



MAY 2011

FINAL REPORT FOUNDATION INVESTIGATION AND DESIGN

**BONNECHERE RIVER BRIDGE REHABILITATION
HIGHWAY 60
DEACON, ONTARIO
MINISTRY OF TRANSPORTATION
W.P. 247-99-01**

Submitted to:
Mr. Andrew Hachborn
MMM Group Limited
100 Commerce Valley Drive West
Thornhill, Ontario
L3T 0A1



REPORT



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GEOCRES NO: 31F-165

Report Number: 09-1111-6062

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May 16, 2011

Project No. 09-1111-6062

Mr. Andrew Hachborn, P.Eng.
MMM Group Limited
100 Commerce Valley Drive West
Thornhill, ON
L3T 0A1

**BONNECHERE RIVER BRIDGE REHABILITATION
HIGHWAY 60
DEACON, ONTARIO
MINISTRY OF TRANSPORTATION
W.P. 247-99-01**

Dear Mr. Hachborn:

Golder Associates Ltd. (Golder) has been retained by MMM Group Limited (MMM) to provide geotechnical services associated with a proposed bridge deck replacement at the Highway 60 and Bonnechere River crossing in Deacon, Ontario. The main component of the geotechnical services was to provide an assessment of the carrying capacity of the existing timber piles supporting the superstructure.

BONNECHERE RIVER BRIDGE

The existing bridge, constructed circa 1954, carries Highway 60 over the Bonnechere River near Deacon, Ontario.

The bridge is a fifteen (15) span structure with a total length of approximately 91.5 m. The substructure consists of sixteen (16) creosote treated timber pile bents. Each bent consists of twelve (12) timber piles varying from about 7.6 m to 10.7 m in length.

SUBSURFACE CONDITIONS

The following provides a summary of the subsurface conditions encountered at the Bonnechere River Bridge site based on the field investigation carried out by Houle Chevrier Engineering Ltd. (Houle Chevrier) in December 2007 (Report, Geotechnical Investigation, Proposed Bridge Rehabilitation, Bonnechere River, Highway 60, Deacon, Ontario, dated January 2008).

The field investigation carried out by Houle Chevrier consisted of advancing a total of two (2) boreholes – one (1) borehole near each abutment of the existing bridge. Borehole 1 (advanced in the vicinity of the east abutment) and Borehole 2 (advanced near the west abutment) were advanced to depths of 21.11 m and 21.31 m below the



ground surface, respectively. The approximate locations of the boreholes and the inferred soil stratigraphy are shown on Drawing 1 following the text of this letter report. The borehole locations as shown on the plan are based on the approximate borehole location plan provided in the Houle Chevrier report and the approximate ground surface elevations have been obtained from a digital survey provided by MMM (elevations in the Houle Chevrier report are related to local datum).

The subsoils near the Highway 60 and Bonnechere River crossing generally consist of surficial or near surface layers of topsoil, sand to silty sand and clayey silt containing organics, underlain in the two boreholes by a stratum about 6.4 m and 8.4 m thick of generally very loose to compact silt and sandy silt. The measured SPT "N" values in this stratum generally range from 2 to 12 blows per 0.3 m of penetration, although there are three (3) values in Borehole 2 corresponding to the weight of hammer. The sandy silt to silt stratum is in turn underlain in the two boreholes by about 6.1 m and 9.8 m of glacial till deposit comprised of silty sand and containing cobbles and boulders. The till deposit is typically compact to dense with measured SPT "N" values generally varying from 13 to 41 blows per 0.3 m of penetration, although one (1) value of weight of hammer and one value of 70 blows per 0.3 m of penetration were measured. The boreholes were advanced with hollow-stem augers. Upon withdrawing the augers there may have been some upward flow of water which could have led to lower SPT "N" values. The till deposit overlies a fresh to faintly weathered bedrock consisting of granodiorite, diorite and gabbro; the bedrock was encountered at 17.4 m and 16.9 m depth in Boreholes 1 and 2, respectively.

The measured groundwater level in the piezometers installed in separate boreholes adjacent to Boreholes 1 and 2 was at a depth of 0.6 m (Elevation 96.53 m local datum; Elevation 169.5 m) and 0.7 m (Elevation 96.95 m local datum; Elevation 169.2 m) below the ground surface, respectively. The water level in the river was at Elevation 96.53 m (local datum) at the time of this investigation. It should be noted that all the elevations were surveyed by Houle Chevrier with respect to a local datum (i.e. the centreline of Highway 60 at the west abutment of the existing Bonnechere River bridge).

