

**DETAIL**  
**FOUNDATION INVESTIGATION AND DESIGN REPORT**  
**LITTLE WHITE RIVER II BRIDGE REPLACEMENT**  
**HIGHWAY 546, DISTRICT OF ALGOMA**  
**G.W.P. 512-00-00, W.P. 513-00-01, SITE: 38S-056**

**Geocres Number: 41J-76**

**Report to**

**MMM Group**

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**PART A: FOUNDATION INVESTIGATION REPORT**

**1 INTRODUCTION**

This report presents the factual findings obtained from a foundation investigation conducted at the site of the proposed replacement bridge to carry Highway 546 over the Little White River in Algoma, Ontario.

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, records of boreholes, stratigraphic profile and cross-sections, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions was developed from the data obtained in the course of the investigation.

A Preliminary Foundation Investigation was completed by Thurber in the spring of 2007. The factual information obtained in the course of that investigation has been combined with that obtained in the course of the current investigation.

A previous investigation was reported in 2004 by Golder Associates Ltd. related to the replacement of the existing temporary modular bridge (TMB). The factual data from that investigation is included in Appendix C and has been considered in the analysis and preparation of recommendations contained in this report.

Thurber carried out the investigation as a sub-consultant to MMM Group, under the Ministry of Transportation Ontario (MTO) Agreement Number 5005-E-0042.

**2 SITE DESCRIPTION**

The site is located on Highway 546 approximately 50 km north of Highway 17 and 1.4 km south of the junction with Highway 639. In general, the Little White River flows towards the southwest, paralleling Highway 546 and joining the Mississagi River near Wharncliffe, approximately 40 km to the south. At the site, the river crosses northwest to southeast (project west to east) under the highway.

The river flows on a relatively gentle gradient at the site, with poorly developed meanders. The channel is approximately 21 m wide and 3 m deep (in the middle of the channel). The river banks are approximately 2 m high at the site, though higher, actively eroding banks were observed approximately 200 m upstream from the existing crossing. The river level was recorded as Elevation 297.2 m in October 2006.

Photographs of the site are included in Appendix D and show the existing bridge, the approaches and the soil exposure upstream from the bridge (in the background of Photo 1, just below the “Little White River” sign).

Geologically, the site lies within the Canadian Shield, which is characterized by Pre-Cambrian bedrock. Locally, however, the Little White River flows across post-glacial deposits of sand and gravel and the area is comparatively flat and well treed. There are no buildings or other developments in the immediate vicinity of the site.

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

Site investigation and testing for this project included preliminary and detailed design stages:

- During the preliminary investigation, six foundation boreholes (numbered 07-LW1 to 07-LW6) were drilled on three alternative bridge alignments and eight boreholes (07-LW7 to 07-LW14) were drilled along the proposed embankment. The depths of these boreholes ranged from 23.2 to 32.3 m at the structure and 2.9 to 3.7 m at the embankment. The fieldwork for the preliminary investigation was carried out during the period February 19 to March 17, 2007.

Logs for all boreholes drilled during the preliminary investigation have been included in this report for reference, though boreholes 07-LW5 and 07-LW6 are the most relevant to the foundations on the selected alignment.

- Investigation for detail design consisted of ten sampled boreholes (numbered 07-LW15 through 07-LW24) drilled to depths of 8.2 to 11.3 m at the structure and approaches to supplement those drilled during the preliminary investigation. The fieldwork for detail design was carried out during the period September 12 to September 20, 2007.

The approximate locations of the boreholes are shown on the attached Borehole Locations and Soil Strata Drawings in Appendix F. The Record of Borehole sheets are included in Appendix A.

Prior to commencing the site investigation, clearance was obtained from utility companies having plant in the area.

A combination of hollow-stem auger drilling and NW casing techniques were used to advance the boreholes. Samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in the overburden soils. Dynamic Cone Penetration Testing (DCPT) was undertaken adjacent to eight of the boreholes.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. At each foundation location, one or more standpipe piezometers consisting of 19 mm PVC pipe with a slotted screen were installed and enclosed in filter sand to permit longer term groundwater level monitoring. Boreholes without piezometer installations were grouted with bentonite upon completion, or backfilled with drill cuttings if less than 3 m deep. The completion details of the piezometers and boreholes are shown in Table 3.1.

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

**Table 3.1 – Borehole Completion Details**

<b>Borehole Location</b>	<b>Piezometer Tip Depth/ Elevation (m)</b>	<b>Completion Details</b>
07-LW1 South Foundation	29.9 / 270.0	Piezometer with 1.5 m slotted screen installed with sand filter to 27.8 m, bentonite seal from 27.8 m to ground surface.
07-LW2 North Foundation	22.8 / 275.8	Piezometer with 1.5 m slotted screen installed with sand filter to 21.0 m, bentonite seal from 21.0 m to ground surface.
07-LW5 South Foundation	30.5 / 270.2	Piezometer with 1.5 m slotted screen installed with sand filter to 28.4 m, bentonite seal from 28.4 m to ground surface.
07-LW6 North Foundation	24.4 / 273.3	Piezometer with 1.5 m slotted screen installed with sand filter to 22.9 m, bentonite seal from 22.9 m to ground surface.
07-LW15 South Foundation	10.7 / 289.9	Piezometer with 1.5 m slotted screen installed at 10.7 m with sand filter to 8.1 m, bentonite seal to 6.7 m, grout to 0.6 m and sand to ground surface.
07-LW17 North Foundation	11.3 / 287.0	Piezometer with 1.5 m slotted screen installed at 11.3 m with sand filter to 9.3 m, bentonite seal to 8.3 m, grout to 0.6 m and sand to ground surface.
07-LW3 07-LW4	No Installation	Bentonite grout to ground surface.
07-LW7 to 07-LW-14	No Installation	Bentonite grout to depths of 0.3 to 0.6 m, auger cuttings to ground surface.
07-LW16 07-LW18 to 07-LW-24	No Installation	Bentonite grout to depths of 0.3 to 0.6 m, auger cuttings to ground surface.

#### 4 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. The results of this testing are shown on the Record of Borehole sheets in Appendix A.

Selected samples were subjected to gradation analysis and the results of this testing program are shown on the Record of Borehole sheets in Appendix A and on the figures contained in Appendix B. A summary of the results is provided in the following section.

## **5 DESCRIPTION OF SUBSURFACE CONDITIONS**

Reference is made to the Record of Borehole sheets in Appendix A. Details of the encountered soil stratigraphy along the bridge and embankment alignments are presented in this appendix and on the “Borehole Locations and Soil Strata” drawings in Appendix F. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.

The description presented below relates to the selected alignment and is based on the boreholes specifically drilled on that alignment (boreholes 07-LW5, 07-LW6, 07-LW10, 07-LW-11 and 07-LW15 to 07-LW24).

The soil encountered in the boreholes consists primarily of a deep deposit of sand with layers grading from sand and gravel to sandy silt. On and adjacent to the existing highway alignment, the sand is overlain by granular fill forming the existing road embankments. On the north side of the river, the upper portion of the sand contains organics and appears to comprise alluvial material.

### **5.1 Topsoil**

A layer of topsoil or organic material was encountered at 8 of 14 locations drilled along the proposed alignment. This material ranged from peaty deposits near the river to sandy topsoil above the riverbank. The topsoil/organic layer ranged in thickness from 75 to 200 mm.

The topsoil thickness may vary between and beyond the borehole locations and the data is not intended for the purpose of estimating quantities.

### **5.2 Sand Fill**

Sand fill, grading locally to sand and gravel fill, was encountered at the south foundation and in three other boreholes along both embankments. The sand was typically described as brown and moist, with trace to some gravel and occasional cobbles.

SPT N-values obtained in the fill ranged from 19 to 106 blows/0.3 m, indicating a compact to very dense condition. In some cases, the high SPT values may reflect the presence of cobbles or boulders.

Moisture contents ranged from approximately 2 to 16 %.

The fill ranged in thickness from 0.2 to 2.4 m. The underside of the fill was recorded at elevations 297.3 to 299.9 m, generally rising towards the south.

### **5.3 Sand with Layers of Sandy Silt to Sand and Gravel**

The soils encountered below the topsoil and fill predominantly consisted of sand with a trace of gravel and silt. The sand contains deposits grading locally from sandy silt to sand and gravel, as well as cobbles and boulders. The sand was described as brown and moist,

becoming grey and wet with depth in some boreholes, or grey and wet for the full depth of drilling in other boreholes.

Organics comprising decayed wood, roots and/or peat were observed in the upper part of the sand deposit in the boreholes drilled on the north side of the river. The organic material extended to depths of about 2.2 to 4.1 m (elevation 294.0 to 296.6 m, locally elevation 298.4 m in approach borehole 07-11). This zone appears to comprise alluvial material deposited in a former river meander.

SPT N-values obtained in the sand deposit varied widely from one blow/0.3 m to 100 blows/0.15 m, indicating very loose to very dense conditions. The loose to very loose conditions were typically encountered in the upper alluvial part of boreholes drilled on the north side of the river, extending to depths ranging from 2.2 to 5.7 m (elevation 292.4 to 298.4 m). In some cases, the high SPT values may reflect the presence of cobbles or boulders.

The results of laboratory tests carried out on 31 samples were as follows:

	Sand (21 samples)	Sand and Gravel (6 samples)	Silty Sand to Sandy Silt (4 samples)
Gravel (%)	0 to 20	29 to 68	0 to 7
Sand (%)	80 to 99	31 to 69	29 to 75
Silt (%)	0 to 8	1 to 5	18 to 66
Clay (%)	-	-	2 to 5

The grain size distribution curves for the samples tested are shown in Figures B2 to B10 and B13 to B15 in Appendix B.

The natural moisture content generally ranged from 2 to 28%. Higher moisture contents of 30 to 64% were measured in the upper alluvial zone containing organics on the north side of the river.

All boreholes except borehole 07-LW22 were terminated in the sand deposit at depths of 3.7 to 32.3 m (elevation 268.4 to 297.5 m).

#### **5.4 Silt to Clayey Silt**

A layer of cohesive silt to clayey silt was encountered in two boreholes drilled at the north approach. In borehole 07-LW6, the silt layer was 0.8 m thick with an underside at elevation 290.2 m. Borehole 07-LW22 was terminated 1.4 m into the clayey silt at a depth of 8.2 m (elevation 289.9 m).

A single SPT value of 26 blows/0.3 indicates that the silt is very stiff.



The grain size curve for the sample tested is shown in Figure B16, Appendix B. The results of a laboratory test carried out on a sample were as follows:

Gravel (%)	0
Sand (%)	2
Silt (%)	79
Clay (%)	19

Moisture contents of 19 to 23% were measured in the clayey silt.

## 5.5 Groundwater Conditions

Standpipe piezometers were installed in selected boreholes and water levels were measured after completion of drilling, prior to demobilization from the site. The levels in the piezometers installed during the preliminary investigation were also measured. The water level readings are presented in Table 5.1.

**Table 5.1 – Water Level Measurements**

Location	Borehole	Tip Depth (m)	Date	Water Level (m)	
				Depth	Elevation
South Foundation	07-LW5	30.5	15-Mar-07	3.7	297.0
			12-Sep-07	3.4	297.3
	07-LW15	10.7	13-Sep-07	3.5	297.1
North Foundation	07-LW6	24.4	08-Mar-07	0.8	296.9
			12-Sep-07	0.3	297.4
	07-LW17	11.3	20-Sep-07	1.2	297.1

The water level in Little White River, shown on the road profile drawing, is elevation 297.2 m. Based on the short-term piezometer readings, the groundwater level is near the water level in the river. The water table will be strongly influenced by the level of the river and will fluctuate seasonally and after severe weather events.

## 6 MISCELLANEOUS

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

The drilling and sampling operations in the field were supervised on a full time basis by Mr. Stephane Loranger and Mr. George Azzopardi of Thurber.

The coordinates for the boreholes and the ground surface elevations were provided by MMM Group.

Mr. Murray Anderson, P.Eng., prepared the Foundation Investigation Report. Mr. Alastair Gorman, P.Eng. directed the field operations and reviewed the report. Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations projects, also reviewed the report.

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**PART B: FOUNDATION DESIGN REPORT**

**7 GENERAL**

This report presents interpretation of the geotechnical data in the factual report and presents geotechnical design recommendations to assist the design team to select and design a suitable foundation system and approach embankments for the new bridge structure.

It is understood that Highway 546 will cross the Little White River on a single-span temporary modular bridge (TMB) that will lie on a new alignment approximately 7.75 m east of the existing bridge.

It is anticipated that the grade of the highway as it crosses the new structure will be approximately Elevation 300.5 m. The resulting approach embankments will be up to approximately 1.5 m above the original ground level at the south and up to about 2.5 m above original ground at the north.

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 this investigation.

**8 STRUCTURE FOUNDATIONS**

The stratigraphy identified during the foundation investigation consists primarily of a deep deposit of sand with layers grading from sand and gravel to sandy silt. On and adjacent to the existing highway alignment, the sand is overlain by granular fill forming the existing road embankments. On the north side of the river, the upper 2.2 to 5.7 m of the sand contains organics, is loose to very loose, and appears to be of alluvial origin.

The existing temporary modular bridge (TMB) is supported on timber cribs as shown in Photo 1 in Appendix D. These crib foundations appear to be performing satisfactorily. The approach spans from the ends of the TMB to the river bank are assumed to be supported on shallow footings or sleepers that are not readily visible.

In the preparation of the geotechnical design recommendations, consideration has been given to the following foundation types:

- Spread footings bearing on native soil
- Spread footings on engineered fill
- Crib foundations
- Steel H-piles driven into very dense soil
- Drilled shafts founded in very dense soil

A comparison of the foundation alternatives based on advantages and disadvantages of each is included in Appendix D. While deep foundations are a viable alternative at this site, it is recognized that spread footings may provide the more cost effective solution for support of a TMB.

We understand that the bridge will be in use for longer than three years and therefore the use of a crib foundation is not recommended. If employed, a TMB on crib foundations should be constructed in accordance with OPSS 918 and OPSS 907.

## **8.1 Spread Footings**

Spread footings founded on native soil are generally the most cost effective form of foundation for the support of a TMB. At the south foundation, the native soil typically consists of compact sand and is considered capable of supporting spread footings. However at the north foundation, the upper 2.2 to 3.4 m of native sand, extending to depths of some 1.7 to 2.3 m below the normal water level in the adjacent river, is in a loose to very loose condition and spread footings on native ground are not recommended.

Recommendations for design of spread footings on native soil at the south foundation and on engineered fill at the north foundation are presented in the sections below. In the discussions, it is anticipated that the design founding level for the footings will be at elevation 299.0 m. The footing design must incorporate provisions to prevent the footings from being undermined by scour.

### **8.1.1 South Foundation**

At the south foundation (boreholes 07-LW5, 07-LW15 and 07-LW16), the soil at the assumed founding level of elevation 299.0 m comprises compact native sand overlain in two boreholes by 0.2 to 0.7 m of existing sand fill. Construction of spread footings on the existing dense to very dense fill and compact native sand at this level is considered feasible.

Assuming a minimum 2.5 m wide footing, the recommended geotechnical resistances to be used for design of the south footing are 350 kPa at factored ULS and 150 kPa at SLS. These values take into account the slope of the river channel in front of the foundation,

assuming a 2H:1V slope in front of the footing and a minimum 2.0 m horizontal distance between the forward edge of the footing and the slope face at the footing base level.

To achieve higher resistance values, excavation of the existing fill and native soil and replacement with a uniform pad of granular engineered fill could be considered to support the footing. The recommended geotechnical resistances for the south footing, constructed near the channel slope on a 1.5 m thick pad of engineered fill with a base near elevation 297.5 m, are 450 kPa at factored ULS and 200 kPa at SLS.

The stated bearing resistances are for vertical, concentric loads. In the case of eccentric or inclined loading, the geotechnical resistance must be calculated as illustrated in the CHBDC, 2006 Clause 6.7.3 and Clause 6.7.4.

The coefficient of sliding resistance to use in design is 0.55.

### **8.1.2 North Foundation**

In the vicinity of the north foundation (boreholes 07-LW6, 07-LW17 and 07-LW18), the native soil is in a loose to very loose state to depths of approximately 2.2 to 3.4 m (elevation 294.9 to 295.5 m), some 1.7 to 2.3 m below the normal water level in the river.

Excavation of the loose to very loose sand to construct footings in the underlying compact to very dense sand is not considered practical due to the need for excavation shoring and dewatering below the river water level. For this reason, spread footings on native soil are not recommended for the north foundation.

Construction of footings on a 2.0 m thick pad of granular engineered fill may be considered. The base of the engineered fill should be maintained above elevation 297.2 m to avoid excavation below the groundwater level. To reduce post-construction settlement in the loose to very loose sand remaining below the base of the fill pad, placement of a temporary surcharge is recommended in conjunction with engineered fill construction. The recommended procedure for construction of the engineered fill pad is as follows:

1. Excavate the existing soil from the north foundation area to the groundwater level prevailing at the time of construction, expected to be at approximate elevation 297.2 m.
2. Place a 1.0 m thickness of free draining Granular A fill before attempting compaction.
3. Continue placing compacted granular fill to elevation 302.0 m.
4. Maintain the full height of fill in place for at least 2 weeks.
5. Remove the fill surcharge and excavate to the founding level, elevation 299.0 m, and construct the footing.

It is recommended that a minimum 2.5 m wide footing constructed on a 2.0 m thick pad of engineered fill as outlined above be designed using a factored resistance at ULS of 350 kPa and a resistance at SLS of 150 kPa. These values take into account the slope of the river channel in front of the foundation, assuming a 2H:1V slope in front of the footing and a minimum 2.0 m horizontal distance between the forward edge of the footing and the slope face at the footing base level.

The engineered fill must consist of OPSS Granular A compacted to 100% of its SPMDD at  $\pm 2\%$  of optimum moisture content and generally conforming to the geometry illustrated in Figure 1, Appendix D.

The stated bearing resistance is for vertical, concentric loads. In the case of eccentric or inclined loading, the geotechnical resistance must be calculated as illustrated in the CHBDC, 2006 Clause 6.7.3 and Clause 6.7.4.

The coefficient of sliding resistance to use in design is 0.55.

## 8.2 Steel H-Piles

The foundations may be supported on steel H-piles bearing in the very dense native soil.

It is recommended that the H-piles be founded in very dense native sand as recommended in Table 8.2 below. The pile tips should be at least 6 m below the depth of scour likely to be developed at the site within the design life of the structure.

