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FOUNDATION INVESTIGATION AND DESIGN REPORT
VARIABLE MESSAGE SIGN #14
HIGHWAY 17 EASTBOUND, APPROXIMATELY 5 KM
EAST OF HIGHWAY 11
NORTH BAY, ONTARIO
G.W.P. 5766-04-01

Submitted to:

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GEOCRES NO.: 31L-122

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July 15, 2008 07-1191-0039-14

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by IBI Group (IBI) to carry out a foundation investigation as part of the detailed design for a variable message sign (VMS) on Highway 17 eastbound, approximately 5 km east of Highway 11 and approximately 500 m east of Centennial Cr. West, in North Bay, Ontario, for the Ministry of Transportation, Ontario (MTO). The general location of the site is shown on the Key Plan on Drawing 1.

The terms of reference for the scope of work were outlined in Golder's proposal P7-1191-0039, dated June 25, 2007, that formed part of the Consultant's Agreement (Number 5006-E-0083) for this project. The work was carried out in accordance with Golder's Quality Control Plan for this project dated October 2007.

The plans detailing the proposed sign location were provided to Golder by IBI in May 2008. We understand the proposed structure will be a single-pole mounted sign founded on a spread footing.

2.0 SITE DESCRIPTION

The site is located on Highway 17 eastbound approximately 5 km east of Highway 11 and approximately 500 m east of the Centennial Cr. west intersection, at Station 10+128 in East Ferris Township, east of North Bay, Ontario. The section of Highway 17 in this area consists of two eastbound lanes and a single westbound lane. A 3.5 m wide granular shoulder and shallow ditch parallels the eastbound lane. A bedrock outcrop is exposed adjacent to the proposed sign location; the ground surface at the proposed sign location is at approximately Elevation 220.6 m.

3.0 INVESTIGATION PROCEDURES

3.1 Foundation Investigation

The subsurface investigation work for the VMS structure was carried out on April 22, 2008, at which time one sampled borehole and two Dynamic Cone Penetration Tests (DCPT), numbered BH08-1 and DCPT08-1 and DCPT08-2, respectively, were advanced at the locations shown on Drawing 1. Borehole BH08-1 was drilled in the shoulder of the eastbound lane at Station 10+128, approximately 0.5 m from the centre of the proposed sign location, closer to the edge of pavement; Dynamic Cone Penetration Tests DCPT08-1 and DCPT08-2 were advanced at Stations 10+133 and 10+123, respectively, located 5.0 m east and 5.0 m west of Borehole BH08-1, respectively.

The foundations investigation was carried out using a truck-mounted CME-55 drill rig supplied and operated by Landcore Drilling of Chelmsford, Ontario. The borehole was advanced using hollow stem augers and NQ-size diamond drilling equipment. Soil samples were obtained, where possible, at intervals ranging from 0.75 m in depth, using a 50 mm outside diameter, split-spoon sampler in accordance with Standard Penetration Test procedures (ASTM D1586-99). The borehole and DCPTs were advanced to refusal, which was encountered at depths ranging from 2.6 m to 2.7 m below ground surface. Approximately 4.2 m of bedrock core was obtained at the borehole location. Details of the subsurface conditions are shown on the Record of Borehole and Drillhole sheets following the text of this report. The DCPT results are shown on the Record of Penetration Test sheets, also following the text of this report. The borehole was backfilled in accordance with Ontario Regulation 372 (Amendment to O. Reg. 903); the DCPT holes were allowed to collapse as the drill rod string was extracted.

The fieldwork was supervised throughout by members of Golder's engineering and technical staff, who located the borehole and DCPTs, arranged for the clearance of underground services and traffic protection, supervised the drilling, sampling and in situ testing operations, logged the borehole and DCPTs, and examined and cared for the soil and rock samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to Golder's Sudbury geotechnical laboratory where the samples underwent further visual examination and laboratory testing. Point load tests were carried out on selected samples of the rock core in general accordance with MTO Standards.

The borehole and DCPTs were located by tape measurement relative to the stake positioned in the field by IBI. The as-drilled borehole and DCPT locations (relative to MTM NAD83) were subsequently surveyed by IBI and forwarded to Golder. The borehole and DCPT locations are depicted on Drawing 1 and the borehole and DCPT coordinates and ground surface elevations (referenced to Geodetic datum) are presented in the borehole and DCPT logs and are summarized below.

