



November 28, 2014

FOUNDATION INVESTIGATION AND DESIGN REPORT

VARIABLE MESSAGE SIGN #21  
HIGHWAY 17 SOUTHBOUND  
APPROXIMATELY 1.1 KM NORTH OF HIGHWAY 101  
WAWA, ONTARIO  
MINISTRY OF TRANSPORTATION, ONTARIO  
GWP 5143-11-00

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REPORT



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# **PART A**

**FOUNDATION INVESTIGATION REPORT**

**VARIABLE MESSAGE SIGN #21**

**HIGHWAY 17 SOUTHBOUND**

**APPROXIMATELY 1.1 KM NORTH OF HIGHWAY 101**

**WAWA, ONTARIO**

**GWP 5143-11-00**



## **1.0 INTRODUCTION**

Golder Associates Ltd. (Golder) has been retained by IBI Group (IBI) on behalf of Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for a variable message sign (VMS #21) on Highway 17 southbound about 1 km north of Wawa, Ontario. 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 MTO's Request for Proposal (RFP) dated January 11, 2010. Golder's Proposal P0-1191-0006, dated February 5, 2010, and subsequent Change Request No. 1, dated December 3, 2010, and Revised Change Request No. 2, dated October 31, 2011, formed part of IBI's agreement (Number 5009-E-0018) for this project. The work was carried out in accordance with Golder's Quality Control Plan for this project dated August 23, 2010. The site plan was provided to Golder by EXP Services Inc. on behalf of IBI in September 2014.

The purpose of this investigation is to establish the subsurface conditions at the locations of the proposed sign by methods of borehole drilling, in situ testing and laboratory testing on selected soil samples.

We understand that the proposed variable message sign will be mounted on a single pole supported by a spread footing.

## **2.0 SITE DESCRIPTION**

The proposed VMS #21 is to be located on the west (southbound) side of the Highway 17 alignment, approximately 1.1 km north of the intersection with Highway 101 at approximately STA 15+548 in the Township of McMurray, Wawa, Ontario. This section of Highway 17 consists of a two-lane highway. For the purposes of this report, the Highway 17 alignment is in a north-south orientation and therefore may differ from those shown on the drawings which represent magnetic north. The ground surface at the proposed structure location is at approximately Elevation 256.5 m.

The topography of the site consists of a generally flat-lying area with scattered trees bordering both sides of the highway corridor. Bordering the west side of the highway corridor just outside the right-of-way and along the east side of the highway, low lying areas of swamp/terrain are present. The entrance to the MTO Wawa area maintenance yard is located approximately 0.4 km north of the proposed sign location. An above-ground electrical/communication corridor parallels the highway along the southbound side, and overhead lines cross the highway immediately to the south of the sign location. Two photographs of the site are presented following the text of this report.

## **3.0 INVESTIGATION PROCEDURES**

The fieldwork for the investigation for VMS #21 site was carried out on December 14, 2011, at which time one sampled Borehole (BH-VMS#21) and one Dynamic Cone Penetration Test (DCPT) were advanced approximately at the proposed VMS location as shown on Drawing 1.

The foundation 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 to a depth of 9.8 m below ground surface, using 108 mm inner diameter hollow stem augers. Soil samples were obtained within the sampled borehole at intervals of depth of about 0.75 m to 1.5 m, using a 50 mm outside diameter split-spoon sampler operated by an



automatic hammer on the truck mounted drill rig, performed in accordance with the Standard Penetration Test (SPT) procedures (ASTM D1586). Details of the subsurface conditions encountered at the borehole and DCPT locations are shown on the Record of Borehole sheet following the text of this report. The borehole was backfilled with bentonite upon completion of drilling in accordance with Ontario Regulation 903 Wells (as amended).

The fieldwork was supervised throughout by a member of Golder's technical staff, who located the borehole, arranged for the clearance of underground services and for traffic protection, observed the drilling, sampling and in situ testing operations, logged the boreholes and DCPT, and examined and cared for the soil 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 classification testing (water contents and grain size distributions) of selected samples. All of the laboratory tests were carried out to MTO and/or ASTM standards, as appropriate.

The as-drilled borehole and DCPT locations were measured in reference to stakes positioned at the proposed sign locations by IBI and the locations were subsequently converted into MTM NAD 83 coordinates in AutoCAD. Borehole elevations were inferred from the cross-section survey provided IBI. The borehole and DCPT coordinates, ground surface locations and drilled/driven depths are presented below.

| <b>Borehole Number</b> | <b>MTM NAD83 Zone 13 Northing (m)</b> | <b>MTM NAD83 Zone 13 Easting (m)</b> | <b>Ground Surface Elevation (m)</b> | <b>Depth Drilled (m)</b> |
|------------------------|---------------------------------------|--------------------------------------|-------------------------------------|--------------------------|
| BH-VMS#21              | 5 315 826.3                           | 245 760.0                            | 256.5                               | 9.8                      |
| DCPT                   | 5 315 825.3                           | 245 761.1                            | 256.5                               | 9.1                      |

## **4.0 GENERAL SITE GEOLOGY AND STRATIGRAPHY**

### **4.1 Regional Geology**

Based on terrain mapping by the Ontario Geological Survey<sup>1</sup>, the subsurface soils in the vicinity of the site consist of alluvial plain deposits comprising primarily sands. The bedrock in the vicinity of the site is characterized by the Ministry of Natural Resources<sup>2</sup> maps as felsic to intermediate metavolcanic rocks very closely bordered by mafic metavolcanic rocks both of the early Precambrian Era.

### **4.2 General Overview of Local Subsurface Conditions**

The detailed descriptions of the subsurface soil and groundwater conditions as encountered in the borehole and DCPT advanced during this investigation, together with the results of the laboratory tests carried out on selected samples, are given on the attached Record of Borehole sheet in Appendix A and the soil laboratory test sheets provided in Appendix B. The results of the in situ field tests (i.e., SPT 'N'-values and Resistance plot) as presented on the Record of Borehole sheets and in this section are uncorrected. The stratigraphic boundaries

<sup>1</sup> Ontario Geological Survey, Ministry of Northern Development and Mines, and Northeast Science and Information Section, Ministry of Natural Resources 2005. Digital Northern Ontario Engineering Geology Terrain Study (NOEGTS); Ontario Geological Survey, Miscellaneous Release--Data 160.

<sup>2</sup> Ministry of Natural Resources, 1980, Geological Highway Map, Northern Ontario, Map 2440.



shown on the Record of Borehole sheet are inferred from non-continuous sampling, observations of drilling progress and the results of SPTs. These boundaries, therefore, represent transitions between material types rather than exact planes of geological change. Further, subsurface conditions will vary beyond the borehole location.

In summary, the subsoil conditions at the site consist of granular fill (roadway shoulder materials and embankment fill) underlain by deposits of loose to very loose sand and loose to compact silt. A more detailed description of the subsurface conditions encountered in the borehole is provided in the following sections.

#### **4.2.1 Sand to Sand and Gravel (Fill)**

A 3.8 m deposit of fill comprised of moist to wet, brown, sand grading to sand and gravel at depth was encountered from ground surface at Elevation 256.5 m.

The SPT 'N'-values measured in the fill deposit range from 9 blows to 36 blows per 0.3 m of penetration, indicating a loose to dense relative density.

Grain size distribution tests were carried out on two samples of the granular fill and the test results are presented on Figure B1 in Appendix B.

