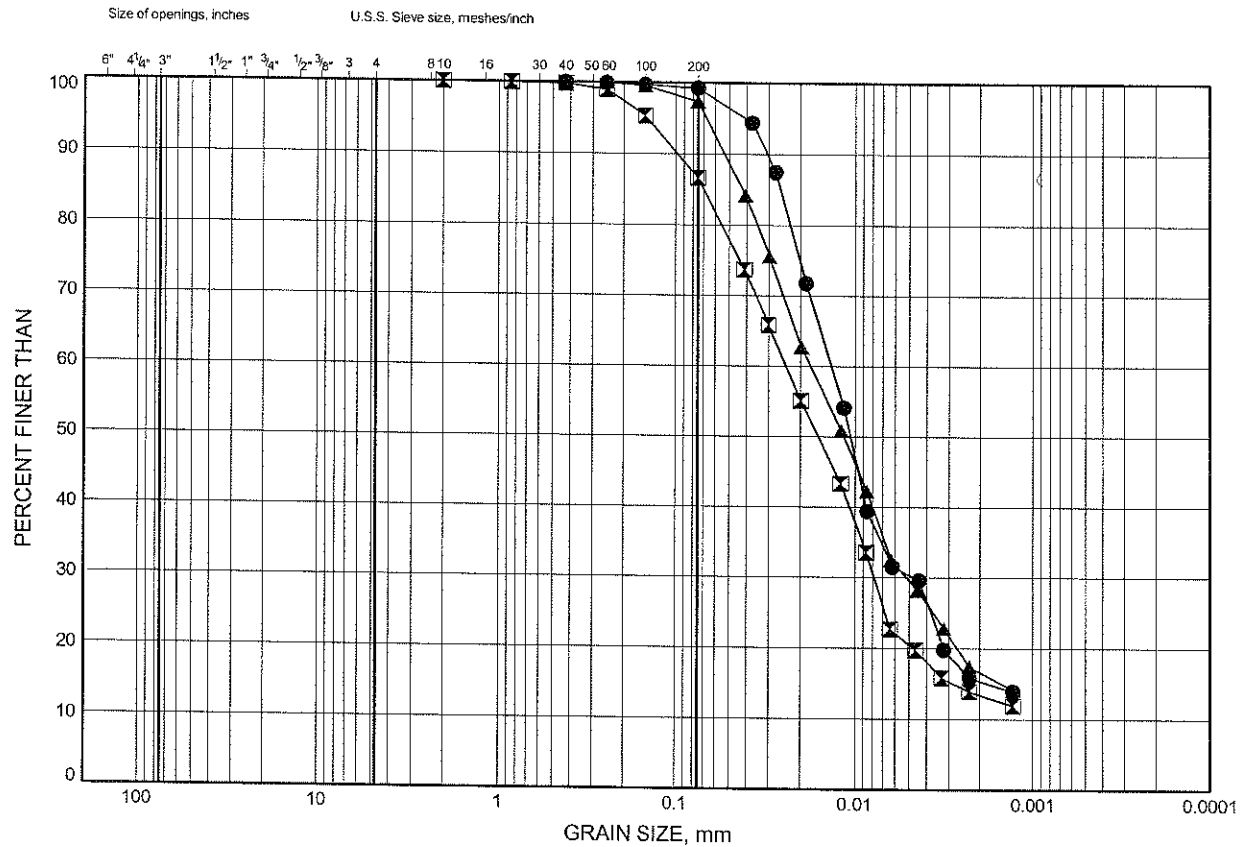
Lower Silty Clay



Beatty Creek Bridge Replacement GRAIN SIZE DISTRIBUTION

FIGURE B10

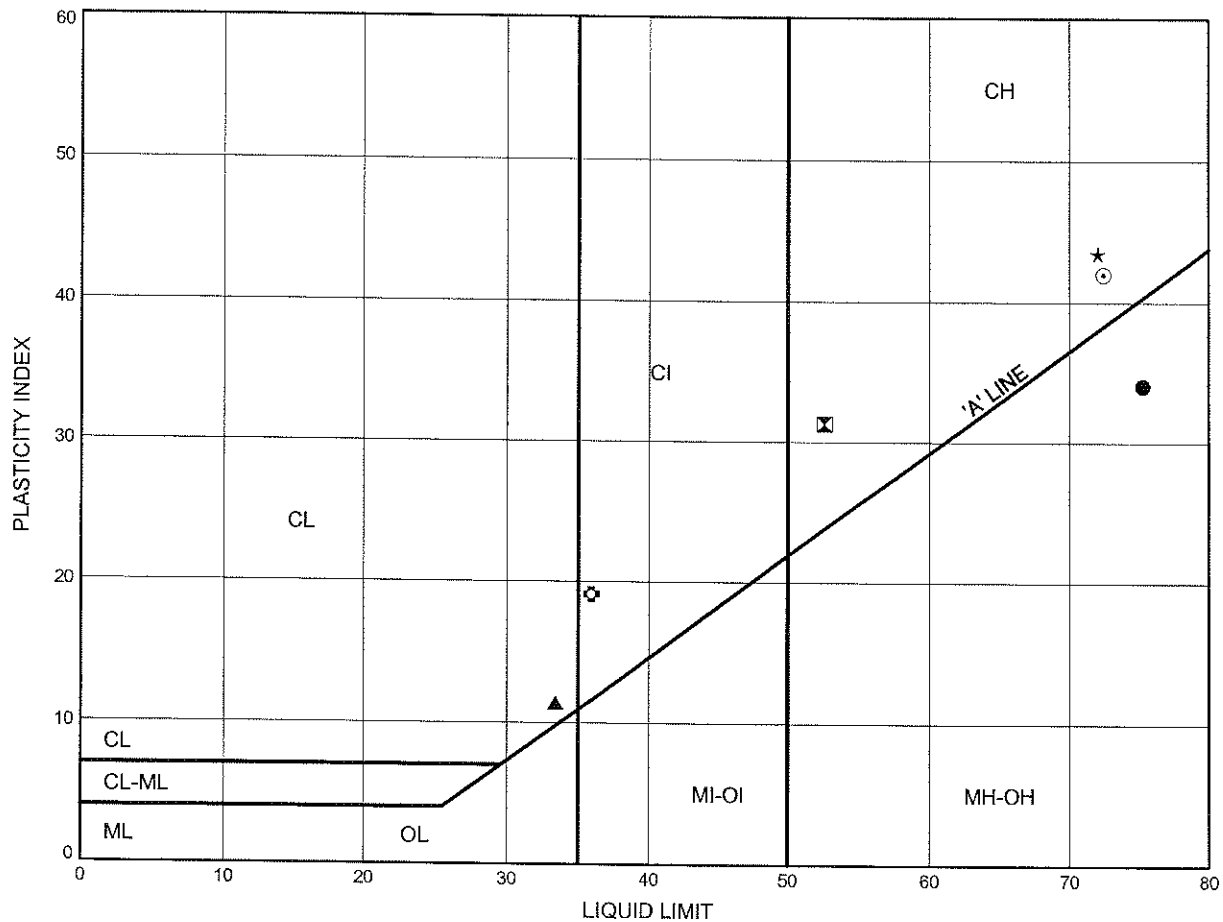
Lower Clayey Silt



Beatty Creek Bridge Replacement ATTERBERG LIMITS TEST RESULTS

FIGURE B11

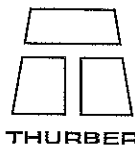
Upper Silty Clay



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-B01	4.88	192.22
⊠	06-B02	12.50	184.90
▲	06-B03	4.88	194.12
★	06-B04	6.40	192.60
⊙	06-B04	7.62	191.38
⊛	06-B04	13.72	185.28

Date December 2006

Project 5200-03-00



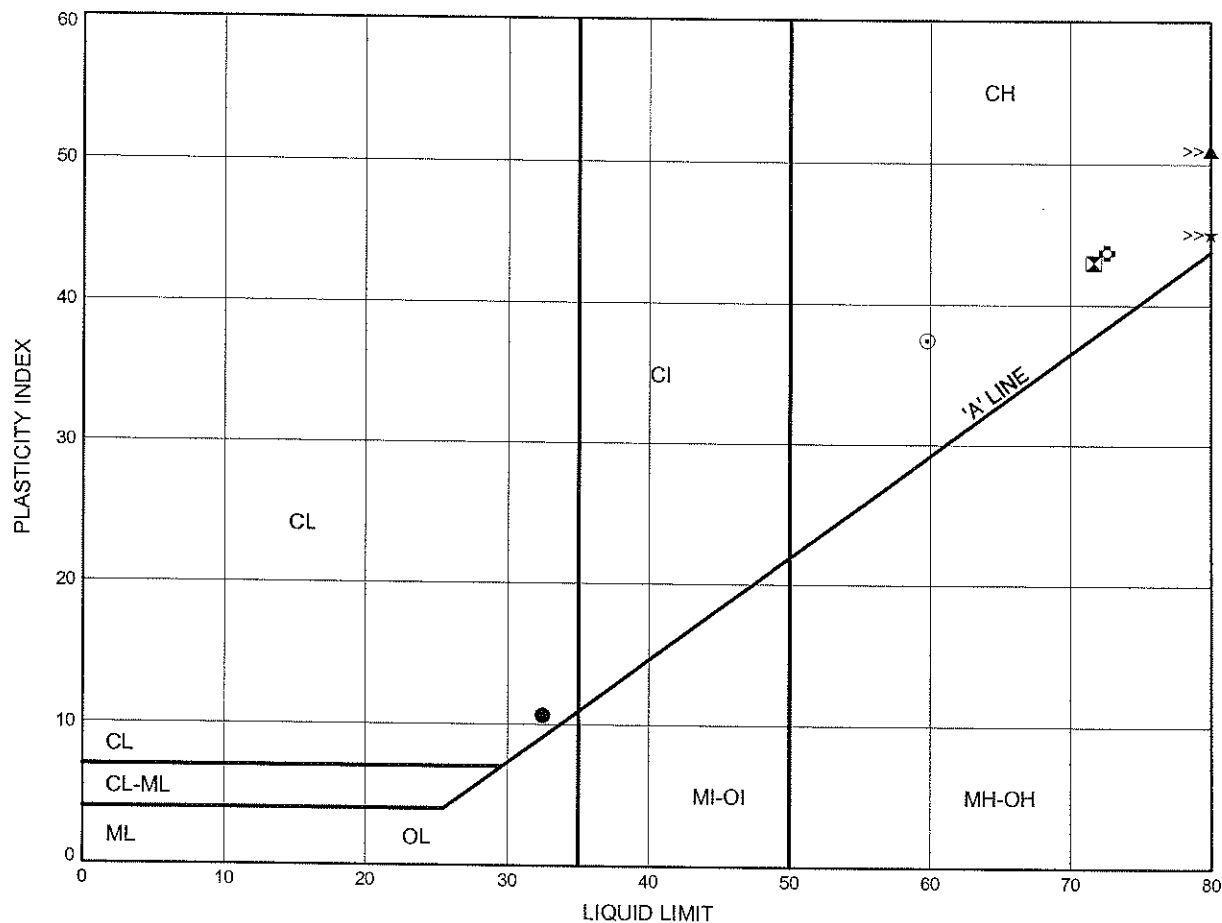
Prep'd JHL

Chkd. MRA

Beatty Creek Bridge Replacement ATTERBERG LIMITS TEST RESULTS

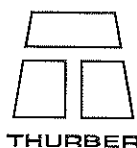
FIGURE B12

Upper Silty Clay



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-B06	3.35	193.65
⊠	06-B06	4.88	192.12
▲	06-B07	7.92	189.98
★	06-B08	6.40	191.60
⊙	06-B08	15.54	182.46
⊛	06-B09	6.40	191.70