DISCUSSION

Timber Piles

As noted previously, the Bonnechere River bridge substructure consists of sixteen (16) pile bents (fourteen (14) pier bents and two (2) abutment bents) with each bent being comprised of twelve (12) timber piles. The timber piles, approximately 300 mm in diameter, range from 7.6 m to 10.7 m in length. Furthermore, the embedment length of the timber piles varies considerably across the site (potentially as small as 3 m at Bent 9, approximately 5 m or greater at Bents 6 to 8 and approximately 6 m outside the Bonnechere River banks (i.e. onshore). The timber piles were reportedly driven to refusal; however, it should be noted that a discrepancy exists between the approximate line of refusal (as shown on the original General Arrangement drawing) and the SPT "N" values indicated on the borehole logs completed by Houle Chevrier. According to the drawing, the timber piles were selected such that they would extend slightly below the refusal line; whereas the borehole logs indicate very loose materials below the pile tip along the western portion of the pile bents.

In addition, a detailed timber inspection report was completed by Harmer Podolak Engineering in December 2007 to assess the condition of the substructure. The report also includes a summary of results from a separate underwater inspection that was conducted on September 25, 2007 to assess the condition of the

timber piles submerged at the Bonnechere River. The following points summarize some of the key points from the report:

- The timber piles are generally in a good condition;
- Internal rot was detected in a total of nine (9) out of 180 piles, however, in many cases the rot has been noted to be minimal;
- The timber pile caps were also generally in a good condition and there were no visible signs of distress between the pile caps and the steel beams supporting the deck, and;
- Bracing between the pile bents was typically in a good condition as well.

It should also be noted that the timber piles which have been identified as deteriorated will be repaired. The repair procedure, as outlined by MMM, will essentially include the removal of the deteriorated section of the timber pile, installation of the replacement section of the pile, installation of a steel collar around the timber pile and the pumping of grout material between the annulus of the existing/replaced pile and the steel collar.

Geotechnical Resistance

According to Houle and Chevrier, the Serviceability Limit States (SLS) load on the timber piles associated with the existing deck under normal service conditions is 148 kN. It is also pointed out that there are no observed settlement problems associated with the existing substructure.

Based on the MTO – Foundation Design Section Report titled, “Pile Load and Extraction Tests 1954 – 1992” and dated September 1993, pile load tests were carried out at several sites which are relevant to the Bonnechere River bridge in terms of time of construction, pile type and size, embedment length and the nature of the founding material. In addition, it should be noted that these timber piles were driven to final sets of 10 blows per 25 mm or greater which suggests that this was the driving criterion by MTO for timber piles at the time when the Bonnechere River bridge was being constructed. This set would result in high capacities for the timber piles.

Based on the results obtained from the pile load tests discussed above, the failure loads were greater than about 450 kN and 700 kN with corresponding axial capacities at Serviceability Limit States (SLS) of approximately 150 kN to 230 kN. These ultimate failure loads would result in factored axial resistances at Ultimate Limit States (ULS) of about 225 kN to 350 kN (using a resistance factor of 0.5).

It is understood based on information provided by MMM that the SLS load per timber pile for the existing structure is 175 kN and that the SLS load associated with the new rehabilitated structure will be 160 kN, which represents a decrease in the SLS load. It is further understood that the factored axial load at ULS will also be reduced from 270 kN for the existing structure to 250 kN for the rehabilitated structure.

Based on the estimates of the existing SLS load associated with the existing structure, and taking into account the fact that the SLS load associated with the new structure will be reduced to 160 kN and considering that the timber piles are generally in a good condition and that the deteriorated timber piles will be repaired (allowing the loads to be transferred through these piles as well), the existing timber pile foundations will support the new superstructure at the Highway 60 and Bonnechere River crossing.

Furthermore, if the lateral loads imposed on the rehabilitated superstructure are expected to be the same or lower compared to the lateral loads associated with the existing Bonnechere River bridge and, given the satisfactory performance of the bridge (i.e. no adverse lateral movement of the existing bridge has been observed) and given that the existing timber piles and bracing between the pile bents is generally in good condition (deteriorated piles to be repaired), the lateral capacity of the existing timber pile foundations is sufficient to support the lateral loads.

From a geotechnical point of view, we have no further comments regarding foundation issues associated with the rehabilitation of the Bonnechere River bridge.

CLOSURE

This report was prepared by Mr. Tomasz Zalucki, E.I.T. and reviewed by Mr. Murty Devata, P.Eng. (specialist advisor for the project) and Ms. Anne Poschmann, P.Eng., a senior geotechnical engineer and Principal with Golder. Mr. Fintan Heffernan, P.Eng., Golder's Designated MTO Contact for this project conducted an independent quality control review of the report.