The natural water content measured on two samples of the fill are about 3 per cent and 6 per cent.

#### **4.2.2 Sand**

A 2.8 m thick deposit of wet, brown, sand, trace to some gravel was encountered below the fill material at Elevation 252.7 m.

The SPT 'N'-values measured in the sand deposit range from 3 blows to 9 blows per 0.3 m of penetration, indicating a very loose to loose relative density.

A grain size distribution test was carried out on one sample of the sand deposit and the test result is presented on Figure B2 in Appendix B.

The natural water content measured on one sample of the sand is about 20 per cent.

#### **4.2.3 Silt**

A deposit of wet, grey silt, some sand, trace clay was encountered below the sand deposit. The surface of the silt deposit was encountered at Elevation 249.9 m and the deposit was explored for a thickness of 3.2 m without penetrating through the deposit.

The SPT 'N'-values measured in the silt deposit are 5 blows and 10 blows per 0.3 m of penetration, indicating a loose to compact relative density.

A grain size distribution test was carried out on one sample of the silt deposit and the test result is presented on Figure B3 in Appendix B.

The natural water content measured on one sample of the silt is 25 per cent.



#### **4.2.4 Groundwater Conditions**

Details of the groundwater conditions and water levels observed at the time of drilling are summarized on the Record of Borehole sheet following the text of this report. In Borehole BH-VMS#21, the groundwater level was observed in the open borehole at a depth of 2.3 m below the existing ground surface upon completion of drilling, corresponding to Elevation 254.2 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 for this project was carried out by Mr. Ed Savard from our Sudbury office under the coordination of Mr. David Muldowney, P.Eng. This report was prepared by, Mr. Adam Core, E.I.T., and the technical aspects were reviewed by Ms. Sarah E. M. Poot, P.Eng., Associate. Mr. Jorge M.A. Costa, P.Eng., a Principal with Golder and a Designated MTO Contact for Golder, conducted a quality control review of the report.



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# **PART B**

**FOUNDATION DESIGN REPORT**

**VARIABLE MESSAGE SIGN #21**

**HIGHWAY 17 SOUTHBOUND**

**APPROXIMATELY 1.1 KM NORTH OF HIGHWAY 101**

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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 #21) on the west side of Highway 17 north of Wawa, Ontario. The recommendations are based on interpretation of the factual data obtained from the borehole and auger probes advanced during the subsurface investigation at this site and from site observations. The interpretation and recommendations provided are intended only to provide the designers with sufficient information to assess feasible foundation design 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 that the proposed sign will be located on the west side of Highway 17 at STA 15+533 facing the southbound traffic with the centre of the sign support located approximately 4.5 m from the edge of the pavement.

Borehole BH-VMS#21 was advanced at STA 15+533 approximately 2.1 m east of the centre of the proposed sign location (i.e., approximately 2.1 m from the edge of the pavement) and encountered granular fill to a depth of 3.8 m below the existing ground surface. A loose to very loose sand deposit extending to a depth of 6.6 m below ground surface was encountered underlying the fill, which is in turn underlain by a layer of loose to compact silt to a depth of 9.8 m below the ground surface. The unstabilized groundwater level in the open borehole upon completion of drilling is 2.3 m below the existing ground surface. A DCPT was advanced adjacent to Borehole BH-VMS#21 to a depth of 9.2 m below the ground surface corresponding to Elevation 247.3 m.

VMS pole mounted sign supports are typically designed using a standard caisson foundation in accordance with the requirements in MTO's Sign Support Manual (2011). Based on discussions with IBI and the structural designer, given the existing subsurface conditions at the location of the proposed sign, the preferred foundation alternative for supporting the overhead sign is a standard caisson founded on native soils. Alternatively, a spread footing option is also suitable from a foundation perspective and the foundation options are discussed in Sections 6.2.2 and 6.2.3.

Table 1 summarizes the advantages, disadvantages, relative costs and risk/consequences of the foundation alternatives.

#### **6.2.1 Frost Protection**

As shown on Ontario Provincial Standard Drawing (OPSD) 3090.100 (Foundation, Frost Penetration Depths for Northern Ontario), the depth of frost penetration for the Wawa area is about 2.2 m. As such, it is recommended that the footing, if adopted as the support foundation, be covered with a minimum thickness of 2.2 m of soil cover or equivalent thickness of insulation for protection from frost penetration.



## 6.2.2 Caisson Foundation

A caisson foundation for the overhead sign should be designed in accordance with the requirements in the Sign Support Manual (2011) for standard size signs. The Sign Support Manual (2011) includes a standard caisson foundation design (Section 8 and Standard Drawing SS118-3), in which caissons are extended 5 m below the design frost depth (2.2 m for this site), except where bedrock is encountered within this depth. For a pole mounted sign foundation for the VMS #21 site, the minimum caisson founding depth would therefore be 7.2 m below ground surface.

The minimum design parameters/values specified in Sign Support Manual (2011) for caissons are applicable to the design of the foundation for VMS #21 given that the minimum soil conditions for Case 1 (Sand) are available:

- Sand with a friction angle of 28 degrees surrounding the upper two-thirds of the portion of caisson foundation below the frost depth, and sand with a friction angle of 30 degrees surrounding the lower third portion of the caisson below the design frost depth.

For cohesionless soils, the unfactored passive lateral earth pressure,  $P_p$  (kPa), distributed along the depth of the caisson foundation, may be calculated using the following equations:

$$P_p = K_p \gamma d_w \text{ above the groundwater table; and}$$

$$P_p = K_p \gamma d_w + K_p \gamma' (d - d_w) \text{ below the groundwater table}$$

where  $K_p$  is the passive earth pressure coefficient;

$\gamma$  is the bulk unit weight of the soil (kN/m<sup>3</sup>);

$\gamma'$  is the effective unit weight of the soil below the groundwater level (kN/m<sup>3</sup>);

$d$  is the depth below the ground surface (m); and

$d_w$  is the depth to the groundwater level (m).

In the design of the foundations, the passive resistance within the upper 2.2 m below ground surface should be neglected to account for frost action. In addition, for foundation design, full passive resistance will be mobilized only where the ground surface in front of and behind the caisson is level. The  $K_p$  value of the sand fill, sand and upper portion of the silt deposit is 3.0 (i.e.,  $\Phi$  equal to 30°). Where sloping ground is present adjacent to the caisson foundation or where the foundation will be installed at the crest of an embankment, the  $K_p$  values used in the calculation of the passive resistance should be adjusted to account for the presence of the sloping ground.

Based on the subsurface conditions encountered at the proposed sign location (i.e., loose to dense sand fill, very loose to loose sand and loose to compact silt, and a moderately high water table at Elevation 254.2 m at the time of drilling), the installation of the caisson should be carried out with a temporary steel liner to avoid the open hole from caving or sloughing prior to pouring concrete. The caisson should be advanced with a full balanced head of water condition and maintained at all times during construction/drilling to reduce the potential for base heave in the bottom of the caisson and ground loss. Tremie concrete and placement will likely be required when placing concrete within the caisson.

As concrete is placed in the liner-protected hole (by tremie placement method when under water) the temporary steel liner should be removed progressively to the extent that the surface of the concrete is always within the steel liner to prevent caving-in of the hole, and removal of the liner can occur simultaneously.



