

**FOUNDATION INVESTIGATION AND
DESIGN REPORTS, HIGHWAY 417 /
CYRVILLE ROAD OVERHEAD SIGN
SUPPORT, CITY OF OTTAWA, ONTARIO
G.W.P. 4011-06-00, GEOCRES 31G5-238**

AECOM

Project: TRANETOB01226AC
March 24 2011

March 24, 2011

AECOM
5080 Commerce Boulevard
Mississauga, Ontario
L4W 4P2

Attention: Ms. Peggy Baleka

Dear Madam:

**RE: Foundation Investigation and Design Reports, Highway 417/Cyrville Road Overhead Sign,
City of Ottawa, Ontario, G.W.P. 4011-06-00**

Please find attached the Foundation Investigation and Design Reports relating to the above noted site.

For and on behalf of Coffey Geotechnics Inc.



Ramon Miranda, P.Eng.
Manager, Transportation division

**FOUNDATION INVESTIGATION REPORT
HIGHWAY 417 / CYRVILLE ROAD
OVERHEAD SIGN SUPPORT,
CITY OF OTTAWA, ONTARIO
G.W.P. 4011-06-00, GEOCRES 31G5-238**

AECOM

Project: TRANETOB01226AC
March 24, 2011

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**FOUNDATION INVESTIGATION REPORT
HIGHWAY 417/CYRVILLE ROAD OVERHEAD SIGN
CITY OF OTTAWA, ONTARIO
G.W.P. 4011-06-00**

1 INTRODUCTION

As part of Cyrville Road Underpass Bridge Replacement over Highway 417 in the City of Ottawa, the existing overhead sign structure will be replaced with a new overhead sign. Coffey Geotechnics Inc. (Coffey) was retained by AECOM to carry out a foundation investigation at the site of the proposed overhead sign.

The purpose of the investigation was to obtain information about the subsurface conditions at the site by means of boreholes, and to determine the engineering characteristics of the subsurface soils by means of field and laboratory tests.

The new overhead sign was planned to be installed at about Station 13+032, i.e. the same location as the existing, at the early stage of the project and the foundation investigation was performed adjacent to the existing overhead sign structure. Subsequently, the proposed overhead sign location was moved further to the south-west and the proposed overhead sign will be located at about Station 12+990 or about 42 m south-west of the existing overhead sign. This report was prepared based on the subsurface information obtained adjacent to the original sign location. No additional investigation was performed for the latest overhead sign location.

The findings of the investigation are presented in this report.

2 SITE DESCRIPTION AND GEOLOGY

The project site is located at the intersection of Cyrville Road with Highway 417 in the City of Ottawa, Ontario.

According to the Physiography of Southern Ontario by L.J. Chapman and D.F. Putnam, 1984, the project site is located within the Physiographic Region known as the Russell and Prescott Sand Plains.

The site lies on a glacial till plain characterized by glacial till and silt/sand deposits. In addition, however, the presence of silty clay deposits is not uncommon at the site. Topography across the site is generally flat.

According to the Southern Ontario Geological Highway Map (Map 2418), the bedrock underlying this area consists of a dark grey to black shale of the Billings Formation and is found to be considerably weathered and fractured. The geological explanation for rock in this condition is that at the time of the glacials, the frost penetrated to great depths and the softer shale layers were disturbed by frost action. This explanation is also advanced for the presence of shale fragments in the overburden above the parent rock.

3 INVESTIGATION PROCEDURES

The fieldwork for the proposed overhead sign was performed on October 07 and 08, 2008. The following table summarizes the borehole locations and drilling depths. The borehole locations are shown on Drawing No. 1.

Table 3.1: Borehole Locations and Drilling Depths

| Borehole No. | Location | Depth of Borehole Below Existing Ground Surface (m) | Piezometer |
|--------------|---|---|------------|
| S1 | Paved inside shoulder at Station 13+032, 1.4 m Lt of North Edge of Pavement, Highway 417 EBL | 6.2 | - |
| S2 | Near ditch at Station 13+032, 10.5 m Rt of South Edge of Pavement, Highway 417 EBL | 5.4 | - |

Marathon Drilling near Ottawa, Ontario carried out the drilling, testing and sampling work, under the direction and supervision of technical personnel from Coffey. The boreholes were advanced using a truck mounted drilling rig, outfitted with tools and equipment for soil sampling and testing. The boreholes were advanced using continuous flight hollow-stem augers.

Samples in the boreholes were taken at frequent intervals of depth by the Standard Penetration Test method (SPT), in general accordance with ASTM D1586. This test consists of freely dropping a 63.5 kg hammer a vertical distance of 0.76 m to drive a 51 mm O.D. split barrel (SS – split-spoon) sampler into the ground. The number of blows of the hammer required to drive the sampler into the relatively undisturbed ground by a vertical distance of 0.30 m is recorded as the Standard Penetration Resistance or the N-value of the soil which is indicative of the compactness condition of non-cohesive granular soils (gravels, sands and silts) or the consistency of cohesive soils (clays and clayey silts). These tests were also performed in the shale and provide some information on the condition of the rock.

Groundwater conditions in the boreholes were observed during drilling and upon their completion in the open boreholes.

The borehole locations were established in the field by Coffey engineering staff, in relation to the existing features. The geodetic elevations of the existing grade at the borehole locations were subsequently provided to us by AECOM.

The soil and rock samples were transported to our geotechnical laboratory in Toronto for further visual examination and classification. A laboratory testing programme, consisting of natural moisture content determinations, and grain size analyses, was performed on selected samples. The results of the laboratory tests are presented on the Record of Borehole Sheets (Appendix A) and also in Appendix B.

4 SUBSURFACE CONDITIONS

The subsurface conditions were explored at two (2) boreholes (see Table 3.1 in Section 3) for this project. The plan location of the boreholes is shown on Drawing No. 1. Details of subsurface conditions encountered at each borehole location for the investigation, including the results of in-situ testing, groundwater observations and results of laboratory testing, are presented on the Record of Borehole Sheets in Appendix A.