We trust that this report is satisfactory for your purposes. Should you have any questions or require additional information please do not hesitate to contact us.

Yours truly,

GOLDER ASSOCIATES LTD.



Tomasz Zalucki, E.I.T.
Geotechnical Engineering Group



Anne Poschmann, P.Eng.
Senior Geotechnical Engineer, Principal

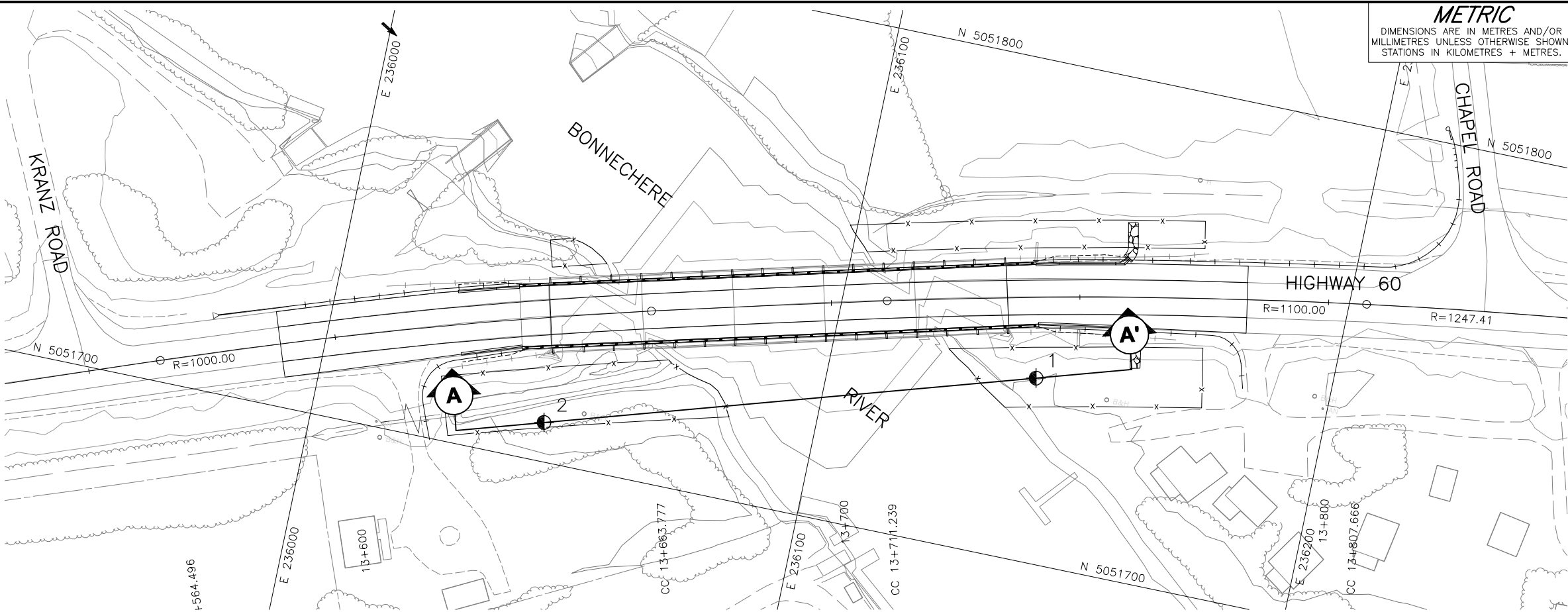


Fintan J. Heffernan, P.Eng.
Designated MTO Contact

TZ/MD/ASP/FJH/jl

Attachments: Drawing 1 – Borehole Location and Soil Strata
Appendix A – Record of Borehole Logs and Laboratory Test Results from Houle Chevrier Engineering Ltd. Report titled, "Geotechnical Investigation, Proposed Bridge Rehabilitation, Bonnechere River, Highway 60, Deacon, Ontario", dated January 2008

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METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
WP No. 247-99-01

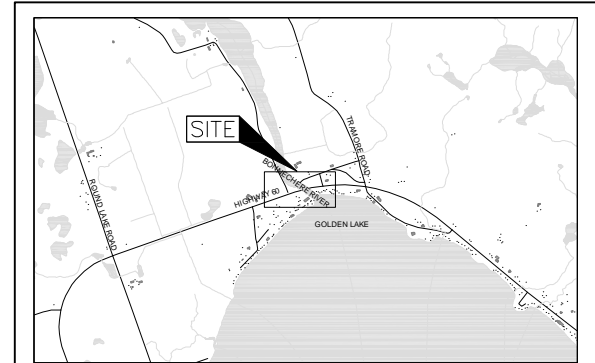
HIGHWAY 60
BONNECHERE BRIDGE
BOREHOLE LOCATIONS AND SOIL STRATA



SHEET



Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



LEGEND

- Borehole - Previous Investigation (Houle Chevrier Engineering Ltd., 2008)
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- WL in piezometer, measured on December 18, 2007