Borehole / DCPT Number	MTM NAD83 Zone 17 Northing (m)	MTM NAD 83 Zone 17 Easting (m)	Ground Surface Elevation (m)
BH08-1	5128551.6	315061.7	220.6
DCPT08-1	5128550.1	315065.6	220.7
DCPT08-2	5128553.8	315058.5	220.7

4.0 GENERAL SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology and Site Stratigraphy

Based on terrain mapping in the vicinity of the site, the subsurface soils consist of glaciolacustrine deposits comprising sand, silt and/or clay[1]. The bedrock at the site is characterized by metasediments of the middle Precambrian eon, including biotite gneiss derived from greywacke, siltstone, immature sandstone, and minor calcareous siltstone and sandstone[2].

4.2 Subsurface Conditions

Detailed descriptions of the subsurface soil as encountered in Borehole BH08-1 and Dynamic Cone Penetration Tests DCPT08-1 and DCPT08-2 advanced during this investigation, together with the results of the laboratory tests carried out on selected samples, are given on the Record of Borehole, Drillhole and Penetration Test sheets following the text of this report. The stratigraphic boundaries shown on the Record of Borehole and Drillhole sheets are inferred from non-continuous sampling, observations of drilling and in situ testing. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Further, subsurface conditions will vary beyond the borehole location.

As indicated previously, Borehole BH08-1 was drilled in the shoulder of the eastbound lane approximately 0.5 m from the proposed sign location further away from the edge of pavement; Dynamic Cone Penetration Tests DCPT08-1 and DCPT08-2 were located 5.0 m east and 5.0 m west of Borehole BH08-1, respectively, to confirm the relative density of the subsurface deposits and depth to refusal on either side of the proposed sign. The results of the two DCPTs indicate that the subsurface conditions at the DCPT and borehole locations were relatively uniform.

4.2.1 Fill

Sand to gravelly sand fill was encountered to a depth of 2.8 m below the existing ground surface in Borehole BH08-1. The fill had a compact to loose relative density based on SPT N values of 30 to 7 blows per 0.3 m of penetration and is generally compact above the groundwater level noted during drilling.

The natural water content of samples of the fill material ranged from 2 percent to 7 percent. Grain size distribution tests on selected samples of the fill are shown on Figure 1.

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[1] Northern Ontario Engineering Geology Terrain Study, OGS Map 5041

[2] Sudbury Cobalt Geological Compilation Series, OGS Map 2361

4.2.2 Bedrock

Bedrock was exposed on each side of the highway adjacent to the proposed sign location.

Borehole BH08-1 encountered bedrock below the highway fill, at a depth of 2.8 m below existing ground surface. About 4.2 m of bedrock coring was carried out. Based on observations of the rock core, the bedrock consists of slightly weathered pinkish grey gneiss.

Rock Quality Designation (RQD) values measured on the recovered bedrock core samples ranged from 94 percent to 100 percent, indicating that the rock is of excellent quality.

Point load testing was performed on two samples of the rock core, resulting in measured unconfined compressive strengths of 81 MPa and 122 MPa, as shown in Table 1. Using the Intact Rock Strength Classification table, these values indicate the bedrock is classified as strong to very strong.

4.2.3 Groundwater Conditions

Details of the groundwater conditions and water level observed in the open borehole at the time of drilling are summarized on the Record of Borehole sheet following the text of this report. The unstabilized groundwater level observed in the open borehole was recorded at a depth of 2.3 m below the existing ground surface upon completion of drilling, corresponding to Elevation 218.3 m. It should be noted that this water level does not represent the stabilized water level and that the groundwater elevation will fluctuate seasonally depending on precipitation and local soil permeability and should be expected to rise during wet periods of the year.

5.0 CLOSURE

The fieldwork was carried out by a technician from our Sudbury office under the coordination of Mr. André Bom, P.Eng. This report was prepared by Mr. Evan Childerhose, EIT, and was reviewed by Mr. André Bom, P.Eng., Mr. André Zerwer, P.Eng. and Mr. Jorge Costa, Principal and Designated MTO Contact for Golder. Mr. Costa also conducted a quality control review of the report.

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PART B

FOUNDATION DESIGN REPORT
VARIABLE MESSAGE SIGN #14
HIGHWAY 17 EASTBOUND, APPROXIMATELY 5 KM
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6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

6.1 General

This section of the report provides foundation design recommendations for the proposed variable message sign (VMS #14) foundation. The recommendations are based on interpretation of the factual data obtained from the borehole and DCPTs advanced during the subsurface investigation and from site observations. The interpretation and recommendations provided are intended only to provide the designers with sufficient information to assess the feasible alternatives and to design the proposed sign foundation. As such, where comments are made on construction, they are provided only in order to highlight those aspects which could affect the planning of the project. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods, scheduling and the like.