Boreholes S1 and S2 were put down from the existing grades at El. 69.6 and 69.0 m, on the north and south sides of Highway 417 eastbound lanes (EBL), respectively.

Beneath a veneer of topsoil and fill in Borehole S2 and pavement structure in Borehole S1, the boreholes show the presence of a glacial till which consists of a heterogeneous mixture of silty sand with some gravel and traces of clay size particles. These overburden materials are underlain by a dark grey to black shale bedrock belonging to the Billings Formation at about 2.3 m to 3.1 m below the existing grade, or at about El. 66.7 and 66.5 m.

Details of the subsurface conditions encountered in the boreholes are presented on the Record of Borehole Sheets in Appendix A. The following paragraphs are only meant to amplify and complement these data.

4.1 Pavement Structure

Borehole S1, drilled from the existing paved inside shoulder of Highway 417 EBL, contacted a 160 mm thick asphaltic concrete. Below the asphaltic concrete, about 0.25 m thick granular base and 0.35 m thick granular sub-base were encountered.

4.2 Topsoil

In Borehole S2, which was advanced from near the roadside ditch, an about 0.2 m thick topsoil layer was contacted at the existing grade.

4.3 Fill

Underlying the topsoil in Borehole S2, an about 0.6 m thick fill consisting of silty sand was contacted and found to extend to a depth of 0.8 m or El. 68.2 m. The fill contains traces of gravel and some topsoil.

The grain size distribution of a sample from the fill is presented in Figure B-1 in Appendix B. The curve indicates the following grain-size distribution.

Gravel: 12 %

Sand: 61 %

Silt: 19 %

Clay: 8 %

Standard Penetration tests performed in this basically granular fill material yielded an N-value of 52 blows/0.3 m, indicating a very dense relative density. This recorded high N-value may be due to the presence of gravel in the fill. The measured natural moisture content of the recovered sample from this fill was about 8 %.

4.4 Silty Sand Till

Underlying the fill materials, a heterogeneous mixture of silty sand with traces of gravel, shale fragments and clay was encountered in Boreholes S1 and S2. This is a glacial till deposit and it was contacted at a depth of 0.8 m below the ground surface or at El. 68.8 and 68.2 m. The deposit was found to extend to depths of 3.1 and 2.3 m or to El. 66.5 and 66.7 m, at Boreholes S1 and S2, respectively.

The grain size distributions of two samples from the silty sand till are presented in Figure B-2 in Appendix B. The curves indicate the following grain-size distribution.

Gravel: 11-17 %

Sand: 45-62 %

Silt: 18-30 %

Clay: 8-9 %

Standard Penetration tests performed in this basically granular soil deposit yielded N-values of 8 to in excess of 100 blows/0.3 m. These results indicate that the relative density of the granular soil can be described as loose to very dense, but generally compact in Borehole S1 and loose near the surface in Borehole S2, becoming very dense. The measured natural moisture contents of the recovered samples from this deposit were about 4 to 16 %.

The presence of cobbles and boulders should be expected to occur in the till deposit, due to its mode of deposition.

4.5 Bedrock

Boreholes S1 and S2 encountered a dark grey to black shale bedrock at depths of 3.1 and 2.3 m below the existing grade or El. 66.5 and 66.7 m, respectively. The boreholes were advanced 3.1 m into the bedrock by augering. In addition to these two boreholes, Borehole P1 was drilled near Borehole S1 at the median of the existing Highway 417 (presented in our Foundation Investigation Report for Highway 417/Cyrville Road Bridge, issued on Oct 27, 2010, GEOCREC NO. 31G5-229) and in this borehole the surface of the bedrock was encountered at El. 66.2 m. From these, the bedrock surface at this overhead sign location can be considered to be relatively flat.

The bedrock underlying this area of Ottawa is known to consist of grey and black shales of the Billings Formation. The formation belongs to the Upper Ordovician Period and is approximately 460 million years old.

Standard Penetration tests performed in the shale bedrock yielded N-values of in excess of 100 blows/0.3 m.

It should be noted that the surface of the bedrock elevations should be considered to be approximate. Based on the fact that it was possible to penetrate the bedrock by augering and also the fact that penetration tests could be performed, the bedrock within the depths drilled is considered a weathered and relatively weak rock type.

4.6 Groundwater Conditions

Groundwater conditions were observed in the open boreholes during the investigation and upon completion of the boreholes. No free-standing water was observed in the boreholes during these times.

In Boreholes S2, the upper 0.7 m of the silty sand till immediately below the fill near the ditch was found to be moist to wet and this may indicate possible groundwater level, or a perched condition on the surface of the very dense (i.e. less pervious) zone of till.

The observed groundwater conditions represent the conditions at the time of our investigation and that they would be subject to fluctuations, both seasonally and in response to major weather events. It should be noted that while no free groundwater was observed in Boreholes S1 and S2 of this investigation, this is unlikely to represent the stabilized groundwater conditions in the boreholes. It should also be pointed out that in the boreholes drilled for the proposed Cyrville Bridge replacement adjacent to the site the groundwater table was observed at El. 68 to 70 m. Based on these, the groundwater level at the site would likely be at about El. 68 m, but would be subject to fluctuation, as mentioned above.

For and on behalf of Coffey Geotechnics Inc.



Gwangha Roh, Ph.D.