BOREHOLE CO-ORDINATES 1

No.	ELEVATION 2	NORTHING	EASTING
1	170.1	5051736.8	236141.4
2	169.9	5051707.8	236046.4

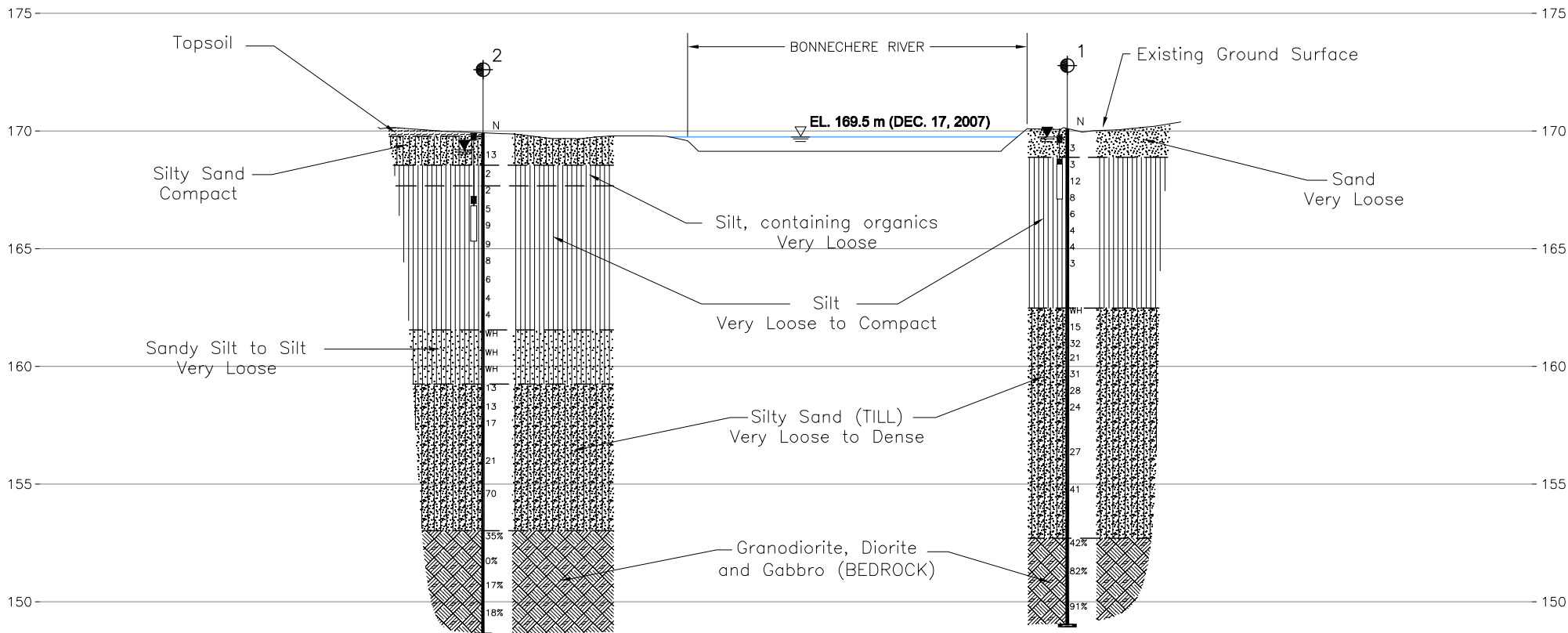
NOTES:
1 Borehole co-ordinates based on approximate borehole location plan provided by Houle Chevrier Engineering Ltd.
2 Approximate elevations based on survey data provided by MMM Group Ltd.

NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.
The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.
The complete Foundation Investigation and Design Letter Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

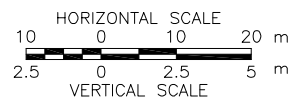
REFERENCE

Base plans provided in digital format by MMM, drawing file nos. Base-Bonnechere River Bridge.dwg, Bonnechere.dwg and Bonnechere-Align.dwg, received November 25, 2010.