Date December 2006
Project 5200-03-00

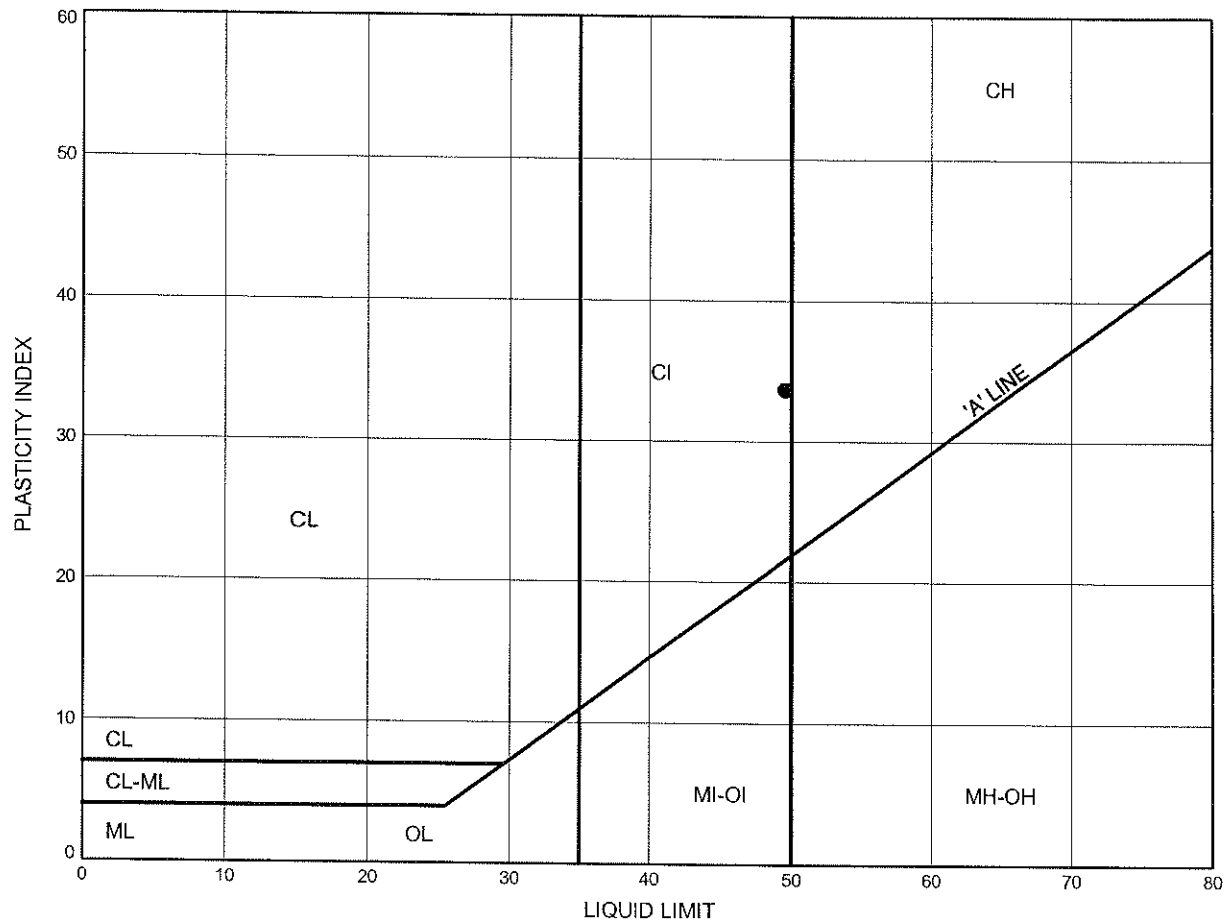


Prep'd JHL
Chkd. MRA

Beatty Creek Bridge Replacement ATTERBERG LIMITS TEST RESULTS

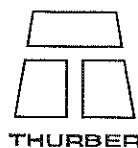
FIGURE B13

Upper Silty Clay



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-B10	7.62	191.88

Date December 2006
Project 5200-03-00

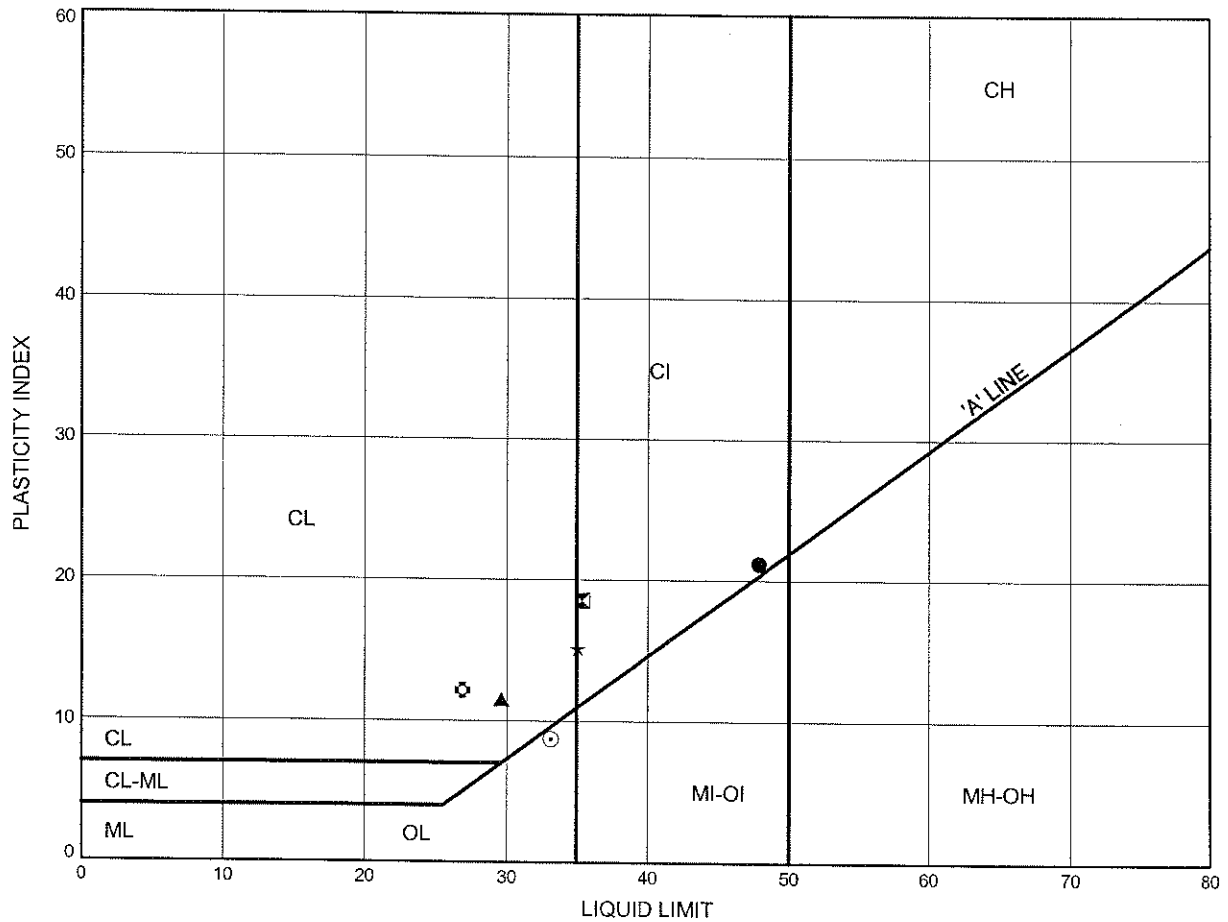


Prep'd JHL
Chkd. MRA

Beatty Creek Bridge Replacement ATTERBERG LIMITS TEST RESULTS

FIGURE B14

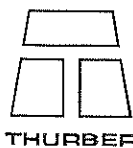
Lower Silty Clay



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-B01	30.78	166.32
⊠	06-B02	30.78	166.62
▲	06-B03	21.34	177.66
★	06-B03	30.48	168.52
⊙	06-B04	30.48	168.52
⊛	06-B04	33.53	165.47

Date December 2006

Project 5200-03-00



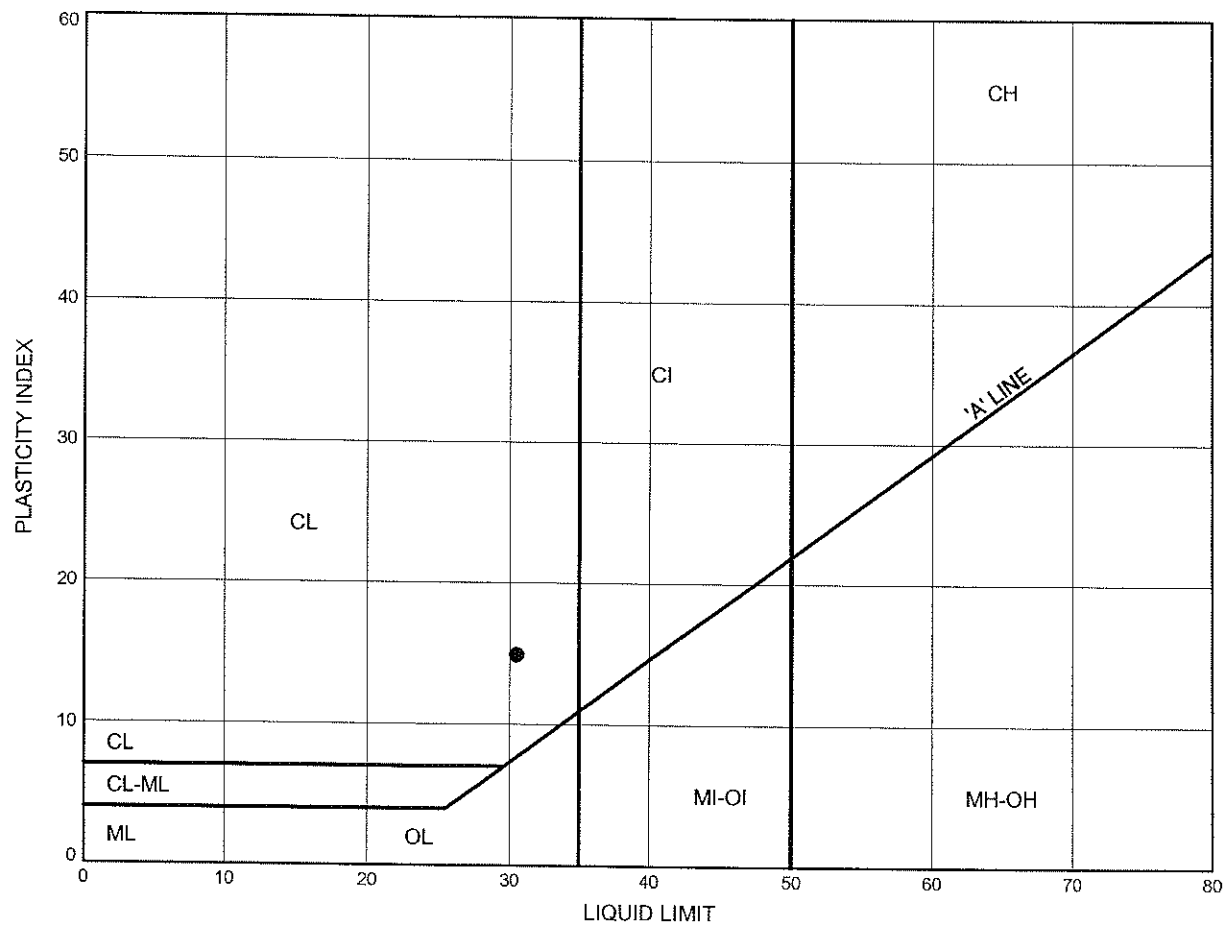
Prep'd JHL

Chkd. MRA

Beatty Creek Bridge Replacement ATTERBERG LIMITS TEST RESULTS

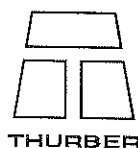
FIGURE B15

Lower Silty Clay



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-B06	33.83	163.17

Date December 2006
Project 5200-03-00



Prep'd JHL
Chkd. MRA



Consolidation Test Report

CLIENT: McCormick Rankin Corporation

FILE NUMBER: 18-45-1 / 19-1351-98

PROJECT: Mindemoya and Beatty Creek

REPORT DATE: 24-Oct-06

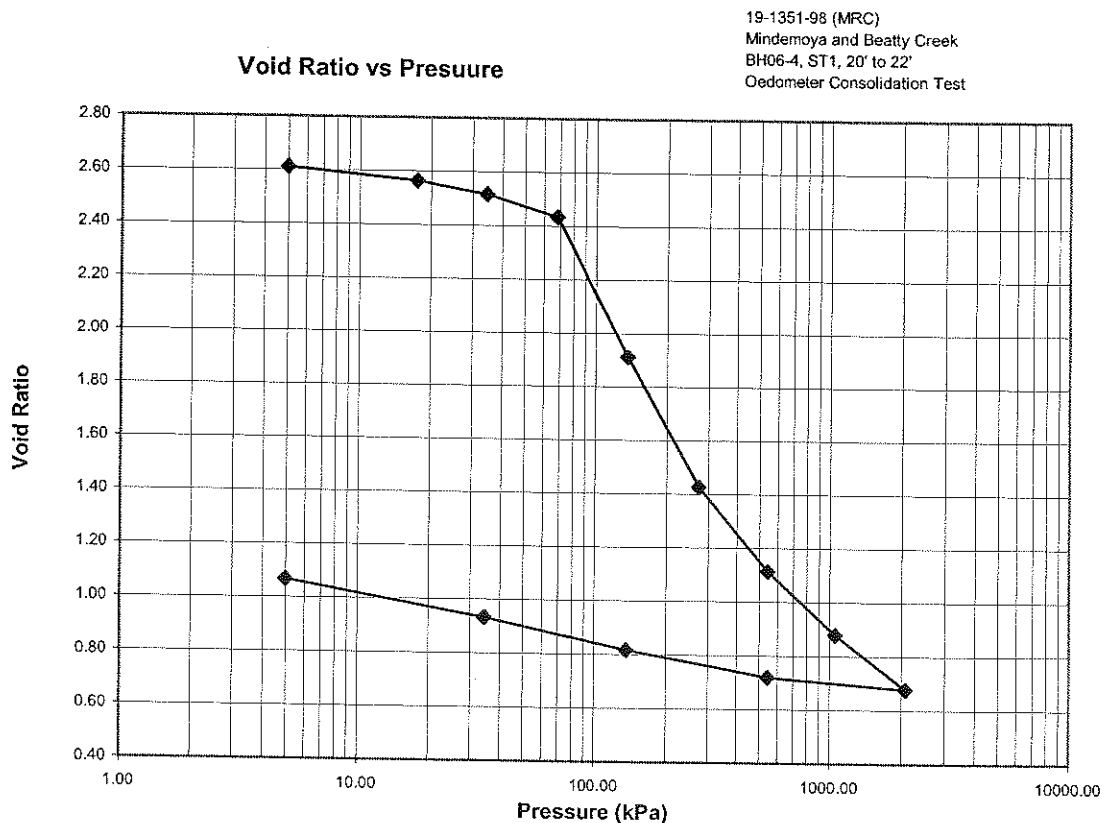
TEST DATES: September 13, 2006 - September 27, 2006

SAMPLE: BH06-4, ST1, 20'-22'
Silty Clay, dark grey, plastic, (CH), Lab Vane: 20 - 23 kPa (Soft)
Grain Size: 67 % Clay & 33 % Silt

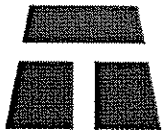
PROCEDURE: Tested in accordance with Standard Test Method for One-Dimensional Consolidation Properties of Soils, ASTM D 2435-04, method B

	<u>Start of Test</u>	<u>End of Test</u>
Wet Dens. (kg/m ³)	1488.5	2095.2
Dry Dens. (kg/m ³)	770.7	1349.1
Moisture Cont. (%)	93.1	55.3
Void Ratio	2.612	1.064
Saturation (%)	99.3	

Note: A Specific Gravity of 2.78 was measured for the void ratio and saturation calculations



TEST DONE BY: EA
REVIEWED BY: JPL



Consolidation Test Report

Mindemoya and Beatty Creek
18-45-1 / 19-1351-98

BH06-4, ST1, 20'-22'

TRIMMING: The Specimen was manually trimmed to the size of consolidation ring, then mounted in a fixed ring consolidometer

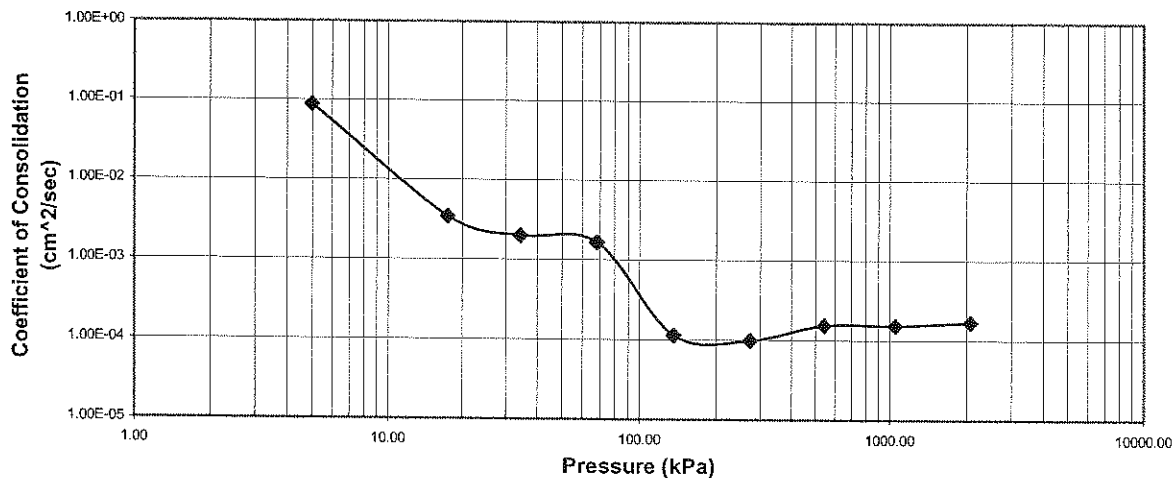
LOADING: A seating load of 5 kPa was applied and the consolidometer was flooded with distilled water. Sample was monitored to ensure no swelling effect occurred before the start of the test. Subsequent loads were applied and the duration of each load step was 24 hrs.