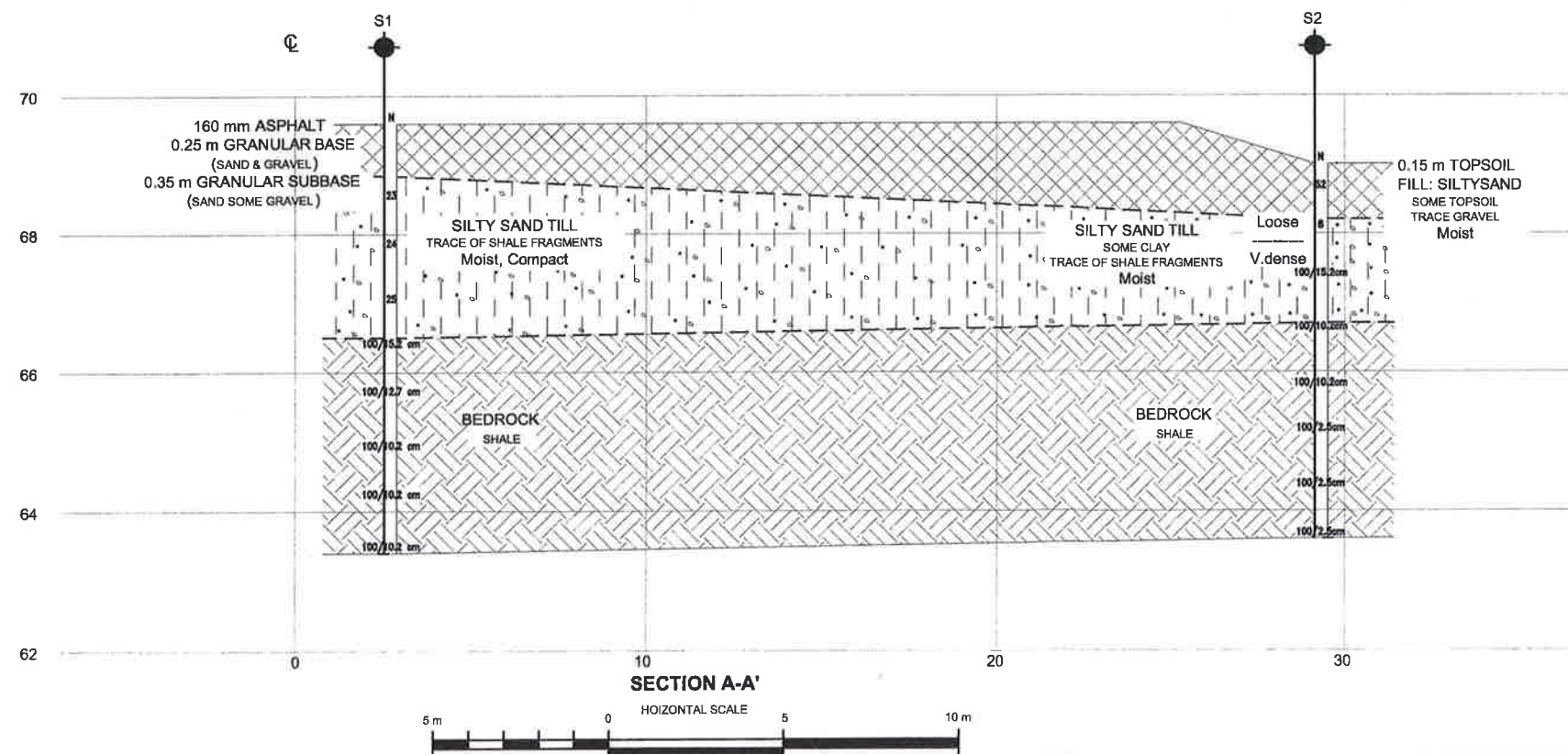
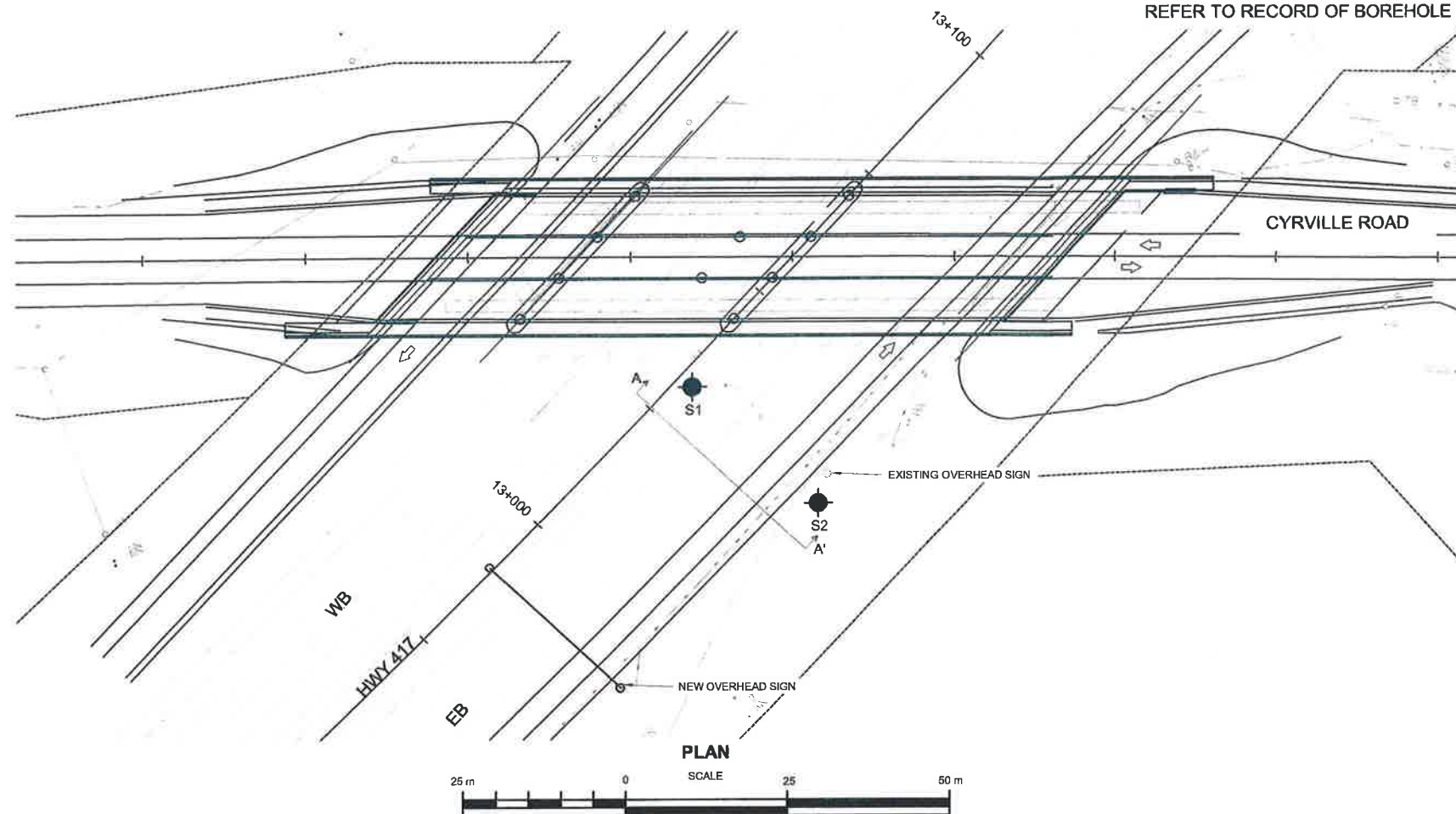


Ramon Miranda, P.Eng.



