

**FOUNDATION INVESTIGATION REPORT  
PROPOSED WATERMAIN RELOCATIONS  
HIGHWAY 11 FOUR-LANING  
FROM 0.5 km NORTH OF HIGHWAY 520 NORTHERLY 5.7 km  
G.W.P. No. 473-93-00**

**GEOCREC Number: 31E-299**

**Report to**

**MMM Group Limited**

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August 7, 2009  
File: 19-5161-16

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**PART 1: FACTUAL INFORMATION**

## **1 INTRODUCTION**

This report presents the factual findings obtained from foundation investigations conducted at the sites of two proposed watermain relocations required in connection with the four-laning of Highway 11 at Burk's Falls, Ontario.

One site is located adjacent to the south side of Highway 520 at the proposed Highway 11 northbound lane structure. The other site is located at the current end of Sharpe Street, to become the extension of Cameron Street, in Burk's Falls.

The purpose of the investigation was to explore the subsurface conditions in the vicinity of the watermain relocations and, based on the data obtained, to provide a borehole location plan, record of borehole sheets, laboratory test results and a written description of the subsurface conditions. For the Highway 520 location, existing borehole information from a previous foundation investigation conducted for the Magnetawan River/Highway 520 overpass of the Highway 11 Northbound Lanes was used for this purpose.

Thurber Engineering Ltd. (Thurber) was retained by MMM Group Limited (MMM) to carry out the foundation investigation under the Ministry of Transportation Ontario (MTO) Agreement Number 5006-E-0063.

## **2 SITE DESCRIPTION**

The area along the Highway 11 corridor is predominantly undeveloped, with heavy vegetation. The current site is occupied by the Village of Burk's Falls which consists of a mixture of residential dwellings and commercial buildings.

The site is located in the Physiographic Region known as the Highway 11 Strip, which is characterized by a narrow strip that was positioned just below the shoreline of Glacial Lake Algonquin. The overburden materials are typically composed of sand, silt and clay deposited by watercourses entering the lake. Sands were deposited in shallow waters near the abandoned shoreline as deltas while the finer particles were deposited as deep water sediments further offshore. The bedrock is composed of black to grey gneissic granite that has undergone extensive tectonization and distinct changes in lithology.

### 3 SITE INVESTIGATION AND FIELD TESTING

Borehole information presented in the Foundation Investigation Report previously prepared by Thurber for the proposed Highway 11 Northbound overpass structure at Magnetawan River / Highway 520 was used to determine the subsurface conditions at the Highway 520 site (W.P. 482-93-01, Site 44-188N, Geocres No. 31E-267, report dated November 22, 2006). Boreholes 06-28 and 06-29 from the Thurber investigation, as well as Boreholes 3 and 4 from an earlier investigation by AGRA Earth & Environmental Ltd., were employed.

Site-specific investigation and field testing was carried out for the Sharpe Street location. The fieldwork consisted of drilling and sampling one borehole (Borehole N-WM) to 6.7 m depth. The borehole was drilled on February 18, 2009.

The approximate locations of the current and previous boreholes are shown on the Borehole Location Drawing in Appendix C. The coordinates and elevations of the boreholes are given on this drawing and on the individual Record of Borehole Sheets in Appendix A.

Prior to the start of drilling, the borehole location was marked in the field and utility clearances were obtained by Thurber.

A member of Thurber's engineering staff supervised the drilling and sampling operations on a full time basis. The inspector logged the borehole, secured the recovered samples in labelled containers, and transported the samples to Thurber's laboratory for further examination and testing.

Hollow stem augers were used to advance the borehole. Samples were obtained at selected intervals using a 50 mm diameter split spoon sampler in conjunction with Standard Penetration Testing (SPT). The borehole was backfilled with bentonite upon completion in accordance with O.Reg. 903 (as amended by O.Reg. 372/07).

### 4 LABORATORY TESTING

All 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.