### 8.2.1 Axial Resistance

The following geotechnical resistances are recommended for design of piles founded in the very dense native soils:

**Table 8.1 – Pile Geotechnical Resistance**

Pile Section	Geotechnical Resistance (kN)	
	Factored ULS	SLS (25 mm settlement)
HP 310 X 110	1 600	1 400
HP 360 X 132	1 800	1 600

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

The highest recommended tip elevations for the H-piles are as follows:

**Table 8.2 – Pile Tip Elevations**

	Highest Pile Tip Elevation
North Foundation	275 m
South Foundation	270 m

The elevation at which the design capacity is achieved is expected to vary and in some cases a pile may encounter refusal on cobbles and boulders. The pile tip elevations shown above should be used for cost estimating purposes only. The actual pile tip elevations will be controlled as described in Section 8.3.2 Pile Installation.

The tip elevations are based on the present depth of the river channel. If hydraulic analysis shows that significant scour may develop, the elevations should be lowered accordingly.

### 8.2.2 Pile Installation

Pile installation should be in accordance with Special Provision No. 903S01.

Pile driving should be controlled by the Hiley Formula and an ultimate pile resistance to be specified by the designer in accordance with Clause 3.3.2 (b) Construction Stage of the Structural Manual. The appropriate pile driving note is "Piles to be driven in accordance with Standard SS 103-11 using an ultimate resistance of "R" kN per pile". "R" must have minimum values shown of 3,200 kN for HP 310x110 and 3,600 kN for HP 360x132.

Due to the presence of cobbles and boulders, the tips of all piles should be fitted with H-section driving shoes as per OPSD 3000.100.

### 8.2.3 Downdrag

Downdrag on the piles is not an issue at this site.

### 8.2.4 Lateral Resistance of Piles

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:

$$k_s = n_h \cdot z / D \quad (\text{kN/m}^3)$$

$$p_{ult} = 3 \cdot \gamma \cdot z \cdot K_p \quad (\text{kPa})$$

where

$z$  = depth of embedment of pile in metres

$D$  = pile width in metres

$n_h$  = coefficient of horizontal subgrade reaction (Table 8.3)

$\gamma$  = unit weight (Table 8.3),  
use submerged weight below river level

$K_p$  = passive earth pressure coefficient (Table 8.3)

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/m<sup>3</sup>),  $D$  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 8.3 – Parameters for Lateral Pile Resistance**

Location	Elevation (m)	$n_h$ (kN/m <sup>3</sup> )	$K_p$	Unit Weight (kN/m <sup>3</sup> )
South Foundation	OGL to 297	8,000	3.5	21
	297 to 270	6,000	3.5	11
North Foundation	OGL to 297	2,500	2.9	20
	297 to 295	1,500	2.9	10
	295 to 275	6,000	3.5	11

The total horizontal passive resistance of a single pile used in design should not exceed the following values:

**Table 8.4 – Maximum Horizontal Passive Resistance of Piles**

Foundation	Pile	Maximum Passive Resistance (kN)	
		Factored ULS	SLS
South	HP 310X110	120	50
	HP360X132	160	60
North	HP 310X110	110	50
	HP360X132	150	50

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 8.5. Intermediate values may be obtained by linear interpolation.

**Table 8.5 – 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 breadth of pile

In the case of conventional abutments, i.e. not integral, horizontal loads may be resisted by means of battered piles.



### **8.3 Drilled Shafts**

Initial consideration was given to the use of drilled shafts to support the structure. However, the use of drilled shafts is not recommended for the following reasons:

1. Drilled shafts are not cost-effective for a TMB foundation at this site.
2. Based on the available information from the investigation, the drilled shaft piles would be founded in cohesionless soils below the water table. Drilling with mud and/or the simultaneous advance of a steel liner would be required in order to maintain stable sides.
3. It would not be possible to unwater the shaft, necessitating placement of concrete by tremie methods, and preferably by pumping.
4. There is a high risk that the geotechnical resistance of the soil would be compromised due to disturbance of the founding soil caused by drilling below the groundwater level.

In view of these potential problems and in the absence of any significant technical advantage, drilled shafts are not recommended and were not analyzed.

### **8.4 Recommended Foundation**

For the purpose of supporting a TMB, and on the assumption that jacking and levelling of abutments are acceptable, the recommended foundation type is spread footings on native soil/existing fill at the south foundation and on engineered fill at the north foundation.

### **8.5 Scour and Frost Protection**

Scour and riverbank protection must be provided to prevent channel erosion and undermining of footings and pile caps. Design of the scour and erosion protection measures must consider hydrologic and hydraulic concerns and should be carried out by specialists in these fields.

Assuming that jacking and levelling are of abutments acceptable for a TMB, frost protection is not considered to be an issue. If pile caps or footings requiring frost protection are planned, the depth of earth cover required at this site is 2.0 m.

It is possible to reduce the thickness of earth cover by the substitution of synthetic insulation, with 25 mm of rigid, extruded polystyrene insulation being equivalent to 600 mm of earth cover. Synthetic insulation must be covered to provide protection where it is used.

## **9 EXCAVATION**

Excavation for foundation construction is expected to extend to a maximum depth of 3.5 m below the existing road grade and be maintained above the typical river water level of Elevation 297.0 m. All excavation must be carried out in accordance with the Occupational Health and Safety Act (OHSA). For the purposes of the OHSA, the soils within the probable depth of excavation at this site may be classed as Type 3 soils above the water table. Excavation slopes should not be steeper than 1V:1H above the groundwater level.

Excavation below the groundwater level without prior dewatering is not recommended since the inflow of groundwater will cause boiling and sloughing of the soil below the water table making it difficult to maintain a dry, sound base on which to work.

If excavation will be extended below the natural groundwater level, the groundwater must be depressed to a level below the deepest excavation level sufficient to maintain a stable base and prevent soil disturbance by construction traffic. Due to the proximity of the river, control of groundwater in an open excavation will be difficult and consideration may have to be given to excavating inside a cofferdam.

The design of the cofferdam or alternate shoring method is the responsibility of the Contractor. The Contract Documents should alert him to the requirement to maintain a stable excavation and to the fact that any shoring system should be designed by a specialist, taking account of the need to control groundwater and prevent basal instability within the excavation.

## **10 UNWATERING**

Considering the recommended foundation type (spread footings), it is anticipated that excavation at the foundations will not extend below the groundwater level.

If excavation below the groundwater level is required, the design of any unwatering system should be the responsibility of the Contractor and the Contract Documents should alert him to this responsibility and the need to engage a dewatering specialist. While the responsibility for dewatering should remain with the Contractor, suitable systems that might be employed include pumping from filtered sumps for penetration in the order of 0.5 m below the groundwater level and the use of vacuum wellpoints for deeper penetration below the groundwater level. The installation of wellpoints may be difficult at this site. The design of the unwatering system should be coordinated with the design of the cofferdam, where required.

## **11 BRIDGE APPROACHES AND EMBANKMENTS**

The foundation soil at the site generally comprises non-cohesive sand with sand and gravel and sandy silt layers. The native soils are loose to very loose to approximate depths 1.6 to 5.7 m on the north side of the river, and typically compact to very dense below this level and on the south side of the river.

No long-term settlement problems are anticipated for approach embankments built at this site. Similarly, the 1 to 2 m high embankments likely to be constructed will be stable at side slopes of 2H:1V and no overall stability issues are expected provided the new embankment does not encroach on the river bank.

For long-term stability, either allowance should be made for possible erosion of the river bank or the river bank must be armoured to prevent erosion and migration towards the embankment.

## **12 BACKFILL TO ABUTMENTS**

If abutments are provided under the bridge, granular backfill consisting of OPSS Granular “B” Type II must be used behind the abutment wall.

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

Compaction equipment to be used adjacent to retaining structures must be restricted in accordance with SP 105S10.

The design of the abutment must incorporate a subdrain as shown in OPSD 3102.100.

## **13 EARTH PRESSURE COEFFICIENTS**

Earth pressures acting on the structure 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)

$\gamma$  = 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 13.1.

**Table 13.1 – Earth Pressure Coefficient (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 $\phi = 32^\circ, \gamma = 21.2 \text{ kN/m}^3$	
	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)
Active (Unrestrained Wall)	0.27	0.40*	0.31	0.43*
At rest (Restrained Wall)	0.43	-	0.47	-
Passive (Movement Towards Soil Mass)	3.7	-	3.3	-

\* 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.

The factors in Table 13.1 are “ultimate” values and require certain movements for the respective conditions to be mobilized. The values to use in design can be estimated from Figure C6.9.1 (a) in the Commentary to the Canadian Highway Bridge Design Code.

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.

## 14 SEISMIC CONSIDERATIONS

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                        0.02

Based on these parameters, seismic design is not an issue at this site.

## 15 CONSTRUCTION CONCERNS

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

### 1. Pile Installation

The presence of cobbles and boulders in a very dense matrix of sand and gravel may present difficulties in installing piles to the specified depth and to the specified tolerances for location and verticality.

### 2. Excavation

Hydraulic equipment is expected to be capable of excavating to the depths required for spread footing and engineered fill construction. If excavations advance below the existing groundwater level, groundwater control measures must be implemented in order to maintain stable sides and base in the excavation.

### 3. Unwatering

The pervious nature of the soils encountered at this site and the proximity to the river will make unwatering of excavations difficult. Depending on the locations of the foundation, steps may have to be taken to control the river and exclude it from the excavations. Typically, a combination of a sheet pile cutoff and vacuum well-points may be required. Fluctuations in the river water level should be anticipated.

## 16 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 E. Gorman, P.Eng. The report was also reviewed by Dr. P.K. Chatterji, Ph.D., a Designated Principal Contact for MTO Foundations Projects.

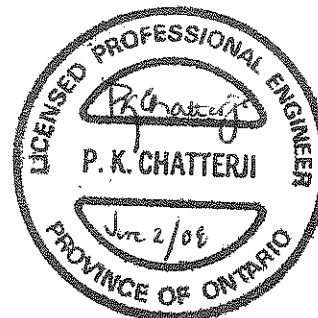
Thurber Engineering Ltd.  
Murray R. Anderson, P.Eng., M.Eng.  
Senior Geotechnical Engineer



Alastair E. Gorman, P.Eng.,  
Senior Foundations Engineer



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



**Appendix A**

**Record of Borehole Sheets**

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

### 1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

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

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

NOTE: Hierarchy of Soil Strength Prediction

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



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

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

### 5. LEGEND FOR RECORDS OF BOREHOLES

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

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

 Water Level  
 Shear Strength Determination by Pocket Penetrometer



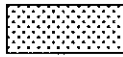


- (1) SPT 'N' Value      Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT              Dynamic Cone Penetration Test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

# UNIFIED SOILS CLASSIFICATION

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



## EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION		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		Field Estimation of Hardness*
			(MPa)	(psi)	
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.

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

### 1. TEXTURAL CLASSIFICATION OF SOILS

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And (e.g. sand and gravel)	35 to 50%

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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<sub>pen</sub> 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.

# RECORD OF BOREHOLE No 07-LW01

1 OF 4

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 794.62 E 394 842.35 ORIGINATED BY GA  
 HWY 546 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY MFA  
 DATUM Geodetic DATE 2007.03.10 - 2007.03.13 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
299.9								20 40 60 80 100						
0.0	SAND AND GRAVEL, trace silt, occasional rootlets Very Dense Brown (SP)		1	SS	59			○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
									20 40 60 80 100					
			2	SS	74		299					31 52 17 (SI+CL)		
298.4														
1.5	SAND, trace gravel Dense Brown (SP)		3	SS	37		298							
297.6														
2.4	SAND AND GRAVEL Compact to Dense Brown (SP)		4	SS	45		297					28 68 4 (SI+CL)		
					5	SS	16		296					
295.3														
4.6	SAND, trace gravel Compact to Dense Brown Wet (SP)		6	SS	15		295					0 97 3 (SI+CL)		
								294						
					7	SS	31		293					8 81 11 (SI+CL)
					8	SS	19		292					
							291							
			9	SS	17							0 96 4 (SI+CL)		

Continued Next Page

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

20  
16  
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 07-LW01

2 OF 4

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 794.62 E 394 842.35 ORIGINATED BY GA  
HWY 546 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY MFA  
DATUM Geodetic DATE 2007.03.10 - 2007.03.13 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
	Continued From Previous Page													
289.3 10.7	SAND, trace gravel Compact to Dense Brown Wet (SP)													
	SAND AND GRAVEL Compact to Dense Brown Wet (SP)		10	SS	21		289						43 53 4 (SI+CL)	
							288							
			11	SS	27		287							
							286						43 54 3 (SI+CL)	
			12	SS	30		285							
							284							
			13	SS	27		283							
							282							
			14	SS	17		281							
							280							
			15	SS	30								29 62 9 (SI+CL)	

Continued Next Page

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

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 07-LW01

3 OF 4

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 794.62 E 394 842.35 ORIGINATED BY GA  
 HWY 546 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY MFA  
 DATUM Geodetic DATE 2007.03.10 - 2007.03.13 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		SHEAR STRENGTH kPa			WATER CONTENT (%)			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	GR SA SI CL				
	Continued From Previous Page																
	SAND AND GRAVEL, occasional cobbles Compact to Dense Brown Wet (SP)		16	SS	43		279								70 29 1 (SI+CL)		
							278										
			17	SS	19		277								52 46 2 (SI+CL)		
							276										
							275										
274.0							274										
25.9	SAND, some gravel Dense to Very Dense Brown Wet (SP)		18	SS	40		273										
							272										
							271								13 85 2 (SI+CL)		
			19	SS	112												

Continued Next Page

+ 3 X 3 : Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 07-LW01

4 OF 4

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 794.62 E 394 842.35 ORIGINATED BY GA  
 HWY 546 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY MFA  
 DATUM Geodetic DATE 2007.03.10 - 2007.03.13 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT  γ KN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40					
	Continued From Previous Page													
269.1	SAND, some gravel Very Dense Brown Wet (SP)		20	SS	101									
30.8	END OF BOREHOLE AT 30.78m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 13/03/07 4.88 295.02						269							

ONTMT4S 2333LW.GPJ 2/11/08

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

20  
15-4-5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 07-LW02

1 OF 3

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 821.99 E 394 861.84 ORIGINATED BY GA  
 HWY 546 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY MFA  
 DATUM Geodetic DATE 2007.03.16 - 2007.03.17 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
298.6 0.0	<b>SAND</b> , trace silt, trace to some gravel, occasional cobbles Very Dense Brown (SP)		1	SS	50/ .150									
297.8 0.8	<b>SILT</b> , trace clay, trace sand, occasional cobbles Firm Brown		2	SS	8									
297.1 1.5	<b>SAND AND GRAVEL</b> Dense Brown Wet (GP)		3	SS	32									61 38 1 (SI+CL)
296.3 2.3	<b>SAND</b> , trace to some gravel Very Dense Brown (SP)		4	SS	55									
			5	SS	50/ .075									
294.5 4.1	Sandy <b>SILT</b> , trace clay, trace gravel Compact Grey (SM-NP)		6	SS	16									5 27 63 5
292.9 5.6	<b>SAND</b> Compact to Dense Brown (SP)		7	SS	30									
			8	SS	27									
			9	SS	29									0 100 0 (SI+CL)

Continued Next Page

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

20  
15 10 5  
(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 07-LW02

2 OF 3

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 821.99 E 394 861.84 ORIGINATED BY GA  
 HWY 546 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY MFA  
 DATUM Geodetic DATE 2007.03.16 - 2007.03.17 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	WATER CONTENT (%) 20 40 60			GR SA SI CL
	SAND Compact to Dense Brown (SP)											
	Very Dense		10	SS	84		288					
							287					
			11	SS	26		286					1 96 3 (SI+CL)
							285					
			12	SS	27		284					0 93 7 (SI+CL)
							283					
	occasional gravel seam 15.85 to 16.46m.		13	SS	23		282					0 100 0 (SI+CL)
							281					
280.7			14	SS	22		280					
17.8	SAND AND GRAVEL, occasional cobbles Very Dense Grey (SP)		15	SS	82		279					

Continued Next Page

+ 3, × 3: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 07-LW02

3 OF 3

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 821.99 E 394 861.84 ORIGINATED BY GA  
 HWY 546 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY MFA  
 DATUM Geodetic DATE 2007.03.16 - 2007.03.17 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	W <sub>p</sub> W W <sub>L</sub>	WATER CONTENT (%)		
277.2	SAND AND GRAVEL, occasional cobbles Very Dense Grey (SP)		16	SS	102		278					
21.3	SAND, some gravel Very Dense Grey (SP)		17	SS	103		277					17 78 5 (SI+CL)
275.4			18	SS	108		276					
23.2	END OF BOREHOLE AT 23.16m. BOREHOLE OPEN TO 22.86m IN CASING. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 16/03/07 1.83 296.77											

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

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 07-LW03

1 OF 3

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 786.98 E 394 843.37 ORIGINATED BY SLI  
 HWY 546 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY JHL  
 DATUM Geodetic DATE 2007.02.20 - 2007.02.20 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED    + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE					
300.3													
0.0 0.1	TOPSOIL: (75 mm)  SAND AND GRAVEL, occasional cobbles Very Dense Brown		1	SS	50/ 125								
299.2													
1.1	SAND, trace gravel Compact Brown Moist		2	SS	21								
			3	SS	15								
			4	SS	7								
			5	SS	17								
294.8													
5.5	SAND AND GRAVEL, occasional cobbles Compact Grey Wet		6	SS	17								
			7	SS	20								
			8	SS	17								

Continued Next Page

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

20  
15 5  
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 07-LW03

2 OF 3

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 786.98 E 394 843.37 ORIGINATED BY SLL  
HWY 546 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY JHL  
DATUM Geodetic DATE 2007.02.20 - 2007.02.20 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT Y kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
	Continued From Previous Page													
289.8	SAND AND GRAVEL, occasional cobbles Compact						290							
10.5	SAND, trace to some silt, trace gravel Compact Grey Wet		9	SS	17		289							2 94 4 (SI+CL)
							288							
			10	SS	23		287							
	some gravel, trace silt		11	SS	21		286							
							285							
	occasional cobbles		12	SS	21		284							
							283							
			13	SS	12		282							
							281							
			14	SS	20									

Continued Next Page

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

20  
15 5  
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 07-LW03

3 OF 3

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 786.98 E 394 843.37 ORIGINATED BY SLL  
HWY 546 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY JHL  
DATUM Geodetic DATE 2007.02.20 - 2007.02.20 CHECKED BY AEG

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 <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE				WATER CONTENT (%) W P W W L			
	Continued From Previous Page		15	SS	20										
	SAND, trace to some silt, trace gravel Compact Grey Wet					280									1 97 2 (SI+CL)
	occasion gravel seams loss of water in between 22.86m and 25.91 m					279									
						278									
			16	SS	15	277									
						276									
275.0															
25.3	AUGER REFUSAL AT 25.3m. DCPT REFUSAL AT 27.41m. BOREHOLE BACKFILLED WITH BENTONITE GROUT.  WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 29/03/07 3.05 297.25														

# RECORD OF BOREHOLE No 07-LW04

1 OF 4

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 821.16 E 394 872.30 ORIGINATED BY GA  
 HWY 546 BOREHOLE TYPE Hollow Stem Auger COMPILED BY MFA  
 DATUM Geodetic DATE 2007.03.08 - 2007.03.09 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT		
300.5 0.0	SAND AND GRAVEL, occasional cobbles Compact to Very Dense Brown (FILL)(SP)		1	SS	84		300						
			2	SS	78		299						67 28 5 (SI+CL)
			3	SS	100/ .075		298						
			4	SS	11		297						
297.4 3.0	SAND, trace gravel, trace clay Loose to Very Dense Grey to Brown (SP)		5	SS	5		296						1 97 2 (SI+CL)
			6	SS	12		295						
			7	SS	50/ .150		294						
293.5 7.0	SILT, some clay, trace gravel, trace sand Hard (ML)		8	SS	41		293						3 9 69 19
			9	SS	45		292						
							291						

Continued Next Page

+ 3, x 3 Numbers refer to  
Sensitivity

20  
15 10 5  
10 (%) STRAIN AT FAILURE

## METRIC

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







# RECORD OF BOREHOLE No 07-LW05

1 OF 4

METRIC



G.W.P. 512-00-00 LOCATION Little White River N 5 167 778.62 E 394 853.61 ORIGINATED BY GA  
 HWY 546 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY MFA  
 DATUM Geodetic DATE 2007.03.14 - 2007.03.15 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	
300.7 0.0	SAND AND GRAVEL, trace silt, occasional cobbles Very Dense Brown (FILL)(SP)		1	SS	106							
299.2			2	SS	90							
1.5 299.2	SAND, trace silt, occasional gravel Very Dense Brown (FILL)(SP)		3	SS	78							
298.3			4	SS	22							
2.4	SAND, trace gravel, trace to some silt Compact Brown (SP)		5	SS	11							
			6	SS	15							
			7	SS	33							
			8	SS	51							
			9	SS	17							
	Occasional dense or very dense seams											
	cobbles at 8.99 to 9.14m.											