CALCULATIONS: Coefficients of Consolidation were calculated by the square root time method.

Pressure (kPa)	Corr. Hgt (mm)	Avg. Hgt. (mm)	T90 (min)	Cv (cm ² /sec)	Void Ratio	mv (m ² /kN)	k (cm/s)
0.00	19.850	19.850			2.612		
5.00	19.844	19.847	0.16	8.70E-02	2.611	1.06E-03	9.05E-06
17.50	19.581	19.712	4.00	3.43E-03	2.563	7.75E-04	2.61E-07
34.46	19.320	19.450	6.76	1.98E-03	2.516	6.68E-04	1.29E-07
68.42	18.869	19.094	7.84	1.64E-03	2.434	2.11E-03	3.40E-07
136.78	16.003	17.436	94.09	1.14E-04	1.912	9.87E-04	1.10E-08
273.12	13.331	14.667	77.40	9.82E-05	1.426	3.18E-04	3.06E-09
545.39	11.612	12.472	36.00	1.53E-04	1.114	1.27E-04	1.90E-09
1057.63	10.320	10.966	28.09	1.51E-04	0.878	5.46E-05	8.09E-10
2080.12	9.212	9.766	20.05	1.68E-04	0.677	7.58E-06	1.25E-10
545.39	9.443	9.328			0.719		
136.78	9.982	9.713			0.817		
34.46	10.618	10.300			0.933		
5.00	11.352	10.985			1.066		

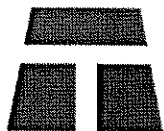
Coefficient of Consolidation vs Pressure

19-1351-98 (MRC)
Mindemoya and Beatty Creek
BH06-4, ST1, 20' to 22'
Oedometer Consolidation Test



Notes: Cv and k calculated using t_{90} values

TEST DONE BY: EA
REVIEWED BY: JPL



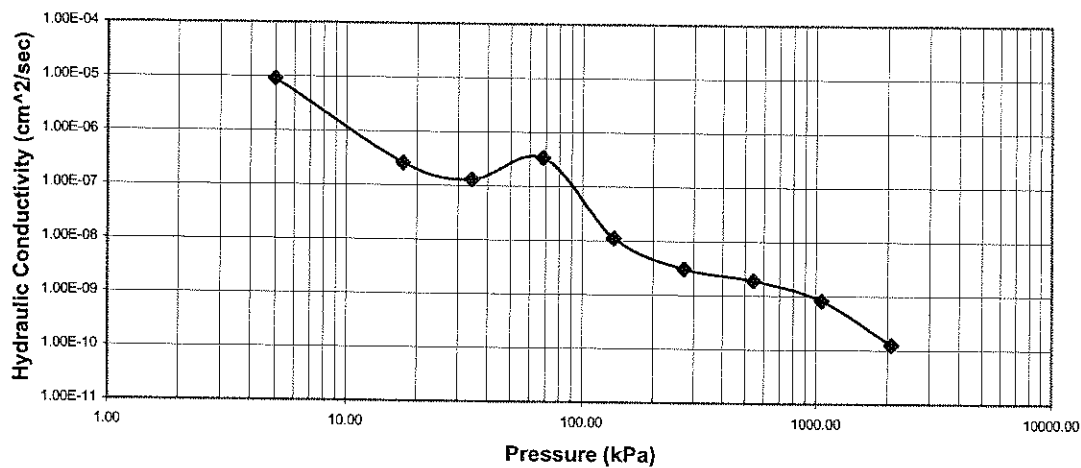
Consolidation Test Report

Mindemoya and Beatty Creek
18-45-1 / 19-1351-98

BH06-4, ST1, 20'-22'

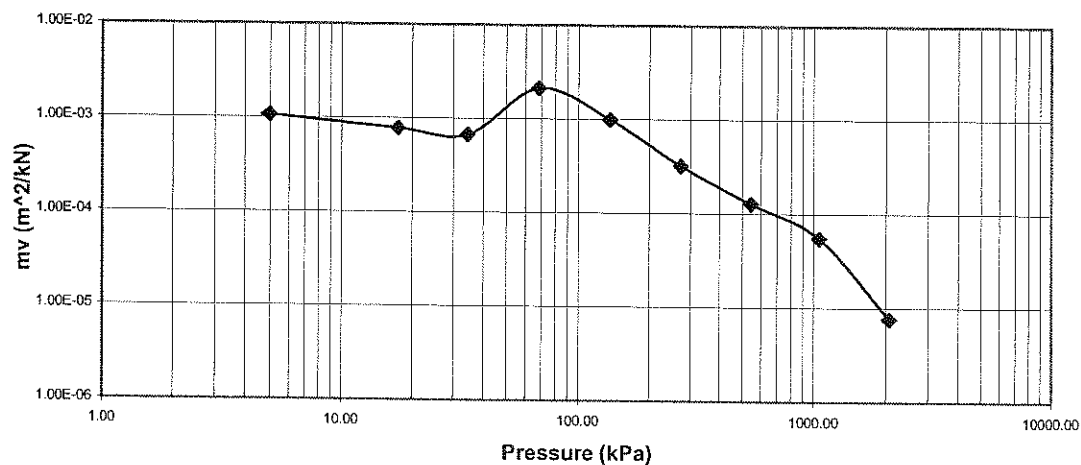
Hydraulic Conductivity vs Pressure

19-1351-98 (MRC)
Mindemoya and Beatty Creek
BH06-4, ST1, 20' to 22'
Oedometer Consolidation Test



mv vs Pressure

19-1351-98 (MRC)
Mindemoya and Beatty Creek
BH06-4, ST1, 20' to 22'
Oedometer Consolidation Test



TEST DONE BY: EA
REVIEWED BY: JPL



Consolidation Test Report

CLIENT: McCormick Rankin Corporation

FILE NUMBER: 18-45-1 /19-1351-98

PROJECT: Mindemoya and Beatty Creek

REPORT DATE: 24-Oct-06

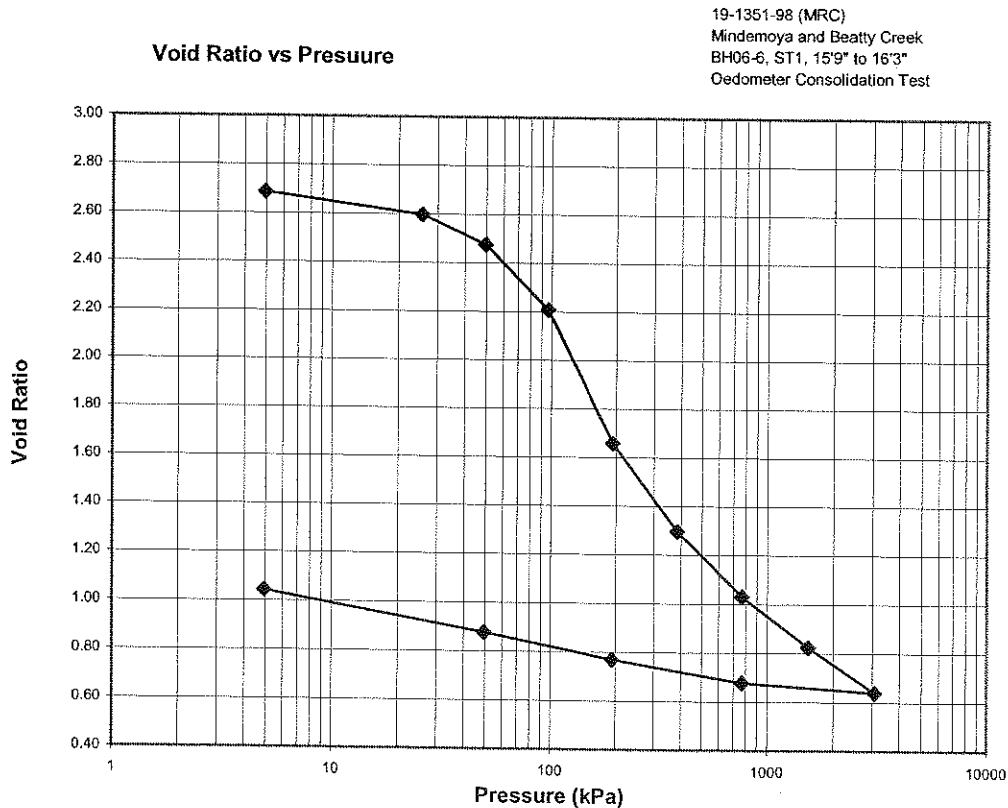
TEST DATES: September 13, 2006 - September 27, 2006

SAMPLE: BH06-6-ST1, 15'9" -16'3"
Silty Clay, dark grey, plastic, (CH)
Lab Vane: 16-20 kPa (Soft), Grain Size: 26 % Clay & 74 % Silt

PROCEDURE: Tested in accordance with Standard Test Method for One-Dimensional Consolidation Properties of Soils, ASTM D 2435-04, method B

	<u>Start of Test</u>	<u>End of Test</u>
Wet Dens. (kg/m ³)	1478.8	2005.6
Dry Dens. (kg/m ³)	752.7	1358.0
Moisture Cont. (%)	96.5	43.8
Void Ratio	2.680	1.040
Saturation (%)	99.7	

Note: A Specific Gravity of 2.77 was measured for the void ratio and saturation calculations



TEST DONE BY: EA
REVIEWED BY: JPL



Consolidation Test Report

Mindemoya and Beatty Creek
18-45-1 /19-1351-98

BH06-6-ST1, 15'9" -16'3"

TRIMMING: The Specimen was manually trimmed to the size of consolidation ring, then mounted in a fixed ring consolidometer

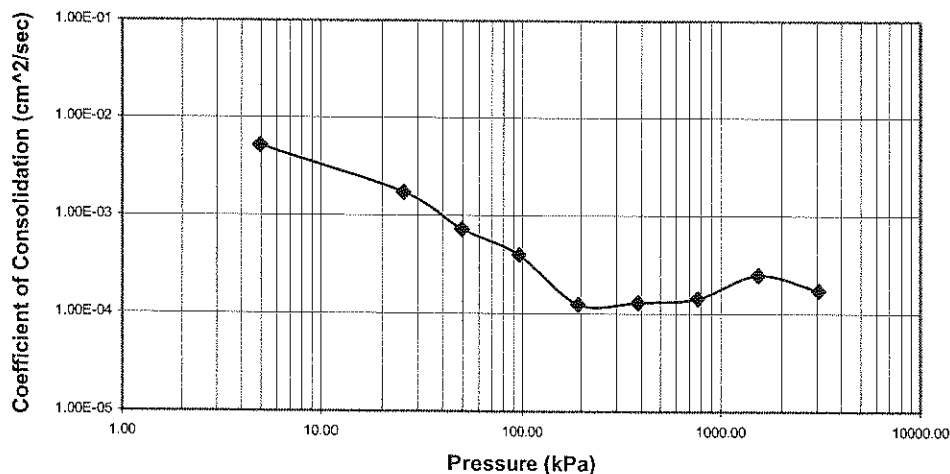
LOADING: A seating load of 4.97 kPa was applied and the consolidometer was flooded with distilled water. Sample was monitored to ensure no swelling effect occurred before the start of the test. Subsequent loads were applied and the duration of each load step was 24 hours.

CALCULATIONS: Coefficients of Consolidation were calculated by the square root time method.

Pressure (kPa)	Corr. Hgt (mm)	Avg. Hgt. (mm)	T90 (min)	Cv (cm ² /sec)	Void Ratio	mv (m ² /kN)	k (cm/s)
0.00	25.350	25.350			2.680		
4.97	25.395	25.372	4.41	5.16E-03	2.687	1.18E-03	5.97E-07
25.67	24.783	25.089	12.96	1.72E-03	2.597	1.37E-03	2.30E-07
49.86	23.957	24.370	29.16	7.20E-04	2.475	1.55E-03	1.10E-07
96.65	22.139	23.048	47.61	3.94E-04	2.208	1.55E-03	5.98E-08
193.24	18.396	20.267	116.64	1.24E-04	1.657	5.08E-04	6.20E-09
385.77	15.948	17.172	81.00	1.29E-04	1.297	1.88E-04	2.37E-09
770.72	14.140	15.044	56.25	1.42E-04	1.031	7.30E-05	1.02E-09
1540.91	12.733	13.436	26.01	2.45E-04	0.824	3.25E-05	7.81E-10
3081.80	11.482	12.107	30.25	1.71E-04	0.639	4.42E-06	7.42E-11
770.72	11.737	11.609			0.677		
193.24	12.361	12.049			0.769		
49.86	13.096	12.728			0.877		
4.97	14.213	13.655			1.041		

Coefficient of Consolidation vs Pressure

19-1351-98 (MRC)
Mindemoya and Beatty Creek
BH06-6, ST1, 15'9" to 16'3"
Oedometer Consolidation Test



Notes: Cv and k calculated using t_{90} values

TEST DONE BY: EA
REVIEWED BY: JPL



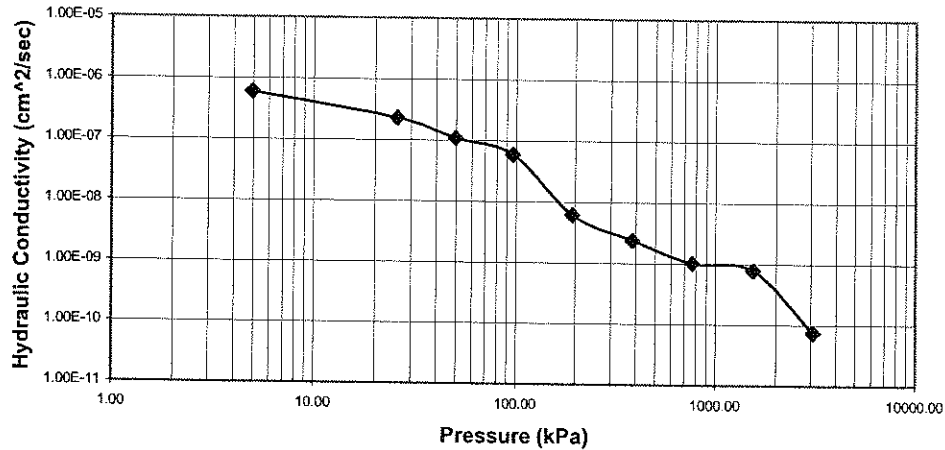
Consolidation Test Report

Mindemoya and Beatty Creek
18-45-1 /19-1351-98

BH06-6-ST1, 15'9" -16'3"