A-A'

PROFILE



NO.	DATE	BY	REVISION
Geocres No.	HWY. 60	PROJECT NO. 09-1111-6062	DIST.
SUBM'D. TZ	CHKD.	DATE: 12/6/2010	SITE:
DRAWN: JFC	CHKD. TZ	APPD. ASP	DWG. 1



APPENDIX A

**Record of Borehole Logs and Laboratory Test Results from Houle
Chevrier Engineering Ltd. Report titled, “Geotechnical Investigation,
Proposed Bridge Rehabilitation, Bonnechere River, Highway 60, Deacon,
Ontario”, dated January 2008**

RECORD OF BOREHOLE 1

SHEET 1 OF 1

PROJECT: 07-656

DATUM: Local

LOCATION: See Site Plan, Figure 2

SPT HAMMER: 63.6 kg; drop 0.76 m

BORING DATE: December 11, 2007

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION				
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH				WATER CONTENT, PERCENT							
								CU, kPa	nat. V - rem. V - B	+ - U - C	Q - U - C	Wp	W			W	W		
								20	40	60	80			10 ⁻⁷	10 ⁻⁶	10 ⁻⁵	10 ⁻⁴		
								20	40	60	80								
0		Ground Surface		97.13															Native Backfill
1		Very loose, brown fine to coarse SAND		95.91 1.22	1	DO	3												Bentonite seal
2		Very loose to compact gray SILT, trace to some clay, trace sand			2	DO	3												1.5 m long, 32 mm diameter PVC well screen
3			3	DO	12														
4			4	DO	9														
5			5	DO	8														
6			6	DO	6														
7			7	DO	4														
8			8	DO	3														
9			Very loose to dense grey silty sand, trace clay, some gravel, cobbles and boulders, some sand and gravel pockets (GLACIAL TILL)		89.51 7.62	9	DO	WH											
10		10		DO	15														
11		11		DO	32														
12		12		DO	21														
13		13		DO	31														
14		14		DO	28														
15		15		DO	24														
16		16		DO	27														
17		17		DO	41														
18		Firm to faintly weathered, pink, grey and grey green GRANODIORITE and DIORITE BEDROCK, some open joints			79.72 17.41	CS1	RC	TCR=54% SCR=46% RQD=42%											
19			CS2	RC	TCR=100% SCR=95% RQD=02%														
20			CS3	RC	TCR=98% SCR=56% RQD=91%														
21		End of borehole		75.02 21.11															
22																			
23																			
24																			
25																			

PROJECT: 07-656

RECORD OF BOREHOLE 2

SHEET 1 OF 1

LOCATION: See Site Plan, Figure 2

DATUM: Local

BORING DATE: December 14, 2007

SPT HAMMER: 63.6 kg; drop 0.76 m

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION	
		DESCRIPTION	STRATA PLOT ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH				WATER CONTENT, PERCENT					
							Cu, kPa	nat. V - rem. V -	+ - O -	O -	W _p	W	W			W
							20	40	60	80		10 ⁻⁷	10 ⁻⁶	10 ⁻⁵	10 ⁻⁴	
0		Ground Surface	97.65													
		Dark brown silty sand, (TOPSOIL)	0.15													
1		Compact grey brown SILTY SAND														
			98.28	1	50	13										
2		Very loose grey CLAYEY SILT, trace organic material	1.37	2	50	2										
			95.37	3	50	2										
3		Very loose to loose grey SILT, trace to some clay, trace sand	2.28	4	50	6										
				5	50	9										
4				6	50	9										
5				7	50	8										
6				8	50	6										
7				9	50	4										
8				10	50	4										
9		Grey SANDY SILT and SILT, trace clay, some sand	88.27	11	50	WH										
			8.38	12	50	WH										
10				13	50	WH										
			86.98	14	50	13										
11		Very loose to dense gray silty sand, trace clay, some gravel, cobbles and boulders, some sand and gravel pockets (GLACIAL TILL)	10.67	15	50	13										
12				16	50	17										
13																
14				17	50	21										
15																
16				18	50	70										
17			80.74													
			16.91	CS1	RC	TCR=100% SCR=35% RQD=35%										
18		Fresh to faintly weathered, pink, grey and grey green GRANODIORITE, DIORITE and GABBRO BEDROCK, occasional vugs with quartz crystals, some open joints, some highly weathered seams from 16.9 to 18.2 metres depth.		CS2	RC	TCR=83% SCR=21% RQD=0%										
19				CS3	RC	TCR=100% SCR=47% RQD=17%										
20																
21				CS4	RC	TCR=100% SCR=40% RQD=18%										
22		End of borehole	76.34													
			21.31													
23																
24																
25																