Continued Next Page

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

## METRIC

ELEV DEPTH	SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20 40 60 80 100	W <sub>P</sub> W W <sub>L</sub>	20 40 60		
	Continued From Previous Page											
							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE		WATER CONTENT (%)			
							20 40 60 80 100		20 40 60			

[illegible]

+ 3, X 3: Numbers refer to Sensitivity

CONTMT4\$ 2333LW.GPJ 2/11/08

## METRIC

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

ONTMT4S 2333LW.GPJ 2/11/08

RECORD OF BOREHOLE No 07-LW05

4 OF 4

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 778.62 E 394 853.61 ORIGINATED BY GA  
 HWY 546 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY MFA  
 DATUM Geodetic DATE 2007.03.14 - 2007.03.15 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT  w <sub>p</sub>	NATURAL MOISTURE CONTENT  w	LIQUID LIMIT  w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
	Continued From Previous Page							20 40 60 80 100	○ UNCONFINED	+ FIELD VANE					
			20	SS	104			20 40 60 80 100	● QUICK TRIAXIAL	× LAB VANE					
268.4	SAND, trace silt, trace gravel Very Dense						270								5 91 4 (SI+CL)
32.3	END OF BOREHOLE AT 32.31m. BOREHOLE OPEN TO 32.00m IN CASING Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 15/03/07 3.66 297.04 12/09/07 3.40 297.30						269								

# RECORD OF BOREHOLE No 07-LW06

1 OF 3

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 811.91 E 394 880.99 ORIGINATED BY SLI/GA  
 HWY 546 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY MFA  
 DATUM Geodetic DATE 2007.03.07 - 2007.03.07 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>P</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
297.7								○ UNCONFINED    + FIELD VANE						
0.0	ORGANICS, with roots and rootlets							● QUICK TRIAXIAL    × LAB VANE						
0.2	SAND, trace gravel, with wood fragments Loose to Dense Brown Wet		1	SS	1									
			2	SS	1									
			3	SS	15									
			4	SS	36									
			5	SS	26									
			6	SS	70									
291.0	trace gravel Very Dense Brown/Grey													
6.7	SILT, some clay Hard Grey Moist													
290.2														
7.5	SAND, trace silt, trace to some gravel Loose to Compact Grey Wet (SP)		7	SS	10									
			8	SS	23									
	becoming brown													

Continued Next Page

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

RECORD OF BOREHOLE No 07-LW06

2 OF 3

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 811.91 E 394 880.99 ORIGINATED BY SLL/GA  
HWY 546 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY MFA  
DATUM Geodetic DATE 2007.03.07 - 2007.03.07 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
								20 40 60 80 100								
	Continued From Previous Page							20 40 60 80 100								
	SAND, trace silt, some gravel Loose to Compact Brown Wet						287								20 80 0 (SI+CL)	
			9	SS	20											
			10	SS	30											

ONTMT4S 2333LW/GPJ 2/11/08

Continued Next Page

+<sup>3</sup> × 3

Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 07-LW06

3 OF 3

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 811.91 E 394 880.99 ORIGINATED BY SLL/GA  
 HWY 546 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY MFA  
 DATUM Geodetic DATE 2007.03.07 - 2007.03.07 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  Y  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						WATER CONTENT (%)	
								20	40	60	80			100	20
								20 40 60 80 100				20 40 60			
								UNCONFINED + FIELD VANE				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			
								QUICK TRIAXIAL X LAB VANE				w <sub>P</sub> w w <sub>L</sub>			
								20 40 60 80 100				20 40 60			

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

RECORD OF BOREHOLE No 07-LW07

1 OF 1

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 596.63 E 394 857.60 ORIGINATED BY SLL  
 HWY 546 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JHL  
 DATUM Geodetic DATE 2007.02.19 - 2007.02.19 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
301.8								○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE					
0.0 0.0								20 40 60 80 100					
	TOPSOIL: (50 mm)												
	SAND, trace gravel, occasional cobbles Very Dense Brown Moist		1	AS									
			1	SS	50/ .125								
			2	SS	23								
			3	SS	50/ .150								
			2	AS									
298.7													
3.1	END OF BOREHOLE AT 3.08 m. BOREHOLE OPEN TO 0.84 m AND DRY TO BOTTOM UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE GROUT TO SURFACE.		1	SS	60/ .025								

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

20  
15 5  
10 (%) STRAIN AT FAILURE






# RECORD OF BOREHOLE No 07-LW08

1 OF 1

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 645.13 E 394 850.56 ORIGINATED BY SLL  
 HWY 546 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JHL  
 DATUM Geodetic DATE 2007.02.20 - 2007.02.20 CHECKED BY AEG


SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ KN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								20 40 60 80 100	20 40 60	○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
301.3																		
0.0	TOPSOIL: (50 mm)																	
	SAND AND GRAVEL, occasional cobbles Compact Brown Moist Cobble		1	SS	50/ 100		301											
			2	SS	25		300											
299.1																		
2.2	SAND, some silt Dense Brown Moist		3	SS	40		299								0 97 3 (SI+CL)			
			4	SS	30		298											
297.6																		
3.7	END OF BOREHOLE AT 3.66 m. BOREHOLE OPEN TO 1.83 m AND DRY TO BOTTOM UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE GROUT TO SURFACE.																	

RECORD OF BOREHOLE No 07-LW09

1 OF 1

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 696.02 E 394 848.00 ORIGINATED BY SLL  
 HWY 546 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JHL  
 DATUM Geodetic DATE 2007.02.20 - 2007.02.20 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT      NATURAL LIMIT      MOISTURE CONTENT      LIQUID LIMIT		UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR   SA   SI   CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL      x LAB VANE		WATER CONTENT (%) w <sub>p</sub> w      w <sub>L</sub>			
301.0 0.0 0.0	TOPSOIL: (50 mm)  SAND AND GRAVEL, occasional cobbles Loose to Dense Brown Moist  Cobble		1	AS									
			1	SS	50/ .100								
			2	SS	8								
			3	SS	19								
			4	SS	36								
297.3	END OF BOREHOLE AT 3.66 m. BOREHOLE OPEN TO 1.60 m AND DRY TO BOTTOM UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE GROUT TO SURFACE.												22   76   2 (SI+CL)

# RECORD OF BOREHOLE No 07-LW10

1 OF 1

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 744.62 E 394 829.68 ORIGINATED BY SLL  
 HWY 546 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JHL  
 DATUM Geodetic DATE 2007.02.20 - 2007.02.20 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
301.2								20	40	60	80	100		
0.0														
0.1	TOPSOIL: (75 mm)													
	SAND, trace silt, trace gravel Very Loose to Compact Brown Moist		1	SS	1		301							
			2	SS	6		300							
			3	SS	20		299							2 94 4 (Si+CL)
			4	SS	23		298							0 97 3 (Si+CL)
297.5														
3.7	END OF BOREHOLE AT 3.66 m. BOREHOLE OPEN TO 3.05 m AND DRY TO BOTTOM UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE GROUT TO SURFACE.													

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

20  
15 10 5  
(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 07-LW11

1 OF 1

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 838.20 E 394 892.09 ORIGINATED BY GA  
 HWY 546 BOREHOLE TYPE Hollow Stem Auger COMPILED BY MFA  
 DATUM Geodetic DATE 2007.03.17 - 2007.03.17 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  Y  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								WATER CONTENT (%)					
300.6							20 40 60 80 100						
0.0							20 40 60 80 100						
0.1	TOPSOIL		1	SS	6								
	Sandy SILT, trace clay, occasional rootlets and wood fibres Loose Brown (SM)		2	SS	5								
			3	SS	6								
298.4													
2.2	SAND AND GRAVEL		4	SS	11								
	Compact Grey Wet (SP)		5	SS	28								
296.9													
3.7	END OF BOREHOLE AT 3.7m. BOREHOLE OPEN TO 1.2m AND BACKFILLED WITH BENTONITE GROUT TO SURFACE.  WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 17/03/07 0.76 299.84												

## METRIC

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

RECORD OF BOREHOLE No 07-LW13

1 OF 1

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 889.58 E 394 967.43 ORIGINATED BY GA  
 HWY 546 BOREHOLE TYPE Hollow Stem Auger COMPILED BY MFA  
 DATUM Geodetic DATE 2007.03.10 - 2007.03.10 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  Y  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL									
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa														
20 40 60 80 100																						
305.3	SAND, trace to some gravel, occasional rootlets Very Dense Brown (SP)		1	SS	50/ .125		305															
304.5																						
0.8			SAND AND GRAVEL, Very Dense Brown (SP)		2										SS	50/ .150		304				
					3	SS	50/ .150		303													
			4	SS	50/ .150																	
302.4																						
2.9	END OF BOREHOLE AT 2.9m. BOREHOLE OPEN TO 2.9m AND BACKFILLED WITH BENTONITE GROUT TO SURFACE.  WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 10/03/07 2.90 302.40																					

RECORD OF BOREHOLE No 07-LW14

1 OF 1

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 913.38 E 395 012.85 ORIGINATED BY GA  
HWY 546 BOREHOLE TYPE Hollow Stem Auger COMPILED BY MFA  
DATUM Geodetic DATE 2007.03.10 - 2007.03.10 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT						UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
								○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    x LAB VANE							
307.3							20 40 60 80 100								
0.0	SAND AND GRAVEL, occasional cobbles Very Dense Brown (SP)   <														

+<sup>3</sup>. x<sup>3</sup>: Numbers refer to  
Sensitivity



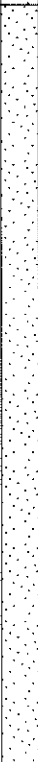

20  
15  
10  
(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 07-LW15

1 OF 2

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 778.33 E 394 849.56 ORIGINATED BY SLL  
 HWY 546 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY ES  
 DATUM Geodetic DATE 2007.09.12 - 2007.09.13 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ  kn/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE							
								● QUICK TRIAXIAL	× LAB VANE							
300.6						20	40	60	80	100	20	40	60			
0.0	SAND, some gravel, occasional cobbles Dense Brown Moist (FILL)		1	SS	31											
299.2																
1.4	SAND, fine, trace gravel, trace silt Compact Brown Moist		2	SS	28											
			3	SS	20											
			4	SS	14											
296.8																
3.8	SAND, some gravel, trace silt, occasional cobbles Dense to Compact Brown Wet															
			5	SS	43											
			6	SS	19											
	Grey															
			7	SS	31											
291.8																
8.8	SAND and GRAVEL, trace silt Compact Grey		8	SS	16											
290.8																
9.8	SAND, some gravel, trace silt,															

Continued Next Page

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



# RECORD OF BOREHOLE No 07-LW15

2 OF 2

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 187 778.33 E 394 849.56 ORIGINATED BY SLL  
 HWY 546 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY ES  
 DATUM Geodetic DATE 2007.09.12 - 2007.09.13 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES							
289.3	Continued From Previous Page  <b>SAND</b> , some gravel, trace silt, occasional cobbles Compact Grey Wet		9	SS	25		290					
11.3	END OF BOREHOLE AT 11.28m. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 13/09/07 3.48 297.07											

# RECORD OF BOREHOLE No 07-LW16

1 OF 2

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 773.45 E 394 853.30 ORIGINATED BY SLL  
 HWY 546 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY ES  
 DATUM Geodetic DATE 2007.09.18 - 2007.09.18 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
299.0												
0.0												
0.2	SAND, trace gravel Brown Moist (FILL)											
	SAND, fine, trace silt Compact to Loose Brown Moist		1	SS	16							
			2	SS	21							
			3	SS	10							
			4	SS	7							
294.7												
4.3	SAND and GRAVEL, trace silt, occasional cobbles Compact to Dense Grey Wet		5	SS	18							
			6	SS	30							
			7	SS	13							
290.3												
8.7	SAND, trace gravel, trace silt Compact Grey Wet		8	SS	21							

Continued Next Page

+ 3. X 3: Numbers refer to  
Sensitivity

20  
15 0.5  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 07-LW16

2 OF 2

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 773.45 E 394 853.30 ORIGINATED BY SLL  
 HWY 546 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY ES  
 DATUM Geodetic DATE 2007.09.18 - 2007.09.18 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
	Continued From Previous Page													
288.3	SAND, trace gravel, trace silt Compact Grey Wet						289							
10.7	END OF BOREHOLE AT 10.75m. BOREHOLE BACKFILLED WITH BENTONITE TO SURFACE.			SS	.075									

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+<sup>3</sup> x<sup>3</sup> Numbers refer to  
Sensitivity

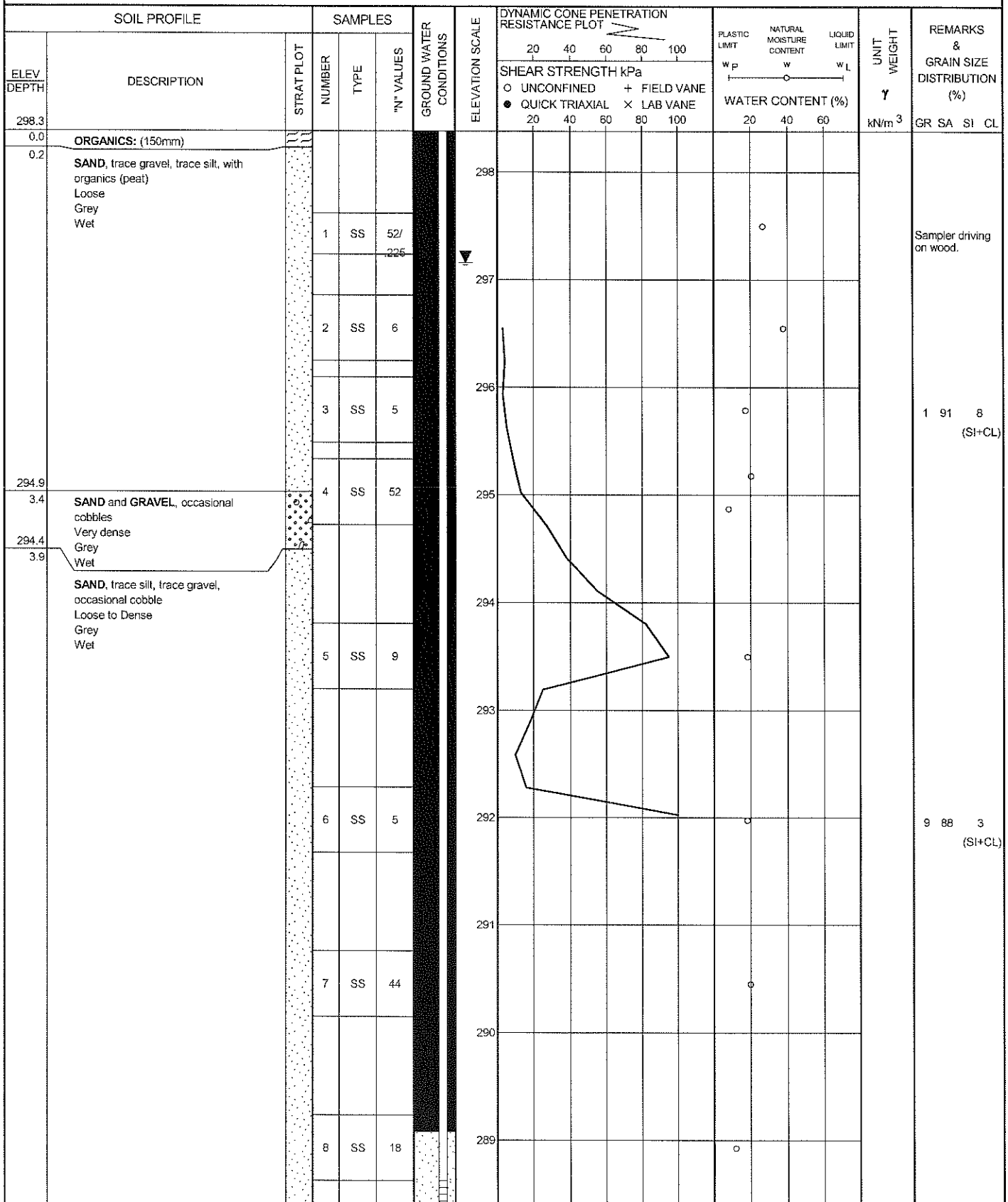
20  
15 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 07-LW17