6.2 Sign Foundation

We understand the proposed sign will be located on the south side of Highway 17 approximately 4.5 m from the edge of pavement at Station 10+128 facing the eastbound traffic. Borehole BH08-1 was advanced approximately 0.5 m from the centre of the proposed sign location closer to the edge of pavement in the eastbound shoulder at Station 10+128; DCPT08-1 and DCPT08-2 were advanced 5.0 m to the east and to the west of Borehole BH08-1 along the shoulder of Highway 17. Borehole BH08-1 encountered loose to compact sand to gravelly sand fill to a depth of about 2.8 m below ground surface. Refusal on bedrock was encountered below the fill materials and 4.2 m of bedrock was cored. DCPT08-1 and DCPT08-2 encountered refusal at approximately 2.6 m and 2.7 m depth below existing ground surface, respectively. The unstabilized groundwater level in the open borehole upon completion of drilling was 2.3 m below the existing ground surface.

Overhead sign supports are typically designed with a standard caisson foundation in accordance with the requirements in MTO's *Sign Support Manual*. However, for the proposed site, we understand from IBI that a site-specific design consisting of a single-pole mounted sign founded on a spread footing has been selected. The following sections provide recommendations for both a caisson foundation and spread footing.

6.2.1 Caisson Foundation

Caisson foundations for overhead sign supports should be designed in accordance with the requirements in MTO's *Sign Support Manual*. The *Sign Support Manual* includes a standard caisson foundation design (Section 4 and Standard Drawings SS118-3, SS118-4 and SS118-5), in which the caissons are extended 5 m below the design frost depth except where bedrock is encountered within this depth. Based on the depth of frost penetration isopleths for Northern Ontario[3], the depth of frost penetration for the North Bay area is approximately 1.9 m; the typical caisson founding level would therefore be 6.9 m below the ground surface.

The surface of the bedrock was encountered at a depth of 2.8 m below existing ground surface, which is higher than the proposed founding level of the caisson foundation as indicated above. In accordance with Standard Drawing SS118-3 of MTO's *Sign Support Manual*, where bedrock is encountered at a depth of less than 5 m below the bottom of the frost layer (z, in metres), the required depth of the foundation below the frost layer may be taken as:

$$z + (5\text{ m} - z)/2$$

Based on the above equation, the caissons for the support of the overhead sign would be socketted 2.05 m below the bedrock surface in the gneiss bedrock.

Point load testing was performed on two samples of the rock core, resulting in measured unconfined compressive strengths of 95 MPa and 144 MPa, as shown in Table 1, indicating the bedrock is strong to very strong suggesting that it would be difficult to penetrate 2 m into the bedrock. Therefore, a spread footing alternative should be considered, as described below.

6.2.2 Spread Footing

We understand from IBI that the preferred alternative foundation design for the support of VMS #14 is a spread footing, 5 m long and 2.5 m wide with the centre of the footing located 4.5 m from the edge of pavement. The founding depth of the spread footing should be below the depth of frost penetration (i.e. 1.9 m below final ground surface) within the granular fill.

Based on the subsurface conditions encountered at the borehole location, and depending on space availability adjacent to the roadway, an open cut excavation of short duration is considered feasible for the proposed footing construction. The excavation for the proposed footing should be carried out in accordance with the latest Occupational Health and Safety Act for Construction Projects (OHSA). The excavation for footing construction will extend through the fill material and when referencing OHSA, the fill material is classified as "Type 3 Soil". An excavation above the groundwater level should be sloped at a gradient of 1 horizontal (H) to 1 vertical (V) or flatter. An excavation below the groundwater level should be sloped at 2H to 1V or flatter.

Assuming excavation side slopes of 1H to 1V and a depth of excavation of 1.9 m, the crest of the excavation on the roadway side of the proposed footing will be located within 1 m from the existing edge of pavement. If side slopes flatter than 1H to 1V are required during construction,

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[3] Ontario Provincial Standard Drawing (OPSD) 3090.100

provision for protection of the existing pavement structure will be required in accordance with MTO's Special Provision No. 105S19 Construction Specification for Protection Systems, designed to meet Performance Level 2.

Relevant design parameters for the shoring are provided below.

Design Parameter	Fill
Unit Weight above Groundwater Level γ (kN/m^3)	18
Unit Weight below Groundwater Level γ' (kN/m^3)	8
Friction Angle ϕ (°)	27
K_a*	0.37
K_p*	2.66
K_o*	0.55

* Earth pressure coefficients for horizontal backfill.