DEPTH SCALE

1 to 125

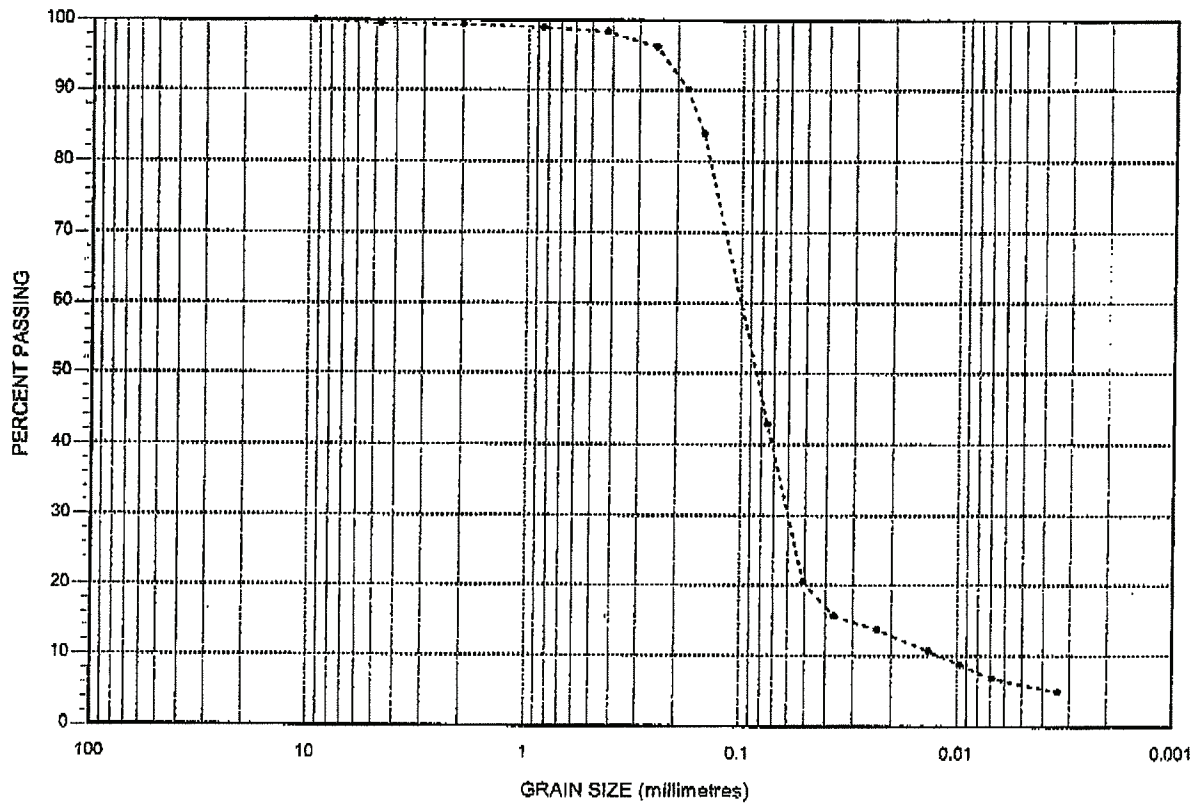
Houle Chevrier Engineering Ltd.

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GRAIN SIZE DISTRIBUTION - NATIVE SILTY SAND -

FIGURE 3



COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	CLAY
GRAVEL			SAND			SILT			