Consideration can be given to leaving the steel liner in place permanently. However, the standard caisson foundation design for a cantilever static sign support, as specified in the Sign Support Manual (2011), assumes that there is intimate contact between the poured concrete and the subgrade soils, which cannot occur with use of a permanent steel liner. If the temporary steel liner is to be left in place, the design for the caisson foundation should be checked considering a friction factor between the steel and the native subgrade soil of  $\tan \delta = 0.25$ .

### **6.2.3 Spread Footing**

This section of the report provides recommendations for the support of VMS #21 on a spread footing as an alternative to a caisson foundation.

A spread footing constructed on the properly prepared subgrade at or below the frost penetration depth given in Section 6.2.1 may be designed based on a factored geotechnical axial resistance of 250 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 reaction value of 100 kPa for Serviceability Limit States (for 25 mm settlement) may be used for design. Design of the proposed sign foundation should also be checked for and provisions made to resist buoyant forces, assuming a groundwater level at Elevation 254.2 m. 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 for loads that will be applied perpendicular to the surface of the footing. 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.

Resistance to lateral forces/sliding resistance between the concrete footing and the prepared subgrade should be calculated in accordance with Section 6.7.5 of the CHBDC. For a cast-in-place concrete footing constructed on a compacted granular working pad, the coefficient of friction,  $\tan \delta$ , can be taken as 0.55. For a cast-in-place concrete footing constructed directly on the existing sand to sand and gravel fill, the coefficient of friction,  $\tan \delta'$ , can be taken as 0.50 (NAVFAC, 1982). The above noted values are unfactored.

An open cut excavation of short duration through the granular fill is considered feasible for the proposed footing. The excavation for the proposed footing should be carried out in accordance with the latest Occupational Health and Safety Act for Construction Projects (OHSA). When referencing OHSA, the existing granular fill should be considered as "Type 3 Soil" and temporary excavation side slopes should be made no steeper than 1 horizontal (H) to 1 vertical (V). Depending on the season of construction, the groundwater level may be at or above the proposed founding depth and the excavation side slopes may have to be flatter (i.e., 2H:1V). Further, for this condition, an open cut excavation may not be practical for the proposed footing construction due to the proximity of Highway 17 located adjacent to the proposed excavation, unless appropriate dewatering is carried out to adequately depress the groundwater level. Given the anticipated size of the excavation, dewatering may be possible using standard construction techniques such as pumps and filtered sumps and the excavation side walls maintained at 1H to 1V. The sumps should be installed at least 1.0 m below the base of the excavation within a filtered pipe surround. The pumps should be installed before or not later than immediately upon encountering the groundwater level and sufficient time should be given to allow for localized dewatering and lowering of the groundwater level prior to reaching the excavation base.



Care must be taken by the contractor during excavation adjacent to the highway to minimize impact to the existing roadway. Provision for protection of the existing pavement structure may be required and should be in accordance with Ontario Provincial Standard Specification (OPSS) 539 (Temporary Protection Systems), designed to meet Performance Level 2. Relevant design parameters for the shoring are provided below.

| <b>Design Parameter</b>  | <b>Granular Fill &amp; Sand and Silt</b> |
|--|--|
| Unit Weight of soil above Groundwater Level $\gamma$ (kN/m <sup>3</sup> )  | 20                                       |
| Unit Weight of soil below Groundwater Level $\gamma'$ (kN/m <sup>3</sup> ) | 10                                       |
| Friction Angle ( $^{\circ}$ )  | 30                                       |
| $K_a^*$  | 0.33                                     |
| $K_p^*$  | 3.0                                      |
| $K_o^*$  | 0.5                                      |

\* Earth pressure coefficients for horizontal backfill.

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 the overall local embankment slope. 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. Therefore, OPSS 902 (Excavating and Backfilling – Structures) 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 the foundation area has been adequately prepared for construction of the spread footing.

The base of the excavation should be free of water and loose soil prior to placing concrete. Should the material(s) 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 300 mm thick granular working pad consisting of compacted Granular 'B' Type II meeting the requirements in OPSS.PROV 1010 (Aggregates) or by a concrete working slab as detailed in the Non-Standard Special Provision (NSSP) included in Appendix C. The working pad/slab should be placed across the bottom of the excavation immediately upon completion of the excavation and review by the QVE. The purpose of the working slab/granular pad is to limit disturbance of the sand to sand and gravel fill and to provide a platform for construction of the spread footing. The Granular 'B' Type II should be placed in 300 mm loose lifts and uniformly compacted to the requirements outlined in OPSS 501 (Compacting).

As an alternative to Granular 'B' Type II, granular material meeting the specifications for Granular 'A' in OPSS.PROV 1010 (Aggregates) or granular material meeting the specifications for 19.0 mm Clear Stone Type I or Type II as per OPSS.PROV 1004 (Aggregates – Miscellaneous), may be used to construct a granular working pad at this site. Note that if Granular 'A' is used, the material should be placed in dry condition in the excavation as it will not be possible to properly compact it in wet conditions.



### 6.3 Construction Considerations

The performance of the caisson is dependent on the cleanliness of the base of the caisson such that all loose cuttings are removed to ensure the concrete is in intimate contact with the founding stratum at the base of the shaft. The inspection of the base of the shafts can be accomplished, after flushing and cleaning of the base by means of a Shaft Inspection Device (SID) such as a video camera. Should the camera inspection indicate that loosened/unacceptable soil is present at the base; the caisson base would need to be re-cleaned and re-inspected. The drilling and construction of the caisson foundations should be observed throughout by the QVE to confirm that the conditions encountered are consistent with the information obtained from the boreholes and that the required base and cleanliness has been achieved. At the least, the caisson should be measured for depth to verify/confirm that it is fully open/unobstructed to the design and drilled depth.

The excavation around and above the spread footing may be backfilled using an approved granular material such as OPSS.PROV.1010 (Aggregates) Granular 'A' or Granular 'B' (Type I or II) placed in 300 mm thick loose lifts and uniformly compacted to the requirements outlined in OPSS 501 (Compacting). The gradation of the existing sand to sand and gravel fill essentially lies within the gradation envelope for OPSS.PROV 1010 (Aggregates) Granular 'B' Type I except for a slightly greater (about 2 per cent) quantity of fines but is considered suitable for re-use for the roadway shoulder and as backfill to the footing.

The final grade surrounding the sign should be sloped to promote drainage of surface water and from the pavement structure away from the pavement and sign, to the adjacent ditch and surfaced with topsoil and seed in accordance with OPSS 804 (Seed and Cover), or granular sheeting in accordance with OPSS.PROV 1004 (Aggregates - Miscellaneous). If the resulting side slopes in the immediate vicinity of the sign support foundation are steeper than 2 Horizontal to 1 Vertical, the slope should be covered with R-10 Rip-Rap, in accordance with OPSS.PROV 1004 (Aggregates - Miscellaneous), to reduce the potential for erosion of the slope locally."

We recommend that a NSSP be included in the Contract Documents to warn the contractor of the following item which is expected to affect the installation of the variable message sign foundation:

- **Control of Groundwater and of Overburden Soils for Foundation Excavation:** Excavations for the sign foundation will be advanced through generally cohesionless soil which, if below the groundwater table, should be expected to be unstable. It should be anticipated that the excavations will have to be advanced using a liner of shoring, for a caisson or spread footing foundation, respectively, possibly in conjunction with controlled dewatering, in order to minimize ground loss during excavation and concrete placement. The contractor is responsible for ensuring that appropriate construction procedures and equipment are used for construction. An example NSSP to warn the contractor of such conditions is presented in Appendix C.