As noted in Section 6.2, the unstabilized groundwater level in Borehole BH08-1 was encountered at a depth of 2.3 m below the existing ground surface. Depending on the seasonal time of footing construction, the groundwater level or perched groundwater may be encountered during construction. Depending on the season of construction, inflow of water into the excavation may likely be removed by pumping from properly filtered sumps.

During construction, stockpiles should be placed well away from the edge of the excavation, and their height should be controlled so they do not surcharge the sides of the excavation and/or overall slope. Generally speaking, for this site, the distance between the crest of the excavation and the toe of the stockpile should generally be greater than the diameter of the base of the stockpile.

Disturbance of the underlying materials during construction of the spread footing could influence the settlement of the structure. MTO's Special Provision No. 902S01 should be included in the Contract Documents, requiring inspection and approval of the foundation area by the Quality Verification Engineer (QVE) prior to footing construction, to ensure that adequate preparation of the foundation areas has been carried out.

The base of the excavation should be free of water and loose soil prior to placing concrete. Should the materials at bearing level become saturated or disturbed, we recommend that the affected material be removed immediately prior to placing concrete. We recommend that the prepared subgrade be protected using a 150 mm thick mud mat comprised of a minimum 5 MPa concrete or a minimum 300 mm thick working mat of compacted Granular 'B' Type II or Granular 'A' meeting MTO's Special Provision SP110S13. The mat should be placed across the bottom of the excavation immediately upon completion of the excavation and review by the QVE to limit disturbance of the underlying fill and to provide a platform for construction of the spread footing.

6.2.3 Geotechnical Resistance

Spread footings constructed on the properly prepared subgrade at or below the depth given in Section 6.2.2 may be designed based on a factored geotechnical axial resistance of 200 kPa at Ultimate Limit States (ULS) for a footing rectangular in shape up to 5.0 m long by 2.5 m wide. For the same spread footing dimension indicated above, a geotechnical axial resistance value of 100 kPa for Serviceability Limit States (SLS; for 25 mm settlement) design may be assumed. Design of the proposed sign foundation should also be checked for and provisions made to resist buoyant forces.

The ULS resistance and settlement are dependent on the footing size, configuration and applied loads; the geotechnical resistances should, therefore, be reviewed if the selected footing dimensions or founding depth differs from those given above.

The geotechnical resistances provided above are given under the assumption that the loads will be applied perpendicular to the surface of the footings. Where the load is not applied perpendicular to the surface of the footing, inclination of the load should be taken into account in accordance with Clauses 6.7.4 and C6.7.4 of the *Canadian Highway Bridge Design Code (CHBDC, 2006)* and the related commentary.

6.2.4 Resistance to Lateral Loads

Resistance to lateral forces / sliding resistance between the concrete footings and the prepared subgrade should be calculated in accordance with Section 6.7.5 of the *CHBDC*. For cast-in-place concrete footings constructed on a compacted granular pad or against the base of the prepared foundation area, the coefficient of friction, tan φ', can be taken as 0.45. For cast-in-place concrete footings constructed on a concrete mud mat, the coefficient of friction, tan φ', can be taken as 0.55. The above noted values are unfactored; in accordance with the *CHBDC*, a factor of 0.8 is to be applied in calculating the horizontal resistance.

6.3 Construction Considerations

The excavation around and above the spread footing may be backfilled using an approved granular material meeting MTO’s Special Provision SP110S13 such as Granular ‘A’ or ‘B’ Type II placed in 300 mm loose lifts and uniformly compacted to 95 percent standard Proctor maximum dry density. The use of the excavated fill materials as backfill is not recommended. The final grade surrounding the sign should be sloped to promote surface water drainage and pavement structure drainage away from the pavement and sign, to the adjacent ditch.

7.0 CLOSURE

This report was prepared by Mr. André Bom, P.Eng., a Geotechnical Engineer, and the technical aspects were reviewed by Mr. André Zerwer, P.Eng. and Jorge M.A. Costa, a Principal with Golder. Mr. Costa, also a Designated MTO Contact for Golder, conducted a quality control review of the report.