1 OF 2

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 812.26 E 394 872.95 ORIGINATED BY SLL  
 HWY 546 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY ES  
 DATUM Geodetic DATE 2007.09.19 - 2007.09.20 CHECKED BY AEG



Continued Next Page

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

# RECORD OF BOREHOLE No 07-LW17

2 OF 2

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 812.26 E 394 872.95 ORIGINATED BY SLL  
 HWY 546 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY ES  
 DATUM Geodetic DATE 2007.09.19 - 2007.09.20 CHECKED BY AEG

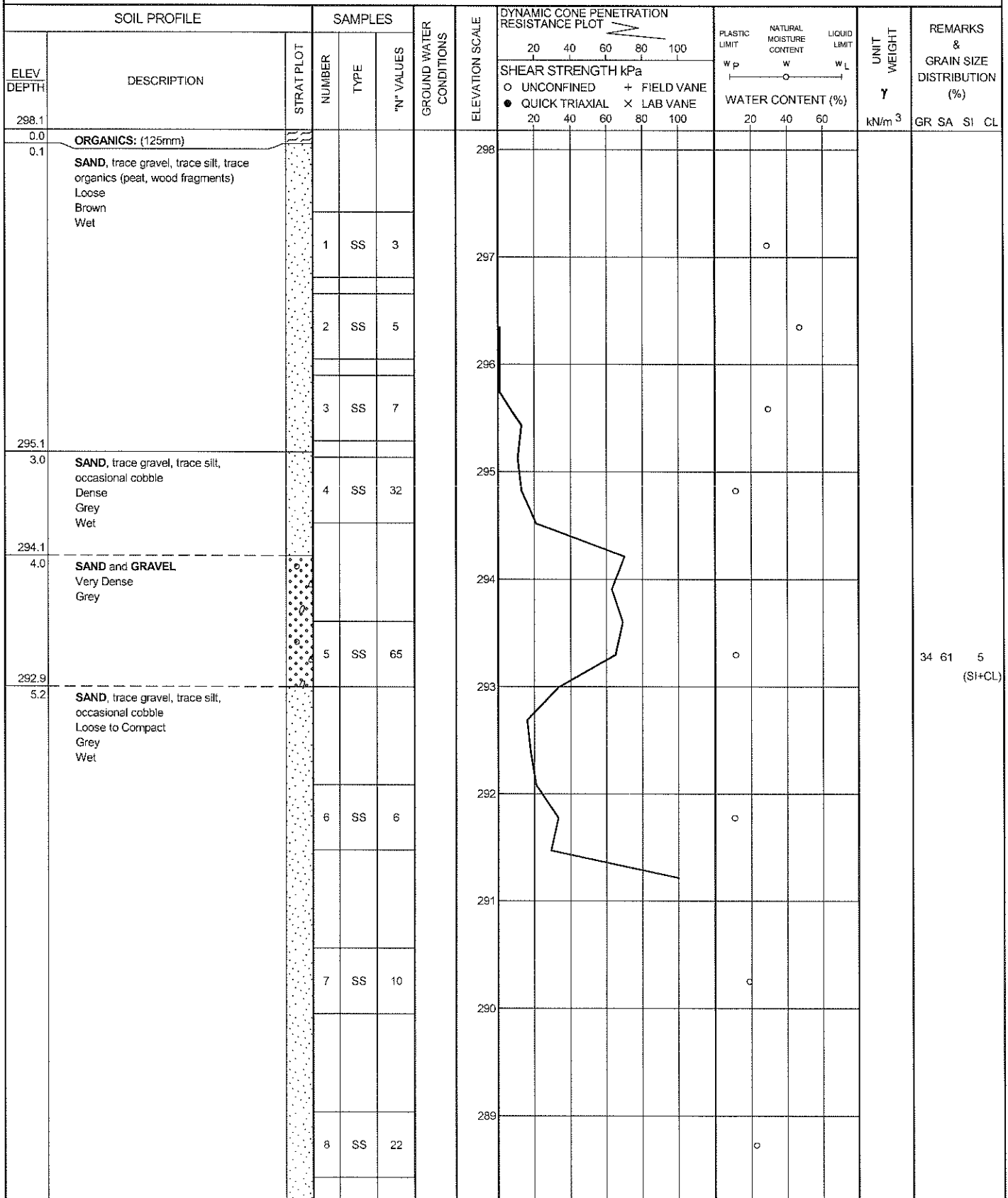
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page													
287.0	SAND, trace silt, trace gravel, occasional cobble Loose to Dense Grey Wet		9	SS	21		288							
11.3	END OF BOREHOLE AT 11.28m. Piezometer installation consists of 19mm diameter schedule 40 PVC pipe with a 1.52 slotted screen.  WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 20/09/07 1.22 297.10													

# RECORD OF BOREHOLE No 07-LW18

1 OF 2

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 806.53 E 394 877.31 ORIGINATED BY SLL  
 HWY 546 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY ES  
 DATUM Geodetic DATE 2007.09.20 - 2007.09.20 CHECKED BY AEG



Continued Next Page

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

RECORD OF BOREHOLE No 07-LW18

2 OF 2

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 806.53 E 394 877.31 ORIGINATED BY SLL  
 HWY 546 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY ES  
 DATUM Geodetic DATE 2007.09.20 - 2007.09.20 CHECKED BY AEG

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100		
	Continued From Previous Page						SHEAR STRENGTH kPa						
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE						
							20	40	60	80	100		
							WATER CONTENT (%)						
							20	40	60				
							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT						
							W <sub>p</sub> W W <sub>L</sub>						
286.8	SAND, trace gravel, trace silt, occasional cobble Compact Grey Wet		9	SS	21	288							5 93 2
11.3	END OF BOREHOLE AT 11.28m. BOREHOLE BACKFILLED WITH BENTONITE TO SURFACE.					287							(SI+CL)

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

20  
15 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 07-LW19

1 OF 1

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 749.89 E 394 836.67 ORIGINATED BY SLL  
 HWY 546 BOREHOLE TYPE Hollow Stem Augers COMPILED BY ES  
 DATUM Geodetic DATE 2007.09.18 - 2007.09.18 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
300.3							20 40 60 80 100						
0.0	<b>SAND</b> , trace gravel Brown Moist (FILL)  <b>SAND</b> , fine, trace gravel, trace silt Compact to Dense Brown Moist   <												

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RECORD OF BOREHOLE No 07-LW20

1 OF 1

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 762.21 E 394 842.15 ORIGINATED BY SLL  
HWY 546 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY ES  
DATUM Geodetic DATE 2007.09.18 - 2007.09.18 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
300.0														
0.0	TOPSOIL: (125mm)						300							
0.1	SAND, fine, trace gravel, trace silt, occasional cobble Compact to Dense Brown Moist		1	SS	16		299							
			2	SS	35		298							
			3	SS	36		297							
	Wet		4	SS	21		296							
			5	SS	18		295							
			6	SS	37		294							
	with gravel layer		7	SS	34		293							
291.8							292							
8.2	END OF BOREHOLE AT 8.23m. BOREHOLE BACKFILLED WITH BENTONITE TO SURFACE.													

ONTMT4S 2333LW.GPJ 2/11/08

# RECORD OF BOREHOLE No 07-LW21

1 OF 1

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 770.12 E 394 847.59 ORIGINATED BY SLL  
 HWY 546 BOREHOLE TYPE Hollow Stem Augers COMPILED BY ES  
 DATUM Geodetic DATE 2007.09.13 - 2007.09.13 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
299.7														
0.0	TOPSOIL: (150mm)													
0.2	SAND, fine to medium, trace gravel, trace silt Compact Brown Moist		1	SS	16		299							
			2	SS	19		298							
			3	SS	22		297							1 97 2 (SI+CL)
	Wet		4	SS	14		296							
							295							
	cobble		5	SS	50/ .125		294							
293.6							293							
6.1	SAND and GRAVEL, trace silt Compact Grey Wet		6	SS	19		292							55 43 2 (SI+CL)
292.2							291							
7.5	SAND, trace gravel, trace silt Compact Grey Wet		7	SS	11		290							
291.5							289							
8.2	END OF BOREHOLE AT 8.23m. BOREHOLE BACKFILLED WITH BENTONITE TO SURFACE.						288							

ONTMT4S 2333LW/GPJ 2/11/08

# RECORD OF BOREHOLE No 07-LW22

1 OF 1

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 812.72 E 394 877.77 ORIGINATED BY SLL  
 HWY 546 BOREHOLE TYPE Hollow Stem Augers COMPILED BY ES  
 DATUM Geodetic DATE 2007.09.19 - 2007.09.19 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
298.1														
0.0	ORGANICS: (150mm)													
0.2	SAND, trace to some gravel, trace silt Compact to Very Loose Brown Wet		1	SS	15		298							
	wood fragment Dark Brown		2	SS	3		297							
	Grey		3	SS	5		296							
			4	SS	1		295							
							294							
			5	SS	7		293							
	Very Dense		6	SS	50/ 150		292							
291.3	SILT, clayey, trace sand Very stiff Grey						291							
6.8	250mm layer of sand		7	SS	26		290							
289.9	END OF BOREHOLE AT 8.23m. BOREHOLE BACKFILLED WITH BENTONITE TO SURFACE.													
8.2														

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

20  
15 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 07-LW23

1 OF 1

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 821.74 E 394 881.34 ORIGINATED BY SLL  
 HWY 546 BOREHOLE TYPE Hollow Stem Augers COMPILED BY ES  
 DATUM Geodetic DATE 2007.09.19 - 2007.09.19 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR   SA   SI   CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL      × LAB VANE	20   40   60   80   100	20   40   60	w <sub>p</sub> w      w <sub>L</sub>			
300.2														
0.0 0.1	Surface treatment: (50mm)													
	SAND, some gravel, occasional cobbles Compact Brown Moist (FILL)		1	SS	27									
			2	SS	27									
297.9														
2.3	SILT sandy, with black organics Loose Brown Wet		3	SS	4									
			4	SS	8									
296.1														
4.1	SAND, trace gravel, trace silt Compact Brown Wet		5	SS	15									
294.7														
5.5	SAND and GRAVEL, trace silt, occasional cobbles Dense to Compact Brown to Grey Wet		6	SS	49									
			7	SS	29									
292.0														
8.2	END OF BOREHOLE AT 8.23m. BOREHOLE BACKFILLED WITH BENTONITE TO SURFACE.													

ONTMT4S 2333LW/GPJ 2/11/08

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

20  
15  
10





(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 07-LW24

1 OF 1

METRIC

G.W.P. 512-00-00 LOCATION Little White River N 5 167 831.02 E 394 891.59 ORIGINATED BY SLL  
 HWY 546 BOREHOLE TYPE Hollow Stem Augers COMPILED BY ES  
 DATUM Geodetic DATE 2007.09.19 - 2007.09.19 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
								20 40 60 80 100								
								20 40 60 80 100								
299.6																
0.0	SAND, some gravel, occasional cobbles Dense to Compact Brown Moist (FILL)		1	SS	39		299									
			2	SS	19		298									
297.3																
2.3	SAND, trace gravel, trace wood fragments Loose to compact Brown Moist becoming wet		3	SS	4		297									
			4	SS	64		296									
295.3																
4.3	SAND and GRAVEL, occasional cobbles Compact Grey Wet		5	SS	19		295									
294.2																
5.4	SAND, medium to coarse grained, some gravel, occasional cobbles Compact to Loose Grey Wet		6	SS	15		294									
			7	SS	8		293									
291.4																
8.2	END OF BOREHOLE AT 8.23m. BOREHOLE BACKFILLED WITH BENTONITE TO SURFACE.															

ONTMT4S 2333LW/GPJ 6/2/08

## **Appendix B**

### **Laboratory Test Results**

## FIGURE B1

Size of openings, inches

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

PERCENT FINER THAN

GRAIN SIZE, mm

Grain Size (mm)	Percent Finer (%)
100	100
47.5	100
25	74
15	51
10	42
7.5	34
4.75	27
2.5	22
1.5	16
1.0	11
0.75	7
0.6	5

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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-LW04	1.07	299.41

Date January 2008  
Project 512-00-00

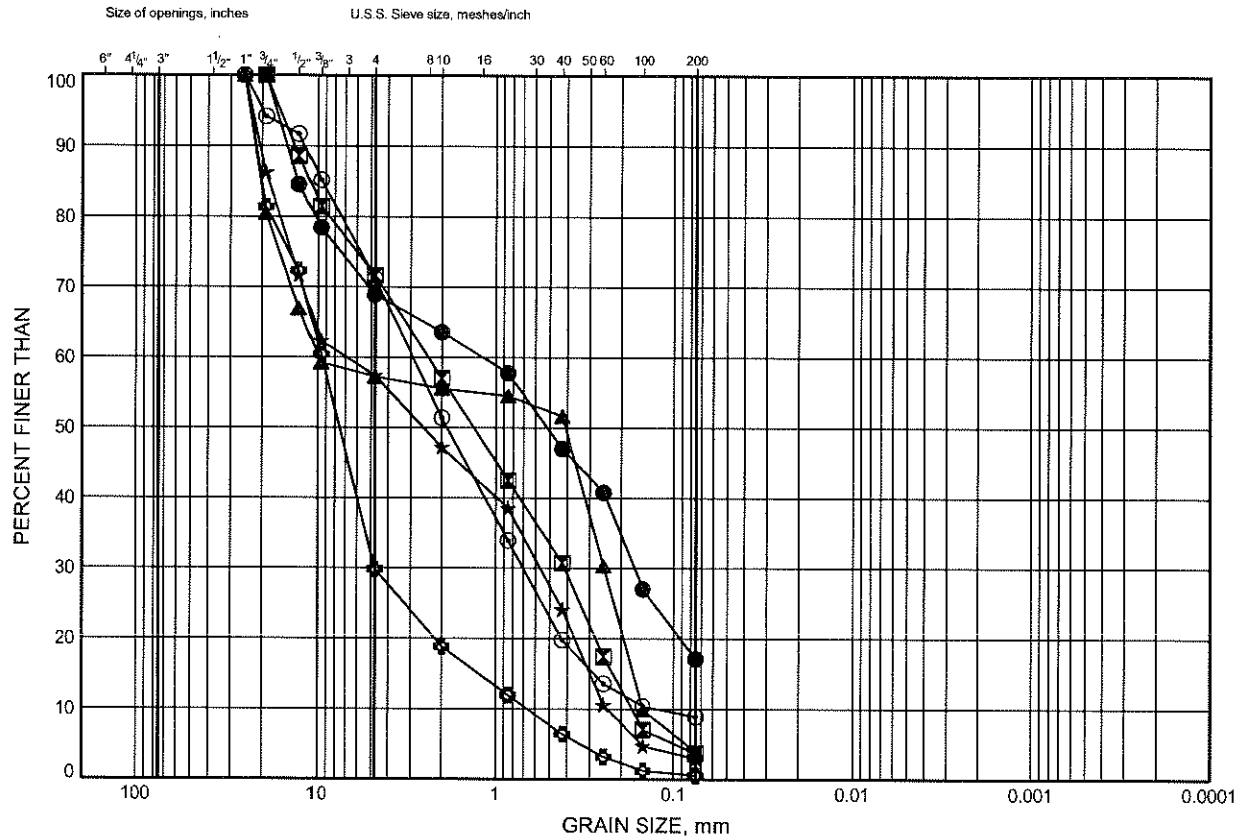


Prep'd ..... MFA .....  
Chkd. .... MRA .....

# Little White River GRAIN SIZE DISTRIBUTION

FIGURE B2

## SAND AND GRAVEL



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-LW01	0.30	299.62
⊠	07-LW01	2.59	297.33
▲	07-LW01	10.97	288.95
★	07-LW01	14.02	285.90
⊙	07-LW01	18.59	281.33
⊕	07-LW01	20.12	279.80