### 7.0 CLOSURE

This report was prepared by Mr. Adam Core, E.I.T. and the technical aspects were reviewed by Ms. Sarah E. M. Poot, P.Eng., Associate. Mr. Jorge M. A. Costa, P.Eng., a Principal with Golder and Designated MTO Contact for Golder, conducted a quality control review of the report.



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- Unified Facilities Criteria, U.S. Navy. 1982. NAVFAC Design Manual 7.02. Soil Mechanics, Foundation and Earth Structures. Alexandria, Virginia

## STANDARDS

### ASTM International

- |            |   |
|------------|---|
| ASTM D1586 | Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils |
|------------|---|

### Ontario Provincial Standard Drawings

- |               |   |
|---------------|---|
| OPSD 3090.100 | Foundation, Frost Penetration Depths for Northern Ontario |
|---------------|---|

### Ontario Provincial Standard Specifications

- |                |  |
|----------------|--|
| OPSS 501       | Construction Specification for Compacting  |
| OPSS 539       | Construction Specification for Temporary Protection Systems                                  |
| OPSS 902       | Construction Specification for Excavating and Backfilling – Structures                       |
| OPSS.PROV 1004 | Material Specification for Aggregates – Miscellaneous  |
| OPSS.PROV 1010 | Material Specification for Aggregates – Base, Subbase, Select Subgrade and Backfill Material |

### Ontario Water Resources Act

- |                           |       |
|---------------------------|-------|
| Ontario Regulation 903/90 | Wells |
|---------------------------|-------|



**Table 1: Evaluation of Foundation Alternatives**

| Options        | Rank | Advantages  | Disadvantages  | Relative Costs  | Risks/Consequences   |
|----------------|------|---|--|---|--|
| Caisson        | 1    | <ul style="list-style-type: none"><li>■ Subsurface conditions are suitable for standard caisson foundation design as per the Sign Support Manual.</li><li>■ Typical foundation alternative for sign of standard size.</li></ul> | <ul style="list-style-type: none"><li>■ Requires specialized drilling equipment.</li><li>■ Temporary liner for soil support will be required during installation to prevent sloughing and caving of cohesionless deposits.</li><li>■ Depending on water level at time of construction, dewatering will likely be required within the liner for concrete placement in the dry, or concrete will have to be placed by tremie methods below water.</li><li>■ May require a levelling pad (fill or excavation of slope) to accommodate drilling equipment.</li></ul> | <ul style="list-style-type: none"><li>■ Mobilization of specialized drilling equipment is relatively expensive, compared to equipment required to construct spread footing.</li><li>■ Reduced cost if equipment is available locally for construction of other sign caisson foundations for this project.</li></ul> | <ul style="list-style-type: none"><li>■ Risk of need for placement of concrete by tremie methods if unable to dewater within caisson liner.</li></ul>            |
| Spread Footing | 2    | <ul style="list-style-type: none"><li>■ Conventional construction and construction equipment.</li><li>■ Design easily adaptable for non-standard sign size/configuration.</li></ul>   | <ul style="list-style-type: none"><li>■ Larger excavation required compared to caisson with potential impact to roadway.</li><li>■ Depending on water level at time of construction, local dewatering and/or temporary shoring of excavation may be required.</li><li>■ Site specific design to determine footing size to satisfy all loading conditions may result in larger footing being required.</li></ul>  | <ul style="list-style-type: none"><li>■ Much lower overall cost compared to caisson.</li><li>■ Additional costs required for control of overburden as applicable.</li></ul>   | <ul style="list-style-type: none"><li>■ Risk of requiring dewatering and/or temporary shoring during construction depending on season of construction.</li></ul> |


Note: This table should be read in conjunction with the Foundation Investigation and Design Report.

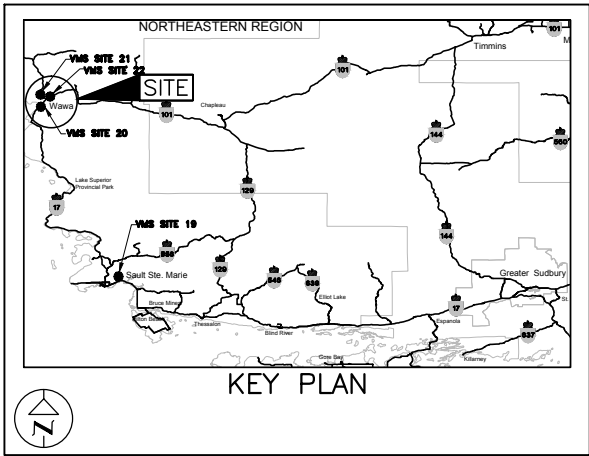
Compiled by: AC Reviewed by: JMAC

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



CONT No. **GWP No.5143-11-00**

VARIABLE MESSAGE SIGN #21  
HIGHWAY 17, WAWA  
BOREHOLE LOCATION

  
**SHEET**



**LEGEND**

|   |  |
|---|--|
|  | Approximate Borehole Location                      |
|  | Approximate Dynamic Cone Penetration Test Location |

| BOREHOLE CO-ORDINATES |           |           |          |
|-----------------------|-----------|-----------|----------|
| No.                   | ELEVATION | NORTHING  | EASTING  |
| BH-VMS#21             | 256.5     | 5315826.3 | 245760.0 |
| DCPT                  | 256.5     | 5315825.3 | 245761.1 |

**NOTES**

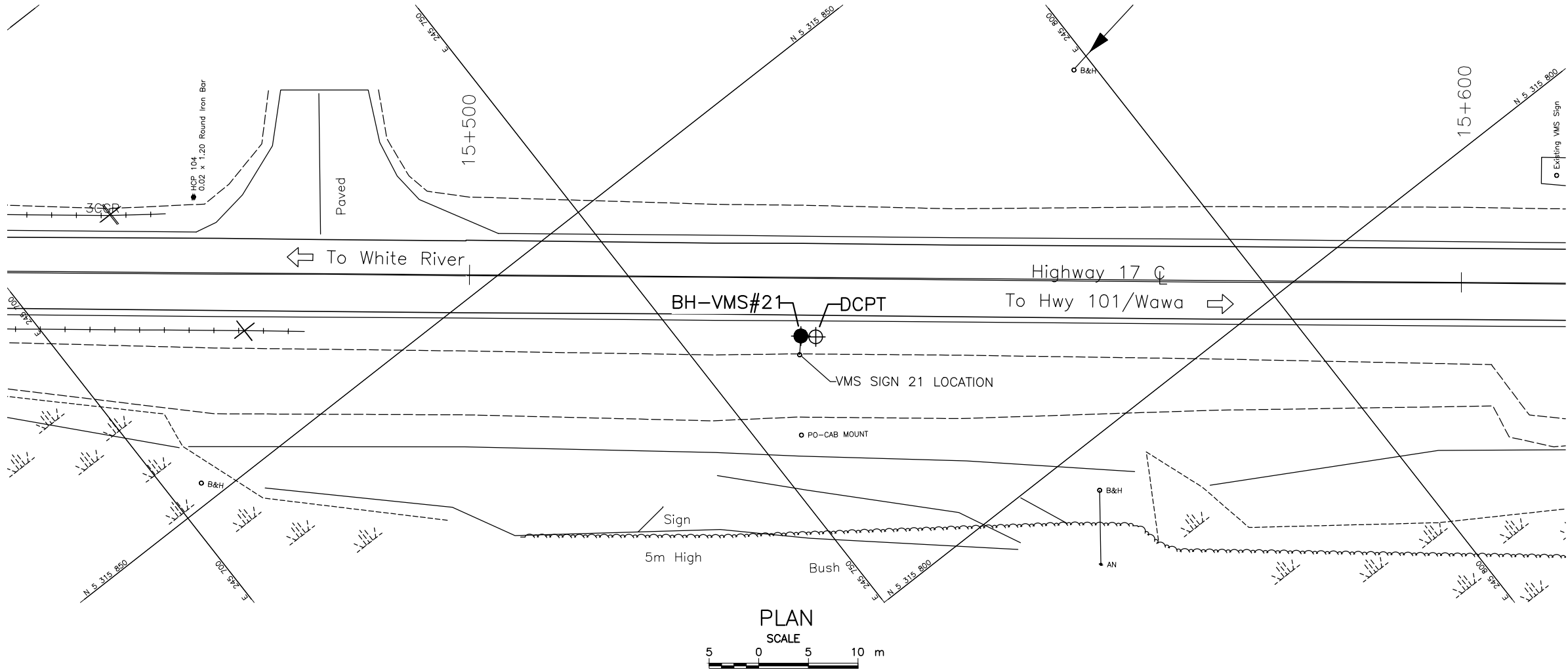
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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 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**