Zuhtu Ozden, P.Eng.

Drawing



METRIC

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

CONT No.

GWP: 4011-06-00

HIGHWAY 417 OVERHEAD SIGN
OTTAWA, ONTARIO
BOREHOLE LOCATION PLAN
AND SOIL STRATA



SHEET

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KEY PLAN
N.T.S.

LEGEND

- Borehole
- Blows / 0.3 m (Std. Pen. Test, 475 J/blow)
- Water Level at Time of Investigation (W. L. NOT STABILIZED)
- Water Level in Piezometer
- Piezometer

| No. | ELEVATION (m) | EASTING | NORTHING |
|-----|---------------|----------|-----------|
| S1 | 69.6 | 373287.7 | 5031707.5 |
| S2 | 69.0 | 373279.6 | 5031683.7 |

-NOTE-

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

NOTE: This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

| REVISIONS | DATE | BY | DESCRIPTION |
|-----------|------|----|-------------|
| | | | |
| | | | |
| | | | |

| | | |
|----------------------|-----------------|------------------|
| Geacres No. 31G5-238 | TRANETOB01228AC | DIST |
| SUBM'D | CHECKED | DATE Feb 18 2011 |
| DRAWN | SH | CHECKED RM |
| APPROVED | ZO | DWG |
| 1 | | |



Appendix A

Record of Borehole Sheets

TRANETO01226AC Highway 417 Overhead Sign, Ottawa

RECORD OF BOREHOLE No S1

1 OF 1

METRIC

GWP 4011-05-00 LOCATION Sta 13+032.1 4 m LI (EB North EP Line) Paved Sh
DIST HWY 417 BOREHOLE TYPE Hollow Stem Auger
DATUM Geodetic DATE 10/7/2000

ORIGINATED BY SK

COMPILED BY GR

CHECKED BY ZO

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _P | NATURAL MOISTURE CONTENT W _L | UNIT WEIGHT Y kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL | |
|----------------|---|-------------|---------|------|-----------------------|----------------------------|-----------------|---|-------------------|------------------------------------|--|--|--|--|
| ELEV. DEPTH | DESCRIPTION | STRAT. PLOT | NUMBER | TYPE | N ^o VALUES | | | SHEAR STRENGTH (kPa) | WATER CONTENT (%) | | | | | |
| 69.5 0.0 | GROUND SURFACE | | | | | | | | | | | | | |
| 68.5 0.8 | 160 mm ASPHALT 0.25 m GRANULAR BASE (Sand & Gravel) 0.35 m GRANULAR SUBBASE (Sand, some gravel) | | | | | | | | | | | | | |
| 68.5 0.8 | SILTY SAND TILL traces of shale fragments, dark grey moist, compact | | 1 | SS | 23 | | | | | | | | | |
| | | | 2 | SS | 24 | | | | | | | | | |
| | | | 3 | SS | 25 | | | | | | | | | |
| | | | 4 | SS | 26 | | | | | | | | | |
| 68.5 3.1 | BEDROCK shale, dark grey weathered | | 5 | SS | 27 | | | | | | | | | |
| | | | 6 | SS | 28 | | | | | | | | | |
| | | | 7 | SS | 29 | | | | | | | | | |
| | | | 8 | SS | 30 | | | | | | | | | |
| 63.4 6.2 | End of borehole * borehole found open & dry upon completion | | | | | | | | | | | | | |

+ 3 × 3

Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

TRANETOBO1226AC : Highway 417 Overhead Sign, Ottawa

RECORD OF BOREHOLE No S2

1 OF 1

METRIC

GWP 4011-06-00 LOCATION Sta 13+032 10.5 m RI (EB South EP Line) ORIGINATED BY SK
DIST HWY 417 BOREHOLE TYPE Hollow Stem Auger COMPILED BY GR
DATUM Geodetic DATE 10/8/2008 CHECKED BY ZO

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | UNIT WEIGHT Y kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|----------------|---|-------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|--|---|
| ELEV. DEPTH | DESCRIPTION | STRAT. PLOT | NUMBER | TYPE | "N" VALUES | | | 20 | 40 | 60 | 80 | 100 | | |
| 69.0 0.0 | GROUND SURFACE | | | | | | | | | | | | | |
| 68.2 0.8 | 0.15 m TOPSOIL FILL: Silty Sand some topsoil, trace gravel dark brown, moist | | 1 | SS | 52 | | | | | | | | | 12 61 19 8 gravel @ spoon tip |
| | A layer of fine to medium sand, loose moist to wet | | 2 | SS | 8 | | | | | | | | | |
| | v dense, moist | | 3 | SS | 15.2 | | | | | | | | | 17 45 30 8 |
| | SILTY SAND TILL some clay, trace of shale fragments dark grey to grey | | 4 | SS | 10.2 | | | | | | | | | |
| 66.7 2.3 | SHAPE shale, dark grey weathered | | 5 | SS | 10.2 | | | | | | | | | |
| | | | 6 | SS | 10.2 | | | | | | | | | |
| | | | 7 | SS | 10.2 | | | | | | | | | |
| 63.6 5.4 | End of borehole * borehole dry and open upon completion. | | 8 | SS | 10.2 | | | | | | | | | |