Date January 2008  
Project 512-00-00



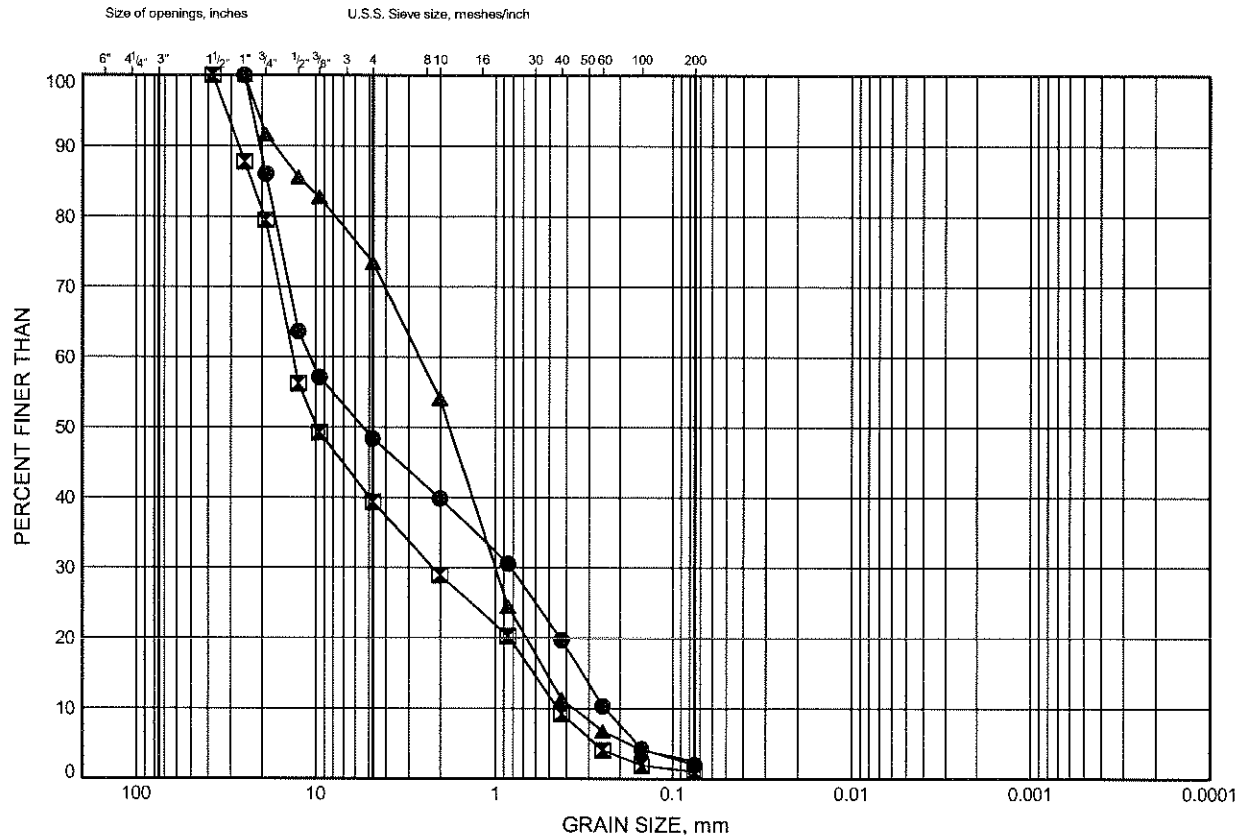
Prep'd MFA  
Chkd. MRA



# Little White River GRAIN SIZE DISTRIBUTION

FIGURE B3

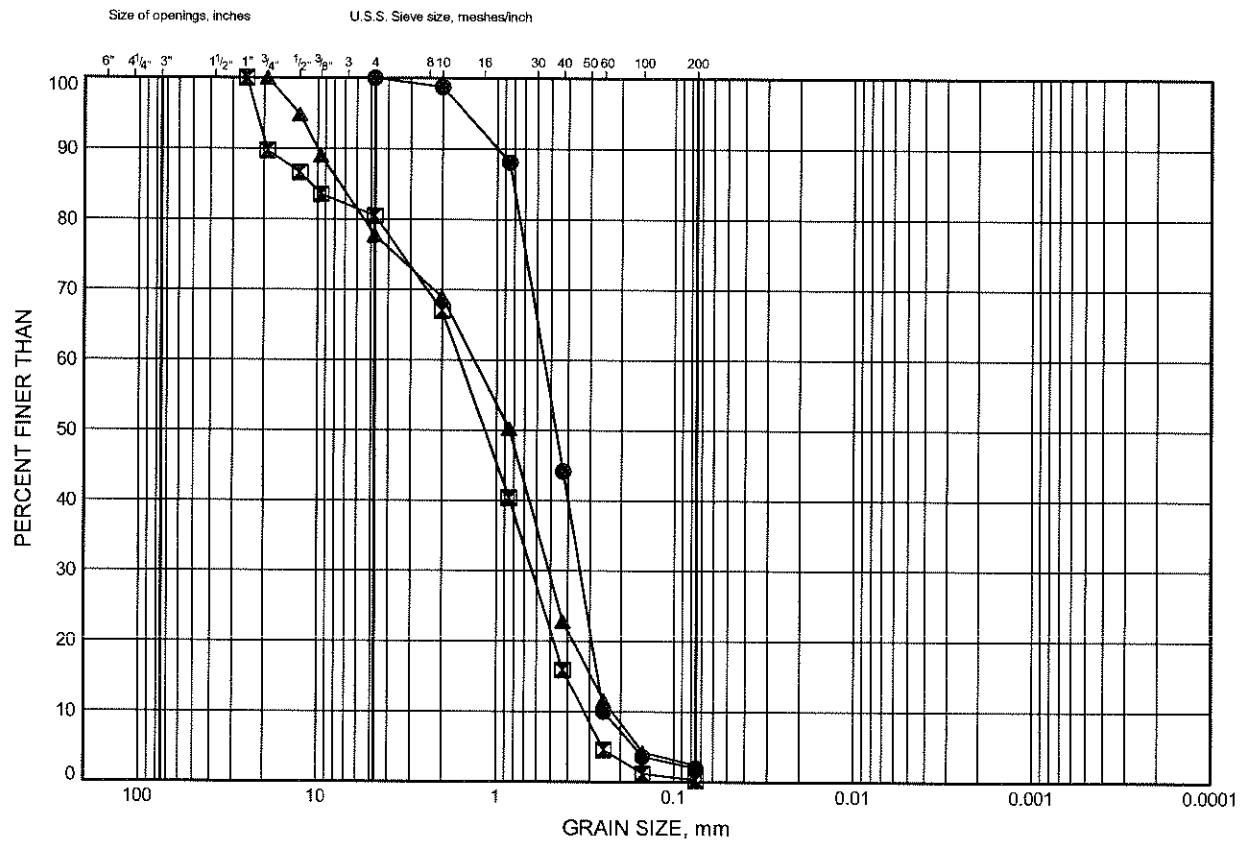
## SAND AND GRAVEL



# Little White River GRAIN SIZE DISTRIBUTION

FIGURE B4

## SAND



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-LW04	18.59	281.89
⊠	07-LW06	10.97	286.70
▲	07-LW09	2.59	298.41

Date January 2008  
Project 512-00-00

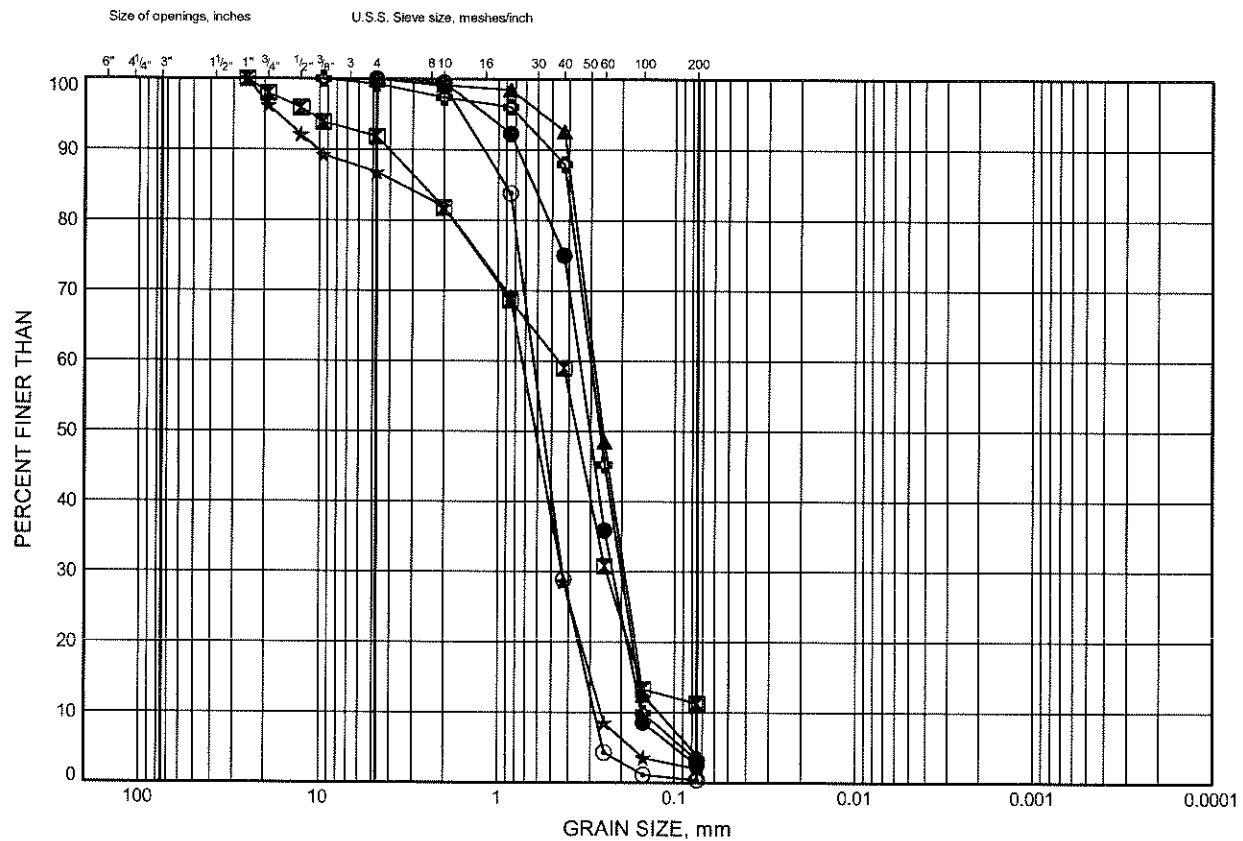


Prep'd MFA  
Chkd. MRA

# Little White River GRAIN SIZE DISTRIBUTION

FIGURE B5

## SAND



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-LW01	4.88	295.04
⊠	07-LW01	6.40	293.52
▲	07-LW01	9.45	290.47
★	07-LW01	29.26	270.66
⊙	07-LW02	9.45	289.13
⊕	07-LW02	12.50	286.08

Date January 2008  
Project 512-00-00

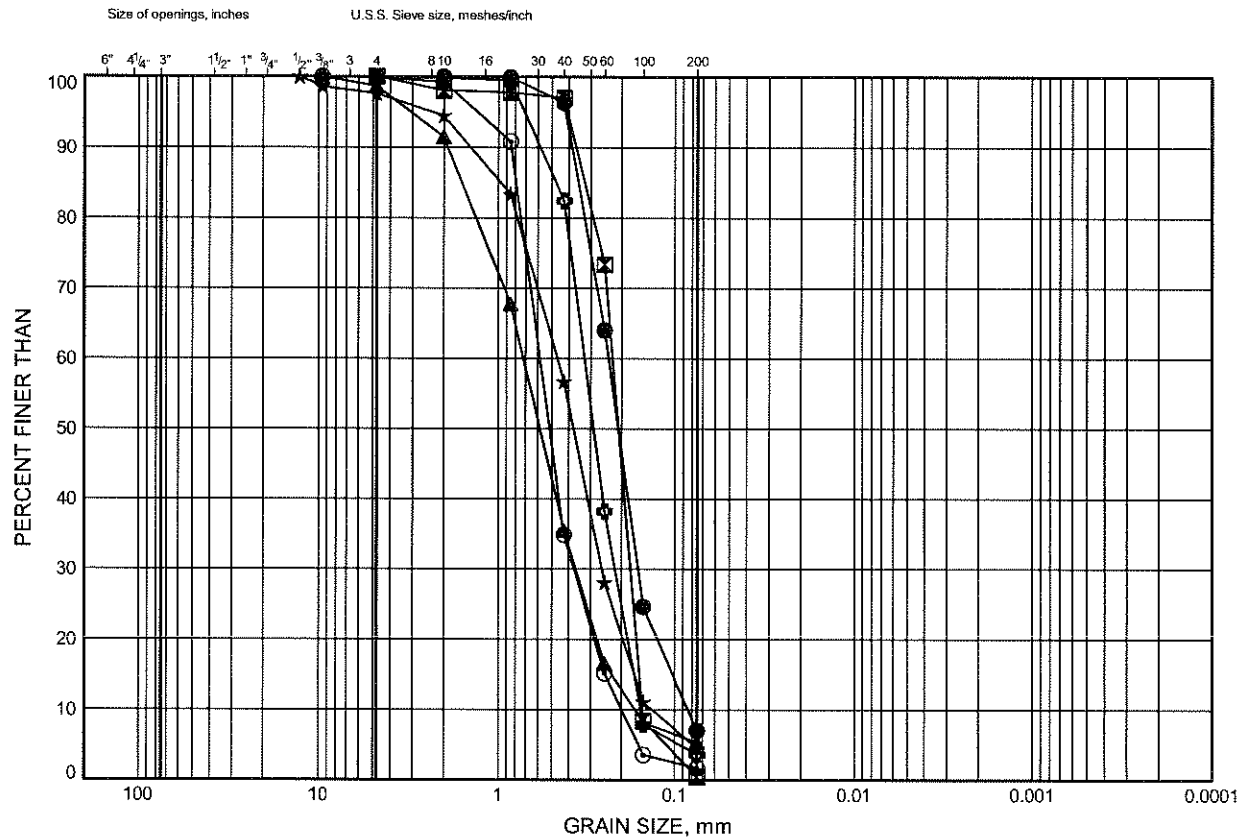


Prep'd MFA  
Chkd. MRA

# Little White River GRAIN SIZE DISTRIBUTION

FIGURE B6

## SAND



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-LW02	14.02	284.56
⊠	07-LW02	15.54	283.04
▲	07-LW03	2.59	297.74
★	07-LW03	10.97	289.36
⊙	07-LW05	2.59	298.11
⊕	07-LW05	6.40	294.30

Date January 2008  
Project 512-00-00

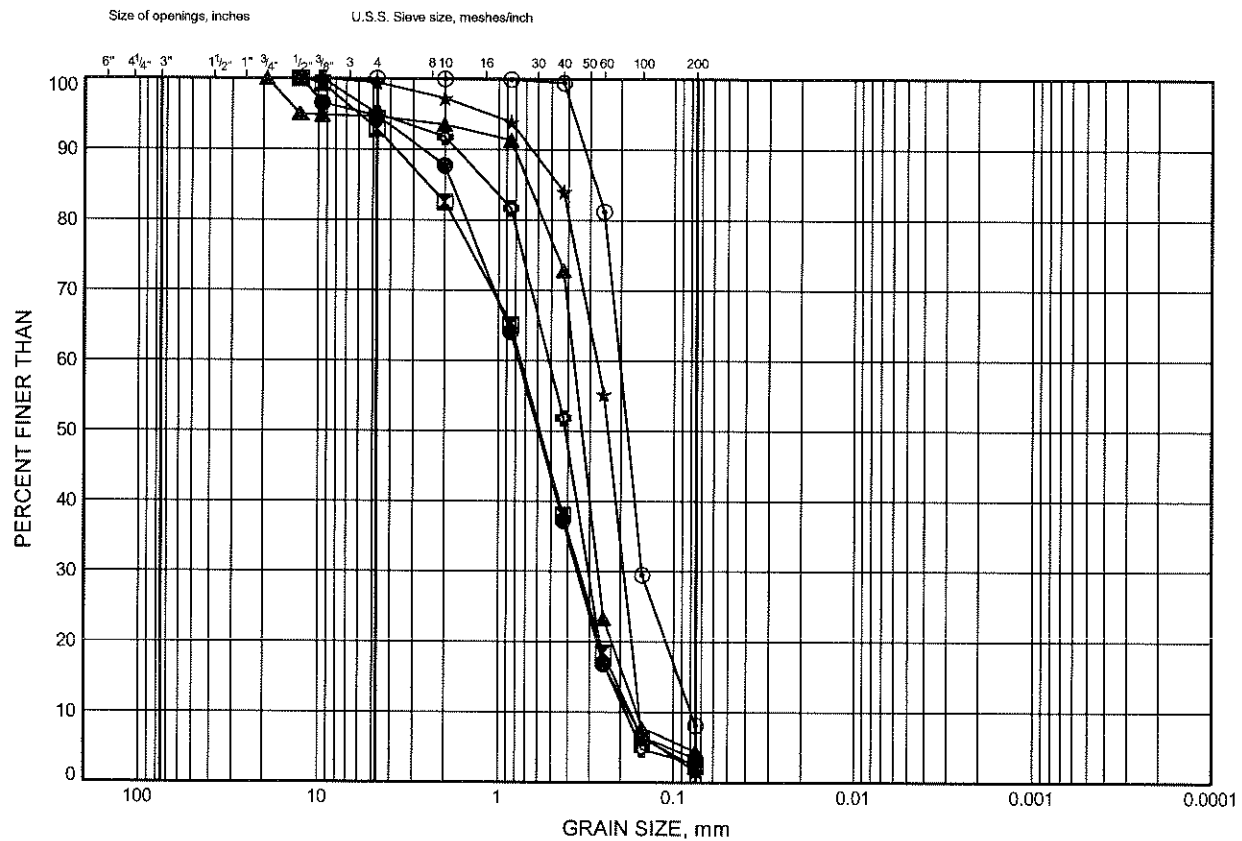


Prep'd MFA  
Chkd. MRA

# Little White River GRAIN SIZE DISTRIBUTION

FIGURE B7

## SAND



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-LW05	9.45	291.25
⊠	07-LW05	20.12	280.58
▲	07-LW05	30.63	270.07
★	07-LW06	4.88	292.79
⊙	07-LW06	15.54	282.13
⊕	07-LW07	1.83	299.97

Date January 2008  
Project 512-00-00

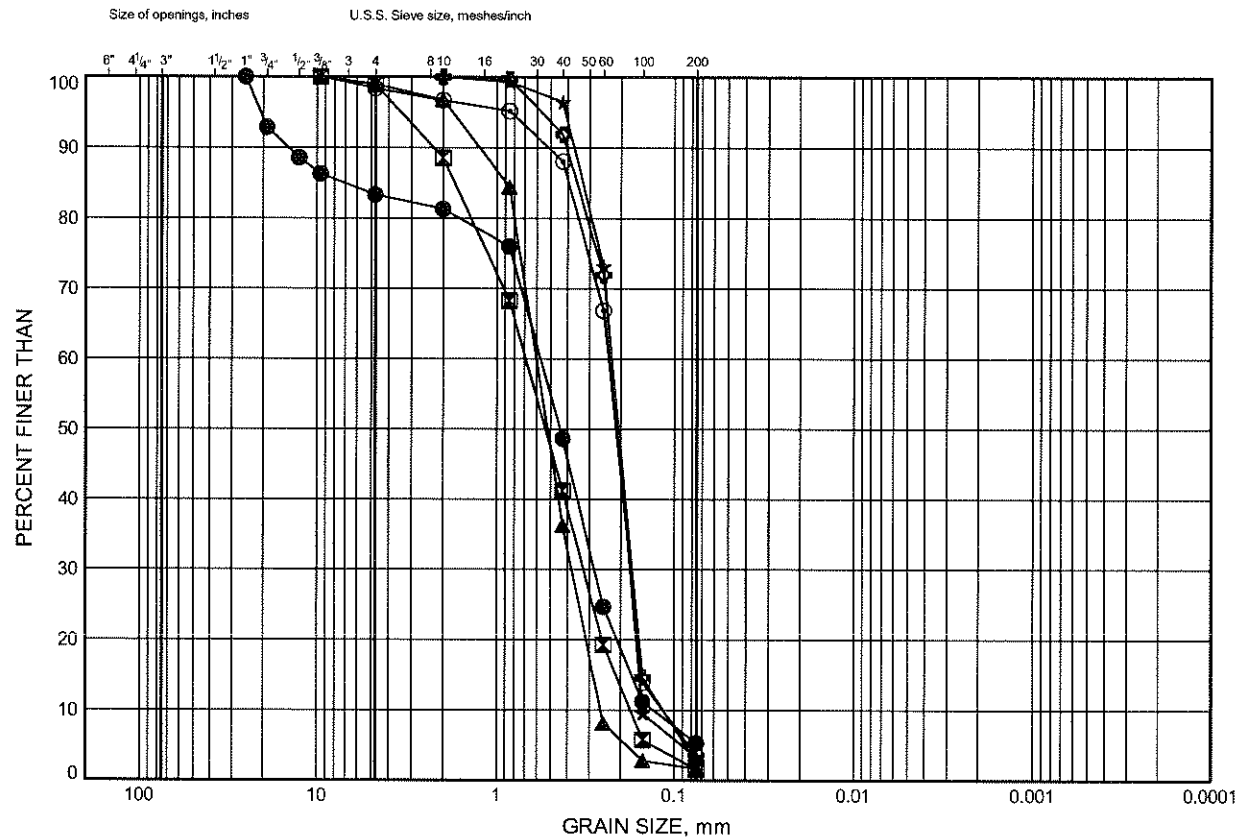


Prep'd MFA  
Chkd. MRA

# Little White River GRAIN SIZE DISTRIBUTION

FIGURE B8

## SAND



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-LW02	21.64	276.94
⊠	07-LW03	20.12	280.21
▲	07-LW04	4.88	295.60
★	07-LW08	2.59	298.71
⊙	07-LW10	1.83	299.37
⊗	07-LW10	3.35	297.85