Key plan provided in digital format by IBI, drawing file no. TM-TWG-keyplan.dwg, received December 7, 2010.  
Base plans provided in digital format by IBIGroup, drawing file no. VMS SIGN 21.dwg, received Sep 03, 2014.



|                    |                          |                  |               |
|--------------------|--------------------------|------------------|---------------|
| NO.                | DATE                     | BY               | REVISION      |
|                    |                          |                  |               |
| Geocres No. 41N-29 |                          |                  |               |
| HWY. 17            | PROJECT NO. 10-1191-0006 | DIST. .          |               |
| SUBM'D.            | CHKD. .                  | DATE: 11/28/2014 | SITE: VMS #21 |
| DRAWN: TB          | CHKD. AB                 | APPD. JMAC       | DWG. 1        |



**Photograph 1: Looking north from sign location**



**Photograph 2: Looking south from sign location**





# APPENDIX A

## Record of Borehole and Drillhole



## LIST OF SYMBOLS

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

### I. GENERAL

|             |                                       |
|-------------|---------------------------------------|
| $\pi$       | 3.1416                                |
| $\ln x$ ,   | natural logarithm of x                |
| $\log_{10}$ | x or log x, logarithm of x to base 10 |
| g           | acceleration due to gravity           |
| t           | time                                  |
| FoS         | factor of safety                      |

### II. STRESS AND STRAIN

|                                |  |
|--------------------------------|--|
| $\gamma$                       | shear strain   |
| $\Delta$                       | change in, e.g. in stress: $\Delta \sigma$                                 |
| $\varepsilon$                  | linear strain  |
| $\varepsilon_v$                | volumetric strain  |
| $\eta$                         | coefficient of viscosity   |
| $\nu$                          | Poisson's ratio  |
| $\sigma$                       | total stress   |
| $\sigma'$                      | effective stress ( $\sigma' = \sigma - u$ )                                |
| $\sigma'_{vo}$                 | initial effective overburden stress  |
| $\sigma_1, \sigma_2, \sigma_3$ | principal stress (major, intermediate, minor)                              |
| $\sigma_{oct}$                 | mean stress or octahedral stress<br>$= (\sigma_1 + \sigma_2 + \sigma_3)/3$ |
| $\tau$                         | shear stress   |
| u                              | porewater pressure   |
| E                              | modulus of deformation   |
| G                              | shear modulus of deformation   |
| K                              | bulk modulus of compressibility  |

### III. SOIL PROPERTIES

|                    |  |
|--------------------|--|
| <b>(a)</b>         | <b>Index Properties</b>  |
| $\rho(\gamma)$     | 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   |
| $\gamma'$          | unit weight of submerged soil<br>( $\gamma' = \gamma - \gamma_w$ )                                   |
| $D_R$              | 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   |

### (a) Index Properties (continued)

|             |  |
|-------------|--|
| w           | water content  |
| $w_l$ or LL | liquid limit   |
| $w_p$ or PL | plastic limit  |
| $I_p$ or PI | 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 = $(e_{max} - e) / (e_{max} - e_{min})$<br>(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<br>(coefficient of permeability) |
| j | seepage force per unit volume                           |

### (c) Consolidation (one-dimensional)

|             |   |
|-------------|---|
| $C_c$       | compression index<br>(normally consolidated range)    |
| $C_r$       | recompression index<br>(over-consolidated range)      |
| $C_s$       | swelling index  |
| $C_\alpha$  | secondary compression index                           |
| $m_v$       | coefficient of volume change                          |
| $C_v$       | coefficient of consolidation (vertical direction)     |
| $C_h$       | coefficient of consolidation (horizontal direction)   |
| $T_v$       | time factor (vertical direction)                      |
| U           | degree of consolidation                               |
| $\sigma'_p$ | pre-consolidation stress                              |
| OCR         | over-consolidation ratio = $\sigma'_p / \sigma'_{vo}$ |

### (d) Shear Strength

|                  |  |
|------------------|--|
| $\tau_p, \tau_r$ | peak and residual shear strength                         |
| $\phi'$          | effective angle of internal friction                     |
| $\delta$         | angle of interface friction                              |
| $\mu$            | coefficient of friction = $\tan \delta$                  |
| $c'$             | 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  |

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

Notes: 1  
2

$$\tau = c' + \sigma' \tan \phi'$$
$$\text{shear strength} = (\text{compressive strength})/2$$



## LIST OF ABBREVIATIONS

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

### I. SAMPLE TYPE

|    |                     |
|----|---------------------|
| AS | Auger sample        |
| BS | Block sample        |
| CS | Chunk sample        |
| DS | Denison type sample |
| FS | Foil sample         |
| RC | Rock core           |
| SC | Soil core           |
| SS | Split-spoon         |
| 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

#### Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm<sup>2</sup> 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) Non-Cohesive (Cohesionless) Soils

| Density Index    | N                        |
|------------------|--------------------------|
| Relative Density | 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        | 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 <sup>1</sup>                                       |
| CIU      | consolidated isotropically undrained triaxial test with porewater pressure measurement <sup>1</sup> |
| $D_R$    | 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)  |
| $\gamma$ | unit weight   |

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

### V. MINOR SOIL CONSTITUENTS

| Per cent by Weight | Modifier   | Example   |
|--------------------|--|---|
| 0 to 5             | Trace  | Trace sand  |
| 5 to 12            | Trace to Some (or Little)                            | Trace to some sand  |
| 12 to 20           | Some   | Some sand   |
| 20 to 30           | (ey) or (y)  | Sandy   |
| over 30            | And (non-cohesive (cohesionless)) or With (cohesive) | Sand and Gravel<br>Silty Clay with sand / Clayey Silt with sand |