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TABLE 1
POINT LOAD TEST RESULTS
G.W.P 5766-04-01
VMS #14, NORTH BAY

Borehole Number	Sample Depth [1] (m)	Rock Type	Test Type [2]	Core Diameter (mm)	Ram Pressure (MPa)	Load (kN)	I_s Diametral [2] (MPa)	I_s 50 mm [2] (MPa)	Approximate UCS [2] (MPa)
BH08-1	4.0	Gneiss	D	47.0	9.74	0.008	4.18	4.06	81
BH08-1	6.1	Gneiss	D	47.0	14.63	0.0014	6.28	6.11	122

NOTES:

1. Depths are given below the ground surface at the borehole location.
2. Where: D = Diametral test;
   I_s Diametral = Uncorrected point load strength;
   I_s 50 mm = Corrected point load strength; and
   UCS = Unconfined Compressive Strength = I_s 50 mm x 20 (based on experience with similar rock types).

Compiled by: EC
Checked by: AB

LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

1. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
SS	Split-spoon
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:
The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.).

Dynamic Cone Penetration Resistance, N_d:
The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH:	Sampler advanced by hydraulic pressure
PM:	Sampler advanced by manual pressure
WH:	Sampler advanced by static weight of hammer
WR:	Sampler advanced by weight of sampler and rod

Piezocone Penetration Test (CPT)
An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Cohesionless Soils

Density Index (Relative Density)	N Blows/300 mm or Blows/ft.
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) Cohesive Soils

Consistency

	C_u,S_u kPa	C_u,S_u psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	over 200	over 4,000

IV. SOIL TESTS

w	water content
w_p	plastic limit
w_l	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, G_s)
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
γ	unit weight

Note: 1 Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

1. GENERAL

π	3.1416
in x,	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
F	factor of safety
V	volume
W	weight

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma$-u)
σ_{vo}	initial effective overburden stress
σ_1, σ_2, σ_3	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight*)
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma$-γ_w)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s/\rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density x acceleration due to gravity).

(a) Index Properties (continued)

w	water content
w_l	liquid limit
w_p	plastic limit
I_p	plasticity index – $(w_l – w_p)$
w_s	shrinkage limit
I_L	liquidity index $= (w – w_p)/I_p$
I_c	consistency index $= (w_l – w)/I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index $= (e_{max} – e) / (e_{max} – e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_a	coefficient of secondary consolidation
m_v	coefficient of volume change
c_v	coefficient of consolidation
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation pressure
OCR	over-consolidation ratio $= \sigma'_p / \sigma'_{vo}$

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan δ
c′	effective cohesion
c_u,s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 + \sigma_3)/2$ or $(\sigma'_1 + \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 + \sigma_3)$
S_t	sensitivity

Notes: 1 $\tau = c' + \sigma' \tan \phi'$
2 Shear strength = (Compressive strength)/2

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERING STATE

Fresh: no visible sign of weathering

Faintly weathered: weathering limited to the surface of Major discontinuities

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock Mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock texture and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	> 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	< 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	> 3 m
Wide	1 – 3 m
Moderately close	0.3 – 1 m
Close	50 – 300 mm
Very close	< 50 mm

GRAIN SIZE

Terms	Size*
Very Coarse Grained	> 60 mm
Coarse Grained	2 – 60 mm
Medium Grained	60 microns – 2 mm
Fine Grained	2 – 60 microns
Very Fine Grained	< 2 microns

* Note: Grains > 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varies from 0% for completely broken core to 100% for core in solid sticks.

DISCONTINUITY DATA

Fracture Index

A count of the number of discontinuities (physical separation) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to (W.R.T.) Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole, a discontinuity with a 90° angle is horizontal.

Description and Notes

An abbreviated description of the discontinuities, whether naturally occurring separation such as fractures, bedding planes and foliation planes or mechanically induced fractures caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

B	- Bedding	⊥	- Perpendicular To
FO	- Foliation / Schistosity	∥	- Parallel To
CL	- Cleavage	P	- Polished
SH	- Shear Plane / Zone	K	- Slickensided
VN	- Vein	SM	- Smooth
F	- Fault	R	- Rough
CO	- Contact	ST	- Stepped
J	- Joint	PL	- Planar
FR	- Fracture	U	- Undulating
MF	- Mechanical Fracture	C	- Curved

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RECORD OF BOREHOLE No BH08-1

 METRIC

PROJECT 07-1191-0039-14
W.P. 5766-04-01
LOCATION N 5128551.6 ;E 315061.7
ORIGINATED BY TDM
DIST
HWY 17
BOREHOLE TYPE Hollow Stem Auger, NQ Coring
COMPILED BY MM
DATUM Geodetic
DATE April 22, 2008
CHECKED BY AB