Date January 2008  
Project 512-00-00

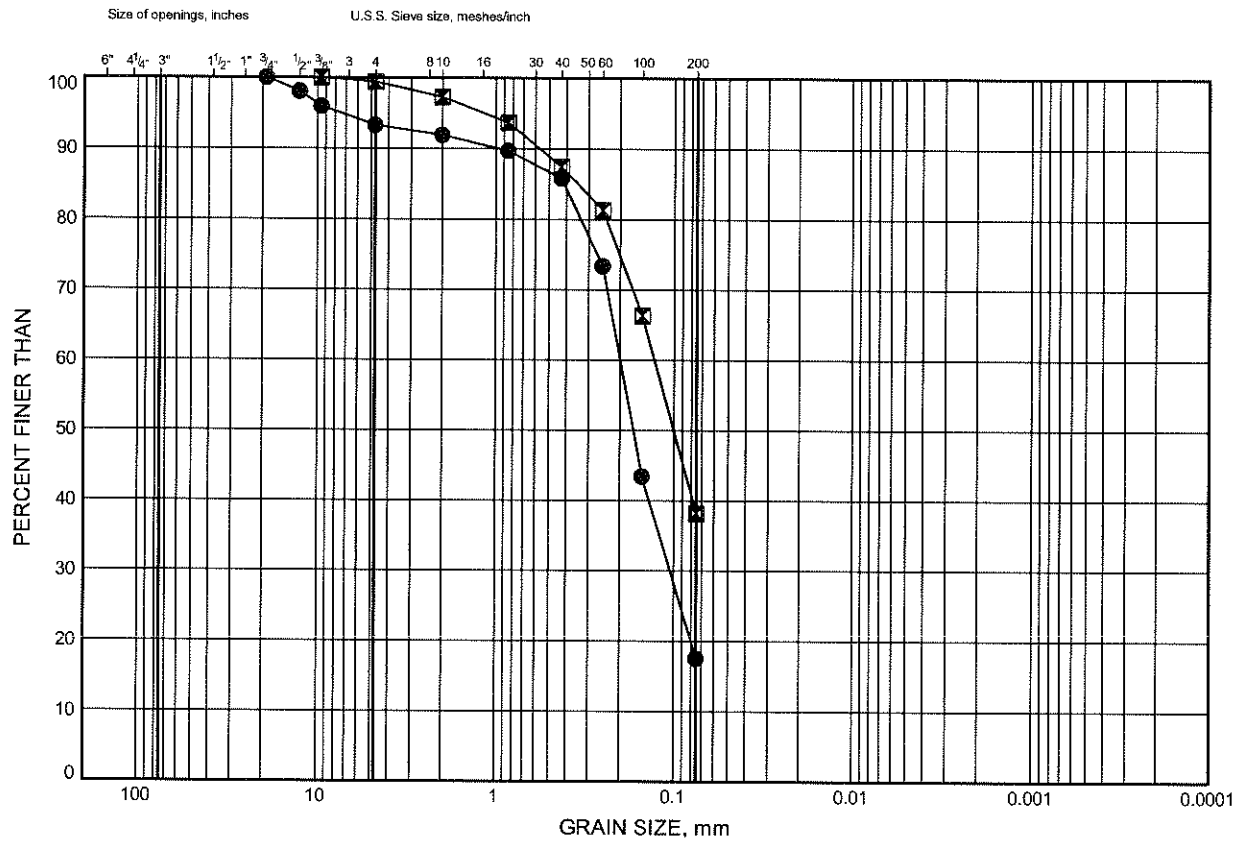


Prep'd MFA  
Chkd. MRA

# Little White River GRAIN SIZE DISTRIBUTION

FIGURE B9

## SILTY SAND



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-LW05	14.02	286.68
⊠	07-LW05	23.16	277.54

Date January 2008  
Project 512-00-00



Prep'd MFA  
Chkd. MRA

## FIGURE B10

Size of openings, inches

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

PERCENT FINER THAN

GRAIN SIZE, mm

Grain Size (mm)	Percent Finer Than (%) - Circular Markers	Percent Finer Than (%) - Square Markers
100	100	100
10	100	100
4.75	98	100
2.0	95	100
0.85	90	100
0.425	85	100
0.25	82	100
0.15	80	98
0.075	68	70
0.0425	52	45
0.025	43	35
0.015	32	24
0.0075	20	20
0.00425	15	15
0.0025	11	11
0.0015	8	8
0.00075	5	5
0.000425	3	3

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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-LW02	4.88	293.70
⊠	07-LW11	1.07	299.53

Date January 2008  
Project 512-00-00



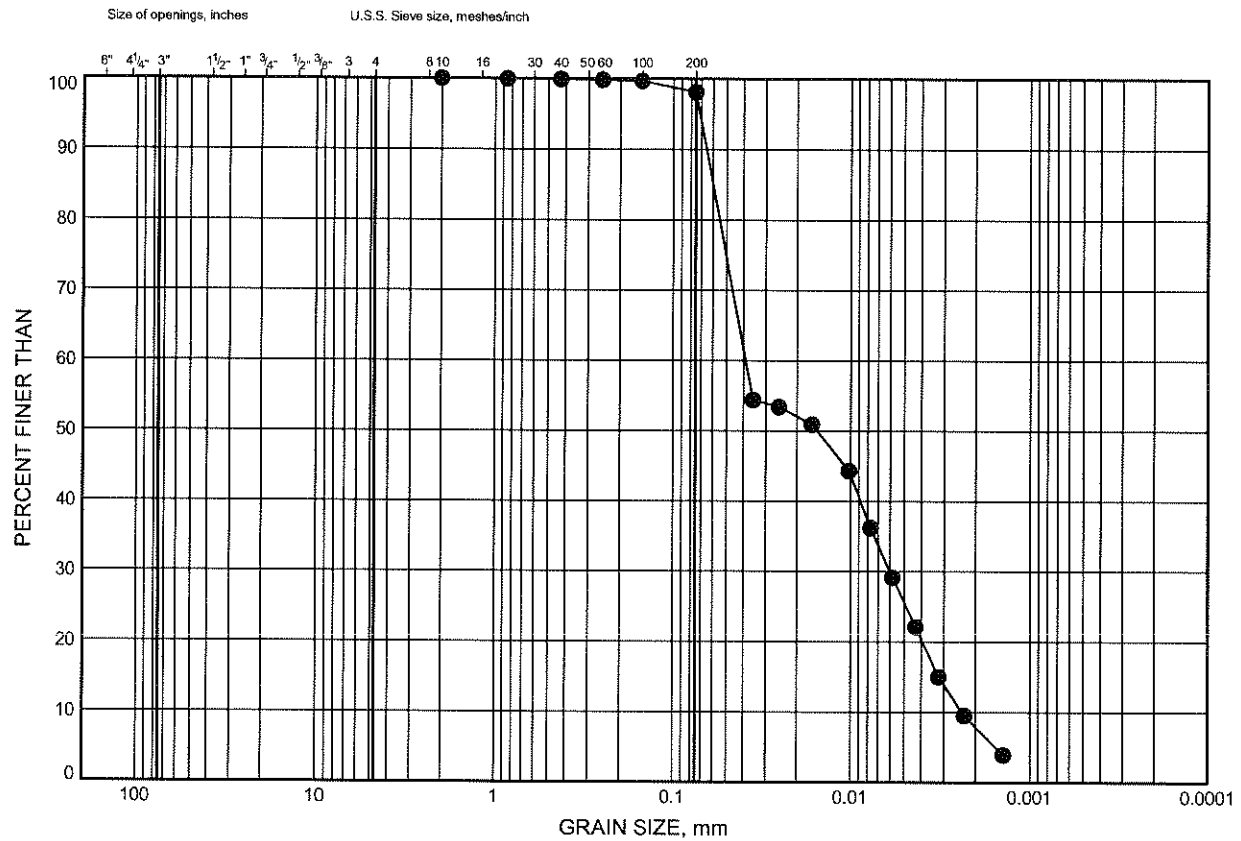
Prep'd ..... MFA .....  
Chkd. .... MRA .....



# Little White River GRAIN SIZE DISTRIBUTION

FIGURE B11

## SILT



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-LW12	3.35	298.65

Date January 2008  
Project 512-00-00

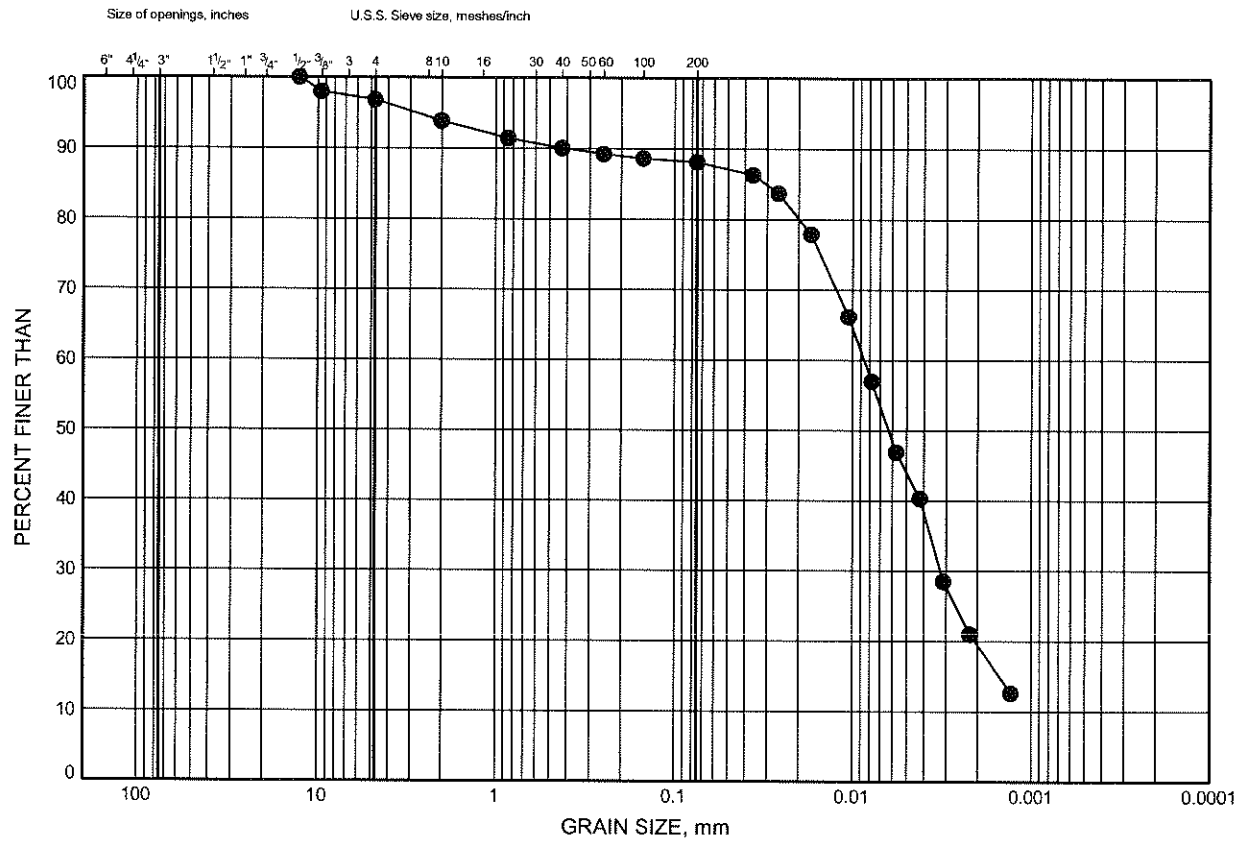


Prep'd MFA  
Chkd. MRA

# Little White River GRAIN SIZE DISTRIBUTION

FIGURE B12

SILT, SOME CLAY



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-LW04	7.92	292.56

Date January 2008  
Project 512-00-00

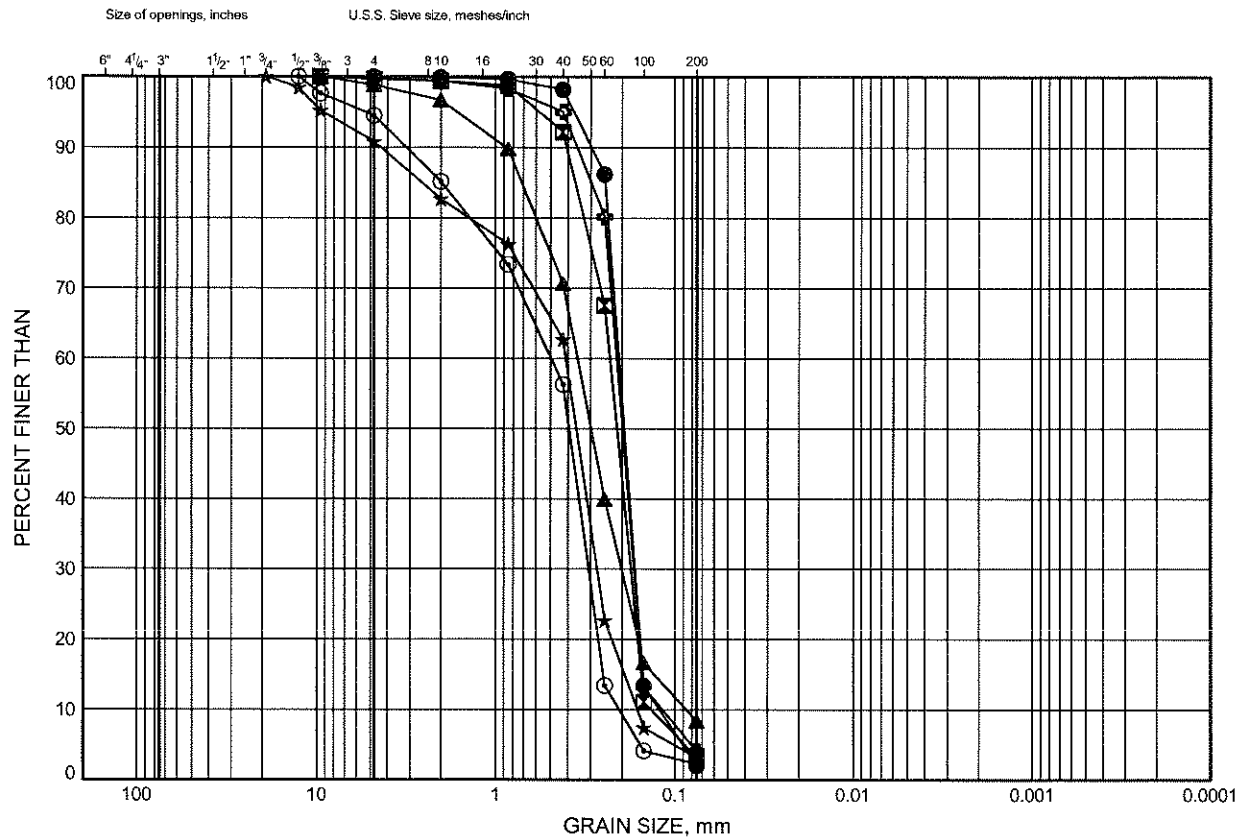


Prep'd MFA  
Chkd. MRA

# Little White River GRAIN SIZE DISTRIBUTION

FIGURE B13

## SAND



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-LW15	3.32	297.28
⊠	07-LW16	2.59	296.41
▲	07-LW17	2.59	295.71
★	07-LW17	6.40	291.90
⊙	07-LW18	10.97	287.13
☆	07-LW19	2.59	297.71

Date January 2008  
Project 512-00-00

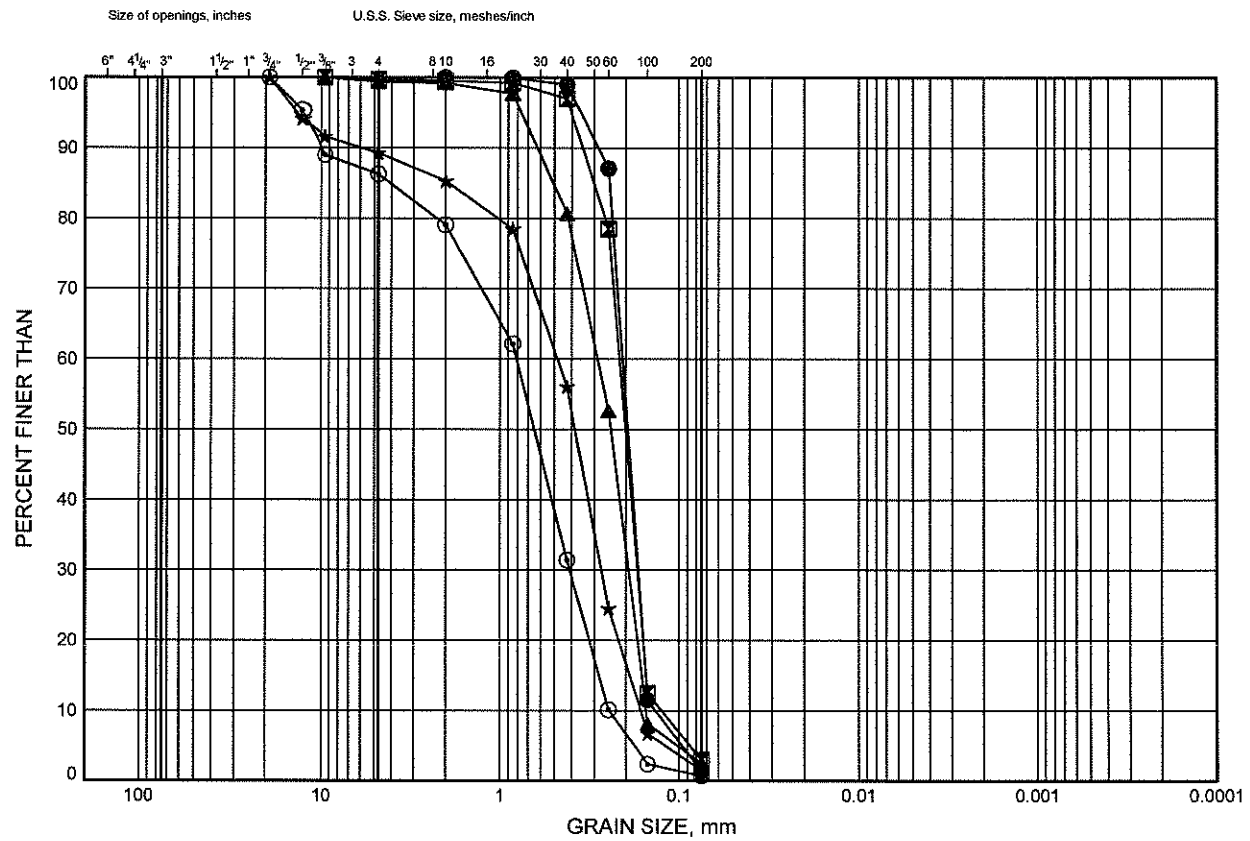


Prep'd MFA  
Chkd. MRA

# Little White River GRAIN SIZE DISTRIBUTION

FIGURE B14

## SAND



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-LW19	6.40	293.90
⊠	07-LW20	6.40	293.60
▲	07-LW21	2.59	297.11
★	07-LW22	6.40	291.70
⊙	07-LW24	7.92	291.68