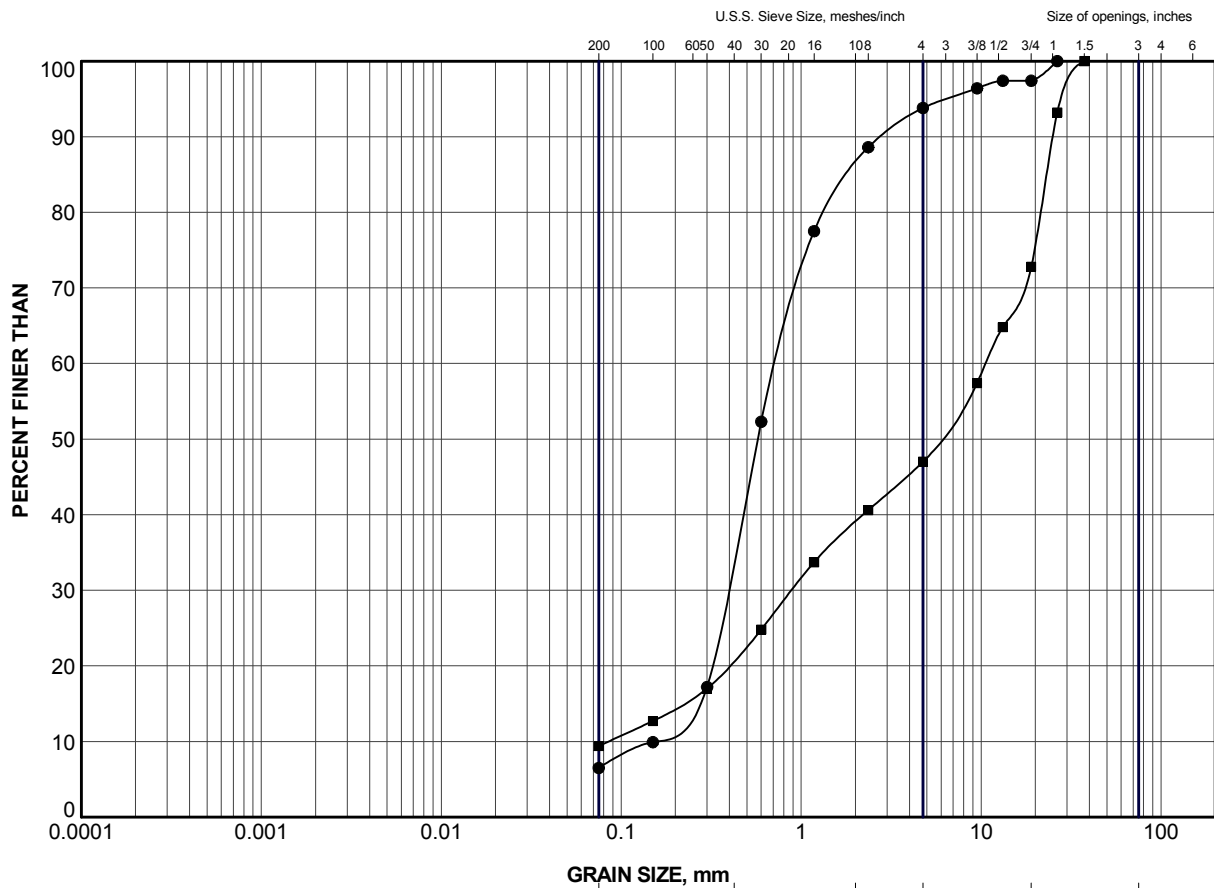
| PROJECT       |   | 10-1191-0006 |         | <b>RECORD OF BOREHOLE No BH-VMS#21</b> |            | 1 OF 1 <b>METRIC</b>                             |                 |   |   |  |  |             |  |  |                                       |   |    |    |    |    |
|---------------|---|--------------|---------|--|------------|--|-----------------|---|---|--|--|-------------|--|--|---------------------------------------|---|----|----|----|----|
| G.W.P.        |   | 5143-11-00   |         | LOCATION                               |            | N 5315826.3; E 245760.0                          |                 |   |   |  |  |             |  |  |                                       |   |    |    |    |    |
| DIST          |   | HWY 17       |         | BOREHOLE TYPE                          |            | 108 mm I.D. Continuous Flight Hollow Stem Augers |                 |   |   |  |  |             |  |  |                                       |   |    |    |    |    |
| DATUM         |   | GEODETIC     |         | DATE                                   |            | December 14, 2011                                |                 |   |   |  |  |             |  |  |                                       |   |    |    |    |    |
| ORIGINATED BY |   | EHS          |         | COMPILED BY                            |            | DAM  |                 |   |   |  |  |             |  |  |                                       |   |    |    |    |    |
| CHECKED BY    |   | AB           |         |  |            |  |                 |   |   |  |  |             |  |  |                                       |   |    |    |    |    |
| SOIL PROFILE  |   |              | SAMPLES |  |            | DYNAMIC CONE PENETRATION RESISTANCE PLOT         |                 |   | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT |  |  | UNIT WEIGHT |  |  | REMARKS & GRAIN SIZE DISTRIBUTION (%) |   |    |    |    |    |
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT   | NUMBER  | TYPE                                   | "N" VALUES | GROUND WATER<br>CONDITIONS                       | ELEVATION SCALE | SHEAR STRENGTH kPa<br>○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL × REMOULDED |   |  |  |             | W <sub>p</sub> W W <sub>L</sub><br>WATER CONTENT (%) |  |                                       | γ | GR | SA | SI | CL |
| 256.5         | GROUND SURFACE  |              |         |  |            |  |                 | 20 40 60 80 100   |   |  |  |             |  |  |                                       |   |    |    |    |    |
| 0.0           | Sand to sand and gravel, trace silt (FILL)<br>Loose to dense<br>Brown<br>Moist to wet   |              | 1       | AS                                     | -          |  | 256             |   |   |  |  |             |  |  |                                       |   |    |    |    |    |
|               |   |              | 2       | AS                                     | -          |  |                 |   |   |  |  |             |  |  |                                       |   |    |    |    |    |
|               |   |              | 3       | SS                                     | 9          |  |                 |   |   |  |  |             |  |  |                                       |   |    |    |    |    |
|               |   |              | 4       | SS                                     | 24         |  |                 |   |   |  |  |             |  |  |                                       |   |    |    |    |    |
|               |   |              | 5       | SS                                     | 36         |  |                 |   |   |  |  |             |  |  |                                       |   |    |    |    |    |
|               |   |              | 6       | SS                                     | 33         |  |                 |   |   |  |  |             |  |  |                                       |   |    |    |    |    |
| 252.7         | SAND, trace to some gravel, trace silt<br>Very loose to loose<br>Brown<br>Wet   |              | 7       | SS                                     | 9          |  |                 |   |   |  |  |             |  |  |                                       |   |    |    |    |    |
| 3.8           |   |              | 8       | SS                                     | 5          |  |                 |   |   |  |  |             |  |  |                                       |   |    |    |    |    |
|               |   |              | 9       | SS                                     | 3          |  |                 |   |   |  |  |             |  |  |                                       |   |    |    |    |    |
| 249.9         | SILT, some sand, trace clay<br>Loose to compact<br>Grey<br>Wet  |              |         |  |            |  |                 |   |   |  |  |             |  |  |                                       |   |    |    |    |    |
| 6.6           | About 0.6 m heave in augers at 7.6 m depth.   |              | 10      | SS                                     | 10         |  |                 |   |   |  |  |             |  |  |                                       |   |    |    |    |    |
|               |   |              | 11      | SS                                     | 5          |  |                 |   |   |  |  |             |  |  |                                       |   |    |    |    |    |
| 246.7         | END OF BOREHOLE   |              |         |  |            |  |                 |   |   |  |  |             |  |  |                                       |   |    |    |    |    |
| 9.8           | Notes:<br>1. Water level at a depth of 2.3 m below ground surface (Elev. 254.2 m) upon completion of drilling.<br>2. DCPT advanced 1.5 m south of borehole. |              |         |  |            |  |                 |   |   |  |  |             |  |  |                                       |   |    |    |    |    |