4 3 X 3

Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

Appendix B

Laboratory Test Results

UNIFIED SOIL CLASSIFICATION SYSTEM

| CLAY AND SILT | | | SAND | | | GRAVEL | | |
|---------------------------|--|--|------|--------|--------|--------|--------|--|
| GRAIN SIZE IN MICROMETERS | | | Fine | Medium | Coarse | Fine | Coarse | |

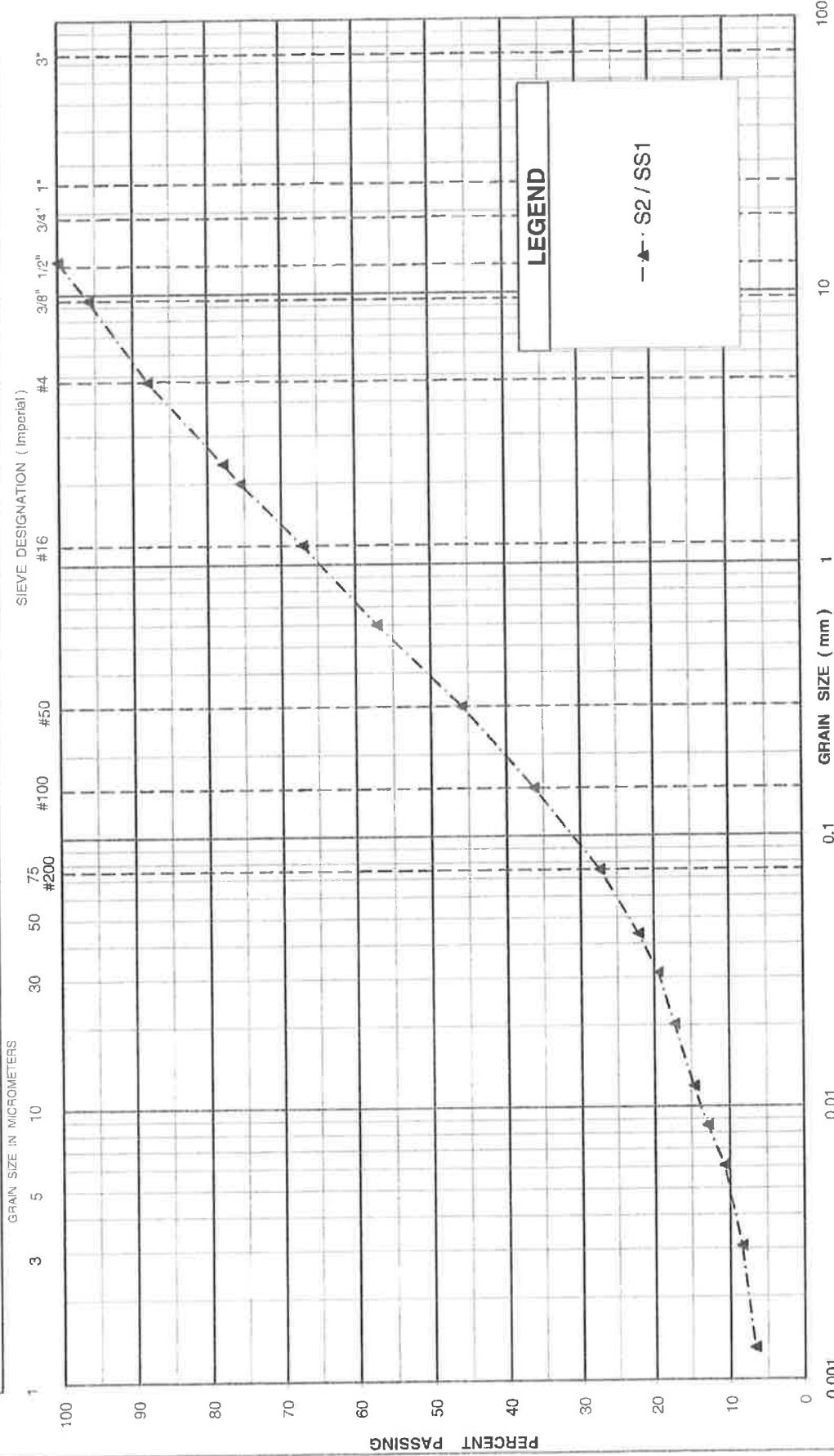
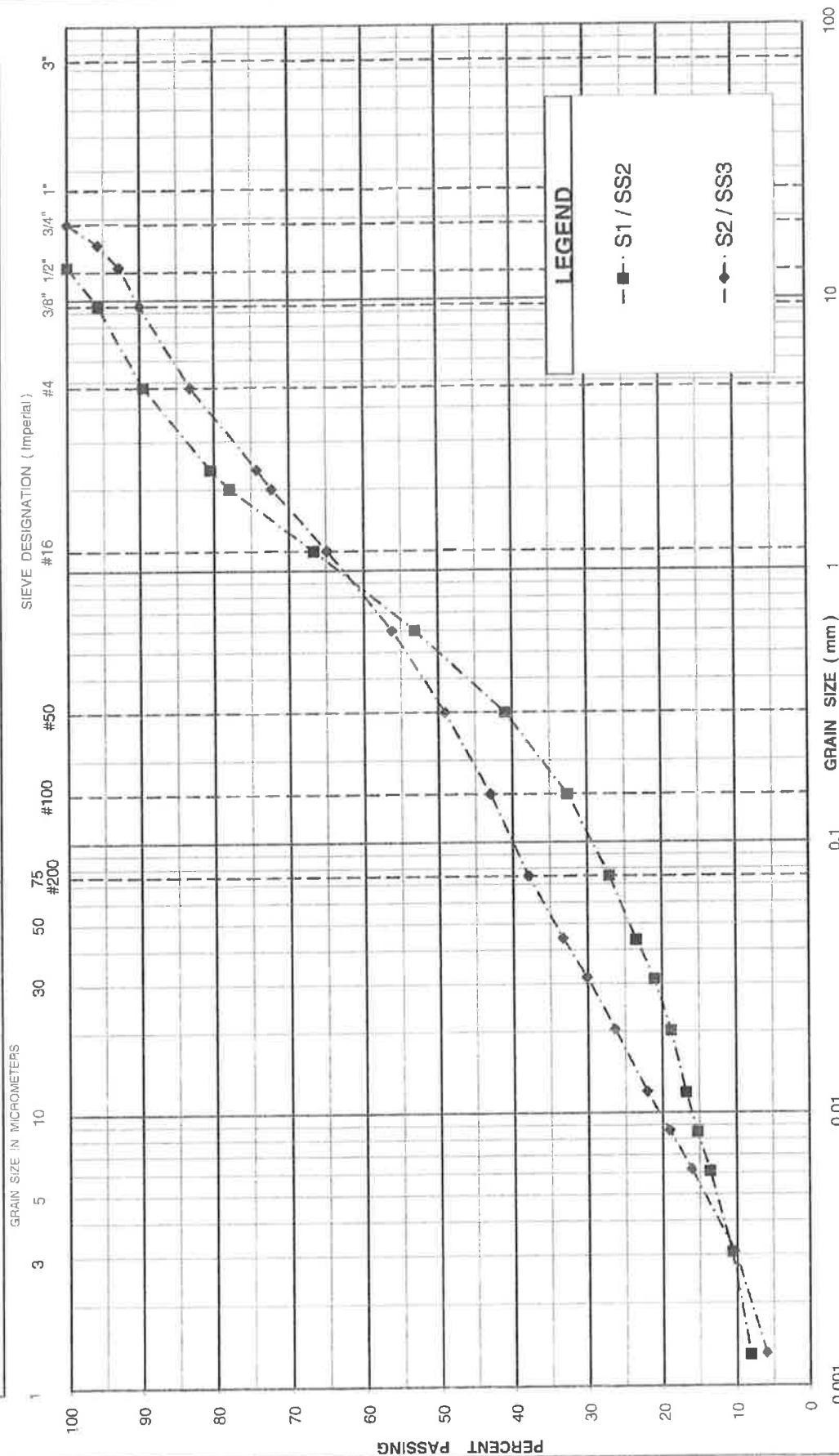