Approximately 25% of the recovered samples were subjected to grain size distribution analyses (sieve and hydrometer) and Atterberg Limits testing when appropriate. The results of the testing program for the current and previous Thurber boreholes are shown on the Record of Borehole Sheets in Appendix A and on the figures in Appendix B.

### 5 DESCRIPTION OF SUBSURFACE CONDITIONS

#### 5.1 General

Reference is made to the Record of Borehole Sheets in Appendix A for details of the encountered soil stratigraphy. 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.

## 5.2 Highway 520 Site (BH's 06-28, 06-29, 3 and 4)

The soils encountered at the Highway 520 structure borehole locations consisted of 75 to 100 mm of topsoil overlying 2.1 to 3.3 m of sandy silt, clayey silt and/or silty clay fill, underlain by a 2.5 to 3.7 m thick layer of sand. The sand is underlain by a 0.8 to 2.2 m thick unit variously described as sandy silt till, gravelly sand, or sand, silt and gravel till, which overlies bedrock.

The clay fill encountered in Borehole 4 was described as being stiff to firm with SPT N-values of 7 to 13 blows/0.3 m. Moisture contents ranged from 21 to 28%. The lower boundary of the clay fill was encountered at 2.2 m depth (Elev. 284.9 m).

Brown sandy silt was encountered below the topsoil in Boreholes 06-28 and 06-29. SPT N-values obtained in the sandy silt typically ranged from 9 to 20 blows/0.3 m (compact), with one value of 61 obtained near 2.5 m depth in Borehole 06-28. The silt became clayey below 1.2 m depth (Elev. 285.4 m) in Borehole 06-29, with an N-value of 20 blows/0.3 m (very stiff). Moisture contents ranged from 18 to 37%. The lower boundary of the silt was encountered at 3.4 and 2.2 m depth (Elev. 283.7 and 284.4 m).

The upper boundary of the sand layer was encountered at depths of 2.2 to 3.4 m (Elev. 283.7 to 284.9 m). The sand was described as brown to grey and moist to wet. SPT N-values varied widely from 5 to 53 blows/0.3 m, indicating a loose to very dense condition. Moisture contents ranged from 15 to 25%. The lower boundary of the sand layer was at 5.5 to 5.9 m depth (Elev. 281.2 m).

The layer of sand/silt till lying between the sand unit and bedrock contained gravel, cobbles and boulders. Two SPT N-values of 24 blows/0.3 m and 50/0.14 m were obtained in this layer, indicating a compact to very dense condition. Moisture contents of 6 and 14% were measured.

Bedrock and probable bedrock were encountered at depths of 6.7 to 8.1 m (Elev. 279.0 to 280.4 m). Borehole 06-28 was terminated upon refusal on probable bedrock at 6.7 m depth. Boreholes 06-29 and 4 were advanced by coring to depths of 9.9 and 11.2 m (Elev. 276.7 and 275.9 m). The bedrock consists of granite to granitic gneiss.

Upon completion of drilling, water was observed in borehole 06-28 at 3.2 m depth (Elev. 283.9 m). The most recent water levels measured in standpipe piezometers installed in Boreholes 06-29 and 4 were as follows:

Borehole	Date	Water Level (m)	
		Depth	Elevation
06-29	26-Jul-2006	2.7	284.0
4	03-Sep-1999	3.1	284.0

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

### 5.3 Sharpe Street Site (BH N-WM)

The soils encountered in Borehole N-WM consisted of a 0.8 m thick layer of sand and gravel fill (granular road base) underlain primarily by silty sand. The granular fill and silty sand were frozen to 0.9 m depth at the time of the investigation.

The underlying silty sand was described as grey to brown and moist. SPT N-values generally ranged from 15 to 27 blows/0.3, indicating a compact condition. The sand contained a firm (N = 6 blows) clayey silt layer between 2.3 and 3.0 m depth. Moisture contents ranged from 17 to 27%, 31% in the clayey silt. The thickness of the silty sand layer, including the clayey silt, was 5.3 m.