LEGEND

--- BH 2 SA 1

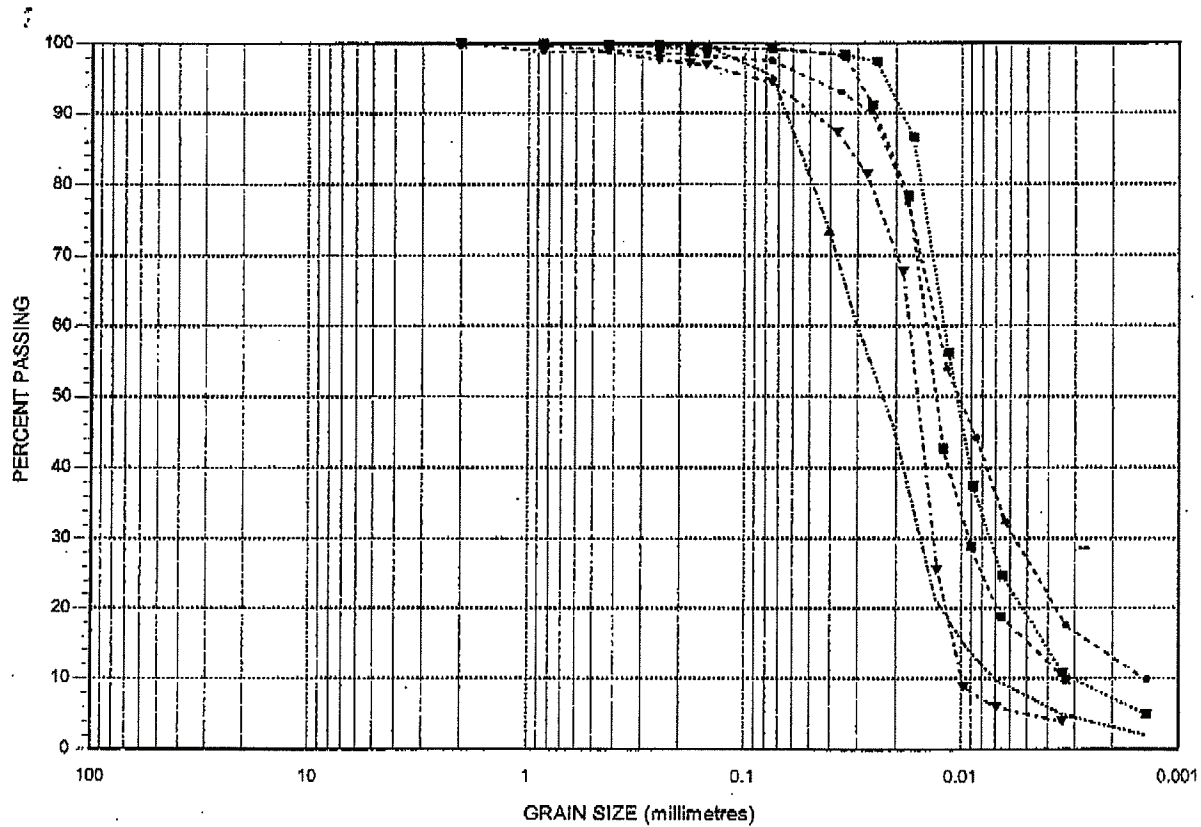
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Project 07-656

GRAIN SIZE DISTRIBUTION - NATIVE SILT -

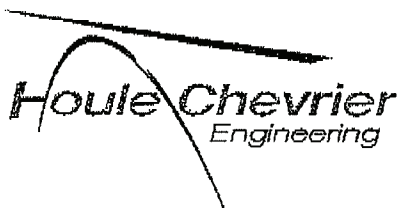
FIGURE 4



COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	CLAY
GRAVEL			SAND			SILT			