FIGURE No.: B1
 REF. No: TRANETOBO1225AC
 DATE: Jan, 2011

GRAIN SIZE DISTRIBUTION
 FILL: Silty Sand , Some Gravel, Trace Clay

UNIFIED SOIL CLASSIFICATION SYSTEM

| CLAY AND SILT | | | SAND | | | GRAVEL | | |
|---------------------------|---|----|------|--------|--------|--------|--------|-----|
| GRAIN SIZE IN MICROMETERS | | | Fine | Medium | Coarse | Fine | Coarse | |
| 3 | 5 | 10 | 30 | 50 | 75 | #200 | #100 | #50 |



geotechnics
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GRAIN SIZE DISTRIBUTION SILTY SAND TILL, Some Gravel, Trace Clay

FIGURE No.: B-2
REF. No: TRANETOB01226AC
DATE: Jan 2011

Appendix C

Site Photographs



Photograph 1 Cyrville Road Bridge over Highway 417 (looking South East)



Photograph 2 Cyrville Road Bridge over Highway 417 (looking North East)

Appendix D

Explanation of Terms Used in Report

EXPLANATION OF TERMS USED IN REPORT

N-VALUE: THE STANDARD PENETRATION TEST (SPT) N-VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N-VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N-VALUE IS DENOTED THUS \bar{N}_v .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

| C_u (kPa) | 0 - 12 | 12 - 25 | 25 - 50 | 50 - 100 | 100 - 200 | >200 |
|-------------|-----------|---------|---------|----------|------------|------|
| | VERY SOFT | SOFT | FIRM | STIFF | VERY STIFF | HARD |

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

| N (BLOWS/0.3m) | 0 - 5 | 5 - 10 | 10 - 30 | 30 - 50 | >50 |
|----------------|------------|--------|---------|---------|------------|
| | VERY LOOSE | LOOSE | COMPACT | DENSE | VERY DENSE |

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY IS:

| RQD (%) | 0 - 25 | 25 - 50 | 50 - 75 | 75 - 90 | 90 - 100 |
|---------|-----------|---------|---------|---------|-----------|
| | VERY POOR | POOR | FAIR | GOOD | EXCELLENT |

JOINT AND BEDDING:

| SPACING | 50mm | 50 - 300mm | 0.3m - 1m | 1m - 3m | >3m |
|----------|------------|------------|------------|---------|------------|
| JOINTING | VERY CLOSE | CLOSE | MOD. CLOSE | WIDE | VERY WIDE |
| BEDDING | VERY THIN | THIN | MEDIUM | THICK | VERY THICK |

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

| | | | |
|----|---------------------|----|---------------------------|
| SS | SPLIT SPOON | TP | THINWALL PISTON |
| WS | WASH SAMPLE | OS | OSTERBERG SAMPLE |
| ST | SLOTTED TUBE SAMPLE | RC | ROCK CORE |
| BS | BLOCK SAMPLE | PH | TW ADVANCED HYDRAULICALLY |
| CS | CHUNK SAMPLE | PM | TW ADVANCED MANUALLY |
| TW | THINWALL OPEN | FS | FOIL SAMPLE |

STRESS AND STRAIN

| | | |
|---|-----|-------------------------------|
| u_w | kPa | PORE WATER PRESSURE |
| r_u | 1 | PORE PRESSURE RATIO |
| σ | kPa | TOTAL NORMAL STRESS |
| σ' | kPa | EFFECTIVE NORMAL STRESS |
| τ | kPa | SHEAR STRESS |
| $\sigma_1, \sigma_2, \sigma_3$ | kPa | PRINCIPAL STRESSES |
| ϵ | % | LINEAR STRAIN |
| $\epsilon_{1e}, \epsilon_{2e}, \epsilon_{3e}$ | % | PRINCIPAL STRAINS |
| E | kPa | MODULUS OF LINEAR DEFORMATION |
| G | kPa | MODULUS OF SHEAR DEFORMATION |
| μ | 1 | COEFFICIENT OF FRICTION |