Medium-grained sand, some silt, was encountered below the silty sand at 6.1 m depth (Elev. 294.2 m). An N-value of 15 (compact) and moisture content of 3% were obtained in this unit. Borehole N-WM was terminated in this unit at 6.7 m depth (Elev. 293.6 m).

Water was not observed in the borehole during or upon completion of drilling.

## 6 MISCELLANEOUS

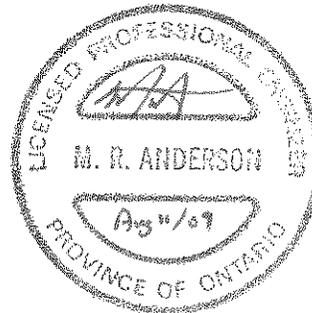
The location and ground surface elevation for the current borehole were supplied by MMM Group Limited. The drilling and sampling equipment was supplied and operated by Eastern Ontario Diamond Drilling Ltd. of Hawkesbury, Ontario.

Full time supervision of the field activities was carried out by Mr. Luke Gilarski of Thurber. Supervision of the field program was performed by Mr. David Elwood.

Interpretation of the field data and preparation of the report was performed by Mr. Murray Anderson, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.

Murray R. Anderson, P.Eng., M.Eng.  
Senior Foundations Engineer



P.K. Chatterji, P.Eng., Ph.D.  
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			

### RECORD OF BOREHOLE No N-WM

1 OF 1

**METRIC**

G.W.P. 473-93-00 LOCATION N 5 052 815.3 E 311 591.4 ORIGINATED BY LG  
 HWY 11 BOREHOLE TYPE Hollow Stem Auger COMPILED BY LG  
 DATUM Geodetic DATE 2009.02.18 - 2009.02.18 CHECKED BY DE

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 (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80			100
300.3														
0.0	SAND and GRAVEL, some silt Frozen (FILL)													
299.5														
0.8	Silty SAND, trace clay, trace gravel Compact Grey Moist		1	SS	50									
			2	SS	15									
298.0														
2.3	Clayey SILT, some sand, trace gravel Firm Grey		3	SS	6									1 23 58 18
297.3														
3.0	Silty SAND, trace clay, trace gravel Compact Grey Moist		4	SS	15									
	Clayey Silt Interbeds for 0.7m		5	SS	13									
	Brown		6	SS	27									5 53 34 8
294.2														
6.1	SAND, medium grained, some silt Compact Light Brown Moist		7	SS	15									
293.6														
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE OPEN AND DRY TO 6.7m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE TO 0.2m, THEN SAND TO SURFACE.													

ONTMT4S 6116.GPJ 4/15/09

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



### RECORD OF BOREHOLE No 06-29

1 OF 2

METRIC

G.W.P. 473-93-00 LOCATION N 5 052 957.38 E 311 429.49 Magnetawan River/Hwy 520 Overpass (NBL) ORIGINATED BY SLL  
 HWY 11 BOREHOLE TYPE Hollow Stem Augers / NW Casing / NQ Core Barrel COMPILED BY JHL  
 DATUM Geodetic DATE 2006-07-18 - 2006-07-19 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20	40					
286.7	TOPSOIL: (75 mm)												
0.0 0.1	Sandy SILT Loose to Compact Brown Moist	1	SS	9									
285.4		2	SS	13									
1.2	Clayey SILT, trace sand, trace roots Very Stiff Brown Moist	3	SS	20									0 6 67 27
284.4		4	SS	25									
2.2	SAND, some silt to silty Compact to Dense Brown Moist to Wet	5	SS	36									0 79 21 (SI+CL)
		6	SS	21									
281.2													
5.5	Gravelly SAND, trace silt, some cobbles and boulders	1	RUN										
		2	RUN										
279.7													
6.9	BEDROCK												
279.3	Pink, white and black, crystalline, faintly weathered to fresh, strong, GRANITIC GNEISS												
7.3	Subvertical joint from 7.06 to 7.11 m Slightly weathered, rough joint surface	3	RUN										RUN 3# TCR=100%, SCR=74%, RQD=28%, UCS=79MPa
	Pink, white and black, crystalline, faintly weathered to fresh, strong, GRANITE (PEGMATITE)												
	Rubble zone from 7.32 to 7.42 m												
	Rubble zone from 8.12 to 8.46 m												
		4	RUN										RUN 4# TCR=100%, SCR=76%, RQD=34%, UCS=83MPa
	Rubble zone from 9.12 to 9.17 m												
	Rubble zone from 9.30 to 9.93 m												
276.7													