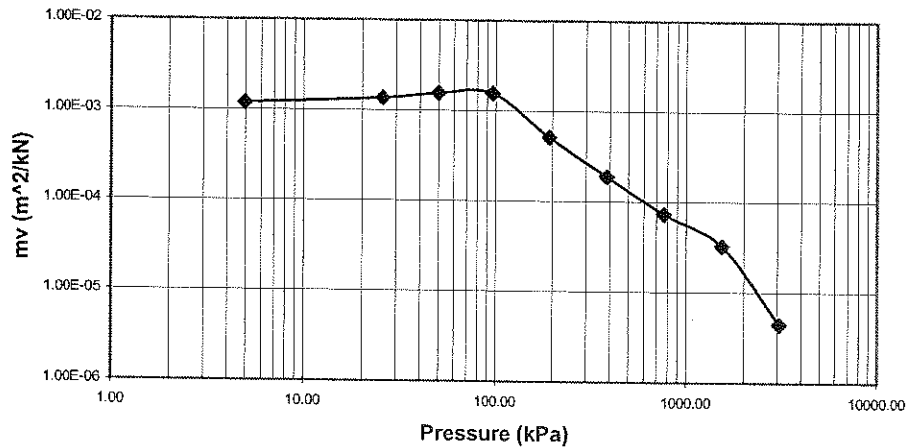
Hydraulic Conductivity vs Pressure

19-1351-98 (MRC)
Mindemoya and Beatty Creek
BH06-6, ST1, 15'9" to 16'3"
Oedometer Consolidation Test



mv vs Pressure

19-1351-98 (MRC)
Mindemoya and Beatty Creek
BH06-6, ST1, 15'9" to 16'3"
Oedometer Consolidation Test



TEST DONE BY: EA
REVIEWED BY: JPL



THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

UNCONFINED COMPRESSION TEST REPORT

CLIENT: McCormick Rankin Corporation

FILE NUMBER: 19-1351-98

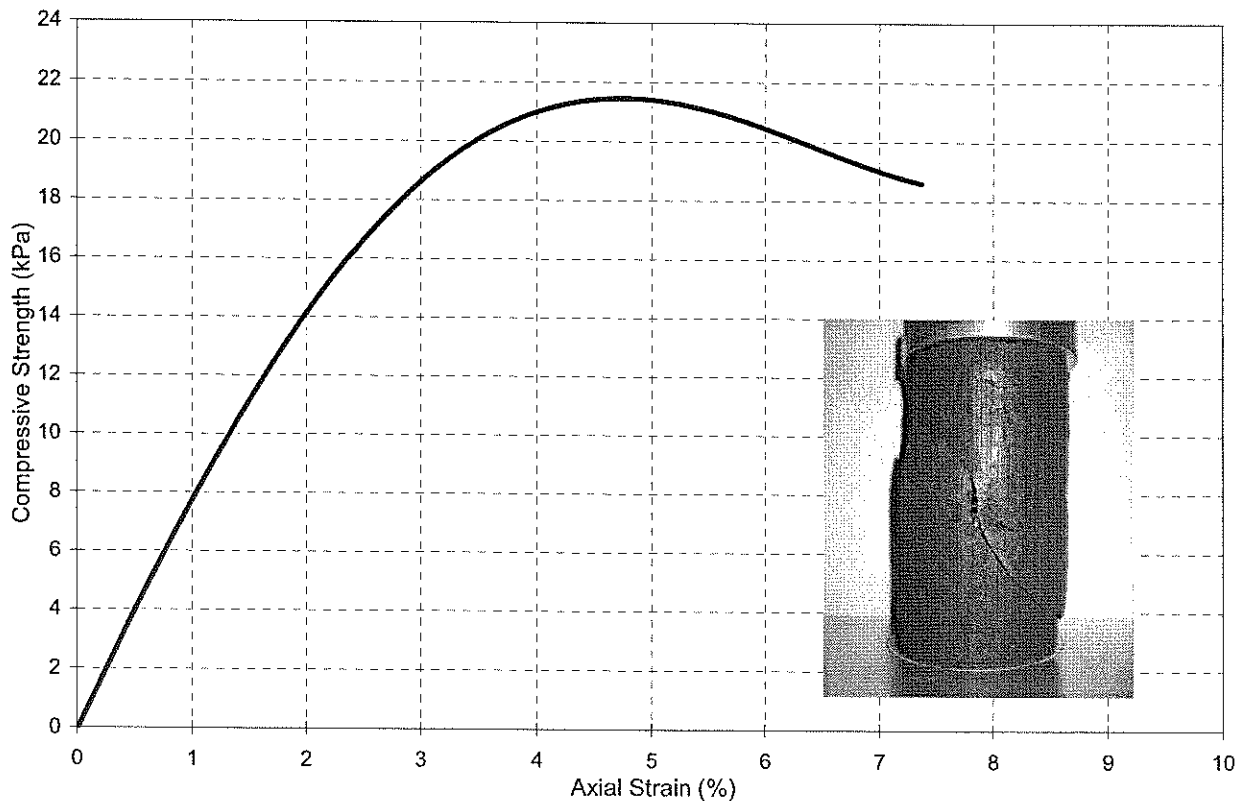
PROJECT: Mindemoya and Beatty Creek

REPORT DATE: 31-Oct-06

BOREHOLE No.: BH06-4 TEST DATE: 31-Oct-06
SAMPLE: ST-1, 6.1 - 6.4 m
DESCRIPTION: Silty CLAY (CH), dark grey, soft, plastic, undisturbed, Lab Vane: 20 kPa

Avg. Height (cm):	13.99	Wet Density (kg/cu.m.):	1,535
Avg. Diameter (cm):	6.94	Dry Density (kg/cu.m.):	863
Height to Dia. Ratio	2:1	Moisture Content* (%):	77.8
Weight (g):	812.2	Void Ratio:	2.221
Measured Sp. Gr.:	2.78	Saturation (%):	97

AVG. RATE OF STRAIN TO FAILURE: 1%
UNCONFINED COMPRESSIVE STRENGTH: 21.5 kPa @ 4.85 % strain
UNDRAINED SHEAR STRENGTH: 10.8 kPa



Note: * The water content was obtained after shear from the entire specimen
** Type of Failure: Diagonal shear approximately 58° from horizontal

TEST DONE BY: WM
REVIEWED BY: JPL

BH06-4-ST1(UCS).xls



THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

UNCONFINED COMPRESSION TEST REPORT

CLIENT: McCormick Rankin Corporation

FILE NUMBER: 19-1351-98

PROJECT: Mindemoya and Beatty Creek

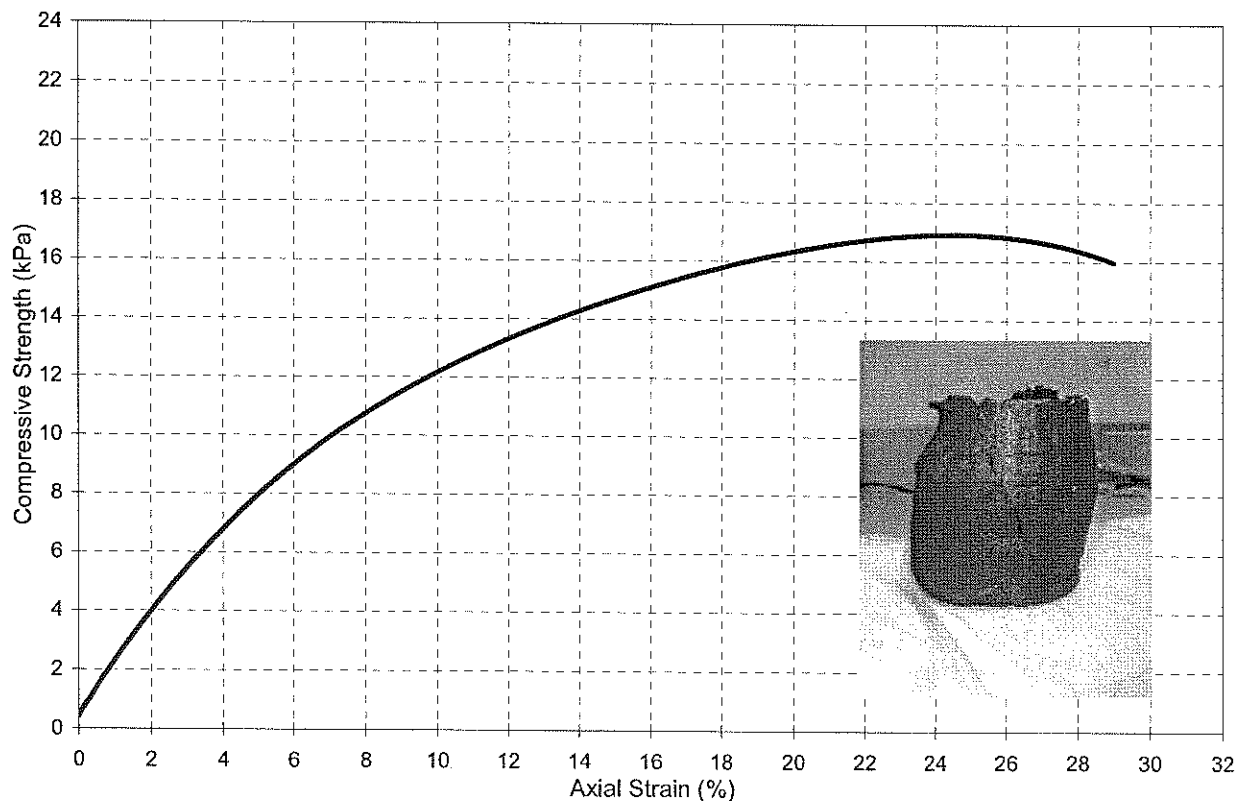
REPORT DATE: 31-Oct-06

BOREHOLE No.: BH06-6
SAMPLE: ST-1, 4.6 - 4.8 m
DESCRIPTION: Silty CLAY (CH), dark grey, very soft to soft, plastic, undisturbed

TEST DATE: 31-Oct-06

Avg. Height (cm):	13.30	Wet Density (kg/cu.m.):	1,554
Avg. Diameter (cm):	6.86	Dry Density (kg/cu.m.):	875
Height to Dia. Ratio	2:1	Moisture Content* (%):	77.5
Weight (g):	763.8	Void Ratio:	2.164
Measured Sp. Gr.:	2.77	Saturation (%):	99

AVG. RATE OF STRAIN TO FAILURE: 1%
UNCONFINED COMPRESSIVE STRENGTH: 17.0 kPa @ 24.2 % strain
UNDRAINED SHEAR STRENGTH: 8.5 kPa



Note * The water content was obtained after shear from the entire specimen
** Type of Failure: Bulged and diagonal shear approximately 60° from horizontal

TEST DONE BY: WM
REVIEWED BY: JPL

BH06-6-ST1(UCS).xls

Appendix C

Photographs, Figures and Tables

Beatty Creek Bridge Replacement



Photograph 1: North side of existing bridge looking east (May 2006).



Photograph 2: North side of existing bridge looking northeast (March 2006).

Beatty Creek Bridge Replacement



Photograph 3: North side of existing bridge looking west (May 2006).



Photograph 4: Looking west toward Beatty Creek bridge from Hwy 654 (September 2007).

	Gamma C	Phi	Piezo
	kN/m ³	deg	Surf.
Earth Fill	21	0	32
Silt/Sand	20	0	29
Soft-Firm Clay	18	25	0
Very Soft Clay	15	18	0
Soft-Firm Clay	18	25	0
Silt	20	0	30
Soft-Stiff Clay	18	30	0
Sand	21	0	32

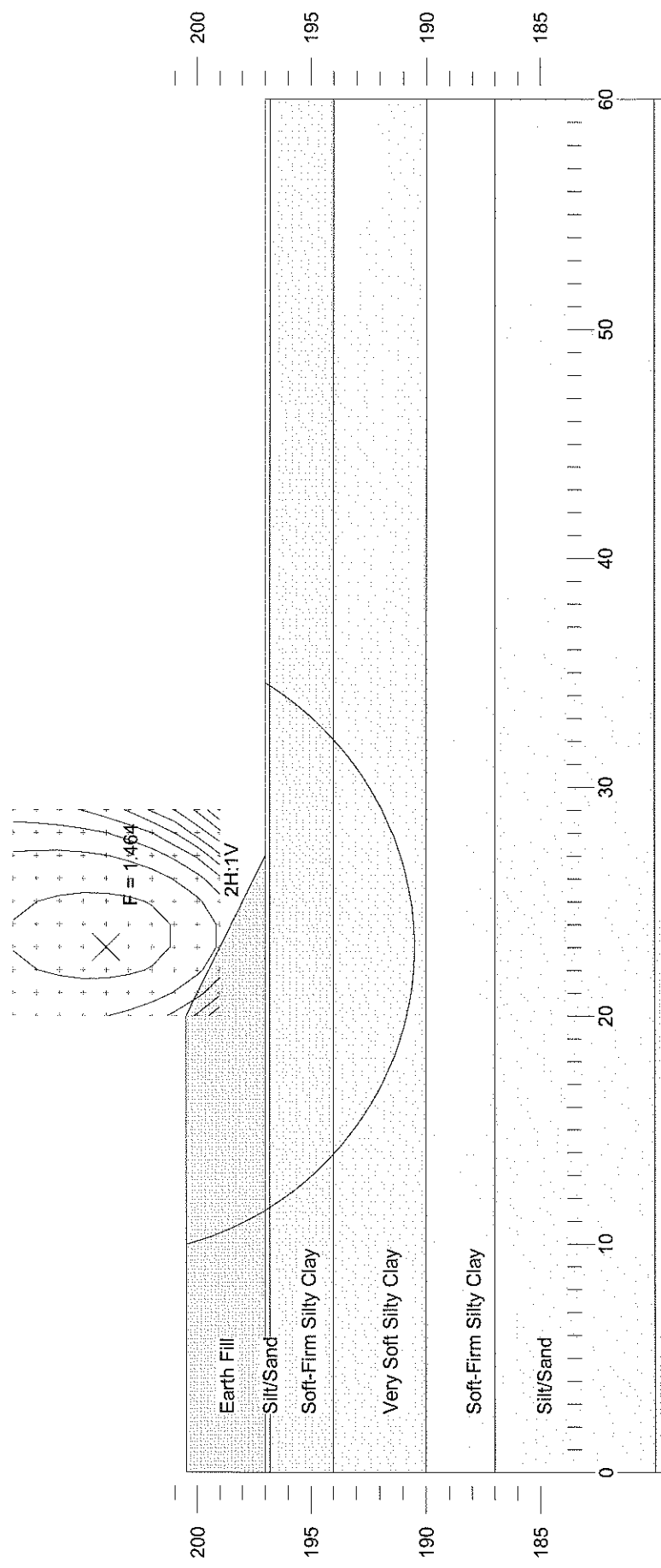


Fig. C1

Thurber Engineering Ltd. - Toronto
 19-1351-98
 Beatty Creek
 October 2007
 3.5 m High Earth Embankment
 Long Term

	Gamma C	Phi	Piezo
	kN/m ³	deg	Surf.
Earth Fill	21	32	0
Silt/Sand	20	29	1
Soft-Firm Clay	17	27	1
Very Soft Clay	15	25	1
Soft-Firm Clay	17	27	1
Silt	20	30	1
Soft-Stiff Clay	17	28	1
Sand	21	32	1