SUD-MTO 001 1011910006.GPJ GAL-MISS.GDT 24/11/14 DATA INPUT:



# APPENDIX B

## Laboratory Test Results



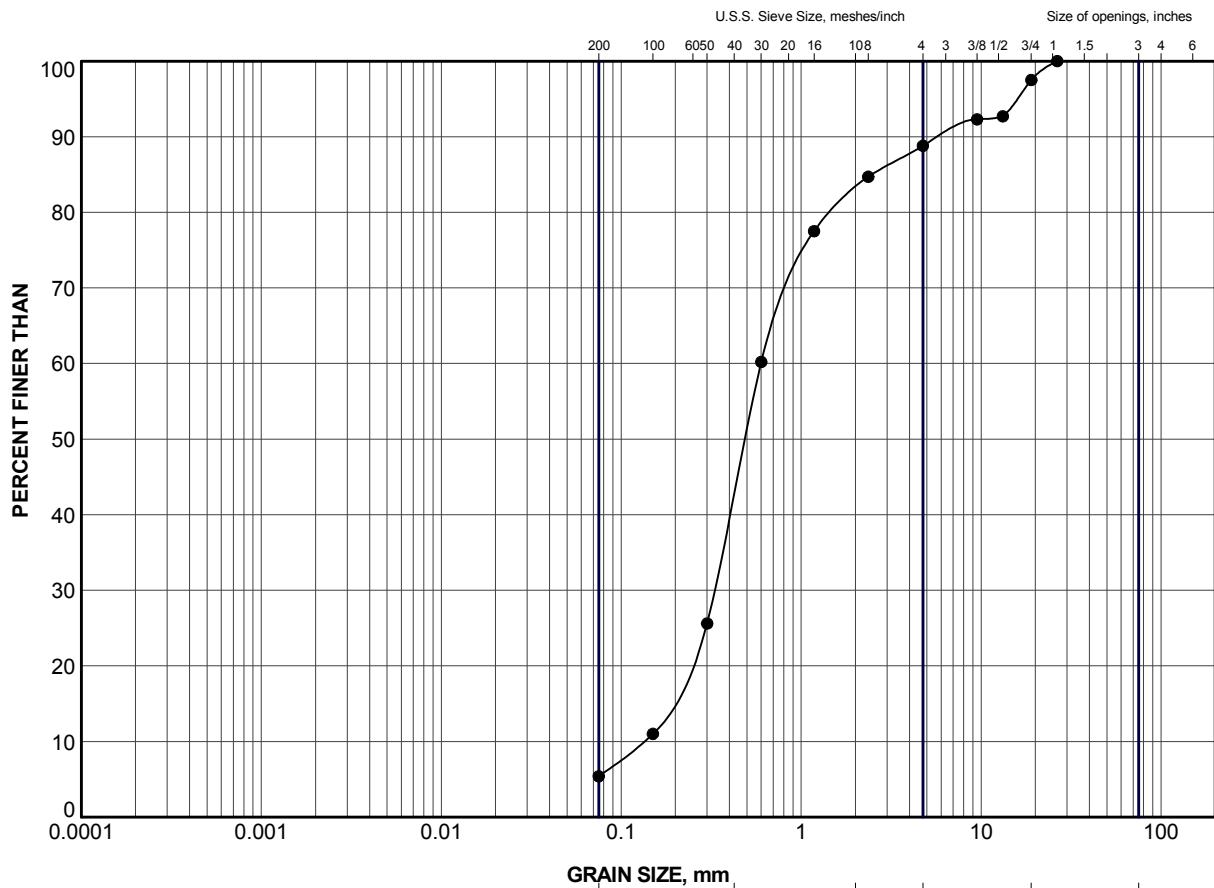
|               |                |        |        |             |        |             |
|---------------|----------------|--------|--------|-------------|--------|-------------|
| CLAY AND SILT | GRAIN SIZE, mm |        |        |             |        | Cobble Size |
|               | fine           | medium | coarse | fine        | coarse |             |
| SAND SIZE     |                |        |        | GRAVEL SIZE |        |             |

#### LEGEND

| SYMBOL | BOREHOLE  | SAMPLE | ELEV (m) |
|--------|-----------|--------|----------|
| ●      | BH-VMS#21 | 3      | 255.4    |
| ■      | BH-VMS#21 | 5      | 253.9    |

|             |      |          |              |     |      |   |  |  |                  |  |  |
|-------------|------|----------|--------------|-----|------|---|--|--|------------------|--|--|
| PROJECT     |      |          |              |     |      | HIGHWAY 17<br>VARIABLE MESSAGE SIGN #21                   |  |  |                  |  |  |
| TITLE       |      |          |              |     |      | GRAIN SIZE DISTRIBUTION<br>SAND to SAND and GRAVEL (FILL) |  |  |                  |  |  |
| PROJECT No. |      |          | 10-1191-0006 |     |      | FILE No.  |  |  | 1011910006.GPJ   |  |  |
| DRAWN       | TB   | Oct 2014 | SCALE        | N/A | REV. |   |  |  |                  |  |  |
| CHECK       | AB   | Oct 2014 |              |     |      |   |  |  |                  |  |  |
| APPR        | JMAC | Oct 2014 |              |     |      |   |  |  |                  |  |  |
|             |      |          |              |     |      |   |  |  | <b>FIGURE B1</b> |  |  |