MECHANICAL PROPERTIES OF SOIL

| | | |
|----------------|-------------------|--------------------------------------|
| m_v | kPa ⁻¹ | COEFFICIENT OF VOLUME CHANGE |
| c_c | 1 | COMPRESSION INDEX |
| c_s | 1 | SWELLING INDEX |
| c_{α} | 1 | RATE OF SECONDARY CONSOLIDATION |
| α_v | m ² /s | COEFFICIENT OF CONSOLIDATION |
| H | m | DRAINAGE PATH |
| T_v | 1 | TIME FACTOR |
| U | % | DEGREE OF CONSOLIDATION |
| σ'_{vo} | kPa | EFFECTIVE OVERBURDEN PRESSURE |
| σ'_p | kPa | PRECONSOLIDATION PRESSURE |
| τ_f | kPa | SHEAR STRENGTH |
| c' | kPa | EFFECTIVE COHESION INTERCEPT |
| ϕ' | ° | EFFECTIVE ANGLE OF INTERNAL FRICTION |
| c_u | kPa | APPARENT COHESION INTERCEPT |
| ϕ_u | ° | APPARENT ANGLE OF INTERNAL FRICTION |
| τ_R | kPa | RESIDUAL SHEAR STRENGTH |
| τ_r | kPa | REMOULDED SHEAR STRENGTH |
| S_r | 1 | SENSITIVITY = c_u / τ_r |

PHYSICAL PROPERTIES OF SOIL

| | | | | | | | | |
|----------------|-------------------|--------------------------------|----------------|------|---------------------------------------|----------------|-------------------|---|
| P_s | kg/m ³ | DENSITY OF SOLID PARTICLES | θ | 1, % | VOID RATIO | θ_{min} | 1, % | VOID RATIO IN DENSEST STATE |
| γ_s | kN/m ³ | UNIT WEIGHT OF SOLID PARTICLES | n | 1, % | POROSITY | I_D | 1 | DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$ |
| P_w | kg/m ³ | DENSITY OF WATER | w | 1, % | WATER CONTENT | D | mm | GRAIN DIAMETER |
| γ_w | kN/m ³ | UNIT WEIGHT OF WATER | s_r | % | DEGREE OF SATURATION | D_n | mm | N PERCENT - DIAMETER |
| P | kg/m ³ | DENSITY OF SOIL | w_L | % | LIQUID LIMIT | C_u | 1 | UNIFORMITY COEFFICIENT |
| γ' | kN/m ³ | UNIT WEIGHT OF SOIL | w_p | % | PLASTIC LIMIT | h | m | HYDRAULIC HEAD OR POTENTIAL |
| P_d | kg/m ³ | DENSITY OF DRY SOIL | w_s | % | SHRINKAGE LIMIT | q | m ² /s | RATE OF DISCHARGE |
| γ_d | kN/m ³ | UNIT WEIGHT OF DRY SOIL | I_p | % | PLASTICITY INDEX = $(w_L - w_p)$ | v | m/s | DISCHARGE VELOCITY |
| P_{sat} | kg/m ³ | DENSITY OF SATURATED SOIL | I_L | 1 | LIQUIDITY INDEX = $(w - w_p) / I_p$ | i | 1 | HYDRAULIC GRADIENT |
| γ_{sat} | kN/m ³ | UNIT WEIGHT OF SATURATED SOIL | I_C | 1 | CONSISTENCY INDEX = $(w_L - w) / I_p$ | k | m/s | HYDRAULIC CONDUCTIVITY |
| P' | kg/m ³ | DENSITY OF SUBMERGED SOIL | θ_{max} | 1, % | VOID RATIO IN LOOSEST STATE | j | kN/m ² | SEEPAGE FORCE |
| γ' | kN/m ³ | UNIT WEIGHT OF SUBMERGED SOIL | | | | | | |

**FOUNDATION DESIGN REPORT
HIGHWAY 417 / CYRVILLE ROAD
OVERHEAD SIGN SUPPORT,
CITY OF OTTAWA, ONTARIO
G.W.P. 4011-06-00, GEOCRES 31G5-238**

AECOM

Project: TRANETOB01226AC
March 24, 2011

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Appendix

Appendix E: Limitations of Report

**FOUNDATION DESIGN REPORT
HIGHWAY 417/CYRVILLE ROAD OVERHEAD SIGN
CITY OF OTTAWA, ONTARIO
G.W.P. 4011-06-00**

5 DISCUSSION AND RECOMMENDATIONS

We understand that the existing overhead sign structure at the eastbound lanes of Highway 417, located south-west of the Cyrville Road Bridge in the City of Ottawa, will be replaced with a new tri-chord static sign.

The new overhead sign was originally planned to be installed at about Station 13+032, i.e. at the same location as the existing sign, at the early stages of the project and this foundation investigation was performed adjacent to the existing overhead sign structure. . The proposed overhead sign location was then moved to about 17.5 m south-west of the existing overhead sign location. Subsequently, the proposed overhead sign location was moved further to the south-west and the proposed overhead sign will be located about 42 m south-west of the existing overhead sign. It is recommended that an additional foundation investigation at the proposed overhead sign location be carried out to verify the subsurface conditions at the actual proposed location.

The sub-surface conditions were explored at two (2) boreholes (see Table 3.1 in Section 3 of the foundation investigation section of this report) in October 2008. In general, beneath topsoil, asphaltic concrete and fill materials, the boreholes show the presence of a silty sand glacial till deposit overlying a dark grey to black shale bedrock. Boreholes contacted the surface of the bedrock at about Elevations of 66.7 and 66.5 m or about 2.3 to 3.1 m below the existing grades. The bedrock belongs to the Billings Formation and is considered weathered within the depth of this investigation.

At the time of investigation no free-standing water was observed in the boreholes at their completion. These short term observations may however not reflect stabilized water level conditions. It should be noted that the groundwater conditions can expected to be subject to seasonal fluctuations and in response to major weather events. Other boreholes drilled in the general area for the replacement of Cyrville Road Bridge structure suggest that the groundwater table may be at about El. 68 m or about 1 m below the road surface.