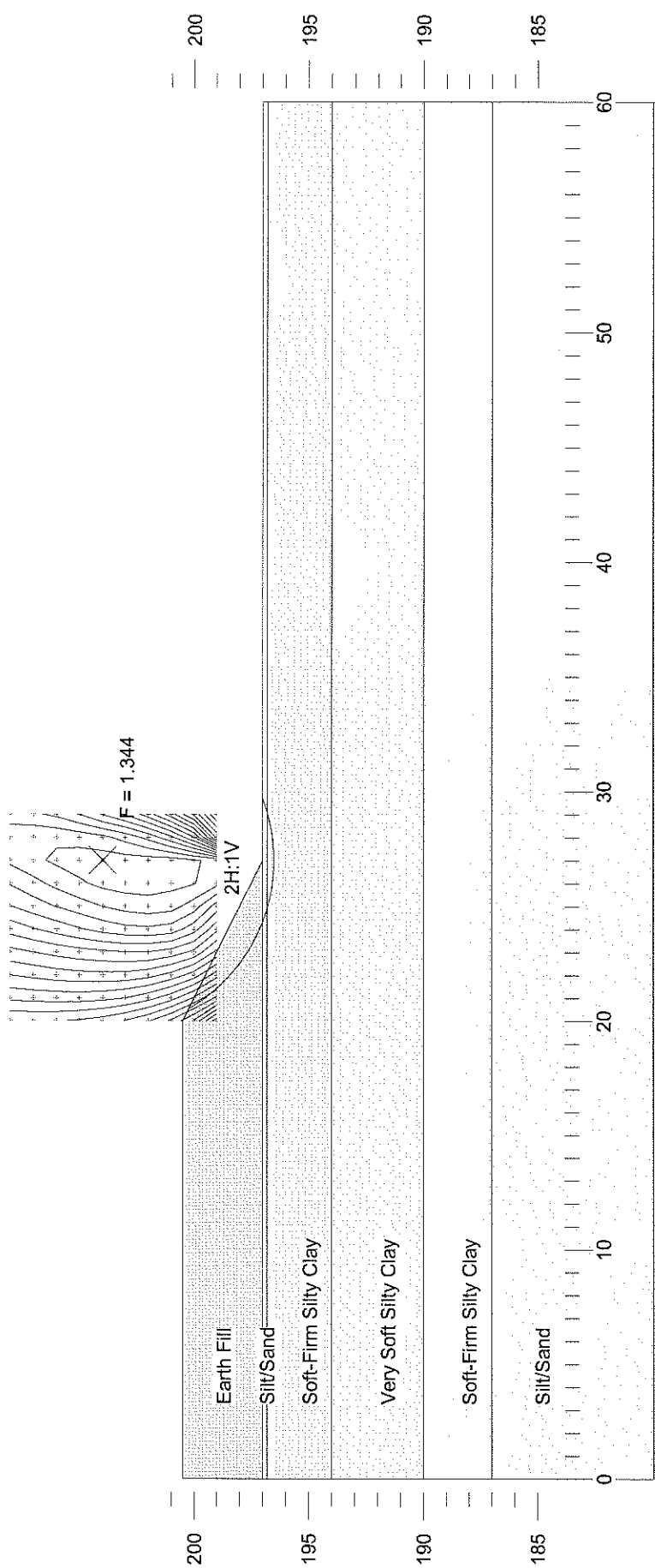


Fig. C2

Thurber Engineering Ltd. - Toronto
 19-1351-98
 Beatty Creek
 October 2007
 3.5 m High Rockfill Embankment
 Short Term

	Gamma C	Phi	Piezo
	kN/m ³	deg	Surf.
Rockfill	19	0	42
Silt/Sand	20	0	29
Soft-Firm Clay	18	25	0
Very Soft Clay	15	18	0
Soft-Firm Clay	18	25	0
Silt	20	0	30
Soft-Stiff Clay	18	30	0
Sand	21	0	32

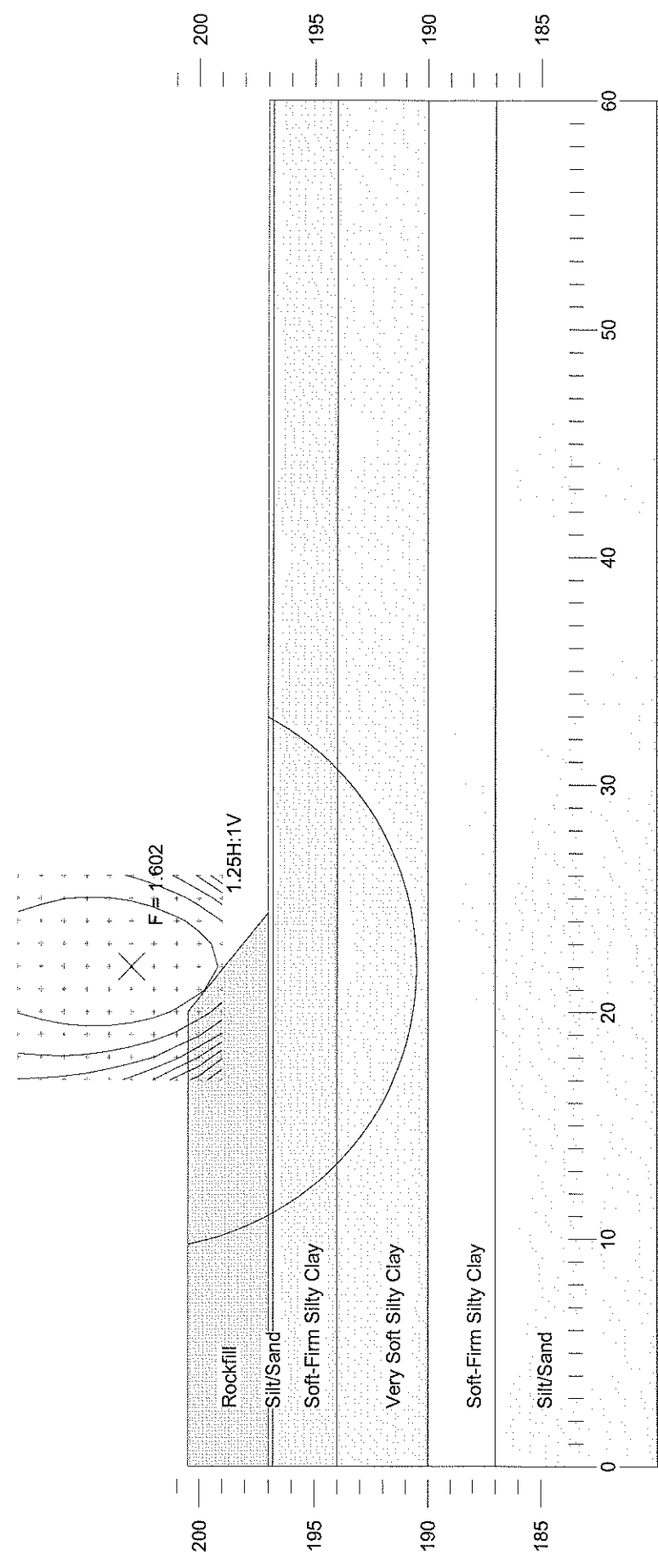


Fig. C3

Thurber Engineering Ltd. - Toronto
 19-1351-98
 Beatty Creek
 October 2007
 3.5 m High Rockfill Embankment
 Long Term

	Gamma C	Phi	Piezo
	kN/m ³	deg	Surf.
Rockfill	19	0	42
Silt/Sand	20	0	29
Soft-Firm Clay	17	0	27
Very Soft Clay	15	0	25
Soft-Firm Clay	17	0	27
Silt	20	0	30
Soft-Stiff Clay	17	0	28
Sand	21	0	32

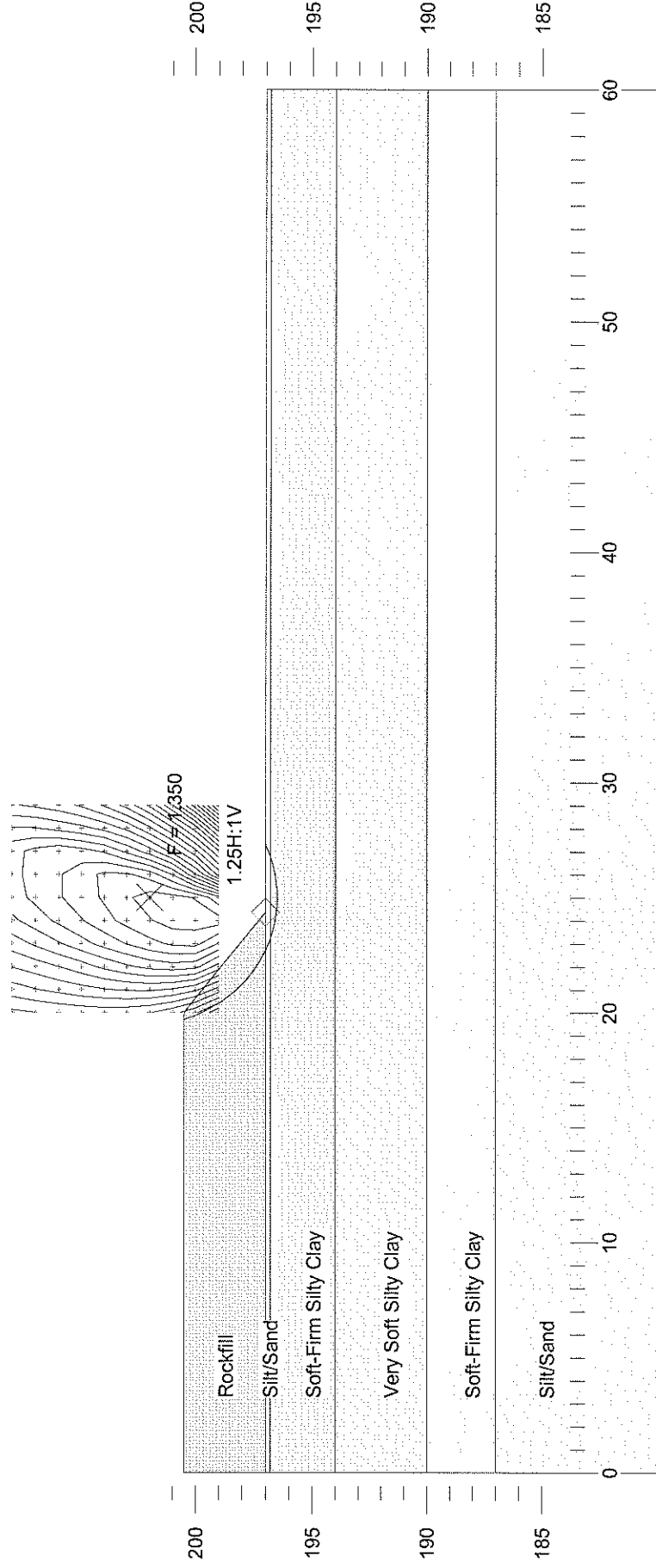
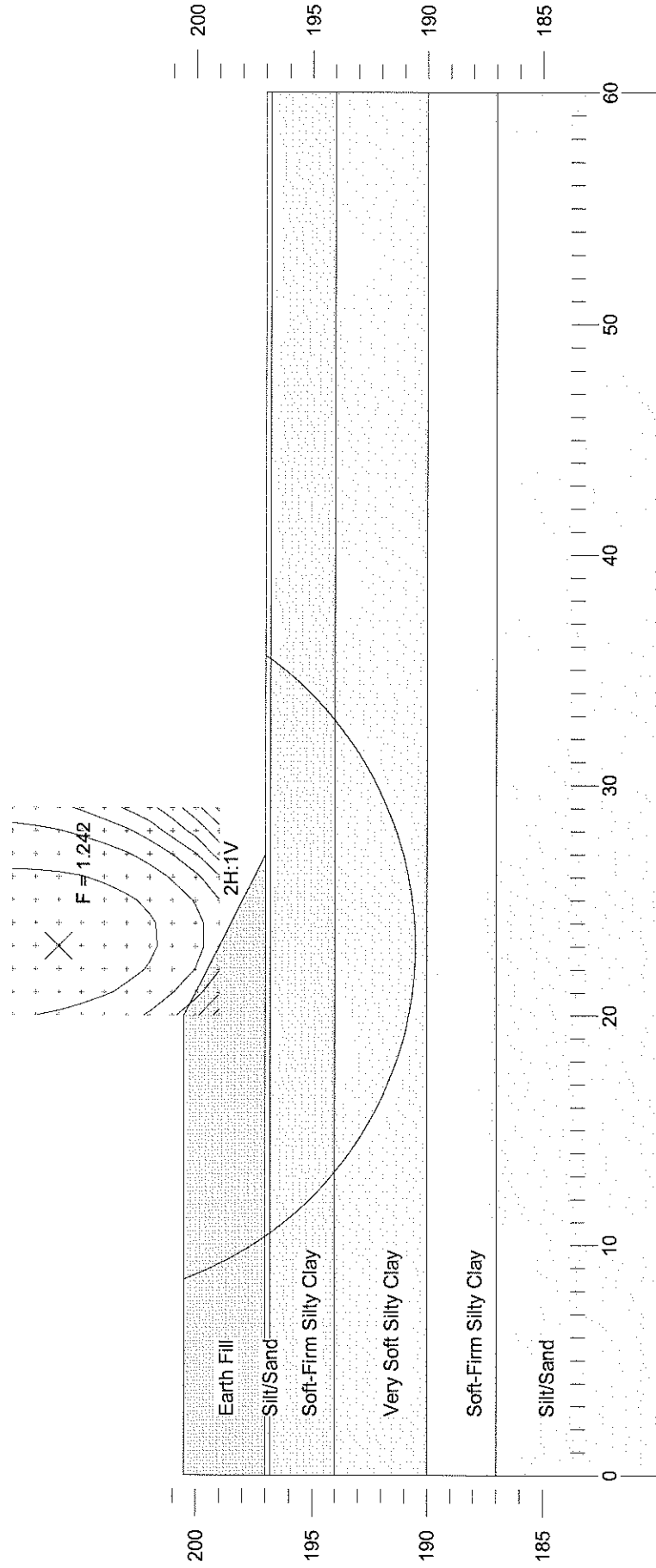