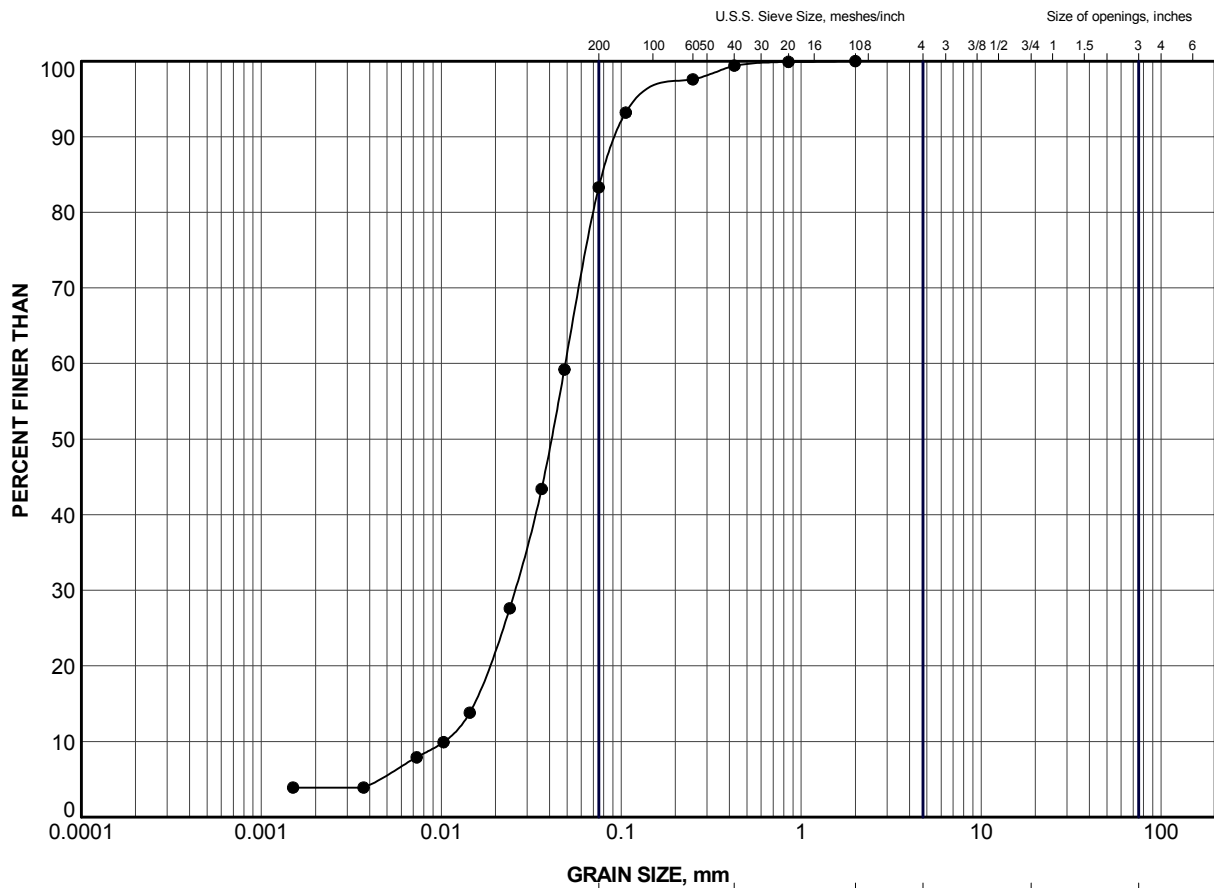
| GRAIN SIZE, mm |           |        |        |             |        |             |
|----------------|-----------|--------|--------|-------------|--------|-------------|
| CLAY AND SILT  | fine      | medium | coarse | fine        | coarse | Cobble Size |
|                | SAND SIZE |        |        | GRAVEL SIZE |        |             |

#### LEGEND

| SYMBOL | BOREHOLE  | SAMPLE | ELEV (m) |
|--------|-----------|--------|----------|
| ●      | BH-VMS#21 | 8      | 251.6    |

|             |      |          |  |              |     |   |  |                  |  |                |  |
|-------------|------|----------|--|--------------|-----|---|--|------------------|--|----------------|--|
| PROJECT     |      |          |  |              |     | HIGHWAY 17<br>VARIABLE MESSAGE SIGN #21 |  |                  |  |                |  |
| TITLE       |      |          |  |              |     | GRAIN SIZE DISTRIBUTION<br>SAND         |  |                  |  |                |  |
| PROJECT No. |      |          |  | 10-1191-0006 |     | FILE No.                                |  |                  |  | 1011910006.GPJ |  |
| DRAWN       | TB   | Oct 2014 |  | SCALE        | N/A | REV.                                    |  |                  |  |                |  |
| CHECK       | AB   | Oct 2014 |  |              |     |   |  |                  |  |                |  |
| APPR        | JMAC | Oct 2014 |  |              |     |   |  |                  |  |                |  |
|             |      |          |  |              |     |   |  | <b>FIGURE B2</b> |  |                |  |





|               |           |        |        |             |        |                |
|---------------|-----------|--------|--------|-------------|--------|----------------|
| CLAY AND SILT | fine      | medium | coarse | fine        | coarse | Cobble<br>Size |
|               | SAND SIZE |        |        | GRAVEL SIZE |        |                |

**LEGEND**

| SYMBOL | BOREHOLE  | SAMPLE | ELEV (m) |
|--------|-----------|--------|----------|
| ●      | BH-VMS#21 | 10     | 248.6    |

|             |      |          |              |     |      |   |  |  |                |  |  |
|-------------|------|----------|--------------|-----|------|---|--|--|----------------|--|--|
| PROJECT     |      |          |              |     |      | HIGHWAY 17<br>VARIABLE MESSAGE SIGN #21 |  |  |                |  |  |
| TITLE       |      |          |              |     |      | GRAIN SIZE DISTRIBUTION<br>SILT         |  |  |                |  |  |
| PROJECT No. |      |          | 10-1191-0006 |     |      | FILE No.                                |  |  | 1011910006.GPJ |  |  |
| DRAWN       | TB   | Oct 2014 | SCALE        | N/A | REV. | <b>FIGURE B3</b>                        |  |  |                |  |  |
| CHECK       | AB   | Oct 2014 |              |     |      |   |  |  |                |  |  |
| APPR        | JMAC | Oct 2014 |              |     |      |   |  |  |                |  |  |



SUD-MTO GSD (NEW) GLDR\_LDN.GDT



# APPENDIX C

## Non-Standard Special Provisions

## **WORKING SLAB - Item No.**

---

Special Provision

---

### **1.0 SCOPE**

This Special Provision covers the requirements for the supply and placement of a concrete working slab under structure foundations.

### **2.0 REFERENCES**

This Special Provision refers to the following standards, specifications or publications:

#### **Ontario Provincial Standard Specifications, Construction**

OPSS 902      Excavating and Backfilling - Structures

### **3.0 DEFINITIONS - Not Used**

### **4.0 DESIGN AND SUBMISSION REQUIREMENTS - Not Used**

### **5.0 MATERIALS**

Concrete for working slabs shall have a minimum 28 day strength of 20 MPa.

### **6.0 EQUIPMENT - Not Used**

### **7.0 CONSTRUCTION**

#### **7.01 Excavation**

Excavation for the working slab shall be according to OPSS 902.

#### **7.02 Protection of Founding Soil**

Following inspection and approval of the prepared subgrade, a working slab with a minimum thickness of 100 mm shall be placed on the foundation subgrade as specified in the Contract Documents.

#### **7.03 Protection of Founding Bedrock**

The surface of the footing founding rock shall be exposed, cleaned and any loose or fractured parts removed so that sound rock is exposed. The working slab shall be placed on the exposed cleaned sound founding rock surface as specified in the Contract Documents.

Thickness of the mass concrete pad shall depend on the slope and irregularities in the exposed founding rock surface. A nominal thickness and a footprint plan view area has been specified on the Contract Documents

#### **7.04 Dewatering**

Dewatering shall be carried out according to OPSS 902.

### **8.0 QUALITY ASSURANCE - Not Used**

**9.0 MEASUREMENT FOR PAYMENT - Not Used**

**10.0 BASIS OF PAYMENT**

**10.01 Working Slab - Item**

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment and Material to do the work.

## **CONTROL OF GROUNDWATER AND OF OVERBURDEN SOILS FOR FOUNDATION EXCAVATION – ITEM NO.**

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### **Non-Standard Special Provision**

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The Contactor is hereby notified that the overburden soils at the proposed location of VMS #21 are comprised of non-cohesive loose to dense sand to sand and gravel fill, very loose to loose sand and loose to compact silt deposits which are water-bearing. These soil deposits are susceptible to cave-in, sloughing and boiling if the groundwater level is higher than the base of the excavation made for the sign foundation. The Contractor shall ensure that appropriate construction procedures and equipment are employed to maintain the excavation open and adequately cleaned, to allow for construction of the sign foundation in-the-dry for a footing foundation, or ensuring that balanced hydrostatic conditions are present for a caisson foundation to allow for placement of concrete by tremie methods.

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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