Date January 2008

Project 512-00-00

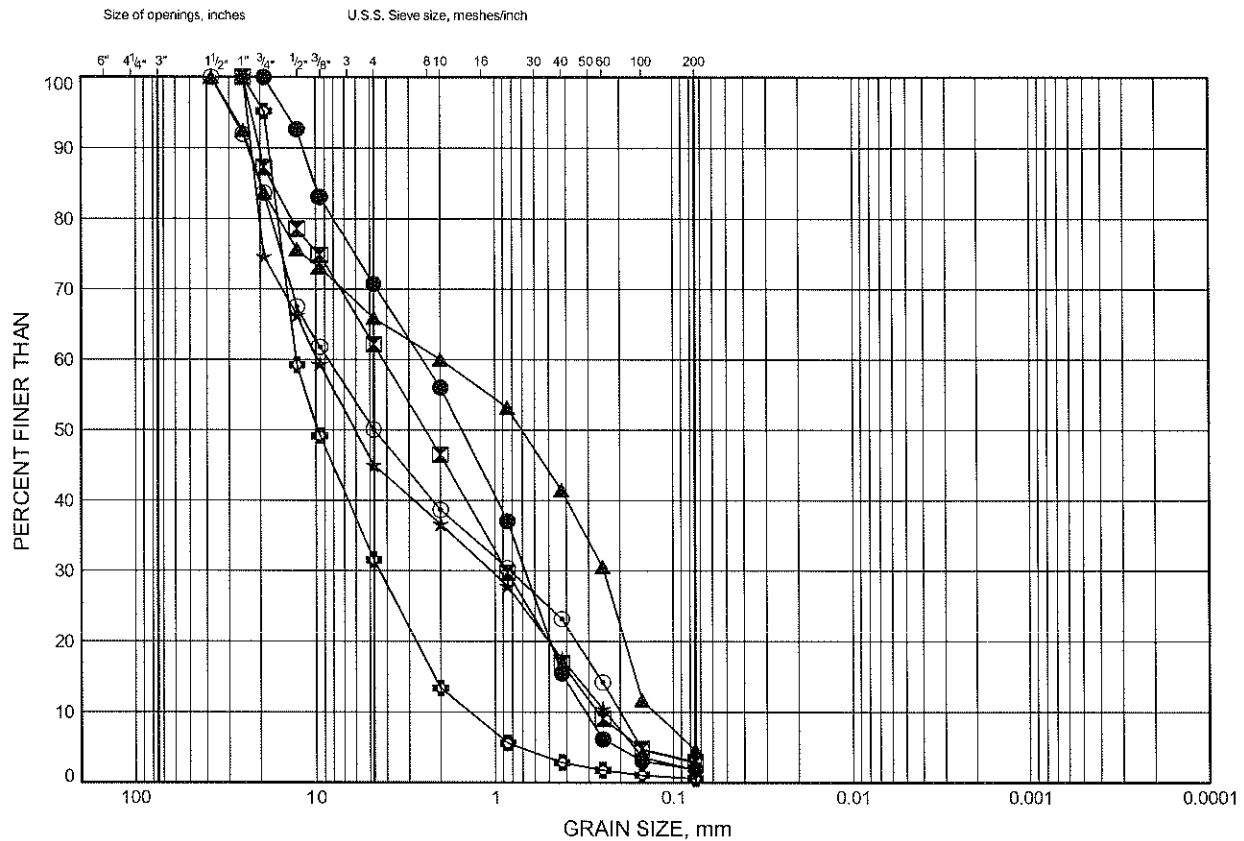
Prep'd MFA

Chkd. MRA

# Little White River GRAIN SIZE DISTRIBUTION

FIGURE B15

## SAND AND GRAVEL



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-LW15	9.45	291.15
⊠	07-LW16	7.92	291.08
▲	07-LW18	4.88	293.22
★	07-LW21	6.40	293.30
⊙	07-LW23	6.40	293.80
⊕	07-LW24	4.88	294.72

Date January 2008

Project 512-00-00



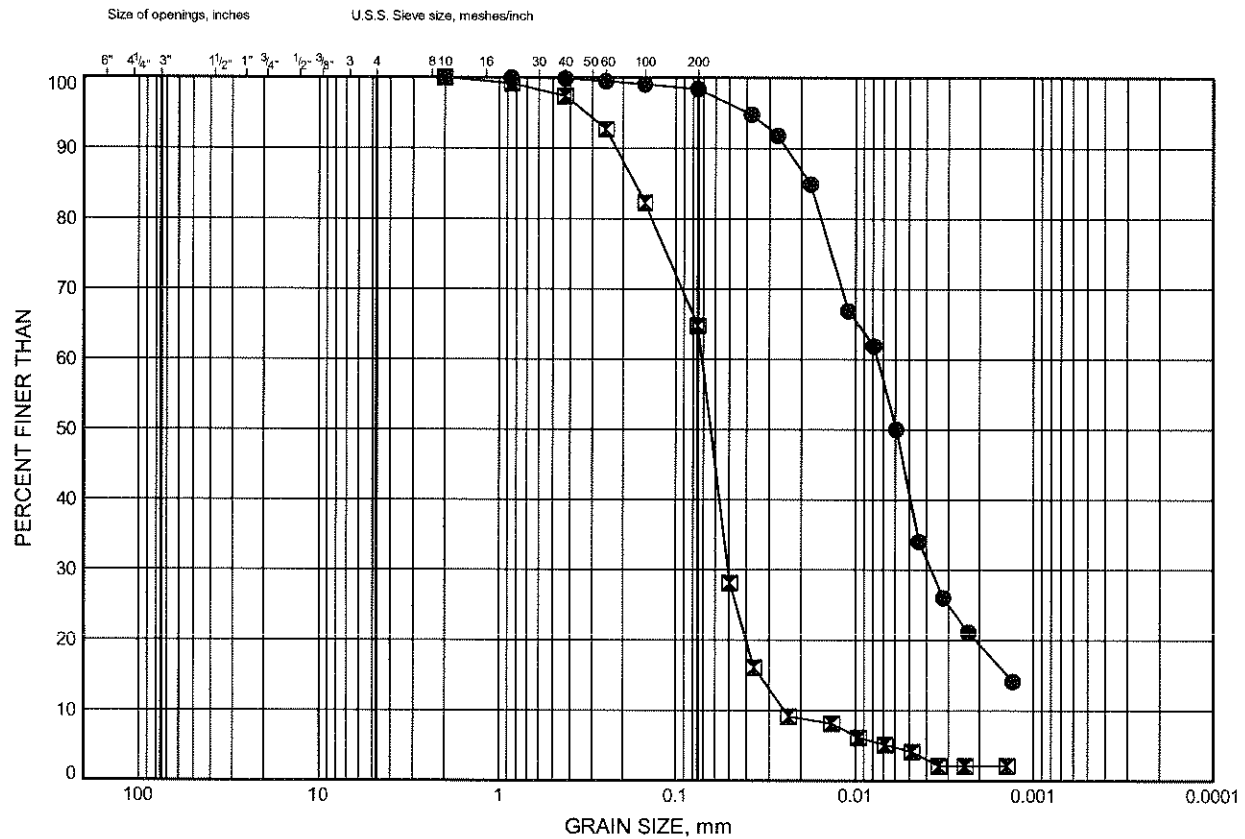
Prep'd MFA

Chkd. MRA

# Little White River GRAIN SIZE DISTRIBUTION

FIGURE B16

## SANDY SILT, CLAYEY SILT



## **Appendix C**

### **Factual Information from 2004 Investigation Report**



PROJECT 03-1111-029		RECORD OF BOREHOLE No LW2-1		1 OF 3	METRIC
W.P. 513-00-01	LOCATION N 199995.9 E 100009.8			ORIGINATED BY GB	
DIST 62 HWY 546	BOREHOLE TYPE CME 55 POWER AUGER AND WET ROTARY WITH NO CORE BARREL			COMPILED BY KG	
DATUM Local	DATE October 31, 2003			CHECKED BY JPD	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						60	80	100	10	20	30
								SHEAR STRENGTH kPa							WATER CONTENT (%)					
100.7	GROUND SURFACE																			
0.0	Silty Sand, some gravel and rootlets, occasional cobbles Loose Brown Moist (Fill)		1	SS	5															
99.3			2	SS	7															
1.4	Sand and Gravel, trace silt, occasional cobbles Compact Brown Moist (Fill)		3	SS	19															
97.7																				
3.0	Sand and Gravel, trace silt, occasional cobbles Loose to compact Brown Wet		4	SS	11															
			5	SS	7															
			6	SS	12															
			7	SS	22															
91.0	End of Borehole																			
9.8	Notes:  1. Borehole was advanced to a depth of 1.8 m using 108 mm I.D. hollow stem augers, beyond which, further boring to 9.75 m depth was carried out using 'N' size casing and 'NQ' size core barrel.  2. Difficulties were experienced with sand blowing into the casing during drilling and sampling operations.  3. Dynamic Cone Penetration Test (DCPT) was carried out between depths of 9.75 m to 30.2 m.																			

CHECKED BY: JPD

JPD

Continued Next Page

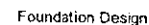
MISS\_MTO 03-1111-029-BA-MTO.GPJ ON\_MOT.GDT 9/2/04

Continued Next Page

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







+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

MISS\_MTO 03-1111-029-BA-MTO.GPJ ON\_MOT.GDT 9/2/04



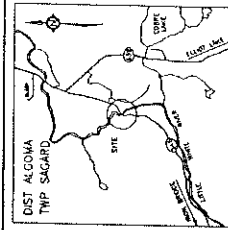


LITTLE WHITE RIVER#2

### BOREHOLE LOCATIONS




**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



## KEY PLAN

### LEGEND

- |   |                                  |
|---|----------------------------------|
|  | Borehole - Current Investigation |
|  | Dynamic Cone Penetration Test    |
|  | Borehole and Cone                |

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
LW2-1	100.7	199955.9	100009.8
LW2-2	100.0	200022.7	100037.1

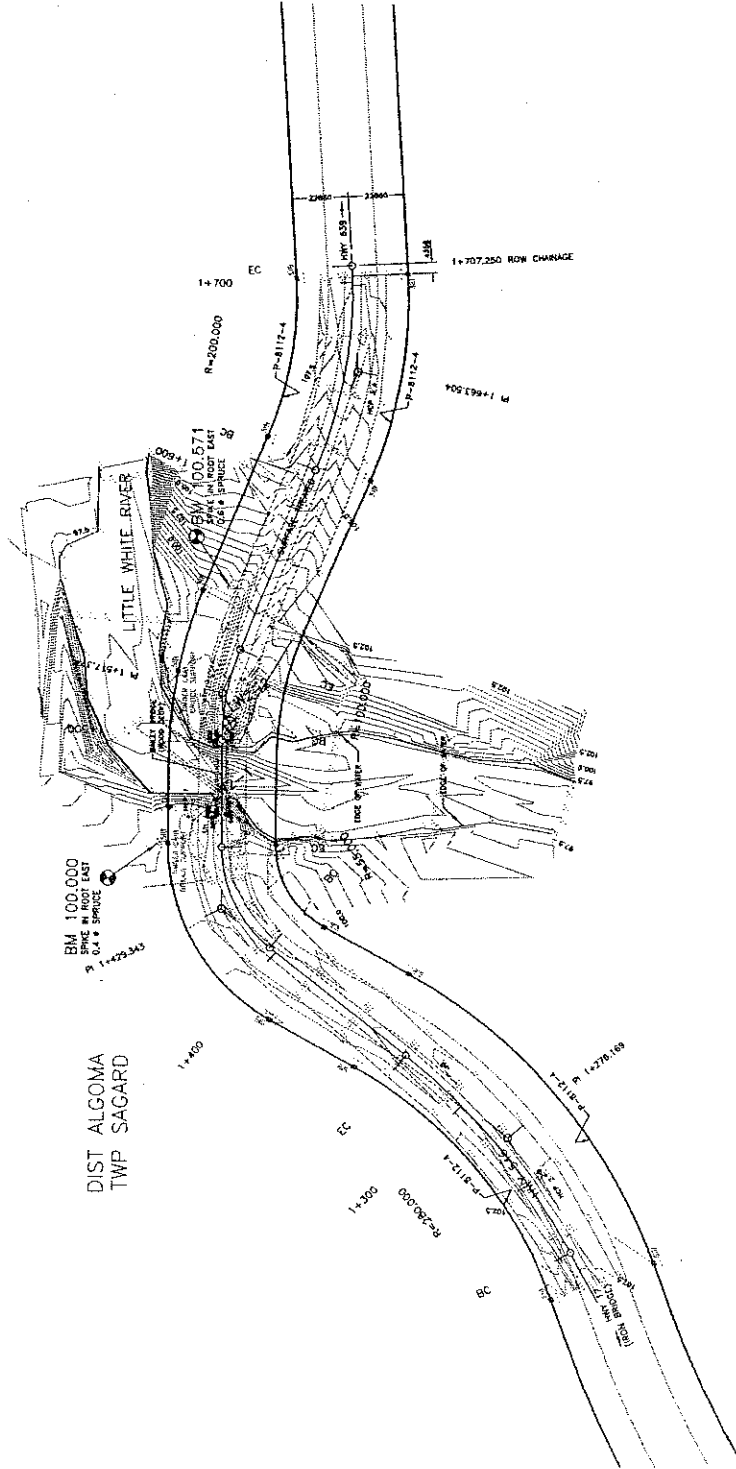
**NOTE**

**NOTE**

1. Northings and Eastings presented on this drawing are as presented by Northling Engineering and are not in UTM coordinate system, but are based on a local meridian grid.

## REFERENCE

Base plans provided in digital format by Northland Engineering (1987) limited, drawing file nos. LWA # 2-E-Pion.dwg, received November 25, 2003.

[illegible]

A scale bar labeled "SCALE" with markings for 20, 0, 20, and 40 METRES.

## PLAN

## **Appendix D**

### **Photographs, Figures and Tables**

Little White River II Bridge Replacement  
Highway 546, Algoma

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Photo 1. East side of existing bridge from southeast, April 2006.

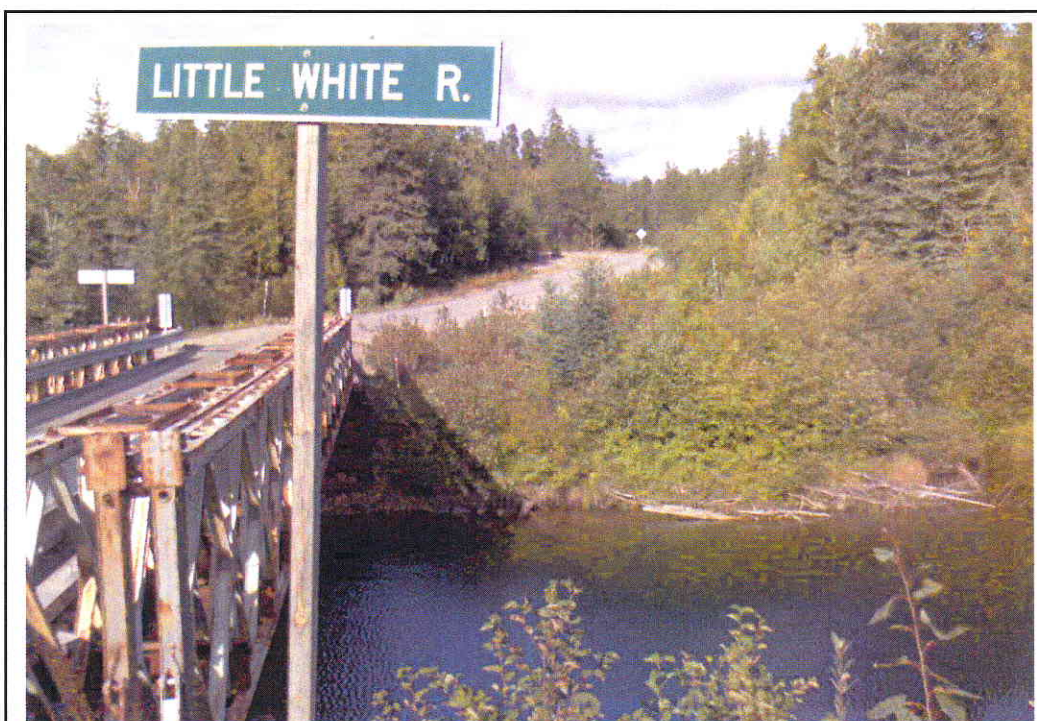


Photo 2. North approach on east side of existing bridge, September 2007.



Little White River II Bridge Replacement  
Highway 546, Algoma

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Photo 3. South approach on east side of existing bridge, September 2007.