Fig. C4

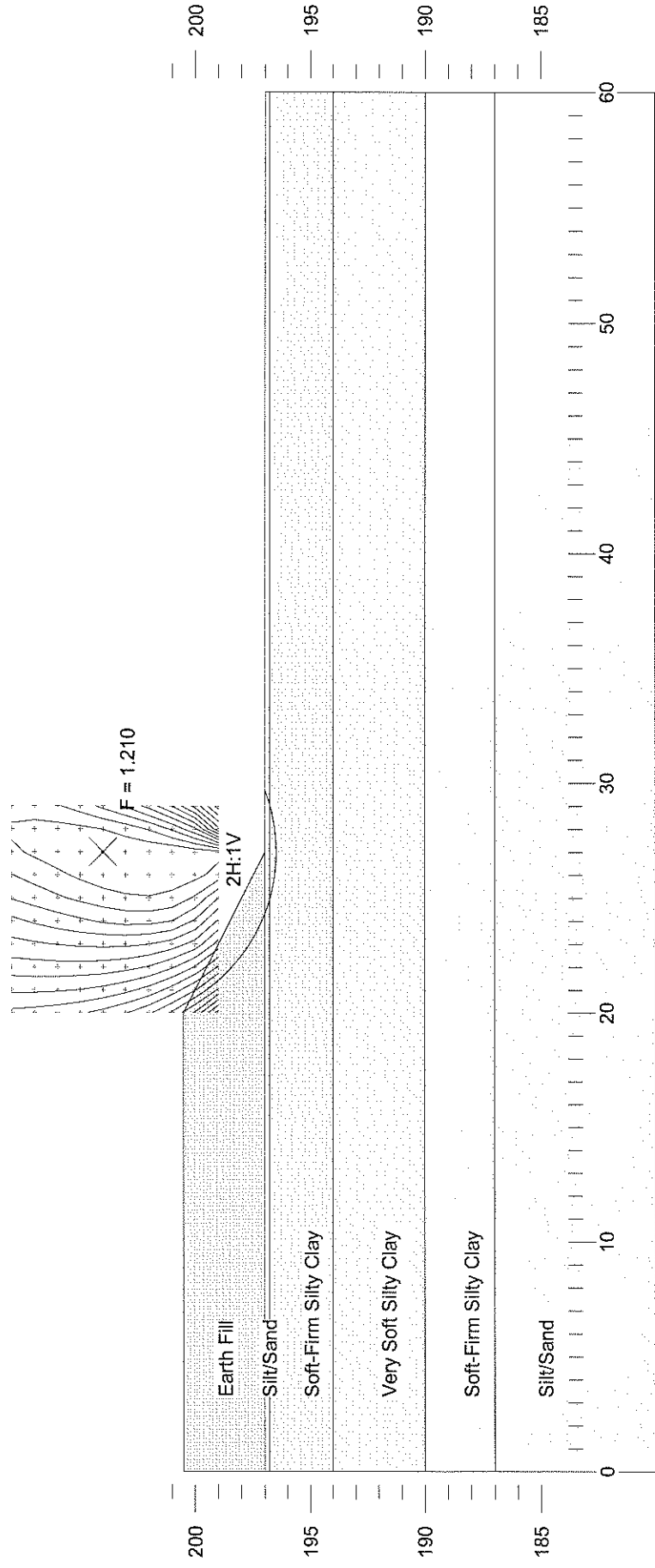
	Gamma C	Phi	Piezo
	kN/m ³	deg	Surf.
Earth Fill	21	32	0
Silt/Sand	20	29	1
Soft-Firm Clay	18	25	1
Very Soft Clay	15	18	1
Soft-Firm Clay	18	25	1
Silt	20	30	1
Soft-Stiff Clay	18	30	1
Sand	21	32	1

Seismic coefficient = 0.04



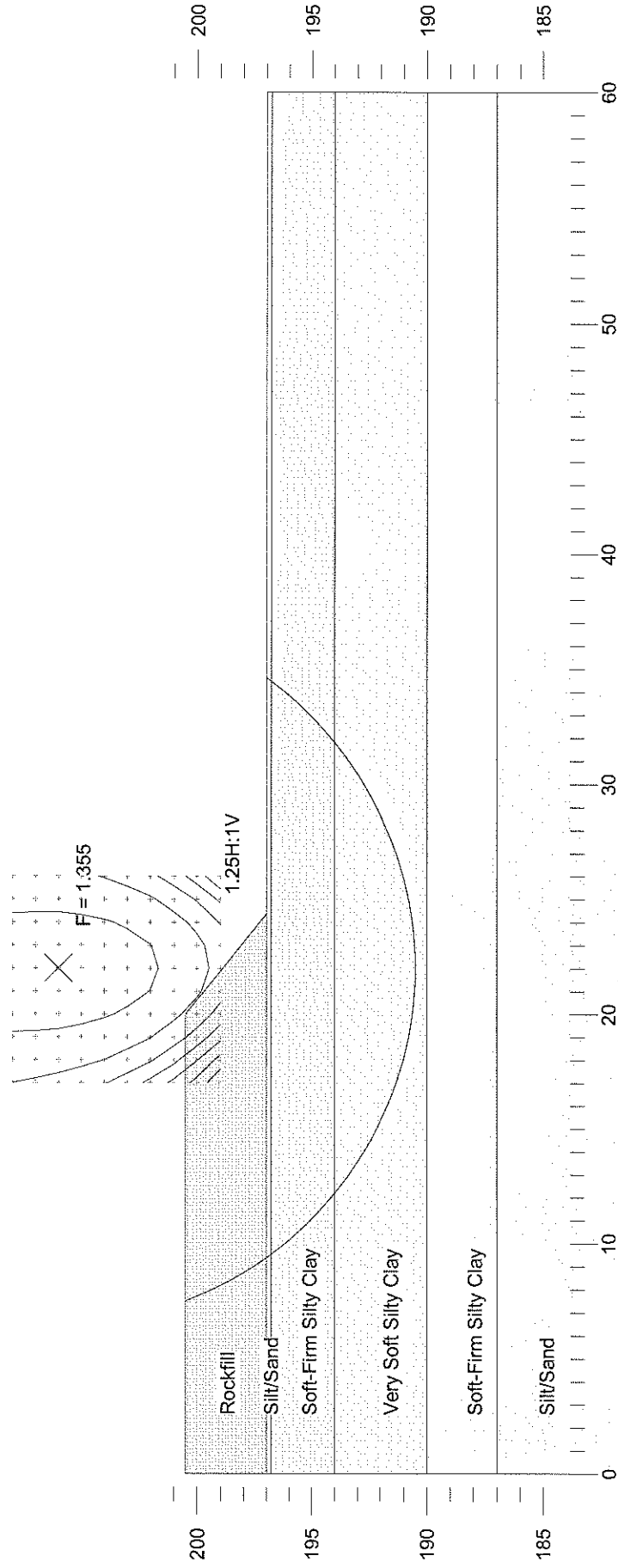
	Gamma C	Phi	Piezo
	kN/m ³	deg	Surf.
Earth Fill	21	32	0
Silt/Sand	20	29	1
Soft-Firm Clay	17	27	1
Very Soft Clay	15	25	1
Soft-Firm Clay	17	27	1
Silt	20	30	1
Soft-Stiff Clay	17	28	1
Sand	21	32	1

Seismic coefficient = 0.04



	Gamma C	Phi	Piezo
	kN/m ³	deg	Surf.
Rockfill	19	0	42
Silt/Sand	20	0	29
Soft-Firm Clay	18	25	0
Very Soft Clay	15	18	0
Soft-Firm Clay	18	25	0
Silt	20	0	30
Soft-Stiff Clay	18	30	0
Sand	21	0	32

Seismic coefficient = 0.04



Thurber Engineering Ltd. - Toronto
 19-1351-98
 Beatty Creek
 October 2007
 3.5 m High Rockfill Embankment
 Long Term

	Gamma	C	Phi	Piezo
	kN/m ³	kPa	deg	Surf.
Rockfill	19	0	42	0
Silt/Sand	20	0	29	1
Soft-Firm Clay	17	0	27	1
Very Soft Clay	15	0	25	1
Soft-Firm Clay	17	0	27	1
Silt	20	0	30	1
Soft-Stiff Clay	17	0	28	1
Sand	21	0	32	1

Seismic coefficient = 0.04

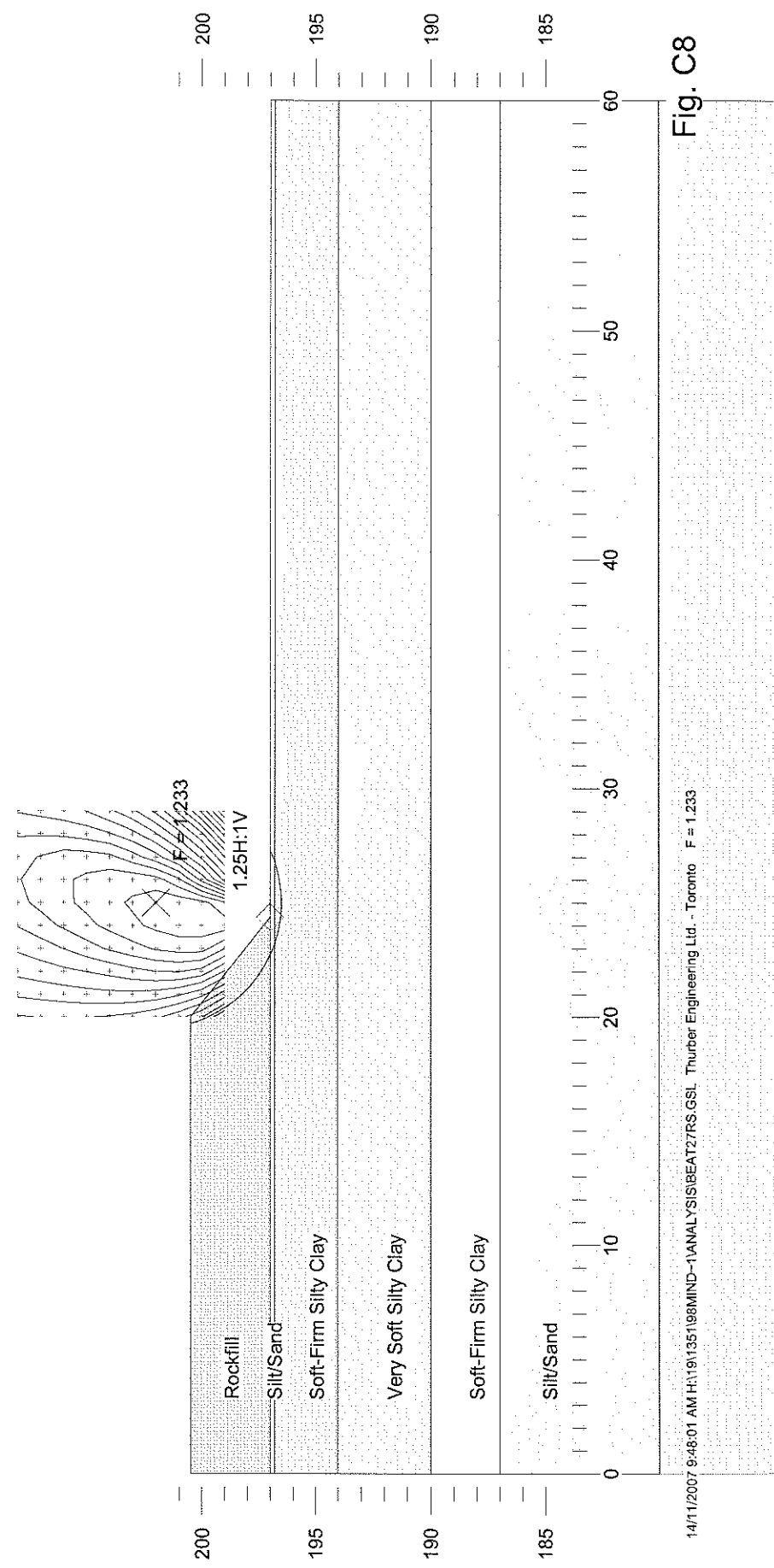


Fig. C8

TABLE C1 – PIEZOMETER DETAILS

Piezometer Location	Tip Position (m)		Completion Details
	Depth	Elevation	
BH06-B01	42.7	154.4	Sand filter and screen from 42.7 to 40.8 m, bentonite seal to 39.6, grout to 9.1 m, bentonite to surface.
BH06-B02	40.5	156.9	Sand filter and screen from 40.5 to 38.7 m, bentonite seal to surface.
BH06-B06	42.5	154.5	Sand filter and screen from 42.5 to 40.7 m, bentonite seal to surface.
BH06-B08	16.8	181.2	Sand filter and screen from 16.8 to 14.9 m, bentonite seal to 14.0 m, grout to 6.1 m, bentonite to surface.
BH06-B10	20.1	179.4	Sand filter and screen from 20.1 to 17.7 m, bentonite seal to surface.
BH07-B1	4.6	192.6	Grout from 15.2 to 5.5 m, bentonite seal to 4.6 m, sand filter and screen from 4.6 to 2.7 m, bentonite to 1.8 m, grout to 0.9 m, bentonite to surface.
BH07-B2	10.7	186.3	Grout from 15.2 to 11.3 m, bentonite seal to 10.7 m, sand filter and screen from 10.7 to 8.8 m, bentonite to 8.2 m, grout to 4.6 m, concrete to surface.
BH07-B4	23.8	175.2	Grout from 45.3 to 25.0 m, bentonite seal to 24.4 m, sand filter and screen from 24.4 to 21.9 m, bentonite to 21.3 m, grout to 3.0 m, sand to 0.9 m, bentonite to 0.45 m, sand to 0.15 m, asphalt to surface.
BH07-B5	9.0	190.0	Grout from 45.5 to 9.0 m, sand filter and screen from 45.5 to 6.2 m, bentonite to 1.1 m, sand to surface.
BH07-B7	7.6	190.6	Grout from 38.7 to 9.1 m, bentonite seal to 7.6 m, sand filter and screen from 7.6 to 5.8 m, bentonite to 4.9 m, grout to 1.5 m, bentonite to surface.
BH07-B8	9.1	189.1	Grout from 41.1 to 11.0 m, bentonite seal to 9.1 m, sand filter and screen from 9.1 to 7.3 m, bentonite to 6.4 m, grout to 1.2 m, bentonite to surface.

TABLE C2: COMPARISON OF FOUNDATION ALTERNATIVES

Footings on Native Soil	Footings on Engineered Fill	Driven Piles	Caissons
<p>Advantages:</p> <ul style="list-style-type: none"> i. Ease of construction. ii. Allows choice of semi-integral or conventional abutment. iii. Lower cost than deep foundations. <p>Disadvantages:</p> <ul style="list-style-type: none"> i. Low geotechnical resistance available on native soil at this site. ii. Potential for post-construction settlement. iii. May require increased bridge span and/or increased abutment height. iv. Excavation within existing embankment fill below creek water level. <p>NOT RECOMMENDED</p>	<p>Advantages:</p> <ul style="list-style-type: none"> i. Would permit use of higher geotechnical resistance than is available on the native soil. ii. Allows choice of semi-integral or conventional abutment. iii. Allows use of perched abutments. iv. Lower cost than deep foundations. <p>Disadvantages:</p> <ul style="list-style-type: none"> i. Cost of constructing engineered fill. v. Potential for post-construction settlement. vi. May require increased bridge span and/or increased abutment height. ii. Excavation within existing dam embankment fill below lake and groundwater level. <p>NOT RECOMMENDED</p>	<p>Advantages:</p> <ul style="list-style-type: none"> i. Piles will develop high geotechnical resistance if driven to refusal on bedrock. ii. Construction of piles could continue in freezing weather. iii. Allows choice of integral, semi-integral or conventional abutment design. iv. Readily installed. v. Bridge span can be minimized. <p>Disadvantages:</p> <ul style="list-style-type: none"> i. Higher unit costs than footings. ii. Possibility that cobbles and boulders may be encountered in existing embankment fill or native sand above bedrock. iii. Downdrag will reduce the capacity of piles. <p>RECOMMENDED</p>	<p>Advantages:</p> <ul style="list-style-type: none"> i. High resistance is available for caissons founded on bedrock. ii. Construction of caissons could continue in freezing weather. iii. Choice of semi-integral or conventional abutment design. <p>Disadvantages:</p> <ul style="list-style-type: none"> i. Possibility of boulders being encountered during augering. ii. Significant depth to bedrock bearing stratum. iii. Steel liner will be required to support caisson excavation sidewalls and reduce seepage into caisson excavation below groundwater level. iv. Difficulty excluding seepage and flow of soil under rim of liner. <p>NOT RECOMMENDED</p>

Appendix D

Special Provisions

SUPPLY AND INSTALLATION OF EMBANKMENT MONITORING EQUIPMENT - Item No.