ONTMT-4S 2331-MAG.GPJ 4/15/09

Continued Next Page

+ 3, X 3: Numbers refer to Sensitivity  $\frac{20}{15} \frac{5}{10}$  (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 06-29

2 OF 2

METRIC

G.W.P. 473-93-00 LOCATION N 5 052 957.38 E 311 429.49 Magnetawan River/Hwy 520 Overpass (NBL) ORIGINATED BY SLL  
 HWY 11 BOREHOLE TYPE Hollow Stem Augers / NW Casing / NQ Core Barrel COMPILED BY JHL  
 DATUM Geodetic DATE 2006-07-18 - 2006-07-19 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
9.9	Continued From Previous Page  END OF BOREHOLE AT 9.93 m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 07/20/06 2.71 283.99 07/21/06 2.70 284.00 07/22/06 2.73 283.97 07/23/06 2.71 283.99 07/24/06 2.70 284.00 07/25/06 2.70 284.00 07/26/06 2.69 284.01															GR SA SI CL	

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

RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 473-93-00 LOCATION N 5052954 & E311426.5 ORIGINATED BY MA  
 DIST 52 HWY 11 BOREHOLE TYPE Dynamic Cone Penetration Test (DCPT) COMPILED BY AD  
 DATUM Geodatic DATE 28 May 1999 CHECKED BY SP

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					
287.5 0.0	NO SAMPLING & TESTING												
282													
281.5 8.1	END of DCPT												

+ 3 x 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.P. 473-93-00 LOCATION N 5052951.7 E311416.0 ORIGINATED BY MA  
 DIST 52 HWY 11 BOREHOLE TYPE Hollow Stem Augering COMPILED BY AD  
 DATUM Geodetic DATE 27 May 1999 CHECKED BY SP

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	NUMBER	TYPE	"N" VALUES			20	40						60	80	100	20	40	60	80	100	10	20
287.1	0.1m TOPSOIL	1	SS	12		287																	
	grey/brown Silty Clay FILL Organic stained stiff to firm moist	2	SS	13		286																	
284.9	with Sand	3	SS	7		285																	
2.2	Silty trace Gravel	4	SS	36		284																	10 57 31 2
	brown SAND wet	5	SS	34		283																	
	dense compact loose	6	SS	11		282																	
		7	SS	5		281																	
		8	SS	8		280																	
281.2	5.9	9	SS	24		279																	12 71 16 1
	grey HETEROGENEOUS MIXTURE of SAND, SILT & GRAVEL (GLACIAL TILL) compact to very dense wet	10	SS	50/14		278																	Auger Refusal @ 7.6m on cobbles & boulders
279.0	8.1	11	RC			277																	RC11: REC=100% R.Q.D.=100%
	Cobbles	12	RC			276																	RC12: REC=100% R.Q.D.=88%
	GRANITE BEDROCK massive, closely to moderately closely jointed	13	RC			275																	RC13: REC=100% R.Q.D.=79%
275.9	11.2					274																	
	END of BOREHOLE																						
	DCPT conducted 1.0m north																						
	Water Level in Piezometer: July 9/99: 2.8m depth Sept 3/99: 3.1m depth Elev. 284.0m																						