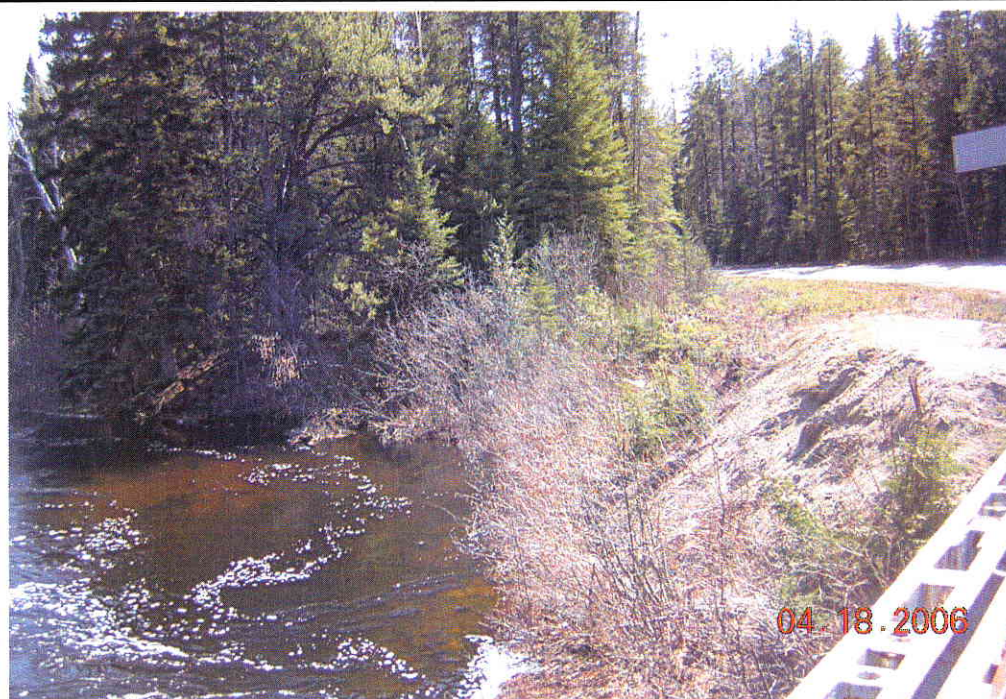
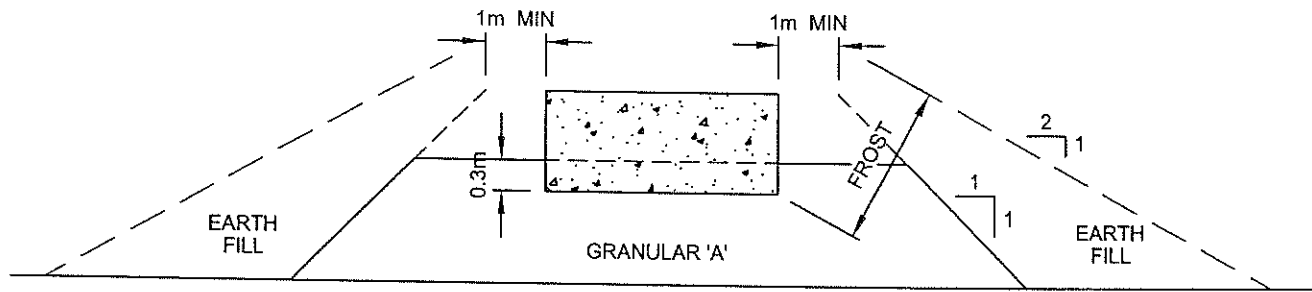
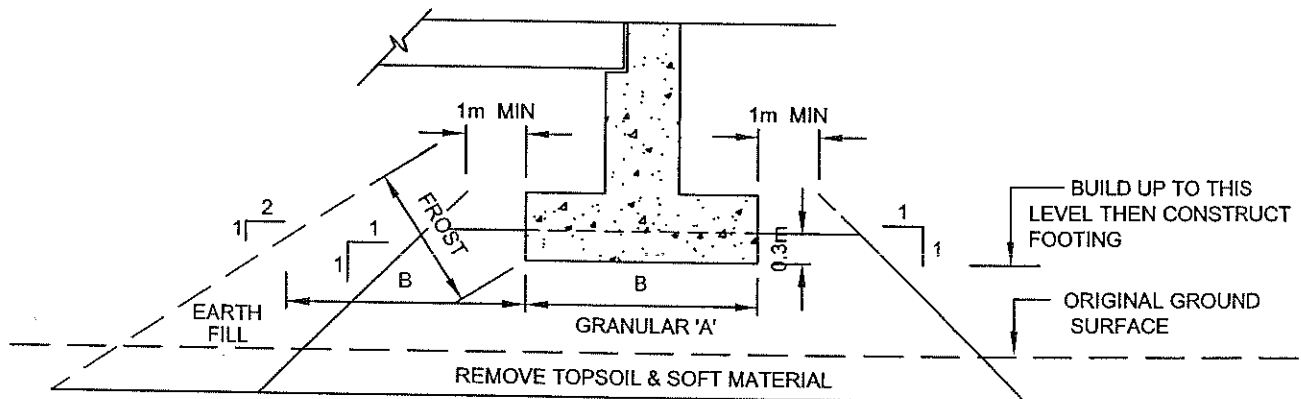


Photo 4. South approach on east side of existing bridge, April 2006.



## CROSS-SECTION



## LONGITUDINAL SECTION

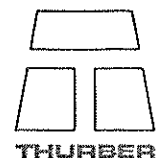
NOT TO SCALE

### NOTES:

1. REMOVE TOPSOIL AND OR SOFT SUBSOIL UNDER AREA OF COMPACTED GRANULAR 'A' AND EARTH FILL.
2. PLACE GRANULAR 'A' AND EARTH FILL TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO O.P.S.S. 501.
3. CONSTRUCT CONCRETE FOOTING.
4. PLACE REMAINDER OF GRANULAR 'A' AND EARTH FILL AS REQUIRED.
5. SOURCE M.T.C. 1982.

ENGINEER	AEG
DRAWN	SS
DATE	April , 2004
APPROVED	PKC
SCALE	NTS

ABUTMENT ON COMPACTED FILL SHOWING  
GRANULAR A CORE



DWG. NO.

FIGURE 1



**COMPARISON OF FOUNDATION ALTERNATIVES FOR EACH FOUNDATION ELEMENT**

Spread Footings	Spread Footings on Engineered Fill	Driven Piles	Drilled Shafts
<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. Simpler construction than deep foundation elements.</li> <li>ii. Generally the most cost-effective foundation for a TMB.</li> </ul> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Low geotechnical resistance available due to variable and very loose soils at the surface.</li> <li>ii. Shallow foundations near the edge of the river may be subject to scour.</li> <li>iii. Deeper excavations that may be required to contact competent native soil or as a result of scour protection will be difficult to dewater and maintain in an undisturbed condition.</li> </ul> <p><b>FEASIBLE FOR SOUTH FOUNDATION BUT NOT RECOMMENDED FOR NORTH FOUNDATION</b></p>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. Simpler construction than deep foundation elements.</li> <li>ii. Generally more cost-effective than deep foundations for a TMB.</li> <li>iii. Can eliminate need to excavate below groundwater level.</li> <li>iv. Can achieve higher geotechnical resistance than spread footings on native soil.</li> </ul> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Resistance is influenced by the variable and very loose soils at the surface.</li> <li>ii. Shallow foundations or engineered fill pads near the edge of the river may be subject to scour.</li> <li>iii. Deeper excavations that may be required as a result of scour protection will be difficult to dewater and maintain in an undisturbed condition.</li> </ul> <p><b>RECOMMENDED, SUBJECT TO REQUIREMENTS DESCRIBED IN THE BODY OF THE REPORT</b></p>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. High geotechnical resistance may be developed by driving the piles into very dense soil.</li> <li>ii. Comparatively short abutment stem possible</li> <li>iii. Permits integral abutment design</li> <li>iv. Readily permits founding below the scour depth</li> </ul> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Higher unit cost compared to footings.</li> <li>ii. Potential for encountering obstructions or damaging piles while driving through very dense sand and gravel containing cobbles and boulders.</li> </ul> <p><b>TECHNICALLY FEASIBLE BUT NOT CONSIDERED TO BE COST EFFECTIVE</b></p>	<p><b>Advantages:</b></p> <ul style="list-style-type: none"> <li>i. High geotechnical resistance is potentially available using deep shafts</li> </ul> <p><b>Disadvantages:</b></p> <ul style="list-style-type: none"> <li>i. Higher costs compared to spread footings. Probably higher costs compared to driven piles.</li> <li>ii. Difficulties advancing through very dense sand and gravel containing cobbles and boulders.</li> <li>iii. High risk of not being able to maintain undisturbed shaft walls and base below the groundwater level.</li> <li>iv. An integral abutment design is not an available option</li> <li>v. It may be necessary to place concrete by tremie methods.</li> </ul> <p><b>NOT RECOMMENDED</b></p>

## **Appendix E**

### **Special Provisions and NSSPs**

The following have been referenced in the report:

SP 105S10

SP 902S01

SP 903S01

SS 103-11

OPSS 902

OPSS 907

OPSS 918

OPSD 3000.100

OPSD 3101.150

OPSD 3101.200

OPSD 3102.100

## **Appendix F**

### **Borehole Locations and Soil Strata Drawings**






DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

LITTLE WHITE RIVER II  
BRIDGE REPLACEMENT  
BOREHOLE LOCATION PLAN



**THURBER ENGINEERING LTD.**  
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS



	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
07-LW1	299.9	5 167 794.62	394 842.35
07-LW2	298.6	5 167 821.99	394 861.84
07-LW3	300.3	5 167 786.98	394 843.37
07-LW4	300.5	5 167 821.16	394 872.30
07-LW5	300.7	5 167 778.62	394 853.61
07-LW6	297.7	5 167 811.91	394 880.99
07-LW7	301.8	5 167 596.63	394 857.60
07-LW8	301.3	5 167 645.13	394 850.56
07-LW9	301.0	5 167 696.02	394 848.00
07-LW10	301.2	5 167 744.62	394 829.68
07-LW11	300.6	5 167 838.20	394 892.09
07-LW12	302.0	5 167 854.29	394 930.36
07-LW13	305.3	5 167 889.58	394 967.43
07-LW14	307.3	5 167 913.38	395 012.85
07-LW15	300.6	5 167 778.33	394 849.56
07-LW16	299.0	5 167 773.45	394 853.30
07-LW17	298.3	5 167 812.26	394 872.95
07-LW18	298.1	5 167 806.53	394 877.31

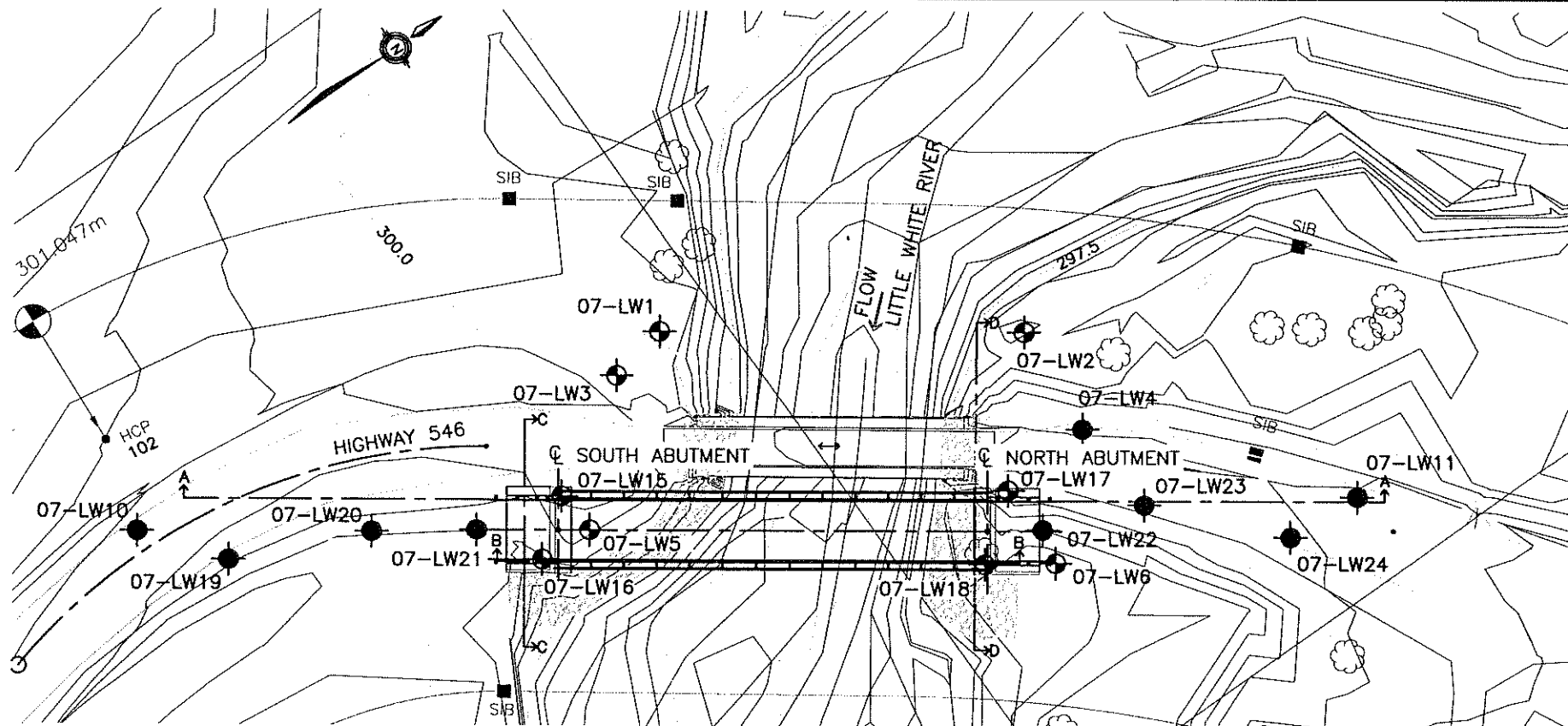
- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

**GEOCRES No. 41J-76**

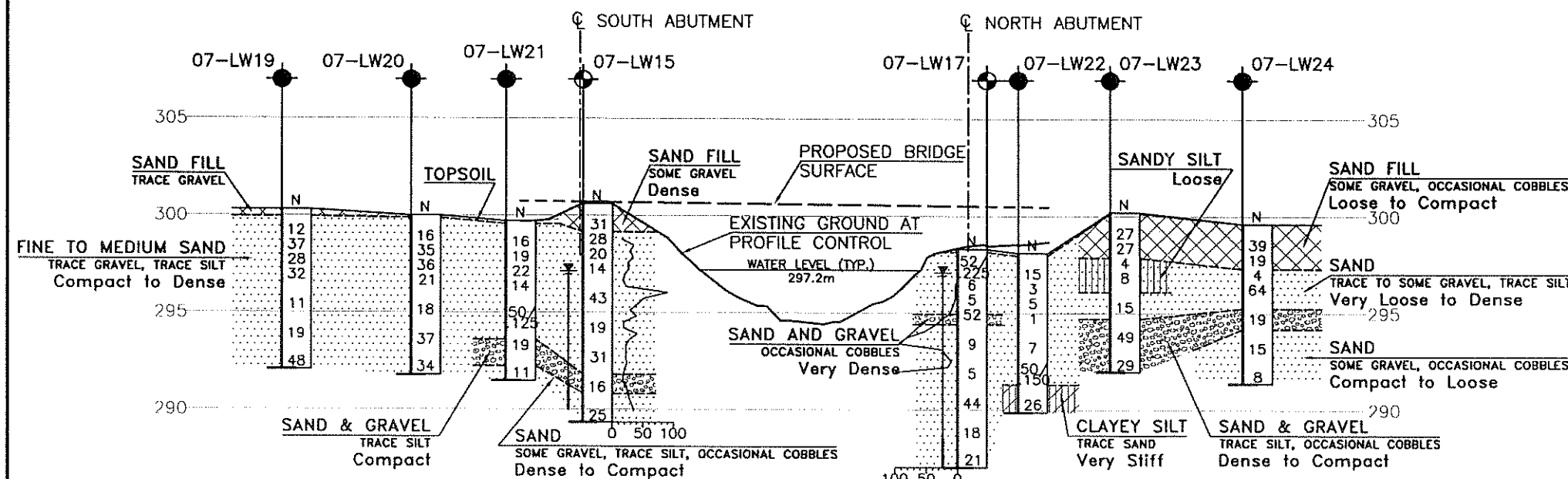


DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

REVISIONS							
	DATE	BY	DESCRIPTION				
DESIGN	MRA	CHK	PKC	CODE	LOAD	DATE	FEB 200
DRAWN	MFA	CHK	MRA	SITE	STRUCT	DWG	



PLAN  
 0 6 12m



PROFILE A-A

0 50 100  
 0 5 10m  
 HOR  
 VER

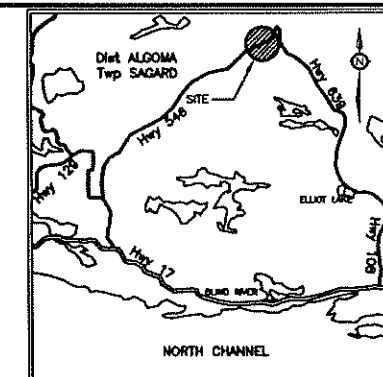
**METRIC**  
 DIMENSIONS ARE IN METRES  
 AND/OR MILLIMETRES  
 UNLESS OTHERWISE SHOWN

HIGHWAY 546  
 CONT No  
 GWP No 512-00-00



LITTLE WHITE RIVER II  
 BRIDGE REPLACEMENT  
 BOREHOLE LOCATION PLAN AND SOIL  
 STRATA

SHEET



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
- W Water Level
- HA Head Artesian Water
- PZ Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
07-LW1	299.9	5 167 794.62	394 842.35
07-LW2	298.6	5 167 821.99	394 861.84
07-LW3	300.3	5 167 786.98	394 843.37
07-LW4	300.5	5 167 821.16	394 872.30
07-LW5	300.7	5 167 778.62	394 853.61
07-LW6	297.7	5 167 811.91	394 880.99
07-LW15	300.6	5 167 778.33	394 849.56
07-LW16	299.0	5 167 773.45	394 853.30
07-LW17	298.3	5 167 812.26	394 872.95
07-LW18	298.1	5 167 806.53	394 877.31
07-LW19	300.3	5 167 749.89	394 836.67
07-LW20	300.0	5 167 762.21	394 842.15
07-LW21	299.7	5 167 770.12	394 847.59
07-LW22	298.1	5 167 812.72	394 877.77
07-LW23	300.2	5 167 821.74	394 881.34
07-LW24	299.6	5 167 831.02	394 891.59

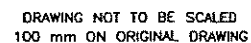
**NOTES:**

- 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. 41J-76

DRAWING NOT TO BE SCALED  
 100 mm ON ORIGINAL DRAWING

DATE	BY	DESCRIPTION
DESIGN	MRA	CHK PKC CODE
DRAWN	MFA	CHK MRA SITE
LOAD		DATE FEB 2008
STRUCT		DWG



REVISIONS								
	DATE	BY	DESCRIPTION					
	DESIGN	MRA	CHK	PKC	CODE	LOAD	DATE FEB 20	
	DRAWN	MFA	CHK	MRA	SITF	STRUCT	DWG	