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	WATER CONTENT (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
220.6	Refer to previous page							
0.0	Sand, some gravel to Gravelly Sand, trace to some silt (FILL) Compact to loose Brown Moist to wet	1	AS	–		220	o	13 79 (8)
		2	SS	30			o	
		3	SS	22	∇	219	o	17 69 (14)
217.8 / 2.8		4	SS	7		218	o	24 67 (9)
2.8	GNEISS (BEDROCK) Bedrock cored from 2.8 m to 6.9 m depth. For coring details see Record of Drillhole BH08-1	1	RC	REC 100%		217		RQD = 94%
		2	RC	REC 100%		216		RQD = 100%
		3	RC	REC 100%		215		RQD = 100%
213.7		4	RC	REC 100%		214		RQD = 100%
6.9	End of Borehole Note: 1. Water level at a depth of 2.3 m below ground surface (Elev. 218.3 m) upon completion of drilling.							

Column headings also include: STRAT PLOT; DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × REMOULDED (20 40 60 80 100); PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) 15 30 45; UNIT WEIGHT γ kN/m³.

+3, ×3: Numbers refer to Sensitivity   O 3% STRAIN AT FAILURE

PROJECT: 07-1191-0039-14

RECORD OF DRILLHOLE: BH08-1

SHEET 1 OF 1

LOCATION: N 5128551.6 ;E 315061.7

DRILLING DATE: April 22, 2008

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: LANDCORE DRILLING

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH / COLOUR % RETURN	RECOVERY (TOTAL CORE %, SOLID CORE %)	R.Q.D. %	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.
		Refer to previous page										
3–6	04/22/2008	GNEISS Fine to medium grained Slightly weathered Strong to very strong Pinkish grey		217.8 2.8	1				J, U, R,,, J, U, R,,, J, U, R,,, J, U, R,,, J, U, R,,, J, PL, R,,, J, U, R,,, J, PL, R,,, J, U, R,,, J, ST, R,,, J, U, R,,,			
					2				J, U, R,,, J, U, R,,,			
					3				J, U, R,,, J, U, R,,, J, U, R,,, J, U, R,,, J, U, R,,,			
				213.7 6.9	4				J, U, R,,, J, U, R,,, J, U, R,,, J, U, R,,,			
7		End of Drillhole										

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: TDM

CHECKED: AB

MIS-RCK 004 BH08-1SOIL & ROCK.GPJ GAL-MISS.GDT 7/15/08 ACM

RECORD OF PENETRATION TEST No DCPT08-1 — METRIC

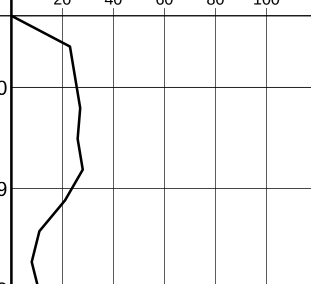
PROJECT 07-1191-0039-14
W.P. 5766-04-01
LOCATION N 5128550.1 ;E 315065.6
ORIGINATED BY TDM
DIST HWY 17
BOREHOLE TYPE Dynamic Cone Penetration Test
COMPILED BY MM
DATUM Geodetic
DATE April 22, 2008
CHECKED BY AB

ELEV / DEPTH	SOIL PROFILE – DESCRIPTION	STRAT PLOT	SAMPLES – NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
220.7	GROUND SURFACE										
0.0							220, 219				
218.1 / 2.6	End of DCPT Refusal to Further Penetration (Hammer Bouncing)										

RECORD OF PENETRATION TEST No DCPT08-2 — METRIC

PROJECT 07-1191-0039-14
W.P. 5766-04-01
LOCATION N 5128553.8 ;E 315058.5
ORIGINATED BY TDM
DIST HWY 17
BOREHOLE TYPE Dynamic Cone Penetration Test
COMPILED BY MM
DATUM Geodetic
DATE April 22, 2008
CHECKED BY AB

ELEV / DEPTH	SOIL PROFILE – DESCRIPTION	STRAT PLOT	SAMPLES – NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
220.7	GROUND SURFACE										
0.0							220, 219, 218				
218.0 / 2.7	End of DCPT Refusal to Further Penetration (Hammer Bouncing)										



Legend: SHEAR STRENGTH kPa — ○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × REMOULDED; PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L.