Special Provision

1.0 GENERAL

1.0.1 Scope

This special provision contains the requirements for the supply and installation of the following geotechnical instrument:

- Settlement Pins (SP)

1.0.2 Purpose

The purpose of these instruments is to directly monitor settlement of the embankment during the preload period following placement of embankment fill at the Beatty Creek bridge.

1.0.3 Personnel

The Contractor shall retain a Geotechnical Consultant with MTO RAQS classification of >Geotechnical (Structures and Embankments) – Medium Complexity=, to undertake the supply and installation of geotechnical instruments.

The Contractor shall be understood to refer to the Contractor and their Geotechnical Consultant.

1.0.4 Or equal

The term, >or equal= shall be understood to indicate that the equal product is the same or better than the specified product in function, performance, reliability, quality and general configuration. Only one supplier should be selected for the supply of vibrating wire instruments (piezometers and settlement cells).

1.0.5 Notification

The Contract Administrator shall be notified a minimum of 15 working days in advance of commencing the installation of instruments.

1.0.6 Submission Requirements

The Contractor shall submit details of the proposed installation methods of all instruments including survey benchmarks and installation schedule to the Contract Administrator, a minimum of 15 days before the start of instrument installation.

1.0.7 Drawings

1.0.8 Subsurface Conditions

The subsurface conditions at the sites are described in the reports:

- Foundation Investigation Report – Beatty Creek Bridge Replacement, Highway 534, G.W.P. 5200-03-00, Site 44-016 by Thurber Engineering Ltd.

1.0.9 Equipment Operation and Weather Conditions

All installation and monitoring equipment and associated materials shall be capable of withstanding the range of temperatures possible for their location within the ground or on the surface. The instruments shall be capable of operating within the manufacturer's stated accuracy throughout the temperature range. Monitoring shall be conducted year round.

1.1. **INSTALLATION**

1.1.1 Instrument Location

Prior to the installation of instruments, the Contractor shall accurately survey and stake the location of each instrument and obtain a ground elevation at each instrument location.

1.1.2 Survey Benchmarks (BM-1)

The Contractor shall provide a minimum of one non-yielding deep seated survey benchmark at the site as specified below. More than one benchmark may be required.

The required number and locations of benchmarks shall be such that direct sighting is possible from all settlement pins (SP) to at least one benchmark.

1.1.3 Accuracy of Surveying for Elevations

Elevations shall be surveyed to an accuracy of ± 2 mm or better.

1.1.4 Materials and Equipment

The Contractor shall supply all materials and equipment required for the installation and monitoring of instrumentation unless otherwise noted.

1.1.5 Underground Utilities

The Contractor shall be responsible for locating and protecting all underground utilities prior to drilling boreholes for installing instruments. Any damage to underground utilities caused by the Contractor's work shall be repaired by the Contractor, at no cost to the Contract Administrator.

1.1.6 Marking and Labelling

The location of any above ground monitoring fixture shall be made clearly visible to nearby traffic before, during and after embankment construction. Marking shall be of sufficient size to be visible from a reversing vehicle and after heavy snow falls.

Instruments shall be clearly labelled in the field, each instrument having a unique identifier. The labelling shall remain legible for at least 2 years, but shall last until the end of construction.

1.1.7 Protection of Instruments

All instruments shall be adequately protected by the Contractor such that they are not damaged during construction. Any instrument damaged by the Contractor's work shall be immediately replaced at the Contractor's cost.

1.1.8 Boreholes

The Contractor shall make a basic stratigraphic log of boreholes as they are being drilled for installation of instruments. In-situ or laboratory testing is not required.

Boreholes shall be advanced using conventional drilling methods and shall be as straight and vertical as practicable.

1.1.9 Installation Program

Instrument installation shall be completed immediately upon completion of preload embankment construction.

5.0 SETTLEMENT PINS (SP) - SUPPLY & INSTALLATION

5.1 GENERAL

5.1.1 Scope

This section contains the requirements for the supply and installation of settlement pins.

The purpose of the settlement pin is to directly monitor settlement of the embankment. Settlement is measured by survey of the top of the pin with reference to stable non-settling benchmarks.

5.1.2 General Procedure

The settlement pins shall be cast into concrete at the top of the embankments, as per attached drawings.

The concrete will be cast in-situ in an approximate 0.5 m deep hole dug at the specified locations.

5.1.3 Location

The locations of the settlement pins are as follows:

Stations 19+025, 19+050, 19+100, 19+125, 19+150
Offset: 5.0 m Left

5.2 MATERIALS

5.2.1 General

The Contractor shall supply all materials and equipment required for the installation of the settlement pins.

5.2.2 Concrete

The Contractor shall supply concrete (OPSS 1350) with strength and set time sufficient to secure the settlement pin within two days of placing.

5.2.3 Pin

The Contractor shall supply a 25.4 mm minimum diameter reinforcing steel bar (OPSS 905) cut to a length of 0.4 m.

The top of the reinforcing steel bar shall be angled or rounded in such a way that a single survey point can be clearly identified and repeated.

5.3 INSTALLATION

5.3.1 General

The Contractor shall install settlement pins as per the drawings provided.

5.4 COORDINATION WITH MONITORING

5.4.1 Notification

The Contractor shall notify the Contract Administrator no later than three days after installing a settlement pin. At this time, the Contractor shall also supply the following information to the Contract Administrator.

- Settlement pin location, easting, northing;
- Elevation of top of pin;
- Dates of installation and datum readings;
- Installation notes / sketches.

5.4.2 Monitoring

Monitoring of the settlement pins shall be carried out by others. Monitoring shall be conducted during the embankment and surcharge construction. The Contractor shall provide installation information as specified above and provide access to the settlement pins for monitoring.

9.0 PAYMENT

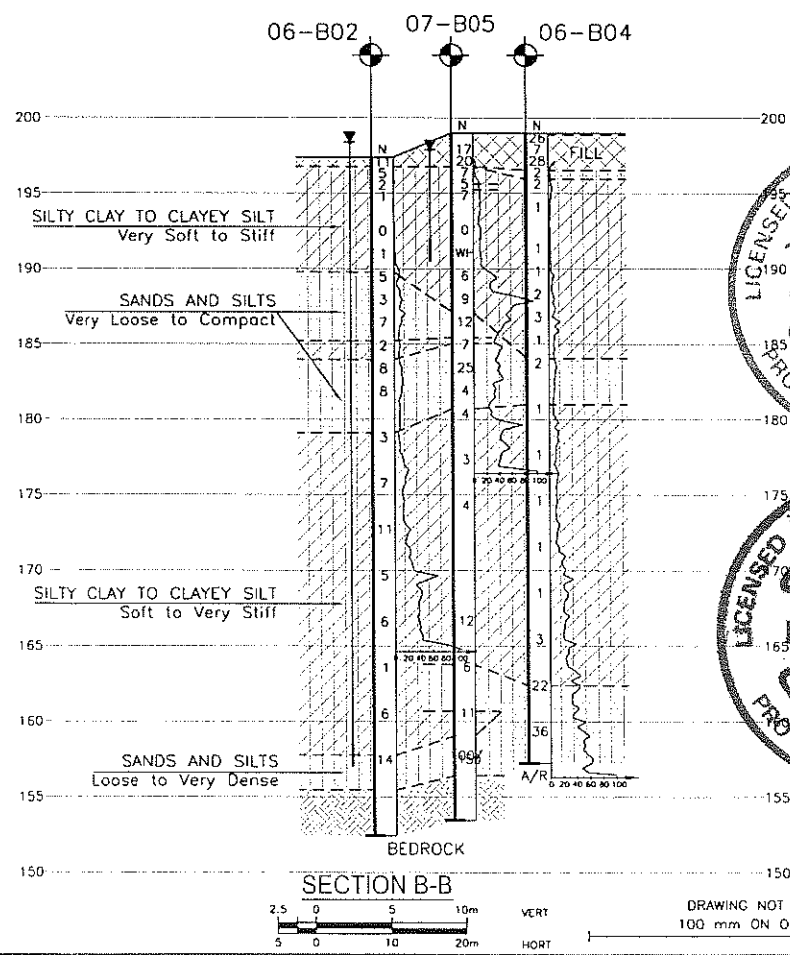
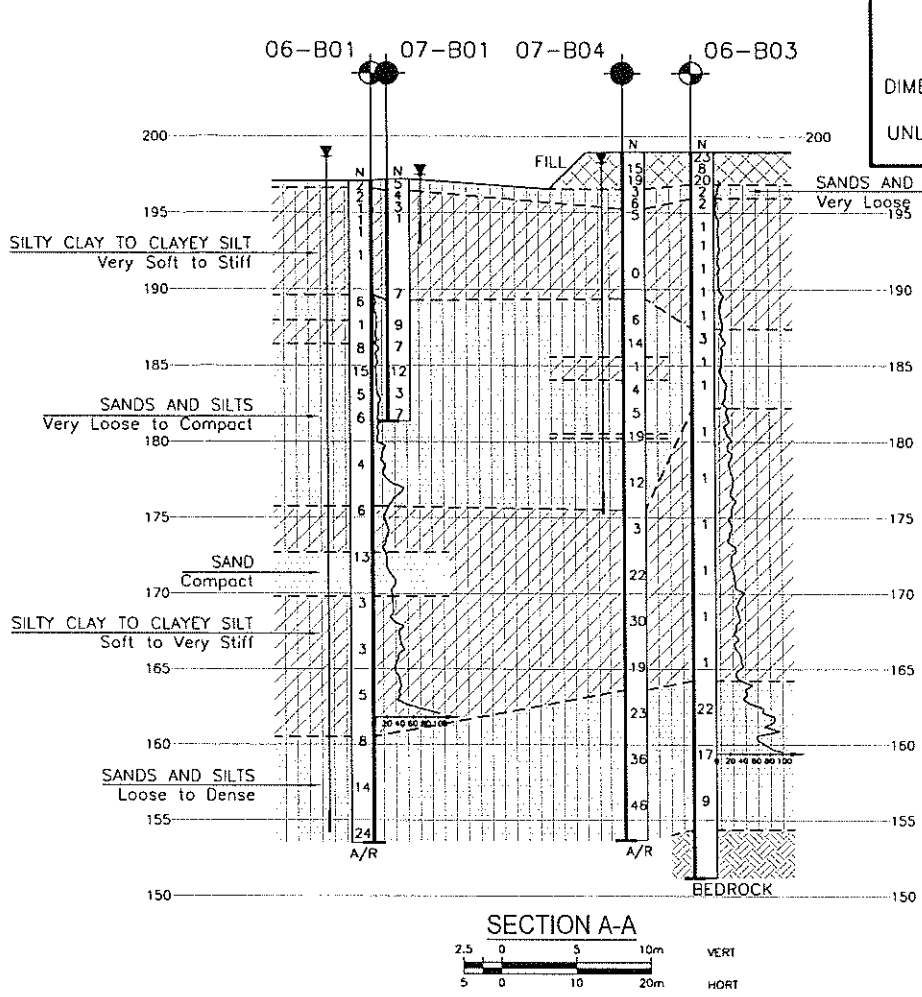
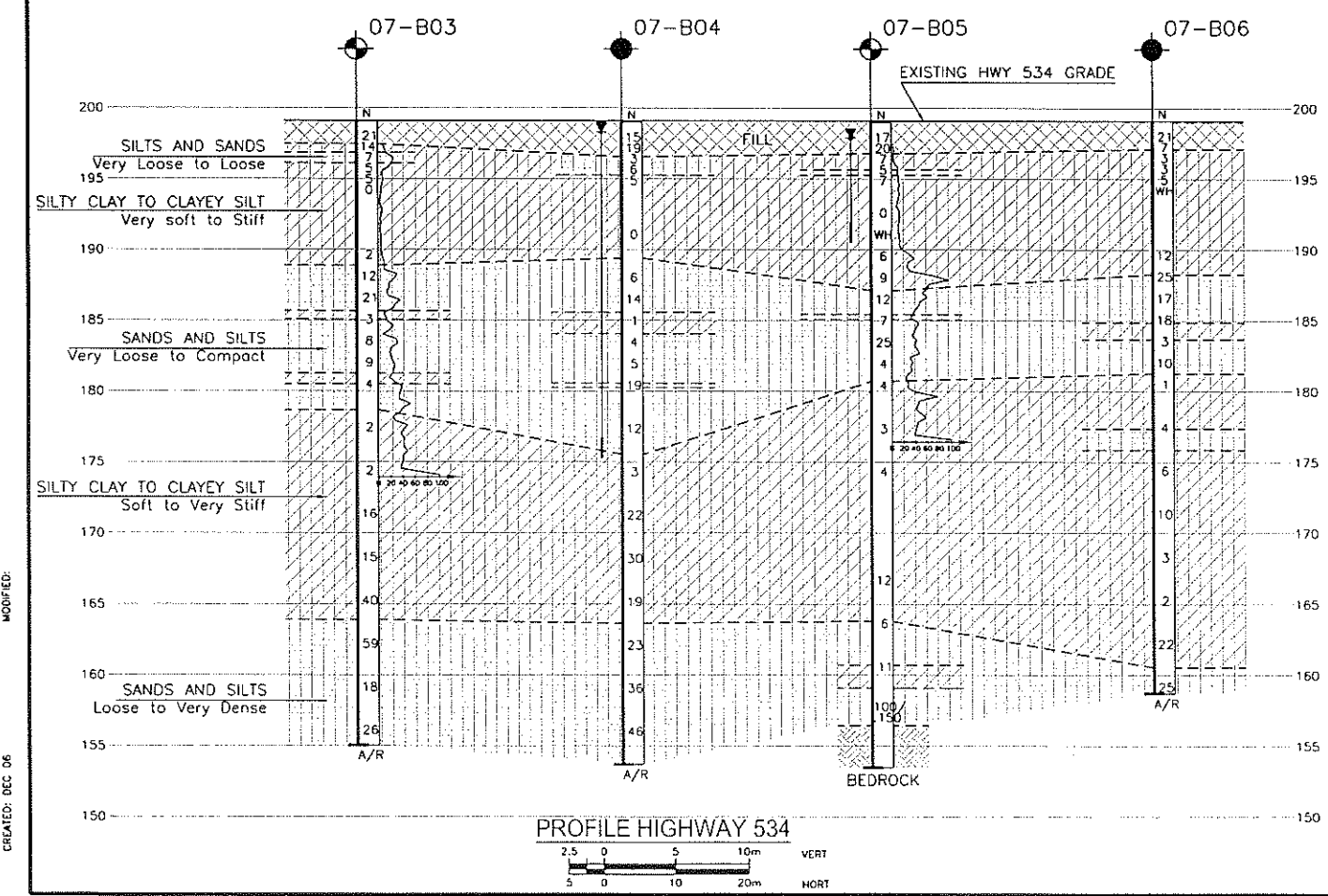
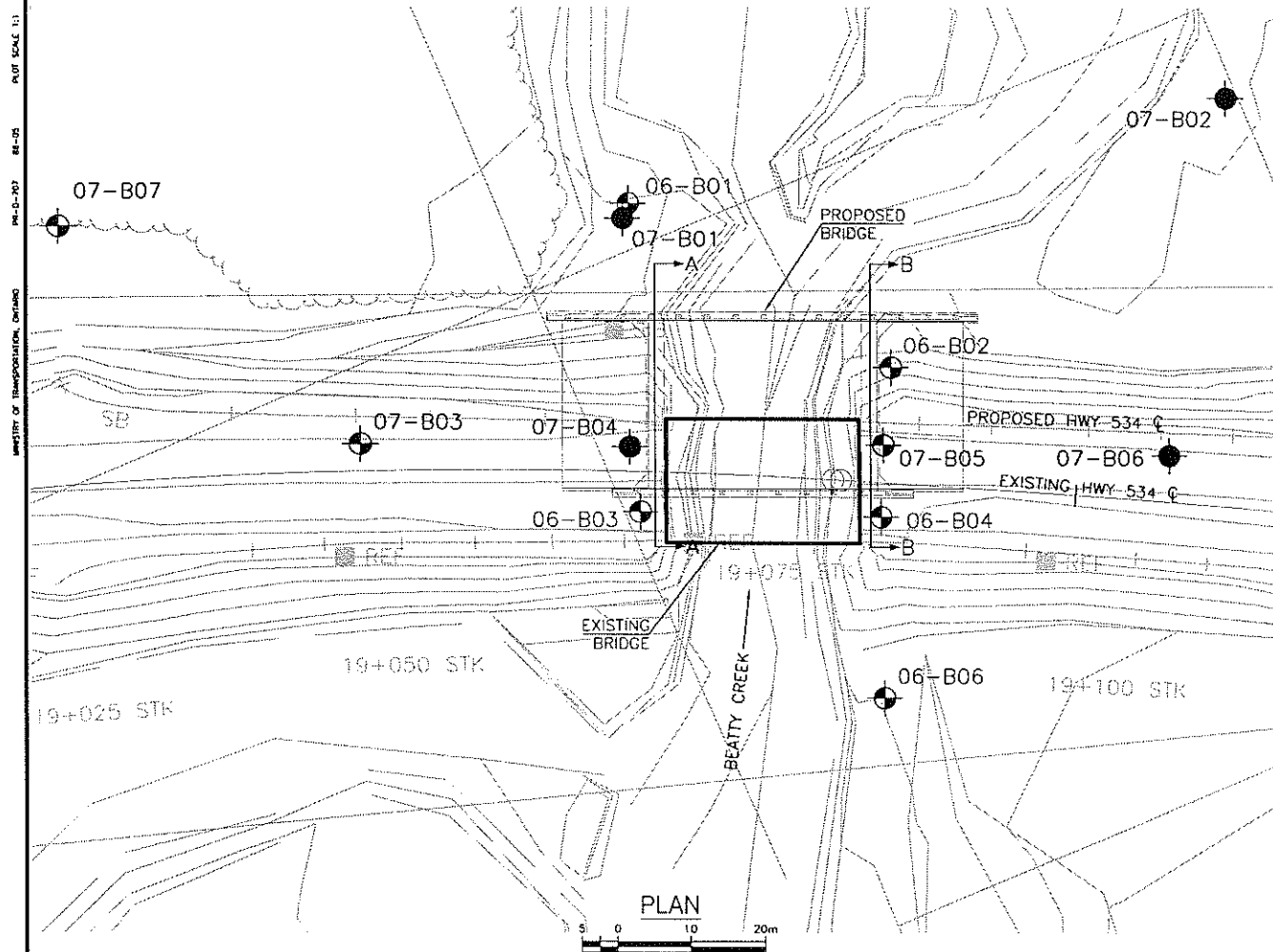
9.1 BASIS OF PAYMENT