5.1 Design Considerations

Generally, overhead sign structures are supported on caisson (i.e. drilled and cast-in-place concrete pile) type foundations and the depth of the caissons would vary depending on the details of the structure, such as its height, the subsurface conditions encountered at each location, etc. According to MTO practice, the design can be carried out in accordance with the method described by Broms, as detailed in the following papers:

BROMS, B.B.: Lateral Resistance of Piles in Cohesive Soils, Journal of the Soil Mechanics and Foundation Division, ASCE, Vol. 90, SM2, March 1964.

BROMS, B.B.: Lateral Resistance of Piles in Cohesionless Soils, Journal of the Soil Mechanics and Foundation Division, ASCE, Vol. 90, SM3, March 1964.

BROMS, B.B.: Design of Laterally Loaded Piles, Journal of the Soil Mechanics and Foundation Division, ASCE, Vol. 91, SM3, May 1965.

Based on the results of the two boreholes drilled, the soil parameters at each pole location are given in Table 5.1.1. The following notations have been adopted:

ϕ = angle of internal friction for cohesionless (i.e. granular) soils in degrees.

q_u = unconfined compressive strength in kPa.

γ = bulk unit weight of material in kN/m³.

Table 5.1.1 Recommended Design Parameters

| Area Reference/ Borehole No. | Applicable Elevation (m) | Material Type | Consistency or Compactness Condition | q_u (kPa) | ϕ (degrees) | γ (kN/m ³) | Groundwater Elevation (m) |
|---------------------------------|--------------------------|------------------------|--------------------------------------|-------------|------------------|-------------------------------|-----------------------------------|
| S1 | 69.4-68.8 | Pavement fill | - | - | 34 | 21.5 | Dry upon completion ^{♦*} |
| | 68.8-66.5 | Granular glacial till | Compact | - | 33 | 21.5 | |
| | 66.5-65.5 | Highly Weathered Shale | - | 500 | - | 22.0 | |
| | 65.5-63.8 | Weathered Shale | - | 2,000 | - | 23.0 | |
| | 63.8- 63.4* | Shale* | - | 5,000* | - | 23.5* | |
| S2 | 68.8-68.2 | Silty Sand Fill | - | - | 30 | 19.0 | Dry upon completion ^{♦*} |
| | 68.2-67.5 | Granular glacial till | Loose | - | 30 | 20.5 | |
| | 67.5-66.7 | Granular glacial till | V.dense | - | 35 | 22.0 | |
| | 66.7-65.7 | Highly Weathered Shale | - | 500 | - | 22.0 | |
| | 65.7-64.0 | Weathered Shale | - | 2,000 | - | 23.0 | |
| | 64.0- 63.6* | Shale* | - | 5,000* | - | 23.5* | |

* Similar values can be assumed for shale below El. 63.4-63.6 m to about El. 62.0 m.

♦* = Not stabilized. Based on the boreholes drilled for the proposed Cyrville Bridge replacement, It is our opinion that groundwater at the site would be at about El. 68 m. We recommend that this value can be used for design purposes.

It should be noted that the q_u values provided for the rock are assumed values. q_u values are assumed to increase with depth based on the weathering of the rock. Unconfined compressive strength tests performed on solid rock samples from the proposed Cyrville Road Bridge site adjacent to this overhead sign site indicated q_u values about 37 MPa. However, reduced q_u values are listed in the above table due to the possible variability of rock strength as well as possible variable depths of weathering.

The contribution to lateral resistance of the soil within the frost depth (i.e. 1.8 m) should not be included in the calculations, except of course, for the weight of the soil. Research shows, however, that restraint (fixity) provided at the ground surface level plays a significant role in the performance of sign support structures and, therefore, the placement of well compacted, competent material at and near the ground surface immediately around the caisson is recommended.

Reductions of resistance for design of sign foundations should be taken into consideration on or near slopes or near vertical faces, if any.

5.2 Construction Comments

The boreholes show the presence of some granular fill followed by essentially granular (non-cohesive) glacial till. The granular glacial till is further underlain by shale bedrock at the site. During our investigation

at the borehole locations, no groundwater was observed, however, high groundwater level (at about El. 68 to 70 m) was observed in the boreholes drilled for the proposed Cyrville Bridge replacement adjacent to the site.

The granular soils above the shale bedrock may cause instability problems during the installation of the caissons, especially with high groundwater table. In this case, consideration can be given to the use of temporary steel casing. The steel casing would be carefully withdrawn as the concrete is poured. It is recommended that the Contractor shall maintain the stability of the holes for the caisson foundations at all times, from the commencement of their construction to the placing of the concrete.

Being of glacial origin, glacial till deposits can be expected to contain random cobbles and boulders. As well, shale fragments/slabs may occur immediately above the bedrock surface. The contractor should be made aware that the presence of cobbles and boulders as well as shale fragments/slabs can be expected which can cause problems during the installation of the caissons, such as increasing the time required for drilling, necessitating the employment of special equipment, etc.

We also recommend that the Contractor be alerted to the fact that the shale bedrock can be expected to be a relatively stronger below the upper highly weathered zones and hard layers in the bedrock may be encountered. These may present difficulties during the installation of the caissons.

6. CLOSURE

As was mentioned, our investigation was performed adjacent to the existing overhead sign which was originally planned to be replaced with a new overhead sign at the same location. As the proposed overhead sign location has been moved to about 42 m south-west of the originally proposed location, we recommend that an additional investigation be conducted to verify the subsurface conditions at the newly proposed location.

The Limitations of Report, as quoted in Appendix E, is an integral part of this report.

For and on behalf of Coffey Geotechnics Inc.



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Appendix E

Limitations of Report

LIMITATIONS OF REPORT

This report is intended solely for the Client named. The material in it reflects our best judgment in light of the information available to Coffey Geotechnics Inc. (Coffey) at the time of preparation. Unless otherwise agreed in writing by Coffey, it shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. No portion of this report may be used as a separate entity, it is written to be read in its entirety.

The conclusions and recommendations given in this report are based on information determined at the testhole locations. The information contained herein in no way reflects on the environment aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the testhole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Coffey accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.