$+^3, \times^3$: Numbers refer to Sensitivity   ○$^{3\%}$ STRAIN AT FAILURE

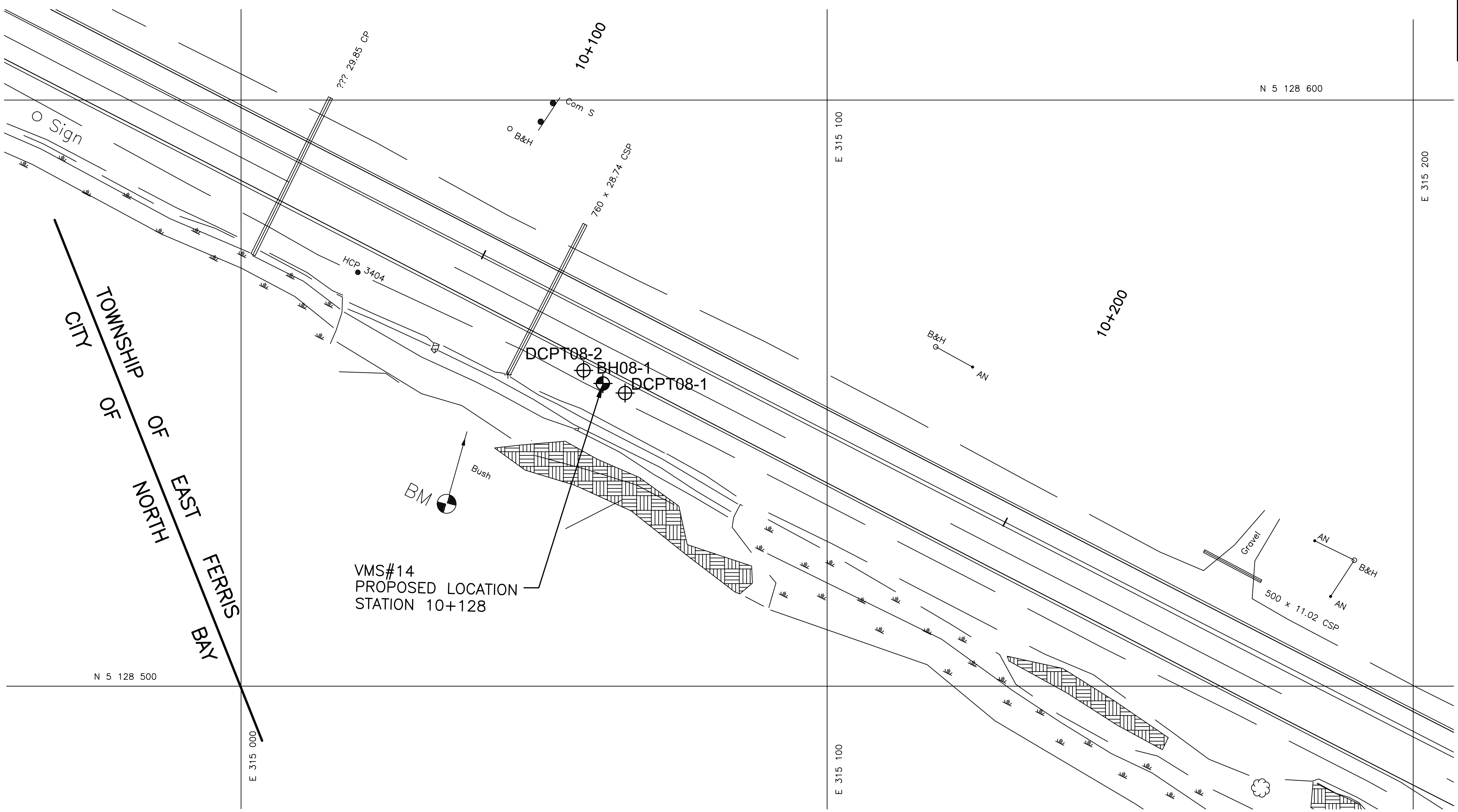
CONT No.
WP No. 5766-04-01

SHEET

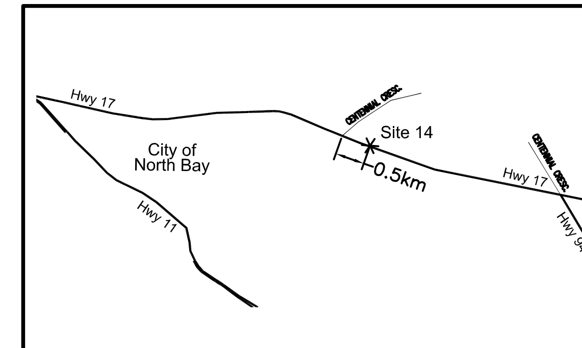
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