Payment at the Lump Sum price for this tender item shall be full compensation for all labour, monitoring equipment and material to do the work.

Appendix E

Borehole Locations and Soil Strata Drawings

MIN. D-307 RE-05
MIN. D-307 RE-05
MIN. D-307 RE-05



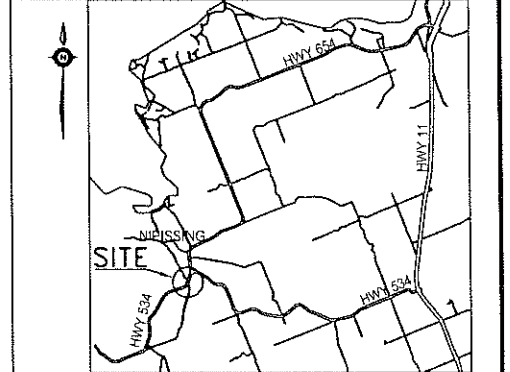
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CONT No
GWP No.5200-03-00

HIGHWAY 534
BEATTY CREEK BRIDGE
REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

MCCORMICK RANKIN CORPORATION

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS



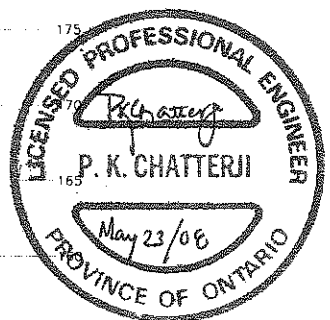
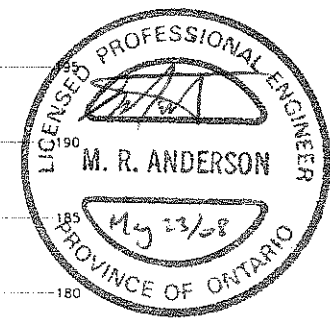
KEYPLAN
LEGEND

- Borehole
- Borehole and Cone
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60' Cone, 475J/blow)
- PH Pressure, Hydraulic
- Water Level
- Head Artesian Water
- Piezometer
- 90% Rock Quality Designation (ROD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
06-B01	197.1	5 105 308.55	303 697.02
06-B02	197.4	5 105 320.69	303 714.37
06-B03	199.0	5 105 301.00	303 716.81
06-B04	199.0	5 105 316.00	303 723.57
06-B06	197.0	5 105 311.29	303 735.18
06-B07	197.9	5 105 093.68	303 642.56
06-B08	198.0	5 105 196.21	303 667.23
06-B09	198.1	5 105 202.30	303 701.05
06-B10	199.5	5 105 376.19	303 758.13
07-B01	197.2	5 105 307.80	303 697.80
07-B02	197.0	5 105 349.20	303 706.40
07-B03	199.1	5 105 285.10	303 705.00
07-B04	199.0	5 105 302.10	303 712.40
07-B05	199.0	5 105 318.10	303 719.10
07-B06	199.1	5 105 335.90	303 727.40
07-B07	198.2	5 105 271.90	303 683.20
07-B08	198.2	5 105 376.10	303 735.30
07-B09	200.3	5 105 413.50	303 761.10

-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.

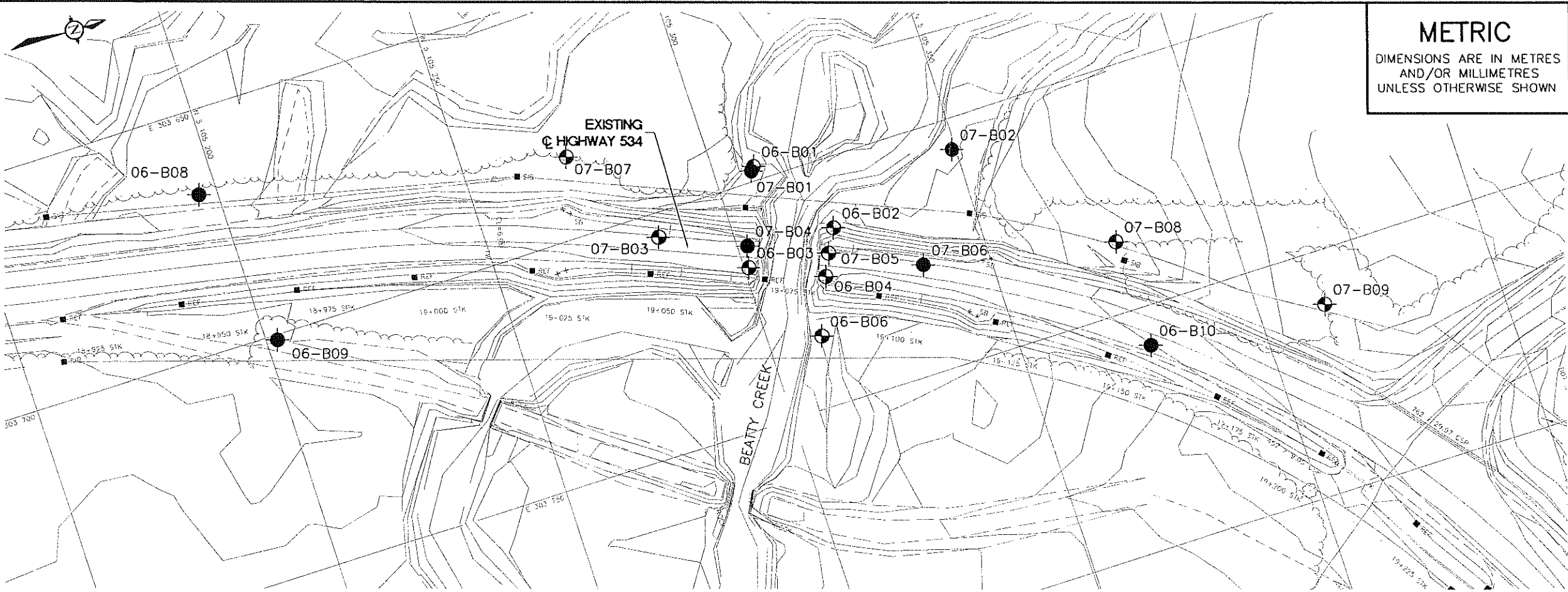
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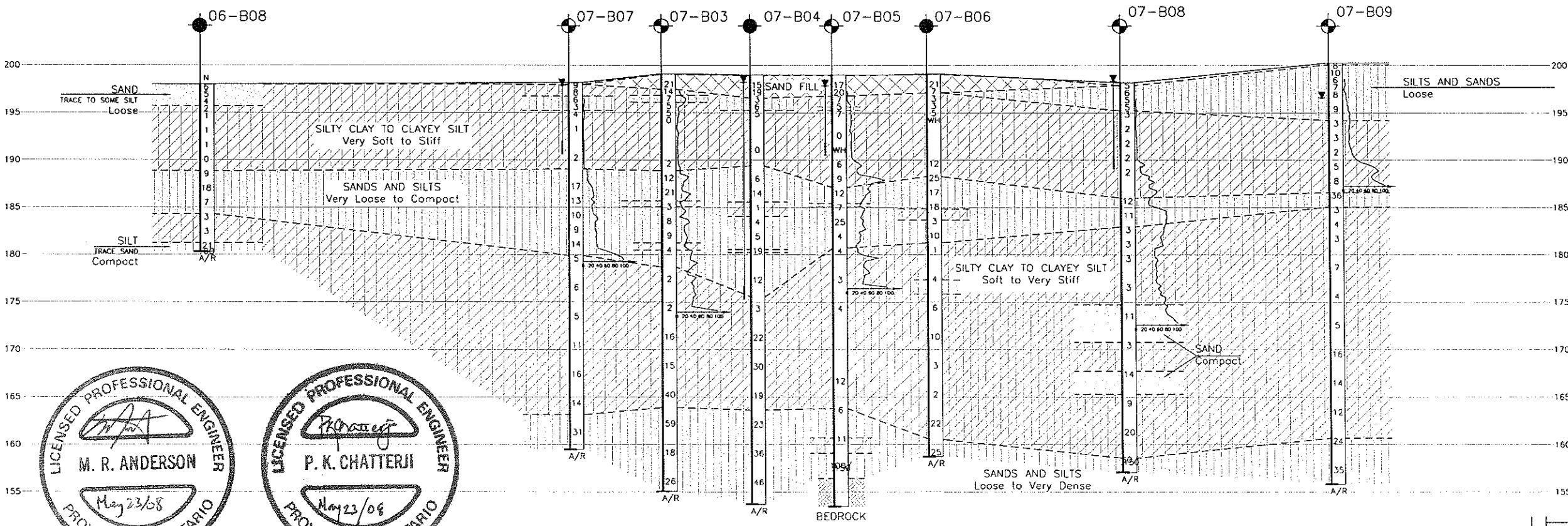
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PR-D-207
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PLOT SCALE 1:1



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PROFILE HIGHWAY 534
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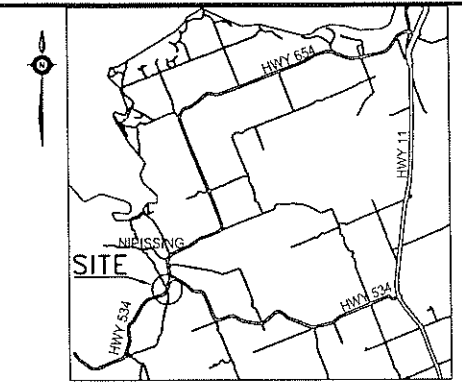
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GWP No.5200-03-00

HIGHWAY 534
BEATTY CREEK BRIDGE
REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

McCORMICK RANKIN
CORPORATION

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

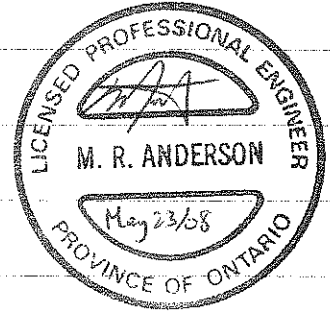


KEYPLAN
LEGEND

- Borehole
- Borehole and Cone
- N
Blows /0.3m (Std Pen Test, 475J/blow)
- CONE
Blows /0.3m (60' Cone, 475J/blow)
- PH
Pressure, Hydraulic
- Water Level
- Head Artesian Water
- Piezometer
- 90%
Rock Quality Designation (RQD)
- A/R
Auger Refusal

NO	ELEVATION	NORTHING	EASTING
06-B01	197.1	5 105 308.55	303 697.02
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07-B09	200.3	5 105 413.50	303 761.10

- 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. 31L-120



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