LEGEND

---◆---	BH 1	SA 2
---■---	BH 1	SA 5
---●---	BH 1	SA 8
---▼---	BH 2	SA 4
---▲---	BH 2	SA 8

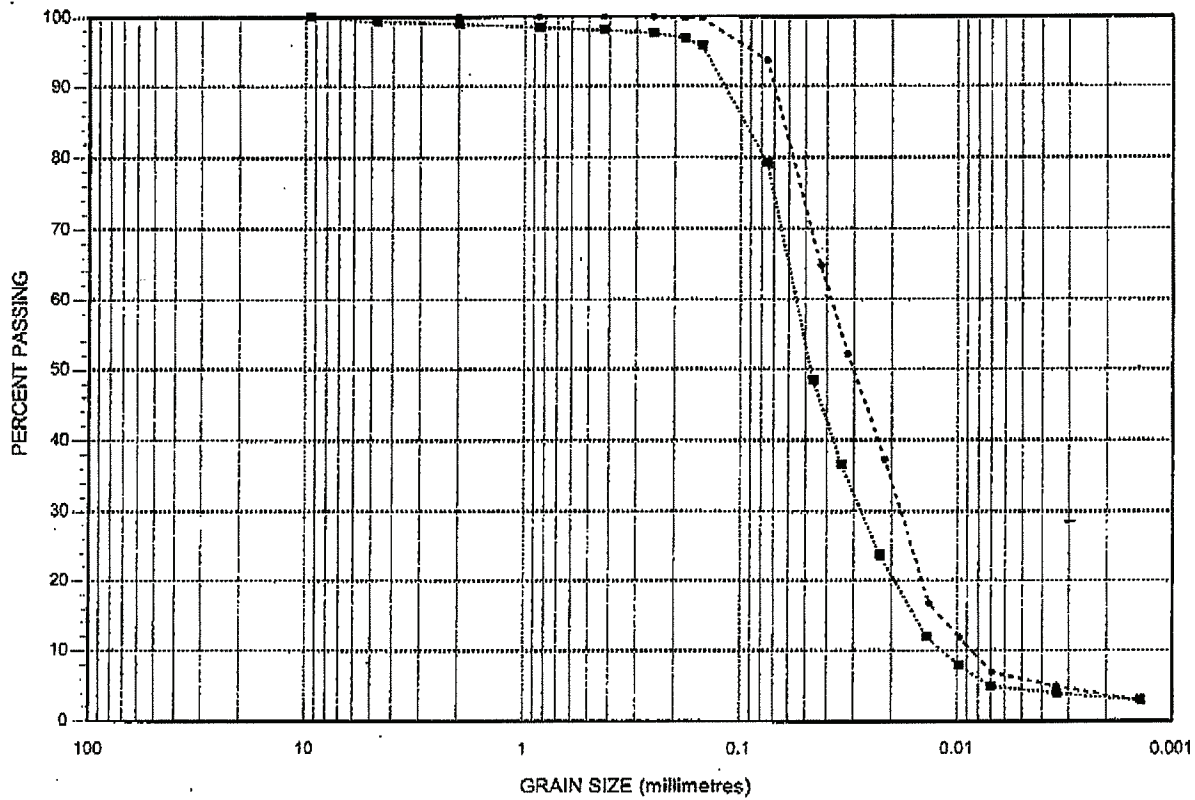


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GRAIN SIZE DISTRIBUTION - NATIVE SANDY SILT AND SILT -

FIGURE 5



COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	CLAY
GRAVEL			SAND			SILT			

LEGEND
 - - - BH 2 SA 11
 - ■ - BH 2 SA 13

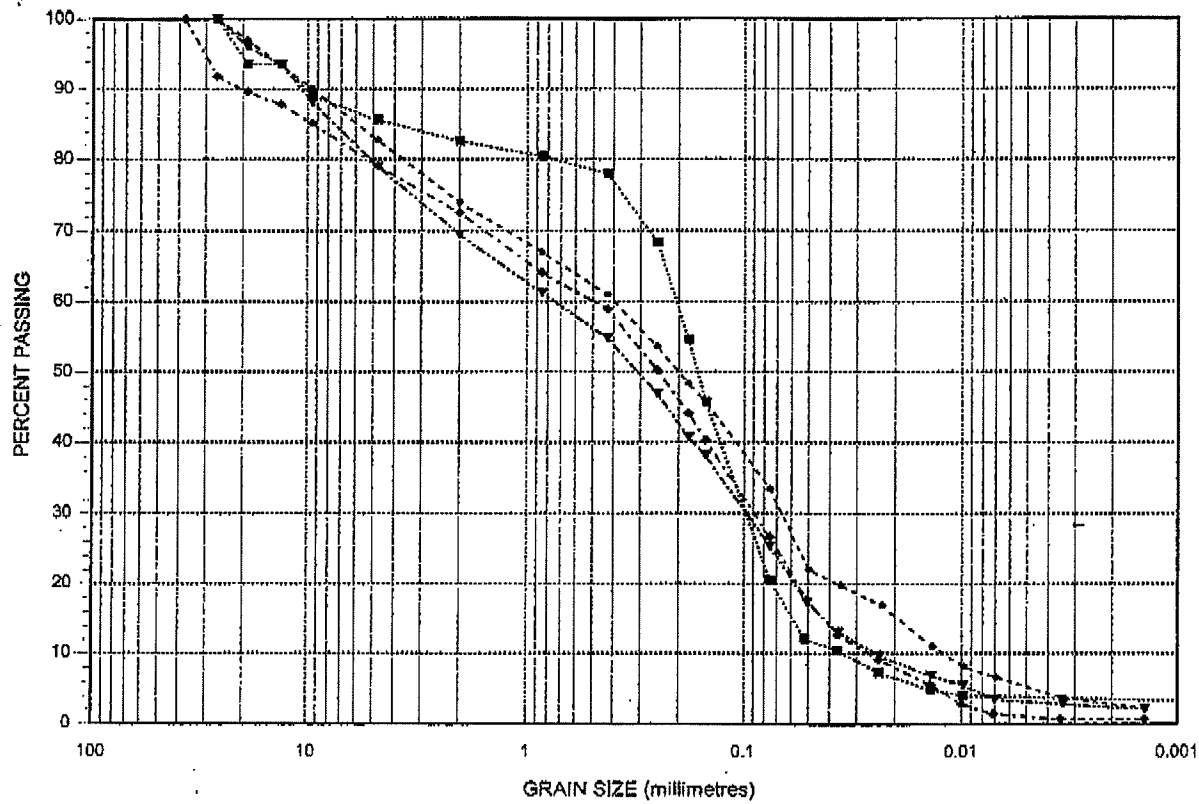
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GRAIN SIZE DISTRIBUTION - GLACIAL TILL -

FIGURE 6



COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	CLAY
GRAVEL			SAND			SILT			

LEGEND

---●---	BH 1	SA 10
---■---	BH 1	SA 17
---▲---	BH 2	SA 14
---◆---	BH 2	SA 17

Houle Chevrier
Engineering

Date January 2008

Project 07-656

At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

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