HIGHWAY 17 WESTBOUND, NORTH BAY VARIABLE MESSAGE SIGN #14 (STATION 10+128) BOREHOLE AND DCPT LOCATIONS

Golder Associates Ltd.
SUDBURY, ONTARIO, CANADA



PLAN
SCALE
10 0 10 20 m



KEY PLAN
SCALE
1 0 1 Km

LEGEND

Borehole Location
Dynamic Cone Penetration Test Location

No.	ELEVATION(m)	CO-ORDINATES	
		NORTHING	EASTING
BH08-1	220.6	5128551.6	315061.7
DCPT08-1	220.7	5128550.1	315065.6
DCPT08-2	220.7	5128553.8	315058.5

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 complete foundation investigation and design 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 IBI, drawing file no. kplans.dwg received January, 2008 and VMS#14 PHASE TWO received May, 2008.

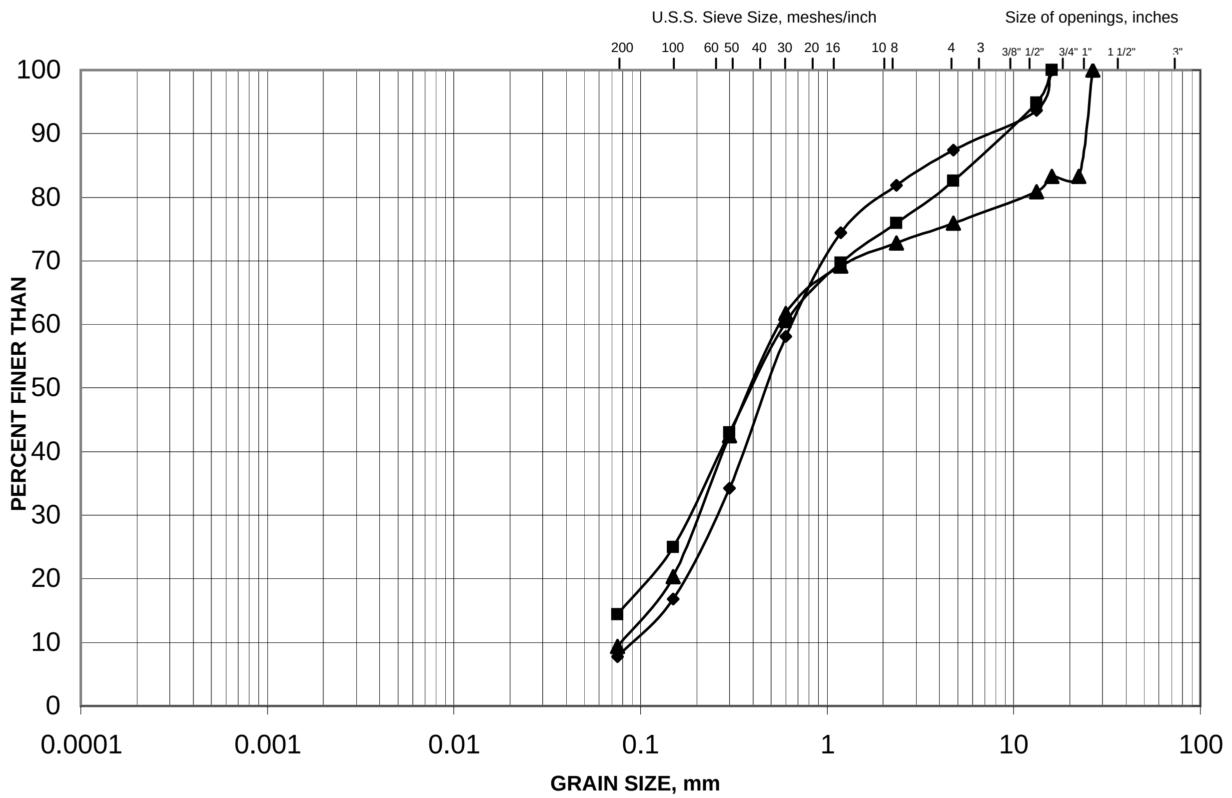
NO.	DATE	BY	REVISION

Geocres No. 31L-122

HWY. 17		PROJECT NO. 07-1191-0039-14	DIST.
SUBM'D. AB	CHKD. JMAC	DATE: JULY, 2008	SITE:
DRAWN: MM	CHKD.	APPD. JMAC	DWG. 1

GRAIN SIZE DISTRIBUTION
Sand to Gravelly Sand (Fill)

FIGURE 1



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
◆	08-1	1B	220.1
■	08-1	3	218.8
▲	08-1	4	218.1

Project Number: 07-1191-0039

Checked By: AB

Golder Associates

Date: July 2008