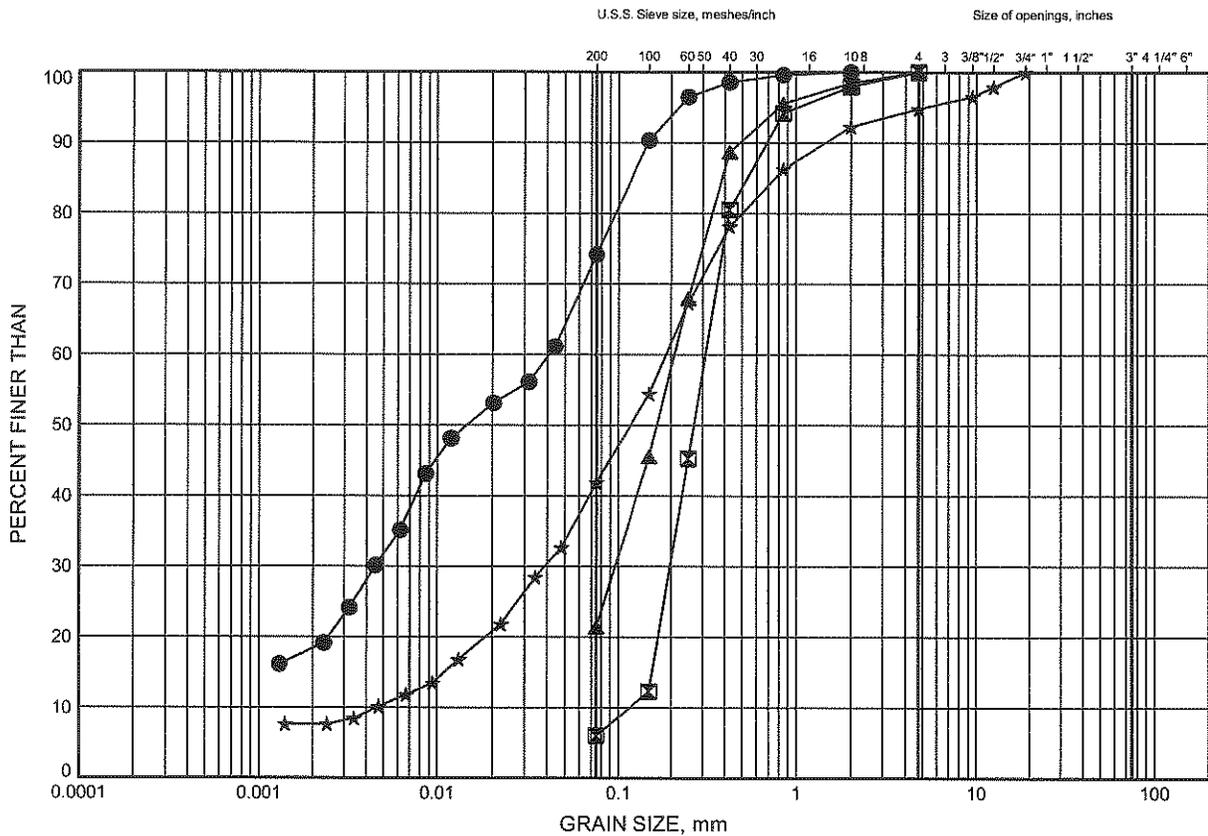
+ 3 x 3 Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

**Appendix B**

**Laboratory Test Results**

GRAIN SIZE DISTRIBUTION

SANDY SILT TO SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	06-28	1.83	285.25
⊠	06-28	4.11	282.96
▲	06-29	3.35	283.30
★	N-WM	4.88	295.46

GRAIN SIZE DISTRIBUTION - THURBER 6116.GPJ 4/16/09

W.P.# .473-93-00.....  
 Prepared By .MFA.....  
 Checked By .MRA.....





**Appendix C**

**Borehole Locations and Soil Strata Drawing**

